California Environmental Protection Agency

AIR RESOURCES BOARD

STAFF REPORT: INITIAL STATEMENT OF REASONS FOR THE PROPOSED REGULATION TO REDUCE METHANE EMISSIONS FROM MUNICIPAL SOLID WASTE LANDFILLS

Stationary Source Division
Emissions Assessment Branch

May 2009

State of California
AIR RESOURCES BOARD

STAFF REPORT: INITIAL STATEMENT OF REASONS FOR PROPOSED RULEMAKING

Public Hearing to Consider

PROPOSED REGULATION TO REDUCE METHANE EMISSIONS FROM MUNICIPAL SOLID WASTE LANDFILLS

To be considered by the Air Resources Board on June 25-26, 2009, at:

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Byron Sher Auditorium
1001 I Street
Sacramento, California

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State of California
AIR RESOURCES BOARD

PROPOSED REGULATION TO REDUCE METHANE EMISSIONS FROM MUNICIPAL SOLID WASTE LANDFILLS

Staff Report

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ACRONYMS

AB	Assembly Bill
AB 32	Assembly Bill 32, California Global Warming Solutions Act 2006
AERMOD	Air Dispersion Model
APCD	Air Pollution Control District
APCO	Air Pollution Control Officer
AQMD	Air Quality Management District
ARB/Board	Air Resources Board
BAAQMD	Bay Area Air Quality Management District
BMP	Best Management Practices
Btu	British Thermal Units
Btu/ft^3	British Thermal Units per Standard Cubic Foot
Btu/hr	British Thermal Units per Hour
CCA	California Clean Air Act
CCR	California Code of Regulations
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CIWMB	California Integrated Waste Management Board
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2E	Carbon Dioxide Equivalent
CFR	Code of Federal Regulations
CNG	Compressed Natural Gas
DTSC	Department of Toxic Substances Control
EG	Emission Guidelines
EO	Executive Order
FOD	First-Order Decay
GHG	Greenhouse Gas
GWP	Global Warming Potential
HAP	Hazardous Air Pollutant
H&S Code	Health and Safety Code
IPCC	Intergovernmental Panel on Climate Change
IC Engines	Internal Combustion Engines
ICLEI	International Council for Local Environmental Initiatives
ISC	Industrial Source Complex
ISOR	Initial Statement of Reasons
k	Factor tied to moisture content of landfill
LACSD	Los Angeles County Sanitation District
LandGEM	Landfill Gas Emissions Model
LCRS	Leachate Collection Removal System
LEA	Local Enforcement Agencies
LFG	Landfill Gas
LFGTE	Landfill Gas-to-Energy
LNG	Liquefied Natural Gas

ACRONYMS (Cont.)

Lo	Potential Methane Generation Capacity
MMBtu/hr	Million British Thermal Units per hour
MMT	Million Metric Tons
$MMTCO_2E$	Million Metric Tons of Carbon Dioxide Equivalents
$MTCO_2E$	Metric Tons of Carbon Dioxide Equivalents
MSW	Municipal Solid Waste
N_2O	Nitrous Oxide
NAAQS	National Ambient Air Quality Standards
NESHAP	National Emission Standards for Hazardous Air Pollutants
NMOC	Non-Methane Organic Compounds
NOx	Nitrogen Oxide Compounds
NSPS	New Source Performance Standards
ORS	Optical Remote Sensing
OSHA	Occupational Safety and Health Administration
pH	Acidity of Substance
PM	Particulate Matter
PPM	Parts Per Million
ppmv	Parts Per Million by Volume
PVC	Polyvinyl Chloride
RPM	Radial Plume Mapping
RWQCB	Regional Water Quality Control Boards
SCAQMD	South Coast Air Quality Management District
SWIS ID	Solid Waste Information System Identification Number
SWRCB	State Water Resources Control Board
TAC	Toxic Air Contaminant
U.S. EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
WIP	Waste-in-Place

State of California
AIR RESOURCES BOARD

Executive Summary

I. INTRODUCTION

A. Overview

The California Air Resources Board (ARB or Board) staff is proposing a regulation to reduce methane emissions from municipal solid waste (MSW) landfills. Methane is a major contributor to climate change, having a global warming potential of about 21 times that of carbon dioxide (CO_2), the most common greenhouse gas (GHG). Methane has a relatively short atmospheric lifetime of about 10 years. Changes in a methane source's emissions level can affect atmospheric GHG concentrations in a relatively short time scale.

In 2006, the Legislature passed and Governor Schwarzenegger signed the California Global Warming Solutions Act of 2006 (Assembly Bill 32; Stats. 2006, chapter 488). In Assembly Bill (AB) 32, the Legislature declared that global warming poses a serious threat to the economic well-being, public health, natural resources, and the environment of California. AB 32 creates a comprehensive, multi-year program to reduce GHG emissions in California, with the overall goal of restoring emissions to 1990 levels by the year 2020. AB 32 requires ARB to take actions that include:

- Establishing a statewide GHG emissions cap for 2020, based on 1990 emissions;
- Adopting a scoping plan by January 1, 2009, indicating how emission reductions will be achieved from significant GHG sources via regulations, market mechanisms, and other actions;
- Adopting a list of discrete, early action GHG emission reduction measures by June 30, 2007, which can be implemented and enforced no later than January 1, 2010; and
- Adopting regulations by January 1, 2010, to implement the measures identified on the list of discrete early action measures.

In June 2007, the Board identified a measure to reduce methane emissions from MSW landfills as a discrete early action measure. This proposed regulation was developed to implement this early action measure. The proposed regulation was developed in close collaboration with California Integrated Waste Management Board (CIWMB) staff.

The proposed regulation would require owners and operators of certain smaller and other uncontrolled landfills to install gas collection and control systems. The proposed regulation also includes requirements to ensure that existing and newly installed gas collection and control systems are operating optimally. There are about 367 landfills currently in ARB's landfill emissions inventory that have the potential to generate methane emissions. Of these, 218 landfills (14 of which are uncontrolled) may be subject to the proposed regulation. The remaining landfills are likely to qualify for an exemption.

Based on ARB staff's 2020 forecast of landfill emissions, if all 14 of the uncontrolled landfills were to install gas collection and control systems for methane, there would be a reduction of about 0.4 million metric tons of carbon dioxide equivalents ($MMTCO_2E$). The implementation and enforcement of this proposed regulation for the remaining estimated 204 affected MSW landfills (including those with gas collections systems already installed) is expected to result in an additional estimated emission reduction of 1.1 $MMTCO_2E$. Overall, the proposed regulation will result in reductions of about 1.5 $MMTCO_2E$ in 2020 at an average cost of about $9 per metric ton of carbon dioxide equivalent ($MTCO_2E$) reduced. This is equivalent to an average increase of about 10 cents per month to the waste disposal cost per California household.

In developing this proposed regulation, staff evaluated economic and environmental impacts and found no significant adverse impacts. Staff also found that reducing methane emissions would have a beneficial impact on climate change and would further reduce emissions of toxic compounds and ozone precursors that are also present in landfill gas.

B. Background

1. Why is ARB proposing to control methane emissions from MSW landfills?

In California, MSW landfills are the second largest anthropogenic source of methane and are an important source of GHG emissions that must be reduced to meet the goals of AB 32. The organic portion of solid waste disposed in MSW landfills decomposes to form landfill gas. Approximately 1.2 billion tons of solid waste has accumulated in the State's landfills with an additional 40 million tons being added each year. In 1990, GHG emissions from MSW landfills were estimated to be about 6.3 $MMTCO_2E$; in 2000 the GHG emission level dropped to 5.8 $MMTCO_2E$ and returned to 6.3 $MMTCO_2E$ in 2006. These emissions are forecasted to increase to approximately 7.7 $MMTCO_2E$ in 2020. Emissions from MSW landfills represent about 1 percent of the statewide greenhouse gas inventory. If not captured, combusted, or treated in control systems, landfill gas can either be released into the atmosphere as fugitive emissions or migrate underground to cause groundwater contamination.

2. How is landfill gas formed?

Landfill gas is produced naturally by the aerobic (with air) and anaerobic (without air) decomposition of organic waste in MSW landfills. MSW is compacted and buried and the buried wastes decompose over time. Since the wastes are insulated from outside air, decomposition occurs anaerobically producing large quantities of methane. In general, landfill operators are required to provide a daily cover of soil or other approved material over the waste that is received by the landfill to prevent odors and other nuisances.

Landfill gas typically consists of roughly 50 percent methane and 50 percent CO_2, with trace levels of non-methane organic compounds (NMOC). NMOCs represent less than 1 percent of landfill gas and they include volatile organic compounds (VOC), toxic air contaminants, and odorous compounds.

3. How is landfill gas controlled?

Methane emissions from MSW landfills are controlled by first containing the gas by using soil, compacted clay, geomembrane, biocovers, or other surface covers, and then capturing the gas through the installation and operation of gas collection and control systems. These systems consist most commonly of vertical wells and in some cases horizontal trenches that are buried within the waste and connected to header pipes which route the gas to a pump or blower station. Vacuum applied to the wells by a pump or blower draws the gas to a control device, such as a flare, internal combustion engine, boiler, gas turbine, or microturbine. The collected gas can either be combusted, used to produce energy, or purified for offsite use.

4. What does the proposed regulation require?

The proposed measure will require the installation and proper operation of gas collection and control systems at active, inactive, and closed MSW landfills having 450,000 tons of greater of waste-in-place and that received waste after January 1, 1977. The proposed regulation contains performance standards for the gas collection and control system, and specifies monitoring requirements to ensure that that the system is being maintained and operated in a manner to minimize methane emissions. The proposed standards include a leak standard for gas collection and control system components, a monitoring requirement for wellheads, methane destruction efficiency requirements for most control devices, surface methane emission standards, and reporting requirements.

5. Are there any applicable federal or local air district landfill regulations?

MSW landfills are regulated under local air district rules that implement the requirements of the federal New Source Performance Standards (NSPS) and Emission Guidelines (EG) (40 CFR Part 60 Subparts WWW and Cc) for MSW landfills. The NSPS applies to “new” MSW landfills that commenced construction, modification, or reconstruction on, or after May 30, 1991. The EG applies to “existing” MSW landfills that commenced construction, modification, or reconstruction before May 30, 1991, and that have accepted waste at any time since November 8, 1987, or have additional capacity for future waste deposition. The NSPS and EG require the installation of a landfill gas collection and control system when a MSW landfill reaches a design capacity of 2.75 million tons or greater and has a non-methane organic compound emission rate of 55 tons per year, or greater. The United States Environmental Protection Agency (U.S. EPA) promulgated the National Emission Standards for Hazardous Air Pollutants (NESHAP) for MSW landfills (40 CFR Part 63 Subpart AAAA) on January 16, 2003. The NESHAP has the same requirements as the NSPS but also contains provisions for start-up, shut-down, and additional recordkeeping and reporting requirements.

The local air districts implement the federal requirements for MSW landfills. Additionally, many districts also issue permits to construct and operate landfill gas collection systems and control equipment used at landfills. Some districts, such as the Bay Area Air Quality Management District (BAAQMD) and the South Coast Air Quality Management District (SCAQMD), also have their own rules that apply more stringent requirements, such as surface emission standards and monitoring requirements, in order to achieve reductions of NMOCs beyond what the federal regulations require.

The proposed regulation differs from federal NSPS and NESHAP requirements and local air district rules in that it, in general, applies to smaller landfills (in addition to larger landfills) and has more stringent requirements for methane collection and control, and component leak testing and surface emissions monitoring. The more stringent requirements in the proposed regulation are necessary to maximize cost-effective GHG emission reductions. Since the requirements of the proposed regulation are more stringent, they do not conflict with or impede compliance with existing federal and local air district requirements.

II. SUMMARY OF THE PROPOSED MEASURE

The proposed regulation will require the installation of a gas collection and control system at certain MSW landfills. The proposed regulation contains performance standards for the gas collection and control system, and specifies monitoring requirements to ensure that that the system is being maintained and operated in a manner to minimize methane emissions. The key sections of the proposed measure are discussed below.

A. Applicability and Exemptions

The proposed regulation applies to all MSW landfills that received solid waste after January 1, 1977. This date excludes approximately 1,500 closed, illegal, or abandoned disposal sites, including burn dumps and other types of sites that are not likely to generate landfill gas. MSW landfills having greater than, or equal to 450,000 tons of waste-in-place would be required to install active gas collection and control systems and comply with the requirements of the proposed regulation unless exemption conditions are met.

Active MSW landfills having less than 450,000 tons of waste-in-place are exempt from the substantive requirements of the proposed regulation; however, the owner or operator must comply with limited reporting requirements. Staff is proposing to exempt landfills meeting the above conditions from the substantive requirements because it is unlikely that these landfills will generate sufficient gas to support a gas collection and control system. Closed and inactive MSW landfills having less than 450,000 tons of waste-in-place are exempt from the proposed regulation because they are not expected to generate sufficient amounts of landfill gas to support a control device operating on a continuous basis without the use of supplemental fuel. Hazardous waste landfills and landfills containing only construction and demolition waste or non-decomposable solid waste, which is incapable of degrading biologically to form significant amounts of landfill gas, are also exempt from the requirements of the proposed regulation.

B. Determination for Installing a Gas Collection and Control System

If a MSW landfill has 450,000 tons of waste-in-place or greater, the owner or operator must determine if they are required to install a gas collection and control system based on the landfill's gas heat input capacity. The proposed regulation uses a landfill gas input heat capacity threshold of 3.0 million British thermal units per hour (MMBtu/hr) to determine if a MSW landfill may is able to sustain a gas control system, operating on a continuous basis, without the need for supplemental fuel.

If the landfill gas heat input capacity is less than 3.0 MMBtu/hr and the MSW landfill is active, the landfill gas heat input capacity is recalculated annually until it is determined to be either greater than or equal to 3.0 MMBtu/hr or the landfill closes and ceases to accept waste. If the MSW landfill is closed or inactive and the landfill gas heat input capacity is less than 3.0 MMBtu/hr, a gas collection and control system is not required and the requirements of the proposed regulation no longer apply.

If the landfill gas heat input capacity is greater than or equal to 3.0 MMBtu/hr, the owner or operator must either install a gas collection and control system, or demonstrate that after four consecutive quarterly monitoring periods there is no leak at any location on the landfill surface that exceeds a methane concentration of 200 parts per million by volume (ppmv) or greater. If the MSW landfill is active and there is no leak exceeding 200 ppmv, the owner or operator must recalculate the landfill gas heat input capacity annually until either the MSW landfill requires a gas collection and control system or closes and ceases to accept waste. If the MSW landfill is closed or inactive and there is no leak exceeding 200 ppmv, a gas collection and control system is not required and the owner or operator only needs to comply with limited reporting requirements.

C. Gas Collection and Control System Requirements

The proposed regulation requires the installation of a properly designed and operated gas collection and control system that minimizes methane emissions. The proposed regulation requires a Design Plan to be prepared by a professional engineer registered with the State of California and submitted to the Executive Officer for approval. The Design Plan details how the design of the collection system will handle the landfill's methane generation potential and maintain negative pressure at all wellheads. It also specifies the gas control devices that will be used. Any owner or operator of an active landfill subject to the proposed regulation must install an active gas collection and control system within 18 months after approval of the Design Plan. Closed or inactive MSW landfills, which do not directly generate revenue, are provided an additional 12 months (for a total of 30 months after approval of the Design Plan) in order to obtain the necessary funds to comply. The proposed regulation also includes a provision for amending the Design Plan to respond to changes in site conditions.

The proposed regulation requires gas control devices, such as enclosed flares, rich-burn engines, boilers, gas turbines, and microturbines to meet a methane destruction efficiency of at least 99 percent. However, lean-burn engines, which can not meet this standard, are allowed if they are able to meet a 3,000 ppmv outlet methane concentration limit (dry basis, corrected to 15 percent oxygen). Requiring these engines to shut-down would result in a reduction of electrical generation capacity in the state and would unnecessarily affect the State's electrical supply. The collected landfill gas may also be routed to an offsite pipeline or to a treatment system for cleanup and subsequent use as a natural gas fuel, either in transportation or stationary sources.

D. Surface Methane Emission Standards

The proposed measure includes emission standards for both instantaneous and integrated monitoring of the landfill surface. Instantaneous monitoring is used to identify fugitive emissions from holes, cracks, or fissures in the landfill surface. Integrated monitoring is a good indicator of how well the gas collection system is operating overall. The proposed regulation establishes a 500 ppmv instantaneous surface monitoring standard and a 25 ppmv integrated surface monitoring standard to ensure that the gas collection system is adequately controlling emissions. The 500 ppmv instantaneous standard is currently being implemented at MSW landfills having existing gas collection and control systems (installed pursuant to existing regulations for NMOCs) and will continue to be implemented.

Most landfill operators, however, do not currently conduct integrated surface monitoring, and uncontrolled landfills do not currently test for compliance with either surface standard. Staff is proposing that these requirements become effective January 1, 2011. This effective date allows sufficient time for landfill owners and operators to become familiar with the surface standards and make the appropriate adjustments to their operating practices. Landfills required to install new gas collection and control systems are required to meet these standards upon commencing operation of the system. It should be noted that landfills that are currently subject to local or federal landfill rules will need to continue to ensure compliance with the 500 ppmv instantaneous standard.

E. Alternative Compliance Options

The proposed regulation recognizes the site-specific nature of landfills and provides flexibility allowing owners and operators to request alternatives to test methods, monitoring requirements, and operational requirements, subject to approval of the

Executive Officer. Owners and operators will need to demonstrate why consideration of an alternative is necessary in order to comply with the proposed regulation. They must also demonstrate that requested alternatives provide equivalent levels of methane emission control and enforceability.

F. Monitoring and Test Procedures

1. Surface Emissions Monitoring

The proposed regulation specifies procedures for conducting instantaneous and integrated surface monitoring. In both cases, the landfill is divided into individually identified 50,000 square foot grid patterns. This allows for better identification and tracking of any surface leaks or problem areas. Monitoring is performed quarterly using a portable hydrocarbon detector, such as an organic vapor analyzer or a toxic vapor analyzer set in flame ionization detector mode. The walking pattern must be no more than a 25-foot spacing interval and must traverse each monitoring grid. Landfill owners and operators have three opportunities to repair or remediate any leaks before a leak constitutes a violation. If the landfill owner or operator has no exceedances of the surface methane emission standards after four consecutive quarterly monitoring periods, the monitoring procedures provide an incentive which allows the walking pattern spacing to be increased to 100-foot intervals. Additionally, closed and inactive landfills can increase their sampling period from quarterly to annually. The increased spacing and sampling period can continue to be used as long as the landfill remains in compliance with surface standards. This provision decreases the compliance cost for well-controlled landfills.

Landfill owners or operators of closed or inactive MSW landfills, or any closed or inactive areas on an active MSW landfills, have an additional incentive for early compliance. To qualify for this incentive, the landfill must demonstrate that in the past three years prior to the effective date of the proposed regulation that there were no measured exceedances of the surface methane emission standards by annual or quarterly monitoring. If a successful demonstration is made, the landfill owner or operator may monitor compliance with the surface methane emissions standards annually and may increase the walking pattern spacing from 25-foot to 100-foot intervals. The increased spacing and sampling period can continue to be used as long as the landfill remains in compliance with the surface methane emission standards.

2. Gas Control System Equipment Monitoring

The proposed regulation contains a component leak standard of 500 ppmv. The purpose of the component leak testing requirement is to ensure that there are no point sources along the positive pressure side of the gas transfer path with methane concentrations exceeding 500 ppmv. Landfills are required to conduct this monitoring quarterly. Additionally, the proposed regulation specifies monitoring parameters for gas control devices such as flares to ensure that these devices are operating optimally and meeting the destruction efficiency standards.

3. Wellhead Monitoring

Monthly well monitoring is required to demonstrate that the gas extraction rate for an active gas collection system is sufficient. This requirement (in conjunction with the surface emission standards) helps to minimize groundwater impacts by ensuring that methane is routed through the gas collection system to a gas control device. A negative pressure must be maintained at each wellhead, except under certain conditions (a landfill subsurface fire, fire prevention, repair of the gas collection system, or construction activities). If a positive pressure is measured, the owner or operator must initiate corrective action within five days. If the corrective action is not successful, an expansion of the gas collection may be necessary and must be completed within 120 days of the date the positive pressure was measured.

G. Recordkeeping and Reporting Requirements

In order to assure and monitor compliance with the requirements of the proposed regulation, landfill owners and operators are subject to recordkeeping and reporting requirements. These requirements include maintaining records of a landfill's waste acceptance rates, instantaneous and integrating surfacing sampling measurements, component leak checks, equipment downtime, gas flow rates, and control device destruction efficiency testing. Most records are required to be kept for a five-year period; however, control device records must be maintained for the life of the control device. Some of these recordkeeping items are required to be included in the annual report, which must be submitted annually and cover the period of January 1 through December 31 of each year. Additionally, there are some specific reports that need to be submitted under specific conditions, such as a waste-in-place report for landfills with less than 450,000 tons of waste-in-place or a closure notification report for landfills that are ceasing waste acceptance and closing. Additionally, an equipment removal report is required when a landfill is seeking to decommission the gas collection and control system. These reporting requirements are similar to what is already required in local air district and federal rules for many landfills in California.

III. IMPACTS OF THE PROPOSED REGULATION

A. Emissions and Emissions Reductions

Based on ARB staff's estimate, there would be a reduction of about 0.4 $MMTCO_2E$ due to bringing 14 uncontrolled MSW landfills into compliance with the proposed regulation in 2020. The implementation and enforcement of this proposed regulation for the remaining estimated 204 affected MSW landfills (including those with gas collections systems already installed) is expected to result in an additional estimated emission reduction of 1.1 $MMTCO_2E$ in 2020. This total 1.5 $MMTCO_2E$ emission reduction exceeds the initial emission reduction estimate of 1.0 $MMTCO_2E$ from MSW landfills presented in the AB 32 Scoping Plan approved in December 2008.

B. Economic Impacts

As part of the economic impact assessment performed by ARB, compliance costs incurred by affected entities are estimated. Two of the main measures of cost are the proposed regulation's total cost and the cost-effectiveness (expressed in dollars spent per metric ton of pollutant reduced).

The cost to affected public agencies and to affected government agencies and businesses would be approximately $27 million dollars in initial capital costs and between $6 million to $14 million dollars in annual recurring costs (in 2008 dollars). Over the 23-year life of the regulation, this corresponds to a total cost of approximately $340 million dollars. These costs are summarized in the Table ES-1 below.

Table ES-1. Estimated Compliance Costs for All Affected Landfills

Landfill Compliance Status	Reporting Costs [1]	Capital Costs [2]	Operation and Maintenance Costs [3]	Monitoring Costs [4]
Landfills Subject to Reporting Requirements Only	$139,000	N/A	N/A	N/A
Landfills Having Existing Compliant Control Systems	$154,000	$2.4 million	$56 million	$151 million
Landfills Without Existing Compliant Control Systems	$13,000	$25 million	$92 million	$8.6 million
Totals	**$308,000**	**$27 million**	**$148 million**	**$154 million**

1. Costs to affected landfills to prepare and submit required WIP and Landfill Gas Heat Input Capacity reports.
2. Includes engineering, permitting, testing, purchase, installation, shipping, and other initial costs related to the set-up of a new gas collection and control system.
3. Recurring costs for the operation of a gas collection and control system; includes parts and materials, labor, utilities, taxes, and administration.
4. Monitoring costs include the purchase of monitoring and calibration equipment as well as labor for performing monitoring work as required in the proposed regulation.

The cost-effectiveness is estimated to be approximately $9 per $MTCO_2E$ reduced. Over the 23-year lifetime of the regulation, the total cost of the proposed regulation expressed on a per-household basis is about 10 cents per month.

The majority of the affected landfills are owned and/or operated by public entities at the local, State, or federal level. ARB staff believes that most, if not all, of these public entities, as well as affected private businesses, will be able to meet the proposed regulation's compliance costs. However, it is possible that a small number of businesses (those with marginal profitability) may experience financial difficulty in complying with the proposed regulation. Further discussion of the economic impacts of the proposed regulation can be found in Chapter VII of this report.

C. Environmental Impacts

No significant adverse environmental impacts are expected to occur from adoption of and compliance with the proposed regulation. The implementation of the proposed regulation may slightly increase criteria pollutant emissions such as oxides of nitrogen (NO_x) and carbon monoxide (CO) if landfills installed energy recovery systems such as an internal combustion (IC) engine. However, since these systems are typically installed at very large landfills (greater than one million tons of waste-in-place) as part of energy-recovery projects and are very costly compared to an enclosed flare, this increase is not expected. In addition, energy recovery systems such IC engines may slightly increase criteria pollutants as compared to flaring the gas, which would be required if there was no energy recovery system.

D. Health Impacts

The compound subject to the proposed measure is the GHG methane. Methane is not a hazardous air pollutant or carcinogen; however, toxic contaminants such as vinyl chloride, benzene, ethylene dibromide, ethylene dichloride, methylene chloride, perchloroethylene, and trichloroethylene are present in landfill gas. By installing gas collection and control systems at MSW landfills that are currently uncontrolled and ensuring that existing and newly installed gas collection and control systems are operated optimally, toxic air contaminants contained in the landfill gas will also be reduced, thereby minimizing the public’s potential exposure to these compounds. Staff therefore concludes that public health will not be adversely affected by the proposed measure. Compliance with the proposed regulation is not expected to result in any adverse localized impacts.

IV. KEY ISSUES

A. Instantaneous Surface Monitoring Standard

During the development of the proposed regulation, ARB staff had initially proposed an instantaneous surface methane emission standard of 200 ppmv. However, stakeholders expressed concern that the 200 ppmv surface methane emission limit may cause landfill fires, decrease the ability to meet federal wellhead monitoring limits for oxygen and nitrogen, and interfere with landfill gas-to-energy projects. ARB staff requested that stakeholders submit documentation to support their concerns; however, the documentation was not available because under existing requirements landfill owners and operators are only required to report exceedances over 500 ppmv. Additionally, CIWMB’s landfill fire expert also expressed a concern about the potential for landfill fires associated with a 200 ppmv instantaneous surface standard.

In the absence of data to verify whether or not landfill fires may increase as a result of a 200 ppmv limit, instantaneous surface methane concentration levels were set at 500 ppmv. However, the proposed regulation requires reporting of instantaneous readings of 200 ppmv and greater in an effort to collect additional data to help ARB staff determine the range of surface methane emission levels at landfills that fall below 500 ppmv and whether or not landfill fires are reported. Staff will analyze this data and return to the Board at a future date if the collected data indicates that a lower surface emission standard is feasible and does not result in landfill fires.

B. Phase-in of the Integrated Surface Monitoring Standard

Stakeholders expressed concern that the majority of landfill operators would be unfamiliar with conducting integrated surface monitoring and would need time to make the necessary system adjustments and improvements, establish monitoring protocols and procedures, purchase monitoring equipment, train staff, and develop recordkeeping and reporting systems in order to comply with the proposed 25 ppmv integrated surface sampling standard. The indicated preference was to use 50 ppmv, which is the current standard in SCAQMD Rule 1150.1, and implement a data collection scheme and use that information to phase-in a lower standard at some point in the future. Based on the compliance data obtained from SCAQMD, ARB staff believes that a 25 ppmv standard is feasible now. However, it is reasonable to expect that some landfills will require some time to make the necessary adjustments to their gas collection and control systems and operational practices, as appropriate. Therefore, the proposed regulation includes the 25 ppmv standard but establishes an effective date for compliance with this standard on January 1, 2011 (about one year after the effective date of the proposed regulation).

V. PUBLIC OUTREACH

Staff has made extensive efforts to provide opportunities for participation in the rulemaking process. Staff's public outreach efforts included meetings with stakeholders through a series of seven technical workgroup meetings and three public workshops. These groups included representatives from the solid waste industry, local air districts, local enforcement agencies, CIWMB, U.S. EPA, environmental organizations, and other interested parties. Staff also created a website and maintained an email address list to automatically update interested parties about rulemaking developments. The website can be accessed at: http://www.arb.ca.gov/cc/landfills/landfills.htm.

