LANDFILL GAS COLLECTION SYSTEM DESIGN CALCULATIONS

WASHINGTON RENEWABLE ENERGY, LLC
FORTY WEST LANDFILL
HAGERSTOWN, MARYLAND

Prepared for
Washington Renewable Energy, LLC

February 2010

URS

1375 Euclid Avenue, Suite 600
Cleveland, Ohio 44115
Project No. 13813514

Stage I

Cells 1 through Cell 4
LandGEM Calculations

JOB Forty West Landfill, Cells 1-4
DESCRIPTION Mueller Equation Calcs

PROJECT NO. 13813514.00001
COMPUTED BY KMC DATE: 01 Dec 2009
CHECKED BY NSG/JDM DATE: 18 Jan 2010

7 The accumulated condensate production is calculated by using Antoine's Equation.

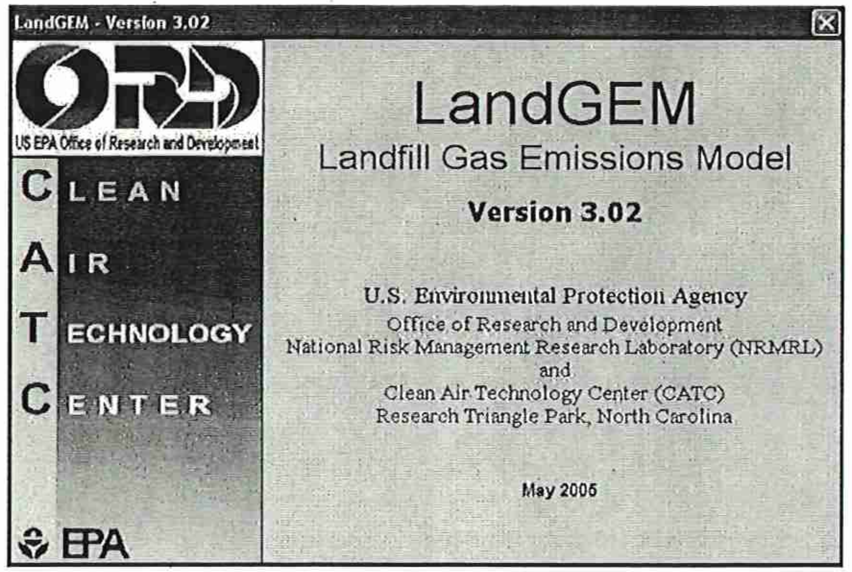
$$V_{(cond)} = \frac{5{,}694 \times 10^{\beta}}{P_s}$$

$$\beta = 6.32 - \frac{3{,}081}{T + 385}$$

The volume produced per million cubic foot of LFG calculated by Antoine's Equation is then multiplied by the flow of LFG to find the rate of condensate produced. Where P_s = system pressure in psia and T = temperature of the landfill gas within the header system in °F.

8 Using Manning's Formula for gravity flow, solve for the depth of the condensate based on the pipe's slope, pipe size, and flow.

9 The worst case lateral was taken to be the farthest well from the blower that was expected to have the largest headloss. After an evaluation of the plan drawings, well HW-4-1 was chosen to be the worst case lateral.



Summary Report

Landfill Name or Identifier: Forty West Landfill--Cells 1 - 4

Date: Friday, February 19, 2010

Description/Comments:
*Assuming 1% annual waste placement increase after 2008.
**Capacity of Cells 1-4 is 4,047,000 cubic yards. At an effective density of 0.60 tons/cubic yard, yields 2,428,200 short tons.

About LandGEM:

First-Order Decomposition Rate Equation:

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} kL_o \left(\frac{M_i}{10} \right) e^{-kt_{ij}}$$

Where,
Q_{CH4} = annual methane generation in the year of the calculation (*m^3/year*)
i = 1-year time increment
n = (year of the calculation) - (initial year of waste acceptance)
j = 0.1-year time increment
k = methane generation rate (*$year^{-1}$*)
L_o = potential methane generation capacity (*m^3/Mg*)

M_i = mass of waste accepted in the i^{th} year (*Mg*)
t_{ij} = age of the j^{th} section of waste mass M_i accepted in the i^{th} year (*decimal years*, e.g., 3.2 years)

LandGEM is based on a first-order decomposition rate equation for quantifying emissions from the decomposition of landfilled waste in municipal solid waste (MSW) landfills. The software provides a relatively simple approach to estimating landfill gas emissions. Model defaults are based on empirical data from U.S. landfills. Field test data can also be used in place of model defaults when available. Further guidance on EPA test methods, Clean Air Act (CAA) regulations, and other guidance regarding landfill gas emissions and control technology requirements can be found at http://www.epa.gov/ttnatw01/landfill/landflpg.html.

LandGEM is considered a screening tool — the better the input data, the better the estimates. Often, there are limitations with the available data regarding waste quantity and composition, variation in design and operating practices over time, and changes occurring over time that impact the emissions potential. Changes to landfill operation, such as operating under wet conditions through leachate recirculation or other liquid additions, will result in generating more gas at a faster rate. Defaults for estimating emissions for this type of operation are being developed to include in LandGEM along with defaults for convential landfills (no leachate or liquid additions) for developing emission inventories and determining CAA applicability. Refer to the Web site identified above for future updates.

Input Review

LANDFILL CHARACTERISTICS

Landfill Open Year	**2000**	
Landfill Closure Year (with 80-year limit)	**2018**	
Actual Closure Year (without limit)	***2018***	
Have Model Calculate Closure Year?	**Yes**	
Waste Design Capacity	**2,428,200**	*short tons*

MODEL PARAMETERS

Methane Generation Rate, k	**0.040**	*$year^{-1}$*
Potential Methane Generation Capacity, L_o	**100**	*m^3/Mg*
NMOC Concentration	**109**	*ppmv as hexane*
Methane Content	**50**	*% by volume*

GASES / POLLUTANTS SELECTED

Gas / Pollutant #1:	**Total landfill gas**
Gas / Pollutant #2:	**Methane**
Gas / Pollutant #3:	**Carbon dioxide**
Gas / Pollutant #4:	**NMOC**

WASTE ACCEPTANCE RATES

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
2000	1,818	2,000	0	0
2001	92,454	101,699	1,818	2,000
2002	108,285	119,113	94,272	103,699
2003	119,441	131,385	202,556	222,812
2004	136,451	150,096	321,997	354,197
2005	158,062	173,868	458,448	504,293
2006	141,335	155,468	616,510	678,161
2007	121,698	133,868	757,845	833,629
2008	120,305	132,336	879,543	967,497
2009	121,509	133,659	999,848	1,099,833
2010	122,724	134,996	1,121,357	1,233,492
2011	123,951	136,346	1,244,080	1,368,488
2012	125,190	137,709	1,368,031	1,504,834
2013	126,442	139,086	1,493,221	1,642,544
2014	127,707	140,477	1,619,664	1,781,630
2015	128,984	141,882	1,747,370	1,922,107
2016	130,274	143,301	1,876,354	2,063,989
2017	131,576	144,734	2,006,628	2,207,290
2018	69,251	76,176	2,138,204	2,352,024
2019	0	0	2,207,455	2,428,200
2020	0	0	2,207,455	2,428,200
2021	0	0	2,207,455	2,428,200
2022	0	0	2,207,455	2,428,200
2023	0	0	2,207,455	2,428,200
2024	0	0	2,207,455	2,428,200
2025	0	0	2,207,455	2,428,200
2026	0	0	2,207,455	2,428,200
2027	0	0	2,207,455	2,428,200
2028	0	0	2,207,455	2,428,200
2029	0	0	2,207,455	2,428,200
2030	0	0	2,207,455	2,428,200
2031	0	0	2,207,455	2,428,200
2032	0	0	2,207,455	2,428,200
2033	0	0	2,207,455	2,428,200
2034	0	0	2,207,455	2,428,200
2035	0	0	2,207,455	2,428,200
2036	0	0	2,207,455	2,428,200
2037	0	0	2,207,455	2,428,200
2038	0	0	2,207,455	2,428,200
2039	0	0	2,207,455	2,428,200

WASTE ACCEPTANCE RATES (Continued)

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	(short tons/year)	(Mg)	(short tons)
2040	0	0	2,207,455	2,428,200
2041	0	0	2,207,455	2,428,200
2042	0	0	2,207,455	2,428,200
2043	0	0	2,207,455	2,428,200
2044	0	0	2,207,455	2,428,200
2045	0	0	2,207,455	2,428,200
2046	0	0	2,207,455	2,428,200
2047	0	0	2,207,455	2,428,200
2048	0	0	2,207,455	2,428,200
2049	0	0	2,207,455	2,428,200
2050	0	0	2,207,455	2,428,200
2051	0	0	2,207,455	2,428,200
2052	0	0	2,207,455	2,428,200
2053	0	0	2,207,455	2,428,200
2054	0	0	2,207,455	2,428,200
2055	0	0	2,207,455	2,428,200
2056	0	0	2,207,455	2,428,200
2057	0	0	2,207,455	2,428,200
2058	0	0	2,207,455	2,428,200
2059	0	0	2,207,455	2,428,200
2060	0	0	2,207,455	2,428,200
2061	0	0	2,207,455	2,428,200
2062	0	0	2,207,455	2,428,200
2063	0	0	2,207,455	2,428,200
2064	0	0	2,207,455	2,428,200
2065	0	0	2,207,455	2,428,200
2066	0	0	2,207,455	2,428,200
2067	0	0	2,207,455	2,428,200
2068	0	0	2,207,455	2,428,200
2069	0	0	2,207,455	2,428,200
2070	0	0	2,207,455	2,428,200
2071	0	0	2,207,455	2,428,200
2072	0	0	2,207,455	2,428,200
2073	0	0	2,207,455	2,428,200
2074	0	0	2,207,455	2,428,200
2075	0	0	2,207,455	2,428,200
2076	0	0	2,207,455	2,428,200
2077	0	0	2,207,455	2,428,200
2078	0	0	2,207,455	2,428,200
2079	0	0	2,207,455	2,428,200

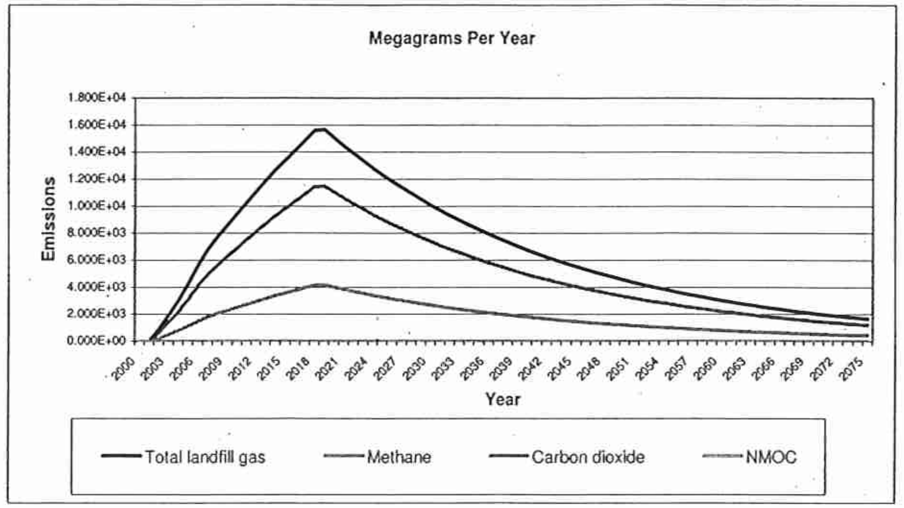
Pollutant Parameters

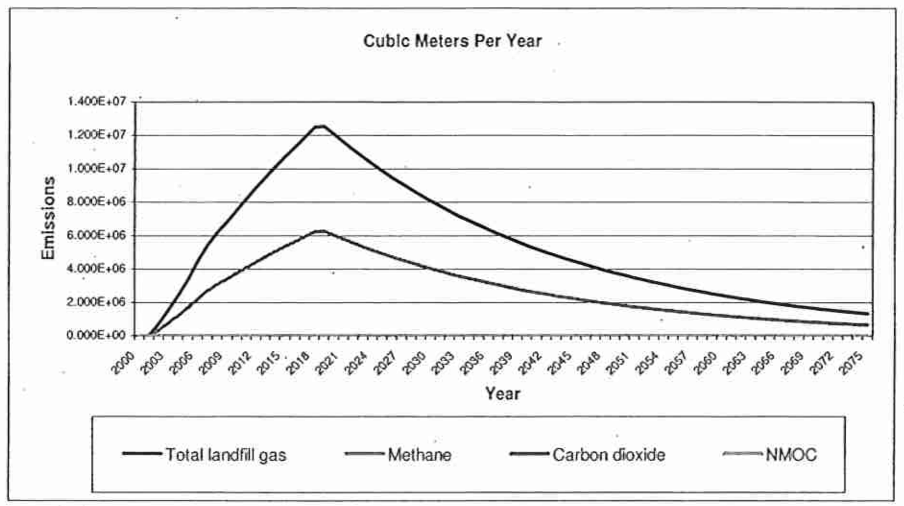
	Gas / Pollutant Default Parameters:			User-specified Pollutant Parameters:	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Gases	Total landfill gas		0.00		
	Methane		16.04		
	Carbon dioxide		44.01		
	NMOC	4,000	86.18		
Pollutants	1,1,1-Trichloroethane (methyl chloroform) - HAP	0.48	133.41		
	1,1,2,2-Tetrachloroethane - HAP/VOC	1.1	167.85		
	1,1-Dichloroethane (ethylidene dichloride) - HAP/VOC	2.4	98.97		
	1,1-Dichloroethene (vinylidene chloride) - HAP/VOC	0.20	96.94		
	1,2-Dichloroethane (ethylene dichloride) - HAP/VOC	0.41	98.96		
	1,2-Dichloropropane (propylene dichloride) - HAP/VOC	0.18	112.99		
	2-Propanol (isopropyl alcohol) - VOC	50	60.11		
	Acetone	7.0	58.08		
	Acrylonitrile - HAP/VOC	6.3	53.06		
	Benzene - No or Unknown Co-disposal - HAP/VOC	1.9	78.11		
	Benzene - Co-disposal - HAP/VOC	11	78.11		
	Bromodichloromethane - VOC	3.1	163.83		
	Butane - VOC	5.0	58.12		
	Carbon disulfide - HAP/VOC	0.58	76.13		
	Carbon monoxide	140	28.01		
	Carbon tetrachloride - HAP/VOC	4.0E-03	153.84		
	Carbonyl sulfide - HAP/VOC	0.49	60.07		
	Chlorobenzene - HAP/VOC	0.25	112.56		
	Chlorodifluoromethane	1.3	86.47		
	Chloroethane (ethyl chloride) - HAP/VOC	1.3	64.52		
	Chloroform - HAP/VOC	0.03	119.39		
	Chloromethane - VOC	1.2	50.49		
	Dichlorobenzene - (HAP for para isomer/VOC)	0.21	147		
	Dichlorodifluoromethane	16	120.91		
	Dichlorofluoromethane - VOC	2.6	102.92		
	Dichloromethane (methylene chloride) - HAP	14	84.94		
	Dimethyl sulfide (methyl sulfide) - VOC	7.8	62.13		
	Ethane	890	30.07		
	Ethanol - VOC	27	46.08		

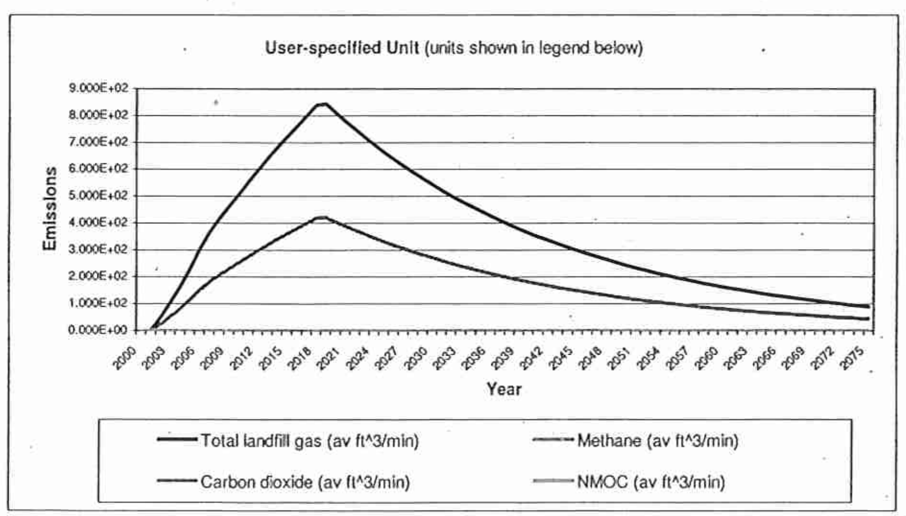
Pollutant Parameters (Continued)

	Compound	Gas / Pollutant Default Parameters: Concentration (*ppmv*)	Molecular Weight	User-specified Pollutant Parameters: Concentration (*ppmv*)	Molecular Weight
Pollutants	Ethyl mercaptan (ethanethiol) - VOC	2.3	62.13		
	Ethylbenzene - HAP/VOC	4.6	106.16		
	Ethylene dibromide - HAP/VOC	1.0E-03	187.88		
	Fluorotrichloromethane - VOC	0.76	137.38		
	Hexane - HAP/VOC	6.6	86.18		
	Hydrogen sulfide	36	34.08		
	Mercury (total) - HAP	2.9E-04	200.61		
	Methyl ethyl ketone - HAP/VOC	7.1	72.11		
	Methyl isobutyl ketone - HAP/VOC	1.9	100.16		
	Methyl mercaptan - VOC	2.5	48.11		
	Pentane - VOC	3.3	72.15		
	Perchloroethylene (tetrachloroethylene) - HAP	3.7	165.83		
	Propane - VOC	11	44.09		
	t-1,2-Dichloroethene - VOC	2.8	96.94		
	Toluene - No or Unknown Co-disposal - HAP/VOC	39	92.13		
	Toluene - Co-disposal - HAP/VOC	170	92.13		
	Trichloroethylene (trichloroethene) - HAP/VOC	2.8	131.40		
	Vinyl chloride - HAP/VOC	7.3	62.50		
	Xylenes - HAP/VOC	12	106.16		

Graphs


Megagrams Per Year
Emissions
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


Cubic Meters Per Year
Emissions
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


