

Report

Lea County, New Mexico

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

Maximum H₂S Emissions Estimates

September 2016

01058015



PARKHILLSMITH&COOPER

CK Disposal, LLC

Applicant's Exhibit u

NMOCD Case No. 15617

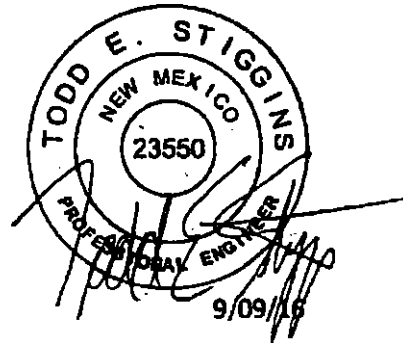
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GIVEN

Incoming truckloads of exploration and production (E&P) liquids with a hydrogen sulfide (H₂S) concentration greater than or equal to 10 ppm must be treated with calcium hypochlorite (Ca(ClO)₂) to lower the H₂S concentration to below 1 ppm.

FIND

Estimate maximum downwind H₂S concentrations at receptor heights of 1 m, 2 m, and 10 m for fugitive H₂S 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 H₂S 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).

H₂S concentrations are measured on a parts per million volume (ppmv) basis.

Permit restrictions for CK Disposal Facility for H₂S maximum concentration allowed is 10 ppmv.

Henry's Law is used to estimate the equilibrium liquid phase concentration of H₂S in the truck based upon maximum H₂S vapor phase concentration of 10 ppmv. Assume atmospheric pressure equal to 1 atm.

All of the H₂S in the E&P liquids escape into the atmosphere during loadout. - *conservative*

Vapor phase H₂S 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 H₂S in the liquid phase in milligrams per liter.

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

where: p = mol H₂S/mol air
 c = mg H₂S/L water
 H_D = atm-L/mg, $2.72 \times (10^{-4})$ atm-L/mg¹
 P_T = atm, assumed to be 1 atm

$$10 \times (10^{-6}) \frac{\text{mol H}_2\text{S}}{\text{mol air}} = \frac{2.72 \times (10^{-4}) \frac{\text{atm L}}{\text{mg}} \times c}{1 \text{ atm}}$$

$$c = \frac{10 \times (10^{-6}) \frac{\text{mol H}_2\text{S}}{\text{mol air}} \times 1 \text{ atm}}{2.72 \times (10^{-4}) \frac{\text{atm L}}{\text{mg}}}$$

$$c = 0.03676 \frac{\text{mg H}_2\text{S}}{\text{L H}_2\text{O}}$$

Notes:

¹Source: 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 H₂S, in grams per second, based on 900 gpm of E&P liquids from the tanker truck.

$$M = 0.03676 \frac{\text{mg H}_2\text{S}}{\text{L H}_2\text{O}} \times \frac{3.8 \text{ L}}{\text{gallon}} \times \frac{900 \text{ gallons}}{\text{minute}} \times \frac{1 \text{ g}}{1000 \text{ mg}} \times \frac{1 \text{ minute}}{60 \text{ seconds}}$$

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

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- C. Calculate area emission rate (Q) of H₂S in grams per second per square meter based on area of loadout point basin open to atmosphere for one loadout point.

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

$$Q = 2.26 \times 10^{-4} \frac{\text{g}}{\text{s-m}^2}$$

- D. Use EPA SCREEN3 to estimate maximum downwind concentrations of H₂S 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 ₂ S Emissions Per Loadout Point (µg/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, m³
- m = mass of gas, g
- R = universal gas constant, 8.3145 m³-Pa/K-mol
- T = temperature, K
- MW = molecular weight, g/mol

Find volume of one microgram of H₂S:

$$V = \frac{1 \times 10^{-6} \text{ g} \times 8.3145 \frac{\text{m}^3 \cdot \text{Pa}}{\text{K} \cdot \text{mol}} \times (273.15 + 20) \text{ K}}{34.0809 \frac{\text{g}}{\text{mol}} \times 101,325 \text{ Pa}}$$