VI. ENVIRONMENTAL JUSTICE

On December 13, 2001, the Board approved "Policies and Actions for Environmental Justice," which formally established a framework for integration of environmental justice into ARB's programs, consistent with the directive of California state law. These policies apply to all communities in California, however, environmental justice issues have been raised specifically in the context of low-income areas and ethnically diverse communities. The proposed regulation is consistent with our environmental justice policy to reduce health risk in all communities, including those with low-income and ethnically diverse populations, regardless of location. Potential risks from global warming due to GHGs can affect both urban and rural communities. Therefore, reducing emissions of GHGs from landfill operations will provide benefits to both urban and rural communities in the State, including low-income and ethnically diverse communities. The decrease in GHG emissions will occur in areas where landfill operations are generally located, which is typically far from most residential areas.

VII. IMPLEMENTATION AND ENFORCEMENT

The local air districts currently implement and enforce rules related to the control of hydrocarbons (including toxic compounds) from landfills and, pursuant to the Health and Safety Code, are the primary implementation and enforcement agency for airborne toxic control measures for stationary sources adopted by ARB. The proposed regulation is developed pursuant to AB 32, which did not directly provide a mechanism for the local air districts to implement and enforce regulations developed under AB 32. Therefore, the proposed regulation reflects ARB's role as primary monitor and enforcer of regulations adopted under AB 32. However, ARB staff is exploring mechanisms by which local air districts can participate as partners in the implementation and enforcement of the proposed regulation. ARB staff believes local air district participation is critical to assure compliance with the proposed regulation, to help attain GHG emission reduction goals, to reduce the cost of implementing the proposed regulation, and to reduce governmental redundancy. In addition, local air districts are familiar with landfill operations and currently issue permits and inspect landfills and related landfill gas and emissions control equipment. Accordingly, the proposed regulation allows ARB to enter into agreements with local air districts to implement and enforce the proposed regulation, although it also ensures that ARB retains the necessary authority to monitor compliance and enforce the regulation directly. It also permits local air districts to assess fees to cover costs associated with these agreements.

VIII. RECOMMENDATION

ARB staff recommends the Board approve the proposed regulation presented in Appendix A of the staff report.

I. INTRODUCTION

This report presents ARB staff's technical justification and analysis of the proposed regulation to reduce methane emissions from MSW landfills. Methane is a potent GHG having a high global warming potential of about 21 times that of CO_2. The proposed rulemaking is designed in accordance with the discrete early action measure requirements as set forth in the California Global Warming Solutions Act of 2006 (AB 32, Chap. 488, Stats. 2006, Health and Safety Code Section 38500 *et seq.*).

A. Overview

AB 32 was signed into law in September of 2006. AB 32 creates a comprehensive, multi-year program to reduce GHG emissions in California, with the overall goal of restoring GHG emissions to 1990 levels by the year 2020. Pursuant to AB 32, ARB was required to identify a list of "discrete early action GHG reduction measures" by June 30, 2007. Once on the list, these measures must be developed into regulatory proposals. Discrete early action measure must also be adopted and made enforceable before January 1, 2010, and achieve the maximum technologically feasible and cost-effective reduction in greenhouse gases toward achieving 2020 GHG emission limit levels. ARB is also required to develop market-based compliance mechanisms. Beyond the requirements of AB 32, the Governor's Executive Order EO-S-03-05 calls for an additional GHG reduction of 80 percent by 2050.

In June 2007, the Board identified a measure to reduce methane emissions from MSW landfills as a discrete early action measure. MSW landfills generate landfill gas in which methane typically accounts for about 50 percent of the total landfill gas composition. Methane gas is produced by the anaerobic decomposition of organic waste in MSW landfills. Methane emissions are controlled by means of covers (such as geomembranes, soil, and compost) and by the installation and operation of gas collection and control systems. This proposed regulation was developed in close collaboration with California Integrated Waste Management Board (CIWMB) staff.

B. Summary of the Proposed Regulation

The proposed regulation applies to active, inactive, and closed MSW landfills that received solid waste after January 1, 1977, and have at least 450,000 tons of waste-in-place. Staff estimates that there will be 218 landfills that will be subject to the proposed regulation. These landfills will be required to install (if currently uncontrolled) and maintain landfill gas collection and control systems. These systems will significantly reduce the emissions of methane and other VOCs produced as organic materials decompose in landfills. The proposed regulation contains performance standards for gas collection and control systems, and specifies monitoring requirements to ensure that that the systems are being maintained and operated in a manner to minimize methane emissions.

ARB staff estimates that there are 14 uncontrolled landfills with at least 450,000 tons of waste-in-place that may generate sufficient gas to support the installation of a gas collection and control system. Based on ARB staff's 2020 forecast of landfill emissions, if all 14 of those landfills were to install emission controls for methane, there would be a reduction of about 0.4 $MMTCO_2E$. The implementation and enforcement of this proposed regulation for the remaining estimated 204 affected MSW landfills (including those with gas collections systems already installed) is expected to result in an additional estimated emission reduction of 1.1 $MMTCO_2E$. The overall cost of the proposed regulation is about $9 per metric ton of carbon dioxide equivalent reduced. This is equivalent to an increase of about 10 cents per month to the waste disposal cost per California household.

The proposed regulation includes monitoring requirements to ensure that gas collection and control systems are operating optimally and that fugitive emissions are minimized. Staff is proposing an instantaneous surface monitoring standard of 500 parts per million by volume (ppmv) and an integrated surface monitoring standard of 25 ppmv to ensure that the gas collection system is adequately controlling emissions. Instantaneous surface monitoring is used to monitor the integrity of the landfill surface and to identify point sources where methane may be escaping into the atmosphere (e.g., around cover penetrations, areas of distressed vegetation, cracks, or seeps in the landfill cover system). Integrated surface sampling accumulates and averages the instantaneous surface monitoring readings and provides a more direct means of revealing clusters of emissions that would indicate possible gas collection system problems. Landfill owners and operators are given the opportunity to repair leaks or make the appropriate adjustments to their gas collection and control systems before an exceedance of the standard is considered a violation.

Uncontrolled landfills, with 450,000 tons of waste-in-place or greater, must submit a Design Plan prepared by a registered professional engineer. The Design Plan must provide for the control of the collected landfill gas through the use of a gas collection and control system and be designed to collect gas at a sufficient extraction rate to maintain negative pressure at all wellheads (except under specified conditions). Active landfills must install an active gas collection and control system within 18 months after approval of the Design Plan. This compliance schedule should provide sufficient time for the operator to obtain the necessary local agency permits and for installation of the system. Closed and inactive landfills that must install a gas collection and control system have up to 30 months to comply. This compliance schedule provides an extra year for closed or inactive landfills to secure the necessary funds to comply.

Beginning January 1, 2011, owners and operators that are required to install a gas collection and control system, or are already operating a gas collection and control system, must monitor the surface of their landfills to ensure compliance with the surface methane emissions standards. This compliance schedule allows landfill owners or operators time to make the necessary system adjustments and improvements, establish monitoring protocols and procedures, purchase monitoring equipment, train staff, and develop recordkeeping and reporting systems.

C. Need for the Proposed Regulation

In California, MSW landfills are the second largest anthropogenic source of methane and are an important source of GHGs that must be reduced to meet the goals of AB 32. The organic portion of solid waste disposed in MSW landfills decomposes to form landfill gas. Approximately 1.2 billion tons of solid waste has accumulated in the State's landfills with an additional 40 million tons being added each year. In 1990, GHG emissions from MSW landfills were estimated to be about 6.3 $MMTCO_2E$; in 2000 the GHG emission level dropped to 5.8 $MMTCO_2E$ and returned to 6.3 $MMTCO_2E$ in 2006. These emissions are forecasted to increase to approximately 7.7 $MMTCO_2E$ in 2020. If not captured, combusted, or treated in control systems, landfill gas can either be released into the atmosphere as fugitive emissions or migrate underground to cause groundwater contamination. Accordingly, ARB staff recommends adoption of the proposed regulation.

II. REGULATORY REQUIREMENTS AND RELAVENT PROGRAMS

This chapter describes State law requirements related to setting GHG emission limits. It also summarizes existing regulation and programs that affect landfill operations.

A. Greenhouse Gas Reductions Through Early Actions

AB 32 requires the Board to identify a list of discrete early action GHG emission reduction measures by June 30, 2007. Discrete early action measures are to be adopted and become legally enforceable (approved by the Office of Administrative Law) by January 1, 2010. The proposed regulation to reduce methane emissions from MSW landfills is one of the nine discrete early action measures listed by the Board.

B. AB 32 Requirements and Criteria

AB 32, the California Global Warming Solutions Act of 2006, creates a comprehensive, multi-year program to reduce GHG emissions in California. Health and Safety Code (H&S Code) section 38560.5 requires ARB to adopt regulations by January 1, 2010, to implement discrete early action GHG emission reduction measures. These measures, such as the proposed regulatory action, must achieve the maximum technologically feasible and cost-effective reductions in GHG emissions from the sources identified for early action measures.

AB 32 contains additional standards in H&S Code section 38562 that apply to regulations that will be adopted for general emissions reductions consistent with ARB's scoping plan. Among other things, this section requires that reductions must be real, permanent, quantifiable, verifiable, and enforceable. ARB is also required to adopt rules and regulations in an open, public process. While section 38562 does not directly apply to early action measures enacted under section 38560.5, ARB is interested in ensuring that its early action measures, such as the proposed regulatory action, meets the broader criteria for the GHG reduction regulations that will follow.

The proposed regulatory action has been designated as a discrete early action measure and would reduce GHG emissions attributable to MSW landfills. Appendix E provides a discussion of why staff believes this proposed regulatory action meets the limited criteria applicable to discrete early action measures, as well as further meets the later requirements of State law applicable to GHG measures generally.

C. Summary of Relevant Regulations and Related Programs

1. <u>Federal Requirements</u>

<u>New Source Performance Standards (NSPS) and Emission Guidelines (EG)</u>

MSW landfills are regulated under local air district rules that implement the requirements of the NSPS and EG (40 CFR Part 60 Subparts WWW and Cc) for MSW landfills. The NSPS applies to "new" MSW landfills that commenced construction, modification, or reconstruction on, or after May 30, 1991. The EG applies to "existing" MSW landfills that commenced construction, modification, or reconstruction before May 30, 1991, and that have accepted waste at any time since November 8, 1987, or have additional capacity for future waste deposition. The NSPS and EG require the installation of a landfill gas collection and control system when a MSW landfill reaches a design capacity of 2.75 million tons or greater and has a non-methane organic compound emission rate of 55 tons per year, or greater.

ARB and the local air districts were required to develop and submit a "State Plan" to U.S. EPA for implementing and enforcing the requirements of the EG. Local air districts that elected not to adopt rules to implement the EG were placed under a Federal Plan, which is directly enforced by U.S. EPA. In general, the larger air districts adopted rules whereas several smaller districts are subject to the Federal Plan. U.S. EPA promulgated the NSPS and EG on March 12, 1996.

National Emission Standards for Hazardous Air Pollutants (NESHAP)

U.S. EPA promulgated the NESHAP for MSW landfills (40 CFR Part 63 Subpart AAAA) on January 16, 2003. The NESHAP has the same requirements as the NSPS but also contains provisions for start-up, shut-down, and additional recordkeeping and reporting requirements. The proposed regulation differs from federal NSPS and NESHAP requirements in that it applies to smaller landfills (450,000 versus 2,750,000 tons of waste-in-place) and has more stringent requirements for methane collection and control, component leak testing and surface emissions monitoring, and compliance schedules. The more stringent requirements in the proposed regulation are needed to maximize GHG emission reductions. Since the requirements of the proposed regulation are more stringent, they do not conflict with or impede compliance with the existing federal requirements.

2. State Requirements

In addition to ARB, several state agencies, including CIWMB, the State Water Resources Control Board (SWRCB), and the Department of Toxic Substances and Control (DTSC), have regulatory authority over solid waste disposal operations. The responsibilities of each agency are discussed in the following paragraphs.

California Integrated Waste Management Board (CIWMB)

CIWMB is the State's lead agency for the management and recycling of solid waste. The California Code of Regulations (CCR), Title 27, Sections 20917 to 20939, requires monitoring and control of landfill gas. The landfill owner or operator is required to take action to control hazards or nuisances caused by landfill gas. A gas control system approved by the local enforcement agency is required if monitoring indicates gas is migrating offsite. Title 27, Sections 20510 to 20660 also contains operating and design specifications for landfills as well as general requirements for leachate collection, treatment, and disposal.

After closure of the landfill, the owner or operator must maintain and repair the final cover of the landfill as needed, and maintain and operate a gas monitoring system. The owner or operator must prepare a written post-closure plan describing the monitoring and routine maintenance activities. Financial assurance criteria are included in the post-closure plan to ensure owners or operators have sufficient funds available to properly close the landfill.

California State Water Resources Control Board (SWRCB)

Specific requirements for the design and construction of landfills are contained in the CCR, Title 27, Sections 20310-20377, which is administered by SWRCB through the Regional Water Quality Control Boards (RWQCBs). These regulations delineate classification (e.g., municipal, hazardous, etc.) and siting, and provide construction standards for waste management facilities. Leachate collection systems and monitoring programs are required to ensure surface and ground water is not contaminated by landfilling operations.

California Department of Toxic Substances Control (DTSC)

DTSC has the authority to regulate the management of hazardous waste and to clean up contaminated sites. DTSC also controls the acceptance of hazardous waste into landfills. If a hazardous waste landfill generates toxic gases in sufficient amounts to cause potential adverse health effects, the local air district, in consultation with DTSC, may require the installation of a gas collection and control system or other corrective action pursuant to California Health and Safety Code (H&S Code) Section 41805.5.

3. Local Air District Rules

Local air districts have adopted rules to implement the federal requirements for MSW landfills. However, the focus of these rules is to reduce VOC and NMOC emissions from MSW landfills, not methane. The following paragraphs provide examples of some of the landfill rules that are currently being implemented by the larger local air districts to reduce NMOC emissions.

South Coast Air Quality Management District (SCAQMD)

SCAQMD Rule 1150.1 addresses the control of gaseous emissions from active and inactive landfills and requires the installation of a landfill gas control system that must be specifically operated and maintained. This rule also requires landfill owners or operators to monitor offsite gas migration and to determine the concentrations of organic compounds and toxic air contaminants emitted from the landfill. Under these requirements, a sufficient amount of landfill gas must be captured in the collection system to prevent the average concentration of total organic compounds over the landfill surface from exceeding 50 ppmv. The maximum concentration of organic compounds measured as methane must not exceed 500 ppmv at any point on the surface of the landfill.

Bay Area Air Quality Management District (BAAQMD)

BAAQMD Regulation 8, Rule 34 requires the collection of landfill gas through a gas collection system at landfills with more than one million tons of waste-in-place. This rule establishes requirements for collecting and processing of landfill gases by either burning the gases in a flare or an internal combustion engine, processing the gases by a control device or facility demonstrated to reduce the amount of organic compounds by at least 98 percent by weight, or by collecting and processing the gases for delivery to a fuel distribution pipeline.

4. Local Enforcement Agencies

Local Enforcement Agencies (LEA), such as city or county environmental health agencies, that are designated by the governing body of a county or city, and certified by CIWMB have the authority to implement CIWMB programs that ensure the correct operation and closure of MSW landfills. LEA responsibilities include the implementation of certain state regulations with respect to MSW landfill siting, construction, operation, closure, post-closure maintenance, and inspection requirements. LEAs are not expected to have a principal role in the implementation and enforcement of the proposed regulation.

5. Summary of Related Programs

Composting

CIWMB is pursuing activities for increasing the production and markets for compost and diverting organic materials from MSW landfills. These activities include an economic and life cycle assessment of organic diversion alternatives; compost-based best management practices (BMP); development of compost specifications for agriculture; and a study examining the effectiveness of using compost as cover material to mitigate methane from MSW landfills. Diversion of organic materials from MSW landfills can provide a significant reduction of GHG by removing methane-generating materials from landfilled waste.

Best Management Practice Guidance for Reducing Greenhouse Gases at Municipal Solid Waste Landfills

CIWMB sponsored a study to provide owners and operators of MSW landfills guidance on BMPs to reduce their GHG emissions. Prior to this study, there was no overall practical guide or roadmap to maximize landfill methane capture from landfills in California. The lack of such guidance presented a barrier for maximizing emissions reductions. The CIWMB study provides recommendations to optimize landfill design, construction, operation, and closure and post-closure practices for GHG emissions reductions on a voluntary basis. The BMP guidance document compliments the proposed regulation and also supports potential future CIWMB rulemaking in areas within CIWMB's regulatory purview not otherwise addressed by the proposed regulation.

Commercial Recycling

CIWMB is evaluating a measure that focuses on increasing commercial waste diversion. California has about 24,000 commercial businesses that generate over half of the statewide solid waste (ARB, 2008c). By recovering traditional recyclable materials from the commercial waste stream, with the goal of remanufacturing these materials, GHG emissions can be reduced and the use of virgin materials can be decreased.

Anaerobic Digestion and Waste-to-Energy

CIWMB is evaluating anaerobic digestion as means to reduce GHG emissions. Anaerobic digestion is a type of conversion technology that diverts organic materials, such as: green waste, food waste and other organic components from the waste stream to be utilized as feedstock for a digestion process that produces energy and displaces fuel or energy derived from fossil fuels in a sustainable manner. The energy derived from the anaerobic digestion process can be used in the form of LNG, CNG, or electricity for on-site energy needs. It may also (in some cases) be exported to the energy grid.

Mandatory Reporting

ARB's Mandatory Reporting of GHGs Regulation became effective January 1, 2009. MSW landfills are not required to do mandatory reporting of GHGs, except when the landfill operator has operational control of electric generating facilities and general combustion sources using landfill gas. MSW landfill operators with electricity generators rated 1 megawatt or higher and emitting at least 2,500 metric tons per year of CO_2 would be required to report emissions. Operators with flaring or other combustion emissions exceeding 2,500 metric tons per year of CO_2 are also required to report emissions.

III. MUNICIPAL SOLID WASTE LANDFILLS

This chapter provides an overview of MSW landfill GHG emissions and discusses the management of MSW, the methane generation process, methods for optimizing collection efficiencies, and control technologies for reducing methane emissions from MSW landfills.

A. Background

Methane is a major contributor to climate change, having a global warming potential of 21 times that of CO_2. In California, MSW landfills are the second largest anthropogenic source of methane (ARB, 2009b). The organic portion of solid waste disposed in MSW landfills decomposes to form landfill gas in which methane typically accounts for about 50 percent of the total landfill gas composition. Approximately 1.2 billion tons of solid waste has accumulated in the State's landfills with an additional 40 million tons being added each year (CIWMB, 2007c). About 94 percent of the total statewide estimated 1.2 billion tons of waste-in-place (WIP) is contained in landfills with gas control and control systems (CIWMB, 2007c). ARB staff estimates that fugitive emissions of methane from MSW landfills represent about 1 percent of the statewide gas GHG inventory. If not captured, combusted, or treated in control systems, landfill gas can either be released into the atmosphere as fugitive emissions or migrate underground to cause groundwater contamination.

B. Municipal Solid Waste Disposal and Recycling

1. <u>Waste Generation and Disposal</u>

MSW is a broad term which includes wastes such as durable goods, nondurable goods, containers and packaging, food scraps, yard trimmings, and miscellaneous inorganic wastes from residential, commercial, institutional, and industrial sources. Examples of waste from these categories include appliances, paper, wood pallets, and cafeteria wastes. MSW does not include waste such as industrial process wastes, automobile bodies, municipal sludge, and combustion ash. As shown in Table III-1, paper and other organic waste constitute the two largest components of the MSW stream for both commercial and residential categories, followed by construction demolition, plastic, metals, and glass (CIWMB, 2004). Commercial sources accounted for approximately 72 percent or 37 million tons of all MSW in 2004, while residential sources accounted for about 28 percent or 14 million tons of all MSW in 2004 (CIWMB, 2004).

Table III-1. Overview of California's Overall Waste Stream Sources in 2004

	Business (MMT)	Household (MMT)
Paper	13.2	4.0
Other Organics	12.3	6.6
Construction & Demolition	4.1	0.7
Plastic	3.8	1.3
Metal	2.4	0.7
Glass	1.1	0.6
Mixed Residue	0.2	0.6
Household Hazardous Waste	0.1	0.05
Special Waste	0.03	0.004
Total Waste	37	14
Percent Contributed to Total Waste	**72**	**28**

Source: Statewide Profile et al CIWMB, 2004.

Landfilling is basically a three step process consisting of: spreading the waste into thin layers; compacting the waste; and covering with soil. Methods for depositing the waste include the area fill method, the trench method, and the ramp method. In the area fill method, waste is placed on the ground surface or landfill liner, spread into layers, and compacted by heavy equipment. Successive layers are built up until a depth of 10 to 12 feet is reached. At the end of each day's operations, an intermediate soil cover is spread over the top and sides of the compacted waste. The cover material may be imported or may be excess material from other parts of the landfill. In the trench method, successive parallel trenches are excavated and filled. Soil from the excavation is used for cover material and as windbreaks. The ramp method is typically used on sloping land. The waste is spread and compacted as in the area methods, with the cover material being obtained directly in front of the working face of the filling operation (ARB, 1990).

For all three methods there is a basic landfill cell. After compaction, daily cover material is applied to the cells. In good practice, a 6-inch soil cover is placed over newly received waste at the end of the day. Intermediate covers consist of one foot of thick, compacted earthen material which is placed on all surfaces of the fill. After this intermediate cover is placed, there is an 180-day period where no additional solid waste is allowed to be deposited in order to control vectors (e.g. flies, rodents, etc.), fires, odors, blowing litter, and scavenging. Afterwards, a final cover is placed on top of the intermediate cover with physical dimensions that should not be steeper than a horizontal to vertical ratio of one and three quarters to one, with a minimum of one 15-foot wide bench for every 50 feet of vertical height. The requirements for daily, intermediate, and final covers can be found in Title 27, Division 2, §20700 - §21090(a)(1).

Biofiltration and Biocovers. Biofiltration or biocovers (or compost) can be used on older, closed MSW landfills. Natural methane oxidation has been shown to occur in landfill cover materials thereby reducing emissions, and it may be possible to enhance such oxidation through use of compost in cover soils.

Biofiltration uses bacteria to metabolize and remove organic and odorous vapor phase pollutants from gas streams at composting facilities, sewage plants, and similar operations. Landfills provide advantages for biofiltration operations due to their immense internal surface areas, close proximity to most LFG fuel electricity generation, and low incremental costs. In addition, biofiltration beds do not generate secondary gaseous pollutants such as NOx and oxides of sulfur (SOx), unlike combustion based mitigation measures. Emissions are limited to CO_2 and water vapor emissions. Challenges to using biofiltration is the lack of active gas control and monitoring capabilities, as well as the large biofiltration bed sizes required to treat air/LFG mixtures (URS, 2008).

Biocovers are final covers that enhance methane oxidation into CO_2 before venting to the atmosphere. The biocovers are typically composed of a gas dispersion layer situated below a methane oxidation layer. The gas dispersion layer is a permeable layer of gravel, broken glass, or sand that helps evenly distribute the fugitive LFG to the methane oxidation layer, and to remove excess moisture. The methane oxidation layer is typically made of soil or compost which converts the methane into CO_2 (URS, 2008).

The use of biocovers or biofiltration to reduce landfill gas emissions is still being researched and can not be considered as an alternative means of compliance at this time.

2. <u>Disposal Options</u>

There are five main options for the management of MSW: source reduction, recycling, composting, municipal waste combustion, and landfilling. Source reduction, or the elimination of waste before it is generated, is important due to: dwindling natural resources, the potential toxic hazards posed by some waste materials, and the growing shortage of disposal capacity. Recycling is the practice of recovering used materials from the waste stream and then incorporating those same materials into manufacturing processes. Based on CIWMB's 2004 statewide profile, paper, glass, and metals, which together account for almost 43 percent of the MSW stream can easily be recycled (CIWMB, 2004). Composting is the controlled biological decomposition of yard waste which can also achieve significant volume reductions. By utilizing available recycling and composting alternatives the volume and toxicity of waste going to landfills should be reduced. Municipal waste combustion is the high temperature burning of biosolids using a fuel supply such as natural gas or diesel fuel. Currently, there are only three municipal waste combustion facilities in California. The last approach is landfilling where MSW is buried in specially designed disposal sites.

In 2005, approximately 88 million tons of MSW were generated statewide, with about 46 million tons being diverted due to source reductions, recycling, and composting. The remaining 42 million tons were disposed in landfills (CIWMB, 2009). This 2005 diversion figure exceeds the 50 percent waste diversion threshold required by Assembly Bill 939, the Integrated Waste Management Act. AB 939 required jurisdictions to meet diversion goals of 25 percent by 1995 and 50 percent by the year 2000.

C. Methane Generation

1. Landfill Gas Composition

Biological decomposition of organic waste contained in MSW landfills leads to the production of landfill gas, consisting primarily of about 50 percent methane, 50 percent CO_2, and trace amounts (less than 1 percent) of NMOCs. Methane is a combustible and explosive gas in air having a lower explosive limit of 5 percent methane and an upper explosive limit of 15 percent methane. The heat content of landfill gas is approximately 500 British thermal units per cubic feet (Btu/ft^3) – compared to natural gas which has a heat content of about 1,000 Btu/ft^3 – and consists almost entirely of methane. Methane has a short atmospheric lifetime of about 10 years and changes in methane sources can affect atmospheric concentrations in a relatively short time scale (SCS, 2007a).

NMOCs can be precursors to ozone formation. Some of these compounds are toxic air contaminants and some are highly odorous compounds. NMOCs may be incorporated into the landfill gas through vaporization, chemical reaction, and biological decomposition. Vaporization is affected by the concentration of compounds in the landfill, the physical properties of the individual organic constituents, and the landfill conditions. Odorous NMOCs include alcohols, esters, and mercaptans.

2. Landfill Gas Generation

Landfill gas is produced via aerobic and anaerobic decomposition processes. The aerobic process lasts several days to weeks. In the first phase, oxygen is present at the time waste is placed and CO_2 is the primary gas produced. The second phase, the anaerobic phase, begins once all of the oxygen has been depleted. In this phase, acid-forming bacteria break down complex organic molecules into simpler organic acids. The third phase involves methane production, and a decrease in CO_2 production. In the fourth and final phase, the gas generation reaches a relatively steady state condition. This final phase can last 15 to 60 years. At this point, the gas is typically 25 to 60 percent methane and 40 to 75 percent CO_2, with trace amounts of other gases.

Gas generation rates can vary from site-to-site and are dependent on several factors, such as: the amount of moisture present, quantity and composition of the waste (i.e., degradable fraction of waste), age of the waste, the landfill's temperature, pH, and alkalinity, and quality of nutrients. A lack of moisture, which is typical of many California landfills, leads to a slower gas generation rate and also extends the time during which a landfill actively generates gas.

3. Landfill Gas Movement

Landfill gas moves due to molecular diffusion, compaction and settling, barometric pressure changes, water table fluctuations, and internal pressure differentials. If uncontrolled, or inadequately controlled, landfill gas can migrate laterally underground and eventually make its way to the surface where it can present an odor or air quality problem. In addition, fires and explosions may result from the accumulation of the landfill gas in basements and crawl spaces of structures on and around MSW landfills.

D. Controlling Methane Emissions

1. Landfill Gas Collection Systems

Landfill gas collection systems can either be active or passive and are specially designed to mitigate underground gas migration and surface emissions.

