Report

Lea County, New Mexico

C.K. Disposal E & P Landfill and Processing Facility

Maximum H_2S Emissions Estimates

September 2016

01058015

PARKHILLSMITH&COOPER

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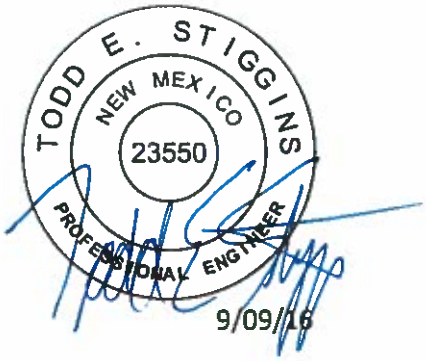
Maximum H_2S Emissions Estimates



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GIVEN

Incoming truckloads of exploration and production (E&P) liquids with a hydrogen sulfide (H_2S) concentration greater than or equal to 10 ppm must be treated with calcium hypochlorite (Ca(ClO)2) to lower the H_2S concentration to below 1 ppm.

FIND

Estimate maximum downwind H_2S concentrations at receptor heights of 1 m, 2 m, and 10 m for fugitive H_2S emissions at the facility using EPA SCREEN3 for the following locations:

1) North C.K. Disposal property boundary
2) South straight-line URENCO property boundary
3) Southernmost straight-line URENCO building

ASSUMPTIONS

The critical emissions event occurs at loadout points when trucks are evacuated of E&P liquids. From there, E&P liquids are collected and pumped into enclosed tanks and evaporation ponds for processing, treatment, and stabilization, in accordance with the H_2S Management Plan (Attachment K, Appendix A) of the permit application.

Loadout point basins are treated as individual area sources. They measure 10' by 10' (3.048 m by 3.048 m).

Emissions release point is estimated at the top of the loadout point basin (4' (1.219 m) above existing ground level).

H_2S concentrations are measured on a parts per million volume (ppmv) basis.

Permit restrictions for CK Disposal Facility for H_2S maximum concentration allowed is 10 ppmv.

Henry's Law is used to estimate the equilibrium liquid phase concentration of H_2S in the truck based upon maximum H_2S vapor phase concentration of 10 ppmv. Assume atmospheric pressure equal to 1 atm.

All of the H_2S in the E&P liquids escape into the atmosphere during loadout.

Vapor phase H_2S remains in the truck during loadout as truck tanks are evacuated from the bottom.

According to Galyean, LP, manufacturer of tanker trucks in Henderson, TX, a 130-bbl truck tank can be evacuated in approximately six minutes. Assume 900 gallons per minute flow rate for E&P liquids into the loadout point.

EPA SCREEN3 is used to estimate the maximum downwind concentration based upon all stability classes and meteorological conditions.

SOLUTION

A. Using Henry's Law, we estimate the equilibrium concentration of H_2S in the liquid phase in milligrams per liter.

$$p = \frac{H_D\, c}{P_T}$$

where: p = mol H_2S/mol air
c = mg H_2S/L water
H_D = atm-L/mg, $2.72x(10^{-4})$ atm-L/mg [1]
P_T = atm, assumed to be 1 atm

$$10 \times (10^{-6}) \frac{\text{mol } H_2S}{\text{mol air}} = \frac{2.72 \times (10^{-4}) \frac{\text{atm L}}{\text{mg}} \times c}{1 \text{ atm}}$$

$$c = \frac{10 \times (10^{-6}) \frac{\text{mol } H_2S}{\text{mol air}} \times 1 \text{ atm}}{2.72 \times (10^{-4}) \frac{\text{atm L}}{\text{mg}}}$$

$$c = 0.03676 \frac{\text{mg } H_2S}{\text{L } H_2O}$$

Notes:
[1]Source: Davis, M. L. and D. A. Cornwell. (2008) Introduction to Environmental Engineering, Fourth Edition. New York, NY: McGraw-Hill.

