Engineering Analysis

Facility Name:	**Mt. Carberry Landfill**	Sheet:	1 of 12
Facility Location:	**80 Hutchins Street, Berlin, NH**	Engineer:	chm
Facility ID No.:	**3300790120**	Date:	01/31/07
Application No.:	**FY06-0159**		

LFG Generation, Methane Generation, and NMOC Emissions

LFG Generation – as predicted by LandGEM[1]:

	2007	2026	Peak 2051
Mass Flow Rates:			
Mg/yr	9,309	29,470	40,670
kg/hr	1,063	3,364	4,643
ton/yr	10,261	32,485	44,831
lb/hr	2,343	7,417	10,235
Volumetric Flow Rates:			
m^3/yr (× 10^6)	7.455	23.60	32.57
m^3/min	14.18	44.90	61.97
scf/yr (× 10^6)	263.2	833.3	1,150.0
scfm	500.8	1,585.5	2,188.1

Methane Generation – as predicted by LandGEM[1]:

	2007	2026	Peak 2051
Mass Flow Rates:			
Mg/yr	2,487	7,872	10,860
kg/hr	284	899	1,240
ton/yr	2,741	8,677	11,971
lb/hr	626	1,981	2,733
Volumetric Flow Rates:			
m^3/yr (× 10^6)	3.727	11.80	16.28
m^3/min	7.09	22.45	30.97
scf/yr (× 10^6)	131.6	416.7	574.8
scfm	250.4	792.7	1,093.7

NMOC Emissions – based on average conc. of 536 ppmv as hexane[2]:

	2007	2026	Peak 2051
Mass Flow Rates:			
Mg/yr	14.3	45.3	62.5
kg/hr	1.63	5.17	7.14
ton/yr	15.8	49.9	68.9
lb/hr	3.60	11.40	15.74

[1] Values for Mg/yr and m^3/yr as reported in Attachment 1 of permit application; all other values are converted.

[2] Average total NMOC concentration in landfill gas samples collected Aug - Sep 2006.

Sample calculations:

(536 ppmv / 1000000 ppmv) × 86.18 kg/kgmol ÷ 24.055 m^3/kgmol × 14.18 m^3/min x 60 min/hr = 1.63 kg/hr = 14.3 Mg/yr

(536 ppmv / 1000000 ppmv) × 86.18 lb/lbmol ÷ 385.33 scf/lbmol × 500.8 scf/min x 60 min/hr = 3.60 lb/hr = 15.8 ton/yr

Engineering Analysis

Facility Name:	**Mt. Carberry Landfill**	Sheet:	2 of 12
Facility Location:	**80 Hutchins Street, Berlin, NH**	Engineer:	chm
Facility ID No.:	**3300790120**	Date:	01/31/07
Application No.:	**FY06-0159**		

Emission Calculations
Source: LANDFILL
Year: 2007

SCENARIO A

Input Values:

LFG Collection Efficiency	**0.75**
LFG Fugitive Emission Fraction	0.25

	Annual Volume MMscf	*Flow Rate scfm*
LFG Generation	263	500
LFG Emissions	66	125

Emissions:

Pollutant	*Concentration ppmv*		*Emission Factor lb/MMscf*		*Emission Rate lb/hr*	*Emissions ton/yr*
VOC	183	a	47	b	0.35	1.55
H_2S	4,741	c	419	d	3.14	13.77

a Average total VOC concentration = 188 ppmv in landfill gas samples collected Aug - Sep 2006; corrected to 50% methane based on average methane concentration of 51.37% in gas samples: 188 ppmv x 0.50/0.5137 = 183 ppmv.

b EF = 183 ppmv × 100.0 lb/lbmol ÷ 385.3 scf/lbmol = 47 lb/MMscf. (Average molecular weight of 100.0 is assumed.)

c Average hydrogen sulfide concentration = 4,871 ppmv in landfill gas samples collected Aug - Sep 2006; corrected to 50% methane based on average methane concentration of 51.37% in gas samples: 4,871 ppmv x 0.50/0.5137 = 4,741 ppmv.

d EF = 4,741 ppmv × 34.08 lb/lbmol ÷ 385.3 scf/lbmol = 419 lb/MMscf.

Sample calculation for VOC:

66 MMscf/yr x 47 lb/MMscf ÷ 8760 hr/yr = 0.35 lb/hr = 1.55 ton/yr

Note: Stated emissions represent fugitive emissions, excluding any undestroyed fractions passing through control devices.

Engineering Analysis

Facility Name:	**Mt. Carberry Landfill**	Sheet:	3 of 12
Facility Location:	**80 Hutchins Street, Berlin, NH**	Engineer:	chm
Facility ID No.:	**3300790120**	Date:	01/31/07
Application No.:	**FY06-0159**		

Emission Calculations
Source: LANDFILL
Year: 2026

SCENARIO B

Input Values:

LFG Collection Efficiency	**0.75**
LFG Fugitive Emission Fraction	0.25

	Annual Volume MMscf	*Flow Rate scfm*
LFG Generation	841	1,600
LFG Emissions	210	400

Emissions:

Pollutant	*Concentration ppmv*		*Emission Factor lb/MMscf*		*Emission Rate lb/hr*	*Emissions ton/yr*
VOC	183	a	47	b	1.13	4.94
H_2S	4,741	c	419	d	10.06	44.05

a Average total VOC concentration = 188 ppmv in landfill gas samples collected Aug - Sep 2006; corrected to 50% methane based on average methane concentration of 51.37% in gas samples: 188 ppmv x 0.50/0.5137 = 183 ppmv.

b EF = 183 ppmv × 100.0 lb/lbmol ÷ 385.3 scf/lbmol = 47 lb/MMscf. (Average molecular weight of 100.0 is assumed.)

c Average hydrogen sulfide concentration = 4,871 ppmv in landfill gas samples collected Aug - Sep 2006; corrected to 50% methane based on average methane concentration of 51.37% in gas samples: 4,871 ppmv x 0.50/0.5137 = 4,741 ppmv.

d EF = 4,741 ppmv × 34.08 lb/lbmol ÷ 385.3 scf/lbmol = 419 lb/MMscf.