Active Systems. Active systems use mechanical blowers or compressors to create a pressure gradient (or vacuum) in order to extract the landfill gas. Active collection systems have three main components: gas extraction wells and/or trenches, gas moving equipment, and gas disposal/treatment equipment. Vertical extraction wells consist of 4- to 8-inch pipe casings set in 24- to 36-inch boreholes. These wells are typically installed in areas where filling operations have been completed. Horizontal trenches are installed within a landfill as each layer of waste is applied. This method is most suitable for new or expanding landfills. The collected landfill gas is then sent through a header system by a blower or compressor. Design elements depend on the total gas flow rate, total system pressure drop, and vacuum requirements. The collected gas is generally directed to a control device, such as a flare, or energy recovery equipment, such as a boiler, gas turbine, or internal combustion engine. However, it can also be directed to a carbon adsorption system for pretreatment where NMOCs are stripped from the gas and then vented into the atmosphere. For the purposes of this proposed regulation, carbon adsorption systems are not considered to be appropriate gas control systems since they do not reduce methane emissions.

Passive Systems. Passive systems are used to control offsite underground gas migration and can be installed on both active and closed landfills. These systems consist of cutoff trenches or vents that penetrate the landfill cover, allowing gases to flow into the atmosphere as pressure within the landfill increases. Passive systems rely on natural pressure or concentration gradients as a driving force for gas flow and thus have much lower collection efficiencies than active systems. Since these systems do not actively collect, process, or treat landfill gas, but allow methane to be freely vented into the atmosphere, they are not considered to be appropriate gas collection systems for the purpose of the proposed regulation.

2. Landfill Gas Collection Efficiency

Landfill gas collection efficiency is highly dependent on how well the gas collection system is designed and operated and therefore is difficult to quantify. U.S. EPA uses a default value of 75 percent; however, some landfill owners and operators claim rates of up to and above 95 percent, while environmental organizations believe these rates are much lower, about 20 to 40 percent (see Chapter VIII for a summary of research efforts on collection efficiency uncertainty). A properly designed and operated system should include gas moving equipment capable of handling the expected landfill gas generation flow rate, collection wells and trenches configured such that the landfill gas is effectively collected from all areas of the landfill, and design provisions for monitoring and adjusting the operation of individual extraction wells and trenches.

The efficiency of a collection system depends on the proper location of wells and trenches. To effectively control emissions from all areas of a landfill, the areas in which the wells or trenches exert a negative pressure (also known as the "zone of influence") should overlap. The zone of influence determines the spacing between extraction wells or the location of trenches. The zone of influence depends on the landfill depth, magnitude of the pressure gradient applied by the blower or compressor, waste type, waste compaction, and gas moisture content. Each extraction well should have a throttling valve and pressure gauge to adjust and monitor the collection system. Extraction wells are typically placed in an equilateral triangle arrangement to maximize their collection efficiency, and are installed in areas where filling operations have been completed. Horizontal extraction trenches can be applied in each landfill cell as each layer of waste is added. Loose-jointed pipes are connected through laterals to a collection header. However, these are most suitable for new or expanding landfills because they can easily draw in air from the surface until a significant height of refuse and cover is placed over them.

3. Optimizing Gas Collection Efficiency

Optimizing gas collection efficiency is dependent on landfill design, operation and maintenance of the gas collection system, and closure/post-closure practices.

Landfill Design, Operation, and Maintenance. A 2007 CIWMB study reported that common practice among landfill operators in collecting their landfill gas is to wait until a landfill cell is completed prior to installing vertical wells using standard design for the well placement and spacing (SCS, 2007b). This practice results in adequate gas collection from the landfill. However, to enhance landfill gas recovery at MSW landfills, the study suggests several design and operations-related best management practices (BMPs), such as: the use of horizontal or surface collectors, tighter spacing of landfill gas wells, mixed horizontal and vertical well systems, connection of the leachate collection and removal system to the gas collection system, deep multi-depth vertical wells, enhancing seals on landfill gas wells and boreholes, promotion of deeper landfills, limiting delays on the installation of final cover systems, and earlier installation of the gas collection system. A description of these BMPs is provided in Table III-2.

Table III-2. Design and Operations-Related Best Management Practices

Best Management Practice	Description
Horizontal or Surface Collectors	Horizontal collectors collect landfill gas before vertical wells are installed. Surface collectors collect gas from a landfill where traditional wells fail due to water infiltration.
Tighter Spacing of Landfill Gas Wells	Vertical wells are closely spaced to increase the overlap of the zone of influence.
Mixed Horizontal and Vertical Well Systems	Horizontal collectors are installed in active areas while vertical wells are placed where they are not at risk of damage from operations.
Connection of the Leachate Collection Removal System (LCRS) to Landfill Gas System	LCRS is connected to the landfill gas recovery system to collect gas along the bottom of the landfill.
Deep Multi-depth Vertical Wells	Wells place at multiple depths in the same boring at higher vacuum. Also, wells can alternate between shallow and deep.
Enhance Seals on Landfill Gas Wells and Boreholes	Improved seals allow more vacuum to be applied to landfill gas wells.
Promote Deeper Landfills	Deeper landfills are allowed without requiring a larger footprint.
Limiting Delays on Final Cover Systems	Final cover is applied to landfills sooner.
Earlier Installation of the Gas Collection System	Landfill gas systems are installed earlier than currently required by regulation.

Source: SCS, 2008

Gas collection and control systems should be operated and maintained to minimize the escape of landfill gas into the environment. To effectively operate an active landfill gas collection system, gas moving equipment capable of handling the expected landfill gas generation flow rate is required, along with collection wells and trenches configured so that landfill gas is effectively collected from all areas of the landfill. Monitoring and adjustment is also needed for the proper operation of these wells and trenches. Collection header pipes should be sized to minimize pressure drop. And, each extraction well has a zone of influence in which it can effectively collect landfill gas. Placement of wells should be designed with this in mind.

Quarterly surface emission testing is typically used to evaluate the effectiveness of the gas collection system and to check for surface emissions. The testing is conducted using a hydrocarbon detector or other equivalent device to monitor methane concentrations within three inches of the landfill surface. All areas are monitored except steep slopes and other areas which may pose a hazard to the inspector or technician. All breaks between the cover and the waste and native soil interface are also checked. Repeated exceedances of established surface emission standards may be an indicator of insufficient vacuum on gas wells or the need to expand the gas collection system.

Areas where the surface of the landfill has been penetrated (e.g., around landfill well casings and bore holes) can be a significant source of surface gas leaks and air intrusion due to cracking around the point of penetration. Wellboots and geomembranes composed of an impermeable substance such as polyvinyl chloride (PVC) are successful in minimizing leakage in many cases. Geomembranes prevent gas leaks through the use of plastic covers several centimeters thick that cover the top of the landfill surface and surrounds the bore holes drilled to collect methane gas. Wellboots consist of flexible skirts typically made of plastic that covers the lower section of the well bore pipes and connects to the geomembrane to prevent leakage from the gaps between the bore and geomembrane. The impenetrable barrier allows landfill operators to maximize emissions mitigation through the use of higher vacuum pressures at the well head to extract the landfill gas. Furthermore, geomembranes are flexible covers and can be installed in a collapsed position to accommodate future settlement around the well casing. As settlement occurs due to waste refuse decomposition and compaction, the initially collapsed boot elongates. The boot can then be readjusted to a new collapsed position before the membrane reaches its elastic limit (Landtec, 2004).

Closure/Post-Closure Practices. Closure is the process during which a landfill, or a portion thereof, is no longer receiving waste and is being prepared for post-closure maintenance according to an approved plan. When a landfill is closed, it has ceased accepting waste. Landfill owners and operators are required by CIWMB to submit closure/post-closure maintenance plans to ensure that the closure/post-closure maintenance and the eventual reuse of their landfills will conform to State performance standards and requirements. The landfill owner or operator must also provide demonstrations of financial responsibility for both closure and post-closure maintenance.

Closure and post-closure practices, such as the type of final cover used on landfills cells, are important factors in optimizing gas collection efficiency. The permeability of a landfill's final cover affects the efficiency of gas extraction, the amount of moisture in the cell, and consequently the flow of landfill gas in the cell (URS, 2008). If a landfill has a more permeable cover, it may allow higher occurrences of surface emissions or air intrusion into the landfill. In comparison, highly impermeable covers will greatly reduce the entrance of moisture into the landfill cell and slow the degradation process. The ideal situation for enhanced waste decomposition at a landfill is using a low permeability cover in combination with highly permeable materials that surround the perforated gas collection wells and trenches (URS, 2008).

Examples of landfill cover materials used to enhance gas collection efficiency include soil, compacted clay, geomembranes, and biocovers. Excluding biocovers, geomembranes provide the highest methane collection (URS, 2008). Final covers consist of a foundation layer made from soil or other approved materials and must be more than two feet thick. The foundation layer is followed with a low impact hydraulic conductivity layer to prevent water entry, leachate production, and gas migration. The hydraulic layer is finally covered by an erosion resistant layer that is either vegetative or mechanical. Vegetative layers are typically made of more than one foot of soil that could sustain plant growth. Mechanical layers are comprised of ultraviolet light resistant materials such as asphalt, cement, and soil sealants (Title 27, Chapter 3, §20950).

4. Landfill Gas Control Systems

a. Flares

Flares are either open (also referred to as “candlestick” or “elevated” flares) or enclosed (also referred to as “ground-type” flares). These control devices destroy landfill gas via combustion. Methane is converted to CO_2, resulting in a large greenhouse gas reduction (ATSDR, 2001). Flares can be the primary method of methane control at a landfill or a back up for emergencies or when other control devices undergo repair or maintenance. The main components of these devices are a gas burner, stack, water seal/liquid trap, flame arrestors, air and combustion controls, temperature sensor, pilot burner, and an ignition system. Flare manufacturers typically include parameters that ensure proper gas stream contact with the flame, turbulent mixing of the air and fuel, and flame retention time. Flares may be used when gas production is not sufficient to economically support either energy recovery systems or purification techniques.

Open Flares. Open flares are inexpensive in comparison to enclosed flares and represent the simplest flaring technology. They consist of a pipe through which the gas is pumped, a pilot light to ignite the gas, and a means to regulate the gas flow. However, since they are essentially an exposed flame they cannot be easily be sampled for compliance testing. It is not feasible to source test or measure the percent reduction of methane concentration for open flares. Open flares also emit more luminosity, noise, and heat radiation compared to enclosed flares.

Enclosed Flares. Enclosed flares are more expensive and complex than open flares. They consist of multiple gas burners enclosed within fire resistant walls that extend above the flame. The multiple gas burners are grouped and staged to operate at wide ranges of flow rates. The enclosure reduces luminosity, noise, and heat radiation problems and allows the flare to be located at ground level. Unlike open flares, the amount of gas and air entering can be controlled making combustion more reliable and efficient. The intake of air is automatically adjusted by the opening and closing of dampers at the bottom of the shell, which are regulated by the combustion temperature. As combustion efficiency increases, in general so does the concentration of NOx. Enclosed flares can be easily source tested to measure flare destruction and treatment efficiency. Based on ARB staff’s review of source tests results, enclosed flares can achieve destruction efficiencies for methane of 99 percent or greater.

b. Energy Recovery Systems

Internal Combustion Engines. Internal combustion engines (IC engines) are the most commonly used energy-recovery technology for landfill gas applications. IC engines have significant energy conservation benefits in comparison to flares. They are widely used because of their low cost and high efficiency (ARB, 1998). They also have a short construction time, are easy to install, and can operate over a wide range of speeds and loads. They have 25 to 30 percent efficiency for power generation when operating on landfill gas (ARB, 1998).

The air to fuel ratio has a major effect on the combustion efficiency of the IC engine. When combustion efficiency decreases, the emissions of VOCs and CO increase. Also, NOx forms due to high pressures and temperatures during the combustion process. Issues may arise with environmental permitting since these engines have relatively high NOx emissions. Other primary emissions from IC engines include CO, PM, and VOCs. Rich-burn internal combustion engines can typically achieve destruction efficiencies for methane of at least 99 percent, in comparison to lean-burn engines which have destruction efficiencies for methane ranging from 87 to 95 percent.

Gas Turbines. Gas turbines can be used to drive pumps, compressors, or electrical generators. There are two types of generators used: simple cycle and regenerative cycle. Simple cycle turbines combust fuel in one or more compressor stages and combustion chambers, and this combusted fuel turns on one or more turbines. The turbine is started with an electric motor, diesel engine, or other energy source to rotate a compressor that provides compressed air to the combustors. Fuel is introduced into the combustors and burned to produce hot gases that rotate the turbine fan and shaft. A regenerative cycle gas turbine differs from a simple cycle turbine in that it has an added heat exchanger. The regenerative cycle turbine is more efficient than the simple cycle because it recovers thermal energy from the hot exhaust gases, and uses this to preheat the compressed inlet air, which means less fuel is required to heat the compressed air. Gas turbines emit NOx, CO, PM, and VOCs (ARB, 1998). The peak temperature of the flame in the destruction zone has the largest effect on VOC destruction efficiency. As the peak flame temperature decreases, VOC and CO emissions increase. Also, NOx emissions increase with an increasing peak flame temperature and increasing pressure ratios. Gas turbines can achieve destruction efficiencies for methane of 99 percent or higher.

Boilers. Boilers are used as a simple source of heat and hot water and to generate steam. The usable steam produced can either be used on-site at the landfill or off-site. Steam produced by the boiler can also be used to power a turbine generator set and produce electricity. The boiler/steam turbine combination mixes a conventional boiler, usually a packaged unit, and a steam turbine generator that produces electricity. The majority of landfill gas-fired boilers are of the industrial type with heat inputs of about 10 million Btu/hr and 90 million Btu/hr. Boilers emit PM, SOx, NOx, and smaller amounts of CO and VOCs (ARB, 1998). Increases in flame temperature, oxygen availability, and/or residence time at high temperature leads to an increase in NOx production. The rate of CO emissions from boilers is dependent on combustion efficiency. Boilers are the least used technology for landfill gas recovery systems and are applicable mainly for larger projects. Boilers can achieve destruction efficiencies for methane of at least 99 percent.

Microturbines. Microturbines are suitable for smaller landfills with lower gas flow rates. However, the use of this technology requires the landfill gas to be pretreated to remove impurities. Microturbines are more expensive than IC engines. Microturbines are derived from turbocharger technologies found either in large trucks or the turbines of aircraft auxiliary power units. Many of these engines are still undergoing field tests or are part of large-scale demonstrations, but have almost reached commercial status at this point. There are two general classes of microturbines: recuperated and unrecuperated. Recuperated microturbines recover heat from the exhaust gas in order to boost the temperature of combustion and increase its efficiency. Unrecuperated microturbines have lower efficiencies but they also have lower capital costs. Microturbines produce 25 to 500 kilowatts of power and emit a relatively low level of NOx (BAAQMD, 2007). Microturbines can achieve destruction efficiencies for methane of 99 percent or higher.

Fuel Cells. The phosphoric acid fuel cell is a non-combustion technology that can be used with landfill gas to produce energy. Other types of fuel cells (molten carbonate, solid oxide, and solid polymer) are still in varying stages of development and have not yet been demonstrated with landfill gas (ARB, 1998). All fuel cells use hydrogen gas as a primary fuel source to produce electricity. Landfill gas is a potential source of hydrogen gas. Fuel cells are a potentially attractive option for controlling landfill gas because of their high electrical conversion levels, suitability to both small and large landfills, low labor and maintenance requirements, minimal noise impact, and extremely low air emissions. The major drawback for using fuel cells is that they are expensive and the landfill gas must first go through pretreatment to remove impurities, such as water, undesirable VOCs, and CO_2 (ARB, 1998).

c. Other Treatment Options

Compressed and Liquefied Natural Gas Motor Vehicle Fuel. Compressed natural gas (CNG) can be used for motor vehicle fuel. The main steps involved in processing landfill gas into CNG are water removal, pretreatment to remove trace organics, membrane technology to separate CO_2, and final compression to about 3,600 pounds per square inch. Compressed landfill gas has essentially the same qualities and properties as CNG, once it has been processed to remove contaminants. Using compressed landfill gas as an alternative fuel for motor vehicles has been used commercially for several years now. The Los Angeles County Sanitation Districts have been successfully using compressed landfill gas as a vehicle fuel since 1994. Production of liquefied natural gas (LNG) from landfill gas is more challenging and requires additional steps in the form of purification and cryogenic systems. Currently, California does not have any commercial plants in operation for producing LNG.

The primary emission reduction benefits from using landfill gas as a vehicle fuel come from displacing the fossil fuels uses for vehicle fuel. Additional emission reduction benefits occur when landfill gas is used as a vehicle fuel instead of being flared. However, converting landfill gas to a vehicle fuel produces small quantities of NOx, carbon monoxide (CO), VOCs, and PM.

Landfill Gas to Pipeline Quality Methane. Raw landfill gas can be upgraded to pipeline quality natural gas if it is pretreated to remove contaminants such as water, VOCs, and CO_2. The gas must also be dehydrated and the VOCs collected before removal of CO_2 can begin. Pretreatment techniques include physical absorption, adsorption onto a solid, and molecular diffusion membrane separation. After treatment, the resulting gas stream typically consists of approximately 55 percent methane, 45 percent CO_2, up to 5 percent nitrogen, and 1 percent CO_2. Using compressed landfill gas as a vehicle fuel may be particularly viable for landfills that are not close to an electric grid or gas pipeline.

E. Emerging Technologies for Monitoring and Evaluating Collection Efficiency

1. Optical Remote Sensing and Radial Plume Mapping

Some stakeholders recommended using optical remote sensing (ORS) and radial plume mapping (RPM) in lieu of surface emissions monitoring. U.S. EPA is evaluating a method for measuring landfill gas emissions using these technologies. ORS involves placing laser emitters and sensors at opposite corners of the landfill. RPM is a one-dimensional methodology designed to map pollutant concentrations in either a horizontal or vertical plane. ARB staff believes that this technology is limited to flat topographies, low wind speeds, and is weather sensitive. The test method also requires significant ambient light and the equipment cannot be operated unattended. The technology is very expensive: approximately $450,000 in capital investment and another $100,000 for one week staff time and on-going training is required for staff due to the frequent updating of the computer software.

2. Gas Tracers

Stakeholders submitted comments that gas tracers are a more accurate way of quantifying capture efficiency of gas collection systems. Methane gas emissions have been challenging to measure due to the high variability in the reported methane emissions data. Traditional methods of measuring collection efficiencies based on recovery or production methods is expensive since data is needed from the entire landfill and may not be able to assess the efficiency of gas collection from different regions of the same landfill. Tracer gases on the other hand can potentially track the efficiency of an existing collection system as a landfill cell moves from active to intermediate to final cover, or to evaluate various operational changes on the collection efficiency of one well or a system of wells.

Tracer gases (e.g., sulfur hexafluoride, helium or diflluromethane) are injected into a particular location within a landfill which is then followed by continuous sampling of gas in nearby gas collection wells until the monitored tracer gases reach a certain concentration. By knowing the mass of tracer injected, the measured breakthrough curve, and the gas flow rate from the extraction well, the fraction of tracer mass collected in the gas collection well can be determined (Imhoff, 2008).

IV. EMISSIONS

This chapter discusses the development of ARB's landfill emissions inventory, number of potentially affected MSW landfills, and methane emission reduction estimates.

A. Emissions Inventory

1. <u>Sources</u>

In California, MSW landfills are the second largest anthropogenic source of methane (ARB, 2009b). CIMWB provided data on 372 landfills known to contain waste that is biodegradable at least in part and have the ability to generate methane emissions. This information was used to develop ARB's landfill inventory. Landfills containing only inert waste, like ash and masonry from demolition sites, were excluded. The landfill inventory also excludes approximately 1,500 closed, illegal, or abandoned disposal sites, including burn dumps and other types of sites that are not likely to generate landfill gas. The landfill inventory was used to develop requirements for MSW landfills that considered the landfill's size, age, methane generation flow rate (or landfill gas heat input capacity), and the ability to support the continuous operation of a gas control device without the use of supplemental fuel.

The total number of landfills in ARB's inventory is a count of each landfill's Solid Waste Information System identification numbers (SWIS ID), which is issued by CIWMB. However, a few landfills were assigned multiple SWIS ID numbers because they were separated into individual waste units. Since the emissions were estimated for each landfill as a whole and not for individual waste units, the landfills are counted by facility site name instead of by their SWIS identification numbers for the purpose of this chapter. This makes the total number of landfills currently in the inventory 367 opposed to 372.

Table IV-1 provides a breakdown of the number of potentially affected landfills and their emissions. Of the 367 landfills, 218 received solid waste after January 1, 1977, and are potentially affected by the proposed regulation. This includes landfills that may be subject to control requirements in the future from the baseline year 2009 up to and including 2020. Out of the 218 landfills: 72 landfills would be subject to only reporting requirements because they are below the landfill size threshold of 450,000 tons of waste-in-place and the landfill gas heat input capacity of 3.0 MMBtu/hr; 132 landfills already have gas collection and control systems installed; and 14 are currently uncontrolled but may be required to install controls based on their size and estimated landfill gas heat input capacities. The 14 landfills include those having carbon adsorption or passive venting systems, which are not considered controls with respect to methane.

Table IV-1. Potentially Affected MSW Landfills

Category	Number of Landfills
Total number of landfills	367
Landfills potentially affected by the proposed regulation	218
Landfills subject to reporting requirements only	72
Landfills already having gas collection and control systems	132
Landfills which may be required to install new gas collection and control systems	14

Table IV-2 provides the number of MSW landfills by local air district that may be required to install gas collection and control systems. The majority of these landfills are currently active; however, by 2015 about half of these landfills will be closed and no longer accepting waste. Out of the 14 MSW landfills, 10 are public; three are private; one is operated by the military; 11 have no form of emission control, two have carbon adsorption systems, and one has a passive venting system. The estimated landfill gas (LFG) heat input capacities of the 14 landfills are all above 3.0 MMBtu/hr by 2020, except for one landfill which is expected to have a Btu value of 2.9 MMBtu/hr by 2012 and 2.2 MMBtu/hr by 2020. For this one landfill, the 2012 and 2020 values may be insufficient to support the continuous operation of a flare without the use of supplemental fuel. In this particular case, the installation of a gas collection and control system may not be justified (the landfill would need to conduct a more detailed analysis).

Table IV-2. MSW Landfills Potentially Required to Install Gas Collection and Control Systems

Local Air District	Number of Landfills	Closure Year	2006 Waste-in-Place (MMT)	"Current" 2010 Control Type	Status	Estimated 2010 LFG Heat Input Capacity (MMBtu/hr)	Estimated 2020 LFG Heat Input Capacity (MMBtu/hr)
Bay Area	1	2020	0.8	None	Private	5.4	6.9
Calaveras	1	2032	0.6	None	Public	2.7	4.3
Glenn	1	2021	0.8	None	Public	3.0	3.4
Imperial	1	2010	2.0	None	Private	8.5	14
Lake	1	2027	1.0	None	Public	6.7	8.1
Mendocino	1	2001	0.8	Passive Venting	Public	3.2	2.2
Mojave	1	2007	1.6	None	Public	6.1	8.2
Mojave	1	2013	0.9	None	Public	4.3	6.9
Sacramento	1	2013	3.6	Carbon Adsorption	Private	15	23
San Diego	1	2184	0.8	None	Military	3.4	4.3
San Joaquin	1	2009	1.0	None	Public	4.6	6.3
San Joaquin	1	2020	1.1	None	Public	5.6	12
San Joaquin	1	2043	4.0	Carbon Adsorption	Public	17	23
Shasta	1	2013	2.1	None	Public	15	21

3. Methodology

CIWMB provided data to ARB to assist in the development of the landfill inventory. In addition, ARB staff requested site-specific landfill gas collection data from MSW landfill owners and operators through landfill surveys, but received answers for only certain years and for less than half of the landfilled waste (approximately 42 percent in 2005). Therefore, ARB staff opted to use a model to estimate landfill emissions for all sites, and used the survey data to supplement the model estimates where appropriate.

ARB staff used the Mathematically Exact First-Order Decay model from the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines (IPCC, 2006b). This model assumes that a fixed fraction of the waste available will degrade at any moment. The amount that degrades over a given amount of time is determined by a factor (k), which is tied to the moisture content in the landfill. The k values used in the model were obtained from U.S. EPA and are a function of the annual precipitation occurring at each landfill; rainfall being used as a surrogate for landfill moisture content. The model assumes that the carbon in the landfilled waste is biodegraded into equal amounts of CO_2 and methane (see Appendix C).

The IPCC emission model equations and default values used to determine the landfill gas heat input capacity are incorporated into the proposed regulation. A landfill gas tool is being developed by ARB staff to assist landfill owners and operators in doing the calculations. U.S. EPA's Landfill Gas Emissions Model (LandGEM) Version 3.02 was not used because IPCC is now available and is being used in several countries and is the most recent model for estimating emissions from landfills. The landfill emissions inventory is based on IPCC's methodology. The main advantages of the IPCC model is that it allows the user to: adjust the potential methane generation capacity on a year-to-year basis; use specific degradation parameters by waste type; use time delays other than six months; and correct for methane oxidation. The primary drawback of LandGEM is its inability to allow for potential methane generation capacity variation on a year-to-year basis over the lifetime of the landfill, which is very important to the results. A more detailed discussion of the methodology used to develop the landfill inventory is provided in Appendix C.

B. Emissions and Emission Reductions

1. <u>Emissions</u>

ARB staff estimated methane emissions from the 367 MSW landfills in the inventory. Based on 2006 data, GHG emissions from MSW landfills were estimated to be about 6.3 $MMTCO_2E$ in 1990. In 2000 the GHG emission level dropped to 5.9 $MMTCO_2E$. During this time period, several landfill gas control measures were adopted (e.g., ARB's suggested control measure for landfill gas emissions, local air district landfill gas rules, the federal NSPS and EG, and the federal NESHAP) to reduce landfill gas emissions. Although these measures targeted primarily NMOCs and VOCs, it also had the added benefit of reducing GHG emissions such as methane. However, due to population growth and increased waste disposal, without additional regulation, GHG emissions are forecasted to increase to approximately 7.7 MMTCO2E in 2020.

2. Landfill Gas Collection Efficiency Measurement Study

There are uncertainties concerning methane collection efficiencies. Collection efficiency is a measure of the ratio of methane captured by the control system plus the amount naturally oxidized to the total methane generated. The effectiveness of an active landfill gas collection system depends greatly on the design and operation of the system and is difficult to quantify. U.S. EPA's *Compilation of Air Pollutant Emission Factors* (AP-42) assumes a range from 60 to 85 percent, with 75 percent as "typical" for sites having a well-designed active collection control system in place. ARB staff used this default value in calculations to initially estimate methane emissions from MSW landfills. Some stakeholders are concerned that the actual capture efficiencies are significantly lower than the default value because gas generation starts before control systems are in place, although such generation may be relatively low. Other stakeholders believe actual capture efficiencies are significantly higher especially for landfills in California where relatively arid conditions occur, and where very stringent emissions control standards have been in place since 1990. Recent direct measurement studies of landfills by the Los Angeles County Sanitation Districts conclude very high capture efficiencies of above 95 percent are being achieved (CIWMB, 2007b).

ARB staff evaluated a study conducted by the Los Angeles County Sanitation Districts (LACSD) in the 1990's for measuring landfill gas collection efficiency at the Palos Verdes landfill. This study is the first of two such studies which examined this issue. LACSD developed a methodology for measuring gas collection efficiency based on a combination of readily acquired integrated surface methane concentration data and modeling using the U.S. EPA Industrial Source Complex (ISC) air dispersion model (Hutric, 2007). The methodology was applied to estimate landfill gas collection efficiency at a LACSD landfill and indicated an efficiency approaching 95 percent (Hutric, 2007). However, the results of ARB staff's evaluation of the LACSD study using U.S. EPA's latest air dispersion model AERMOD, which replaced ISC, demonstrated a collection efficiency of about 85 percent for the gas collection system at the Palos Verdes landfill. Further discussion on ARB staff's review of the LASCD study is provided in Appendix D.

The Palos Verdes landfill is subject to SCAQMD Rule 1150.1 which contains surface emissions monitoring requirements that are more stringent than existing federal requirements for MSW landfills and are similar in stringency to the proposed regulation. Accordingly, ARB staff believes that MSW landfills that are subject to the proposed regulation can achieve a gas collection efficiency of at least 85 percent, which is used for estimating the emission reductions.