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

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Convert micrograms per cubic meter to ppmv:

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

Example

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

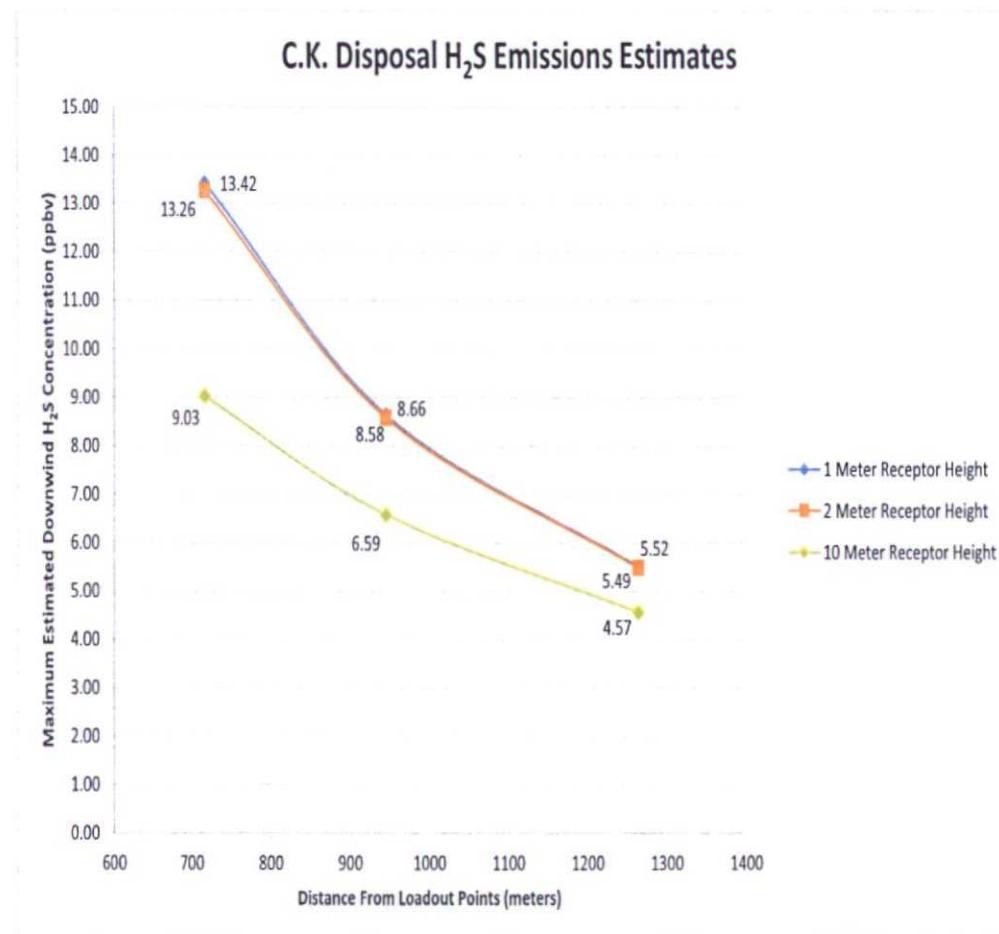
$$\text{ppmv} = 2.377 \frac{\mu\text{g}}{\text{m}^3} \times 7.0583 \times 10^{-10} \frac{\text{m}^3}{\mu\text{g}} \times 10^6 = 0.00168 \text{ ppmv}$$