B. Calculate mass flow rate (M) of H_2S, in grams per second, based on 900 gpm of E&P liquids from the tanker truck.

$$M = 0.03676 \frac{\text{mg } H_2S}{\text{L } H_2O} \times \frac{3.8 \text{ L}}{\text{gallon}} \times \frac{900 \text{ gallons}}{\text{minute}} \times \frac{1 \text{ g}}{1000 \text{ mg}} \times \frac{1 \text{ minute}}{60 \text{ seconds}}$$

$$M = 0.002096 \frac{\text{g}}{\text{s}}$$

C. Calculate area emission rate (Q) of H_2S in grams per second per square meter based on area of loadout point basin open to atmosphere for one loadout point.

$$Q=0.002096\ \frac{g}{s}\times\frac{1}{(3.048\ m)^2}$$

$$Q=2.26\times10^{-4}\frac{g}{s\text{-}m^2}$$

D. Use EPA SCREEN3 to estimate maximum downwind concentrations of H_2S in micrograms per cubic meter based on calculated area emission rate (Q) for one loadout point. See attached figure.

- North C.K. Disposal property boundary – 717 meters from source
- South straight-line URENCO property boundary – 945 meters from source
- Southernmost straight-line URENCO building – 1264 meters from source

C.K. Disposal H_2S Emissions Per Loadout Point ($\mu g/m^3$)				
		Receptor Height (m)		
Distance (M)		1	2	10
C.K. Property Boundary	717	2.377	2.348	1.599
URENCO Property Boundary	945	1.533	1.52	1.167
URENCO Building	1264	0.9776	0.972	0.81

E. Convert downwind concentrations from micrograms per cubic meter to parts per million volume basis using Ideal Gas Law.

$$V=\frac{mRT}{MW\times P}$$

where: P = atmospheric pressure, Pa
V = volume, m^3
m = mass of gas, g
R = universal gas constant, 8.3145 m^3-Pa/K-mol
T = temperature, K
MW = molecular weight, g/mol

Find volume of one microgram of H_2S:

$$V=\frac{1\times10^{-6}g\times8.3145\ \frac{m^3\text{-}Pa}{K\text{-}mol}\times(273.15+20)K}{34.0809\frac{g}{mol}\times101{,}325Pa}$$

$$V=7.0583\times10^{-10}\frac{m^3}{\mu g}$$

Convert micrograms per cubic meter to ppmv:

$$\text{ppmv} = \frac{\mu g}{m^3} \times 7.0583 \times 10^{-10} \frac{m^3}{\mu g} \times 10^6$$

Example

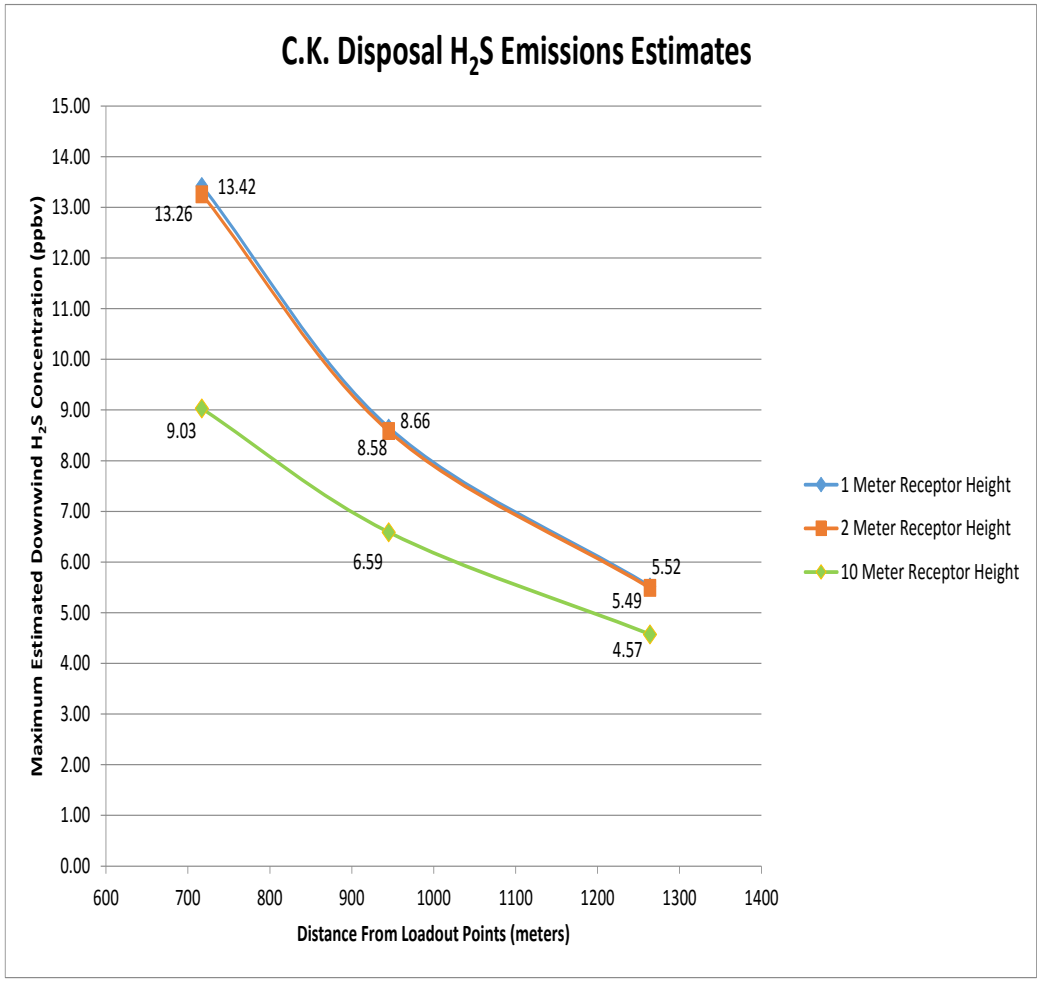
For a receptor height of 1 meter at the C.K. Disposal property boundary:

$$\text{ppmv} = 2.377 \frac{\mu g}{m^3} \times 7.0583 \times 10^{-10} \frac{m^3}{\mu g} \times 10^6 = 0.00168 \text{ ppmv}$$

C.K. Disposal H_2S Emissions Per Loadout Point (ppmv)				
		Receptor Height (m)		
Distance (M)		1	2	10
C.K. Property Boundary	717	0.00168	0.00166	0.00113
URENCO Property Boundary	945	0.00108	0.00107	0.00082
URENCO Building	1264	0.00069	0.00069	0.00057

F. In accordance with the Landfill Phasing Plan (Attachment K, Section 4.1) of the permit application, four loadout points will be constructed during Phase I and four additional loadout points will be constructed in Phase 3. Assuming a worst case scenario where tanker truck evacuation is occurring simultaneously at all eight loadout points, use EPA SCREEN3 to estimate downwind concentrations of H_2S in parts per billion volume (ppbv) basis.

C.K. Disposal H_2S Emissions for Eight Loadout Points (ppbv)				
		Receptor Height (m)		
Distance (M)		1	2	10
C.K. Property Boundary	717	13.42	13.26	9.03
URENCO Property Boundary	945	8.66	8.58	6.59
URENCO Building	1264	5.52	5.49	4.57


C.K. Disposal H2S Emissions Estimates
Maximum Estimated Downwind H2S Concentration (ppbv)
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
600
700
800
900
1000
1100
1200
1300
1400
Distance From Loadout Points (meters)
13.42
13.26
8.66
8.58
9.03
6.59
5.52
5.49
4.57
1 Meter Receptor Height
2 Meter Receptor Height
10 Meter Receptor Height

C.K. Disposal E & P Landfill & Processing Facility

New Landfill Site and Processing Faciilty

Lea County, New Mexico

PARKHILLSMITH&COOPER
PSC

APPENDIX A

EPA SCREEN 3 RESULTS

09/08/16

17:03:54
  *** SCREEN3 MODEL RUN ***
  *** VERSION DATED 13043 ***

 C.K. Loadout Emissions - 1-M Receptor

 SIMPLE TERRAIN INPUTS:
    SOURCE TYPE   =   AREA
    EMISSION RATE (G/(S-M**2)) =   0.226000E-03
    SOURCE HEIGHT (M)   =   1.2190
    LENGTH OF LARGER SIDE (M)   =   3.0480
    LENGTH OF SMALLER SIDE (M) =   3.0480
    RECEPTOR HEIGHT (M)   =   1.0000
    URBAN/RURAL OPTION   =   RURAL
 THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
 THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

    MODEL ESTIMATES DIRECTION TO MAX CONCENTRATION

 BUOY. FLUX =   0.000 M**4/S**3; MOM. FLUX =   0.000 M**4/S**2.