3. Methane Emissions Reductions

ARB staff identified 14 currently uncontrolled MSW landfills that may generate sufficient gas to support the installation of gas collection and control systems. Based on the latest ARB 2020 forecast of landfill emissions, if all 14 of these landfills with 450,000 tons of waste-in-place or more were to install emission controls for methane, emissions would be reduced by 0.4 $MMTCO_2E$ in 2020. The statewide implementation and enforcement of this proposed regulation for all affected MSW landfills (including those with gas collections systems already installed) is expected to result in an additional estimated emission reduction of 1.1 $MMTCO_2E$ in 2020. This estimate assumes a collection efficiency of 85 percent resulting from the implementation of ARB's enhanced surface emissions monitoring requirements. The total emission reductions resulting from the implementation of the proposed regulation are expected to be 1.5 $MMTCO_2E$ in 2020. Table IV-3 summarizes the emission reduction estimates.

Table IV-3. Estimated Methane Emission Reductions

Category	Number of Landfills	Methane Emission Reductions ($MMTCO_2E$)[1]		
		2011	2015	2020
Landfills with existing controls[2]	92	0.9	1.0	1.1
Landfills potentially required to install controls	14	N/A	0.4	0.4
Totals	106	0.9	1.4	1.5

1. Assumes an 85 percent collection efficiency.
2. Excludes 40 MSW landfills that are subject to SCAQMD Rule 1150.1.

C. Further Inventory Improvements

A more complete California-specific landfill survey data on landfill gas collection and composition will help improve outputs from the IPCC model. Better information on the cover types present at landfills and further details on gas collection systems will allow for better collection and oxidation factor estimates. Ongoing research and other studies to improve estimates of landfill gas emissions will be followed closely by staff (see Chapter VIII). Additionally, the proposed regulation contains reporting requirements that will be used to further update the landfill inventory.

V. DEVELOPMENT OF THE PROPOSED REGULATION

This chapter summarizes the requirements of the proposed regulation presented in Appendix A of this Staff Report. The proposed regulation reflects comments received at the public workshops and landfill technical review workgroup meetings; comments received based on public review of draft versions of the proposed regulation; and comments received through interagency review. This chapter also discusses alternatives considered during the development of the proposed regulation.

A. Summary of the Proposed Regulation

The proposed regulation will require the installation of gas collection and control systems at active, inactive, and closed MSW landfills having 450,000 tons of waste-in-place or greater and applies to all MSW landfills that received waste after January 1, 1977. An active MSW landfill is one that is currently accepting solid waste for disposal. Inactive landfills are no longer accepting solid waste for disposal and are typically unstaffed, whereas closed landfills still have on-site staff overseeing the operation of the landfill.

The proposed regulation contains performance standards for the gas collection and control system, and specifies monitoring requirements to ensure that the system is being maintained and operated in a manner to minimize methane emissions. The proposed regulation establishes standards for gas collection and control systems including a leak standard for gas collection and control system components, a monitoring requirement for wellheads, methane destruction efficiency requirements for most control devices, and surface methane emission standards. The specific design of the gas collection and control system to meet these requirements is determined by the MSW landfill owner or operator.

1. Applicability (Section 95461)

The proposed regulation applies to all MSW landfills that received solid waste after January 1, 1977. This date excludes approximately 1,500 closed, illegal, or abandoned disposal sites, including burn dumps and other types of sites that are not likely to generate landfill gas in sufficient quantities to be collected and controlled. There are about 367 landfills currently in ARB's landfill emissions inventory that have the potential to generate sufficient methane emissions.

MSW landfills having 450,000 tons of waste-in-place or greater would be required to install active gas collection and control systems and comply with the requirements of the proposed regulation unless exemption conditions are met. The threshold of 450,000 tons of waste-in-place was selected because landfills with less waste-in-place are not expected to generate enough landfill gas to operate a gas collection and control system without supplemental fuel. To determine this threshold, ARB staff considered a flare to represent the most readily available and feasible means of treating landfill gas. Based on discussions with industry representatives, local air district staff, and CIWMB staff, ARB staff determined that the smallest commercially available flares are capable of processing approximately 133 standard cubic feet per minute of landfill gas (or 3.0 MMBtu/hr) without the use of supplemental fuel. According to the inventory, this corresponds to landfills with 450,000 tons of waste-in-place or greater and represents a feasible lower limit for the installation of a gas collection and control system at a typical landfill.

2. Exemptions (Section 95462)

The intent of the proposed measure is to minimize methane emissions from MSW landfills. Therefore, hazardous waste landfills, landfills that receive construction and demolition wastes, and landfills containing only non-decomposable solid waste, which is incapable of degrading biologically to form landfill gas, are exempt from the requirements of the proposed regulation. However, in some cases, these landfills may be subject to other local, State, and federal requirements.

3. Determination for Installing a Gas Collection and Control System (Section 95463)

MSW Landfills with 450,000 Tons of Waste-in-Place or Greater

If a MSW landfill has 450,000 tons of waste-in-place or greater, the owner or operator must first determine if they are required to install a gas collection and control system based on the landfill's gas heat input capacity. The proposed regulation uses a landfill gas input heat capacity threshold of 3.0 MMBtu/hr to determine whether or not a MSW landfill may not be able to sustain an enclosed flare, operating on a continuous basis, without the need for supplemental fuel. If the landfill gas heat input capacity is less than 3.0 MMBtu/hr and the MSW landfill is active, the landfill gas heat input capacity is recalculated annually until it is determined to be either greater than or equal to 3.0 MMBtu/hr or the landfill closes and ceases to accept waste. If the MSW landfill is closed or inactive and the landfill gas heat input capacity is less than 3.0 MMBtu/hr, a gas collection and control system is not required and the requirements of the proposed regulation no longer apply.

If the landfill gas heat input capacity is greater than or equal to 3.0 MMBtu/hr, the owner or operator must either install a gas collection and control system, or demonstrate to the satisfaction of the Executive Officer that after four consecutive quarterly monitoring periods there is no leak at any location of the landfill surface that exceeds a methane concentration of 200 ppmv or greater. If the MSW landfill is active and there is no leak exceeding 200 ppmv, the owner or operator must recalculate the landfill gas heat input capacity annually until either the MSW landfill requires a gas collection system or closes and ceases to accept waste. If the MSW landfill is closed or inactive and there is no leak exceeding 200 ppmv, a gas collection and control system is not required and the owner or operator only needs to comply with limited reporting requirements.

MSW Landfills with Less Than 450,000 Tons of Waste-in-Place

Active MSW landfills having less than 450,000 tons of waste-in-place are exempt from the substantive requirements of the proposed regulation but the owner or operator must comply with limited reporting requirements. These landfills currently do not generate sufficient gas to support a gas collection and control system. Active MSW landfills must submit a Waste-in-Place Report annually until either the landfill size threshold is exceeded, or the landfill closes. This allows ARB to monitor when these landfills may become of sufficient size to support a gas collection and control system. Appendix B presents a flow chart showing the steps for determining whether the landfill must be controlled. Owners and operators of closed or inactive MSW landfills are exempt from the regulation.

4. Gas Collection and Control System Requirements (Section 95464)

The proposed regulation requires the installation of a properly designed gas collection and control system that minimizes methane emissions and the proper operation of that system. Carbon adsorption and passive systems are not considered to be appropriate systems since they do not reduce methane emissions. The proposed regulation requires a Design Plan to be prepared by a professional engineer registered with the State of California and submitted to the Executive Officer for approval.

The Design Plan details how the design of the collection system will handle the landfill's methane generation potential and maintain negative pressure at all wellheads, and when the collection system must be expanded. This wellhead pressure requirement, in conjunction with the surface methane emissions standards, helps to minimize groundwater impacts by ensuring that methane is routed through the gas collection system to a gas control device. It also specifies the gas control devices that will be used (e.g., an enclosed flare). The Design Plan must be submitted either within one year of the effective date of the proposed regulation, within one year after the determining that the landfill gas heat input capacity is greater than 3.0 MMBtu/hr, or within one year of measuring a leak on the landfill surface that exceeds 200 ppmv.

Any owner or operator of an active landfill subject to the proposed regulation must install an active gas collection and control system within 18 months after approval of the Design Plan. This allows sufficient time to obtain the necessary permits, and to procure and install the system. Closed or inactive MSW landfills, which do not directly generate revenue, are provided an additional 12 months for installation (for a total of 30 months) in order to obtain the necessary funds to comply. The proposed regulation includes a provision for amending the Design Plan to respond to changes in site conditions.

Flares are expected to be the most common control device selected by MSW landfill owners and operators to comply with the proposed regulation. If a flare is used as the control device, it must be an enclosed flare that meets a methane destruction efficiency of 99 percent or higher. Enclosed flares are more reliable (compared to open flares), efficient, and can be easily source tested to measure their destruction efficiency.

Open flares cannot be easily source tested and are not considered to be best available control technology. However, the proposed regulation allows the continued use of the five open flares currently operating in California until January 1, 2018. The continued operation past January 1, 2018, is allowed only if the owner or operator can demonstrate that the gas quality and flow rate is insufficient to support the continuous operation of an enclosed flare. Otherwise, the temporary use of an open flare is permitted only under limited conditions including during the repair or maintenance of the gas control system, or if necessary to remedy a situation where there is gas migrating offsite.

Gas control devices, except for open flares must be source tested annually. If the gas control device remains in compliance after three consecutive annual source tests, it may be tested every three years. Any subsequent tests showing that the control device is out of compliance will return the source testing frequency to annual.

The proposed regulation requires other gas control devices, such as gas turbines, boilers, and rich-burn engines, to meet a methane destruction efficiency of 99 percent or higher. However, lean-burn engines are allowed although they are only capable of achieving a methane destruction efficiency ranging from 87 to 95 percent. There are several older lean-burn engines currently operating in California, which are used for energy recovery. Requiring these engines to shut-down would result in a reduction of electrical generation capacity in the state. Based on the review of source test data, ARB staff determined that most lean-burn engines are able to meet a 3,000 ppmv outlet methane concentration limit (dry basis, corrected to 15 percent oxygen), which is acceptable for the purposes of the proposed regulation. This alternative standard ensures that the proposed regulation will not unnecessarily affect the State's electrical supply.

Landfill gas may also be routed to a treatment system that processes the collected gas for subsequent sale or use, or injected into the natural gas pipeline. However, all emissions that are vented to the atmosphere from an on-site gas treatment system must be routed to a control device, such as an enclosed flare.

5. <u>Surface Methane Emission Standards (Section 95465)</u>

The proposed regulation establishes a 500 ppmv instantaneous surface monitoring standard and a 25 ppmv integrated surface monitoring standard to ensure that the gas collection system is adequately controlling emissions. Instantaneous monitoring is used to identify fugitive emissions from cracks or fissures in the landfill surface. Integrated monitoring is a good indicator of how well the gas collection system is operating overall. Any difficulties in meeting an integrated monitoring standard would be an indicator of problems with the collection system.

A 500 ppmv instantaneous standard is present in federal and local air district regulations for non-methane organic compounds. ARB staff believes that this is an appropriate and attainable standard for methane. The integrated standard is modeled after South Coast Air Quality Management District (SCAQMD) Rule 1150.1. Although the SCAQMD rule requires an integrated surface standard of 50 ppmv (for non-methane organic compounds), ARB staff reviewed historical compliance data which indicated that very few landfills would not be able to meet a 25 ppmv integrated surface methane standard using current operating practices. Given that that these standards will be new for many California landfills and more stringent for some, the proposed regulation begins implementation on January 1, 2011. ARB staff believes this effective date allows sufficient time for landfill owners and operators to make the necessary system adjustments and improvements, establish monitoring protocols and procedures, purchase monitoring equipment, train staff, and develop recordkeeping and reporting systems. Landfills required to install new gas collection and control systems are required to meet these standards upon commencing system operation. It should be noted that landfills that are currently subject to local or federal landfill rules will need to continue to ensure compliance with the 500 ppmv instantaneous standard.

6. Alternative Compliance Options (Section 95468)

Landfills are dynamic sources and there are a number of site-specific factors involved in the design and operation of gas collection and control systems. Accordingly, there may be some very limited cases where alternatives to test methods, monitoring requirements, and operational requirements may warrant consideration. Therefore, the proposed regulation contains a provision that allows owners and operators to request such alternatives, subject to approval of the Executive Officer. Owners and operators will need to demonstrate why consideration of an alternative is necessary in order to comply with the proposed regulation. Any requested alternatives that do not provide equivalent levels of methane emission control or enforceability will not be approved.

7. Monitoring Requirements and Test Procedures (Sections 95469 and 95471)

Surface Emissions Monitoring

The proposed regulation specifies procedures for conducting instantaneous and integrated surface monitoring. In both cases, the landfill is divided into individually identified 50,000 square foot grid patterns. This allows for better identification and tracking of any surface leaks or problem areas. Monitoring is performed quarterly using a portable hydrocarbon detector, such as an organic vapor analyzer or a toxic vapor analyzer set in flame ionization detector mode. The walking pattern must be no more than a 25-foot spacing interval and must traverse each monitoring grid. Landfill owners and operators are given three opportunities to repair or remediate any leaks before it constitutes a violation.

The proposed regulation provides an incentive for establishing a history of compliance with the surface emission standards. If the landfill owner or operator has no exceedances of the surface methane emission standards after four consecutive quarterly monitoring periods, the monitoring procedures provide an incentive which allows the walking pattern spacing to be increased to 100-foot intervals. Additionally, closed and inactive landfills can also increase their sampling period from quarterly to annually. The increased spacing and sampling period can continue to be used as long as the landfill remains in compliance with the surface methane emission standards.

Landfill owners or operators of closed or inactive MSW landfills, or any closed or inactive areas on an active MSW landfills, have an additional incentive for early compliance. To qualify for this incentive, the landfill must demonstrate that in the past three years prior to the effective date of the proposed regulation that there were no measured exceedances of the surface methane emission standards by annual or quarterly monitoring. If a successful demonstration is made, the landfill owner or operator may monitor compliance with the surface methane emissions standards annually and may increase the walking pattern spacing from 25-foot to 100-foot intervals. The increased spacing and sampling period can continue to be used as long as the landfill remains in compliance with the surface methane emission standards.

Gas Control System Equipment Monitoring

The proposed regulation contains a component leak standard of 500 ppmv. The purpose of the component leak testing requirement is to ensure that there are no point sources along the positive pressure side of gas transfer path with methane concentrations exceeding 500 ppmv. Landfills are required to conduct this monitoring on a quarterly basis. Additionally, the proposed regulation specifies monitoring parameters for gas control devices such as flares to ensure that these devices are operating optimally and meeting the destruction efficiency standards.

Wellhead Monitoring

Monthly well monitoring is required to demonstrate that the gas extraction rate for an active gas collection system is sufficient. A negative pressure must be maintained at each wellhead, except under certain conditions (for example a landfill subsurface fire, fire prevention, repair of the gas collection system, or construction activities). If a positive pressure is measured, the owner or operator must initiate corrective action, including, but not limited to, any necessary expansion of the gas collection system. Any expansion of the gas collection system must be completed and all new wells operating within 120 days of the date the positive pressure was measured.

8. Recordkeeping and Reporting Requirements (Section 95470)

In order to assure and monitor compliance with the requirements of the proposed regulation, landfill owners and operators are subject to recordkeeping and reporting requirements. These requirements include maintaining records of a landfill's waste acceptance rate, instantaneous and integrating surfacing sampling, component leak checks, equipment downtime, gas flow rates, and control device destruction efficiency testing. Most records are required to be kept for a five-year period; however, control device records must be maintained for the life of the control device. Some of these recordkeeping items are required to be included in the annual report, which must be submitted annually and cover the period of January 1 through December 31 of each year. Additionally, there are some specific reports that need to be submitted under specific conditions, such as a waste-in-place report for landfills with under 450,000 tons of waste-in-place or a closure notification report for landfills that are ceasing waste acceptance and closing. Finally, an equipment removal report is required when a landfill is seeking to decommission the gas collection and control system.

9. Definitions (Section 95476)

To ensure common understanding and improve enforceability of the regulation this section provides definitions that are similar to those currently being used in existing rules and regulations pertaining to emissions from MSW landfills.

B. Implementation and Enforcement of the Proposed Regulation

The local air districts currently implement and enforce rules related to the control of toxics and NMOCs from landfills and, pursuant to the Health and Safety Code, are the primary implementation and enforcement agency for airborne toxic control measures adopted by ARB. The proposed regulation is developed pursuant to AB 32, which does not explicitly provide for local air district implementation and enforcement. Therefore, the proposed regulation reflects ARB's role as primary monitor and enforcer of regulations adopted under AB 32. However, ARB staff is exploring mechanisms by which local air districts can participate as partners in monitoring compliance with and enforcing the proposed regulation. ARB staff believes local air district participation is critical to assure compliance with the proposed regulation, to help ARB attain GHG emission reduction goals, to reduce the cost of implementing the proposed regulation, and to reduce governmental redundancy. In addition, local air districts are familiar with landfill operations and currently issue permits and inspect landfills and related landfill gas and emissions control equipment.

One potential mechanism may be an agreement between a local air district and ARB in which the local air district assists ARB with monitoring compliance with and enforcing the proposed regulation. Under this approach, an air district's ability to recover its costs associated with implementation and enforcement may be an issue. Accordingly, the proposed regulation allows ARB to consider such agreements and includes a provision (Section 95473) that requires the owner or operator to pay any fees assessed by the local air district pursuant to any such agreement. Another mechanism may be for ARB to work with interested local air districts on their adoption of an equivalent or more stringent local rule that meets the requirements of the proposed regulation. Under this latter approach, ARB anticipates that a local air district would most likely be able to use their existing fee and permitting authority to appropriately address any cost recovery issues. These or any other mechanism considered would be structured to ensure that ARB retains the necessary authority to monitor and enforce the regulations, which will also be evidenced by ARB's maintained authority to directly implement and enforce the proposed regulation as ARB deems necessary. In addition, this statewide regulation will constitute the regulatory floor.

C. Alternatives Considered

California Government Code section 11346.2 requires ARB to consider and evaluate reasonable alternatives to the proposed regulation. Staff evaluated five key alternatives to the proposed regulation to minimize methane emissions from MSW landfills.

1. No Action

A "no action" alternative would forego the adoption of the proposed regulation. This alternative was rejected as it would result in failure to make progress in reducing emissions of methane, a GHG with a high global warming potential, from MSW landfills.

2. Instantaneous Surface Methane Standard of 200 ppmv

ARB staff had initially proposed establishing an instantaneous surface methane standard of 200 ppmv (compared to the 500 ppmv standard in federal and local air district rules). However, stakeholders expressed the concern that a 200 ppmv surface methane emission limit may cause landfill fires and decrease the ability to meet federal wellhead monitoring limits for oxygen and nitrogen. Additionally, CIWMB's landfill fire expert also expressed a concern about potential landfill fires (CIWMB, 2008). This potential exists as it is possible for landfill operators to potentially "overdraw" their gas collection and control systems thereby introducing excess amounts of oxygen into the landfill.

Given that current regulations only require reporting of exceedances above a 500 ppmv instantaneous surface standard, no data was available to ascertain at what level a landfill fire would result. Therefore, given the catastrophic nature of a landfill fire, the instantaneous surface limit was set at 500 ppmv. However, the proposed regulation requires reporting of instantaneous readings of 200 ppmv and greater in an effort to collect additional data to help ARB staff understand at what level landfill fires may become a concern.

3. Phase-in of the Integrated Surface Sampling Standard

Some stakeholders commented that ARB staff's proposed 25 ppmv integrated surface sampling standard was new in the industry. The indicated preference was to use 50 ppmv and implement a data collection scheme and use that information to phase-in a lower standard at some point in the future. Based on the compliance data obtained from SCAQMD (SCAQMD, 2007), ARB staff believes that a 25 ppmv standard is feasible. However, it is reasonable to expect that some landfills will require some time to make the necessary adjustments to their gas collection and control systems and operational practices, as appropriate. Therefore, the proposed regulation maintains the 25 ppmv standard but begins compliance with this standard until January 1, 2011 (about one year after the effective date of the proposed regulation).

4. Wellhead Methane Concentration

Some stakeholders expressed the belief that wells under vacuum and having a methane concentration of 55 percent or less are good indicators of high landfill gas collection efficiency. Other stakeholders indicated that wellhead methane concentrations can and do vary somewhat over 55 percent and that such a limit was only critical to those landfills with landfill gas-to-energy projects and would otherwise be difficult to maintain. ARB staff concurs with this assessment and recognizes the importance of increased management of wellhead methane concentrations for these landfills. As a compromise, a requirement to maintain wells under a vacuum (as appropriate) was added. This requirement helps ensure that the gas collection and control system is operating efficiently and helps the landfill to comply with the surface emission standards. It may also help minimize methane levels in groundwater.

5. Extended Time to Install Gas Collection and Control Systems at Closed and Inactive MSW Landfills

A few comments from stakeholders were received stating that at least a five-year period would be needed for closed or inactive landfills to obtain the necessary funding to install a gas collection and control system, if required. ARB staff recognizes the challenges in securing the necessary funds to comply but also is mindful of methane's high global warming potential and the need for timely action. As a compromise, the time period for installing controls at closed or inactive MSW landfills was revised from 18 months to 30 months. ARB staff believes that the additional year will provide sufficient time to secure the necessary funds while still enabling ARB to meet its GHG reduction goals.

D. Public Outreach

In complex rulemaking, the Administrative Procedures Act (Government Code section 11340 *et seq.*) requires ARB to involve potentially regulated parties before publishing its notice of proposed rulemaking. Staff has made extensive efforts to provide opportunities for participation in the rulemaking process. Staff's public outreach efforts included meetings with stakeholders through a series of technical workgroup meetings and public workshops. These groups included representatives from the solid waste industry, local air districts, local enforcement agencies, CIWMB, U.S. EPA, environmental organizations, and other interested parties.

Staff's outreach activities included the following:

- Formed the Landfill Technical Review Workgroup and conducted seven workgroup conference calls/meetings with group members;
- Held three public workshops;
- Made extensive personal contacts with industry representatives and other interested parties through meetings, telephone calls, emails, and mail-outs;
- Created a website and maintained an email address list to automatically update interested parties about rulemaking developments;

- Mailed workshop notices and posted workshop materials on the website; and
- Conducted seven site visits to landfills to observe landfill operations and demonstrations of emerging landfill technologies.

VI. ENVIRONMENTAL IMPACTS

A. Introduction

The proposed measure is intended to reduce the impact of GHG on the environment by reducing methane emissions from landfills. This chapter describes the potential impacts of the proposed measure on air, water, energy, noise, and vegetation. Based on available information, ARB staff has determined that no significant adverse environmental impacts should occur as a result of adopting the proposed regulation.

B. Legal Requirements

The California Environmental Quality Act (CEQA) and ARB policy require an analysis to determine the potential environmental impacts of proposed regulations. Because ARB's program involving the adoption of regulations has been certified by the Secretary of Resources pursuant to Public Resources Code section 21080.5, the CEQA environmental analysis requirements may be included in the Initial Statement of Reasons (ISOR) for this rulemaking. In the ISOR, ARB must include a “functionally equivalent” document, rather than adhering to the format described in CEQA of an Initial Study, a Negative Declaration, and an Environmental Impact Report. In addition, staff will respond, in the Final Statement of Reasons for the proposed regulation, to all significant environmental issues raised by the public during the public review period or at the Board public hearing.

Public Resources Code section 21159 requires that the environmental impact analysis conducted by ARB include the following:

- An analysis of reasonably foreseeable environmental impacts of the methods of compliance;
- An analysis of reasonably foreseeable feasible mitigation measures (CEQA requires an agency to identify and adopt feasible mitigation measures that would minimize any significant adverse environmental impacts); and
- An analysis of reasonably foreseeable alternative means of compliance with the proposed regulation.

ARB staff’s analysis of these requirements is presented below. We have concluded that the proposed regulation is needed to reduce methane emissions from MSW landfills pursuant to AB 32 (California Global Warming Solutions Act), and to fulfill the goals of the ARB’s landfill methane capture strategy adopted by the Board in June 2007. We have also concluded that implementation of the proposed measure will have no significant adverse environmental consequences requiring mitigation and that there are no alternative means of compliance with the requirements of AB 32 that would achieve similar methane reductions at a lower cost.

C. Potential Environmental Impacts

1. Air Quality

The combustion of landfill gas, like any other similar process, generates pollutants. Control devices such as engines, flares, gas turbines, and other combustion-based technologies produce, in addition to CO_2 and water, other combustion products which can potentially be detrimental to the environment. Chapter IV discusses the GHG reductions that are expected to results from the implementation of the proposed regulation. However, the implementation of the proposed regulation is not expected to increase criteria pollutant emissions such as NO_x and CO for the currently 14 uncontrolled landfills that may require controls. Energy recovery systems such as IC engines may slightly increase criteria pollutants when compared to flaring the gas. However, staff is not anticipating the installation of energy recovery systems at any of the 14 uncontrolled landfill due to the high cost of installing such systems compared to an enclosed flare. Accordingly, any increases in criteria pollution emissions are expected to be insignificant.

Measurable amounts of toxic compounds (or NMOCs) can be found in landfill gas at some sites. Under California's landfill gas testing program (Health and Safety Code section 41805.5), MSW landfills were tested for 10 toxic compounds: vinyl chloride, benzene, ethylene dibromide, ethylene dichloride, methylene chloride, perchloroethylene, carbon tetrachloride, methyl chloroform, trichloroethylene, and chloroform, to determine if these compounds were being emitted into the air. Analysis of the test results by ARB indicated that the toxic composition of landfill gas is highly site-specific. Gas collection systems with flares or other combustion devices are currently the best means of reducing methane (a potent greenhouse gas) and the potential risk to surrounding populations posed by emissions of toxic air contaminants contained in landfill gas. The proposed regulation is expected to reduce emissions of these toxic compounds because the control technologies for both toxics and GHGs from MSW landfills are complementary. Table VI-1 shows the potential NMOC reductions than are expected with implementation of the proposed regulation.

Table VI-1. NMOC Reductions for California Landfills

	NMOC Emission Reductions (Tons)		
Year	**2011**	**2015**	**2020**
Total	13,700	21,300	22,800

Local air district permitting requirements for new or modified sources such as landfill gas control devices vary. Each, however, includes a control technology requirement and a mitigation requirement for the residual emissions after control. Some districts provide exemptions from the mitigation requirements for required air pollution control technology while others do not have this exemption. Any increase in the generation of criteria pollutants as a result of landfill gas combustion will need to be evaluated by each local air district to ensure that State and national ambient air quality standards are maintained in their respective air basins. This potential increase in criteria pollutant emissions is a potential concern when landfill gas-to-energy projects are being considered. Depending on a local air district's non-attainment status and their specific local requirements, emission control devices and/or offsets may be required before a permit can be issued.

2. <u>Water Quality</u>

The main impact on water quality associated with gas collection systems is the generation of leachate (also referred to as "condensate") from landfill gas. Standard practice in the past was to return the collected leachate to the waste. However, this practice is currently prohibited by the Regional Water Quality Control Boards (RWQCB). The current practice is to store the collected leachate in double-walled tanks which can be periodically pumped out. The collected leachate is then transported to a disposal facility. This practice significantly mitigates the potentially adverse environmental impact of leachate disposal.

Unlike modern landfills, very few older landfills had liners and leachate removal systems to prevent the leachate from moving out of the landfill. Gas may migrate from an uncontrolled landfill in such a manner as to contaminate the groundwater. In such a case, RWQCB may require the installation of a gas collection system as part of the remedial action. Modern landfills are equipped with liners and leachate removal systems to prevent contamination to the groundwater. The proposed regulation contains a provision to ensure that wellheads are maintained under a vacuum. This requirement, in conjunction with the surface methane emissions standards, helps ensure that methane is routed through the gas collection system to a gas control device. Therefore, the proposed regulation is not expected to have an impact on the effectiveness of liners or the operation of leachate removal systems and, in some cases, may help reduce the methane levels in groundwater.

