COMMUNITY RISK ASSESSMENT

FOR HAZARDOUS MATERIALS

CITY OF MERCED, CALIFORNIA

City of Merced Fire Department

Tait Environmental Services, Inc.

October 2018

Primarily prepared and edited by

Tait Environmental Services, Inc.
In Cooperation with the
City of Merced Fire Department

The development of the 2018 Community Risk Assessment for Hazardous Materials for the City of Merced was possible through the coordinated effort of the staff of the City of Merced Fire Department.

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1.0 Introduction

Tait Environmental Services, Inc. (Tait) in coordination with the City of Merced, Fire Department (MFD) is pleased to submit this 2018 Community Risk Assessment for Hazardous Materials (CRAHM) for the City of Merced. Funding was provided by the U.S. Department of Transportation's Hazardous Materials Emergency Preparedness (HMEP) Grant administered by the California Office of Emergency Services (OES).

The objective of the CRAHM is to produce a stand-alone document which supplements Chapter 3 (Risk Assessment) of the Local Hazard Mitigation Plan which was prepared by the City of Merced in 2015. Chapter 3 of the Local Hazard Mitigation Plan is referred to in this document as the 2015 Risk Assessment. The 2015 Risk Assessment covers other areas than hazardous materials; however, the transportation of hazard materials through the city is one of the major risks facing the city.

The CRAHM will initially discuss the findings of the 2015 Risk Assessment, regarding hazardous materials, and then focus on potential hazardous materials release scenarios at key intersections and locations along transportation routes, at fixed facilities, and from underground pipelines within the city. The CRAHM will rely on data obtained during the City of Merced Hazardous Materials Commodities Flow Study (Flow Study), which was prepared for the City of Merced Fire Department (MFD) in June 2018.

The CRAHM will analyze potential high-risk locations for a hazardous materials release in the city of Merced and allow for the City of Merced Fire Department (MFD) and other response agencies to plan the incident response in advance of the incident, and to provide additional information toward the planning needs of the MFD. These high-risk locations were determined by the MFD through historical knowledge of transportation and transportation incident patterns throughout the city. These locations are considered to be risk control points.

The CRAHM will assess the risks applied to the two most toxic and critical chemicals of concern (COCs) observed travelling through the city of Merced during the Flow Study. These chemicals are chlorine (UN ID #1017) and anhydrous ammonia (UN ID #1005). Each of the risk control points will be analyzed using the U.S. Environmental Protection Agency (EPA) CAMEO suite, which includes CAMEO chemicals ALOHA plume modeling and MARPLOT, which assists in plotting the information onto various map bases, such as Google Earth. Plume models for chlorine and anhydrous ammonia are prepared for the risk control points.

The CRAHM will also look at the potential results of a rail car incident involving crude oil (UN ID #1267). Data from this incident could equally be applied to a tanker truck incident involving gasoline (NU ID #1203).

The CRAHM will also discuss potential incidents involving releases from liquefied gas and natural gas pipelines within the city of Merced.

The data from the CRAHM will be discussed in light of specific areas of risk for the release of hazardous materials incidents within the city of Merced. A discussion on mitigation measures first responders will need to utilize to respond to a major as well as a minor incident of the release of hazardous materials within the city limits. A discussion of equipment and training necessary for first responders will also be included.

2.0 City of Merced 2015 Risk Assessment

In 2015, the City of Merced prepared a Local Hazard Mitigation Plan. As part of this plan, a Risk Assessment was performed on all potential man-made and natural hazards that pose a risk to the community and that, although varying in intensity, could have a detrimental impact on the city of Merced. The 2015 Risk Assessment was presented as Chapter 3 in the Local Hazard Mitigation Plan. It was determined in the 2015 Risk Assessment that hazardous materials transportation through the city of Merced posed the highest threat level of all incidents that could impact the city.

In the section that follows, a discussion of the hazardous materials transportation data from the 2015 Risk Assessment, Sections 3.2.1 (Overview) and 3.2.3 (Risk Ranking) are summarized.

2.1 Risk Ranking

The City of Merced identified and ranked a number of man-made and natural hazards that could vary in potential in the impact and intensity that the hazards could impact the city. The screening process involved two steps as follows:

- Step 1: the identification of likely hazards that could occur in the city, and
- Step 2: identification of the prevalent hazards by a ranking system.

The City of Merced identified 19 hazards that could occur that could impact the city, and determined the threat level of each of these hazards. Transportation of hazardous materials on trains and commercial freight vehicles on railways and roadways was determined to be one of the 19 hazards.

Risk factors for the 19 hazards were scored according to the following three (3) broad risk factors:

1. Probability and Frequency - Prediction of how often a hazard will occur in the future.
2. Consequence and Severity – Extent of physical damage to structures and lifelines (power, water, sanitation, roads, etc.).
3. Vulnerability – Vulnerability covers 3 interrelated factors as follows:
    a. Area impacted by the hazard event,
    b. Capability of the hazard event to trigger additional hazards, and
    c. Onset, or the period of time between initial recognition of an approaching hazard and when the hazard begins to impact the community.

The risk factors allowed for each of the 19 identified hazards to be scored for its hazard-threat level. The hazard threat level scores for the most prevalent hazards to the city of Merced were determined, and they are shown below in Table 3-6 from the 2015 Risk Assessment.

Table 3-6 - Hazard Threat Level Scores	
Hazard Threat Levels	**Hazard Threat Scores**
Moderately-High Hazard	
• *Hazardous Materials*	**36**
• *Flooding*	27
Moderate Hazard	
• *Fire*	**24**
• *Extreme Temperatures*	24
• *Fog*	24
• *Storm-Related Hazards*	**18**
• *Dam Failure*	**16**
Moderately-Low Hazard	
• *Earthquake*	12
• *Tornadoes*	12
• *Drought*	8

Based on the data presented in the 2015 Risk Assessment, it was determined that a hazardous materials incident resulting from railway and roadway transport, although considered to be a moderately high hazard, posed the most significant threat to the city of Merced.

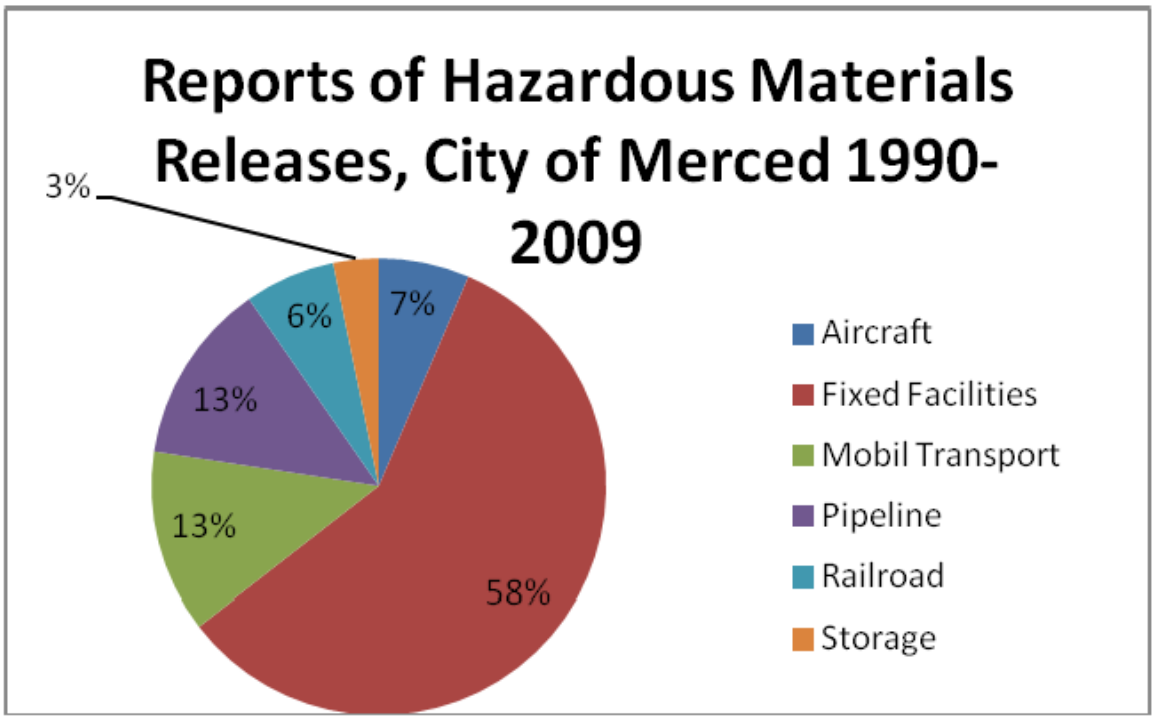
2.2 Hazardous Materials

A discussion of hazardous materials is contained in Section 3.3.4 of the Risk Assessment. Sources of hazardous materials outlined in this section include the following:

- Hazardous Material Generators/Handler Facilities (Fixed Locations)
- Hazardous Waste Cleanup Areas
- Transport Corridors/Transportation-Related Hazardous Materials
- Natural and Liquefied Gas Pipelines
- Agricultural Sites
- Intentional Release-Related Hazardous Materials

For the purposes of this CRAHM, only hazardous materials transported over railways, roadways, and pipelines, as well as the potential for incidents at fixed facilities are covered.

Data obtained from the National Response Center covering the period from 1990 through 2009 indicated that there were 31 material releases within the city of Merced. The sources of these materials releases are shown in the following chart.



2.3 Vulnerability to Hazardous Materials

Vulnerability to hazardous materials in the city of Merced is contained in Section 3.4.7 of the 2015 Risk Assessment. This section describes potential hazardous materials incidents as follows:

- Spill or Release: Exposure to toxic vapors , gases, liquids, and solids, requiring City residents and business to undertake protective actions, such as evacuation or shelter-in-place. Secondary risk to the environment is possible including contamination of subsurface drinking water sources, soil contamination, and danger to the health of wildlife.
- Fire: Toxic chemicals may be produced when hazardous materials burn creating inhalation and skin adsorption issues from toxic clouds and plumes, and it may require City residents and business to undertake protective actions such as evacuation or shelter in place. Fires related to hazardous materials tend to be focused around industrial areas and transportation corridors.
- Explosion: Explosions can occur with fires at hazardous materials sites, and represent a physical hazards as well as a chemical hazard. As with fires related to hazardous materials, explosions tend to occur in industrial areas and along transportation corridors. Explosions related to pipelines may also pose threat to city residents and businesses.

Section 3.4.1 (Asset Inventory) of the 2015 Risk Assessment lists the critical facilities that could be impacted by a hazardous materials incident:

- City Hall and Departments
- Parks, Community Services, and Schools

- Public Safety Buildings
- Public Works Infrastructure and Facilities
- Transportation Backbone

Other assets that could be affected by a hazardous materials incident are:

- Vulnerable Populations
- Residential Building Stock

Vulnerable populations are present in close proximity to the transportation corridors. Many of these areas are relatively high-density residential areas, and from a demographic standpoint, they tend to be lower-income areas.

The 2015 Risk Assessment summarized the total assets at risk for specific hazards that could impact the City of Merced including hazardous materials incidents, and that information is shown in Table 3-12 from the 2015 Risk Assessment.

Table 3-12: City of Merced, Overall Summary of Total Assets at Risk

Hazards	Hazard Area	Population		Residential Buildings		Critical Facilities	
		No	%	No.	%	No.	%
Flooding	100-year floodplain	55,205	65	8,026	44	202	64
	500-year floodplain	67,585	79	9,271	51	37	12
Wildfire	Open Space Grasslands	3,462	4	1,695	9	53	17
Drought	Planning Area	85,190	100	18,227	100	313	100
Hazardous Materials-Transportation Corridor	Highway 99	21,235	25	4,034	22	89	28
	Railroads	33,643	39	6,753	37	127	40
Earthquake	Planning Area	85,190	100	18,227	100	313	100
Dam Failure	Inundation Areas	36,461	43	9,856	54	136	43
Extreme Temperature	Planning Area	85,190	100	18,227	100	313	100
Tornado	Planning Area	85,190	100	18,227	100	313	100
Fog	Planning Area	85,190	100	18,227	100	313	100
Storm-Related	Planning Area	85,190	100	18,227	100	313	100

Vulnerability maps were prepared for various hazardous materials incident scenarios and are contained in the 2015 Risk Assessment. The maps are based on the impact on life, safety, and health, which covers, high-risk, sensitive populations such as youth, elderly, and low income areas. Low income areas are often located near industrial areas and transportation corridors, and people with limited English skills. The vulnerability maps also

cover critical facilities in the city of Merced that are located within a ½-mile radius of transportation corridors, Highway 99, railroads, and pipelines, as well as fixed facilities that are located in these areas.

Vulnerability maps from the 2015 Risk Assessment are shown in Appendix A.

2.3 Hazard Mitigation Goals

The Local Hazard Mitigation Plan (2015), which contains the 2015 Risk Assessment as Chapter 3, determined hazard mitigation goals that pertained directly to all potential hazards that could occur within the city of Merced, and they are directly applicable to the transportation of hazardous materials through the city. These goals, which are designed to reduce or avoid long-term vulnerabilities and effects of the profiled hazards are contained in Section 4.2.2 of the Local Hazard Mitigation Plan and are stated below.

Goal 1: Provide protection for people's lives from hazards.

Goal 2: Minimize or reduce damage to property.

Goal 3: Minimize disruption of essential services, facilities, and infrastructure.

Goal 4: Maintain, enhance, and restore the natural environment's capacity to deal with the impacts of disasters.

Goal 5: Promote hazard mitigation as an integrated policy.

Goal 6 Increase public awareness.

3.0 COMMUNITY RISK ASSESSMENT FOR HAZARDOUS MATERIALS

This Community Risk Assessment for Hazardous Materials (CRAHM) is developed to further refine and define the areas of increased risk within the city of Merced that are vulnerable to a significant hazardous materials release from a highway, railroad, fixed facility, or pipeline incident. Data from the Flow Study, which was completed for the MFD in June 2018, identified the major toxic chemicals that could present a danger to vulnerable areas of the city during a release incident.

The major goals of the CRAHM are to determine potential high-risk locations for a hazardous materials release in the city of Merced to allow for MFD and other first responders to plan the incident response in advance of the incident, and to provide additional information toward the planning needs of the MFD. The planning needs were originally outlined in the Flow Study.

The scope of work for the completion of the CRAHM was focused on the following areas:

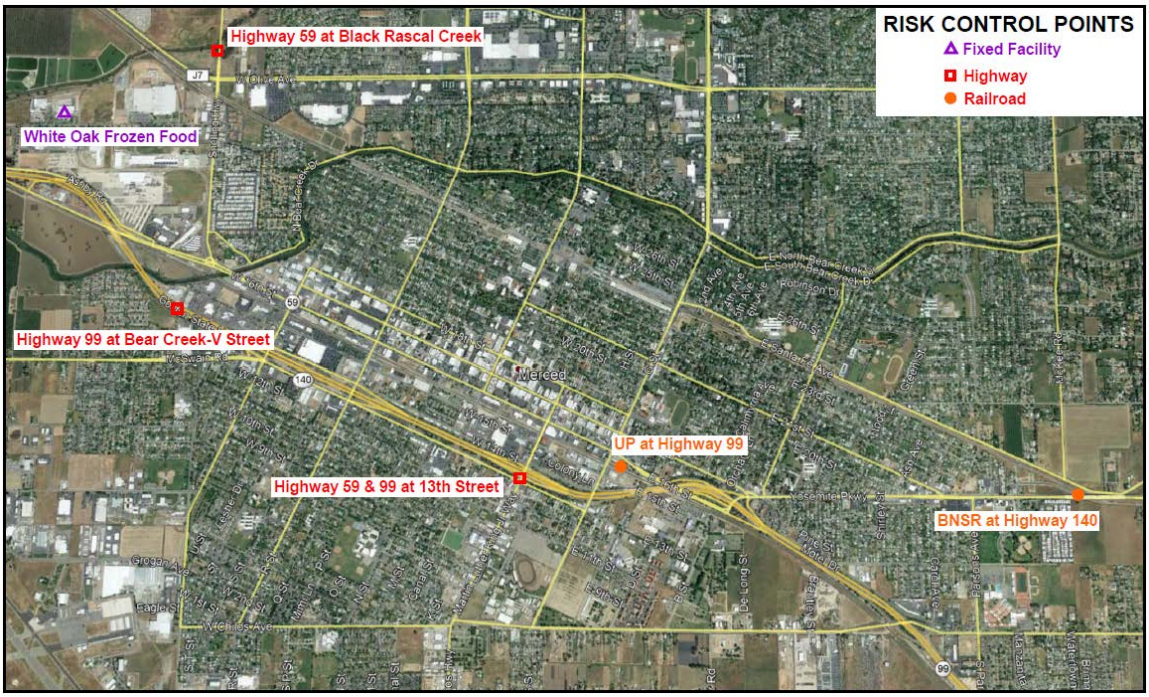
- Hazardous materials producers/users/transporters located within the city, mainly fixed facilities.
- Transportation routes of hazardous materials along Highway 99, Union Pacific Railroad (UP) and Burlington Northern and Santa Fe Railroad (BNSF), and pipelines.
- Evaluation of risk control points related to fixed facilities, highways, railroads, and pipelines. Risk control points are defined as locations where a hazardous incident is more likely to occur.
- Land use in high-risk areas (commercial, industrial, residential).
- Demographics.
- Utilization of CalARP data from the City/County.
- Incorporation of ALOHA/CAMEO/MARPLOT data into the CRA for high-risk areas.
- Potential impacts in high-risk areas.
- Evaluation of the vulnerability of specific areas.
- Training and equipment requirements based on the Planning Needs Assessment in the Flow Study.

3.1 Risk Control Points

With the assistance of the MFD, six (6) locations or risk control points were identified where additional analysis of a potential release incident of hazardous materials could have a significant effect on the surrounding communities. These risk control points were utilized in plume modeling to determine the extent of the plume dispersion of specific toxic chemicals. Three of these points were along major highways, two were along the railroads, and one was identified as a fixed facility. These locations are shown on the map below and are summarized as follows:

- White Oak Frozen Food (fixed facility)
- BNSF bend at Highway 140 (railroad)
- UP at Highway 99 (railroad)
- Highway 59 and 99 at 13th Street (highway)

- Highway 59 at Black Rascal Creek (highway)
- Highway 99 bend at Bear Creek and V Street (highway)



The locations described above represent the most likely points where hazardous materials releases could occur. Many of these points are located in close proximity to Highway 99 and the central part of the city of Merced. The 2015 Risk Assessment identified vulnerable receptors, including high-risk populations in proximity to the risk control points. Additional fixed facility locations that could be potential risk control points are listed on the CalARP list for the city of Merced. This list is part of an overall Merced County List of CalARP facilities that is included in the 2018 Merced County Area Plan.

City of Merced - Active Total CalARP Facilities FY2017-2018

FACILITY NAME	FACILITY ID	SITE ADDRESS	CITY NAME	PROGRAM/ELEMENT
Active Total CalARP Facilities FY2017-2018				
Cascade Specialties, Inc dba:White Oak Frozen Foods	FA0003585	2525 Cooper Ave.	Merced	2601 Cal-ARP ANNUAL PERMIT
Helena Chemical Company	FA0001422	50 E. Reilly Rd.	Merced	2601 Cal-ARP ANNUAL PERMIT
McLane Pacific, Inc.	FA0000504	3876 Childs Ave.	Merced	2601 Cal-ARP ANNUAL PERMIT
Stanislaus Farm Supply (Merced, CA)	FA0001478	674 S. HWY 59	Merced	2601 Cal-ARP ANNUAL PERMIT

3.2 Critical Facilities

Critical facilities are discussed in Section 3.4.1 of the 2015 Risk Assessment and summarized above in this document in Section 2.2. Critical Facilities are defined in the overall 2015 Local Hazard Mitigation Plan in Section 4.1.4 as:

> *A facility that is vital for the City's ability to provide essential services and protect life and property and/or loss of which would have a severe economic or catastrophic impact.*

The 2015 Local Hazard Mitigation Plan classifies these critical facilities that apply to all hazards as follows:

CITY HALL AND DEPARTMENTS
- City Civic Center
- County Administrative Offices

PARKS AND COMMUNITY SERVICES
- Educational Facilities
- City Parks
- Non-profit Community Services

PUBLIC SAFETY
- Health Centers
- Fire Stations
- Police Stations

PUBLIC WORKS
- Water Supply
- Corporation Yard
- Wastewater Treatment Facilities
- Power Grid
- Storm Drainage Systems

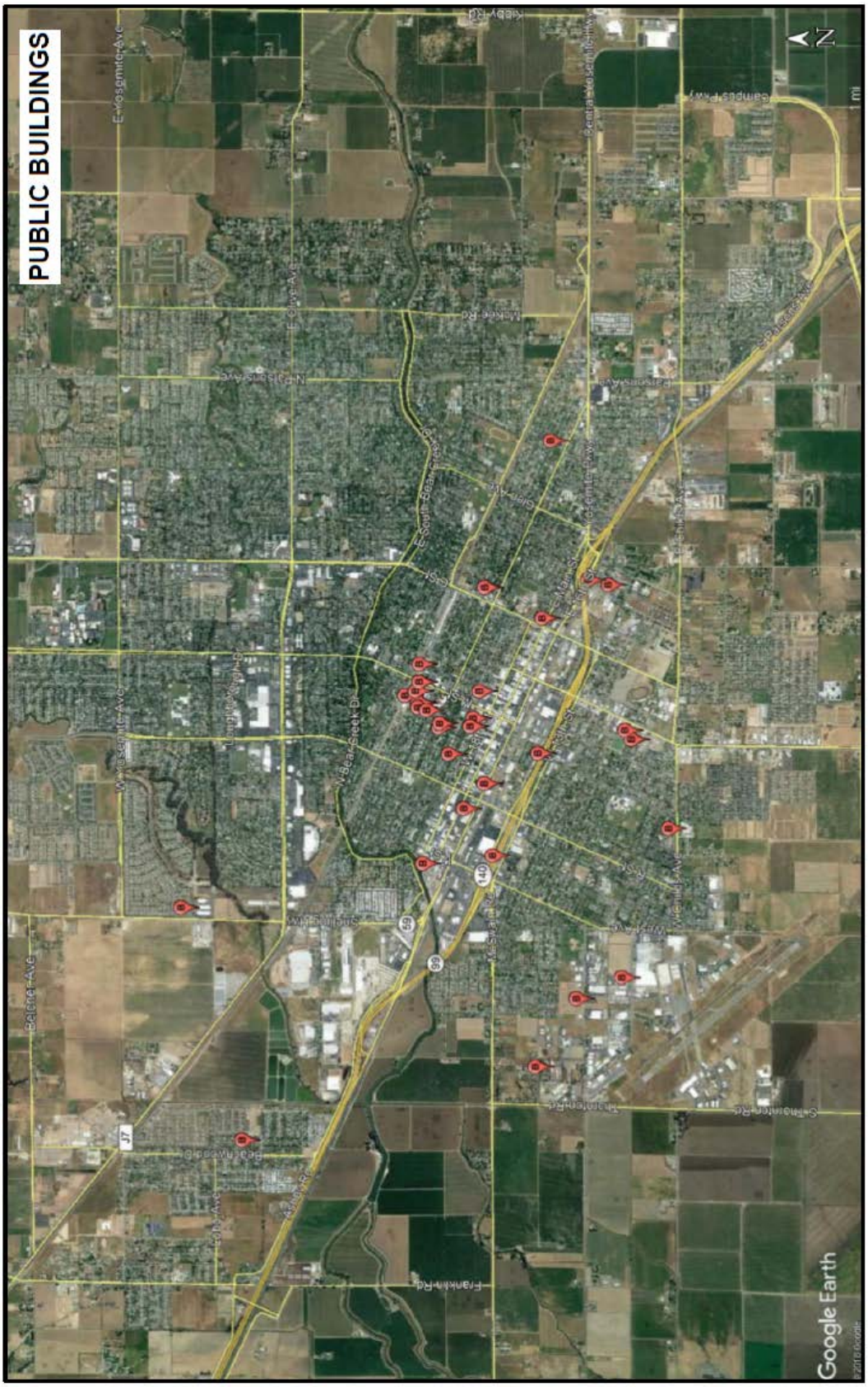
TRANSPORTATION
- State Highways
- Major Arterial Streets
- Rail Bridges (rail and creek)
- Railroads
- Airports

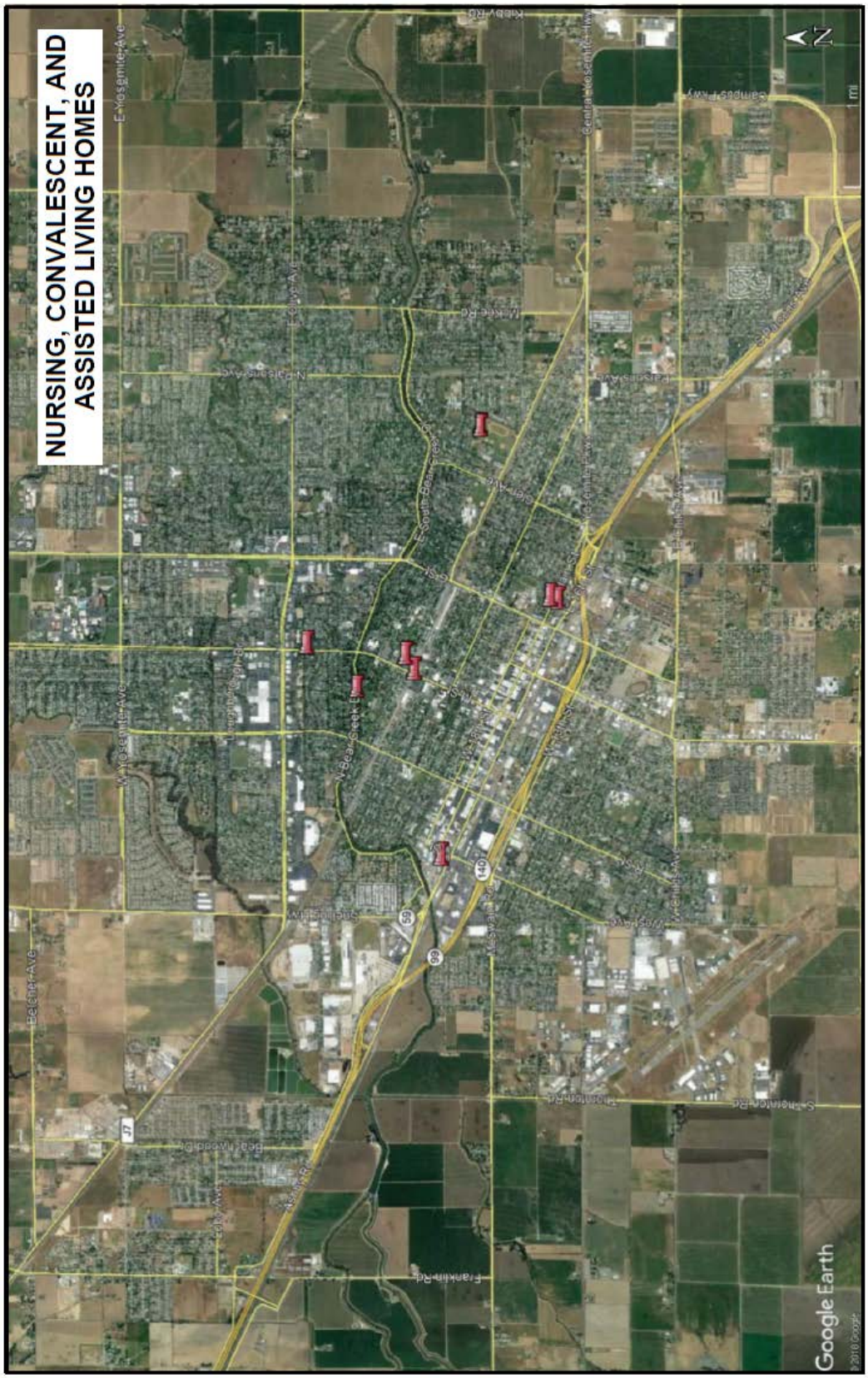
Many of these facilities are relevant to other hazards than the release of hazardous materials. As a result, and for the purposes of this CRAHM, critical facilities will refer to facilities that may contain vulnerable or essential emergency populations that will require mitigation/evacuation in the event of a hazardous materials release. Also included in these critical facilities are City of Merced water production wells. The critical facilities that have been identified with respect to a hazardous materials release are as follows:

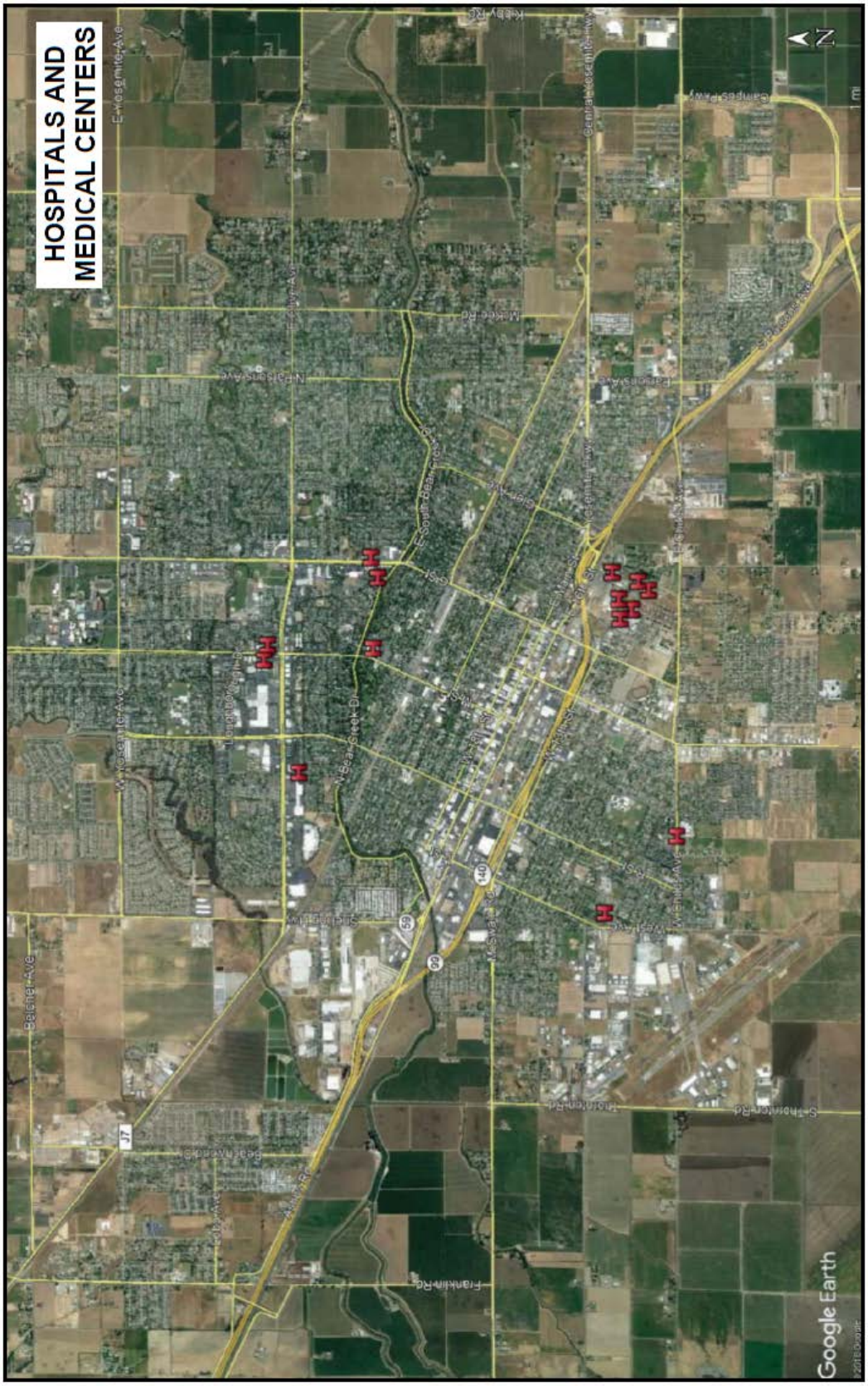
- Schools
- Public Buildings, including Police Departments and Jails, Fire Departments, Dispatch Centers
- Nursing, Assisted Living, and Convalescent Homes
- Hospitals, Medical Centers, Ambulance Services
- Homeless Shelters, Crisis Shelters
- Merced City Production Wells

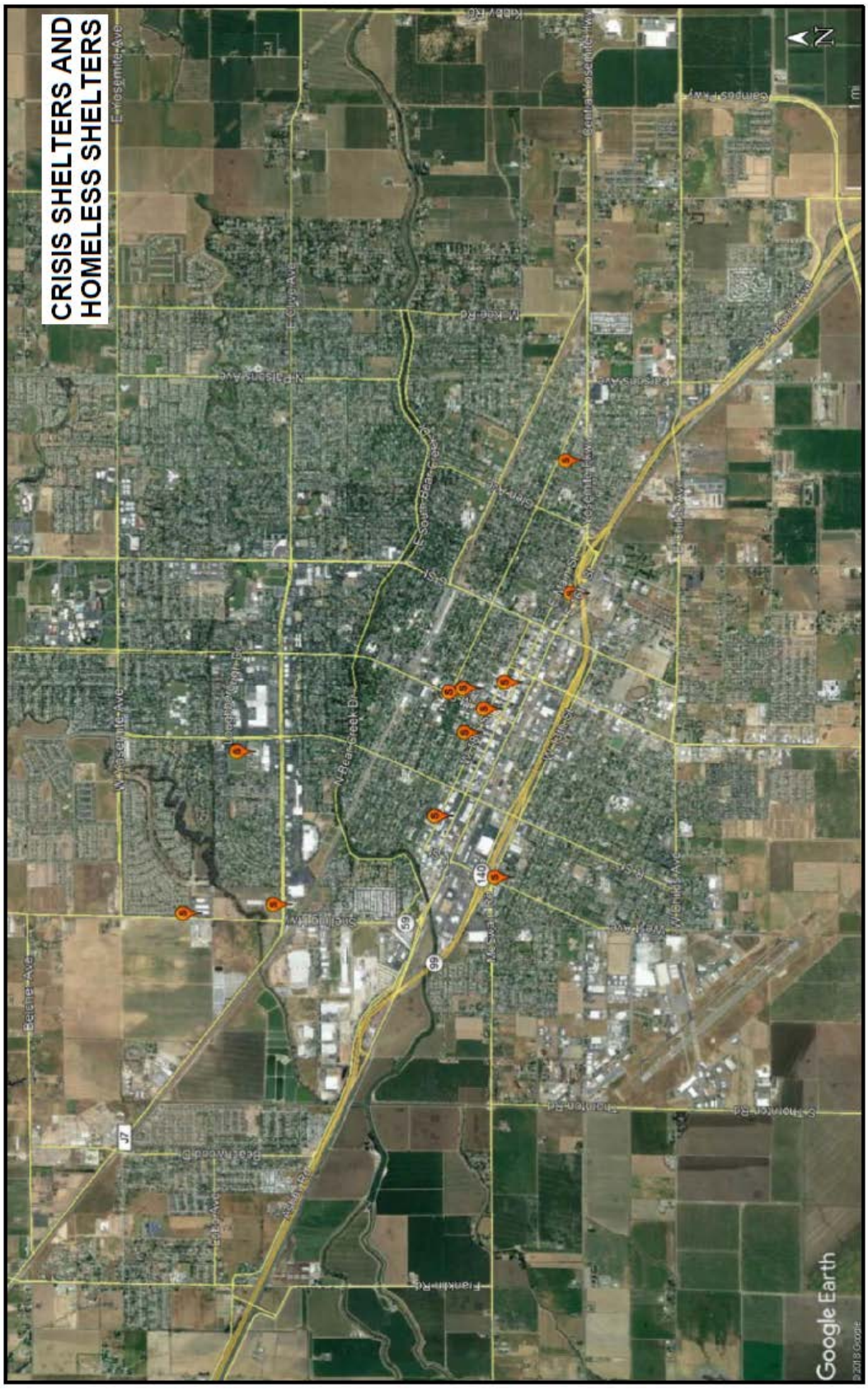
A list of more than 100 of these critical facilities, which are located within one mile of the risk control points is contained in Appendix B. Maps showing the critical facilities listed above are contained in the following pages.

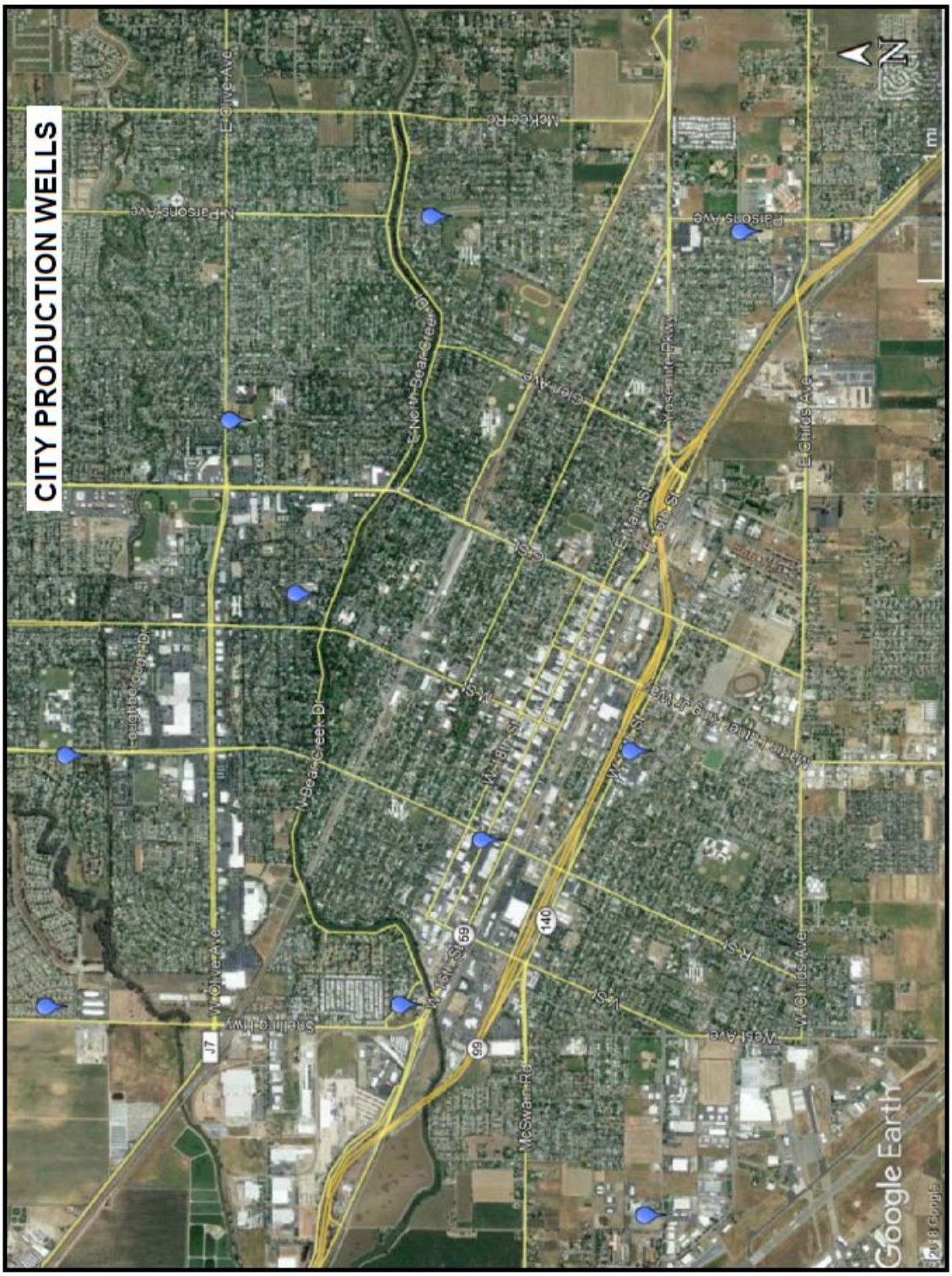
SCHOOLS
Google Earth

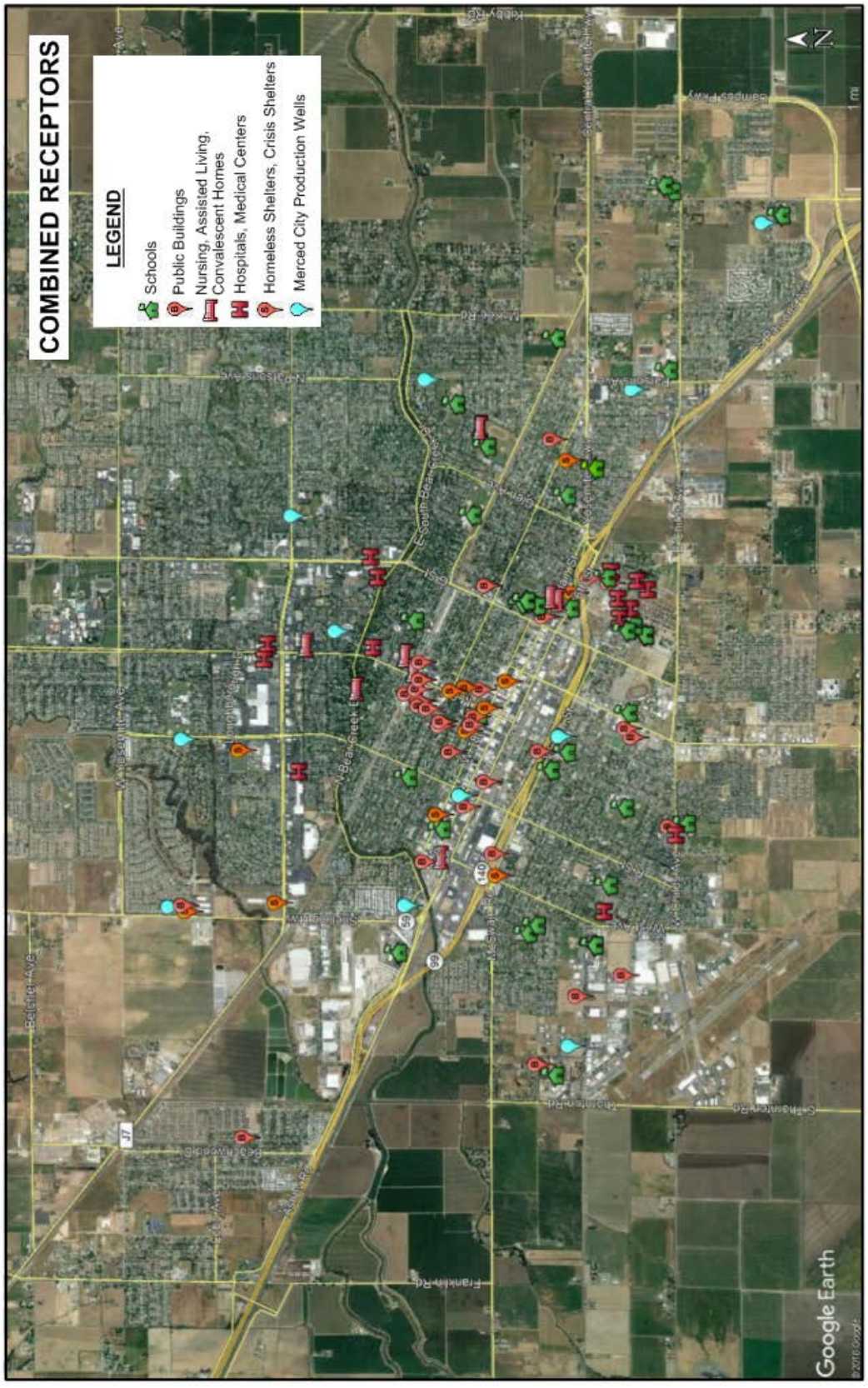

PUBLIC BUILDINGS
N
Google Earth


NURSING, CONVALESCENT, AND ASSISTED LIVING HOMES
N
1 mi
Google Earth


HOSPITALS AND MEDICAL CENTERS
N
Google Earth


CRISIS SHELTERS AND
HOMELESS SHELTERS
N
Google Earth


CITY PRODUCTION WELLS
Google Earth


COMBINED RECEPTORS
LEGEND
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
N
1 mi
Google Earth

3.3 Release Plume Analysis

Plume diagrams for release of hazardous materials from the risk control points are contained in this section. The plume diagrams are determined using the CAMEO suite of programs created by the U.S. Environmental Protection Agency (EPA). The CAMEO suite consists of CAMEO chemicals, ALOHA plume modeling through various release scenarios, and MARPLOT, which assists in plotting the information onto various map bases, such as Google Earth.

The plume diagrams are utilized in determining the extent of threat zones based on the release of a particular chemical. Three threat zones are mapped for each chemical release:

- Red zone: Highest threat level
- Orange Zone: Moderate threat level
- Yellow Zone: Low threat level

The following information was also utilized in the preparation of the plume maps:

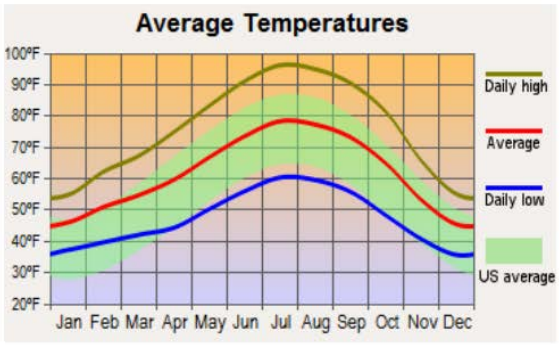
- Assumed weather conditions at the time of release,
- Identity and amount of chemical released,
- The amount of the chemical entering the vapor phase (air),
- Location of the release, and
- Time and date of release.

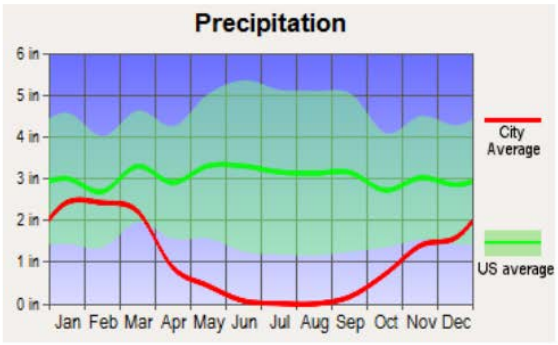
3.3.1 Background Weather Data

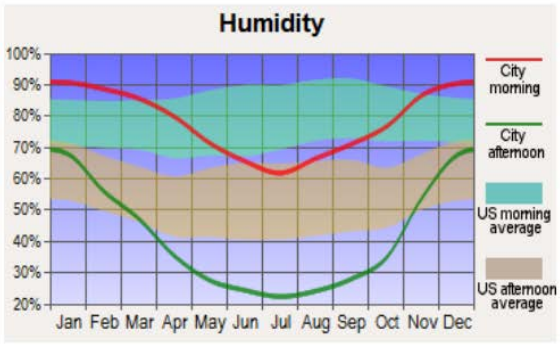
Background weather data for use in the plume diagrams were obtained from the following websites:

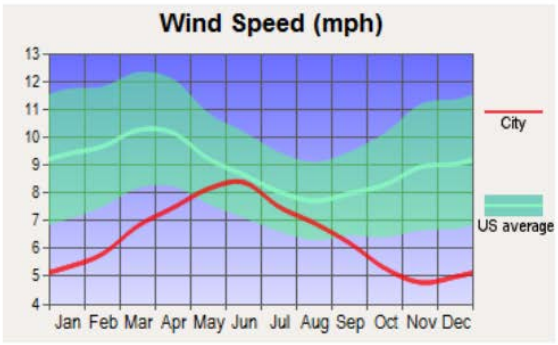
- Weather data contained in the 2015 Risk Assessment was obtained from http://www.city-data.com/city/Merced-California.html
- Detailed wind data were obtained from http://www.iwindsurf.com/windandwhere.iws?regionID=128&siteID=1053

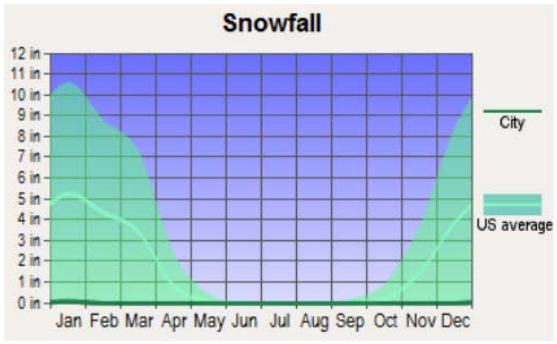
Weather data compiled for the city of Merced, some of which is contained in the 2015 Risk Assessment, are shown in the images below.

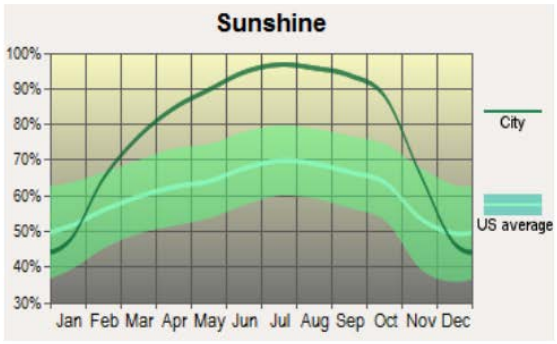


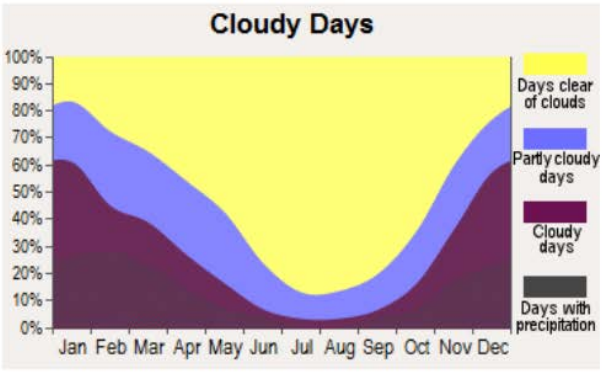












Wind rose data from the Windsurf website are contained in Appendix C. Based on the wind rose data, the major wind direction for the City of Merced is from the northwest to north-northwest. A secondary wind direction from the southeast was noted from October

through April, and this southeasterly direction was the dominant wind direction from January through March.

The following table summarizes the average weather conditions in Merced throughout the year.

CITY OF MERCED - ANNUAL WEATHER DATA												
	January	February	March	April	May	June	July	August	September	October	November	December
Wind Direction Primary	S45°E	S50°E	S45°E	N35°W	N35°W	N35°W	N40°W	N40°W	N40°W	N40°W	N45°W	N22°W
Wind Direction Secondary	N22°W	N35°W	N22°W	N/A	N/A	N/A	N/A	N/A	N/A	S45°E	S45°E	S45°E
Average Wind Speed (mph)	5.3	5.8	6.8	7.5	8.1	8.4	7.5	6.9	6	5.3	4.8	5
Daily High Temperature (average)	55	62	68	75	84	91	97	95	90	80	65	55
Daily Low Temperature (average)	38	40	42	44	50	56	60	59	56	47	40	37
Average Temperature	47	51	55	60	66	73	79	77	72	65	53	46
Average Precipitation (inches)	2.5	2.4	2.3	0.8	0.5	0.2	0.1	0.1	0.3	0.7	1.4	1.6
% Cloudiness	55	35	25	15	10	5	2	4	6	12	35	55

Based on the weather data above, it was determined that in order to cover the two major wind directions, as well as seasonal temperature and precipitation variations, plume analysis for January and July would be undertaken. The average daily high temperatures for January and July would be utilized in this analysis, as a release incident could cover an extended period of time throughout a 24-hour period.

CITY OF MERCED - ANNUAL WEATHER DATA		
	January	July
Wind Direction Primary	S45°E	N40°W
Wind Direction Secondary	N22°W	N/A
Average Wind Speed (mph)	5.3	7.5
Daily High Temperature (average)	55	97
Daily Low Temperature (average)	38	60
Average Temperature	47	79
Average Precipitation (inches)	2.5	0.1
% Cloudiness	55	2

3.3.2 Background Plume Analysis Parameters

The following information was obtained from the National Oceanic and Atmospheric Administration (NOAA), Office of Response and Restoration guidelines concerning Levels of Concern (LOCs), which are available on line at:

https://response.restoration.noaa.gov/oil-and-chemical-spills/chemical-spills/resources/levels-concern.html

A Toxic LOC will determine what level (threshold concentration) of inhalation exposure to a chemical would be injurious if inhaled over a defined length of time (exposure duration). In general, the lower the Toxic LOC value, the more toxic the substance is by inhalation.

ALOHA (Areal Locations of Hazardous Atmospheres) is used for emergency response or planning situations to assess the threat posed to the general public by a chemical release. ALOHA utilizes public exposure guidelines to predict how members of the general public would be affected if they are exposed to a particular hazardous chemical in an emergency response scenario.

ALOHA preferentially uses Acute Exposure Guideline Levels (AEGLs), as they are considered to be the best public exposure Toxic LOCs. As of mid-2016, AEGLs had been finalized for about 175 chemicals. ALOHA uses only the AEGL values for a 60-minute exposure duration.

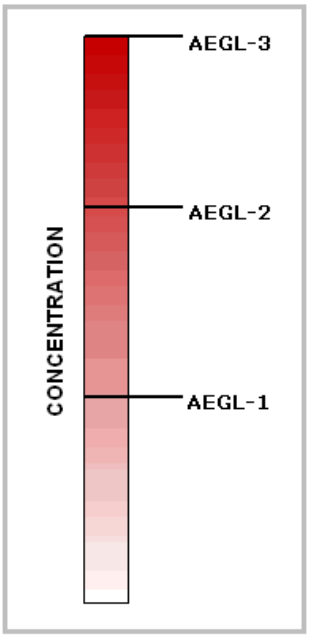
AEGLs are subdivided into 3 tiers which correspond to specific health effects. The AEGL tiers and their corresponding threat levels are as follows:

- AEGL-3: Red Threat Zone Level
- AEGL-2: Orange Threat Zone Level
- AEGL-1: Yellow Threat Zone Level

A more detailed discussion of the AEGLs is copied from the NOAA data at https://response.restoration.noaa.gov/oil-and-chemical-spills/chemical-spills/resources/acute-exposure-guideline-levels-aegls.html as follows:

What are AEGLs? • top

AEGLs estimate the concentrations at which most people—including sensitive individuals such as old, sick, or very young people—will begin to experience health effects if they are exposed to a hazardous chemical for a specific length of time (duration). For a given exposure duration, a chemical may have up to three AEGL values, each of which corresponds to a specific tier of health effects.



The three AEGL tiers are defined as follows:

- **AEGL-3** is the airborne concentration, expressed as parts per million (ppm) or milligrams per cubic meter (mg/m^3), of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.
- **AEGL-2** is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.
- **AEGL-1** is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

All three tiers (AEGL-1, AEGL-2, and AEGL-3) are developed for five exposure periods: 10 minutes, 30 minutes, 60 minutes, 4 hours, and 8 hours. The table below shows how the chlorine AEGL values vary with exposure duration.

Final AEGLs for chlorine (in parts per million)

	10 minutes	30 minutes	60 minutes	4 hours	8 hours
AEGL-1	0.50	0.50	0.50	0.50	0.50
AEGL-2	2.8	2.8	2.0	1.0	0.71
AEGL-3	50	28	20	10	7.1

Typically, the AEGL values will be different for each exposure duration (such as the AEGL-3 values in the table above). This is because the physical effects are typically related to dose (that is, concentration over exposure duration). However, in some cases, the AEGL values will be the same for all durations. This situation usually occurs at the AEGL-1 level (as in the table above), because it is a threshold for non-disabling effects; some effects (for example, whether people will be able to smell the chemical) depend only on concentration—not on the length of time people are exposed.

3.3.3 Chemicals of Concern for Plume Analysis

Based on the information contained in the Flow Study, two (2) chemicals were observed travelling through the city of Merced that were of major concern from a release incident standpoint. In the event of a release of these chemicals, isolation and protective distances from the release point will need to employed as outlined in the 2016 Emergency Response Guide (ERG), which was published by the U.S. Department of Transportation (DOT), Pipeline and Hazardous Materials Safety Administration (PHMSA).

These two chemicals of concern (COCs) included anhydrous ammonia and chlorine. Anhydrous ammonia (UN ID #1005) was observed travelling northbound along Highway 99 through the City of Merced in a tanker, and chlorine gas (UN ID #1017) was observed travelling southbound along Highway 99 through the City of Merced in a semi-truck trailer. Conversations with the MFD indicated anhydrous ammonia is a common hazardous material transported through the survey area.