User-specified Unit (units shown in legend below)
Emissions
Year
Total landfill gas (av ft^3/min)
Methane (av ft^3/min)
Carbon dioxide (av ft^3/min)
NMOC (av ft^3/min)

Results

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2000	0	0	0	0	0	0
2001	1.784E+01	1.429E+04	9.599E-01	4.766E+00	7.143E+03	4.800E-01
2002	9.244E+02	7.402E+05	4.973E+01	2.469E+02	3.701E+05	2.487E+01
2003	1.951E+03	1.562E+06	1.050E+02	5.211E+02	7.810E+05	5.248E+01
2004	3.046E+03	2.439E+06	1.639E+02	8.137E+02	1.220E+06	8.195E+01
2005	4.266E+03	3.416E+06	2.295E+02	1.139E+03	1.708E+06	1.148E+02
2006	5.650E+03	4.524E+06	3.040E+02	1.509E+03	2.262E+06	1.520E+02
2007	6.815E+03	5.457E+06	3.667E+02	1.820E+03	2.729E+06	1.833E+02
2008	7.742E+03	6.199E+06	4.165E+02	2.068E+03	3.100E+06	2.083E+02
2009	8.619E+03	6.902E+06	4.637E+02	2.302E+03	3.451E+06	2.319E+02
2010	9.473E+03	7.586E+06	5.097E+02	2.530E+03	3.793E+06	2.548E+02
2011	1.031E+04	8.253E+06	5.545E+02	2.753E+03	4.126E+06	2.773E+02
2012	1.112E+04	8.903E+06	5.982E+02	2.970E+03	4.452E+06	2.991E+02
2013	1.191E+04	9.538E+06	6.408E+02	3.182E+03	4.769E+06	3.204E+02
2014	1.268E+04	1.016E+07	6.825E+02	3.388E+03	5.079E+06	3.412E+02
2015	1.344E+04	1.076E+07	7.231E+02	3.590E+03	5.381E+06	3.616E+02
2016	1.418E+04	1.135E+07	7.629E+02	3.787E+03	5.677E+06	3.814E+02
2017	1.490E+04	1.193E+07	8.017E+02	3.980E+03	5.966E+06	4.009E+02
2018	1.561E+04	1.250E+07	8.398E+02	4.169E+03	6.249E+06	4.199E+02
2019	1.568E+04	1.255E+07	8.434E+02	4.187E+03	6.276E+06	4.217E+02
2020	1.506E+04	1.206E+07	8.103E+02	4.023E+03	6.030E+06	4.052E+02
2021	1.447E+04	1.159E+07	7.786E+02	3.865E+03	5.794E+06	3.893E+02
2022	1.390E+04	1.113E+07	7.480E+02	3.714E+03	5.567E+06	3.740E+02
2023	1.336E+04	1.070E+07	7.187E+02	3.568E+03	5.348E+06	3.594E+02
2024	1.283E+04	1.028E+07	6.905E+02	3.428E+03	5.139E+06	3.453E+02
2025	1.233E+04	9.874E+06	6.635E+02	3.294E+03	4.937E+06	3.317E+02
2026	1.185E+04	9.487E+06	6.374E+02	3.165E+03	4.744E+06	3.187E+02
2027	1.138E+04	9.115E+06	6.124E+02	3.041E+03	4.558E+06	3.062E+02
2028	1.094E+04	8.758E+06	5.884E+02	2.921E+03	4.379E+06	2.942E+02
2029	1.051E+04	8.414E+06	5.654E+02	2.807E+03	4.207E+06	2.827E+02
2030	1.010E+04	8.084E+06	5.432E+02	2.697E+03	4.042E+06	2.716E+02
2031	9.700E+03	7.767E+06	5.219E+02	2.591E+03	3.884E+06	2.609E+02
2032	9.320E+03	7.463E+06	5.014E+02	2.489E+03	3.731E+06	2.507E+02
2033	8.954E+03	7.170E+06	4.818E+02	2.392E+03	3.585E+06	2.409E+02
2034	8.603E+03	6.889E+06	4.629E+02	2.298E+03	3.445E+06	2.314E+02
2035	8.266E+03	6.619E+06	4.447E+02	2.208E+03	3.309E+06	2.224E+02
2036	7.942E+03	6.359E+06	4.273E+02	2.121E+03	3.180E+06	2.136E+02
2037	7.630E+03	6.110E+06	4.105E+02	2.038E+03	3.055E+06	2.053E+02
2038	7.331E+03	5.870E+06	3.944E+02	1.958E+03	2.935E+06	1.972E+02
2039	7.044E+03	5.640E+06	3.790E+02	1.881E+03	2.820E+06	1.895E+02
2040	6.768E+03	5.419E+06	3.641E+02	1.808E+03	2.710E+06	1.821E+02
2041	6.502E+03	5.207E+06	3.498E+02	1.737E+03	2.603E+06	1.749E+02
2042	6.247E+03	5.002E+06	3.361E+02	1.669E+03	2.501E+06	1.681E+02
2043	6.002E+03	4.806E+06	3.229E+02	1.603E+03	2.403E+06	1.615E+02
2044	5.767E+03	4.618E+06	3.103E+02	1.540E+03	2.309E+06	1.551E+02
2045	5.541E+03	4.437E+06	2.981E+02	1.480E+03	2.218E+06	1.491E+02
2046	5.324E+03	4.263E+06	2.864E+02	1.422E+03	2.131E+06	1.432E+02
2047	5.115E+03	4.096E+06	2.752E+02	1.366E+03	2.048E+06	1.376E+02
2048	4.914E+03	3.935E+06	2.644E+02	1.313E+03	1.968E+06	1.322E+02
2049	4.722E+03	3.781E+06	2.540E+02	1.261E+03	1.890E+06	1.270E+02

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
2050	4.536E+03	3.633E+06	2.441E+02	1.212E+03	1.816E+06	1.220E+02
2051	4.359E+03	3.490E+06	2.345E+02	1.164E+03	1.745E+06	1.173E+02
2052	4.188E+03	3.353E+06	2.253E+02	1.119E+03	1.677E+06	1.127E+02
2053	4.023E+03	3.222E+06	2.165E+02	1.075E+03	1.611E+06	1.082E+02
2054	3.866E+03	3.095E+06	2.080E+02	1.033E+03	1.548E+06	1.040E+02
2055	3.714E+03	2.974E+06	1.998E+02	9.921E+02	1.487E+06	9.991E+01
2056	3.568E+03	2.857E+06	1.920E+02	9.532E+02	1.429E+06	9.600E+01
2057	3.429E+03	2.745E+06	1.845E+02	9.158E+02	1.373E+06	9.223E+01
2058	3.294E+03	2.638E+06	1.772E+02	8.799E+02	1.319E+06	8.862E+01
2059	3.165E+03	2.534E+06	1.703E+02	8.454E+02	1.267E+06	8.514E+01
2060	3.041E+03	2.435E+06	1.636E+02	8.122E+02	1.217E+06	8.180E+01
2061	2.922E+03	2.339E+06	1.572E+02	7.804E+02	1.170E+06	7.860E+01
2062	2.807E+03	2.248E+06	1.510E+02	7.498E+02	1.124E+06	7.551E+01
2063	2.697E+03	2.160E+06	1.451E+02	7.204E+02	1.080E+06	7.255E+01
2064	2.591E+03	2.075E+06	1.394E+02	6.921E+02	1.037E+06	6.971E+01
2065	2.490E+03	1.994E+06	1.339E+02	6.650E+02	9.968E+05	6.697E+01
2066	2.392E+03	1.915E+06	1.287E+02	6.389E+02	9.577E+05	6.435E+01
2067	2.298E+03	1.840E+06	1.237E+02	6.139E+02	9.202E+05	6.183E+01
2068	2.208E+03	1.768E+06	1.188E+02	5.898E+02	8.841E+05	5.940E+01
2069	2.122E+03	1.699E+06	1.141E+02	5.667E+02	8.494E+05	5.707E+01
2070	2.038E+03	1.632E+06	1.097E+02	5.445E+02	8.161E+05	5.483E+01
2071	1.958E+03	1.568E+06	1.054E+02	5.231E+02	7.841E+05	5.268E+01
2072	1.882E+03	1.507E+06	1.012E+02	5.026E+02	7.534E+05	5.062E+01
2073	1.808E+03	1.448E+06	9.727E+01	4.829E+02	7.238E+05	4.863E+01
2074	1.737E+03	1.391E+06	9.345E+01	4.640E+02	6.954E+05	4.673E+01
2075	1.669E+03	1.336E+06	8.979E+01	4.458E+02	6.682E+05	4.489E+01
2076	1.603E+03	1.284E+06	8.627E+01	4.283E+02	6.420E+05	4.313E+01
2077	1.541E+03	1.234E+06	8.289E+01	4.115E+02	6.168E+05	4.144E+01
2078	1.480E+03	1.185E+06	7.964E+01	3.954E+02	5.926E+05	3.982E+01
2079	1.422E+03	1.139E+06	7.651E+01	3.799E+02	5.694E+05	3.826E+01
2080	1.366E+03	1.094E+06	7.351E+01	3.650E+02	5.471E+05	3.676E+01
2081	1.313E+03	1.051E+06	7.063E+01	3.507E+02	5.256E+05	3.532E+01
2082	1.261E+03	1.010E+06	6.786E+01	3.369E+02	5.050E+05	3.393E+01
2083	1.212E+03	9.704E+05	6.520E+01	3.237E+02	4.852E+05	3.260E+01
2084	1.164E+03	9.323E+05	6.264E+01	3.110E+02	4.662E+05	3.132E+01
2085	1.119E+03	8.958E+05	6.019E+01	2.988E+02	4.479E+05	3.009E+01
2086	1.075E+03	8.607E+05	5.783E+01	2.871E+02	4.303E+05	2.891E+01
2087	1.033E+03	8.269E+05	5.556E+01	2.758E+02	4.135E+05	2.778E+01
2088	9.922E+02	7.945E+05	5.338E+01	2.650E+02	3.972E+05	2.669E+01
2089	9.533E+02	7.633E+05	5.129E+01	2.546E+02	3.817E+05	2.564E+01
2090	9.159E+02	7.334E+05	4.928E+01	2.446E+02	3.667E+05	2.464E+01
2091	8.800E+02	7.046E+05	4.734E+01	2.351E+02	3.523E+05	2.367E+01
2092	8.455E+02	6.770E+05	4.549E+01	2.258E+02	3.385E+05	2.274E+01
2093	8.123E+02	6.505E+05	4.370E+01	2.170E+02	3.252E+05	2.185E+01
2094	7.805E+02	6.250E+05	4.199E+01	2.085E+02	3.125E+05	2.100E+01
2095	7.499E+02	6.005E+05	4.034E+01	2.003E+02	3.002E+05	2.017E+01
2096	7.205E+02	5.769E+05	3.876E+01	1.924E+02	2.885E+05	1.938E+01
2097	6.922E+02	5.543E+05	3.724E+01	1.849E+02	2.771E+05	1.862E+01
2098	6.651E+02	5.326E+05	3.578E+01	1.776E+02	2.663E+05	1.789E+01
2099	6.390E+02	5.117E+05	3.438E+01	1.707E+02	2.558E+05	1.719E+01
2100	6.139E+02	4.916E+05	3.303E+01	1.640E+02	2.458E+05	1.652E+01

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
2101	5.899E+02	4.723E+05	3.174E+01	1.576E+02	2.362E+05	1.587E+01
2102	5.667E+02	4.538E+05	3.049E+01	1.514E+02	2.269E+05	1.525E+01
2103	5.445E+02	4.360E+05	2.930E+01	1.454E+02	2.180E+05	1.465E+01
2104	5.232E+02	4.189E+05	2.815E+01	1.397E+02	2.095E+05	1.407E+01
2105	5.026E+02	4.025E+05	2.704E+01	1.343E+02	2.012E+05	1.352E+01
2106	4.829E+02	3.867E+05	2.598E+01	1.290E+02	1.934E+05	1.299E+01
2107	4.640E+02	3.716E+05	2.496E+01	1.239E+02	1.858E+05	1.248E+01
2108	4.458E+02	3.570E+05	2.399E+01	1.191E+02	1.785E+05	1.199E+01
2109	4.283E+02	3.430E+05	2.305E+01	1.144E+02	1.715E+05	1.152E+01
2110	4.115E+02	3.295E+05	2.214E+01	1.099E+02	1.648E+05	1.107E+01
2111	3.954E+02	3.166E+05	2.127E+01	1.056E+02	1.583E+05	1.064E+01
2112	3.799E+02	3.042E+05	2.044E+01	1.015E+02	1.521E+05	1.022E+01
2113	3.650E+02	2.923E+05	1.964E+01	9.749E+01	1.461E+05	9.819E+00
2114	3.507E+02	2.808E+05	1.887E+01	9.367E+01	1.404E+05	9.434E+00
2115	3.369E+02	2.698E+05	1.813E+01	9.000E+01	1.349E+05	9.064E+00
2116	3.237E+02	2.592E+05	1.742E+01	8.647E+01	1.296E+05	8.709E+00
2117	3.110E+02	2.491E+05	1.673E+01	8.308E+01	1.245E+05	8.367E+00
2118	2.988E+02	2.393E+05	1.608E+01	7.982E+01	1.196E+05	8.039E+00
2119	2.871E+02	2.299E+05	1.545E+01	7.669E+01	1.150E+05	7.724E+00
2120	2.759E+02	2.209E+05	1.484E+01	7.369E+01	1.104E+05	7.421E+00
2121	2.650E+02	2.122E+05	1.426E+01	7.080E+01	1.061E+05	7.130E+00
2122	2.547E+02	2.039E+05	1.370E+01	6.802E+01	1.020E+05	6.850E+00
2123	2.447E+02	1.959E+05	1.316E+01	6.535E+01	9.796E+04	6.582E+00
2124	2.351E+02	1.882E+05	1.265E+01	6.279E+01	9.412E+04	6.324E+00
2125	2.259E+02	1.809E+05	1.215E+01	6.033E+01	9.043E+04	6.076E+00
2126	2.170E+02	1.738E+05	1.168E+01	5.796E+01	8.688E+04	5.838E+00
2127	2.085E+02	1.669E+05	1.122E+01	5.569E+01	8.347E+04	5.609E+00
2128	2.003E+02	1.604E+05	1.078E+01	5.351E+01	8.020E+04	5.389E+00
2129	1.925E+02	1.541E+05	1.035E+01	5.141E+01	7.706E+04	5.177E+00
2130	1.849E+02	1.481E+05	9.949E+00	4.939E+01	7.404E+04	4.974E+00
2131	1.777E+02	1.423E+05	9.559E+00	4.746E+01	7.113E+04	4.779E+00
2132	1.707E+02	1.367E+05	9.184E+00	4.560E+01	6.834E+04	4.592E+00
2133	1.640E+02	1.313E+05	8.824E+00	4.381E+01	6.566E+04	4.412E+00
2134	1.576E+02	1.262E+05	8.478E+00	4.209E+01	6.309E+04	4.239E+00
2135	1.514E+02	1.212E+05	8.145E+00	4.044E+01	6.062E+04	4.073E+00
2136	1.455E+02	1.165E+05	7.826E+00	3.885E+01	5.824E+04	3.913E+00
2137	1.398E+02	1.119E+05	7.519E+00	3.733E+01	5.595E+04	3.760E+00
2138	1.343E+02	1.075E+05	7.224E+00	3.587E+01	5.376E+04	3.612E+00
2139	1.290E+02	1.033E+05	6.941E+00	3.446E+01	5.165E+04	3.471E+00
2140	1.240E+02	9.925E+04	6.669E+00	3.311E+01	4.963E+04	3.334E+00

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2000	0	0	0	0	0	0
2001	1.308E+01	7.143E+03	4.800E-01	5.582E-03	1.557E+00	1.046E-04
2002	6.775E+02	3.701E+05	2.487E+01	2.892E-01	8.068E+01	5.421E-03
2003	1.430E+03	7.810E+05	5.248E+01	6.103E-01	1.703E+02	1.144E-02
2004	2.233E+03	1.220E+06	8.195E+01	9.531E-01	2.659E+02	1.787E-02
2005	3.126E+03	1.708E+06	1.148E+02	1.335E+00	3.723E+02	2.502E-02
2006	4.141E+03	2.262E+06	1.520E+02	1.768E+00	4.931E+02	3.313E-02
2007	4.995E+03	2.729E+06	1.833E+02	2.132E+00	5.948E+02	3.997E-02
2008	5.674E+03	3.100E+06	2.083E+02	2.422E+00	6.757E+02	4.540E-02
2009	6.317E+03	3.451E+06	2.319E+02	2.697E+00	7.523E+02	5.055E-02
2010	6.943E+03	3.793E+06	2.548E+02	2.964E+00	8.269E+02	5.556E-02
2011	7.553E+03	4.126E+06	2.773E+02	3.224E+00	8.996E+02	6.044E-02
2012	8.149E+03	4.452E+06	2.991E+02	3.479E+00	9.704E+02	6.520E-02
2013	8.729E+03	4.769E+06	3.204E+02	3.726E+00	1.040E+03	6.985E-02
2014	9.297E+03	5.079E+06	3.412E+02	3.969E+00	1.107E+03	7.439E-02
2015	9.850E+03	5.381E+06	3.616E+02	4.205E+00	1.173E+03	7.882E-02
2016	1.039E+04	5.677E+06	3.814E+02	4.436E+00	1.238E+03	8.315E-02
2017	1.092E+04	5.966E+06	4.009E+02	4.662E+00	1.301E+03	8.739E-02
2018	1.144E+04	6.249E+06	4.199E+02	4.883E+00	1.362E+03	9.154E-02
2019	1.149E+04	6.276E+06	4.217E+02	4.904E+00	1.368E+03	9.193E-02
2020	1.104E+04	6.030E+06	4.052E+02	4.712E+00	1.315E+03	8.833E-02
2021	1.061E+04	5.794E+06	3.893E+02	4.527E+00	1.263E+03	8.486E-02
2022	1.019E+04	5.567E+06	3.740E+02	4.350E+00	1.214E+03	8.154E-02
2023	9.790E+03	5.348E+06	3.594E+02	4.179E+00	1.166E+03	7.834E-02
2024	9.406E+03	5.139E+06	3.453E+02	4.015E+00	1.120E+03	7.527E-02
2025	9.037E+03	4.937E+06	3.317E+02	3.858E+00	1.076E+03	7.232E-02
2026	8.683E+03	4.744E+06	3.187E+02	3.707E+00	1.034E+03	6.948E-02
2027	8.343E+03	4.558E+06	3.062E+02	3.561E+00	9.935E+02	6.676E-02
2028	8.015E+03	4.379E+06	2.942E+02	3.422E+00	9.546E+02	6.414E-02
2029	7.701E+03	4.207E+06	2.827E+02	3.288E+00	9.172E+02	6.162E-02
2030	7.399E+03	4.042E+06	2.716E+02	3.159E+00	8.812E+02	5.921E-02
2031	7.109E+03	3.884E+06	2.609E+02	3.035E+00	8.466E+02	5.689E-02
2032	6.830E+03	3.731E+06	2.507E+02	2.916E+00	8.134E+02	5.466E-02
2033	6.563E+03	3.585E+06	2.409E+02	2.801E+00	7.816E+02	5.251E-02
2034	6.305E+03	3.445E+06	2.314E+02	2.692E+00	7.509E+02	5.045E-02
2035	6.058E+03	3.309E+06	2.224E+02	2.586E+00	7.215E+02	4.848E-02
2036	5.820E+03	3.180E+06	2.136E+02	2.485E+00	6.932E+02	4.657E-02
2037	5.592E+03	3.055E+06	2.053E+02	2.387E+00	6.660E+02	4.475E-02
2038	5.373E+03	2.935E+06	1.972E+02	2.294E+00	6.399E+02	4.299E-02
2039	5.162E+03	2.820E+06	1.895E+02	2.204E+00	6.148E+02	4.131E-02
2040	4.960E+03	2.710E+06	1.821E+02	2.117E+00	5.907E+02	3.969E-02
2041	4.765E+03	2.603E+06	1.749E+02	2.034E+00	5.675E+02	3.813E-02
2042	4.579E+03	2.501E+06	1.681E+02	1.955E+00	5.453E+02	3.664E-02
2043	4.399E+03	2.403E+06	1.615E+02	1.878E+00	5.239E+02	3.520E-02
2044	4.227E+03	2.309E+06	1.551E+02	1.804E+00	5.033E+02	3.382E-02
2045	4.061E+03	2.218E+06	1.491E+02	1.733E+00	4.836E+02	3.249E-02
2046	3.902E+03	2.131E+06	1.432E+02	1.666E+00	4.646E+02	3.122E-02
2047	3.749E+03	2.048E+06	1.376E+02	1.600E+00	4.464E+02	3.000E-02
2048	3.602E+03	1.968E+06	1.322E+02	1.537E+00	4.289E+02	2.882E-02
2049	3.460E+03	1.890E+06	1.270E+02	1.477E+00	4.121E+02	2.769E-02