Note: Stated emissions represent fugitive emissions, excluding any undestroyed fractions passing through control devices.

Engineering Analysis

Facility Name:	**Mt. Carberry Landfill**	Sheet:	4 of 12
Facility Location:	**80 Hutchins Street, Berlin, NH**	Engineer:	chm
Facility ID No.:	**3300790120**	Date:	01/31/07
Application No.:	**FY06-0159**		

Emission Calculations
Source: LANDFILL
Year: 2026

SCENARIO C

Input Values:

LFG Collection Efficiency	**0.90**
LFG Fugitive Emission Fraction	0.10

	Annual Volume MMscf	*Flow Rate scfm*
LFG Generation	841	1,600
LFG Emissions	84	160

Emissions:

Pollutant	*Concentration ppmv*		*Emission Factor lb/MMscf*		*Emission Rate lb/hr*	*Emissions ton/yr*
VOC	183	a	47	b	0.45	1.98
H_2S	4,741	c	419	d	4.02	17.62

a Average total VOC concentration = 188 ppmv in landfill gas samples collected Aug - Sep 2006; corrected to 50% methane based on average methane concentration of 51.37% in gas samples: 188 ppmv x 0.50/0.5137 = 183 ppmv.

b EF = 183 ppmv × 100.0 lb/lbmol ÷ 385.3 scf/lbmol = 47 lb/MMscf. (Average molecular weight of 100.0 is assumed.)

c Average hydrogen sulfide concentration = 4,871 ppmv in landfill gas samples collected Aug - Sep 2006; corrected to 50% methane based on average methane concentration of 51.37% in gas samples: 4,871 ppmv x 0.50/0.5137 = 4,741 ppmv.

d EF = 4,741 ppmv × 34.08 lb/lbmol ÷ 385.3 scf/lbmol = 419 lb/MMscf.

Note: Stated emissions represent fugitive emissions, excluding any undestroyed fractions passing through control devices.

Engineering Analysis

Facility Name:	**Mt. Carberry Landfill**	Sheet:	5 of 12
Facility Location:	**80 Hutchins Street, Berlin, NH**	Engineer:	chm
Facility ID No.:	**3300790120**	Date:	01/31/07
Application No.:	**FY06-0159**		

Emission Calculations
Source: LANDFILL GAS FLARE **SCENARIO A**
Year: 2007

Input Values:

LFG Higher Heating Value, *Btu/scf*	500
Max. Heat Input to Flare, *MMBtu/hr*	11.3
LFG Collection Efficiency	**0.75**

	Annual Volume MMscf	*Flow Rate scfm*
LFG Generation	263	500
LFG Delivered to Flare	197	375

Emissions:

Pollutant	*Influent Concentration ppmv*		*Emission Factor lb/MMscf*		*Emission Rate lb/hr*	*Emissions ton/yr*
CO	–		375	a	8.4	37.0
NOx	–		20	a	0.45	1.97
PM_{10}	–		8.5	a	0.19	0.84
SO_2 w/o pretreatment	4,772	b	778	c	17.5	76.7
SO_2 w/ pretreatment	1,000	d	163	e	3.7	16.1
VOC	183	f	0.95	g	0.02	0.09
H_2S w/o pretreatment	4,741	h	8.4	i	0.19	0.83
H_2S w/ pretreatment	1,000	d	1.7	j	0.04	0.17
HCl	18	k	1.7	l	0.04	0.17

[a] USEPA, AP-42 Table 2.4-5, "Emission Rates for Secondary Compounds Exiting Control Devices," for landfill gas @ 50% methane.

[b] Average total reduced sulfur concentration = 4,903 ppmv in landfill gas samples collected Aug - Sep 2006; corrected to 50% methane based on average methane concentration of 51.37% in gas samples: 4,903 ppmv x 0.50/0.5137 = 4,772 ppmv.

[c] Assumed conversion efficiency of TRS to SO_2 = 98%. EF = 0.98 × 4,772 ppmv × 64.07 lb/lbmol ÷ 385.3 scf/lbmol = 778 lb/MMscf.

[d] Total reduced sulfur in landfill gas after pretreatment: maximum concentration in effluent stream just prior to recharging of media.

[e] Assumed conversion efficiency of TRS to SO_2 = 98%. EF = 0.98 × 1,000 ppmv × 64.07 lb/lbmol ÷ 385.3 scf/lbmol = 163 lb/MMscf.

[f] Average total VOC concentration = 188 ppmv in landfill gas samples collected Aug - Sep 2006; corrected to 50% methane based on average methane concentration of 51.37% in gas samples: 188 ppmv x 0.50/0.5137 = 183 ppmv.

[g] Assumed destruction efficiency of VOC = 98%. EF = (1 – 0.98) × 183 ppmv × 100.0 lb/lbmol ÷ 385.3 scf/lbmol = 0.95 lb/MMscf. (Average molecular weight of 100.0 is assumed.)

[h] Average hydrogen sulfide concentration = 4,871 ppmv in landfill gas samples collected Aug - Sep 2006; corrected to 50% methane based on average methane concentration of 51.37% in gas samples: 4,871 ppmv x 0.50/0.5137 = 4,741 ppmv.