Data from the ERG concerning isolation and protective distances for anhydrous ammonia and chlorine are shown below:

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TABLE 1 - INITIAL ISOLATION AND PROTECTIVE ACTION DISTANCES

ID No.	Guide	NAME OF MATERIAL	SMALL SPILLS (From a small package or small leak from a large package) First ISOLATE in all Directions Meters (Feet)	SMALL SPILLS Then PROTECT persons Downwind during DAY Kilometers (Miles)	SMALL SPILLS Then PROTECT persons Downwind during NIGHT Kilometers (Miles)	LARGE SPILLS (From a large package or from many small packages) First ISOLATE in all Directions Meters (Feet)	LARGE SPILLS Then PROTECT persons Downwind during DAY Kilometers (Miles)	LARGE SPILLS Then PROTECT persons Downwind during NIGHT Kilometers (Miles)
1005	125	Ammonia, anhydrous	30 m (100 ft)	0.1 km (0.1 mi)	0.2 km (0.1 mi)	Refer to table 3		
1005	125	Anhydrous ammonia						
1008	125	Boron trifluoride	30 m (100 ft)	0.1 km (0.1 mi)	0.7 km (0.4 mi)	400 m (1250 ft)	2.2 km (1.4 mi)	4.8 km (3.0 mi)
1008	125	Boron trifluoride, compressed						
1016	119	Carbon monoxide	30 m (100 ft)	0.1 km (0.1 mi)	0.2 km (0.1 mi)	200 m (600 ft)	1.2 km (0.7 mi)	4.4 km (2.8 mi)
1016	119	Carbon monoxide, compressed						
1017	124	Chlorine	60 m (200 ft)	0.3 km (0.2 mi)	1.1 km (0.7 mi)	Refer to table 3		

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TABLE 3 - INITIAL ISOLATION AND PROTECTIVE ACTION DISTANCES FOR LARGE SPILLS FOR DIFFERENT QUANTITIES OF SIX COMMON TIH (PIH in the US) GASES

	First ISOLATE in all Directions		Then PROTECT persons Downwind during DAY Low wind (< 6 mph = < 10 km/h)		DAY Moderate wind (6-12 mph = 10 - 20 km/h)		DAY High wind (> 12 mph = > 20 km/h)		NIGHT Low wind (< 6 mph = < 10 km/h)		NIGHT Moderate wind (6-12 mph = 10 - 20 km/h)		NIGHT High wind (> 12 mph = > 20 km/h)	
	Meters	(Feet)	km	(Miles)	km	(Miles)	km	(Miles)	km	(Miles)	km	(Miles)	km	(Miles)
TRANSPORT CONTAINER	**UN1005 Ammonia, anhydrous: Large Spills**													
Rail tank car	300	(1000)	1.7	(1.1)	1.3	(0.8)	1.0	(0.6)	4.3	(2.7)	2.3	(1.4)	1.3	(0.8)
Highway tank truck or trailer	150	(500)	0.9	(0.6)	0.5	(0.3)	0.4	(0.3)	2.0	(1.3)	0.8	(0.5)	0.6	(0.4)
Agricultural nurse tank	60	(200)	0.5	(0.3)	0.3	(0.2)	0.3	(0.2)	1.3	(0.8)	0.3	(0.2)	0.3	(0.2)
Multiple small cylinders	30	(100)	0.3	(0.2)	0.2	(0.1)	0.1	(0.1)	0.7	(0.5)	0.3	(0.2)	0.2	(0.1)
TRANSPORT CONTAINER	**UN1017 Chlorine: Large Spills**													
Rail tank car	1000	(3000)	9.9	(6.2)	6.4	(4.0)	5.1	(3.2)	11+	(7+)	9.0	(5.6)	6.7	(4.2)
Highway tank truck or trailer	600	(2000)	5.8	(3.6)	3.4	(2.1)	2.9	(1.8)	6.7	(4.3)	5.0	(3.1)	4.1	(2.5)
Multiple ton cylinders	300	(1000)	2.1	(1.3)	1.3	(0.8)	1.0	(0.6)	4.0	(2.5)	2.4	(1.5)	1.3	(0.8)
Multiple small cylinders or single ton cylinder	150	(500)	1.5	(0.9)	0.8	(0.5)	0.5	(0.3)	2.9	(1.8)	1.3	(0.8)	0.6	(0.4)

"+" means distance can be larger in certain atmospheric conditions

AEGLs for chlorine and ammonia as determined by the NOAA are as follows:

Final AEGLs for Chlorine (7782-50-5)

Exposure Period	AEGL-1	AEGL-2	AEGL-3
10 minutes	0.5 ppm	2.8 ppm	50 ppm
30 minutes	0.5 ppm	2.8 ppm	28 ppm
60 minutes	0.5 ppm	2 ppm	20 ppm
4 hours	0.5 ppm	1 ppm	10 ppm
8 hours	0.5 ppm	0.71 ppm	7.1 ppm

(NAC/NRC, 2017)

Final AEGLs for Ammonia (7664-41-7)

Exposure Period	AEGL-1	AEGL-2	AEGL-3
10 minutes	30 ppm	220 ppm	2700 ppm
30 minutes	30 ppm	220 ppm	1600 ppm
60 minutes	30 ppm	160 ppm	1100 ppm
4 hours	30 ppm	110 ppm	550 ppm
8 hours	30 ppm	110 ppm	390 ppm

(NAC/NRC, 2017)

3.3.4 Basis for Plume Analysis

The plume analysis diagrams contained in Section 4 are based on the following parameters:

- Weather Conditions: Both January and July data represent 2 separate endpoints of weather conditions in Merced, and the following weather parameters are included in the analysis:
  - Differing wind directions
  - Wind speed
  - Temperature extremes. (The average high temperatures for January and July are used in the analysis)
  - Cloud cover
- COCs: Utilization of chlorine and anhydrous ammonia as the COCs.
- Worst-Case Scenario: Assumption that a worst-case scenario situation where a maximum amount of the COCs from either a tanker truck or railroad tanker car are released to the environment. By utilizing the worst-case scenario default situation, the plume analysis diagrams will allow for a more significant area of impact than may be encountered in a realistic scenario.

- Probable Scenario: A probable or likely scenario was used on some of the plume analysis diagrams where supported by assumptions.

3.4 Chlorine Gas Summary

The release scenarios outlined above in Sections 4.1, and 4.2 are considered to be worst-case scenarios. In these scenarios, an 18,440-gallon railroad car or a tanker truck holding 11,500 gallons of liquefied chlorine has been involved in an accident, and a release of the contents of liquefied chlorine to the atmosphere has occurred. Both types of transport containers are pressurized. The chlorine quickly vaporizes and forms a toxic cloud migrating downwind from the source.

Information concerning the characteristics of chlorine and the migration of a chlorine gas cloud is well represented in the literature, and the general information summarized here was obtained from the following references:

Centers for Disease Control and Prevention (CDC): *Facts about Chlorine*, on line at https://emergency.cdc.gov/agent/chlorine/basics/facts.asp.

RAND Corporation, 2010, Evaluating *the Reliability of Emergency Response Systems for Large-Scale Incident Operations, Chapter Title: Describing a Chlorine Release Scenario and Relevant Response Parameters*, on line at https://www.jstor.org/stable/pdf/10.7249/mg994fema.11.pdf.

Scientific American, October 20, 2011, *Chlorine Accidents Take a Big Human Toll*, Scientific American, on line at https://www.scientificamerican.com/article/chlorine-accidents-take-big-human-toll/.

Oxychem, 2018, *Chlorine Handbook*, on line at https://www.oxy.com/OurBusinesses/Chemicals/Products/Documents/Chlorine/Chlorhb1.pdf.

Airgas, March 23, 2017, *Chlorine Safety Data Sheet*, on line at https://www.airgas.com/msds/001015.pdf.

Chlorine is one of the most widely used industrial chemicals, and approximately 13 million tons are produced annually in the United States. It is a powerful corrosive substance utilized in manufacturing, purifying water supplies, sewage treatment, refrigerants, disinfectants, pesticides, and other consumer products. Chlorine gas is pressurized and cooled to change it to a liquefied state for storage and transport. Chlorine gas is greenish yellow in color and has a strong, pungent and irritating odor like that of bleach. Chlorine gas is heavier that air and when released stays close to the ground and spreads out rapidly. According to the CDC exposure to dangerous concentrations of chlorine may result in the following symptoms:

- Blurred vision.
- Burning pain, redness, and blisters on the skin if exposed to gas. Skin injuries similar to frostbite can occur if it is exposed to liquid chlorine.
- Burning sensation in the nose, throat, and eyes.
- Coughing.
- Chest tightness.
- Difficulty breathing or shortness of breath. These may appear immediately if high concentrations of chlorine gas are inhaled, or they may be delayed if low concentrations of chlorine gas are inhaled.
- Fluid in the lungs (pulmonary edema) that may be delayed for a few hours.
- Nausea and vomiting.
- Watery eyes.
- Wheezing.

Characteristics of chlorine gas are contained on an Airgas Safety Data Sheet (Appendix D).

Chlorine is generally transported or stored as a liquid at -34°C under high-pressure and/or low temperature conditions. Chlorine releases have occurred during tank failures at fixed facilities, as well as railroad tank car and highway tank car transportation accidents. Once a container of liquefied chlorine is ruptured during an incident, the chlorine leaks out as a pool of boiling chlorine liquid that generates a greenish yellow cloud of chlorine vapor.

Once the liquid has vaporized the first area affected is the area in the immediate proximity to the source of the release. The vapor cloud will travel with the local airflows, and as it is heavier than air, it will remain close to the ground surface and follow depressions in the ground surface. The vapor cloud will eventually disperse with the concentrations of chlorine decreasing to below toxic levels.

The Rand Corporation document (cited above) contains a table of health effects based on the concentrations of chlorine gas, and that table is presented below:

Table 3.1
Health Effects of Chlorine Gas by Parts per Million (ppm)

Chlorine Concentration	Effect on Humans
0.2–0.4 ppm	Odor threshold
1–3 ppm	Mild, mucous membrane irritation
10 ppm	Immediately dangerous to life and health (IDLH)[a]
5–15 ppm	Moderate irritation of the respiratory tract
30 ppm	Immediate chest pain, vomiting, dyspnea, and cough
40–60 ppm	Toxic pneumonitis and pulmonary edema
430 ppm	Lethal over 30 minutes
1,000 ppm	Fatal within a few minutes

SOURCE: Chlorine Institute, 1999.

[a] In conditions above the IDLH level, appropriate protective equipment is recommended before entering the area (Chlorine Institute, 1999).

The Rand Corporation document also contains a schematic diagram of the evolution of a chlorine release over time as Figure 3.1 and response options at the source of the release in Figure 3.2. These diagrams are shown below:

Figure 3.1
Schematic of the Time Evolution of a Chlorine Release

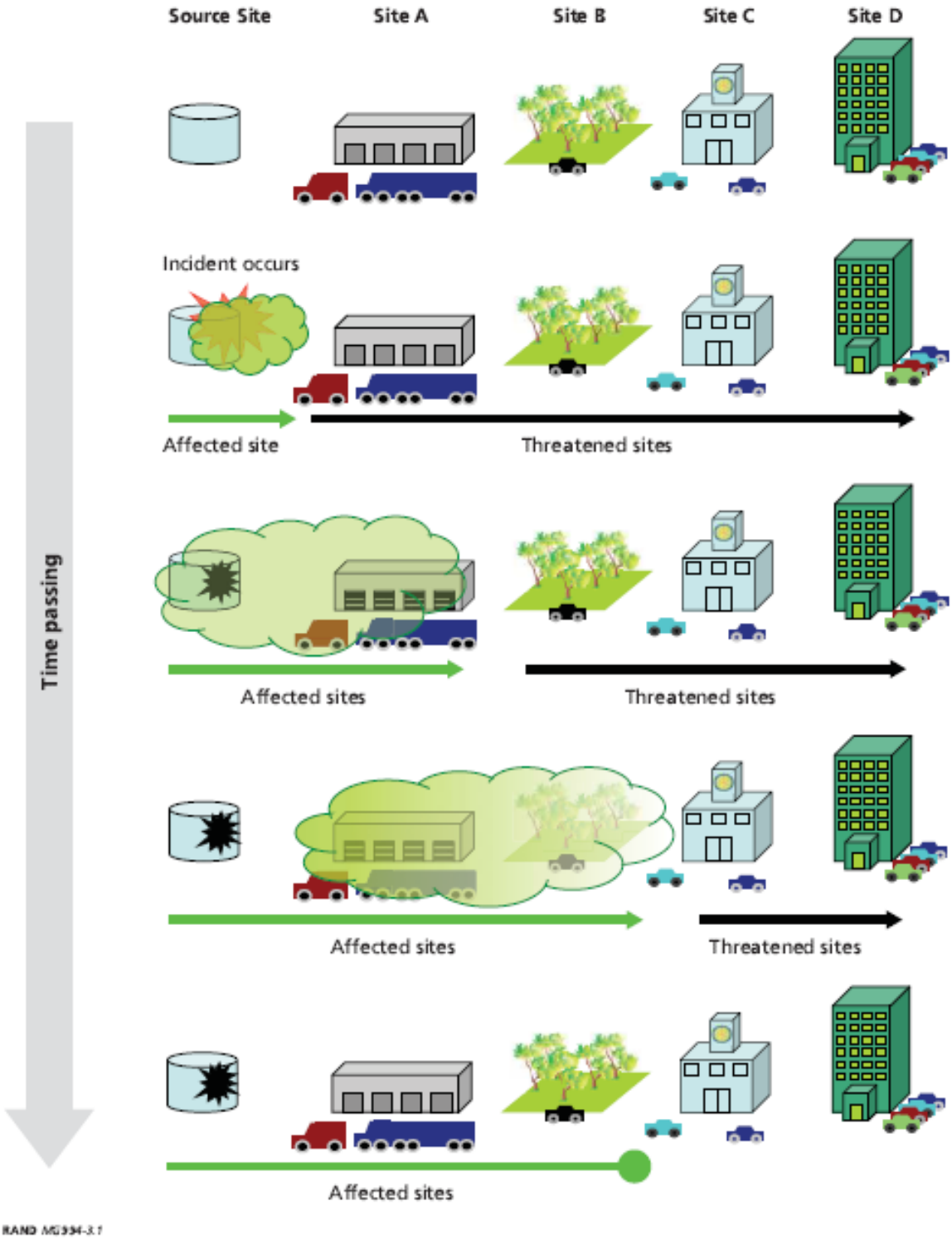
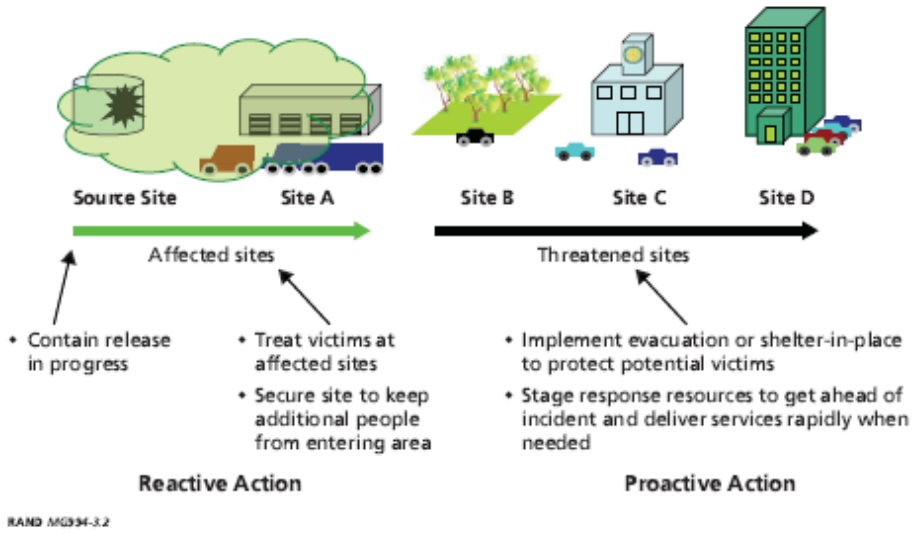


Figure 3.2
Response Options at Source, Affected and Threatened Sites



2. *Action at Threatened Sites.* If the opportunity exists to get ahead of the incident and take proactive action at threatened sites, the potential consequences of the incident can be reduced.
   - Actions such as evacuation or shelter-in-place interventions at each site would shield or remove part of the potential victim population out of harm's way.
   - More-limited proactive actions, including predeployment of response resources in advance of needs, could make it possible to rapidly intervene when needed, since treatment after chlorine exposure is time-sensitive.
3. *Action at Affected Sites.* Once sites are affected, intervention is focused on keeping exposed individuals from becoming casualties. Actions include:
   - *Assisting exposed individuals to leave the cloud rapidly.* Fast rescue efforts attempt to keep their dose below the point at which they will be injured.
   - *Decontamination, if necessary.* Though exposure to chlorine gas does not usually require victims to be decontaminated, some individuals might require it. Structures or material exposed to sufficient chlorine to cause damage might require decontamination.[6]
   - *Treatment of "lightly injured" individuals at the scene.* Action to prevent individuals who were exposed but are readily treatable from progressing to more serious injury.
   - *Stabilization and transport of seriously injured.* More significant medical action (including movement to hospitals) of individuals at serious risk.

In addition, the CDC recommends the following initial isolation and protective action distances:

- If a tank, rail car, or tank truck is involved in a fire, isolate it for 0.5 mi (800 m) in all directions; also consider initial evacuation for 0.5 mi (800 m) in all directions.

- Small spills (involving the release of approximately 52.83 gallons (200 liters) or less)
- First isolate in all directions: 100 ft (30 m).
- Then protect persons downwind during the day: 0.2 mi (0.2 km).
- Then protect persons downwind during the night: 0.8 mi (1.2 km).
- Large spills (involving quantities greater than 52.83 gallons (200 liters))
- First isolate in all directions: 800 ft (240 m).
- Then protect persons downwind during the day: 1.5 mi (2.4 km).
- Then protect persons downwind during the night: 4.6 mi (7.4 km).

3.5 Ammonia Gas Summary

The release scenarios outlined above in Sections 4.1, and 4.2 are considered to be worst-case scenario in the case of a rail tank car, worst-case and probable scenarios with respect to truck transport and fixed facility storage. In these scenarios, a 33,600-gallon railroad car, a truck hauling a 1,000-gallon nurse tank, or a fixed facility containing a tank holding 2,900 gallons of ammonia has ruptured, and toxic cloud of liquefied ammonia has been involved in an accident, and a release of the contents of liquefied ammonia from the pressurized tanks to the atmosphere has occurred. The ammonia quickly combines with moisture in the air, vaporizes, and forms a toxic cloud migrating downwind from the source.

1005
INHALATION HAZARD
ANHYDROUS AMMONIA

PROCOR
PROX 29834
PROX 29
GATX

Information concerning the characteristics of ammonia and anhydrous ammonia and the migration of an ammonia gas cloud is well represented in the literature, and the general information summarized here was obtained from the following references:

Centers for Disease Control and Prevention (CDC), Ammonia *Solution (UN3318); Ammonia, Anhydrous (UN1005): Lung Damaging Agent*, on line at https://www.cdc.gov/niosh/ershdb/emergencyresponsecard_29750013.html.

United States Department of Labor, 2018, Ammonia *Refrigeration Emergency Response*, on line at https://www.osha.gov/SLTC/etools/ammonia_refrigeration/emergency/index.html.

United States Department of Labor, 2018, Ammonia *Refrigeration Properties of Ammonia*, on line at https://www.osha.gov/SLTC/etools/ammonia_refrigeration/ammonia/index.html.

Illinois Fertilizer and Chemical Association, 2018, *Fertilizer's Role in Agriculture,* on line at https://www.ifca.com/media/files/27_3.pdf.

Transcaer, Section 4, Anhydrous Ammonia Response, on line at https://www.transcaer.com/docs/AATour/Transcaer_Ammonia_Training_2011Response_IG_rev14.pdf.

Airgas, February 15, 2018, Ammonia Safety Data Sheet, on line at https://www.airgas.com/msds/001003.pdf.

Ammonia/anhydrous ammonia is one of the highest production chemicals in the United States. It is used in manufacturing, refrigeration, and as an agricultural fertilizer, and is common in household chemicals. Ammonia can be absorbed into the body by inhalation, ingestion, and by skin and eye contact. A poisonous and visible vapor cloud is produced when ammonia comes in contact with water. Ammonia is extremely corrosive, and when it mixes with air it forms an explosive mixture. Although anhydrous ammonia is classified by the U.S Department of Transportation (USDOT) as nonflammable, ammonia vapor is flammable at concentrations of 15% to 28% by volume of air.

The odor threshold for ammonia is between 5 and 50 parts per million (ppm) of air, and the permissible exposure limit (PEL) is 50 ppm over an 8-hour time period. The USDOT summarizes the properties of ammonia as follows:

Summary of properties:

Boiling Point	-28°F
Weight per gallon of liquid at -28°F	5.69 pounds
Weight per gallon of liquid at 60°F	5.15 pounds
Specific gravity of the liquid (water=1)	0.619
Specific gravity of the gas (air=1)	0.588
Flammable limits in air	16-25%
Ignition temperature	1204°F
Vapor pressure at 0°F	16 psi
Vapor pressure at 68°F	110 psi
Vapor pressure at 100°F	198 psi
One cubic foot of liquid at 60°F expands to	850 cubic foot of gas

Ammonia can be absorbed into the body by inhalation, ingestion, and by skin and eye contact. According to the CDC exposure to dangerous concentrations of ammonia may result in the following symptoms:

- Rapid eye irritation and burning sensation, and possible severe corrosive eye injury.
- Upon ingestion, nausea, vomiting abdominal pain and corrosive burns to the mouth, esophagus, and stomach
- Skin inflammation, including blistering, tissue death, and deep penetrating burns.
- Exposure to liquefied ammonia gas may lead to severe frostbite and burns.

Characteristics of ammonia/anhydrous ammonia are contained on an Airgas Safety Data Sheet (Appendix E).

Ammonia is generally transported via highway in high-pressure nurse tanks on trailers pulled by trucks, or truck cargo tankers. Each truck cargo and carry 20 tons of ammonia. Ammonia can be transported in pressurized rail cars containing 80 tons of ammonia. The majority of ammonia is transported by rail. Fixed facilities that use ammonia for refrigeration purposes may contain pressurized tanks of ammonia.

Ammonia gas is lighter than air, and when it comes in contact with moisture in the air, it will form an ammonia fog. Once it forms a fog, however, the fog is heavier than air and is likely to remain low to the ground. This fog or cloud is white in color. The ammonia fog can travel along the ground aided by wind in the direction of the prevailing wind. Higher

temperatures will cause the ammonia cloud to move and disperse more rapidly than colder temperatures.

Emergency response to an ammonia release is covered in detail in the above-referenced CDC document and is summarized below:

- Red Zone: (generally corresponds to Red Zone of ALOHA plume designation): Personal Protective Equipment (PPE) in Level A or Level B should be used. In this zone, the exposure to chemical hazards, is above IDLH or greater than AEGL-2.
- Yellow Zone (generally corresponds to Orange Zone of ALOHA plume designation): PPE in Level C, with canister-type gas mask for ammonia levels in air above AEGL-2, and particulate cartridge/filter combination or a continuous flow respirator for ammonia levels in air above AEGL-1.
- Green Zone (Generally corresponds to Yellow Zone of ALOHA plume designation): Level D when exposure limit is less than AEGL-1.

In addition, the CDC recommends the following initial isolation and protective action distances:

- **When UN 1005 (anhydrous, liquefied), UN 2073 (35% to 50%), or UN 3318 (> 50%)** is involved in a tank, rail car, or tank truck fire:
  - Isolate it for 1 mi (1600 m) in all directions; also, consider initial evacuation for 1 mi (1600 m) in all directions.

- **When UN 1005 (anhydrous, liquefied) or UN 3318 (> 50%)** is involved in small spills (involving the release of approximately 52.83 gallons (200 liters) or less):
  - First isolate in all directions: 100 ft (30 m).
  - Then protect persons downwind during the day: 0.1 mi (0.1 km).
  - Then protect persons downwind during the night: 0.1 mi (0.1 km).

- **When UN 1005 (anhydrous, liquefied) or UN 3318 (> 50%)** is involved in large spills (involving quantities greater than 52.83 gallons (200 liters)):
  - First isolate in all directions: 200 ft (60 m).

- Then protect persons downwind during the day: 0.4 mi (0.6 km).
- Then protect persons downwind during the night: 1.4 mi (2.2 km).

4.0 Toxic Plume Analysis

This section contains plume analysis for Toxic LOCs for the COCs chlorine and ammonia based on the input of specific parameters, as outlined above in Section 3.3.4. As noted above, these parameters have been determined to illustrate a worst-case scenario and/or probable scenario with respect to a major release of the COCs within the city of Merced. As ALOHA data input requires a date input, the arbitrary dates of January 2 and July 18 are used.

The plume diagrams produced using the ALOHA modeling program for the risk control points at the highways, the railroad locations, and the fixed facility, and they are described in the following sections. In each section, the basis of the ALOHA plume maps are presented with the following summary data:

- Text Summary: the text summary describes the parameters under which the plume data were prepared. This includes:
    - Site Data which has been input specifically for the location.
    - Chemical Data for the specific chemical (in this case chlorine or ammonia), including AEGL-1, AEGL-2 and AEGL-3 (60 minutes), other specific chemical characteristics, and the "Immediately Dangerous to Life and Health (IDLH) concentration.
    - Atmospheric Data derived from the weather data for the city of Merced for either January or July.
    - Source Strength, including quantity spilled/released into the atmosphere and conditions under which it was released.
    - Threat zone, which defines the red, orange, and yellow threat zones.
- Toxic Threat Zone: This is a schematic of the plume size and shape with a summary of the threat zone.
- Release Rate: This is a graph of the data contained in the text portion under Source Strength.
- Plume Diagram: The plume diagram is superimposed on a Google Earth base. The 3 threat zones (red, orange, and yellow) are shown, as are the critical facilities receptors.

4.1 Highways

At the highway risk control points, it will be assumed that the hazardous materials spill of a COC will result from an incident with a tanker truck holding 10,000 gallons of the chlorine (worst-case scenario), a tanker truck holding 10,000 gallons of ammonia (worst-case scenario), and one 1,000-gallon nurse tank of ammonia (probable scenario). The individual details are contained in the sections below.

4.1.1 Highway 59 and 99 at 13th Street

The six scenarios for plume analysis at this location are for each of the COCs (chlorine-2 and ammonia-4) for the months of January and July.

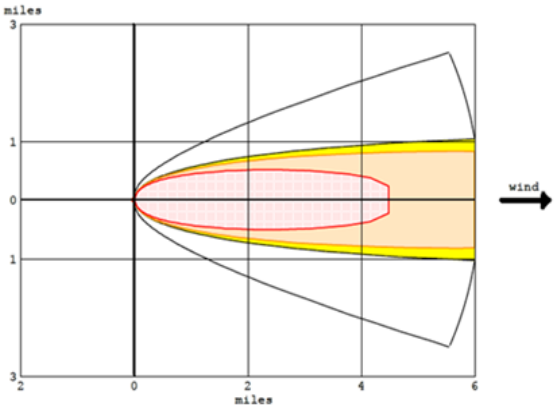
Scenario 1: Chlorine – January

Text Summary ALOHA® 5.4.7

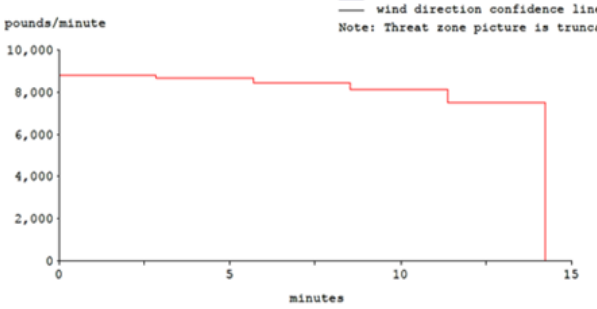
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 0.60 (unsheltered single storied)
  Time: January 15, 2018  0730 hours PST (user specified)

CHEMICAL DATA:
  Chemical Name: CHLORINE
  CAS Number: 7782-50-5                  Molecular Weight: 70.91 g/mol
  AEGL-1 (60 min): 0.5 ppm   AEGL-2 (60 min): 2 ppm   AEGL-3 (60 min): 20 ppm
  IDLH: 10 ppm
  Ambient Boiling Point: -29.5° 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: 5.3 miles/hour from SE at 3 meters
  Ground Roughness: open country         Cloud Cover: 5 tenths
  Air Temperature: 47° F                 Stability Class: E
  No Inversion Height                    Relative Humidity: 0%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Non-flammable chemical is escaping from tank
  Tank Diameter: 6.33 feet               Tank Length: 48.83 feet
  Tank Volume: 11500 gallons
  Tank contains liquid                   Internal Temperature: 47° F
  Chemical Mass in Tank: 59.0 tons       Tank is 85% full
  Opening Length: 10 inches              Opening Width: 0.5 inches
  Opening is 1 inches from tank bottom
  Note: RAILCAR predicts a stationary cloud or 'mist pool' will form.
  Model Run: traditional ALOHA tank
  Release Duration: 14 minutes
  Max Average Sustained Release Rate: 8,800 pounds/min
     (averaged over a minute or more)
  Total Amount Released: 118,000 pounds
  Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 4.5 miles --- (20 ppm = AEGL-3 [60 min])
  Orange: greater than 6 miles --- (2 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (0.5 ppm = AEGL-1 [60 min])
```

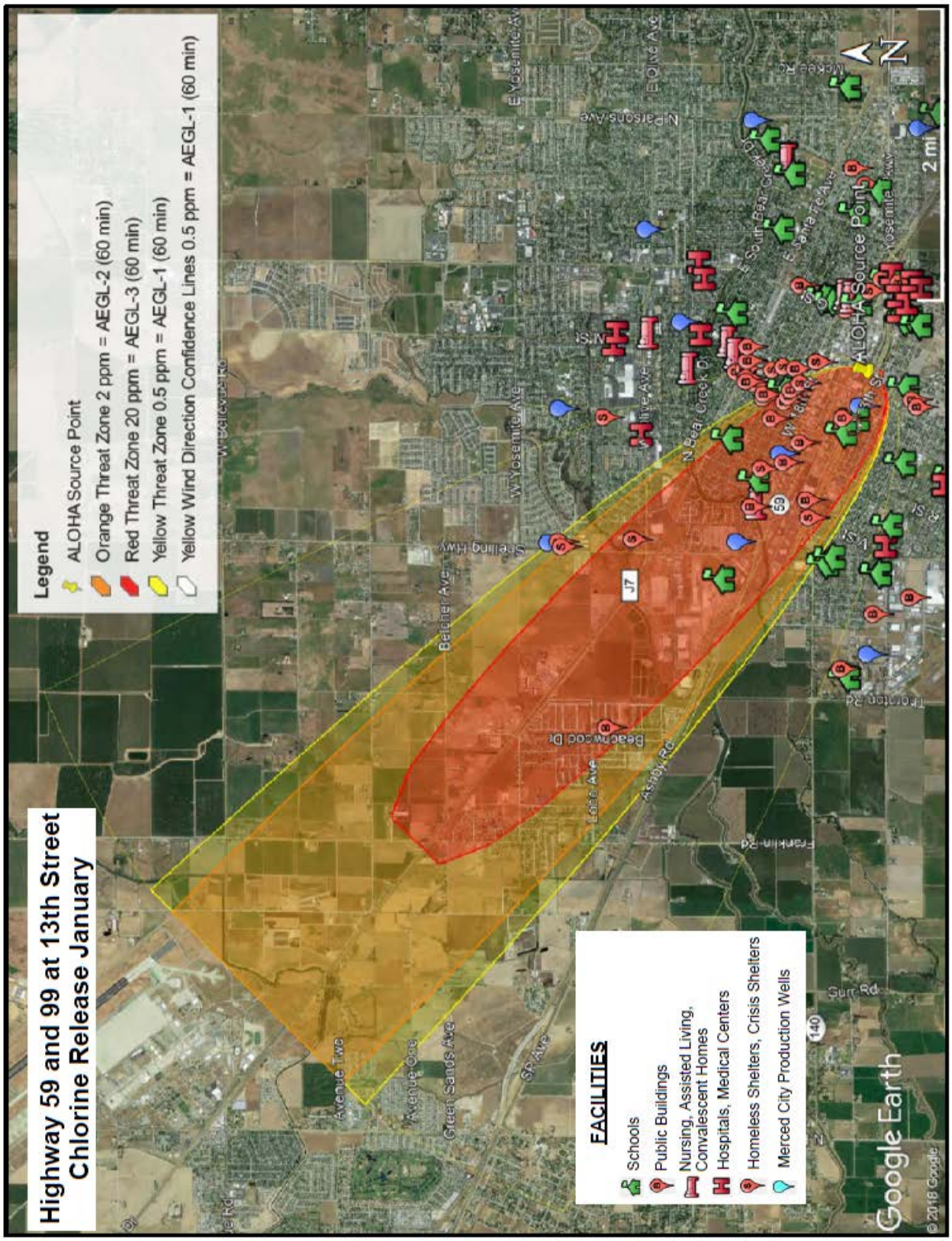
Toxic Threat Zone ALOHA® 5.4.7

```
Time: January 15, 2018  0730 hours PST (user specified)

Chemical Name: CHLORINE

Wind: 5.3 miles/hour from SE at 3 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 4.5 miles --- (20 ppm = AEGL-3 [60 min])
  Orange: greater than 6 miles --- (2 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (0.5 ppm = AEGL-1 [60 min])
```



greater than 20 ppm (AEGL-3 [60 min])
greater than 2 ppm (AEGL-2 [60 min])
greater than 0.5 ppm (AEGL-1 [60 min])
wind direction confidence lines
Note: Threat zone picture is truncated at the 6 mile limit.

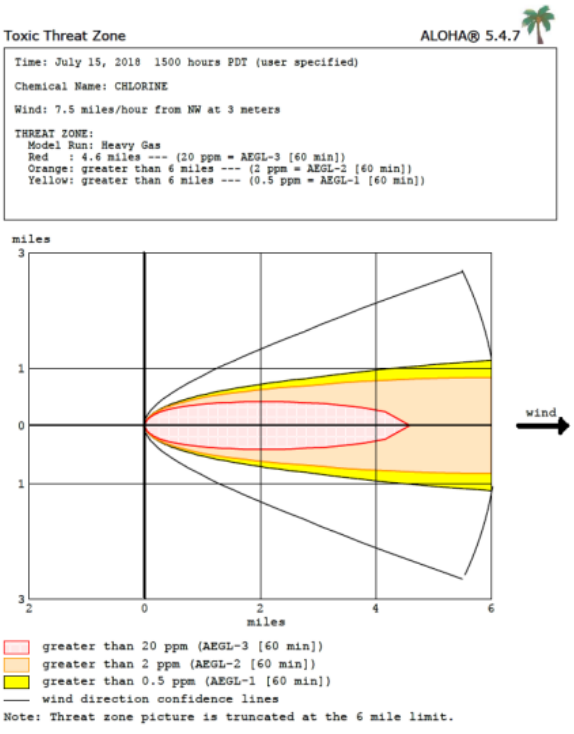


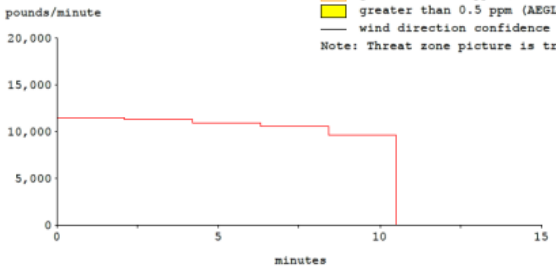


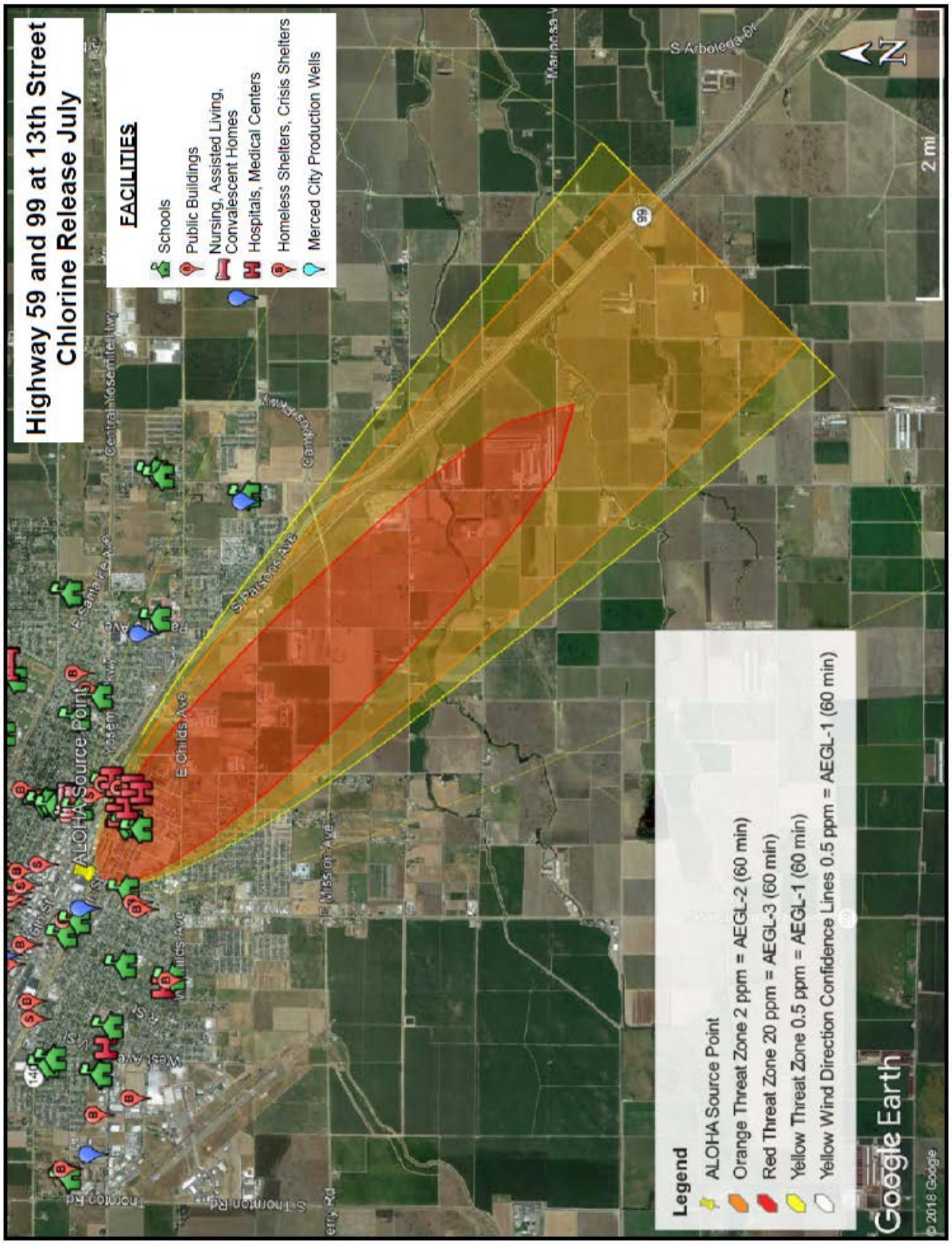
Scenario 2: Chlorine – July

Text Summary ALOHA® 5.4.7

```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 0.74 (unsheltered single storied)
  Time: July 15, 2018  1500 hours PDT (user specified)

CHEMICAL DATA:
  Chemical Name: CHLORINE
  CAS Number: 7782-50-5                  Molecular Weight: 70.91 g/mol
  AEGL-1 (60 min): 0.5 ppm   AEGL-2 (60 min): 2 ppm   AEGL-3 (60 min): 20 ppm
  IDLH: 10 ppm
  Ambient Boiling Point: -29.5° 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: 7.5 miles/hour from NW at 3 meters
  Ground Roughness: open country         Cloud Cover: 0 tenths
  Air Temperature: 79° F                 Stability Class: C
  No Inversion Height                    Relative Humidity: 0%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Non-flammable chemical is escaping from tank
  Tank Diameter: 6.33 feet               Tank Length: 48.83 feet
  Tank Volume: 11500 gallons
  Tank contains liquid                   Internal Temperature: 79° F
  Chemical Mass in Tank: 56.9 tons       Tank is 85% full
  Opening Length: 10 inches              Opening Width: 0.5 inches
  Opening is 1 inches from tank bottom
  Release Duration: 11 minutes
  Max Average Sustained Release Rate: 11,600 pounds/min
     (averaged over a minute or more)
  Total Amount Released: 113,800 pounds
  Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 4.6 miles --- (20 ppm = AEGL-3 [60 min])
  Orange: greater than 6 miles --- (2 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (0.5 ppm = AEGL-1 [60 min])
```






Highway 59 and 99 at 13th Street
Chlorine Release July
FACILITIES
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
ALOHA Source Point
Legend
ALOHA Source Point
Orange Threat Zone 2 ppm = AEGL-2 (60 min)
Red Threat Zone 20 ppm = AEGL-3 (60 min)
Yellow Threat Zone 0.5 ppm = AEGL-1 (60 min)
Yellow Wind Direction Confidence Lines 0.5 ppm = AEGL-1 (60 min)
Google Earth
2 mi
N

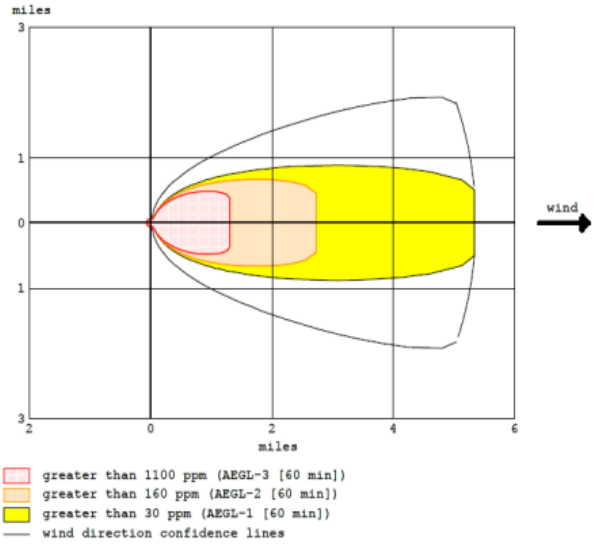
Scenario 3: Ammonia 10,000-Gallon Tanker – January

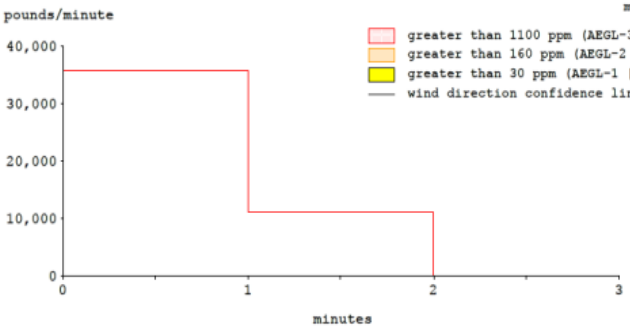
Text Summary ALOHA® 5.4.7

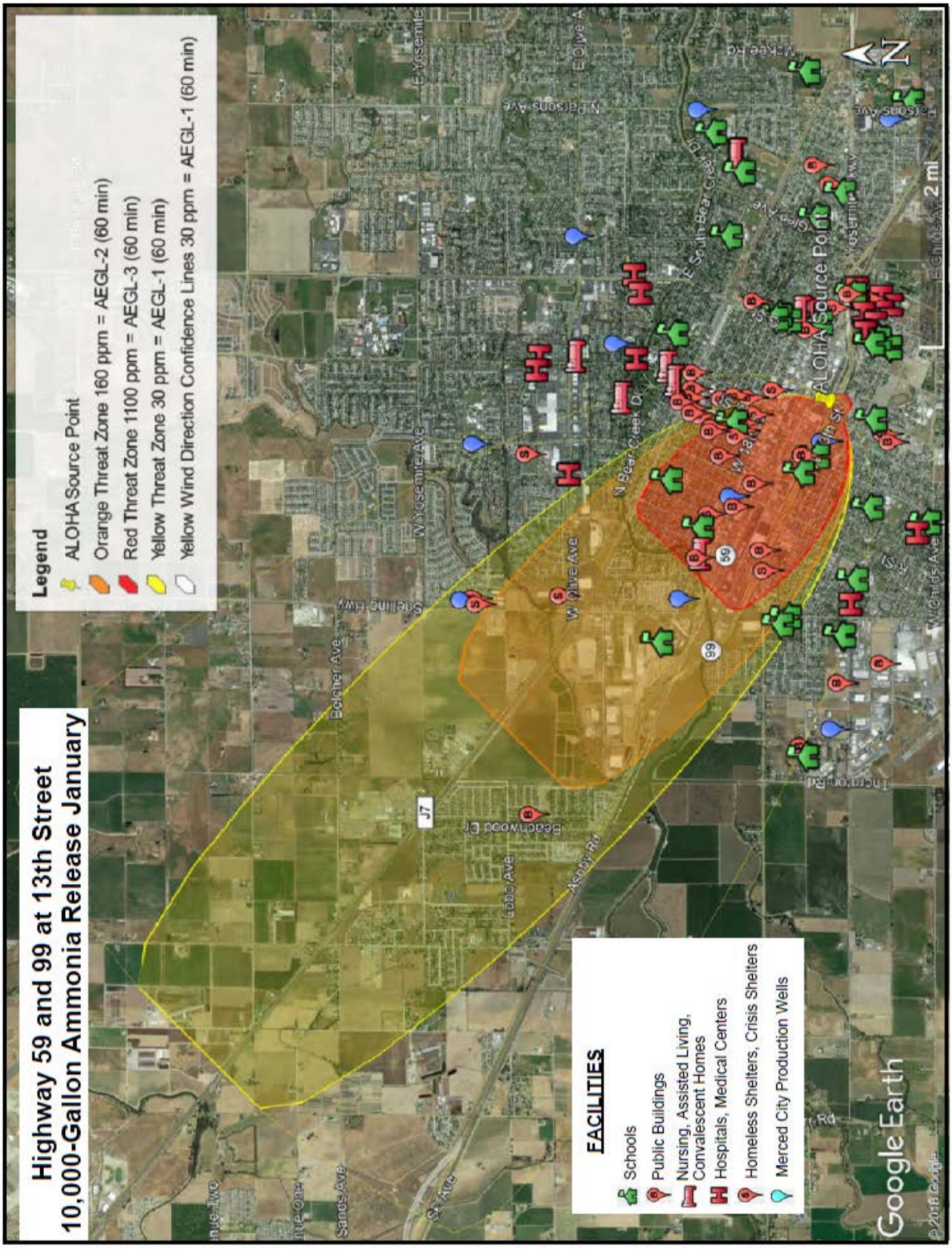
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 0.60 (unsheltered single storied)
  Time: January 15, 2018  0730 hours PST (user specified)

CHEMICAL DATA:
  Chemical Name: AMMONIA
  CAS Number: 7664-41-7                  Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm     UEL: 280000 ppm
  Ambient Boiling Point: -28.4° 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: 5.3 miles/hour from SE at 3 meters
  Ground Roughness: open country         Cloud Cover: 5 tenths
  Air Temperature: 47° F                 Stability Class: E
  No Inversion Height                    Relative Humidity: 0%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Flammable chemical escaping from tank (not burning)
  Tank Diameter: 7.03 feet               Tank Length: 36.5 feet
  Tank Volume: 10600 gallons
  Tank contains liquid                   Internal Temperature: 47° F
  Chemical Mass in Tank: 23.6 tons       Tank is 85% full
  Circular Opening Diameter: 6 inches
  Opening is 6 inches from tank bottom
  Note: RAILCAR predicts a stationary cloud or 'mist pool' will form.
  Model Run: traditional ALOHA tank
  Release Duration: 2 minutes
  Max Average Sustained Release Rate: 35,500 pounds/min
     (averaged over a minute or more)
  Total Amount Released: 46,571 pounds
  Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 1.3 miles --- (1100 ppm = AEGL-3 [60 min])
  Orange: 2.7 miles --- (160 ppm = AEGL-2 [60 min])
  Yellow: 5.3 miles --- (30 ppm = AEGL-1 [60 min])
```

Toxic Threat Zone ALOHA® 5.4.7

```
Time: January 15, 2018  0730 hours PST (user specified)

Chemical Name: AMMONIA

Wind: 5.3 miles/hour from SE at 3 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 1.3 miles --- (1100 ppm = AEGL-3 [60 min])
  Orange: 2.7 miles --- (160 ppm = AEGL-2 [60 min])
  Yellow: 5.3 miles --- (30 ppm = AEGL-1 [60 min])
```






Highway 59 and 99 at 13th Street
10,000-Gallon Ammonia Release January
Legend
ALOHA Source Point
Orange Threat Zone 160 ppm = AEGL-2 (60 min)
Red Threat Zone 1100 ppm = AEGL-3 (60 min)
Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
Yellow Wind Direction Confidence Lines 30 ppm = AEGL-1 (60 min)
FACILITIES
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
ALOHA Source Point
N
2 mi
Google Earth

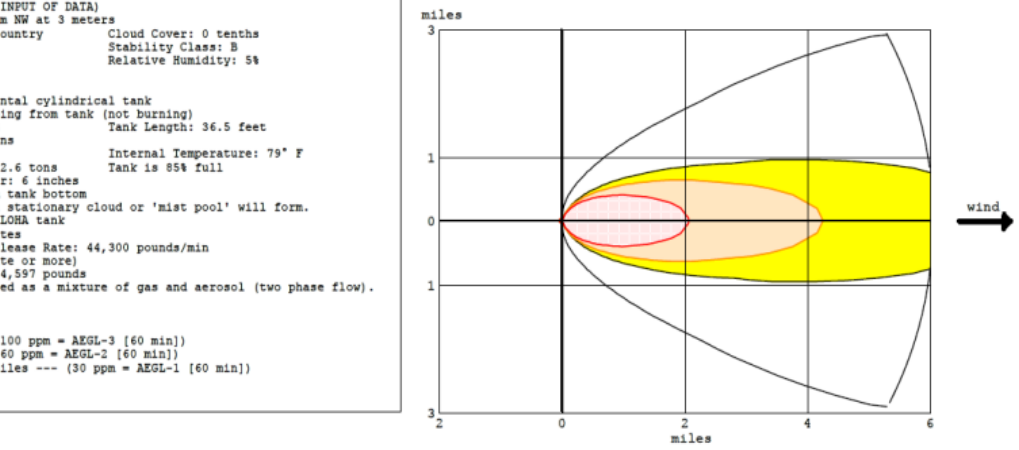
Scenario 4: Ammonia 10,000-Gallon Tanker – July

Text Summary ALOHA® 5.4.7

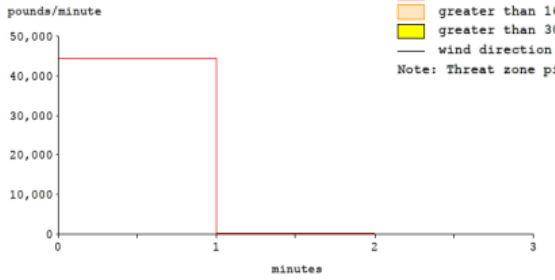
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 0.75 (unsheltered single storied)
  Time: July 18, 2018  1130 hours PDT (user specified)

CHEMICAL DATA:
  Chemical Name: AMMONIA
  CAS Number: 7664-41-7                 Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm        LEL: 150000 ppm      UEL: 280000 ppm
  Ambient Boiling Point: -28.4° 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: 7.5 miles/hour from NW at 3 meters
  Ground Roughness: open country        Cloud Cover: 0 tenths
  Air Temperature: 79° F                Stability Class: B
  No Inversion Height                   Relative Humidity: 5%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Flammable chemical escaping from tank (not burning)
  Tank Diameter: 7.03 feet              Tank Length: 36.5 feet
  Tank Volume: 10600 gallons
  Tank contains liquid                  Internal Temperature: 79° F
  Chemical Mass in Tank: 22.6 tons      Tank is 85% full
  Circular Opening Diameter: 6 inches
  Opening is 6 inches from tank bottom
  Note: RAILCAR predicts a stationary cloud or 'mist pool' will form.
  Model Run: traditional ALOHA tank
  Release Duration: 2 minutes
  Max Average Sustained Release Rate: 44,300 pounds/min
     (averaged over a minute or more)
  Total Amount Released: 44,597 pounds
  Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 2.1 miles --- (1100 ppm = AEGL-3 [60 min])
  Orange: 4.3 miles --- (160 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (30 ppm = AEGL-1 [60 min])
```

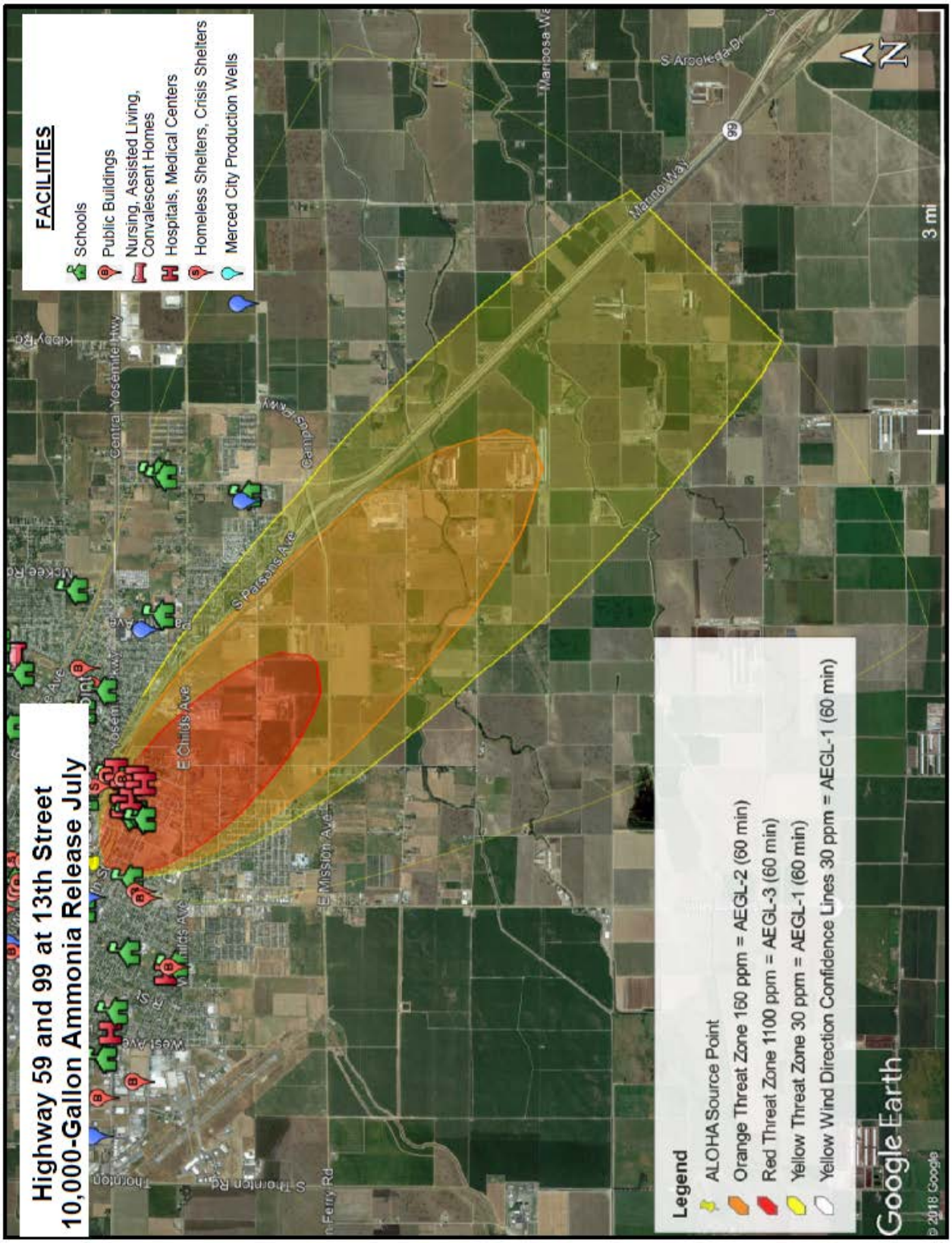
Toxic Threat Zone ALOHA® 5.4.7

```
Time: July 18, 2018  1130 hours PDT (user specified)

Chemical Name: AMMONIA

Wind: 7.5 miles/hour from NW at 3 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 2.1 miles --- (1100 ppm = AEGL-3 [60 min])
  Orange: 4.3 miles --- (160 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (30 ppm = AEGL-1 [60 min])
```



greater than 1100 ppm (AEGL-3 [60 min])
greater than 160 ppm (AEGL-2 [60 min])
greater than 30 ppm (AEGL-1 [60 min])
wind direction confidence lines
Note: Threat zone picture is truncated at the 6 mile limit.




Highway 59 and 99 at 13th Street
10,000-Gallon Ammonia Release July
FACILITIES
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
Legend
ALOHA Source Point
Orange Threat Zone 160 ppm = AEGL-2 (60 min)
Red Threat Zone 1100 ppm = AEGL-3 (60 min)
Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
Yellow Wind Direction Confidence Lines 30 ppm = AEGL-1 (60 min)
Google Earth
© 2018 Google
3 mi
N
S Arboleda Dr
Marino Way
Campus Pkwy
S Parsons Ave
E Childs Ave
E Mission Ave
Central Yosemite Hwy
Kibby Rd
West Ave
S Thornton Rd
Ferry Rd
Mariposa Way

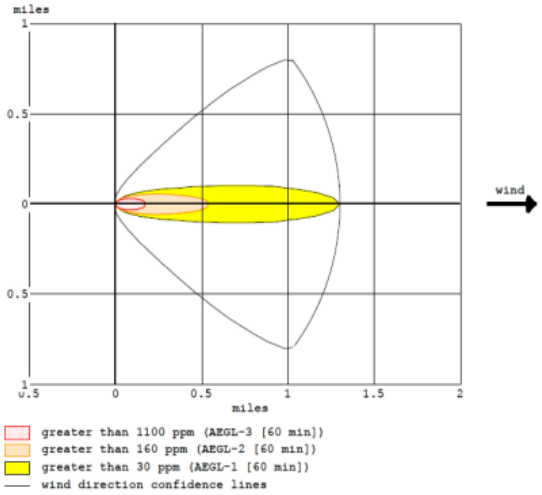
Scenario 5: Ammonia 1,000-Gallon Nurse Tank – January

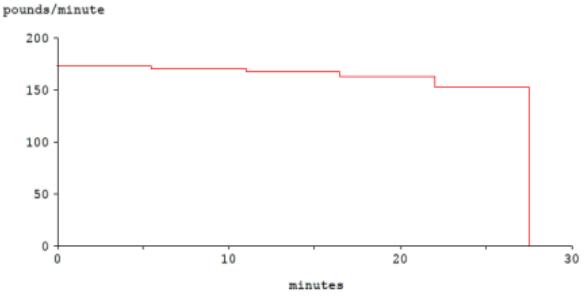
Text Summary ALOHA® 5.4.7

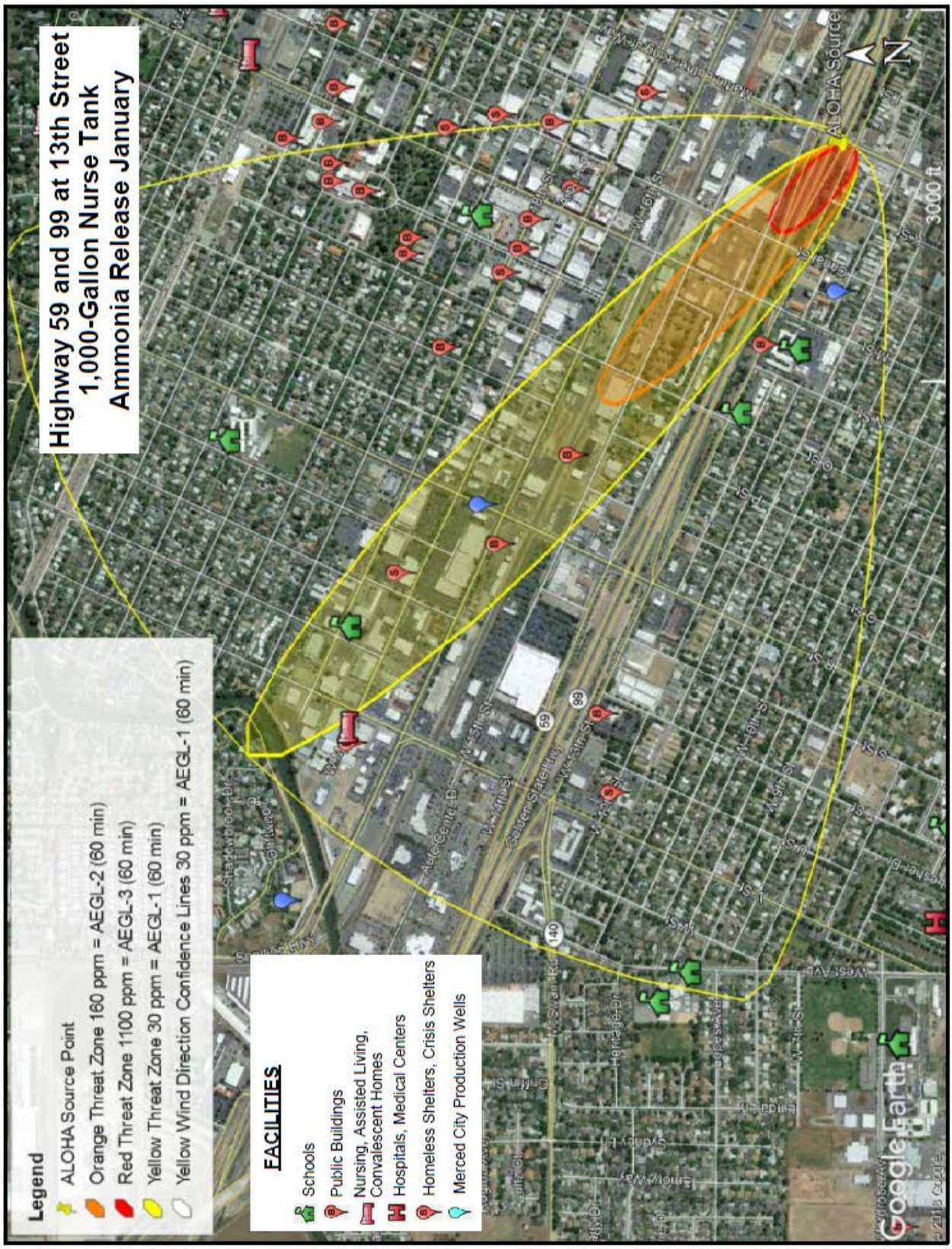
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 0.54 (unsheltered single storied)
  Time: January 15, 2018  0800 hours PST (user specified)

CHEMICAL DATA:
  Chemical Name: AMMONIA
  CAS Number: 7664-41-7                  Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm     UEL: 280000 ppm
  Ambient Boiling Point: -28.4° 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: 5.3 miles/hour from SE at 10 meters
  Ground Roughness: open country         Cloud Cover: 5 tenths
  Air Temperature: 47° F                 Stability Class: C
  No Inversion Height                    Relative Humidity: 50%

SOURCE STRENGTH:
  Leak from short pipe or valve in horizontal cylindrical tank
  Flammable chemical escaping from tank (not burning)
  Tank Diameter: 3.66 feet               Tank Length: 13 feet
  Tank Volume: 1,023 gallons
  Tank contains liquid                   Internal Temperature: 47° F
  Chemical Mass in Tank: 2.28 tons       Tank is 85% full
  Circular Opening Diameter: 3/4 inches
  Opening is 0 feet from tank bottom
  Note: RAILCAR predicts a stationary cloud or 'mist pool' will form.
  Model Run: traditional ALOHA tank
  Release Duration: 28 minutes
  Max Average Sustained Release Rate: 173 pounds/min
     (averaged over a minute or more)
  Total Amount Released: 4,560 pounds
  Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 300 yards --- (1100 ppm = AEGL-3 [60 min])
  Orange: 951 yards --- (160 ppm = AEGL-2 [60 min])
  Yellow: 1.3 miles --- (30 ppm = AEGL-1 [60 min])
```

