Preliminary Engineering Evaluation

for

BAAQMD PERMIT APPLICATION # 24495

Proposed Project:
New 7.9 MW Landfill Gas to Energy Plant
Including: a Landfill Gas Treatment System and
Four Landfill Gas Fired Lean Burn IC Engines Controlled by
Oxidation Catalysts and Selective Catalytic Reduction Systems,

BAAQMD PLANT # 1179 / SITE # A1179

Applicant: Redwood Landfill, Inc.
Location: Redwood Landfill, Novato, CA

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

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A. BACKGROUND

Redwood Landfill, Inc., a Waste Management company, operates the Redwood Landfill Facility in Novato, CA (Plant # 1179 / Site # A1179). This facility includes an active MSW landfill, dry waste material recovery operations, soil stockpiles, a sludge pond, composting and green waste processing operations, an aerated leachate pond, a non-retail gasoline dispensing facility, diesel engines that provide portable or standby power, and two enclosed landfill gas flares. Trucks with water sprays control the dust generated by landfill activities, composting operations, green waste processing sources, dry waste material recovery operations, and soil stockpiles.

Redwood Landfill submitted this application in May 2012 to request an Authority to Construct and Permit to Operate for a proposed new 9.6 MW landfill gas to energy facility consisting of six lean-burn engines (2233 bhp each). On July 25, 2013, Redwood Landfill requested to modify this application by using newer and more efficient engines (same make and model). The revised energy plant proposal is a 7.9 MW facility. The major components of this energy plant will include: a regenerative landfill gas treatment system, four lean-burn internal combustion engines (Caterpillar G3520C, 2739 bhp each), and four generators (nominal 1.966 MW each). Each engine will be equipped with an oxidation catalyst to control carbon monoxide (CO), precursor organic compounds (POC), and formaldehyde emissions from the engines, and each engine will be equipped with a selective catalytic reduction (SCR) system to control nitrogen oxide (NO_x) emissions.

For landfills and landfill gas fired energy plants, the prevention of significant deterioration (PSD) thresholds are 250 tons/year for criteria pollutants and 100,000 tons/year of carbon dioxide equivalent (CO_2e) emissions for greenhouse gases (GHG). For both criteria pollutants and GHG, fugitive emissions are excluded when determining PSD applicability, because landfills and landfill gas energy plants are not in one of the specific source categories for which fugitive emissions must be included.

The applicant is voluntarily accepting facility-wide emission limits that will ensure that this site is not a PSD major facility for criteria air pollutants. In particular, this site will be subject to an emission limit of: 237.5 tons/year of carbon monoxide (CO) for all landfill gas fired combustion equipment. The site will also meet an emission limit of: 99.0 tons/year of sulfur dioxide (SO_2) for all landfill gas fired combustion equipment to ensure that this facility does not trigger District SO_2 offset requirements.

In accordance with EPA's July 20, 2011 adoption of regulatory amendments to the PSD and Title V applicability criteria for greenhouse gas (GHG) emissions from bioenergy and biogenic sources, bioenergy sites with more than 100,000 tons/year of CO_2e emissions have been deferred from the PSD and Title V programs until July 1, 2014. Although the U.S. Court of Appeals adopted an order to vacate EPA's biogenic GHG deferral amendments[1], the Court has not - as of October 7, 2013 - issued the mandate that would make the Court's decision effective. As discussed in more detail in the Statement of Compliance Section below, the District has concluded that this facility will not be a new major facility of greenhouse gas emissions at this time, because non-fugitive non-biogenic GHG emissions will be less than 100,000 tons/year of CO_2e after this proposed project is installed.

Gas Treatment System and Desorption Process:

The landfill gas treatment system uses chillers, filters, and compressors to remove water and particulate matter from the collected landfill gas and to meet inlet gas condition requirements for the engines. The gas treatment system will treat up to 2900 scfm of landfill gas (4,176,000 scf/day) or about 1524 MM scf/year of landfill gas. The specific parameters of the gas treatment system are still under design. Redwood Landfill will provide additional data at least 30 days prior to initial operation.

At this time, the landfill gas treatment system is expected to contain a carbon adsorption step that will remove siloxane, organic, and sulfur compounds from the landfill gas prior to combustion in the engines, to ensure proper operation of the catalytic emission control systems. This carbon adsorption media will be regenerated on a routine basis by a desorption cycle (S-71) that involves heating the carbon and flushing it with a neutral gas. The type of flush gas and the flow rate for this flush gas are not known at this time.

The desorption cycle waste gas stream will contain siloxanes, precursor organic compounds (POC), non-precursor organic compounds (NPOC), total reduced sulfur compounds (TRS), and toxic air contaminants (TAC). This waste gas stream will be blended with landfill gas and controlled by one of the existing enclosed landfill gas flares (A-51 or A-60). The blend ratios of waste gas and landfill gas are not known at this time, but sufficient landfill gas will be added to maintain the current minimum combustion zone temperature of 1400 °F. The maximum hourly emissions from this desorption cycle are also unknown at this time. With Redwood Landfill's concurrence, the District estimated maximum hourly emission rates from S-71 based on Redwood Landfill's landfill gas composition and source test data for Ameresco's gas treatment systems located at their Keller Canyon and Ox Mountain facilities (Plant # 17667 and Plant # 17040).

Landfill Gas Fired Internal Combustion Engines:

The proposed landfill gas to energy plant will include four 2739 bhp lean-burn internal combustion engines (S-64, S-65, S-66, and S-67). These engines will be fired on treated landfill gas (about 725 cfm per engine). The combustion of treated landfill gas produces: nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter (PM_{10} and $PM_{2.5}$), precursor organic compounds (POC), non-precursor organic compounds (NPOC), greenhouse gases (carbon dioxide, methane, and nitrous oxide), and secondary toxic air contaminants (TACs) including formaldehyde, acid gases, naphthalene, and PAHs. Carbon monoxide and organic compound emissions will be controlled by oxidation catalysts: A-64, A-65, A-66, and A-67. Nitrogen oxide emissions will be controlled by SCR systems: A-74, A-75, A-76, and A-77. The SCR emission control process results in secondary emissions of ammonia (NH_3, a TAC).

[1] On July 12, 2013, the United States Court of Appeals, DC Circuit, adopted an order to vacate EPA's July 20, 2011 Biogenic GHG Deferral amendments (see Case No. 11-1101). Subsequently on August 26, 2013, the U.S. Court of Appeals granted an extension of the deadline for rehearing petitions in this case. The petitions are now due 30 days after the Supreme Court's decision regarding Case No. 12-1146 Utility Air Regulatory Group v. EPA.

B. EMISSIONS

Since Application # 24495 will involve the shifting of landfill gas combustion from existing permitted equipment to new permitted equipment as well as facility wide emission limits, it is important to understand the current underlying limits on landfill gas generation and landfill gas combustion at this site. The District recently reviewed and approved a modification of the S-5 Redwood Landfill pursuant to Application # 20607. From the Engineering Evaluation Report for Application # 20607, the District determined that the peak landfill gas generation rate for the landfill (after modification) would be 4995 scfm of landfill gas (based on landfill gas containing 50% methane and 50% carbon dioxide). Currently, all of this landfill gas is controlled by the two existing landfill gas flares (A-51 and A-60). When operating individually, each flare is permitted to operate at its maximum capacity of 90 MM BTU/hour (3000 scfm of landfill gas). However, A-51 and A-60 have permit limits on the combined throughput of landfill gas of 2207.52 MM scf/year of landfill gas, which is equivalent to an annual average heat input rate of 126 MM BTU/hour and a combined average flow rate of 4200 scfm. Based on this limit, the flares are capable of handling 84% of the landfill gas that could be generated by the landfill. Currently, the flares are collecting and controlling an average of 2780 scfm of landfill gas.

As discussed in the Background Section, the proposed energy plant (Application #24495) involves installation of four lean-burn internal combustion engines that will be fueled on treated landfill gas. Each engine has the capacity to burn about 725 scfm of landfill gas or about 2900 scfm of landfill gas for all four engines combined. The current gas collection rate is sufficient to fuel the four proposed engines at 96% operating capacity. The proposed engines are capable of handling 58% of the peak landfill gas generation rate. When the engines are all running at full capacity, an additional 2095 scfm of landfill gas will need to be controlled by flaring. Either existing flare (A-51 or A-60) has the capacity to control about 3000 scfm of landfill gas, and each flare has sufficient capacity to control all of this excess landfill gas that will exceed the capacity of the proposed energy plant.

The combined landfill gas control capacity of the two flares (4200 scfm) and the four engines (2900 scfm) is 7100 scfm of landfill gas, which is 42% greater than the projected peak gas generation of 4995 scfm. Thus, the engines and the flares will not ever be concurrently running at maximum capacity. If 100% of the generated landfill gas is collected and burned, two possible operating scenarios for the landfill gas combustion devices are:

(A) Burn all of the gas in the flares (up to 4995 scfm) with no engines operating and no combustion of gas treatment system waste gas at the flares.

(B) Run the engines at full capacity (up to 2900 scfm of treated landfill gas), run the gas treatment system at full capacity, mix the remainder of the landfill gas (about 2095 scfm) with gas treatment system waste gas, and burn this gas mixture in the flares;

Emission limits for the proposed engines will be discussed in more detail below, but a comparison of the proposed emission limits for the engines and the current emission limits for the flares indicates that the engines will have higher emissions of CO, POC, NPOC, $PM_{10}/PM_{2.5}$, and non-biogenic greenhouse gases (non-bio GHG) primarily due to methane (CH_4), while the flares will have higher emissions of NO_x and SO_2. As a result, operating Scenario A above will result in the highest project emissions for NO_x and SO_2. Operating Scenario B above will result in the highest project emissions for CO, POC, NPOC, $PM_{10}/PM_{2.5}$, and GHG. Potential to emit calculations will need to consider both of these possible operating scenarios in order to determine the worst case project emissions and worst-case project emission increases for each pollutant.

Maximum Project Emissions for Scenario A:

For Scenario A, project emissions are based on the two existing flares (A-51 and A-60) burning a combined total of 4995 scfm of landfill gas (the current maximum permitted gas generation rate for the landfill) with no landfill gas throughput at the engines. This scenario requires a throughput increase at A-51 and A-60. Due to a potentially high variability in the sulfur content of the desorption cycle waste gas, the A-51 and A-60 flares will also require increases in the maximum hourly sulfur dioxide emission rate. Redwood Landfill has proposed to accept a limit of 99.0 tons/year of SO_2 for the combined emissions from the flares and IC engines to ensure that the Regulation 2-2-302 sulfur dioxide offsets requirements are not triggered for this project. Based on the average measured sulfur content of the landfill gas during the last three years (412 ppmv of TRS in LFG), burning 4995 scfm of landfill gas will result in about 90 tons/year of SO_2. Therefore, the District expects that Redwood Landfill should be able to demonstrate compliance with an annual limit of 99.0 tons of SO_2.

For Scenario A, the proposed and current emissions for A-51 and A-60 are presented in Table B-1. The emission increases for Scenario A are also presented in Table B-1. Scenario A will result in an increase in permitted emission levels for all pollutants. In accordance with District cumulative emission increase calculation procedures (see Regulations 2-2-604.2 and 2-2-605.1-605.3), cumulative emission increases for the flares should be determined based on the Potential – Actual calculation method, because the facility has not provided offsets for any of the flare emissions.

Table B-1 Project Emissions and Increases for Scenario A

	Proposed Project Emissions	Current Permitted Emissions	Increase in Permitted Emissions	Current Actual Emissions	Cumulative Emission Increases
	tons/year	tons/year	tons/year	tons/year	tons/year
CO	130.466	110.376	20.090	21.576	108.890
NO_x	39.138	33.113	6.027	17.669	21.469
POC	9.119	7.716	1.404	6.878	2.243
SO_2	99.000	64.338	30.662	49.486	49.514
$PM_{10}/PM_{2.5}$	11.157	9.440	1.718	6.242	4.915
GHG (non-bio) as CO_2 equiv.	5820.7	4924.6	896.3	3256.4	2564.6
Total GHG as CO_2 equiv.	154,344	130,583	23,761	86,348	67,997

Maximum Project Emissions for Scenario B:

For Scenario B, project emissions were calculated by assuming the landfill is generating gas at the maximum rate (4995 scfm of landfill gas), the proposed engines are operating at maximum capacity (2899 scfm), and the remainder of the landfill gas (2096 scfm) is burned in one of the two existing flares (A-51 or A-60). Since the engines are new sources, the baseline throughput rate is zero and all emissions are also emission increases. Engine emissions are summarized in Table B-2.

Table B-2 Emissions and Increases for the Proposed LFG-Fired Engines

	Emissions per Engine	Total for 4 Engines	Baseline Emissions	Engine Emission Increases
	tons/year	tons/year	tons/year	tons/year
CO	47.607	190.429	0	190.429
NO_x	3.967	15.869	0	15.869
POC	4.232	16.927	0	16.927
SO_2	4.729	18.918	0	18.918
$PM_{10}/PM_{2.5}$	2.645	10.579	0	10.579
GHG (non-bio) as CO_2 equiv.	8,435	33,740	0	33,740
Total GHG as CO_2 equiv.	28,655	114,620	0	114,620

For the flares, the District is proposing to modify the SO_2 emission limit because the waste gas stream is expected to have a higher concentration of sulfur in it than the current untreated landfill gas steam. Current SO_2 emission limits for the flares were based on landfill gas sulfur contents of 600 ppmv (max) and 350 ppmv (annual average). These sulfur contents equate to outlet concentrations of 125 ppmv (max) and 73 ppmv (annual average) of SO_2 at 0% O_2. The current SO_2 emission limits for each flare are: 17.99 pounds/hour, 431.7 pounds/day, 45.956 tons/year. The current SO_2 emission limit for the two flares combined is: 64.338 tons/year.

The landfill gas treatment process will remove much of the sulfur from the landfill gas and concentrate it into the waste gas stream from the carbon desorption process. The flares are subject to Regulation 9-1-302, which limits sulfur dioxide concentration in any exhaust point to 300 ppmv of SO_2. This regulation does not specify an oxygen concentration at which the 300 ppmv limit applies. To determine worst case hourly and daily emissions allowed by this limit, the District as assumed that the maximum outlet oxygen concentration will be 15% O_2 (typically the flares have 10%-12% O_2 in the stack exhaust). The equivalent limits are: 300 ppmv of SO_2 at 15% O_2, 1063 ppmv SO_2 at 0% O_2, and 1.6938 pounds SO_2/MM BTU. For either A-51 or A-60 operating at 90 MM BTU/hour for up to 24 hours/day, the new maximum permitted SO_2 emission rates will be: 152.4 pounds/hour and 3659 pounds/day.

If this new daily emission rate were to continue for 365 days/year, SO_2 emissions from one flare would be 668 tons/year, and the site would trigger PSD. But this emission rate limit would vastly overstate the expected SO_2 emissions due to landfill gas combustion. At the current average landfill gas sulfur content of 412 ppmv of total reduced sulfur (expressed as H_2S) and the maximum projected landfill gas generation rate of 4995 scfm of landfill gas, annual average emissions would be 89.6 tons/year of SO_2. To ensure that SO_2 emissions are not overestimated and to prevent triggering the Regulation 2-2-303 SO_2 offset requirement, the District is proposing to limit the SO_2 emissions from the engines and the flares combined to 99.0 tons/year (with about 20% of the SO_2 emissions expected to come from the engines and about 80% of the SO_2 emissions expected to come from the flares).[2]

The proposed emission rates from a flare operating under Scenario B (burning 2096 scf of landfill gas mixed with an as yet unknown amount of waste gas) are compared to the current permitted emission levels for the flares in Table B-3. For all pollutants except SO_2, the emissions for Scenario B do not exceed the current maximum permitted emission levels for the flares.

[2] The other sources of SO_2 at this site currently have a maximum permitted emission rate of only 0.3 tons/year of SO_2.

Therefore, Scenario B will only result in SO_2 emission increases, and SO_2 emission increases must be calculated by comparing the proposed emission level to the actual emission level pursuant to Regulations 2-2-604.2 and 2-2-605.1-605.3.

Table B-3 Flare Emissions and Increases for Scenario B (Flares Burning 2096 scfm of LFG)

	Proposed Project Emissions	Current Permitted Emissions	Current Actual Emissions	Increase in Permitted Emissions	Increase in Actual Emissions
	tons/year	tons/year	tons/year	tons/year	tons/year
CO	54.745	110.376	21.576	none	
NO_x	16.423	33.113	17.669	none	
POC	3.827	7.716	6.878	none	
SO_2	80.082	64.338	49.486	15.744	30.596
$PM_{10}/PM_{2.5}$	4.682	9.440	6.242	none	
GHG (non-bio) as CO_2 equiv.	2442.5	4924.6	3256.4	none	
Total GHG as CO_2 equiv.	64,767	130,583	86,348	none	

At the applicant's proposed CO emission limit of 1.8 grams/bhp-hr per engine, the total CO emissions from the four engines combined would be 190.4 tons/year. When the flares are burning the remaining amount of landfill gas, flare emissions would be 54.7 tons/year of CO. This facility also has portable and emergency standby diesel engines that currently have limits totaling 2.44 tons/year of CO. Thus, total site-wide CO emissions would be: (190.4+54.7+2.4) = 248 tons/year of CO, which is close to the PSD threshold level of 250 tons/year. To ensure that PSD would not be triggered in the event that additional sources are added in the future, the applicant has agreed to limit the CO emissions from the flares and engines combined to 237.5 tons/year. In this case, site-wide PTE is less than 240 tons/year of CO. The proposed CO limit is reflected below in Table B-4.

The maximum emission rates for the engines and flares combined and the combined emission increases for Scenario B are shown in Table B-4.

Table B-4 Combined Project Emissions and Emission Increases for Scenario B

	Engine Emission Limits	Flare Emission Limits	Scenario B Emission Limits	Engine Emission Increases	Flare Emission Increases	Scenario B Emission Increases
	tons/year	tons/year	tons/year	tons/year	tons/year	tons/year
CO	237.500		237.500	190.429		190.429
NO_x	15.869	16.423	32.291	15.869		15.869
POC	16.927	3.827	20.752	16.927		16.927
SO_2	99.000		99.000	18.918	30.596	49.514
$PM_{10}/PM_{2.5}$	10.579	4.682	15.260	10.579		10.579
GHG (non-bio) as CO_2 equiv.	33,740	2,443	36,182	33,740		33,740
Total GHG as CO_2 equiv.	114,620	64,767	179,387	114,620		114,620

Maximum Project Emissions and Maximum Project Emission Increases:

The District compared the limits for Scenario A and Scenario B above to determine the maximum project emission limits. For each pollutant, actual project emission increases are calculated by comparing the maximum project emission limit to the current actual flare emissions.

Table B-5 Maximum Project Emissions and Actual Project Emission Increases

	Scenario A Emission Limits	Scenario B Emission Limits	Maximum Project Emission Limits	Current Actual Flare Emissions	Actual Project Emission Increases
	tons/year	tons/year	tons/year	tons/year	tons/year
CO	130.466	237.500	237.500	21.576	215.924
NO_x *	39.138	32.291	39.138	17.669	21.469
POC	9.119	20.752	20.752	6.878	13.875
SO_2	99.000	99.000	99.000	49.486	49.514
$PM_{10}/PM_{2.5}$	11.157	15.260	15.260	6.242	9.019
GHG (non-bio) as CO_2e	5,821	36,182	36,182	3256.4	32,926
Total GHG as CO_2e	154,344	179,387	179,387	86,348	93,039

* Note that Scenario A results in higher NO_x emissions than Scenario B. For all other pollutants, Scenario B results in the highest project emissions.

The cumulative emission increases for each of the above scenarios are compared below. The maximum project cumulative emission increases are the highest of the cumulative emission increases for any particular scenario.

Table B-6 Maximum Project Emission Increases

	Scenario A Emission Increases	Scenario B Emission Increases	Actual Project Emission Increases	Max. Project Emission Increases
	tons/year	tons/year	tons/year	tons/year
CO	108.890	190.429	215.924	215.924
NO_x	21.469	15.869	21.469	21.469
POC	2.243	16.927	13.875	16.927
SO_2	49.514	49.514	49.514	49.514
$PM_{10}/PM_{2.5}$	4.915	10.579	9.019	10.579
GHG (non-bio) as CO_2e	2,565	33,740	32,926	33,740
Total GHG as CO_2e	67,997	114,620	93,039	114,620

Criteria Pollutant Emissions from LFG-Fired Engines:

The operating assumptions for the proposed new lean-burn landfill gas fired internal combustion engines are presented below. The basis for each of the criteria pollutant emission factors is presented in Table B-7. Equivalent emission factors and outlet concentrations are presented in Table B-8.

Each landfill gas fired engine is assumed to operate for 24 hours per day and 365 days per year (8760 hours/year). All maximum daily criteria pollutant emission limits for these engines were based on these operating rates and the emission factors noted below. As discussed previously, maximum annual CO emissions are based on the combined emission limit of 237.5 tons/year for the engines and flares combined to ensure that PSD is not applicable. Maximum annual SO_2 emissions are based on the combined emission limit of 99.0 tons/year for the engines and flares to prevent triggering SO_2 offsets. For all other pollutants, maximum annual emissions are based on the operating rate of 8760 hours/year.

Table B-7 Engines: Basis for Criteria Pollutant Emission Factors and Daily Emissions

Basis for Emission Factor	Pollutant	Limit	Units	Pounds/Day Per Engine
Applicant's Proposed Limit and BACT(2): Permit Condition Limit with Control by Oxidation Catalyst	CO	1.8	g/bhp-hr	260.9
Applicant's Proposed Limit and BACT(2): Permit Condition Limit with Control by SCR System	NO_x	0.15	g/bhp-hr	21.74
BACT(2): Permit Condition Limit with Control by Oxidation Catalyst	POC	0.16	g/bhp-hr	23.19
BACT(2): Permit Condition Limit for Treated LFG	SO_2	150	ppmv of total sulfur (as H_2S) in LFG	25.92
Applicant's Proposed Limit and BACT(2): Manufacturer Guarantee	PM_{10}	0.1	g/bhp-hr	14.49
BACT(2): same as PM_{10}	$PM_{2.5}$	0.1	g/bhp-hr	14.49
Cumulative Increase: BAAQMD Calculation	NPOC	5%	of POC emission rate	1.16

Table B-8 Equivalent Emission Factors and Outlet Concentration Limits for the Engines

Pollutant	grams / bhp-hour	pounds / hour	pounds / MM BTU	pounds / M scf LFG	ppmv @ 0% O_2	ppmv @ 3% O_2	ppmv @ 15% O_2	grains/sdcf @ 0% O_2
CO	1.800	8.861	0.4973	0.2471	722	618	204	
NO_x	0.150	0.738	0.0414	0.0206	37	31	10	
POC	0.160	0.788	0.0442	0.0220	112	96	32	
SO_2	0.181	0.899	0.0500	0.0248	31	27	9	
PM_{10}	0.100	0.492	0.0276	0.0137				0.020
$PM_{2.5}$	0.100	0.492	0.0276	0.0137				0.020
NPOC	0.008	0.039	0.0022	0.0011	6	5	2	

GHG Emissions:

Landfill gas contains greenhouse gases: approximately 50% methane (CH_4), 50% carbon dioxide (CO_2), and 0.001% nitrous oxide (N_2O). During the combustion of landfill gas, methane is converted to CO_2 and nitrous oxide is converted to NO_2. Since the CO_2 that is present in landfill gas and the CO_2 produced during combustion of landfill gas are both derived from the decomposition of organic waste materials (primarily vegetable matter), this CO_2 is considered to be biogenic CO_2. Biogenic CO_2 emission rates from the engines were calculated using standard BAAQMD emission factors for these types of landfill gas combustion operations.

Non-biogenic greenhouse gas emissions include the residual methane and residual nitrous oxide that is left over after combustion. Residual methane emission from the engines and the flare were calculated using emission factors derived from CARB's Landfill Methane Control Measure. This rule limits outlet methane emissions resulting from the combustion of landfill gas in lean-burn IC engines to 3000 ppmv at 15% O_2, dry basis per H&SC Section 95464(b)(3)(A)(1). Residual nitrous oxide emissions were determined based on a 75% conversion rate due to combustion by the engines. The SCR systems for the engines are expected to achieve an additional 75% conversion of N_2O to NO_2.

The greenhouse gas emission factors are presented below.

Table B-9 Greenhouse Gas Emission Factors

Basis for Emission Factor	Pollutant	From Engines Pounds / M scf of LFG	From Engines Pounds / MM BTU
BAAQMD Standard Emission Factors	CO_2	106.16	213.6
CARB Landfill Methane Control Measure Limit	CH_4	2.108	4.24
BAAQMD Calculations	N_20	7.1E-5	1.4E-4

The emissions of methane and nitrous oxide are converted to a carbon dioxide equivalent emission rate using the global warming potentials of 21 for methane and 310 for nitrous oxide.

Toxic Air Contaminant Emissions:

The engines will burn gases that contain numerous toxic organic compounds and several toxic inorganic compounds. Site-specific landfill gas analyses and default AP-42 landfill gas concentration data were used to determine a maximum expected landfill gas concentration for each TAC. This data is presented in Appendix A.

The gas treatment system is expected to remove a large percentage of the TACs from landfill gas before it is burned in the engines. The District assumed that 100% of the organic TACs and hydrogen sulfide (H_2S) that would be present due to the landfill gas fuel requirement for this site would be adsorbed by the treatment process and then desorbed into the waste gas purge stream that is vented to a flare (either A-51 or A-60) for control. The District determined that the maximum annual emissions from the flares would be no greater than the currently permitted emission rates. However, these emissions would be concentrated and emitted in shorter time periods (during the desorption cycle for the carbon system at S-71) instead of at an average rate over the entire year. To estimate maximum hourly emissions, the District assumed that the maximum 1-hour concentration in the waste gas and landfill gas mixture burned at the flare would be 5 times the annual average concentration in untreated landfill gas. To estimate the maximum possible hourly emissions, the District assumed that each flare will achieve 98% by weight destruction for each TAC in the purge air stream. Formaldehyde emissions from enclosed flares are estimated using a CATEF[3] emission factor for landfill gas combustion in turbines. Hydrogen chloride (HCl) and hydrogen fluoride (HF) emissions were determined by assuming that all of the chloride and fluoride ions present in the purge air stream would be converted to HCl and HF, respectively.

Although the gas treatment system is expected to remove most of the TACs from the landfill gas prior to combustion in the engines, the District conservatively assumed that the treated landfill gas burned by the engines would contain 50% of the maximum permitted concentration for untreated landfill gas. The District assumed that the engines would achieve at least 85% destruction by weight for each TAC. The oxidation catalysts are expected to reduce residual organic TAC emissions by an additional 50%.

IC engines burning gaseous fuels will emit formaldehyde and acetaldehyde as combustion byproducts. Lean-burn IC engines fired on landfill gas can have very high secondary formaldehyde emission levels, and the District has found that these formaldehyde emissions are typically the largest contributor to health risks for landfill gas energy plants. For this project, the District determined that secondary formaldehyde emissions from the engines are the largest contributor to both acute health impacts and the increased cancer risk for this project. At the applicant's request, the formaldehyde emission limit for the proposed engines (after control by the oxidation catalysts) was maximized based on the results of the health risk screening analysis. As discussed in the September 16, 2013 HRSA report, formaldehyde emissions will be limited to 0.51 pounds/hour per engine to ensure that site-wide cancer risks will not exceed 10.0 in a million cancer risk. This hourly formaldehyde emission rate is equivalent to an emission factor of: 2.36E-2 lbs/MM BTU. A 2009 source test at engine # 1 at Ameresco Half Moon Bay (a treated landfill gas fired engine equipped with an oxidation catalyst) found formaldehyde emissions of 3.1E-3 lbs/MM BTU. Therefore, the District expects that Redwood Landfill's proposed engines equipped with oxidation catalysts should be able to meet the proposed formaldehyde emission limit of 0.51 pounds/hour.

Naphthalene and PAH emissions from engines are estimated using a CATEF emission factor for landfill gas combustion in lean burn engines. Hydrogen chloride (HCl) and hydrogen fluoride (HF) emissions were determined by assuming that all of the chloride and fluoride ions present in the landfill gas would be converted to HCl and HF, respectively.

The SCR systems convert urea to ammonia, which reduces NO_x emissions from the engines. Ammonia emissions in the engine stacks were determined based on a maximum outlet concentration of 10% NH_3 at 15% O_2, dry basis, which is a typical ammonia slip rate for properly operating SCR systems. Source testing in 2011 and 2012 at engine # 1 at the Ameresco Half Moon Bay facility demonstrated that the SCR system was emitting less than 10 ppmv of NH_3 at 15% O_2. Therefore, the District expects that Redwood Landfill's engines should be able to comply with this limit.

The most significant TAC emissions from the engines are summarized below and are compared to the risk screen trigger levels. Detailed spreadsheets are presented in Appendix A. Since both acute and chronic emissions will exceed trigger levels, a health risk screening analysis (HRSA) is required for this project.

[3] The California Air Resources Board (CARB) maintains an on-line searchable database for TAC emission factors for numerous types of combustion devices and fuels. The link to this California Air Toxic Emission Factor (CATEF) database is: (http://www.arb.ca.gov/app/emsinv/catef_form.html).

Table B-10 Significant Toxic Emissions from Proposed Engines (Post-Control)

	Emissions Per Engine	Emissions for 4 Engines	Risk Screen Trigger	Emissions Per Engine	Emissions for 4 Engines	Risk Screen Trigger
	lbs/hr	lbs/hr	lbs/hr	lbs/year	lbs/year	lbs/year
Ammonia	3.26E-01	1.30E+00	7.10E+00	2.85E+03	**1.14E+04**	7.70E+03
Formaldehyde	**5.10E-01**	**2.04E+00**	1.20E-01	**4.47E+03**	**1.79E+04**	1.80E+01
Hydrogen Chloride	8.23E-02	3.29E-01	4.60E+00	**7.21E+02**	**2.99E+03**	3.50E+02
Hydrogen Sulfide	**1.46E-01**	**5.83E-01**	9.30E-02	**1.28E+03**	**5.11E+03**	3.90E+02
Naphthalene	9.48E-04	3.79E-03	NA	**8.30E+00**	**3.32E+01**	3.20E+00
PAHs	2.00E-05	7.98E-05	NA	**1.75E-01**	**6.99E-01**	6.90E-03
Vinyl Chloride	5.29E-04	2.12E-03	4.00E+02	**4.63E+00**	**1.85E+01**	1.40E+00

* Emissions in bold text exceed the risk screen trigger levels.

Site-Wide Potential to Emit:

A site-wide potential to emit (PTE) is required in order to determine the applicability of various District and federal regulations. The District determined maximum permitted or maximum potential emission rates for each source or group of sources currently located at this site and the proposed limits for the engines and flares combined pursuant to this application. The total site-wide PTE is summarized below and compared to various thresholds.

Table B-11 Site-Wide Potential to Emit and Applicable Regulatory Thresholds

Site-Wide PTE	CO tons/yr	NOx tons/yr	POC tons/yr	SO2 tons/yr	PM10 tons/yr	HAP tons/yr	GHG tons/yr
Including Fugitives (+ F)	239.9	50.8	76.6	99.3	183.3	37.5	329,805
Excluding Fugitives (- F)	239.9	50.8	22.0	99.3	25.4	18.5	180,615
PSD Threshold	250	250	250	250	250	NA	100,000
PTE (+ F) > PSD Threshold?	No	No	No	No	No	NA	Yes, but deferred to 2014
PTE (- F) > PSD Threshold?	No	No	No	No	No	NA	Yes, but deferred to 2014 *
Title V Major Facility Threshold	100	100	100	100	100	25	100,000
PTE (+ F) > TV Threshold?	Yes	No	No	No	Yes	Yes	Yes, but deferred to 2014
PTE (- F) > TV Threshold?	Yes	No	No	No	No	No	Yes, but deferred to 2014
Regulation 2-2-303 Offset Thresholds	NA	NA	NA	100	100	NA	NA
PTE (+ F) > Offset Threshold?				No	Yes		
PTE (- F) > Offset Threshold?				No	No		

Site-Wide PTE	CO tons/yr	NOx tons/yr	POC tons/yr	SO2 tons/yr	PM10 tons/yr	HAP tons/yr	GHG tons/yr
Regulation 2-2-302 Offset Thresholds	NA	10	10	NA	NA	NA	NA
PTE (+ F) > Offset Threshold?		Yes	Yes				
Small Facility Banking Account Threshold	NA	35	35	NA	NA	NA	NA
PTE (+ F) > SFBA Threshold?		Yes	Yes				

* Although both total GHG emissions and non-biogenic GHG emissions for this facility are greater than 100,000 tons/year as CO2e, non-fugitive non-biogenic GHG emissions are less than 100,000 tons/year. In addition, the non-biogenic GHG emission increases for this project are less than 75,000 tons/year.

C. STATEMENT OF COMPLIANCE

Regulation 2, Rule 1 (CEQA)

A landfill gas energy project at this location was evaluated in an Environmental Impact Report (EIR) prepared for Marin County in 2008.[4] Mitigation measure 3.2.5.c. for the landfill expansion project required Redwood Landfill to apply for power generation engines (4-5 MW capacity) fueled by landfill gas as a mitigation measure for the greenhouse gas emission increases that would occur due to the expansion of the landfill and the increases in decomposable waste that would be placed in the landfill. The EIR also considered a mitigated alternative that would maximize use of landfill gas in energy producing equipment. Emissions were presented in the final EIR for two potential energy projects: 5 MW capacity and 13 MW capacity and compared to emissions due to flaring landfill gas. Excerpts from Table 3.2-6a of the FEIR (May 2008) are presented below.