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
2050	3.325E+03	1.816E+06	1.220E+02	1.419E+00	3.959E+02	2.660E-02
2051	3.194E+03	1.745E+06	1.173E+02	1.364E+00	3.804E+02	2.556E-02
2052	3.069E+03	1.677E+06	1.127E+02	1.310E+00	3.655E+02	2.456E-02
2053	2.949E+03	1.611E+06	1.082E+02	1.259E+00	3.512E+02	2.360E-02
2054	2.833E+03	1.548E+06	1.040E+02	1.209E+00	3.374E+02	2.267E-02
2055	2.722E+03	1.487E+06	9.991E+01	1.162E+00	3.242E+02	2.178E-02
2056	2.615E+03	1.429E+06	9.600E+01	1.116E+00	3.115E+02	2.093E-02
2057	2.513E+03	1.373E+06	9.223E+01	1.073E+00	2.993E+02	2.011E-02
2058	2.414E+03	1.319E+06	8.862E+01	1.031E+00	2.875E+02	1.932E-02
2059	2.320E+03	1.267E+06	8.514E+01	9.902E-01	2.762E+02	1.856E-02
2060	2.229E+03	1.217E+06	8.180E+01	9.514E-01	2.654E+02	1.783E-02
2061	2.141E+03	1.170E+06	7.860E+01	9.141E-01	2.550E+02	1.713E-02
2062	2.057E+03	1.124E+06	7.551E+01	8.782E-01	2.450E+02	1.646E-02
2063	1.977E+03	1.080E+06	7.255E+01	8.438E-01	2.354E+02	1.582E-02
2064	1.899E+03	1.037E+06	6.971E+01	8.107E-01	2.262E+02	1.520E-02
2065	1.825E+03	9.968E+05	6.697E+01	7.789E-01	2.173E+02	1.460E-02
2066	1.753E+03	9.577E+05	6.435E+01	7.484E-01	2.088E+02	1.403E-02
2067	1.684E+03	9.202E+05	6.183E+01	7.190E-01	2.006E+02	1.348E-02
2068	1.618E+03	8.841E+05	5.940E+01	6.908E-01	1.927E+02	1.295E-02
2069	1.555E+03	8.494E+05	5.707E+01	6.637E-01	1.852E+02	1.244E-02
2070	1.494E+03	8.161E+05	5.483E+01	6.377E-01	1.779E+02	1.195E-02
2071	1.435E+03	7.841E+05	5.268E+01	6.127E-01	1.709E+02	1.149E-02
2072	1.379E+03	7.534E+05	5.062E+01	5.887E-01	1.642E+02	1.103E-02
2073	1.325E+03	7.238E+05	4.863E+01	5.656E-01	1.578E+02	1.060E-02
2074	1.273E+03	6.954E+05	4.673E+01	5.434E-01	1.516E+02	1.019E-02
2075	1.223E+03	6.682E+05	4.489E+01	5.221E-01	1.457E+02	9.787E-03
2076	1.175E+03	6.420E+05	4.313E+01	5.016E-01	1.399E+02	9.403E-03
2077	1.129E+03	6.168E+05	4.144E+01	4.820E-01	1.345E+02	9.034E-03
2078	1.085E+03	5.926E+05	3.982E+01	4.631E-01	1.292E+02	8.680E-03
2079	1.042E+03	5.694E+05	3.826E+01	4.449E-01	1.241E+02	8.340E-03
2080	1.001E+03	5.471E+05	3.676E+01	4.275E-01	1.193E+02	8.013E-03
2081	9.621E+02	5.256E+05	3.532E+01	4.107E-01	1.146E+02	7.699E-03
2082	9.244E+02	5.050E+05	3.393E+01	3.946E-01	1.101E+02	7.397E-03
2083	8.881E+02	4.852E+05	3.260E+01	3.791E-01	1.058E+02	7.107E-03
2084	8.533E+02	4.662E+05	3.132E+01	3.643E-01	1.016E+02	6.828E-03
2085	8.199E+02	4.479E+05	3.009E+01	3.500E-01	9.764E+01	6.560E-03
2086	7.877E+02	4.303E+05	2.891E+01	3.363E-01	9.381E+01	6.303E-03
2087	7.568E+02	4.135E+05	2.778E+01	3.231E-01	9.013E+01	6.056E-03
2088	7.271E+02	3.972E+05	2.669E+01	3.104E-01	8.660E+01	5.819E-03
2089	6.986E+02	3.817E+05	2.564E+01	2.982E-01	8.320E+01	5.590E-03
2090	6.712E+02	3.667E+05	2.464E+01	2.865E-01	7.994E+01	5.371E-03
2091	6.449E+02	3.523E+05	2.367E+01	2.753E-01	7.681E+01	5.161E-03
2092	6.196E+02	3.385E+05	2.274E+01	2.645E-01	7.379E+01	4.958E-03
2093	5.953E+02	3.252E+05	2.185E+01	2.541E-01	7.090E+01	4.764E-03
2094	5.720E+02	3.125E+05	2.100E+01	2.442E-01	6.812E+01	4.577E-03
2095	5.496E+02	3.002E+05	2.017E+01	2.346E-01	6.545E+01	4.398E-03
2096	5.280E+02	2.885E+05	1.938E+01	2.254E-01	6.288E+01	4.225E-03
2097	5.073E+02	2.771E+05	1.862E+01	2.166E-01	6.042E+01	4.059E-03
2098	4.874E+02	2.663E+05	1.789E+01	2.081E-01	5.805E+01	3.900E-03
2099	4.683E+02	2.558E+05	1.719E+01	1.999E-01	5.577E+01	3.747E-03
2100	4.499E+02	2.458E+05	1.652E+01	1.921E-01	5.359E+01	3.600E-03

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
2101	4.323E+02	2.362E+05	1.587E+01	1.845E-01	5.148E+01	3.459E-03
2102	4.154E+02	2.269E+05	1.525E+01	1.773E-01	4.947E+01	3.324E-03
2103	3.991E+02	2.180E+05	1.465E+01	1.704E-01	4.753E+01	3.193E-03
2104	3.834E+02	2.095E+05	1.407E+01	1.637E-01	4.566E+01	3.068E-03
2105	3.684E+02	2.012E+05	1.352E+01	1.573E-01	4.387E+01	2.948E-03
2106	3.539E+02	1.934E+05	1.299E+01	1.511E-01	4.215E+01	2.832E-03
2107	3.401E+02	1.858E+05	1.248E+01	1.452E-01	4.050E+01	2.721E-03
2108	3.267E+02	1.785E+05	1.199E+01	1.395E-01	3.891E+01	2.614E-03
2109	3.139E+02	1.715E+05	1.152E+01	1.340E-01	3.739E+01	2.512E-03
2110	3.016E+02	1.648E+05	1.107E+01	1.288E-01	3.592E+01	2.413E-03
2111	2.898E+02	1.583E+05	1.064E+01	1.237E-01	3.451E+01	2.319E-03
2112	2.784E+02	1.521E+05	1.022E+01	1.189E-01	3.316E+01	2.228E-03
2113	2.675E+02	1.461E+05	9.819E+00	1.142E-01	3.186E+01	2.141E-03
2114	2.570E+02	1.404E+05	9.434E+00	1.097E-01	3.061E+01	2.057E-03
2115	2.469E+02	1.349E+05	9.064E+00	1.054E-01	2.941E+01	1.976E-03
2116	2.373E+02	1.296E+05	8.709E+00	1.013E-01	2.826E+01	1.898E-03
2117	2.280E+02	1.245E+05	8.367E+00	9.731E-02	2.715E+01	1.824E-03
2118	2.190E+02	1.196E+05	8.039E+00	9.349E-02	2.608E+01	1.753E-03
2119	2.104E+02	1.150E+05	7.724E+00	8.983E-02	2.506E+01	1.684E-03
2120	2.022E+02	1.104E+05	7.421E+00	8.631E-02	2.408E+01	1.618E-03
2121	1.942E+02	1.061E+05	7.130E+00	8.292E-02	2.313E+01	1.554E-03
2122	1.866E+02	1.020E+05	6.850E+00	7.967E-02	2.223E+01	1.493E-03
2123	1.793E+02	9.796E+04	6.582E+00	7.655E-02	2.135E+01	1.435E-03
2124	1.723E+02	9.412E+04	6.324E+00	7.354E-02	2.052E+01	1.379E-03
2125	1.655E+02	9.043E+04	6.076E+00	7.066E-02	1.971E+01	1.325E-03
2126	1.590E+02	8.688E+04	5.838E+00	6.789E-02	1.894E+01	1.273E-03
2127	1.528E+02	8.347E+04	5.609E+00	6.523E-02	1.820E+01	1.223E-03
2128	1.468E+02	8.020E+04	5.389E+00	6.267E-02	1.748E+01	1.175E-03
2129	1.411E+02	7.706E+04	5.177E+00	6.021E-02	1.680E+01	1.129E-03
2130	1.355E+02	7.404E+04	4.974E+00	5.785E-02	1.614E+01	1.084E-03
2131	1.302E+02	7.113E+04	4.779E+00	5.558E-02	1.551E+01	1.042E-03
2132	1.251E+02	6.834E+04	4.592E+00	5.340E-02	1.490E+01	1.001E-03
2133	1.202E+02	6.566E+04	4.412E+00	5.131E-02	1.431E+01	9.618E-04
2134	1.155E+02	6.309E+04	4.239E+00	4.930E-02	1.375E+01	9.241E-04
2135	1.110E+02	6.062E+04	4.073E+00	4.737E-02	1.321E+01	8.879E-04
2136	1.066E+02	5.824E+04	3.913E+00	4.551E-02	1.270E+01	8.530E-04
2137	1.024E+02	5.595E+04	3.760E+00	4.372E-02	1.220E+01	8.196E-04
2138	9.841E+01	5.376E+04	3.612E+00	4.201E-02	1.172E+01	7.875E-04
2139	9.455E+01	5.165E+04	3.471E+00	4.036E-02	1.126E+01	7.566E-04
2140	9.084E+01	4.963E+04	3.334E+00	3.878E-02	1.082E+01	7.269E-04

Stage I

Cells 1 through Cell 4
Mueller Equation Calculations

JOB Forty West Landfill, Cells 1-4
DESCRIPTION Mueller Equation Calcs

PROJECT NO. 13813514.00001
COMPUTED BY KMC
CHECKED BY NSG/JDM

DATE: 01 Dec 2009
DATE: 18 Jan 2010

Calculation Methodology
Stage 1 - Cells 1 through 4

I. OBJECTIVE

To prepare a detailed design of an active gas collection system for use by Washington Renewable Energy to construct the system in existing Cells 1, 2, 3, and 4. The attached calculations performed are to properly size the header piping system based on the information provided.

II. ASSUMPTIONS

1 Landfill gas production is based on the LandGEM model provided by U.S. EPA. The following assumptions were used for the LandGEM model:

- **a:** Methane Generation Rate, k = 0.04 (Inventory Conventional)
- **b:** Potential Methane Generation Capacity, L_0 = 100 (Inventory Conventional)
- **c:** NMOC Concentration, 109 ppmv as hexane (based on Tier 2 Landfill Gas Analysis Report performed by URS submitted July 17, 2007).
- **d:** Methane Content, 50% by volume (CAA)
- **e:** 1% annual growth on waste placement on years after 2009.

2 Landfill Design Capacity for Cells 1 through 4 is 2,428,200 short tons. This value was obtained from most recent aerial photogrammetry data provided by Aerometric, Inc. for Cells 1 through 3 (1,859,000 yd^3) and design values for Cell 4 (2,188,000 yd^3). The sum of volume available is then multiplied by the average density of the waste received by the facility (0.60 tons/yd^3).

3 The system pressure of the header system is assumed to be 2.0 psia and the specific density of the landfill gas is similar to that of air (1.0). These values are typical for MSW landfills.

4 The temperature of the gas within the header system is assumed to be 100°F and fully saturated. This value is a conservative value for MSW landfills.

III. CALCULATIONS AND PROCEDURES

1 The Radius of Influence (ROI) is the effective area around the vertical gas extraction well applied by the vacuum. The ROI is obtained using the EPA Method with the following equation:

$$R=1311\times\left[\frac{Q_w DC}{L\rho Q_{gen}\pi}\right]^{1/2}$$

The equation is based on the number of wells in operation within the system and the gas generated by the system. Using the maximum values generated by LandGEM and typical values found in MSW landfills, the ROI typically ranges around 200 feet. In order to be conservative, a spacing of 175 feet was used to accomplish overlap in coverage.

2 Using a 175 feet offset for each vertical well, a total of 55 extraction wells were required for Cells 1 through 4. The individual wells were then connected to a proposed header located outside the limits of waste through a total of 19 laterals.

3 The maximum flow of gas handled by the extraction system is based on the LandGEM model. The maximum flow is then divided by the footprint of the cells to get an expected flow per square feet. The flow per square foot was found to be approximately 3.795×10^{-4} ft^3/min.

4 To determine the maximum flow for each lateral, the total number of wells within the cells is divided into the footprint for each cell. The flow is then multiplied by the number of wells connected to each lateral (node) at the the connection to the header pipe.

5 The Low Pressure Mueller Equation is then used to determine the pressure the system must overcome in the design and selection of a blower. Using an iterative process, the pipe diameter of header is determined by minimizing the head required of the blower.

$$\Delta p = L\left(\frac{60\times Q\times G^{0.425}}{2971\times d^{2.725}}\right)^{1/0.575} = \left[\frac{Q}{49.52\times d^{2.725}}\right]^{1/0.575}$$

The flow, "Q" is solved for above, "d" is equal to the pipe diameter, and "G" is assumed to be 1 for the specific density of the gas.

6 The velocity of the gas is then determined using the continuity equation.

$$Q = AV$$

JOB	**Forty West Landfill - Cells 1 - 4**	PROJECT NO.:	13813514.00001		
DESCRIPTION	**Mueller Equation Calculation Summary**	COMPUTED BY	KMC	DATE:	29-Jan-10
		CHECKED BY	NSG/JDM	DATE:	1-Feb-10

	Total Flow (scfm)	Headloss (in H_2O)
South Header	843.41	9.29
Flare Station Piping	1728.69	0.17

Total Headloss (max.)	9.47
Operational Head	10.00
Total Vaccum Required	19.47

1) Operational head is the theoretical vacuum available at the most remote wellhead.
2) System minor losses are accounted for by the pressure drop safety factor of 1.5.