Toxic Threat Zone ALOHA® 5.4.7

```
Time: January 15, 2018  0800 hours PST (user specified)

Chemical Name: AMMONIA

Wind: 5.3 miles/hour from SE at 10 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 300 yards --- (1100 ppm = AEGL-3 [60 min])
  Orange: 951 yards --- (160 ppm = AEGL-2 [60 min])
  Yellow: 1.3 miles --- (30 ppm = AEGL-1 [60 min])
```






Highway 59 and 99 at 13th Street
1,000-Gallon Nurse Tank
Ammonia Release January
Legend
ALOHA Source Point
Orange Threat Zone 160 ppm = AEGL-2 (60 min)
Red Threat Zone 1100 ppm = AEGL-3 (60 min)
Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
Yellow Wind Direction Confidence Lines 30 ppm = AEGL-1 (60 min)
FACILITIES
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
ALOHA Source
N
3000 ft
Google Earth

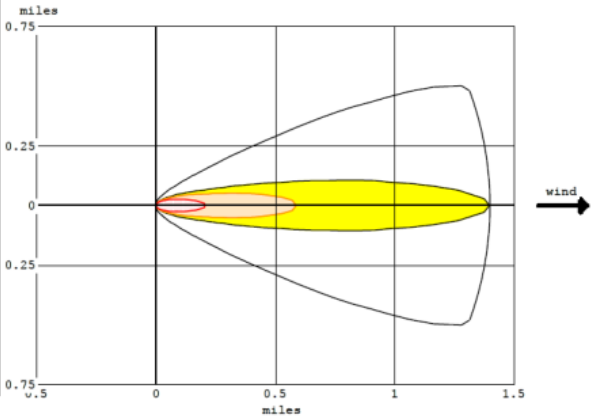
Scenario 6: Ammonia 1,000-Gallon Nurse Tank – July

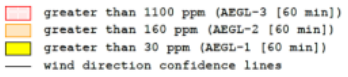
Text Summary ALOHA® 5.4.7

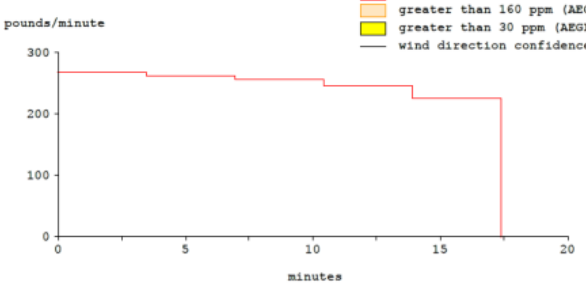
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 0.63 (unsheltered single storied)
  Time: July 15, 2018  1500 hours PDT (user specified)

CHEMICAL DATA:
  Chemical Name: AMMONIA
  CAS Number: 7664-41-7                  Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm     UEL: 280000 ppm
  Ambient Boiling Point: -28.4° 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: 7.5 miles/hour from NW at 10 meters
  Ground Roughness: open country         Cloud Cover: 0 tenths
  Air Temperature: 79° F                 Stability Class: C
  No Inversion Height                    Relative Humidity: 0%

SOURCE STRENGTH:
  Leak from short pipe or valve in horizontal cylindrical tank
  Flammable chemical escaping from tank (not burning)
  Tank Diameter: 3.66 feet               Tank Length: 13 feet
  Tank Volume: 1,023 gallons
  Tank contains liquid                   Internal Temperature: 79° F
  Chemical Mass in Tank: 2.18 tons       Tank is 85% full
  Circular Opening Diameter: 3/4 inches
  Opening is 0 feet from tank bottom
  Release Duration: 17 minutes
  Max Average Sustained Release Rate: 267 pounds/min
      (averaged over a minute or more)
  Total Amount Released: 4,360 pounds
  Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 364 yards --- (1100 ppm = AEGL-3 [60 min])
  Orange: 1035 yards --- (160 ppm = AEGL-2 [60 min])
  Yellow: 1.4 miles --- (30 ppm = AEGL-1 [60 min])
```

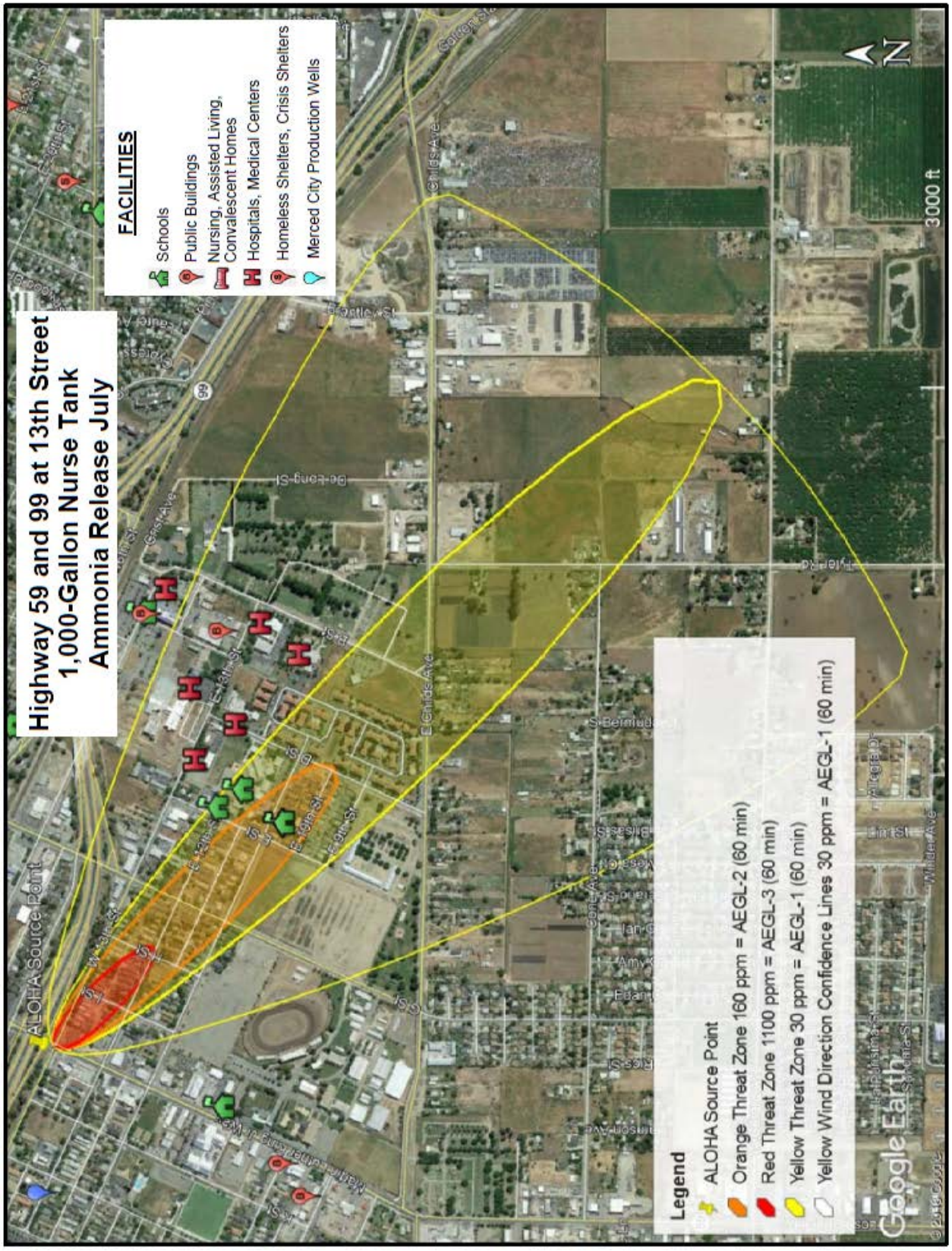
Toxic Threat Zone ALOHA® 5.4.7

```
Time: July 15, 2018  1500 hours PDT (user specified)

Chemical Name: AMMONIA

Wind: 7.5 miles/hour from NW at 10 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 364 yards --- (1100 ppm = AEGL-3 [60 min])
  Orange: 1035 yards --- (160 ppm = AEGL-2 [60 min])
  Yellow: 1.4 miles --- (30 ppm = AEGL-1 [60 min])
```








Highway 59 and 99 at 13th Street
1,000-Gallon Nurse Tank
Ammonia Release July
FACILITIES
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
ALOHA Source Point
Legend
ALOHA Source Point
Orange Threat Zone 160 ppm = AEGL-2 (60 min)
Red Threat Zone 1100 ppm = AEGL-3 (60 min)
Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
Yellow Wind Direction Confidence Lines 30 ppm = AEGL-1 (60 min)
N
3000 ft
Google Earth

4.1.2 Highway 59 at Black Rascal Creek

The six scenarios for plume analysis at this location are for each of the COCs (chlorine-2 and ammonia-4) for the months of January and July.

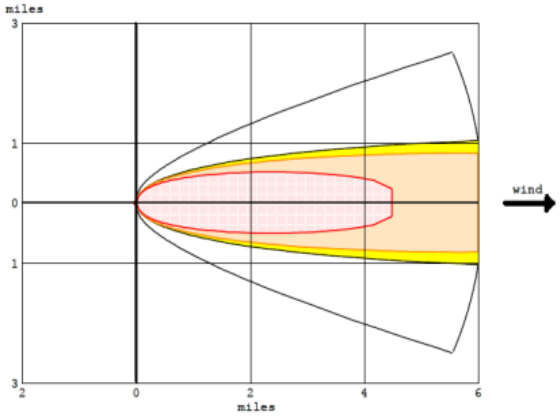
Scenario 1: Chlorine – January

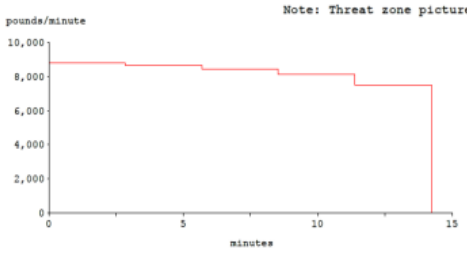
Text Summary ALOHA® 5.4.7

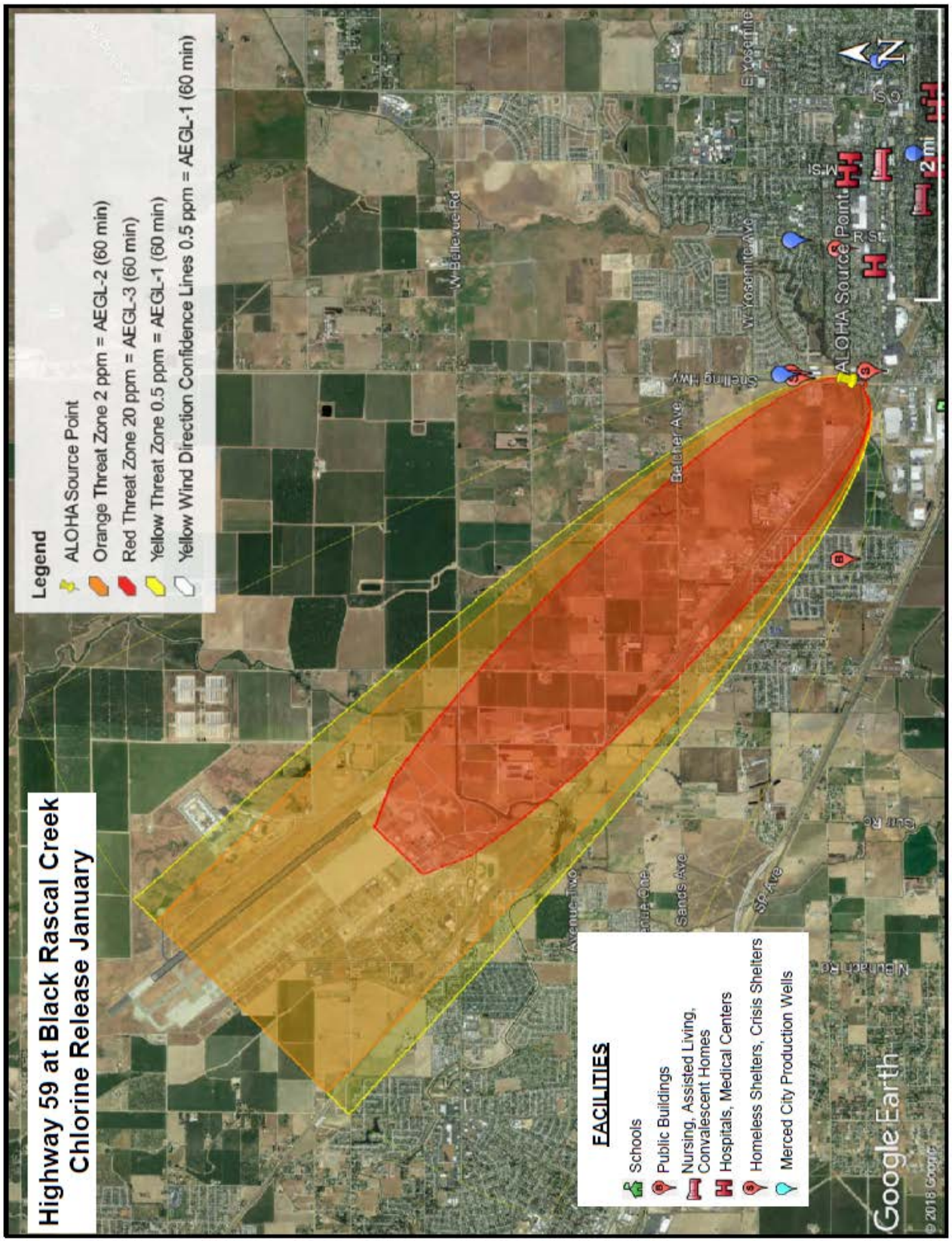
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 0.60 (unsheltered single storied)
  Time: January 15, 2018  0730 hours PST (user specified)

CHEMICAL DATA:
  Chemical Name: CHLORINE
  CAS Number: 7782-50-5                  Molecular Weight: 70.91 g/mol
  AEGL-1 (60 min): 0.5 ppm   AEGL-2 (60 min): 2 ppm   AEGL-3 (60 min): 20 ppm
  IDLH: 10 ppm
  Ambient Boiling Point: -29.5° 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: 5.3 miles/hour from SE at 3 meters
  Ground Roughness: open country         Cloud Cover: 5 tenths
  Air Temperature: 47° F                 Stability Class: E
  No Inversion Height                    Relative Humidity: 0%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Non-flammable chemical is escaping from tank
  Tank Diameter: 6.33 feet               Tank Length: 48.83 feet
  Tank Volume: 11500 gallons
  Tank contains liquid                   Internal Temperature: 47° F
  Chemical Mass in Tank: 59.0 tons       Tank is 85% full
  Opening Length: 10 inches              Opening Width: 0.5 inches
  Opening is 1 inches from tank bottom
  Note: RAILCAR predicts a stationary cloud or 'mist pool' will form.
  Model Run: traditional ALOHA tank
  Release Duration: 14 minutes
  Max Average Sustained Release Rate: 8,800 pounds/min
     (averaged over a minute or more)
  Total Amount Released: 118,000 pounds
  Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 4.5 miles --- (20 ppm = AEGL-3 [60 min])
  Orange: greater than 6 miles --- (2 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (0.5 ppm = AEGL-1 [60 min])
```

Toxic Threat Zone ALOHA® 5.4.7

```
Time: January 15, 2018  0730 hours PST (user specified)

Chemical Name: CHLORINE

Wind: 5.3 miles/hour from SE at 3 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 4.5 miles --- (20 ppm = AEGL-3 [60 min])
  Orange: greater than 6 miles --- (2 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (0.5 ppm = AEGL-1 [60 min])
```






Highway 59 at Black Rascal Creek
Chlorine Release January
Legend
ALOHA Source Point
Orange Threat Zone 2 ppm = AEGL-2 (60 min)
Red Threat Zone 20 ppm = AEGL-3 (60 min)
Yellow Threat Zone 0.5 ppm = AEGL-1 (60 min)
Yellow Wind Direction Confidence Lines 0.5 ppm = AEGL-1 (60 min)
FACILITIES
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
ALOHA Source Point
2 mi
Google Earth

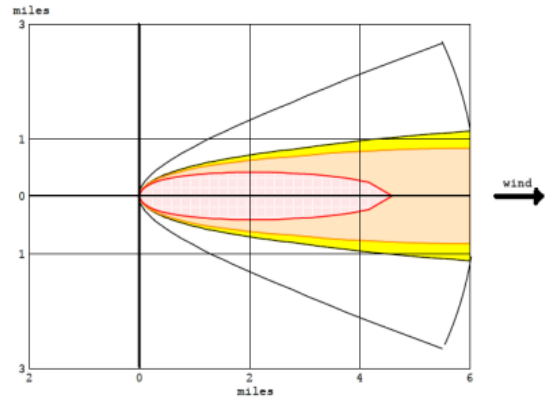
Scenario 2: Chlorine – July

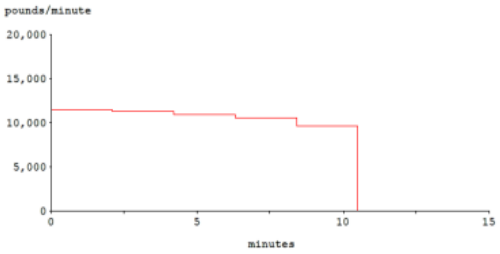
Text Summary ALOHA® 5.4.7

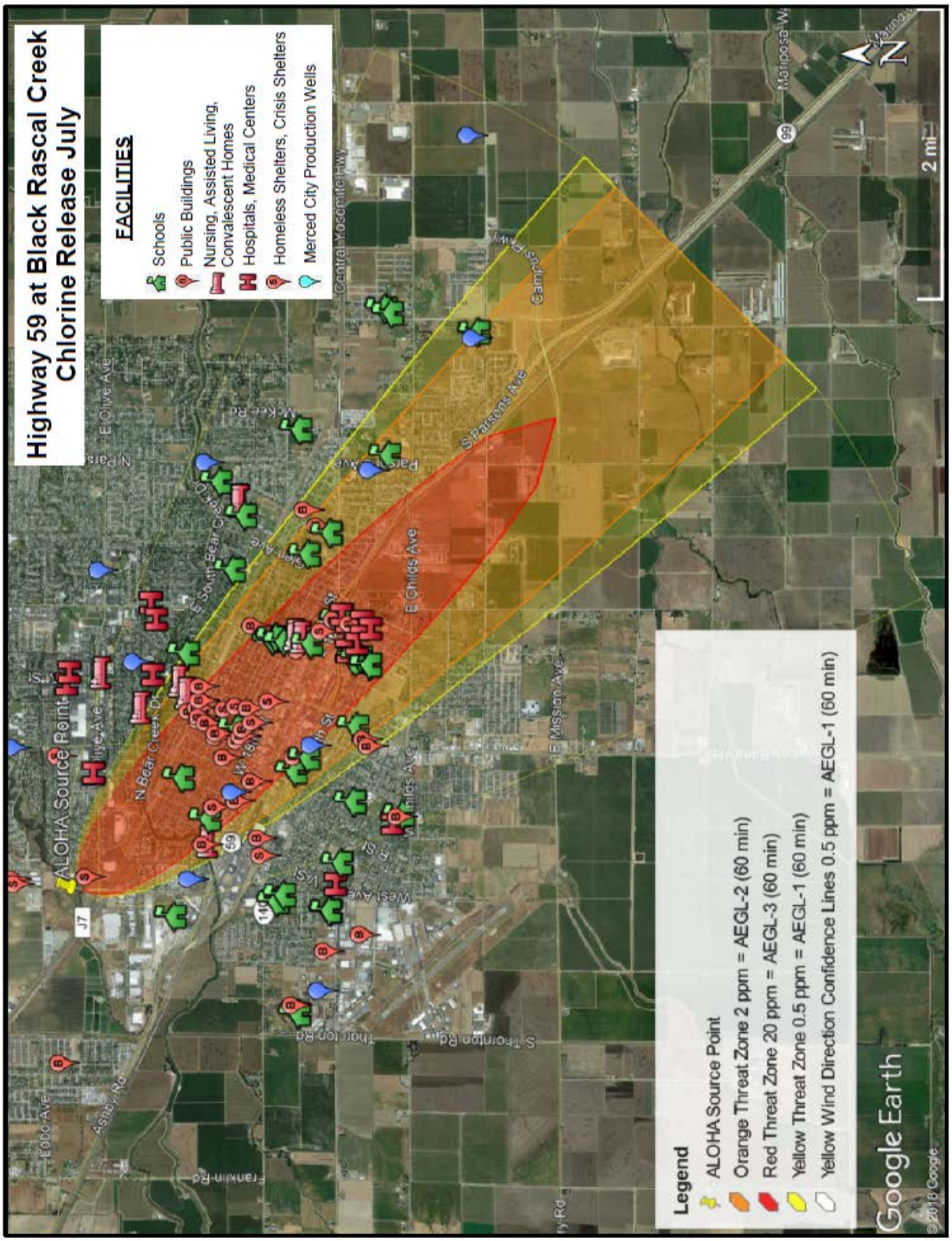
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 0.74 (unsheltered single storied)
  Time: July 15, 2018  1500 hours PDT (user specified)

CHEMICAL DATA:
  Chemical Name: CHLORINE
  CAS Number: 7782-50-5                  Molecular Weight: 70.91 g/mol
  AEGL-1 (60 min): 0.5 ppm   AEGL-2 (60 min): 2 ppm   AEGL-3 (60 min): 20 ppm
  IDLH: 10 ppm
  Ambient Boiling Point: -29.5° 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: 7.5 miles/hour from NW at 3 meters
  Ground Roughness: open country         Cloud Cover: 0 tenths
  Air Temperature: 79° F                 Stability Class: C
  No Inversion Height                    Relative Humidity: 0%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Non-flammable chemical is escaping from tank
  Tank Diameter: 6.33 feet               Tank Length: 48.83 feet
  Tank Volume: 11500 gallons
  Tank contains liquid                   Internal Temperature: 79° F
  Chemical Mass in Tank: 56.9 tons       Tank is 85% full
  Opening Length: 10 inches              Opening Width: 0.5 inches
  Opening is 1 inches from tank bottom
  Release Duration: 11 minutes
  Max Average Sustained Release Rate: 11,600 pounds/min
     (averaged over a minute or more)
  Total Amount Released: 113,800 pounds
  Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 4.6 miles --- (20 ppm = AEGL-3 [60 min])
  Orange: greater than 6 miles --- (2 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (0.5 ppm = AEGL-1 [60 min])
```

Toxic Threat Zone ALOHA® 5.4.7

```
Time: July 15, 2018  1500 hours PDT (user specified)

Chemical Name: CHLORINE

Wind: 7.5 miles/hour from NW at 3 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 4.6 miles --- (20 ppm = AEGL-3 [60 min])
  Orange: greater than 6 miles --- (2 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (0.5 ppm = AEGL-1 [60 min])
```






Highway 59 at Black Rascal Creek
Chlorine Release July
FACILITIES
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
Legend
ALOHA Source Point
Orange Threat Zone 2 ppm = AEGL-2 (60 min)
Red Threat Zone 20 ppm = AEGL-3 (60 min)
Yellow Threat Zone 0.5 ppm = AEGL-1 (60 min)
Yellow Wind Direction Confidence Lines 0.5 ppm = AEGL-1 (60 min)
ALOHA Source Point
Google Earth
2 mi

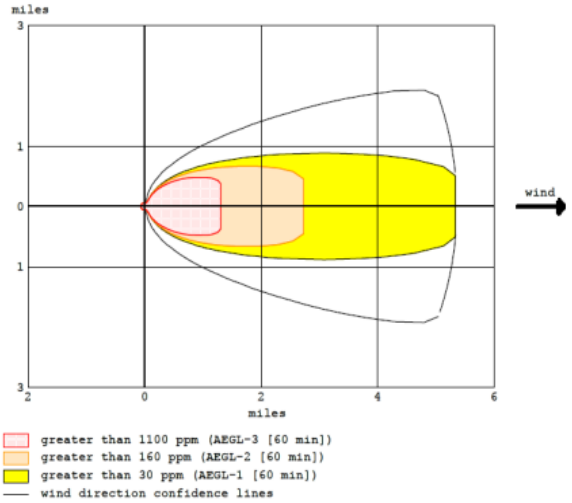
Scenario 3: Ammonia 10,000-Gallon Tanker – January

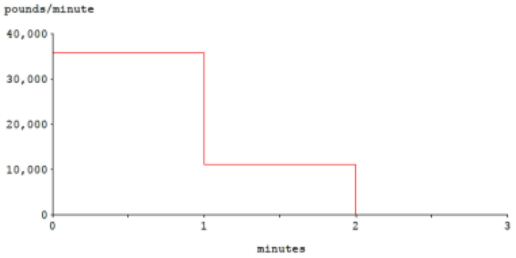
Text Summary ALOHA® 5.4.7

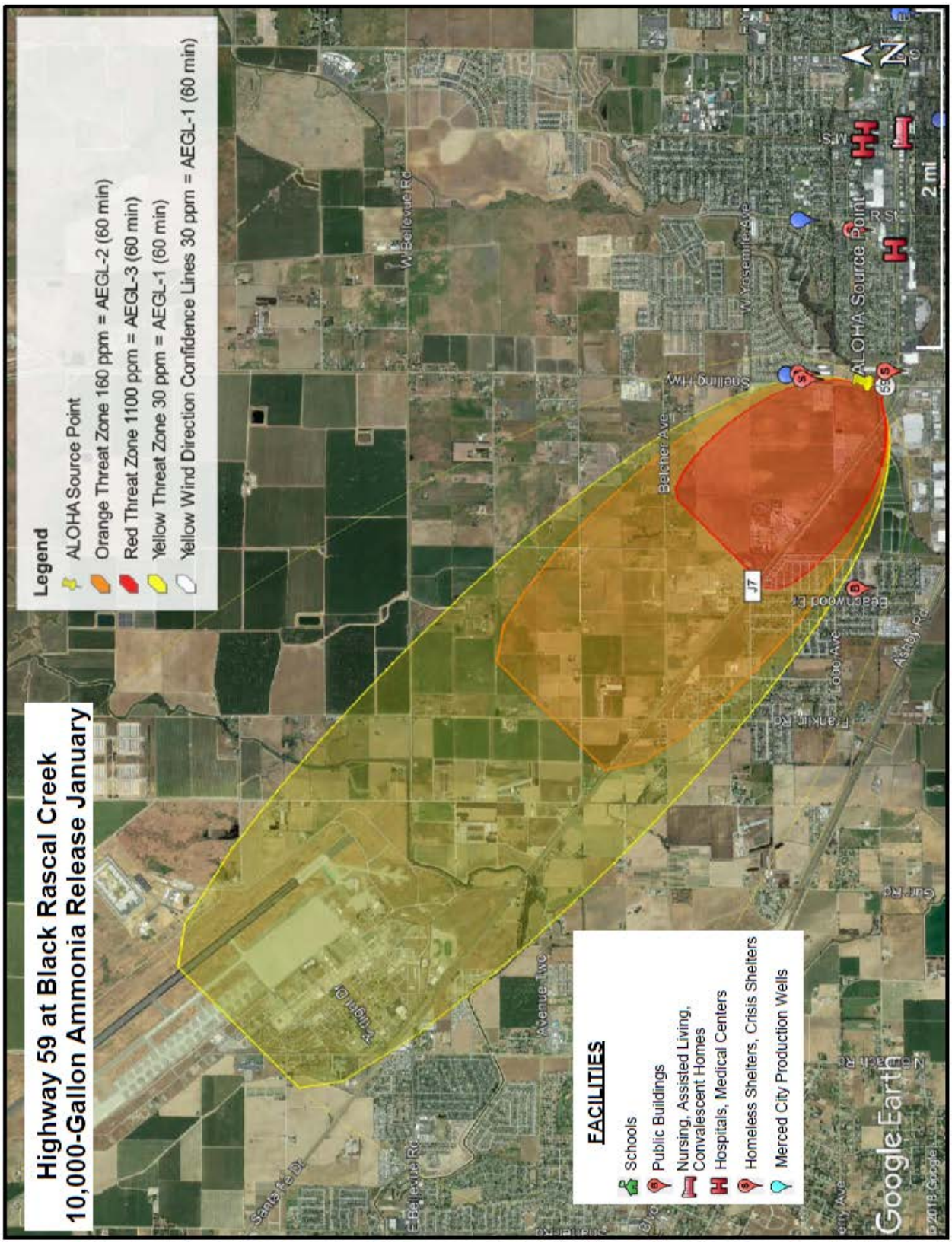
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 0.60 (unsheltered single storied)
  Time: January 15, 2018  0730 hours PST (user specified)

CHEMICAL DATA:
  Chemical Name: AMMONIA
  CAS Number: 7664-41-7                  Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm     UEL: 280000 ppm
  Ambient Boiling Point: -28.4° 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: 5.3 miles/hour from SE at 3 meters
  Ground Roughness: open country         Cloud Cover: 5 tenths
  Air Temperature: 47° F                 Stability Class: E
  No Inversion Height                    Relative Humidity: 0%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Flammable chemical escaping from tank (not burning)
  Tank Diameter: 7.03 feet               Tank Length: 36.5 feet
  Tank Volume: 10600 gallons
  Tank contains liquid                   Internal Temperature: 47° F
  Chemical Mass in Tank: 23.6 tons       Tank is 85% full
  Circular Opening Diameter: 6 inches
  Opening is 6 inches from tank bottom
  Note: RAILCAR predicts a stationary cloud or 'mist pool' will form.
  Model Run: traditional ALOHA tank
  Release Duration: 2 minutes
  Max Average Sustained Release Rate: 35,500 pounds/min
     (averaged over a minute or more)
  Total Amount Released: 46,571 pounds
  Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 1.3 miles --- (1100 ppm = AEGL-3 [60 min])
  Orange: 2.7 miles --- (160 ppm = AEGL-2 [60 min])
  Yellow: 5.3 miles --- (30 ppm = AEGL-1 [60 min])
```

Toxic Threat Zone ALOHA® 5.4.7

```
Time: January 15, 2018  0730 hours PST (user specified)

Chemical Name: AMMONIA

Wind: 5.3 miles/hour from SE at 3 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 1.3 miles --- (1100 ppm = AEGL-3 [60 min])
  Orange: 2.7 miles --- (160 ppm = AEGL-2 [60 min])
  Yellow: 5.3 miles --- (30 ppm = AEGL-1 [60 min])
```






Highway 59 at Black Rascal Creek
10,000-Gallon Ammonia Release January
Legend
ALOHA Source Point
Orange Threat Zone 160 ppm = AEGL-2 (60 min)
Red Threat Zone 1100 ppm = AEGL-3 (60 min)
Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
Yellow Wind Direction Confidence Lines 30 ppm = AEGL-1 (60 min)
FACILITIES
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
ALOHA Source Point
2 mi
Google Earth

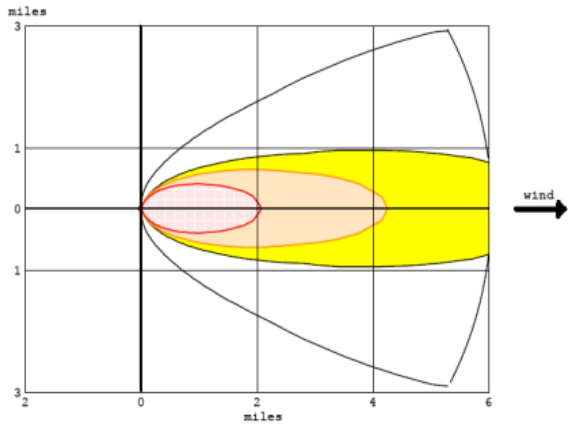
Scenario 4: Ammonia 10,000-Gallon Tanker – July

Text Summary ALOHA® 5.4.7

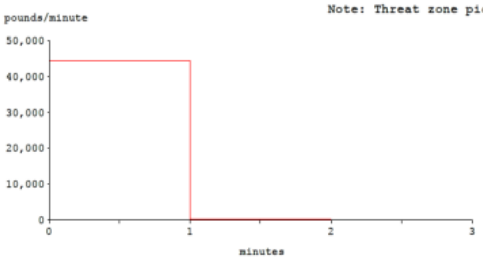
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 0.75 (unsheltered single storied)
  Time: July 18, 2018  1130 hours PDT (user specified)

CHEMICAL DATA:
  Chemical Name: AMMONIA
  CAS Number: 7664-41-7                  Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm     UEL: 280000 ppm
  Ambient Boiling Point: -28.4° 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: 7.5 miles/hour from NW at 3 meters
  Ground Roughness: open country         Cloud Cover: 0 tenths
  Air Temperature: 79° F                 Stability Class: B
  No Inversion Height                    Relative Humidity: 5%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Flammable chemical escaping from tank (not burning)
  Tank Diameter: 7.03 feet               Tank Length: 36.5 feet
  Tank Volume: 10600 gallons
  Tank contains liquid                   Internal Temperature: 79° F
  Chemical Mass in Tank: 22.6 tons       Tank is 85% full
  Circular Opening Diameter: 6 inches
  Opening is 6 inches from tank bottom
  Note: RAILCAR predicts a stationary cloud or 'mist pool' will form.
  Model Run: traditional ALOHA tank
  Release Duration: 2 minutes
  Max Average Sustained Release Rate: 44,300 pounds/min
     (averaged over a minute or more)
  Total Amount Released: 44,597 pounds
  Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 2.1 miles --- (1100 ppm = AEGL-3 [60 min])
  Orange: 4.3 miles --- (160 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (30 ppm = AEGL-1 [60 min])
```

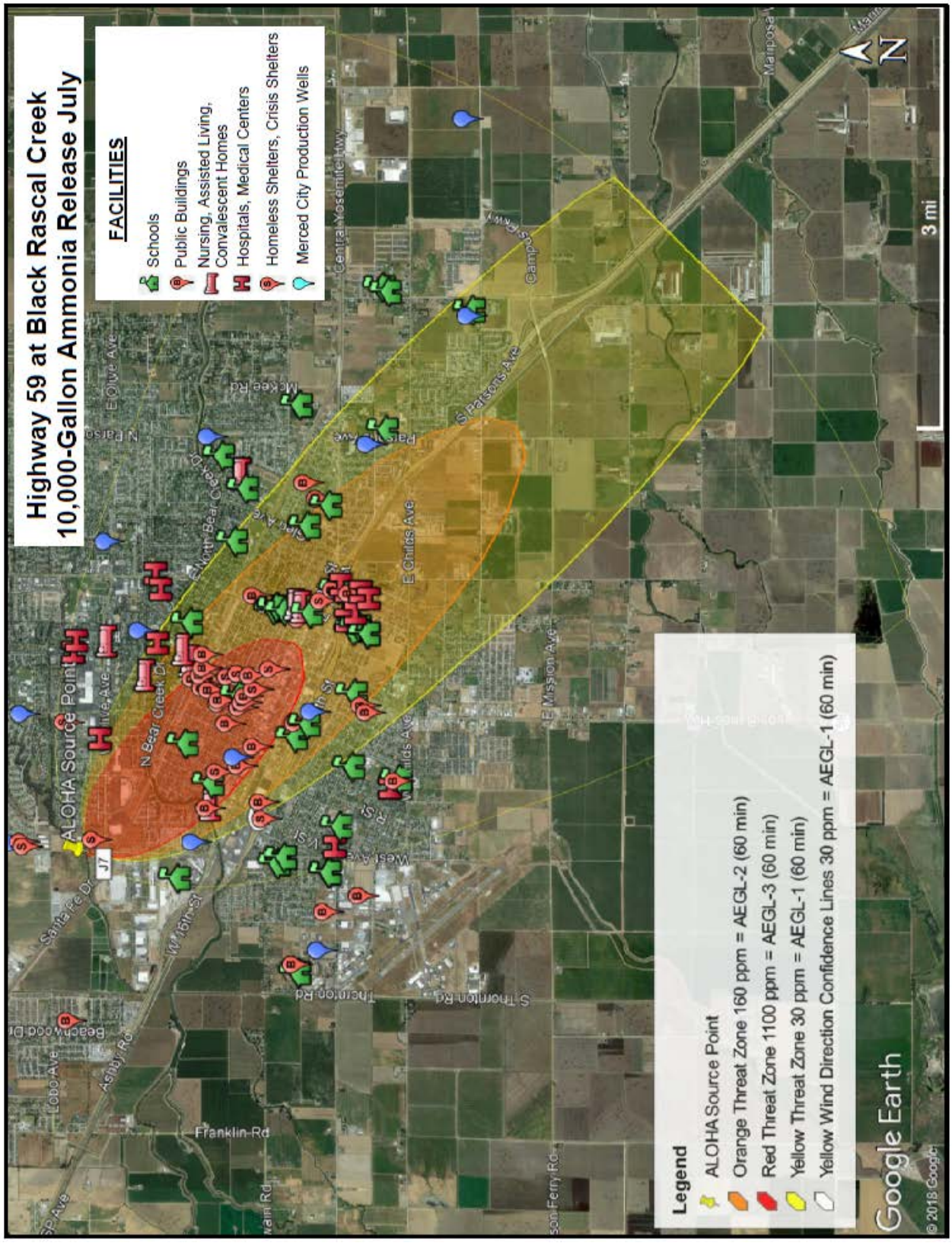
Toxic Threat Zone ALOHA® 5.4.7

```
Time: July 18, 2018  1130 hours PDT (user specified)

Chemical Name: AMMONIA

Wind: 7.5 miles/hour from NW at 3 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 2.1 miles --- (1100 ppm = AEGL-3 [60 min])
  Orange: 4.3 miles --- (160 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (30 ppm = AEGL-1 [60 min])
```



Note: Threat zone picture is truncated at the 6 mile limit.




Highway 59 at Black Rascal Creek
10,000-Gallon Ammonia Release July
FACILITIES
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
Legend
ALOHA Source Point
Orange Threat Zone 160 ppm = AEGL-2 (60 min)
Red Threat Zone 1100 ppm = AEGL-3 (60 min)
Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
Yellow Wind Direction Confidence Lines 30 ppm = AEGL-1 (60 min)
ALOHA Source Point
3 mi
N
Google Earth
© 2018 Google

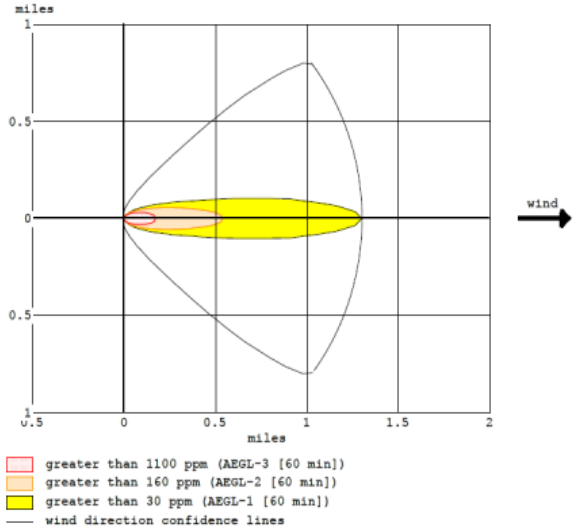
Scenario 5: Ammonia 1,000-Gallon Nurse Tank – January

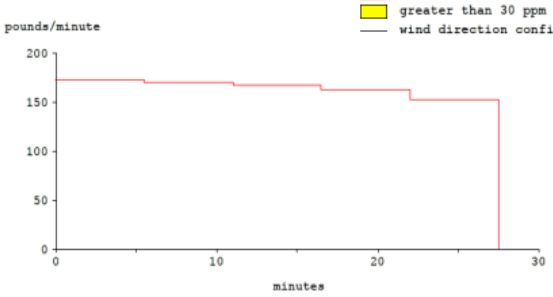
Text Summary ALOHA® 5.4.7

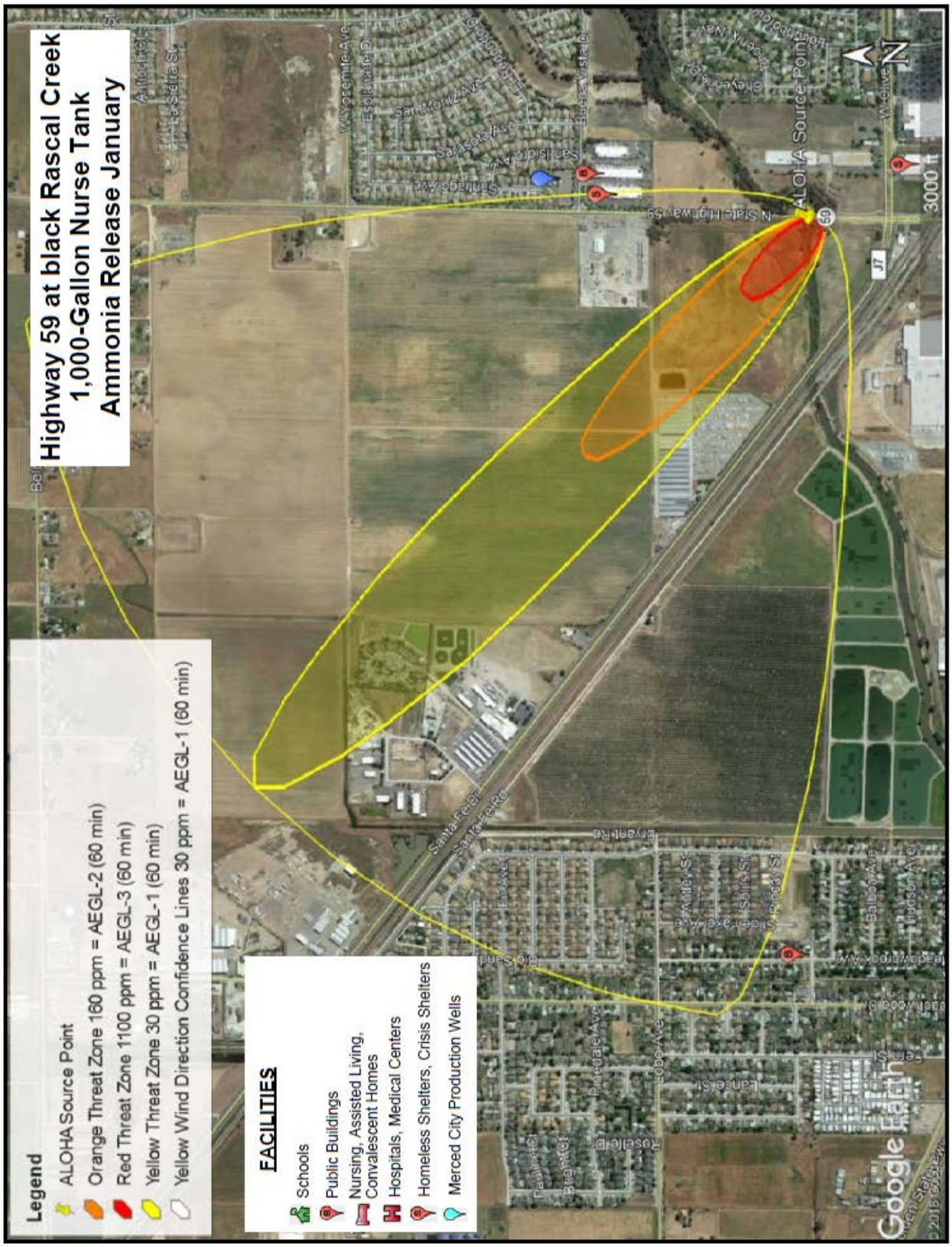
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 0.54 (unsheltered single storied)
  Time: January 15, 2018  0800 hours PST (user specified)

CHEMICAL DATA:
  Chemical Name: AMMONIA
  CAS Number: 7664-41-7                  Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm     UEL: 280000 ppm
  Ambient Boiling Point: -28.4° 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: 5.3 miles/hour from SE at 10 meters
  Ground Roughness: open country         Cloud Cover: 5 tenths
  Air Temperature: 47° F                 Stability Class: C
  No Inversion Height                    Relative Humidity: 50%

SOURCE STRENGTH:
  Leak from short pipe or valve in horizontal cylindrical tank
  Flammable chemical escaping from tank (not burning)
  Tank Diameter: 3.66 feet               Tank Length: 13 feet
  Tank Volume: 1,023 gallons
  Tank contains liquid                   Internal Temperature: 47° F
  Chemical Mass in Tank: 2.28 tons       Tank is 85% full
  Circular Opening Diameter: 3/4 inches
  Opening is 0 feet from tank bottom
  Note: RAILCAR predicts a stationary cloud or 'mist pool' will form.
  Model Run: traditional ALOHA tank
  Release Duration: 28 minutes
  Max Average Sustained Release Rate: 173 pounds/min
     (averaged over a minute or more)
  Total Amount Released: 4,560 pounds
  Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 300 yards --- (1100 ppm = AEGL-3 [60 min])
  Orange: 951 yards --- (160 ppm = AEGL-2 [60 min])
  Yellow: 1.3 miles --- (30 ppm = AEGL-1 [60 min])
```

Toxic Threat Zone ALOHA® 5.4.7

```
Time: January 15, 2018  0800 hours PST (user specified)

Chemical Name: AMMONIA

Wind: 5.3 miles/hour from SE at 10 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 300 yards --- (1100 ppm = AEGL-3 [60 min])
  Orange: 951 yards --- (160 ppm = AEGL-2 [60 min])
  Yellow: 1.3 miles --- (30 ppm = AEGL-1 [60 min])
```






Highway 59 at black Rascal Creek
1,000-Gallon Nurse Tank
Ammonia Release January
Legend
ALOHA Source Point
Orange Threat Zone 160 ppm = AEGL-2 (60 min)
Red Threat Zone 1100 ppm = AEGL-3 (60 min)
Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
Yellow Wind Direction Confidence Lines 30 ppm = AEGL-1 (60 min)
FACILITIES
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
ALOHA Source Point
3000 ft
N
Google Earth

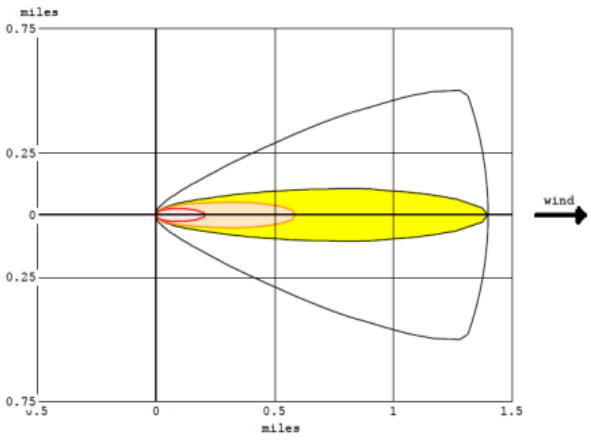
Scenario 6: Ammonia 1,000-Gallon Nurse Tank – July

Text Summary ALOHA® 5.4.7

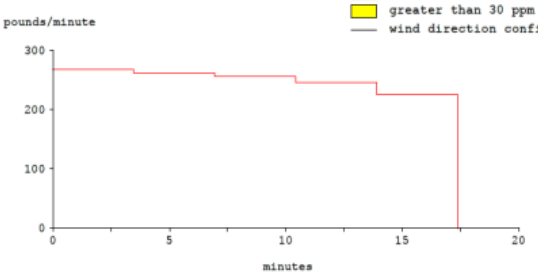
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 0.63 (unsheltered single storied)
  Time: July 15, 2018  1500 hours PDT (user specified)

CHEMICAL DATA:
  Chemical Name: AMMONIA
  CAS Number: 7664-41-7                  Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm     UEL: 280000 ppm
  Ambient Boiling Point: -28.4° 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: 7.5 miles/hour from NW at 10 meters
  Ground Roughness: open country         Cloud Cover: 0 tenths
  Air Temperature: 79° F                 Stability Class: C
  No Inversion Height                    Relative Humidity: 0%

SOURCE STRENGTH:
  Leak from short pipe or valve in horizontal cylindrical tank
  Flammable chemical escaping from tank (not burning)
  Tank Diameter: 3.66 feet               Tank Length: 13 feet
  Tank Volume: 1,023 gallons
  Tank contains liquid                   Internal Temperature: 79° F
  Chemical Mass in Tank: 2.18 tons       Tank is 85% full
  Circular Opening Diameter: 3/4 inches
  Opening is 0 feet from tank bottom
  Release Duration: 17 minutes
  Max Average Sustained Release Rate: 267 pounds/min
     (averaged over a minute or more)
  Total Amount Released: 4,360 pounds
  Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 364 yards --- (1100 ppm = AEGL-3 [60 min])
  Orange: 1035 yards --- (160 ppm = AEGL-2 [60 min])
  Yellow: 1.4 miles --- (30 ppm = AEGL-1 [60 min])
```

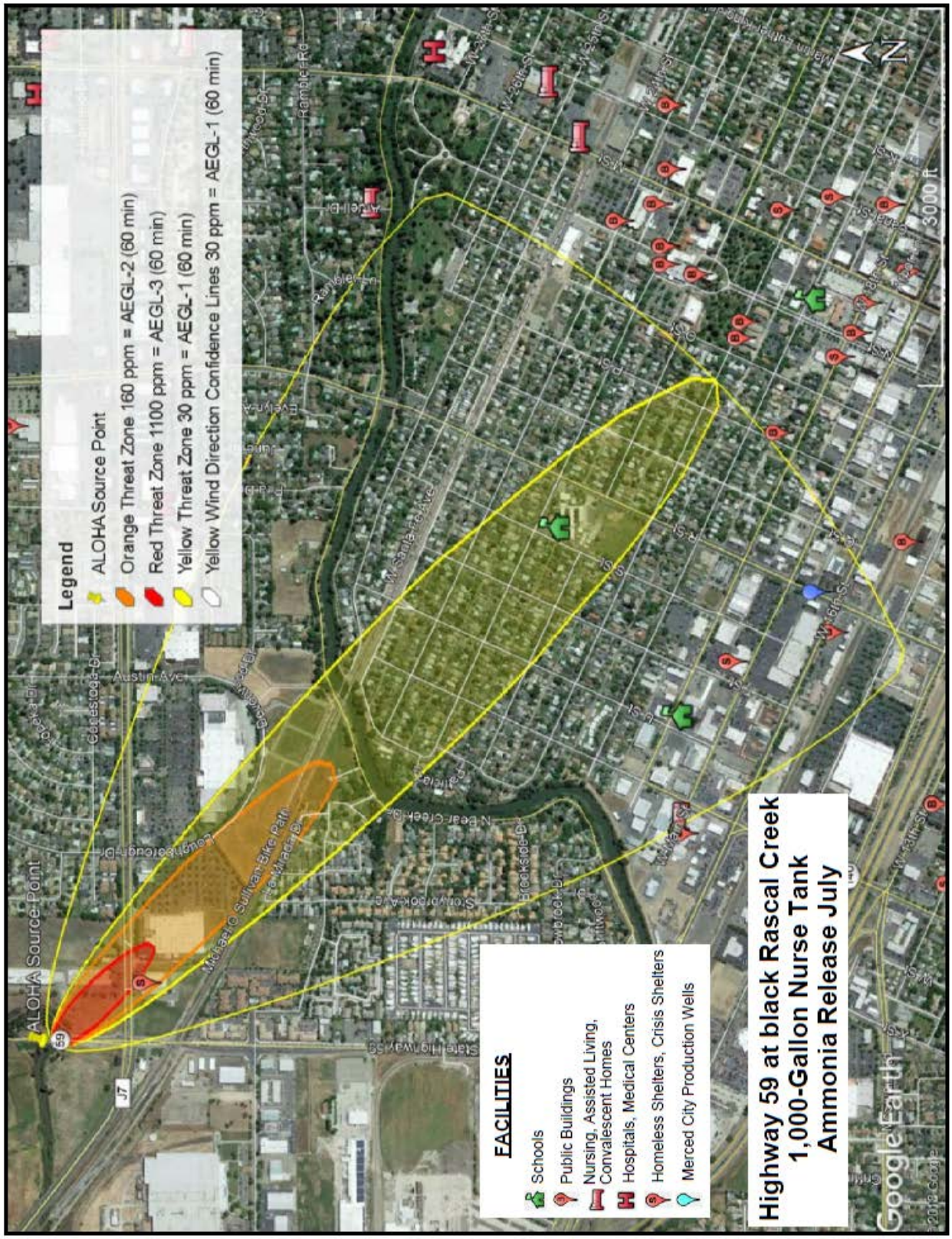
Toxic Threat Zone ALOHA® 5.4.7

```
Time: July 15, 2018  1500 hours PDT (user specified)

Chemical Name: AMMONIA

Wind: 7.5 miles/hour from NW at 10 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 364 yards --- (1100 ppm = AEGL-3 [60 min])
  Orange: 1035 yards --- (160 ppm = AEGL-2 [60 min])
  Yellow: 1.4 miles --- (30 ppm = AEGL-1 [60 min])
```



greater than 1100 ppm (AEGL-3 [60 min])
greater than 160 ppm (AEGL-2 [60 min])
greater than 30 ppm (AEGL-1 [60 min])
wind direction confidence lines




Legend
ALOHA Source Point
Orange Threat Zone 160 ppm = AEGL-2 (60 min)
Red Threat Zone 1100 ppm = AEGL-3 (60 min)
Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
Yellow Wind Direction Confidence Lines 30 ppm = AEGL-1 (60 min)
FACILITIES
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
Highway 59 at black Rascal Creek
1,000-Gallon Nurse Tank
Ammonia Release July
ALOHA Source Point
N
3000 ft
Google Earth

4.1.3 Highway 99 at Bear Creek

The six scenarios for plume analysis at this location are for each of the COCs (chlorine-2 and ammonia-4) for the months of January and July.

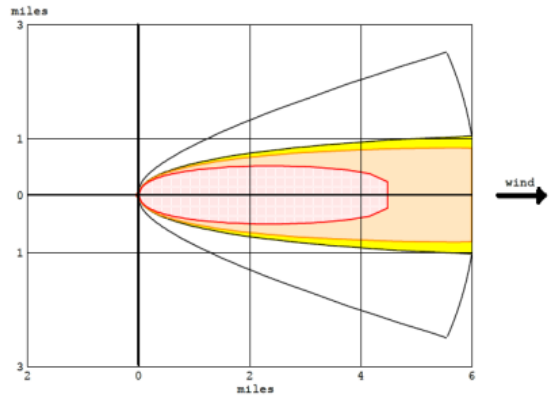
Scenario 1: Chlorine – January

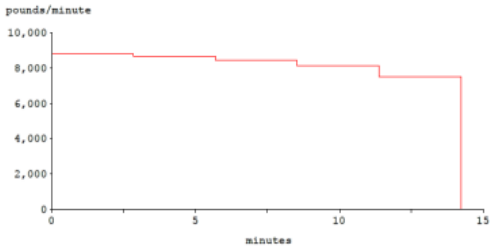
Text Summary ALOHA® 5.4.7

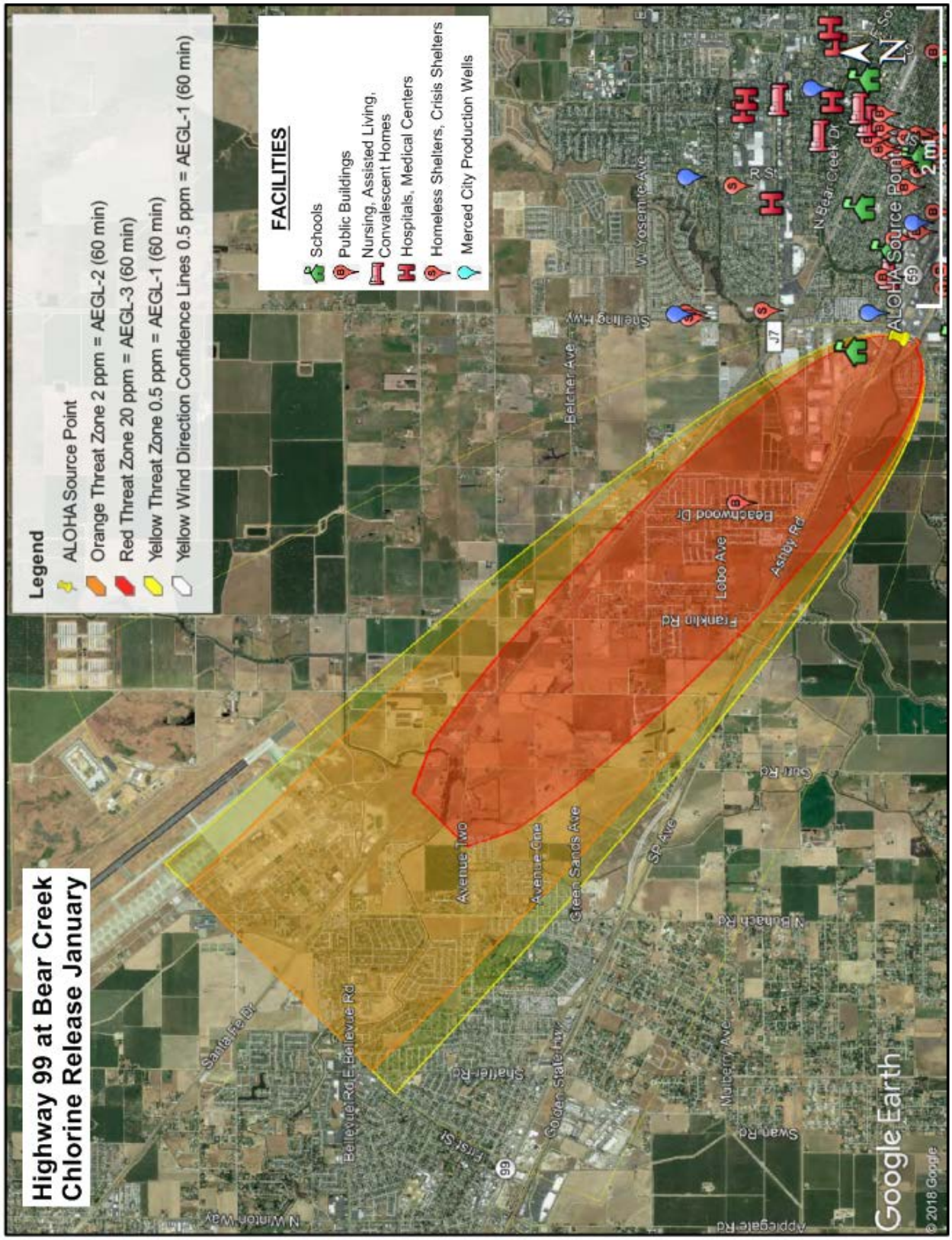
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 0.60 (unsheltered single storied)
  Time: January 15, 2018  0730 hours PST (user specified)

CHEMICAL DATA:
  Chemical Name: CHLORINE
  CAS Number: 7782-50-5                Molecular Weight: 70.91 g/mol
  AEGL-1 (60 min): 0.5 ppm   AEGL-2 (60 min): 2 ppm   AEGL-3 (60 min): 20 ppm
  IDLH: 10 ppm
  Ambient Boiling Point: -29.5° 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: 5.3 miles/hour from SE at 3 meters
  Ground Roughness: open country       Cloud Cover: 5 tenths
  Air Temperature: 47° F               Stability Class: E
  No Inversion Height                  Relative Humidity: 0%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Non-flammable chemical is escaping from tank
  Tank Diameter: 6.33 feet             Tank Length: 48.83 feet
  Tank Volume: 11500 gallons
  Tank contains liquid                 Internal Temperature: 47° F
  Chemical Mass in Tank: 59.0 tons     Tank is 85% full
  Opening Length: 10 inches            Opening Width: 0.5 inches
  Opening is 1 inches from tank bottom
  Note: RAILCAR predicts a stationary cloud or 'mist pool' will form.
  Model Run: traditional ALOHA tank
  Release Duration: 14 minutes
  Max Average Sustained Release Rate: 8,800 pounds/min
     (averaged over a minute or more)
  Total Amount Released: 118,000 pounds
  Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 4.5 miles --- (20 ppm = AEGL-3 [60 min])
  Orange: greater than 6 miles --- (2 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (0.5 ppm = AEGL-1 [60 min])
```