[i] Assumed conversion efficiency of H_2S to SO_2 = 98%. EF = (1 – 0.98) × 4,741 ppmv × 34.08 lb/lbmol ÷ 385.3 scf/lbmol = 8.4 lb/MMscf.

[j] Assumed conversion efficiency of H_2S to SO_2 = 98%. EF = (1 – 0.98) × 1,000 ppmv × 34.08 lb/lbmol ÷ 385.3 scf/lbmol = 1.7 lb/MMscf.

[k] Average total chlorine concentration = 19 ppmv in landfill gas samples collected Aug - Sep 2006; corrected to 50% methane based on average methane concentration of 51.37% in gas samples: 19 ppmv x 0.50/0.5137 = 18 ppmv.

[l] Assumed conversion efficiency of total chlorine to HCl = 98%. EF = 0.98 × 18 ppmv × 36.46 lb/lbmol ÷ 385.3 scf/lbmol = 1.7 lb/MMscf.

Sample calculation for NOx:

197 MMscf/yr x 20 lb/MMscf / 8760 hr/yr = 0.45 lb/hr = 1.97 ton/yr

Engineering Analysis

Facility Name:	**Mt. Carberry Landfill**	Sheet:	6 of 12
Facility Location:	**80 Hutchins Street, Berlin, NH**	Engineer:	chm
Facility ID No.:	**3300790120**	Date:	01/31/07
Application No.:	**FY06-0159**		

Emission Calculations
Source: LANDFILL GAS FLARE **SCENARIO B**
Year: 2026

Input Values:

LFG Higher Heating Value, *Btu/scf*	500
Max. Heat Input to Flare, *MMBtu/hr*	36.0
LFG Collection Efficiency	**0.75**

	Annual Volume MMscf	*Flow Rate scfm*
LFG Generation	841	1,600
LFG Delivered to Flare	631	1,200

Emissions:

Pollutant	*Influent Concentration ppmv*		*Emission Factor lb/MMscf*		*Emission Rate lb/hr*	*Emissions ton/yr*
CO	–		375	a	27.0	118.3
NOx	–		20	a	1.44	6.31
PM_{10}	–		8.5	a	0.61	2.68
SO_2 w/o pretreatment	4,772	b	778	c	56.0	245.4
SO_2 w/ pretreatment	1,000	d	163	e	11.7	51.4
VOC	183	f	0.95	g	0.07	0.30
H_2S w/o pretreatment	4,741	h	8.4	i	0.60	2.65
H_2S w/ pretreatment	1,000	d	1.7	j	0.12	0.54
HCl	18	k	1.7	l	0.12	0.54

[a] USEPA, AP-42 Table 2.4-5, "Emission Rates for Secondary Compounds Exiting Control Devices," for landfill gas @ 50% methane.

[b] Average total reduced sulfur concentration = 4,903 ppmv in landfill gas samples collected Aug - Sep 2006; corrected to 50% methane based on average methane concentration of 51.37% in gas samples: 4,903 ppmv x 0.50/0.5137 = 4,772 ppmv.

[c] Assumed conversion efficiency of TRS to SO_2 = 98%. EF = 0.98 × 4,772 ppmv × 64.07 lb/lbmol ÷ 385.3 scf/lbmol = 778 lb/MMscf.

[d] Total reduced sulfur in landfill gas after pretreatment: maximum concentration in effluent stream just prior to recharging of media.

[e] Assumed conversion efficiency of TRS to SO_2 = 98%. EF = 0.98 × 1,000 ppmv × 64.07 lb/lbmol ÷ 385.3 scf/lbmol = 163 lb/MMscf.

[f] Average total VOC concentration = 188 ppmv in landfill gas samples collected Aug - Sep 2006; corrected to 50% methane based on average methane concentration of 51.37% in gas samples: 188 ppmv x 0.50/0.5137 = 183 ppmv.

[g] Assumed destruction efficiency of VOC = 98%. EF = (1 – 0.98) × 183 ppmv × 100.0 lb/lbmol ÷ 385.3 scf/lbmol = 0.95 lb/MMscf. (Average molecular weight of 100.0 is assumed.)

[h] Average hydrogen sulfide concentration = 4,871 ppmv in landfill gas samples collected Aug - Sep 2006; corrected to 50% methane based on average methane concentration of 51.37% in gas samples: 4,871 ppmv x 0.50/0.5137 = 4,741 ppmv.

[i] Assumed conversion efficiency of H_2S to SO_2 = 98%. EF = (1 – 0.98) × 4,741 ppmv × 34.08 lb/lbmol ÷ 385.3 scf/lbmol = 8.4 lb/MMscf.

[j] Assumed conversion efficiency of H_2S to SO_2 = 98%. EF = (1 – 0.98) × 1,000 ppmv × 34.08 lb/lbmol ÷ 385.3 scf/lbmol = 1.7 lb/MMscf.

[k] Average total chlorine concentration = 19 ppmv in landfill gas samples collected Aug - Sep 2006; corrected to 50% methane based on average methane concentration of 51.37% in gas samples: 19 ppmv x 0.50/0.5137 = 18 ppmv.

Assumed conversion efficiency of total chlorine to HCl = 98%. EF = 0.98 × 18 ppmv × 36.46 lb/lbmol ÷ 385.3 scf/lbmol = 1.7 lb/MMscf.