JOB	Forty West Landfill, Cells 1-4 Header	PROJECT NO.:	13813514.00001
DESCRIPTION	Mueller Equation Calcs.	COMPUTED BY	KMC
		CHECKED BY	NSG/JDM

DATE: 1-Dec-09
DATE: 18-Jan-10

Primary Header Pipe in Cells I-IV

Total Header Pipe Length (Slope Adjusted)	14,582.59 lineal feet	Node Separation	263.27 feet (max)
Allowable Pressure Drop	0.01	CFM/Node	varies
Pressure Drop Safety Factor	1.50	Pipe Diameter	12.00 inches
Cumulative Pressure Drop	9.29 inches of H_2O	Accumulated Flow	843.41 scfm

Effective Area 51.02 acres 2,222,431.20 ft^2
Total Gas Generation 843.41 scfm
Flow/ft^2 0.0003795 cfm/ft^2

Gas from S Header 843.41 scfm
Total Gas Collected 843.41 scfm

Cell 4

Node ID	# of Wells	Area (ft^2)	Maximum Flow (scfm)	Length (LF)	Accumulated Flow (scfm)	Required Diameter (in)	Actual Diameter (in)	Actual Pressure Drop/ft	Actual Pressure Drop (in)	Slope (%)	Gas Velocity (fps)	Accumulated Condensate Production (gal/min)	Condensate Depth (in)
EFFECTIVE CELL AREA		617,245.20											
HW-4-1	1	123,449.04	46.85	646.47	46.85	2.82	6	0.000280	0.180799	3.00	1.66	0.12	0.06
4A	0	-	-	635.50	46.85	2.82	12	0.000010	0.006653	2.00	0.41	0.12	0.08
4B	1	123,449.04	46.85	697.26	93.70	3.64	12	0.000035	0.024369	2.00	0.83	0.25	0.08
4C	1	123,449.04	46.85	790.92	140.55	4.22	12	0.000071	0.055953	2.00	1.24	0.37	0.10
4D	1	123,449.04	46.85	697.33	187.40	4.69	12	0.000117	0.081361	2.00	1.66	0.49	0.12
4E	1	123,449.04	46.85	836.66	234.24	5.09	12	0.000172	0.143902	2.00	2.07	0.62	0.13
Totals	5	493,796.16		3,657.67					0.312239				

Cell 3

Node ID	# of Wells	Area (ft^2)	Maximum Flow (scfm)	Length (LF)	Accumulated Flow (scfm)	Required Diameter (in)	Actual Diameter (in)	Actual Pressure Drop/ft	Actual Pressure Drop (in)	Slope (%)	Velocity (fps)	Accumulated Condensate Production (gal/min)	Condensate Depth (in)
EFFECTIVE CELL AREA		634,233.60											
3A	3	90,604.80	34.38	740.41	268.63	5.35	12	0.000218	0.161599	2.00	2.38	0.71	0.14
3B	4	120,806.40	45.85	686.75	314.48	5.67	12	0.000287	0.197143	2.00	2.78	0.83	0.15
3C	3	90,604.80	34.38	647.40	348.86	5.89	12	0.000344	0.222601	2.00	3.08	0.92	0.16
3D	4	120,806.40	45.85	694.56	394.71	6.17	12	0.000426	0.296020	2.00	3.49	1.04	0.16
3E	3	90,604.80	34.38	647.88	429.09	6.36	12	0.000493	0.319296	2.00	3.79	1.13	0.17
3F	4	120,806.40	45.85	609.78	474.94	6.60	12	0.000588	0.358546	2.00	4.20	1.25	0.17
Totals	21	634,233.60		4,026.78					1.555204				

Cell 2													
Node ID	# of Wells	Area (ft²)	Maximum Flow (scfm)	Length (LF)	Accumulated Flow (scfm)	Required Diameter (in)	Actual Diameter (in)	Actual Pressure Drop/ft	Actual Pressure Drop (in)	Slope (%)	Velocity (fps)	Accumulated Condensate Production (gal/min)	Condensate Depth (in)
EFFECTIVE CELL AREA		470,448.00											
2A	3	88,209.00	33.48	723.34	508.41	6.77	12	0.000662	0.478804	2.00	4.50	1.34	0.18
2B	4	117,612.00	44.63	675.28	553.05	6.98	12	0.000766	0.517435	2.00	4.89	1.46	0.19
2C	2	58,806.00	22.32	780.61	575.36	7.08	12	0.000821	0.640745	2.00	5.09	1.52	0.19
2D	3	88,209.00	33.48	904.17	608.84	7.23	12	0.000905	0.818869	2.00	5.38	1.61	0.20
2E	4	117,612.00	44.63	991.07	653.47	7.42	12	0.001024	1.015088	2.00	5.78	1.73	0.20
Totals	16	470,448.00		4,074.47					3.470941				

Cell 1													
Node ID	# of Wells	Area (ft²)	Maximum Flow (scfm)	Length (LF)	Accumulated Flow (scfm)	Required Diameter (in)	Actual Diameter (in)	Actual Pressure Drop/ft	Actual Pressure Drop (in)	Slope (%)	Velocity (fps)	Accumulated Condensate Production (gal/min)	Condensate Depth (in)
EFFECTIVE CELL AREA		500,504.40											
1A	5	192,501.69	73.05	1157.17	726.53	7.71	12	0.001231	1.425080	2.00	6.42	1.92	0.21
1B	5	192,501.69	73.05	878.2	799.58	7.99	12	0.001455	1.277622	2.00	7.07	2.11	0.22
1C	3	115,501.02	43.83	785.38	843.41	8.15	12	0.001596	1.253714	2.00	7.46	2.23	0.23
									-				
									-				
Totals	13	500,504.40		2,820.75					3.956416				

Cumulative Totals:	55	2,098,982.16		14,579.67	843.41				9.29

JOB	Forty West Landfill, Cells 1 - 4	PROJECT NO.:	13813514.00001	
DESCRIPTION	Mueller Equation Calcs. (PIPE TO FLARE STATION)	COMPUTED BY	KMC	DATE: 29-Jan-10
		CHECKED BY	NSG/JDM	DATE:

The worst case lateral calculation is intended to ensure that the dimensions specified for the entire system is properly sized to accommodate the losses from the farthest well from the blower.

SUMMARY OF RESULTS FOR PIPE TO FLARE STATION

Allowable Pressure Drop	0.01	
Pressure Drop Safety Factor	1.50	

Total Landfill Area*	188.99 acres	8,232,404.40 ft^2	Gas from N Header	- scfm
Total Gas Generation	843.41 scfm**		Gas from S Header	843.41 scfm
Flow/ft^2	0.00010245 cfm/ft^2		Total Gas Collected	843.41 scfm

Pipe to Flare Station													
Node ID	# of Wells	Area (ft^2)	Maximum Flow (scfm)	Length (LF)	Accumulated Flow (scfm)	Required Diameter (in)	Actual Diameter (in)	Max Actual Pressure Drop/ft	Actual Pressure Drop (in H_2O)	Slope (%)	Gas Velocity (fps)	Accumulated Condensate Production (gal/min)	Condensate Depth (in)
Pipe to Flare	n/a	n/a	n/a	311.12	843.41	8.15	15	0.000554	0.172771	6.00	4.77	2.23	

Closure
Cells 1 through Cells 14
LandGEM Calculations

JOB Forty West Landfill, Phase 1 - 2
DESCRIPTION Mueller Equation Calcs

PROJECT NO. 13813514.00001
COMPUTED BY KMC
CHECKED BY NSG/JDM

DATE: 01 Dec 2009
DATE: 18 Jan 2010

Calculation Methodology - At Closure

I. OBJECTIVE

To prepare a detailed design of an active gas collection system for use by Washington Renewable Energy to construct the system through Phase 1 and Phase 2 of the Forty West Landfill in Hagerstown, Maryland. The attached calculations performed are to provide a preliminary size the header piping system based on the preliminary layout for Stage 2 (Cells 5, 6, and 7) and a preliminary layout of Phase 2 (Cells 8 through 14). Design calculations should be revised based on the future LFG system layout.

II. ASSUMPTIONS

1 Landfill gas production is based on the LandGEM model provided by U.S. EPA. The following assumptions were used for the LandGEM model:

- a: Methane Generation Rate, k = 0.04 (Inventory Conventional)
- b: Potential Methane Generation Capacity, L_0 = 100 (Inventory Conventional)
- c: NMOC Concentration, 109 ppmv as hexane (based on Tier 2 Landfill Gas Analysis Report performed by URS submitted July 17, 2007).
- d: Methane Content, 50% by volume (CAA)
- e: 1% annual growth on waste placement on years after 2009.

2 Landfill Design Capacity for the landfill is 7,402,496 short tons. This value is based from most recent aerial photogrammetry data provided by Aerometric, Inc. for Cells 1 through 3 (1,859,000 yd^3) and design values for Cells 4 through 14 (10,478,493 yd^3). The sum of volume available is then multiplied by the average density of the waste received by the facility (0.60 tons/yd^3).

3 The system pressure (vacuum) of the header system is assumed to be 2.0 psia and the specific density of the landfill gas is similar to that of air (1.0). These values are typical for MSW landfills and landfill gas collection systems (taken from *Landfill Gas System Engineering Design Courseware by Landtec Corp*).

4 The temperature of the gas within the header system is assumed to be 100°F and fully saturated. This value is a conservative value for MSW landfills.

III. CALCULATIONS AND PROCEDURES

1 The Radius of Influence (ROI) is the effective area around the vertical gas extraction well applied by the vacuum. The ROI is obtained using the EPA Method with the following equation:

$$R = 1311 \times \left[\frac{Q_w D C}{L \rho Q_{gen} \eta} \right]^{1/2}$$

The equation is based on the number of wells in operation within the system and the gas generated by the system. Using the maximum values generated by LandGEM and typical values found in MSW landfills, the ROI typically ranges around 200 feet. In order to be conservative, a spacing of 175 feet was used to accomplish overlap in coverage.

2 Using a 175 feet offset for each vertical well, a total of 35 extraction wells were required for the northern section of the system (Northern Header) and 84 extraction wells for the southern section of the system (Southern Header). The individual wells were then connected to a proposed header located outside the limits of waste through a total of 63 laterals and 119 extraction wells for the entire site at final completion.

3 The maximum flow of gas handled by the extraction system is based on the LandGEM model. The maximum flow is then divided by the footprint of the cells to get an expected flow per square feet. The flow per square feet was found to be approximately 2.8×10^{-4} ft^3/min.

4 To determine the maximum flow for each lateral, the effective area for each cell is divided into the total number of wells within the cells. The flow is then multiplied by the number of wells connected to each lateral (node) at the the connection to the header pipe.

5 The Low Pressure Mueller Equation is then used to determine the pressure the system must overcome in the design and selection of a blower. Using an iterative process, the pipe diameter of header is determined by minimizing the head required of the blower.

$$\Delta p = L\left(\frac{60 \times Q \times G^{0.425}}{2971 \times d^{2.725}}\right)^{1/0.575} = \left[\frac{Q}{49.52 \times d^{2.725}}\right]^{1/0.575}$$

JOB Forty West Landfill, Phase 1 - 2
DESCRIPTION Mueller Equation Calcs

PROJECT NO. 13813514.00001
COMPUTED BY KMC
CHECKED BY NSG/JDM

DATE: 01 Dec 2009
DATE: 18 Jan 2010

The flow, "Q" is solved for above, "d" is equal to the pipe diameter, and "G" is assumed to be 1 for the specific density of the gas.

6 The velocity of the gas is then determined using the continuity equation.

$$Q = AV$$

7 The accumulated condensate production is calculated by using Antoine's Equation.

$$V_{(cond)} = \frac{5{,}694 \times 10^{\beta}}{P_s}$$

$$\beta = 6.32 - \frac{3{,}081}{T + 385}$$

The volume produced per million cubic foot of LFG calculated by Antoine's Equation is then multiplied by the flow of LFG to find the rate of condensate produced. Where P_s = system pressure in psia and T = temperature of the landfill gas within the header system in °F.

8 Using Manning's Formula for gravity flow, solve for the depth of the condensate based on the pipe's slope, pipe size, and flow.

IV. RESULTS

The active gas extraction system will require a blower capable of producing a vacuum at 48.12" H_2O at a flow rate of a 1,728 scfm at landfill closure. The system is divided into two sections, a north header and a south header. The North Header was found to require a flowrate of 970 scfm of gas at a vaccum of 28.11 inches of water while the soule requires flowrate of approximately 758 scfm at a vacuum of 32.5 inches of water.

Summary Report

Landfill Name or Identifier: Forty West Landfill--Phase 1 and Phase 2

Date: Friday, February 19, 2010

Description/Comments:
*Assuming 1% annual waste placement increase after 2008.
**Landfill Design Capacity for the landfill is 7,402,496 short tons. This value is based from data provided by Buchart-horn, Inc. for Cells 1 through 3 (1,859,000 yd3) and design values for Cells 4 through 14 (10,478,493 yd3). The sum of volume available is then multiplied by the average density of the waste received by the facility (0.60 tons/yd3).

About LandGEM:

First-Order Decomposition Rate Equation:

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} kL_o \left(\frac{M_i}{10}\right) e^{-kt_{ij}}$$

Where,
Q_{CH4} = annual methane generation in the year of the calculation ($m^3/year$)
i = 1-year time increment
n = (year of the calculation) - (initial year of waste acceptance)
j = 0.1-year time increment
k = methane generation rate ($year^{-1}$)
L_o = potential methane generation capacity (m^3/Mg)

M_i = mass of waste accepted in the i^{th} year (*Mg*)
t_{ij} = age of the j^{th} section of waste mass M_i accepted in the i^{th} year (*decimal years*, e.g., 3.2 years)

LandGEM is based on a first-order decomposition rate equation for quantifying emissions from the decomposition of landfilled waste in municipal solid waste (MSW) landfills. The software provides a relatively simple approach to estimating landfill gas emissions. Model defaults are based on empirical data from U.S. landfills. Field test data can also be used in place of model defaults when available. Further guidance on EPA test methods, Clean Air Act (CAA) regulations, and other guidance regarding landfill gas emissions and control technology requirements can be found at http://www.epa.gov/ttnatw01/landfill/landflpg.html.

LandGEM is considered a screening tool — the better the input data, the better the estimates. Often, there are limitations with the available data regarding waste quantity and composition, variation in design and operating practices over time, and changes occurring over time that impact the emissions potential. Changes to landfill operation, such as operating under wet conditions through leachate recirculation or other liquid additions, will result in generating more gas at a faster rate. Defaults for estimating emissions for this type of operation are being developed to include in LandGEM along with defaults for convential landfills (no leachate or liquid additions) for developing emission inventories and determining CAA applicability. Refer to the Web site identified above for future updates.

Input Review

LANDFILL CHARACTERISTICS

Landfill Open Year	**2000**	
Landfill Closure Year (with 80-year limit)	**2047**	
Actual Closure Year (without limit)	***2047***	
Have Model Calculate Closure Year?	**Yes**	
Waste Design Capacity	**7,402,496**	*short tons*

MODEL PARAMETERS

Methane Generation Rate, k	**0.040**	*$year^{-1}$*
Potential Methane Generation Capacity, L_o	**100**	*m^3/Mg*
NMOC Concentration	**109**	*ppmv as hexane*
Methane Content	**50**	*% by volume*

GASES / POLLUTANTS SELECTED

Gas / Pollutant #1:	**Total landfill gas**
Gas / Pollutant #2:	**Methane**
Gas / Pollutant #3:	**Carbon dioxide**
Gas / Pollutant #4:	**NMOC**

WASTE ACCEPTANCE RATES

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
2000	1,818	2,000	0	0
2001	92,454	101,699	1,818	2,000
2002	108,285	119,113	94,272	103,699
2003	119,441	131,385	202,556	222,812
2004	136,451	150,096	321,997	354,197
2005	158,062	173,868	458,448	504,293
2006	141,335	155,468	616,510	678,161
2007	121,698	133,868	757,845	833,629
2008	120,305	132,336	879,543	967,497
2009	121,509	133,659	999,848	1,099,833
2010	122,724	134,996	1,121,357	1,233,492
2011	123,951	136,346	1,244,080	1,368,488
2012	125,190	137,709	1,368,031	1,504,834
2013	126,442	139,086	1,493,221	1,642,544
2014	127,707	140,477	1,619,664	1,781,630
2015	128,984	141,882	1,747,370	1,922,107
2016	130,274	143,301	1,876,354	2,063,989
2017	131,576	144,734	2,006,628	2,207,290
2018	132,892	146,181	2,138,204	2,352,024
2019	134,221	147,643	2,271,096	2,498,206
2020	135,563	149,120	2,405,317	2,645,849
2021	136,919	150,611	2,540,880	2,794,968
2022	138,288	152,117	2,677,799	2,945,579
2023	139,671	153,638	2,816,087	3,097,696
2024	141,068	155,174	2,955,758	3,251,334
2025	142,478	156,726	3,096,826	3,406,508
2026	143,903	158,293	3,239,304	3,563,234
2027	145,342	159,876	3,383,207	3,721,528
2028	146,796	161,475	3,528,549	3,881,404
2029	148,263	163,090	3,675,345	4,042,879
2030	149,746	164,721	3,823,608	4,205,969
2031	151,244	166,368	3,973,354	4,370,690
2032	152,756	168,032	4,124,598	4,537,057
2033	154,284	169,712	4,277,354	4,705,089
2034	155,826	171,409	4,431,637	4,874,801
2035	157,385	173,123	4,587,464	5,046,210
2036	158,959	174,854	4,744,848	5,219,333
2037	160,548	176,603	4,903,807	5,394,188
2038	162,154	178,369	5,064,355	5,570,790
2039	163,775	180,153	5,226,508	5,749,159

WASTE ACCEPTANCE RATES (Continued)

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	(short tons/year)	(Mg)	(short tons)
2040	165,413	181,954	5,390,284	5,929,312
2041	167,067	183,774	5,555,696	6,111,266
2042	168,738	185,611	5,722,763	6,295,040
2043	170,425	187,468	5,891,501	6,480,651
2044	172,129	189,342	6,061,926	6,668,119
2045	173,851	191,236	6,234,055	6,857,461
2046	175,589	193,148	6,407,906	7,048,697
2047	146,047	160,651	6,583,495	7,241,845
2048	0	0	6,729,542	7,402,496
2049	0	0	6,729,542	7,402,496
2050	0	0	6,729,542	7,402,496
2051	0	0	6,729,542	7,402,496
2052	0	0	6,729,542	7,402,496
2053	0	0	6,729,542	7,402,496
2054	0	0	6,729,542	7,402,496
2055	0	0	6,729,542	7,402,496
2056	0	0	6,729,542	7,402,496
2057	0	0	6,729,542	7,402,496
2058	0	0	6,729,542	7,402,496
2059	0	0	6,729,542	7,402,496
2060	0	0	6,729,542	7,402,496
2061	0	0	6,729,542	7,402,496
2062	0	0	6,729,542	7,402,496
2063	0	0	6,729,542	7,402,496
2064	0	0	6,729,542	7,402,496
2065	0	0	6,729,542	7,402,496
2066	0	0	6,729,542	7,402,496
2067	0	0	6,729,542	7,402,496
2068	0	0	6,729,542	7,402,496
2069	0	0	6,729,542	7,402,496
2070	0	0	6,729,542	7,402,496
2071	0	0	6,729,542	7,402,496
2072	0	0	6,729,542	7,402,496
2073	0	0	6,729,542	7,402,496
2074	0	0	6,729,542	7,402,496
2075	0	0	6,729,542	7,402,496
2076	0	0	6,729,542	7,402,496
2077	0	0	6,729,542	7,402,496
2078	0	0	6,729,542	7,402,496
2079	0	0	6,729,542	7,402,496