Toxic Threat Zone ALOHA® 5.4.7

```
Time: January 15, 2018  0730 hours PST (user specified)

Chemical Name: CHLORINE

Wind: 5.3 miles/hour from SE at 3 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 4.5 miles --- (20 ppm = AEGL-3 [60 min])
  Orange: greater than 6 miles --- (2 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (0.5 ppm = AEGL-1 [60 min])
```






Highway 99 at Bear Creek
Chlorine Release January
Legend
ALOHA Source Point
Orange Threat Zone 2 ppm = AEGL-2 (60 min)
Red Threat Zone 20 ppm = AEGL-3 (60 min)
Yellow Threat Zone 0.5 ppm = AEGL-1 (60 min)
Yellow Wind Direction Confidence Lines 0.5 ppm = AEGL-1 (60 min)
FACILITIES
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
ALOHA Source Point
2 mi
Google Earth
© 2018 Google

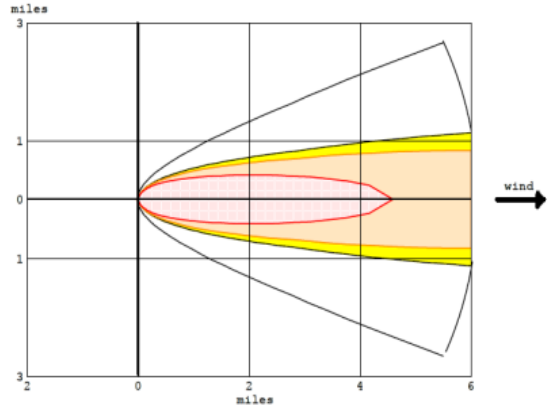
Scenario 2: Chlorine – July

Text Summary ALOHA® 5.4.7

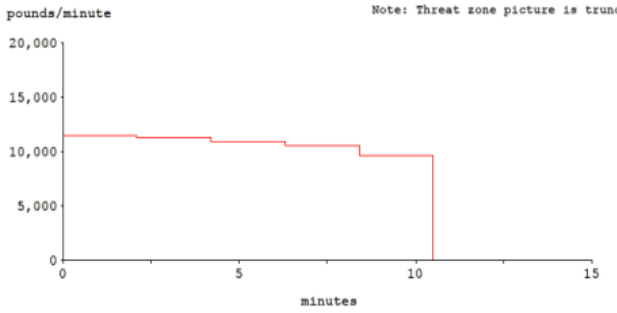
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 0.74 (unsheltered single storied)
  Time: July 15, 2018  1500 hours PDT (user specified)

CHEMICAL DATA:
  Chemical Name: CHLORINE
  CAS Number: 7782-50-5                  Molecular Weight: 70.91 g/mol
  AEGL-1 (60 min): 0.5 ppm   AEGL-2 (60 min): 2 ppm   AEGL-3 (60 min): 20 ppm
  IDLH: 10 ppm
  Ambient Boiling Point: -29.5° 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: 7.5 miles/hour from NW at 3 meters
  Ground Roughness: open country         Cloud Cover: 0 tenths
  Air Temperature: 79° F                 Stability Class: C
  No Inversion Height                    Relative Humidity: 0%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Non-flammable chemical is escaping from tank
  Tank Diameter: 6.33 feet               Tank Length: 48.83 feet
  Tank Volume: 11500 gallons
  Tank contains liquid                   Internal Temperature: 79° F
  Chemical Mass in Tank: 56.9 tons       Tank is 85% full
  Opening Length: 10 inches              Opening Width: 0.5 inches
  Opening is 1 inches from tank bottom
  Release Duration: 11 minutes
  Max Average Sustained Release Rate: 11,600 pounds/min
     (averaged over a minute or more)
  Total Amount Released: 113,800 pounds
  Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 4.6 miles --- (20 ppm = AEGL-3 [60 min])
  Orange: greater than 6 miles --- (2 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (0.5 ppm = AEGL-1 [60 min])
```

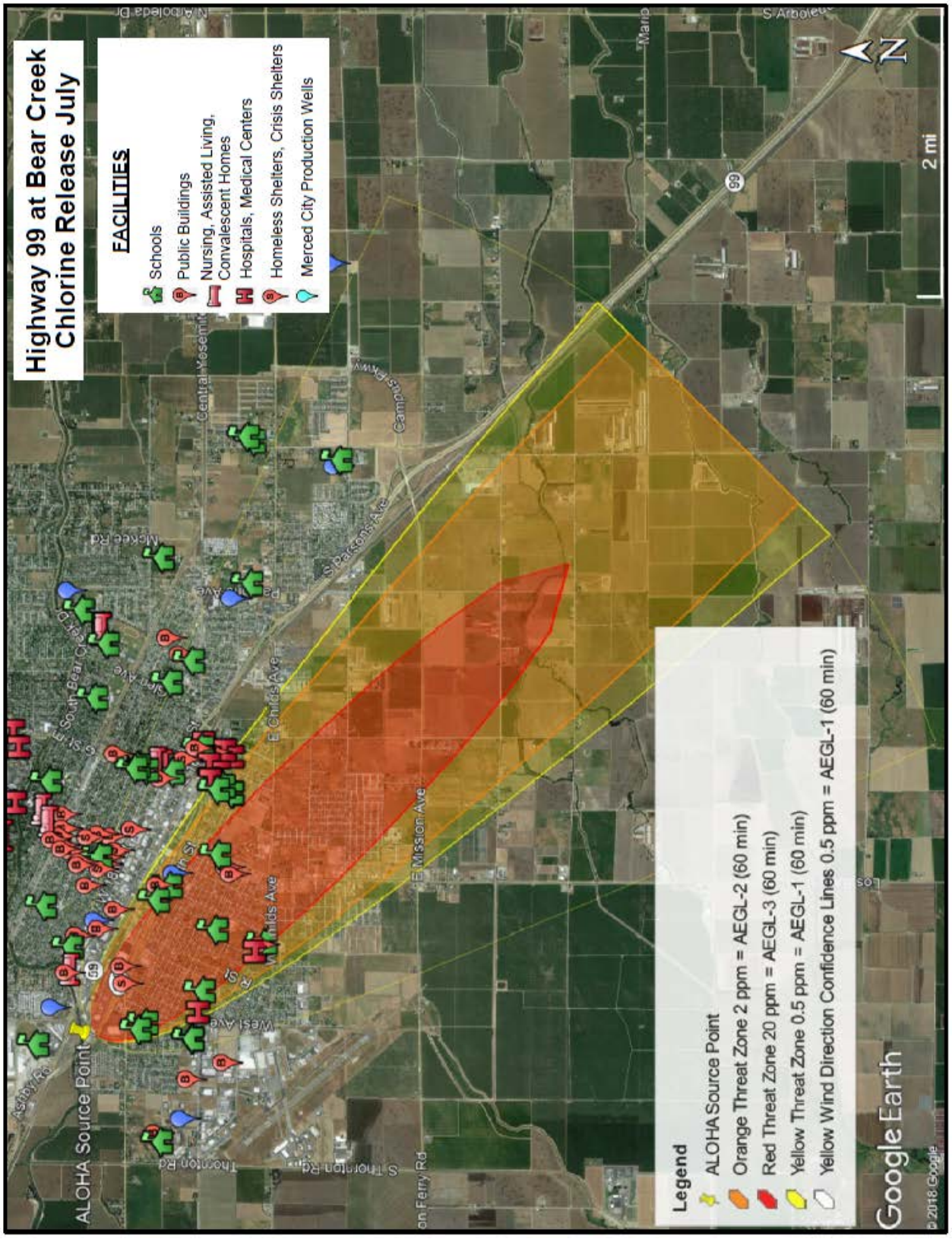
Toxic Threat Zone ALOHA® 5.4.7

```
Time: July 15, 2018  1500 hours PDT (user specified)

Chemical Name: CHLORINE

Wind: 7.5 miles/hour from NW at 3 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 4.6 miles --- (20 ppm = AEGL-3 [60 min])
  Orange: greater than 6 miles --- (2 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (0.5 ppm = AEGL-1 [60 min])
```



greater than 20 ppm (AEGL-3 [60 min])
greater than 2 ppm (AEGL-2 [60 min])
greater than 0.5 ppm (AEGL-1 [60 min])
wind direction confidence lines
Note: Threat zone picture is truncated at the 6 mile limit.




Highway 99 at Bear Creek
Chlorine Release July
FACILITIES
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
Legend
ALOHA Source Point
Orange Threat Zone 2 ppm = AEGL-2 (60 min)
Red Threat Zone 20 ppm = AEGL-3 (60 min)
Yellow Threat Zone 0.5 ppm = AEGL-1 (60 min)
Yellow Wind Direction Confidence Lines 0.5 ppm = AEGL-1 (60 min)
ALOHA Source Point
2 mi
Google Earth
© 2018 Google

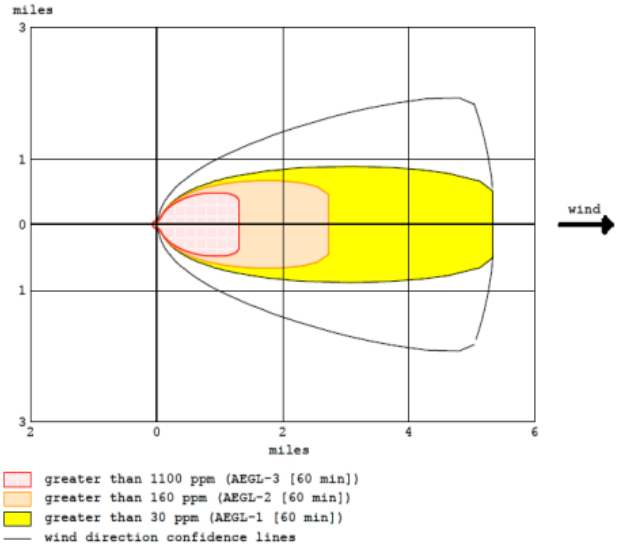
Scenario 3: Ammonia 10,000-Gallon Tanker– January

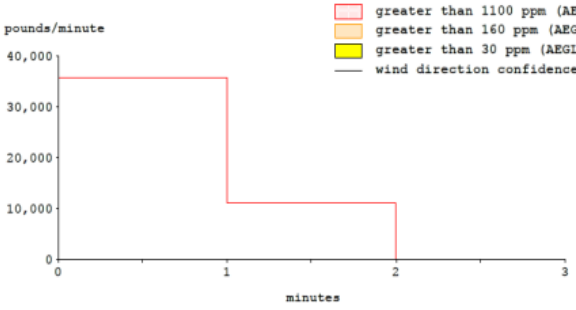
Text Summary ALOHA® 5.4.7

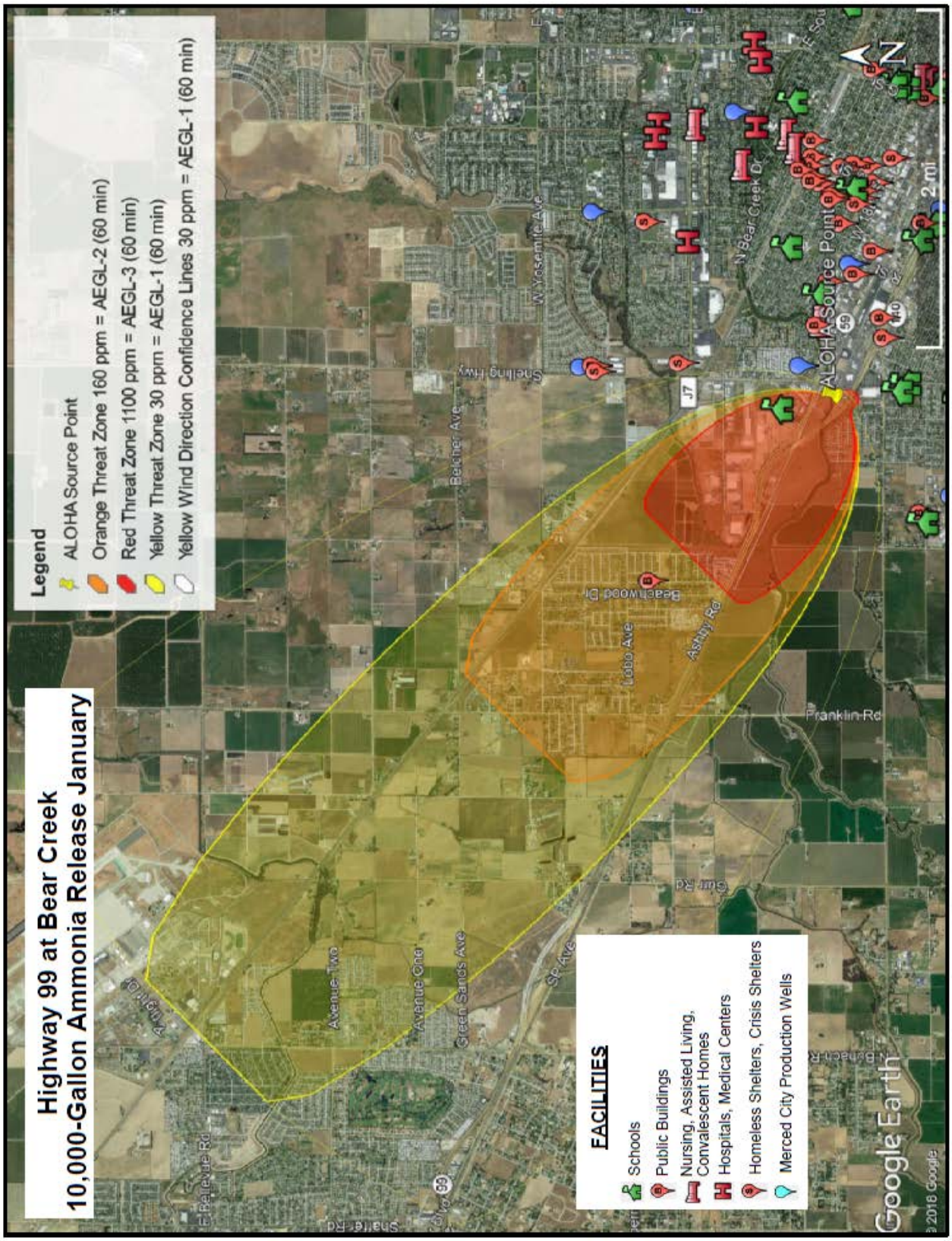
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 0.60 (unsheltered single storied)
  Time: January 15, 2018  0730 hours PST (user specified)

CHEMICAL DATA:
  Chemical Name: AMMONIA
  CAS Number: 7664-41-7                  Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm     UEL: 280000 ppm
  Ambient Boiling Point: -28.4° 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: 5.3 miles/hour from SE at 3 meters
  Ground Roughness: open country         Cloud Cover: 5 tenths
  Air Temperature: 47° F                 Stability Class: E
  No Inversion Height                    Relative Humidity: 0%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Flammable chemical escaping from tank (not burning)
  Tank Diameter: 7.03 feet               Tank Length: 36.5 feet
  Tank Volume: 10600 gallons
  Tank contains liquid                   Internal Temperature: 47° F
  Chemical Mass in Tank: 23.6 tons       Tank is 85% full
  Circular Opening Diameter: 6 inches
  Opening is 6 inches from tank bottom
  Note: RAILCAR predicts a stationary cloud or 'mist pool' will form.
  Model Run: traditional ALOHA tank
  Release Duration: 2 minutes
  Max Average Sustained Release Rate: 35,500 pounds/min
     (averaged over a minute or more)
  Total Amount Released: 46,571 pounds
  Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 1.3 miles --- (1100 ppm = AEGL-3 [60 min])
  Orange: 2.7 miles --- (160 ppm = AEGL-2 [60 min])
  Yellow: 5.3 miles --- (30 ppm = AEGL-1 [60 min])
```

Toxic Threat Zone ALOHA® 5.4.7

```
Time: January 15, 2018  0730 hours PST (user specified)

Chemical Name: AMMONIA

Wind: 5.3 miles/hour from SE at 3 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 1.3 miles --- (1100 ppm = AEGL-3 [60 min])
  Orange: 2.7 miles --- (160 ppm = AEGL-2 [60 min])
  Yellow: 5.3 miles --- (30 ppm = AEGL-1 [60 min])
```






Highway 99 at Bear Creek
10,000-Gallon Ammonia Release January
Legend
ALOHA Source Point
Orange Threat Zone 160 ppm = AEGL-2 (60 min)
Red Threat Zone 1100 ppm = AEGL-3 (60 min)
Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
Yellow Wind Direction Confidence Lines 30 ppm = AEGL-1 (60 min)
FACILITIES
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
ALOHA Source Point
Shelling Hwy
Belcher Ave
W Yosemite Ave
N Bear Creek Dr
Beachwood Dr
Lobo Ave
Ashby Rd
Franklin Rd
Avenue Two
Avenue One
Green Sands Ave
Shaffer Rd
Google Earth
2 mi

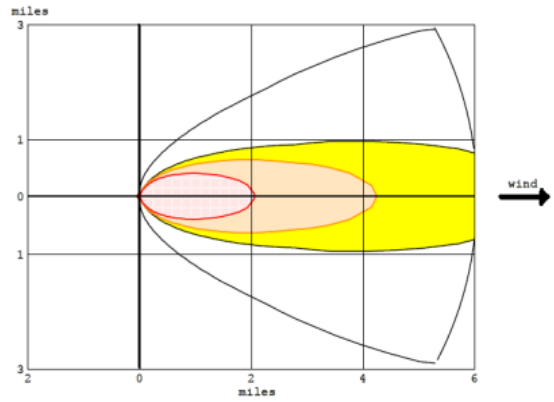
Scenario 4: Ammonia 10,000-Gallon Tanker – July

Text Summary ALOHA® 5.4.7

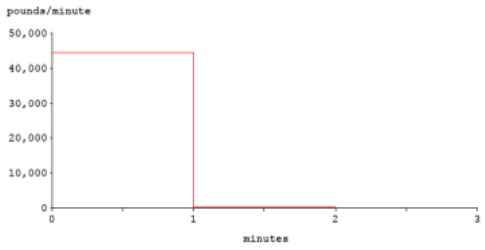
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 0.75 (unsheltered single storied)
  Time: July 18, 2018  1130 hours PDT (user specified)

CHEMICAL DATA:
  Chemical Name: AMMONIA
  CAS Number: 7664-41-7                  Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm       LEL: 150000 ppm     UEL: 280000 ppm
  Ambient Boiling Point: -28.4° 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: 7.5 miles/hour from NW at 3 meters
  Ground Roughness: open country         Cloud Cover: 0 tenths
  Air Temperature: 79° F                 Stability Class: B
  No Inversion Height                    Relative Humidity: 5%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Flammable chemical escaping from tank (not burning)
  Tank Diameter: 7.03 feet               Tank Length: 36.5 feet
  Tank Volume: 10600 gallons
  Tank contains liquid                   Internal Temperature: 79° F
  Chemical Mass in Tank: 22.6 tons       Tank is 85% full
  Circular Opening Diameter: 6 inches
  Opening is 6 inches from tank bottom
  Note: RAILCAR predicts a stationary cloud or 'mist pool' will form.
  Model Run: traditional ALOHA tank
  Release Duration: 2 minutes
  Max Average Sustained Release Rate: 44,300 pounds/min
     (averaged over a minute or more)
  Total Amount Released: 44,597 pounds
  Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 2.1 miles --- (1100 ppm = AEGL-3 [60 min])
  Orange: 4.3 miles --- (160 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (30 ppm = AEGL-1 [60 min])
```

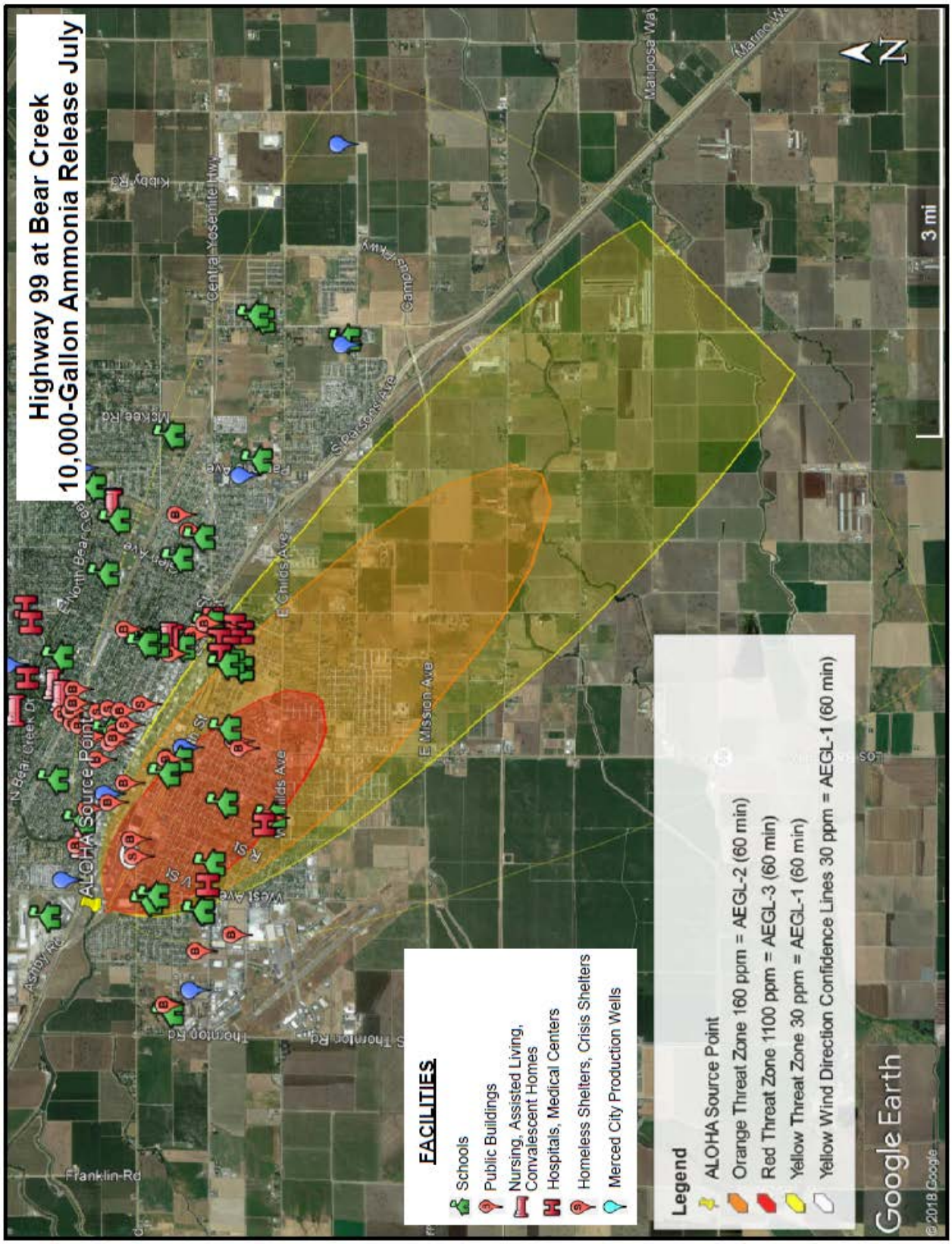
Toxic Threat Zone ALOHA® 5.4.7

```
Time: July 18, 2018  1130 hours PDT (user specified)

Chemical Name: AMMONIA

Wind: 7.5 miles/hour from NW at 3 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 2.1 miles --- (1100 ppm = AEGL-3 [60 min])
  Orange: 4.3 miles --- (160 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (30 ppm = AEGL-1 [60 min])
```



greater than 1100 ppm (AEGL-3 [60 min])
greater than 160 ppm (AEGL-2 [60 min])
greater than 30 ppm (AEGL-1 [60 min])
wind direction confidence lines
Note: Threat zone picture is truncated at the 6 mile limit.




Highway 99 at Bear Creek
10,000-Gallon Ammonia Release July
FACILITIES
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
Legend
ALOHA Source Point
Orange Threat Zone 160 ppm = AEGL-2 (60 min)
Red Threat Zone 1100 ppm = AEGL-3 (60 min)
Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
Yellow Wind Direction Confidence Lines 30 ppm = AEGL-1 (60 min)
Google Earth
3 mi
N
ALOHA Source Point
Franklin Rd
Thornton Rd
West Ave
E Mission Ave
E Childs Ave
S Parsons Ave
Mariposa Way
Marino Way
Central Yosemite Hwy
Campus Pkwy
Kibby Rd
Ashby Rd
N Bear Creek Dr
E North Bear Creek
Clear Ave
Mckee Rd
Pa
Ave
Childs Ave
Mariposa Way
Los

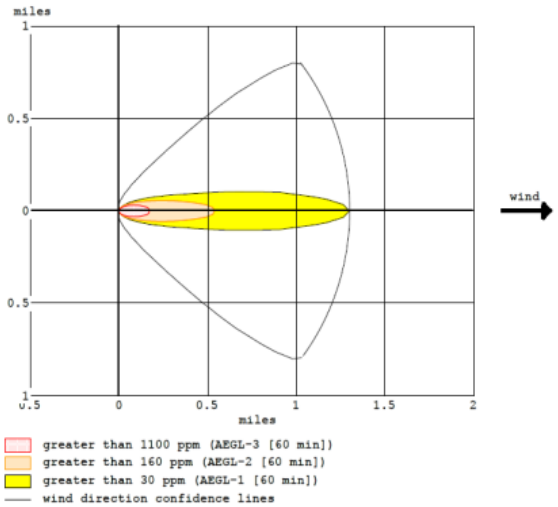
Scenario 5: Ammonia 1,000-Gallon Nurse Tank– January

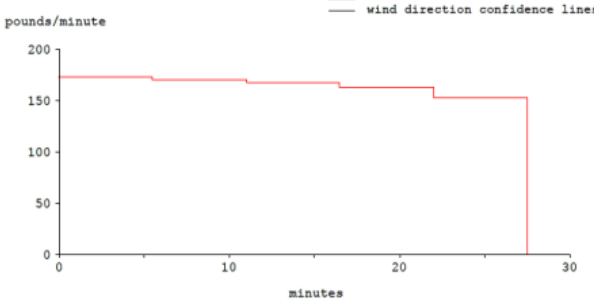
Text Summary ALOHA® 5.4.7

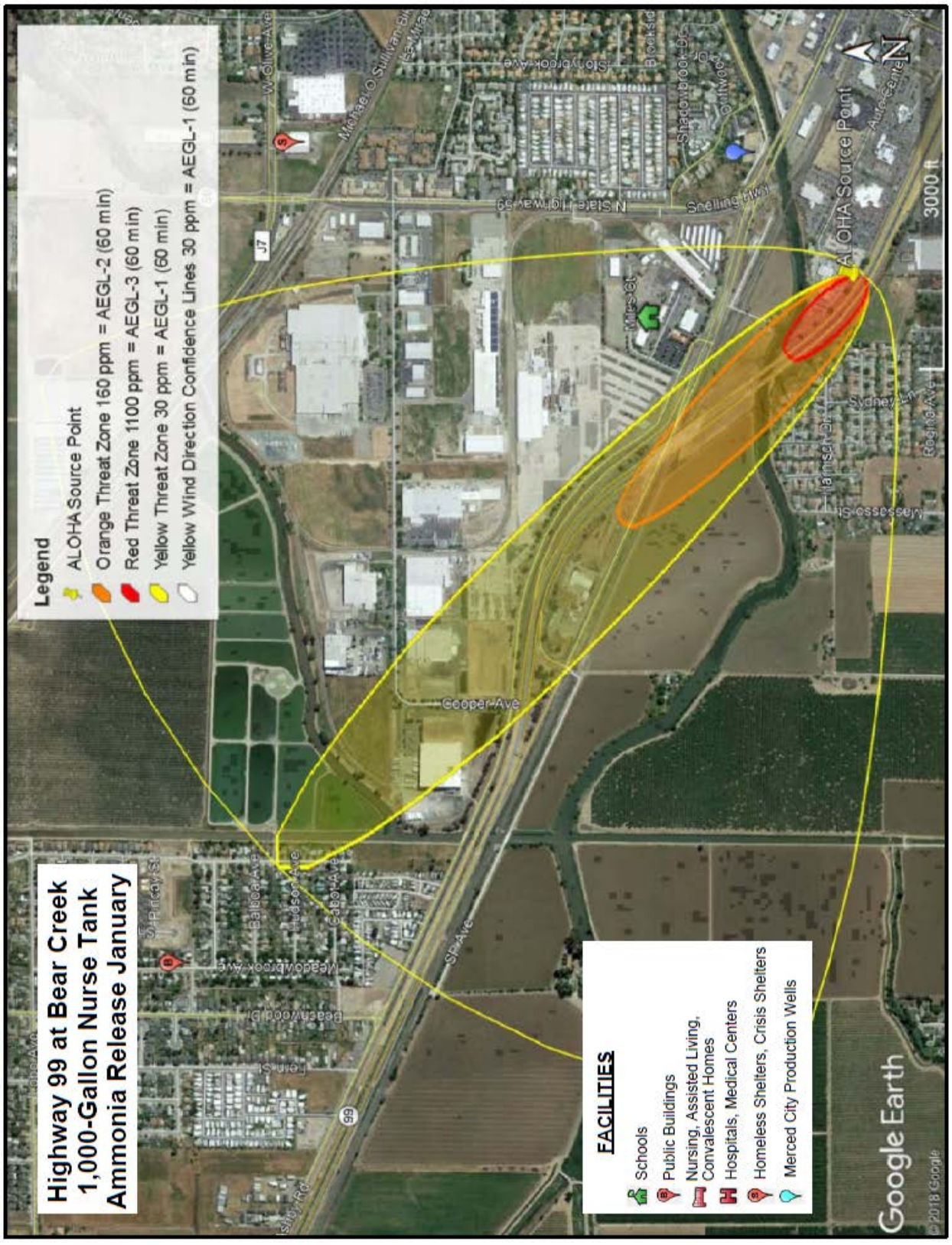
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 0.54 (unsheltered single storied)
  Time: January 15, 2018  0800 hours PST (user specified)

CHEMICAL DATA:
  Chemical Name: AMMONIA
  CAS Number: 7664-41-7                 Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm    UEL: 280000 ppm
  Ambient Boiling Point: -28.4° 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: 5.3 miles/hour from SE at 10 meters
  Ground Roughness: open country        Cloud Cover: 5 tenths
  Air Temperature: 47° F                Stability Class: C
  No Inversion Height                   Relative Humidity: 50%

SOURCE STRENGTH:
  Leak from short pipe or valve in horizontal cylindrical tank
  Flammable chemical escaping from tank (not burning)
  Tank Diameter: 3.66 feet              Tank Length: 13 feet
  Tank Volume: 1,023 gallons
  Tank contains liquid                  Internal Temperature: 47° F
  Chemical Mass in Tank: 2.28 tons      Tank is 85% full
  Circular Opening Diameter: 3/4 inches
  Opening is 0 feet from tank bottom
  Note: RAILCAR predicts a stationary cloud or 'mist pool' will form.
  Model Run: traditional ALOHA tank
  Release Duration: 28 minutes
  Max Average Sustained Release Rate: 173 pounds/min
     (averaged over a minute or more)
  Total Amount Released: 4,560 pounds
  Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
  Model Run: Heavy Gas
  Red   : 300 yards --- (1100 ppm = AEGL-3 [60 min])
  Orange: 951 yards --- (160 ppm = AEGL-2 [60 min])
  Yellow: 1.3 miles --- (30 ppm = AEGL-1 [60 min])
```

Toxic Threat Zone ALOHA® 5.4.7

```
Time: January 15, 2018  0800 hours PST (user specified)

Chemical Name: AMMONIA

Wind: 5.3 miles/hour from SE at 10 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red   : 300 yards --- (1100 ppm = AEGL-3 [60 min])
  Orange: 951 yards --- (160 ppm = AEGL-2 [60 min])
  Yellow: 1.3 miles --- (30 ppm = AEGL-1 [60 min])
```






Highway 99 at Bear Creek
1,000-Gallon Nurse Tank
Ammonia Release January
Legend
ALOHA Source Point
Orange Threat Zone 160 ppm = AEGL-2 (60 min)
Red Threat Zone 1100 ppm = AEGL-3 (60 min)
Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
Yellow Wind Direction Confidence Lines 30 ppm = AEGL-1 (60 min)
FACILITIES
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
ALOHA Source Point
3000 ft
Google Earth
© 2018 Google

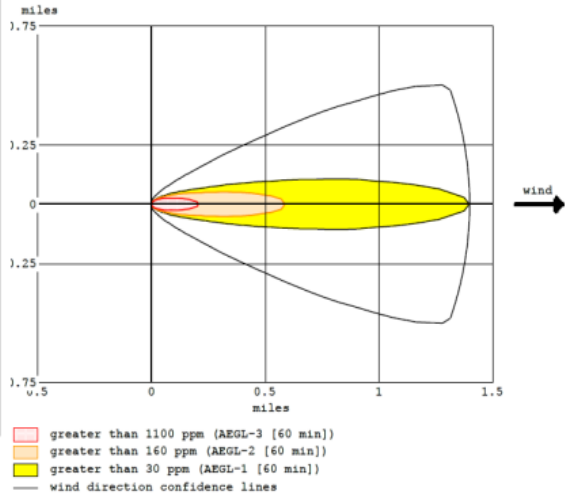
Scenario 6: Ammonia 10,000-Gallon Nurse Tank - July

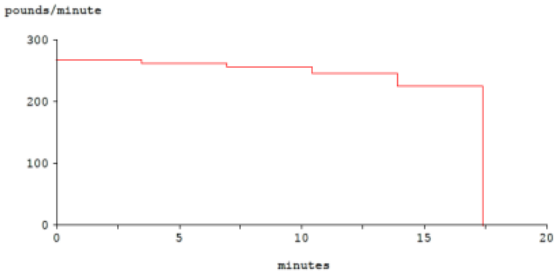
Text Summary ALOHA® 5.4.7

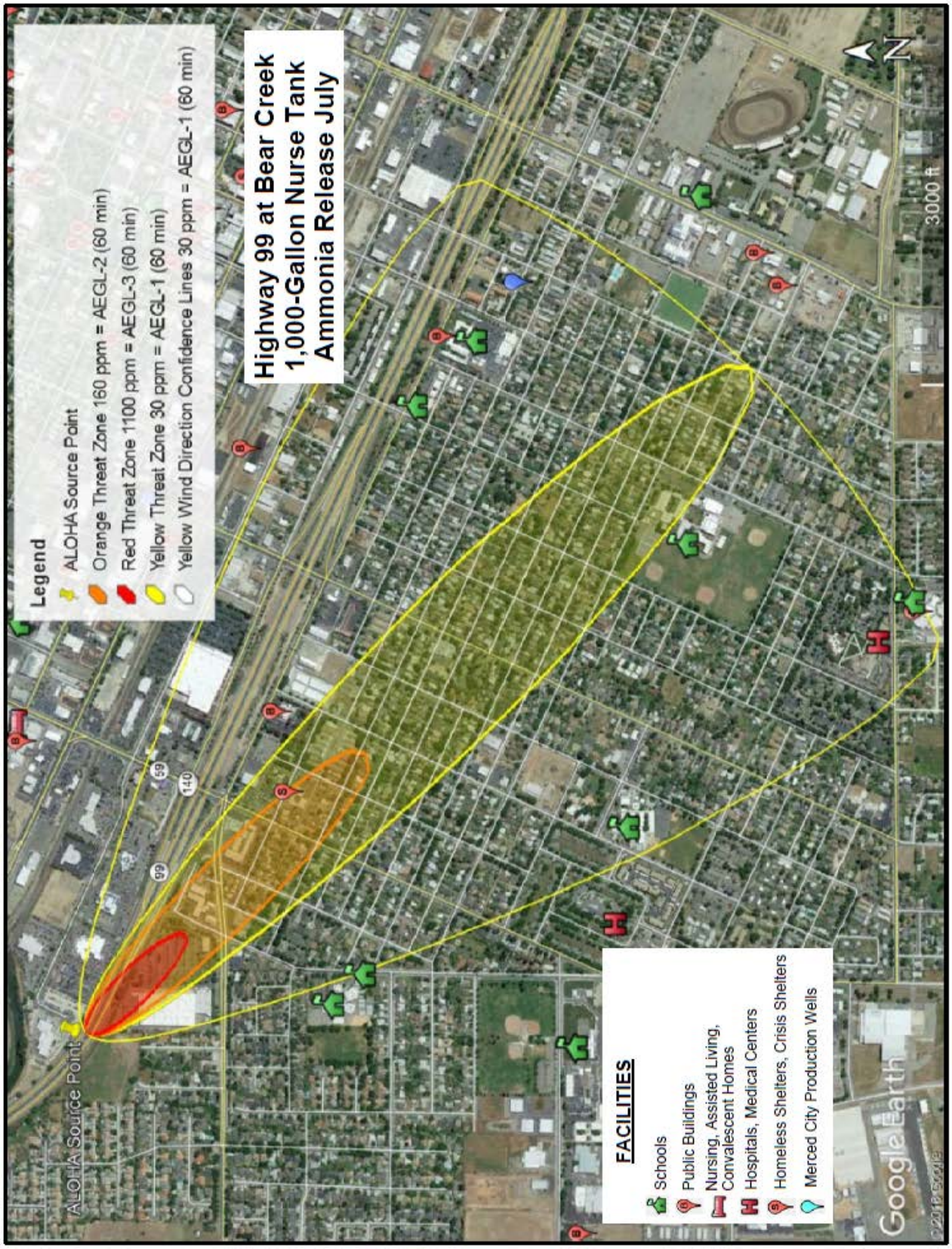
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 0.63 (unsheltered single storied)
  Time: July 15, 2018  1500 hours PDT (user specified)

CHEMICAL DATA:
  Chemical Name: AMMONIA
  CAS Number: 7664-41-7                  Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm     UEL: 280000 ppm
  Ambient Boiling Point: -28.4° 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: 7.5 miles/hour from NW at 10 meters
  Ground Roughness: open country         Cloud Cover: 0 tenths
  Air Temperature: 79° F                 Stability Class: C
  No Inversion Height                    Relative Humidity: 0%

SOURCE STRENGTH:
  Leak from short pipe or valve in horizontal cylindrical tank
  Flammable chemical escaping from tank (not burning)
  Tank Diameter: 3.66 feet               Tank Length: 13 feet
  Tank Volume: 1,023 gallons
  Tank contains liquid                   Internal Temperature: 79° F
  Chemical Mass in Tank: 2.18 tons       Tank is 85% full
  Circular Opening Diameter: 3/4 inches
  Opening is 0 feet from tank bottom
  Release Duration: 17 minutes
  Max Average Sustained Release Rate: 267 pounds/min
     (averaged over a minute or more)
  Total Amount Released: 4,360 pounds
  Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 364 yards --- (1100 ppm = AEGL-3 [60 min])
  Orange: 1035 yards --- (160 ppm = AEGL-2 [60 min])
  Yellow: 1.4 miles --- (30 ppm = AEGL-1 [60 min])
```

Toxic Threat Zone ALOHA® 5.4.7

```
Time: July 15, 2018  1500 hours PDT (user specified)

Chemical Name: AMMONIA

Wind: 7.5 miles/hour from NW at 10 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 364 yards --- (1100 ppm = AEGL-3 [60 min])
  Orange: 1035 yards --- (160 ppm = AEGL-2 [60 min])
  Yellow: 1.4 miles --- (30 ppm = AEGL-1 [60 min])
```






Highway 99 at Bear Creek
1,000-Gallon Nurse Tank
Ammonia Release July
Legend
ALOHA Source Point
Orange Threat Zone 160 ppm = AEGL-2 (60 min)
Red Threat Zone 1100 ppm = AEGL-3 (60 min)
Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
Yellow Wind Direction Confidence Lines 30 ppm = AEGL-1 (60 min)
ALOHA Source Point
FACILITIES
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
N
3000 ft
Google Earth

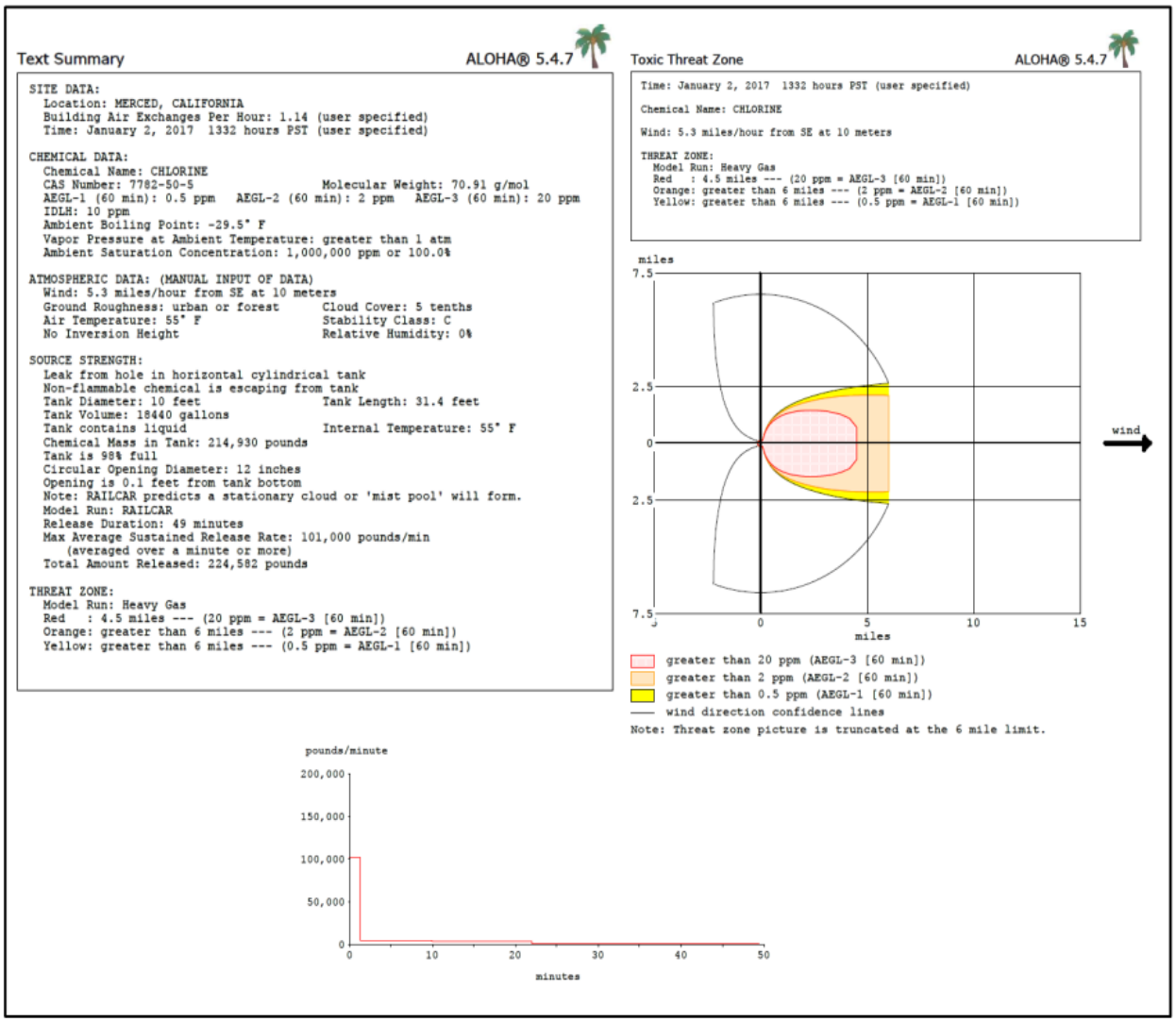
4.2 Railroads

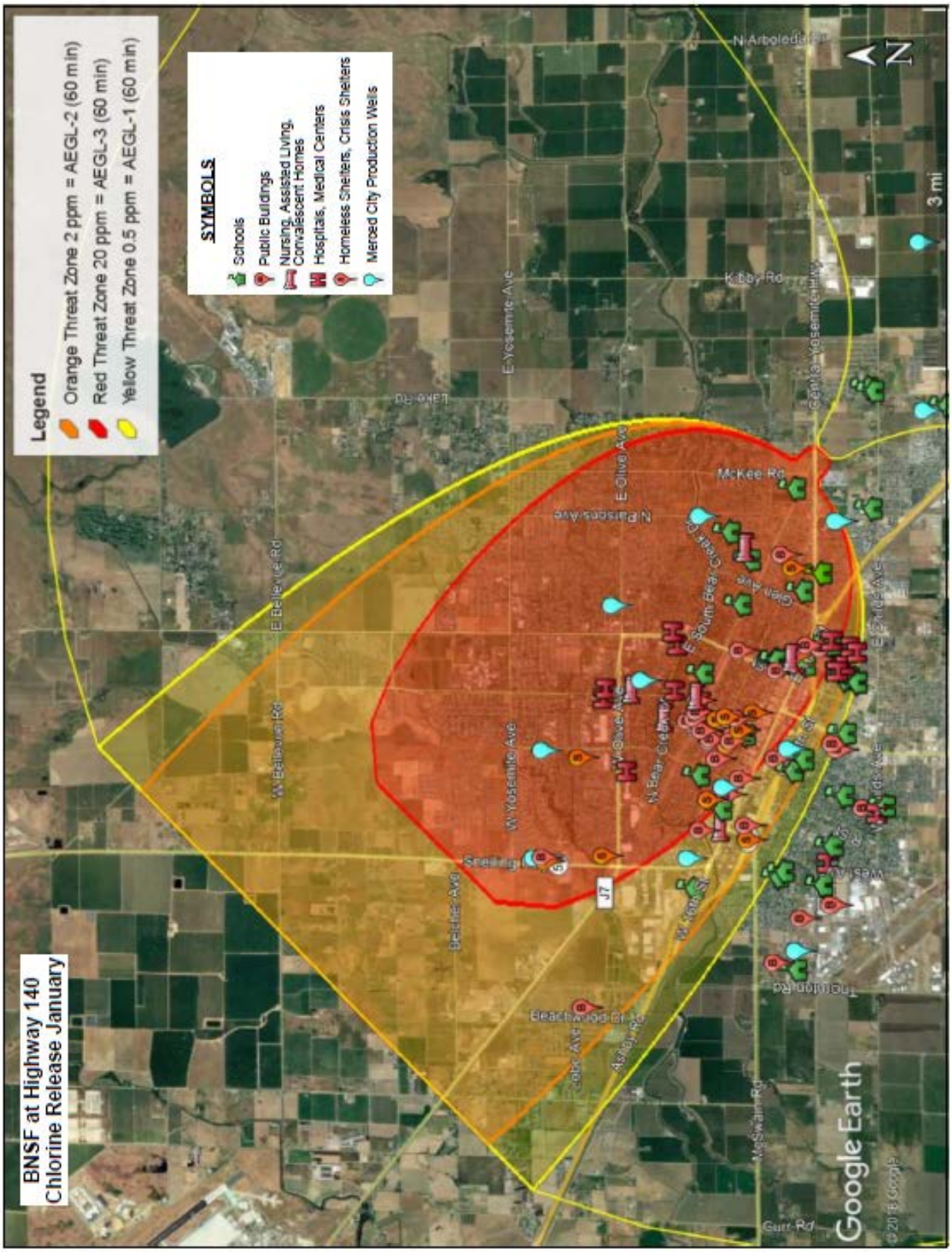
At the railroad risk control points, it will be assumed that the hazardous materials spill of a COC will result from a worst-case scenario incident with a tanker train car holding 18,440 gallons of chlorine or a tanker train car holding 33,600 gallons of ammonia. The plume analysis maps are shown below.

4.2.1 BNSF at Highway 140

The four scenarios for plume analysis at this location are based on the general railroad data outlined above in Section 4.2. The ALOHA plume analyses maps for this location for each of the 4 scenarios are shown below.

Scenario 1: Chlorine Release – January




BNSF at Highway 140
Chlorine Release January
Legend
Orange Threat Zone 2 ppm = AEGL-2 (60 min)
Red Threat Zone 20 ppm = AEGL-3 (60 min)
Yellow Threat Zone 0.5 ppm = AEGL-1 (60 min)
SYMBOLS
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
N
3 mi
Google Earth

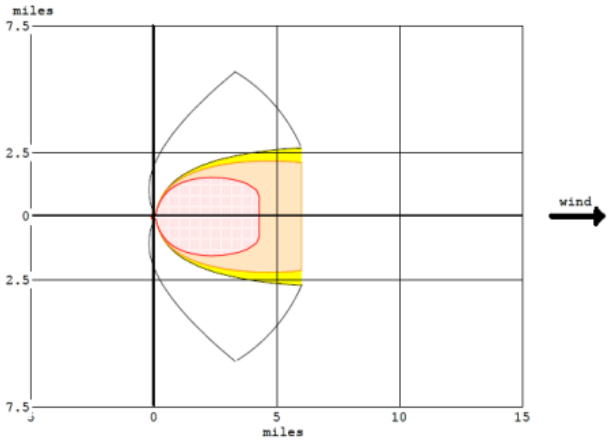
Scenario 2: Chlorine Release – July

Text Summary ALOHA® 5.4.7

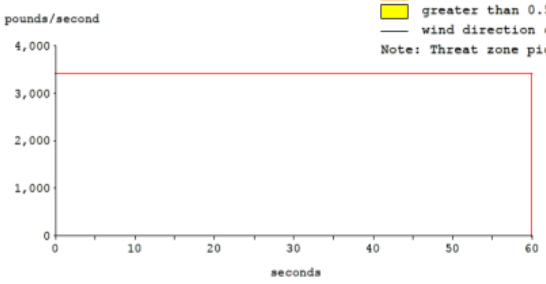
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 1.14 (user specified)
  Time: July 18, 2017  1500 hours PDT (user specified)

CHEMICAL DATA:
  Chemical Name: CHLORINE
  CAS Number: 7782-50-5                  Molecular Weight: 70.91 g/mol
  AEGL-1 (60 min): 0.5 ppm   AEGL-2 (60 min): 2 ppm   AEGL-3 (60 min): 20 ppm
  IDLH: 10 ppm
  Ambient Boiling Point: -29.5° 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: 7.5 miles/hour from NW at 10 meters
  Ground Roughness: urban or forest      Cloud Cover: 2 tenths
  Air Temperature: 97° F                 Stability Class: C
  No Inversion Height                    Relative Humidity: 0%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Non-flammable chemical is escaping from tank
  Tank Diameter: 10 feet                 Tank Length: 31.4 feet
  Tank Volume: 18440 gallons
  Tank contains liquid                   Internal Temperature: 97° F
  Chemical Mass in Tank: 205,060 pounds
  Tank is 98% full
  Circular Opening Diameter: 12 inches
  Opening is 0.1 feet from tank bottom
  Note: RAILCAR predicts a stationary cloud or 'mist pool' will form.
  Model Run: traditional ALOHA tank
  Release Duration: 1 minute
  Max Average Sustained Release Rate: 3,420 pounds/sec
     (averaged over a minute or more)
  Total Amount Released: 205,060 pounds
  Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 4.3 miles --- (20 ppm = AEGL-3 [60 min])
  Orange: greater than 6 miles --- (2 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (0.5 ppm = AEGL-1 [60 min])
```

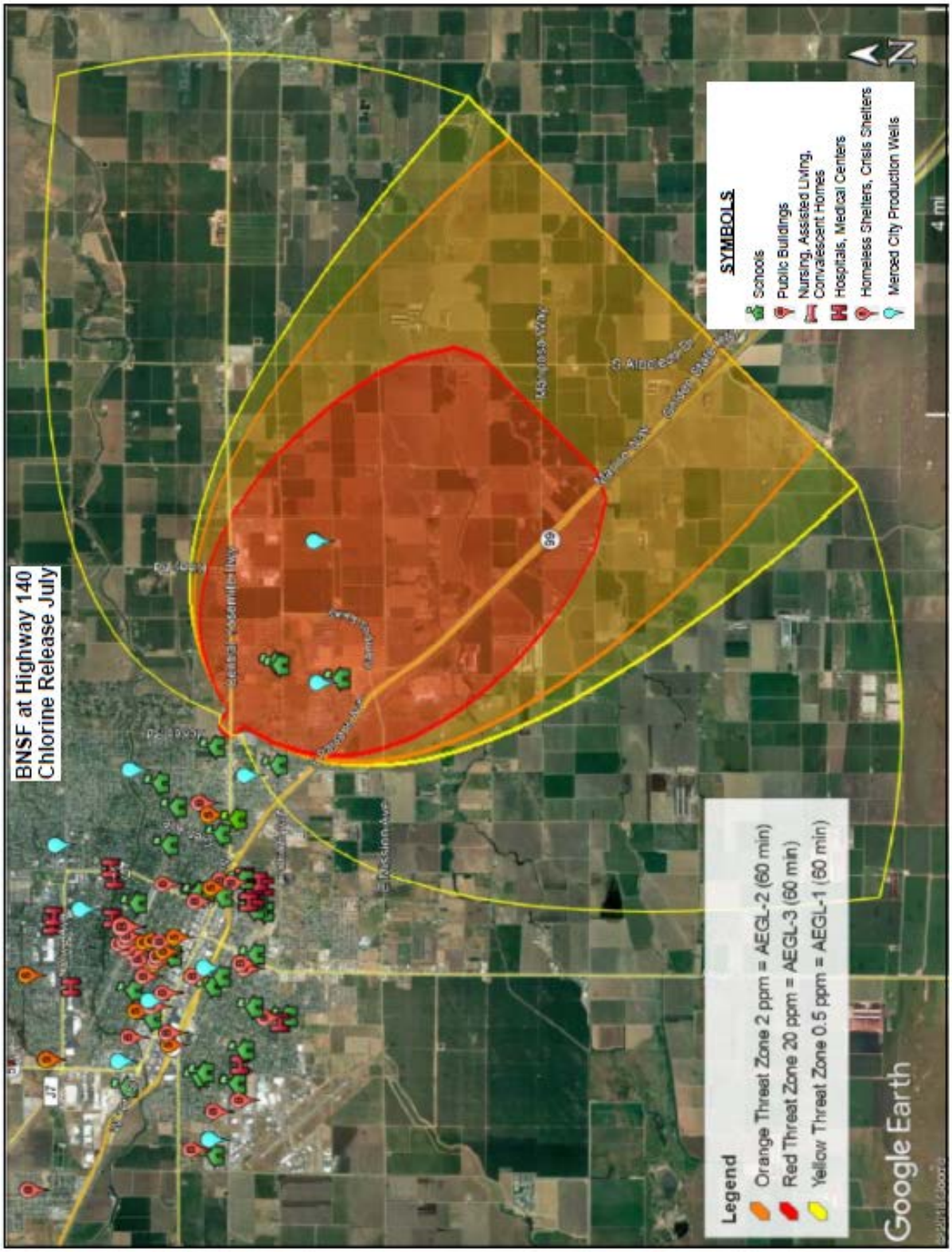
Toxic Threat Zone ALOHA® 5.4.7

```
Time: July 18, 2017  1500 hours PDT (user specified)

Chemical Name: CHLORINE

Wind: 7.5 miles/hour from NW at 10 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 4.3 miles --- (20 ppm = AEGL-3 [60 min])
  Orange: greater than 6 miles --- (2 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (0.5 ppm = AEGL-1 [60 min])
```



greater than 20 ppm (AEGL-3 [60 min])
greater than 2 ppm (AEGL-2 [60 min])
greater than 0.5 ppm (AEGL-1 [60 min])
wind direction confidence lines
Note: Threat zone picture is truncated at the 6 mile limit.