Table C-1 Emissions Due to Energy Projects and Flares as Presented in FEIR

	Current Flare Emissions pounds/day	Project Flare Emissions pounds/day	Engine Emissions for 5 MW project pounds/day	Engine Emissions for 13 MW project pounds/day
NO_x	205	245	229	596
CO	700	833	802	2085
POC	48	57	84	218
PM_{10}	58	69	38	99
SO_2	484	577	577	577

The proposed project (7.9 MW) is between the two potential project sizes. The maximum emission levels from either flaring or the proposed engine project for this application (from Table B-5 converted to pounds/day) are compared to the highest emissions evaluated in the EIR in Table C-2.

[4] State Clearing House No. 1991033042; Final EIR (May 2008) was certified on June 10, 2008.

Table C-2 Application # 24495 Proposed Emissions versus EIR Evaluated Emissions

	Application # 24495 Max. LFG Combustion Emissions pounds/day	Highest Engine Emissions Evaluated under 2008 EIR pounds/day	Do App. Emissions Exceed Levels Evaluated in EIR?
NO_x	214	596	no
CO	1301	2085	no
POC	114	218	no
PM_{10}	84	99	no
SO_2	542	577	no

As shown in Table C-2, the maximum landfill gas combustion emissions that will result from the proposed emission limits for Application # 24495 will not exceed the emission levels that were evaluated in the 2008 EIR. Therefore, the District concludes that the air emissions for the proposed project have been adequately evaluated pursuant to the 2008 EIR, and no further CEQA review is necessary.

Regulation 2, Rule 1 (Public School Notice Requirements)

The project is over 1000 feet from the nearest school and is therefore not subject to the public notification requirements of Regulation 2-1-412.

Regulation 2, Rule 2 (NSR – BACT)

In accordance with Regulation 2-2-301, best available control technology (BACT) is required for any source that emits more than 10 pounds per highest day of a criteria pollutant.

Engines (S-64, S-65, S-66, and S-67):
As shown in Table B-7, each of the proposed IC engines will emit more than 10 pounds per day of CO, NO_x, POC, SO_2 and $PM_{10}/PM_{2.5}$. Therefore, the proposed engines must comply with BACT requirements for each of these pollutants. The control equipment, emission limits, and compliance assurance monitoring procedures that will be imposed to satisfy these BACT requirements are summarized below. A detailed BACT analysis is presented in Appendix B.

Table C-3 District Proposed BACT Requirements for Each Engine

Pollutant	Emission Control Technology	Emission Limit or Concentration Limit	Monitoring Procedure
CO	Oxidation Catalyst [a] (Proposed by Applicant, including a LFG Treatment System Upstream of Engines)	Outlet Emissions: $\leq$ 1.8 g CO/bhp-hr [b], averaged over applicable test period	Quarterly Testing By Either Approved Source Test Procedures or By Portable Analyzer [c]
NO_x	Selective Catalytic Reduction (SCR) System [a] (Proposed by Applicant, including a LFG Treatment System Upstream of Engines)	Outlet Emissions: $\leq$ 0.15 g NO_x/bhp-hr [b], averaged over applicable test period	Quarterly Testing By Either Approved Source Test Procedures or By Portable Analyzer [c]
POC	Oxidation Catalyst [a] (Proposed by Applicant, including a LFG Treatment System Upstream of Engines)	Outlet Emissions: $\leq$ 0.16 g/bhp-hr [b], (POC expressed as CH_4) averaged over applicable test period	Annual Source Testing [d]
SO_2	LFG Treatment System (Proposed by Applicant)	Fuel Sulfur Content to Engines: $\leq$ 150 ppmv of total sulfur in fuel (expressed as H_2S, dry basis)	Quarterly Fuel Sulfur Content Tests Using Laboratory Analyses or Portable Analyzer [c] and Annual Source Testing [d]
PM_{10} & $PM_{2.5}$	LFG Treatment System (Proposed by Applicant)	Outlet Emissions: $\leq$ 0.1 g/bhp-hr,	Source Testing (one engine each year) [d]

(a) Use of oxidation or SCR catalysts requires a landfill gas treatment system be employed to remove siloxane and other contaminants from the landfill gas fuel prior to combustion in the engine. The applicant proposed to use a landfill gas treatment system for this project and proposed to use both an oxidation catalyst and an SCR system for each engine.

(b) This limit includes use of a BAAQMD approved calculation procedure to convert a measured outlet concentration into units of g/bhp-hr.

(c) Portable analyzer method requires that outlet concentration is measured for at least 15 minutes, see also BAAQMD Regulation 9-8-503. When portable analyzers are used to determine compliance with NO_x and CO BACT limits, the applicant will be allowed to meet a daily average limit calculated based on at least 3 portable analyzer readings conducted at evenly spaced intervals.

(d) Compliance demonstration tests must be conducted in accordance with Source Test (ST) methods provided in the BAAQMD Manual of Procedures or in accordance with equivalent EPA approved test methods. The District is allowing a 3-hour average for the POC limit. Outlet NMOC is assumed to 100% POC unless the operator tests for ethane and other NPOCs at the stack.

(e) Laboratory analyses for fuel sulfur content shall be conducted in accordance with BAAQMD approved procedures and shall measure for concentrations of at least the following compounds (dry basis): hydrogen sulfide, carbon disulfide, carbonyl sulfide, dimethyl sulfide, ethyl mercaptan, and methyl mercaptan. If a portable analyzer is used that only measures hydrogen sulfide, the total sulfur concentration shall be determined using this measured H_2S data and a BAAQMD approved calculation procedure. The District is allowing a daily average limit determined based on the average of at least 3 samples collected at evenly spaced intervals.

Gas Treatment System – Desorption Process (S-71):

For the S-71 Landfill Gas Treatment System – Desorption Process, The District estimated that uncontrolled organic emissions from S-71 will be: a maximum of 40.1 lbs/hour of POC and 0.65 pounds/hour of NPOC and an average of 313.4 lbs/day of POC and 5.18 pounds/day of NPOC. Therefore, BACT is required for POC emissions from S-71.

The applicant proposed to satisfy BACT for POC emissions from S-71 by venting all organic emissions from the desorption cycle to one of the existing enclosed flares (A-51 or A-60). These flares are capable of achieving at least 98% control for POC, NPOC, and toxic air contaminant (TAC) emissions. Incineration in an enclosed landfill gas fired flare is the standard method used to control the waste stream emissions from regenerative landfill gas treatment systems (see BACT/TBACT Guideline; Document # 101.1). To ensure adequate destruction of toxic constituents, the District typically requires a minimum retention time of 0.6 seconds and a minimum combustion zone temperature of 1400 °F for such enclosed flares (see BACT/TBACT Guideline; Document # 80.1). Temperature monitoring and control systems with automatic combustion air controls, alarms, and restart systems are also required for these flares to ensure that the proper operating temperature is attained as quickly as possible and maintained under a variety operating conditions.

The existing A-51 and A-60 Landfill Gas Flares are designed to meet the minimum retention time of 0.6 seconds and are equipped with the necessary temperature monitoring and control systems. Each flare is currently required to meet the minimum operating temperature of 1400 °F at all times that landfill gas is vented to the flares. Permit conditions for A-51 and A-60 will be modified to ensure that these requirements continue to apply while the flare is abating S-71. As a result, A-51 or A-60 will satisfy BACT for control of the POC emissions from S-71. The District expects these flares will continue to comply with the Regulation 8-34-301.3 NMOC emission limits under all operating conditions.

As part of this project, the District is increasing the maximum landfill gas throughout limit to the flares which will result in about a 20% increase in the existing annual emission limits for these flares. In addition, the District estimated that flare emissions could be significantly higher on an hourly basis due to the waste gas desorption cycle emissions from S-71. The District estimated new maximum hourly and maximum annual emission rates from A-51 and A-60 and included these new rates in the September 16, 2013 HRSA that was conducted for this application.

Regulation 2, Rule 2 (NSR – RACT for Secondary Emissions from Abatement Devices)

In addition to controlling POC and NPOC emissions, the A-51 and A-60 Landfill Gas Flares will have secondary combustion emissions due to burning waste gas from S-71 and fuels (landfill gas and propane). Pursuant to Regulation 2-2-110, secondary emissions from abatement devices that are required to meet BACT or BARCT requirements for another pollutant are exempt from the Regulation 2-2-301 BACT requirements but must achieve a RACT level of control for these secondary pollutants instead. These flares are already required to meet RACT for NO_x, CO, and PM_{10} secondary emissions. The A-51 and A-60 flares are expected to continue to meet the current RACT limits of 0.06 pounds of NO_x/MM BTU and 0.20 pounds of CO/MM BTU (see BACT/TBACT Guideline # 80.1) during control of the S-71 waste gas stream. PM_{10} emissions are minimized by using fuel gas filters and knockout vessels, but no specific PM_{10} limit has been established as RACT other than compliance with the AP-42 emission factor (17 pounds PM_{10}/MM scf of Methane from AP-42 Table 2.4-5). The flares are equipped with fuel filters and knockout vessels and are expected to continue to meet the AP-42 emission factor during combustion of the S-71 waste gas stream. Therefore, the flares as they exist now will comply with RACT for NO_x, CO, and PM_{10} / $PM_{2.5}$.

RACT for Secondary SO_2 from A-51 or A-60:
The A-51 and A-60 flares will also emit secondary SO_2 due to the combustion of landfill gas and due to the combustion of the S-71 desorption cycle waste gas stream. As discussed in the Background and Emissions sections, the S-71 gas treatment system will shift sulfur and organic compounds from the landfill gas stream into a waste gas desorption stream. The waste gas stream

will contain a higher concentration of compounds but be emitted over a shorter period of time. The sulfur compounds in this waste gas stream will be converted to sulfur dioxide by the combustion process.

Based on a review of the recent landfill gas sulfur content data and the District's estimate of the increase in sulfur concentration that will occur when these compounds are shifted from the landfill gas stream to the waste gas stream, the District expects that the flares may exceed the current emission limits, at least on an hourly and daily basis. The District is proposing to increase the SO_2 limit at the flares to accommodate the higher sulfur compounds concentrations anticipated for the waste gas stream.

The applicable BARCT limit for the A-51 and A-60 flares is the Regulation 9-1-302 limit of no more than 300 ppmv of SO_2 in any exhaust point. The flares are necessary to control the gas treatment system emissions, which is acting as a SO_2 control measure for the IC engines. The additional treatment technologies that would be needed to prevent combustion of sulfur at this flare are expected to be prohibitively expensive. No add-on sulfur dioxide control technologies are reasonably available for waste gas flares. Therefore, compliance with the Regulation 9-1-302 limit will be considered RACT for secondary SO_2 emissions. As discussed in the Emissions section, the District calculated maximum permitted SO_2 emissions based on a maximum expected oxygen content of 15% O_2, but SO_2 concentrations under typical flare oxygen conditions are expected to be less than 235 ppmv of SO_2 at 10% O_2. Therefore, the flares are expected to comply with a RACT limit of 300 ppmv of SO_2, during all operating conditions including during combustion of desorption cycle waste gases.

Permit conditions will require quarterly testing for sulfur content in (a) the untreated landfill gas fuel used at the flares, (b) the desorption cycle waste gas sent to the flare (during the time of maximum expected sulfur content), [5] and (c) the treated landfill fuel used at the engines. The flares and engines will also be required to undergo annual SO_2 emissions testing. Annual source testing is an appropriate method of demonstrating compliance with RACT and BACT emission limits if the sulfur content does not vary significantly. The quarterly testing above will indicate if sulfur content in any of these gas streams fluctuates significantly.

<u>Regulation 2, Rule 2 (NSR – Offsets: NO_x and POC)</u>

As shown in Table B-6, this project will result in a maximum of 21.469 tons/year of NO_x emission increases and 16.927 tons/year of POC emissions increases. Regulation 2-2-302 requires offsets for NO_x and POC emission increases, if the facility-wide NO_x or POC emissions will exceed 10 tons per year. From Table B-11, facility-wide emissions will be 50.8 tons/year of NO_x and 76.6 tons/year of POC. Therefore, offsets are required for both NO_x and POC emission increases. Since NO_x and POC emissions will each exceed 35 tons/year, this facility does not qualify for the District's small facility banking account, and offsets must be supplied at a ratio of 1.15:1.0 for each pollutant.

5 The District has observed that sulfur compounds are desorbed from the carbon at fairly low temperatures. The maximum sulfur content in the desorption cycle waste gas occurs early on in the duration of the carbon desorption cycle. The District will work with the site operators and the source tester to determine the appropriate time periods for this sulfur testing to ensure that the quarterly testing will be representative of the peak sulfur content that occurs during the desorption cycle.

The offsets required for Application # 24495 are:

(21.469 tons/year NO_x increases)*(1.15)	=	24.689 tons/year for NO_x
(16.927 tons/year POC increases)*(1.15)	=	19.466 tons/year for POC
Total Offsets Required	=	44.155 tons/year

Redwood Landfill also has 28.172 tons/year of NO_x emission increases and 19.124 tons/year of POC emission increases that have not yet been offset or reimbursed in databank. Reimbursements and offsets were surrendered previously for Applications # 21287 and # 20607. The processing of these offsets is still under way.

Although the California Health and Safety Code Section 42314 may allow Districts to not require offsets from resource recovery projects meeting the provisions in that section, Section 42314(4) states that the applicant must provide offsets to the extent they are available from facilities it owns or operates in the air basin. Since Redwood Landfill owns 118 tons/year of POC emission reduction credits, these credits must be surrendered before the District may consider waiving the site's offset obligation or providing offsets on behalf of the facility.

Regulation 2, Rule 2 (NSR – Offsets: PM_{10} and SO_2)

Regulation 2-2-303 requires PM_{10} and SO_2 offsets for major facilities that have more than 100 tons/year of PM_{10} or SO_2 emissions. The Regulation 2-2-303 offset requirements apply on a pollutant specific basis. In other words, PM_{10} offsets are only required if the site is a major facility for PM_{10} emissions and if it emits more than 100 tons/year of PM_{10}. Likewise, SO_2 offsets are only required if the site is a major facility of SO_2 and emits more than 100 tons/year of SO_2.

For both Title V and PSD major facility definitions, fugitive emissions are excluded when determining if a site is a major facility when the site is not one of the 28 specifically identified source categories. Landfills are not one of these 28 source categories. Therefore, the PSD major facility threshold is 250 tons/year for each criteria pollutant and fugitive emissions may be excluded when determining if a site is major for a particular pollutant. Thus, for Redwood Landfill, fugitive emissions of PM_{10}, POC, and GHG are excluded when determining if a site is major for these pollutants. Since the non-fugitive PM_{10} potential to emit for this site (see Table B-11) is less than 100 tons/year, Redwood Landfill is not a major facility for PM_{10} emissions and offsets are not required for PM_{10} emission increases.

As discussed earlier, the District is imposing a limit of 99.0 tons/year of SO_2 emissions on the landfill gas combustion operations (engines and flares). The PTE for all other sources of SO_2 emissions is only 0.3 tons/year of SO_2, and the site-wide PTE for SO_2 is less than 100 tons/year (see Table B-11). Therefore, Redwood Landfill is not a major facility for SO_2 emissions, and offsets are not required for SO_2 emission increases.

Regulation 2, Rule 2 (NSR – PSD)

Prevention of Significant Deterioration (PSD) review is required for facilities that emit more than 250 tons/year of a regulated air pollutant, or that emit more than 100 tons/year if the facility is one of 28 source categories that are subject to the lower PSD threshold of 100 tons/year. Landfill gas fired IC engines, gas treatment systems, and flares are not in one of the 28 special PSD source categories. Therefore, the PSD threshold for this site is 250 tons/year. Since this facility will emit less than 250 tons/year of each regulated air pollutant (see Table B-11), PSD does not apply to this site due to regulated air pollutants.

EPA's tailoring rule for greenhouse gases (GHG) established an alternative PSD and Title V Major Facility threshold of 100,000 tons/year of CO_2 equivalent GHG emissions. However, the implementation of the PSD and Major Facility requirements for bioenergy facilities has been deferred until July 1, 2014 pursuant to a July 20, 2011 federal register posting: http://www.gpo.gov/fdsys/pkg/FR-2011-07-20/pdf/2011-17256.pdf. Although the U.S. Court of Appeals adopted an order to vacate EPA's biogenic GHG deferral amendments on July 12, 2013 [6], the Court has not - as of October 7, 2013 - issued the mandate that would make the Court's decision effective. Consequently, EPA's biogenic GHG deferral amendments remain in effect.

The proposed project is a bioenergy facility and qualifies for the EPA regulatory deferral discussed above for biogenic GHG. After this proposed project, the facility-wide potential to emit (PTE) will be 166,100 tons/year of CO_2e for non-biogenic GHG emissions (methane and nitrous oxide) and 329,800 tons/year of total GHG. However, most of these GHG emissions are due to the existing fugitive methane emissions from the landfill. Since this facility is not in one of the specific PSD source categories for which fugitive emissions must be included, fugitive GHG emissions may be excluded from comparison to the 100,000 tons/year PSD threshold for GHG emissions.

The site-wide PTE's for non-fugitive GHG emissions will be: 37,400 tons/year CO_2e for non-biogenic GHG emissions and 180,600 tons/year CO_2e for total biogenic and non-biogenic non-fugitive GHG. Although non-fugitive total GHG emissions from this site will be greater than the 100,000 ton/year PSD major facility threshold, this site is not yet deemed to be a major facility of GHG emissions due to EPA's bioenergy facility deferral. If biogenic GHG emissions are excluded from this PSD major facility threshold, this site would not be major for GHG emissions.

Regulation 2, Rule 2 (Publication and Public Comment)

Regulation 2-2-405 requires publication and public comment for new major facilities or for major modifications of existing major facilities. This site is a major facility due to CO emissions, because the PTE is greater than 100 tons/year of CO (see Table B-11). This application is considered to be a major modification, as defined in Regulation 2-2-221, because it will result in more than 100 tons/year of CO emission increases and more than 40 tons/year of SO_2 emission increases (see Table B-6). Therefore, the publication and public comment procedures of Regulation 2-2-405 are required.

Regulation 2, Rule 5 (NSR – Toxic Air Contaminants)

Since toxic air contaminant (TAC) emissions for this project will exceed risk screen trigger levels (see Table B-10), a Health Risk Screening Analysis (HRSA) is required for this project pursuant to Regulation 2-5-401. The District conducted an HRSA for this project in accordance with the BAAQMD HRSA Guidelines. The results of this HRSA are summarized below. Detailed HRSA reports are attached in Appendix C.

[6] On July 12, 2013, the United States Court of Appeals, DC Circuit, adopted an order to vacate EPA's July 20, 2011 Biogenic GHG Deferral amendments (see Case No. 11-1101). Subsequently on August 26, 2013, the U.S. Court of Appeals granted an extension of the deadline for rehearing petitions in this case. The petitions are now due 30 days after the Supreme Court's decision regarding Case No. 12-1146 Utility Air Regulatory Group v. EPA.

Table C-4. Project Risk for Application # 24495

Health Impact Type	Receptor Type	4 LFG Engines (App 24495)	Landfill (S-5)	LFG Flares (A-51 & A-60)	Maximum Project Impacts
Acute HI	Resident or Worker	0.55	0.75	0.25	0.75
Chronic HI	Worker	0.08	0.08	0.02	0.11
Chronic HI	Resident	0.12	0.23	0.02	0.23
Cancer Risk in a million	Worker	3.03	0.98	0.08	3.39
Cancer Risk in a million	Resident	9.57	6.07	0.14	9.82

TBACT:
Regulation 2-5-301 requires best available control technology for toxic air contaminants (TBACT) for each source that has a source risk of more than 1.0 in a million cancer risk or more than 0.2 chronic hazard index. As shown in Table C-4, the four energy plant engines combined have an increased cancer risk of 9.6 in a million. The average cancer risk per engine is 2.4 in a million. Since this source risk exceeds 1 in a million, TBACT is required for each of the proposed energy plant engines.

As discussed in the HRSA report, cancer risks from these landfill gas fired engines are primarily due to formaldehyde, which is a secondary precursor organic compounds that is formed as a byproduct of combustion of methane and other organic compounds. As discussed in the District's new BACT guideline for biogas fired engines (see Appendix B), Best Available Control Technology for Toxics (TBACT) from biogas fired engines is the use of oxidation catalysts, which achieve good control of organic TACs and in particular, good control of formaldehyde. The applicant has proposed to use oxidation catalysts on each engine. Therefore, this project will satisfy the TBACT control technology requirement.

Due to limited availability of source test data, no specific TBACT formaldehyde emission limit has been established yet. The applicant has agreed to meet a formaldehyde emission limit of 0.51 pounds/hour (2.36E-2 pounds/MM BTU) to comply with the project risk limits discussed below. For comparison, a source test on a landfill gas fired engine equipped oxidation catalysts found a formaldehyde emission rate 3.1E-3 pounds/MM BTU. Therefore, the District expects that Redwood Landfill should be able to comply with the proposed formaldehyde emission limit, which represents a 78% reduction compared to the maximum expected uncontrolled formaldehyde emission rate of 0.105 lbs/MM BTU.

Project Risks:
Regulation 2-5-302 limits project risks to 10.0 in a million cancer risk, 1.0 chronic hazard index, and 1.0 acute hazard index. The total project risks are identified in Table C-4, and these project risks are all less than the Regulation 2-5-302 project risk limits. Therefore, this project – as proposed – will comply with Regulation 2-5-302.

As indicated in the September 16, 2013 HRSA Report, the District also reviewed site-wide health risks pursuant to the AB-2588 Air Toxic Hot Spots Act. At the proposed formaldehyde emission limit of 0.51 pounds/hour per engine, site-wide health risks will not exceed the AB-2588 public notice thresholds of 10 in a million cancer risk, 1.0 chronic hazard index, or 1.0 acute hazard index.

Regulation 2, Rule 6 (Major Facility Review)

This site is subject to Title V permitting requirements and this project will require a significant revision of the Title V permit.

BAAQMD Regulation 6 (Particulate Matter and Visible Emissions)

Properly operating landfill gas fired IC engines and landfill gas flares will have no visible particulate emissions. Therefore, the proposed engines (S-64, S-65, S-66, and S-67) are expected to comply with the Regulation 6-1-301 Ringelmann 1.0 limitation and the Regulation 6-1-302 20% opacity limitation.

Each stack is also subject to the Regulation 6-1-310 particulate weight limitation of 0.15 grains/dscf. At the proposed emission limit of 0.10 g/bhp-hr, the grain loading in the exhaust from each engine will be 0.020 grains/dscf at an outlet oxygen concentration of 0% by volume. Compliance with these limits will be determined by initial source testing at each engine and subsequent periodic testing (one engine per year) of the engines.

At the maximum expected emission rate of 17 pounds/MM scf CH_4 (pursuant to AP-42, Chapter 2.4, Table 2.4-5) from each landfill gas flare, the grain loading in the exhaust will be 0.013 grains/dscf at an outlet oxygen concentration of 0% by volume, which is well below the Regulation 6-1-310 limit of 0.15 gr/dscf (compliance margin of more than 10:1). Since non-compliance is highly unlikely and particulate emissions testing is expensive, the District does not typically require particulate emissions source testing at landfill gas flares to verify compliance with this AP-42 emission factor. The District is not proposing to add a PM_{10} emission limit in the permit conditions for the existing A-51 or A-60 flares and is not proposing any source testing for PM_{10} emissions from these flares.

BAAQMD Regulation 8, Rule 34 (Solid Waste Disposal Sites)

Landfill gas combustion operations are subject to Regulation 8, Rule 34. The proposed IC engines (S-64, S-65, S-66, and S-67) are energy recovery devices that are subject to Regulations 8-34-301.2, 8-34-301.4, 8-34-412, 8-34-413, 8-34-501.2, 8-34-501.4, 8-34-501.6, 8-34-501.10, 8-34-501.11, 8-34-501.12, 8-34-503, 8-34-504, 8-34-508, and 8-34-509. The A-51 and A-60 Landfill Gas Flares are subject to Regulations 8-34-301.2, 8-34-301.3, 8-34-412, 8-34-413, 8-34-501.2, 8-34-501.3, 8-34-501.4, 8-34-501.6, 8-34-501.10, 8-34-501.12, 8-34-503, 8-34-504, 8-34-507, and 8-34-508.

Regulation 8-34-301.2 limits the leaks from any component of a landfill gas emission control system to 1000 ppmv expressed as methane. Properly operated landfill gas fired engines and flares are not expected to result in any component leaks in excess of this limit. Regulations 8-34-503 and 504 require quarterly testing of all control system components that contain landfill gas using a portable gas analyzer. Regulations 8-34-501.4, 501.6, and 501.12 require the site to maintain records of these test results for at least five years. These monitoring and record keeping requirements are sufficient to demonstrate compliance with Regulation 8-34-301.2. The facility plans to use a consulting firm to comply with the necessary testing and record keeping provisions.

Regulation 8-34-301.3 requires each enclosed flare to achieve 98% by weight destruction efficiency for NMOC or to emit less than 30 ppmv of NMOC, expressed as methane at 3% oxygen, dry basis. This requirement is echoed in the proposed permit conditions for the gas treatment system, because this NMOC emission limit is also a BACT requirement for S-71. Regulations 8-34-412 and 413 and permit conditions will require this site to conduct annual source tests on the flare to demonstrate compliance with the NMOC emission limit. In addition, Regulation 8-34-507 requires a continuous temperature monitor and recorder for this flare. The temperature limit will initially be set to no less than 1400 degrees F to ensure compliance with BACT and TBACT requirements. Regulation 8-34-501.3 and permit conditions will require this site to maintain continuous records of flare combustion zone temperature. These monitoring and record keeping requirements are sufficient to demonstrate compliance with Regulation 8-34-301.3. The facility plans to use independent source testing and consulting firms to comply with these requirements.

Regulation 8-34-301.4 requires each energy recovery device to achieve 98% by weight destruction efficiency for NMOC or to emit less than 120 ppmv of NMOC, expressed as methane at 3% oxygen, dry basis. Regulations 8-34-412 and 413 and permit conditions will require this site to conduct annual source tests to demonstrate compliance with the NMOC emission limit. In addition, Regulation 8-34-509 requires this site to establish a key emission control system operating parameter and monitoring schedule for each engine that will demonstrate compliance with Regulation 8-34-301.4 on an on-going basis. CO emissions and NMOC emissions from landfill gas fired engines commonly follow the same trend, especially when NMOC emissions are high. Therefore CO emissions are usually a good indicator of NMOC compliance. In accordance with Regulation 9, Rule 8, CO emissions from engines must be monitored on a quarterly basis. This CO monitoring will also serve as the key emission control system parameter monitoring for these engines. Regulation 8-34-501.4 and 8-34-501.11 require this site to maintain records of the key parameter monitoring data and all other test data necessary to demonstrate compliance with this rule. These monitoring and record keeping requirements are sufficient to demonstrate compliance with Regulation 8-34-301.4. The facility plans to use independent source testing and consulting firms to comply with these requirements.

In order to determine actual landfill gas consumption rates for energy recovery devices and the operating times for all landfill gas control system devices, Regulation 8-34-508 requires continuous monitoring of the landfill gas flow rates to the engines, and Regulation 8-34-501.2 requires records of all emission control system downtime. These monitoring and record keeping requirements will also demonstrate compliance with the applicable heat input limits for these engines. The gas treatment system flare and the engines will be equipped with the necessary flow rate monitoring and recording devices.

<u>BAAQMD Regulation 9, Rule 1 (Sulfur Dioxide)</u>

Regulation 9-1-302 limits sulfur dioxide concentrations in any exhaust point to 300 ppmv (dry basis). For the engines, the inlet fuel sulfur content will be limit to 150 ppmv of TRS, which results in 32 ppmvd of SO_2 (at 0% excess oxygen) in the exhaust from each engine. Permit conditions will require annual source testing and quarterly analyses of the fuel sulfur content to ensure compliance with this limit.

For the flares, the inlet concentration may vary depending on the effectiveness of the gas treatment system at removing sulfur from the landfill gas. Permit conditions will require compliance with the Regulation 9-1-302 outlet concentration limit or 300 ppmv of SO_2 at 15% O_2, whichever is lower. Based on recent source test data for Redwood Landfill, the landfill gas sulfur content in the untreated landfill gas has been ranging from 300-540 ppmv, which resulted in flare outlet concentrations of 60 ppmv SO_2 or less. As a worst case, the District expects that the waste gas desorption cycle could increase this outlet concentration by four to five times, which results in a maximum outlet concentration of 300 ppmv of SO_2 for the flare when the sulfur compounds are desorbing from the carbon. Therefore, the flare is expected to meet the Regulation 9-1-302 limit. The permit conditions will require initial and quarterly testing of the flare and desorption cycle waste gases to evaluate desorption cycle emissions and annual source testing after that to demonstrate compliance with the Regulation 9-1-302 limit.

BAAQMD Regulation 9, Rule 8 (NO_x and CO from Stationary IC Engines)

Regulation 9, Rule 8 applies to stationary internal combustion engines rated at 50 bhp or more. Sections 301 and 302 limit nitrogen oxides (NO_x) and carbon monoxide (CO) emissions from gas fired IC engines. Sections 330 and 331 apply to emergency standby engines only. The proposed engines are subject to Regulation 9-8-302 only, which applies to waste gas fired engines. Regulation 9-8-302.1 limits the outlet NO_x concentration to 70 ppmv NO_x, corrected to 15% O_2, dry basis. Regulation 9-8-302.3 limits the outlet CO concentration to 2000 ppmv, corrected to 15% oxygen, dry basis, for any waste gas fired engines. At the proposed BACT limits for NO_x and CO, the outlet concentrations for the proposed engines will be: 10 ppmv of NO_x at 15% O_2 and 204 ppmv of CO at 15% O_2. Therefore, the proposed engines will comply with the requirements of Regulation 9, Rule 8. The initial source test and quarterly monitoring required by the permit conditions will satisfy the requirements of Regulation 9-8-501 and 9-8-503, respectively.

Federal Requirements (NSPS and NESHAPs)

Reciprocating engines are potentially subject to the following federal requirements: 40 CFR, Part 60, Subpart JJJJ – Standards of Performance for Stationary Spark Ignition Internal Combustion Engines and 40 CFR, Part 63, Subpart ZZZZ – National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines. The applicability of each of these federal regulations is discussed in more detail below.

NSPS:

The 40 CFR, Part 60, Subpart JJJJ NSPS for spark-ignition (SI) internal combustion engines (ICE) applies to both engine manufacturers and engine owners. This discussion covers the requirements for owners and operators. Section 60.4230(a)(4)(i) indicates that Subpart JJJJ applies to owners/operators of engines that commence construction after June 12, 2006, where the engine power rating is greater than 500 hp and the engine is manufactured after July 1, 2007. The proposed energy plant engines meet these criteria. In accordance with 40 CFR Part 60.4233(e), SI ICE meeting the above criteria must comply with the emission limits in Table 1 of Subpart JJJJ. For landfill/digester gas fired engines ≥ 500 bhp, the Subpart JJJJ, Table 1 standards below are effective as of 7/1/2010:

Table C-5 Proposed Engine Limits Compared to Applicable NSPS Limits

	Proposed Engine Limits	NSPS Limits: 40 CFR Part 60, Subpart JJJJ, Table 1	
	g/bhp-hr	g/bhp-hr	ppmv at 15% O2
NOx	0.15	2.0	150
CO	1.80	5.0	610
VOC	0.16	1.0	80

As shown above, the proposed emission limits for the energy plant engines (S-64, S-65, S-66, and S-67) are well below the applicable NSPS limits.

For the energy plant engines, the owner/operator is subject to Section 60.4243(b) and must demonstrate compliance with the Subpart JJJJ, Table 1 limits by complying with 60.4243(b)(2) and using the test procedures in 60.4244. Pursuant to 60.4243(b)(2)(ii), the operator must keep a maintenance plan and records of maintenance conducted. These requirements were added as Condition # 25635, Part 15(d-e). The operator must also conduct initial and subsequent performance tests (every 8760 hours of operation or every 3 years, whichever comes first). The testing requirements in Condition # 25635, Part 13 will satisfy this requirement.

In accordance with 40 CFR 60.4245(a), the operator must maintain records of: all notifications, all maintenance conducted on the engines, and all performances tests. Initial notification is required pursuant to 40 CFR 60.4245(c) and 60.7(a)(1). The record keeping and notification requirements in Condition # 25635, Part 15 will satisfy these provisions.

NESHAP:

The 40 CFR, Part 63, Subpart ZZZZ NESHAP for reciprocating internal combustion engines (RICE) applies to both major and area sources of HAPs. The applicable provisions depend, in part, on whether the site is a major source of HAPs or an area source of HAPs. The total HAP potential to emit for this site is currently 24.9 tons/year. As shown in Table B-11, the proposed total HAP PTE will be 37.5 tons/year when you include the additional HAP emissions (primarily formaldehyde) that result from burning landfill gas in IC engines compared to flares. In accordance with BAAQMD Regulation 2-6-212.2 and 40 CFR Part 63.6585(b), fugitive HAP emissions should be included when determining if a site is a major facility of HAP. Since site-wide HAPs (including fugitive emissions) will be greater than 25 tons/year as a result of Application # 24495, this facility will be a major source of HAP emissions.