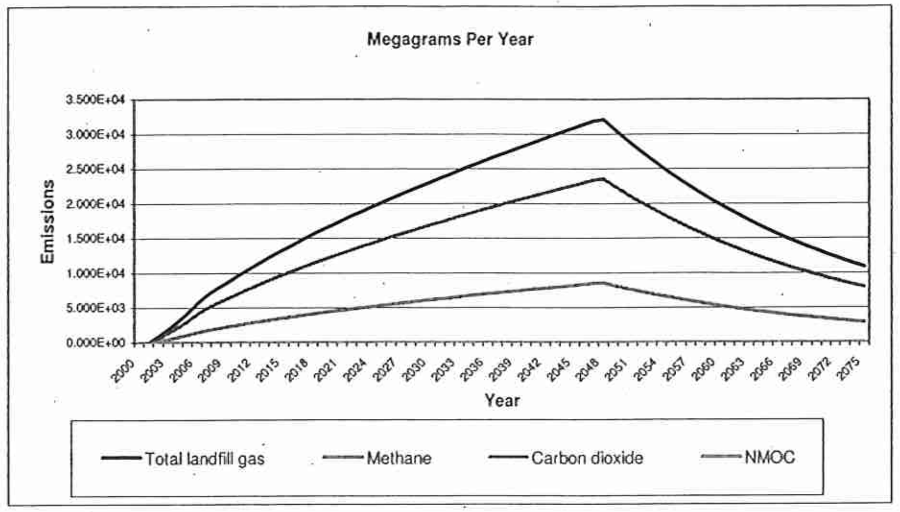
Pollutant Parameters

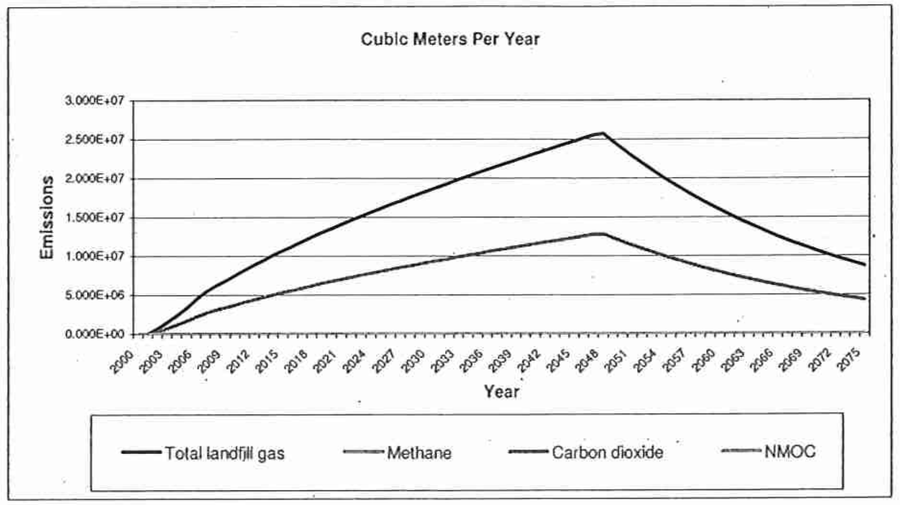
		Gas / Pollutant Default Parameters:		*User-specified Pollutant Parameters:*	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Gases	Total landfill gas		0.00		
	Methane		16.04		
	Carbon dioxide		44.01		
	NMOC	4,000	86.18		
Pollutants	1,1,1-Trichloroethane (methyl chloroform) - HAP	0.48	133.41		
	1,1,2,2-Tetrachloroethane - HAP/VOC	1.1	167.85		
	1,1-Dichloroethane (ethylidene dichloride) - HAP/VOC	2.4	98.97		
	1,1-Dichloroethene (vinylidene chloride) - HAP/VOC	0.20	96.94		
	1,2-Dichloroethane (ethylene dichloride) - HAP/VOC	0.41	98.96		
	1,2-Dichloropropane (propylene dichloride) - HAP/VOC	0.18	112.99		
	2-Propanol (isopropyl alcohol) - VOC	50	60.11		
	Acetone	7.0	58.08		
	Acrylonitrile - HAP/VOC	6.3	53.06		
	Benzene - No or Unknown Co-disposal - HAP/VOC	1.9	78.11		
	Benzene - Co-disposal - HAP/VOC	11	78.11		
	Bromodichloromethane - VOC	3.1	163.83		
	Butane - VOC	5.0	58.12		
	Carbon disulfide - HAP/VOC	0.58	76.13		
	Carbon monoxide	140	28.01		
	Carbon tetrachloride - HAP/VOC	4.0E-03	153.84		
	Carbonyl sulfide - HAP/VOC	0.49	60.07		
	Chlorobenzene - HAP/VOC	0.25	112.56		
	Chlorodifluoromethane	1.3	86.47		
	Chloroethane (ethyl chloride) - HAP/VOC	1.3	64.52		
	Chloroform - HAP/VOC	0.03	119.39		
	Chloromethane - VOC	1.2	50.49		
	Dichlorobenzene - (HAP for para isomer/VOC)	0.21	147		
	Dichlorodifluoromethane	16	120.91		
	Dichlorofluoromethane - VOC	2.6	102.92		
	Dichloromethane (methylene chloride) - HAP	14	84.94		
	Dimethyl sulfide (methyl sulfide) - VOC	7.8	62.13		
	Ethane	890	30.07		
	Ethanol - VOC	27	46.08		

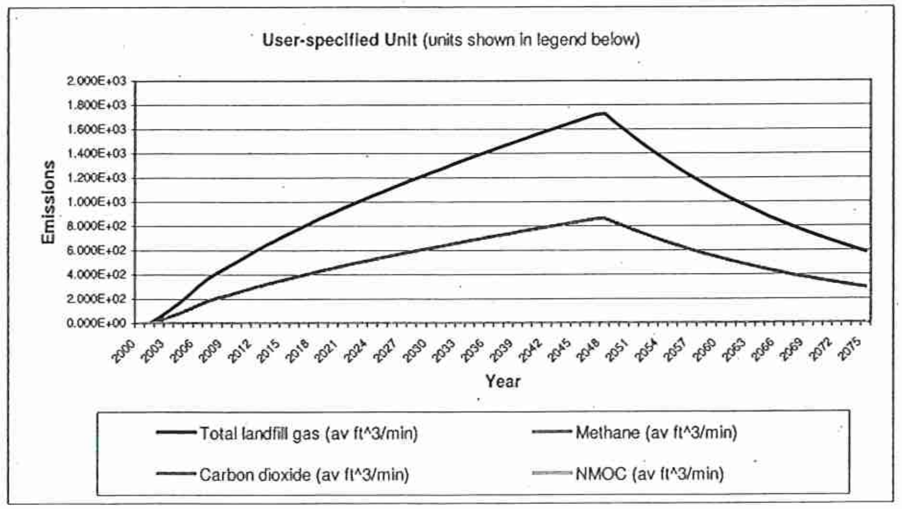
Pollutant Parameters (Continued)

	Gas / Pollutant Default Parameters:			User-specified Pollutant Parameters:	
	Compound	Concentration (ppmv)	Molecular Weight	Concentration (ppmv)	Molecular Weight
Pollutants	Ethyl mercaptan (ethanethiol) - VOC	2.3	62.13		
	Ethylbenzene - HAP/VOC	4.6	106.16		
	Ethylene dibromide - HAP/VOC	1.0E-03	187.88		
	Fluorotrichloromethane - VOC	0.76	137.38		
	Hexane - HAP/VOC	6.6	86.18		
	Hydrogen sulfide	36	34.08		
	Mercury (total) - HAP	2.9E-04	200.61		
	Methyl ethyl ketone - HAP/VOC	7.1	72.11		
	Methyl isobutyl ketone - HAP/VOC	1.9	100.16		
	Methyl mercaptan - VOC	2.5	48.11		
	Pentane - VOC	3.3	72.15		
	Perchloroethylene (tetrachloroethylene) - HAP	3.7	165.83		
	Propane - VOC	11	44.09		
	t-1,2-Dichloroethene - VOC	2.8	96.94		
	Toluene - No or Unknown Co-disposal - HAP/VOC	39	92.13		
	Toluene - Co-disposal - HAP/VOC	170	92.13		
	Trichloroethylene (trichloroethene) - HAP/VOC	2.8	131.40		
	Vinyl chloride - HAP/VOC	7.3	62.50		
	Xylenes - HAP/VOC	12	106.16		

Graphs


Megagrams Per Year
Emissions
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


Cubic Meters Per Year
Emissions
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


User-specified Unit (units shown in legend below)
Emissions
Year
Total landfill gas (av ft^3/min)
Methane (av ft^3/min)
Carbon dioxide (av ft^3/min)
NMOC (av ft^3/min)

Results

Year	Total landfill gas			Methane		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
2000	0	0	0	0	0	0
2001	1.784E+01	1.429E+04	9.599E-01	4.766E+00	7.143E+03	4.800E-01
2002	9.244E+02	7.402E+05	4.973E+01	2.469E+02	3.701E+05	2.487E+01
2003	1.951E+03	1.562E+06	1.050E+02	5.211E+02	7.810E+05	5.248E+01
2004	3.046E+03	2.439E+06	1.639E+02	8.137E+02	1.220E+06	8.195E+01
2005	4.266E+03	3.416E+06	2.295E+02	1.139E+03	1.708E+06	1.148E+02
2006	5.650E+03	4.524E+06	3.040E+02	1.509E+03	2.262E+06	1.520E+02
2007	6.815E+03	5.457E+06	3.667E+02	1.820E+03	2.729E+06	1.833E+02
2008	7.742E+03	6.199E+06	4.165E+02	2.068E+03	3.100E+06	2.083E+02
2009	8.619E+03	6.902E+06	4.637E+02	2.302E+03	3.451E+06	2.319E+02
2010	9.473E+03	7.586E+06	5.097E+02	2.530E+03	3.793E+06	2.548E+02
2011	1.031E+04	8.253E+06	5.545E+02	2.753E+03	4.126E+06	2.773E+02
2012	1.112E+04	8.903E+06	5.982E+02	2.970E+03	4.452E+06	2.991E+02
2013	1.191E+04	9.538E+06	6.408E+02	3.182E+03	4.769E+06	3.204E+02
2014	1.268E+04	1.016E+07	6.825E+02	3.388E+03	5.079E+06	3.412E+02
2015	1.344E+04	1.076E+07	7.231E+02	3.590E+03	5.381E+06	3.616E+02
2016	1.418E+04	1.135E+07	7.629E+02	3.787E+03	5.677E+06	3.814E+02
2017	1.490E+04	1.193E+07	8.017E+02	3.980E+03	5.966E+06	4.009E+02
2018	1.561E+04	1.250E+07	8.398E+02	4.169E+03	6.249E+06	4.199E+02
2019	1.630E+04	1.305E+07	8.770E+02	4.354E+03	6.526E+06	4.385E+02
2020	1.698E+04	1.360E+07	9.135E+02	4.535E+03	6.798E+06	4.567E+02
2021	1.764E+04	1.413E+07	9.492E+02	4.713E+03	7.064E+06	4.746E+02
2022	1.829E+04	1.465E+07	9.843E+02	4.887E+03	7.325E+06	4.922E+02
2023	1.893E+04	1.516E+07	1.019E+03	5.058E+03	7.581E+06	5.094E+02
2024	1.956E+04	1.566E+07	1.053E+03	5.225E+03	7.832E+06	5.263E+02
2025	2.018E+04	1.616E+07	1.086E+03	5.390E+03	8.080E+06	5.429E+02
2026	2.079E+04	1.665E+07	1.118E+03	5.552E+03	8.323E+06	5.592E+02
2027	2.138E+04	1.712E+07	1.151E+03	5.712E+03	8.562E+06	5.753E+02
2028	2.197E+04	1.759E+07	1.182E+03	5.869E+03	8.797E+06	5.911E+02
2029	2.255E+04	1.806E+07	1.213E+03	6.024E+03	9.029E+06	6.066E+02
2030	2.312E+04	1.851E+07	1.244E+03	6.176E+03	9.257E+06	6.220E+02
2031	2.368E+04	1.897E+07	1.274E+03	6.326E+03	9.483E+06	6.371E+02
2032	2.424E+04	1.941E+07	1.304E+03	6.475E+03	9.705E+06	6.521E+02
2033	2.479E+04	1.985E+07	1.334E+03	6.621E+03	9.925E+06	6.668E+02
2034	2.533E+04	2.028E+07	1.363E+03	6.766E+03	1.014E+07	6.814E+02
2035	2.587E+04	2.071E+07	1.392E+03	6.909E+03	1.036E+07	6.958E+02
2036	2.640E+04	2.114E+07	1.420E+03	7.051E+03	1.057E+07	7.101E+02
2037	2.692E+04	2.156E+07	1.448E+03	7.191E+03	1.078E+07	7.242E+02
2038	2.744E+04	2.197E+07	1.476E+03	7.330E+03	1.099E+07	7.382E+02
2039	2.796E+04	2.239E+07	1.504E+03	7.467E+03	1.119E+07	7.521E+02
2040	2.847E+04	2.280E+07	1.532E+03	7.604E+03	1.140E+07	7.658E+02
2041	2.897E+04	2.320E+07	1.559E+03	7.739E+03	1.160E+07	7.794E+02
2042	2.948E+04	2.360E+07	1.586E+03	7.874E+03	1.180E+07	7.930E+02
2043	2.998E+04	2.400E+07	1.613E+03	8.007E+03	1.200E+07	8.064E+02
2044	3.047E+04	2.440E+07	1.640E+03	8.140E+03	1.220E+07	8.198E+02
2045	3.097E+04	2.480E+07	1.666E+03	8.272E+03	1.240E+07	8.331E+02
2046	3.146E+04	2.519E+07	1.693E+03	8.403E+03	1.260E+07	8.463E+02
2047	3.195E+04	2.558E+07	1.719E+03	8.534E+03	1.279E+07	8.595E+02
2048	3.213E+04	2.573E+07	1.729E+03	8.582E+03	1.286E+07	8.643E+02
2049	3.087E+04	2.472E+07	1.661E+03	8.246E+03	1.236E+07	8.305E+02

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
2050	2.966E+04	2.375E+07	1.596E+03	7.922E+03	1.188E+07	7.979E+02
2051	2.850E+04	2.282E+07	1.533E+03	7.612E+03	1.141E+07	7.666E+02
2052	2.738E+04	2.192E+07	1.473E+03	7.313E+03	1.096E+07	7.365E+02
2053	2.631E+04	2.106E+07	1.415E+03	7.027E+03	1.053E+07	7.077E+02
2054	2.527E+04	2.024E+07	1.360E+03	6.751E+03	1.012E+07	6.799E+02
2055	2.428E+04	1.945E+07	1.307E+03	6.486E+03	9.723E+06	6.533E+02
2056	2.333E+04	1.868E+07	1.255E+03	6.232E+03	9.341E+06	6.276E+02
2057	2.242E+04	1.795E+07	1.206E+03	5.988E+03	8.975E+06	6.030E+02
2058	2.154E+04	1.725E+07	1.159E+03	5.753E+03	8.623E+06	5.794E+02
2059	2.069E+04	1.657E+07	1.113E+03	5.527E+03	8.285E+06	5.567E+02
2060	1.988E+04	1.592E+07	1.070E+03	5.311E+03	7.960E+06	5.348E+02
2061	1.910E+04	1.530E+07	1.028E+03	5.102E+03	7.648E+06	5.139E+02
2062	1.835E+04	1.470E+07	9.874E+02	4.902E+03	7.348E+06	4.937E+02
2063	1.763E+04	1.412E+07	9.487E+02	4.710E+03	7.060E+06	4.744E+02
2064	1.694E+04	1.357E+07	9.115E+02	4.525E+03	6.783E+06	4.558E+02
2065	1.628E+04	1.303E+07	8.758E+02	4.348E+03	6.517E+06	4.379E+02
2066	1.564E+04	1.252E+07	8.414E+02	4.177E+03	6.262E+06	4.207E+02
2067	1.503E+04	1.203E+07	8.084E+02	4.014E+03	6.016E+06	4.042E+02
2068	1.444E+04	1.156E+07	7.768E+02	3.856E+03	5.780E+06	3.884E+02
2069	1.387E+04	1.111E+07	7.463E+02	3.705E+03	5.554E+06	3.731E+02
2070	1.333E+04	1.067E+07	7.170E+02	3.560E+03	5.336E+06	3.585E+02
2071	1.280E+04	1.025E+07	6.889E+02	3.420E+03	5.127E+06	3.445E+02
2072	1.230E+04	9.851E+06	6.619E+02	3.286E+03	4.926E+06	3.310E+02
2073	1.182E+04	9.465E+06	6.359E+02	3.157E+03	4.732E+06	3.180E+02
2074	1.136E+04	9.094E+06	6.110E+02	3.033E+03	4.547E+06	3.055E+02
2075	1.091E+04	8.737E+06	5.871E+02	2.915E+03	4.369E+06	2.935E+02
2076	1.048E+04	8.395E+06	5.640E+02	2.800E+03	4.197E+06	2.820E+02
2077	1.007E+04	8.066E+06	5.419E+02	2.690E+03	4.033E+06	2.710E+02
2078	9.677E+03	7.749E+06	5.207E+02	2.585E+03	3.875E+06	2.603E+02
2079	9.298E+03	7.445E+06	5.003E+02	2.484E+03	3.723E+06	2.501E+02
2080	8.933E+03	7.153E+06	4.806E+02	2.386E+03	3.577E+06	2.403E+02
2081	8.583E+03	6.873E+06	4.618E+02	2.293E+03	3.436E+06	2.309E+02
2082	8.247E+03	6.603E+06	4.437E+02	2.203E+03	3.302E+06	2.218E+02
2083	7.923E+03	6.345E+06	4.263E+02	2.116E+03	3.172E+06	2.131E+02
2084	7.613E+03	6.096E+06	4.096E+02	2.033E+03	3.048E+06	2.048E+02
2085	7.314E+03	5.857E+06	3.935E+02	1.954E+03	2.928E+06	1.968E+02
2086	7.027E+03	5.627E+06	3.781E+02	1.877E+03	2.814E+06	1.890E+02
2087	6.752E+03	5.406E+06	3.633E+02	1.803E+03	2.703E+06	1.816E+02
2088	6.487E+03	5.194E+06	3.490E+02	1.733E+03	2.597E+06	1.745E+02
2089	6.233E+03	4.991E+06	3.353E+02	1.665E+03	2.495E+06	1.677E+02
2090	5.988E+03	4.795E+06	3.222E+02	1.600E+03	2.398E+06	1.611E+02
2091	5.753E+03	4.607E+06	3.095E+02	1.537E+03	2.304E+06	1.548E+02
2092	5.528E+03	4.426E+06	2.974E+02	1.477E+03	2.213E+06	1.487E+02
2093	5.311E+03	4.253E+06	2.858E+02	1.419E+03	2.126E+06	1.429E+02
2094	5.103E+03	4.086E+06	2.745E+02	1.363E+03	2.043E+06	1.373E+02
2095	4.903E+03	3.926E+06	2.638E+02	1.310E+03	1.963E+06	1.319E+02
2096	4.711E+03	3.772E+06	2.534E+02	1.258E+03	1.886E+06	1.267E+02
2097	4.526E+03	3.624E+06	2.435E+02	1.209E+03	1.812E+06	1.218E+02
2098	4.348E+03	3.482E+06	2.340E+02	1.161E+03	1.741E+06	1.170E+02
2099	4.178E+03	3.345E+06	2.248E+02	1.116E+03	1.673E+06	1.124E+02
2100	4.014E+03	3.214E+06	2.160E+02	1.072E+03	1.607E+06	1.080E+02