Engineering Analysis

Facility Name:	**Mt. Carberry Landfill**	Sheet:	7 of 12
Facility Location:	**80 Hutchins Street, Berlin, NH**	Engineer:	chm
Facility ID No.:	**3300790120**	Date:	01/31/07
Application No.:	**FY06-0159**		

Emission Calculations
Source: LANDFILL GAS FLARE **SCENARIO C**
Year: 2026

Input Values:

LFG Higher Heating Value, *Btu/scf*	500
Max. Heat Input to Flare, *MMBtu/hr*	43.2
LFG Collection Efficiency	**0.90**

	Annual Volume MMscf	*Flow Rate scfm*
LFG Generation	841	1,600
LFG Delivered to Flare	757	1,440

← Note: Value exceeds rated capacity of flare; additional installed capacity would be required at this flow rate.

Emissions:

Pollutant	*Input Concentration ppmv*		*Emission Factor lb/MMscf*		*Emission Rate lb/hr*	*Emissions ton/yr*
CO	–		375	a	32.4	141.9
NOx	–		20	a	1.73	7.57
PM_{10}	–		8.5	a	0.73	3.22
SO_2 w/o pretreatment	4,772	b	778	c	67.2	294.4
SO_2 w/ pretreatment	1,000	d	163	e	14.1	61.7
VOC	183	f	0.95	g	0.08	0.36
H_2S w/o pretreatment	4,741	h	8.4	i	0.73	3.18
H_2S w/ pretreatment	1,000	d	1.7	j	0.15	0.64
HCl	18	k	1.7	l	0.15	0.64

[a] USEPA, AP-42 Table 2.4-5, "Emission Rates for Secondary Compounds Exiting Control Devices," for landfill gas @ 50% methane.

[b] Average total reduced sulfur concentration = 4,903 ppmv in landfill gas samples collected Aug - Sep 2006; corrected to 50% methane based on average methane concentration of 51.37% in gas samples: 4,903 ppmv x 0.50/0.5137 = 4,772 ppmv.

[c] Assumed conversion efficiency of TRS to SO_2 = 98%. EF = 0.98 × 4,772 ppmv × 64.07 lb/lbmol ÷ 385.3 scf/lbmol = 778 lb/MMscf.

[d] Total reduced sulfur in landfill gas after pretreatment: maximum concentration in effluent stream just prior to recharging of media.

[e] Assumed conversion efficiency of TRS to SO_2 = 98%. EF = 0.98 × 1,000 ppmv × 64.07 lb/lbmol ÷ 385.3 scf/lbmol = 163 lb/MMscf.

[f] Average total VOC concentration = 188 ppmv in landfill gas samples collected Aug - Sep 2006; corrected to 50% methane based on average methane concentration of 51.37% in gas samples: 188 ppmv x 0.50/0.5137 = 183 ppmv.

[g] Assumed destruction efficiency of VOC = 98%. EF = (1 – 0.98) × 183 ppmv × 100.0 lb/lbmol ÷ 385.3 scf/lbmol = 0.95 lb/MMscf. (Average molecular weight of 100.0 is assumed.)

[h] Average hydrogen sulfide concentration = 4,871 ppmv in landfill gas samples collected Aug - Sep 2006; corrected to 50% methane based on average methane concentration of 51.37% in gas samples: 4,871 ppmv x 0.50/0.5137 = 4,741 ppmv.

[i] Assumed conversion efficiency of H_2S to SO_2 = 98%. EF = (1 – 0.98) × 4,741 ppmv × 34.08 lb/lbmol ÷ 385.3 scf/lbmol = 8.4 lb/MMscf.

[j] Assumed conversion efficiency of H_2S to SO_2 = 98%. EF = (1 – 0.98) × 1,000 ppmv × 34.08 lb/lbmol ÷ 385.3 scf/lbmol = 1.7 lb/MMscf.

[k] Average total chlorine concentration = 19 ppmv in landfill gas samples collected Aug - Sep 2006; corrected to 50% methane based on average methane concentration of 51.37% in gas samples: 19 ppmv x 0.50/0.5137 = 18 ppmv.

Assumed conversion efficiency of total chlorine to HCl = 98%. EF = 0.98 × 18 ppmv × 36.46 lb/lbmol ÷ 385.3 scf/lbmol = 1.7 lb/MMscf.

Engineering Analysis

Facility Name: **Mt. Carberry Landfill**
Facility Location: **80 Hutchins Street, Berlin, NH**
Facility ID No.: **3300790120**
Application No.: **FY06-0159**