In accordance with 40 CFR Part 63.6590(a)(2)(i), the proposed engines will be a new stationary RICE source, because the engines are greater than 500 bhp capacity, located at a major source of HAPs, and will commence construction after 12/19/2002. Also, since new major source RICE (>500 bhp) are not listed in Part 63.6590(c)(1-7), the proposed engines are considered affected sources and must comply with all applicable provisions of Subpart ZZZZ upon start-up of these engines instead of just complying with the applicable NSPS provisions identified earlier.

In accordance with 40 CFR Part 63.6600(b-c), the proposed energy plant engines would normally be required to comply with the emission limits and operating requirements in Tables 2a and 2b, but the proposed engines are not required to meet these limits and operating requirements in this case, because the engines will combust landfill gas in an amount exceeding 10% of the gross annual heat input to the engines.

Landfill gas fired engines (new major source RICE >500 bhp) must comply with the notification and record keeping requirements of 63.6645(c) and 63.6655(a and c). No further requirements apply to these engines under 40 CFR Part 63, Subpart ZZZZ.

State Requirements (Landfill Methane Control Measure)

CARB's landfill methane control measure establishes landfill gas collection and control requirements and sets landfill surface leak limits and collection and control system component leak limits and methane emission standards for landfill facilities.

All control system components under positive pressure including pumps, valves, flanges, and piping to the flares, landfill gas treatment system, and engines must comply with a leak limit of 500 ppmv expressed as methane pursuant to CCR, Title 17, Section 95464(b)(1)(B).

The flares are required to meet a methane destruction efficiency of 99% by weight pursuant to CCR, Title 17, Section 95464(b)(2)(A)(1) and must meet design criteria specified in Section 95464(b)(2)(A)(2-4).

The proposed energy plant engines must meet an alternative methane outlet concentration limit of 3000 ppmv as methane at 15% O_2 pursuant to CCR, Title 17, Section 95464(b)(3)(A)(1).

Section 95464(b)(4) requires annual source testing at the flares and engines to demonstrate compliance with the above methane emission limits. Section 95469(b)(1)(A) requires continuous temperature monitoring and recording for flares. Section 95469(b)(3) requires quarterly leak detection monitoring for all components under positive pressure. Records of all testing and monitoring results must be maintained pursuant to Sections 95470(a)(1)(H) and 95470(a)(2)(C).

D. PERMIT CONDITIONS

The District is proposing three new sets of permit conditions for this project: site-wide conditions (Condition # 25634), engine conditions (Condition # 25635), and gas treatment system conditions (Condition # 25636). In addition, the District is proposing to modify the existing permit conditions for the A-51 and A-60 Landfill Gas Flares (Condition # 19867) to increase throughput and emission limits for these flares. These permit conditions are necessary to ensure compliance with all of the applicable requirements discussed above. The basis for each limit or requirement is identified in parentheses for each part.

CONDITION # 25634
FOR: ALL LANDFILL GAS FIRED COMBUSTION EQUIPMENT AT PLANT # 1179

1. The total landfill gas throughput to the landfill gas combustion equipment located at Plant # 1179 shall not exceed 2625 million scf of landfill gas during any consecutive rolling 4-quarter period. For the purposes of this condition, landfill gas fired combustion equipment includes the following devices: A-51, A-60, S-64, S-65, S-66, and S-67. (Basis: Regulation 2-1-403 and Cumulative Increase)

2. Total carbon monoxide (CO) emissions from all landfill gas fired combustion equipment located at Plant # 1179 shall not exceed 237.5 tons of CO during any consecutive rolling 4-quarter period. (Basis: Regulation 2-1-403, Cumulative Increase, Not Trigger PSD)

3. Total sulfur dioxide (SO_2) emissions from all landfill gas fired combustion equipment located at Plant # 1179 shall not exceed 99.0 tons of SO_2 during any consecutive rolling 4-quarter period. (Basis: Regulation 2-1-403, Cumulative Increase, Not Trigger SO_2 Offsets)

4. To demonstrate compliance with Parts 1-3, the owner/operator of Plant # 1179 shall comply with the following record keeping procedures. (Basis: Regulation 2-1-403 and Cumulative Increase)
   a. On a quarterly basis, the owner/operator shall calculate and record the combined total landfill gas flow rate to: A-51, A-60, S-64, S-65, S-66, and S-67 based on gas flow meter data for each of these devices, and the owner/operator shall summarize this quarterly total landfill gas throughput rate for each rolling 4-quarter period.
   b. On a quarterly basis, the owner/operator shall calculate and record the CO and SO_2 emissions (tons per quarter) from each landfill gas fired combustion device located at this site (A-51, A-60, S-64, S-65, S-66, and S-67). The CO and SO_2 emissions shall be calculated using District approved procedures based on flow meter data, portable analyzer readings, source test data, conversion factors, and operating records for each type of device.
   c. The owner/operator shall calculate and record the total CO emissions and total SO_2 emissions from all landfill combustion devices for each quarter, and the owner/operator shall summarize the total CO and SO_2 emissions for each rolling 4-quarter period.
   d. The owner/operator shall keep all records on-site or have them readily available to District staff upon request.
   e. The owner/operator shall retain all records for at least five years from the date of entry.

CONDITION # 25635

FOR: LFG-FIRED LEAN-BURN INTERNAL COMBUSTION ENGINES (S-64, S-65, S-66, AND S-67); OXIDATION CATALYSTS (A-64, A-65, A-66, AND A-67); AND SELECTIVE CATALYTIC REDUCTION SYSTEMS (A-74, A-75, A-76, AND A-77)

1. The owner/operator shall fire the energy plant engines (S-64, S-65, S-66, and S-67) exclusively on treated landfill gas. Treated landfill gas means landfill gas that has been processed at the S-71 Landfill Gas Treatment System to remove water, particulate matter, siloxanes, and organic and sulfur contaminants and that has been conditioned to meet engine operating requirements. (Basis: BACT)

2. The owner/operator shall ensure that the heat input to each energy plant engine (S-64, S-65, S-66, and S-67) does not exceed 189,300 million BTU (HHV) during any consecutive rolling 4-quarter period. (Basis: Cumulative Increase)

3. The owner/operator shall ensure that emissions from each energy plant engine (S-64, S-65, S-66, and S-67) are vented to a properly operating and properly maintained oxidation catalyst (A-64, A-65, A-66, and A-67, respectively) to control carbon monoxide (CO) and organic compound emissions. The owner/operator shall ensure that emissions from the oxidation catalysts are subsequently vented to a properly operating and properly maintained selective catalytic reduction system (A-74, A-75, A-76, and A-77, respectively) to control nitrogen oxide (NOx) emissions. (Basis: BACT and Regulation 2-5-302)

4. Nitrogen oxide (NO_x) emissions from each engine shall not exceed an emission rate of 0.15 grams of NO_x (calculated as NO_2) per brake-horsepower-hour, averaged over the test period. When using a portable analyzer to demonstrate compliance with this limit, the owner/operator shall ensure that NO_x emissions from each engine do not exceed the equivalent outlet concentration limit of 10 ppmv of NO_x, corrected to 15% oxygen, dry basis, averaged over a 24-hour period. These limits do not apply during periods of startup or shutdown, provided the startup period does not exceed 2 hours and the shutdown period does not exceed 1 hour. (Basis: BACT)

5. Carbon monoxide (CO) emissions from each engine shall not exceed an emission rate of 1.8 grams of CO per brake-horsepower-hour, averaged over the test period. When using a portable analyzer to demonstrate compliance with this limit, the owner/operator shall ensure that CO emissions from each engine do not exceed the equivalent outlet concentration of 204 ppmv of CO, corrected to 15% oxygen, dry basis, averaged over a 24-hour period. These limits do not apply during periods of startup or shutdown, provided the startup period does not exceed 2 hours and the shutdown period does not exceed 1 hour. (Basis: BACT)

6. Precursor organic compound (POC) emissions from each engine shall not exceed an emission rate of 0.16 grams of POC (calculated as methane, CH_4) per brake-horsepower-hour, averaged over a 3-hour source test period, or the equivalent outlet concentration limit of 32 ppmv of POC (expressed as CH_4), corrected to 15% oxygen, dry basis, averaged over a 3-hour source test period. These limits do not apply during periods of startup or shutdown, provided the startup period does not exceed 2 hours and the shutdown period does not exceed 1 hour. The owner/operator shall calculate the measured POC emission rate using one of the assumptions below. (Basis: BACT)
   a. Assume that NMOC measured pursuant to Part 13h is 100% POC. In this case, the calculated concentration of POC (C_{POC}, ppmv of POC, expressed as CH_4 at 15% O_2, dry basis) is equal to the corrected concentration of NMOC (C_{NMOC}) measured pursuant to Part 13h: $C_{POC} = C_{NMOC}$. Likewise, the calculated POC emission rate (E_{POC}, grams/bhp-hr) is equal to the NMOC emission rate (E_{NMOC}, grams/bhp-hr) calculated pursuant to Part 13k: $E_{POC} = E_{NMOC}$
   b. Assume that POC is equal to measured NMOC minus the sum of all measured NPOC, if NPOCs are detected during annual source testing. NPOC are defined in Regulation 2-1-207 and include; ethane and acetone as well as the compounds specifically listed in Regulation 2-1-207. For this case, the outlet concentrations of all measured NPOC shall be expressed as methane prior to summing the Total NPOC Concentration (Total C_{NPOC}):
   $C_{POC} = C_{NMOC} - \text{Total } C_{NPOC}$ and
   $E_{POC} = E_{NMOC} - \text{Total } E_{NPOC}$

7. Sulfur dioxide (SO_2) emissions from each engine shall not exceed a daily average emission rate of 0.18 grams of SO_2 per brake-horsepower-hour, or the equivalent outlet concentration of 9 ppmv of SO_2, corrected to 15% oxygen, dry basis, on a daily average basis. (Basis: BACT)

8. Particulate matter (PM_{10}) emissions from each engine shall not exceed an emission rate of 0.10 grams of PM_{10} per brake-horsepower-hour, or the equivalent outlet grain loading of 0.006 grains/sdcf, corrected to 15% oxygen, dry basis, averaged over the test period. (Basis: BACT)

9. Formaldehyde emissions from each engine shall not exceed an emission rate of 0.51 pounds per hour, averaged over the test period. (Basis: Regulation 2-5-302.3)

10. Ammonia (NH_3) concentration in the exhaust from each engine shall not exceed 10 ppmv of NH_3, corrected to 15% oxygen, dry basis, averaged over the test period. (Basis: Regulation 2-5-302)

11. To demonstrate compliance with Parts 4 and 5, the owner/operator shall comply with the following monitoring and record keeping requirements:
    a. Perform quarterly periodic testing as required by Regulation 9-8-503 and maintain records of all test dates and test results.
    b. During any quarter in which a source test is not performed, periodic testing shall be conducted using a portable analyzer following the procedures described in Regulation 9-8-503 and below.
        i. Conduct at least 3 test runs at evenly spaced intervals throughput a 24-hour period.
        ii. For each test run, NOx and CO concentrations shall be averaged over a consecutive 15 minute period and corrected to 15% oxygen, dry basis.
        iii. Calculate the average NOx and CO concentration for the total number of test runs conducted during the 24-hour period and compare this average to the 24-hour average outlet NOx and CO concentration limits in Parts 4 and 5.

    (Basis: BACT, Cumulative Increase, Offsets, and Regulations 2-1-403, 2-6-423.2, and 9-8-503)

12. To demonstrate compliance with Part 7, the owner/operator shall comply with the following fuel sulfur content limit and monitoring requirements. (BACT)
    a. The total sulfur content in the treated landfill gas fuel burned at the engines shall not exceed 150 ppmv of total sulfur, expressed as hydrogen sulfide (H_2S), on a daily average basis.
    b. On a quarterly basis (during any quarter in which a Part 13 source test is not conducted), the owner/operator shall measure the total sulfur content in the treated landfill gas fuel delivered to the engines using either District approved laboratory analysis methods or a District approved portable hydrogen sulfide monitor. The owner/operator shall collect a minimum of three 30-minute samples at evenly spaced intervals throughout a 24 hour period and shall record the sampling dates and times and measurement results in a District approved log.
        i. If a laboratory analysis method is used, the total sulfur concentration in the treated landfill gas shall be calculated as the sum of the measured concentrations for the individual sulfur compounds, expressed as H_2S. As a minimum, the owner/operator shall test for the following compounds: hydrogen sulfide, carbon disulfide, carbonyl sulfide, dimethyl sulfide, ethyl mercaptan, and methyl mercaptan.
        ii. If the portable H_2S analysis method is used, the total sulfur concentration shall be calculated by multiplying the measured H_2S concentration by 1.2 (Total Sulfur = 1.2 * H_2S).
        iii. The owner/operator shall calculate and record the average of all the samples collected during a 24-hour period and shall compare this daily average sulfur content to the limits in Part 7 above.

13. In order to demonstrate compliance with Parts 4-10 above and Regulations 8-34-301.4, 9-1-302, 9-8-302.1, 9-8-302.3, and 40 CFR 60.4233(e), the owner/operator shall ensure that

a District approved source test is conducted within 90 days of initial start-up of each engine and annually thereafter (with the exception of PM10 and formaldehyde emissions testing, which are subject to a testing frequency of one engine per year, in sequence, provided initial testing demonstrates compliance with the PM10 and formaldehyde limits). The initial source test shall be conducted while the engine is operating at or near the maximum operating rate. Each subsequent source test shall be conducted while the engine is operating under normal operating conditions and shall not include startup or shutdown periods. Each source test shall determine all items identified below, except as noted in Part 13(l) below. The Source Test Section of the District shall be contacted to obtain approval of the source test procedures at least 14 days in advance of each source test. The Source Test Section shall be notified of the scheduled test date at least 7 days in advance of each source test. The source test report for the initial compliance demonstration test shall be submitted to the Source Test Section and the Engineering Division within 60 days of the test date. Subsequent annual source test reports shall be submitted to the Compliance and Enforcement Division and the Source Test Section within 60 days of the test date. (Basis: BACT, Cumulative Increase, and Regulations 2-5-302, 8-34-301.4, 8-34-412, 9-1-302, 9-8-302.1, and 9-8-302.3)

a. Actual gross electrical output (kW-hrs) from each engine during the test period and the calculated power output (bhp) from each engine determined using the following equation: bhp = 1.3932 * kW-hrs;
b. Total flow rate (standard cubic feet per minute, dry basis, or sdcfm) of gaseous fuel to each engine;
c. Concentrations (percent by volume or ppmv, dry basis) of: carbon dioxide (CO_2); nitrogen (N_2); oxygen (O_2); methane (CH_4); total non-methane organic compounds (NMOC), expressed as CH_4; and total sulfur compounds in the gaseous fuel delivered to the engines. For total NMOC and (if measured) ethane, the exhaust concentrations shall be measured using three sampling periods of 1-hour each;
d. Higher heating value (BTU/scf) for the gaseous fuel delivered to the engines;
e. Heat input rate (BTU/hour) to each engine averaged over the test period;
f. Exhaust gas flow rate (sdcfm) from each engine based on EPA Method 19;
g. Concentrations (ppmv or percent by volume, dry basis) of NO_x, CO, CH_4, NMOC (expressed as CH_4), SO_2, NH_3, formaldehyde, and O_2 in the exhaust gas from each engine;
h. Corrected concentrations (ppmv, corrected to 15% O_2, dry basis) of NO_x, CO, CH_4, NMOC (expressed as CH_4), SO_2, and NH_3 in the exhaust gas from each engine;
i. Corrected concentration (ppmv, corrected to 3% O_2, dry basis) of NMOC (expressed as CH_4) in the exhaust gas from each engine;
j. NMOC destruction efficiency (weight percent) achieved by each engine;
k. Emission rates (grams/bhp-hour) of NO_x (calculated as NO_2), CO, NMOC (calculated as CH_4), and SO_2 from each engine;
l. Emission rate of PM_{10} (grams/bhp-hr) from each engine and the PM_{10} grain loading rate (grains/dscf) from each engine. During the initial compliance demonstration test, PM testing shall be conducted on each engine. For subsequent years, the owner/operator may reduce PM testing to one engine per year, cycling through all of the engines.
m. Emission rate for formaldehyde (pounds/hour) from each engine;
n. Average temperature of the oxidation and SCR catalysts for each engine during the test period.
o. During the initial compliance demonstration source test, the owner/operator shall also measure concentrations of NO_x, CO, and O_2 (ppmv) in the exhaust from

each engine using the portable analyzer procedures described in Part 11b. The portable analyzer measurements of corrected NO_x and CO concentrations shall be compared to the values measured pursuant to Part 13h.

14. The owner/operator shall measure and record the methane content of the treated landfill gas supplied to the engines on a quarterly basis (during any quarter in which a Part 13 annual source test is not conducted) using a District approved monitoring device or District approved source test procedures. The flow meter, recorder and, if applicable, methane monitor shall be installed and properly calibrated prior to any engine operation; this equipment shall be maintained in good working condition. (Basis: Cumulative Increase)

15. The owner/operator shall maintain the following plans and records on-site for a minimum of 5 years from the date of entry. The plans and records shall be made available to District staff upon request. (Basis: Cumulative Increase, Regulations 9-8-502.3 and 9-8-502.4, and 40 CFR 60.4243(b)(2)(ii))
    a. Records of heat input to each engine for each quarter and for each rolling 4-quarter period. Heat input shall be calculated using District approved procedures based on measured landfill gas flow rate data and measured landfill gas methane concentration data. The calculated heat input rates shall be recorded in a data acquisition system or electronic spreadsheet.
    b. Records of all monitoring or source testing conducted pursuant to Parts 11-14, and as required by Regulation 8, Rule 34, Regulation 9, Rule 8, and 40 CFR 60.4243(b)(2)(ii).
    c. Records of all excursions identified under Parts 11-13 and records of the dates and results of all subsequent monitoring or source testing events. If any corrective actions are taken in response to detecting an excursion, identify the problem or suspected cause of the excursion, the corrective action taken, and the date and time that the corrective action was completed.
    d. An engine maintenance plan that satisfies the requirements of 40 CFR 60.4243(b)(2)(ii).
    e. Records of all maintenance conducted on each engine.
    f. Records of start-ups, shut-downs, and malfunctions for each engine. For any malfunctions, the records shall include the cause of the malfunction, the actions taken to correct the malfunction, the date and time that the malfunction was corrected, and the actions taken to prevent such malfunctions in the future.
    g. Records of all notifications required pursuant to Regulation 1 or 40 CFR Parts 60 or 63.

CONDITION # 25636
FOR S-71 GAS TREATMENT SYSTEM –DESORPTION PROCESS:

1. All waste gas generated by the desorption cycle at S-71 shall be vented to either the A-51 Landfill Gas Flare or the A-60 Landfill Gas Flare. The desorption cycle waste gas shall be blended with a sufficient amount of landfill gas to ensure that the flare will meet the minimum temperature requirement specified in Condition # 19867, Part 22. (Basis: BACT)

2. Set NMOC limit for S-71 desorption cycle waste gas, as necessary to ensure that flares will meet the 8-34-301.3 NMOC outlet concentration limit during combustion of this waste gas. (Basis: BACT and Regulation 8-34-301.3)

3. Set total sulfur content limit for S-71 desorption cycle waste gas, as necessary to ensure that flares will meet the 9-1-302 SO2 outlet concentration limit during combustion of this waste gas. (Basis: RACT and Regulation 9-1-302)

4. The owner/operator of S-71 shall conduct a characterization of the desorption cycle waste gas on a quarterly basis with one test concurrent with one of the annual source tests required by Condition # 19867, Part 30. A waste gas sample shall be collected once every X hours during the S-71 desorption cycle. Each quarterly waste gas sample shall be analyzed for total non-methane organic compounds (expressed as CH_4), total sulfur compounds (expressed as H_2S) and the specific organic and sulfur compounds listed below. All concentrations shall be reported on a dry basis. The laboratory reports for these waste gas characterization tests shall be included with the source test report and shall be submitted to the Compliance and Enforcement Division and the Source Test Section within 60 days of the test date. The maximum measured NMOC and total sulfur concentrations shall be compared to the limits in Parts 2-3 above. Average concentrations of the toxic air contaminants will be compared to engineering evaluation report calculated concentration data to improve emission estimates and ensure that health risk determinations are valid. Upon completion of four quarters of testing, subsequent testing shall be conducted annually. (Basis: AB-2588 Air Toxics Hot Spots Act, Cumulative Increase, and Regulations 2-5-302, 8-34-412, 9-1-302, and 9-2-301)

Organic Compounds	Sulfur Compounds
acrylonitrile	carbon disulfide
benzene	carbonyl sulfide
carbon tetrachloride	dimethyl sulfide
chlorobenzene	ethyl mercaptan
benzyl chloride	hydrogen sulfide
chloroethane	methyl mercaptan
chloroform	
1,1 dichloroethane	
1,1 dichlorethene	
1,2 dichlorethane	
1,4 dichlorobenzene	
methyl alcohol	
MTBE	
ethylbenzene	
ethylene dibromide	
styrene	
hexane	
isopropyl alcohol	
methyl ethyl ketone	
methylene chloride	
perchloroethylene	
toluene	
1,1,1 trichloroethane	
1,1,2,2 tetrachloroethane	
trichloroethylene	
vinyl chloride	
xylenes	

Condition # 19867

FOR: S-5 REDWOOD LANDFILL WITH GAS COLLECTION SYSTEM; A-18 WATER SPRAYS; A-51 LANDFILL GAS FLARE; AND A-60 LANDFILL GAS FLARE

1. The maximum design capacity of the landfill (total volume of all wastes and cover materials placed in the landfill, excluding final cover) shall not exceed 25.0 million cubic yards, unless the Permit Holder can demonstrate that an increase of this design capacity limit will not result in any increases in the maximum permitted emission rates for the S-5 Redwood Landfill, A-51 Landfill Gas Flare, and A-60 Landfill Gas Flare, which are identified in the Engineering Evaluations for Applications #19098, ~~and~~ #20607, and # 24495. (Basis: Regulation 2-1-301)

2. The total cumulative amount of all decomposable materials placed in the landfill (total weight of all decomposable wastes and all decomposable cover materials placed in the landfill, excluding final cover) shall not exceed 541,140 tons per calendar year and shall not exceed a cumulative amount of 23.185 million tons, unless the Permit Holder can demonstrate that increases of these limits will not result in increases in waste decomposition related emissions. The maximum permitted fugitive precursor organic compound (POC) emission rate is 26.380 tons/year of POC from the S-5 Redwood Landfill. The maximum permitted residual POC emission rate is 7.716 tons/year from the flares (A-51 and A-60). Any changes in waste acceptance rates, types of waste accepted, or other practices that will result in an increase in the maximum permitted POC, NPOC, or toxic air contaminant emission rates for S-5 or A-51 or A-60, which are identified in the Engineering Evaluations for Applications #19098, ~~and~~ #20607, and #24495, shall be considered a modification of S-5, A-51, or A-60 pursuant to Regulation 2-1-234. (Basis: Regulations 2-1-301 and 2-5-302, Cumulative Increase, and Offsets)

3. Total particulate emissions from the S-5 Redwood Landfill and the associated waste and cover material delivery, placement, and compaction operations shall not exceed 992.5 pounds of PM10 per day and shall not exceed 154.25 tons of PM10 per year. Compliance with these emission limits shall be demonstrated by meeting the requirements of Parts 3-11. The total amount of all materials accepted at the landfill (total waste for disposal, total materials for composting, total materials for recycling, and total decomposable cover materials, but excluding non-decomposable cover materials and construction materials, which are also excluded from the equivalent limit in the SWFP) shall not exceed 2310 tons per day (except during temporary emergency situations approved by the Local Enforcement Agency) and shall not exceed 718,410 tons per calendar year. The total amount of sewage sludge accepted at the landfill shall not exceed 310 wet tons per day (except during temporary emergency situations approved by the Local Enforcement Agency) and shall not exceed 96,410 wet tons per calendar year. (Basis: Regulation 2-1-301)

4. The total amount of all cover materials (excluding final cover) placed in the landfill shall not exceed 1160 tons per day, with no more than 350 tons per day to consist of decomposable cover materials, and shall not exceed 360,760 tons per calendar year, with no more than 108,850 tons per calendar year from decomposable cover materials. (Basis: Regulation 2-1-301)

5. In order to demonstrate compliance with Parts 1-4 above, the Permit Holder shall maintain the following records in an APCO approved log book:
   a. Record on a daily basis the type and amount of all materials received at the landfill.
   b. For each type of material received at the landfill, clearly identify how the material will be used at this site (i.e. disposed of in the landfill directly, used as daily cover material, used as intermediate cover material, used in composting operations, sent to yard and green waste recycling operations, sent to other recycling operations, used for on-site road construction or surfacing, used for other construction purposes, sent to on-site stockpiles for later use, etc.). For material types that may be used for multiple purposes at this site, identify the amount of material used for each purpose.
   c. For each type of material received at the landfill, clearly identify whether the material is decomposable or inert. Inert materials are defined by Regulation 8-34-203. For the purposes of this condition, soils containing more than 50 ppm by weight of volatile organic compounds (VOC) or "contaminated soil" as defined in Regulation 8-40-205 are decomposable materials. Soils containing 50 ppm by weight VOC or less are inert materials.
   d. If cover materials are taken from on-site stockpiles, record on a daily basis the amount of material removed from the stockpiles and used as cover material (for each type of material).
   e. Summarize on a monthly basis: the total amount of all wastes accepted, the total amount of sewage sludge accepted, the total amount of accepted materials that were directly used as cover material, the amount of cover materials that were removed from on-site stockpiles, the total amount of materials used for cover, the total amount of decomposable cover materials, the total amount of decomposable wastes placed in the landfill, the total amount of non-decomposable wastes disposed of in the landfill, the total amount of decomposable materials placed in the landfill, and the total amount of all materials placed in the landfill.

   The Permit Holder shall begin maintaining the above records by no later than December 1, 2002. These records shall be kept at site for at least 5 years from the date the data is entered and shall be made available to the District staff for inspection. (Basis: Regulations 2-1-301, 8-34-501, and 40 CFR 60.758)

6. The mean vehicle fleet weight for all off-site vehicles traveling on paved roads shall not exceed 15.31 tons. The mean vehicle fleet weight for all off-site vehicles traveling on gravel or dirt roads shall not exceed 16.63 tons. (Basis: Regulation 2-1-301)

7. The mean vehicle fleet weight for all on-site landfilling and construction related vehicles (bulldozers, scrapers, back hoes, compactors, road graders, loaders, dump trucks, soil trucks, water trucks, fuel trucks, or maintenance vehicles, etc.) shall not exceed 28.37 tons. (Basis: Regulation 2-1-301)

8. The total vehicle miles traveled (VMT) by the off-site vehicle fleet shall not exceed the following limits:
   a. 280 VMT per day on gravel roads
   b. 639 VMT per day on dirt roads
   c. 662 VMT per day on paved roads

d. 87,080 VMT per calendar year on gravel roads
e. 198,650 VMT per calendar year on dirt roads
f. 205,880 VMT per calendar year on paved roads

(Basis: Regulation 2-1-301)

9. The total vehicle miles traveled (VMT) by the on-site vehicle fleet shall not exceed the following limits:
   a. 61 VMT per day (all travel is assumed to occur on dirt roads)
   b. 19,080 VMT per calendar year (all travel is assumed to occur on dirt roads)

   (Basis: Regulation 2-1-301)

10. In order to demonstrate compliance with Parts 6-9, the Permit Holder shall maintain the following records in an APCO approved log book:
    a. For each type of vehicle fleet (off-site vehicles and on-site construction equipment) maintain a list of all the types of vehicles in the fleet. For each vehicle type, record the empty vehicle weight, maximum load weight, and average vehicle weight (average of full and empty weights). This list shall be reviewed annually and updated whenever necessary to ensure that the list accurately reflects the types of vehicles that may be present at the landfill during any calendar year.
    b. For the off-site vehicle fleet, record on a daily basis and summarize on a monthly basis: the number of vehicle trips (round trips to/from the landfill) for each type of vehicle in the fleet.
    c. For the on-site vehicle fleet, record on a daily basis and summarize on a monthly basis: the number of vehicle trips for each type of vehicle in the fleet. For construction vehicles like bulldozers or compactors that have no set travel route but instead make many small trips across the active face, the number of vehicle trips can be estimated from operating times and procedures or odometer readings and the maximum round trip travel distance (see subpart f. below). If no data is available for estimating vehicle trips, the vehicle trips shall be recorded as 1 vehicle trip per day per vehicle used during that day.
    d. At least once per calendar year, the Permit Holder shall calculate and record the mean vehicle fleet weight for each type of vehicle fleet. For each vehicle fleet, the mean vehicle fleet weight shall be calculated using the vehicle trip data for: (i) the day with the highest number of vehicle trips during the previous calendar year; and (ii) the day with the highest total amount of waste accepted during the previous calendar year. Mean vehicle fleet weights shall also be recalculated whenever new vehicle types are added to a vehicle fleet. The mean vehicle fleet weight (MVFW) is a weighted average calculated by multiplying the average vehicle weight for each vehicle type (AVWi) times the number of vehicle trips per day for that vehicle type (DVTi), summing AVWi*DVTi for all vehicle types, and dividing the resulting sum by the total number of vehicle trips for that day (DVT).
    e. For the off-site vehicle fleet, the Permit Holder shall determine (using odometer measurements, maps, or other appropriate means) the maximum round trip distance traveled on-site by each vehicle type in the fleet on gravel roads, dirt roads, and paved roads (VMT per round trip per vehicle type per road type). Alternatively, the Permit Holder may determine a maximum round trip distance per road type for one or more

groups of vehicle types, if all vehicle types in the group travel essentially the same roads and distances. This distance shall be determined at least once per calendar year and whenever significant changes to on-site travel routes have occurred.

f. For the on-site vehicle fleet, the Permit Holder shall determine (using odometer measurements, maps, or other appropriate means) the maximum round trip distance traveled by each vehicle type in the fleet on dirt roads (VMT per round trip per vehicle type). Alternatively, the Permit Holder may determine a maximum round trip distance per road type for one or more groups of vehicle types, if all vehicle types in the group travel essentially the same roads and distances. This distance shall be determined at least once per calendar year and whenever significant changes to travel routes have occurred.

g. For each vehicle fleet type, the Permit Holder shall calculate and record the total vehicle miles traveled (VMT) per day on each type of road (dirt, gravel, and paved for off-site vehicles and dirt only for on-site vehicles) using the data recorded pursuant to subparts b., c., d., and f. The daily VMT per road type shall be summarized for each calendar month and for each calendar year.

The Permit Holder shall begin maintaining the above records by no later than December 1, 2002. These records shall be kept at site for at least 5 years from the date the data is entered and shall be made available to the District staff for inspection. (Basis: Regulations 2-1-301, 8-34-501, and 40 CFR 60.758)

11. Particulate emissions from any operation of the landfill shall be abated by A-18 Water Sprays in such a manner that visible dust emissions shall not exceed Ringelmann 1.0 or result in fallout on adjacent property in such quantities as to cause a public nuisance per Regulation 1-301. The Permit Holder shall meet the following minimum watering requirements:

a. On any dry operating days, water shall be applied to unpaved roads and parking areas at a rate of 0.5 gallons per square yard or more.

b. On any dry operating days, water shall be applied to unpaved roads at a frequency of at least once every three hours of operation.

c. On any dry operating days, water shall be applied to unpaved parking areas or infrequently traveled unpaved roads at least twice per day or at least once per every 150 vehicle trips (whichever is more frequent).

d. On any dry operating days, water shall be applied to the active landfill face, the active area of stockpiles, composting operations, or other dust prone areas at least twice per day.

e. On any operating day when rain fall is not sufficient to prevent visible emissions, additional water shall be applied to any road, parking area, active face, stockpile, or dusty area as frequently as necessary to prevent visible emissions that persist for longer than 3 minutes in an hour.

In order to demonstrate compliance with this requirement, the Permit Holder shall maintain the following information in an APCO approved log book:

f. Accurate maps of the facility showing the locations of all roads and parking areas at the facility (dirt, gravel, and paved roads shall be clearly distinguished), stockpiles, and active filling areas. The current travel routes for both off-site and on-site vehicle traffic and the water spray trucks shall be clearly indicated on the maps.

g. Record the frequency of water spray applications (on gravel roads, dirt roads, stockpiles, the active face, and any other dust prone areas) for each operating day.

(Basis: Regulations 1-301, 2-1-301, and 6-301)

*12. If the plant receives two or more violation notices from the District for "Public Nuisance" in any consecutive 12 month period, the Permit Holder shall implement the following control measures, as applicable, or any other measures that the District deems necessary and/or appropriate, within the time period specified by the District. If requested by the District, the Permit Holder shall submit to the District a permit application to modify the Permit to Operate and/or these permit conditions, within 30 days of notification. (Basis: Regulation 1-301)

a. Pave main haul roads and parking areas associated with the nuisance operation such as roads for landfilling, composting, recycling, or sludge handling operations.
b. Add gravel or other aggregate based surfacing to dirt roads and parking areas that are associated with the nuisance operation.
c. Use chemical suppressants on unpaved roads and unpaved parking areas that are associated with the nuisance operation.
d. Increase the frequency of water application on unpaved roads, parking areas, the active face of the landfill, stockpiles, or any other dust prone areas that are associated with the nuisance operation.
e. Use frequent sweeping and/or water flushing, during the dry season, on paved areas that are associated with the nuisance operation.