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
2101	3.857E+03	3.088E+06	2.075E+02	1.030E+03	1.544E+06	1.037E+02
2102	3.705E+03	2.967E+06	1.994E+02	9.898E+02	1.484E+06	9.968E+01
2103	3.560E+03	2.851E+06	1.915E+02	9.509E+02	1.425E+06	9.577E+01
2104	3.421E+03	2.739E+06	1.840E+02	9.137E+02	1.370E+06	9.202E+01
2105	3.286E+03	2.632E+06	1.768E+02	8.778E+02	1.316E+06	8.841E+01
2106	3.158E+03	2.528E+06	1.699E+02	8.434E+02	1.264E+06	8.494E+01
2107	3.034E+03	2.429E+06	1.632E+02	8.103E+02	1.215E+06	8.161E+01
2108	2.915E+03	2.334E+06	1.568E+02	7.786E+02	1.167E+06	7.841E+01
2109	2.801E+03	2.243E+06	1.507E+02	7.480E+02	1.121E+06	7.534E+01
2110	2.691E+03	2.155E+06	1.448E+02	7.187E+02	1.077E+06	7.238E+01
2111	2.585E+03	2.070E+06	1.391E+02	6.905E+02	1.035E+06	6.954E+01
2112	2.484E+03	1.989E+06	1.336E+02	6.635E+02	9.945E+05	6.682E+01
2113	2.386E+03	1.911E+06	1.284E+02	6.374E+02	9.555E+05	6.420E+01
2114	2.293E+03	1.836E+06	1.234E+02	6.124E+02	9.180E+05	6.168E+01
2115	2.203E+03	1.764E+06	1.185E+02	5.884E+02	8.820E+05	5.926E+01
2116	2.117E+03	1.695E+06	1.139E+02	5.654E+02	8.474E+05	5.694E+01
2117	2.034E+03	1.628E+06	1.094E+02	5.432E+02	8.142E+05	5.471E+01
2118	1.954E+03	1.565E+06	1.051E+02	5.219E+02	7.823E+05	5.256E+01
2119	1.877E+03	1.503E+06	1.010E+02	5.014E+02	7.516E+05	5.050E+01
2120	1.804E+03	1.444E+06	9.704E+01	4.818E+02	7.221E+05	4.852E+01
2121	1.733E+03	1.388E+06	9.323E+01	4.629E+02	6.938E+05	4.662E+01
2122	1.665E+03	1.333E+06	8.958E+01	4.447E+02	6.666E+05	4.479E+01
2123	1.600E+03	1.281E+06	8.607E+01	4.273E+02	6.405E+05	4.303E+01
2124	1.537E+03	1.231E+06	8.269E+01	4.105E+02	6.154E+05	4.135E+01
2125	1.477E+03	1.182E+06	7.945E+01	3.944E+02	5.912E+05	3.972E+01
2126	1.419E+03	1.136E+06	7.633E+01	3.790E+02	5.680E+05	3.817E+01
2127	1.363E+03	1.092E+06	7.334E+01	3.641E+02	5.458E+05	3.667E+01
2128	1.310E+03	1.049E+06	7.047E+01	3.498E+02	5.244E+05	3.523E+01
2129	1.258E+03	1.008E+06	6.770E+01	3.361E+02	5.038E+05	3.385E+01
2130	1.209E+03	9.681E+05	6.505E+01	3.229E+02	4.841E+05	3.252E+01
2131	1.162E+03	9.302E+05	6.250E+01	3.103E+02	4.651E+05	3.125E+01
2132	1.116E+03	8.937E+05	6.005E+01	2.981E+02	4.468E+05	3.002E+01
2133	1.072E+03	8.586E+05	5.769E+01	2.864E+02	4.293E+05	2.885E+01
2134	1.030E+03	8.250E+05	5.543E+01	2.752E+02	4.125E+05	2.771E+01
2135	9.898E+02	7.926E+05	5.326E+01	2.644E+02	3.963E+05	2.663E+01
2136	9.510E+02	7.615E+05	5.117E+01	2.540E+02	3.808E+05	2.558E+01
2137	9.137E+02	7.317E+05	4.916E+01	2.441E+02	3.658E+05	2.458E+01
2138	8.779E+02	7.030E+05	4.723E+01	2.345E+02	3.515E+05	2.362E+01
2139	8.435E+02	6.754E+05	4.538E+01	2.253E+02	3.377E+05	2.269E+01
2140	8.104E+02	6.489E+05	4.360E+01	2.165E+02	3.245E+05	2.180E+01

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2000	0	0	0	0	0	0
2001	1.308E+01	7.143E+03	4.800E-01	5.582E-03	1.557E+00	1.046E-04
2002	6.775E+02	3.701E+05	2.487E+01	2.892E-01	8.068E+01	5.421E-03
2003	1.430E+03	7.810E+05	5.248E+01	6.103E-01	1.703E+02	1.144E-02
2004	2.233E+03	1.220E+06	8.195E+01	9.531E-01	2.659E+02	1.787E-02
2005	3.126E+03	1.708E+06	1.148E+02	1.335E+00	3.723E+02	2.502E-02
2006	4.141E+03	2.262E+06	1.520E+02	1.768E+00	4.931E+02	3.313E-02
2007	4.995E+03	2.729E+06	1.833E+02	2.132E+00	5.948E+02	3.997E-02
2008	5.674E+03	3.100E+06	2.083E+02	2.422E+00	6.757E+02	4.540E-02
2009	6.317E+03	3.451E+06	2.319E+02	2.697E+00	7.523E+02	5.055E-02
2010	6.943E+03	3.793E+06	2.548E+02	2.964E+00	8.269E+02	5.556E-02
2011	7.553E+03	4.126E+06	2.773E+02	3.224E+00	8.996E+02	6.044E-02
2012	8.149E+03	4.452E+06	2.991E+02	3.479E+00	9.704E+02	6.520E-02
2013	8.729E+03	4.769E+06	3.204E+02	3.726E+00	1.040E+03	6.985E-02
2014	9.297E+03	5.079E+06	3.412E+02	3.969E+00	1.107E+03	7.439E-02
2015	9.850E+03	5.381E+06	3.616E+02	4.205E+00	1.173E+03	7.882E-02
2016	1.039E+04	5.677E+06	3.814E+02	4.436E+00	1.238E+03	8.315E-02
2017	1.092E+04	5.966E+06	4.009E+02	4.662E+00	1.301E+03	8.739E-02
2018	1.144E+04	6.249E+06	4.199E+02	4.883E+00	1.362E+03	9.154E-02
2019	1.195E+04	6.526E+06	4.385E+02	5.100E+00	1.423E+03	9.559E-02
2020	1.244E+04	6.798E+06	4.567E+02	5.312E+00	1.482E+03	9.957E-02
2021	1.293E+04	7.064E+06	4.746E+02	5.520E+00	1.540E+03	1.035E-01
2022	1.341E+04	7.325E+06	4.922E+02	5.724E+00	1.597E+03	1.073E-01
2023	1.388E+04	7.581E+06	5.094E+02	5.924E+00	1.653E+03	1.110E-01
2024	1.434E+04	7.832E+06	5.263E+02	6.120E+00	1.707E+03	1.147E-01
2025	1.479E+04	8.080E+06	5.429E+02	6.313E+00	1.761E+03	1.183E-01
2026	1.523E+04	8.323E+06	5.592E+02	6.503E+00	1.814E+03	1.219E-01
2027	1.567E+04	8.562E+06	5.753E+02	6.690E+00	1.866E+03	1.254E-01
2028	1.610E+04	8.797E+06	5.911E+02	6.874E+00	1.918E+03	1.289E-01
2029	1.653E+04	9.029E+06	6.066E+02	7.055E+00	1.968E+03	1.322E-01
2030	1.695E+04	9.257E+06	6.220E+02	7.234E+00	2.018E+03	1.356E-01
2031	1.736E+04	9.483E+06	6.371E+02	7.410E+00	2.067E+03	1.389E-01
2032	1.776E+04	9.705E+06	6.521E+02	7.584E+00	2.116E+03	1.422E-01
2033	1.817E+04	9.925E+06	6.668E+02	7.755E+00	2.164E+03	1.454E-01
2034	1.856E+04	1.014E+07	6.814E+02	7.925E+00	2.211E+03	1.485E-01
2035	1.896E+04	1.036E+07	6.958E+02	8.092E+00	2.258E+03	1.517E-01
2036	1.935E+04	1.057E+07	7.101E+02	8.258E+00	2.304E+03	1.548E-01
2037	1.973E+04	1.078E+07	7.242E+02	8.423E+00	2.350E+03	1.579E-01
2038	2.011E+04	1.099E+07	7.382E+02	8.585E+00	2.395E+03	1.609E-01
2039	2.049E+04	1.119E+07	7.521E+02	8.746E+00	2.440E+03	1.639E-01
2040	2.086E+04	1.140E+07	7.658E+02	8.906E+00	2.485E+03	1.669E-01
2041	2.123E+04	1.160E+07	7.794E+02	9.065E+00	2.529E+03	1.699E-01
2042	2.160E+04	1.180E+07	7.930E+02	9.222E+00	2.573E+03	1.729E-01
2043	2.197E+04	1.200E+07	8.064E+02	9.379E+00	2.617E+03	1.758E-01
2044	2.233E+04	1.220E+07	8.198E+02	9.534E+00	2.660E+03	1.787E-01
2045	2.270E+04	1.240E+07	8.331E+02	9.689E+00	2.703E+03	1.816E-01
2046	2.306E+04	1.260E+07	8.463E+02	9.843E+00	2.746E+03	1.845E-01
2047	2.342E+04	1.279E+07	8.595E+02	9.996E+00	2.789E+03	1.874E-01
2048	2.355E+04	1.286E+07	8.643E+02	1.005E+01	2.804E+03	1.884E-01
2049	2.262E+04	1.236E+07	8.305E+02	9.658E+00	2.694E+03	1.810E-01

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
2050	2.174E+04	1.188E+07	7.979E+02	9.279E+00	2.589E+03	1.739E-01
2051	2.089E+04	1.141E+07	7.666E+02	8.916E+00	2.487E+03	1.671E-01
2052	2.007E+04	1.096E+07	7.365E+02	8.566E+00	2.390E+03	1.606E-01
2053	1.928E+04	1.053E+07	7.077E+02	8.230E+00	2.296E+03	1.543E-01
2054	1.852E+04	1.012E+07	6.799E+02	7.907E+00	2.206E+03	1.482E-01
2055	1.780E+04	9.723E+06	6.533E+02	7.597E+00	2.120E+03	1.424E-01
2056	1.710E+04	9.341E+06	6.276E+02	7.299E+00	2.036E+03	1.368E-01
2057	1.643E+04	8.975E+06	6.030E+02	7.013E+00	1.957E+03	1.315E-01
2058	1.578E+04	8.623E+06	5.794E+02	6.738E+00	1.880E+03	1.263E-01
2059	1.517E+04	8.285E+06	5.567E+02	6.474E+00	1.806E+03	1.214E-01
2060	1.457E+04	7.960E+06	5.348E+02	6.220E+00	1.735E+03	1.166E-01
2061	1.400E+04	7.648E+06	5.139E+02	5.976E+00	1.667E+03	1.120E-01
2062	1.345E+04	7.348E+06	4.937E+02	5.742E+00	1.602E+03	1.076E-01
2063	1.292E+04	7.060E+06	4.744E+02	5.517E+00	1.539E+03	1.034E-01
2064	1.242E+04	6.783E+06	4.558E+02	5.300E+00	1.479E+03	9.936E-02
2065	1.193E+04	6.517E+06	4.379E+02	5.093E+00	1.421E+03	9.546E-02
2066	1.146E+04	6.262E+06	4.207E+02	4.893E+00	1.365E+03	9.172E-02
2067	1.101E+04	6.016E+06	4.042E+02	4.701E+00	1.312E+03	8.812E-02
2068	1.058E+04	5.780E+06	3.884E+02	4.517E+00	1.260E+03	8.467E-02
2069	1.017E+04	5.554E+06	3.731E+02	4.340E+00	1.211E+03	8.135E-02
2070	9.767E+03	5.336E+06	3.585E+02	4.170E+00	1.163E+03	7.816E-02
2071	9.384E+03	5.127E+06	3.445E+02	4.006E+00	1.118E+03	7.509E-02
2072	9.016E+03	4.926E+06	3.310E+02	3.849E+00	1.074E+03	7.215E-02
2073	8.663E+03	4.732E+06	3.180E+02	3.698E+00	1.032E+03	6.932E-02
2074	8.323E+03	4.547E+06	3.055E+02	3.553E+00	9.912E+02	6.660E-02
2075	7.997E+03	4.369E+06	2.935E+02	3.414E+00	9.524E+02	6.399E-02
2076	7.683E+03	4.197E+06	2.820E+02	3.280E+00	9.150E+02	6.148E-02
2077	7.382E+03	4.033E+06	2.710E+02	3.151E+00	8.791E+02	5.907E-02
2078	7.092E+03	3.875E+06	2.603E+02	3.028E+00	8.447E+02	5.675E-02
2079	6.814E+03	3.723E+06	2.501E+02	2.909E+00	8.115E+02	5.453E-02
2080	6.547E+03	3.577E+06	2.403E+02	2.795E+00	7.797E+02	5.239E-02
2081	6.290E+03	3.436E+06	2.309E+02	2.685E+00	7.492E+02	5.034E-02
2082	6.044E+03	3.302E+06	2.218E+02	2.580E+00	7.198E+02	4.836E-02
2083	5.807E+03	3.172E+06	2.131E+02	2.479E+00	6.916E+02	4.647E-02
2084	5.579E+03	3.048E+06	2.048E+02	2.382E+00	6.644E+02	4.464E-02
2085	5.360E+03	2.928E+06	1.968E+02	2.288E+00	6.384E+02	4.289E-02
2086	5.150E+03	2.814E+06	1.890E+02	2.199E+00	6.134E+02	4.121E-02
2087	4.948E+03	2.703E+06	1.816E+02	2.112E+00	5.893E+02	3.960E-02
2088	4.754E+03	2.597E+06	1.745E+02	2.030E+00	5.662E+02	3.804E-02
2089	4.568E+03	2.495E+06	1.677E+02	1.950E+00	5.440E+02	3.655E-02
2090	4.389E+03	2.398E+06	1.611E+02	1.873E+00	5.227E+02	3.512E-02
2091	4.217E+03	2.304E+06	1.548E+02	1.800E+00	5.022E+02	3.374E-02
2092	4.051E+03	2.213E+06	1.487E+02	1.729E+00	4.825E+02	3.242E-02
2093	3.892E+03	2.126E+06	1.429E+02	1.662E+00	4.636E+02	3.115E-02
2094	3.740E+03	2.043E+06	1.373E+02	1.596E+00	4.454E+02	2.993E-02
2095	3.593E+03	1.963E+06	1.319E+02	1.534E+00	4.279E+02	2.875E-02
2096	3.452E+03	1.886E+06	1.267E+02	1.474E+00	4.111E+02	2.762E-02
2097	3.317E+03	1.812E+06	1.218E+02	1.416E+00	3.950E+02	2.654E-02
2098	3.187E+03	1.741E+06	1.170E+02	1.360E+00	3.795E+02	2.550E-02
2099	3.062E+03	1.673E+06	1.124E+02	1.307E+00	3.647E+02	2.450E-02
2100	2.942E+03	1.607E+06	1.080E+02	1.256E+00	3.504E+02	2.354E-02