Sheet: 8 of 12
Engineer: chm
Date: 01/31/07

RTAPs: Measured Concentrations and Predicted Generation Rates

CAS Number	Parameter Name	Molecular Weight	Average Concentration [a] (ppbv)	Average Concentration Corrected [b] (ppbv)	2007 Generation Rate [c] (g/s)	2007 Generation Rate [c] (lb/hr)	2026 Generation Rate [c] (g/s)	2026 Generation Rate [c] (lb/hr)
56-23-5	Carbon Tetrachloride	153.82	50	48	0.00007	0.0006	0.00023	0.0018
64-17-5	Ethanol	46.07	2,573	2,505	0.00113	0.0090	0.00359	0.0285
67-63-0	Isopropyl Alcohol	60.09	2,766	2,692	0.00159	0.0126	0.00504	0.0400
67-64-1	Acetone	58.08	6,300	6,132	0.00350	0.0278	0.01108	0.0880
67-66-3	Chloroform	119.38	50	48	0.00006	0.0004	0.00018	0.0014
71-43-2	Benzene	78.11	502	489	0.00038	0.0030	0.00119	0.0094
71-55-6	1,1,1-Trichloroethane	133.42	69	68	0.00009	0.0007	0.00028	0.0022
74-83-9	Bromomethane	94.94	50	48	0.00005	0.0004	0.00014	0.0011
74-87-3	Chloromethane	50.49	248	241	0.00012	0.0010	0.00038	0.0030
74-93-1	Methyl Mercaptan	48.11	19,109	18,600	0.00880	0.0698	0.02785	0.2210
75-00-3	Chloroethane	64.51	129	126	0.00008	0.0006	0.00025	0.0020
75-01-4	Vinyl Chloride	62.50	1,224	1,191	0.00073	0.0058	0.00232	0.0184
75-08-1	Ethyl Mercaptan	62.14	18,631	18,134	0.01108	0.0879	0.03507	0.2784
75-09-2	Methylene Chloride	84.93	2,043	1,988	0.00166	0.0132	0.00526	0.0417
75-15-0	Carbon Disulfide	76.14	180	175	0.00013	0.0010	0.00041	0.0033
75-18-3	Dimethyl Sulfide	62.14	19,259	18,746	0.01145	0.0909	0.03626	0.2877
75-25-2	Bromoform	252.73	50	48	0.00012	0.0010	0.00038	0.0030
75-34-3	1,1-Dichloroethane	98.96	123	120	0.00012	0.0009	0.00037	0.0029
75-35-4	1,1-Dichloroethene	96.94	50	48	0.00005	0.0004	0.00015	0.0012
75-69-4	Trichlorofluoromethane	137.37	1,682	1,638	0.00221	0.0176	0.00700	0.0556
75-71-8	Dichlorodifluoromethane	120.91	520	507	0.00060	0.0048	0.00191	0.0151
76-13-1	1,1,2-Trichloro-1,2,2-Trifluoroethane	187.37	53	52	0.00010	0.0008	0.00030	0.0024
76-14-2	1,2-Dichloro-1,1,2,2-Tetrafluoroethane	170.92	53	52	0.00009	0.0007	0.00028	0.0022
78-87-5	1,2-Dichloropropane	112.99	50	48	0.00005	0.0004	0.00017	0.0013
78-93-3	Methyl Ethyl Ketone	72.11	7,478	7,279	0.00516	0.0410	0.01634	0.1297
79-00-5	1,1,2-Trichloroethane	133.42	50	48	0.00006	0.0005	0.00020	0.0016
79-01-6	Trichloroethene	131.39	294	287	0.00037	0.0029	0.00117	0.0093
79-34-5	1,1,2,2-Tetrachloroethane	167.85	60	58	0.00010	0.0008	0.00031	0.0024
87-68-3	Hexachlorobutadiene	260.76	197	192	0.00049	0.0039	0.00156	0.0123
95-47-6	o-Xylene	106.17	1,242	1,209	0.00126	0.0100	0.00400	0.0317
95-50-1	1,2-Dichlorobenzene	147.02	50	49	0.00007	0.0006	0.00022	0.0018
95-63-6	1,2,4-Trimethylbenzene	120.19	966	940	0.00111	0.0088	0.00352	0.0279
98-82-8	Isopropylbenzene	120.19	196	191	0.00023	0.0018	0.00072	0.0057
100-41-4	Ethylbenzene	106.17	1,936	1,885	0.00197	0.0156	0.00623	0.0494
100-42-5	Styrene	104.15	217	211	0.00022	0.0017	0.00068	0.0054
100-44-7	Benzyl Chloride	126.58	50	48	0.00006	0.0005	0.00019	0.0015
106-42-3	m,p-Xylene	106.17	4,839	4,710	0.00492	0.0390	0.01557	0.1235
106-46-7	1,4-Dichlorobenzene	147.02	75	73	0.00010	0.0008	0.00033	0.0026
106-93-4	1,2-Dibromoethane	187.86	50	48	0.00009	0.0007	0.00028	0.0022
106-99-0	1,3-Butadiene	54.09	50	48	0.00003	0.0002	0.00008	0.0006
107-05-1	3-Chloropropene	76.52	197	192	0.00014	0.0011	0.00046	0.0036
107-06-2	1,2-Dichloroethane	98.96	54	53	0.00005	0.0004	0.00016	0.0013
108-10-1	4-Methyl-2-Pentanone	100.16	292	285	0.00028	0.0022	0.00089	0.0070
108-67-8	1,3,5-Trimethylbenzene	120.19	576	561	0.00066	0.0053	0.00210	0.0167
108-88-3	Toluene	92.14	17,352	16,889	0.01530	0.1214	0.04843	0.3844
108-90-7	Chlorobenzene	112.56	50	49	0.00005	0.0004	0.00017	0.0014
109-79-5	n-Butyl Mercaptan	90.19	18,628	18,131	0.01608	0.1276	0.05090	0.4039
109-99-9	Tetrahydrofuran	72.11	938	913	0.00065	0.0051	0.00205	0.0163
110-54-3	Hexane	86.18	3,019	2,939	0.00249	0.0198	0.00788	0.0626
110-82-7	Cyclohexane	84.16	1,522	1,481	0.00123	0.0097	0.00388	0.0308
120-82-1	1,2,4-Trichlorobenzene	181.45	197	192	0.00034	0.0027	0.00108	0.0086
127-18-4	Tetrachloroethene	165.83	217	211	0.00034	0.0027	0.00109	0.0086
142-82-5	Heptane	100.20	2,996	2,916	0.00287	0.0228	0.00910	0.0722
156-59-2	cis-1,2-Dichloroethene	96.94	339	330	0.00031	0.0025	0.00100	0.0079
463-58-1	Carbonyl Sulfide	60.08	18,640	18,143	0.01072	0.0851	0.03393	0.2693
540-84-1	2,2,4-Trimethylpentane	114.23	616	600	0.00067	0.0053	0.00213	0.0169
591-78-6	2-Hexanone	100.16	197	192	0.00019	0.0015	0.00060	0.0047
1634-04-4	Methyltertiarybutylether	88.15	1,427	1,389	0.00120	0.0096	0.00381	0.0302
7440-48-4	Cobalt	58.93	0.05	0.05	0.00000	0.0000	0.00000	0.0000
7783-06-4	Hydrogen Sulfide	34.08	4,870,582	4,740,687	1.58868	12.6086	5.02858	39.9096