*13. The Permit Holder may use non-hazardous contaminated materials containing no more than 50 ppm by weight of Volatile Organic Compounds (VOC) as daily or interim cover material, provided that these materials are properly handled and disposed of in accordance with this part and any other applicable requirements.

a. Any metal laden materials (materials that have been contaminated with arsenic, asbestos, beryllium, cadmium, hexavalent chromium, nickel, copper, lead, mercury, selenium, or zinc) shall be properly handled at all times and shall be abated by appropriate dust mitigation measures including: the use of covers during on-site transport, the use of frequent water sprays during active handling (loading, unloading, spreading, etc.) of these materials, and the use of water sprays, covers, or chemical dust suppressants on inactive storage areas.
b. If metal laden materials are used as interim cover, the metal laden material shall be covered with a non-contaminated material such as clean soil or compacted green waste prior to subjecting the area to frequent vehicle or construction equipment traffic.
c. Metal laden materials shall not be used in the construction of unpaved roadways or parking lots.

(Basis: Regulation 2-5-302)

14. This part applies to the acceptance, handling, storage, and on-site reuse of VOC-laden soil. VOC-laden soil is any soil that contains volatile organic compounds, as defined in Regulation 8-40-213, other than contaminated soil. As defined in Regulation 8-40-205, contaminated soil contains more than 50 ppmw of VOC or has a surface concentration greater than 50 ppmv of VOC as C1, and contaminated soil is subject to Part 15 below instead of this part. Materials containing only non-volatile hydrocarbons and materials meeting the

requirements of Regulation 8-40-113 are not subject to this part. For each lot of VOC-laden soil accepted at this site, the Permit Holder shall comply with the daily limits identified in either subpart a or subpart b below and shall comply with the annual emissions limit identified in subpart c below. To demonstration compliance with the daily and annual emission limits, the Permit Holder shall comply with the monitoring procedures listed in subpart a(i-v). If the Permit Holder opts to comply with the daily concentration limit in subpart b rather than the daily emission limit in subpart a, then the Permit Holder shall also comply with the soil screening procedures listed in subpart b(i-v).

a. Unless the Permit Holder demonstrates compliance with Regulation 8-2-301 in accordance with subpart b below, the Permit Holder shall limit the quantity of VOC laden soil handled per day such that no more than 15 pounds of total carbon could be emitted to the atmosphere per day. In order to demonstrate compliance with this subpart and the annual emissions limit specified in subpart c, the Permit Holder shall maintain the following records in a District approved log for all VOC-laden soil accepted at the landfill.
    i. Record on a daily basis the amount of VOC laden soil accepted for each truckload or each soil lot, as appropriate. This amount (in units of pounds per day) is Q in the equation in subpart a(iii) below.
    ii. Record on a daily basis the VOC content for each truckload or each soil lot, as appropriate. This VOC Content (C in the equation below) should be expressed as parts per million by weight as total carbon (or C1).
    iii. Calculate and record on a daily basis the VOC Emission Rate (E) using the following equation: $E = Q * C / 1E6$
    This equation may be applied to each truckload or to each soil lot received per day depending on the amount of soil that is represented by the VOC Content data. If the equation is applied to multiple loads per day, the VOC Emission Rate shall be totaled for all loads received each day.
    iv. Summarize all daily emission rates on a monthly and calendar year basis.
    v. All records shall be maintained on site or shall be made readily available to District staff upon request for at least 5 years from the date of entry.

b. Unless the Permit Holder demonstrates compliance with Regulation 8-2-301 in accordance with subpart a above, the Permit Holder shall screen each lot of VOC laden soil accepted per day for VOC surface emissions to show that each lot of VOC laden soil is not contaminated soil.
    i. The Permit Holder shall use the testing procedures outlined in Regulation 8-40-604.
    ii. The screening test shall be representative of the entire lot of VOC-laden soil. The soil surface shall be disturbed prior to screening to ensure that the screening is representative of the entire load.
    iii. The Permit Holder shall maintain records of all testing conducted to satisfy this subpart and shall record the amount of VOC-laden soil accepted and the highest surface concentration measured pursuant to this subpart. These records shall be maintained for each truckload or each soil lot accepted, as

appropriate, provided that the records are made or summarized on at least a daily basis.

iv. Summarize the daily waste acceptance rates and the weighted average of the surface concentration records on a monthly basis and for each calendar year.

v. All records shall be maintained on site or shall be made readily available to District staff upon request for at least 5 years from the date of entry.

c. The Permit Holder shall limit the quantity of VOC laden soil handled per year such that annual VOC emissions due to on-site handling, storage, disposal, or reuse of VOC laden soil shall not exceed 10,530 pounds per calendar year. The Permit Hold shall comply with the monitoring procedures in subpart a(i-v) above to demonstrate compliance with this annual emissions limit.

(Basis: Offsets and Regulation 8-2-301)

15. Handling Procedures for Soil Containing Volatile Organic Compounds:

a. The procedures listed below in subparts b-l do not apply if the following criteria are satisfied. However, the record keeping requirements in subpart m below are applicable.

i. The Permit Holder has appropriate documentation demonstrating that either the organic content of the soil or the organic concentration above the soil is below the "contaminated" level (as defined in Regulation 8, Rule 40, Sections 205, 207, and 211). The handling of soil containing VOCs in concentrations below the "contaminated" level is subject to Part 14 above.

ii. The Permit Holder has no documentation to prove that soil is not contaminated, but source of the soil is known and there is no reason to suspect that the soil might contain organic compounds.

b. The Permit Holder shall provide notification to the Compliance and Enforcement Division of the Permit Holder's intention to accept contaminated soil at the facility at least 24 hours in advance of receiving the contaminated soil. The Permit Holder shall provide an estimate of the amount of contaminated soil to be received, the degree of contamination (range and average VOC Content), and the type or source of contamination.

c. Any soil received at the facility that is known or suspected to contain volatile organic compounds (VOCs) shall be handled as if the soil were contaminated, unless the Permit Holder receives test results proving that the soil is not contaminated. To prove that the soil is not contaminated, the Permit Holder shall collect soil samples in accordance with Regulation 8-40-601 within 24 hours of receipt of the soil by the facility. The organic content of the collected soil samples shall be determined in accordance with Regulation 8-40-602.

i. If these test results indicate that the soil is still contaminated or if the soil was not sampled within 24 hours of receipt by the facility, the Permit Holder must continue to handle the soil in accordance with the procedures subparts d-l below, until the soil has completed treatment or has been placed in a final disposal location and adequately covered. Storing soil in a temporary stockpile or pit is not considered treatment. Co-mingling, blending, or mixing of soil lots is not considered treatment.

ii. If these test results indicate that the soil - as received at the facility - has an organic content of 50 ppmw or less, then the soil may be considered to be not contaminated and need not be handled in accordance with the procedures listed in subparts d-l below, but shall be handled in accordance with Part 14 above.

d. Any contaminated soil received at the facility shall be clearly identified as contaminated soil, shall be handled in accordance with subparts e-l below, and shall be segregated from non-contaminated soil. Contaminated soil lots may not be co-mingled, blended, or otherwise mixed with non-contaminated soil lots prior to treatment, reuse, or disposal. Mixing soil lots in an attempt to reduce the overall concentration of the contaminated soil or to circumvent any requirements or limits is strictly prohibited.

e. On-site handling of contaminated soil shall be limited to no more than 2 on-site transfers per soil lot. For instance, unloading soil from off-site transport vehicles into a temporary storage pile is considered one transfer. Moving soil from a temporary storage to a staging area is considered one transfer. Moving soil from a temporary storage pile to a final disposal site is one transfer. Moving soil from a staging area to a final disposal site is one transfer. Therefore, unloading soil from off-site transport into a temporary storage pile and then moving the soil from that temporary storage pile to the final disposal site is allowed. Unloading soil from off-site transport into a staging area and then moving the soil from that staging area to the final disposal site is allowed. However, unloading soil from off-site transport to a temporary storage pile, moving this soil to a staging area, and then moving the soil again to a final disposal site is 3 on-site transfers and is not allowed.

f. All contaminated soil shall be either treated, deposited in a final disposal site, or transported off-site for treatment, within 90 days of receipt at the facility.

g. The total amount of contaminated soil disposed of at this site shall not exceed 6240 tons during any calendar year. The Permit Holder shall apply for a change of conditions before accepting any soil containing more than 100 ppm by weight of VOC. (Basis: Offsets)

h. All active storage piles shall meet the requirements of Regulation 8-40-304 by using water sprays, vapor suppressants or approved coverings to minimize emissions. The exposed surface area of any active storage pile (including the active face at a landfill) shall be limited to 6000 ft^2. The types of storage piles that may become subject to these provisions include (but are not limited to) truck unloading areas, staging areas, temporary stockpiles, soil on conveyors, bulldozers or trucks, the active face of a landfill, or other permanent storage pile at the final disposal location.

i. All inactive storage piles shall meet the requirements of Regulation 8-40-305 including the requirement to cover contaminated soil during periods of inactivity longer than one hour. The types of storage piles that may become subject to these provisions include (but are not limited to) soil on trucks or other on-site equipment, staging areas, temporary stockpiles, and the permanent storage pile at the final disposal location. District approved coverings for inactive storage piles include continuous heavy-duty plastic sheeting (in good condition, joined at the seams, and securely anchored) or encapsulating vapor suppressants (with re-treatment as necessary to prevent emissions).

j. The Permit Holder must:
   i. Keep contaminated soil covered with continuous heavy-duty plastic sheeting (in good condition, joined at the seams, and securely anchored) whenever soil is to be stored in temporary stockpiles or during on-site transport in trucks. Soil in trucks shall not be left uncovered for more than 1 hour.
   ii. Establish a tipping area for contaminated soils near the active face that is isolated from the tipping area for other wastes.
   iii. Spray contaminated soil with water or vapor suppressant immediately after dumping the soil from a truck at the tipping area.
   iv. Ensure that all contaminated soil is transferred from the tipping area to the active face immediately after spraying with water or vapor suppressant.
   v. Ensure that contaminated soil in the tipping area is not disturbed by subsequent trucks. Trucks shall not drive over contaminated soil in the tipping area or track contaminated soil out of the tipping area on their wheels.
   vi. Spray contaminated soil on the active face with water or vapor suppressant (to keep the soil visibly moist) until the soil can be covered with an approved covering.
   vii. Limit the area of exposed soil on the active face to no more than 6000 ft^2.
   viii. Ensure that contaminated soil spread on the active face is completely covered on all sides with one of the following approved coverings: at least 6 inches of clean compacted soil, at least 12 inches of compacted garbage, or at least 12 inches of compacted green waste.
   ix. Ensure that covering of soil on the active face is completed within one hour of the time that the soil was first dumped from a truck at the tipping area.

k. Contaminated soil shall not be used as daily, intermediate, or final cover material for landfill waste operations unless the requirements of Regulation 8, Rule 40, Sections 116 or 117 have been satisfied.

l. Contaminated soil is considered to be a decomposable solid waste pursuant to Regulation 8, Rule 34. All contaminated soil disposed of at a site shall be included in any calculations of the amount of decomposable waste in place for annual reporting requirements or for purposes of Regulation 8-34-111 or 8-34-304.

m. The Permit Holder shall keep the following records for each lot of soil received, in order to demonstrate on-going compliance with the applicable provisions of Regulation 8, Rule 40 and this part.
   i. For all soil received by the facility (including soil with no known contamination), record the arrival date at the facility, the soil lot number, the amount of soil in the lot, the organic content or organic concentration of the lot (if known), the type of contamination (if any), and keep copies of any test data or other information that documents whether the soil is contaminated (as defined in 8-40-205) or not contaminated, with what, and by how much.

ii. If the soil is tested for organic content after receipt by the facility, a report with the sampling date, test results, and the date results were received.

iii. For all on-site handling of contaminated soil, use a checklist or other approved method to demonstrate that appropriate procedures were followed during all on-site handling activities. One checklist shall be completed for each day and for each soil lot (if multiple lots are handled per day).

iv. For soil aerated in accordance with 8-40-116 or 117 record the soil lot number, the amount of soil in the lot, the organic content, the final placement date, the final placement location, and describe how the soil was handled or used on-site.

v. For final disposal at a landfill, record on a daily basis the soil lot number, the amount of soil placed in the landfill, the disposal date, and the disposal location.

vi. Summarize the total amount of contaminated soil disposed of at this site on a monthly and calendar year basis to demonstrate compliance with subpart g.

All records shall be retained for at least 5 years from the date of entry and shall be made available for District inspection upon request.

(Basis: Offsets and Regulation 8-40-301, 8-40-304 and 8-40-305)

16. During all times that the landfill gas collection system is operating, all collected landfill gas shall be vented to one of the following control system configurations: A-51 Landfill Gas Flare operating alone, A-60 Landfill Gas Flare operating alone, or A-51 and A-60 operating concurrently. In order to assure compliance with this condition, A-51 and A-60 shall be equipped with local and remote alarms and auto restart capabilities. Upon completion of construction of the energy plant, landfill gas may be diverted from the flares to the landfill gas treatment system (S-71) followed by combustion in one or more of the energy plant engines (S-61, S-64, S-65, S-66, and S-67), provided this diversion does not result in any significant decrease in the overall landfill gas collection rate for the site. At least one flare (A-51 or A-60) shall continue to operate at all times during diversion of landfill gas to the treatment system and energy plant to control generated landfill gas that exceeds the capacity of the operational engines and to abate the emissions from the desorption cycle at S-71. (Basis: 8-34-301.1, 8-34-301.3, and 40 CFR 60.752(b)(2)(iii))

17. The landfill gas collection system described in subpart a below shall be operated continuously as defined in Regulation 8-34-219. Wells, collectors, and adjustment valves shall not be shut off, disconnected, or removed from operation without written authorization from the District, unless the Permit Holder complies with all applicable requirements of Regulation 8, Rule 34, Sections 113, 116, 117, and 118. The Permit Holder shall apply for and receive an Authority to Construct before altering the landfill gas collection system described in subpart a below. Increasing or decreasing the number of wells or collectors, or significantly changing the length of collectors or the locations of wells or collectors are alterations that are subject to the Authority to Construct requirement. Adding or altering risers, laterals, or header pipes are not subject to this Authority to Construct requirement. The authorized number of landfill gas collection system components is the baseline count listed below plus any components added and minus any components decommissioned pursuant to Part

17b as evidenced by start-up/shut-down notification letters submitted to the District.

a. The Permit Holder has been issued a Permit to Operate for the landfill gas collection system components listed below, which includes all start-up/shut-down notifications submitted through February 1, 2010. Well and collector locations, depths, and lengths are as described in detail in Permit Application #21623.

	Required Components
Total Number of Vertical Wells:	90
Total Number of Horizontal Collectors:	7

b. The Permit Holder has been issued an Authority to Construct for the landfill gas collection system components listed below. Specific well and collector locations, depths, and lengths of associated piping are as described in detail in Permit Application #21623.

	Minimum	Maximum
Install New Vertical Wells:	0	36
Decommission Vertical Wells:	0	20
Install New Horizontal Collectors	0	10
Decommission Horizontal Collectors	0	5
Replace Vertical Wells *	0	15

* one-for-one well replacement at new optimal locations

Wells installed or shutdown pursuant to subpart b shall be added to or removed from subpart a in accordance with the procedures identified in Regulations 2-6-414 or 2-6-415. The Permit Holder shall maintain records of the decommissioning date for each well that is shut down and the initial operation date for each new well.

(Basis: Regulations 2-1-301, 8-34-301.1, 8-34-304, 8-34-305, and 2-6-413)

18. The concentrations of non-methane organic compounds (NMOC), toxic air contaminants (TAC), and total reduced sulfur (TRS) compounds in landfill gas collected from the S-5 Redwood Landfill shall not exceed the limits listed below.

a. Total Non-Methane Organic Compounds: 360 ppmv
(calculated as hexane equivalent)
(Basis: Cumulative Increase and Offsets)

*b. For toxic air contaminants (TACs):

Compound	Concentration
Acrylonitrile	300 ppbv
Benzene	1,500 ppbv
Benzyl Chloride	500 ppbv
Carbon Tetrachloride	200 ppbv
Chlorobenzene	200 ppbv
Chloroethane	500 ppbv
Chloroform	200 ppbv
1,4 Dichlorobenzene	1,000 ppbv
Ethylbenzene	4,000 ppbv
Ethylene Dibromide	200 ppbv
Ethylene Dichloride	200 ppbv
Ethylidene Dichloride	500 ppbv
Hexane	2,000 ppbv
Isopropyl Alcohol	10,000 ppbv
Methyl Alcohol	300,000 ppbv
Methyl Ethyl Ketone	15,000 ppbv

Methylene Chloride	1,000 ppbv
Methyl tert-Butyl Ether	500 ppbv
Perchloroethylene	1,000 ppbv
1,1,2,2 Tetrachloroethane	200 ppbv
Styrene	500 ppbv
Toluene	20,000 ppbv
1,1,1 Trichloroethane	200 ppbv
Trichloroethylene	500 ppbv
Vinyl Chloride	2,000 ppbv
Vinylidene Chloride	500 ppbv
Xylenes	20,000 ppbv

(Basis: Regulation 2-5-302)

c. The concentration of total reduced sulfur compounds (TRS) in collected landfill gas shall not exceed an annual average of 350 ppmv (calculated as H2S) and shall not exceed the following peak limits during any single test:

505 ppmv of TRS (calculated as H2S), during 2011-2014;
450 ppmv of TRS (calculated as H2S), during 2015-2018;
410 ppmv of TRS (calculated as H2S), during 2019-2022; and
370 ppmv of TRS (calculated as H2S), during 2023 and later.

The peak and annual average TRS concentrations shall be measured and calculated in accordance with Parts 31a and 31b. (Basis: Cumulative Increase, RACT, AB-2588 Air Toxics Hot Spots Act, and Regulations 2-5-302.3, 9-1-302, and 9-2-301)

19. The A-51 and A-60 Landfill Gas Flares shall be fired on landfill gas. Upon completion of construction of the S-71 Gas Treatment System, waste gas from the desorption cycle of S-71 may be delivered to either flare (A-51 or A-60) for control. During any time that desorption cycle waste gases are being vented to a flare, a sufficient amount of landfill gas shall be burned as fuel in the flare to ensure that the flare continues to meet all temperature and emission limits specified in Parts 22-27 below. (Basis: RACT and Regulation 2-2-112)

20. The throughput of landfill gas (with an HHV of 500 BTU/scf) to the A-51 Landfill Gas Flare shall not exceed shall not exceed 4,320,000 scf during any one day. The throughput of landfill gas (with an HHV of 500 BTU/scf) to the A-60 Landfill Gas Flare shall not exceed 4,320,000 scf during any one day. The total throughput of landfill gas (with an HHV of 500 BTU/scf) to the A-51 and A-60 Flares combined shall not exceed ~~2,207,520,000~~ 2625 million scf during any consecutive 12 month period. In order to demonstrate compliance with this condition, the A-51 and A-60 Flares shall each be equipped with one or more properly operating continuous gas flow meters. (Basis: Cumulative Increase, 40 CFR 60.756(b)(2)(i))

21. [deleted]

22. The temperature in the combustion zone of each flare shall be maintained at the minimum temperature listed below, averaged over any 3-hour period. In order to demonstrate compliance with this condition, A-51 and A-60 shall each be equipped with a continuous temperature monitor and recorder. The A-60 Flare shall be equipped with a continuous temperature monitor in each operating zone of the stack (Zone A and Zone B). The temperature recorder for A-60 shall

continuously record either the Zone A or the Zone B temperature, compatible with the zone the flare is operating in. If a source test demonstrates compliance with all applicable requirements at a different temperature, the APCO may revise these temperature limits, in accordance with the procedures identified in Regulation 2-6-414 or 2-6-415, based on the following criteria. The minimum combustion zone temperature for the flare shall be equal to the average combustion zone temperature determined during the most recent complying source test minus 50 degrees F, provided that the minimum combustion zone temperature is not less than 1400 degrees F. (Basis: Regulations 2-5-302, 8-34-301.3 and 8-34-501.3, and 40 CFR 60.756(b)(1))

a. The minimum combustion zone temperature for A-51 is 1400 degrees F, averaged over any 3-hour period.

b. The minimum combustion zone temperature for each stack zone at A-60 (Zone A and Zone B) is 1400 degrees F, averaged over any 3-hour period.

23. The A-51 and A-60 Landfill Gas Flares shall comply with the NMOC emission limit in Regulation 8-34-301.3. (Basis: Cumulative Increase, 8-34-301.3, and 40 CFR 60.752(b)(2)(iii)(B))

*24. [deleted]

25. Nitrogen oxides (NO_x) emissions from each enclosed flare (A-51 and A-60) shall not exceed 0.06 pounds of NO_x, calculated as NO_2, per million BTU. Compliance with this emission limit may be demonstrated by not exceeding the following flue gas concentration limit: 15 ppmv of NO_x, corrected to 15% oxygen, dry basis. (Basis: RACT and Offsets)

26. Carbon monoxide (CO) emissions from each enclosed flare (A-51 and A-60) shall not exceed 0.20 pounds of CO per million BTU. Compliance with these emission limits may be demonstrated by not exceeding the following flue gas concentration limits: 82 ppmv of CO, corrected to 15% oxygen, dry basis. (Basis: RACT and Cumulative Increase)

27. ~~[deleted]~~Sulfur dioxide (SO_2) emissions from each enclosed flare (A-51 and A-60) shall not exceed 1.69 pounds of SO_2 per million BTU and shall not exceed the Regulation 9-1-302 flue gas concentration limit of 300 ppmv of SO_2. (Basis: RACT, Cumulative Increase, and Regulation 9-1-302)

28. [deleted]

29. The Permit Holder shall maintain records of all planned and unanticipated shut downs of the A-51 and A-60 Flares and of any temperature excursions. The records shall include the date, time, duration, and reason for any shut down or excursion. Any unanticipated shut downs or temperature excursions shall be reported to the Enforcement Division immediately. All inspection and maintenance records, records of shut downs and excursions, gas flow records, temperature records, analytical results, source test results, and any other records required to demonstrate compliance with the above permit conditions, Regulation 8 Rule 34, or 40 CFR Part 60 Subpart WWW shall be retained on site for a minimum of five years and shall be made available to District staff upon request. (Basis: 2-6-501, 8-34-501, 40 CFR 60.758)

30. In order to demonstrate compliance with Parts 22, 23, 25, ~~and~~ 26, and 27 above, Regulations 8~~, Rule~~ -34~~, Sections~~ -301.3, 8-34- ~~and~~ 412, 9-1-302, and 40 CFR 60.8 and 60.752(b)(2)(iii)(B), the Permit Holder shall ensure that a District approved source test is conducted annually on the A-51 Landfill Gas Flare and the A-60 Landfill Gas Flare. Within 90 days of initial start-up of the gas treatment system (S-71), the owner/operator shall conduct an initial compliance demonstration source test on a flare during a desorption cycle event when waste gas from the gas treatment system is being vented to the flare for control. In addition to Parts 30(a-g) below, the owner/operator shall also determine Parts 30(h-k) while the flare is controlling desorption cycle waste gases. Each annual source test shall determine the following:

a. landfill gas flow rate to the flare (dry basis);
b. concentrations (dry basis) of carbon dioxide (CO_2), nitrogen (N_2), oxygen (O_2), total hydrocarbons (THC), methane (CH_4), and total non-methane organic compounds (NMOC) in the landfill gas;
c. stack gas flow rate from the flare (dry basis);
d. concentrations (dry basis) of NO_x, CO, NMOC, and O_2 in the flare stack gas;
e. NMOC destruction efficiency achieved by the flare;
f. NO_x and CO emission rates from the flare in units of pounds per MM BTU,
g. average combustion zone temperature in the flare during the test period.

Upon completion of construction of the gas treatment system and energy plant, the owner/operator shall determine the following during initial and annual source tests:

h. desorption cycle waste gas flow rate to the flare (dry basis);
i. concentrations of NMOC (expressed as CH_4) and total sulfur (expressed as H_2S) in the desorption cycle waste gas. During the initial compliance demonstration test for this new process, the operator shall take sufficient readings during the entire desorption cycle to capture both the peak NMOC and sulfur concentrations during the desorption cycle and the average NMOC and sulfur concentrations over the entire cycle.
j. concentration of sulfur dioxide (SO_2) in the flare stack gas;
k. SO_2 emission rate in units of pounds per MM BTU.

Annual source tests shall be conducted no later than 12 months after the previous test. The annual source test at A-60 may be conducted while it is operating in either zone, provided that each operating zone is tested at least once every five years. The Source Test Section of the District shall be contacted to obtain approval of the source test procedures at least 14 days in advance of each source test. The Source Test Section shall be notified of the scheduled test date at least 7 days in advance of each source test. The source test report shall be submitted to the Compliance and Enforcement Division and the Source Test Section within 60 days of the test date. (Basis: Cumulative Increase, RACT, Offsets, Regulations 2-5-501, 8-34-301.3, 8-34-412, 40 CFR 60.8 and 40 CFR 60.752(b)(2)(iii)(B))

31. Landfill Gas Testing:

a. The Permit Holder shall conduct a characterization of the landfill gas on a quarterly basis with one test concurrent with one of the annual source tests required by Part 30 above. The landfill gas sample shall be drawn from the main landfill gas header. Each quarterly landfill gas sample shall be analyzed for the sulfur compounds listed below. Once per year (concurrent with a Part 30 annual source test) the landfill gas shall be analyzed for all the organic and sulfur compounds listed below. All concentrations shall be reported on a dry basis. The laboratory analysis report for the annual organic and sulfur compound gas characterization test shall be included with the Part 30 source test report and shall be submitted to the Compliance and Enforcement Division and the Source Test Section within 60 days of the test date. (Basis: AB-2588 Air Toxics Hot Spots Act, Cumulative Increase, and Regulations 2-5-302, 8-34-412, 9-1-302, and 9-2-301)

Organic Compounds	Sulfur Compounds
acrylonitrile	carbon disulfide
benzene	carbonyl sulfide
carbon tetrachloride	dimethyl sulfide
chlorobenzene	ethyl mercaptan
benzyl chloride	hydrogen sulfide
chloroethane	methyl mercaptan
chloroform	
1,1 dichloroethane	
1,1 dichlorethene	
1,2 dichlorethane	
1,4 dichlorobenzene	
methyl alcohol	
MTBE	
ethylbenzene	
ethylene dibromide	
styrene	
hexane	
isopropyl alcohol	
methyl ethyl ketone	
methylene chloride	
perchloroethylene	
toluene	
1,1,1 trichloroethane	
1,1,2,2 tetrachloroethane	
trichloroethylene	
vinyl chloride	
xylenes	

b. Once per week, beginning no later than March 31, 2005, the Permit Holder shall analyze the landfill gas for hydrogen sulfide (H2S) concentration using a Draeger tube to further demonstrate compliance with Part 18c and Regulation 9-1-302. The landfill gas sample shall be drawn from the main landfill gas header. The Permit Holder shall follow the manufacturer's procedures for using the Draeger tube and interpreting the results. The total reduced sulfur (TRS) content of the landfill gas shall be calculated using the average ratio of TRS/H2S for this site according to the following equation: TRS = 1.015 * H2S measured by Draeger tube. The Permit Holder shall maintain records of all Draeger tube test dates and test results and shall summarize the average H2S concentrations and the calculated TRS content of the landfill gas on a quarterly basis. Each Draeger tube test result (after conversion to TRS content) and the quarterly laboratory analysis in Part 31a shall be compared to the Peak TRS Limit in Part 18c. On a rolling quarterly basis, the Permit Holder shall determine the annual average TRS content for comparison to the Annual Average TRS Limit in Part 18c. (Basis: Cumulative Increase, RACT, and Regulations 9-1-302 and 9-2-301).

32. The annual report required by BAAQMD Regulation 8-34-411 shall be submitted in two semi-annual increments. The reporting period for the first increment of the Regulation 8-34-411 annual report that is submitted subsequent to the issuance of the MFR Permit for this site shall be from December 1, 2003 through April 30, 2004. This first increment report shall be submitted by May 31, 2004. The reporting periods and report submittal due dates for all subsequent increments of the Regulation 8-34-411 report shall be synchronized with the reporting periods and report submittal due dates for the semi-annual MFR Permit monitoring reports that are required by Section I.F of the MFR Permit for this site. A single report may be submitted to satisfy the requirements of Section I.F, Regulation 8-34-411, and 40 CFR Part 63.1980(a), provided that all items required by each applicable reporting requirement are included in the single report. (Basis: Regulation 8-34-411 and 40 CFR Part 63.1980(a))

33. Within 3 months of approval of the permit condition changes pursuant to Application # 20607, the Permit Holder shall submit a proposal for monitoring ground level hydrogen sulfide concentrations at or near the fence line or property boundary for this facility and a proposal that identifies all feasible hydrogen sulfide emission reduction measures that could be implemented at this site if necessary. The Permit Holder shall initiate hydrogen sulfide monitoring within 3 months of receiving District approval for the monitoring protocol. If a measured hydrogen sulfide concentration at the fence line or property boundary exceeds a concentration limit in Regulation 9-2-301 (0.03 ppmv averaged over 60 minutes or 0.06 ppmv averaged over 3 minutes), the Permit Holder shall notify the District of the excess and shall implement any hydrogen sulfide emission reduction measures required by the District at that time. Ground level hydrogen sulfide monitoring may be discontinued five years after this facility ceases waste disposal activities or when the TRS content in the collected landfill gas (measured pursuant to Part 31b) is less than 110 ppmv of TRS for at least 8 consecutive quarters, whichever occurs sooner. (Basis: Regulation 9-2-301)

E. RECOMMENDATION

The District has completed the review of the material contained in the permit application for this proposed project and has made a preliminary determination that the proposed project is expected to comply with all applicable requirements of District, state, and federal air quality-related regulations. The preliminary recommendation is to issue an Authority to Construct for the new equipment listed below and a Change of Conditions for the existing landfill gas flares (A-51 and A-60).

However, the proposed project triggers public notification pursuant to Regulation 2-2-405 because this facility is a Title V major facility (it has the potential to emit more than 100 tons/year of CO emissions) and because this proposed project will result in more than 100 tons/year of CO emission increases and more than 40 tons/year of SO_2 emission increases from the proposed new equipment. Regulation 2-2-405 requires a 30 day public comment period. After comments are received and reviewed, the District will make a final determination on the permit.

I recommend that the District initiate a public notice for this project in accordance with the requirements of Regulation 2-2-405 and consider any comments received prior to taking final action on the issuance of the Authority to Construct for the following equipment:

S-64 **Internal Combustion Engine # 1**; Caterpillar 3520 C (1.966 MW); 2739 bhp, 21.61 MM BTU/hour; fired on treated landfill gas, 725 scfm; abated by **A-64 Oxidation Catalyst**, Miratech, SP-IQ-RE-300X with guard bed (SP-IQ-RE-30GB) or equivalent; and abated by **A-74 Selective Catalytic Reduction System**, Miratech, RFV.1250.55.0075.450 (18 ft^3), with urea injection and ACIS II controller or equivalent.

S-65 **Internal Combustion Engine # 2**; Caterpillar 3520 C (1.966 MW); 2739 bhp, 21.61 MM BTU/hour; fired on treated landfill gas, 725 scfm; abated by **A-65 Oxidation Catalyst**, Miratech, SP-IQ-RE-300X with guard bed (SP-IQ-RE-30GB) or equivalent; and abated by **A-75 Selective Catalytic Reduction System**, Miratech, RFV.1250.55.0075.450 (18 ft^3), with urea injection and ACIS II controller or equivalent.

S-66 **Internal Combustion Engine # 3**; Caterpillar 3520 C (1.966 MW); 2739 bhp, 21.61 MM BTU/hour; fired on treated landfill gas, 725 scfm; abated by **A-66 Oxidation Catalyst**, Miratech, SP-IQ-RE-300X with guard bed (SP-IQ-RE-30GB) or equivalent; and abated by **A-76 Selective Catalytic Reduction System**, Miratech, RFV.1250.55.0075.450 (18 ft^3), with urea injection and ACIS II controller or equivalent.

S-67 **Internal Combustion Engine # 4**; Caterpillar 3520 C (1.966 MW); 2739 bhp, 21.61 MM BTU/hour; fired on treated landfill gas, 725 scfm; abated by **A-67 Oxidation Catalyst**, Miratech, SP-IQ-RE-300X with guard bed (SP-IQ-RE-30GB) or equivalent; and abated by **A-77 Selective Catalytic Reduction System**, Miratech, RFV.1250.55.0075.450 (18 ft^3), with urea injection and ACIS II controller or equivalent.

S-71 **Landfill Gas Treatment System – Desorption Process**; custom design; abated by A-51 or A-60 Enclosed Landfill Gas Flares.

I recommend that the District initiate a public notice for this project in accordance with the requirements of Regulation 2-2-405 and consider any comments received prior to taking final action on the issuance of a Change of Conditions for the following equipment:

A-60 Landfill Gas Flare; abating S-5 Redwood Landfill and S-71 Landfill Gas Treatment System – Desorption Process.