BNSF at Highway 140
Chlorine Release July
SYMBOLS
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
Legend
Orange Threat Zone 2 ppm = AEGL-2 (60 min)
Red Threat Zone 20 ppm = AEGL-3 (60 min)
Yellow Threat Zone 0.5 ppm = AEGL-1 (60 min)
Google Earth
N
4 mi

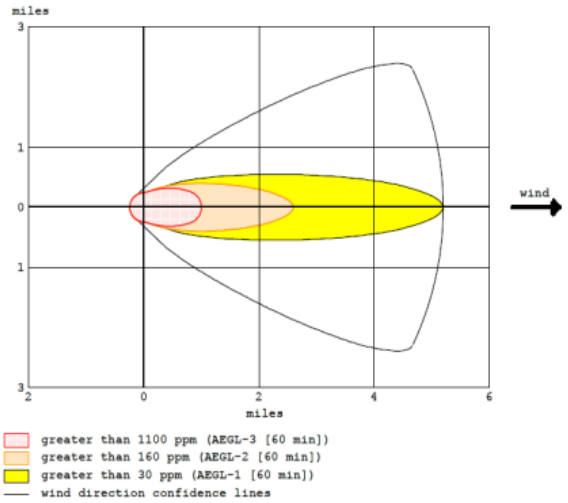
Scenario 3: Ammonia Release – January

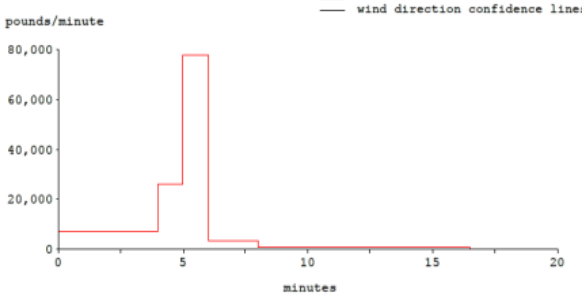
Text Summary ALOHA® 5.4.7

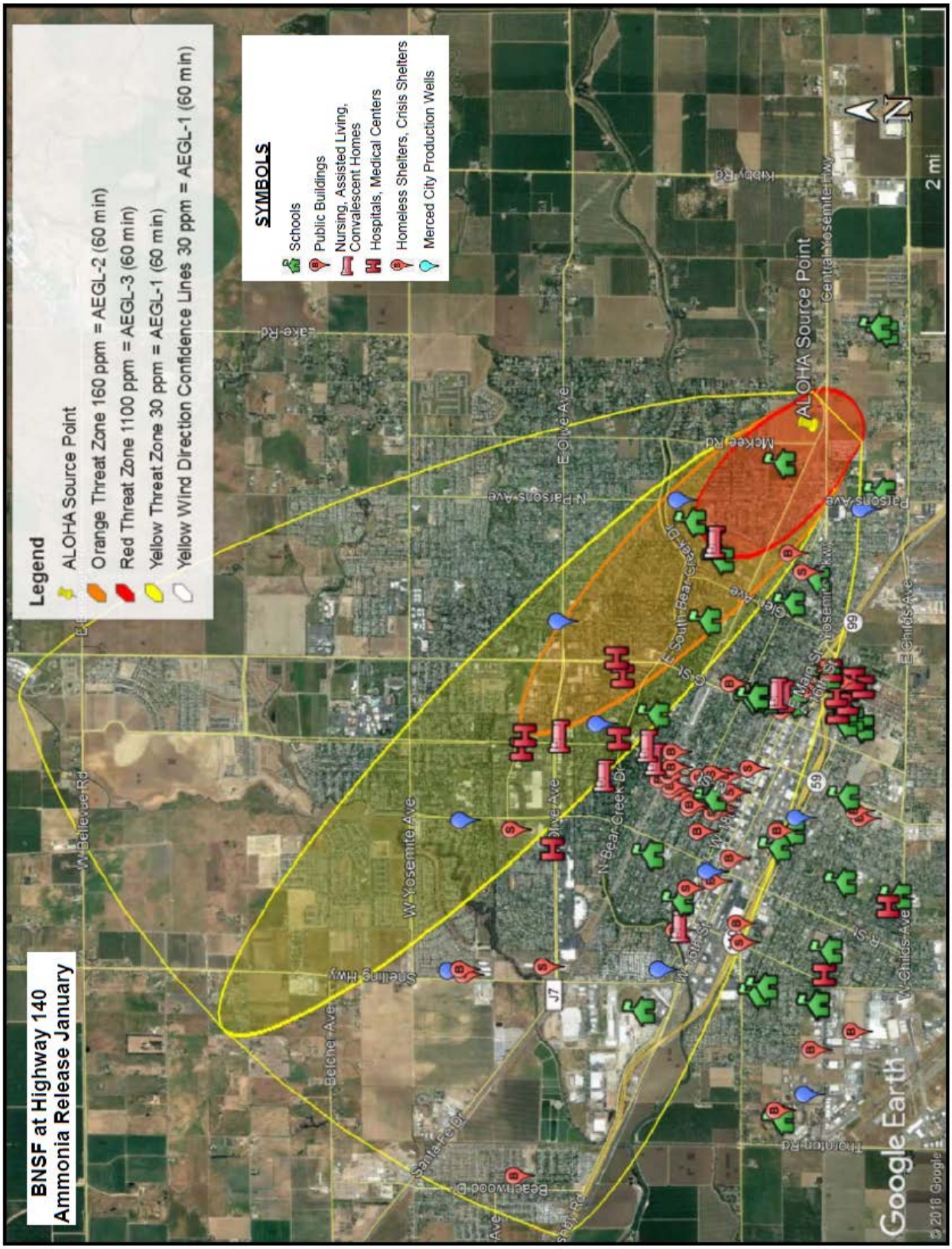
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 0.60 (unsheltered single storied)
  Time: January 18, 2018  0800 hours PST (user specified)

CHEMICAL DATA:
  Chemical Name: AMMONIA
  CAS Number: 7664-41-7                  Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm     UEL: 280000 ppm
  Ambient Boiling Point: -28.4° 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: 5.3 miles/hour from SE at 3 meters
  Ground Roughness: open country         Cloud Cover: 5 tenths
  Air Temperature: 47° F                 Stability Class: C
  No Inversion Height                    Relative Humidity: 5%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Flammable chemical escaping from tank (not burning)
  Tank Diameter: 10.0 feet               Tank Length: 57.2 feet
  Tank Volume: 33660 gallons
  Tank contains liquid                   Internal Temperature: 47° F
  Chemical Mass in Tank: 74.9 tons       Tank is 85% full
  Circular Opening Diameter: 6 inches
  Opening is 1 inches from tank bottom
  Note: RAILCAR predicts a stationary cloud or 'mist pool' will form.
  Model Run: RAILCAR
  Release Duration: 16 minutes
  Max Average Sustained Release Rate: 77,400 pounds/min
     (averaged over a minute or more)
  Total Amount Released: 145,153 pounds

THREAT ZONE:
  Model Run: Gaussian
  Red    : 1758 yards --- (1100 ppm = AEGL-3 [60 min])
  Orange: 2.6 miles --- (160 ppm = AEGL-2 [60 min])
  Yellow: 5.2 miles --- (30 ppm = AEGL-1 [60 min])
```

Toxic Threat Zone ALOHA® 5.4.7

```
Time: January 18, 2018  0800 hours PST (user specified)

Chemical Name: AMMONIA

Wind: 5.3 miles/hour from SE at 3 meters

THREAT ZONE:
  Model Run: Gaussian
  Red    : 1758 yards --- (1100 ppm = AEGL-3 [60 min])
  Orange: 2.6 miles --- (160 ppm = AEGL-2 [60 min])
  Yellow: 5.2 miles --- (30 ppm = AEGL-1 [60 min])
```






BNSF at Highway 140
Ammonia Release January
Legend
ALOHA Source Point
Orange Threat Zone 160 ppm = AEGL-2 (60 min)
Red Threat Zone 1100 ppm = AEGL-3 (60 min)
Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
Yellow Wind Direction Confidence Lines 30 ppm = AEGL-1 (60 min)
SYMBOLS
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
ALOHA Source Point
N
2 mi
Google Earth

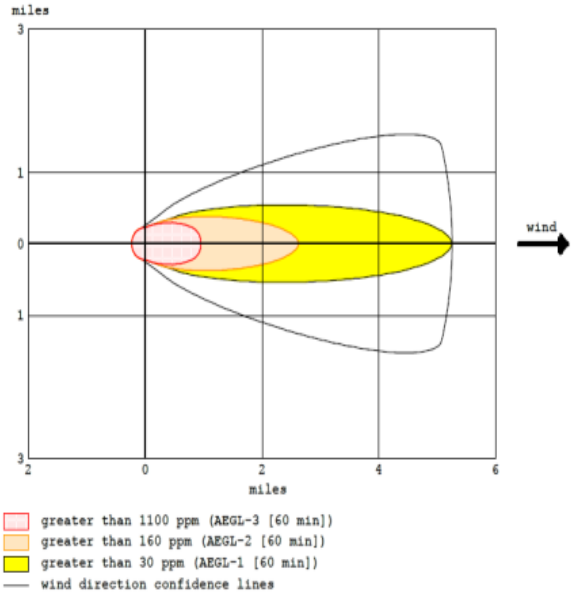
Scenario 4: Ammonia Release – July

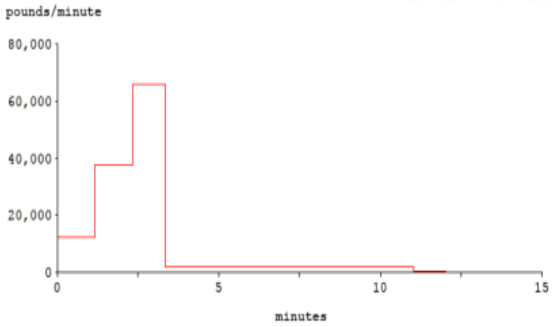
Text Summary ALOHA® 5.4.7

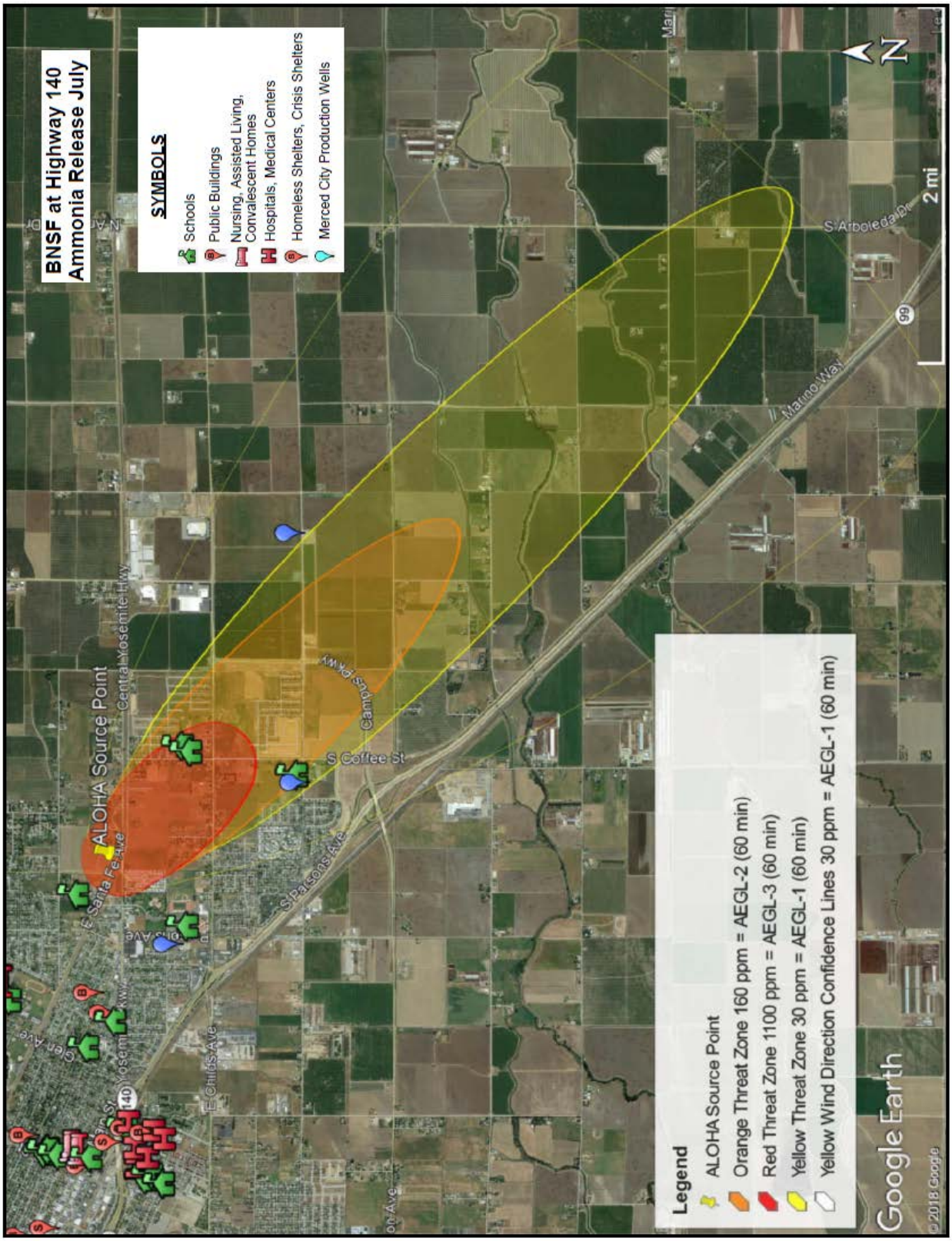
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 0.74 (unsheltered single storied)
  Time: July 15, 2018  1100 hours PDT (user specified)

CHEMICAL DATA:
  Chemical Name: AMMONIA
  CAS Number: 7664-41-7                  Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm     UEL: 280000 ppm
  Ambient Boiling Point: -28.4° 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: 7.5 miles/hour from NW at 3 meters
  Ground Roughness: open country         Cloud Cover: 0 tenths
  Air Temperature: 79° F                 Stability Class: C
  No Inversion Height                    Relative Humidity: 5%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Flammable chemical escaping from tank (not burning)
  Tank Diameter: 10.00 feet              Tank Length: 57.2 feet
  Tank Volume: 33600 gallons
  Tank contains liquid                   Internal Temperature: 79° F
  Chemical Mass in Tank: 71.7 tons       Tank is 85% full
  Circular Opening Diameter: 6 inches
  Opening is 1 inches from tank bottom
  Note: RAILCAR predicts a stationary cloud or 'mist pool' will form.
  Model Run: RAILCAR
  Release Duration: 12 minutes
  Max Average Sustained Release Rate: 65,800 pounds/min
     (averaged over a minute or more)
  Total Amount Released: 141,066 pounds

THREAT ZONE:
  Model Run: Gaussian
  Red   : 1695 yards --- (1100 ppm = AEGL-3 [60 min])
  Orange: 2.6 miles --- (160 ppm = AEGL-2 [60 min])
  Yellow: 5.3 miles --- (30 ppm = AEGL-1 [60 min])
```

Toxic Threat Zone ALOHA® 5.4.7

```
Time: July 15, 2018  1100 hours PDT (user specified)

Chemical Name: AMMONIA

Wind: 7.5 miles/hour from NW at 3 meters

THREAT ZONE:
  Model Run: Gaussian
  Red   : 1695 yards --- (1100 ppm = AEGL-3 [60 min])
  Orange: 2.6 miles --- (160 ppm = AEGL-2 [60 min])
  Yellow: 5.3 miles --- (30 ppm = AEGL-1 [60 min])
```






BNSF at Highway 140
Ammonia Release July
SYMBOLS
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
ALOHA Source Point
Central Yosemite Hwy
E Santa Fe Ave
S Coffee St
S Parsons Ave
Campus Pkwy
E Childs Ave
S Arboleda Dr
Marino Way
99
140
N
2 mi
Legend
ALOHA Source Point
Orange Threat Zone 160 ppm = AEGL-2 (60 min)
Red Threat Zone 1100 ppm = AEGL-3 (60 min)
Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
Yellow Wind Direction Confidence Lines 30 ppm = AEGL-1 (60 min)
Google Earth
©2018 Google

4.2.2 UP at Highway 99

The four scenarios for plume analysis at this location are based on the general railroad data outlined above in Section 4.2. The ALOHA plume analyses maps for this location for each of the 4 scenarios are shown below.

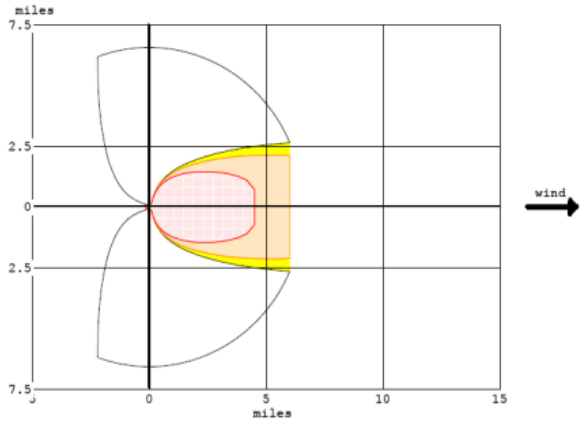
Scenario 1: Chlorine Release– January

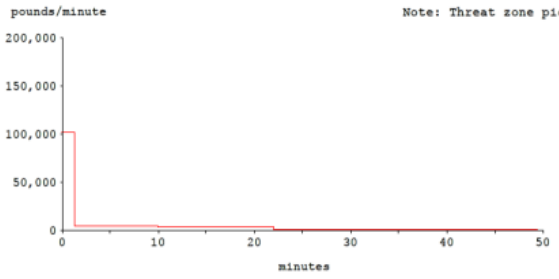
Text Summary ALOHA® 5.4.7

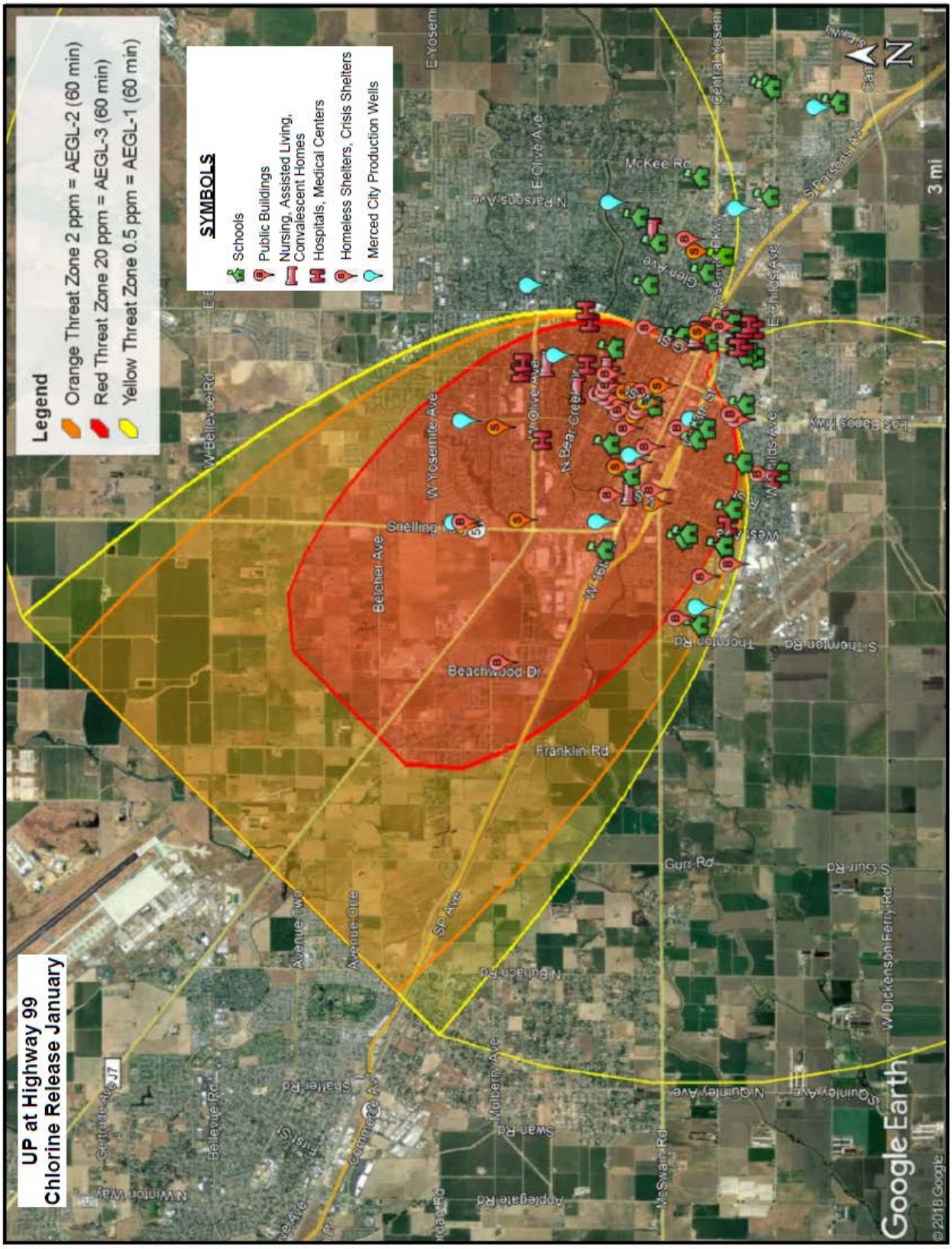
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 1.14 (user specified)
  Time: January 2, 2017  1332 hours PST (user specified)

CHEMICAL DATA:
  Chemical Name: CHLORINE
  CAS Number: 7782-50-5                  Molecular Weight: 70.91 g/mol
  AEGL-1 (60 min): 0.5 ppm   AEGL-2 (60 min): 2 ppm   AEGL-3 (60 min): 20 ppm
  IDLH: 10 ppm
  Ambient Boiling Point: -29.5° 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: 5.3 miles/hour from SE at 10 meters
  Ground Roughness: urban or forest      Cloud Cover: 5 tenths
  Air Temperature: 55° F                 Stability Class: C
  No Inversion Height                    Relative Humidity: 0%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Non-flammable chemical is escaping from tank
  Tank Diameter: 10 feet                 Tank Length: 31.4 feet
  Tank Volume: 18440 gallons
  Tank contains liquid                   Internal Temperature: 55° F
  Chemical Mass in Tank: 214,930 pounds
  Tank is 98% full
  Circular Opening Diameter: 12 inches
  Opening is 0.1 feet from tank bottom
  Note: RAILCAR predicts a stationary cloud or 'mist pool' will form.
  Model Run: RAILCAR
  Release Duration: 49 minutes
  Max Average Sustained Release Rate: 101,000 pounds/min
    (averaged over a minute or more)
  Total Amount Released: 224,582 pounds

THREAT ZONE:
  Model Run: Heavy Gas
  Red   : 4.5 miles --- (20 ppm = AEGL-3 [60 min])
  Orange: greater than 6 miles --- (2 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (0.5 ppm = AEGL-1 [60 min])
```

Toxic Threat Zone ALOHA® 5.4.7

```
Time: January 2, 2017  1332 hours PST (user specified)

Chemical Name: CHLORINE

Wind: 5.3 miles/hour from SE at 10 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red   : 4.5 miles --- (20 ppm = AEGL-3 [60 min])
  Orange: greater than 6 miles --- (2 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (0.5 ppm = AEGL-1 [60 min])
```






UP at Highway 99
Chlorine Release January
Legend
Orange Threat Zone 2 ppm = AEGL-2 (60 min)
Red Threat Zone 20 ppm = AEGL-3 (60 min)
Yellow Threat Zone 0.5 ppm = AEGL-1 (60 min)
SYMBOLS
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
3 mi
N
Google Earth
© 2018 Google

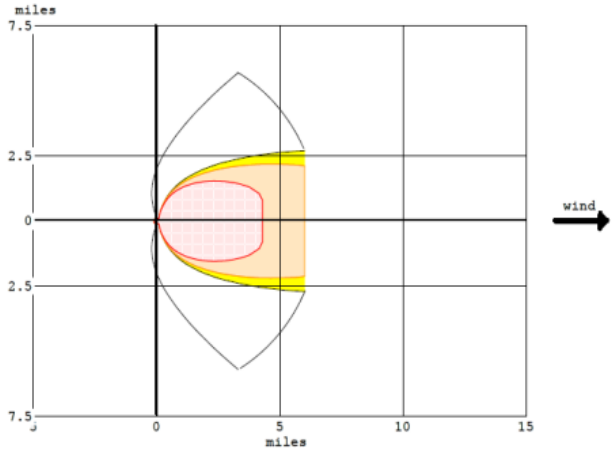
Scenario 2: Chlorine Release – July

Text Summary ALOHA® 5.4.7

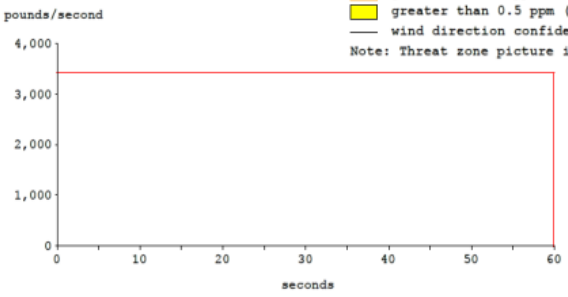
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 1.14 (user specified)
  Time: July 18, 2017  1500 hours PDT (user specified)

CHEMICAL DATA:
  Chemical Name: CHLORINE
  CAS Number: 7782-50-5                  Molecular Weight: 70.91 g/mol
  AEGL-1 (60 min): 0.5 ppm   AEGL-2 (60 min): 2 ppm   AEGL-3 (60 min): 20 ppm
  IDLH: 10 ppm
  Ambient Boiling Point: -29.5° 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: 7.5 miles/hour from NW at 10 meters
  Ground Roughness: urban or forest      Cloud Cover: 2 tenths
  Air Temperature: 97° F                 Stability Class: C
  No Inversion Height                    Relative Humidity: 0%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Non-flammable chemical is escaping from tank
  Tank Diameter: 10 feet                 Tank Length: 31.4 feet
  Tank Volume: 18440 gallons
  Tank contains liquid                   Internal Temperature: 97° F
  Chemical Mass in Tank: 205,060 pounds
  Tank is 98% full
  Circular Opening Diameter: 12 inches
  Opening is 0.1 feet from tank bottom
  Note: RAILCAR predicts a stationary cloud or 'mist pool' will form.
  Model Run: traditional ALOHA tank
  Release Duration: 1 minute
  Max Average Sustained Release Rate: 3,420 pounds/sec
     (averaged over a minute or more)
  Total Amount Released: 205,060 pounds
  Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 4.3 miles --- (20 ppm = AEGL-3 [60 min])
  Orange: greater than 6 miles --- (2 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (0.5 ppm = AEGL-1 [60 min])
```

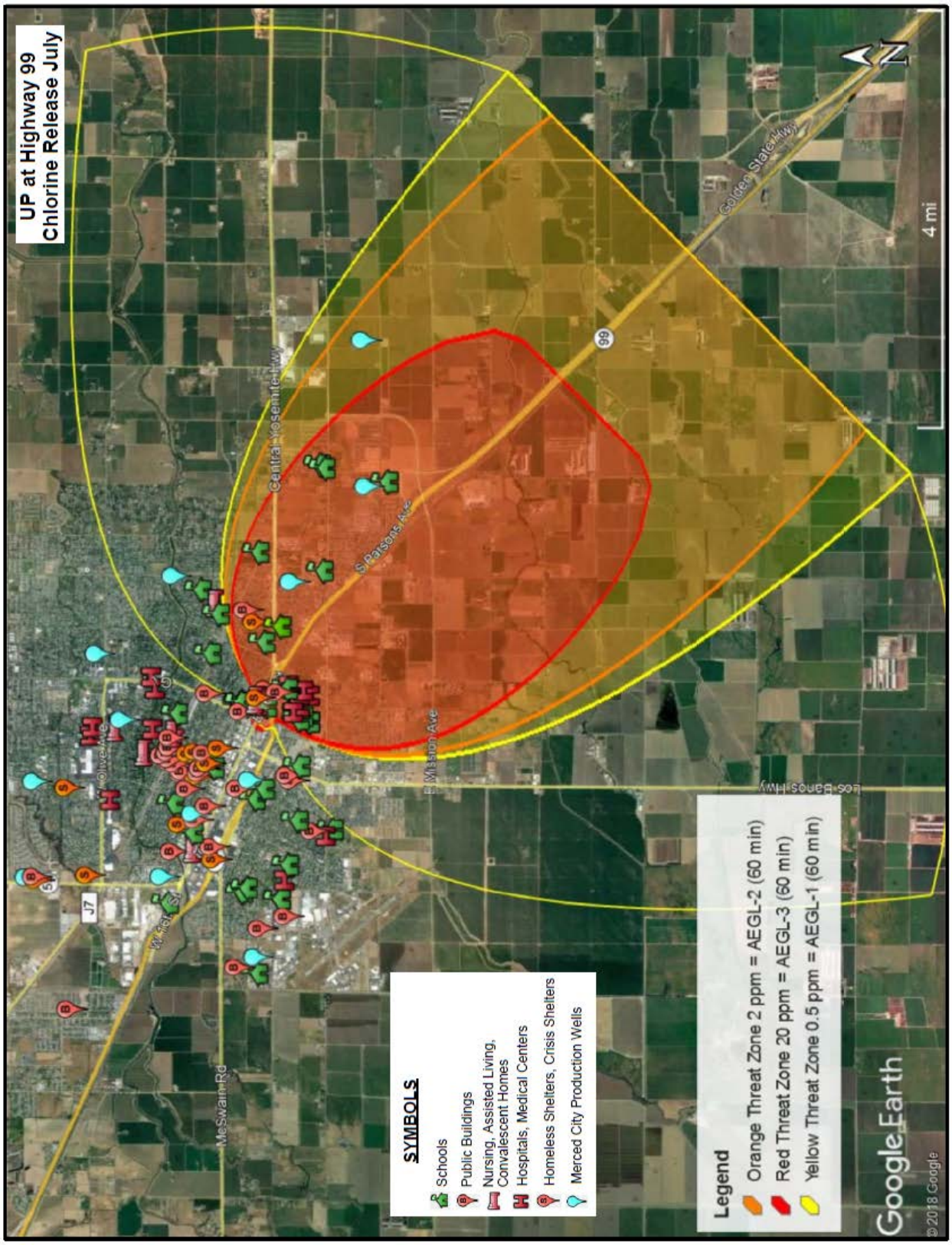
Toxic Threat Zone ALOHA® 5.4.7

```
Time: July 18, 2017  1500 hours PDT (user specified)

Chemical Name: CHLORINE

Wind: 7.5 miles/hour from NW at 10 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 4.3 miles --- (20 ppm = AEGL-3 [60 min])
  Orange: greater than 6 miles --- (2 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (0.5 ppm = AEGL-1 [60 min])
```



greater than 20 ppm (AEGL-3 [60 min])
greater than 2 ppm (AEGL-2 [60 min])
greater than 0.5 ppm (AEGL-1 [60 min])
wind direction confidence lines
Note: Threat zone picture is truncated at the 6 mile limit.




UP at Highway 99
Chlorine Release July
N
4 mi
Golden State Hwy
99
Central Yosemite Hwy
S Parsons Ave
E Mission Ave
W Olive Ave
W Yosemite Ave
W Main St
J7
McSwain Rd
SYMBOLS
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
Legend
Orange Threat Zone 2 ppm = AEGL-2 (60 min)
Red Threat Zone 20 ppm = AEGL-3 (60 min)
Yellow Threat Zone 0.5 ppm = AEGL-1 (60 min)
Google Earth
© 2018 Google

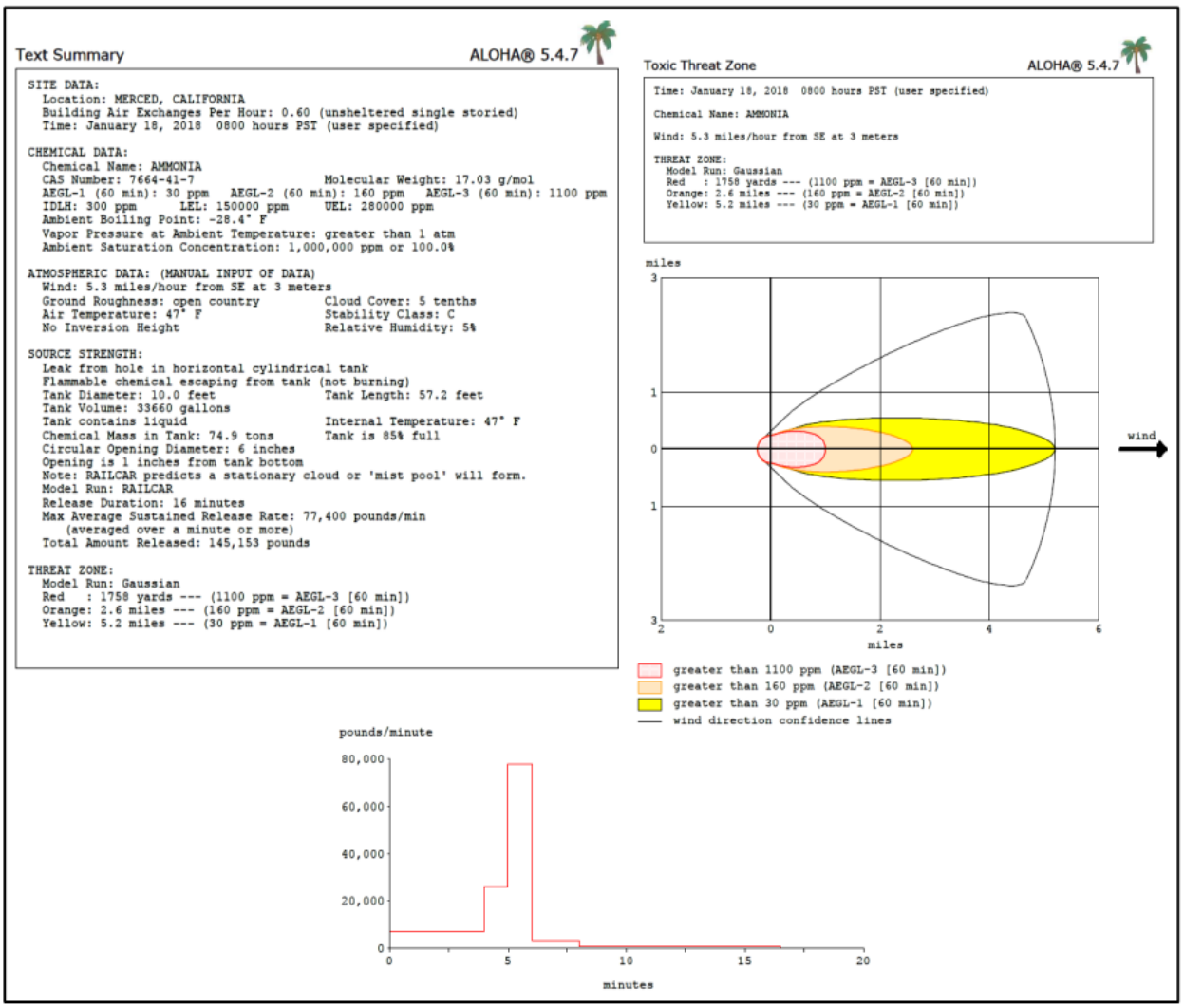
Scenario 3: Ammonia – January

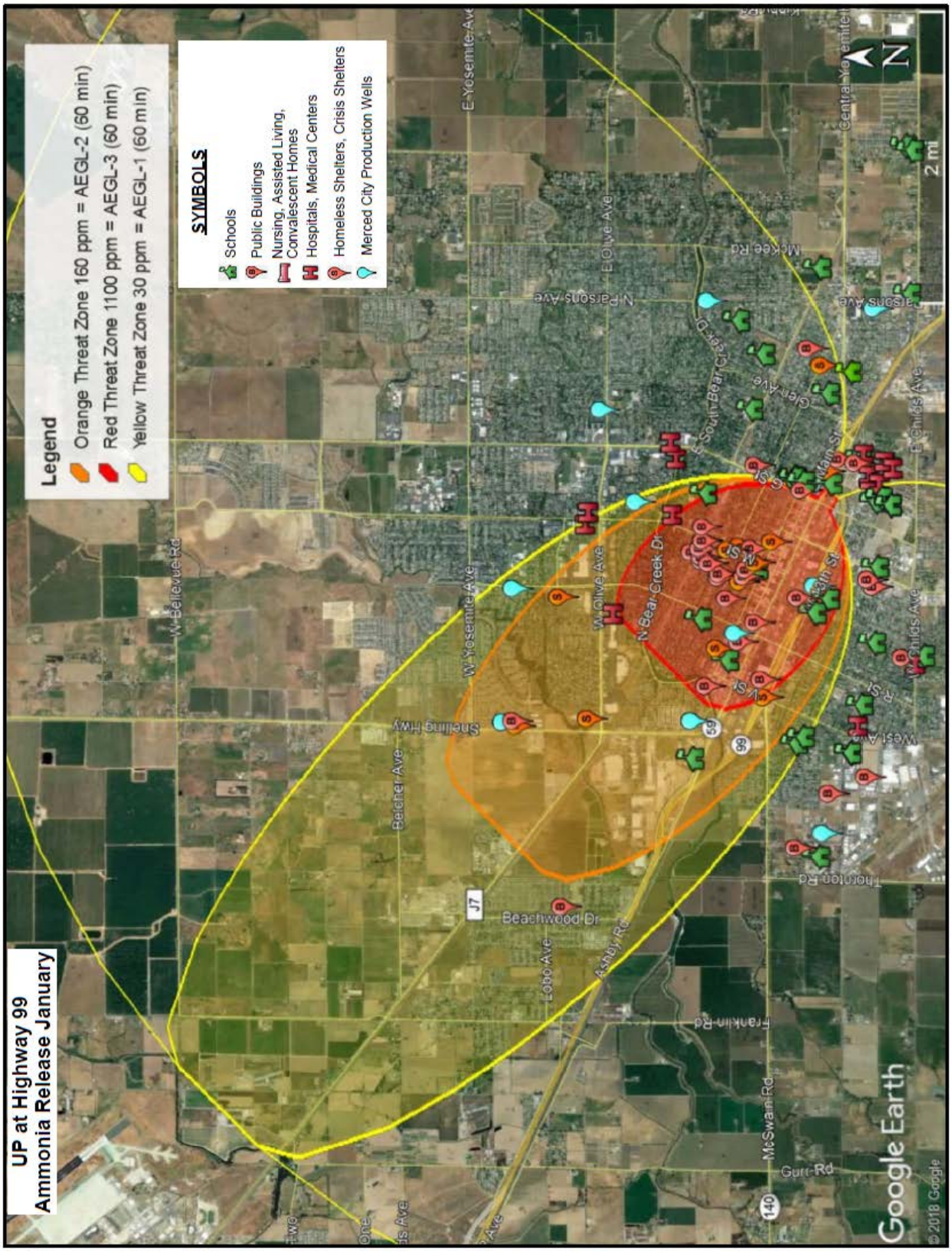
Text Summary ALOHA® 5.4.7

```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 0.60 (unsheltered single storied)
  Time: January 18, 2018  0800 hours PST (user specified)

CHEMICAL DATA:
  Chemical Name: AMMONIA
  CAS Number: 7664-41-7                  Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm     UEL: 280000 ppm
  Ambient Boiling Point: -28.4° 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: 5.3 miles/hour from SE at 3 meters
  Ground Roughness: open country         Cloud Cover: 5 tenths
  Air Temperature: 47° F                 Stability Class: C
  No Inversion Height                    Relative Humidity: 5%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Flammable chemical escaping from tank (not burning)
  Tank Diameter: 10.0 feet               Tank Length: 57.2 feet
  Tank Volume: 33660 gallons
  Tank contains liquid                   Internal Temperature: 47° F
  Chemical Mass in Tank: 74.9 tons       Tank is 85% full
  Circular Opening Diameter: 6 inches
  Opening is 1 inches from tank bottom
  Note: RAILCAR predicts a stationary cloud or 'mist pool' will form.
  Model Run: RAILCAR
  Release Duration: 16 minutes
  Max Average Sustained Release Rate: 77,400 pounds/min
     (averaged over a minute or more)
  Total Amount Released: 145,153 pounds

THREAT ZONE:
  Model Run: Gaussian
  Red   : 1758 yards --- (1100 ppm = AEGL-3 [60 min])
  Orange: 2.6 miles --- (160 ppm = AEGL-2 [60 min])
  Yellow: 5.2 miles --- (30 ppm = AEGL-1 [60 min])
```

Toxic Threat Zone ALOHA® 5.4.7

```
Time: January 18, 2018  0800 hours PST (user specified)

Chemical Name: AMMONIA

Wind: 5.3 miles/hour from SE at 3 meters

THREAT ZONE:
  Model Run: Gaussian
  Red   : 1758 yards --- (1100 ppm = AEGL-3 [60 min])
  Orange: 2.6 miles --- (160 ppm = AEGL-2 [60 min])
  Yellow: 5.2 miles --- (30 ppm = AEGL-1 [60 min])
```




UP at Highway 99
Ammonia Release January
Legend
Orange Threat Zone 160 ppm = AEGL-2 (60 min)
Red Threat Zone 1100 ppm = AEGL-3 (60 min)
Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
SYMBOLS
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
N
2 mi
Google Earth
© 2018 Google

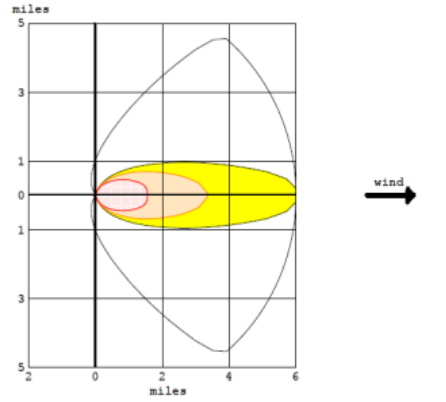
Scenario 4: Ammonia – July

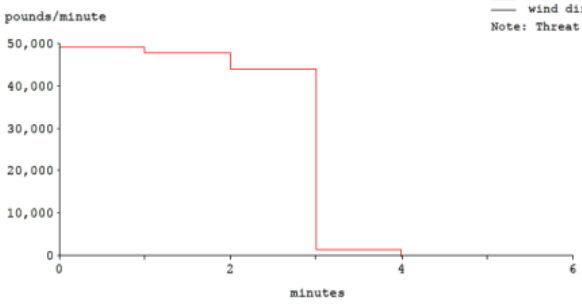
Text Summary ALOHA® 5.4.7

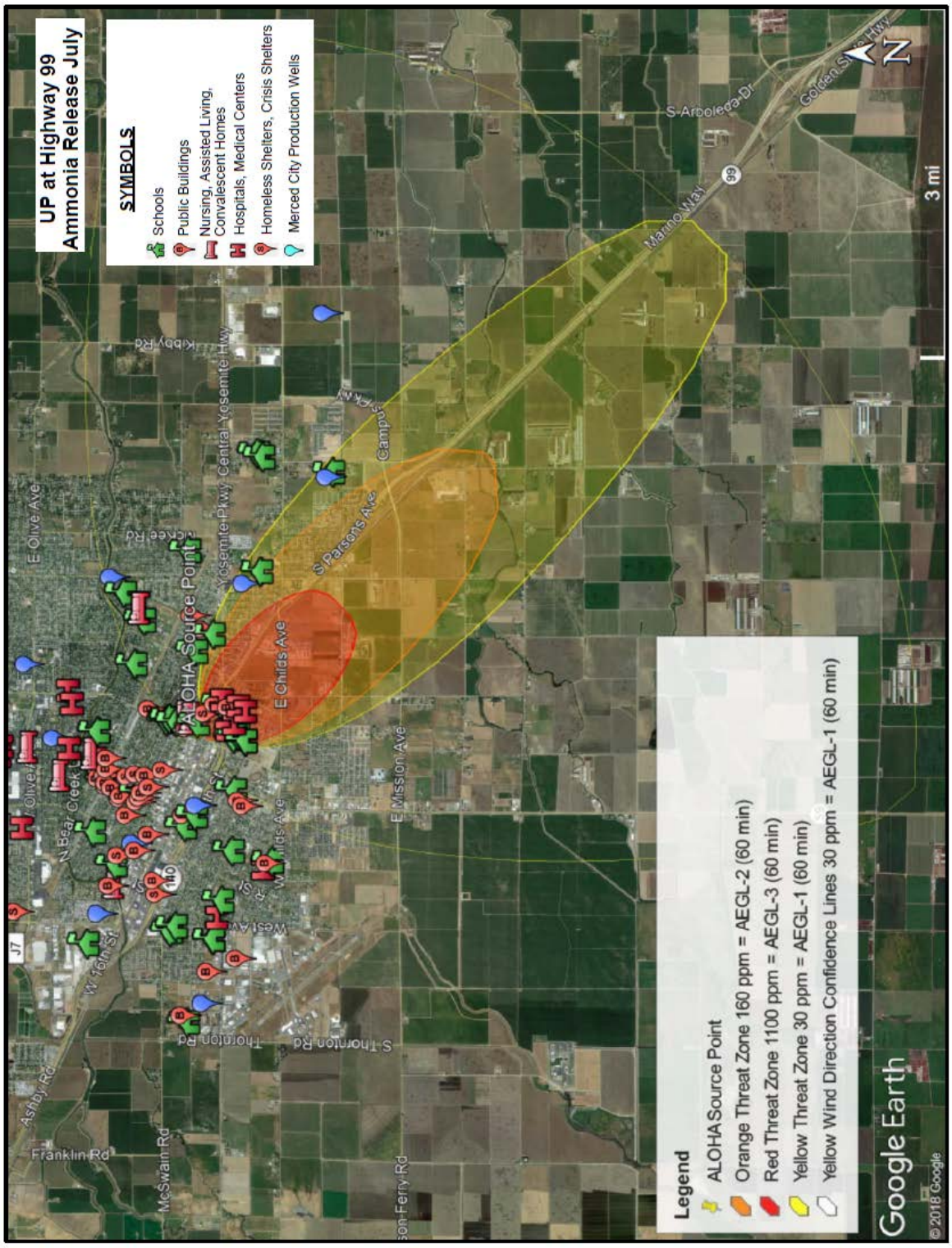
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 0.49 (unsheltered single storied)
  Time: July 18, 2018  1130 hours PDT (user specified)

CHEMICAL DATA:
  Chemical Name: AMMONIA
  CAS Number: 7664-41-7                  Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm     UEL: 280000 ppm
  Ambient Boiling Point: -28.4° 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: 7.5 miles/hour from NW at 10 meters
  Ground Roughness: urban or forest      Cloud Cover: 2 tenths
  Air Temperature: 79° F                 Stability Class: B
  No Inversion Height                    Relative Humidity: 5%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Flammable chemical escaping from tank (not burning)
  Tank Diameter: 10.00 feet              Tank Length: 57.2 feet
  Tank Volume: 33600 gallons
  Tank contains liquid                   Internal Temperature: 79° F
  Chemical Mass in Tank: 71.7 tons       Tank is 85% full
  Circular Opening Diameter: 6 inches
  Opening is 6 inches from tank bottom
  Release Duration: 4 minutes
  Max Average Sustained Release Rate: 49,100 pounds/min
     (averaged over a minute or more)
  Total Amount Released: 142,444 pounds
  Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 1.6 miles --- (1100 ppm = AEGL-3 [60 min])
  Orange: 3.4 miles --- (160 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (30 ppm = AEGL-1 [60 min])
```

Toxic Threat Zone ALOHA® 5.4.7

```
Time: July 18, 2018  1130 hours PDT (user specified)

Chemical Name: AMMONIA

Wind: 7.5 miles/hour from NW at 10 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 1.6 miles --- (1100 ppm = AEGL-3 [60 min])
  Orange: 3.4 miles --- (160 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (30 ppm = AEGL-1 [60 min])
```






UP at Highway 99
Ammonia Release July
SYMBOLS
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
Legend
ALOHA Source Point
Orange Threat Zone 160 ppm = AEGL-2 (60 min)
Red Threat Zone 1100 ppm = AEGL-3 (60 min)
Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
Yellow Wind Direction Confidence Lines 30 ppm = AEGL-1 (60 min)
Google Earth
© 2018 Google
3 mi
N
ALOHA Source Point
E Olive Ave
Kibby Rd
Yosemite Pkwy Central Yosemite Hwy
Campus Pkwy
S Parsons Ave
E Childs Ave
E Mission Ave
Marino Way
S Arboleda Dr
Golden State Hwy
Thornton Rd
S Thornton Rd
Franklin Rd
McSwain Rd
Ashby Rd
W 16th St
West Ave
N Bear Creek
J7

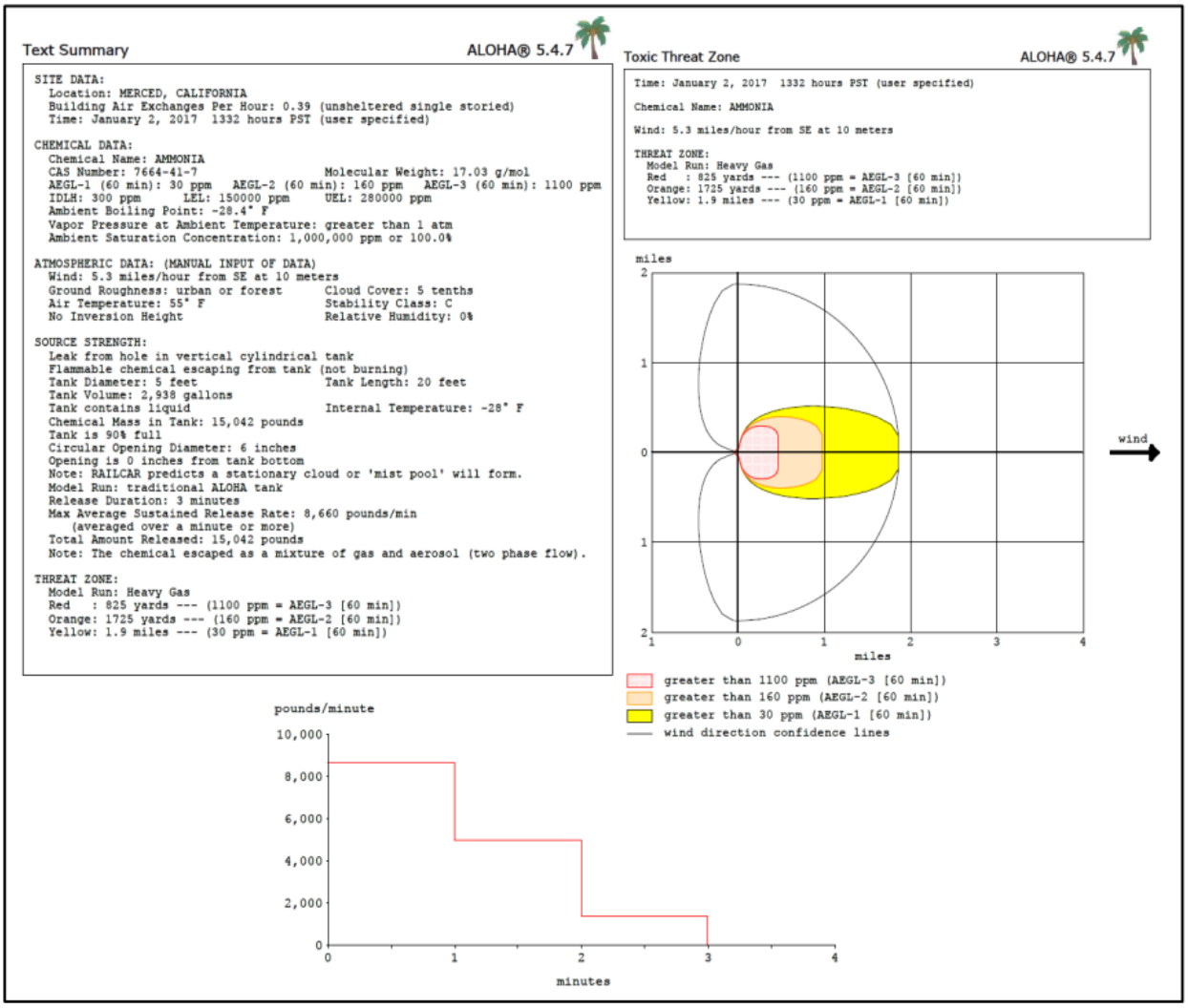
4.3 Fixed Facility

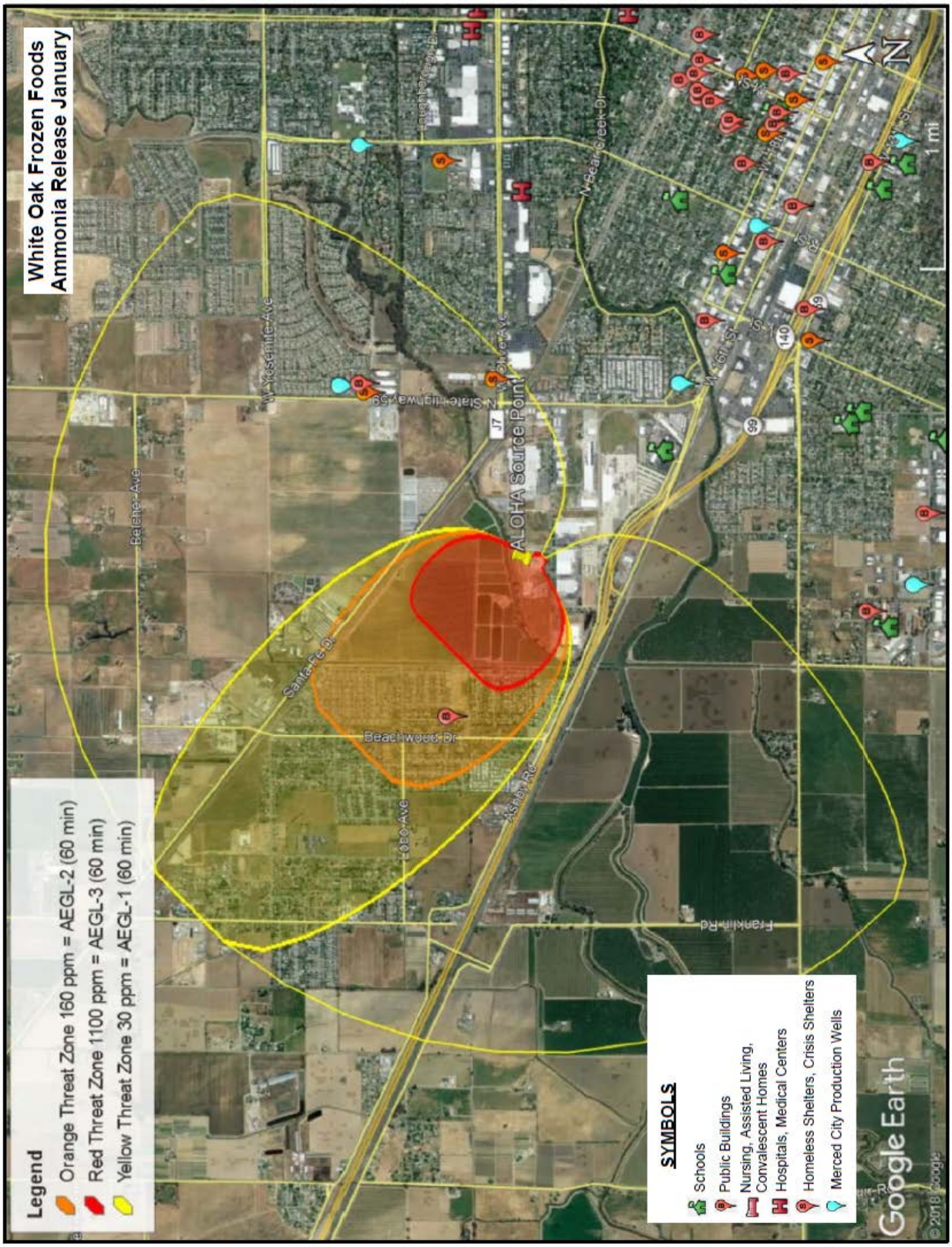
At the highway risk control points, it will be assumed that the hazardous materials spill of a COC will result from a probable scenario incident with an on-site tank 2,938 gallons of ammonia. The individual details are contained in the sections below.

4.3.1 White Oak Frozen Foods

The two scenarios for plume analysis at this location are for ammonia for the months of January and July.

Scenario 1: Ammonia Release – January




White Oak Frozen Foods
Ammonia Release January
Legend
Orange Threat Zone 160 ppm = AEGL-2 (60 min)
Red Threat Zone 1100 ppm = AEGL-3 (60 min)
Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
SYMBOLS
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
ALOHA Source Point
Beachwood Dr
Santa Fe Dr
Belcher Ave
Lobo Ave
Ashby Rd
Franklin Rd
N State Highway 59
W Yosemite Ave
N Bear Creek Dr
1 mi
Google Earth
© 2018 Google

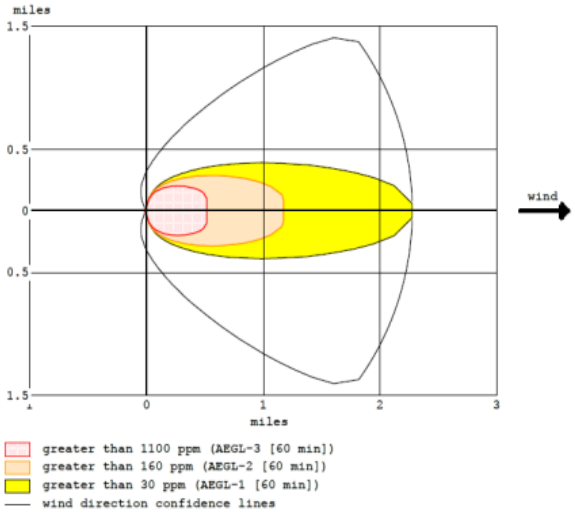
Scenario 2: Ammonia Release – July

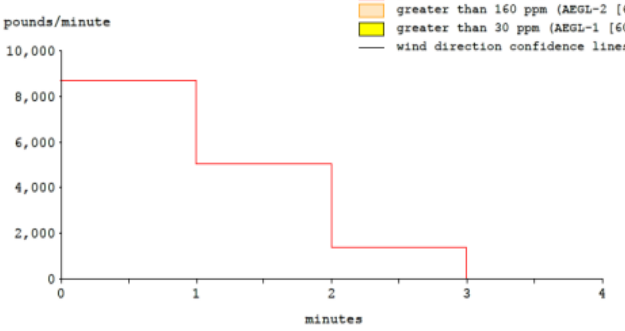
Text Summary ALOHA® 5.4.7

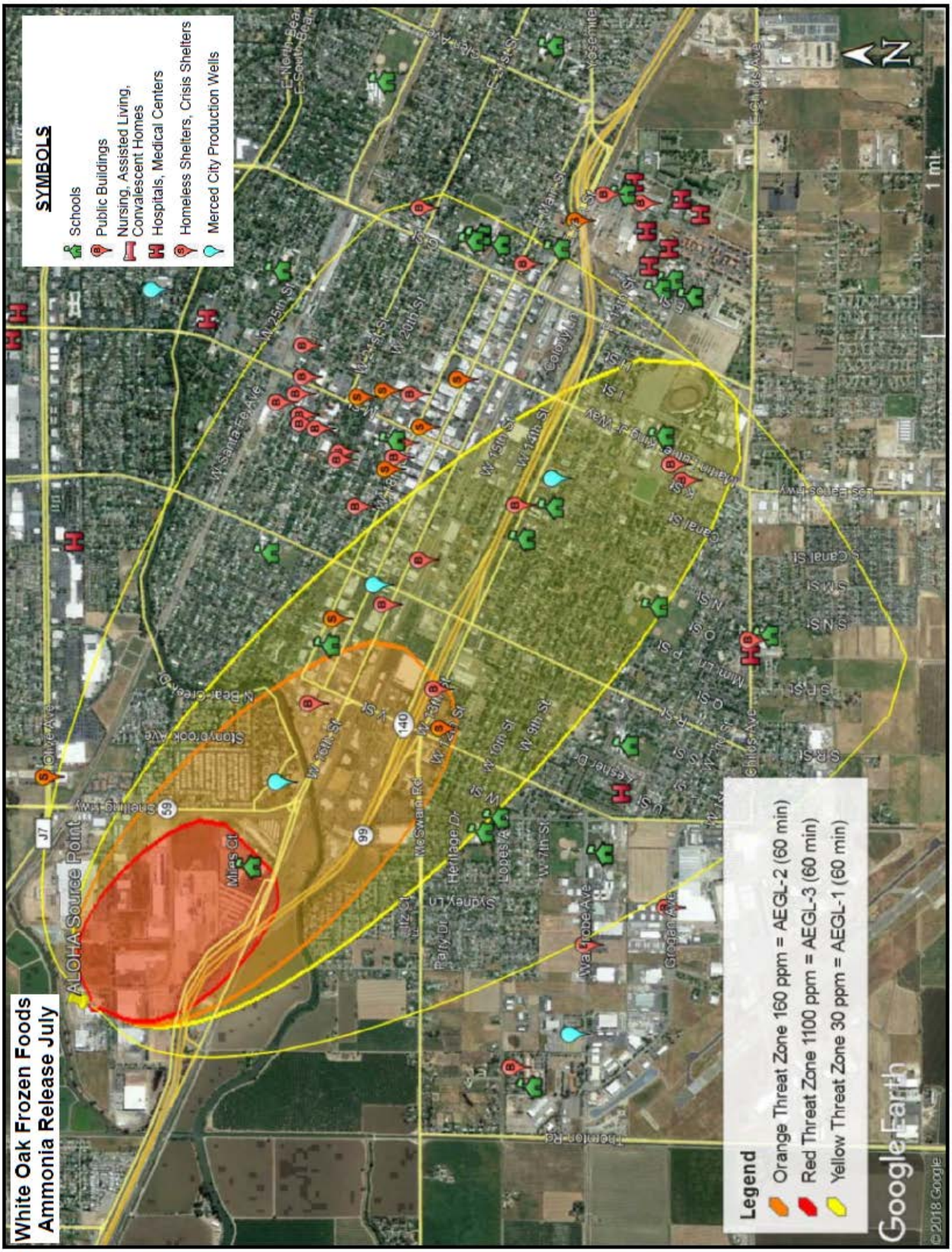
```
SITE DATA:
  Location: MERCED, CALIFORNIA
  Building Air Exchanges Per Hour: 0.57 (unsheltered single storied)
  Time: July 17, 2018  1500 hours PDT (user specified)