 *** FULL METEOROLOGY ***

 ****
 *** SCREEN AUTOMATED DISTANCES ***
 ****

 *** TERRAIN HEIGHT OF   0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	MAX DIR (DEG)
1.	310.4	5	1.0	1.0	10000.0	1.22	45.
100.	56.22	6	1.0	1.0	10000.0	1.22	45.
200.	19.53	6	1.0	1.0	10000.0	1.22	31.
300.	10.14	6	1.0	1.0	10000.0	1.22	31.
400.	6.301	6	1.0	1.0	10000.0	1.22	33.
500.	4.343	6	1.0	1.0	10000.0	1.22	32.
600.	3.199	6	1.0	1.0	10000.0	1.22	40.
700.	2.469	6	1.0	1.0	10000.0	1.22	38.
800.	1.997	6	1.0	1.0	10000.0	1.22	44.
900.	1.657	6	1.0	1.0	10000.0	1.22	40.
1000.	1.401	6	1.0	1.0	10000.0	1.22	33.
1100.	1.210	6	1.0	1.0	10000.0	1.22	38.
1200.	1.059	6	1.0	1.0	10000.0	1.22	41.

1300.	0.9363	6	1.0	1.0	10000.0	1.22	41.
1400.	0.8355	6	1.0	1.0	10000.0	1.22	38.
1500.	0.7514	6	1.0	1.0	10000.0	1.22	41.
1600.	0.6804	6	1.0	1.0	10000.0	1.22	38.
1700.	0.6199	6	1.0	1.0	10000.0	1.22	41.
1800.	0.5678	6	1.0	1.0	10000.0	1.22	41.
1900.	0.5225	6	1.0	1.0	10000.0	1.22	38.
2000.	0.4829	6	1.0	1.0	10000.0	1.22	37.

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 1. M:

6.	936.9	6	1.0	1.0	10000.0	1.22	45.

****
*** SCREEN DISCRETE DISTANCES ***
****

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	MAX DIR (DEG)
717.	2.377	6	1.0	1.0	10000.0	1.22	40.
945.	1.533	6	1.0	1.0	10000.0	1.22	44.
1264.	0.9776	6	1.0	1.0	10000.0	1.22	38.

09/08/16

17:13:44
  *** SCREEN3 MODEL RUN ***
  *** VERSION DATED 13043 ***

 C.K. Loadout Emissions - 2-M Receptor

 SIMPLE TERRAIN INPUTS:
    SOURCE TYPE   =   AREA
    EMISSION RATE (G/(S-M**2)) =   0.226000E-03
    SOURCE HEIGHT (M)   =   1.2190
    LENGTH OF LARGER SIDE (M)   =   3.0480
    LENGTH OF SMALLER SIDE (M) =   3.0480
    RECEPTOR HEIGHT (M)   =   2.0000
    URBAN/RURAL OPTION   =   RURAL
 THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
 THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

    MODEL ESTIMATES DIRECTION TO MAX CONCENTRATION

 BUOY. FLUX =   0.000 M**4/S**3; MOM. FLUX =   0.000 M**4/S**2.

 *** FULL METEOROLOGY ***

 ****
 *** SCREEN AUTOMATED DISTANCES ***
 ****

 *** TERRAIN HEIGHT OF   0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	MAX DIR (DEG)
1.	0.1682E-01	5	1.0	1.0	10000.0	1.22	45.
100.	45.83	6	1.0	1.0	10000.0	1.22	45.
200.	18.00	6	1.0	1.0	10000.0	1.22	31.
300.	9.689	6	1.0	1.0	10000.0	1.22	31.
400.	6.119	6	1.0	1.0	10000.0	1.22	33.
500.	4.254	6	1.0	1.0	10000.0	1.22	32.
600.	3.149	6	1.0	1.0	10000.0	1.22	40.
700.	2.438	6	1.0	1.0	10000.0	1.22	38.
800.	1.977	6	1.0	1.0	10000.0	1.22	38.
900.	1.642	6	1.0	1.0	10000.0	1.22	40.
1000.	1.391	6	1.0	1.0	10000.0	1.22	33.
1100.	1.202	6	1.0	1.0	10000.0	1.22	38.
1200.	1.052	6	1.0	1.0	10000.0	1.22	41.