Carol L Allen

10/7/13

Prepared By: Date:

Carol Allen
Supervising Air Quality Engineer

APPENDIX A

Emissions Calculations
for Application # 24495

Redwood Landfill (Plant # 1179)
Facility Wide Maximum Potential to Emit
October 2013

Source #	Source Description	NOx	CO	POC	NPOC	PM10	SO2	HAP	GHG	non-biogenic GHG as CO2e
		Maximum Potential Emissions (tons/year)								
S-2	Sewage Sludge Storage, Main Pond			0.11		0.11		0.11		
S-5	Redwood Landfill, waste decomposition			26.38	0.26			13.08	149190	128665
S-34	Active Compost and Co-Compost Windrows			22.50		1.06		0.23		
S-39	Trommell Screening Processes					0.01				
S-41	Temporary Stockpiles for Yard and Green Waste Shredding Operations					2.43				
S-42	Soil Stockpiles (including VOC-laden soil)			2.64		0.03		2.64		
S-49	Diesel Engine (BUG)	0.03	0.00	0.00		0.00	0.00	0.00	48	48
S-55	Gasoline Dispensing Facility G# 8573			0.99				0.10		
S-56	Horizontal Grinder (exempt)					10.00				
S-57	Diesel Engine for Portable Horizontal Grinder (exempt)	10.00	1.67	0.12		0.13	0.26	0.12	809	809
S-58	Aerated Leachate Pond			0.08	0.05			0.08		
A-51 & A-60	Landfill Gas Flares	39.138	130.460	9.119	0.091	11.157	99.000	6.525	154344	5821
S-61	Portable Diesel Engine for Waste Tipper	0.83	0.38	0.04	0.00	0.01	0.02	0.04	189	189
S-62	Portable Diesel Engine for Power Screens	0.83	0.38	0.04	0.00	0.01	0.02	0.04	189	189
S-76	Redwood Landfill, waste and cover material disposal					102.83				
S-76	Redwood Landfill, contaminated soil disposal			0.31				0.31		
S-76	Redwood Landfill, VOC-laden soil as daily cover			2.63				2.63		
S-77	Redwood Landfill, excavating, bulldozing, and compacting activities					51.42				
Total	All Sources and Abatement Devices	50.828	132.901	64.966	0.405	179.184	99.294	25.906	304769	135720
Total	All Non-Fugitive Emissions	50.828	132.901	10.398	0.141	124.150	99.294	6.916	155579	7055

		NOx	CO	POC	NPOC	PM10	SO2	HAP	GHG	non-biogenic GHG as CO2e
	Total of All Sources Above, Excluding Flares	11.690	2.440	55.846	0.314	168.026	0.294	19.381	150424	129900
S-64, S-65, S-66, & S-67	Total for Landfill Gas to Energy Project (App 24495) at new BACT Limits	39.138	237.500	16.927	0.846	10.579	99.000	11.617	114620	33740
A-51 & A-60	Remaining LFG Controlled By Flares (Peak Gen Rate - Total Flow Rate to LFG Engines)			3.826	0.038	4.681		2.738	64767	2443
Proposed	Total With Engines at Prpsd Limits Plus Remaining Gas to Flares	50.828	239.940	76.600	1.199	183.287	99.294	33.736	329812	166082
Proposed	Above Excluding Fugitive Emissions	50.828	239.940	22.032	0.935	25.420	99.294	14.746	180622	37417

Pre Project Facility Wide PTE		NOx	CO	POC	NPOC	PM10	SO2	HAP	GHG	non-biogenic GHG as CO2e
Total	All Sources and Abatement Devices	44.803	112.816	63.562	0.391	177.466	64.631	24.879	281007	134824
Total	All Non-Fugitive Emissions	44.803	112.816	8.994	0.127	71.016	64.631	5.889	131818	6159

	NOx	CO	POC	NPOC	PM10	SO2	HAP	GHG	non-biogenic GHG as CO2e
PTE Increases	6.025	127.124	13.038	0.807	5.821	34.662	8.857	48804	31258
New Flare and Engine Limits Combined	39.138	237.500	20.753	0.885	15.261	99.000	14.355	179387	36182
Actual Average Flare Emissions	17.669	21.576	6.878		6.242	49.486	6.878	86348	3256
Project Increase (Potential - Actual)	21.469	215.924	13.875	0.885	9.019	49.514	7.477	93039	32926
Engine Increases Alone (Increases for New Equipment)	15.869	190.429	16.927	0.846	10.579	18.918	11.617	114620	33740
Max Project Increases (Potential - Actual) or (Engine Increases)	21.469	215.924	16.927	0.885	10.579	49.514	11.617	114620	33740
Offsets Required:	24.689		19.466						

Plant # 1179, Redwood Landfill, Inc.
Application # 24495
(Revised based on Redwood's 7/25/13 Submittal)

Emission Calculations for LFG-Fired Engines

IC Engine Manufacturer Data:

Rated Horsepower	2739	bhp
Nominal Power Output	1.966	MW
Reported Electrical Efficiency	37.5%	
Reported Fuel Consumption Rate:	6936	BTU (LHV) / bhp-hour
Reported Max Fuel Usage Rate:	18.998	MM BTU (LHV) / hour
Calculated Fuel Usage (HHV)	21.079	MM BTU (HHV) / hour (at 60 F)

Operating Time:	60	minute/hour
Operating Time:	24	hours/day
Operating Time:	365	days/year
Number of Engines:	4	engines

IC Engine Calculation Basis:

Rated Horsepower	2739	bhp			
Requested Max Permitted Fuel Use:	21.610	MM BTU (HHV)/hour, based on LFG at 70°F (725 scfm at 496.9 BTU/scf)			
Max Permitted Fuel Rate:	7890	BTU (HHV)/bhp-hour			
LFG Heat Content (HHV) at 70 °F	496.9	BTU (HHV) / scf of LFG containing 50% methane at 70°F			
Max Permitted Gas Flow Rate:	725	scfm	per engine		
Max Hourly Gas Flow Rate:	43486	scf/hour	per engine	21.61	MM BTU/hour per eng
Max Daily Gas Flow Rate:	1043660	scf/day	per engine	518.6	MM BTU/day per eng
Max Annual Gas Flow Rate:	380935940	scf/year	per engine	189304	MM BTU/year per eng
Total Annual Gas Flow Rate:	1524	MM scf/yr	all engines	757214	MM BTU/year all engs

Determination of Flue Gas Exhuast Rates:

LFG Flue Gas Factor:	4.785	sdcf of flue gas at 0% O_2 / scf of LFG burned
Oxygen in Ambient Air	20.90%	O_2 by volume, dry basis
Typical Flue Gas Oxygen:	9.1%	O_2 by volume, dry basis
Typical Exhaust Temperature:	928	°F
Typical Flue Gas Water Content:	6.0%	H_2O by volume
Standard Dry Flue Gas, 0% O_2	3468	sd cfm of flue gas at 0% O_2
Standard Dry Flue Gas, 9.1% O_2	6142	sd cfm of flue gas at 9.1% O_2
Actual Dry Flue Gas, 9.1% O_2	16085	ad cfm of flue gas at 9.1% O_2
Actual Wet Flue Gas, 9.1% O_2	17050	aw cfm of flue gas at 9.1% O_2

IC Engine Emission Factors: Scenario A: Applicant's Proposal: Gas Pretreatment, Oxidation Catalysts, SCR

									Equivalent Emission Limits and Outlet Concentrations					
Basis for Uncontrolled Emission Factor	Pollutant	Units	Hourly or ST Period Limit	grams / bhp-hour	pounds / hour	pounds / day	tons/year per engine	Total tons/year (4 engines)	pounds / MM BTU	pounds / M scf LFG	ppmv @ 0% O_2	ppmv @ 3% O_2	ppmv @ 15% O_2	grains / sdcf @ 0% O_2
Mfg Guarantee, Permit Condition Limit	CO	g/bhp-hr	1.8	1.800	10.869	260.86	47.607	190.429	0.50297	0.24995	722	618	204	
Mfg Guarantee, Permit Condition Limit	NOx	g/bhp-hr	0.15	0.150	0.906	21.74	3.967	15.869	0.04191	0.02083	37	31	10	
Reg 8-34-301.4 NMOC Outlet Conc. Limit	POC	ppmv as CH_4 @ 3% O_2	120	0.200	1.208	29.00	5.293	21.172	0.05592	0.02779	140	120	40	
Applicant Proposed Limit (annual avg.; peak =505)	SO2	ppmv of TRS (as H_2S) in LFG	350	0.417	2.520	60.47	11.035	44.142	0.11659	0.05794	403	345	114	
Applicant Proposed BACT Limit	PM10	g/bhp-hr	0.1	0.100	0.604	14.49	2.645	10.579	0.02794	0.01389				0.0203
BAAQMD Calculation	NPOC	of POC emission rate	5%	0.010	0.060	1.45	0.265	1.059	0.00280	0.00139	7	6	2	
SCR Mfg. Guarantee	NH3	ppmv @ 15% O_2	20	0.107	0.649	15.57	2.841	11.365	0.03002	0.01492	71	61	20	

IC Engine Emission Factors: Scenario B: Gas Pretreatment, Oxidation Catalysts, SCR, with District Proposed Limits

									Equivalent Emission Limits and Outlet Concentrations						
Basis for Uncontrolled Emission Factor	Pollutant	Units	Hourly or ST Period Limit	grams / bhp-hour	pounds / hour	pounds / day	tons/year per engine	Total tons/year (4 engines)	pounds / MM BTU	pounds / M scf LFG	ppmv @ 0% O_2	ppmv @ 3% O_2	ppmv @ 15% O_2	grains / sdcf @ 0% O_2	grains / sdcf @ 15% O_2
District Proposed BACT Limit	CO	g/bhp-hr	1.8	1.800	10.869	260.86	47.607	190.429	0.50297	0.24995	722	618	204		
District Proposed BACT Limit	NOx	g/bhp-hr	0.15	0.150	0.906	21.74	3.967	15.869	0.04191	0.02083	37	31	10		
District Proposed BACT Limit	POC	g/bhp-hr	0.16	0.160	0.966	23.19	4.232	16.927	0.04471	0.02222	112	96	32		
District Proposed BACT Limit	SO2	ppmv of TRS (as H_2S) in LFG	150	0.179	1.080	25.92	4.729	18.918	0.04997	0.02483	31	27	9		
District Proposed BACT Limit	PM10	g/bhp-hr or 10.0 lb/day limit	0.1	0.100	0.604	14.49	2.645	10.579	0.02794	0.01389				0.0203	0.0057
BAAQMD Calculation	NPOC	of POC emission rate	5%	0.008	0.048	1.16	0.212	0.846	0.00224	0.00111	6	5	2		
District Proposed TBACT Limit	NH3	ppmv @ 15% O_2	10	0.054	0.324	7.78	1.421	5.683	0.01501	0.00746	35	30	10		

GHG Emissions

		grams / bhp-hour	pounds / hour	pounds / day	tons/year per engine	Total tons/year (4 engines)	pounds / MM BTU	pounds / M scf LFG	ppmv @ 0% O_2	ppmv @ 3% O_2	ppmv @ 15% O_2	Engines tons/yr as CO2e
CH4	3000 ppmv at 15% O2 (CARB Limit from Landfill Methane CM)	15.179	91.658		401.46	1605.8	4.24146	2.10777	10627	9102	3000	33,723
N2O	0.001% in LFG, 75% dest. by comb, 75% control by SCR	0.001	0.003		0.014	0.1	0.00014	0.000071				17
Total CO2e (non-biogenic)			1925.776	46219	8434.9	33739.6		44.285				33,740
Biogenic CO2	106.16 lbs/M scf of LFG		4616.457		20220.1	80880.3	213.626	106.160				80,880
Total GHG expressed as CO2e (including both non-biogenic and biogenic sources of CO2e)					28655	114620						114,620

	lbs/MM BTU	Lbs/M scf
CH4		2.108E+00
N2O		7.108E-05
CO2 (biogenic)		1.062E+02

	scfm of LFG
Total Gas to Engines	2899
Remainder of Gas to Flares:	2096
Total (projected gas generation rate)	4995

APPLICATION #24495: New LFG Fired Energy Plant Including 4 IC Engines Equipped with Oxidation Catalyst and SCR System Controls (2739 bhp, 725 sc

Proposed TAC Emissions from S-64 through S-67 LFG-Fired IC Engines with LFG Pre-Treatment and Post-Combustion Oxidation Catalysts (A-64 - A-67) and SCR System (S-74 - S-77) Controls

Capacity (each engine)	21.610	MM BTU/hour	Number of Engines:	4
LFG Methane Content	50%			
LFG Heat Content	496.9	BTU/scf		
Max LFG Flow Rate to Each Engine	725	scfm of LFG		
Max Hourly LFG to Each Engine	43486	scf/hr of LFG		
Capacity (combined)	86.4	MM BTU/hour		
Annual (combined)	757214	MM BTU/year		
Annual Average to Each Engine	380935940	scf/yr of LFG		

Toxic Air Contaminants	Molecular Weights	District Permitted Concentration Levels in LFG	Gas Treatment System Removal Efficiency	Inlet to Each Engine	Combustion Destruction Efficiency	Outlet From Engine (resid + 2nd TACs)	Oxidation Catalyst Control Efficiency	After Oxidation Catalyst	After SCR
	Lbs/Lb-mol	PPBV	%	lbs/MM BTU		lbs/MM BTU		lbs/MM BTU	lbs/MM BTU
Acetaldehyde	44.053	200	50%	2.301E-05	85%	3.451E-06	50%	1.726E-06	1.726E-06
Acrylonitrile	53.063	300	50%	4.157E-05	85%	6.235E-06	50%	3.118E-06	3.118E-06
Benzene	78.112	1500	50%	3.060E-04	85%	4.589E-05	50%	2.295E-05	2.295E-05
Benzyl Chloride *	126.583	500	50%	1.653E-04	85%	2.479E-05	50%	1.240E-05	1.240E-05
1,3 Butadiene	54.090	500	50%	7.062E-05	85%	1.059E-05	50%	5.297E-06	5.297E-06
Carbon Tetrachloride (tetrachloromethane)	153.822	200	50%	8.034E-05	85%	1.205E-05	50%	6.025E-06	6.025E-06
Chlorobenzene	112.557	200	50%	5.878E-05	85%	8.818E-06	50%	4.409E-06	4.409E-06
Chloroethane (ethyl chloride)	64.514	500	50%	8.423E-05	85%	1.263E-05	50%	6.317E-06	6.317E-06
Chloroform	119.377	200	50%	6.235E-05	85%	9.352E-06	50%	4.676E-06	4.676E-06
1,4 Dichlorobenzene	147.001	1000	50%	3.839E-04	85%	5.758E-05	50%	2.879E-05	2.879E-05
Ethyl Benzene	106.165	4000	50%	1.109E-03	85%	1.663E-04	50%	8.317E-05	8.317E-05
Ethylene Dibromide (1,2-dibromoethane)	187.861	200	50%	9.811E-05	85%	1.472E-05	50%	7.358E-06	7.358E-06
Ethylene Dichloride (1,2-dichloroethane)	98.959	200	50%	5.168E-05	85%	7.752E-06	50%	3.876E-06	3.876E-06
Ethylidene Dichloride (1,1-dichloroethane)	98.959	500	50%	1.292E-04	85%	1.938E-05	50%	9.690E-06	9.690E-06
Hexane	86.175	2000	50%	4.501E-04	85%	6.751E-05	50%	3.375E-05	3.375E-05
Hydrogen Sulfide	34.082	505000	50%	4.494E-02	85%	6.742E-03	0%	6.742E-03	6.742E-03
Isopropyl Alcohol (isopropanol)	60.095	10000	50%	1.569E-03	85%	2.354E-04	50%	1.177E-04	1.177E-04
Methyl Alcohol (methanol) *	32.042	300000	50%	2.510E-02	85%	3.765E-03	50%	1.883E-03	1.883E-03
Methyl Ethyl Ketone (2-butanone)	72.106	15000	50%	2.824E-03	85%	4.237E-04	50%	2.118E-04	2.118E-04
Methylene Chloride (dichloromethane)	84.932	1000	50%	2.218E-04	85%	3.327E-05	50%	1.663E-05	1.663E-05
Methyl tert-Butyl Ether	88.148	500	50%	1.151E-04	85%	1.726E-05	50%	8.632E-06	8.632E-06
Perchloroethylene (tetrachloroethylene)	165.832	1000	50%	4.330E-04	85%	6.496E-05	50%	3.248E-05	3.248E-05
1,1,2,2 Tetrachloroethane	167.848	200	50%	8.766E-05	85%	1.315E-05	50%	6.575E-06	6.575E-06
Styrene	104.149	500	50%	1.360E-04	85%	2.040E-05	50%	1.020E-05	1.020E-05
Toluene	92.138	20000	50%	4.812E-03	85%	7.218E-04	50%	3.609E-04	3.609E-04
1,1,1 Trichloroethane (methyl chloroform)	133.403	200	50%	6.967E-05	85%	1.045E-05	50%	5.225E-06	5.225E-06
Trichloroethylene	131.387	500	50%	1.715E-04	85%	2.573E-05	50%	1.287E-05	1.287E-05
Vinyl Chloride	62.498	2000	50%	3.264E-04	85%	4.896E-05	50%	2.448E-05	2.448E-05
Vinylidene Chloride (1,1-dichloroethylene)	96.943	500	50%	1.266E-04	85%	1.899E-05	50%	9.493E-06	9.493E-06
Xylenes (o, m, & p)	106.165	20000	50%	5.545E-03	85%	8.317E-04	50%	4.158E-04	4.158E-04
Hydrogen Chloride	36.461	40000	50%	3.808E-03	85%	3.808E-03	0%	3.808E-03	3.808E-03
Hydrogen Fluoride	20.006	4000	50%	2.090E-04	85%	2.090E-04	0%	2.090E-04	2.090E-04
Formaldehyde	30.026	(based on hourly emission limit needed to pass risk screen)						2.360E-02	2.360E-02
Naphthalene		(CATEF Factor: 2.18E-2 lbs/MM scf LFG)				4.387E-05	0%	4.387E-05	4.387E-05
PAH as benzo(a)pyrene equivalent		(CATEF Factor: 4.59E-4 lbs/MM scf LFG)				9.236E-07	0%	9.236E-07	9.236E-07
Ammonia from SCR	17.030	(assuming permit limit of 10 ppmv NH3 in outlet at 15% O2)							1.508E-02
Mercury (inorganic)	200.59	77	0	8.067E-05	0%	6.333E-07	0%	6.333E-07	6.333E-07

Total NMOC as CH_4 at outlet (3% O_2)	120	ppmv at 3% O_2
Total Outlet NMOC	140	ppmv at 0% O_2
Theoretical Flue Gas Generation Rate	4.7847	ft3 flue gas/ft3 LFG
F-Factor for LFG	9628	ft3 flue gas at 0% O_2/MM BTU
NMOC EF, lbs/MM BTU	5.617E-02	lbs NMOC as methane/MM BTU
If total NMOC is 100% formaldehyde the formaldehyde emission factor is:	1.051E-01	lbs formaldehyde/MM BTU

Formaldehyde Emission Rate for Each Engine (if all NMOC=Form.)

2.272E+00 pounds/hour per engine

	Per Engine (lbs/hr)
Formaldehyde Limit to Pass Risk Screen:	0.51

If uncontrolled NMOC is at Max Limit and NMOC is 100% Formaldehyde, the Ox Catalyst will need to achieve: 78% control.

:f of LFG, and 21.610 MM BTU/hr each)

Acute (Hourly)				Chronic (Annual)			
Outlet Emissions per Engine	Outlet Emissions from 4 Engines	Risk Screen Trigger Level	Are Emissions > Trigger ?	Outlet Emissions per Engine	Outlet Emissions from 4 Engines	Risk Screen Trigger Level	Are Emissions > Trigger ?
lbs/hour	lbs/hour	lbs/hour		lbs/year	lbs/year	lbs/year	
3.729E-05	1.492E-04	1.00E+00	no	3.267E-01	1.307E+00	3.80E+01	no
6.737E-05	2.695E-04	NA	NA	5.902E-01	2.361E+00	3.80E-01	YES
4.959E-04	1.984E-03	2.90E+00	no	4.344E+00	1.738E+01	3.80E+00	YES
2.679E-04	1.071E-03	5.30E-01	no	2.347E+00	9.386E+00	2.20E+00	YES
1.145E-04	4.578E-04	NA	NA	1.003E+00	4.011E+00	6.30E-01	YES
1.302E-04	5.208E-04	4.20E+00	no	1.141E+00	4.562E+00	2.50E+00	YES
9.527E-05	3.811E-04	NA	NA	8.346E-01	3.338E+00	3.90E+04	no
1.365E-04	5.461E-04	NA	NA	1.196E+00	4.784E+00	1.20E+06	no
1.010E-04	4.042E-04	3.30E-01	no	8.852E-01	3.541E+00	2.00E+01	no
6.222E-04	2.489E-03	NA	NA	5.450E+00	2.180E+01	9.50E+00	YES
1.797E-03	7.189E-03	NA	NA	1.574E+01	6.298E+01	4.30E+01	YES
1.590E-04	6.361E-04	NA	NA	1.393E+00	5.572E+00	1.50E+00	YES
8.376E-05	3.351E-04	NA	NA	7.338E-01	2.935E+00	5.30E+00	no
2.094E-04	8.376E-04	NA	NA	1.834E+00	7.338E+00	6.60E+01	no
7.294E-04	2.918E-03	NA	NA	6.390E+00	2.556E+01	2.70E+05	no
1.457E-01	5.827E-01	9.30E-02	YES	1.276E+03	5.105E+03	3.90E+02	YES
2.543E-03	1.017E-02	7.10E+00	no	2.228E+01	8.912E+01	2.70E+05	no
4.068E-02	1.627E-01	6.20E+01	no	3.564E+02	1.426E+03	1.50E+05	no
4.578E-03	1.831E-02	3.90E+01	no	4.010E+01	1.604E+02	NA	NA
3.595E-04	1.438E-03	3.10E+01	no	3.149E+00	1.260E+01	1.10E+02	no
1.865E-04	7.461E-04	NA	NA	1.634E+00	6.536E+00	2.10E+02	no
7.018E-04	2.807E-03	4.40E+01	no	6.148E+00	2.459E+01	1.80E+01	YES
1.421E-04	5.683E-04	NA	NA	1.245E+00	4.978E+00	1.90E+00	YES
2.204E-04	8.816E-04	4.60E+01	no	1.931E+00	7.723E+00	3.50E+04	no
7.799E-03	3.120E-02	8.20E+01	no	6.832E+01	2.733E+02	1.20E+04	no
1.129E-04	4.517E-04	1.50E+02	no	9.892E-01	3.957E+00	3.90E+04	no
2.780E-04	1.112E-03	NA	NA	2.436E+00	9.742E+00	5.40E+01	no
5.290E-04	2.116E-03	4.00E+02	no	4.634E+00	1.854E+01	1.40E+00	YES
2.051E-04	8.206E-04	NA	NA	1.797E+00	7.188E+00	2.70E+03	no
8.986E-03	3.595E-02	4.90E+01	no	7.872E+01	3.149E+02	2.70E+04	no
8.230E-02	3.292E-01	4.60E+00	no	7.209E+02	2.884E+03	3.50E+02	YES
4.516E-03	1.806E-02	5.30E-01	no	3.956E+01	1.582E+02	5.40E+02	no
5.100E-01	2.040E+00	1.20E-01	YES	4.468E+03	1.787E+04	1.80E+01	YES
9.480E-04	3.792E-03	NA	NA	8.304E+00	3.322E+01	3.20E+00	YES
1.996E-05	7.984E-05	NA	NA	1.748E-01	6.994E-01	6.90E-03	YES
3.258E-01	1.303E+00	7.10E+00	no	2.854E+03	1.142E+04	7.70E+03	YES
1.369E-05	5.474E-05	1.30E-03	no	1.199E-01	4.796E-01	2.70E-01	YES

May 2009 Test Data from Ameresco HMB

	lbs/MM scf	lbs/MM BTU	Redwood Factors lbs/MM BTU	Are Any < Source Test Data?	Ratio Redwood/ Test data
PAH	5.86E-06	1.13E-08	9.236E-07	no	82
Formaldehyc	1.61E+00	3.10E-03	2.360E-02	no	8
Benzene	1.08E-03	2.08E-06	2.295E-05	no	11
Dichlorobenz	6.08E-03	1.17E-05	2.879E-05	no	2

CH4	52.3%
BTU/scf	519.3

Redwood Factors Are OK, even a bit high

0.037 grams/bhp-hr

HAPs (total - H2S - IPA - NH3 - MEK) — tons/year 11.617

	per engine lbs/year	tons/year
Acetaldehyde	0.3	0.001
Acrylonitrile	0.6	0.001
Benzene	4.3	0.009
Benzyl Chloride *	2.3	0.005
1,3 Butadiene	1.0	0.002
Carbon Tetrachloride (tetrachloromethane)	1.1	0.002
Chlorobenzene	0.8	0.002
Chloroethane (ethyl chloride)	1.2	0.002
Chloroform	0.9	0.002
1,4 Dichlorobenzene	5.5	0.011
Ethyl Benzene	15.7	0.031
Ethylene Dibromide (1,2-dibromoethane)	1.4	0.003
Ethylene Dichloride (1,2-dichloroethane)	0.7	0.001
Ethylidene Dichloride (1,1-dichloroethane)	1.8	0.004
Hexane	6.4	0.013
Hydrogen Sulfide	1276.2	2.552
Isopropyl Alcohol (isopropanol)	22.3	0.045
Methyl Alcohol (methanol) *	356.4	0.713
Methyl Ethyl Ketone (2-butanone)	40.1	0.080
Methylene Chloride (dichloromethane)	3.1	0.006
Methyl tert-Butyl Ether	1.6	0.003
Perchloroethylene (tetrachloroethylene)	6.1	0.012
1,1,2,2 Tetrachloroethane	1.2	0.002
Styrene	1.9	0.004
Toluene	68.3	0.137
1,1,1 Trichloroethane (methyl chloroform)	1.0	0.002
Trichloroethylene	2.4	0.005
Vinyl Chloride	4.6	0.009
Vinylidene Chloride (1,1-dichloroethylene)	1.8	0.004
Xylenes (o, m, & p)	78.7	0.157
Hydrogen Chloride	720.9	1.442
Hydrogen Fluoride	39.6	0.079
Formaldehyde	4467.6	8.935
Naphthalene	8.3	0.017
PAH as benzo(a)pyrene equivalent	0.2	0.000
Ammonia from SCR	2853.8	5.708
Mercury (inorganic)	0.1	0.000

Note: HEV below include new acute and chronic RELs for 1,3 butadiene adopted 7/29/13.

OEHHA Health Effects Values (as of 8/1/13)				Acute	Chronic	Cancer	Acute	Chronic	Cancer
Acute REL	Chronic REL	Chronic CPF	HARP multi PW factor	Weighted Emissions per Engine	Weighted Emissions per Engine	Weighted Emissions per Engine			
µg/m³	µg/m³	(mg/kg-day)⁻¹		g/s	g/s	g/s			
4.70E+02	1.40E+02	1.00E-02		1.384E-08	3.356E-08	4.698E-08	0.0%	0.0%	0.0%
NA	5.00E+00	1.00E+00		NA	1.698E-06	8.489E-06		0.0%	0.5%
1.30E+03	6.00E+01	1.00E-01		6.655E-08	1.041E-06	6.248E-06	0.0%	0.0%	0.4%
2.40E+02	NCR	1.70E-01		1.947E-07	NCR	5.738E-06	0.0%		0.4%
6.60E+02	2.00E+00	6.00E-01		3.026E-08	7.211E-06	8.653E-06	0.0%	0.1%	0.5%
1.90E+03	4.00E+01	1.50E-01		1.196E-08	4.101E-07	2.461E-06	0.0%	0.0%	0.2%
NA	1.00E+03	NC		NA	1.200E-08	NC		0.0%	
NA	3.00E+04	NC		NA	5.734E-10	NC		0.0%	
1.50E+02	3.00E+02	1.90E-02		1.175E-07	4.244E-08	2.419E-07	0.0%	0.0%	0.0%
NA	8.00E+02	4.00E-02		NA	9.799E-08	3.136E-06		0.0%	0.2%
NA	2.00E+03	8.70E-03		NA	1.132E-07	1.970E-06		0.0%	0.1%
NA	8.00E-01	2.50E-01		NA	2.504E-05	5.009E-06		0.2%	0.3%
NA	4.00E+02	7.20E-02		NA	2.639E-08	7.599E-07		0.0%	0.0%
NA	NCR	5.70E-03		NA	NCR	1.504E-07			0.0%
NA	7.00E+03	NC		NA	1.313E-08	NC		0.0%	
4.20E+01	1.00E+01	NC		6.051E-04	1.836E-03	NC	26.8%	17.5%	
3.20E+03	7.00E+03	NC		1.387E-07	4.578E-08	NC	0.0%	0.0%	
2.80E+04	4.00E+03	NC		2.535E-07	1.281E-06	NC	0.0%	0.0%	
1.30E+04	NCR	NC		6.143E-08	NCR	NC	0.0%		
1.40E+04	4.00E+02	3.50E-03		4.479E-09	1.132E-07	1.585E-07	0.0%	0.0%	0.0%
NA	8.00E+03	1.80E-03		NA	2.938E-09	4.231E-08		0.0%	0.0%
2.00E+04	3.50E+01	2.10E-02		6.122E-09	2.527E-06	1.857E-06	0.0%	0.0%	0.1%
NA	NCR	2.00E-01		NA	NCR	3.580E-06			0.2%
2.10E+04	9.00E+02	NC		1.831E-09	3.085E-08	NC	0.0%	0.0%	
3.70E+04	3.00E+02	NC		3.677E-08	3.276E-06	NC	0.0%	0.0%	
6.80E+04	1.00E+03	NC		2.897E-10	1.423E-08	NC	0.0%	0.0%	
NA	6.00E+02	7.00E-03		NA	5.839E-08	2.452E-07		0.0%	0.0%
1.80E+05	NCR	2.70E-01		5.127E-10	NCR	1.800E-05	0.0%		1.1%
NA	7.00E+01	NC		NA	3.693E-07	NC		0.0%	
2.20E+04	7.00E+02	NC		7.126E-08	1.618E-06	NC	0.0%	0.0%	
2.10E+03	9.00E+00	NC		6.837E-06	1.152E-03	NC	0.3%	11.0%	
2.40E+02	1.40E+01	NC		3.283E-06	4.064E-05	NC	0.1%	0.4%	
5.50E+01	9.00E+00	2.10E-02		1.618E-03	7.140E-03	1.349E-03	71.7%	68.1%	84.8%
NA	9.00E+00	1.20E-01		NA	1.327E-05	1.433E-05		0.1%	0.9%
NA	NCR	3.90E+00	16.4	NA	NCR	1.610E-04			10.1%
3.20E+03	2.00E+02	NC		1.776E-05	2.052E-04	NC	0.8%	2.0%	
6.00E-01	3.00E-02	NC		3.979E-06	5.748E-05	NC	0.2%	0.5%	

		Acute	Chronic	Cancer
		g/s	g/s	g/s
Sum of Wtd E per Engine		2.2557E-03	1.0489E-02	1.5915E-03
SCREEN3			0.100	0.100
(coonverts max 1-hr ground level cncntrtn to annual avg				
Exposure Adjustements	Resident	1.000	0.962	0.962
	Worker	1.000	0.224	0.128
Breathing Rates (L/kg-day)	Resident			302
	Worker			447
CRAF (for Age Sensitivity)	Resident			1.7
	Worker			1.0
		ISCST3 Input Factors per Engine		
		Acute	Chronic	Cancer
	Resident	2.2557E-03	1.0086E-03	7.8565E-02
	Worker	2.2557E-03	2.3534E-04	9.1206E-03

APPLICATION #24495: Increase Combined Landfill Gas Throughput Rate to Flares from 2208 million scf/yr to 2625 million scf/yr

Revised TAC Emissions from A-51 and A-60 Based on New District LFG Concentration Limits and New Combined Annual Throughput Limit (2625 million scf/yr of LFG ~ 4995

Capacity (each flare)	90	MM BTU/hour
LFG Methane Content	50%	
LFG Heat Content	496.9	BTU/scf
Max Landfill Gas Flow Rate to Each Flare	3018	scfm of LFG
Max Hourly LFG to Each Flare	181107	scf/hr of LFG
Capacity (combined)	148.927	MM BTU/hour
Annual (combined)	1304602	MM BTU/year
Annual (combined)	2625252346	scf/yr of LFG
Annual Average to Each Flare	1312626173	scf/yr of LFG