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
2101	2.826E+03	1.544E+06	1.037E+02	1.207E+00	3.366E+02	2.262E-02
2102	2.716E+03	1.484E+06	9.968E+01	1.159E+00	3.234E+02	2.173E-02
2103	2.609E+03	1.425E+06	9.577E+01	1.114E+00	3.107E+02	2.088E-02
2104	2.507E+03	1.370E+06	9.202E+01	1.070E+00	2.986E+02	2.006E-02
2105	2.409E+03	1.316E+06	8.841E+01	1.028E+00	2.868E+02	1.927E-02
2106	2.314E+03	1.264E+06	8.494E+01	9.879E-01	2.756E+02	1.852E-02
2107	2.223E+03	1.215E+06	8.161E+01	9.491E-01	2.648E+02	1.779E-02
2108	2.136E+03	1.167E+06	7.841E+01	9.119E-01	2.544E+02	1.709E-02
2109	2.052E+03	1.121E+06	7.534E+01	8.762E-01	2.444E+02	1.642E-02
2110	1.972E+03	1.077E+06	7.238E+01	8.418E-01	2.348E+02	1.578E-02
2111	1.895E+03	1.035E+06	6.954E+01	8.088E-01	2.256E+02	1.516E-02
2112	1.820E+03	9.945E+05	6.682E+01	7.771E-01	2.168E+02	1.457E-02
2113	1.749E+03	9.555E+05	6.420E+01	7.466E-01	2.083E+02	1.400E-02
2114	1.680E+03	9.180E+05	6.168E+01	7.173E-01	2.001E+02	1.345E-02
2115	1.615E+03	8.820E+05	5.926E+01	6.892E-01	1.923E+02	1.292E-02
2116	1.551E+03	8.474E+05	5.694E+01	6.622E-01	1.847E+02	1.241E-02
2117	1.490E+03	8.142E+05	5.471E+01	6.362E-01	1.775E+02	1.193E-02
2118	1.432E+03	7.823E+05	5.256E+01	6.113E-01	1.705E+02	1.146E-02
2119	1.376E+03	7.516E+05	5.050E+01	5.873E-01	1.638E+02	1.101E-02
2120	1.322E+03	7.221E+05	4.852E+01	5.643E-01	1.574E+02	1.058E-02
2121	1.270E+03	6.938E+05	4.662E+01	5.422E-01	1.513E+02	1.016E-02
2122	1.220E+03	6.666E+05	4.479E+01	5.209E-01	1.453E+02	9.764E-03
2123	1.172E+03	6.405E+05	4.303E+01	5.005E-01	1.396E+02	9.381E-03
2124	1.126E+03	6.154E+05	4.135E+01	4.808E-01	1.341E+02	9.013E-03
2125	1.082E+03	5.912E+05	3.972E+01	4.620E-01	1.289E+02	8.660E-03
2126	1.040E+03	5.680E+05	3.817E+01	4.439E-01	1.238E+02	8.320E-03
2127	9.990E+02	5.458E+05	3.667E+01	4.265E-01	1.190E+02	7.994E-03
2128	9.599E+02	5.244E+05	3.523E+01	4.098E-01	1.143E+02	7.681E-03
2129	9.222E+02	5.038E+05	3.385E+01	3.937E-01	1.098E+02	7.380E-03
2130	8.861E+02	4.841E+05	3.252E+01	3.782E-01	1.055E+02	7.090E-03
2131	8.513E+02	4.651E+05	3.125E+01	3.634E-01	1.014E+02	6.812E-03
2132	8.179E+02	4.468E+05	3.002E+01	3.492E-01	9.741E+01	6.545E-03
2133	7.859E+02	4.293E+05	2.885E+01	3.355E-01	9.359E+01	6.288E-03
2134	7.551E+02	4.125E+05	2.771E+01	3.223E-01	8.992E+01	6.042E-03
2135	7.255E+02	3.963E+05	2.663E+01	3.097E-01	8.640E+01	5.805E-03
2136	6.970E+02	3.808E+05	2.558E+01	2.975E-01	8.301E+01	5.577E-03
2137	6.697E+02	3.658E+05	2.458E+01	2.859E-01	7.975E+01	5.359E-03
2138	6.434E+02	3.515E+05	2.362E+01	2.747E-01	7.663E+01	5.149E-03
2139	6.182E+02	3.377E+05	2.269E+01	2.639E-01	7.362E+01	4.947E-03
2140	5.939E+02	3.245E+05	2.180E+01	2.535E-01	7.074E+01	4.753E-03

Closure

Cells 1 through Cells 14
Mueller Equation Calculations

JOB	**Forty West Landfill - At Closure**	PROJECT NO.:	13813514.00001
DESCRIPTION	**Mueller Equation Calculation Summary**	COMPUTED BY	KMC	DATE: 29-Jan-10
		CHECKED BY	NSG/JDM	DATE: 18-Jan-10

	Total Flow (scfm)	Headloss (in H_2O)
North Header	970.54	10.69
South Header	758.15	11.57
Flare Station Piping	1728.69	0.60

Total Headloss (max.)	12.17
Operational Head	10.00
Total Vaccum Required	22.17

1) Total Headloss (max.) is the headloss from the headers to the flare station plus the larger of the two header head loss values.
2) Operational head is the theoretical vacuum available at the most remote wellhead.
3) Headloss through the 4" lateral pipes was negligible (<0.1 inches)
4) System minor losses are accounted for by the pressure drop safety factor of 1.5.

JOB: Forty West Landfill, Southern Header
DESCRIPTION: Mueller Equation Calcs. (Cells 10, 9,13, 11, 14, 4, 3, 2, 1)

PROJECT NO.: 13813514.00001
COMPUTED BY: KMC — DATE: 29-Jan-10
CHECKED BY: NSG/JDM — DATE: 18-Jan-10

Primary Header Pipe in Cells 5-14

Total Header Pipe Length (Slope Adjusted)	19,250.69	lineal feet	Node Separation	263.27	feet (max)
Allowable Pressure Drop	0.01		CFM/Node	varies	
Pressure Drop Safety Factor	1.50		Pipe Diameter	12.00	inches
Cumulative Pressure Drop	11.57	inches of H_2O	Accumulated Flow	758.15	scfm

Total Landfill Area* 189.00 acres 8,232,632.51 ft^2
Total Gas Generation 1,728.69 scfm
Flow/ft^2 0.00020998 cfm/ft^2
Gas from S Header 758.15 scfm

* Total gas generation is taken from gas generation from entire landfill at closing therefore, it will not equal to flow collected by this portion of the system as calculated below.

Cell 10

Node ID	# of Wells	Area (ft^2)	Maximum Flow (scfm)	Length (LF)	Accumulated Flow (scfm)	Required Diameter (in)	Actual Diameter (in)	Actual Pressure Drop/ft	Actual Pressure Drop (In H_2O)	Slope (%) - (Min. Slope used)	Gas Velocity (fps)	Accumulated Condensate Production (gal/min)	Condensate Depth (in)
EFFECTIVE CELL AREA		228,109.20											
10BS	1	57,027.30	11.97	169.47	11.97	1.71	12	0.000001	0.000165	2.00	0.11	0.03	0.04
10CS	1	57,027.30	11.97	190.07	23.95	2.20	12	0.000003	0.000619	2.00	0.21	0.06	0.06
10DS	1	57,027.30	11.97	122.70	35.92	2.56	12	0.000007	0.000809	2.00	0.32	0.09	0.06
10ES	1	57,027.30	11.97	384.19	47.90	2.84	12	0.000011	0.004180	2.00	0.42	0.13	0.07
		-	-		-	-	12	-	-	2.00	-	0.00	0.08
		-	-		-	-	12	-	-	2.00	-	0.00	
		-	-		-	-	12	-	-	2.00	-	0.00	
		-	-		-	-	12	-	-	2.00	-	0.00	
Totals	4	228,109.20		866.43					0.005775				

Cell 9

Node ID	# of Wells	Area (ft^2)	Maximum Flow (scfm)	Length (LF)	Accumulated Flow (scfm)	Required Diameter (in)	Actual Diameter (in)	Actual Pressure Drop/ft	Actual Pressure Drop (In H_2O)	Slope (%) - (Min. Slope used)	Velocity (fps)	Accumulated Condensate Production (gal/min)	Condensate Depth (in)
EFFECTIVE CELL AREA		192,099.60											
9AS	1	48,024.90	10.08	246.38	57.98	3.05	12	0.000015	0.003737	2.00	0.51	0.15	0.09
9BS	1	48,024.90	10.08	217.68	68.07	3.24	12	0.000020	0.004364	2.00	0.60	0.18	0.09
9CS	1	48,024.90	10.08	338.23	78.15	3.40	12	0.000025	0.008622	2.00	0.69	0.21	0.10
9ES	1	48,024.90	10.08	429.85	88.24	3.56	12	0.000031	0.013533	2.00	0.78	0.23	0.11
		-	-		-	-	12	-	-	2.00	-	0.00	0.11
		-	-		-	-	12	-	-	2.00	-	0.00	
						-	12	-	-	2.00	-	0.00	
Totals	4	192,099.60		1,232.14					0.030257				

Cell 13													
Node ID	# of Wells	Area (ft^2)	Maximum Flow (scfm)	Length (LF)	Accumulated Flow (scfm)	Required Diameter (in)	Actual Diameter (in)	Actual Pressure Drop/ft	Actual Pressure Drop (in H_2O)	Slope (%) - (Min. Slope used)	Velocity (fps)	Accumulated Condensate Production (gal/min)	Condensate Depth (in)
EFFECTIVE CELL AREA		38,376.36											
13AS	1	19,188.18	4.03	50.13	92.26	3.62	12	0.000034	0.001706	2.00	0.82	0.24	0.12
13BS	1	19,188.18	4.03	192.4	96.29	3.67	12	0.000037	0.007052	2.00	0.85	0.25	0.12
		-	-		-	-	12	-	-	2.00	-	0.00	0.13
		-	-		-	-	12	-	-	2.00	-	0.00	0.14
		-	-		-	-	12	-	-	2.00	-	0.00	0.14
		-	-		-	-	12	-	-	2.00	-	0.00	
Totals	2	38,376.36		242.53					0.008757				

Cell 11													
Node ID	# of Wells	Area (ft^2)	Maximum Flow (scfm)	Length (LF)	Accumulated Flow (scfm)	Required Diameter (in)	Actual Diameter (in)	Actual Pressure Drop/ft	Actual Pressure Drop (in H_2O)	Slope (%) - (Min. Slope used)	Velocity (fps)	Accumulated Condensate Production (gal/min)	Condensate Depth (in)
EFFECTIVE CELL AREA		463,042.80											
11A	1	92,608.56	19.45	50.13	115.74	3.93	12	0.000050	0.002530	2.00	1.02	0.31	0.15
11B	1	92,608.56	19.45	306.58	135.19	4.16	12	0.000066	0.020270	2.00	1.20	0.36	0.15
11C	1	92,608.56	19.45	214.39	154.63	4.37	12	0.000084	0.017907	2.00	1.37	0.41	0.15
11D	1	92,608.56	19.45	396.45	174.08	4.57	12	0.000103	0.040690	2.00	1.54	0.46	0.16
11E	1	92,608.56	19.45	267.64	193.52	4.75	12	0.000123	0.033024	2.00	1.71	0.51	0.16
		-	-		-	-	12	-	-	2.00	-	0.00	0.16
Totals	5	463,042.80		1,235.19					0.114422				

Cell 14													
Node ID	# of Wells	Area (ft^2)	Maximum Flow (scfm)	Length (LF)	Accumulated Flow (scfm)	Required Diameter (in)	Actual Diameter (in)	Actual Pressure Drop/ft	Actual Pressure Drop (in H_2O)	Slope (%) - (Min. Slope used)	Velocity (fps)	Accumulated Condensate Production (gal/min)	Condensate Depth (in)
EFFECTIVE CELL AREA		466,527.60											
14A	1	93,305.52	19.59	179.31	213.12	4.92	12	0.000146	0.026165	2.00	1.88	0.56	0.17
14B	1	93,305.52	19.59	198.74	232.71	5.08	12	0.000170	0.033793	2.00	2.06	0.61	0.17
14C	1	93,305.52	19.59	218.18	252.30	5.23	12	0.000196	0.042699	2.00	2.23	0.67	0.18
14D	1	93,305.52	19.59	237.61	271.89	5.38	12	0.000223	0.052961	2.00	2.40	0.72	0.18
14E	1	93,305.52	19.59	257.05	291.49	5.52	12	0.000252	0.064664	2.00	2.58	0.77	0.18
		-	-		-	-	12	-	-	2.00	-	0.00	
Totals	5	466,527.60		1,090.89					0.220282				

Cell 4

Node ID	# of Wells	Area (ft^2)	Maximum Flow (scfm)	Length (LF)	Accumulated Flow (scfm)	Required Diameter (in)	Actual Diameter (in)	Actual Pressure Drop/ft	Actual Pressure Drop (in H_2O)	Slope (%) - (Min. Slope used)	Velocity (fps)	Accumulated Condensate Production (gal/min)	Condensate Depth (in)
EFFECTIVE CELL AREA		617,245.20											
4A	3	115,733.48	24.30	635.50	315.79	5.68	12	0.000289	0.183756	2.00	2.79	0.83	0.19
4B	4	154,311.30	32.40	697.26	348.19	5.89	12	0.000343	0.238944	2.00	3.08	0.92	0.20
4C	2	77,155.65	16.20	790.92	364.39	5.99	12	0.000371	0.293349	2.00	3.22	0.96	0.20
4D	3	115,733.48	24.30	697.33	388.69	6.13	12	0.000415	0.289370	2.00	3.44	1.03	
4E	4	154,311.30	32.40	836.66	421.09	6.31	12	0.000477	0.399061	2.00	3.72	1.11	
		-	-		-	-	12	-	-	2.00	-	0.00	
Totals	16	617,245.20		3,657.67					1.404479				

Cell 3

Node ID	# of Wells	Area (ft^2)	Maximum Flow (scfm)	Length (LF)	Accumulated Flow (scfm)	Required Diameter (in)	Actual Diameter (in)	Actual Pressure Drop/ft	Actual Pressure Drop (in H_2O)	Slope (%) - (Min. Slope used)	Velocity (fps)	Accumulated Condensate Production (gal/min)	Condensate Depth (in)
EFFECTIVE CELL AREA		634,233.60											
3A	3	90,604.80	19.03	740.41	440.12	6.42	12	0.000515	0.381364	2.00	3.89	1.16	
3B	4	120,806.40	25.37	686.75	465.49	6.55	12	0.000568	0.389933	2.00	4.12	1.23	
3C	3	90,604.80	19.03	647.40	484.51	6.65	12	0.000609	0.394112	2.00	4.28	1.28	
3D	4	120,806.40	25.37	694.56	509.88	6.77	12	0.000665	0.462062	2.00	4.51	1.35	
3E	3	90,604.80	19.03	647.88	528.90	6.87	12	0.000709	0.459362	2.00	4.68	1.40	
3F	4	120,806.40	25.37	609.78	554.27	6.98	12	0.000769	0.469047	2.00	4.90	1.46	
Totals	21	634,233.60		3,417.00	554.27				2.555879				

Cell 2

Node ID	# of Wells	Area (ft^2)	Maximum Flow (scfm)	Length (LF)	Accumulated Flow (scfm)	Required Diameter (in)	Actual Diameter (in)	Actual Pressure Drop/ft	Actual Pressure Drop (in H_2O)	Slope (%) - (Min. Slope used)	Velocity (fps)	Accumulated Condensate Production (gal/min)	Condensate Depth (in)
EFFECTIVE CELL AREA		470,448.00											
2A	3	88,209.00	18.52	723.34	572.79	7.07	12	0.000814	0.589132	2.00	5.06	1.51	
2B	4	117,612.00	24.70	675.28	597.49	7.18	12	0.000876	0.591884	2.00	5.28	1.58	
2C	2	58,806.00	12.35	780.61	609.84	7.23	12	0.000908	0.708985	2.00	5.39	1.61	
2D	3	88,209.00	18.52	904.17	628.36	7.31	12	0.000957	0.865071	2.00	5.56	1.66	
2E	4	117,612.00	24.70	991.07	653.06	7.42	12	0.001023	1.013964	2.00	5.77	1.72	
		-	-		-	-	12	-	-	2.00	-	0.00	
Totals	16	470,448.00		4,074.47	653.06				3.769036				

Cell 1

Node ID	# of Wells	Area (ft^2)	Maximum Flow (scfm)	Length (LF)	Accumulated Flow (scfm)	Required Diameter (in)	Actual Diameter (in)	Actual Pressure Drop/ft	Actual Pressure Drop (in H_2O)	Slope (%) - (Min. Slope used)	Velocity (fps)	Accumulated Condensate Production (gal/min)	Condensate Depth (in)
EFFECTIVE CELL AREA		500,504.40											
1A	5	192,501.69	40.42	1,157.17	693.48	7.58	12	0.001136	1.314242	2.00	6.13	1.83	
1B	5	192,501.69	40.42	878.20	733.90	7.74	12	0.001253	1.100680	2.00	6.49	1.94	
1C	3	115,501.02	24.25	785.38	758.15	7.83	12	0.001326	1.041607	2.00	6.70	2.00	
		-	-		-	-	12	-	-	2.00	-	0.00	
		-	-		-	-	12	-	-	2.00	-	0.00	
		-	-		-	-	12	-	-	2.00	-	0.00	
Totals	13	500,504.40		2,820.75	758.15				3.456529				

Cumulative Total:	86	3,610,586.76		18,637.07	758.15				11.57

JOB	Forty West Landfill, Northern Header	PROJECT NO.:	13813514.00001		
DESCRIPTION	Mueller Equation Calcs. (Cells 10, 9, 13, 12, 8, 5, 6, 7)	COMPUTED BY	KMC	DATE:	29-Jan-10
		CHECKED BY	NSG/JDM	DATE:	18-Jan-10

Total Header Pipe Length (Slope Adjusted)	13,525.02	lineal feet	Node Separation	263.27 feet (max)
Allowable Pressure Drop	0.01		CFM/Node	varies
Pressure Drop Safety Factor	1.50		Pipe Diameter	12.00 inches
Cumulative Pressure Drop	10.69	inches of H_2O	Accumulated Flow	970.54 scfm

Total Landfill Area* 189.00 acres 8,232,632.51 ft^2
Total Gas Generation* 1,728.69 scfm Gas from N Header 970.54 scfm
Flow/ft^2 0.00020998 cfm/ft^2

* Total gas generation is taken from gas generation from entire landfill at closing therefore, it will not equal to flow collected by this portion of the system as calculated below.