3. <u>Energy</u>

Landfill gas collection systems without energy recovery devices (e.g., boilers or engines) require energy to run the blowers and pumps. The power requirements of a gas collection and control system installed at the 14 uncontrolled landfills (out of a total 218 affected) is not expected to place an undue burden on existing electrical generation or distribution capacities.

4. <u>Noise</u>

Major noise associated with gas collection systems are from blowers used to extract gas from the site. Most landfills are located in remote areas away from sensitive receptors. However, if surrounding populations are near a site, blowers, engines and other such equipment are typically located in the remote areas of the site to mitigate noise impacts. If this is not feasible, the equipment can be enclosed in a building or surrounded by a retaining wall to effectively mitigate noise impacts. The proposed regulation requires the installation of blowers as part of gas collection control systems for those landfills with 450,000 tons or more of waste-in-place that do have these systems. Given the options to mitigate noise and the remoteness of the uncontrolled landfills, compliance with the proposed regulation is not expected to present any additional noise concerns.

5. Vegetation

In areas where wells, trenches, pumps, and other gas collection system components are installed, the vegetation is disturbed. After installation, landfills typically replace the disturbed vegetation. In general, the net effect on on-site vegetation is expected be positive due to the reduction in the amount of landfill gas seeping through the cover into the root zone. High CO_2 and methane concentrations and low oxygen levels can be injurious to many types of vegetation.

D. Reasonably Foreseeable Feasible Mitigation Measures

ARB staff has concluded that no adverse environmental impacts should occur from adoption of and compliance with the proposed regulation. Therefore, no further mitigation would be necessary. Reducing methane emissions from MSW landfills will also remove NMOCs that would have otherwise been emitted. The potential benefits of the proposed regulation on reducing gas migration, odors, and water quality impacts have not been quantified.

E. Reasonably Foreseeable Alternative Means of Compliance

Alternatives to the proposed regulation have been discussed earlier in Chapter V of this Staff Report. ARB staff has concluded that there are no alternative means of compliance with the requirements of AB 32 that will achieve similar methane emission reductions at a lower cost. Therefore, staff has determined that no alternative to the proposed regulation would be more effective and none would be as effective less burdensome to affected private persons.

Alternatives to not complying with the regulations would result in potential methane emissions to the atmosphere. As previously stated, methane is a major contributor to global climate change having a global warming potential 21 times that of CO_2. Instead, methane can be combusted and converted to CO_2 and water, or it could be used as a source of auxiliary power generation for neighboring facilities, which could potentially reduce costs and air toxics from the extra power usage if the landfill gas is not harnessed.

F. Environmental Justice and Community Health

1. <u>Environmental Justice</u>

Environmental justice is defined as the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies. ARB is committed to integrating environmental justice into all of our activities. On December 13, 2001, the Board approved “Policies and Actions for Environmental Justice,” which formally established a framework for integration of environmental justice into ARB’s programs, consistent with the directive of California state law. These policies apply to all communities in California, however, environmental justice issues have been raised specifically in the context of low-income areas and ethnically diverse communities (ARB, 2001a).

Our environmental justice policies are intended to promote the fair treatment of all Californians and cover the full spectrum of ARB’s activities. Underlying these policies is a recognition that the agency needs to engage community members in a meaningful way as it carries out its activities. ARB recognizes its obligation to work closely with all communities, environmental organizations, industry, business owners, other agencies, and all other interested parties to successfully implement these policies.

The proposed regulation is consistent with our environmental justice policy to reduce health risk in all communities, including those with low-income and ethnically diverse populations, regardless of location. Potential risks from global warming due to GHGs can affect both urban and rural communities. Therefore, reducing emissions of GHGs from landfill operations will provide benefits to both urban and rural communities in the State, including low-income and ethnically diverse communities. The decrease in GHG emissions will occur in areas where landfill operations are generally located, which is typically far from most residential areas.

2. <u>Potential Health Impacts</u>

Methane is not a toxic air contaminant; however, toxic air contaminants such as vinyl chloride, benzene, ethylene dibromide, ethylene dichloride, methylene chloride, perchloroethylene, and trichloroethylene are present in landfill gas. By installing gas collection and control systems at MSW landfills that are currently uncontrolled, toxic air contaminants contained in the landfill gas will also be reduced, thereby minimizing the public’s potential exposure to these compounds. Staff therefore concludes that public health will not be adversely affected by the proposed regulation. Compliance with the proposed regulation will not result in any adverse localized impacts.

VII. ECONOMIC IMPACTS

This chapter presents the economic impacts associated with implementation of the proposed regulation. Capital and recurring costs are presented for both private landfills (businesses) and landfills owned/operated by government agencies, including cities and counties. Some landfills owned by government agencies, usually the smaller landfills, are operated under contract by businesses; however, the responsibility for regulatory compliance is still borne by the government entity.

ARB staff has quantified the economic impacts to the extent feasible, but forward-looking estimates such as this one are subject to uncertainty, being based on unpredictable future compliance behavior and actions. In addition, due to the many site-specific factors (as well as their complex interaction) influencing landfill gas collection and control system design and costs, a comprehensive cost analysis of each affected landfill was not feasible. The cost estimates are based on average or typical costs for the actions necessary to comply with the proposed regulation. It is acknowledged that the actual costs to an affected landfill may be lower or higher than estimated, but the total cost to all affected landfills is expected to be consistent with the stated estimates.

The individual landfill compliance threshold trigger dates stated in this analysis are generated for cost estimation purposes only and are not intended to indicate actual compliance dates. Actual compliance dates and actions for individual landfills should be determined by the methods specified in the proposed regulation.

This analysis assumes the scenario where the use of enclosed flare technology is solely used for compliance. Many existing landfills, especially the larger ones, successfully employ various alternative technologies to use the captured landfill gas to generate energy for use at the landfill or for other purposes. Due to the specialized nature and objectives of these alternative technology projects, no attempt was made to either include these projects in the cost analysis or predict the future rate at which landfill operators may choose this compliance option. To the extent that these projects produce a profit, compliance costs may be reduced for those landfills.

A. Summary

Staff estimates that the total cost of the proposed regulation to affected privately owned and/or operated landfills (businesses) would be approximately 110 million dollars over the 23-year analysis period (assumed lifetime of the regulation) used (i.e., from 2010 to 2033). A majority of the affected landfills are owned and/or operated by government agencies (local, State, and Federal), and these landfills are expected to incur the majority of the cost of the proposed regulation. Estimated costs for the government agency landfills would be approximately 225 million dollars over the previously mentioned analysis period. Costs for ARB enforcement and outreach efforts are expected to be within the range of $25,000 to 1.2 million dollars annually over the analysis period. A small number (less than six) of affected landfills are owned and/or operated by school districts or universities, based on landfill registration data. Thus, no significant impacts to school districts or universities are expected.

The cost-effectiveness is estimated to be approximately $9 per metric ton of carbon dioxide equivalents reduced (average). The total cost of the regulation spread over all California households is estimated at about 10 cents per month (average) over the lifetime of the regulation.

B. Legal Requirements

Section 11346.3 of the Government Code requires State agencies to assess the potential for adverse economic impacts on California business enterprises and individuals when proposing to adopt or amend any administrative regulation. The assessment shall include a consideration of the impact of the proposed regulation on California's jobs, business expansion, elimination or creation, and the ability of California businesses to compete with businesses in other states.

Also, State agencies are required to estimate the cost or savings to any State or local agency and school district in accordance with instructions adopted by the Department of Finance. The estimate shall include any non-discretionary cost or savings to local agencies and the cost or savings in federal funding to the State.

Health and Safety Code section 57005 requires ARB to perform an economic impact analysis of submitted alternatives to a proposed regulation before adopting any major regulation. A major regulation is defined as a regulation that will have a potential cost to California business enterprises in an amount exceeding $10 million in any single year. Although the estimated cost of the regulation to California businesses alone does not exceed $10 million in a single year, given that the annual cost to both businesses and government agencies is expected to exceed $10 million in a single year and the total cost of the regulation is estimated at approximately $335 million, the proposed regulation is being considered a major regulation (ARB, 2009a).

The proposed rulemaking does not constitute a reimbursable mandate because the proposed regulation applies to all entities that own/operate the affected landfills in the state and does not impose unique requirements on local agencies (County of Los Angeles vs. State of California, 43Cal 3d 46 [Jan 1987]).

C. Economic Impact Analysis

This analysis is performed in the year 2009 and all costs are given in 2008 dollars (unless otherwise noted). Where future costs are mentioned, they have been adjusted to 2008 dollars using standard accepted economic analysis procedures. A real interest rate of 5 percent (a 7 percent nominal rate minus an assumed 2 percent inflation rate) is used throughout this analysis, unless otherwise noted.

Initial (or capital) costs, as discussed in this report, are the up-front costs of a compliance expenditure. The initial costs are expressed as a uniform series of payments over the assumed useful life (15 years) of the gas control system (and gas collection system, if applicable), using a real interest rate of 5 percent. The interest rate for capitalization is assumed to reflect the current borrowing costs to affected businesses.

The costs to businesses and government agencies are discussed in separate sections below; the total cost discussion at the end of this chapter includes the costs to both types of landfill owner/operators as well as a discussion of the cost-effectiveness of the proposed regulation. Additional information regarding the analysis is provided in Appendix F.

Analysis Approach

This analysis is intended to estimate the incremental costs associated with the compliance requirements of the proposed regulation. Incremental costs are the increase or decrease in baseline costs (i.e., the normal cost of doing business without the imposition of the regulation's requirements) due to actions that must be taken for compliance.

Analysis Period Selection

Since the majority of the capital expenditures by directly-affected businesses will likely occur after the mandated analysis period, the analysis period has been expanded to the year 2033. The analysis period of 2010 to 2033 was selected based on the effective date of the proposed regulation (2010), with the last of the affected businesses initiating compliance action by the year 2018; a 15-year amortization period for these businesses extends to the year 2033.

Affected Landfill Inventory

CIWMB tracks landfill operations in the State through their Solid Waste Information System (SWIS). With the assistance of CIWMB staff, 367 landfills were identified as receiving municipal solid waste, one of the applicability criteria of the proposed regulation. Of these 367 landfills, 149 were not affected by the proposed regulation due to not having received municipal solid waste on or after January 1, 1977 or had an operational status of closed or inactive by the year 2010 (the effective date of the proposed regulation). While review of the landfill inventory revealed tribal government-owned/operated landfills, none are expected to be affected by the proposed regulation. The ownership status of the remaining 218 landfills is summarized in Table VII-1 (next page).

Table VII-1. Ownership Status of Affected Landfills

Status	Number of Landfills	Expected Compliance Action
Private	60	Reporting Only[1] - 11 Controls/Monitoring[2] - 49
Government (all) (total)	158	Reporting Only - 61 Controls/Monitoring - 97
Government (subtotals):		
- Local	141	Reporting Only - 47 Controls/Monitoring - 94
- State	2	Reporting Only - 1 Controls/Monitoring - 1
- Federal	6	Reporting Only - 6 Controls/Monitoring - 0
- Military	9	Reporting Only - 7 Controls/Monitoring - 2

1. Landfills that are expected to be subject to reporting requirements only.
2. Landfills that are expected to be subject to control and/or monitoring and reporting requirements.

<u>Determination of Small and Typical Business Size</u>

Commonly, a business revenue threshold (typically selected after analysis of industry-specific financial data) has been employed to determine small businesses for the purpose of these analyses. However, given that many business-owned and/or operated landfills are privately held, the revenue data needed to determine if a landfill can be considered a small business are unavailable.

In addition, with the majority of the affected landfills being owned/operated by government agencies, normal small business revenue thresholds are not applicable. This requires the use of known landfill qualities other than revenue to determine small and typical business classifications.

One known quality for all affected landfills is the amount of waste-in-place (WIP), an indicator of the past (and for open landfills, current) revenue stream for a landfill. The waste-in-place figure is used in the proposed regulation as one of the two criteria for determining whether a landfill will need to perform monitoring and possibly install collection and control systems, a significant cost threshold.

The second criterion used for small business determination is the operational status of a landfill. Open landfills and active landfills receive tipping fees and other sources of revenue which can help pay for regulatory compliance costs; closed or inactive landfills lack this revenue stream and, especially for smaller landfills (likely owned by smaller businesses), would have a lowered ability to pay for compliance costs. Another consideration is the methane emissions-generating potential of a landfill; smaller landfills (those with less than 450,000 tons of waste-in-place) as a group, are not expected to generate sufficient methane to make operation of a control device (assumed to be an enclosed flare) feasible.

For the purposes of this analysis, the 450,000 tons of waste-in-place threshold and the operational status were used to determine the small business threshold. Closed or inactive status (as of the year 2010) with less than 450,000 tons of waste-in-place are considered small businesses and are exempt from the proposed regulation. Typical businesses are considered those landfills subject to reporting requirements only (open or active status, with less than 450,000 tons of waste-in-place) or subject to the monitoring, control, and reporting requirements as described in the proposed regulation.

1. Business Impacts/Competitiveness Discussion

The majority of the affected landfills are owned and/or operated by government agencies at the local, State, or Federal level. Due to the longer compliance lead-time for closed landfills, as well as the opportunity to delay control system installation through improved landfill surface maintenance and available funding mechanisms, ARB staff believes that most, if not all, of these agencies, as well as affected private businesses, will be able to meet the proposed regulation's compliance costs. However, it is possible that a small number of businesses (those with marginal profitability) may experience financial difficulty in complying with the proposed regulation.

It is expected that businesses will pass on compliance costs to private individuals and households through increased waste disposal costs. To the extent that compliance costs cannot be passed on to private individuals, costs will have to be absorbed. Government agencies may handle compliance costs through any or a combination of the following methods: redirection of budget funds from other programs, issuance of bonds, regulatory compliance surcharges or assessments, and increased waste disposal fees.

Potential Employment Impact

The proposed regulatory action may lead to the creation of some businesses as well as the expansion of existing businesses. Businesses created include those that design, furnish, install, monitor, and maintain landfill gas collection and control systems, as well as those that provide alternative compliance strategies (including waste-to-energy technologies). Existing businesses that provide the aforementioned scope of services and products are likely to see an increase in business due to the requirements of the proposed regulation.

Potential Business Creation or Expansion

Staff believes that the proposed regulation may lead to the alteration of job duties within existing businesses, as well as a small increase in new jobs for a few businesses due to the creation of business opportunities as discussed in the previous paragraph. Staff believes that there will be little or no significant change in the total number of businesses or jobs.

The proposed regulatory action would not have a significant statewide adverse economic impact directly affecting businesses, including the ability of California businesses to compete with businesses in other states, or on representative private persons.

The proposed regulatory action is not expected to have an impact on small businesses. Small businesses (landfills with less than 450,000 tons of waste-in-place and closed or inactive status) are exempt from all compliance requirements of the proposed regulation.

2. Cost to Affected Businesses

There are 60 California landfills owned and/or operated by businesses that are expected to be affected by the proposed regulation. Of these 60 landfills, 11 are projected to be subject only to the waste-in-place and landfill gas heat input capacity reporting requirements. The remaining 49 landfills are expected to be subject to the reporting requirements as well as control and/or monitoring requirements.

The incremental cost of the proposed regulation (cost increases or savings resulting from a business' actions to comply with the regulatory requirements) was estimated for the affected landfills. Landfill compliance actions were divided into four categories for cost estimation and to compile the total costs. The four categories and the applicability of each to affected landfills are listed below in Table VII-2 (next page).

Table VII-2. Cost Categories and Applicability for Landfills (with > 450,000 Tons WIP and >= 3.0 MM Btu/hr)

Cost Category	Applicability
Capital (initial)	- Uncontrolled Landfills - Landfills w/ Open Flares[1]
Operation and Maintenance	- Uncontrolled Landfills - Landfills w/ Open Flares
Monitoring	- Controlled Landfills - Uncontrolled Landfills - Landfills w/ Open Flares
Reporting	- All Affected Landfills

1. Treated as a separate category because these landfills are required to install enclosed flares (with associated costs) by 2018.

For each affected landfill, costs were estimated in each of the four categories listed above and then summed on a per-landfill basis. These individual costs were then summed by landfill ownership status classification (see Table VII-2 for classifications; Table VII-4 for government agency costs) and also by landfill compliance action needed (Table VII-3).

Due to widely varying landfill characteristics influencing estimated compliance costs, even among similar-sized landfills, using the costs for a single landfill in a decision-making process can be misleading. Instead, ARB staff used the average of the costs for all landfills because we believe it provides a more reasonable estimate. Actual costs for any given landfill may be higher or lower than the estimate, but the overall cost is expected to be consistent with the stated estimates. The estimated costs for these landfills are summarized in Table VII-3.

Table VII-3. Estimated Costs to Affected Businesses[1]

Landfill Compliance Action	Capital (lump sum) (2008 $)	Annual Operation & Maintenance	Monitoring	Reporting	Total
Reporting Only	--	--	--	$10,100	$10,100
Controls/Monitoring	$8.1 million	$43 million	$60 million	$47,000	$111 million
Totals	**$8.1 million**	**$43 million**	**$60 million**	**$54,200**	**$111 million**

1. All numbers have been rounded.

3. Cost to Government Agencies

Costs to Local and Federal Government Agencies

The majority of the affected landfills are owned and/or operated by government agencies at the local, State, or federal level. The compliance requirements and deadlines are the same for both businesses and government agencies. For an explanation of the cost analysis methodology used, please see the discussion in the previous section, Cost to Affected Businesses. The estimated costs for the government agency owned/operated landfills are summarized in Table VII-4 (next page).

While local air pollution control districts are considered local or regional agencies, they do not own or operate landfills and would not incur landfill owner/operator compliance costs. However, to the degree that local air districts have an agreement with ARB to implement and enforce the proposed regulation, these districts would incur enforcement costs. Enforcement costs to local air districts are described in the next section, Costs to ARB and Local Air Districts.

Table VII-4. Cost to Affected Government Agencies[1]

Landfill Compliance Action	Capital (lump sum) (2008 $)	Annual Operation & Maintenance	Monitoring	Reporting	Total
Reporting Only--					
All Government (total)	--	--	--	$129,000	$129,000
- Local	--	--	--	$88,000	$88,000
- State	--	--	--	$3,800	$3,800
- Federal	--	--	--	$13,000	$13,000
- Tribal	--	--	--	0	0
- Military	--	--	--	$25,000	$25,000
Controls/Monitoring--					
All Government (total)	$19 million	$105 million	$101 million	$120,000	$225 million
- Local	$17 million	$96 million	$95 million	$120,000	$208 million
- State	0	0	$420,000	$130	$420,000
- Federal	0	0	0	0	0
- Military	$2.5 million	$8.7 million	$5.4 million	$3,300	$17 million
Totals (rounded)	**$19 million**	**$105 million**	**$101 million**	**$250,000**	**$225 million**

1. All numbers have been rounded. Total cost of the proposed regulation is approximately 335 million dollars over the lifetime of the proposed regulation (2010 to 2033).

Costs to ARB and Local Air Districts

Under the AB 32 guidelines and the proposed regulation language, ARB will have lead authority for enforcement and implementation of the regulatory requirements. This authority would include enforcement activities as well as review and approval of design plans (both initial and updates) submitted by the landfill owner/operators and quarterly monitoring reports. To an unknown degree, some or all of ARB's responsibilities may be delegated to the local air districts via an agreement between ARB and individual local air districts.

The ARB expects costs for enforcement and outreach efforts to be within the range of $25,000 to 1.2 million dollars annually over the analysis period. The variability in the cost range is due to the unknown degree to which local air districts will enter into agreements to implement and enforce the proposed regulation with ARB. The low end of the cost range assumes that all local air districts that currently have rules controlling landfill gas emissions (landfills in these districts are currently under district permits) will seek such an agreement. The high end of the cost range assumes that none of the local air districts enter into an agreement with ARB, and that all implementation and enforcement will be performed by ARB. ARB staff believes that the 20 local air districts known to have rules affecting landfill gas emissions are likely to enter into an agreement with ARB.

To the extent that local air districts enter into agreements with ARB, costs will be shifted from ARB to the districts. It is expected that the local air districts will fully recover their costs under the existing authority granted to them in the California Health and Safety Code, sections 40702, 40727.2(j), and 41512.5. Additionally, Section 95473 of the proposed regulation also provides a cost-recovery mechanism for local air districts to recover their costs.

Costs to Other State Agencies

State agencies that own or operate landfills are expected to incur costs in complying with the proposed regulation. Two landfills owned/operated by State agencies were identified; the landfill at the University of California at Davis is expected to be subject to reporting requirements only (starting in State fiscal year 2010-2011), with an annual compliance cost estimated at less than $300. The second landfill, which is owned/operated by California Polytechnic University at Pomona, is expected to incur ongoing monitoring costs of approximately $17,000 per year, with a one-time upfront cost of $48,000 for monitoring equipment. These costs would commence in the 2011-2012 State fiscal year.

4. Total Cost and Cost-Effectiveness of Proposed Regulation

Total Cost

The total cost to affected public agencies and to affected persons and businesses would be approximately 27 million dollars in initial capital costs with about 6.4 million to 14 million dollars in annual recurring costs (in 2008 dollars.) These costs correspond to 6.4 million to 16 million dollars annually over the 23-year life of the regulation, or a total cost of about 335 million dollars. These costs are summarized in the Table VII-5 (next page).

Table VII-5. Estimated Compliance Costs for All Affected Landfills

Landfill Compliance Status	Reporting Costs[1]	Capital Costs[2]	Operation and Maintenance Costs[3]	Monitoring Costs[4]
Landfills Subject to Reporting Requirements Only	$139,000	N/A	N/A	N/A
Landfills Having Existing Compliant Control Systems	$154,000	$2.4 million	$56 million	$151 million
Landfills Without Existing Compliant Control Systems	$15,000	$25 million	$92 million	$8.6 million
Totals	**$308,000**	**$27 million**	**$148 million**	**$160 million**

1. Costs to affected landfills to prepare and submit required WIP and Landfill Gas Heat Input Capacity reports.
2. Includes engineering, permitting, testing, purchase, installation, shipping, and other initial costs related to the set-up of a new gas collection and control system.
3. Recurring costs for the operation of a gas collection and control system; includes parts and materials, labor, utilities, taxes, and administration.
4. Monitoring costs include the purchase of monitoring and calibration equipment as well as labor for performing monitoring work as required in the proposed regulation.

Expressed as a per-California household figure, the total cost of the proposed regulation is about 10 cents per month per household over the analysis period. This figure was calculated by taking the total cost and dividing it by the number of households in California (the proposed regulation applies to all California landfills; it is assumed that waste from all California households goes to California landfills) over the 23-year analysis period. A constant figure of approximately 13 million California households (DOF, 2009) over the analysis period was used.

Cost-Effectiveness

Based on ARB staff's year 2020 forecast of landfill emissions, if all 14 of the uncontrolled landfills were to install gas collection and control systems for methane, there would be a reduction of about 0.4 million metric tons of carbon dioxide equivalents ($MMTCO_2E$). The implementation and enforcement of this proposed regulation for the remaining estimated 204 affected MSW landfills (including those with gas collections systems already installed) is expected to result in an additional estimated emission reduction of 1.1 $MMTCO_2E$. Overall, the proposed regulation will result in reductions of about 1.5 $MMTCO_2E$ in 2020.

The cost-effectiveness (the ratio of the regulation cost divided by the emission benefits) is one method of expressing the relative benefit of an air quality regulation. For this proposed regulation, the total cost of the regulation over the analysis period was divided by the statewide emission benefits (except for landfills located in SCAQMD) to calculate the cost effectiveness. As discussed in Chapter V, landfills in the SCAQMD are already subject to SCAQMD Rule 1150.1 which, although focused on toxics and not methane, has similar requirements as the proposed regulation; therefore minimal emission reduction benefits are expected from these landfills from compliance with the proposed regulation.

Landfills in the SCAQMD will still need to comply with the requirements of the proposed regulation. The associated costs for these landfills are included in the total cost of the proposed regulation. The cost-effectiveness is estimated to be approximately $9 per metric ton of carbon dioxide equivalent reduced.

VIII. ONGOING AND FUTURE ACTIVITIES

This following is a list of future and ongoing activities that will be pursued by ARB staff to further minimize methane emissions from MSW landfills.

A. Implementation Guidance Document

ARB staff will develop a guidance document to assist owners and operators in complying with the requirements of the proposed regulation. The document will discuss the process used to determine if a gas collection and control system needs to be installed, the compliance schedule, and will explain the monitoring, recordkeeping and reporting requirements. The document will include example report forms to assist owners and operators in meeting their reporting requirements and a Landfill Gas Tool to assist with the determination of a landfill's gas heat input capacities and methane generation rates.

B. Landfill Gas Tool

ARB staff is developing a Landfill Gas Tool to assist owners and operators in estimating their landfill's fugitive methane emissions, potential landfill gas generation rate, and landfill gas heat input capacity. The tool is similar to the tool used by the Local Government Operations Protocol for creating a GHG accounting and reporting standard for local government operations across the United States. The values used in the tool are consistent with those used in ARB's landfill emissions inventory methodology. A draft of this tool is currently available for public review and comment.

C. Improve Understanding of Landfill Emissions and Methane Gas Capture Efficiencies

In March 2006, the California Energy Commission (CEC) initiated a contract as part of the Public Interest Energy Research/CEC landfill methane study (CIWMB, 2007). The goal of this project is to make improvements to the CEC's existing GHG inventory for landfills and to develop a field-validated model that can be implemented on a site-specific basis for determining landfill methane emissions and assigned capture efficiencies. The study will look at different cover materials and configuration, seasonal climate variability, and microbial diurnal responses to assess how each parameter affects methane emissions from the surface. The project is expected to be completed by 2010. The results will be compared to that of similar effort being undertaken by the landfill industry which is using tunable diode laser technology to estimate the methane flux from the surface of a landfill. The results of this industry study are expected by 2010.

D. Future Regulatory Action

As discussed in the AB 32 Scoping Plan, ARB staff will work with CIWMB staff to investigate what regulatory actions can be taken to further reduce methane emissions in support of the proposed regulation. Such actions may include: specific requirements for gas collection system design, construction, timing, and operation; landfill unit and cell design and construction; waste placement methods; daily and intermediate cover materials and practices; use of compost or other biologically active materials in cover soils; and organic materials management.

IX. REFERENCES

ARB, 1990. Air Resources Board. Suggested Control Measure for Landfill Gas Emissions. Prepared by: California Air Pollution Control Officers Association Technical Review Group Landfill Gas Subcommittee. September 13, 1990.

ARB, 1998. Air Resources Board. Noncombustion Landfill Gas Control Technologies. March 1998.

ARB, 2008a. Air Resources Board. R. Crooks, S. Young, R. Green, and N. Stetson: (ARB, CIWMB, WMI) Notes on site visit to Lancaster Landfill to view optical remote sensing/radial plume mapping technology performed by Waste Management Inc. February 13, 2008.

ARB, 2008b. Air Resources Board. Scoping Plan Measure Development and Cost Analysis Template Attachment E.

ARB, 2008c. Air Resources Board. Climate Change Draft Scoping Plan Appendix C, Page 126.

ARB, 2009a. California Air Resources Board. Staff Report: Initial Statement of Reasons for Proposed Regulation to Reduce Greenhouse Gas Emissions From Semiconductor Operations. Sacramento, California. January 2009.

ARB, 2009b. Air Resources Board. California Greenhouse Gas Inventory Data http://www.arb.ca.gov/cc/inventory/data/tables/ghg_inventory_by_sector_2007-11-19.xls.

ATSDR, 2001. Agency for Toxic Substances and Disease Registry. Landfill Gas Primer – An Overview for Environmental Health Professionals, Chapter 5, Page 6. November 2001.

BAAQMD, 2007. Bay Area Air Quality Management District. Email correspondence between Carol Allen of BAAQMD and Renaldo Crooks of ARB on methane destruction efficiency data. October 19, 2007.

Bogner, 2007. (http://www.landfillsplus.com/): Summary for Policy Makers – Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. April-May 2007.

CCAR, 2008a. California Climate Action Registry. Landfill Project Reporting Protocol, Collecting and Destroying Methane from Landfills, Version 2.0. November 18, 2008.