		Acute (Hourly)				Chronic (Annual)			
Toxic Air Contaminants	Molecular Weights	District Estimate of Max. Conc. for any 1 hour	Inlet to Each Flare	Control Efficiency	Outlet Emissions	District Estimate of Annual Avg. Conc.Levels	Inlet to Each Flare	Control Efficiency	Outlet Emissions
	Lbs/Lb-mol	PPBV	lbs/hour		lbs/hour	PPBV	lbs/year		lbs/year
Acrylonitrile	53.063	1500	3.741E-02	98%	7.482E-04	300	5.423E+01	98%	1.085E+00
Benzene	78.112	7500	2.754E-01	98%	5.507E-03	1500	3.992E+02	98%	7.983E+00
Benzyl Chloride *	126.583	2500	1.487E-01	98%	2.975E-03	500	2.156E+02	98%	4.312E+00
Carbon Tetrachloride (tetrachloromethane)	153.822	1000	7.230E-02	98%	1.446E-03	200	1.048E+02	98%	2.096E+00
Chlorobenzene	112.557	1000	5.291E-02	98%	1.058E-03	200	7.669E+01	98%	1.534E+00
Chloroethane (ethyl chloride)	64.514	2500	7.581E-02	98%	1.516E-03	500	1.099E+02	98%	2.198E+00
Chloroform	119.377	1000	5.611E-02	98%	1.122E-03	200	8.134E+01	98%	1.627E+00
1,4 Dichlorobenzene	147.001	5000	3.455E-01	98%	6.910E-03	1000	5.008E+02	98%	1.002E+01
Ethyl Benzene	106.165	20000	9.980E-01	98%	1.996E-02	4000	1.447E+03	98%	2.893E+01
Ethylene Dibromide (1,2-dibromoethane)	187.861	1000	8.830E-02	98%	1.766E-03	200	1.280E+02	98%	2.560E+00
Ethylene Dichloride (1,2-dichloroethane)	98.959	1000	4.651E-02	98%	9.303E-04	200	6.742E+01	98%	1.348E+00
Ethylidene Dichloride (1,1-dichloroethane)	98.959	2500	1.163E-01	98%	2.326E-03	500	1.686E+02	98%	3.371E+00
Hexane	86.175	10000	4.051E-01	98%	8.101E-03	2000	5.872E+02	98%	1.174E+01
Hydrogen Sulfide	34.082	3000000	4.806E+01	98%	9.612E-01	600000	6.966E+04	98%	1.393E+03
Isopropyl Alcohol (isopropanol)	60.095	50000	1.412E+00	98%	2.825E-02	10000	2.047E+03	98%	4.095E+01
Methyl Alcohol (methanol) *	32.042	1500000	2.259E+01	98%	4.518E-01	300000	3.275E+04	98%	6.549E+02
Methyl Ethyl Ketone (2-butanone)	72.106	75000	2.542E+00	98%	5.084E-02	15000	3.685E+03	98%	7.369E+01
Methylene Chloride (dichloromethane)	84.932	5000	1.996E-01	98%	3.992E-03	1000	2.893E+02	98%	5.787E+00
Methyl tert-Butyl Ether	88.148	2500	1.036E-01	98%	2.072E-03	500	1.501E+02	98%	3.003E+00
Perchloroethylene (tetrachloroethylene)	165.832	5000	3.897E-01	98%	7.795E-03	1000	5.649E+02	98%	1.130E+01
1,1,2,2 Tetrachloroethane	167.848	1000	7.889E-02	98%	1.578E-03	200	1.144E+02	98%	2.287E+00
Styrene	104.149	2500	1.224E-01	98%	2.448E-03	500	1.774E+02	98%	3.548E+00
Toluene	92.138	100000	4.331E+00	98%	8.662E-02	20000	6.278E+03	98%	1.256E+02
1,1,1 Trichloroethane (methyl chloroform)	133.403	1000	6.270E-02	98%	1.254E-03	200	9.089E+01	98%	1.818E+00
Trichloroethylene	131.387	2500	1.544E-01	98%	3.088E-03	500	2.238E+02	98%	4.476E+00
Vinyl Chloride	62.498	10000	2.938E-01	98%	5.875E-03	2000	4.258E+02	98%	8.517E+00
Vinylidene Chloride (1,1-dichloroethylene)	96.943	2500	1.139E-01	98%	2.278E-03	500	1.651E+02	98%	3.303E+00
Xylenes (o, m, & p)	106.165	100000	4.990E+00	98%	9.980E-02	20000	7.233E+03	98%	1.447E+02
Hydrogen Chloride	36.461	200000			3.428E+00	40000			4.968E+03
Hydrogen Fluoride	20.006	20000			1.881E-01	4000			2.726E+02
Formaldehyde	30.026				3.260E-02				2.363E+02

					lbs/year
Total		8.816E+01		1.2780E+05	8033.29
HAPs (from each flare at annual ave of 149 MM BTU/hr combined)					6525.37
New combined Limit					6.525
				Heat Content BTU/scf	LFG F-Facto ft3 flue gas a
Theoretical Flue Gas Generation Rate at 50% CH4		4.7847	ft3 flue gas (@ 0% O2) / ft3 LFG	496.9	9628
Worst Case F Factor at 25% CH4		2.8923	ft3 flue gas (@ 0% O2) / ft3 LFG	248.5	11641
Outlet SO2 (Reg 9-1-302 at max O2)		300	ppmv at 15% O2		
Outlet SO2 (Reg 9-1-302 at theoretical O2)		1063	ppmv at 15% O2		
		scf of SO2/hour	scfm of LFG	scf of S / scf LFG	max inlet ppn
at 90 MM BTU/hr and 300 ppmv SO2 at 15% O2 and	50% CH4	9.209E+02	3018	5.085E-03	5085
	25% CH4	1.113E+03	6037	3.074E-03	3074

Summary of Acute Weighted Emissions By Target Organ
Eyes
Respiratory
Central Nervous System

scfm of LFG)

OEHHA Health Effects Values (as of 8/1/13)			Acute	Chronic	Cancer		
Acute REL	Chronic REL	Chronic CPF	Weighted Emissions	Weighted Emissions	Weighted Emissions		
µg/m^3	µg/m^3	(mg/kg-day)$^{-1}$	lbs/hour	lbs/year	lbs/year		
NA	5.00E+00	1.00E+00	NA	2.169E-01	1.085E+00	0.9	1.8
1.30E+03	6.00E+01	1.00E-01	4.236E-06	1.331E-01	7.983E-01	6.7	13.5
2.40E+02	NCR	1.70E-01	1.240E-05	NCR	7.331E-01	3.6	7.3
1.90E+03	4.00E+01	1.50E-01	7.611E-07	5.240E-02	3.144E-01	1.8	3.5
NA	1.00E+03	NC	NA	1.534E-03	NC	1.3	2.6
NA	3.00E+04	NC	NA	7.326E-05	NC	1.9	3.7
1.50E+02	3.00E+02	1.90E-02	7.482E-06	5.422E-03	3.091E-02	1.4	2.7
NA	8.00E+02	4.00E-02	NA	1.252E-02	4.006E-01	8.4	16.9
NA	2.00E+03	8.70E-03	NA	1.447E-02	2.517E-01	24.4	48.8
NA	8.00E-01	2.50E-01	NA	3.200E+00	6.400E-01	2.2	4.3
NA	4.00E+02	7.20E-02	NA	3.371E-03	9.709E-02	1.1	2.3
NA	NCR	5.70E-03	NA	NCR	1.922E-02	2.8	5.7
NA	7.00E+03	NC	NA	1.678E-03	NC	9.9	19.8
4.20E+01	1.00E+01	NC	2.289E-02	1.393E+02	NC	685.0	1370.1
3.20E+03	7.00E+03	NC	8.827E-06	5.849E-03	NC	34.5	69.0
2.80E+04	4.00E+03	NC	1.614E-05	1.637E-01	NC	552.0	1104.1
1.30E+04	NCR	NC	3.911E-06	NCR	NC	62.1	124.2
1.40E+04	4.00E+02	3.50E-03	2.852E-07	1.447E-02	2.025E-02	4.9	9.8
NA	8.00E+03	1.80E-03	NA	3.754E-04	5.405E-03	2.5	5.1
2.00E+04	3.50E+01	2.10E-02	3.897E-07	3.228E-01	2.373E-01	9.5	19.0
NA	NCR	2.00E-01	NA	NCR	4.574E-01	1.9	3.9
2.10E+04	9.00E+02	NC	1.166E-07	3.942E-03	NC	3.0	6.0
3.70E+04	3.00E+02	NC	2.341E-06	4.185E-01	NC	105.8	211.7
6.80E+04	1.00E+03	NC	1.844E-08	1.818E-03	NC	1.5	3.1
NA	6.00E+02	7.00E-03	NA	7.460E-03	3.133E-02	3.8	7.5
1.80E+05	NCR	2.70E-01	3.264E-08	NCR	2.299E+00	7.2	14.4
NA	7.00E+01	NC	NA	4.718E-02	NC	2.8	5.6
2.20E+04	7.00E+02	NC	4.536E-06	2.067E-01	NC	121.9	243.9
2.10E+03	9.00E+00	NC	1.632E-03	5.521E+02	NC	4187.7	8375.5
2.40E+02	1.40E+01	NC	7.836E-04	1.947E+01	NC	229.8	459.6
5.50E+01	9.00E+00	2.10E-02	5.927E-04	2.625E+01	4.962E+00	199.1	398.3

ıt 0% O2/MM BTU

ıv of H2S

		Acute	Chronic	Cancer
		hour	year	year
Sum of Wtd E	lbs/time	2.5955E-02	7.4194E+02	1.2383E+01
Sum in units of	g/s	3.2703E-03	1.0672E-02	1.7811E-04

Chronic Hazard Index Pre-Processing Factors			
			Chrn HI EAF
SCREEN3	1.00E-01	Resident	0.9589
		Worker	0.2237

Cancer Risk Pre-Processing Factors					
SCREEN3	1.00E-01		CR EAF	BR	ASF
Units Convert	1.00E-06	Resident	0.9589	302	1.7
as Risk/MM	1.00E+06	Worker	0.1279	447	1.0

	Acute	Chronic	Cancer
Resident	3.2703E-03	1.0233E-03	8.7683E-03
Worker		2.3877E-04	1.0179E-03

APPLICATION #24495:

New LFG Fired Energy Plant Including 4 IC Engines Equipped with Oxidation Catalyst and SCR System Controls (2739 bhp, 725 scf of LFG, and 21.610 MM BTU/hr each)
Plus LFG Flare Condition Changes to Accommodate Higher Gas Generation Rate and Emissions from New S-71 Gas Treatment System - Desorption Process

ISCST3 Source Parameters for Redwood Landfill Sources and Stacks

		NAD27							Weighted and Pre-Processed Input Factors				
		Easting (X)	Northing (Y)	Base Elevation	Stack Height	Temper-ature	Exit Velocity	Stack Diameter	Acute	Chronic Worker	Chronic Resident	Cancer Worker	Cancer Resident
		m	m	m	m	o K	m/s	m	g/s	g/s	g/s	g/s	g/s
A51	Standard Enclosed Flare	538207	4223570	0.100	15.240	1033.2	6.468	3.658	3.27031E-03	2.38770E-04	1.02330E-03	1.01790E-03	8.76826E-03
A60	Extreme Turn Down Flare	538191	4223583	0.100	12.192	1033.2	4.984	3.639	3.27031E-03	2.38770E-04	1.02330E-03	1.01790E-03	8.76826E-03
S61	Diesel Engine for Tipper	538174	4223623	0.000	2.743	740.9	307.569	0.038		4.34495E-06	5.32035E-06	6.10404E-03	1.50231E-02
S62	Diesel Engine for Power Screen	538770	4223861	0.300	2.743	740.9	307.569	0.038		4.34495E-06	5.32035E-06	6.10404E-03	1.50231E-02

Diesel Engines are portable and locations are variable.

		Anchor Point (NAD27)							Weighted and Pre-Processed Input Factors				
		Easting (X) m	Northing (Y) m	Base Elevation m	Release Height m	Number of Vertices	Capacity of Gas to Engines scfm	Cancer Max. Year	Acute g/s-m2	Chronic Worker g/s-m2	Chronic Resident g/s-m2	Cancer Worker g/s-m2	Cancer Resident g/s-m2
S5	Landfill AreaPoly Source	538162	4223597	50.597	0.000	17	1626 56%	2058	8.26145E-09	7.70237E-10	3.30102E-09	1.06140E-08	9.14297E-08
S5	Landfill AreaPoly Source	538162	4223597	50.597	0.000	17	2847 98%	2044	8.26145E-09	7.70237E-10	3.30102E-09	1.00083E-08	8.62127E-08

	scfm
One LFG Fired Engine	725
Four LFG Fired Engines	2899

		NAD27							Weighted and Pre-Processed Input Factors				
		Easting (X)	Northing (Y)	Base Elevation	Stack Height	Temper-ature	Exit Velocity	Stack Diameter	Acute	Chronic Worker	Chronic Resident	Cancer Worker	Cancer Resident
		m	m	m	m	o K	m/s	m	g/s	g/s	g/s	g/s	g/s
S-64	Each LFG Fired IC Engine								2.25573E-03	2.35339E-04	1.00859E-03	9.12057E-03	7.85654E-02
S-65	Each LFG Fired IC Engine								2.25573E-03	2.35339E-04	1.00859E-03	9.12057E-03	7.85654E-02
S-66	Each LFG Fired IC Engine								2.25573E-03	2.35339E-04	1.00859E-03	9.12057E-03	7.85654E-02
S-67	Each LFG Fired IC Engine								2.25573E-03	2.35339E-04	1.00859E-03	9.12057E-03	7.85654E-02

For Further Refinement, Acute Input Factors Separated by Target Organ

		Eyes	Respiratory	Nervous	Reprd. & Devlp.
g/s-m2	S-5	1.88929E-11	7.91963E-11	8.24175E-09	6.49198E-11
g/s	A-51	3.83170E-04	3.09432E-04	2.88696E-03	1.86729E-06
g/s	A-60	3.83170E-04	3.09432E-04	2.88696E-03	1.86729E-06
g/s	S-64	1.64611E-03	2.85230E-05	6.05581E-04	4.24240E-06
g/s	S-65	1.64611E-03	2.85230E-05	6.05581E-04	4.24240E-06
g/s	S-66	1.64611E-03	2.85230E-05	6.05581E-04	4.24240E-06
g/s	S-67	1.64611E-03	2.85230E-05	6.05581E-04	4.24240E-06

Plant # 1179, Redwood Landfill, Inc.
Application # 24495

Actual Emissions From Existing Landfill Gas Flares

A-51	NOx lbs/MM BTU	CO lbs/MM BTU	POC lbs/MM BTU	SO2 lbs/MM BTU	CH4 %	Heat Content BTU/scf	Flare Temp. °F	F-Factor flue/LFG	SO2 ppmv, O% O2	TRS ppm in LFG
2010	0.050	0.030	0.002	0.120	47.6%	513.186	1447	4.601	81	372.9
2011	0.050	0.030	0.002	0.162	51.2%	553.428	1450	4.873	111	540.0
2012	0.050	0.030	0.003	0.110	47.5%	472.337	1501	4.593	68	314.3

A-60	NOx lbs/MM BTU	CO lbs/MM BTU	POC lbs/MM BTU	SO2 lbs/MM BTU	CH4 %	Heat Content BTU/scf	Flare Temp. °F	F-Factor flue/LFG	SO2 ppmv, O% O2	TRS ppm in LFG
2010	0.050	0.090	0.057	0.121	49.8%	503.674	1450	4.770	77	369.1
2011	0.050	0.120	0.045	0.174	49.7%	514.103	1456	4.765	113	540.1
2012	0.040	0.050	0.002	0.117	47.8%	475.594	1499	4.621	73	336.7

Average	NOx lbs/MM BTU	CO lbs/MM BTU	POC lbs/MM BTU	SO2 lbs/MM BTU	Throughput Mscf/year	Heat Content BTU/scf	Heat Input MM BTU/year
2010	0.050	0.060	0.030	0.121	1375966	508.430	699582
2011	0.050	0.075	0.023	0.168	1492557	533.765	796675
2012	0.045	0.040	0.003	0.114	1462793	473.966	693314

Emissions	NOx tons/year	CO tons/year	POC tons/year	SO2 tons/year	PM10 tons/year	Non-Bio GHG tons/year	Total GHG tons/year	Overall Average ppm of S in LFG
2010	17.490	20.987	10.379	42.251	5.983	3121.286	82766	
2011	19.917	29.875	9.341	66.803	6.813	3554.481	94253	
2012	15.600	13.866	0.913	39.403	5.929	3093.319	82024	
Average	17.669	21.576	6.878	49.486	6.242	3256.362	86348	412.2

* PM10 and GHG emission use permitted factors since no test data is available.

APPENDIX B

BACT Analysis for
Landfill Gas Fired IC Engines
Application # 24495

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
Best Available Control Technology (BACT) Guideline

Source Category

Source:	**IC Engine – Biogas Fired**	**Revision:**	**1**
		Document #:	**96.2.4**
Class:	**≥ 50 Hp Output**	**Date:**	**5/30/2013**

Pollutant	BACT 1. Technologically Feasible/Cost Effective 2. Achieved in Practice	TYPICAL TECHNOLOGY
POC	1. 0.12 g/bhp-hr [a, c, e, f, g, k] 2. 0.16 g/bhp-hr [l, k]	1. Gas Pre-Treatment (filtration, refrigeration & carbon adsorption) + Oxidation Catalyst [a, c, e, f, g, k] 2. Low POC Waste Gas or Gas Pre-Treatment or Gas Pre-Treatment + Oxidation Catalyst [l, k]
NO_x	1. n/s 2. 0.15 g/bhp-hr [a, c, d, e, f, g, i, j, l]	1. Gas Pre-Treatment + Selective Catalytic Reduction (SCR) [f, g, l] 2. Gas Pre-Treatment + Selective Catalytic Reduction (SCR) [a, c, d, f, i, j, l] or NOxTech [e, i, j]
CO	1. 0.89 g/bhp-hr [b, c, f] 2. 1.8 g/bhp-hr [a]	1. Gas Pre-Treatment + Oxidation Catalyst [b, c, f] 2. Gas Pre-Treatment + Oxidation Catalyst [a]
SO_2	1. 100 ppmv of total sulfur in Biogas [c, g] 2. 150 ppmv of total sulfur in Biogas [a, b, h]	1. Low Sulfur Biogas [c] or Gas Pre-Treatment with >80% H_2S Removal [g] 2. Low Sulfur Biogas or Gas Pre-Treatment [a, b, h]
PM_{10}	1. 0.07 g/bhp-hr [b] 2. 0.10 g/bhp-hr [a, c]	1. Gas Pre-Treatment (filtration and condensation) [b] 2. Gas Pre-Treatment [a, c]
NPOC	1. n/d 2. n/s	1. n/d 2. Same as POC

References and Notes for BACT Determination

a. BAAQMD Application # 12649 (Ameresco Half Moon Bay, LLC)
b. BAAQMD Application # 23333 (Potrero Hills Energy Producers)
c. BAAQMD Application # 24388 (Zero Waste Energy)
d. San Joaquin Valley APCD: Ameresco Foothill and Forward Energy Projects
e. San Joaquin Valley APCD: Cambrian Energy Woodville, LLC Energy Projects
f. South Coast AQMD: Orange County Sanitation District Demonstration Project
g. Georgia Dept. of Natural Resources: MAS ASB Cogen, LLC CHP Facility
h. South Coast AQMD: Rule 431.1, amended 6/12/98.
i. South Coast AQMD: Rule 1110.2, Table III-B, amended 9/7/12.
j. San Joaquin Valley APCD: Rule 4702, Table 2, amended 8/18/11.
k. Formaldehyde is both a POC and a toxic air contaminant (TAC) and is typically the largest contributor to the health risks resulting from biogas fired engines. Oxidation catalysts typically achieve 50% or greater control of formaldehyde emissions. Use of an oxidation catalyst will satisfy the Regulation 2-5-301 TBACT requirement.
l. For SCR systems, ammonia emissions are typically limited to an exhaust concentration 10 ppmv of NH_3 at 15% O_2 or less. [c, f]

BACT Determination Report
for Biogas Fired Internal Combustion Engines

May 30, 2013

Background:

Biogas is a naturally occurring gas that is formed during the breakdown of organic materials in a low oxygen (anaerobic) environment. The primary components are methane and carbon dioxide with small amounts of water vapor, oxygen, and nitrogen. It is similar to natural gas except that it has a lower heat content and may contain different contaminants. Common biogas contaminants include hydrogen sulfide, hydrocarbons, siloxanes, and ammonia; concentrations vary depending on the feedstock.

The most widely-known types of biogas are digester gas and landfill gas. Digester gas is produced during the anaerobic digestion of sewage sludge at waste water treatment plants. Landfill gas is produced by the waste decomposition process at landfills. Biogas is also produced by anaerobic composting and manure digesting.(6)

In the Bay Area, digester and landfill gases have been used as fuel for internal combustion (IC) engines for many years. Recently, the use of other types of biogas (from anaerobic composting and manure digesting) as fuel for IC engines is becoming more common due to the emphasis on using renewable energy sources to reduce greenhouse gas emissions.

Although the Bay Area Air Quality Management District ("District" or "BAAQMD") currently has BACT determinations for IC engines fired on digester and landfill gas, the District does not have any BACT determinations for engines that are fired on the other types of biogas. In addition, significant advances have been made in the gas treatment processes for digester and landfill gas, which now enable engines fired on these treated biogases to use the same add-on emissions control technologies that have long been employed on natural gas engines. (12) Several biogas fired engine projects, which include the new gas treatment systems and add-on control technologies, have been operating for over a year and have successfully demonstrated that these projects can meet emission levels that are similar to the levels achieved by natural gas fired engines. Consequently, the District's current BACT guidelines for digester and landfill gas fired engines are obsolete and need to be updated.

The District is proposing to replace the current BACT guidelines for digester and landfill gas fired engines with a new BACT determination for biogas fired engines. This determination will apply to all types of biogas to resolve the District's lack of an appropriate BACT determination for the other types of biogases. The remainder of this report describes the available control technologies for biogas fired engines and the basis for the District's proposed BACT(1) and BACT(2) emission levels for biogas fired engines.

Emissions Control Technologies for Biogas Fired Internal Combustion Engines

Selective catalytic reduction (SCR) systems and oxidation catalysts have been widely used for many years to control nitrogen oxide (NO_x), carbon monoxide (CO), and precursor organic compounds (POC) emissions from a variety of natural gas fired combustion operations. However, the use of these catalytic abatement systems on digester gas and landfill gas fired internal combustion engines was not feasible in the past, because these gases contain siloxanes and other contaminants that can damage or impair the performance of catalytic abatement systems.

During the last decade, gas pre-treatment systems were developed that can successfully remove these problematic siloxane contaminants from landfill and digester gas. As a result, the District and other air pollution control agencies determined that SCR systems and oxidation catalysts are technologically feasible for engines fired on digester gas or landfill gas that has been treated to remove the siloxanes. Since biogas derived from anaerobic composting or manure digesting is not expected to contain any significant levels of siloxanes, catalytic control technologies are also technologically feasible for engines fired on the these biogases.

Initially, the high cost of siloxane treatment systems resulted in limited use of these treatment systems at biogas energy facilities. However, the recent focus on finding clean renewable energy sources spurred additional research regarding these siloxane treatment systems and their use in conjunction with biogas fired internal combustion engines. Siloxane removal systems are now in wider use at landfill and digester gas fired energy facilities because the operators have found that these treatment systems can also provide economic benefits to these projects by reducing engine maintenance costs and extending the useful life of the engines.

Meanwhile, the District and other air pollution control agencies have been investigating all feasible methods for reducing emissions from biogas fired IC engines, because these engines have historically had disproportionately high emissions compared to other energy sources. (12) For example, a new lean--burn landfill gas fired engine (without SCR controls) would have nitrogen oxide emissions that are 9 times higher than a comparable lean-burn natural gas fired engine and 30 times higher than a new natural gas fired gas turbine producing the same amount of power.

The District has been following the progress of a number of recently permitted (2008-2011) biogas energy projects that involve IC engines fired on treated landfill gas, treated digester gas, or other types of biogas with naturally low siloxane levels, which will be equipped with selective catalytic reduction (SCR) systems to control NO_x emissions or oxidation catalysts to control CO and POC emissions. Several of these new biogas engine projects that are equipped with advanced controls have been successfully operating at low emission levels for over one year. The District has reviewed source test results and CEM data (where available) for the following projects:

- BAAQMD Ameresco HMB: The Ameresco Half Moon Bay (HMB), LLC facility is a landfill gas fired energy project located in Half Moon Bay, CA at the Ox Mountain Landfill within the jurisdiction of the Bay Area Air Quality Management District (BAAQMD). The facility includes a regenerative landfill gas treatment system, a waste gas flare, and six lean-burn internal combustion engines (2677 bhp each) fired exclusively on treated landfill gas. All six engines are equipped with oxidation catalysts and one engine is also equipped with an SCR system. This facility has been operating since 2009. (1)

- SCAQMD OCSD: The Orange County Sanitation District (OCSD) conducted a demonstration project at their Fountain Valley, CA waste water treatment facility located within the jurisdiction of the South Coast Air Quality Management District (SCAQMD). The demonstration project (installed in 2009) included the installation of a non-regenerative digester gas treatment system, an oxidation catalyst, and an SCR system on an existing 1992 vintage engine (3471 bhp) fueled on a variable blend of digester gas and natural gas. (12)
- MAS ASB Cogen, LLC. CHP Facility: MAS ASB Cogen, LLC operates a 6.5 MW cogeneration - combined heat and power (CHP) facility located in Atlanta, GA. The facility includes three internal combustion engines (3012 bhp) each fired on up to 100% treated landfill gas or up to 100% natural gas or a combination of these fuels. Each engine is equipped with an SCR system and an oxidation catalyst. This facility has been operating since March 2012. (7, 8)

The test results for the above projects demonstrate that catalytic controls and low emission levels are not just technologically feasible for treated biogas gas fired IC engines, but that significantly lower NO_x, CO, POC, and SO_2 emission levels are now being achieved in practice for IC engines fired on a variety of different biogases. (4, 5) This achieved in practice conclusion is further supported by the fact that two California air districts (South Coast and San Joaquin Valley) have adopted rules that will require existing biogas fired IC engines to meet low emission levels that can only be achieved by using add-on catalytic controls. (11, 14) EPA Region IX staff has also expressed support for an achieved in practice determination regarding the use of gas treatment systems and SCR controls on landfill gas fired engines. (9)

Proposed BACT Limits

BACT is defined in BAAQMD Regulation 2-2-206 as follows:

2-2-206 Best Available Control Technology (BACT): For any new or modified source, except cargo carriers, the more stringent of:

206.1 The most effective emission control device or technique which has been successfully utilized for the type of equipment comprising such a source; or

206.2 The most stringent emission limitation achieved by an emission control device or technique for the type of equipment comprising such a source; or

206.3 Any emission control device or technique determined to be technologically feasible and cost-effective by the APCO; or

206.4 The most effective emission control limitation for the type of equipment comprising such a source which the EPA states, prior to or during the public comment period, is contained in an approved implementation plan of any state, unless the applicant demonstrates to the satisfaction of the APCO that such limitations are not achievable. Under no circumstances shall the emission control required be less stringent than the emission control required by any applicable provision of federal, state or District laws, rules or regulations.

The APCO shall publish and periodically update a BACT/TBACT Workbook specifying the requirements for commonly permitted sources. BACT will be determined for a source by using the workbook as a guidance document or, on a case-by-case basis, using the most stringent definition of this Section 2-2-206.

The District's BACT/TBACT Workbook is available on the District's website at: http://hank.baaqmd.gov/pmt/bactworkbook/default.htm.

As discussed in the District's BACT/TBACT Workbook Policy and Implementation Procedure, the District categorizes BACT in two ways:

- BACT(2) Achieved in Practice, and
- BACT(1) Technological Feasible and Cost Effective.

BACT(2) Assessment:

The BACT(2) or "achieved in practice" category is based on the definitions in BAAQMD Regulations 2-2-206.1, 2-2-206.2, and 2-2-206.4. BACT(2) is the most effective emission control *device* already in use or the most stringent emission *limit* achieved in the field for the source type and capacity under review. Controls or limits are considered BACT(2) if the control device performance or emission limit has been verified by source testing or other appropriate documentation approved by BAAQMD or another California air district. BACT(2) cannot be any less stringent than the emission controls or limits required by any applicable federal, state, or District rule.

For this source category determination, the District identified an emission limit as a BACT(2) limit if the limit has been verified by source test data and supported by other documentation. As noted above, several biogas-fired engine projects equipped with add-on catalytic emission control systems have been operating for a year or longer. Source test data, or in some cases, CEM data demonstrate that these in-operation projects have been meeting the District's proposed BACT(2) emission limits. (1, 4, 5, 12) In addition, South Coast Air Quality Management District and San Joaquin Valley Air Pollution Control District have adopted rules that will require existing biogas fired IC engines to meet emission levels that are similar to the levels achieved by natural gas fired engines. (11, 14) The District's proposed BACT(2), emission limits for biogas fired engines are based on either the permitted emission levels for these in-operation projects, as verified by source test data, or on the regulatory limits specified in SIP-approved rules of this District or other air districts.

BACT(1) Assessment:

The BACT(1) or "technologically feasible and cost effective" category is based on all of the definitions in BAAQMD Regulation 2-2-206 including Section 206.3. BACT(1) is a more stringent level of control than BACT(2) and is technology forcing. For this category, the control equipment must be commercially available and cost-effective.

It often compels the transfer of successfully demonstrated control methods from one source category to a new source category.

For this source category determination, the District identified an emission control technology as BACT(1) if the controls have been permitted by this District or other air districts for projects in this category, even if the applicants have not completed construction or begun operation of these projects yet. In a few cases, these projects were permitted with emission levels that are more stringent than the BACT(2) achieved in practice emission levels discussed above. (2, 3, 10) The District's proposed BACT(1), emission levels were based on these permitted, though not yet necessarily demonstrated, emission levels.

Pollutant-Specific BACT Limits

The following tables present comparisons of the permitted emission limits for various biogas energy projects, the more stringent regulatory emission limits for biogas fired IC engines, and the District's proposed BACT limits for each pollutant. The tables are organized by criteria pollutant in the order of appearance on the District's proposed BACT guideline: POC, NO_x, CO, SO_2, PM_{10}, and NPOC. Each pollutant table starts with the District's proposed BACT(1) and BACT(2) limits followed by a short discussion of the pertinent projects or rules on which the pollutant-specific limit was based.

Comparison of POC Emission Limits for Biogas Fired IC Engine Projects

Emission Limit Units:	grams / bhp-hour	pounds / MM BTU	ppmv as CH_4 @ 15% O_2
Proposed BAAQMD BACT Guideline			
Proposed BAAQMD BACT(1)	0.12	0.039	28
Proposed BAAQMD BACT(2)	0.16	0.042	30
Relevant Projects and Rules			
SCAQMD OCSD Demonstration Project (tests, max)			5.4
BAAQMD Ameresco HMB (source test, max)	0.03		5.7
MAS ASB Cogen , LLC CHP Facility (annual average emission limit)	0.12	0.036	25
SJVAPCD Cambrian Energy Woodville	0.12		
BAAQMD Zero Waste Energy (App 24388)	0.13	0.043	
SCAQMD Rule 1110.2 (as digester gas)	0.15	0.040	30
SCAQMD Rule 1110.2 (as LFG)	0.16	0.042	30

References: (3), (4), (7), (8), (10), (12), and (14)

POC Limits:

Biogas may contain small amounts of precursor organic compounds (POC). The percentages can be very low for some types and biogas, but landfill gas can contain 1% or more POC, and many of these precursor organic compounds are also toxic air contaminants (TAC). The engine's combustion process will combust most of the POC in the fuel, but some residual POC will be emitted. In addition, the engine's combustion process produces secondary emissions of formaldehyde, which is both a POC and a TAC. These secondary POC/TAC emissions can be much higher for lean-burn engines than for rich-burn engines. Source test data on many existing engines indicate that engines burning biogas containing low POCs (such as treated landfill gas, treated digester gas, or raw digester gas from anaerobic green waste composting) can meet low POC emission levels without the use of add-on controls. However, the District expects that most new or modified biogas fired IC engines will be equipped with oxidation catalysts in order to meet the CO BACT requirements discussed below. Oxidation catalysts typically achieve 50% or greater control efficiency for POC including TACs such as formaldehyde and are the best available technology for controlling both POC emissions and organic TAC emissions.

From the federal RACT/BACT/LAER Clearinghouse, the following project was required to meet a pollution prevention limit for VOC of 0.16 g/bhp-hr: NJ-0068 – landfill gas fired engines at Manchester Renewable Power (permitted in 2006).

In September 2012, the South Coast Air Quality Management District (SCAQMD) amended SCAQMD Rule 1110.2 Emissions from Gaseous and Liquid-Fueled Engines. SCAQMD added new limits for landfill and digester (biogas) fired engines that will apply to all existing engines as of January 1, 2016 (see Table III-B in Rule 1110.2). The new limits include a VOC exhaust concentration limit of 30 ppmvd, measured as carbon and corrected to 15% oxygen dry basis. (14) The South Coast's definition of VOC is the same as the BAAQMD's definition of POC. The District used standard BAAQMD landfill gas assumptions to convert South Coast's outlet concentration limit into a g/bhp-hr emissions rate (0.16 g/bhp-hr) for consistency with the BAAQMD's usual emission factor units for NO_x and CO limits from engines.

Based on the documentation above, the District identified 0.16 g/bhp-hr (30 ppmv at 15% O_2) as a potential BACT(2) emission limit. As shown by the source test results for two biogas engine projects that have operated with oxidation catalysts (Ameresco HMB and SCAQMD OCSD, reported in the table above), the abated POC outlet concentration was less than 6 ppmv, expressed as methane at 15% oxygen, dry basis (<0.03 g/bhp-hr), for the tests where POC emissions were detected. (4, 12) For the MAS ASB Cogen facility in Atlanta, GA, source testing in June 2012 on engines equipped with oxidation catalysts and firing 100% landfill gas found an average NMOC emission rate of 0.12 g/bhp-hr for the three engines at this site. (5) This data demonstrates that the District's proposed BACT(2) limit of 0.16 g/bhp-hr has been achieved in practice.