	2007	2026	
	78.86	249.6	g/s
	284	899	kg/hr
	2,487	7,872	Mg/yr
	626	1,981	lb/hr
	2,741	8,677	ton/yr

[a] Values uncorrected, as reported by SME, Inc. for landfill gas samples collected at 38 surface probes, Aug - Sep 2006.
[b] Corrected to 50% methane based on average methane concentration of 51.37% in all samples collected; multiplier = 0.50/0.5137.
[c] Based on corrected concentration values and methane generation rates shown at right.→

Sample calculation for acetone:
(6,132 ppbv acetone / 500,000,000 ppbv methane)× (58.08 MW acetone / 16.04 MW methane) × 626 lb methane/hr = 0.0278 lb acetone/hr

Engineering Analysis

Facility Name: **Mt. Carberry Landfill**
Facility Location: **80 Hutchins Street, Berlin, NH**
Facility ID No.: **3300790120**
Application No.: **FY06-0159**

Sheet: 9 of 12
Engineer: chm
Date: 01/31/07

Chlorinated Compounds: Measured Concentrations

CAS Number	*Parameter Name*	*Molecular Weight*	*Average Concentration (ppbv)*	*Moles of Cl^-*	*Chloride Concentration (ppbv)*
541-73-1	1,3-Dichlorobenzene	147.02	50	2	99
56-23-5	Carbon Tetrachloride	153.82	50	4	198
67-66-3	Chloroform	119.38	50	3	149
71-55-6	1,1,1-Trichloroethane	133.42	69	3	208
74-87-3	Chloromethane	50.49	248	1	248
75-00-3	Chloroethane	64.51	129	1	129
75-01-4	Vinyl Chloride	62.5	1,224	1	1,224
75-09-2	Methylene Chloride	84.93	2,043	2	4,086
75-27-4	Bromodichloromethane	163.83	50	2	99
75-34-3	1,1-Dichloroethane	98.96	123	2	247
75-35-4	1,1-Dichloroethene	96.94	50	2	99
75-69-4	Trichlorofluoromethane	137.37	1,682	3	5,047
75-71-8	Dichlorodifluoromethane	120.91	520	2	1,041
76-13-1	1,1,2-Trichloro-1,2,2-Trifluoroethane	187.37	53	3	160
76-14-2	1,2-Dichloro-1,1,2,2-Tetrafluoroethane	170.92	53	2	107
78-87-5	1,2-Dichloropropane	112.99	50	2	99
79-00-5	1,1,2-Trichloroethane	133.42	50	3	149
79-01-6	Trichloroethene	131.39	294	3	883
79-34-5	1,1,2,2-Tetrachloroethane	167.85	60	4	240
87-68-3	Hexachlorobutadiene	260.76	197	6	1,182
95-50-1	1,2-Dichlorobenzene	147.02	50	2	100
100-44-7	Benzyl Chloride	126.58	50	1	50
106-46-7	1,4-Dichlorobenzene	147.02	75	2	149
107-05-1	3-Chloropropene	76.52	197	1	197
107-06-2	1,2-Dichloroethane	98.96	54	2	109
108-90-7	Chlorobenzene	112.56	50	1	50
120-82-1	1,2,4-Trichlorobenzene	181.45	197	3	591
124-48-1	Dibromochloromethane	208.28	50	1	50
127-18-4	Tetrachloroethene	165.83	217	4	867
156-59-2	cis-1,2-Dichloroethene	96.94	339	2	678
156-60-5	trans-1,2-Dichloroethene	96.94	51	2	102
10061-01-5	cis-1,3-Dichloropropene	110.97	50	2	99
10061-02-6	trans-1,3-Dichloropropene	110.97	50	2	99
				Total	**18,834**

Note: All concentration values uncorrected, as reported by SME, Inc. for landfill gas samples collected at 38 surface probes, Aug - Sep 2006.

Engineering Analysis

Facility Name: **Mt. Carberry Landfill**
Facility Location: **80 Hutchins Street, Berlin, NH**
Facility ID No.: **3300790120**
Application No.: **FY06-0159**

Engineer: chm
Date: 01/31/07

HAPs: Measured Concentrations

CAS Number	*Parameter Name*	*Molecular Weight*	*Average Concentration (ppbv)*
56-23-5	Carbon Tetrachloride	153.82	50
67-66-3	Chloroform	119.38	50
71-43-2	Benzene	78.11	502
74-83-9	Bromomethane	94.94	50
74-87-3	Chloromethane	50.49	248
75-01-4	Vinyl Chloride	62.5	1,224
75-15-0	Carbon Disulfide	76.14	180
75-25-2	Bromoform	252.73	50
78-93-3	Methyl Ethyl Ketone	72.11	7,478
79-00-5	1,1,2-Trichloroethane	133.4	50
79-01-6	Trichloroethene	131.39	294
79-34-5	1,1,2,2-Tetrachloroethane	167.85	60
87-68-3	Hexachlorobutadiene	260.76	197
95-47-6	o-Xylene	106.17	1,242
100-42-5	Styrene	104.15	217
100-44-7	Benzyl Chloride	126.58	50
106-46-7	1,4-Dichlorobenzene	147	75
106-99-0	1,3-Butadiene	54.09	50
107-05-1	3-Chloropropene	76.52	197
108-10-1	4-Methyl-2-Pentanone	100.16	292
108-88-3	Toluene	92.14	17,352
108-90-7	Chlorobenzene	112.56	50
110-54-3	Hexane	86.18	3,019
120-82-1	1,2,4-Trichlorobenzene	181.45	197
127-18-4	Tetrachloroethene	165.83	217
463-58-1	Carbonyl Sulfide	60.08	18,640
540-84-1	2,2,4-Trimethylpentane	114.23	616
1634-04-4	Methyltertiarybutylether	88.15	1,427
		Total	**54,071**

Note: All concentration values uncorrected, as reported by SME, Inc. for landfill gas samples collected at 38 surface probes, Aug - Sep 2006.