C.K. Disposal H ₂ S 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

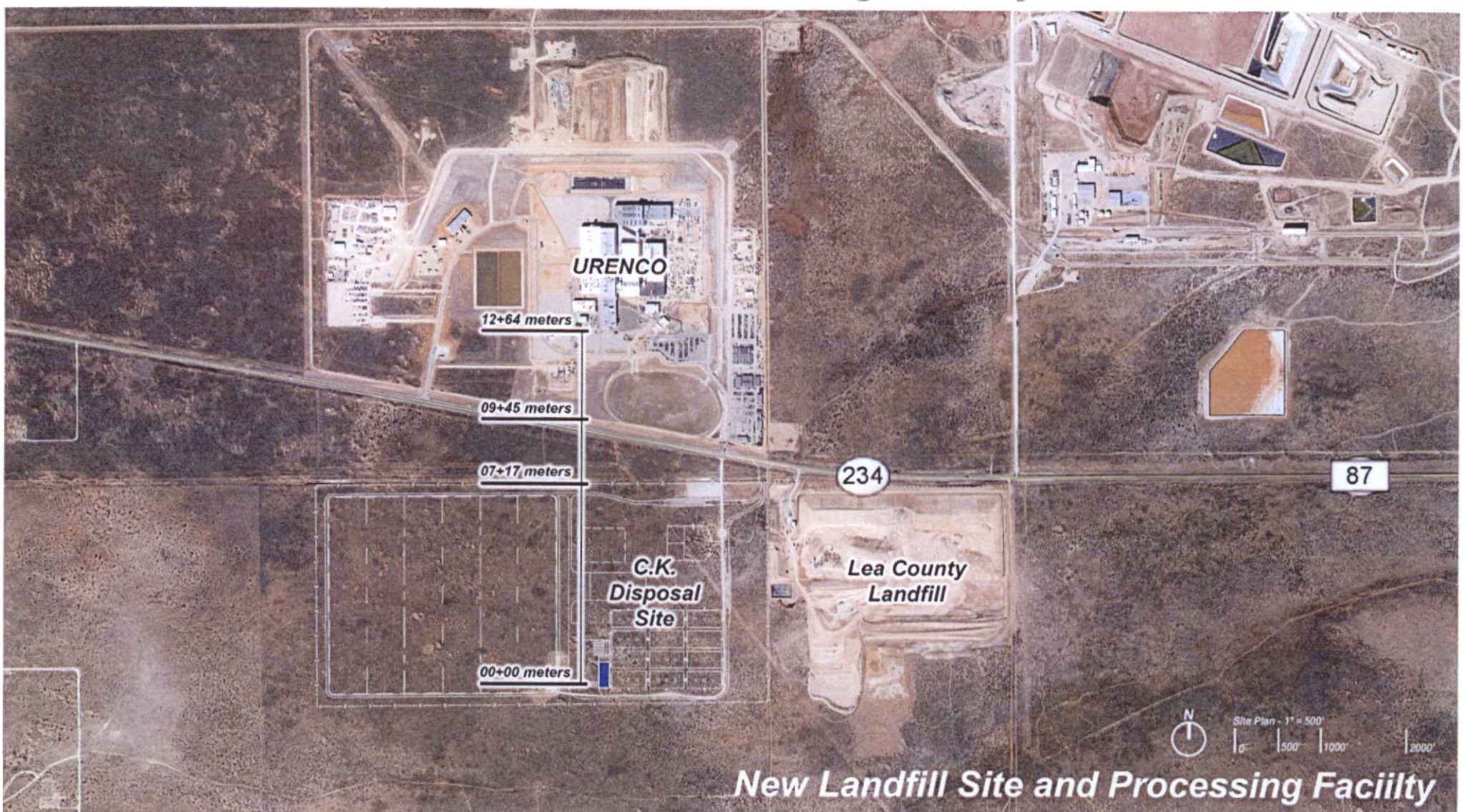
- F. In accordance with the Landfill Phasing Plan (Attachment K, Section 4.1) of the permit application, four loadout points will be constructed during Phase I and four additional loadout points will be constructed in Phase 3. Assuming a worst case scenario where tanker truck evacuation is occurring simultaneously at all eight loadout points, use EPA SCREEN3 to estimate downwind concentrations of H₂S in parts per billion volume (ppbv) basis.

C.K. Disposal H ₂ S 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

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**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.