San Joaquin Valley Air Pollution Control District (SJVAPCD) has issued an Authority to Construct for biogas-fired engines located at the Cambrian Energy Woodville facility. These engines are not installed yet, but will be required to meet a VOC emission limit of 0.12 g/bhp-hr. (10) In addition, the engines at the MAS Cogen facility in Atlanta, GA, which are permitted to burn either treated landfill or natural gas, are limited to an annual average emission rate that is equivalent to 0.12 g/bhp-hr. (7, 8) Therefore, this proposed limit is technologically feasible for a variety of gases. Although the Ameresco HMB and OCSD source test data showed that emission limits much lower than 0.12 grams/bhp-hr of POC (~ equivalent to 28 ppmv of POC as CH_4 at 15% O_2) are possible for engines controlled by oxidation catalysts, the District did not use this data to establish BACT(1) limits because of the limited amount of source test data available for biogas-fired engines with oxidation catalysts and the fact that some recent source tests at Ameresco HMB were inconclusive at demonstrating compliance with the low POC emission levels observed by earlier tests due to high NMOC detection limits. These latter tests were only able to demonstrate that POC emissions were <22 ppmv to <37 ppmv of POC at 15% O_2. (4) Consequently, the District based the BACT(1) limit for POC on the Cambrian Energy facility and MAS Cogen facility limits of 0.12 g/bhp-hr.

As discussed above, oxidation catalysts typically achieve 50% or greater control for POC emissions, including the TAC formaldehyde. Oxidation catalysts are the best available technology for controlling formaldehyde emissions. Formaldehyde is usually the primary contributor to health risks from biogas fired IC engines. Use of an oxidation catalyst will satisfy TBACT, but insufficient data is available at this time to establish a specific TBACT formaldehyde emission limit. One test in May 2009 on an IC engine equipped with an oxidation catalyst found 3.1E-3 pounds of formaldehyde per MM BTU of treated landfill gas burned. (4)

Comparison of NO_x Emission Limits for Biogas Fired IC Engine Projects

Emission Limit Units:	grams / bhp-hour	pounds / MM BTU	ppmv as NO_2 @ 15% O_2
Proposed BAAQMD BACT Guideline			
Proposed BAAQMD BACT(1)	n/s	n/s	n/s
Proposed BAAQMD BACT(2)	0.15	0.039	10
Relevant Projects and Rules			
MAS ASB Cogen , LLC CHP Facility (annual average emission limit)	0.12	0.038	10
SCAQMD OCSD Demonstration Project (CEM, avg)			7.2
BAAQMD Ameresco HMB (source test, max)	0.14		10
BAAQMD Ameresco HMB (App 12649)	0.15	0.039	9.7
BAAQMD Zero Waste Energy (App 24388)	0.15	0.049	13
SJVAPCD Ameresco and Cambrian Projects	0.15		
SCAQMD Rule 1110.2 (with CEM)	0.15	0.040	9.9
SCAQMD Rule 1110.2 (as LFG)	0.17	0.045	11
SJVAPCD Rule 4702 (Table 2d)			11

References: (1), (3), (4), (5), (7), (8), (10), (11), (12), and (14)

NO_x Limits:

As discussed previously, selective catalytic reduction (SCR) systems may be used to control NO_x emissions from biogas fired engines if the biogas has low contaminant levels or has been treated to remove the problematic contaminants (primarily siloxanes and sulfur compounds). Several rules have been adopted that limit NO_x emissions from biogas fired engines to levels that can only be achieved using SCR systems or other types of catalytic controls. (11,14) In addition, several biogas engine projects equipped with SCR systems have been operating in compliance with these low NO_x emission levels. (1, 4, 5, 7, 8, 12) These developments are sufficient for SCR control technology to be deemed achieved in practice for biogas fired engines. The specific rules, projects, and limits are discussed below.

SCAQMD Rule 1110.2 Emissions from Gaseous and Liquid-Fueled Engines includes new limits for landfill and digester (biogas) fired engines that will apply to all existing engines as of January 1, 2016 (see Table III-B in Rule 1110.2). The new limits include a NO_x exhaust concentration limit of 11 ppmvd, measured as NO_2 and corrected to 15% oxygen dry basis. If a longer averaging time is desired, the engines can meet an alternative limit of 9.9 ppmv of NO_x averaged over a 24-hour period, if CEMs are used to demonstrate compliance. (14) Based on standard BAAQMD landfill gas data assumptions, this 9.9 ppmv NO_x concentration is equivalent to 0.15 grams/bhp-hr. SJVAPCD has also adopted an 11 ppmv NO_x at 15% O_2 concentration limit for lean burn engines, which includes lean burn engines fired on biogas. (11)

In addition, there are several projects in operation for a year or longer that have a maximum permitted NO_x emission limit of 0.15 grams/bhp-hr. The Ameresco HMB energy plant is located in Half Moon Bay (HMB), CA at the Los Trancos Canyon Landfill on Ox Mountain. This landfill gas energy plant includes one 2677 bhp lean-burn engine that is fired on treated landfill gas and equipped with a selective catalytic reduction (SCR) system to control NO_x emissions and an oxidation catalyst to control CO emissions (Engine 1) and five other 2677 bhp engines that are only equipped with oxidation catalysts (Engines 2-6). The Ameresco HMB Engine 1 has been operating with SCR controls since mid-2009. (1) Four annual source tests demonstrate that this engine met a NO_x emission level of 0.15 g/bhp-hr, averaged over the source testing period. (4) CEM data (October 2009 through December 2011) also demonstrates that this limit was achieved during normal operations (excluding start-up periods, shut-down periods, and malfunctions when urea injection was insufficient) with the exception of a small number of excursions (<1% of the operating hours). (1, 12) In light of this data, the District will consider longer averaging times if CEMs will be used to demonstrate compliance. For the HMB project, the District approved a maximum permitted NO_x limit of 0.15 g/bhp-hr, averaged over a 24-hr period, for Engine 1 in February 2013. (1) During a 9/20/2010 source test, ammonia emissions were determined to be 62.5 ppmv at 15% O_2, but subsequent testing demonstrated that ammonia emissions were less than 10 ppmv at 15% O_2. (4)

In 2009-2010, the Orange County Sanitation District installed a digester gas clean-up system to remove siloxanes, VOCs, and sulfur compounds at their Fountain Valley Reclamation Plant 1. The treated digester gas fuels a 3471 bhp lean-burn engine that was equipped with an SCR system for NO_x control and an oxidation catalyst for CO control. SCAQMD evaluated this project in conjunction with the proposed amendments to Rule 1110.2. Source tests in 2010 and 2011 demonstrated that NO_x emissions were 6.6 ppmv at 15% O_2 and 6.2 ppmv at 15% O_2 for the engine equipped with SCR compared to 30 ppmv at 15% O_2 for two engines at Plant 1 without SCR. The SCR system achieved about 78% control of NO_x emissions. CEM data was collected from April 1, 2010 through March 31, 2011. After excluding exempt and non-valid data periods (start-up and shut-down periods and non-control system errors), the CEM data demonstrated that the average NO_x concentration was 7.2 ppmv at 15% O_2, the maximum NO_x concentration was 16 ppmv at 15% O_2, and the target NO_x concentration of 11 ppmv at 15% O_2 (equivalent to about 0.15 g/bhp-hr of NOx for digester gas) was met except for a small number of excursions (<0.9% of the measurement periods). After reviewing this data, SCAQMD decided to allow a longer averaging time (24 hours) if CEMs will be used to demonstrate compliance. (12, 14) In addition, monthly ammonia testing from April 2010 through March 2011 demonstrated that ammonia slip was < 5 ppmv at 15% O_2. (12)

The MAS Cogen facility in Atlanta, GA is subject to an annual average limit of 10.5 tons/year of NO_x for three 3012 bhp lean-burn engines, which may burn either 100% natural gas, 100% treated landfill gas, or a blend of these fuels. (7, 8) The June 2012 source tests at this facility found an average NO_x emission rate of 0.14 g/bhp-hr from the three engines while burning 100% landfill gas. (5)

Based on the regulatory limits, the Ameresco HMB project data, the OCSD project data, and the MAS Cogen facility data, the District finds that a limit of 0.15 grams/bhp-hr of NO_x has been achieved in practice (excluding start-up and shut-down periods) for this source category. If this limit will be verified by source testing then the applicable averaging period for the limit is the standard source testing period. If CEMs will be used to demonstrate compliance with this limit, the District recommends a 24-hour averaging period for a 0.15 g/bhp-hr NO_x limit.

In addition to these projects, San Joaquin Valley Air Pollution Control District (SJVAPCD) has issued Authorities to Construct for four projects subject to a NO_x limit of 0.15 grams/bhp-hr. The SJVAPCD Ameresco Foothill and Ameresco Forward projects will each include two 3012 bhp lean-burn engines burning treated landfill gas and controlled by SCR. The SJVAPCD Cambrian Energy Woodville projects includes one 1100 bhp lean burn engine and two 1306 bhp lean burn engines burning digester gas and equipped with NOxTech control systems. (10) BAAQMD issued an Authority to Construct for three lean burn 1108 bhp engines that will burn biogas from an anaerobic green and food waste composting process (the Zero Waste Energy Project in San Jose, CA). These engines will each be equipped with SCR and will be limited to a NO_x emission rate of 0.15 g/bhp-hr (averaged over the test period) and excluding start-up and shut down periods. (3) These projects also support the District's proposed BACT(2) limit.

Comparison of CO Emission Limits for Biogas Fired IC Engine Projects

Emission Limit Units:	grams / bhp-hour	pounds / MM BTU	ppmv as CO @ 15% O_2
Proposed BAAQMD BACT Guideline			
Proposed BAAQMD BACT(1)	0.89	0.291	120
Proposed BAAQMD BACT(2)	1.80	0.472	191
Relevant Projects and Rules			
SCAQMD OCSD Demonstration Project (CEM, max)			42
BAAQMD Zero Waste Energy (App 24388)	0.89	0.291	124
BAAQMD Ameresco HMB (source tests, max)	0.96		121
BAAQMD Potrero Hills (App 23333)	1.20	0.314	127
SJVAPCD Fiscalini Farms and Dairy	1.75		
BAAQMD Ameresco HMB (App 12649)	1.80	0.472	191
MAS ASB Cogen , LLC CHP Facility (max limits)	2.00		270
SCAQMD Rule 1110.2 (with CEM)	2.12	0.555	225
SJVAPCD Cambrian Energy Woodville	2.14		
SCAQMD Rule 1110.2	2.36	0.617	250
SJVAPCD Ameresco Foothill & Forward Projects	2.50		

References: (1), (2), (3), (4), (5), (7), (8), (10), (11), (12), and (14)

CO Limits:

As discussed above for POCs, oxidation catalyst may be used to control CO emissions from biogas fired engines, if the biogas has low contaminant levels or has been treated to remove the siloxanes and sulfur compounds. Several biogas fired engine projects have successfully met low CO emission levels using oxidation catalysts.

The SCAQMD Rule 1110.2 limits CO emissions from landfill and digester gas fired engines 250 ppmv at 15% O_2, which is equivalent to 2.36 g/bhp-hr based on BAAQMD landfill gas data. (14) Therefore, the BACT(2) CO emission level should not be any less stringent than this emission level.

However, the Ameresco HMB project demonstrates that landfill gas fired engines equipped with oxidation catalysts can meet the lower CO emission limit of 1.8 g/bhp-hr on a consistent basis. This landfill gas energy plant includes six 2677 bhp lean-burn engines fired on treated landfill gas. Each engine is equipped with an oxidation catalyst. The engines have been operating since mid-2009. (1) Four annual source tests have been completed at this facility, which included tests on each engine each year. For these annual tests, CO emissions ranged from 0.13 g/bhp-hr to 0.96 g/bhp-hr (17-121 ppmv of CO at 15% O_2). (4) In addition, CEM data was collected on one engine. For a representative time period (July 2010 through April 2011), the CEM data demonstrated that CO emissions were less than 1.3 g/bhp-hr. The District issued a CO emission limit of 1.8 g/bhp-hr, averaged over a 24-hour period (or about 191 ppmv CO at 15% O_2). (1) This limit is the basis for the District's proposed BACT(2) emission limit. If CEMs are used to demonstrate compliance, a 24-hour averaging period is appropriate. If source testing will be used to demonstrate compliance, then it would be more appropriate to set the limit based on the average source test period.

For the Orange County Sanitation District digester gas project, the average CO emission rate was 7.5 ppmv of CO at 15% O_2 and the maximum CO emissions rate was 42.2 ppmv of CO at 15% O_2, based on CEM data. (12) For the MAS Cogen facility, the June 2012 source tests for three engines equipped with oxidation catalysts and burning 100% landfill gas found a maximum CO concentration of 81 ppmv at 15% O_2 (0.65 g/bhp-hr). (5) These projects demonstrate that emission levels below the District's proposed BACT(2) CO limit of 1.8 g/bhp-hr (or about 191 ppmv of CO at 15% O_2) are possible for either treated digester gas or treated landfill gas.

For the BAAQMD Zero Waste Energy project, the District issued a CO emission limit of 0.89 g/bhp-hr for the three 1108 bhp lean-burn engines based on the engine manufacturer's CO emissions data and the expected CO control efficiency of 64.4% provided by the oxidation catalyst manufacturer. (3) Since this emission limit has not yet been demonstrated, this limit is identified as a BACT(1) limit.

In general, the District has observed that landfill gas fired engines have higher baseline CO emissions than digester gas fire engines and that this trend is reflected in post-oxidation catalyst emissions as well. Therefore, the BACT(1) limit shown above for a digester gas fired engine may not be feasible for some landfill gas fired engines. The District will continue to review the CO emissions data from biogas fired engines equipped with oxidation catalysts to refine these BACT(2) and BACT(1) limits.

Comparison of SO_2 Emission Limits for Biogas Fired IC Engine Projects

Emission Limit Units:	ppmv of sulfur in biogas fuel	grams / bhp-hour	pounds / MM BTU	ppmv as SO_2 @ 15% O_2
Proposed BAAQMD BACT Guideline				
Proposed BAAQMD BACT(1)	100	0.09	0.029	5
Proposed BAAQMD BACT(2)	150	0.19	0.050	9
Relevant Projects and Rules				
MAS ASB Cogen , LLC CHP Facility (annual average emission limit)		0.09	0.027	5
BAAQMD Zero Waste Energy (App 24388)	100	0.09	0.029	5
BAAQMD Potrero Hills (App 23333)	150	0.18	0.050	9
BAAQMD Ameresco HMB (App 12649)	150	0.18	0.051	9
SCAQMD Rule 431.1	150	0.19	0.050	9

References: (1), (2), (3), (4), (5), (7), (8), and (13)

SO_2 Limits:

The SCAQMD Rule 431.1 limits the total sulfur content in biogas fuels to 150 ppmv (expressed as H_2S) on a daily average basis. (13) This limit is equivalent to an SO_2 emission rate of 0.05 pounds/MM BTU or an outlet concentration of 9 ppmv of SO_2 at 15% O_2. This rule is the basis for the District's BACT(2) SO_2 limit for biogas fired engines. Some types of biogas, such as biogas from closed landfills and biogas from anaerobic composting projects, are capable of meeting this limit without any additional controls. However some active landfill sites and some sewage treatment sites may have biogas with higher sulfur levels. To meet the BACT(2) limit, the gas will need to be treated to remove the sulfur. As demonstrated below, the gas treatment processes that are currently being used to treat landfill and digester gas in order to remove siloxanes and other contaminants that can foul or poison catalytic control systems have been successful at removing sulfur compounds as well, such that this BACT(2) limit is achieved in practice for treated biogas as well as biogas that has a naturally low sulfur content.

The Ameresco HMB facility is required to meet the proposed BACT(2) sulfur limit of 150 ppmv, expressed as H_2S, for the treated landfill gas burned in the engines. (1) Based on 25 tests, the average sulfur content in the treated landfill gas at Ameresco HMB is 15 ppmv, expressed as H_2S. The maximum sulfur content detected was 47.2 ppmv. (4) For the OCSD project, the total sulfur content in the treated digested gas was less than 35 ppmv. (12) For the MAS ASB Cogen facility, the SO2 concentration in the exhaust was measured as 0.2 ppmv at 15% O_2, which is equivalent to about 3 ppmv of sulfur in the fuel gas. (5) Therefore, a limit of 150 ppmv of total sulfur (expressed as H_2S) has been confirmed to have been achieved in practice for both treated landfill gas and treated digester gas.

The anaerobic composting of green waste and food waste is expected to produce a low-sulfur digester gas. Based on data provided by the Zero Waste Energy site, the District set a total sulfur content limit for this gas of 100 ppmv. (3) This sulfur content is equivalent to an SO_2 emission rate of 0.029 pounds/MM BTU or an outlet concentration of 5 ppmv of SO_2 at 15% O_2. In addition, the MAS Cogen facility is subject to an annual average emission limit of 7.6 tons/year of SO_2, which is equivalent to an average outlet concentration of 5 ppmv of SO_2 at 15% O_2. (7, 8) As a result of these projects and the data above showing measured concentrations of ≤ 50 ppmv of total sulfur for treated biogas (≤ 5 ppmv of SO_2 at 15% O_2), the District is proposing a BACT(1) limit of 100 ppmv of total sulfur for biogas fuel.

Comparison of $PM_{10}/PM_{2.5}$ Emission Limits for Biogas Fired IC Engine Projects

Emission Limit Units:	grams / bhp-hour	pounds / MM BTU	grains/sdcf
Proposed BAAQMD BACT Guideline			
Proposed BAAQMD BACT(1)	0.07	0.019	0.014
Proposed BAAQMD BACT(2)	0.10	0.028	0.023
Relevant Projects and Rules			
BAAQMD Potrero Hills (App 23333)	0.07	0.019	0.014
BAAQMD Zero Waste Energy (App 24388)	0.10	0.032	0.024
BAAQMD Ameresco HMB (App 12649)	0.10	0.028	0.023
AP-42 (Chapter 2.4, Table 2.4-5, 11/98)	0.18	0.048	0.035

References: (1), (2), (3), and (4)

$PM_{10}/PM_{2.5}$ Limits:

Biogas has low particulate levels, and combustion of biogas results in particulate emissions that are similar to natural gas combustion operations. For both natural gas and biogas combustion in IC engines, particulate emissions are minimized by treating the fuel gas using standard filtration and condensation steps.

The particulate emission calculations for several biogas fired engine projects permitted in the District have been based on engine manufacturer guarantees of 0.1 g/bhp-hr of PM_{10} and $PM_{2.5}$. (1, 2, 3) In addition, the federal RACT/BACT/LAER Clearinghouse cites this 0.1 g/bhp-hr PM_{10} level (or an equivalent pound/hour emission rate) as BACT limits for the following projects: NH-0014 (two 1600 kW landfill gas fired engines at University of New Hampshire) and OH-0348 (ten 2233 bhp landfill gas fired engines at Loraine County LFG Power Station).

Source testing was conducted at each of the six engines located at Ameresco HMB for total particulate emissions. Three years of PM data are now available (18 tests). The total particulate emissions ranged from 0.012 g/bhp-hr to 0.036 g/hp-hr, with an average of 0.024 g/bhp-hr. (4) This data demonstrates that a PM10 limit of 0.1 g/bhp-hr has been achieved in practice for engines firing treated landfill gas. Therefore, the 0.1 g/bhp-hr limit is BACT(2) for landfill gas fired engines. Since particulate emissions from all types of biogas fired engines are expected to be similar (after the standard gas pre-treatment steps), the District is proposing this limit as a BACT(2) limit for all types of biogas.

To comply with CEQA requirements, the Potrero Hills Energy Producers, LLC accepted a PM10 limit of 0.07 g/bhp-hr for each of their treated landfill gas fired engines. (2) Since the Ameresco HMB source test data demonstrates that this limit is feasible (4), the District is proposing a limit of 0.07 g/bhp-hr as a BACT(1) limit for $PM_{10}/PM_{2.5}$.

NPOC Limits:

Non-precursor organic compounds (NPOC) include ethane, acetone, and certain halogenated organic compounds such as methylene chloride, perchloroethylene, and many chlorofluorocarbons, which EPA has determined to be non-photochemically reactive (i.e. any organic compounds that EPA has excluded from the definition of VOC). NPOC emissions from biogas fired engines are typically very low and do not usually trigger BACT. (1, 2, 3) However, if BACT is triggered for NPOCs, the control processes would be the same as those described above for POC emissions.

Insufficient NPOC emissions data is available to establish either a BACT(2) or BACT(1) emission limit for NPOCs at this time. NPOC emissions from IC engines are not typically measured because the concentrations of these compounds in the engine exhaust stream are expected to be below source test detection levels. Based on landfill gas analyses, the District has determined that the NPOC content in landfill gas is no more than 5% of the POC content. The District typically applies this same percentage to the outlet POC emission rate from biogas fired engines to estimate maximum NPOC emissions from biogas fired engines. (2)

References

1. Bay Area Air Quality Management District: Permits to Operate (2/7/13) and Addendum Evaluation Report (2/4/13) for Application # 12649, Plant # 17040, Ameresco Half Moon Bay, LLC.
2. Bay Area Air Quality Management District: Authority to Construct (10/24/12) and Engineering Evaluation Report (10/24/12) for Application # 23333, Plant # 20139, Potrero Hills Energy Producers, LLC.
3. Bay Area Air Quality Management District: Authority to Construct (10/29/12), Administrative Change of Permit Conditions (1/7/13), and Engineering Evaluation Report (10/24/12) for Application # 24388. Plant #21277, Zero Waste Energy Development Company, LLC.
4. Bay Area Air Quality Management District: Summary of Source Test Data for Ameresco Half Moon Bay, LLC, Site # 17040 (5/2/13).
5. Bay Area Air Quality Management District: Summary of Source Test Data for MAS ASB Cogen, Atlanta, GA (5/2/13).
6. California Biogas Industry Assessment: White Paper, Rutledge B. (April 2005).
7. Georgia Department of Natural Resources: Air Quality Permit No. 4911-121-0869-S-01-0 (10/18/10) and Narrative for Application # 19829 (8/5/10) for MAS ASB Cogen, LLC. CHP Facility.
8. Georgia Department of Natural Resources: Amendment to Air Quality Permit No. 4911-121-0869-S-01-1 (5/19/11) and Narrative for Application # 20386 (4/12/11) for MAS ASB Cogen, LLC. CHP Facility.
9. San Joaquin Valley Air Pollution Control District: Email (10/6/10): Achieved in Practice Assessment, sent from Laura Yannayon (EPA, Region 9) to Nick Peirce (SJVAPCD).
10. San Joaquin Valley Air Pollution Control District: Email (12/6/12): Summary of Current LFG Projects. sent from Nick Peirce (SJVAPCD) to Carol Allen (BAAQMD).
11. San Joaquin Valley Air Pollution Control District: Rule 4702 Internal Combustion Engines (last amended on 8/18/11).
12. South Coast Air Quality Management District: Assessment of Available Technology for Control of NOx, CO, and VOC Emissions from Biogas-fueled Engines (August 2012).
13. South Coast Air Quality Management District: Rule 431.1 Sulfur Content of Gaseous Fuels (last amended on 6/12/98).
14. South Coast Air Quality Management District: Rule 1110.2 Emissions from Gaseous and Liquid Fueled Engines (last amended on 8/7/12).

APPENDIX C

Health Risk Screening Analyses for Application # 24495

INTEROFFICE MEMORANDUM

September 16, 2013

To: Barry Young *BMY 9/24* Via: Daphne Chong *dyc*

From: Carol Allen

Subject: Updated Health Risk Screening Analysis for Application # 24495
Redwood Landfill, Plant # 1179

Background

Redwood Landfill Company, or "Redwood", submitted Application # 24495 in May 2012 to request an Authority to Construct for a Landfill Gas to Energy (LFGTE) Plant to be located on their Redwood Landfill Facility (Plant # 1179) in Novato, CA. In the initial application materials, Redwood proposed a LFGTE Plant consisting of six Caterpillar 3520 engines (2233 bhp and 1.6 MW each) fired on treated landfill gas and a landfill gas treatment system. Emissions from the gas treatment system would be vented to one of the existing flares. Emissions from each IC engine would be controlled by add-on SCR systems and oxidation catalysts.

The District completed an HRSA for the proposed project in December 2012. This initial HRSA included a number of assumptions about the engines and gas treatment system since data and limits were still under development. The District updated this HRSA in April 2013 to include a corrected cancer risk weighting factor for PAH emissions, a reduced formaldehyde emission limit for the engines, and a higher ammonia slip limit for the SCR systems. This revised HRSA resulted in the following project health impacts:

- Maximum increased cancer risk of 7.8 in a million,
- Maximum chronic hazard index of 0.23
- Maximum acute hazard index of 0.91

While the applicant was reviewing the District's proposed permit condition limits and additional data request pertaining to the gas treatment system, the applicant requested to modify this application. District management agreed that these revisions could be handled within the same application. On July 25, 2013, the District received the proposed revisions to the application, and subsequently received additional data for the gas treatment system and Redwood Landfill's comments on draft permit conditions. Based on this revised application submittal, Redwood is now proposing to install four IC engines instead of six engines. The proposed engines are a newer and more efficient version of the Caterpillar 3520 engine model. Each engine will have capacities of 1.966 MW and 2739 bhp with a maximum heat input rating of 21.61 MM BTU/hour and maximum landfill gas throughput of 725 scfm. Overall, the combined plant capacity will decrease from 9.6 MW to 7.864 MW, the combined horsepower will decrease from 13,398 bhp to 10,956 bhp, and the landfill gas throughput to the engines will decrease from about 3600 scfm to 2900 scfm. Redwood is also requesting to increase the maximum combined landfill gas throughput rate to the flares to ensure the flares can handled the peak gas generation rate that may occur pursuant to the Application # 20607 Landfill Expansion Project.

Current HRSA and Summary of Changes

The District has completed a third HRSA for this application pursuant to the applicant's revisions discussed above. The applicant requested that the District establish a formaldehyde emission limit for the engines that would ensure compliance with Regulation 2-5-302 project risk limits and that would not trigger a public notice trigger pursuant to the AB-2588 Air Toxic Hot Spots Act. The HRSA results reported here conform to these constraints. The major changes included in this HRSA are discussed below:

- The District reduced the number of landfill gas fired engines in this project from six to four and revised the stack parameters for each engine pursuant to the applicant's 7/25/13 submittal.
- The District calculated residual TAC emissions and secondary acid gas emissions from the landfill gas fired engines using the same methods and assumptions as those discussed in previous HRSA reports for this application, but the hourly and annual emission rates for each engine have increased due to the higher landfill gas throughput rate to each of these engines.
- The District determined that a formaldehyde emission limit of 0.51 pounds/hour for each of the four proposed landfill gas fire engines would result in project risks that comply with the Regulation 2-5-302 project risk limits and site-wide health impacts that are less than the public notice thresholds (10 in a million cancer risk, 1.0 chronic hazard index, and 1.0 acute hazard index).
- The District increased the maximum annual emission rates for all residual and secondary TACs from the two existing enclosed flares (A-51 and A-60) pursuant to the applicant's agreement to increase the combined landfill gas throughput limit for these flares.
- This project involves a change in the operation of the flares. The proposed landfill gas treatment system includes a regular media desorption cycle (at least several times per week). During this desorption cycle, emissions will be vented to one of the flares for control. This process results in an increase in the maximum hourly emission rate that may be vented to either flare. This emission rate is not precisely known at this time. Previously the District estimate that the concentration of contaminants in the waste gas stream vented to the flare would be about four times the concentrations in landfill gas. With this HRSA revision, the District has changed this inlet concentration estimate to five times the landfill gas concentrations.
- For this HRSA revision, the District evaluated the project impacts for two possible operating scenarios (Scenario A and Scenario B). For Scenario A (the current operating configuration), all collected landfill gas would be vented to the flares for control. Health impacts for this scenario were determined based on the maximum emission rates for the landfill and for the flares. For Scenario B, collected landfill gas would be vented to engines at the maximum operating rate (about 2900 scfm) while the remainder for the generated landfill gas (2095 scfm) would be vented to a single flare. Each flare has a capacity of 3000 scfm of landfill gas, and one flare is capable of handling all of the excess gas that exceeds the engines combined capacity. For Scenario B, health impacts were evaluated for the landfill, one flare, and four engines combined.
- The District refined the acute health impacts analysis by determining the acute impacts for each separate target organ system.

All other emission calculations and risk screening procedures are the same as those described in detail in the December 12, 2012 and April 26, 2013 HRSA Reports for Application # 24495.

Health Impacts Summary

The project health impacts for each possible operating scenario (A and B) and site-wide health impacts for the currently proposed landfill gas energy plant configuration (7.9 MW capacity including 4 newer and more efficient engines) are presented in Table 1-3 below.

Operating Scenario B (which includes the landfill, one flare, and four landfill gas fired engines) results in a project cancer risk of 9.8 in a million. This project risk is 26% higher than the project risk (7.8 in a million) that was determined for the previously proposed six engine energy plant configuration. The risk is higher because the formaldehyde emission rate for each proposed engine was maximized. The cancer risk for Scenario B is 27% higher than the maximum cancer risk that will occur under the current operating configuration (Scenario A, landfill and flares).

For site-wide impacts, the District used the higher impact operating scenario described above and included two portable diesel fired engines (S-61 and S-62) that were permitted at this site in 2010. Since diesel fuel usage for the S-49 Emergency Standby Engine has been reported to be zero for the last several years, S-49 was not included in this site wide health impact analysis. Actual emissions from S-42, S-55, and S-58 are very low and are not expected to have any measurable impacts on site-wide health risks. For this analysis, the site-wide cancer risk was determined based on landfill emission rates that will not occur for more than thirty years. The current landfill emissions are less than 60% of this maximum rate. When the landfill cancer risk reaches its peak in the year 2058, the landfill gas generation rate will have dropped significantly and could only support the operation of two landfill gas fire engines. Also, the landfill would no longer be accepting waste and would have no need for the S-61 portable waste tipper engine. Thus, the site-wide operating configuration described above (S-5, A-60, S-61, and S-62, S-64, S-65, S-66, and S-67) is considered to be the worst case site-wide operating scenario. Based on the results of this analysis, the site-wide increased cancer risk is 10.0 in a million and remains the same as the previously proposed six engine energy plant configuration.

The proposed four engine energy plant will result in a maximum chronic hazard index of 0.23 for the project, which is the same as the chronic hazard index (HI) for the previously proposed six engine configuration. The maximum site-wide chronic hazard index is also 0.23. Chronic hazard impacts are dominated by fugitive landfill emissions. Peak chronic impacts for the landfill occur on the north side of the landfill. At this location, the proposed landfill gas engines are too far away to have any measureable impact compared to fugitive landfill emissions. The four proposed landfill gas fired engines will result in a maximum chronic HI of 0.12 at the nearest residential receptor.

The proposed project will result in a maximum acute hazard index of 0.75. As discussed previously, the District refined this acute impacts analysis by evaluating the impacts to each target organ. The peak acute HI of 0.75 is primarily due to fugitive hydrogen sulfide emissions from the landfill, and the target organ is the central nervous system. This impact is the same for both the current landfill and flares operating scenario and the proposed energy plant, flare, and landfill scenario. Since the proposed landfill gas fired engines will have very low hydrogen sulfide emissions, the proposed engines' do not increase the maximum acute HI for the project. The acute hazard index for the new engines alone will be 0.55. The health impacts from engine emissions are predominantly due to formaldehyde, which affects the eyes. Acute health impacts to other target organ systems are less than 0.03 acute HI. Since diesel PM does not have an acute health effects value, the portable diesel engines were not included in the site-wide analysis, and the site wide acute health impacts are the same as the project risk for Scenario B.