Engineering Analysis

Facility Name: **Mt. Carberry Landfill**
Facility Location: **80 Hutchins Street, Berlin, NH**
Facility ID No.: **3300790120**
Application No.: **FY06-0159**

Sheet: 11 of 12
Engineer: chm
Date: 02/15/07

Maximum Predicted Impacts: Criteria Pollutants

Pollutant	*Average Period*	*Maximum Impact ug/m 3*	*Background Concentration ug/m 3*	*Total Impact ug/m 3*	*NAAQS ug/m 3*	*Percent of NAAQS*	*Pass/Fail*
CO	1-hr	194	-	194	40,000	0.5	Pass
	8-hr	49	-	49	10,000	0.5	Pass
NO_2	Annual	0.26	23	23.26	100	23.3	Pass
PM_{10}	24-hr	0.64	42	42.64	150	28.4	Pass
	Annual	0.11	22	22.11	50	44.2	Pass
SO_2	3-hr	171	181	352	1,300	27.1	Pass
	24-hr	59	45	104	365	28.5	Pass
	Annual	10	8	18	80	22.5	Pass

Notes:

1. Only the overall maximum impacts are shown; the highest predicted impacts varied by scenario.
2. Annual results reflect maximum impacts; results for other averaging periods are high 2 nd high impacts.
3. SO_2 impacts are conservatively based on SO_2 emission rates without pretreatment.
4. SO_2 background data are from Concord, NH; PM_{10} and NO_2 background data are from Manchester, NH. All background data are from 2003 - 2005.

Engineering Analysis

Facility Name: **Mt. Carberry Landfill**
Facility Location: **80 Hutchins Street, Berlin, NH**
Facility ID No.: **3300790120**
Application No.: **FY06-0159**