CCAR, 2008b. California Climate Action Registry. Landfill Project Verification Protocol, Capturing and Destroying Methane from Landfills, Version 2.0. November 18, 2008.

CEC, 2006. Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2004. CEC Publication CEC-600-2006-013-SF. Available online: http://www.energy.ca.gov/2006publications/CEC-600-2006-013/CEC-600-2006-013 SF.PDF.

CIWMB, 2004. California Integrated Waste Management Board. Statewide Profile for the State of California, http://www.ciwmb.ca.gov/Profiles/Statewide/.

CIWMB, 2007a. G. Franco, California Energy Commission Public Interest Energy Research Program. Landfill Emissions Estimates, Climate Change Workshop. May 8, 2007.

CIWMB, 2007b. California Integrated Waste Management Board. Overview of Climate Change and Analysis of Potential Measures to Implement Greenhouse Gas Emission Reduction Strategies. CIWMB Strategic Policy Development Committee. May 8, 2007.

CIWMB, 2007c. California Integrated Waste Management Board. Scott Walker, Climate Action Team Climate Strategy Update Documentation. August 24, 2007.

CIWMB, 2007d. Solid Waste Characterization Database, California Integrated Waste Management Board, Sacramento. Accessed online, fall 2007 at: http://www.ciwmb.ca.gov/WasteChar/.

CIWMB, 2008. September 2008 e-mail from Todd Thalhammer of CIWMB to ARB on landfill fire risks at closed landfills.

CIWMB, 2009. California Integrated Waste Management Board Local Government Central Statewide Waste Generated, Diverted, and Disposed 1989-2006 Figures: www.ciwmb.ca.gov/LGCentral/Rates/Graphs/RateTable.htm.

DOF, 2009. State of California, Department of Finance, California Current Population Survey Report: March 2007. Sacramento, California. January 2009.

DTSC, 2002. Department of Toxic Substances Control Hazardous Waste Management Program. Hazardous Waste Loadchecking at Municipal Landfills and Transfer Stations, Management Memo #EO-90-001-MM. January 2002.

Environmental Sanitary Engineering Centre, 2003. Thiel, R., S. Purdy and R. Yazdani, Sardinia: “Case History of Exposed Geomembrane Cover for Bioreactor Landfill,” CISA.

Ford, 2009. April 21, 2009, e-mail correspondence from Leslie Ford, ARB to Jon Manji, ARB.

Huitric, 1995. Measuring Landfill Gas Collection Efficiency Using Surface Methane Concentrations. Solid Waste Management Department, Los Angeles County Sanitation Districts.

Imhoff, 2008. Quantifying Capture Efficiency of Gas Collection Systems with Gas Tracers. Department of Civil and Environmental Engineering, University of Delaware. April 24, 2008.

IPCC, 2006a. 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T., and Tanabe K. (eds). Volume 2, Chapter 2: Stationary Combustion: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf.

IPCC, 2006b. Intergovernmental Panel on Climate Change. GHG Inventories, Volume 5, Chapter 3, Annex 3A.1.

Judge, 2009. Personal Communication, Hardip Judge, ARB, to Jon Manji, ARB, April 7, 2009.

Landtec, 2004. WBS-100 Wellbore Seal Product Flyer, 850 South Via Lata, Suite 112, Colton, California 92324.

Locke, 2009a. April 7, 2009 e-mail correspondence from Tim Locke, John Zink Company, to Jon Manji, ARB.

Locke, 2009b. April 8, 2009 e-mail correspondence from Tim Locke, John Zink Company, to Jon Manji, ARB.

Murcal, 2009. SCAQMD Rule 1110.2 goes into effect on February 1, 2009: http://www.murphyswitch.com/murcal%20pages/scaqmd.html.

NRCS, 2007. Map of Average precipitation data for California, US Department of Agriculture National Resources Conservation Service's Geospatial Data Gateway, Accessed online, fall 2007, at: http://datagateway.nrcs.usda.gov/.

Ping, 2009. AERMOD In and Out Modeling Data. Performed at the California Air Resources Board by Ping Di.

SCAQMD, 2007. The 2000-2001 Rule 1150.1 quarterly reports in five boxes from the South Coast Air Quality Management District.

SCS, 2007a. SCS Engineers. Current MSW Industry Position and State of the Practice on LFG Destruction Efficiency in Flares, Turbines, and Engines. Presented to Solid Waste Industry for Climate Solutions (SWICS), July 2007, File No. 01198086.09, Task 1.

SCS, 2007b. SCS Engineers. Current MSW Industry Position and State-of-the Practice on LFG Collection Efficiency, Methane Oxidation, and Carbon Sequestration in Landfills. Presented to Solid Waste Industry for Climate Solutions (SWICS), July 2007, File No. 01198086.09, Task 1.

SCS, 2008. Technologies and Management Options for Reducing Greenhouse Gas Emissions From Landfills, SCS Engineers Contractor's Report to the California Integrated Waste Management Board. April, 2008.

USDL, 2009a. United States Department of Labor, Bureau of Labor Statistics. Occupational Employment Statistics. May 2007 Metropolitan and Nonmetropolitan Area Occupational Employment and Wage Estimates. Website Accessed, March 22, 2009: http://www.bls.gov/oes/2007/may/oes_41860.

USDL, 2009b. United States Department of Labor, Bureau of Labor Statistics. News Release: Employer Costs for Employee Compensation—December 2008. USDL: 09-0247. March 12, 2009.

U.S. EPA, 1991. Air Emissions from Municipal Solid Waste Landfills – Background Information for Proposed Standards and Guidelines, EPA-450/3-90-011. March 1991.

U.S. EPA, 1999. Municipal Solid Waste Landfills, Volume 1: Summary of the Requirements for the New Source Performance Standards and Emission Guidelines for Municipal Solid Waste Landfills, EPA-453R/96-004.

U.S. EPA, 2002. Solid Waste Management and Greenhouse Gases – A Life Cycle Assessment of Emissions and Sinks. 2nd Edition, May 2002. Exhibit 7.3 page 107. U. S. Environmental Protection Agency, EPA publication 530-R-02-006 at: http://www.epa.gov/climatechange/wycd/waste/SWMGHGreport.html.

U.S. EPA, 2007a. U.S. EPA Innovation Program. Innovative Air Monitoring at Landfills Using Optical Remote Sensing with Radial Plume Mapping.

U.S. EPA, 2007b. Municipal Solid Waste Characterization Reports (various years), U. S. Environmental Protection Agency. Accessed online, fall 2007, at: http://www.epa.gov/epawaste/inforesources/pubs/municipal_sw.htm.

U.S. EPA, 2008. AP-42 (5th Edition) Compilation of Air Pollutant Emission Factors, Volume 1, Chapter 2.4-1 Municipal Solid Waste Landfills.

U.S. EPA, 2009. Landfill Methane Outreach Program. LFG Energy Project Development Handbook, Chapter 4, Project Economics and Financing, pg. 4-3. Online publication: Website Accessed, March 23, 2009: http://epa.gov/lmop/res/pdf/pdh_chapter4.pdf.

URS, 2008. URS Corporation: Greenhouse Gas Mitigation: Landfill Gas and Industrial, Institutional and Commercial Boilers, Steam Generators and Process Heaters. Prepared for the Bay Area Air Quality Management District. April 2008.

Walker, 2007. Personal communication (Collection, Lat/Lon, and Control Data for Landfills) between Larry Hunsaker of CA Air Resources Board and Scott Walker, California Integrated Waste Management Board. Fall 2007.

Appendix A

Proposed Regulation to Reduce Methane Emissions from Municipal Solid Waste Landfills

PROPOSED REGULATION ORDER

Adopt new Article 4, Subarticle 6, Methane Emissions from Municipal Solid Waste Landfills, sections 95460 to 95476, title 17, California Code of Regulations, to read as follows:

Note: The entire text below is new language proposed to be added to the California Code of Regulations (CCR).

Subchapter 10: Climate Change
Article 4: Regulations to Achieve Greenhouse Gas Emission Reductions
Subarticle 6. Methane Emissions from Municipal Solid Waste Landfills

Methane Emissions from Municipal Solid Waste Landfills

§ 95460. Purpose

The purpose of this subarticle is to reduce methane emissions from municipal solid waste (MSW) landfills pursuant to the California Global Warming Solutions Act of 2006 (Health & Safety Code, Sections 38500 et. seq.).

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39003, 39500, 39600, and 39601, Health and Safety Code.

§ 95461. Applicability

This subarticle applies to all MSW landfills that received solid waste after January 1, 1977.

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39003, 39500, 39600, and 39601, Health and Safety Code.

§ 95462. Exemptions

(a) This subarticle does not apply to landfills that receive only hazardous waste, or are currently regulated under the Comprehensive Environmental Response, Compensation and Liability Act 42 U.S.C, Chapter 103 *(Promulgated 12/11/80; Amended 10/17/86).*

(b) This subarticle does not apply to landfills that receive only construction and demolition wastes or non-decomposable wastes.

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39003, 39500, 39600, and 39601, Health and Safety Code.

§ 95463. Determination for Installing a Gas Collection and Control System

(a) *Active MSW Landfills Less Than 450,000 Tons of Waste-in-Place:* Each owner or operator of an active MSW landfill having less than 450,000 tons of waste-in-place must submit a Waste-in-Place Report to the Executive Officer pursuant to section 95470(b)(4), within 90 days of the effective date of this subarticle.

(1) The Waste-in-Place report must be prepared for the period of January 1 through December 31 of each year. The report must be submitted to the Executive Officer by March 15 of the following year.

(2) The Waste-in-Place report must be submitted annually until either:

(A) The MSW landfill reaches a size greater than or equal to 450,000 tons of waste-in-place; or

(B) The owner or operator submits a Closure Notification pursuant to section 95470(b)(1).

(b) *MSW Landfills Greater Than or Equal to 450,000 Tons of Waste-in-Place:* Within 90 days of the effective date of this subarticle or upon reaching 450,000 tons of waste-in-place, each owner or operator of an MSW landfill having greater than or equal to 450,000 tons of waste-in-place must calculate the landfill gas heat input capacity pursuant to section 95471(b) and must submit a Landfill Gas Heat Input Capacity Report to the Executive Officer.

(1) If the calculated landfill gas heat input capacity is less than 3.0 million British thermal units per hour (MMBtu/hr) recovered, the owner or operator must:

(A) Recalculate the landfill gas heat input capacity annually using the procedures specified in section 95471(b).

(B) Submit an annual Landfill Gas Heat Input Capacity Report to the Executive Officer until either of the following conditions is met:

1. The calculated landfill gas heat input capacity is greater than or equal to 3.0 MMBtu/hr recovered, or

2. If the MSW landfill is active, the owner or operator submits a Closure Notification pursuant to section 95470(b)(1).

Submitting the Closure Notification fulfills the requirements of this subarticle. If the MSW landfill is *closed or inactive*, submittal of the Closure Notification is not required to fulfill the requirements of the subarticle.

(2) If the landfill gas heat input capacity is greater than or equal to 3.0 MMBtu/hr recovered the owner or operator must either:

(A) Comply with the requirements of sections 95464 through 95476, or

(B) Demonstrate to the satisfaction of the Executive Officer that after four consecutive quarterly monitoring periods there is no measured concentration of methane of 200 parts per million by volume (ppmv) or greater using the instantaneous surface monitoring procedures specified in sections 95471(c)(1) and 95471(c)(2). Based on the monitoring results, the owner or operator must do one of the following:

1. If there is any measured concentration of methane of 200 ppmv or greater from the surface of an active, inactive, or closed MSW landfill, comply with sections 95464 through 95476;

2. If there is no measured concentration of methane of 200 ppmv or greater from the surface of an active MSW landfill, comply with section 95463(b) and recalculate the landfill gas heat input capacity annually as required in section 95463(b) until such time the owner or operator submits a Closure Notification pursuant to section 95470(b)(1); or

3. If there is no measured concentration of methane of 200 ppmv or greater from the surface of a closed or inactive MSW landfill, the requirements of sections 95464 through 95470 no longer apply provided that the following information is submitted to and approved by the Executive Officer within 90 days:

a. A Waste-in-Place Report pursuant to section 95470(b)(4);

b. All instantaneous surface monitoring records.

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39003, 39500, 39600, and 39601, Health and Safety Code.

§ 95464. Gas Collection and Control System Requirements

(a) *Design Plan and Installation.*

(1) *Design Plan*: If a gas collection and control system which meets the requirements of either sections 95464(b)(1), 95464(b)(2) or 95464(b)(3) has not been installed, the owner or operator of a MSW landfill must submit a Design Plan to the Executive Officer within one year after the effective date of this subarticle, or within one year of detecting any leak on the landfill surface exceeding a methane concentration of 200 ppmv pursuant to section 95463(b)(2)(B). The Executive Officer must review and either approve or disapprove the Design Plan within 120 days. The Executive Officer may request that additional information be submitted as part of the review of the Design Plan. At a minimum, the Design Plan must meet the following requirements:

(A) The Design Plan must be prepared and certified by a professional engineer.

(B) The Design Plan must provide for the control of the collected gas through the use of a gas collection and control system meeting the requirements of either sections 95464(b)(1), 95464(b(2) or 95464(b)(3).

(D) The Design Plan must include any proposed alternatives to the requirements, test methods, procedures, compliance measures, monitoring, and recordkeeping or reporting requirements pursuant to section 95468.

(E) A description of potential mitigation measures to be used to prevent the release of methane or other pollutants into the atmosphere during the installation or preparation of wells, piping, or other equipment; during repairs or the temporary shutdown of gas collection system components; or, when solid waste is to be excavated and moved.

(F) For active MSW landfills, the design plan must identify areas of the landfill that are closed or inactive.

(G) Design the gas collection and control system to handle the expected gas generation flow rate from the entire area of the MSW landfill and to collect gas at an extraction rate to comply with the surface methane emission limits in section 95465 and component leak standard in section 95464(b)(1)(B). The expected gas generation flow rate from the MSW landfill must be calculated pursuant to section 95471(e).

1. Any areas of the landfill that contain asbestos-containing waste or non-decomposable solid waste may be excluded from collection provided that the owner or operator submits documentation to the Executive Officer containing the nature, date of deposition, location and amount of asbestos or non-decomposable solid waste deposited in the area. This documentation may be included as part of the Design Plan.

(H) As operating experience is gained and as site conditions change, the Design Plan may be revised, subject to the approval of the Executive Officer.

(2) Any owner or operator of an active MSW landfill must install and operate a gas collection and control system within 18 months after approval of the Design Plan.

(3) Any owner or operator of a closed or inactive MSW landfill must install and operate a gas collection and control system within 30 months after approval of the Design Plan.

(4) If an owner or operator is modifying an existing gas collection and control system to meet the requirements of this subarticle, the existing Design Plan must be amended to include any necessary updates or addenda, and must be certified by a professional engineer.

(5) The gas collection system must be operated, maintained, and expanded in accordance with the procedures and schedules in the approved Design Plan.

(b) *Gas Collection and Control System Requirements.*

(1) *General Requirements.* The owner or operator must satisfy the following requirements when operating a gas collection and control system:

(A) Route the collected gas to a gas control device or devices, and operate the gas collection and control system continuously except as provided in sections 95464(d) and 95464(e).

(B) Operate the gas collection and control system so that there is no landfill gas leak that exceeds 500 ppmv, measured as methane, at any component under positive pressure.

(C) The gas collection system must be designed and operated to draw all the gas toward the gas control device or devices

(2) *Requirements for Flares.* An MSW landfill owner or operator who operates a flare must satisfy the following requirements:

(A) Route the collected gas to an enclosed flare that meets the following requirements:

1. Achieves a methane destruction efficiency of at least 99 percent by weight.

2. Is equipped with automatic dampers, an automatic shutdown device, a flame arrester, and continuous recording temperature sensors.

3. During restart or startup there must be a sufficient flow of propane or commercial natural gas to the burners to prevent unburned collected methane from being emitted to the atmosphere.

4. The gas control device must be operated within the parameter ranges established during the initial or most recent source test.

(B) Route the collected gas to an open flare that meets the requirements of 40 CFR 60.18 (as last amended 65 Fed.Reg. 61752 (October 17, 2000), which is incorporated by reference herein. The operation of an open flare is not allowed except under the following conditions:

1. An open flare installed and operating prior to August 1, 2008, may operate until January 1, 2018.

2. Operation of an open flare on or after January 1, 2018, may be allowed if the owner or operator can demonstrate to the satisfaction of the Executive Officer that the landfill gas heat input capacity is less than 3.0 MMBtu/hr pursuant to section 95471(b) and is insufficient to support the continuous operation of an enclosed flare or other gas control device.

3. The owner or operator is seeking to temporarily operate an open flare during the repair or maintenance of the gas control system, or while awaiting the installation of an enclosed flare, or to address offsite gas migration issues.

   a. Any owner seeking to temporarily operate an open flare must submit a written request to the Executive Officer pursuant to section 95468.

(3) *Requirements for Gas Control Devices other than Flares.* An MSW landfill owner or operator who operates a gas control device other than a flare must satisfy one of the following requirements:

(A) Route the collected gas to an energy recovery device, or series of devices that meets the following requirements:

1. Achieves a methane destruction efficiency of at least 99 percent by weight. Lean burn internal combustion engines must reduce the outlet methane concentration to less than 3,000 ppmv, dry basis, corrected to 15 percent oxygen.

2. If a boiler or a process heater is used as the gas control device, the landfill gas stream must be introduced into the flame zone. Where the landfill gas is not the primary fuel for the boiler or process heater, introduction of the landfill gas stream into the flame zone is not required.

3. The gas control device must be operated within the parameter ranges established during the initial or most recent source test.

(B) Route the collected gas to a treatment system that processes the collected gas for subsequent sale or use. All emissions vented to the atmosphere from the gas treatment system are subject to the requirements of sections 95464(b)(2).

(4) *Source Test Requirements:* The owner or operator must conduct an annual source test for any gas control device(s) subject to the requirements of sections 95464(b)(2)(A) or 95464(b)(3)(A) using the test methods identified in 95471(f). An initial source test must be conducted within 180 days of initial start up of the gas collection and control system. Each succeeding complete annual source test must be conducted no later than 45 days after the anniversary date of the initial source test.

(A) If a gas control device remains in compliance after three consecutive source tests the owner or operator may conduct the source test every three years. If a subsequent source test shows the gas collection and control system is out of compliance the source testing frequency will return to annual.

(c) *Wellhead Gauge Pressure Requirement:* Each wellhead must be operated under a vacuum (negative pressure), except as provided in sections 95464(d) and 95464(e), or under any of the following conditions:

(1) Use of a geomembrane or synthetic cover. The owner or operator must develop acceptable pressure limits for the wellheads and include them in the Design Plan; or

(2) A decommissioned well.

(d) *Well Raising:* The requirements of sections 95464(b)(1)(A), 95464(b)(1)(B), and 95464(c), do not apply to individual wells involved in well raising provided the following conditions are met:

(1) New fill is being added or compacted in the immediate vicinity around the well.

(2) Once installed, a gas collection well extension is sealed or capped until the raised well is reconnected to a vacuum source.

(e) *Repairs and Temporary Shutdown of Gas Collection System Components:* The requirements of sections 95464(b)(1)(A), 95464(b)(1)(B), and 95464(c), do not apply to individual landfill gas collection system components that must be temporarily shut down in order to repair the components, due to catastrophic events such as earthquakes, to connect new landfill gas collection system components to the existing system, to extinguish landfill fires, or to perform construction activities pursuant to section 95466, provided the following requirements are met:

(1) Any new gas collection system components required to maintain compliance with this subarticle must be included in the most recent Design Plan pursuant to section 95464(a)(4).

(2) Methane emissions are minimized during shutdown pursuant to section 95464(a)(1)(E).

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39003, 39500, 39600, and 39601, Health and Safety Code.

§ 95465. Surface Methane Emission Standards

(a) Except as provided in sections 95464(d), 95464(e), and 95466, beginning January 1, 2011, or upon commencing operation of a newly installed gas collection and control system, no location on the MSW landfill surface may exceed either of the following methane concentration limits:

(1) 500 ppmv, other than non-repeatable, momentary readings, as determined by instantaneous surface emissions monitoring.

(2) An average methane concentration limit of 25 ppmv as determined by integrated surface emissions monitoring.

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39003, 39500, 39600, and 39601, Health and Safety Code.

§ 95466. Construction Activities

(a) The requirements of section 95465 do not apply to the working face of the landfill or to areas of the landfill surface where the landfill cover material has been removed and refuse has been exposed for the purpose of installing, expanding, replacing, or repairing components of the landfill gas, leachate, or gas condensate collection and removal system, or for law enforcement activities requiring excavation.

(b) Any new gas collection system components, or modifications to the existing system, must be included in the Design Plan pursuant to section 95464(a).

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39003, 39500, 39600, and 39601, Health and Safety Code.

§ 95467. Permanent Shutdown and Removal of the Gas Collection and Control System

(a) The gas collection and control system at a closed MSW landfill can be capped or removed provided the following requirements are met:

(1) The gas collection and control system was in operation for at least 15 years, unless the owner or operator can demonstrate to the satisfaction of the Executive Officer that due to declining methane rates the MSW landfill will be unable to operate the gas collection and control system for a 15-year period.

(2) Surface methane concentration measurements do not exceed the limits specified in section 95465.

(3) The owner or operator submits an Equipment Removal Report to the Executive Officer pursuant to section 95470(b)(2).

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39003, 39500, 39600, and 39601, Health and Safety Code.

§ 95468. Alternative Compliance Options

(a) The owner or operator may request alternatives to the compliance measures, monitoring requirements, test methods and procedures of sections 95464, 95469, and 95471. Any alternatives requested by the owner or operator must be submitted in writing to the Executive Officer. Alternative compliance option requests may include, but are not limited to, the following:

(1) Semi-continuous operation of the gas collection and control system due to insufficient landfill gas flow rates.

(2) Additional time allowance for leak repairs for landfills having consistent issues related to the procurement and delivery of necessary parts to complete the repair.

(3) Alternative wind speed requirements for landfills consistently having winds in excess of the limits specified in this subarticle.

(b) Criteria that the Executive Officer may use to evaluate alternative compliance option requests include, but are not limited to: compliance history; documentation containing the landfill gas flow rate and measured methane concentrations for individual gas collection wells or components; permits; component testing and surface monitoring results; gas collection and control system operation, maintenance, and inspection records; and historical meteorological data.

(c) The Executive Officer will review the requested alternatives and either approve or disapprove the alternatives within 120 days. The Executive Officer may request that additional information be submitted as part of the review of the requested alternatives.

(1) If a request for an alternative compliance option is denied, the Executive Officer will provide written reasons for the denial.

(2) The Executive Officer must deny the approval of any alternatives not providing equivalent levels of enforceability or methane emission control.

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39003, 39500, 39600, and 39601, Health and Safety Code.

§ 95469. Monitoring Requirements

(a) *Surface Emissions Monitoring Requirements:* Any owner or operator of a MSW landfill with a gas collection and control system must conduct instantaneous and integrated surface monitoring of the landfill surface quarterly using the procedures specified in section 95471(c).

(1) *Instantaneous Surface Monitoring:* Any reading exceeding the limit specified in section 95465(a)(1) must be recorded as an exceedance and the following actions must be taken:

(A) The owner or operator must record the date, location, and value of each exceedance, along with re-test dates and results. The location of each exceedance must be clearly marked and identified on a topographic map of the MSW landfill, drawn to scale with the location of both the grids and the gas collection system clearly identified.

(B) Corrective action must be taken by the owner or operator such as, but not limited to, cover maintenance or repair, or well vacuum adjustments and the location must be remonitored within ten calendar days of a measured exceedance.

1. If the re-monitoring of the location shows a second exceedance, additional corrective action must be taken and the location must be re-monitored again no later than 10 calendar days after the second exceedance.

2. If the re-monitoring shows a third exceedance, the owner or owner or operator must install a new or replacement well as determined to achieve compliance no later than 120 calendar days after detecting the third exceedance, or it is a violation of this subarticle.

(C) Any closed or inactive MSW landfill, or any closed or inactive areas on an active MSW landfill that has no monitored exceedances of the limit specified in section 95465(a)(1) after four consecutive quarterly monitoring periods may monitor annually. Any exceedances of the limits specified in section 95465(a)(1) detected during the annual monitoring that can not be remediated within 10 calendar days will result in a return to quarterly monitoring of the landfill.

(D) Any exceedances of the limit specified in section 95465(a)(1) detected during any compliance inspections will result in a return to quarterly monitoring of the landfill.

(2) *Integrated Surface Monitoring:* Any reading exceeding the limit specified in section 95465(a)(2) must be recorded as an exceedance and the following actions must be taken:

(A) The owner or operator must record the average surface concentration measured as methane for each grid along with re-test dates and results. The location of the grids and the gas collection system must be clearly marked and identified on a topographic map of the MSW landfill drawn to scale.

(B) Within 10 calendar days of a measured exceedance, corrective action must be taken by the owner or operator such as, but not limited to, cover maintenance or repair, or well vacuum adjustments and the grid must be re-monitored.

1. If the re-monitoring of the grid shows a second exceedance, additional corrective action must be taken and the location must be re-monitored again no later than 10 calendar days after the second exceedance.

2. If the re-monitoring in section 95469(a)(2)(B)1. shows a third exceedance, the owner or operator must install a new or replacement well as determined to achieve compliance no later than 120 calendar days after detecting the third exceedance, or it is a violation of this subarticle.

(C) Any closed or inactive MSW landfill, or any closed or inactive areas on an active MSW landfill that has no monitored exceedances of the limit specified in section 95465(a)(2) after 4 consecutive quarterly monitoring periods may monitor annually. Any exceedances of the limits specified in section 95465(a)(2) detected during the annual monitoring that can not be remediated within 10 calendar days will result in a return to quarterly monitoring of the landfill.

(E) Any exceedances of the limits specified in section 95465(a)(2) detected during any compliance inspections will result in a return to quarterly monitoring of the landfill.

(3) An owner or operator of a closed or inactive MSW landfill, or any closed or inactive areas on an active MSW landfill that can demonstrate that in the three years before the effective date of this subarticle that there were no measured exceedances of the limits specified in section 95465 by annual or quarterly monitoring may monitor annually. Any exceedances of the limits specified in section 95465 detected during the annual monitoring that can not be remediated within 10 calendar days will result in a return to quarterly monitoring of the landfill.

(b) *Gas Control System Equipment Monitoring:* The owner or operator must monitor the gas control system using the following procedures:

(1) For enclosed flares the following equipment must be installed, calibrated, maintained, and operated according to the manufacturer's specifications:

(A) A temperature monitoring device equipped with a continuous recorder which has an accuracy of plus or minus (±) 1 percent of the temperature being measured expressed in degrees Celsius or Fahrenheit.

(B) At least one gas flow rate measuring device which must record the flow to the control device(s) at least every 15 minutes.

(2) For a gas control device other than an enclosed flare, demonstrate compliance by providing information describing the operation of the gas control device, the operating parameters that would indicate proper performance, and appropriate monitoring procedures. Alternatives to this section must be submitted as specified in section 95468. The Executive Officer may specify additional monitoring procedures.

(3) Components containing landfill gas and under positive pressure must be monitored quarterly for leaks. Any component leak must be tagged and repaired within 10 calendar days, or it is a violation of this subarticle.

(A) Component leak testing at MSW landfills having landfill gas-to-energy facilities may be conducted prior to scheduled maintenance or during planned outage periods.

(c) *Wellhead Monitoring:* The owner or operator must monitor each individual wellhead monthly to determine the gauge pressure. If there is any positive pressure reading other than as provided in sections 95464(d) and 95464(e), the owner or operator must take the following actions:

(1) Initiate corrective action within five calendar days of the positive pressure measurement.

(2) If the problem cannot be corrected within 15 days of the date the positive pressure was first measured, the owner or operator must initiate further action, including, but not limited to, any necessary expansion of the gas collection system, to mitigate any positive pressure readings.

(3) Corrective actions, including any expansion of the gas collection and control system, must be completed and any new wells must be operating within 120 days of the date the positive pressure was first measured, or it is a violation of this subarticle.