Table 1. Increased Cancer Risks for Application # 24495

	Worker (Cancer Risk per Million)	Resident (Cancer Risk per Million)
Landfill (S-5), Based on Emission in Year 2044	0.98	6.07
LFG Flares (A-51 & A-60)	0.08	0.14
4 LFG Engines (S-64, S-65, S-66, & S-67)	3.03	9.57
Project Risk, Scenario A (S-5, A-51, & A-60)	0.98	6.07
Project Risk, Scenario B (S-5, A-60, S-64, S-65, S-66, S-67)	3.39	9.82
Site Wide Impacts for AB-2588 (S-5, A-60, S-61, S-62, S-64, S-65, S-66, and S-67)	3.84	10.00

Table 2. Chronic Non-Cancer Impacts for Application # 24495

	Worker (Chronic Hazard Index)	Resident (Chronic Hazard Index)
Landfill (S-5) Based on Emissions in Year 2029 at Peak Gas Generation Rate	0.08	0.23
LFG Flares (A-51 & A-60)	0.02	0.02
4 LFG Engines (S-64, S-65, S-66, & S-67)	0.08	0.12
Project Risk, Scenario A (S-5, A-51, & A-60)	0.08	0.23
Project Risk, Scenario B (S-5, A-60, S-64, S-65, S-66, S-67)	0.11	0.23
Site Wide Impacts for AB-2588 (S-5, A-60, S-61, S-62, S-64, S-65, S-66, and S-67)	0.11	0.23

Table 3. Acute Non-Cancer Impacts for Application # 24495

	Acute HI (Eyes)	Acute HI (Central Nervous System)	Acute HI (Respiratory System)
Landfill (S-5), Year 2029	0.002	0.750	0.007
LFG Flares (A-51 & A-60)	0.033	0.250	0.027
4 LFG Engines (S-64, S-65, S-66, & S-67)	0.547	0.201	0.009
Project Risk, Scenario A (S-5, A-51, & A-60)	0.034	0.750	0.029
Project Risk, Scenario B (S-5, A-60, S-64, S-65, S-66, & S-67)	0.551	0.750	0.024

INTEROFFICE MEMORANDUM

April 26, 2013

To: Barry Young *BMY 5/20/13* Via: Daphne Chong *DYC*

From: Carol Allen

Subject: Updated Health Risk Screening Analysis for Application # 24495
Redwood Landfill, Plant # 1179

Changes

The December 12, 2012 HRSA for the proposed Landfill Gas Energy Plant at Redwood Landfill (six new IC engines, 2233 bhp each, fueled on treated landfill gas) has been revised pursuant to the following changes:

- Per Daphne Chong's recommendation, I included a cancer risk weighting factor of 16.4 for cancer risk weighted PAH emissions from the proposed landfill gas fired engines to account for the additional cancer risk that will occur when multiple cancer risk pathways are included instead of just the inhalation pathway alone. PAHs are the only multi-pathway pollutant, and PAHs are only emitted from the proposed LFG-fired engines.
- I reduced the formaldehyde emission limit for the proposed landfill gas fire engines from 0.224 pounds/hour per engine to 0.18 pounds/hour per engine to ensure that the site-wide cancer risk would not exceed 10 in a million or trigger public notification requirements pursuant to AB-2588 Air Toxic Hot Spots criteria. Note that the site-wide impacts were determined based on maximum permitted landfill emission rates that will not occur for more than twenty years. The current landfill emissions are less than 60% of this maximum rate.
- I increased the ammonia slip limit for each landfill gas fired engine from 5 ppmv of NH_3 at 15% O_2 to 10 ppmv of NH_3 at 15% O_2.

All other emission calculations and risk screening procedures are the same as those described in detail in the December 12, 2012 HRSA Report for Application # 24495.

Health Impacts Summary

The revised project risk and site-wide health risks for Application #24495 are presented in the tables below.

The acute hazard index for the project and the site went down from 0.997 based on the December 2012 emissions data to 0.91 for the currently proposed emission limits. This change reflects both a reduction in formaldehyde emissions and an increase in ammonia emissions.

The maximum chronic hazard index for residents and workers remained the same.

For the proposed engines, the cancer risk increased by 1% due to the PAH health risk calculation changes and the formaldehyde emission limit reductions. However, the change in project and site-wide cancer risk was only about a 0.5% increase. The proposed formaldehyde limit for the engines was reduced to 0.18 pounds/hour per engine to keep the site-wide cancer risk from exceeding 10 in a million risk (at maximum permitted levels for all sources).

Note that the site-wide impacts were determined based on maximum permitted landfill emission rates that will not occur for more than twenty years. The current landfill emissions are less than 60% of this maximum rate. At this current emission rate for the landfill and maximum permitted emission rates for all other sources, the site-wide cancer risk is 8.84 in a million.

Table 1. Project Risk for Application # 24495

Health Impact Type	Receptor Type	6 LFG Engines (App 24495)	Landfill (S-5) in Year 2038	LFG Flares (A-51 & A-60)	Maximum Project Impacts
Acute HI	Resident or Worker	0.69	0.75	0.06	0.91
Chronic HI	Worker	0.07	0.08	0.02	0.10
Chronic HI	Resident	0.11	0.23	0.01	0.23
Cancer Risk in a million	Worker	2.45	0.96	0.07	2.76
Cancer Risk in a million	Resident	7.54	5.95	0.12	7.79

Table 2. Site-Wide Health Impacts for Plant # 1179

Health Impact Type	Receptor Type	6 LFG Engines (App 24495)	Landfill (S-5) in Year 2038	LFG Flares (A-51 & A-60)	Diesel Engines (S-61 & S-62)	Maximum Site-Wide Impacts
Acute HI	Resident or Worker	0.69	0.75	0.06	NA	0.91
Chronic HI	Worker	0.07	0.08	0.02	0.002	0.10
Chronic HI	Resident	0.11	0.23	0.01	0.001	0.23
Cancer Risk in a million	Worker	2.45	0.96	0.07	3.12	3.90
Cancer Risk in a million	Resident	7.54	5.95	0.12	3.58	10.0

INTEROFFICE MEMORANDUM

December 12, 2012

To: Barry Young   Via: Daphne Chong dyc

From: Carol Allen

Subject: Health Risk Screening Analysis for Application # 24495
Redwood Landfill, Plant # 1179

Project Description

Redwood Landfill submitted Application # 24495 to request an Authority to Construct and Permit to Operate for a landfill gas fired energy plant that will be located near the existing flare stations. The proposed energy plant will include six 2233 bhp internal combustion engines (nominal 1.6 MW each) that will be fired exclusively on treated landfill gas. Each engine will be controlled by an oxidation catalyst and a selective catalytic reduction (SCR) system. The engines and abatement equipment will be identified by the following devices numbers:

S-64 Engine # 1 abated by A-64 Oxidation Catalyst and S-71 SCR System
S-65 Engine # 2 abated by A-65 Oxidation Catalyst and S-72 SCR System
S-66 Engine # 3 abated by A-66 Oxidation Catalyst and S-73 SCR System
S-67 Engine # 4 abated by A-67 Oxidation Catalyst and S-74 SCR System
S-68 Engine # 5 abated by A-68 Oxidation Catalyst and S-75 SCR System
S-70 Engine # 6 abated by A-70 Oxidation Catalyst and S-76 SCR System

Prior to combustion in the engines, the collected landfill gas will be treated to remove siloxanes and other contaminants. This landfill gas treatment system includes a desorption process (S-71) that is required to regenerate the adsorption media. Waste gases from the S-71 desorption cycle will be vented to either of the existing landfill gas flares (A-51 or A-60) to control these waste gas emissions. On an annual basis, the emissions from each flare are expected to be no greater than the emissions due to landfill gas combustion alone. However, the landfill gas treatment and desorption process may result in higher emissions to the flare on an hourly basis and less overall throughput to the flare. For these reasons, the flare emissions are included as part of this project.

Based on source test data and health risk assessments that have been conducted for other landfill gas fired IC engines, the District has found that formaldehyde emissions from landfill gas fired IC engines are very high compared to other types of gaseous fuels and that these high formaldehyde emissions typically constitute more than 90% of the cancer risk for a landfill gas fired engine project. Source test data collected on various landfill gas fired Caterpillar engines found that these engines have formaldehyde emissions data that are, on average, similar to formaldehyde emissions data for other engine manufacturers. Therefore, the District expects similar uncontrolled formaldehyde emission results for the proposed Caterpillar engines in this project.

To reduce both carbon monoxide (CO) and formaldehyde emissions, the applicant is proposing to use an oxidation catalyst on each IC engine. Oxidation catalysts are known to be effective at reducing formaldehyde emissions in other gaseous fuel combustion exhausts, but no formaldehyde control efficiency data is specifically available for oxidation catalysts used on landfill gas fired IC engines. Consequently, the applicant requested that the District determine the maximum permitted formaldehyde emission level that would enable this project to meet the project health risk limits in Regulation 2-5-302 as well as prevent the triggering of any public notification requirements under the AB2588 Air Toxics Hot Spots Act.

Related Applications and Site-Wide Health Impacts

All applications completed within a two year time period are considered to be related applications pursuant to Regulation 2-5-216. For Redwood Landfill, Applications #20607, #22889, and #23434 were processed within this two-year time frame. Application # 20607 was for a modification and expansion of the S-5 Redwood Landfill and included several new or modified sources of TAC emissions. Application # 22889 was for a new S-63 Dry Waste Material Recovery Facility (MRF) that is prohibited from processing designated or hazardous wastes. Since all emissions from S-63 were expected to be less than the TAC trigger levels, a risk screen was not required for Application # 22889. Application # 23434 was for an alteration of an existing composting operation and did not involve any new or modified equipment. Since Application # 20607 included new or modified sources of TAC emissions and it was processed less than two years ago, this application is considered to be a related part of this current project.

Due to the variable nature of landfill emissions, the District typically evaluates the maximum cancer risk from a landfill source based on the peak of the 70-year average emission rate for the landfill. For Redwood Landfill, the peak 70-year average emission rate will occur in the year 2058. However, during this particular year, the landfill gas generation rate is only projected to be 1626 scfm of landfill gas, which would only support the operation of three of the proposed landfill gas fired engines. The District considered various alternative years and determined that maximum combined health impacts for the combined operation of the landfill and the energy plant would occur during the years when the landfill gas generation rate could support the operation of all six of the proposed engines at the same time (years 2014-2038). During this time period, the 70-year average landfill emissions will be highest during the year 2038, when the 70-year average landfill gas generation rate is 2744 scfm of landfill gas. This case was used to determine both the combined project risk from the modified landfill and the proposed energy plant as well as the maximum site-wide cancer risk for AB2588 purposes. This site-wide health impacts analysis included the proposed energy plant (continuous operation of the six proposed IC engines at maximum permitted emission levels), maximum permitted fugitive emissions from the landfill during the year 2038, maximum permitted emissions from the two flares (A-51 and A-60), and maximum permitted emissions from two portable diesel engines (S-61 and S-62) that were permitted in 2010 and considered to be a related project for Application # 20607. The compost operations (S-34) may potentially result in toxic air contaminant emissions, but the District has not yet identified specific TAC emission rates for compost operations other than ammonia (NH3), which is not carcinogenic. Since carcinogenic emissions are expected to be the limiting factor for this site, the ammonia emissions from the compost operations were not considered in this analysis.

Project Emissions

Pursuant to Application # 20607, the District established maximum permitted landfill gas concentration levels for numerous toxic air contaminants. If a concentration limit was not available, the District used AP-42 default concentration data to estimate landfill gas TAC concentrations. For Application # 24495, the District assumed that the untreated landfill gas contained these maximum permitted concentration levels and that the gas treatment system would remove 50% of each TAC (except that no control was assumed for mercury). The District assumed that the IC engine would destroy at least 85% of each organic TAC and that the oxidation catalyst would destroy another 50% of the residual organic TACs.

As discussed above, the District determined that formaldehyde emissions from each engine (after control by oxidation catalyst) would need to be limited to 0.224 pounds/hour (11,770 pounds/year from all six engines combined) in order to keep site-wide health impacts less than 10.0 in a million cancer risk, which will avoid triggering public notification pursuant to the AB2588 Air Toxic Hot Spots Act. The health impacts discussed below are based on this 0.224 pound/hour per engine formaldehyde emission limit.

Project emissions for Application # 24495 and the emission rates at each source that were used for the site-wide health impacts analysis are presented in the attached tables.

Health Impacts Summary

As discussed in the HRSA report for Application # 20607, the District refined the HRSA analysis by evaluating all receptors located outside of the Redwood Landfill property lines as possible worker receptor locations and by using a smaller set of receptor locations for all possible nearby residential receptor locations (at a dairy farm west of Highway 101, at the Olompali State Park's ranger residence, and at the building on the south side of Burdell Island). All other residential receptors are more than 3000 meters from the site.

Compared to the HRSA for Application # 20607, the District updated the map used to identify the source and receptor locations, the District used the year 2038 emissions data for the landfill (S-5) because this represents the worst case combined emissions from the landfill and LFG-fired engines, and the District added the proposed Application # 24495 Energy Project (six landfill gas fired IC engines. The results of this updated HRSA are summarized in Tables 1 and 2.

Table 1. Project Risk for Application # 24495

Health Impact Type	Receptor Type	6 LFG Engines (App 24495)	Landfill (S-5) in Year 2038	LFG Flares (A-51 & A-60)	Maximum Project Impacts
Acute HI	Resident or Worker	0.78	0.75	0.06	0.997
Chronic HI	Worker	0.08	0.08	0.02	0.11
Chronic HI	Resident	0.13	0.23	0.01	0.23
Cancer Risk in a million	Worker	2.42	0.96	0.07	2.73
Cancer Risk in a million	Resident	7.45	5.95	0.12	7.70

Table 2. Site-Wide Health Impacts for Plant # 1179

Health Impact Type	Receptor Type	6 LFG Engines (App 24495)	Landfill (S-5) in Year 2038	LFG Flares (A-51 & A-60)	Diesel Engines (S-61 & S-62)	Maximum Site-Wide Impacts
Acute HI	Resident or Worker	0.78	0.75	0.06	NA	0.997
Chronic HI	Worker	0.08	0.08	0.02	0.002	0.11
Chronic HI	Resident	0.13	0.23	0.01	0.001	0.23
Cancer Risk in a million	Worker	2.42	0.96	0.07	3.12	3.87
Cancer Risk in a million	Resident	7.45	5.95	0.12	3.58	9.99

The highest cancer risk for the Application # 24495 project was determined to be 7.7 in a million at the nearest residential receptor. The highest cancer risk for the site (which includes the two portable diesel engines) is 9.99 in a million. The highest chronic hazard index was determined to be 0.23 for both the project and the site. The acute hazard index was determined to be 0.997 for both the project and the site. The proposed project complies with the cancer risk and hazard index limits in Regulation 2-5-302.1-3.

For any single landfill gas fired IC engine, the cancer risk could exceed 1.0 in a million. Therefore, each of the proposed landfill gas fired IC engines must comply with TBACT requirements pursuant to Regulation 2-5-301. The applicant has proposed to use add-on controls (oxidation catalysts) to minimize the organic TAC emissions from each engine. These add-on controls are expected to reduce formaldehyde emissions (the primary risk driver) to the maximum extent possible and are expected to satisfy this TBACT requirement. This determination is discussed in more detail in the Engineering Evaluation for Application # 24495.

Modeling Procedures

The ISCST3 air dispersion model was used to determine 1-hour average ambient air concentrations. For the landfill (S-5) and each device (A-51, A-60, S-61, S-62, S-63, S-64, S-65, S-66, S-67, S-68, and S-70), the District determined a set of five input factors for the ISCST3 model: acute, chronic-worker, chronic-resident, cancer-worker, cancer-resident. These input factors are derived based on toxicity weighted emissions and pre-processing of the health risk calculations such that the model results will represent acute HI, chronic HI, and cancer risk per million for the whole project or for the whole site (depending on which sources are included in the summary). The derivations of these input factors are discussed in more detail below (see Input Factors for Air Dispersion Model).

The model was run using RURAL dispersion coefficients. The landfill is an area source with fugitive emissions occurring from the surface of the landfill. The landfill emissions and emission increases are assumed to occur evenly across the entire landfill surface. The new total surface area for the landfill will be 222.5 acres. The final landfill height will be 166 feet for the southern peak and 122 feet for the northern peak. All of the landfill emissions are assumed to be emitted from a base elevation of 166 feet.

The applicant previously provided the exhaust gas data and stack information for the flares and portable engines. Existing building locations and dimensions were determined from November 2012 Google Earth aerial maps of the site. Stack data for the six proposed landfill gas fired IC engines and the dimensions of the proposed energy plant buildings were provided by the Applicant in Application # 24495.

Since there is currently no District approved real meteorological data set for this site, the Screen3 data set was used.[1] Terrain data from the Petaluma River quadrangle was used to determine elevations for all stacks and receptors. Detailed modeling results are available electronically.

The landfill site is primarily surrounded by agricultural land, wetlands, and marshes. There is an old quarry area on the west side. The Olompali State Park is on the southwest side of the site, and Burdell Island and marina are located on the southeast side of the site. An airport is located about ½ mile south of the site. The nearest confirmed residence is within Olompali State Park about 500 m WSW of the southwest corner of the landfill property boundary. There are also several farming residences located on the west side of Highway 101 that are 500 to 2000 meters from Redwood's property line.

<u>Health Impact Assumptions</u>

Estimates of residential risk assume potential exposure to annual average TAC concentrations occur 24 hours per day, 350 days per year, for a 70-year lifetime. Risk estimates for off-site workers assume potential exposure occurs 8 hours per day, 245 day per year, for 40 years. Risk estimates for students were not determined, because this site is not located within 1000 feet of a school.

<u>Input Factors for Air Dispersion Model</u>

The emissions or emission increases discussed above for each operation were modified using one of the health impact calculation procedures below to derive an input factor for the air dispersion modeling program. When these input factors are used for the source emission rates (g/s or g/s-m^2), the results reported by the model will show the total health impact for each case being evaluated. The input factor calculation procedures are discussed below for each type of health impact. Detailed calculations are presented in the attached spreadsheets. The input factors are summarized in Table 3.

[1] The applicant has requested that the District consider approving the use of the Sonoma Bay Lands met-data set for this site or the use of a new met-data set from the Gnoss Field Airport to the south of the landfill. The applicant's consultant is comparing met station data from Sonoma Bay Lands, Gnoss Field Airport, and an on-site weather station to demonstrate the applicability of these data sets for the Redwood Landfill site. Screen3 met-data will be used for this site until the District approves the use of one or more of these alternative met-data sets.

Table 3. Summary of ISCST3 Input Factors for this Project

Health Impact Type	Receptor Type	S-5 $g/s\text{-}m^2$	A-51 and A-60 g/s	S-61 and S-62 g/s	LFG-fired Engines g/s
Acute HI	Resident or Worker	8.2614E-9	7.1112E-4	Not Applicable	1.2287E-3
Chronic HI	Worker	7.7024E-10	1.8550E-4	4.3450E-6	1.3030E-4
Chronic HI	Resident	3.3010E-9	7.9502E-4	5.3203E-6	5.5845E-4
Cancer Risk In a million	Worker	1.0893E-8	8.5795E-4	6.1040E-3	3.8241E-3
Cancer Risk In a million	Resident	9.3832E-8	7.3905E-3	1.5023E-2	3.2941E-2

Acute Non-Cancer Input Factors:

For acute non-cancer impacts, the averaging time for the dispersion model concentration result (maximum 1 hour average) is the same as the evaluation period (1 hour average) for the acute reference exposure level (REL). Therefore, no conversion factors are necessary for concentration averaging time. Since the exposure period (1 hour) for both worker and residential receptors is the same as the source operating time (1 hour), no exposure adjustment factors are necessary either.

The "Σ Acute Weighted Emission Rate" is the sum of the individual acute weighted emission rates for all compounds emitted from a source that have an acute REL. The acute weighted emission rate for each compound is determined from the hourly emission rate for that compound as follows:

Acute Weighted Emission Rate Flux, $g/s\text{-}m^2$ =
(Emission Rate, pounds/hour) * (453.59237 grams/pound) / (3600 seconds/hour) /
(surface area of area source, m^2) / (Acute REL)
or
Acute Weighted Emission Rate, g/s =
(Emission Rate, pounds/hour) * (453.59237 grams/pound) / (3600 seconds/hour) / (Acute REL)

Since diesel PM is the only TAC emitted from the portable diesel engines and diesel PM does not have an acute REL, there are no acute input factors for the two portable diesel engines.

The acute input factors for the landfill, flares, and LFG-fired IC engines are determined using the following equation:

Acute Input Factor (adjusted $g/s\text{-}m^2$ or g/s) = Σ Acute Weighted Emission Rate ($g/s\text{-}m^2$ or g/s)

Chronic Non-Cancer Input Factors:

For chronic non-cancer impacts, a factor of 0.1 is included with the input factor calculations to convert the model result's 1-hr average concentration to an annual average concentration.

The following exposure adjustment factors (EAF_i) are also required for chronic non-cancer health impact calculations:

EAF for Continuously Operating Landfill, Flares, or LFG-Fired IC Egines (EAF_{C-R} and EAF_{C-W}):
Resident (exposure vs. operating time):
EAF_{C-R} = (24 hours/day / 24 hours/day)*(350 days/year / 365 days/year) = 0.9589
Worker (exposure vs. operating time):
EAF_{C-W} = (8 hours/day / 24 hours/day)*(245 days/year / 365 days/year) = 0.2237

EAF for Intermittently Operating Diesel Engines (EAF_{I-R} and EAF_{I-W}):
Resident (exposure vs. operating time):
EAF_{I-R} = (8 hrs/day / 8 hrs/day)*(6 days/wk / 6 days/wk)*(50 wks/yr / 52 wks/yr) = 0.9615
Worker (exposure vs. operating time):
EAF_{I-W} = (8 hrs/day / 8 hrs/day)*(5 days/wk / 6 days/wk)*(49 wks/yr / 52 wks/yr) = 0.7853

The "Σ Chronic Weighted Emission Rate" is the sum of the individual chronic weighted emission rates for all compounds emitted from a source that have a chronic REL. The chronic weighted emission rate for each compound is calculated using the annual emission rate and chronic REL for each compound as follows:
Chronic Weighted Emission Rate Flux, g/s-m^2 =
(Emission Rate, pounds/year) * (453.59237 grams/pound) / (365 days/year) / (24 hours/day) / (3600 seconds/hour) / (surface area of area source, m^2) / (Chronic REL)
or
Chronic Weighted Emission Rate, g/s =
(Emission Rate, pounds/year) * (453.59237 grams/pound) / (365 days/year) / (24 hours/day) / (3600 seconds/hour) / (Chronic REL)

For each set of annual emission rates, two chronic input factors were determined (one for residential receptors and one for worker receptors) using the following equation:
Chronic Input Factor (adjusted g/s-m^2 or g/s)
= (0.1)*(EAF_i)*(Σ Chronic Weighted Emission Rate, g/s-m^2 or g/s)

<u>Cancer Risk Input Factors:</u>
For cancer risk impacts, the health impact calculations are based on cancer potency factors for individual compounds with units of (mg/kg-day)$^{-1}$. The calculations include receptor specific breathing rates (L/kg-day), a factor of 1E-6 (mg-m^3/μg-L) to convert the dispersion model air concentration results (μg/m^3) to the dosage units of mg/L, lifetime exposure adjustment factors for different receptor types, and age sensitivity factors for different receptor types. A factor of 0.1 converts dispersion model concentration results from a 1-hour average to an annual average concentration. A factor of 1E6 is also included so that the dispersion model results will report the health impact as risk per million.

The receptor specific breathing rates, lifetime exposure adjustment factors, and other conversion factors are combined into the following four cancer risk adjustment factors (AF_i) for each source and receptor type:

Cancer Risk Adjustment Factors for Continuously Operating Landfill, Flares, or LFG-Fired IC Engines ($AF_{C\text{-}R}$ and $AF_{C\text{-}W}$):

Resident ($AF_{C\text{-}R}$):
(302 L/kg-day) * (1E-6 mg-m^3/µg-L) * (24 hrs/day / 24 hrs/day) * (350 days/yr / 365 days/yr) * (70 yrs / 70 yrs) * (1.7 ASF) * (0.1 µg/m^3 – ann avg / µg/m^3 1-hr avg) * (1E6 risk per million)
$AF_{C\text{-}R}$ = (3.02E-4)*(1)*(0.9589)*(1)*(1.7)*(1E5) = 49.230 mg/kg-day

Worker ($AF_{C\text{-}W}$):
(447 L/kg-day) * (1E-6 mg-m^3/µg-L) * (8 hrs/day / 24 hrs/day) * (245 days/yr / 365 days/yr) * (40 yrs / 70 yrs) * (1.0 ASF) * (0.1 µg/m^3 – ann avg / µg/m^3 1-hr avg) * (1E6 risk per million)
$AF_{C\text{-}W}$ = (4.47E-4)*(0.3333)*(0.6712)*(0.9423)*(0.5714)*(1.0)*(1E5) = 5.715 mg/kg-day

Cancer Risk Adjustment Factors for Intermittently Operating Diesel Engines ($AF_{I\text{-}R}$ and $AF_{I\text{-}W}$):

Resident ($AF_{I\text{-}R}$):
(302 L/kg-day) * (1E-6 mg-m^3/µg-L) * (8 hrs/day / 8 hrs/day) * (6 days/wk / 6 days/wk) * (50 wks/yr / 52 wks/yr) * (70 yrs / 70 yrs) * (1.7 ASF) * (0.1 µg/m^3 – ann avg / µg/m^3 1-hr avg) * (1E6)
$AF_{I\text{-}R}$ = (3.02E-4)*(1)*(1)*(0.9615)*(1)*(1.7)*(1E5) = 49.365 mg/kg-day

Worker ($AF_{I\text{-}W}$):
(447 L/kg-day) * (1E-6 mg-m^3/µg-L) * (8 hrs/day / 8 hrs/day) * (5 days/wk / 6 days/wk) * (49 wks/yr / 52 wks/yr) * (40 yrs / 70 yrs) * (1.0 ASF) * (0.1 µg/m^3 – ann avg / µg/m^3 1-hr avg) * (1E6)
$AF_{I\text{-}W}$ = (4.47E-4)*(1)*(0.8333)*(0.9423)*(0.5714)*(1.0)*(1E5) = 20.058 mg/kg-day

The "Σ Cancer Risk Weighted Emission Rate" is the sum of the individual cancer risk weighted emission rates for all compounds emitted from a source that have a cancer potency factor. HARP derived adjustment factors were included for compounds (mercury and PAHs) that have non-inhalation impacts. The cancer risk weighted emission rate for each compound is determined from the annual emission rate and cancer potency factor for that compound as follows:

Cancer Risk Weighted Emission Rate Flux, g/s-m^2 per mg/kg-day =
(Emission Rate, pounds/year) * (453.59237 grams/pound) / (365 days/year) / (24 hours/day) / (3600 seconds/hour) / (surface Area of Source, m^2) * (Cancer Potency Factor, (mg/kg-day)$^{-1}$)
or
Cancer Risk Weighted Emission Rate, g/s per mg/kg-day =
(Emission Rate, pounds/year) * (453.59237 grams/pound) / (365 days/year) / (24 hours/day) / (3600 seconds/hour) * (Cancer Potency Factor, (mg/kg-day)$^{-1}$)

For each set of annual emission rates, two cancer risk input factors were determined (one for residential receptors and one for worker receptors) using the following equation:
Cancer Risk Input Factor (g/s-m^2 or g/s) = (AF_i)*(Σ Cancer Risk Weighted Emission Rate)

Conclusions

Health impacts for this project are summarized in Tables 1 and 2 of this report. Aerial photos and maps are attached that show the maximum impact points.

The proposed project will comply with BAAQMD Regulation 2-5-302.1 by having a cancer risk of less than 10.0 in a million, with Regulation 2-5-302.2 by having a chronic HI of less than 1.0, and with Regulation 2-5-302.3 by having an acute HI of less than 1.0.

BAAQMD Regulation 2-5-301 requires TBACT for a source if the source risk exceeds either 1.0 in a million cancer risk or 0.2 chronic hazard index. As illustrated in Table 1, the source risks for the landfill gas fired IC engines are each expected to exceed the TBACT threshold of 1 in a million cancer risk. The applicant has proposed to use oxidation catalysts to satisfy this TBACT requirement.

If the District determines that the landfill gas fired IC engines are complying with TBACT and if Redwood Landfill accepts the District's proposed formaldehyde emission limit of 0.224 pounds/hour per engine, then this project would be acceptable pursuant to the District's toxic new source review requirements.

Prepared by: Carol S. Allen Date: 12/12/12

Carol S. Allen

Table 4. TAC Emissions from Proposed LFG-Fired IC Engines (After Catalytic Controls)

	Emissions Pounds/Hour per Engine	Emissions Pounds/Year per Engine	Total Project Pounds/Year (6 Engines)	Risk Screen Trigger Level Pounds/Year	E > T ?
Acetaldehyde	3.063E-05	2.683E-01	1.610E+00	3.80E+01	no
Acrylonitrile	5.535E-05	4.848E-01	2.909E+00	3.80E-01	YES
Benzene	4.074E-04	3.569E+00	2.141E+01	3.80E+00	YES
Benzyl Chloride	2.201E-04	1.928E+00	1.157E+01	2.20E+00	YES
1,3 Butadiene	9.403E-05	8.237E-01	4.942E+00	6.30E-01	YES
Carbon Tetrachloride (tetrachloromethane)	1.070E-04	9.370E-01	5.622E+00	2.50E+00	YES
Chlorobenzene	7.827E-05	6.856E-01	4.114E+00	3.90E+04	no
Chloroethane (ethyl chloride)	1.122E-04	9.825E-01	5.895E+00	1.20E+06	no
Chloroform	8.301E-05	7.272E-01	4.363E+00	2.00E+01	no
1,4 Dichlorobenzene	5.111E-04	4.477E+00	2.686E+01	9.50E+00	YES
Ethyl Benzene	1.476E-03	1.293E+01	7.760E+01	4.30E+01	YES
Ethylene Dibromide (1,2-dibromoethane)	1.306E-04	1.144E+00	6.866E+00	1.50E+00	YES
Ethylene Dichloride (1,2-dichloroethane)	6.881E-05	6.028E-01	3.617E+00	5.30E+00	no
Ethylidene Dichloride (1,1-dichloroethane)	1.720E-04	1.507E+00	9.042E+00	6.60E+01	no
Hexane	5.992E-04	5.249E+00	3.150E+01	2.70E+05	no
Hydrogen Sulfide *	1.197E-01	1.048E+03	6.291E+03	3.90E+02	YES
Isopropyl Alcohol (isopropanol)	2.089E-03	1.830E+01	1.098E+02	2.70E+05	no
Methyl Alcohol (methanol)	3.342E-02	2.928E+02	1.757E+03	1.50E+05	no
Methyl Ethyl Ketone (2-butanone)	3.761E-03	3.294E+01	1.977E+02	NA	NA
Methylene Chloride (dichloromethane)	2.953E-04	2.587E+00	1.552E+01	1.10E+02	no
Methyl tert-Butyl Ether	1.532E-04	1.342E+00	8.054E+00	2.10E+02	no
Perchloroethylene (tetrachloroethylene)	5.766E-04	5.051E+00	3.030E+01	1.80E+01	YES
1,1,2,2 Tetrachloroethane	1.167E-04	1.022E+00	6.135E+00	1.90E+00	YES
Styrene	1.811E-04	1.586E+00	9.516E+00	3.50E+04	no
Toluene	6.407E-03	5.613E+01	3.368E+02	1.20E+04	no
1,1,1 Trichloroethane (methyl chloroform)	9.277E-05	8.126E-01	4.876E+00	3.90E+04	no
Trichloroethylene	2.284E-04	2.001E+00	1.201E+01	5.40E+01	no
Vinyl Chloride	4.346E-04	3.807E+00	2.284E+01	1.40E+00	YES
Vinylidene Chloride (1,1-dichloroethylene)	1.685E-04	1.476E+00	8.858E+00	2.70E+03	no
Xylenes (o, m, & p)	7.382E-03	6.467E+01	3.880E+02	2.70E+04	no
Hydrogen Chloride	6.761E-02	5.923E+02	3.554E+03	3.50E+02	YES
Hydrogen Fluoride	3.710E-03	3.250E+01	1.950E+02	5.40E+02	no
Formaldehyde *	2.240E-01	1.962E+03	1.1771E+04	1.80E+01	YES
Naphthalene	7.788E-04	6.822E+00	4.093E+01	3.20E+00	YES
PAH as benzo(a)pyrene equivalent	1.640E-05	1.436E-01	8.618E-01	6.90E-03	YES
Ammonia from SCR	1.338E-01	1.172E+03	7.033E+03	7.70E+03	no
Mercury (inorganic)	1.374E-05	1.203E-01	7.220E-01	2.70E-01	YES

* Hourly emissions were also greater than the risk screen trigger levels for hydrogen sulfide and formaldehyde.

Table 5. TAC Emissions Used for Site-Wide Health Impacts Analysis

	S-5 Landfill (Year 2038) Pounds/Year	A-51 or A-60 Pounds/Year per Flare	S-61 or S-62 Pounds/Year per Portable Engine
Acrylonitrile	1.70E+01	9.142E-01	
Benzene	1.53E+02	6.729E+00	
Benzyl Cl	6.76E+01	3.635E+00	
Carbon Tet.	3.30E+01	1.767E+00	
Chlorobenzene	4.15E+01	1.293E+00	
Chloroethane	3.44E+01	1.852E+00	
Chloroform	2.73E+01	1.371E+00	
1,4 Dichlorobenz	1.59E+02	8.442E+00	
Ethyl Benzene	4.64E+02	2.439E+01	
Ethylene DiBr	4.01E+01	2.158E+00	
Ethylene DiCl	2.13E+01	1.137E+00	
Ethylidene DiCl	5.28E+01	2.842E+00	
Hexane	4.34E+02	9.898E+00	
Hydrogen Sulfide	1.27E+04	6.850E+02	
Isopropyl Alcohol	6.41E+02	3.451E+01	
Methyl Alcohol	1.03E+04	5.520E+02	
MEK	4.09E+03	6.211E+01	
Methylene Cl	9.07E+01	4.877E+00	
MTBE	4.70E+01	2.531E+00	
PERC	1.77E+02	9.523E+00	
1,1,2,2 Cl4C2	3.58E+01	1.928E+00	
Styrene	5.56E+01	2.991E+00	
Toluene	2.11E+03	1.058E+02	
1,1,1 TCA	2.85E+01	1.532E+00	
Trichloroethylene	7.03E+01	3.773E+00	
Vinyl Chloride	1.33E+02	7.178E+00	
Vinylidene Cl	5.19E+01	2.784E+00	
Xylenes	2.38E+03	1.219E+02	
Hydrogen Chloride		4.188E+03	
Hydrogen Fluoride		2.298E+02	
Formaldehyde		1.991E+02	
Diesel PM		1.991E+02	1.9235E +01