CHEMICAL DATA:
  Chemical Name: AMMONIA
  CAS Number: 7664-41-7                  Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm     UEL: 280000 ppm
  Ambient Boiling Point: -28.4° 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: 7.5 miles/hour from NW at 10 meters
  Ground Roughness: urban or forest      Cloud Cover: 0 tenths
  Air Temperature: 97° F                 Stability Class: C
  No Inversion Height                    Relative Humidity: 5%

SOURCE STRENGTH:
  Leak from hole in vertical cylindrical tank
  Flammable chemical escaping from tank (not burning)
  Tank Diameter: 5 feet                  Tank Length: 20.0 feet
  Tank Volume: 2938 gallons
  Tank contains liquid                   Internal Temperature: -28° F
  Chemical Mass in Tank: 7.52 tons       Tank is 90% full
  Circular Opening Diameter: 6 inches
  Opening is 0 feet from tank bottom
  Note: RAILCAR predicts a stationary cloud or 'mist pool' will form.
  Model Run: traditional ALOHA tank
  Release Duration: 3 minutes
  Max Average Sustained Release Rate: 8,660 pounds/min
     (averaged over a minute or more)
  Total Amount Released: 15,040 pounds
  Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 919 yards --- (1100 ppm = AEGL-3 [60 min])
  Orange: 1.2 miles --- (160 ppm = AEGL-2 [60 min])
  Yellow: 2.3 miles --- (30 ppm = AEGL-1 [60 min])
```

Toxic Threat Zone ALOHA® 5.4.7

```
Time: July 17, 2018  1500 hours PDT (user specified)