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39003, 39500, 39600, and 39601, Health and Safety Code.

§ 95470. Recordkeeping and Reporting Requirements.

(a) *Recordkeeping Requirements.*

(1) An owner or operator must maintain the following records for at least five years:

(A) All gas collection system downtime exceeding five calendar days, including individual well shutdown and disconnection times, and the reason for the downtime.

(B) All gas control system downtime in excess of one hour, the reason for the downtime, and the length of time the gas control system was shutdown.

(C) Expected gas generation flow rate calculated pursuant to section 95471(e).

(D) Records of all instantaneous surface readings of 200 ppmv or greater; all exceedances of the limits in sections 95464(b)(1)(B) or 95465, including the location of the leak (or affected grid), leak concentration in ppmv, date and time of measurement, the action taken to repair the leak, date of repair, any required re-monitoring and the re-monitored concentration in ppmv, and wind speed during surface sampling; and the installation date and location of each well installed as part of a gas collection system expansion.

(E) Records of any positive wellhead gauge pressure measurements, the date of the measurements, the well identification number, and the corrective action taken.

(F) Annual solid waste acceptance rate and the current amount of waste-in-place.

(G) Records of the nature, location, amount, and date of deposition of non-degradable waste for any landfill areas excluded from the collection system.

(H) Results of any source tests conducted pursuant to section 95464(b)(4).

(I) Records describing the mitigation measures taken to prevent the release of methane or other emissions into the atmosphere:

1. When solid waste was brought to the surface during the installation or preparation of wells, piping, or other equipment;

2. During repairs or the temporary shutdown of gas collection system components; or,

3. When solid waste was excavated and moved.

(J) Records of any construction activities pursuant to section 95466. The records must contain the following information:

1. A description of the actions being taken, the areas of the MSW landfill that will be affected by these actions, the reason the actions are required, and any landfill gas collection system components that will be affected by these actions.

2. Construction start and finish dates, projected equipment installation dates, and projected shut down times for individual gas collection system components.

3. A description of the mitigation measures taken to minimize methane emissions and other potential air quality impacts.

(K) Records of the equipment operating parameters specified to be monitored under sections 95469(b)(1) and 95469(b)(2) as well as records for periods of operation during which the parameter boundaries established during the most recent source test are exceeded. The records must include the following information:

1. For enclosed flares, all 3-hour periods of operation during which the average temperature difference was more than 28 degrees Celsius (or 50 degrees Fahrenheit) below the average combustion temperature during the most recent source test at which compliance with sections 95464(b)(2) and 95464(b)(3)(A) was determined.

2. For boilers or process heaters, whenever there is a change in the location at which the vent stream is introduced into the flame zone pursuant to section 95464(b)(3)(A)2.

3. For any owner or operator who uses a boiler or process heater with a design heat input capacity of 44 megawatts (150 MMBtu/hr) or greater to comply with section 95464(b)(3), all periods of operation of the boiler or process heater (e.g., steam use, fuel use, or monitoring data collected pursuant to other federal, State, local, or tribal regulatory requirements).

(2) The owner or operator must maintain the following records for the life of each gas control device, as measured during the initial source test or compliance determination:

(A) The control device vendor specifications.

(B) The expected gas generation flow rate as calculated pursuant to section 95471(e).

(C) The percent reduction of methane achieved by the control device determined pursuant to section 95471(f).

(D) For a boiler or process heater, the description of the location at which the collected gas vent stream is introduced into the boiler or process heater over the same time period of the performance test.

(E) For an open flare: the flare type (i.e., steam-assisted, air-assisted, or non-assisted); all visible emission readings, heat content determination, flow rate or bypass flow rate measurements, and exit velocity determinations made during the performance test as specified in CFR 40 60.18 (as last amended 65 Fed.Reg. 61752 (October 17, 2000), which is incorporated by reference herein; and records of the flare pilot flame or flare flame monitoring and records of all periods of operations during which the pilot flame or the flare flame is absent.

(3) *Record Storage:* The owner or operator must maintain copies of the records and reports required by this subarticle and provide them to the Executive Officer within five business days upon request. Records and reports must be kept at a location within the State of California.

(b) *Reporting Requirements.*

(1) *Closure Notification:* Any owner or operator of a MSW landfill which has ceased accepting waste must submit a Closure Notification to the Executive Officer within 30 days of waste acceptance cessation.

(A) The Closure Notification must include the last day solid waste was accepted, the anticipated closure date of the MSW landfill, and the estimated waste-in-place.

(B) The Executive Officer may request additional information as necessary to verify that permanent closure has taken place in accordance with the requirements of any applicable federal, State, local, or tribal statues, regulations, and ordinances in effect at the time of closure.

(2) *Equipment Removal Report:* A gas collection and control system Equipment Removal Report must be submitted to the Executive Officer 30 days prior to well capping, removal or cessation of operation of the gas collection, treatment, or control system equipment. The report must contain all of the following information:

(A) A copy of the Closure Notification submitted pursuant to section 95470(b)(1).

(B) A copy of the initial source test report or other documentation demonstrating that the gas collection and control system has been installed and operated for a minimum of 15 years, unless the owner or operator can demonstrate to the satisfaction of the Executive Officer that due to declining methane rates the landfill is unable to operate the gas collection and control system for a 15-year period.

(C) Surface emissions monitoring results needed to verify that landfill surface methane concentration measurements do not exceed the limits specified in section 95465.

(3) *Annual Report:* Any owner or operator subject to the requirements of this subarticle, except section 95463, must prepare an annual report for the period of January 1 through December 31 of each year. Each subsequent annual report must be submitted to the Executive Officer by March 15 of the following year. The annual report must contain the following information:

(A) MSW landfill name, owner and operator, address, and solid waste information system (SWIS) identification number.

(B) Total volume of landfill gas collected (reported in standard cubic feet).

(C) Average composition of the landfill gas collected over the reporting period (reported in percent methane and percent carbon dioxide by volume).

(D) Gas control device type, year of installation, rating, fuel type, and total amount of landfill gas combusted in each control device.

(E) The date that the gas collection and control system was installed and in full operation.

(F) The percent methane destruction efficiency of each gas control device(s).

(G) Type and amount of supplemental fuels burned with the landfill gas in each device.

(H) Total volume of landfill gas shipped off-site, the composition of the landfill gas collected (reported in percent methane and percent carbon dioxide by volume), and the recipient of the gas.

(I) Most recent topographic map of the site showing the areas with final cover and a geomembrane and the areas with final cover without a geomembrane with corresponding percentages over the landfill surface.

(J) The information required by sections 95470(a)(1)(A), 95470(a)(1)(B), 95470(a)(1)(C), 95470(a)(1)(D), 95470(a)(1)(E), and 95470(a)(1)(F), 95470(a)(1)(H), and 95470(a)(1)(K).

(4) *Waste-in-Place Report*: Any owner or operator subject to the requirements of sections 95463(a), or 95643(b)(2)(B) must report the following information to the Executive Officer:

(A) MSW landfill name, owner and operator, address, and solid waste information system (SWIS) identification number.

(B) The landfill's status (active, closed, or inactive) and the estimated waste-in-place, in tons.

(C) Most recent topographic map of the site showing the areas with final cover and a geomembrane and the areas with final cover without a geomembrane with corresponding percentages over the landfill surface.

(5) *Landfill Gas Heat Input Capacity Report:* Any owner or operator subject to the requirements of section 95463(b) must calculate the landfill gas heat input capacity using the calculation procedures specified in section 95471(b) and report the results to the Executive Officer within 90 days of the effective date of this subarticle or upon reaching

450,000 tons of waste-in-place. The calculation, along with relevant parameters, must be provided as part of the report.

(6) Any report, or information submitted pursuant to this subarticle must contain certification by a responsible official of truth, accuracy, and completeness. This certification, and any other certification required under this subarticle, must state that, based on information and belief formed after reasonable inquiry, the statements and information in the document are true, accurate, and complete.

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39003, 39500, 39600, and 39601, Health and Safety Code.

§ 95471. Test Methods and Procedures

(a) *Hydrocarbon Detector Specifications*: Any instrument used for the measurement of methane must be a gas detector or other equivalent instrument approved by the Executive Officer that meets the calibration, specifications, and performance criteria of EPA Reference Method 21, Determination of Volatile Organic Compound Leaks, 40 CFR Part 60, Appendix A (as last amended 65 Fed.Reg. 61744 (October 17, 2000)), which is incorporated by reference herein, except for the following:

(1) “Methane” replaces all references to volatile organic compounds (VOC).

(2) The calibration gas shall be methane.

(b) *Determination of Landfill Gas Heat Input Capacity:* The landfill gas heat input capacity must be determined pursuant to sections 95471(b)(1), 95471(b)(2), or 95471(b)(3), as applicable:

(1) *MSW Landfills without Carbon Adsorption or Passive Venting Systems:* The heat input capacity must be calculated using the procedure as specified in Appendix I. The Executive Officer may request additional information as may be necessary to verify the heat input capacity from the MSW landfill. Site-specific data may be substituted when available.

(2) *MSW Landfills with Carbon Adsorption Systems:* The landfill gas heat capacity must be determined by measuring the actual total landfill gas flow rate, in standard cubic feet per minute (scfm), using a flow meter or other flow measuring device such as a standard pitot tube and methane concentration (percent by volume) using a hydrocarbon detector meeting the requirements of 95471(a). The total landfill gas flow rate must be multiplied by the methane concentration and then multiplied by the gross heating value (GHV) of methane of 1,012 Btu/scf to determine the landfill gas heat input capacity.

(3) *MSW Landfills with Passive Venting Systems:* The landfill gas heat input capacity must be determined pursuant to both of the following and is the higher of those determined values:

(A) Section 95471(b)(1); and

(B) The owner or operator must measure actual landfill gas flow rates (in units of scfm) by using a flow measuring device such as a standard pitot tube and methane concentration (percent by volume) using a hydrocarbon detector meeting the requirements of 95471(a) from each venting pipe that is within the waste mass. Each gas flow rate must then be multiplied by its corresponding methane concentration to obtain the individual methane flow rate. The individual methane flow rates must be added together and then multiplied by the GHV of methane of 1,012 Btu/scf to determine the landfill gas heat input capacity.

(c) *Surface Emissions Monitoring Procedures:* The owner or operator must measure the landfill surface concentration of methane using a hydrocarbon detector meeting the requirements of section 95471(a). The landfill surface must be inspected using the following procedures:

(1) *Monitoring Area:* The entire landfill surface must be divided into individually identified 50,000 square foot grids. The grids must be used for both instantaneous and integrated surface emissions monitoring.

(A) Testing must be performed by holding the hydrocarbon detector's probe within 3 inches of the landfill surface while traversing the grid.

(B) The walking pattern must be no more than a 25-foot spacing interval and must traverse each monitoring grid.

1. If the owner or operator has no exceedances of the limits specified in section 95465 after any four consecutive quarterly monitoring periods, the walking pattern spacing may be increased to 100-foot intervals. The owner or operator must return to a 25-foot spacing interval upon any exceedances of the limits specified in section 95465 that cannot be remediated within 10 calendar days or upon any exceedances detected during a compliance inspection.

2. An owner or operator of a MSW landfill can demonstrate that in the past three years before the effective date of this subarticle that there were no measured exceedances of the limits specified in section 95465 by annual or quarterly monitoring may increase the walking pattern spacing to

100-foot intervals. The owner or operator must return to a 25-foot spacing interval upon any exceedances of the limits specified in section 95465 that cannot be remediated within 10 calendar days or upon any exceedances detected during a compliance inspection.

(C) Portions of slopes that are 30 degrees and greater, wet or icy surfaces, construction areas, and other dangerous areas may be excluded from landfill surface inspection. Paved roads that do not have any cracks, pot holes, or other penetrations may also be excluded.

(D) Surface testing must be terminated when the average wind speed exceeds five miles per hour or the instantaneous wind speed exceeds 10 miles per hour. The Executive Officer may approve alternatives to this wind speed surface testing termination for MSW landfills consistently having measured winds in excess of these specified limits. Average wind speed must be determined on a 15-minute average using an on-site anemometer with a continuous recorder for the entire duration of the monitoring event.

(E) Surface emissions testing must be conducted only when there has been no measurable precipitation in the preceding 72 hours.

(2) *Instantaneous Surface Emissions Monitoring Procedures.*

(A) The owner or operator must record any instantaneous surface readings of methane 200 ppmv or greater, other than non-repeatable, momentary readings.

(B) Surface areas of the MSW landfill that exceed a methane concentration limit of 500 ppmv must be marked and remediated pursuant to section 95469(a)(1).

(C) The wind speed must be recorded during the sampling period.

(D) The landfill surface areas with cover penetrations, distressed vegetation, cracks or seeps must also be inspected visually and with a hydrocarbon detector.

(3) *Integrated Surface Emissions Monitoring Procedures.*

(A) Integrated surface readings must be recorded and then averaged for each grid.

(B) Individual monitoring grids that exceed an average methane concentration of 25 ppmv must be identified and remediated pursuant to section 95469(a)(2).

(C) The wind speed must be recorded during the sampling period.

(d) *Gas Collection and Control System Leak Inspection Procedures.* Leaks must be measured using a hydrocarbon detector meeting the requirements of 95471(a).

(e) *Determination of Expected Gas Generation Flow Rate.* The expected gas generation flow rate must be determined as prescribed in the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories, Chapter 3, which is incorporated by reference herein, using a recovery rate of 75 percent.

(f) *Control Device Destruction Efficiency Determination*. The following methods of analysis must be used to determine the efficiency of the control device in reducing methane:

(1) *Enclosed Combustors:* One of the following test methods, all of which are incorporated by reference herein (and all as promulgated in 40 CFR, Part 60, Appendix A, as last amended 65 Fed.Reg. 61744 (October 17, 2000)), must be used to determine the efficiency of the control device in reducing methane by at least 99 percent, or in reducing the outlet methane concentration for lean burn engines to less than 3,000 ppmv, dry basis, corrected to 15 percent oxygen:

U.S. EPA Reference Method 18, Measurement of Gaseous Organic Compound Emissions By Gas Chromatography;

U.S. EPA Reference Method 25, Determination of Total Gaseous Nonmethane Organic Emissions as Carbon;

U.S. EPA Reference Method 25A, Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer; or

U.S. EPA Reference Method 25C, Determination of Nonmethane Organic Compounds in Landfill Gases.

The following equation must be used to calculate destruction efficiency:

$$Destruction\ Efficiency = \left[1 - \left(\frac{Mass\ of\ Methane - Outlet}{Mass\ of\ Methane - Inlet}\right)\right] \times 100\%$$

(2) *Open Flares:* Open flares must meet the requirements of 40 CFR 60.18 (as last amended 65 Fed.Reg. 61752 (October 17, 2000).

(g) *Determination of Gauge Pressure.* Gauge pressure must be determined using a hand-held manometer, magnahelic gauge, or other pressure measuring device approved by the Executive Officer. The device must be calibrated and operated in accordance with the manufacture's specifications.

(h) *Alternative Test Methods*. Alternative test methods may be used provided that they are approved in writing by the Executive Officer.

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39003, 39500, 39600, and 39601, Health and Safety Code.

§ 95472. Penalties

(a) Penalties may be assessed for any violation of this subarticle pursuant to Health and Safety Code section 38580. Each day during any portion of which a violation occurs is a separate offense.

(b) Any violation of this subarticle may be enjoined pursuant to Health and Safety Code section 41513.

(c) Each day or portion thereof that any report, plan, or document required by this subarticle remains unsubmitted, is submitted late, or contains incomplete or inaccurate information, shall constitute a single, separate violation of this subarticle.

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39003, 39500, 39600, and 39601, Health and Safety Code.

§ 95473. Implementation, Enforcement, and Related Fees

The Executive Officer, at his or her discretion, may enter into an agreement with a District to implement and enforce this subarticle. Pursuant to this agreement, an owner or operator of a MSW landfill must pay any fees assessed by a District for the purpose of recovering the District's cost of implementing and enforcing the requirements of this subarticle.

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39003, 39500, 39600, 39601, and 40001(a), Health and Safety Code.

§ 95474. Applicability of Other Rules and Regulations

Compliance with this regulation does not exempt a person from complying with other federal, State, or local law, including but not limited to, California Health and Safety Code Section 41700; rules pertaining to visible emissions, nuisance, or fugitive dust, or from permitting requirements of a District, the Regional Water Quality Control Board, local enforcement agencies, the Integrated Waste Management Board, and other local, State, and federal agencies.

§ 95475. Definitions

(a) For purposes of this subarticle, the following definitions apply:

(1) "Active MSW Landfill" means a MSW landfill that is accepting solid waste for disposal.

(2) "Component Leak" means the concentration of methane measured one half of an inch or less from a component source that exceeds 500 parts per million by volume (ppmv), other than non-repeatable, momentary readings. Measurements from any vault must be taken within 3 inches above the surface of the vault exposed to the atmosphere.

(3) "Component" means any equipment that is part of the gas collection and control system and that contains landfill gas including, but not limited to, wells, pipes, flanges, fittings, valves, flame arrestors, knock-out drums, sampling ports, blowers, compressors, or connectors.

(4) "Construction and Demolition Wastes" means waste building materials, packaging and rubble resulting from construction, remodeling, repair and demolition operations on pavements, houses, commercial buildings and other structures.

(5) "Continuous Operation" means that the gas collection and control system is operated continuously, the existing gas collection wells are operating under vacuum while maintaining landfill gas flow, and the collected landfill gas is processed by a gas control system 24 hours per day.

(6) "Closed MSW Landfill" means that a MSW landfill is no longer accepting solid waste for disposal and has documentation that the closure was conducted in accordance with the applicable statutes, regulations, and local ordinances in effect at the time of closure, or can document that the landfill is no longer receiving solid waste.

(7) "District" means any air quality management district or air pollution control district in the State of California.

(8) “Destruction Efficiency” means a measure of the ability of a gas control device to combust, transform, or otherwise prevent emissions of methane from entering the atmosphere.

(9) “Enclosed Combustor” means an enclosed flare, steam generating boiler, internal combustion engine, or gas turbine.

(10) “Energy Recovery Device” means any combustion device that uses landfill gas to recover energy in the form of steam or electricity, including, but not limited to, gas turbines, internal combustion engines, boilers, and boiler-to-steam turbine systems.

(11) “Exceedance” means the concentration of methane measured within 3 inches above the landfill surface that exceeds 500 ppmv, other than non-repeatable, momentary readings, as determined by instantaneous surface emissions monitoring; or the average methane concentration measurements exceed 25 ppmv, as determined by integrated surface emissions monitoring.

(12) “Executive Officer” means the Executive Officer of the Air Resources Board, or his or her delegate.

(13) “Facility Boundary” means the boundary surrounding the entire area on which MSW landfill activities occur and are permitted.

(14) “Gas Control Device” means any device used to dispose of or treat collected landfill gas, including, but not limited to, enclosed flares, internal combustion engines, boilers and boiler-to-steam turbine systems, fuel cells, and gas turbines.

(15) “Gas Collection System” means any system that employs various gas collection wells and connected piping, and mechanical blowers, fans, pumps, or compressors to create a pressure gradient and actively extract landfill gas.

(16) “Gas Control System” means any system that disposes of or treats collected landfill gas by one or more of the following means: combustion, gas treatment for subsequent sale, or sale for processing offsite, including for transportation fuel and injection into the natural gas pipeline.

(17) “Inactive MSW Landfill” means a MSW landfill that is no longer accepting solid waste for disposal.

(18) “Landfill Gas” means any untreated, raw gas derived through a natural process from the decomposition of organic waste deposited in a MSW

landfill, from the evolution of volatile species in the waste, or from chemical reactions of substances in the waste.

(19) "Landfill Surface" means the area of the landfill under which decomposable solid waste has been placed, excluding the working face.

(20) "Municipal Solid Waste Landfill" or "MSW Landfill" means an entire disposal facility in a contiguous geographical space where solid waste is placed in or on land.

(21) "Non-decomposable Solid Waste" means materials that do not degrade biologically to form landfill gas. Examples include, but are not limited to, earth, rock, concrete asphalt paving fragments, clay products, inert slag, asbestos-containing waste, and demolition materials containing minor amounts (less than 10 percent by volume) of wood and metals. Materials that do not meet this definition are considered decomposable solid waste.

(22) "Non-repeatable, Momentary Readings" means indications of the presence of methane, which persist for less than five seconds and do not recur when the sampling probe of a portable gas detector is placed in the same location.

(23) "Operator" means any person or entity, including but not limited to any government entity, corporation, partnership, trustee, other legal entity, or individual that:

(A) Operates the MSW landfill;

(B) Is responsible for complying with any federal, state, or local requirements relating to methane emissions from real property used for MSW landfill purposes and subject to this subarticle;

(C) Operates any stationary equipment for the collection of landfill gas;

(D) Purchases landfill gas from an owner or operator of a MSW landfill and operates any stationary equipment for the treatment of landfill gas; or

(E) Purchases untreated landfill gas from an owner or operator of a MSW landfill and operates any stationary equipment for the combustion of landfill gas.

(24) "Owner" means any person or entity, including but not limited to any government entity, corporation, partnership, trustee, other legal entity, or individual that:

(A) Holds title to the real property on which the MSW landfill is located, including but not limited to title held by joint tenancy, tenancy in common, community property, life estate, estate for years, lease, sublease, or assignment, except title held solely as security for a debt such as mortgage;

(B) Is responsible for complying with any federal, state, or local requirements relating to methane emissions from real property used for MSW landfill purposes and subject to this subarticle.

(C) Owns any stationary equipment for the collection of landfill gas;

(D) Purchases the landfill gas from an owner or operator of a MSW landfill and owns any stationary equipment for the treatment of landfill gas; or

(E) Purchases untreated landfill gas from an owner or operator of a MSW landfill and owns any stationary equipment for the combustion of landfill gas.

(25) “Perimeter” means along the MSW landfill’s permitted facility boundary.

(26) “Professional Engineer” means an engineer holding a valid certificate issued by the State of California Board of Registration for Professional Engineers and Land Surveyors or a state offering reciprocity with California.

(27) “Solid Waste” means all decomposable and non-decomposable solid, semisolid, and liquid wastes, including garbage, trash, refuse, paper, rubbish, ashes, industrial waste, manure, vegetable or animal solid and semisolid wastes, sludge, and other discarded solid and semisolid wastes. Solid waste also includes any material meeting the definition of Solid Waste in 40 CFR 60.751 (as last amended 64 Fed.Reg 9262, Feb 24, 1999) as incorporated by reference herein.

(28) “Subsurface Gas Migration” means underground landfill gases that are detected at any point on the perimeter pursuant to California Code of Regulations Title 27, section 20921.

(29) “Waste-in-Place” means the total amount of solid waste placed in the MSW landfill estimated in tons. The refuse density is assumed to be 1,300 pounds per cubic yard and the decomposable fraction is assumed to be 70 percent by weight.

(30) “Well Raising” means a MSW landfill activity where an existing gas collection well is temporarily disconnected from a vacuum source, and the non-perforated pipe attached to the well is extended vertically to allow the addition of a new layer of solid waste or the final cover; or is extended

horizontally to allow the horizontal extension of an existing layer of solid waste or cover material. The extended pipe (well extension) is then re-connected in order to continue collecting gas from that well.

(31) "Working Face" means the open area where solid waste is deposited daily and compacted with landfill equipment.

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39003, 39500, 39600, and 39601, Health and Safety Code.

§ 95476. Severability

Each part of this subarticle is deemed severable, and in the event that any part of this subarticle is held to be invalid, the remainder of this subarticle continues in full force and effect.

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39003, 39500, 39600, and 39601, Health and Safety Code.

1.0 Calculate Heat Input Capacity

Heat Input Capacity (MMBtu/hr) = Methane Gas Generation (scfm) x 60 minutes/1 hour x Collection Efficiency x GHV x 1 MMBtu/1,000,000 Btu

Where:

Collection Efficiency = the landfill gas collection efficiency in percent (%), which is 75 percent.

GHV (Gross Heating Value) = Gross heating value of methane, which is 1,012 in units of British thermal units per standard cubic feet, or Btu/scf; source: http://epa.gov/lmop/res/converter.htm).

2.0 Methane Gas Generation: CH_4 Generation is calculated using the following equation:

$$CH_4 \text{ Generation (Mg of } CH_4) = \{ANDOC_{year\text{-}start} \times [1-e^{-[k]}] - ANDOC_{deposited\text{-}last\ year} \times [1/k \times (e^{-[k \times (1-M/12)]} - e^{-[k]}) - (M/12) \times e^{-[k]}] + ANDOC_{deposited\text{-}same\ year} \times [1-((1/k) \times (1-e^{-[k \times (1-M/12)]} + (M/12))]\} \times FCH_4$$

Where:

CH_4 Generation = CH_4 generated in the inventory year in question (Mg of CH_4) using the Mathematically Exact First-Order Decay Model provided in the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories, Chapter 3 (Source: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_3_Ch3_SWDS.pdf).

FCH_4 = Fraction of decomposing carbon converted into CH_4 (Default = 0.5)

$ANDOC_{year\text{-}start}$ = ANDOC in place at the beginning of the inventory year in question

$ANDOC_{deposited\text{-}last\ year}$ = ANDOC deposited during the previous inventory year

$ANDOC_{deposited\text{-}same\ year}$ = ANDOC deposited during the inventory year in question

3.0 To Convert Methane Generated from Mg of CH_4 to SCFM

CH_4 Gas Generated (scfm) = CH_4 Generation (Mg/year) x 1 year/ 525,600 minutes x 1,000,000 g/Mg x 1 mole CH_4/16.04246 g CH_4 x 0.83662 SCF/mole landfill gas

4.0 Define ANDOC%

ANDOC% = Σ $WIPFRAC_i$ x $TDOC_i$ x $DANF_i$
Where:

WIPFRACi = Fraction of the i^{th} component in the waste-in-place

TDOCi = Total Degradable Organic Carbon fraction of the ith waste component (Mg of that component/Mg of Total waste-in-place

DANFi = Decomposable Anaerobic Fraction of the i^{th} waste component, that fraction capable of decomposition in anaerobic conditions (Mg of decomposable carbon for that component/Mg TDOCi for that component)

5.0 Define ANDOC

ANDOC = WIP (Tons) x 0.9072 (Mg/Ton) x ANDOC%

Where:

ANDOC = Anaerobically Degradable Organic Carbon, carbon that is capable of decomposition in an anaerobic environment (Mg of carbon)

WIP = Waste-in-Place estimate of all the landfilled waste (wet weight) as reported to the CIWMB (tons)

6.0 Calculate $ANDOC_{year\text{-}end}$

$$ANDOC_{year\text{-}end} = ANDOC_{year\text{-}start} \times e^{-[k]} + ANDOC_{deposited\text{-}last\ year} \times [1/k \times (e^{-[k \times (1-M/12)]} - e^{-[k]}) - (M/12) \times e^{-[k]}] + ANDOC_{deposited\text{-}same\ year} \times [(1/k) \times (1-e^{-[k \times (1-M/12)]} + (M/12)]$$

Where:

$ANDOC_{year\text{-}end}$ = ANDOC remaining undecomposed at the end of the inventory year in question

$ANDOC_{year\text{-}start}$ = ANDOC in place at the beginning of the inventory year in question

$ANDOC_{deposited\text{-}last\ year}$ = ANDOC deposited during the previous inventory year

$ANDOC_{deposited\text{-}same\ year}$ = ANDOC deposited during the inventory year in question

M = Assumed delay before newly deposited waste begins to undergo anaerobic decomposition (Months, Default = 6)

k = Assumed rate constant for anaerobic decomposition;
k = ln2/half-life (years); half-life is the number of years required for half of the original mass of carbon to degrade

The following values for the assumed rate constant for anaerobic decomposition (or “k”) must be used:

Table 1. Average Rainfall and k Values

Average Rainfall (Inches/Year)	k Value
<20	0.020
20-40	0.038
>40	0.057

Source: U.S. EPA http//ww.ncgc.nrcs.usda.gov/products/datasets/climate/data/precipitation-state/ca.html.