Cell 10

Node ID	# of Wells	Area (ft^2)	Maximum Flow (scfm)	Length (LF)	Accumulated Flow (scfm)	Required Diameter (in)	Actual Diameter (in)	Actual Pressure Drop/ft	Actual Pressure Drop (in H_2O)	Slope (%)	Gas Velocity (fps)	Accumulated Condensate Production (gal/min)	Condensate Depth (in)
EFFECTIVE CELL AREA		456,446.51											
10AN	1	76,074.42	15.97	256.11	15.97	1.90	12	0.000002	0.000413	2.00	0.14	0.04	0.04
10BN	1	76,074.42	15.97	324.04	31.95	2.45	12	0.000005	0.001743	2.00	0.28	0.08	0.06
10CN	1	76,074.42	15.97	641.10	47.92	2.84	12	0.000011	0.006982	2.00	0.42	0.13	0.07
10DN	1	76,074.42	15.97	448.87	63.90	3.16	12	0.000018	0.008062	2.00	0.56	0.17	0.08
10EN	1	76,074.42	15.97	363.41	79.87	3.43	12	0.000026	0.009622	2.00	0.71	0.21	0.09
10FN	1	76,074.42	15.97	372.67	95.84	3.67	12	0.000036	0.013548	2.00	0.85	0.25	0.10
					-	-	12	-	-		-	0.00	
					-	-	12	-	-		-	0.00	
Totals	6	456,446.51		2,406.20					0.040369				

Cell 9

Node ID	# of Wells	Area (ft^2)	Maximum Flow (scfm)	Length (LF)	Accumulated Flow (scfm)	Required Diameter (in)	Actual Diameter (in)	Actual Pressure Drop/ft	Actual Pressure Drop (in H_2O)	Slope (%)	Velocity (fps)	Accumulated Condensate Production (gal/min)	Condensate Depth (in)
EFFECTIVE CELL AREA		576,298.80											
9A	1	115,259.76	24.20	581.18	120.05	3.98	12	0.000054	0.031255	2.00	1.06	0.32	0.11
9B	1	115,259.76	24.20	425.49	144.25	4.26	12	0.000074	0.031494	2.00	1.28	0.38	0.12
9C	1	115,259.76	24.20	551.89	168.45	4.51	12	0.000097	0.053498	2.00	1.49	0.44	0.13
9D	1	115,259.76	24.20	429.85	192.65	4.74	12	0.000122	0.052625	2.00	1.70	0.51	0.14
9E	1	115,259.76	24.20		216.86	4.95	12	0.000150	-	2.00	1.92	0.57	
		-	-		-	-	12	-	-	2.00	-	0.00	
						-	12	-	-	2.00	-	0.00	
Totals	5	576,298.80		1,988.41					0.168872				

Cell 13

Node ID	# of Wells	Area (ft²)	Maximum Flow (scfm)	Length (LF)	Accumulated Flow (scfm)	Required Diameter (in)	Actual Diameter (in)	Actual Pressure Drop/ft	Actual Pressure Drop (in H_2O)	Slope (%)	Velocity (fps)	Accumulated Condensate Production (gal/min)	Condensate Depth (in)
EFFECTIVE CELL AREA		729,150.84											
13A	1	243,050.28	51.04	540.65	267.89	5.35	12	0.000217	0.117438	2.00	2.37	0.71	0.15
13B	1	243,050.28	51.04	388.81	318.93	5.70	12	0.000294	0.114377	2.00	2.82	0.84	0.16
13C	1	243,050.28	51.04	528.29	369.96	6.02	12	0.000381	0.201181	2.00	3.27	0.98	0.17
		-	-		-	-	12	-	-	2.00	-	0.00	
		-	-		-	-	12	-	-	2.00	-	0.00	
					-	-	12	-	-	2.00	-	0.00	
Totals	3	729,150.84		1,457.75					0.432995				

Cell 12

Node ID	# of Wells	Area (ft²)	Maximum Flow (scfm)	Length (LF)	Accumulated Flow (scfm)	Required Diameter (in)	Actual Diameter (in)	Actual Pressure Drop/ft	Actual Pressure Drop (in H_2O)	Slope (%)	Velocity (fps)	Accumulated Condensate Production (gal/min)	Condensate Depth (in)
EFFECTIVE CELL AREA		694,346.40											
12A	1	231,448.80	48.60	348.09	418.56	6.30	12	0.000472	0.164296	2.00	3.70	1.11	0.18
12B	1	231,448.80	48.60	568.79	467.16	6.56	12	0.000571	0.324981	2.00	4.13	1.23	0.18
12C	1	231,448.80	48.60	342.53	515.76	6.80	12	0.000679	0.232464	2.00	4.56	1.36	0.19
		-	-		-	-	12	-	-	2.00	-	0.00	
		-	-		-	-	12	-	-	2.00	-	0.00	
		-	-		-	-	12	-	-	2.00	-	0.00	
Totals	3	694,346.40		1,259.41					0.721741				

Cell 8

Node ID	# of Wells	Area (ft²)	Maximum Flow (scfm)	Length (LF)	Accumulated Flow (scfm)	Required Diameter (in)	Actual Diameter (in)	Actual Pressure Drop/ft	Actual Pressure Drop (in H_2O)	Slope (%)	Velocity (fps)	Accumulated Condensate Production (gal/min)	Condensate Depth (in)
EFFECTIVE CELL AREA		723,096.00											
8A	1	180,774.00	37.96	446.19	553.72	6.98	12	0.000768	0.342621	2.00	4.90	1.46	0.20
8B	1	180,774.00	37.96	338.83	591.68	7.15	12	0.000862	0.291981	2.00	5.23	1.56	0.20
8C	1	180,774.00	37.96	397.85	629.64	7.32	12	0.000960	0.381995	2.00	5.57	1.66	0.20
8D	1	180,774.00	37.96	298.83	667.60	7.48	12	0.001063	0.317671	2.00	5.90	1.76	0.21
		-	-		-	-	12	-	-	2.00	-	0.00	
		-	-		-	-	12	-	-	2.00	-	0.00	
Totals	4	723,096.00		1,481.70					1.334268				

Cell 5												
Node ID	# of Wells	Area (ft^2)	Maximum Flow (scfm)	Length (LF)	Accumulated Flow (scfm)	Required Diameter (in)	Actual Diameter (in)	Actual Pressure Drop/ft	Actual Pressure Drop (in H_2O)	Slope (%)	Velocity (fps)	Accumulated Condensate Production (gal/min)	Condensate Depth (in)
EFFECTIVE CELL AREA		607,226.40											
5A	1	121,445.28	25.50	355.56	693.10	7.58	12	0.001134	0.403440	2.00	6.13	1.83	0.21
5B	1	121,445.28	25.50	229.92	718.60	7.68	12	0.001208	0.277801	2.00	6.35	1.90	0.21
5C	1	121,445.28	25.50	407.88	744.10	7.78	12	0.001284	0.523634	2.00	6.58	1.97	0.22
5D	1	121,445.28	25.50	334.32	769.60	7.88	12	0.001361	0.455102	2.00	6.80	2.03	0.22
5E	1	121,445.28	25.50	289.68	795.10	7.97	12	0.001440	0.417336	2.00	7.03	2.10	0.22
		-	-		-	-	12	-	-	2.00	-	0.00	
Totals	5	607,226.40		1,617.36					2.077313				

Cell 6													
Node ID	# of Wells	Area (ft^2)	Maximum Flow (scfm)	Length (LF)	Accumulated Flow (scfm)	Required Diameter (in)	Actual Diameter (in)	Actual Pressure Drop/ft	Actual Pressure Drop (in H_2O)	Slope (%)	Velocity (fps)	Accumulated Condensate Production (gal/min)	Condensate Depth (in)
EFFECTIVE CELL AREA		474,368.40											
6A	1	94,873.68	19.92	400.20	815.02	8.05	12	0.001504	0.601916	2.00	7.21	2.15	0.23
6B	1	94,873.68	19.92	259.48	834.95	8.12	12	0.001568	0.407007	2.00	7.38	2.21	0.23
6C	1	94,873.68	19.92	350.55	854.87	8.19	12	0.001634	0.572872	2.00	7.56	2.26	0.23
6D	1	94,873.68	19.92	241.22	874.79	8.26	12	0.001701	0.410318	2.00	7.73	2.31	0.23
6E	1	94,873.68	19.92	369.39	894.71	8.33	12	0.001769	0.653431	2.00	7.91	2.36	0.24
		-	-		-	-	12	-	-	2.00	-	0.00	
Totals	5	474,368.40		1,620.84					2.645544				

Cell 7													
Node ID	# of Wells	Area (ft^2)	Maximum Flow (scfm)	Length (LF)	Accumulated Flow (scfm)	Required Diameter (in)	Actual Diameter (in)	Actual Pressure Drop/ft	Actual Pressure Drop (in H_2O)	Slope (%)	Velocity (fps)	Accumulated Condensate Production (gal/min)	Condensate Depth (in)
EFFECTIVE CELL AREA		361,112.40											
7A	1	90,278.10	18.96	290.68	913.67	8.39	12	0.001834	0.533292	2.00	8.08	2.41	0.24
7B	1	90,278.10	18.96	664.87	932.62	8.45	12	0.001901	1.264145	2.00	8.25	2.46	0.24
7C	1	90,278.10	18.96	368.48	951.58	8.52	12	0.001969	0.725559	2.00	8.41	2.51	0.24
7D	1	90,278.10	18.96	366.62	970.54	8.58	12	0.002037	0.747090	2.00	8.58	2.56	0.24
		-	-		-	-	12	-	-				
		-	-		-	-	12	-	-				
Totals	4	361,112.40		1,690.65					3.270087				

Cumulative Total:	35	4,622,045.75	970.54	13,522.32	970.54				10.69

JOB	**Forty West Landfill, Worst Case Lateral**	PROJECT NO.:	13813514.00001		
DESCRIPTION	**Mueller Equation Calcs. (PIPE TO FLARE STATION)**	COMPUTED BY	KMC	DATE:	29-Jan-10
		CHECKED BY	NSG/JDM	DATE:	

The worst case lateral calculation is intended to ensure that the dimensions specified for the entire system is properly sized to accommodate the losses from the farthest well from the blower.

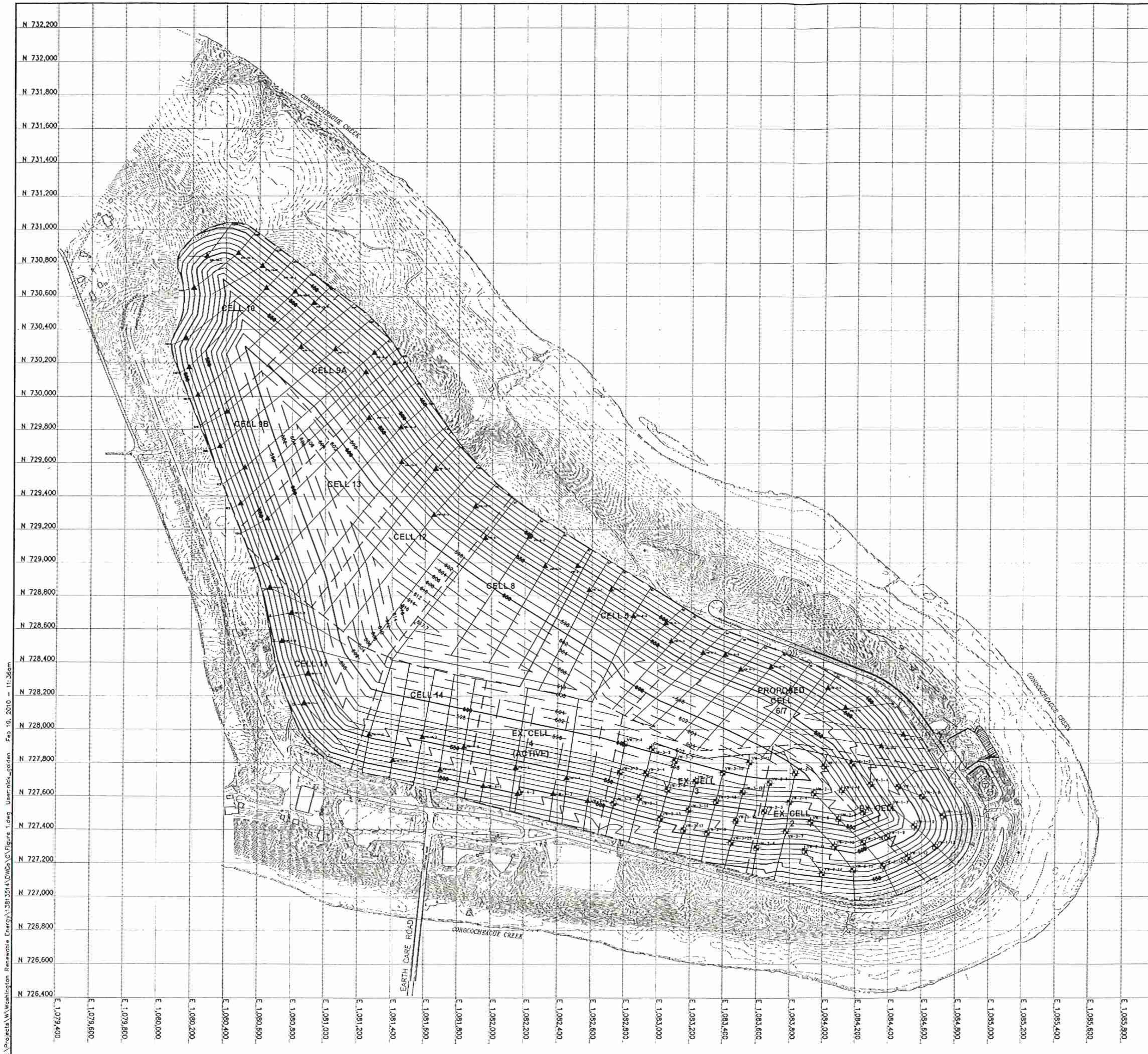
SUMMARY OF RESULTS FOR PIPE TO FLARE STATION

Allowable Pressure Drop	**0.01**	
Pressure Drop Safety Factor	**1.50**	

Total Landfill Area*	188.99 acres	8,232,404.40 ft^2	Gas from N Header	970.54 scfm
Total Gas Generation	1,728.69 scfm**		Gas from S Header	758.15 scfm
Flow/ft^2	0.000209986 cfm/ft^2		Total Gas Collected	1,728.69 scfm

Pipe to Flare Station													
Node ID	# of Wells	Area (ft^2)	Maximum Flow (scfm)	Length (LF)	Accumulated Flow (scfm)	Required Diameter (in)	Actual Diameter (in)	Max Actual Pressure Drop/ft	Actual Pressure Drop (in H_2O)	Slope (%)	Gas Velocity (fps)	Accumulated Condensate Production (gal/min)	Condensate Depth (in)
Pipe to Flare	n/a	n/a	n/a	311.12	1,728.69	10.60	15	0.001931	0.601890	6.00	9.78	4.57	

Figure 1



250 125 0 250 500

GRAPHIC SCALE IN FEET

GENERAL NOTES:

1. EXISTING TOPOGRAPHY IS BASED UPON AERIAL PHOTOGRAMMETRY PROVIDED BY AERO-METRIC (JANUARY 2009).
2. GRID IS BASED ON MARYLAND STATE PLANE COORDINATE SYSTEM, NAD 1983. VERTICAL DATUM IS NAVD 1988.
3. THE FORTY WEST LANDFILL IS AN ACTIVE LANDFILL. THE CONTRACTOR AND ALL SUBCONTRACTORS SHALL FOLLOW ALL POSTED SPEED LIMITS AND SHALL PROVIDE A SAFE ENVIRONMENT FOR SOLID WASTE PERSONNEL, GENERAL PUBLIC AND EMPLOYEES.

BAR IS ONE-INCH ON ORIGINAL DRAWING

0 ½ 1

IF NOT ONE-INCH, THEN ADJUST SCALES ACCORDINGLY

URS

ISSUED FOR BIDDING — DATE — BY

ADDENDUM REVISIONS

ADDENDUM NO	ADDENDUM DATE	BY

ISSUED FOR CONSTRUCTION — DATE — BY

CONSTRUCTION REVISIONS

NO.	DESCRIPTION	DATE	BY

RECORD DRAWINGS — DATE — BY

DRAWN BY: KMC	DATE: 02-19-10
CHECKED BY: NSG	PROJECT #: 13813514
APPROVED BY: JDM	SCALE: AS SHOWN

GRAPHIC SCALE

WASHINGTON RENEWABLE ENERGY, LLC
LANDFILL GAS COLLECTION SYSTEM DESIGN
FOR EXISTING CELLS 1-4

PROPOSED LANDFILL GAS COLLECTION SYSTEM CALCULATIONS

Figure 1

K:\Projects\W\Washington Renewable Energy\13813514\DWGs\C\Figure 1.dwg User:nick_golden Feb 19, 2010 - 11:36am

Stage 1 Gas Well Schedule

URS

WELL/FLARE ID:	LOCATION OF WELL (CELL NUMBER)	COORDIN		LID PIPE NGTH (FT.)	SCREEN LENGTH (FT.)
		NORTHING			
GAS EXTRACTION WELLS					
VW-1-1	CELL 1	727778.56	1	10	20
VW-1-3	CELL 1	727636.01	1	10	32
VW-1-4	CELL 1	727672.01	1	10	18
VW-1-5	CELL 1	727720.00	1	10	14
VW-1-6	CELL 1	727505.05	1	10	31
VW-1-7	CELL 1	727538.93	1	10	35
VW-1-8	CELL 1	727597.18	1	10	31
VW-1-9	CELL 1	727358.05	1	10	40
VW-1-10	CELL 1	727422.24	1	10	44
VW-1-11	CELL 1	727481.79	1	10	21
VW-1-12	CELL 1	727236.18	1	10	38
VW-1-13	CELL 1	727298.24	1	10	26
VW-2-1	CELL 2	727678.73	1	10	38
VW-2-2	CELL 2	727736.71	1	10	34
VW-2-3	CELL 2	727508.50	1	10	45
VW-2-4	CELL 2	727562.46	1	10	44
VW-2-5	CELL 2	727617.23	1	10	38
VW-2-6	CELL 2	727334.00	1	10	25
VW-2-7	CELL 2	727388.96	1	10	51
VW-2-8	CELL 2	727445.46	1	10	38
VW-2-9	CELL 2	727463.73	1	10	28
VW-2-11	CELL 2	727272.96	1	10	35
VW-2-12	CELL 2	727300.46	1	10	34
VW-2-13	CELL 2	727322.89	1	10	32
VW-2-14	CELL 2	727137.96	1	10	10
VW-2-15	CELL 2	727158.96	1	10	24
VW-2-16	CELL 2	727182.96	1	10	32
VW-3-2	CELL 3	727923.67	1	10	18
VW-3-4	CELL 3	727750.91	1	10	24
VW-3-5	CELL 3	727810.00	1	10	23
VW-3-8	CELL 3	727638.00	1	10	23
VW-3-9	CELL 3	727689.00	1	10	27
VW-3-10	CELL 3	727741.50	1	10	31
VW-3-11	CELL 3	727802.71	1	10	12
VW-3-13	CELL 3	727469.00	1	10	16
VW-3-14	CELL 3	727517.50	1	10	32
VW-3-15	CELL 3	727570.50	1	10	33
VW-3-16	CELL 3	727623.80	1	10	35
VW-3-17	CELL 3	727348.24	1	10	15
VW-3-18	CELL 3	727396.50	1	10	22
VW-3-19	CELL 3	727452.80	1	10	40
VW-3-20	CELL 3	727278.80	1	10	22

Note:
1. BASED ON TOP OF FINAL GRADE OF WASTE.
2. BASED ON AS-BUILT TOPO OF TOP OF LCS PROVIDED
3. EXTENDED OR NESTED WELLS TO BE INSTALLED UPO