Chemical Name: AMMONIA

Wind: 7.5 miles/hour from NW at 10 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 919 yards --- (1100 ppm = AEGL-3 [60 min])
  Orange: 1.2 miles --- (160 ppm = AEGL-2 [60 min])
  Yellow: 2.3 miles --- (30 ppm = AEGL-1 [60 min])
```






White Oak Frozen Foods
Ammonia Release July
ALOHA Source Point
SYMBOLS
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
Legend
Orange Threat Zone 160 ppm = AEGL-2 (60 min)
Red Threat Zone 1100 ppm = AEGL-3 (60 min)
Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
Google Earth
1 mi
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4.4 Mitigation Measures

The major rail and highway transportation corridors in the city of Merced are parallel to each other and run generally northwest to southeast through the city. The BNSF railway is located north of the downtown area and parallels Santa Fe Drive and East Santa Fe Avenue. The UP railway is generally adjacent to and parallels the Highway 99 Freeway, which is located immediately adjacent to and southwest of downtown Merced. The area southwest of the Highway 99-UP corridor is primarily older, higher density, lower income residential, and populated by a significant portion of non-English speaking residents.

The downtown area also contains numerous public buildings, medical facilities, schools, and a significant homeless population.

Weather patterns indicate that the two major wind directions are parallel to the transportation corridors, which will result in toxic plumes travelling along the transportation corridor in either direction depending upon the wind direction.

From a demographic standpoint, the area of the transportation corridor is the most challenging area of the city, in the event that an evacuation is required due to a major chlorine or ammonia release incident. Evacuations could be undertaken to remove vulnerable populations from the incident area. Shelters could be set up, generally in northern parts of the city in facilities such as schools, churches, public buildings, and the University of California at Merced. In addition, shelter-in-place procedures will need to be implemented to protect the population in the area. Shelter-in-place procedures are outlined in Appendix 11 of the Merced County Area Plan Update, which was recently completed in June 2018.

Due to the large vulnerable population in the transportation corridor, it is essential that first responders be proactive in attempting to remove/shut down the source of the release. This will require the following:

- Proper PPE, including the ability to respond to the source of the leak in Level A and Level B conditions.
- Proper equipment to enable first responders to quickly mitigate the release.
- Training of emergency personnel to respond quickly and proactively to any release.
- Mutual aid agreements between the response agencies within the city of Merced (city and county) and with adjacent jurisdictions.
- Coordination with Police Departments, County Health Officials, and CalOES in the event of an incident.

5.0 Crude Oil Rail Incident

This section discusses a crude oil release incident from a rail car at the UP at G street, which is essentially in the same location as the UP at Highway 99 discussed above in Section 4.2. The scenario considers that a release of sweet crude oil or Bakken crude oil (UN # 1267) from a 30,000-gallon tank car has occurred and that the spilled contents have ignited. Note that the information outlined below is also applicable to a release gasoline (UN ID #1203) from a large tanker truck.

Although not as dangerous to the public as a release of chlorine or anhydrous ammonia, transportation of Bakken crude oil via rail or gasoline via tanker truck through the city of Merced is a much more frequent occurrence than transportation of chlorine or anhydrous ammonia. Bakken crude is often carried on unit trains where all of the rail cars on the train contain Bakken crude oil. On the other had gasoline tankers are individual units of transport, but due to the gasoline requirements of retail gasoline stations, gasoline tankers travel through all parts of the city.

Numerous recent regulations and other documents regarding oil and other hazardous materials transport by rail have been created. They are outside of the scope of this CRA, but an abbreviated list of these documents is as follows:

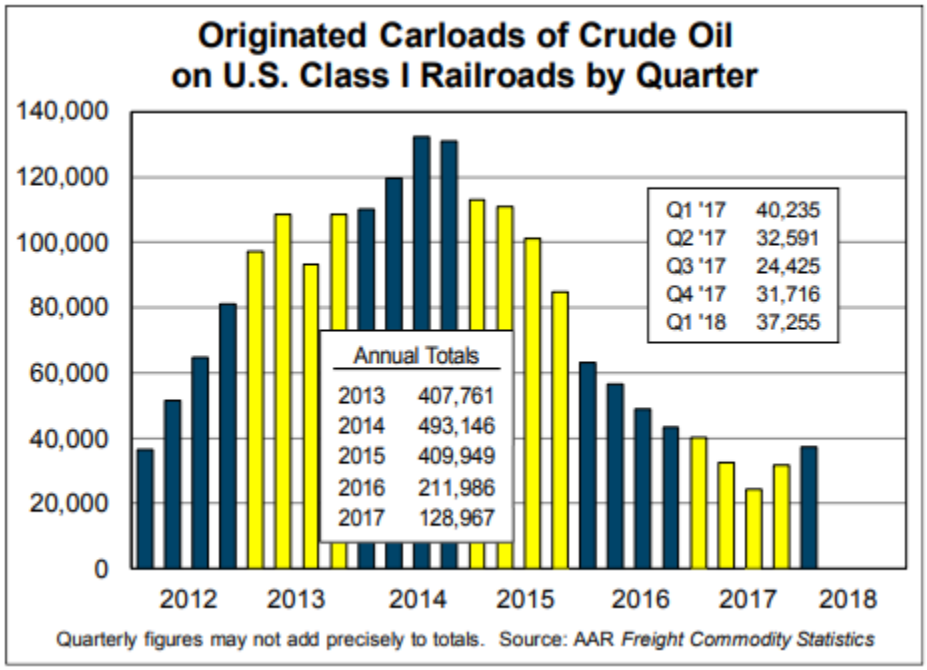
> California State Board of Equalization, October 2018, Railroad Accident Preparedness and Immediate Response Fee, Chapter 7, California Emergency Services Act, on line at http://www.boe.ca.gov/lawguides/business/current/btlg/vol4/rrapir/rrapir-ch7-all.html.
>
> USDOT, PHMSA, May 8, 2015, Hazardous Materials: Enhanced Tank Car Standards and Operation Controls for High-Hazard Flammable Trains, Final Rule, on line at https://www.gpo.gov/fdsys/pkg/FR-2015-05-08/pdf/2015-10670.pdf.
>
> State of California Interagency Rail Safety Working Group, June 10, 2014, Oil by Rail Safety in California, Preliminary Findings and Recommendations, on line at https://www.caloes.ca.gov/FireRescueSite/Documents/IRSWG-Oil%20By%20Rail%20Safety%20in%20California.pdf.

General Information covering rail transport of Bakken crude oil can be found in the following documents:

> U.S. Energy Information Administration, 2018, Petroleum and Other Liquids, U.S. Movements of Crude Oil by Rail, on line at https://www.eia.gov/petroleum/transportation/#tabs-summary-1.
>
> American Association of Railroads, June 2018, U.S. Rail Crude Oil Traffic, on line at https://www.aar.org/wp-content/uploads/2018/07/AAR-US-Rail-Crude-Oil-Traffic.pdf.

Bakken crude oil is one of the most widely transported chemicals in the United States. In July 2018, 228,000 barrels per day were in rail transit across the United States. Latest available American Association of Railroads data are show below concerning the transportation of Bakken crude oil across the United States. At its peak in 2014 crude oil accounted for 1.6% of total

originated carloads on Class I railroads, and it has declined to less than 0.5% in 2017, followed by a modest increase in the fourth quarter 2017 and the first quarter 2018.



Bakken crude oil is a highly flammable substance, both in the liquid and vapor phase, as Bakken crude oil contains a higher concentration of volatile organic compounds relative to other types of crude oils.. Vapors are heavier than air, and liquid is lighter than water. Rail car incidents involving the release of Bakken Crude oil can result in spilled liquid, with or without ignition, ignition resulting in small to large fires, and potential vapor explosion. Bakken crude oil is more prone to explosion than other crude oils.

Health effect of exposure to crude oil are contained in the following documents:

> ConocoPhillips, May 19, 2014, Bakken Crude Oil, Sweet Safety Data Sheet, on line at http://static.conocophillips.com/files/resources/20140530-825378-bakken-crude-oil-sweet.pdf.
>
> CDC, Light crude Oil and Your Health, on line at https://www.cdc.gov/nceh/oil_spill/docs/Light_Crude_Oil_and_Your_Health.pdf.

According to the CDC exposure to elevated concentrations Bakken crude oil can result in the following symptoms:

- Skin irritation.
- Eye irritation.
- Inhalation irritation.

- May be fatal if swallowed.
- Repeated exposure may cause organ damage.
- Suspected carcinogen.

Bakken crude oil is also toxic to aquatic life. Characteristics of Bakken crude oil are contained on Conoco Phillips Safety Data Sheet (Appendix F).

Information concerning the emergency response to a crude oil spill from a rail accident/incident is summarized from information obtained from the following references:

National Fire Protection Association (NFPA), *High Hazard Flammable Trains (HHFT), On-Scene Incident Commander Field Guide*, NFPA Standard 472.

USDOT, 2016, Emergency Response Guidebook, on line at https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/ERG2016.pdf.

CSX, Emergency Response to Unit Train Incidents, on line at http://www.btfire.org/ftp/Documents/CSX%20Unit%20Train%20ER%20Guide.pdf.

USDOT-PHMSA, October 1, 2015, Transportation Rail Incident Preparedness & Response: Flammable Liquid Trains, on line at http://dothazmat.vividlms.com/docs/Instructor-Lesson-Plan/TRIPR-Comprehensive-Instructor-Lesson-Plan.pdf.

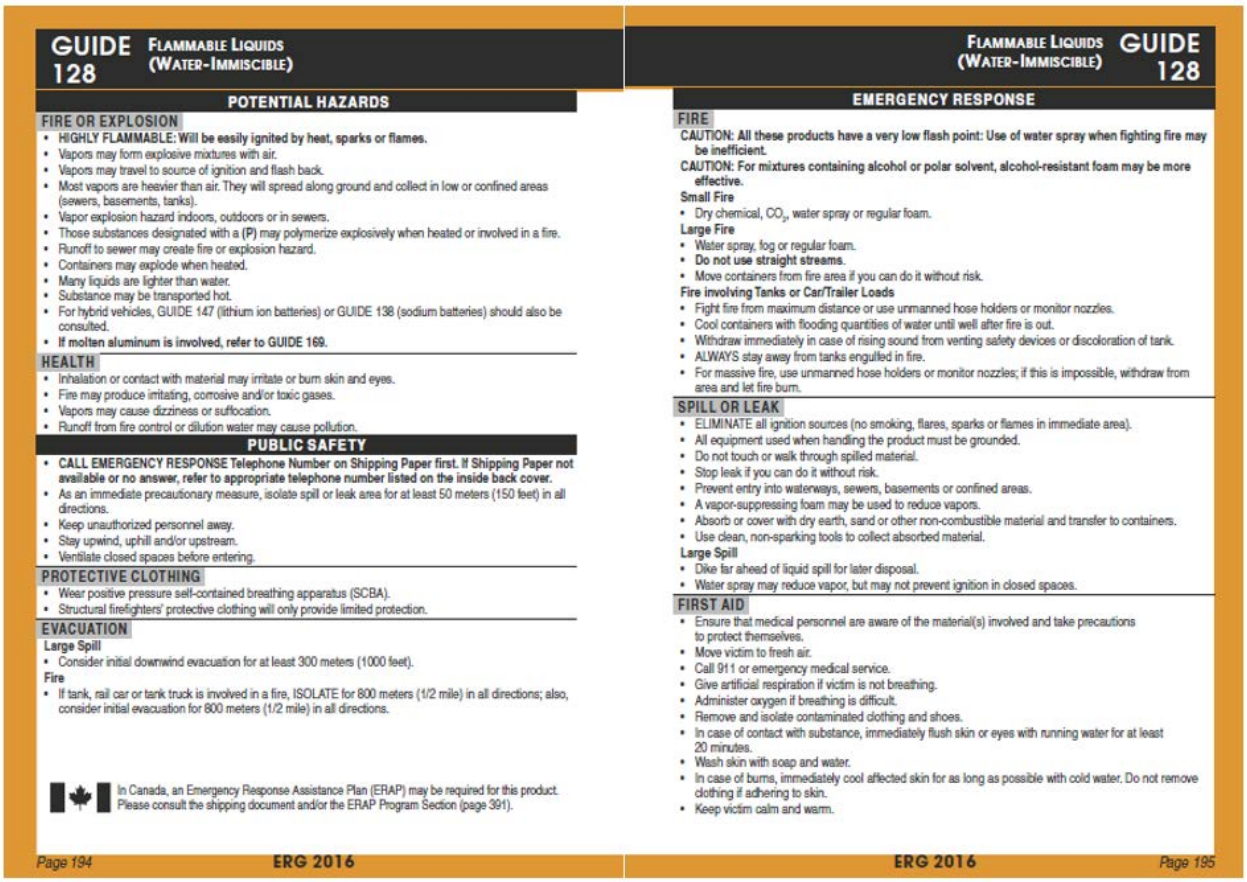
The physical and chemical properties of crude oil (UN#1267) are tabulated from the above-referenced NFPA document and are shown below:

Table 1: Physical and chemical properties of crude oil and related products that may be transported in HHFT's

TABLE 1	LIGHT SWEET CRUDE OIL	DILBIT/SYNBIT (BITUMEN WITH DILUENT*)	BITUMEN (OIL SANDS)	DILUENT
TRANSPORTED AS HAZMAT	Yes - DOT Class 3, UN1267 (ERG Guide No. 128)	Yes - DOT Class 3, UN1267 (ERG Guide No. 128)	Maybe - DOT Class 9, UN3257 (ERG Guide No. 128) If shipped above 212° F and below its flash point	Yes - DOT Class 3, UN1268 or UN 3295 (ERG Guide No. 128)
FLASH POINT	Varies: -30° F - 104° F	Range: 0.4° F (dilbit) - 68° F (synbit)	330° F	<-30° to -4F° F
BOILING POINT	Varies: PGI = <95° F, PGII = >95° F	95° F - >500° F	554° F	100 - 118°F
REID VAPOR PRESSURE	8 - 14 psi	11 psi	4 psi	8 - 14 psi
VISCOSITY** IN CENTIPOISE (CPS) @ ~75 °F:	6-8 (Low - Flowable)	60-70 (Low - Flowable)	100,000-1,000,000 (very high - semi solid when cold)	6-8 (Low - Flowable)
API GRAVITY	Bakken 40° - 43°	Will vary based on amount of diluent; approximately 20°	Approximately 8°	
SPECIFIC GRAVITY	0.80 - 0.8 (Floats on water)	0.90-0.98 Initially (Floats then sinks as light ends volatilize)	0.95 - 1.05 (Will sink in Salt Water; Likely to sink in Fresh Water)	0.480-0.75 (Floats on water)
VAPOR DENSITY	1.0 - 3.9 (Heavier than Air)	>1 (Heavier than Air)	>1 (Heavier than Air)	1.0 - 3.9 (Heavier than Air)
HYDROGEN SULFIDE	0.00001% (potential to accumulate as H_2S in head space of vessels) If H2S concentrations ≥ 0.5% or 5,000 ppm shipped as Sour Crude DOT Class 3, UN3494 (ERG Guide No. 131)	<0.1% (potential to accumulate as H_2S in head space of vessels)	Negligible (contains bonded sulfur, generally not available as H_2S)	<0.5

TABLE 1 (continued)	LIGHT SWEET CRUDE OIL	DILBIT/SYNBIT (BITUMEN WITH DILUENT*)	BITUMEN (OIL SANDS)	DILUENT
BENZENE	Generally <1.0%	0% - 5%	Negligible (Monitor, however it should not be a concern)	0% - 5%
EVAPORATION RATE (TEMPERATURE DEPENDENT)	>1 (High Evaporation Rate)	Diluent will evaporate quickly, Bitumen will not evaporate	None	>1 (High Evaporation Rate)
SOLUBILITY	Low to Moderate	Moderate	Extremely Low	Slightly Soluble
WEATHERING	Quickly	Diluent weathers fairly quickly, will then form Tar Balls	Very Slow - Like Asphalt	Quickly
RESIDUES	Films and Penetrates	Films and Penetrates - residue is very persistent	Heavy Surface contamination - very Persistent	Films and Penetrates
AIR MONITORING	**LEL** (combustible gas indicator), **Benzene** (direct read or tubes), **H_2S** (direct read or tubes)	**LEL** (combustible gas indicator), **Benzene** (direct read or tubes), **H_2S** (direct read or tubes)	**LEL** (combustible gas indicator), **Benzene** (direct read or tubes), **H_2S** (direct read or tubes)	**LEL** (combustible gas indicator), **Benzene** (direct read or tubes), **H_2S** (direct read or tubes)
RECOMMENDED PPE	Clothing: Structural FF Clothing / Fire Retardant Clothing (subject to task and air monitoring) Respiratory Protection: SCBA/APR/Nothing (subject to Task & benzene, H_2S & particulate concentrations)	Clothing: Structural FF Clothing / Fire Retardant Clothing (subject to task and air monitoring) Respiratory Protection: SCBA/APR/Nothing (subject to Task & benzene, H_2S & particulate concentrations)	Clothing: Thermal Protection (if hot) / Fire Retardant Clothing (subject to task and air monitoring) Respiratory Protection: SCBA/APR/Nothing (subject to Task & benzene, H_2S & particulate concentrations)	Clothing: Structural FF Clothing / Fire Retardant Clothing (subject to task and air monitoring) Respiratory Protection: SCBA/APR/Nothing (subject to Task & benzene, H_2S & particulate concentrations)
COMMUNITY, WORKER & RESPONDER SAFETY	Flammability, Benzene, LEL, H_2S	Flammability, Benzene, LEL, H_2S, PAH's (poly-aromatic hydrocarbons)	H_2S, PAH's (poly-aromatic hydrocarbons)	Flammability, Benzene, LEL, H_2S

The Emergency Response Guidebook (ERG) contains information on response procedures to a rail car or tank truck incident. This information is contained in the Orange Section of the ERG as Guide No. 128, and is shown below as follows:



GUIDE 128 FLAMMABLE LIQUIDS (WATER-IMMISCIBLE)

POTENTIAL HAZARDS

FIRE OR EXPLOSION

- **HIGHLY FLAMMABLE: Will be easily ignited by heat, sparks or flames.**
- Vapors may form explosive mixtures with air.
- Vapors may travel to source of ignition and flash back.
- Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks).
- Vapor explosion hazard indoors, outdoors or in sewers.
- Those substances designated with a (P) may polymerize explosively when heated or involved in a fire.
- Runoff to sewer may create fire or explosion hazard.
- Containers may explode when heated.
- Many liquids are lighter than water.
- Substance may be transported hot.
- For hybrid vehicles, GUIDE 147 (lithium ion batteries) or GUIDE 138 (sodium batteries) should also be consulted.
- **If molten aluminum is involved, refer to GUIDE 169.**

HEALTH

- Inhalation or contact with material may irritate or burn skin and eyes.
- Fire may produce irritating, corrosive and/or toxic gases.
- Vapors may cause dizziness or suffocation.
- Runoff from fire control or dilution water may cause pollution.

PUBLIC SAFETY

- **CALL EMERGENCY RESPONSE Telephone Number on Shipping Paper first. If Shipping Paper not available or no answer, refer to appropriate telephone number listed on the inside back cover.**
- As an immediate precautionary measure, isolate spill or leak area for at least 50 meters (150 feet) in all directions.
- Keep unauthorized personnel away.
- Stay upwind, uphill and/or upstream.
- Ventilate closed spaces before entering.

PROTECTIVE CLOTHING

- Wear positive pressure self-contained breathing apparatus (SCBA).
- Structural firefighters' protective clothing will only provide limited protection.

EVACUATION

Large Spill

- Consider initial downwind evacuation for at least 300 meters (1000 feet).

Fire

- If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions.

In Canada, an Emergency Response Assistance Plan (ERAP) may be required for this product. Please consult the shipping document and/or the ERAP Program Section (page 391).

Page 194 ERG 2016

FLAMMABLE LIQUIDS (WATER-IMMISCIBLE) **GUIDE 128**

EMERGENCY RESPONSE

FIRE

CAUTION: All these products have a very low flash point: Use of water spray when fighting fire may be inefficient.

CAUTION: For mixtures containing alcohol or polar solvent, alcohol-resistant foam may be more effective.

Small Fire

- Dry chemical, CO_2, water spray or regular foam.

Large Fire

- Water spray, fog or regular foam.
- **Do not use straight streams.**
- Move containers from fire area if you can do it without risk.

Fire involving Tanks or Car/Trailer Loads

- Fight fire from maximum distance or use unmanned hose holders or monitor nozzles.
- Cool containers with flooding quantities of water until well after fire is out.
- Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank.
- ALWAYS stay away from tanks engulfed in fire.
- For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

SPILL OR LEAK

- ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area).
- All equipment used when handling the product must be grounded.
- Do not touch or walk through spilled material.
- Stop leak if you can do it without risk.
- Prevent entry into waterways, sewers, basements or confined areas.
- A vapor-suppressing foam may be used to reduce vapors.
- Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers.
- Use clean, non-sparking tools to collect absorbed material.

Large Spill

- Dike far ahead of liquid spill for later disposal.
- Water spray may reduce vapor, but may not prevent ignition in closed spaces.

FIRST AID

- Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.
- Move victim to fresh air.
- Call 911 or emergency medical service.
- Give artificial respiration if victim is not breathing.
- Administer oxygen if breathing is difficult.
- Remove and isolate contaminated clothing and shoes.
- In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes.
- Wash skin with soap and water.
- In case of burns, immediately cool affected skin for as long as possible with cold water. Do not remove clothing if adhering to skin.
- Keep victim calm and warm.

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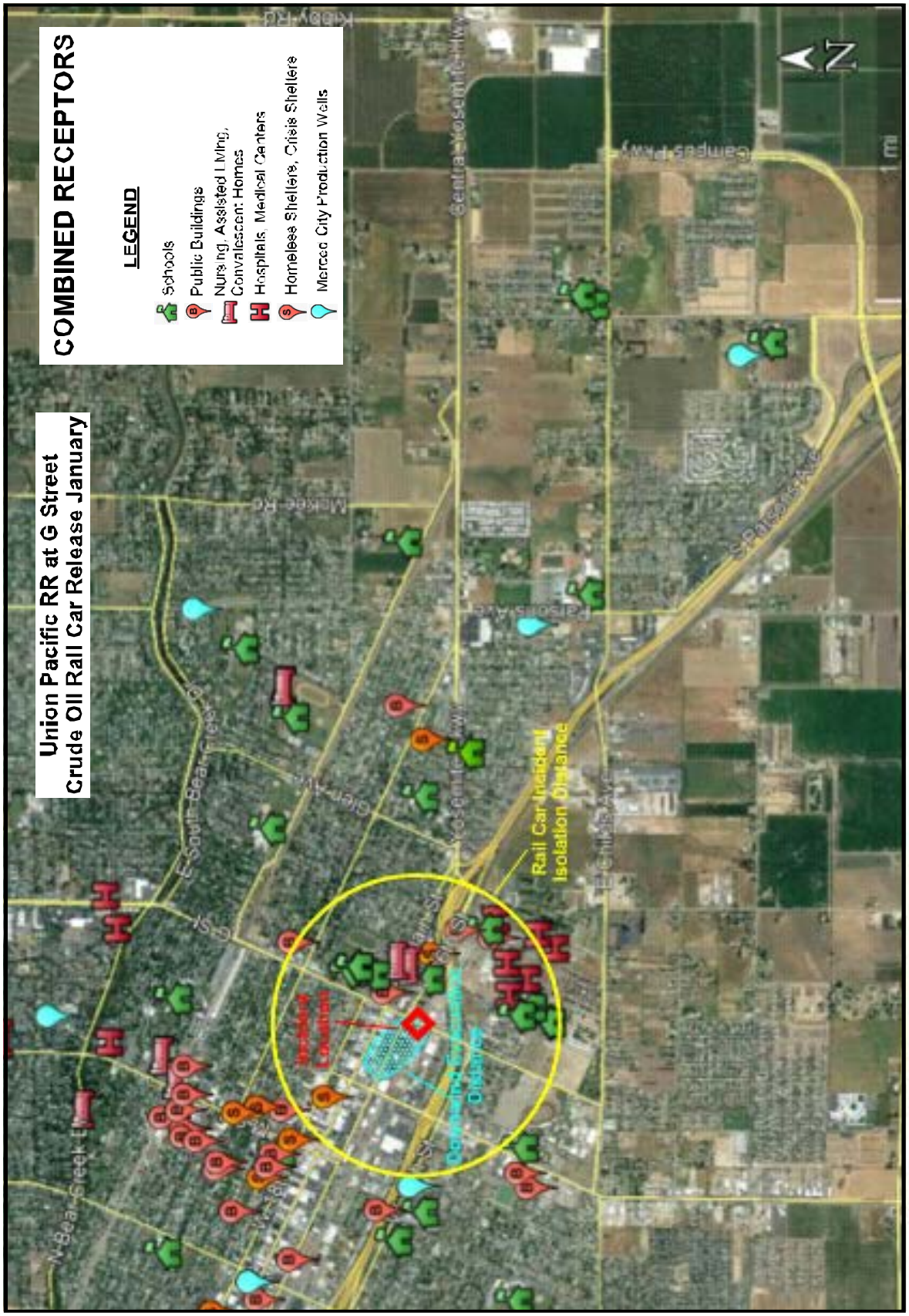
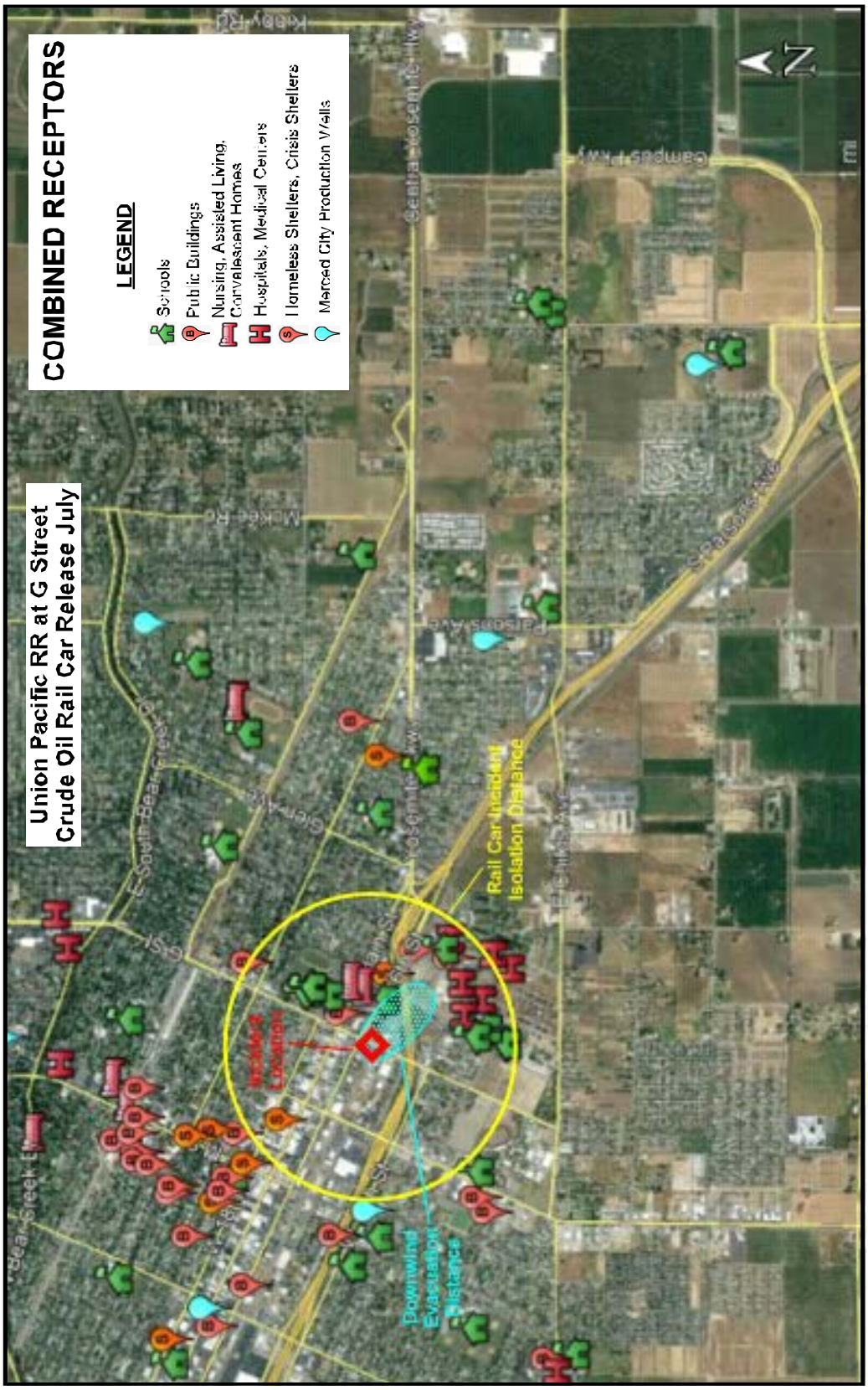
Evacuation distances are shown above and are summarized below:

- Downwind evacuation for 300 meters or 1,000 feet.
- If a tank truck or rail car is involved, isolate for 800 meters or ½ mile in all directions and consider evacuation in this same area as well.

The following map illustrates the evacuation distances for a tank car incident at the BNSF railway at Highway 140 location for the January and July scenarios.


COMBINED RECEPTORS
LEGEND
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
Union Pacific RR at G Street
Crude Oil Rail Car Release January
Rail Car Incident Isolation Distance
Vehicle Location
Downwind Isolation Distance
Kiddy Rd
Campus Pkwy
Mckee Rd
Parsons Ave
E South Bear Creek
N Bear Creek
E Childs Ave
N


COMBINED RECEPTORS
LEGEND
Schools
Public Buildings
Nursing, Assisted Living, Convalescent Homes
Hospitals, Medical Centers
Homeless Shelters, Crisis Shelters
Merced City Production Wells
Union Pacific RR at G Street
Crude Oil Rail Car Release July
Rail Car Incident Isolation Distance
Downwind Evacuation Distance
N
mi

The downwind evacuation zone and the rail car incident isolation distance for a crude oil release is considerably than that shown for chlorine and anhydrous ammonia as described above in Section 4. On the other hand, transport of containers of crude oil by rail through the city of Merced is more frequent than that of chlorine ore anhydrous ammonia, resulting a greater chance of an incident occurring within the city.

Mitigation measure employed by first responders with respect to a crude oil rail car accident and resulting fire covers 3 different areas:

1. Evacuation and isolation of non-essential personnel and containment of the spill.
    - The public and non-essential personnel should be removed from both the downwind evacuation zone and the isolation area.
    - Attempts should be made to contain any liquid migration into waterways, storm drains, sewers or other sensitive receptors.

2. Utilization of proper response equipment and procedures.
    - Use of water spray, fog, or dry chemical or carbon dioxide foams. (DO NOT USE STRAIGHT STREAMS OF WATER).
    - Use of water to cool affected containers (tank cars).
    - Application of water from a distance.
    - Use of water spray to knock down vapors.
    - Use of proper protective equipment.

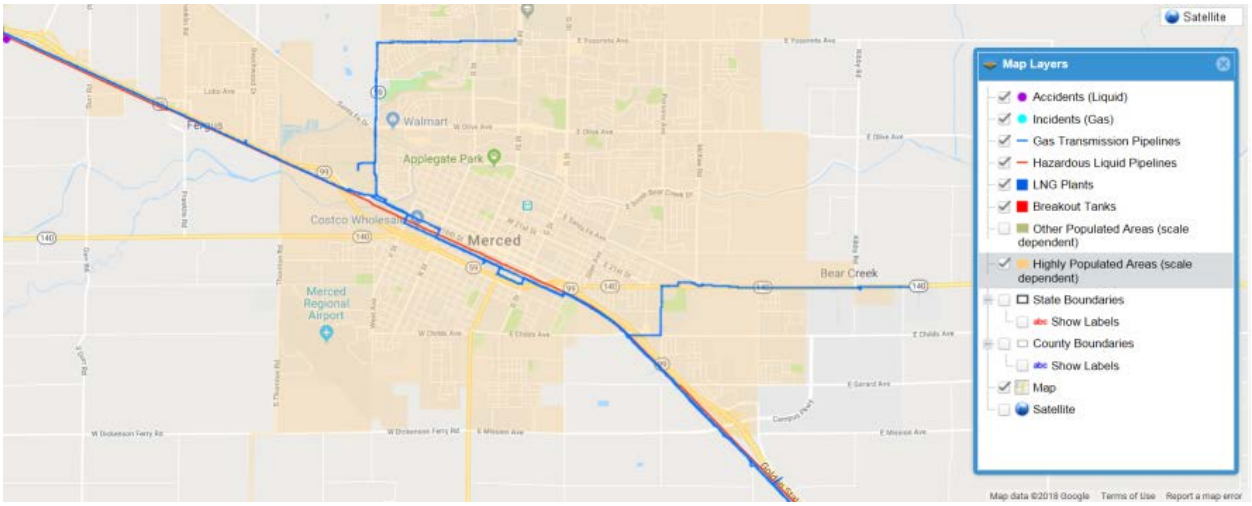
3. Ensure that all first responders have been properly trained in the mitigation procedures of a rail car and tanker truck accident/incident.

6.0 Pipeline Incidents

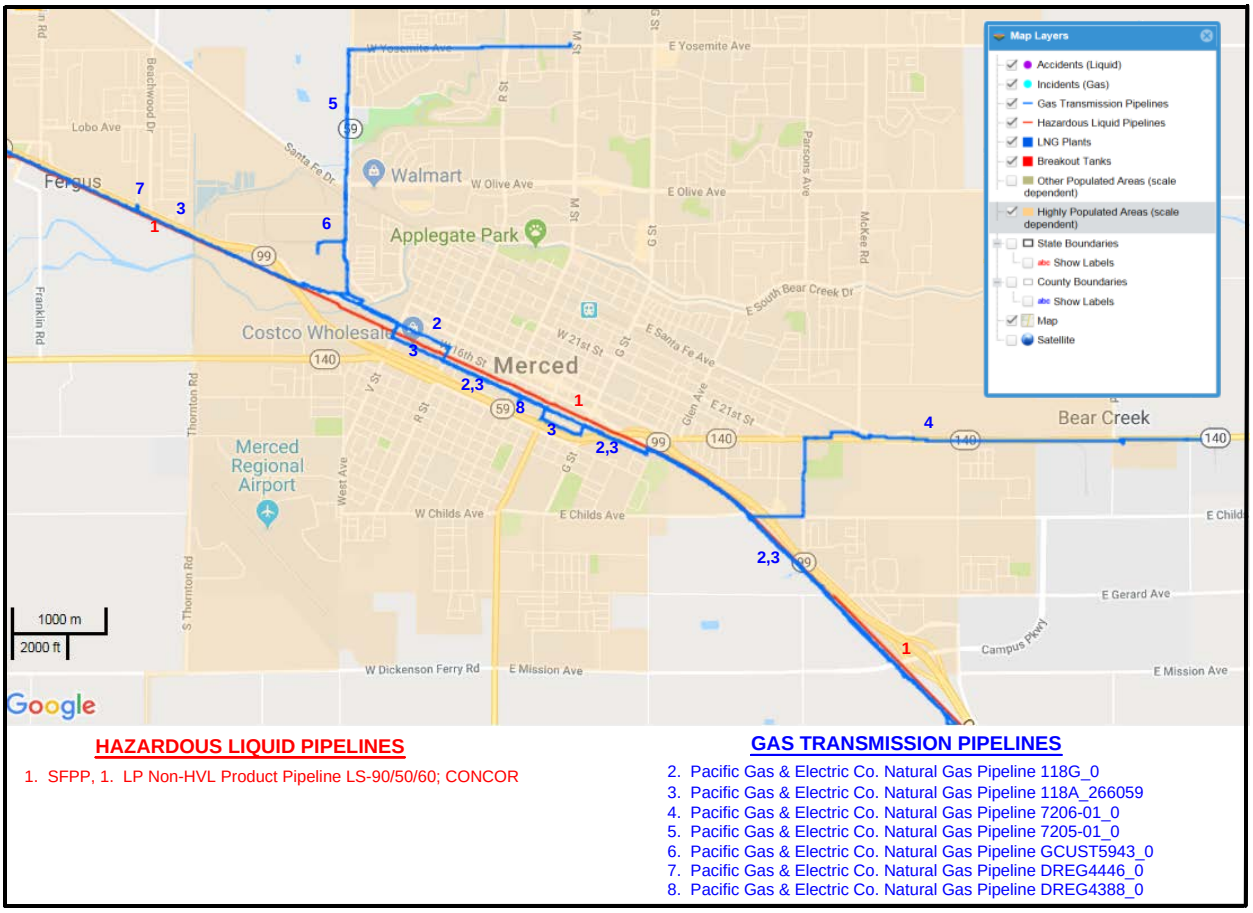
Release incidents can occur along pipelines that can endanger populations located adjacent to the pipelines, as well as those in downstream areas from the pipelines. This is particularly true with the natural gas pipelines, and was evidenced in the 2010 San Bruno PG&E natural gas pipeline explosion and fires.

The following information was taken directly from the Flow Study, and it summarizes the underground pipelines running through the city of Merced.

Information concerning underground pipelines in the City of Merced was obtained from the website of the National Pipeline Mapping System (NPMS) at https://www.npms.phmsa.dot.gov/. A map showing the pipeline locations for the City of Merced and surrounding area is shown below.



A detailed map showing the locations of the pipelines in the City of Merced is shown below. Numbers on the map refer to the individual pipelines, and this information is contained in Appendix G.



HAZARDOUS LIQUID PIPELINES

1. SFPP, 1. LP Non-HVL Product Pipeline LS-90/50/60; CONCOR

GAS TRANSMISSION PIPELINES

2. Pacific Gas & Electric Co. Natural Gas Pipeline 118G_0
3. Pacific Gas & Electric Co. Natural Gas Pipeline 118A_266059
4. Pacific Gas & Electric Co. Natural Gas Pipeline 7206-01_0
5. Pacific Gas & Electric Co. Natural Gas Pipeline 7205-01_0
6. Pacific Gas & Electric Co. Natural Gas Pipeline GCUST5943_0
7. Pacific Gas & Electric Co. Natural Gas Pipeline DREG4446_0
8. Pacific Gas & Electric Co. Natural Gas Pipeline DREG4388_0

Kinder Morgan's Santa Fe Pipeline Partners (SFPP) operates a liquid non-Highly Volatile Liquid (non-HVL) liquid pipeline that runs parallel to Highway 99. The remainder of the pipelines running through the city of Merced are natural gas pipelines operated by Pacific Gas & Electric Company. The main gas line parallels Highway 99.

The major pipelines run along the Highway 99 transportation corridor, and as such present an additional risk for an incident in this area. The highest concentration of highway transportation of hazardous materials, and UP rail transportation of hazardous materials also runs along this corridor.

In order to mitigate any negative results due to a release incident along the pipelines, the City of Merced should coordinate with the pipeline operators to immediately isolate the affected lines. Isolation will ensure that a minimal amount of the population is affected by the incident. In addition, evacuation procedures should be in place to quickly and efficiently remove the affected populations from the areas impacted by the incident.

7.0 Summary

Information from the 2015 Risk assessment combined with the data presented in this CRAHM demonstrates that a major area of the city of Merced contains vulnerable high-risk populations that could be affected by a transportation-related hazardous materials accident/incident. The major rail and highway transportation corridors in the city of Merced are parallel to each other and run generally northwest to southeast through the city. The BNSF railway is located north of the downtown area and parallels Santa Fe Drive and East Santa Fe Avenue. The UP railway is generally adjacent to and parallels the Highway 99 Freeway, which is located immediately adjacent to and southwest of downtown Merced. The area southwest of the Highway 99-UP corridor is primarily older, higher density, lower income residential, and populated by a significant portion of non-English speaking residents.

The downtown area also contains numerous public buildings, medical facilities, schools, and a significant homeless population.

In addition, weather patterns indicate that the two major wind directions are parallel to the transportation corridors, which will result in toxic plumes travelling along the transportation corridor in either direction depending upon the wind direction.

The convergence of demographics, transportation routes, and weather patterns indicates that the area of the transportation corridor is the most challenging area of the city, in the event that an evacuation is required due to a hazardous materials release incident. Evacuations could be undertaken to remove vulnerable populations from the incident area. Shelters could be set up, generally in northern parts of the city in facilities such as schools, churches, public buildings, and the University of California at Merced. In addition, shelter-in-place procedures will need to be implemented to protect the population in the area. Shelter-in-place procedures are outlined in Appendix 11 of the Merced County Area Plan Update, which was recently completed in June 2018.

The scenarios shown above in Sections 4, 5, and 6 represent different possibilities of the results of such incidents on the most vulnerable populations in the city of Merced. An incident involving chlorine or ammonia, as outlined in Section 4, could have catastrophic effects on these populations. The best approach to mitigate such an incident is a proactive approach, which allows properly equipped and trained first responders to immediately respond to an incident and work to mitigate/terminate the source of the incident. This approach is paramount to preventing a massive reactive approach which would include movement and protection of a large vulnerable population.

The crude oil release incident scenario as described in Section 5 would not present as serious an issue as a chlorine or ammonia incident, due to a lower toxicity. However, due to the frequency of the movement of crude oil on trains and unit trains throughout the city on a regular basis, the likelihood of a crude oil incident occurring is significantly higher than the occurrence of a chlorine or ammonia release incident. It should also be noted that an incident involving a release from a gasoline tanker truck would be similar to that encountered with a crude oil rail tank car release. Information from the Flow study indicates that gasoline is the most widely transported hazardous commodity through the city of Merced, and transportation of gasoline to service stations within the city allows for a more widespread area of impact. The most important aspect of immediate response to a crude oil or gasoline incident is to allow properly equipped and trained first

responder to proactively mitigate/terminate the source of the incident. The downwind evacuation zone and the rail car incident isolation distance for a crude oil release is considerably less than that shown for chlorine and anhydrous ammonia and could be completed in tandem with the mitigation of the incident.

The locations of the natural gas and liquefied gas lines within the city are well known and the major lines are along the transportation corridor paralleling Highway 99 and the UP rail line. In order to mitigate any negative results due to a release incident along the pipelines, the City of Merced should coordinate with the pipeline operators to immediately isolate the affected lines. Isolation will ensure that a minimal amount of the population is affected by the incident. In addition, evacuation procedures should be in place to quickly and efficiently remove the affected populations from the areas impacted by the incident.

The vulnerable populations within and adjacent to the transportation corridor along Highway 99 are at high risk in the event of a major hazardous materials incident. Because of this situation, a proactive approach to initial response by first responders, is the best approach, as it reduces the need for an overarching reactive response. There are three elements to this approach:

- Proper protective and response equipment, which will allow first responders to react proactively, quickly, and efficiently to a major hazardous materials release incident.
- Comprehensive training, including focused training of first responders to act both proactively and reactively to a major hazardous materials release incident.
- Mutual aid agreements with other local, and state agencies that can immediately provide additional manpower, equipment, and trained assistance to a major hazardous materials release incident.

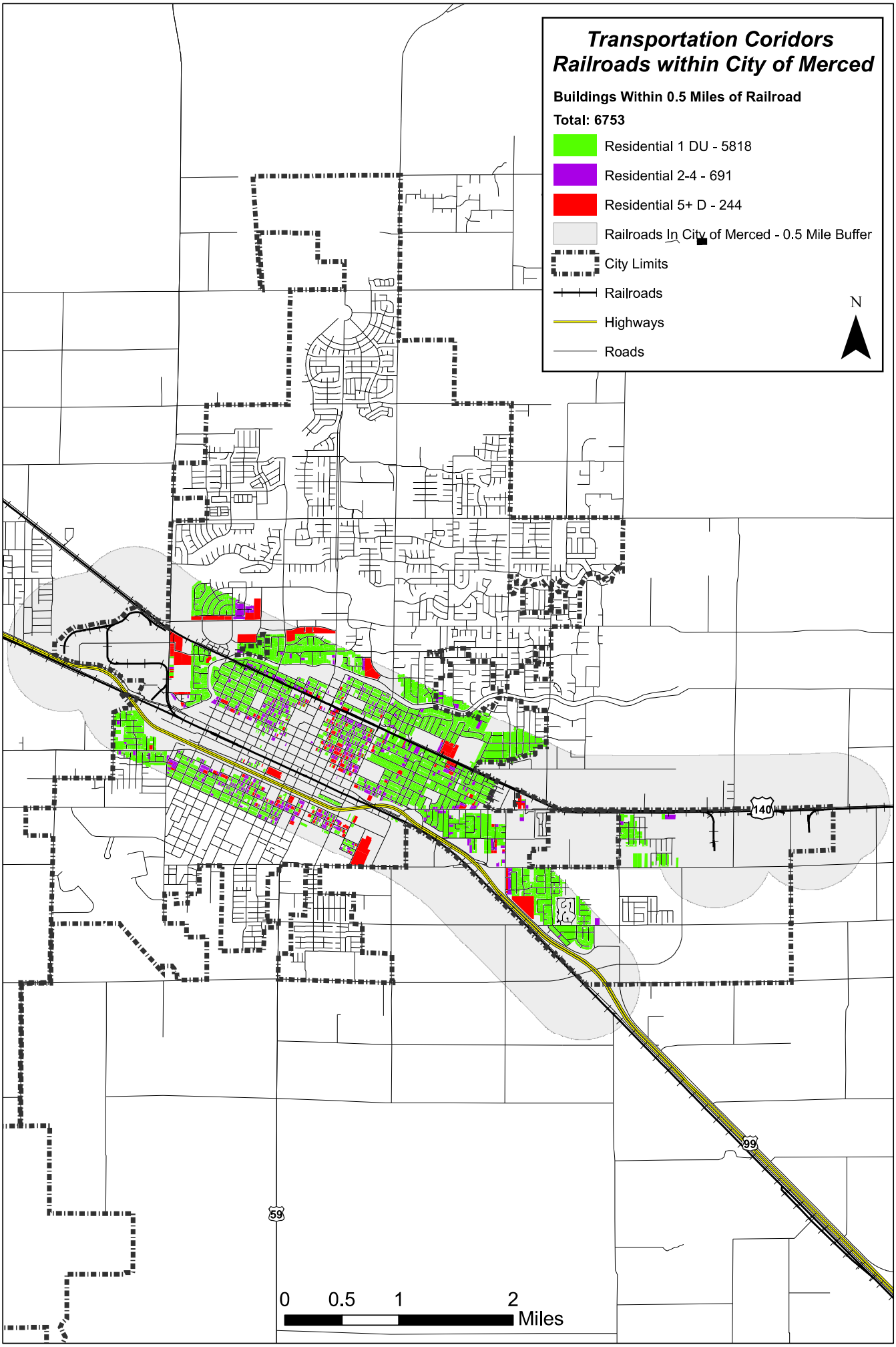
A proactive approach in equipping and training first responders will serve to protect the vulnerable populations within the city of Merced in the event of a transportation-related hazardous material accident/incident. This approach will also minimize disruption of essential services, facilities, and infrastructure, and will ultimately save lives and property.

APPENDICES

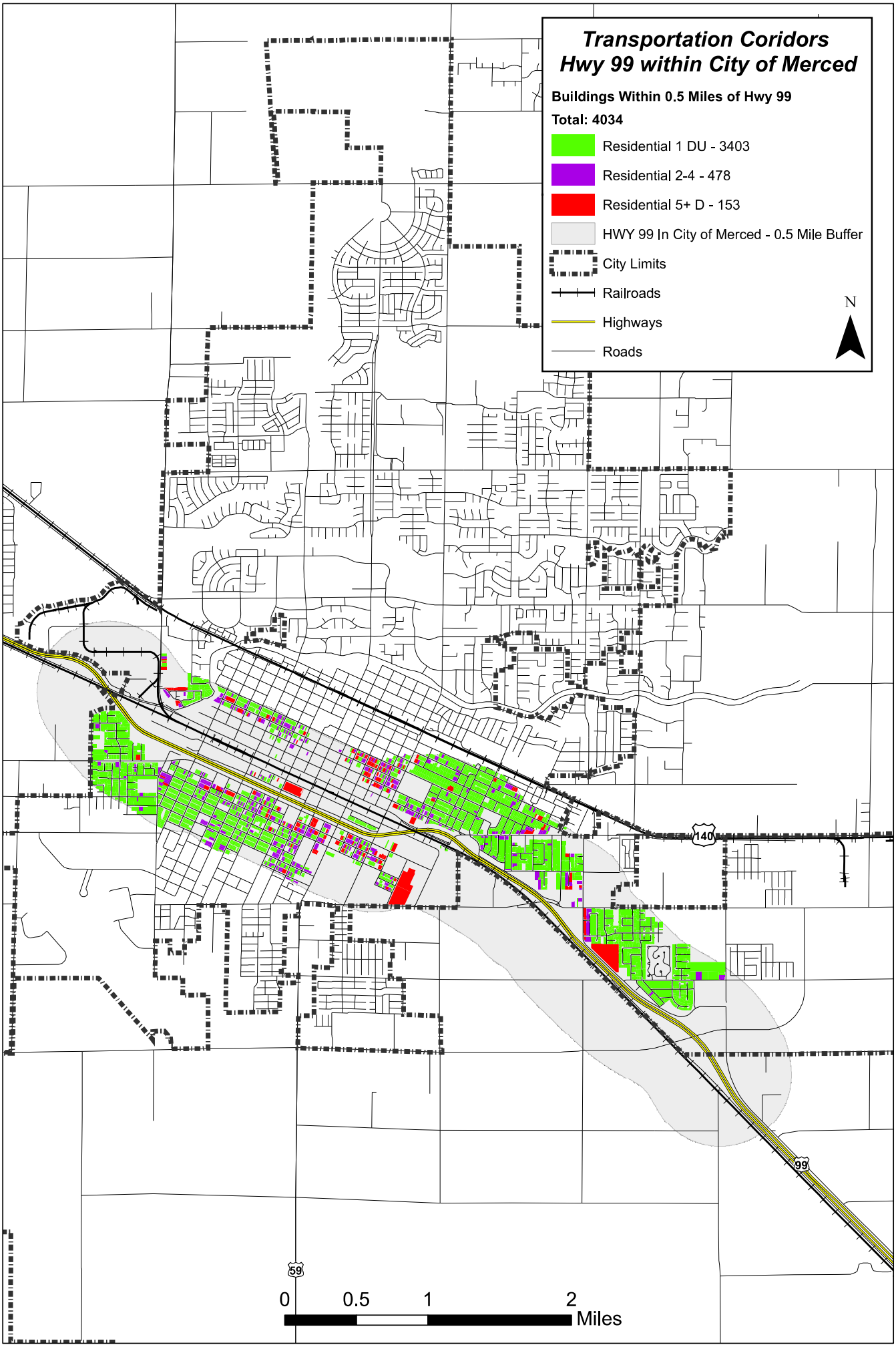
APPENDIX A

Vulnerability Maps

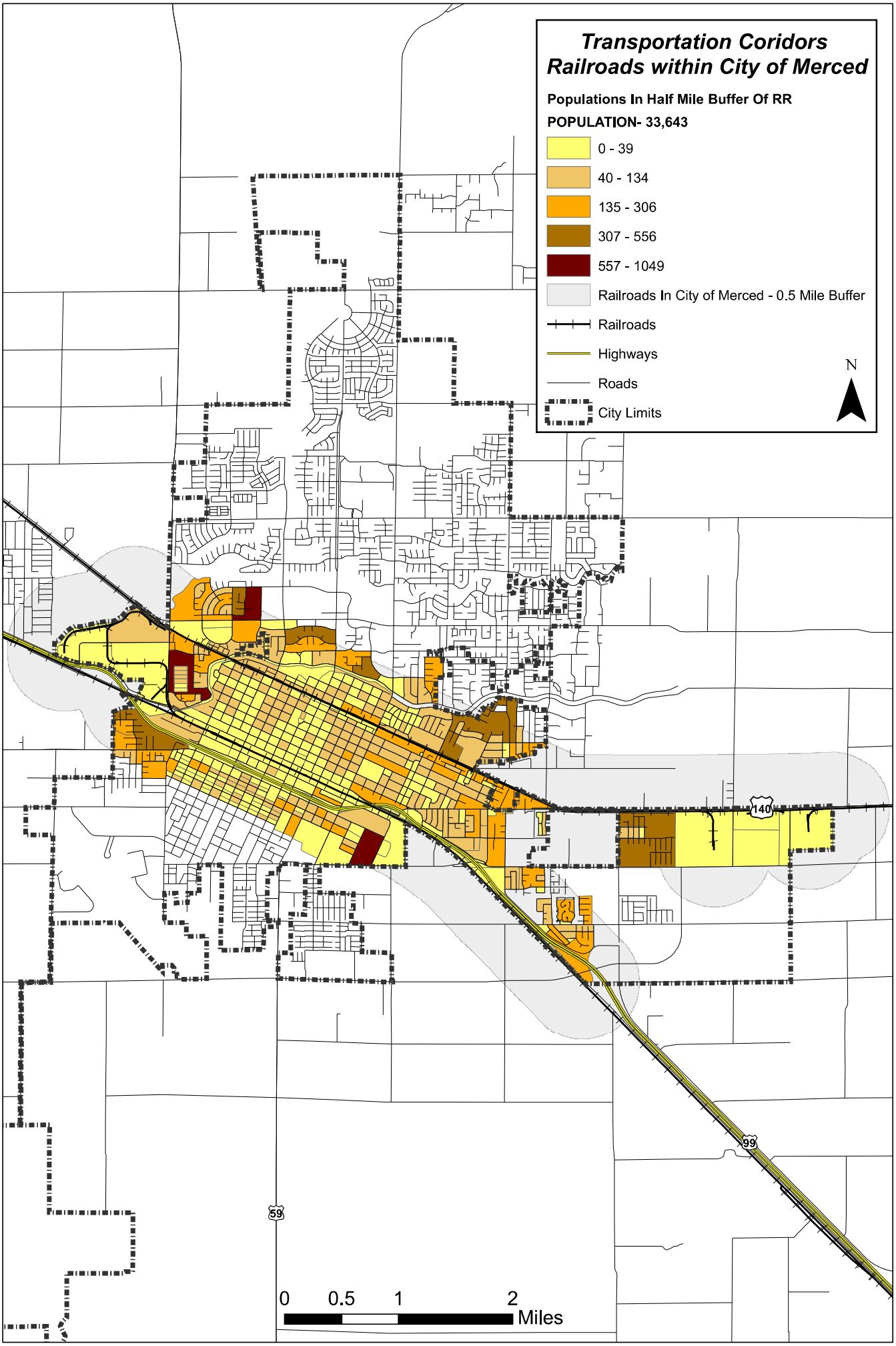
Number of Residential Buildings near Railroads



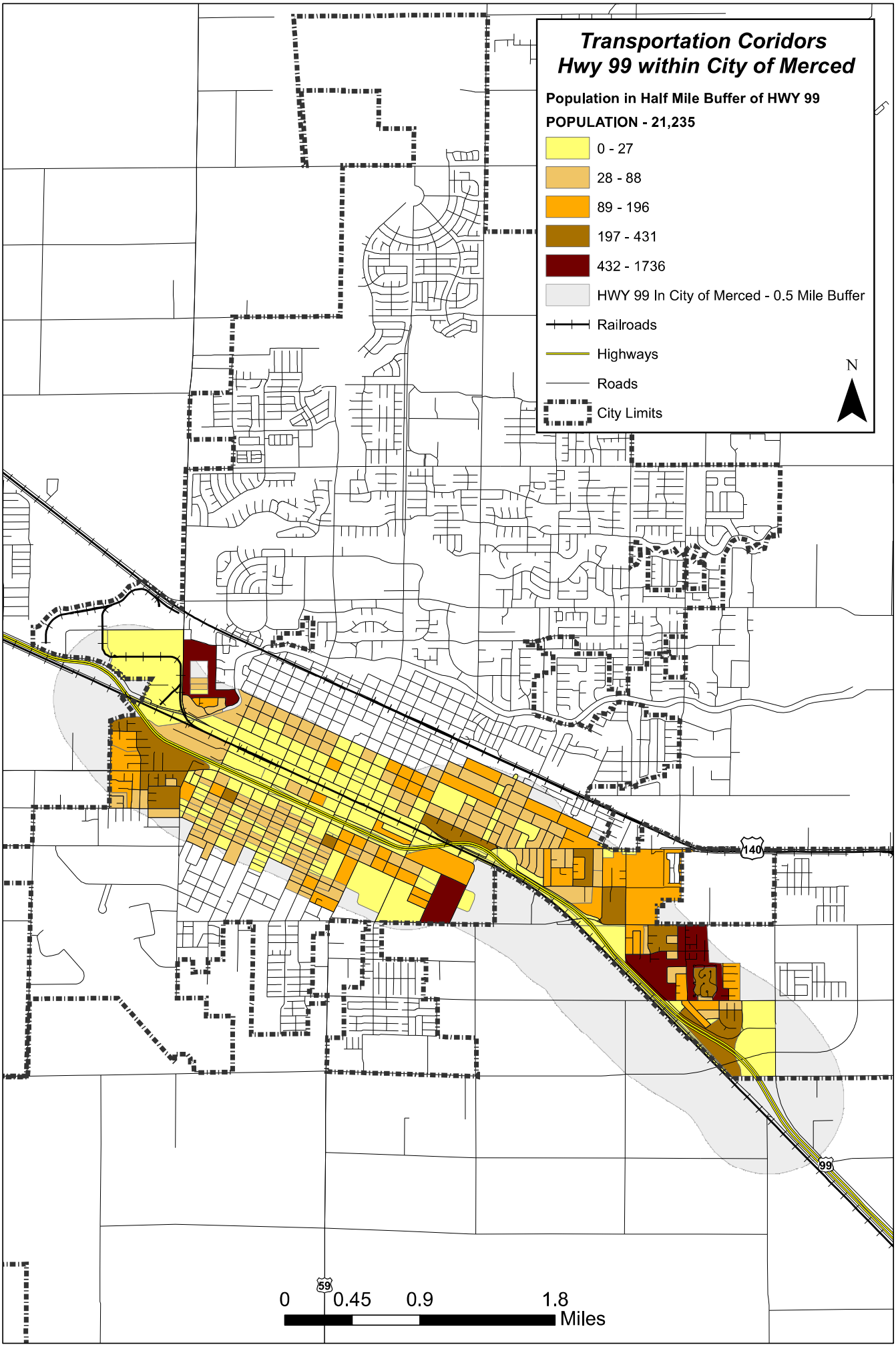
Number of Residential Buildings near Highway



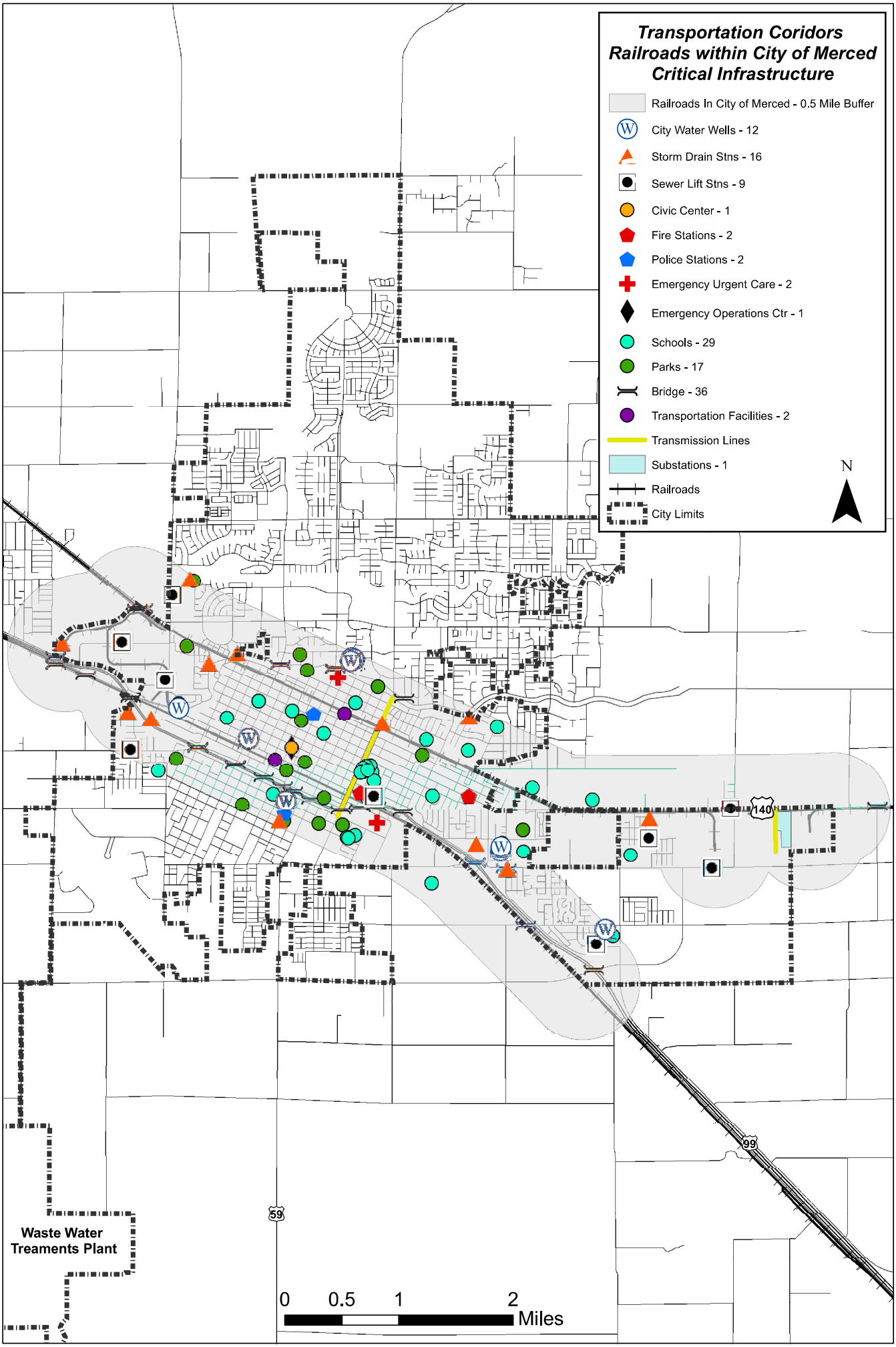
Population Near Railroads



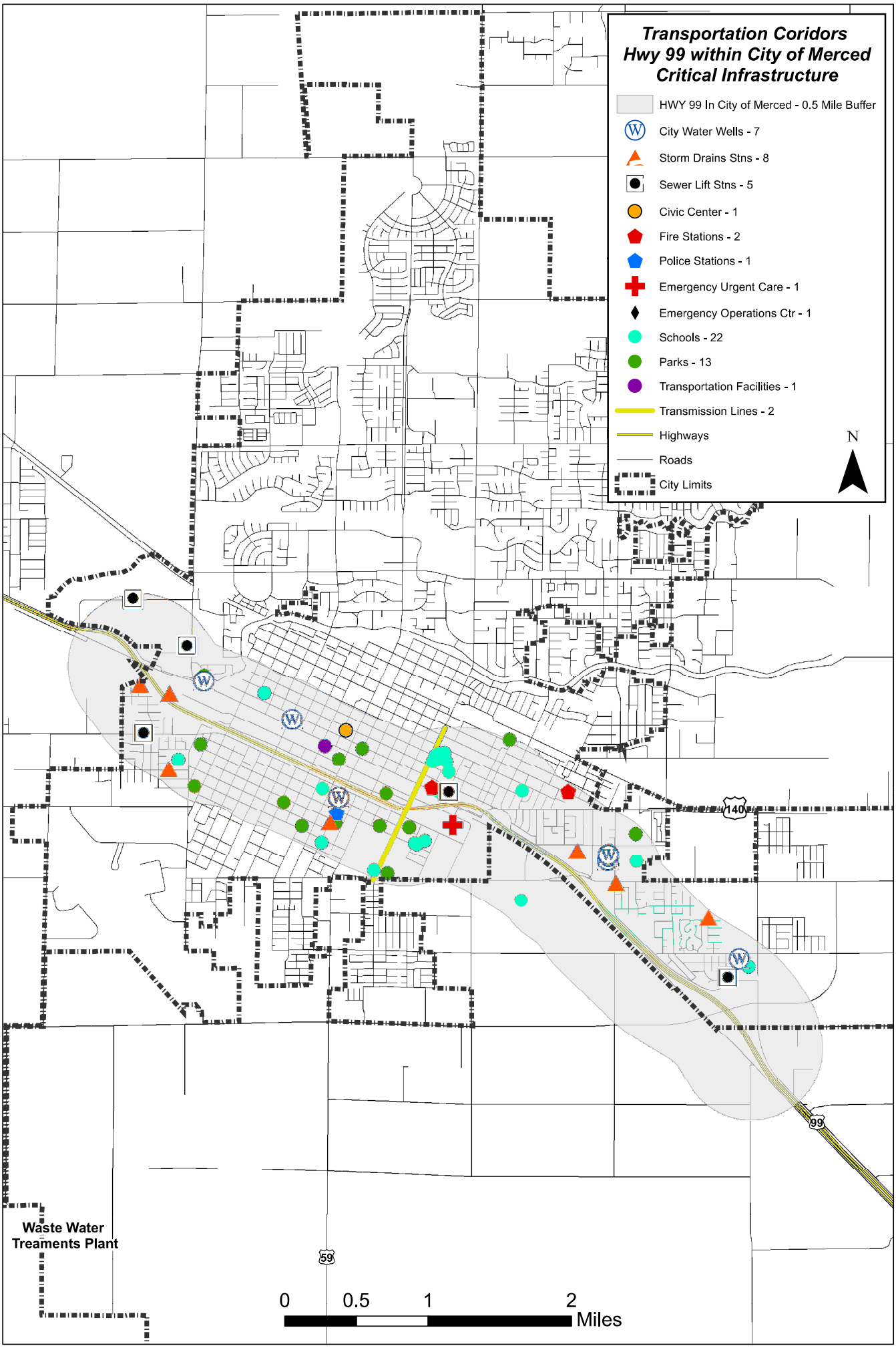
Population Near Highway 99



Critical Facilities near Railroads



Critical Facilities near Highway 99



APPENDIX B

Critical Facilities

RECEPTORS - SCHOOLS			
Receptor Name	**Address**	**Latitude**	**Longitude**
Academia de Trafico	1260 Yosemite Parkway	37.294791	-120.460264
Ada Givens Elementary School	2900 Green Street	37.305746	-120.453864
Advanced Career Institute	1741 Ashby Road	37.310316	-120.508298
Bear Country Pre-School	2115 Wardrobe Avenue	37.297938	-120.520477
Charles Wright Elementary School	900 E. 20th Street	37.296982	-120.462927
Clark Pre-School	211 E. 11th Street	37.290863	-120.476795
Community Day School	1180 E Street	37.292295	-120.476373
Don Stowell Elementary School	251 E. 11th Street	37.291757	-120.47589
Golden Valley High School	2121 E. Childs Avenue	37.288955	-120.450548
Grace Bishop School	2025 E. Santa Fe Avenue	37.297815	-120.44734
Gracey Preschool	945 West Avenue	37.299408	-120.505583
Harvest Christian School	161 E. 16th Street	37.296739	-120.474143
Herbert Hoover Middle School	800 E. 26th Street	37.304432	-120.464895
Independence High School	1900 G Street	37.300194	-120.473373
John C. Fremont Elementary School	1120 W. 22nd Street	37.309517	-120.490941
John Muir Elementary School	300 W. 26th Street	37.30901	-120.475342
Leontine Gracey Elementary School	945 Northwest Avenue	37.300085	-120.506403
Margaret Sheehy Elementary School	1240 W. 6th Street	37.293709	-120.501602
Merced 11th Street Head Start	213 E. 11th Street	37.290863	-120.476795
Merced Adult School	50 E. 20th Street	37.300496	-120.473724
Merced College Traffic School	630 W. 19th Street	37.303982	-120.484737
Merced Head Start	900 Martin Luther King Jr. Way	37.292161	-120.484497
Merced Scholars Charter School	1850 Wardrobe Avenue	37.294833	-120.507569
Merced Valley Community School	1850 Wardrobe Avenue	37.294833	-120.507569
Merced Young Parents Program	260 E. 15th Street	37.293845	-120.471087
Our Lady of Mercy Preschool	1400 E. 27th Street	37.30331	-120.45809
Pioneer Elementary School	2950 E. Gerard	37.280085	-120.435123
Reyes Elementary School	125 S. N Street	37.287551	-120.495498
Sequoia High School	123 W. 18th Street	37.299368	-120.473902
Sierra College of Beauty	1340 W. 18th Street	37.30686	-120.496063
Tenaya Middle School	760 W. 8th Street	37.292438	-120.493921
Valley High School	632 W. 13th Street	37.297001	-120.488437
Weaver Middle School	3076 E. Childs Avenue	37.289334	-120.432178
Weaver Preschool	3076 E. Childs Avenue	37.288676	-120.432752
Wolfe Education Center	732 W. 13th Street	37.29828	-120.490183
Yosemite High School	1900 G Street	37.300194	-120.473373

RECEPTORS - PUBLIC BUILDINGS			
Receptor Name	**Address**	**Latitude**	**Longitude**
California Superior Court	670 W. 22nd Street	37.307126	-120.48329
Meadowbrook Water Co.	2272 Meadowbrook Avenue	37.320948	-120.526649
Merced City Fire Department	99 E. 16th Street	37.297309	-120.474943
Merced City Fire Department Station 54	1425 E. 21st Street	37.296653	-120.457336
Merced City Hall	678 W. 18th Street	37.302981	-120.485641
Merced City Police Department	611 W. 22nd Street	37.307308	-120.48214
Merced City School District	444 W. 23rd Street	37.307005	-120.47945
Merced City School District	933. W. 15th Street	37.301887	-120.491327
Merced City School District	123 S. N Street	37.287387	-120.495739
Merced County Child Support Services	3368 N. State Highway 59	37.325765	-120.503585
Merced County Clerk	2222 M Street	37.307012	-120.481196
Merced County Coroner	455 E. 13th Street	37.292106	-120.471591
Merced County Courthouse Museum	W 21st Street and N Street	37.306433	-120.484051
Merced County DMV	1313 W. 12th Street	37.301234	-120.498449
Merced County Environmental	415 F Street	37.301857	-120.471851
Merced County Fire Department	735 Martin Luther King Jr. Way	37.290803	-120.486025
Merced County Health Department	260 E. 15th Street	37.293746	-120.47112
Merced County Hispanic Chamber of Commerce	855 W. 18th Street	37.304676	-120.48836
Merced County Human Services Agency	2115 Wardrobe Avenue	37.297838	-120.519359
Merced County Investigation	626 W. 18th Street	37.302755	-120.484831
Merced County Jobs	1520 W. Main Street	37.306735	-120.499254
Merced County Office of Education	632 W. 13th Street	37.297647	-120.488289
Merced County Planning and Development	2222 M Street	37.307012	-120.481196
Merced County Private Industry	1108 W. 16th Street	37.303491	-120.493781
Merced County Public Works	345 W. 7th Street	37.290302	-120.486913
Merced County Sheriff Department	700 W. 22nd Street	37.307125	-120.483781
Merced County Work Force Investment	1205 W. 18th Street	37.294633	-120.512596
Merced Courthouse Traffic Division	720 W. 29th Street	37.3054	-120.485342
Merced Irrigation District	744 W. 20th Street	37.305495	-120.485781
Merced Police Department	611 W. 22nd Street	37.302271	-120.482159
Merced Public Works Department	1776 Grogan Avenue	37.291045	-120.510522
Municipal Court Criminal	670 W. 22nd Street	37.307126	-120.48329
Superior Court of California	627 W. 21st Street	37.308132	-120.482595

RECEPTORS - NURSING, ASSISTED LIVING, CONVALESCENT HOMES			
Receptor Name	**Address**	**Latitude**	**Longitude**
Accesscare Home of Merced	128 E. Main Street	37.297597	-120.47329
Amie Marchini's Senior Care	1450 E. 27th Street	37.303761	-120.45621
Country Villa Healthcare Center	516 W. 26th Street	37.309694	-120.47881
Home Away From Home	126 E. 18th Street	37.298235	-120.47299
Home Sweet Home	793 N. Bear Creek Drive	37.313544	-120.4821
La Sierra Care Center	2424 M Street	37.309011	-120.48031
Martin Luther Homes	1530 W. Main Street	37.306849	-120.49883
Mission Gardens Assisted Living	1450 E. 27th Street	37.30374	-120.45607
Park Merced Assisted Living	3050 M Street	37.317516	-120.47774

RECEPTORS - HOSPITALS, MEDICAL CENTERS			
Receptor Name	**Address**	**Latitude**	**Longitude**
Franciscan Health Care	3169 M Street	37.320724	-120.479155
Golden Valley Health Centers	2926 G Street	37.312314	-120.469
Golden Valley Health Centers	401 Lesher Drive	37.293913	-120.504207
Golden Valley Health Centers	797 W. Childs Avenue	37.288233	-120.496573
Hy-Lond Health Care Merced	3170 M Street	37.320433	-120.477658
Marie Green Center	300 E. 15th Street	37.293331	-120.470455
Merced Behavioral Health Center	1255 B Street	37.290447	-120.472226
Merced County Mental Health	480 E. 13th Street	37.291285	-120.471377
Merced Orthopaedic Medical Group	123 N. Bear Creek Drive	37.311764	-120.471017
Mercy General Hospital	2740 M Street	37.312131	-120.477988
Mercy Medical Center Clinic	1248 D Street	37.291816	-120.474129
MFA Medical Group	3385 G Street	37.292691	-120.475086
NICU Childrens Hospital	301 E. 13th Street	37.292802	-120.473141
Valley Childrens Medical Center	1190 Olivewood Drive	37.31798	-120.490299

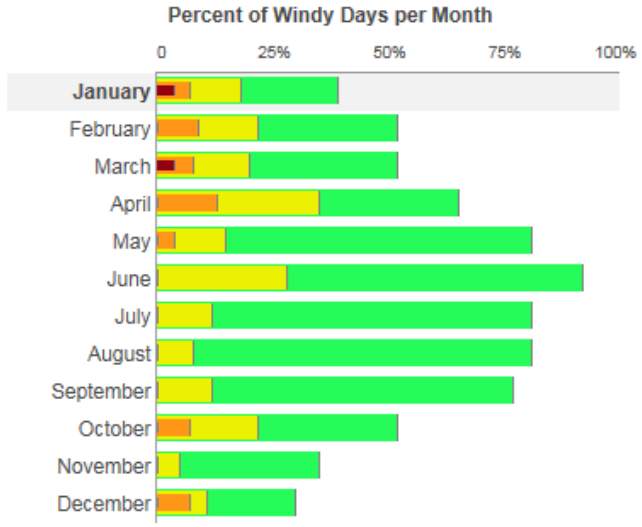
RECEPTORS - HOMELESS SHELTERS, CRISIS SHELTERS			
Receptor Name	**Address**	**Latitude**	**Longitude**
Aspiranet	3360 N. Highway 59	37.325471	-120.504199
Catholic Charities Diocese	336 W. Main Street	37.300183	-120.481335
Community Action Agency	1235 W. Main Street	37.305685	-120.494572
D Street Homeless Shelter Community Action Agency	317 E. 15th Street	37.29501	-120.472559
Hobie House	1301 Yosemite Parkway	37.295381	-120.459411
Homes Shelter	3161-3223 R Street	37.321247	-120.488173
Love INC of Greater Merced	1920 Canal Street	37.30346	-120.481946
Merced County Food Bank	2000 W. Olive Avenue	37.318365	-120.503313
Merced Rescue Mission	527 W. 20th Street	37.304568	-120.482308
Merced United Way	531 Main Street	37.301828	-120.483967
Resources for Independence	710 W. 18th Street	37.303359	-120.486297
Salvation Army Merchd Corps Community Center	1440 W. 12th Street	37.300973	-120.500624
Valley Crisis Center	1960 P Street	37306292	-120.487595

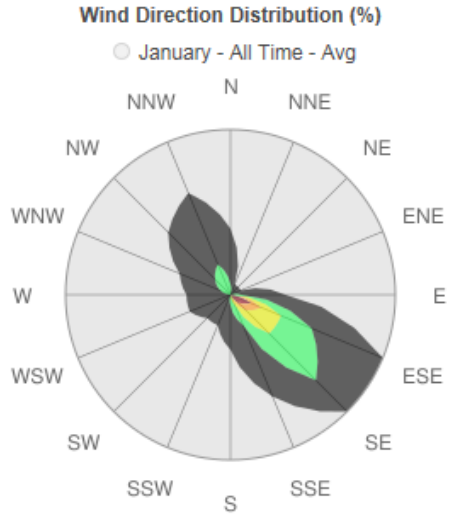
RECEPTORS - MERCED CITY PRODUCTION WELLS			
Receptor Name	**Address**	**Latitude**	**Longitude**
Well No. 1	477 St. Lawrence Drive	37.313643	-120.476381
Well No. 2	1201 S. Parsons Avenue	37.290238	-120.452388
Well No. 3	511 W. 12th Street	37.296022	-120.486817
Well No. 5	1632 R Street	37.303867	-120.492688
Well No. 8	1520 W. North Bear Creek Drive	37.308146	-120.5036
Well No. 9	3391 R Street	37.325749	-120.487105
Well No. 10	4250 E. Gerard Avenue	37.280361	-120.410471
Well No. 13	2890 E. Gerard Avenue	37.27996	-120.435866
Well No. 14	2110 Wardrobe Avenue	37.295244	-120.517541
Well No. 15	1855 Buena Vista Drive	37.326792	-120.503738
Well No. 18	420 E. Olive Avenue	37.317117	-120.464905
Well No. 19	2065 Parson Avenue	37.306538	-120.451398

APPENDIX C

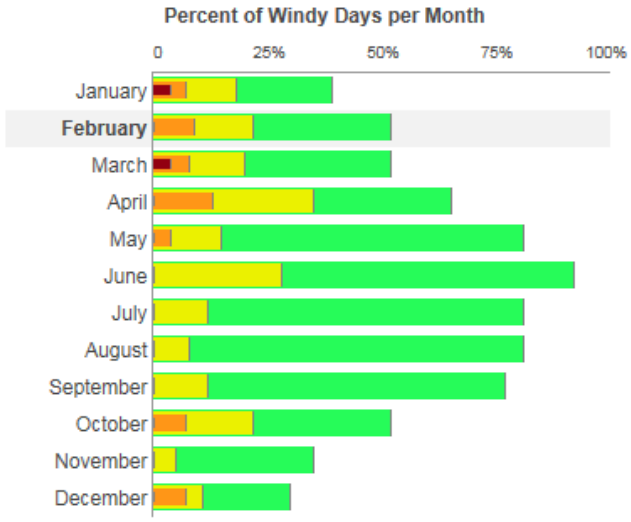
Wind Rose Data

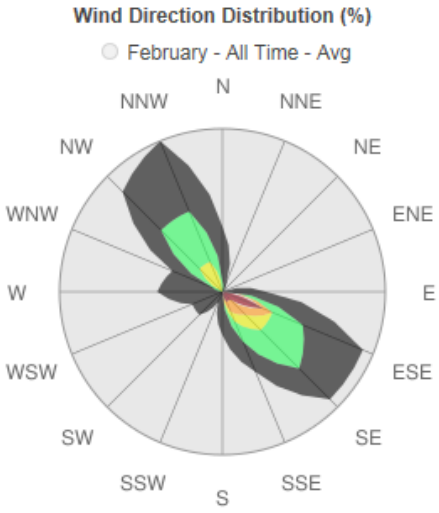
All Time (data from 2008 to 2018) | Average | Daylight



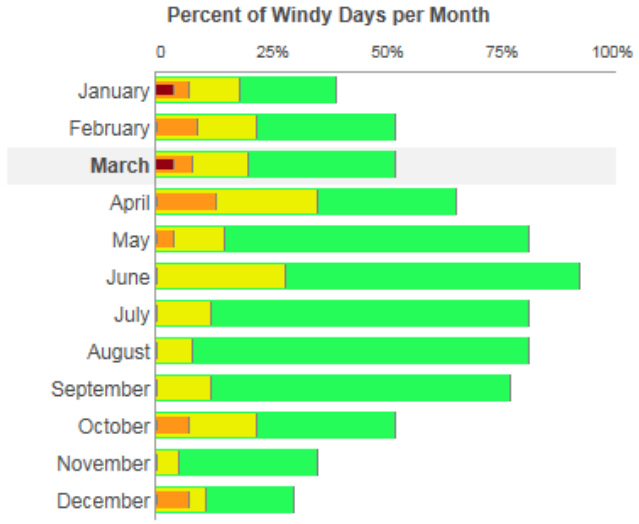


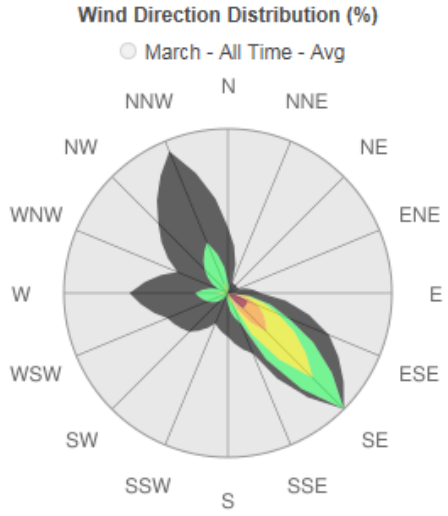
All Time (data from 2008 to 2018) | Average | Daylight





All Time (data from 2008 to 2018) | Average | Daylight





> 10 mph | > 15 mph | > 20 mph | > 25 mph | all

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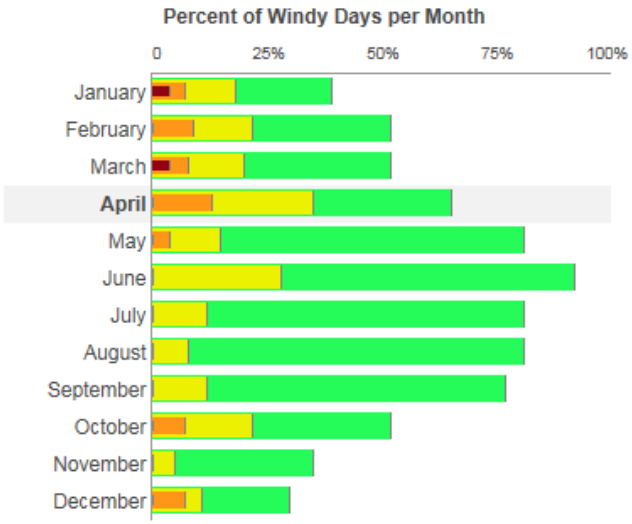

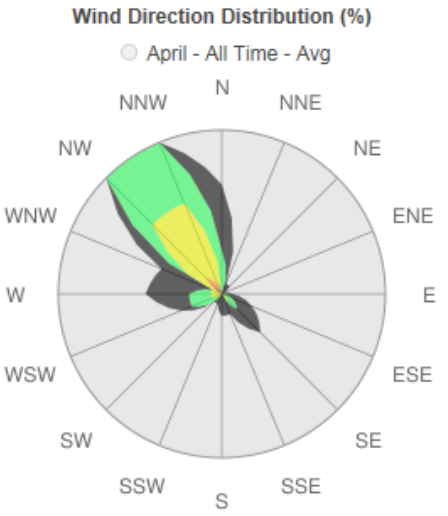

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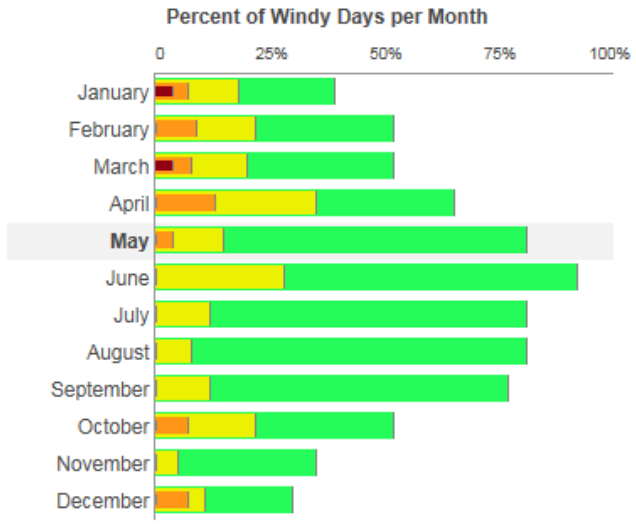

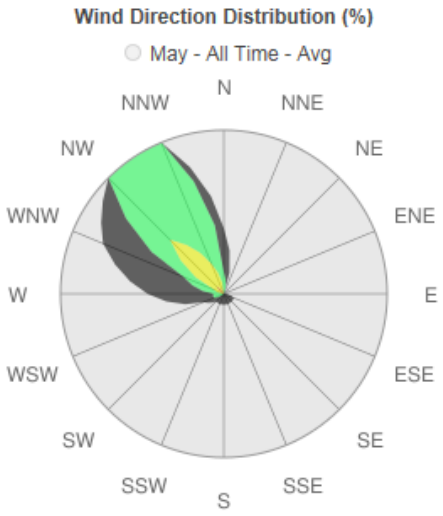

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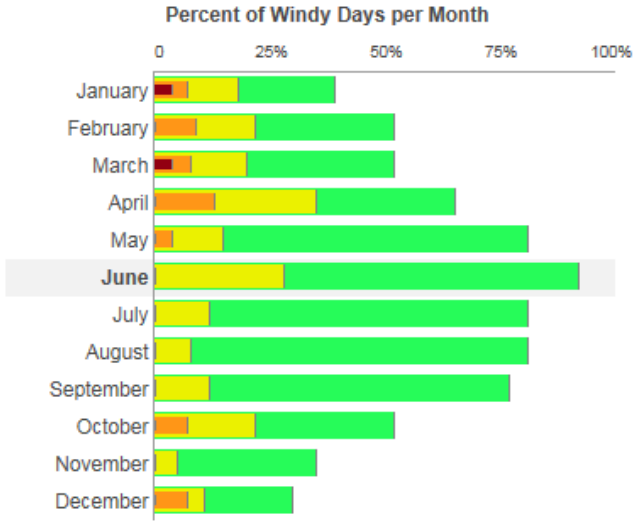

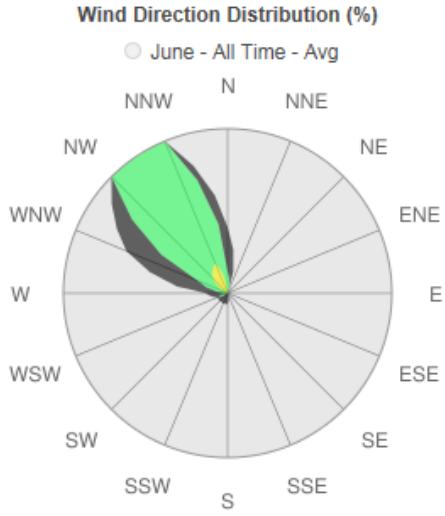

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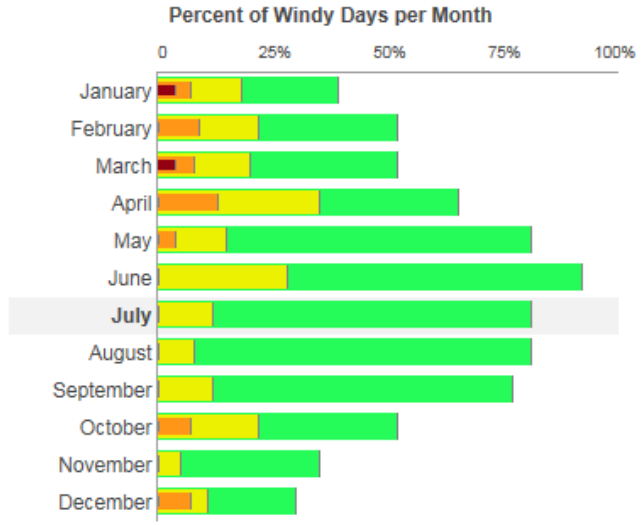

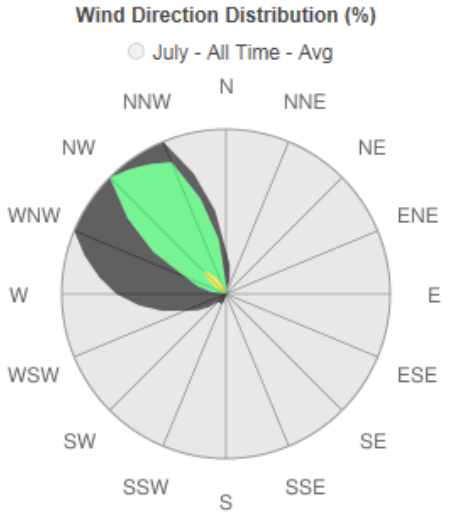

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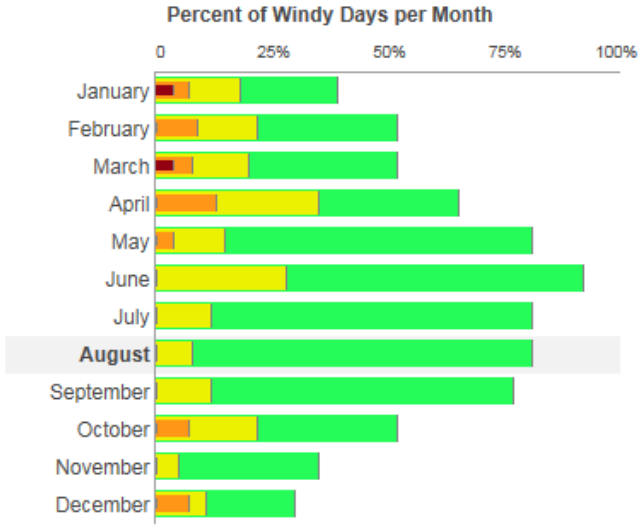

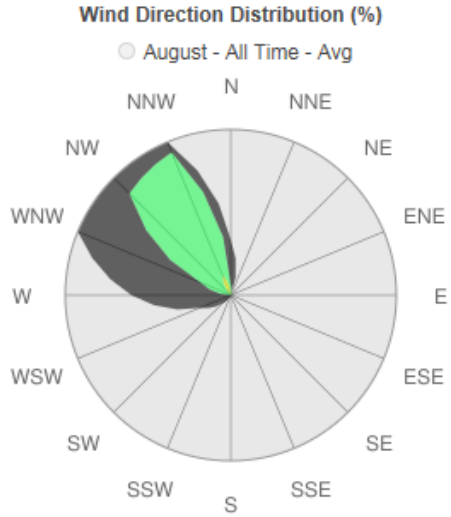

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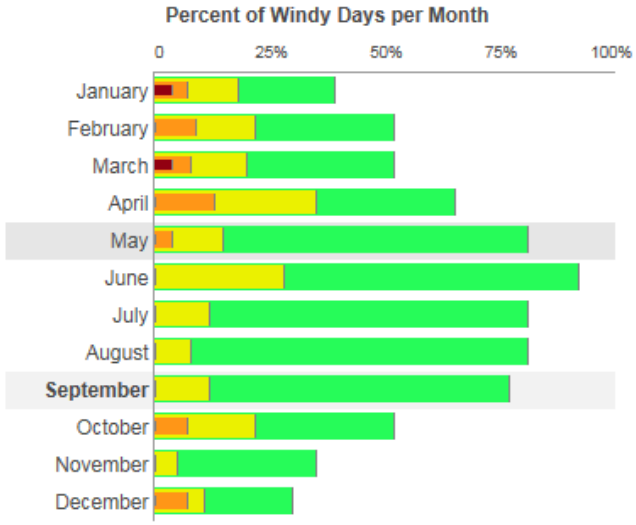

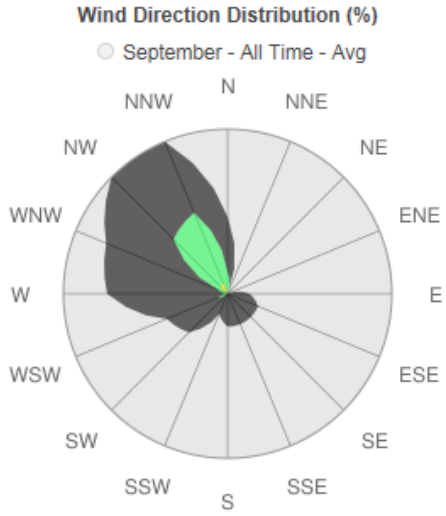

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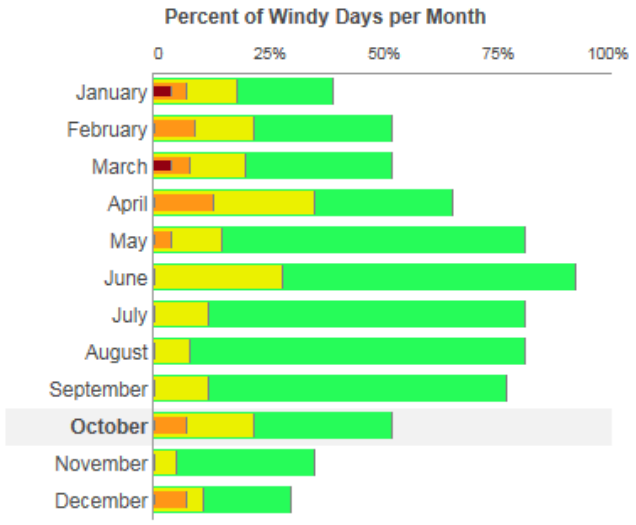

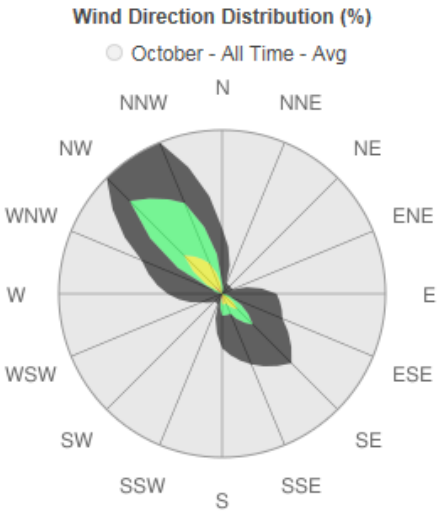

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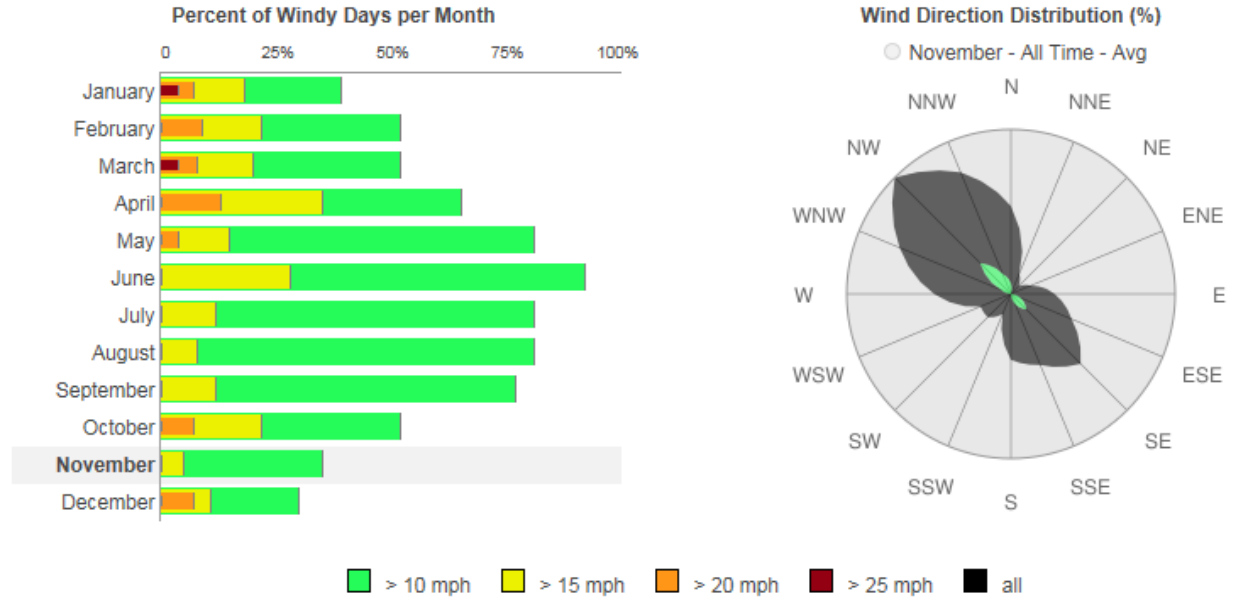

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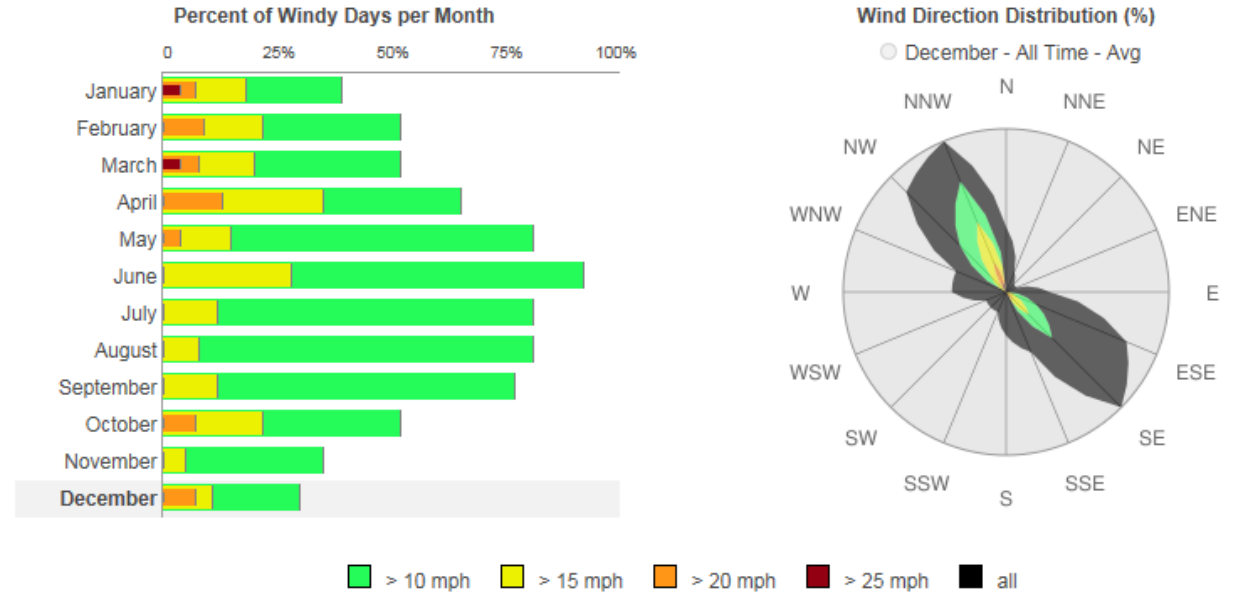


APPENDIX D

Chlorine Safety Data Sheet

SAFETY DATA SHEET

Chlorine

Section 1. Identification

GHS product identifier : Chlorine

Chemical name : chlorine

Other means of identification : Cl2; Bertholite; Chloor; Chlor; Chlore; Chlorine mol.; Cloro; Molecular chlorine; UN 1017

Product use : Synthetic/Analytical chemistry.

Synonym : Cl2; Bertholite; Chloor; Chlor; Chlore; Chlorine mol.; Cloro; Molecular chlorine; UN 1017

SDS # : 001015

Supplier's details : Airgas USA, LLC and its affiliates
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253

24-hour telephone : 1-866-734-3438

Section 2. Hazards identification

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Classification of the substance or mixture : OXIDIZING GASES - Category 1
GASES UNDER PRESSURE - Compressed gas
ACUTE TOXICITY (inhalation) - Category 2
SKIN CORROSION/IRRITATION - Category 1
SERIOUS EYE DAMAGE/ EYE IRRITATION - Category 1
AQUATIC HAZARD (ACUTE) - Category 1
AQUATIC HAZARD (LONG-TERM) - Category 1

GHS label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : May cause or intensify fire; oxidizer.
Contains gas under pressure; may explode if heated.
Fatal if inhaled.
Causes severe skin burns and eye damage.
Very toxic to aquatic life with long lasting effects.

Precautionary statements

General : Read and follow all Safety Data Sheets (SDS'S) before use. Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand. Close valve after each use and when empty. Use equipment rated for cylinder pressure. Do not open valve until connected to equipment prepared for use. Use a back flow preventative device in the piping. Use only equipment of compatible materials of construction. Open valve slowly. Use only with equipment cleaned for Oxygen service.

Prevention : Wear protective gloves. Wear eye or face protection. Wear protective clothing. Wear respiratory protection. Keep away from clothing, incompatible materials and combustible materials. Keep reduction valves, valves and fittings free from oil and grease. Use only outdoors or in a well-ventilated area. Avoid release to the environment. Do not breathe gas. Wash hands thoroughly after handling.

Section 2. Hazards identification

Response : Collect spillage. In case of fire: Stop leak if safe to do so. IF INHALED: Remove person to fresh air and keep comfortable for breathing. Immediately call a POISON CENTER or physician. IF SWALLOWED: Immediately call a POISON CENTER or physician. Rinse mouth. Do NOT induce vomiting. IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water or shower. Wash contaminated clothing before reuse. Immediately call a POISON CENTER or physician. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER or physician.

Storage : Store locked up. Protect from sunlight when ambient temperature exceeds 52°C/125°F. Store in a well-ventilated place.

Disposal : Dispose of contents and container in accordance with all local, regional, national and international regulations.

Hazards not otherwise classified : In addition to any other important health or physical hazards, this product may displace oxygen and cause rapid suffocation.

Section 3. Composition/information on ingredients

Substance/mixture : Substance

Chemical name : chlorine

Other means of identification : Cl2; Bertholite; Chloor; Chlor; Chlore; Chlorine mol.; Cloro; Molecular chlorine; UN 1017

CAS number/other identifiers

CAS number : 7782-50-5

Product code : 001015

Ingredient name	%	CAS number
chlorine	100	7782-50-5

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact : Get medical attention immediately. Call a poison center or physician. Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Chemical burns must be treated promptly by a physician.

Inhalation : Get medical attention immediately. Call a poison center or physician. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Skin contact : Get medical attention immediately. Call a poison center or physician. Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Wash contaminated clothing thoroughly with water before removing it, or wear gloves. Continue to rinse for at least 10 minutes. Chemical burns must be treated promptly by a physician. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : As this product is a gas, refer to the inhalation section.

Most important symptoms/effects, acute and delayed

Section 4. First aid measures

Potential acute health effects

Eye contact : Causes serious eye damage. Contact with rapidly expanding gas may cause burns or frostbite.

Inhalation : Fatal if inhaled. May cause respiratory irritation.

Skin contact : Causes severe burns. Contact with rapidly expanding gas may cause burns or frostbite.

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Ingestion : As this product is a gas, refer to the inhalation section.

Over-exposure signs/symptoms

Eye contact : Adverse symptoms may include the following:, pain, watering, redness

Inhalation : Adverse symptoms may include the following:, respiratory tract irritation, coughing

Skin contact : Adverse symptoms may include the following:, pain or irritation, redness, blistering may occur

Ingestion : Adverse symptoms may include the following:, stomach pains

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Wash contaminated clothing thoroughly with water before removing it, or wear gloves.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

Specific hazards arising from the chemical : Contains gas under pressure. Oxidizing material. This material increases the risk of fire and may aid combustion. Contact with combustible material may cause fire. In a fire or if heated, a pressure increase will occur and the container may burst or explode. This material is very toxic to aquatic life with long lasting effects. Fire water contaminated with this material must be contained and prevented from being discharged to any waterway, sewer or drain.

Hazardous thermal decomposition products : Decomposition products may include the following materials:
halogenated compounds

Special protective actions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Contact supplier immediately for specialist advice. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool. If involved in fire, shut off flow immediately if it can be done without risk.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Shut off all ignition sources. No flares, smoking or flames in hazard area. Do not breathe gas. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions : Ensure emergency procedures to deal with accidental gas releases are in place to avoid contamination of the environment. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). Water polluting material. May be harmful to the environment if released in large quantities. Collect spillage.

Methods and materials for containment and cleaning up

Small spill : Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment.

Large spill : Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8). Contains gas under pressure. Do not get in eyes or on skin or clothing. Do not breathe gas. Avoid release to the environment. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Keep away from clothing, incompatible materials and combustible materials. Keep reduction valves free from grease and oil. Empty containers retain product residue and can be hazardous. Do not puncture or incinerate container. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Protect cylinders from physical damage; do not drag, roll, slide, or drop. Use a suitable hand truck for cylinder movement.

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a segregated and approved area. Store away from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10). Store locked up. Separate from acids, alkalies, reducing agents and combustibles. Keep container tightly closed and sealed until ready for use. Cylinders should be stored upright, with valve protection cap in place, and firmly secured to prevent falling or being knocked over. Cylinder temperatures should not exceed 52 °C (125 °F).

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Section 8. Exposure controls/personal protection

Ingredient name	Exposure limits
chlorine	**ACGIH TLV (United States, 3/2016).** STEL: 2.9 mg/m³ 15 minutes. STEL: 1 ppm 15 minutes. TWA: 1.5 mg/m³ 8 hours. TWA: 0.5 ppm 8 hours. **NIOSH REL (United States, 10/2013).** CEIL: 1.45 mg/m³ 15 minutes. CEIL: 0.5 ppm 15 minutes. **OSHA PEL (United States, 6/2016).** CEIL: 3 mg/m³ CEIL: 1 ppm **OSHA PEL 1989 (United States, 3/1989).** STEL: 3 mg/m³ 15 minutes. STEL: 1 ppm 15 minutes. TWA: 1.5 mg/m³ 8 hours. TWA: 0.5 ppm 8 hours.

Appropriate engineering controls : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Eye/face protection : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: chemical splash goggles and/or face shield. If inhalation hazards exist, a full-face respirator may be required instead.

Skin protection

Hand protection : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Other skin protection : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory protection : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Section 9. Physical and chemical properties

Appearance

Physical state	:	Gas. [GREENISH-YELLOW GAS WITH SUFFOCATING ODOR]
Color	:	Colorless. Green. Yellow.
Molecular weight	:	70.9 g/mole
Molecular formula	:	Cl2
Boiling/condensation point	:	-34°C (-29.2°F)
Melting/freezing point	:	-101°C (-149.8°F)
Critical temperature	:	143.85°C (290.9°F)
Odor	:	Pungent.
Odor threshold	:	Not available.
pH	:	Not available.
Flash point	:	[Product does not sustain combustion.]
Burning time	:	Not applicable.
Burning rate	:	Not applicable.
Evaporation rate	:	Not available.
Flammability (solid, gas)	:	Extremely flammable in the presence of the following materials or conditions: reducing materials, combustible materials, organic materials and alkalis.
Lower and upper explosive (flammable) limits	:	Not available.
Vapor pressure	:	85.3 (psig)
Vapor density	:	2.5 (Air = 1)
Specific Volume (ft^3/lb)	:	5.4054
Gas Density (lb/ft^3)	:	0.185
Relative density	:	Not applicable.
Solubility	:	Very slightly soluble in the following materials: cold water.
Solubility in water	:	7.41 g/l
Partition coefficient: n-octanol/water	:	Not available.
Auto-ignition temperature	:	Not available.
Decomposition temperature	:	Not available.
SADT	:	Not available.
Viscosity	:	Not applicable.

Section 10. Stability and reactivity

Reactivity	:	No specific test data related to reactivity available for this product or its ingredients.
Chemical stability	:	The product is stable.
Possibility of hazardous reactions	:	Hazardous reactions or instability may occur under certain conditions of storage or use. Conditions may include the following: contact with combustible materials Reactions may include the following: risk of causing fire
Conditions to avoid	:	No specific data.

Section 10. Stability and reactivity

Incompatible materials : Highly reactive or incompatible with the following materials:
combustible materials
reducing materials
grease
oil

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

Hazardous polymerization : Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Product/ingredient name	Result	Species	Dose	Exposure
chlorine	LC50 Inhalation Gas.	Rat	293 ppm	1 hours

IDLH : 10 ppm

Irritation/Corrosion

Not available.

Sensitization

Not available.

Mutagenicity

Not available.

Carcinogenicity

Not available.

Reproductive toxicity

Not available.

Teratogenicity

Not available.

Specific target organ toxicity (single exposure)

Name	Category	Route of exposure	Target organs
chlorine	Category 3	Not applicable.	Respiratory tract irritation

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not available.

Information on the likely routes of exposure : Not available.

Potential acute health effects

Eye contact : Causes serious eye damage. Contact with rapidly expanding gas may cause burns or frostbite.

Inhalation : Fatal if inhaled. May cause respiratory irritation.

Skin contact : Causes severe burns. Contact with rapidly expanding gas may cause burns or frostbite.

Section 11. Toxicological information

Ingestion : As this product is a gas, refer to the inhalation section.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact : Adverse symptoms may include the following:, pain, watering, redness

Inhalation : Adverse symptoms may include the following:, respiratory tract irritation, coughing

Skin contact : Adverse symptoms may include the following:, pain or irritation, redness, blistering may occur

Ingestion : Adverse symptoms may include the following:, stomach pains

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Not available.

General : No known significant effects or critical hazards.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

Not available.

Section 12. Ecological information

Toxicity

Product/ingredient name	Result	Species	Exposure
chlorine	Acute EC50 5.1 ppm Marine water	Algae - Macrocystis pyrifera - Young	4 days
	Acute EC50 930000 µg/l Fresh water	Aquatic plants - Lemna minor	4 days
	Acute LC50 2.03 µg/l Fresh water	Crustaceans - Asellus racovitzai	2 days
	Acute LC50 30 µg/l Fresh water	Daphnia - Daphnia pulex	48 hours
	Acute LC50 14 µg/l Fresh water	Fish - Oncorhynchus mykiss	96 hours

Persistence and degradability

Not available.

Bioaccumulative potential

Not available.

Mobility in soil

Section 12. Ecological information

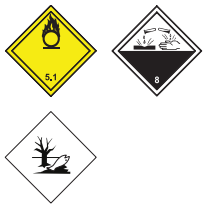
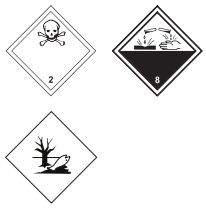
Soil/water partition coefficient (K_{OC}) : Not available.

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Empty Airgas-owned pressure vessels should be returned to Airgas. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Do not puncture or incinerate container.

Section 14. Transport information

	DOT	TDG	Mexico	IMDG	IATA
UN number	UN1017	UN1017	UN1017	UN1017	UN1017
UN proper shipping name	CHLORINE	CHLORINE	CHLORINE	CHLORINE	CHLORINE
Transport hazard class(es)	2.3 (5.1, 8)	2.3 (5.1, 8)	2.3 (5.1, 8) 	2.3 (8) 	2.3 (8)
Packing group	-	-	-	-	-
Environment	No.	No.	No.	Yes.	No.
Additional information	Toxic - Inhalation hazard Zone B This product is not regulated as a marine pollutant when transported on inland waterways in sizes of ≤5 L or ≤5 kg or by road, rail, or inland air in non-bulk sizes, provided the packagings meet the general provisions of §§ 173.24 and 173.24a. **Reportable quantity** 10 lbs / 4.54 kg Package sizes shipped in quantities less than the product reportable quantity are not subject to the RQ (reportable quantity) transportation requirements. **Limited quantity** Yes. **Packaging instruction**	Product classified as per the following sections of the Transportation of Dangerous Goods Regulations: 2.13-2.17 (Class 2), 2.23-2.25 (Class 5), 2.40-2.42 (Class 8), 2.7 (Marine pollutant mark). The marine pollutant mark is not required when transported by road or rail. **Explosive Limit and Limited Quantity Index** 0 **ERAP Index** 500 **Passenger Carrying Ship Index** Forbidden **Passenger Carrying Road or Rail Index**	-	The marine pollutant mark is not required when transported in sizes of ≤5 L or ≤5 kg.	The environmentally hazardous substance mark may appear if required by other transportation regulations. **Passenger and Cargo Aircraft**Quantity limitation: 0 Forbidden **Cargo Aircraft Only** Quantity limitation: 0 Forbidden

Section 14. Transport information

	Passenger aircraft Quantity limitation: Forbidden. **Cargo aircraft** Quantity limitation: Forbidden. **Special provisions** 2, B9, B14, T50, TP19	Forbidden			

"Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product."

Special precautions for user : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code : Not available.

Section 15. Regulatory information

U.S. Federal regulations : **TSCA 8(a) CDR Exempt/Partial exemption**: Not determined

United States inventory (TSCA 8b): This material is listed or exempted.

Clean Water Act (CWA) 311: chlorine

Clean Air Act (CAA) 112 regulated toxic substances: chlorine

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

Name	%	EHS	SARA 302 TPQ (lbs)	SARA 302 TPQ (gallons)	SARA 304 RQ (lbs)	SARA 304 RQ (gallons)
chlorine	100	Yes.	100	-	10	-

SARA 304 RQ : 10 lbs / 4.5 kg

SARA 311/312

Classification : Sudden release of pressure
Immediate (acute) health hazard

Composition/information on ingredients

Section 15. Regulatory information

Name	%	Fire hazard	Sudden release of pressure	Reactive	Immediate (acute) health hazard	Delayed (chronic) health hazard
chlorine	100	No.	Yes.	No.	Yes.	No.

SARA 313

	Product name	CAS number	%
Form R - Reporting requirements	chlorine	7782-50-5	100
Supplier notification	chlorine	7782-50-5	100

SARA 313 notifications must not be detached from the SDS and any copying and redistribution of the SDS shall include copying and redistribution of the notice attached to copies of the SDS subsequently redistributed.

State regulations

Massachusetts : This material is listed.
New York : This material is listed.
New Jersey : This material is listed.
Pennsylvania : This material is listed.

International regulations

International lists

National inventory

Australia : This material is listed or exempted.
Canada : This material is listed or exempted.
China : This material is listed or exempted.
Europe : This material is listed or exempted.
Japan : Not determined.
Malaysia : This material is listed or exempted.
New Zealand : This material is listed or exempted.
Philippines : This material is listed or exempted.
Republic of Korea : This material is listed or exempted.
Taiwan : This material is listed or exempted.

Canada

WHMIS (Canada) : Class A: Compressed gas.
Class D-1A: Material causing immediate and serious toxic effects (Very toxic).
Class E: Corrosive material

CEPA Toxic substances: This material is not listed.
Canadian ARET: This material is not listed.
Canadian NPRI: This material is listed.
Alberta Designated Substances: This material is not listed.
Ontario Designated Substances: This material is not listed.
Quebec Designated Substances: This material is not listed.

Section 16. Other information

Canada Label requirements : Class A: Compressed gas.
Class D-1A: Material causing immediate and serious toxic effects (Very toxic).
Class E: Corrosive material

Hazardous Material Information System (U.S.A.)

Section 16. Other information

Physical hazards	2

Caution: HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks Although HMIS® ratings are not required on SDSs under 29 CFR 1910. 1200, the preparer may choose to provide them. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® is a registered mark of the National Paint & Coatings Association (NPCA). HMIS® materials may be purchased exclusively from J. J. Keller (800) 327-6868.

The customer is responsible for determining the PPE code for this material.

National Fire Protection Association (U.S.A.)

Reprinted with permission from NFPA 704-2001, Identification of the Hazards of Materials for Emergency Response Copyright ©1997, National Fire Protection Association, Quincy, MA 02269. This reprinted material is not the complete and official position of the National Fire Protection Association, on the referenced subject which is represented only by the standard in its entirety.

Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

Procedure used to derive the classification

Classification	Justification
Ox. Gas 1, H270	Expert judgment
Press. Gas Comp. Gas, H280	According to package
Acute Tox. 2, H330	On basis of test data
Skin Corr. 1, H314	Expert judgment
Eye Dam. 1, H318	Expert judgment
STOT SE 3, H335	Expert judgment
Aquatic Acute 1, H400	Expert judgment
Aquatic Chronic 1, H410	On basis of test data

History

Date of printing : 3/23/2017

Date of issue/Date of revision : 3/23/2017

Date of previous issue : No previous validation

Version : 0.01

Key to abbreviations : ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United Nations

References : Not available.

Indicates information that has changed from previously issued version.

Notice to reader

Section 16. Other information

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

APPENDIX E

Ammonia/Anhydrous Ammonia Safety Data Sheet

SAFETY DATA SHEET

Ammonia

Section 1. Identification

GHS product identifier : Ammonia

Chemical name : ammonia

Other means of identification : ammonia; anhydrous ammonia

Product type : Gas.

Product use : Synthetic/Analytical chemistry.

Synonym : ammonia; anhydrous ammonia

SDS # : 001003

Supplier's details : Airgas USA, LLC and its affiliates
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253

24-hour telephone : 1-866-734-3438

Section 2. Hazards identification

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Classification of the substance or mixture : FLAMMABLE GASES - Category 2
GASES UNDER PRESSURE - Liquefied gas
ACUTE TOXICITY (inhalation) - Category 4
SKIN CORROSION - Category 1
SERIOUS EYE DAMAGE - Category 1
AQUATIC HAZARD (ACUTE) - Category 1

GHS label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : Flammable gas.
May form explosive mixtures with air.
Contains gas under pressure; may explode if heated.
May displace oxygen and cause rapid suffocation.
Harmful if inhaled.
Causes severe skin burns and eye damage.
Very toxic to aquatic life.

Precautionary statements

General : Read and follow all Safety Data Sheets (SDS'S) before use. Close valve after each use and when empty. Use equipment rated for cylinder pressure. Do not open valve until connected to equipment prepared for use. Use a back flow preventative device in the piping. Use only equipment of compatible materials of construction. Always keep container in upright position. Approach suspected leak area with caution.

Prevention : Wear protective gloves. Wear eye or face protection. Wear protective clothing. Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. Use only outdoors or in a well-ventilated area. Avoid release to the environment. Avoid breathing gas. Wash hands thoroughly after handling.