Sheet: 12 of 12
Engineer: chm
Date: 02/15/07

Maximum Predicted Impacts: RTAPs

CAS Number	*Parameter Name*	*Molecular Weight*	*Average Conc. in Gas (ppbv)*	*24-hr Impact ug/m 3*	*24-hr AAL ug/m 3*	*Annual Impact ug/m 3*	*Annual AAL ug/m 3*	*Percent of 24-hr AAL*	*Percent of Annual AAL*	*Pass/Fail*
56-23-5	Carbon Tetrachloride	153.82	48	0.001	111	0.000	74	0.00	0.00	Pass
64-17-5	Ethanol	46.07	2505	0.013	9457	0.001	6304	0.00	0.00	Pass
67-63-0	Isopropyl Alcohol	60.09	2692	0.018	1757	0.001	1171	0.00	0.00	Pass
67-64-1	Acetone	58.08	6132	0.039	4243	0.002	2829	0.00	0.00	Pass
67-66-3	Chloroform	119.38	48	0.001	175	0.000	117	0.00	0.00	Pass
71-43-2	Benzene	78.11	489	0.004	5.7	0.000	3.8	0.07	0.00	Pass
71-55-6	1,1,1-Trichloroethane	133.42	68	0.001	6821	0.000	4548	0.00	0.00	Pass
74-83-9	Bromomethane	94.94	48	0.001	20	0.000	5	0.01	0.00	Pass
74-87-3	Chloromethane	50.49	241	0.001	368	0.000	245	0.00	0.00	Pass
74-93-1	Methyl Mercaptan	48.11	18600	0.098	4.9	0.00498	3.3	2.00	0.15	Pass
75-00-3	Chloroethane	64.51	126	0.001	10000	0.000	10000	0.00	0.00	Pass
75-01-4	Vinyl Chloride	62.50	1191	0.008	9.3	0.000	6.2	0.09	0.00	Pass
75-08-1	Ethyl Mercaptan	62.14	18134	0.123	9.2	0.006	4.4	1.34	0.14	Pass
75-09-2	Methylene Chloride	84.93	1988	0.019	621	0.0009	414	0.00	0.00	Pass
75-15-0	Carbon Disulfide	76.14	175	0.001	700	0.000	700	0.00	0.00	Pass
75-18-3	Dimethyl Sulfide	62.14	18746	0.128	529	0.006	252	0.02	0.00	Pass
75-25-2	Bromoform	252.73	48	0.001	19	0.000	12	0.01	0.00	Pass
75-34-3	1,1-Dichloroethane	98.96	120	0.001	2037	0.000	1358	0.00	0.00	Pass
75-35-4	1,1-Dichloroethene	96.94	48	0.001	200	0.000	200	0.00	0.00	Pass
75-69-4	Trichlorofluoromethane	137.37	1638	0.025	28270	0.001	18846	0.00	0.00	Pass
75-71-8	Dichlorodifluoromethane	120.91	507	0.007	73661	0.000	49107	0.00	0.00	Pass
76-13-1	1,1,2-Trichloro-1,2,2-Trifluoroethane	187.37	52	0.001	38581	0.000	25721	0.00	0.00	Pass
76-14-2	1,2-Dichloro-1,1,2,2-Tetrafluoroethane	170.92	52	0.001	104018	0.000	69345	0.00	0.00	Pass
78-87-5	1,2-Dichloropropane	112.99	48	0.001	1745	0.000	4	0.00	0.00	Pass
78-93-3	Methyl Ethyl Ketone	72.11	7279	0.058	5000	0.003	5000	0.00	0.00	Pass
79-00-5	1,1,2-Trichloroethane	133.42	48	0.001	277	0.000	184	0.00	0.00	Pass
79-01-6	Trichloroethene	131.39	287	0.004	961	0.000	640	0.00	0.00	Pass
79-34-5	1,1,2,2-Tetrachloroethane	167.85	58	0.001	25	0.000	16	0.00	0.00	Pass
87-68-3	Hexachlorobutadiene	260.76	192	0.005	1.1	0.000	0.5	0.45	0.00	Pass
95-47-6	o-Xylene	106.17	1209	0.014	1550	0.001	100	0.00	0.00	Pass
95-50-1	1,2-Dichlorobenzene	147.02	49	0.001	536	0.000	357	0.00	0.00	Pass
95-63-6	1,2,4-Trimethylbenzene	120.19	940	0.012	619	0.001	412	0.00	0.00	Pass
98-82-8	Isopropylbenzene	120.19	191	0.003	1237	0.000	400	0.00	0.00	Pass
100-41-4	Ethylbenzene	106.17	1885	0.022	1000	0.001	1000	0.00	0.00	Pass
100-42-5	Styrene	104.15	211	0.002	1000	0.000	1000	0.00	0.00	Pass
100-44-7	Benzyl Chloride	126.58	48	0.00067	19	0.00003	12	0.00	0.00	Pass
106-42-3	m,p-Xylene	106.17	4710	0.054789	1550	0.002786	100	0.00	0.00	Pass
106-46-7	1,4-Dichlorobenzene	147.02	73	0.001	800	0.000	800	0.00	0.00	Pass
106-93-4	1,2-Dibromoethane	187.86	48	0.001	0.05	0.000	0.05	2.00	0.00	Pass
106-99-0	1,3-Butadiene	54.09	48	0.000	2	0.000	2	0.00	0.00	Pass
107-05-1	3-Chloropropene	76.52	192	0.002	11	0.000	1	0.02	0.00	Pass
107-06-2	1,2-Dichloroethane	98.96	53	0.001	143	0.000	95	0.00	0.00	Pass
108-10-1	4-Methyl-2-Pentanone	100.16	285	0.003	3000	0.000	3000	0.00	0.00	Pass
108-67-8	1,3,5-Trimethylbenzene	120.19	561	0.007	619	0.000	412	0.00	0.00	Pass
108-88-3	Toluene	92.14	16889	0.170	671	0.009	400	0.03	0.00	Pass
108-90-7	Chlorobenzene	112.56	49	0.001	231	0.000	154	0.00	0.00	Pass
109-79-5	n-Butyl Mercaptan	90.19	18131	0.179	9	0.009	4.3	1.99	0.21	Pass
109-99-9	Tetrahydrofuran	72.11	913	0.007	2968	0.000	1979	0.00	0.00	Pass
110-54-3	Hexane	86.18	2939	0.028	885	0.001	200	0.00	0.00	Pass
110-82-7	Cyclohexane	84.16	1481	0.014	6000	0.001	6000	0.00	0.00	Pass
120-82-1	1,2,4-Trichlorobenzene	181.45	192	0.004	186	0.000	124	0.00	0.00	Pass
127-18-4	Tetrachloroethene	165.83	211	0.004	607	0.000	405	0.00	0.00	Pass
142-82-5	Heptane	100.20	2916	0.032	8249	0.002	5500	0.00	0.00	Pass
156-59-2	cis-1,2-Dichloroethene	96.94	330	0.004	16521	0.000	7867	0.00	0.00	Pass
463-58-1	Carbonyl Sulfide	60.08	18143	0.119	-	0.006	-	-	-	-
540-84-1	2,2,4-Trimethylpentane	114.23	600	0.008	-	0.000	-	-	-	-
591-78-6	2-Hexanone	100.16	192	0.002	101	0.000	67	0.00	0.00	Pass
1634-04-4	Methyltertiarybutylether	88.15	1389	0.013	3000	0.001	3000	0.00	0.00	Pass
7440-48-4	Cobalt	58.93	0.05	0.000	0.071	0.000	0.048	0.00	0.00	Pass
7647-1-0	**Hydrogen chloride**	**36.46**	**18,300**	**0.043**	**20**	**0.002**	**20**	0.22	0.01	**Pass**
7783-6-4	**Hydrogen sulfide**	**34.08**	**4,741,000**	**17.7**	**50**	**0.900**	**2**	35.40	45.00	**Pass**

Notes:

1. Average concentration in gas is corrected to 50 percent methane.
2. Average concentration of hydrogen chloride, present in flare emissions, is calculated from stoichiometry.
3. Hydrogen sulfide and hydrogen chloride impacts were modeled explicitly.
   All other RTAPs were scaled from the hydrogen sulfide impacts using the ratios of molecular weights and concentrations in landfill gas.
4. Pretreatment of the collected gas has negligible effect on hydrogen sulfide impact; almost all of the impact derives from fugitive emissions rather than flare emissions.

Sample calculation for ethyl mercaptan, 24-hr impact:

$$\frac{\text{Ethyl Mercaptan}\quad \text{MW } 62.14 \times 18.13 \text{ ppmv}}{\text{Hydrogen Sulfide}\quad \text{MW } 34.08 \times 4{,}741 \text{ ppmv}} \times 17.7\text{ug/m}^3 = 0.123 \text{ ug/m}^3$$