1300.	0.9311	6	1.0	1.0	10000.0	1.22	41.
1400.	0.8313	6	1.0	1.0	10000.0	1.22	38.
1500.	0.7479	6	1.0	1.0	10000.0	1.22	41.
1600.	0.6776	6	1.0	1.0	10000.0	1.22	38.
1700.	0.6175	6	1.0	1.0	10000.0	1.22	41.
1800.	0.5657	6	1.0	1.0	10000.0	1.22	41.
1900.	0.5207	6	1.0	1.0	10000.0	1.22	38.
2000.	0.4814	6	1.0	1.0	10000.0	1.22	37.

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 1. M:

20.	189.3	6	1.0	1.0	10000.0	1.22	45.

****
*** SCREEN DISCRETE DISTANCES ***
****

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	MAX DIR (DEG)
717.	2.348	6	1.0	1.0	10000.0	1.22	42.
945.	1.520	6	1.0	1.0	10000.0	1.22	38.
1264.	0.9720	6	1.0	1.0	10000.0	1.22	38.

09/08/16

17:17:08
  *** SCREEN3 MODEL RUN ***
  *** VERSION DATED 13043 ***

 C.K. Disposal Emissions - 10-M Receptor

 SIMPLE TERRAIN INPUTS:
    SOURCE TYPE   =   AREA
    EMISSION RATE (G/(S-M**2)) =   0.226000E-03
    SOURCE HEIGHT (M)   =   1.2190
    LENGTH OF LARGER SIDE (M)   =   3.0480
    LENGTH OF SMALLER SIDE (M) =   3.0480
    RECEPTOR HEIGHT (M)   =   10.0000
    URBAN/RURAL OPTION   =   RURAL
 THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
 THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

    MODEL ESTIMATES DIRECTION TO MAX CONCENTRATION

 BUOY. FLUX =   0.000 M**4/S**3; MOM. FLUX =   0.000 M**4/S**2.

 *** FULL METEOROLOGY ***

 ****
 *** SCREEN AUTOMATED DISTANCES ***
 ****

 *** TERRAIN HEIGHT OF   0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	MAX DIR (DEG)
1.	0.000	5	1.0	1.0	10000.0	1.22	42.
100.	0.7970	5	1.0	1.0	10000.0	1.22	15.
200.	2.615	5	1.0	1.0	10000.0	1.22	29.
300.	2.350	5	1.0	1.0	10000.0	1.22	4.
400.	2.396	6	1.0	1.0	10000.0	1.22	33.
500.	2.184	6	1.0	1.0	10000.0	1.22	32.
600.	1.903	6	1.0	1.0	10000.0	1.22	40.
700.	1.640	6	1.0	1.0	10000.0	1.22	38.
800.	1.419	6	1.0	1.0	10000.0	1.22	44.
900.	1.238	6	1.0	1.0	10000.0	1.22	40.
1000.	1.089	6	1.0	1.0	10000.0	1.22	33.
1100.	0.9676	6	1.0	1.0	10000.0	1.22	38.
1200.	0.8663	6	1.0	1.0	10000.0	1.22	41.

1300.	0.7809	6	1.0	1.0	10000.0	1.22	41.
1400.	0.7082	6	1.0	1.0	10000.0	1.22	38.
1500.	0.6457	6	1.0	1.0	10000.0	1.22	41.
1600.	0.5917	6	1.0	1.0	10000.0	1.22	38.
1700.	0.5446	6	1.0	1.0	10000.0	1.22	41.
1800.	0.5033	6	1.0	1.0	10000.0	1.22	41.
1900.	0.4669	6	1.0	1.0	10000.0	1.22	38.
2000.	0.4346	6	1.0	1.0	10000.0	1.22	37.

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 1. M:

218.	2.642	5	1.0	1.0	10000.0	1.22	16.

****
*** SCREEN DISCRETE DISTANCES ***
****

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	MAX DIR (DEG)
717.	1.599	6	1.0	1.0	10000.0	1.22	40.
945.	1.167	6	1.0	1.0	10000.0	1.22	44.
1264.	0.8100	6	1.0	1.0	10000.0	1.22	38.