Section 2. Hazards identification

Response : Collect spillage. IF INHALED: Remove person to fresh air and keep comfortable for breathing. Immediately call a POISON CENTER or physician. IF SWALLOWED: Immediately call a POISON CENTER or physician. Rinse mouth. Do NOT induce vomiting. IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water or shower. Wash contaminated clothing before reuse. Immediately call a POISON CENTER or physician. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER or physician. Leaking gas fire: Do not extinguish, unless leak can be stopped safely. Eliminate all ignition sources if safe to do so.

Storage : Store locked up. Protect from sunlight. Store in a well-ventilated place.

Disposal : Dispose of contents and container in accordance with all local, regional, national and international regulations.

Hazards not otherwise classified : In addition to any other important health or physical hazards, this product may displace oxygen and cause rapid suffocation.

Section 3. Composition/information on ingredients

Substance/mixture : Substance

Chemical name : ammonia

Other means of identification : ammonia; anhydrous ammonia

Product code : 001003

CAS number/other identifiers

CAS number : 7664-41-7

Ingredient name	%	CAS number
ammonia	100	7664-41-7

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact : Get medical attention immediately. Call a poison center or physician. Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Chemical burns must be treated promptly by a physician.

Inhalation : Get medical attention immediately. Call a poison center or physician. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband. In case of inhalation of decomposition products in a fire, symptoms may be delayed. The exposed person may need to be kept under medical surveillance for 48 hours.

Skin contact : Get medical attention immediately. Call a poison center or physician. Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. To avoid the risk of static discharges and gas ignition, soak contaminated clothing thoroughly with water before removing it. Continue to rinse for at least 10 minutes. Chemical burns must be treated promptly by a physician. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : As this product is a gas, refer to the inhalation section.

Section 4. First aid measures

Most important symptoms/effects, acute and delayed

Potential acute health effects

Eye contact : Causes serious eye damage.

Inhalation : Harmful if inhaled.

Skin contact : Causes severe burns.

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Ingestion : As this product is a gas, refer to the inhalation section.

Over-exposure signs/symptoms

Eye contact : Adverse symptoms may include the following:, pain, watering, redness

Inhalation : No specific data.

Skin contact : Adverse symptoms may include the following:, pain or irritation, redness, blistering may occur

Ingestion : Adverse symptoms may include the following:, stomach pains

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician : In case of inhalation of decomposition products in a fire, symptoms may be delayed. The exposed person may need to be kept under medical surveillance for 48 hours.

Specific treatments : No specific treatment.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Wash contaminated clothing thoroughly with water before removing it, or wear gloves.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

Specific hazards arising from the chemical : Contains gas under pressure. Flammable gas. In a fire or if heated, a pressure increase will occur and the container may burst, with the risk of a subsequent explosion. This material is very toxic to aquatic life. Fire water contaminated with this material must be contained and prevented from being discharged to any waterway, sewer or drain.

Hazardous thermal decomposition products : Decomposition products may include the following materials:
nitrogen oxides

Special protective actions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Contact supplier immediately for specialist advice. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool. If involved in fire, shut off flow immediately if it can be done without risk. If this is impossible, withdraw from area and allow fire to burn. Fight fire from protected location or maximum possible distance. Eliminate all ignition sources if safe to do so.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : Accidental releases pose a serious fire or explosion hazard. No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Shut off all ignition sources. No flares, smoking or flames in hazard area. Do not breathe gas. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialized clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions : Ensure emergency procedures to deal with accidental gas releases are in place to avoid contamination of the environment. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). Water polluting material. May be harmful to the environment if released in large quantities. Collect spillage.

Methods and materials for containment and cleaning up

Small spill : Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment.

Large spill : Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8). Contains gas under pressure. Do not get in eyes or on skin or clothing. Do not breathe gas. Avoid release to the environment. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Do not enter storage areas and confined spaces unless adequately ventilated. Store and use away from heat, sparks, open flame or any other ignition source. Empty containers retain product residue and can be hazardous. Do not puncture or incinerate container. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Protect cylinders from physical damage; do not drag, roll, slide, or drop. Use a suitable hand truck for cylinder movement.

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a segregated and approved area. Store away from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10). Store locked up. Eliminate all ignition sources. Keep container tightly closed and sealed until ready for use. Cylinders should be stored upright, with valve protection cap in place, and firmly secured to prevent falling or being knocked over. Cylinder temperatures should not exceed 52 °C (125 °F).
Refer to ANSI/CGA G-2.1, Section 5.13 for electrical classification of anhydrous ammonia storage and handling areas. Where anhydrous ammonia is stored indoors, use electrical (ventilating, lighting and material handling) equipment with the appropriate electrical classification rating and use only non-sparking tools.

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Ingredient name	Exposure limits
ammonia	**California PEL for Chemical Contaminants (*Table AC-1*) (United States).** PEL: 25 ppm 8 hours. STEL: 35 ppm 15 minutes. **ACGIH TLV (United States, 3/2017).** TWA: 25 ppm 8 hours. TWA: 17 mg/m³ 8 hours. STEL: 35 ppm 15 minutes. STEL: 24 mg/m³ 15 minutes. **OSHA PEL 1989 (United States, 3/1989).** STEL: 35 ppm 15 minutes. STEL: 27 mg/m³ 15 minutes. **NIOSH REL (United States, 10/2016).** TWA: 25 ppm 10 hours. TWA: 18 mg/m³ 10 hours. STEL: 35 ppm 15 minutes. STEL: 27 mg/m³ 15 minutes. **OSHA PEL (United States, 6/2016).** TWA: 50 ppm 8 hours. TWA: 35 mg/m³ 8 hours.

Appropriate engineering controls : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. The engineering controls also need to keep gas, vapor or dust concentrations below any lower explosive limits. Use explosion-proof ventilation equipment.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Eye/face protection : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: chemical splash goggles and/or face shield. If inhalation hazards exist, a full-face respirator may be required instead.

Skin protection

Hand protection : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product. When there is a risk of ignition from static electricity, wear anti-static protective clothing. For the greatest protection from static discharges, clothing should include anti-static overalls, boots and gloves.

Section 8. Exposure controls/personal protection

Other skin protection : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory protection : Based on the hazard and potential for exposure, select a respirator that meets the appropriate standard or certification. Respirators must be used according to a respiratory protection program to ensure proper fitting, training, and other important aspects of use. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Section 9. Physical and chemical properties

Appearance

Physical state : Gas. [Compressed gas.]

Color : Colorless.

Odor : Pungent.

Odor threshold : Not available.

pH : Approx. 11.6

Melting point : -77.7°C (-107.9°F)

Boiling point : -33°C (-27.4°F)

Critical temperature : 132.85°C (271.1°F)

Flash point : Not available.

Evaporation rate : Not available.

Flammability (solid, gas) : Extremely flammable in the presence of the following materials or conditions: oxidizing materials.

Lower and upper explosive (flammable) limits : Lower: 16%
Upper: 25%

Vapor pressure : 114.1 (psig)

Vapor density : 0.59 (Air = 1)

Specific Volume (ft ^{3}/lb) : 20.79

Gas Density (lb/ft ^{3}) : 0.0481 (32°C / 89.6 to °F)

Relative density : SPECIFIC GRAVITY (AIR=1): @ 70°F (21.1°C) = 0.59

Solubility : Soluble in water. Soluble in alcohol and ether.

Solubility in water : 540 g/l

Partition coefficient: n-octanol/water : Not available.

Auto-ignition temperature : 651°C (1203.8°F)

Decomposition temperature : Not available.

Viscosity : Not applicable.

Flow time (ISO 2431) : Not available.

Molecular weight : 17.03 g/mole

Aerosol product

Heat of combustion : -18589392 J/kg

Section 10. Stability and reactivity

Reactivity : No specific test data related to reactivity available for this product or its ingredients.

Chemical stability : The product is stable.

Possibility of hazardous reactions : Under normal conditions of storage and use, hazardous reactions will not occur.

Conditions to avoid : Avoid all possible sources of ignition (spark or flame). Do not pressurize, cut, weld, braze, solder, drill, grind or expose containers to heat or sources of ignition.

Section 10. Stability and reactivity

Incompatible materials : Oxidizers and Yellow Metals (brass & copper)

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

Hazardous polymerization : Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Product/ingredient name	Result	Species	Dose	Exposure
ammonia	LC50 Inhalation Gas.	Rat	7338 ppm	1 hours

Irritation/Corrosion

Not available.

Sensitization

Not available.

Mutagenicity

Not available.

Carcinogenicity

Not available.

Reproductive toxicity

Not available.

Teratogenicity

Not available.

Specific target organ toxicity (single exposure)

Not available.

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not available.

Information on the likely routes of exposure : Not available.

Potential acute health effects

Eye contact : Causes serious eye damage.

Inhalation : Harmful if inhaled.

Skin contact : Causes severe burns.

Ingestion : As this product is a gas, refer to the inhalation section.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact : Adverse symptoms may include the following:, pain, watering, redness

Inhalation : No specific data.

Skin contact : Adverse symptoms may include the following:, pain or irritation, redness, blistering may occur

Section 11. Toxicological information

Ingestion : Adverse symptoms may include the following:, stomach pains

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Not available.

General : No known significant effects or critical hazards.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

Not available.

Other information : IDLH : 300 ppm

Section 12. Ecological information

Toxicity

Product/ingredient name	Result	Species	Exposure
ammonia	Acute EC50 29.2 mg/l Marine water Acute LC50 2080 µg/l Fresh water Acute LC50 0.53 ppm Fresh water Acute LC50 300 µg/l Fresh water Chronic NOEC 0.204 mg/l Marine water	Algae - Ulva fasciata - Zoea Crustaceans - Gammarus pulex Daphnia - Daphnia magna Fish - Hypophthalmichthys nobilis Fish - Dicentrarchus labrax	96 hours 48 hours 48 hours 96 hours 62 days

Persistence and degradability

Not available.

Bioaccumulative potential

Not available.

Mobility in soil

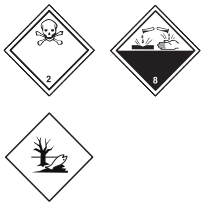
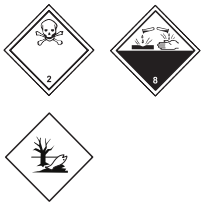
Soil/water partition coefficient (K_{OC}) : Not available.

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Empty Airgas-owned pressure vessels should be returned to Airgas. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Do not puncture or incinerate container.

Section 14. Transport information

	DOT	TDG	Mexico	IMDG	IATA
UN number	UN1005	UN1005	UN1005	UN1005	UN1005
UN proper shipping name	AMMONIA, ANHYDROUS	AMMONIA, ANHYDROUS; OR ANHYDROUS AMMONIA	AMMONIA, ANHYDROUS	AMMONIA, ANHYDROUS	AMMONIA, ANHYDROUS
Transport hazard class(es)	2.2	2.3 (8) 	2.3 (8)	2.3 (8) 	2.3 (8)
Packing group	-	-	-	-	-
Environmental hazards	Yes.	Yes.	Yes. The environmentally hazardous substance mark is not required.	Yes.	Yes. The environmentally hazardous substance mark is not required.

"Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product."

Additional information

DOT Classification : Inhalation hazard
This product is not regulated as a marine pollutant when transported on inland waterways in sizes of ≤5 L or ≤5 kg or by road, rail, or inland air in non-bulk sizes, provided the packagings meet the general provisions of §§ 173.24 and 173.24a.
Reportable quantity 100 lbs / 45.4 kg. Package sizes shipped in quantities less than the product reportable quantity are not subject to the RQ (reportable quantity) transportation requirements.
Limited quantity Yes.
Quantity limitation Passenger aircraft/rail: Forbidden. Cargo aircraft: Forbidden.
Special provisions 13,T50

TDG Classification : Product classified as per the following sections of the Transportation of Dangerous Goods Regulations: 2.13-2.17 (Class 2), 2.40-2.42 (Class 8), 2.7 (Marine pollutant mark).
The marine pollutant mark is not required when transported by road or rail.
Explosive Limit and Limited Quantity Index 0
ERAP Index 3000
Passenger Carrying Ship Index Forbidden
Passenger Carrying Road or Rail Index Forbidden

Section 14. Transport information

Special provisions

Mexico Classification : Toxic Inhalation Hazard Zone D

IMDG : The marine pollutant mark is not required when transported in sizes of ≤5 L or ≤5 kg.

IATA : The environmentally hazardous substance mark may appear if required by other transportation regulations.
Quantity limitation Passenger and Cargo Aircraft: Forbidden. Cargo Aircraft Only: Forbidden. Limited Quantities - Passenger Aircraft: Forbidden.

Special precautions for user : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Transport in bulk according to Annex II of MARPOL and the IBC Code : Not available.

Section 15. Regulatory information

U.S. Federal regulations : **TSCA 8(a) CDR Exempt/Partial exemption**: Not determined

Clean Water Act (CWA) 311: ammonia

Clean Air Act (CAA) 112 regulated toxic substances: ammonia

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Not listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

Name	%	EHS	SARA 302 TPQ		SARA 304 RQ	
			(lbs)	(gallons)	(lbs)	(gallons)
ammonia	100	Yes.	500	-	100	-

SARA 304 RQ : 100 lbs / 45.4 kg

SARA 311/312

Classification : Refer to Section 2: Hazards Identification of this SDS for classification of substance.

SARA 313

	Product name	CAS number	%
Form R - Reporting requirements	ammonia	7664-41-7	100
Supplier notification	ammonia	7664-41-7	100

SARA 313 notifications must not be detached from the SDS and any copying and redistribution of the SDS shall include copying and redistribution of the notice attached to copies of the SDS subsequently redistributed.

State regulations

Massachusetts : This material is listed.

Section 15. Regulatory information

New York : This material is listed.

New Jersey : This material is listed.

Pennsylvania : This material is listed.

International regulations

Chemical Weapon Convention List Schedules I, II & III Chemicals

Not listed.

Montreal Protocol (Annexes A, B, C, E)

Not listed.

Stockholm Convention on Persistent Organic Pollutants

Not listed.

Rotterdam Convention on Prior Informed Consent (PIC)

Not listed.

UNECE Aarhus Protocol on POPs and Heavy Metals

Not listed.

Inventory list

Australia : This material is listed or exempted.

Canada : This material is listed or exempted.

China : This material is listed or exempted.

Europe : This material is listed or exempted.

Japan : **Japan inventory (ENCS)**: This material is listed or exempted.
Japan inventory (ISHL): This material is listed or exempted.

Malaysia : This material is listed or exempted.

New Zealand : This material is listed or exempted.

Philippines : This material is listed or exempted.

Republic of Korea : This material is listed or exempted.

Taiwan : This material is listed or exempted.

Thailand : Not determined.

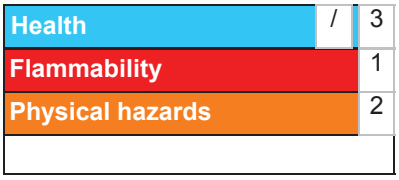
Turkey : This material is listed or exempted.

United States : This material is listed or exempted.

Viet Nam : Not determined.

Section 16. Other information

Hazardous Material Information System (U.S.A.)



Caution: HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks. Although HMIS® ratings and the associated label are not required on SDSs or products leaving a facility under 29 CFR 1910.1200, the preparer may choose to provide them. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® is a registered trademark and service mark of the American Coatings Association, Inc.

The customer is responsible for determining the PPE code for this material. For more information on HMIS® Personal Protective Equipment (PPE) codes, consult the HMIS® Implementation Manual.

National Fire Protection Association (U.S.A.)

Section 16. Other information

Reprinted with permission from NFPA 704-2001, Identification of the Hazards of Materials for Emergency Response Copyright ©1997, National Fire Protection Association, Quincy, MA 02269. This reprinted material is not the complete and official position of the National Fire Protection Association, on the referenced subject which is represented only by the standard in its entirety.

Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

Procedure used to derive the classification

Classification	Justification
FLAMMABLE GASES - Category 2	Expert judgment
GASES UNDER PRESSURE - Liquefied gas	Expert judgment
ACUTE TOXICITY (inhalation) - Category 4	Expert judgment
SKIN CORROSION - Category 1	Expert judgment
SERIOUS EYE DAMAGE - Category 1	Expert judgment
AQUATIC HAZARD (ACUTE) - Category 1	Expert judgment

History

Date of printing : 2/15/2018

Date of issue/Date of revision : 2/15/2018

Date of previous issue : 2/15/2018

Version : 1.04

Key to abbreviations : ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United Nations

References : Not available.

Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

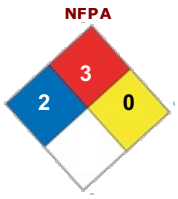
APPENDIX F

Bakken Crude Oil Safety Data Sheet

SAFETY DATA SHEET

SECTION 1 : IDENTIFICATION

Product Name:	**Bakken Crude Oil, Sweet**
SDS Manufacturer Number:	825378
Synonyms:	Crude Oils, Desalted, Sweet, Field Crude, Petroleum Crude, Petroleum Oil, Rock Oil, Separator Crude, Sweet Crude, Crude Oils
Product Use/Restriction:	Refinery Feed
Manufacturer Name:	ConocoPhillips
Address:	600 N. Dairy Ashford Houston, Texas 77079-1175
General Phone Number:	855-244-0762
Health Issues Information:	SDS@conocophillips.com
Emergency Phone Number:	Chemtrec: 800-424-9300 (24 Hours)
Website:	www.conocophillips.com
SDS Creation Date:	May 19, 2014
SDS Revision Date:	May 19, 2014



HMIS

Health Hazard	2*
Fire Hazard	3
Reactivity	1
Personal Protection	X

* Chronic Health Effects

SECTION 2 : HAZARD(S) IDENTIFICATION

GHS Pictograms:

Signal Word: Danger.

GHS Class:

Extremely flammable liquid and vapor Category 1.
Aspiration Hazard, Category 1.
Eye Irritant, Category 2.
Specific Target Organ Toxicity, Single Exposure, Category 3.
Specific Target Organ Toxicity, Repeated Exposure, Category 2.
Carcinogen, Category 1B.
Hazardous to the aquatic environment, long-term, chronic, Category 2.

Hazard Statements:

H224 - Extremely flammable liquid and vapor
H304 - May be fatal if swallowed and enters airways.
H319 - Causes serious eye irritation.
H336 - May cause drowsiness or dizziness.
cH373 - May cause damage to organs through prolonged or repeated exposure.
H351 - Suspected of causing cancer.
H411 - Toxic to aquatic life with long lasting effects.

Hazards not Otherwise Classified
May contain or release poisonous hydrogen sulfide gas

Precautionary Statements:

Keep away from heat/sparks/open flames/hotsurfaces. — No smoking.
Ground/Bond container and receiving equipment.
Use explosion-proof electrical/ventilating/lighting equipment.
Use only non-sparking tools.
Take precautionary measures against static discharge.
In case of fire: Use dry chemical, carbon dioxide to extinguish small fires. Use water for large fires.
Do not breathe dust/fume/gas/mist/vapours/spray.
Wash hands thoroughly after handling.
Wear protective gloves/protective clothing/eye protection/face protection.
Obtain special instructions before use.
Do not handle until all safety precautions have been read and understood.
Keep container tightly closed. Store in a well-ventilated place. Keep cool.
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical advice/attention.
IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
Contaminated work clothing should not be allowed out of the workplace.
IF SWALLOWED: Immediately call a POISON CENTER/doctor/… Do not induce vomiting.
Get medical advice/attention if you feel unwell.
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
Call a POISON CENTER or doctor/physician if you feel unwell.
Collect spillage.
Avoid release to the environment.
Dispose of contents/container in accordance with Local, State, Federal and Provincial regulations.

Emergency Overview:

DANGER! Extremely Flammable. Pulmonary aspiration hazard if swallowed.
Eye and Skin irritant

Route of Exposure: Eyes. Skin. Inhalation. Ingestion.

Potential Health Effects:

Eye: Causes serious eye irritation

Skin:	Causes mild skin irritation. Repeated exposure may cause skin dryness or cracking
Inhalation:	May cause drowsiness and dizziness.
Ingestion:	May be fatal if swallowed and enters airways.
Physical Health Hazard:	This material may contain varying concentrations of polycyclic aromatic hydrocarbons (PAHs) which have been known to produce a phototoxic reaction when contaminated skin is exposed to sunlight. The effect is similar in appearance to an exaggerated sunburn, and is temporary in duration if exposure is discontinued. Continued exposure to sunlight can result in more serious skin problems including pigmentation (discoloration), skin eruptions (pimples), and possible skin cancers. This material may contain or liberate hydrogen sulfide, a poisonous gas with the smell of rotten eggs. The smell disappears rapidly because of olfactory fatigue so odor may not be a reliable indicator of exposure. Effects of overexposure include irritation of the eyes, nose, throat and respiratory tract, blurred vision, photophobia (sensitivity to light), and pulmonary edema (fluid accumulation in the lungs). Severe exposures can result in nausea, vomiting, muscle weakness or cramps, headache, disorientation and other signs of nervous system depression, irregular heartbeats, convulsions, respiratory failure, and death.
Signs/Symptoms:	Effects of overexposure may include irritation of the digestive tract, irritation of the respiratory tract, nausea, vomiting, diarrhea and signs of nervous system depression (e.g., headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue).
Target Organs:	May cause damage to organs through prolonged or repeated exposure. Laboratory animal studies of crude oil by the dermal and inhalation exposure routes have demonstrated toxicity to the liver, blood, spleen and thymus
Aggravation of Pre-Existing Conditions:	Not expected to be a sensitizer

SECTION 3 : COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Name	CAS#	Ingredient Percent	EC Num.
Crude Oil (Petroleum)	8002-05-9	100 by weight	
N-Hexane	110-54-3	<5 by Volume	
Ethyl Benzene	100-41-4	<3 by weight	
Xylenes	1330-20-7	<1 by weight	
Benzene	71-43-2	<1 by weight	
Hydrogen Sulfide	7783-06-4	<0.2 by Volume	
Naphthalene	91-20-3	0 - 0.9 by weight	

Total Sulfur: < 0.5 wt%

Crude oil, natural gas and natural gas condensate can contain minor amounts of sulfur, nitrogen and oxygen containing organic compounds as well as trace amounts of heavy metals like mercury, arsenic, nickel, and vanadium. Composition can vary depending on the source of crude.

SECTION 4 : FIRST AID MEASURES

Eye Contact:	Immediately flush eyes with plenty of water for at least 15 to 20 minutes. Ensure adequate flushing of the eyes by separating the eyelids with fingers. Get immediate medical attention. Remove contacts if present and easy to do.
Skin Contact:	Immediately wash skin with plenty of soap and water for 15 to 20 minutes, while removing contaminated clothing and shoes. Get medical attention if irritation develops or persists.
Inhalation:	If inhaled, remove to fresh air. If not breathing, give artificial respiration or give oxygen by trained personnel. Seek immediate medical attention. If victim is not breathing, clear airway and immediately begin artificial respiration. If breathing difficulties develop, oxygen should be administered by qualified personnel. Seek immediate medical attention.
Ingestion:	Aspiration hazard. Do not induce vomiting or give anything by mouth because this material can enter the lungs and cause severe lung damage. If victim is drowsy or unconscious and vomiting, place on the left side with the head down. If possible, do not leave victim unattended and observe closely for adequacy of breathing. Seek medical attention.
Note to Physicians:	At high concentrations hydrogen sulfide may produce pulmonary edema, respiratory depression, and/or respiratory paralysis. The first priority in treatment should be the establishment of adequate ventilation and the administration of 100% oxygen. Animal studies suggest that nitrites are a useful antidote, however, documentation of the efficacy of nitrites in humans is lacking. If the diagnosis of hydrogen sulfide poisoning is confirmed and if the patient does not respond rapidly to supportive care, the use of nitrites may be an effective antidote if delivered within the first few minutes of exposure. For adults the dose is 10 mL of a 3% $NaNO_2$ solution (0.5 gm $NaNO_2$ in 15 mL water) I.V. over 2-4 minutes. The dosage should be adjusted in children or in the presence of anemia, and methemoglobin levels, arterial blood gases, and electrolytes should be monitored closely. Epinephrine and other sympathomimetic drugs may initiate cardiac arrhythmias in persons exposed to high concentrations of hydrocarbon solvents (e.g., in enclosed spaces or with deliberate abuse). The use of other drugs with less arrhythmogenic potential should be considered. If sympathomimetic drugs are administered, observe for the development of cardiac arrhythmias. Federal regulations (29 CFR 1910.1028) specify medical surveillance programs for certain exposures to benzene above the action level or PEL (specified in Section (i)(1)(i) of the Standard). In addition, employees exposed in an emergency situation shall, as described in Section (i)(4)(i), provide a urine sample at the end of the shift for measurement of urine phenol.
Other First Aid:	Before attempting rescue, first responders should be alert to the possible presence of hydrogen sulfide, a poisonous gas with the smell of rotten eggs, and should consider the need for respiratory protection (see Section 8). Remove casualty to fresh air as quickly as possible. Immediately begin artificial respiration if breathing has ceased. Consider whether oxygen administration is needed. Obtain medical advice for further treatment
Most important symptoms and effects	**Acute:** Headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue **Delayed:** Dry skin and possible irritation with repeated or prolonged exposure.

SECTION 5 : FIRE FIGHTING MEASURES

Flammable Properties:	Extremely flammable.
Flash Point:	<-20°F (<-29°C)
Flash Point Method:	Manual ASTM D53
Auto Ignition Temperature:	Not determined.
Lower Flammable/Explosive Limit:	Not determined.
Upper Flammable/Explosive Limit:	Not determined.
Fire Fighting Instructions:	Long-duration fires involving crude or residual fuel oil stored in tanks may result in a boilover. The contents of the tank may be expelled beyond the containment dikes or ditches. All personnel should be kept back a safe distance when a boilover is anticipated (reference NFPA 11 or API 2021). For fires beyond the initial stage, emergency responders in the immediate hazard area should wear protective clothing. When the potential chemical hazard is unknown, in enclosed or confined spaces, a self contained breathing apparatus should be worn. In addition, wear other appropriate protective equipment as conditions warrant (see Section 8). Isolate immediate hazard area and keep unauthorized personnel out. Stop spill/release if it can be done safely. Move undamaged containers from immediate hazard area if it can be done safely. Water spray may be useful in minimizing or dispersing vapors and to protect personnel. Cool equipment exposed to fire with water, if it can be done safely. Avoid spreading burning liquid with water used for cooling purposes.
Extinguishing Media:	Dry chemical, carbon dioxide, or foam is recommended. Water spray is recommended to cool or protect exposed materials or structures. Carbon dioxide can displace oxygen. Use caution when applying carbon dioxide in confined spaces. Simultaneous use of foam and water on the same surface is to be avoided as water destroys the foam. Water may be ineffective for extinguishment, unless used under favorable conditions by experienced fire fighters.
Protective Equipment:	As in any fire, wear Self-Contained Breathing Apparatus (SCBA), MSHA/NIOSH (approved or equivalent) and full protective gear.
Unusual Fire Hazards:	This material can be ignited by heat, sparks, flames, or other sources of ignition (e.g., static electricity, pilot lights, mechanical/electrical equipment, and electronic devices such as cell phones, computers, calculators, and pagers which have not been certified as intrinsically safe). Vapors may travel considerable distances to a source of ignition where they can ignite, flash back, or explode. May create vapor/air explosion hazard indoors, in confined spaces, outdoors, or in sewers. This product will float and can be reignited on surface water. Vapors are heavier than air and can accumulate in low areas. If container is not properly cooled, it can rupture in the heat of a fire.
Hazardous Combustion Byproducts:	Combustion may yield smoke, carbon monoxide, and other products of incomplete combustion. Hydrogen sulfide and oxides of nitrogen and sulfur may also be formed. Hazardous combustion/decomposition products, including hydrogen sulfide, may be released by this material when exposed to heat or fire. Use caution and wear protective clothing, including respiratory protection.

NFPA Ratings:

NFPA Health:	2
NFPA Flammability:	3
NFPA Reactivity:	0

SECTION 6 : ACCIDENTAL RELEASE MEASURES

Personnel Precautions:	Extremely flammable. Spillages of liquid product will create a fire hazard and may form an explosive atmosphere. Keep all sources of ignition and hot metal surfaces away from spill/release if safe to do so. The use of explosion-proof electrical equipment is recommended. May contain or release poisonous hydrogen sulfide gas. If the presence of dangerous amounts of H2S around the spilled product is suspected, additional or special actions may be warranted, including access restrictions and use of protective equipment. Stay upwind and away from spill/release. Avoid direct contact with material. For large spillages, notify persons down wind of the spill/release, isolate immediate hazard area and keep unauthorized personnel out. Wear appropriate protective equipment, including respiratory protection, as conditions warrant (see Section 8). See Sections 2 and 7 for additional information on hazards and precautionary measures.
Environmental Precautions:	Stop spill/release if it can be done safely. Prevent spilled material from entering sewers, storm drains, other unauthorized drainage systems, and natural waterways. Use foam on spills to minimize vapors. Use water sparingly to minimize environmental contamination and reduce disposal requirements. If spill occurs on water notify appropriate authorities and advise shipping of any hazard. Spills into or upon navigable waters, the contiguous zone, or adjoining shorelines that cause a sheen or discoloration on the surface of the water, may require notification of the National Response Center (phone number 800-424-8802).
Methods for containment:	Dike far ahead of spill for later recovery or disposal. Absorb spill with inert material such as sand or vermiculite, and place in suitable container for disposal. Recommended measures are based on the most likely spillage scenarios for this material; however local conditions and regulations may influence or limit the choice of appropriate actions to be taken. Notify relevant authorities in accordance with all applicable regulations.
Methods for cleanup:	Immediate cleanup of any spill is recommended. If spilled on water remove with appropriate methods (e.g. skimming, booms or absorbents). In case of soil contamination, remove contaminated soil for remediation or disposal, in accordance with local regulations.

SECTION 7 : HANDLING and STORAGE

Handling:	Extremely Flammable. May vaporize easily at ambient temperatures. Keep away from ignition sources such as heat/sparks/open flame – No smoking. Take precautionary measures against static discharge. Nonsparking tools should be used. The vapor is heavier than air and may create an explosive mixture of vapor and air. Beware of accumulation in confined spaces and low lying areas. Open container slowly to relieve any pressure. Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. May contain or release dangerous levels of hydrogen sulfide. Do not breathe vapors or mists. Wear protective gloves/clothing and eye/face protection. Wash thoroughly after handling. Use

	good personal hygiene practices and wear appropriate personal protective equipment (see section 8). Electrostatic charge may accumulate and create a hazardous condition when handling or processing this material. To avoid fire or explosion, dissipate static electricity during transfer by grounding and bonding containers and equipment before transferring material. The use of explosion-proof electrical equipment is recommended and may be required (see appropriate fire codes). Refer to NFPA-70 and/or API RP 2003 for specific bonding/grounding requirements. Do not enter confined spaces such as tanks or pits without following proper entry procedures such as ASTM D-4276 and 29CFR 1910.146. Do not wear contaminated clothing or shoes. Keep contaminated clothing away from sources of ignition such as sparks or open flames.
Storage:	This material may contain or release poisonous hydrogen sulfide gas. In a tank, barge, or other closed container, the vapor space above this material may accumulate hazardous concentrations of hydrogen sulfide. Check atmosphere for oxygen content, H2S, and flammability prior to entry. Keep container(s) tightly closed and properly labeled. Use and store this material in cool, dry, well-ventilated areas away from heat, direct sunlight, hot metal surfaces, and all sources of ignition. Store only in approved containers. Post area "No Smoking or Open Flame." Keep away from any incompatible material (see Section 10). Protect container(s) against physical damage. Outdoor or detached storage is preferred. Indoor storage should meet OSHA standards and appropriate fire codes. "Empty" containers retain residue and may be dangerous. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, flame, sparks, or other sources of ignition. They may explode and cause injury or death. "Empty" drums should be completely drained, properly bunged, and promptly shipped to the supplier or a drum reconditioner. All containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations. Before working on or in tanks which contain or have contained this material, refer to OSHA regulations, ANSI Z49.1, and other references pertaining to cleaning, repairing, welding, or other contemplated operations
Special Handling Procedures:	Mercury and other heavy metals may be present in trace quantities in crude oil, raw natural gas, and condensates. Production and processing of these materials can lead to "drop-out" of elemental mercury in enclosed vessels and pipe work, typically at the low point of any process equipment because of its density. Mercury may also occur in other process system deposits such as sludges, sands, scales, waxes, and filter media. Personnel engaged in work with equipment where mercury deposits might occur (confined space entry, sampling, opening drain valves, draining process lines, etc), may be exposed to a mercury hazard (see sections 3 and 8).
Hygiene Practices:	Wash thoroughly after handling. Do not eat, drink or smoke when using this product. Contaminated work clothing should not be allowed out of the workplace.

SECTION 8 : EXPOSURE CONTROLS, PERSONAL PROTECTION - EXPOSURE GUIDELINES

Engineering Controls:	Use appropriate engineering control such as process enclosures, local exhaust ventilation, or other engineering controls to control airborne levels below recommended exposure limits. Good general ventilation should be sufficient to control airborne levels. Where such systems are not effective wear suitable personal protective equipment, which performs satisfactorily and meets OSHA or other recognized standards. Consult with local procedures for selection, training, inspection and maintenance of the personal protective equipment.
Eye/Face Protection:	Wear appropriate protective glasses or splash goggles as described by 29 CFR 1910.133, OSHA eye and face protection regulation, or the European standard EN 166.
Skin Protection Description:	Wear appropriate protective gloves and other protective apparel to prevent skin contact. Consult manufacturer's data for permeability data.
Hand Protection Description:	Suggested protective materials: Nitrile
Respiratory Protection:	Where there is potential for airborne exposure to hydrogen sulfide (H2S) above exposure limits, a NIOSH approved, self-contained breathing apparatus (SCBA) or equivalent operated in a pressure demand or other positive pressure mode should be used. Under conditions where hydrogen sulfide (H2S) is NOT detected, a NIOSH certified air purifying respirator equipped with organic vapor cartridges/canisters may be used. A respiratory protection program that meets or is equivalent to OSHA 29 CFR 1910.134 and ANSI Z88.2 should be followed whenever workplace conditions warrant a respirator's use. Air purifying respirators provide limited protection and cannot be used in atmospheres that exceed the maximum use concentration (as directed by regulation or the manufacturer's instructions), in oxygen deficient (less than 19.5 percent oxygen) situations, or under conditions that are immediately dangerous to life and health (IDLH). If benzene concentrations equal or exceed applicable exposure limits, OSHA requirements for personal protective equipment, exposure monitoring, and training may apply (29CFR1910.1028 - Benzene). Workplace monitoring plans should consider the possibility that heavy metals such as mercury may concentrate in processing vessels and equipment presenting the possibility of exposure during various sampling and maintenance operations. Implement appropriate respiratory protection and the use of other protective equipment as dictated by monitoring results (See Sections 2 and 7).
Other Protective:	Facilities storing or utilizing this material should be equipped with an eyewash and a deluge shower safety station.
PPE Pictograms:	

EXPOSURE GUIDELINES

Crude Oil (Petroleum) :

Guideline User Defined:	ConocoPhillips Guidelines TWA:100 mg/m3 - 8 hr

N-Hexane :

Guideline ACGIH:	Skin: Yes. TLV-TWA: 50 ppm
Guideline OSHA:	PEL-TWA: 500 ppm

Ethyl Benzene :

Guideline ACGIH:	TLV-TWA: 20 ppm
Guideline OSHA:	PEL-TWA: 100 ppm

Xylenes :

Guideline ACGIH:	TLV-STEL: 150 ppm TLV-TWA: 100 ppm

Benzene :

Guideline ACGIH:	Skin: Yes. TLV-STEL: 2.5 ppm TLV-TWA: 0.5 ppm
Guideline OSHA:	PEL-TWA: 1 ppm PEL-STEL: 5 ppm
Guideline User Defined:	ConocoPhillips Guidelines

	TWA: 0.2 mg/m3 (as total of 17 PNA's measured by NIOSH Method 5506)
Hydrogen Sulfide :	
Guideline ACGIH:	TLV-STEL: 5 ppm TLV-TWA: 1 ppm TLV-TWA: 1 ppm TLV-STEL: 5 ppm
Guideline OSHA:	PEL-Ceiling/Peak: 20 ppm PEL-Ceiling/Peak: 50 ppm Peak
Guideline User Defined:	ConocoPhillips Guidelines TWA: 5 ppm 8hr TWA: 2.5 ppm 12hr STEL: 15 ppm
Naphthalene :	
Guideline ACGIH:	Skin: Yes. TLV-STEL: 15 ppm TLV-TWA: 10 ppm
Guideline OSHA:	PEL-TWA: 10 ppm
Note:	Suggestions provided in this section for exposure control and specific types of protective equipment are based on readily available information. Users should consult with the specific manufacturer to confirm the performance of their protective equipment. Specific situations may require consultation with industrial hygiene, safety, or engineering professionals. State, local or other agencies or advisory groups may have established more stringent limits. Consult an industrial hygienist or similar professional, or your local agencies, for further information.

SECTION 9 : PHYSICAL and CHEMICAL PROPERTIES

Physical State:	Liquid.
Color:	Amber to Black
Odor:	Petroleum. Rotten egg / sulfurous
Odor Threshold:	Not determined.
Boiling Point:	70 to 110 °F (21 to 43 °C)
Melting Point:	Not determined.
Density:	5.83-8.58 lbs/gal Bulk
Specific Gravity:	0.7-1.03 @ 60ºF (15.6ºC) Reference water = 1
Solubility:	Negligible solubility in water.
Vapor Density:	>1 (air = 1)
Vapor Pressure:	8.5-15 psia (Reid VP) @ 100ºF (37.8ºC)
Percent Volatile:	Not determined.
Evaporation Rate:	Not determined.
pH:	Not applicable.
Viscosity:	Not determined.
Coefficient of Water/Oil Distribution:	Not determined.
Flash Point:	<-20ºF (<-29ºC)
Flash Point Method:	Manual ASTM D53
Auto Ignition Temperature:	Not determined.
Note:	Unless otherwise stated, values are determined at 20ºC (68ºF) and 760 mm Hg (1 atm). Data represent typical values and are not intended to be specifications.

SECTION 10 : STABILITY and REACTIVITY

Chemical Stability:	Stable under normal ambient and anticipated conditions of use.
Hazardous Polymerization:	Hazardous Polymerization does not occur.
Conditions to Avoid:	Avoid high temperatures and all sources of ignition. Prevent vapor accumulation.
Incompatible Materials:	Avoid contact with strong oxidizing agents and strong reducing agents.
Special Decomposition Products:	Thermal decomposition or combustion may liberate carbon oxides, aldehydes, and other toxic gases or vapors

SECTION 11 : TOXICOLOGICAL INFORMATION

Crude Oil (Petroleum) :

Eye:	Administration into the eye - Rabbit Standard Draize test : 100 mg [Mild] (RTECS)
Skin:	Administration onto the skin - Rabbit LD50 - Lethal dose, 50 percent kill : >2000 mg/kg [Details of toxic effects not reported other than lethal dose value] (RTECS)
Ingestion:	Oral - Rat LD50 - Lethal dose, 50 percent kill : >4300 mg/kg [Details of toxic effects not reported other than lethal dose value] Oral - Rat LD50 - Lethal dose, 50 percent kill : >5000 mg/kg [Gastrointestinal - Hypermotility, diarrhea] (RTECS)
Carcinogenicity:	May cause cancer Chronic application of crude oil to mouse skin resulted in an increased incidence of skin tumors. IARC concluded in its Crude Oil Monograph that there is limited evidence of

carcinogenicity in animals, and that crude oil is not classifiable as to its carcinogenicity in humans (Group 3). It has not been listed as a carcinogen by NTP or OSHA.

Mutagenicity: Inadequate information available.

Reproductive Toxicity: Inadequate information available. Dermal exposure to crude oil during pregnancy resulted in limited evidence of developmental toxicity in laboratory animals. Decreased fetal weight and increased resorptions were noted at maternally toxic doses. No significant effects on pup growth or other developmental landmarks were observed postnatally.

Other Toxicological Information:

N-Hexane :

Eye: Administration into the eye - Rabbit Standard Draize test : 10 mg [Mild] (RTECS)

Inhalation: Inhalation - Rat LC50 - Lethal concentration, 50 percent kill : 48000 ppm/4H [Details of toxic effects not reported other than lethal dose value]
Inhalation - Rat LC50 - Lethal concentration, 50 percent kill : 627000 mg/m3/3M [Details of toxic effects not reported other than lethal dose value] (RTECS)

Ingestion: Oral - Rat LD50 - Lethal dose, 50 percent kill : 15840 mg/kg [Details of toxic effects not reported other than lethal dose value]
Oral - Rat LD50 - Lethal dose, 50 percent kill : 29700 mg/kg [Behavioral - Somnolence (general depressed activity) Gastrointestinal - Changes in structure or function of salivary glands Gastrointestinal - Hypermotility, diarrhea] (RTECS)

Reproductive Toxicity: Prolonged exposure to high concentrations of n-hexane (>1,000 ppm) resulted in decreased sperm count and degenerative changes in the testes of rats but not those of mice.

Neurological Effects: Excessive exposure to n-hexane can result in peripheral neuropathies. The initial symptoms are symmetrical sensory numbness and paresthesias of distal portions of the extremities. Motor weakness is typically observed in muscles of the toes and fingers but may also involve muscles of the arms, thighs and forearms. The onset of these symptoms may be delayed for several months to a year after the beginning of exposure. The neurotoxic properties of n-hexane are potentiated by exposure to methyl ethyl ketone and methyl isobutyl ketone.

Ethyl Benzene :

Eye: Administration into the eye - Rabbit Standard Draize test : 500 mg [Severe] (RTECS)

Skin: Administration onto the skin - Rabbit LD50 - Lethal dose, 50 percent kill : 17800 uL/kg [Details of toxic effects not reported other than lethal dose value]
Administration onto the skin - Rabbit LD50 - Lethal dose, 50 percent kill : >5000 mg/kg [Details of toxic effects not reported other than lethal dose value] (RTECS)

Inhalation: Inhalation - Rat LC50 - Lethal concentration, 50 percent kill : 55000 mg/m3/2H [Details of toxic effects not reported other than lethal dose value] (RTECS)
In rats and mice exposed to 0, 75, 250, or 750 ppm ethyl benzene in a two year inhalation study there was mild damage to the kidney (tubular hyperplasia), liver (eosinophilio foci, hypertrophy, necrosis), lung (alveolar epithelium metaplasia), thyroid (hyperplasia), thyroid (hyperplasia) and pituitary (hyperplasia). In animal models (particularly rats), ethyl benzene affects the auditory function mainly in the cochlear mid-frequency range and ototoxicity was observed after combined exposure to noise and ethyl benzene. There is no evidence of either ethyl benzene-induced hearing losses or ototoxicity with combined exposure to ethyl benzene and noise in workers.

Ingestion: Oral - Rat LD50 - Lethal dose, 50 percent kill : 3500 mg/kg [Liver - Other changes Kidney/Ureter/Bladder - Other changes]
Oral - Rat LD50 - Lethal dose, 50 percent kill : 3500 mg/kg [Details of toxic effects not reported other than lethal dose value] (RTECS)

Carcinogenicity: Rats and mice exposed to 0, 75, 250, or 750 ppm ethyl benzene in a two year inhalation study demonstrated limited evidence of kidney, liver, and lung cancer. Ethyl benzene has been listed as a possible human carcinogen by IARC.

Xylenes :

Eye: Administration into the eye - Rabbit Standard Draize test : 87 mg [Mild]
Administration into the eye - Rabbit Standard Draize test : 5 mg/24H [Severe] (RTECS)

Skin: Administration onto the skin - Rabbit LD50 - Lethal dose, 50 percent kill : >1700 mg/kg [Details of toxic effects not reported other than lethal dose value] (RTECS)

Inhalation: Inhalation - Rat LC50 - Lethal concentration, 50 percent kill : 5000 ppm/4H [Details of toxic effects not reported other than lethal dose value] (RTECS)

Ingestion: Oral - Rat LD50 - Lethal dose, 50 percent kill : 4300 mg/kg [Liver - Other changes Kidney/Ureter/Bladder - Other changes] (RTECS)

Reproductive Toxicity: Both mixed xylenes and the individual isomers produced limited evidence of developmental toxicity in laboratory animals. Inhalation and oral administration of xylene resulted in decreased fetal weight, increased incidences of delayed ossification, skeletal variations and resorptions, but no evidence of teratogenicity.

Other Toxicological Information: Rats exposed to xylenes at 800, 1000 or 1200 ppm 14 hours daily for 6 weeks demonstrated high frequency hearing loss. Another study in rats exposed to 1800 ppm 8 hours daily for 5 days demonstrated middle frequency hearing loss.

Benzene :

Eye: Administration into the eye - Rabbit Standard Draize test : 88 mg [Moderate]
Administration into the eye - Rabbit Standard Draize test : 2 mg/24H [Severe] (RTECS)

Skin: Administration onto the skin - Rabbit LD50 - Lethal dose, 50 percent kill : >9400 uL/kg [Details of toxic effects not reported other than lethal dose value] (RTECS)

Inhalation: Inhalation - Rat LC50 - Lethal concentration, 50 percent kill : 10000 ppm/7H [Details of toxic effects not reported other than lethal dose value] (RTECS)

Ingestion: Oral - Rat LD50 - Lethal dose, 50 percent kill : 930 mg/kg [Behavioral - Tremor Behavioral - Convulsions or effect on seizure threshold]
Oral - Rat LD50 - Lethal dose, 50 percent kill : 1 mL/kg [Details of toxic effects not reported other than lethal dose value]
Oral - Rat LD50 - Lethal dose, 50 percent kill : 1800 mg/kg [Details of toxic effects not reported other than lethal dose value]
Oral - Rat LD50 - Lethal dose, 50 percent kill : 6400 mg/kg [Peripheral Nerve and Sensation - Recording from peripheral motor nerve Blood - Changes in other cell count (unspecified) Blood - Changes in leukocyte (WBC) count] (RTECS)

Carcinogenicity: Benzene is an animal carcinogen and is known to produce acute myelogenous leukemia (a form of cancer) in humans. Benzene has been identified as a human carcinogen by IARC, the US National Toxicology Program and the US-Occupational Safety and Health Administration.

Mutagenicity:	Benzene exposure has resulted in chromosomal aberrations in human lymphocytes and animal bone marrow cells. Exposure has also been associated with chromosomal aberrations in sperm cells in human and animal studies.
Reproductive Toxicity:	Some studies in occupationally exposed women have suggested benzene exposure increased risk of miscarriage and stillbirth and decreased birth weight and gestational age. The size of the effects detected in these studies was small, and ascertainment of exposure and outcome in some cases relied on self-reports, which may limit the reliability of these results.
Other Toxicological Information:	Prolonged or repeated exposures to benzene vapors can cause damage to the blood and blood forming organs, including disorders like leukopenia, thrombocytopenia, and aplastic anemia.

Hydrogen Sulfide :

Inhalation:	Inhalation - Rat LC50 - Lethal concentration, 50 percent kill : 444 ppm [Lungs, Thorax, or Respiration - Other changes Gastrointestinal - Hypermotility, diarrhea Kidney/Ureter/Bladder - Urine volume increased] Inhalation - Rat LC50 - Lethal concentration, 50 percent kill : 820 mg/m3/3H [Details of toxic effects not reported other than lethal dose value] Inhalation - Rat LC50 - Lethal concentration, 50 percent kill : 700 mg/m3/4H [Details of toxic effects not reported other than lethal dose value] Inhalation - Rat LC50 - Lethal concentration, 50 percent kill : 470 mg/m3/6H [Details of toxic effects not reported other than lethal dose value] Inhalation - Rat LC50 - Lethal concentration, 50 percent kill : 444 ppm/4H [Details of toxic effects not reported other than lethal dose value] (RTECS)

Naphthalene :

Skin:	Administration onto the skin - Rat LD50 - Lethal dose, 50 percent kill : >2500 mg/kg [Details of toxic effects not reported other than lethal dose value] Administration onto the skin - Rabbit LD50 - Lethal dose, 50 percent kill : >20 gm/kg [Details of toxic effects not reported other than lethal dose value] (RTECS)
Ingestion:	Oral - Rat LD50 - Lethal dose, 50 percent kill : 490 mg/kg [Details of toxic effects not reported other than lethal dose value] (RTECS)
Carcinogenicity:	Naphthalene has been evaluated in two year inhalation studies in both rats and mice. The US National Toxicology Program (NTP) concluded that there is clear evidence of carcinogenicity in male and female rats based on increased incidences of respiratory epithelial adenomas and olfactory epithelial neuroblastomas of the nose. NTP found some evidence of carcinogenicity in female mice (alveolar adenomas) and no evidence of carcinogenicity in male mice. Naphthalene has been identified as a carcinogen by IARC and NTP.

SECTION 12 : ECOLOGICAL INFORMATION

Ecotoxicity:	Experimental studies of acute aquatic toxicity show values for crude oil in the range of 2 to over 100 mg/L. These values are consistent with the predicted aquatic toxicity of these substances based on their hydrocarbon compositions. Crude oil should be regarded as harmful to aquatic organisms, with the potential to cause long term adverse effects in the aquatic environment. Classification: H411; Chronic Cat 2.
Environmental Fate:	Persistence per IOPC Fund definition: Persistent
Bioaccumulation:	Log Kow values measured for the hydrocarbon components of this material range from less than 2 to greater than 6, and therefore would be regarded as having the potential to bioaccumulate.
Biodegradation:	Most crude oils are not regarded as readily biodegradable. Most of the non-volatile constituents are inherently biodegradable; some of the highest molecular weight components are persistent in water.
Mobility In Environmental Media:	Crude oil spreads as a film on the surface of water, facilitating loss of its lighter components by volatilization. In air, the volatile hydrocarbons undergo photodegradation by reaction with hydroxyl radicals with half-lives varying from 0.5 days for n-dodecane to 6.5 days for benzene. The lower molecular weight aromatic hydrocarbons and some polar compounds have low but significant water solubility. Some higher molecular weight compounds are removed by emulsification and these also slowly biodegrade; others adsorb to sediment and sink. A further removal process from water involving the heavier fraction is agglomeration to form tars, some of which sink.

SECTION 13 : DISPOSAL CONSIDERATIONS

Waste Disposal:	Consult with the US EPA Guidelines listed in 40 CFR Part 261.3 for the classifications of hazardous waste prior to disposal. Furthermore, consult with your state and local waste requirements or guidelines, if applicable, to ensure compliance. Arrange disposal in accordance to the EPA and/or state and local guidelines. The generator of a waste is always responsible for making proper hazardous waste determinations and needs to consider state and local requirements in addition to federal regulations. This material, if discarded as produced, would not be a federally regulated RCRA "listed" hazardous waste. However, it would likely be identified as a federally regulated RCRA hazardous waste for the following characteristic(s) shown below. See Sections 7 and 8 for information on handling, storage and personal protection and Section 9 for physical/chemical properties. It is possible that the material as produced contains constituents which are not required to be listed in the MSDS but could affect the hazardous waste determination. Additionally, use which results in chemical or physical change of this material could subject it to regulation as a hazardous waste. Container contents should be completely used and containers should be emptied prior to discard. Container residues and rinseates could be considered to be hazardous wastes.
RCRA Number:	EPA Waste Number(s) • D001 - Ignitability characteristic • D018 - Toxicity characteristic (Benzene)

SECTION 14 : TRANSPORT INFORMATION

DOT Shipping Name:	Petroleum crude oil
DOT UN Number:	UN1267
DOT Hazard Class:	3
DOT Packing Group:	I
IATA Shipping Name:	Petroleum crude oil

IATA UN Number:	UN1267
IATA Hazard Class:	3
IATA Packing Group:	I
IMDG UN NUmber :	UN1267
IMDG Shipping Name :	Petroleum crude oil
IMDG Hazard Class :	3
IMDG Packing Group :	I
Notes :	U.S. DOT compliance requirements may apply. See 49 CFR 171.22, 23 & 25. If transported in bulk by marine vessel in international waters, product is being carried under the scope of MARPOL Annex I.

SECTION 15 : REGULATORY INFORMATION

Section 311/312 Hazard Categories:	Acute Health: Yes Chronic Health: Yes Fire Hazard: Yes Pressure Hazard: No Reactive Hazard: No
California PROP 65:	This material may contain detectable quantities of the following chemicals, known to the State of California to cause cancer, birth defects or other reproductive harm, and which may be subject to the warning requirements of California Proposition 65 (CA Health & Safety Code Section 25249.5): Various Polycyclic Aromatic Hydrocarbons: Skin Cancer Toluene: Developmental Toxicant, Female Reproductive Toxicant
Canada WHMIS:	WHMIS Hazard Class: B2 - Flammable Liquids D2A, D2B
Crude Oil (Petroleum) :	
TSCA Inventory Status:	Listed
Canada DSL:	Listed
N-Hexane :	
TSCA Inventory Status:	Listed
Section 313:	EPCRA - 40 CFR Part 372 - (SARA Title III) Section 313 Listed Chemical.: 1.0% de minimis
Canada DSL:	Listed
Ethyl Benzene :	
TSCA Inventory Status:	Listed
Section 313:	EPCRA - 40 CFR Part 372 - (SARA Title III) Section 313 Listed Chemical.: 0.1% de minimis
California PROP 65:	Listed: cancer.
Canada DSL:	Listed
Xylenes :	
TSCA Inventory Status:	Listed
Section 313:	EPCRA - 40 CFR Part 372 - (SARA Title III) Section 313 Listed Chemical.: 1.0% de minimis
Canada DSL:	Listed
Benzene :	
TSCA Inventory Status:	Listed
Section 313:	EPCRA - 40 CFR Part 372 - (SARA Title III) Section 313 Listed Chemical.: 0.1% de minimis
California PROP 65:	Listed: developmental.
Canada DSL:	Listed
Hydrogen Sulfide :	
TSCA Inventory Status:	Listed
Section 302 EHS:	TPQ 500 lb
Section 304 RQ:	100 lb
Canada DSL:	Listed
Naphthalene :	
TSCA Inventory Status:	Listed
Section 313:	EPCRA - 40 CFR Part 372 - (SARA Title III) Section 313 Listed Chemical.: 0.1% de minimis
California PROP 65:	Listed: cancer.
Canada DSL:	Listed

SECTION 16 : ADDITIONAL INFORMATION

HMIS Health Hazard:	2*
HMIS Fire Hazard:	3
HMIS Reactivity:	1

HMIS Personal Protection:	X
SDS Creation Date:	May 19, 2014
SDS Revision Date:	May 19, 2014
MSDS Author:	Actio Corporation
Guide to Abbreviations:	ACGIH = American Conference of Governmental Industrial Hygienists; CASRN = Chemical Abstracts Service Registry Number; CEILING = Ceiling Limit (15 minutes); CERCLA = The Comprehensive Environmental Response, Compensation, and Liability Act; EPA = Environmental Protection Agency; GHS = Globally Harmonized System; IARC = International Agency for Research on Cancer; INSHT = National Institute for Health and Safety at Work; IOPC = International Oil Pollution Compensation; LEL = Lower Explosive Limit; NE = Not Established; NFPA = National Fire Protection Association; NTP = National Toxicology Program; OSHA = Occupational Safety and Health Administration; PEL = Permissible Exposure Limit (OSHA); SARA = Superfund Amendments and Reauthorization Act; STEL = Short Term Exposure Limit (15 minutes); TLV = Threshold Limit Value (ACGIH); TWA = Time Weighted Average (8 hours); UEL = Upper Explosive Limit; WHMIS = Worker Hazardous Materials Information System (Canada)
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