The following waste characterization default values shown in Tables 1A, 1B, 2, and 3 in addition to the model equations must be used in estimating the methane generation potential for a MSW landfill:

Table 1A	**Waste Type (%) by Year**				
Waste Type	**Up to 1964**	**1965-1974**	**1975-1984**	**1985-1992**	**1993-1995**
Newspaper	6.4%	6.4%	5.9%	4.8%	3.9%
Office Paper	10.7%	11.3%	12.0%	13.1%	15.0%
Corrugated Boxes	10.8%	13.5%	11.5%	10.5%	10.3%
Coated Paper	2.2%	2.0%	2.4%	2.1%	1.8%
Food	14.8%	11.3%	9.5%	12.1%	13.4%
Grass	12.1%	10.3%	10.1%	9.0%	6.6%
Leaves	6.1%	5.1%	5.0%	4.5%	3.3%
Branches	6.1%	5.1%	5.0%	4.5%	3.3%
Lumber	3.7%	3.3%	5.1%	7.0%	7.3%
Textiles	2.1%	1.8%	1.7%	3.3%	4.5%
Diapers	0.1%	0.3%	1.4%	1.6%	1.9%
Construction/Demolition	2.6%	2.5%	3.5%	3.9%	4.5%
Medical Waste	0.0%	0.0%	0.0%	0.0%	0.0%
Sludge/Manure	0.0%	0.0%	0.0%	0.0%	0.0%
Source: US EPA Municipal Solid Waste publication: http://www.epa.gov/msw/pubs/03data.pdf.					

Table 1B	**Waste Type (%) by Year**	
Waste Type	**1996-2002[1]**	**2003-present[2]**
Newspaper	4.3%	2.2%
Office Paper	4.4%	2.0%
Corrugated Boxes	4.6%	5.7%
Coated Paper	16.9%	11.1%
Food	15.7%	14.6%
Grass	5.3%	2.8%
Leaves	2.6%	1.4%
Branches	2.4%	2.6%
Lumber	4.9%	9.6%
Textiles	2.1%	4.4%
Diapers	6.9%	4.4%
Construction/Demolition	6.7%	12.1%
Medical Waste	0.0%	0.0%
Sludge/Manure	0.1%	0.1%

Source:
[1]CIWMB Statewide Waste Characterization Study (1999).
[2]CIWMB Statewide Waste Characterization Study (2004).

Table 2		
Waste Type	**TDOC**	**Source**
Newspaper	46.5%	EPA
Office Paper	39.8%	EPA
Corrugated Boxes	40.5%	EPA
Coated Paper	40.5%	EPA
Food	11.7%	EPA
Grass	19.2%	EPA
Leaves	47.8%	EPA
Branches	27.9%	EPA
Lumber	43.0%	IPCC
Textiles	24.0%	IPCC
Diapers	24.0%	IPCC
Construction/Demolition	4.0%	IPCC
Medical Waste	15.0%	IPCC
Sludge/Manure	5.0%	IPCC

Sources
EPA *Solid Waste Management and Greenhouse Gasses: A Life-Cycle Assessment of Emissions and Sinks,* Exhibits 7-2, 7-3 (May 2002).
IPCC *Guidelines for National Greenhouse Gas Inventories*, Chapter 2, Table 2.4, 2.5 and 2.6 (2006).

Table 3		
Waste Type	**DANF**	**Source**
Newspaper	16.1%	EPA
Office Paper	87.4%	EPA
Corrugated Boxes	38.3%	EPA
Coated Paper	21.0%	EPA
Food	82.8%	EPA
Grass	32.2%	EPA
Leaves	10.0%	EPA
Branches	17.6%	EPA
Lumber	23.3%	CEC
Textiles	50.0%	IPCC
Diapers	50.0%	IPCC
Construction/Demolition	50.0%	IPCC
Medical Waste	50.0%	IPCC
Sludge/Manure	50.0%	IPCC
Sources: EPA *Solid Waste Management and Greenhouse Gasses: A Life-Cycle Assessment of Emissions and Sinks* Exhibits 7-2, 7-3 (May 2002). CEC *Inventory of California Greenhouse Gas Emissions and Sinks: 1990-2004* (December 2006). IPCC *Guidelines for National Greenhouse Gas Inventories*, Chapter 3, 3.13 (2006).		

Appendix B

Flowchart for Determining Control Requirements

Figure 1. Flow Chart for Determining Control Requirements

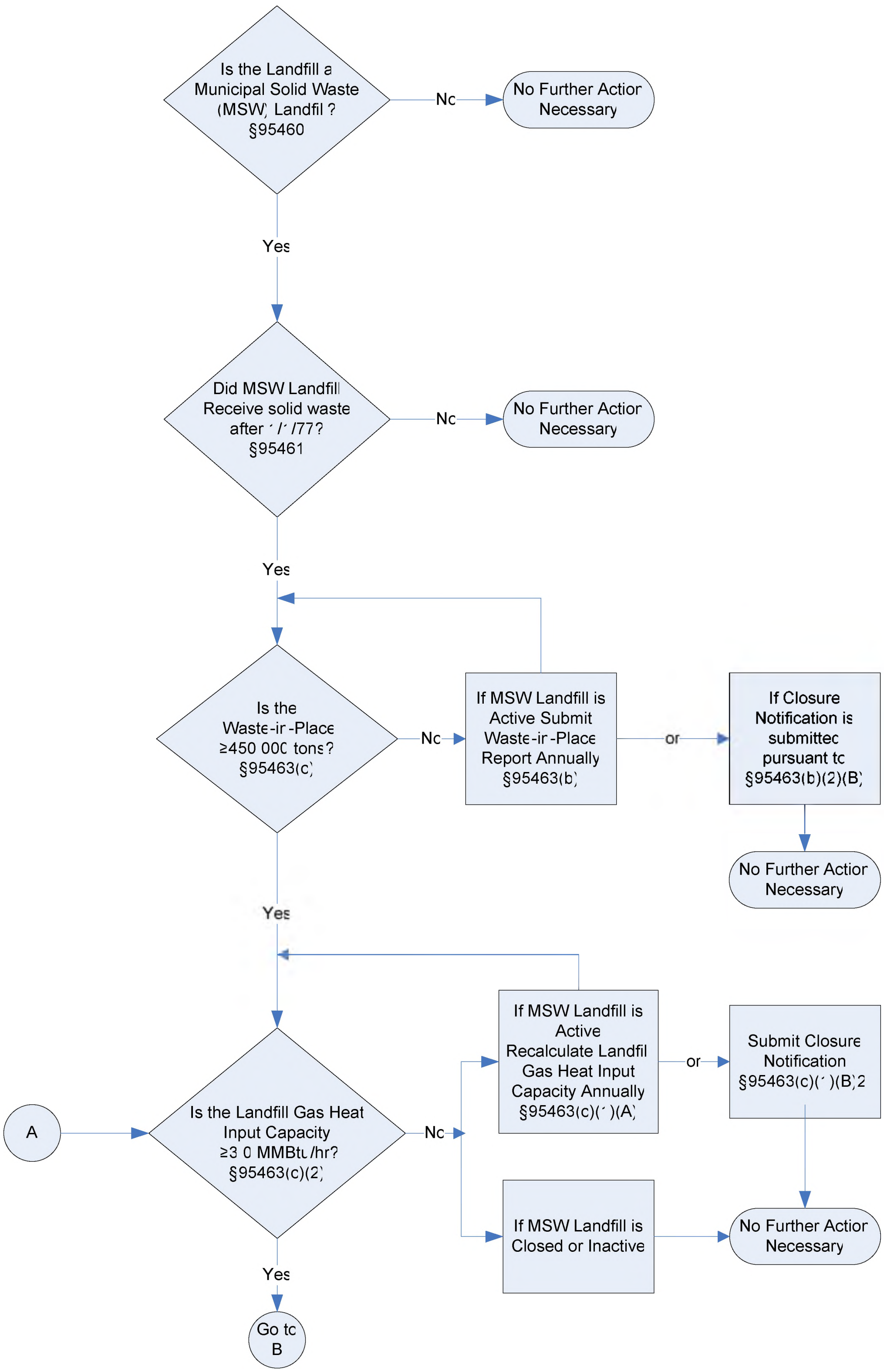
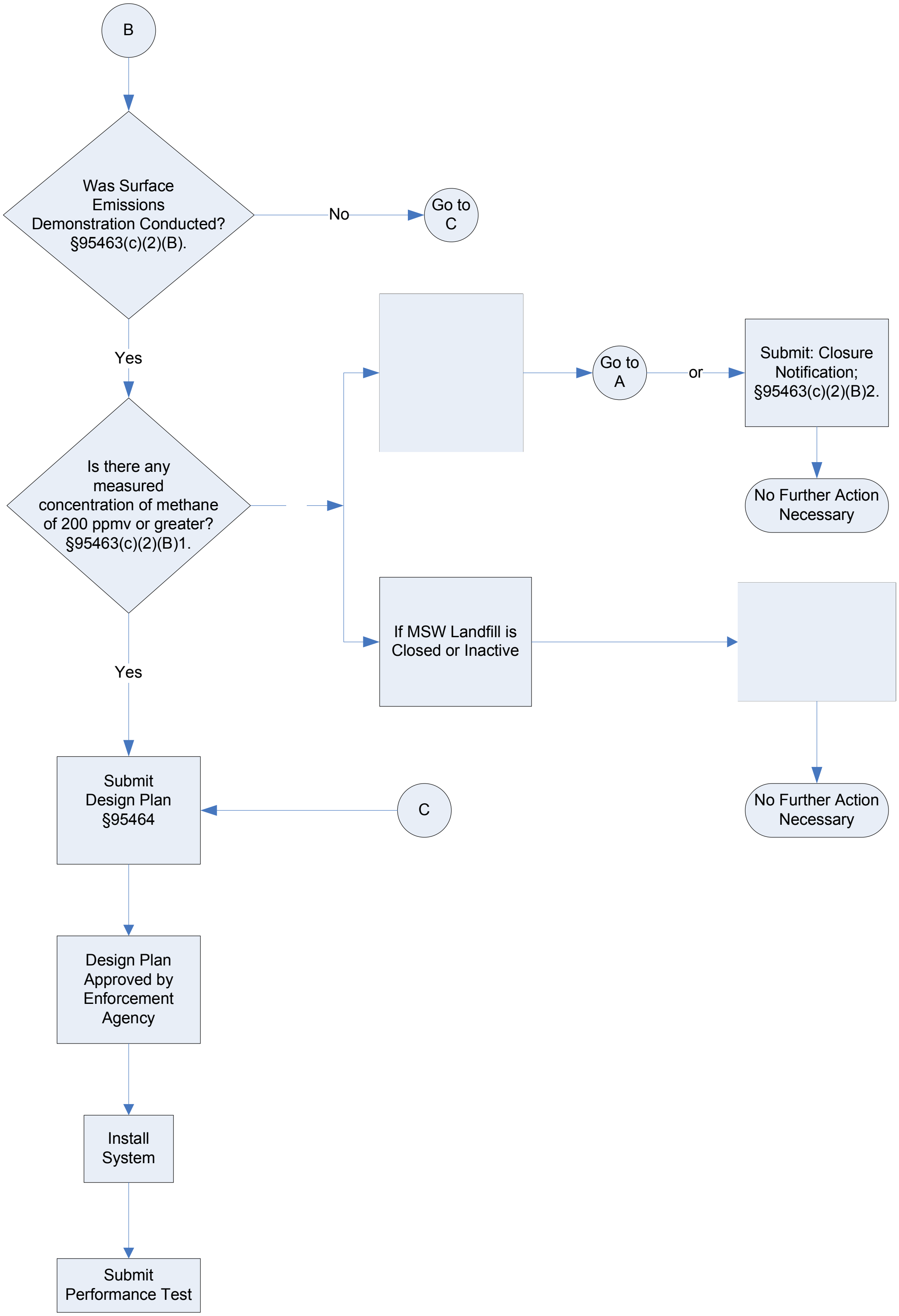


Figure 1. Flow Chart for Determining Control Requirements (Cont.)



Appendix C

Landfill Methane Emissions Methodology

Appendix C

Landfill Methane Emissions Methodology

I. Waste

A. Landfills (IPCC 4A1)

1. <u>Background</u>

Landfills are sites for solid waste disposal in which refuse is buried between layers of dirt so as to fill in or reclaim low-lying ground or excavated pits; they are the oldest form of waste treatment. There are numerous types of landfills accepting different types of waste. The GHG inventory is concerned only with landfills that contain and/or receive biodegradable, carbon-bearing waste. The California Integrated Waste Management Board (CIWMB) has identified 372 such landfills in the State. Most of the waste contained in these landfills (94 percent) is currently under some form of control that reduces the emissions of methane, the principal GHG pollutant generated by landfills.

Landfilled carbon-bearing waste degrades mainly through anaerobic biodegradation. In an anaerobic environment (i.e., without oxygen from the air), water (H_2O) is the source of oxygen (O) for oxidation and becomes the limiting reactant for biodegradation. The water content of a landfill determines how fast the waste degrades. If water is not available, the waste does not degrade. This anaerobic biodegradation process generates approximately equal amounts of CO_2 and CH_4 gas as a byproduct:

Equation 1: Anaerobic biodegradation process

$$2C + 2H_2O \rightarrow CO_2 + CH_4$$

A large fraction (57 percent to 66 percent) of the waste will not degrade under these anaerobic conditions and the carbon it contains is effectively sequestered. This carbon will remain sequestered as long as the landfill's anaerobic conditions persist.

The various gases produced as the waste degrades are collectively called "landfill gas". Landfill gas is an odor nuisance, a source of air toxics and may even be a physical danger to those living near a landfill because the methane it contains is combustible. For these reasons, most landfills in the State (holding over 95% percent) of the waste) are equipped with a gas collection system. However, although those collection systems are designed to collect landfill gas, it is known that a portion of the gas does escape into the atmosphere.

Once collected, landfill gas can simply be vented to the air if the only reason for the collection was to address offsite gas migration issues. Alternatively, the collected landfill gas may be stripped of its non-methane components via carbon adsorption, which main purpose is to reduce odors and/or volatile organic compounds (VOC) and toxics. Carbon adsorption allows most (99 percent) of the CH_4 to escape. Most commonly, the collected landfill gas is combusted, either in a flare (to destroy odors and VOC and toxic components in the gas, or in an engine or turbine to generate electricity.

2. Methodology

ARB staff requested site-specific landfill gas collection data through landfill surveys, but received answers for only certain years and for less than half of the landfilled waste (e.g., approximately 42 percent in 2005). Therefore, staff opted to use a model to estimate landfill emissions for all sites, and used the survey data to supplement these predictions where available.

Staff used the Mathematically Exact First-Order Decay (FOD) model from the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines (IPCC, 2006b). In summary, this model assumes that a fixed fraction of the waste available at any moment will degrade. The amount that degrades over a given amount of time is determined by a factor (*k*), which is tied to the moisture content in the landfill. The *k* values used in the model were obtained from USEPA and are function of the annual precipitation occurring at each landfill; rainfall being used as a surrogate for landfill moisture content. The model assumes that the waste carbon is biodegraded into equal amounts of CO_2 and CH_4 (see Equation 1).

2.1 Model Equations

The inputs to the model are the amount of anaerobically degradable organic carbon (ANDOC), the delay in months before waste begins to decay anaerobically (*M*), the rate at which waste decays (*k*), and the fraction of degraded carbon that is converted into $_{CH4}$ (F_{CH4}). Of these four inputs, three are set by using default values: a six month default for *M*, a 50 percent default for F_{CH4} and USEPA defaults based on rainfall levels for *k*. Only *ANDOC* requires a more detailed method of derivation, which is the focus equation 1 below. The inputs for calculating *ANDOC* are therefore important determinants of landfill emissions estimates.

(a) Anaerobically Degradable Organic Carbon (*ANDOC*)

Equation 2: Anaerobically degradable organic carbon

$$ANDOC = WIP \bullet 0.9072 \bullet \sum_{component} (FW_{component} \bullet DOC_{component} \bullet DANF_{component})$$

Where,

ANDOC	= Anaerobically Degradable Organic Carbon: the amount of waste carbon that is biodegradable in an anaerobic environment (Mg (i.e., 10^6 grams) of carbon)
WIP	= Waste-in-Place: the landfilled waste (wet weight) as reported to the California Integrated Waste Management Board (tons)
0.9072	= Short ton to Mg (a.k.a. tonne or metric ton) conversion
$FW_{component}$	= Fraction of a given waste component in the landfilled waste
$DOC_{component}$	= Degradable Organic Carbon (DOC) content of the given waste component.
$DANF_{component}$	= Decomposable Anaerobic Fraction (DANF) of the given waste component.

With,

Component	= [Newspaper, Office Paper, Corrugated Boxes, Coated Paper, Food, Grass, Leaves, Branches, Lumber, Textiles, Diapers, Construction/Demolition, Medical Waste, Sludge/Manure]

(a.i) Waste-In-Place (WIP)

The California Integrated Waste Management Board (CIWMB) staff provided ARB staff with Waste-in-Place (*WIP*) data in two basic forms: 1) the cumulative amount of waste deposited, by landfill, up to the year 1990 and, 2) the amounts deposited, by landfill, each year from 1991 to 2005 for those landfills still receiving waste after 1990. CIWMB staff also furnished the amounts of green waste and sludge used as daily cover by each landfill from 1995 to 2005. CIMWB staff provided data on 372 landfills known to contain waste that is biodegradable. Landfills containing only inert waste, like ash and masonry from demolition sites, were excluded. ARB staff also received survey data from 30 of these landfills (comprising 41.8% percent of the 2005 WIP) and used them to update the CIWMB data. In most cases, however, these updates were modest.

Yearly amounts of deposited waste are necessary inputs for the IPCC FOD model to work properly. Yearly data were not available before 1990, however, only the cumulative WIP totals in 1990 were known. This led staff to estimate how much of these cumulative amounts were deposited each year from the landfills' opening year to 1990 (or up to their closure year if they closed before 1990). This estimation was made as follows. First, ARB staff inquired about the opening and closure dates for all landfills. CIWMB staff had closure dates for all 372 landfills of interest, but did not have a complete list of opening dates, so an estimate was made for those cases where the opening date was missing. Once these dates were established, the cumulative total of WIP in each landfill was distributed over the pre-1990 years (from opening to 1990, or opening to closure if before 1990) in a manner commensurate to the trend in California's population over those years. As a result, a larger proportion of the waste in place was distributed in the later years of this range than in the earlier ones, since the population kept growing over the time period.

(a.ii) Components of the Waste-in-Place

To determine its DOC and DANF, the WIP must first be disaggregated into its component parts. Disaggregation was done on the basis of waste characterization studies from the CIWMB and the USEPA. The CIWMB studies were conducted in 1999 and 2004; the1999 study was used to characterize waste for 1995 to 2002 and the 2004 study for 2003 and beyond, as suggested by the CIWMB staff. For years prior to 1995, staff used the USEPA study that best applied to a given year. The USEPA did waste characterization studies in 1960, 1970, 1980 and 1990. Staff used the waste profiles from those studies as follows: up to 1964 (1960 survey), 1965-1974 (1970 survey), 1975-1984 (1980 survey) and 1985-1994 (1990 survey). Applying these profiles allowed disaggregating the waste deposited each year into its component parts. The components of interest to estimate TDOC (i.e., those containing biodegradable carbon content) are listed in Table 1.

Table 1: Waste characterization – Percentage of each component in the overall waste in place

Waste Component	***Up to 1964***	***1965 - 1974***	***1975 - 1984***	***1985 - 1994***	***1995 - 2002***	***2003+***
Newspaper	*6.4%*	*6.4%*	*5.9%*	*4.8%*	*4.3%*	*2.2%*
Office Paper	*7.4%*	*8.2%*	*11.6%*	*12.5%*	*4.4%*	*2.0%*
Corrugated Boxes	*13.8%*	*16.2%*	*11.4%*	*10.6%*	*4.6%*	*5.7%*
Coated Paper	*2.5%*	*2.4%*	*2.9%*	*2.5%*	*16.9%*	*11.1%*
Food	*14.8%*	*11.3%*	*9.5%*	*12.1%*	*15.7%*	*14.6%*
Grass	*12.1%*	*10.3%*	*10.1%*	*9.0%*	*5.3%*	*2.8%*
Leaves	*6.1%*	*5.1%*	*5.0%*	*4.5%*	*2.6%*	*1.4%*
Branches	*6.1%*	*5.1%*	*5.0%*	*4.5%*	*2.4%*	*2.6%*
Lumber	*3.7%*	*3.3%*	*5.1%*	*7.0%*	*4.9%*	*9.6%*
Textiles	*2.1%*	*1.8%*	*1.7%*	*4.0%*	*2.1%*	*4.4%*
Diapers	*0.1%*	*0.3%*	*1.4%*	*1.6%*	*6.9%*	*4.4%*
Construction/Demolition	*2.6%*	*2.5%*	*3.5%*	*3.9%*	*6.7%*	*12.1%*
Medical Waste	-	-	-	-	*0.0%*	*0.0%*
Sludge/Manure	-	-	-	-	*0.1%*	*0.1%*

* Dash indicates no data available; percentage assumed to be zero.

The combined amounts of green waste and sludge used as daily cover were included with landfills WIP. According to CIWMB staff, most of the daily cover is green waste, thus ARB staff assumed that 10% of the daily cover amounts were percent sludge and 90 percent green waste. Green waste was further categorized as 50% grass cuttings, 25% leaves and 25% branches, based on USEPA studies (Table 2) Green waste was further split based on USEPA study assumptions that 50 percent is Grass, 25 percent Leaves and 25 percent Branches.

Table 2: Waste characterization of daily cover material

Daily Cover Waste Component	***Assumed Content Percentage***
Sludge/Manure	*10%*
Grass	*45%*
Leaves	*22.5%*
Branches	*22.5%*

(a.iii) Degradable Organic Carbon (DOC) content

Staff obtained values for the Degradable Organic Carbon (DOC) content of solid waste components from USEPA (Newspaper, Office Paper, Corrugated Boxes, Coated Paper, Food, Grass, Leaves, Branches) and from the 2006 IPCC Guidelines (Lumber, Textiles, Diapers, Construction/Demolition, Medical Waste, Sludge/Manure). These values are summarized in Table 3.

Table 3: Degradable Organic Carbon (DOC) content of different MSW components

Waste Component	***DOC Fraction (Mg DOC / Mg wet waste)***	***Source***
Newspaper	*0.465*	*USEPA*
Office Paper	*0.398*	*USEPA*
Corrugated Boxes	*0.405*	*USEPA*
Coated Paper	*0.405*	*USEPA*
Food	*0.117*	*USEPA*
Grass	*0.192*	*USEPA*
Leaves	*0.478*	*USEPA*
Branches	*0.279*	*USEPA*
Lumber	*0.430*	*IPCC*
Textiles	*0.240*	*IPCC*
Diapers	*0.240*	*IPCC*
Construction/Demolition	*0.040*	*IPCC*
Medical Waste	*0.150*	*IPCC*
Sludge/Manure	*0.050*	*IPCC*

(a.iv) Decomposable Anaerobic Fraction (DANF)

Theoretically, all biodegradable carbon-bearing waste can degrade, but only a portion actually degrades in the special anaerobic environment of landfills. The carbon in the waste that does not decompose remains sequestered.

Values for the DANF of different MSW components came from USEPA (Newspaper, Office Paper, Corrugated Boxes, Coated Paper, Food, Grass, Leaves, and Branches), the CEC (lumber) and the IPCC guidelines (default of 50 percent anaerobic decomposition for Textiles, Diapers, Construction/Demolition, Medical Waste, and Sludge/Manure).

Table 4: Decomposable anaerobic fraction (DANF) of the DOC of different MSW components

Waste Component	***Decomposable Anaerobic Fraction***	***Source***
Newspaper	*0.161*	*USEPA*
Office Paper	*0.874*	*USEPA*
Corrugated Boxes	*0.383*	*USEPA*
Coated Paper	*0.210*	*USEPA*
Food	*0.828*	*USEPA*
Grass	*0.322*	*USEPA*
Leaves	*0.100*	*USEPA*
Branches	*0.176*	*USEPA*
Lumber	*0.233*	*CEC*
Textiles	*0.500*	*IPCC*
Diapers	*0.500*	*IPCC*
Construction/Demolition	*0.500*	*IPCC*
Medical Waste	*0.500*	*IPCC*
Sludge/Manure	*0.500*	*IPCC*

(a.v) Overall Waste Profile and Estimate of landfilled Carbon Sequestration

With the data described above, staff calculated the overall waste profile for California (Table 5). Staff also estimated the amount of non-decomposable organic carbon in landfills, that is, the carbon which is expected to remain sequestered until removed from the anaerobic conditions present in landfills (Table 6). Most of the waste in landfills is non-biodegradable. Of that portion that is biodegradable (19% to 24%) most will not decompose in a landfill environment and instead will remain permanently sequestered.

Table 5: Overall waste profile for California - Percentage of each component in the overall waste in place

Waste Type	***Up to 1964***	***1965 - 1974***	***1975 - 1984***	***1985 - 1994***	***1995 - 2002***	***2003+***
Biodegradable Carbon	*23.36%*	*22.96%*	*23.07%*	*23.54%*	*21.78%*	*19.00%*
▪ *Decomposable*	*8.85%*	*8.90%*	*9.47%*	*10.17%*	*7.81%*	*6.72%*
▪ *Sequestered*	*14.51%*	*14.06%*	*13.60%*	*13.37%*	*13.97%*	*12.28%*
Other Materials	*76.64%*	*77.04%*	*76.93%*	*76.46%*	*78.22%*	*81.00%*

Most of the waste in landfills is non-biodegradable. Of that portion that is biodegradable (19 percent to 24 percent) most will not decompose in a landfill environment and instead will remain permanently sequestered.

Table 6: Estimate of carbon sequestration in landfills (million metric tonnes of carbon)

Waste Component	***1990***	***2004***
Newspaper	*0.772*	*0.339*
Office Paper	*0.258*	*0.039*
Corrugated Boxes	*1.092*	*0.567*
Coated Paper	*0.330*	*1.400*
Food	*0.100*	*0.115*
Grass	*0.480*	*0.144*
Leaves	*0.793*	*0.238*
Branches	*0.424*	*0.235*
Lumber	*0.952*	*1.256*
Textiles	*0.198*	*0.210*
Diapers	*0.079*	*0.206*
Construction/Demolition	*0.032*	*0.095*
Medical Waste	*-*	*0.001*
Sludge/Manure	*-*	*0.001*
TOTAL	*5.51*	*4.85*

Note: comprehensive carbon sequestration estimates for all years 1990-2004 are available upon request.

(b) Change in ANDOC

Next, staff used the IPCC FOD model to calculate the change in ANDOC over time, determining how much of the anaerobically degradable organic carbon remains at the end of each year:

Equation 3: Change in anaerobically degradable organic carbon in landfills

$$ANDOCstock_{Year\,(i+1)} = \left\{ \begin{array}{l} ANDOCstock_{year\,(i)} \bullet e^{-k} \\ + ANDOCadded_{year\,(i-1)} \bullet [\frac{1}{k} \bullet (e^{-k \bullet [1 - \frac{M}{12}]} - e^{-k}) - \frac{M}{12} \bullet e^{-k}] \\ + ANDOCadded_{year\,(i)} \bullet [\frac{1}{k} \bullet (1 - e^{-k \bullet [1 - \frac{M}{12}]}) + \frac{M}{12}] \end{array} \right\}$$

Where,

$ANDOCstock_{Year(i+1)}$ = stock of ANDOC remaining un-decomposed at the end of inventory year i, and thus present in the landfill at the beginning of the next year (year i+1), (g)

$ANDOCstock_{Year(i)}$ = stock of ANDOC present in the landfill at the beginning of inventory year i, i.e., remaining un-decomposed at the end of the previous year (i-1), (g)

$ANDOCadded_{Year(i-1)}$ = ANDOC added during the previous inventory year (year i-1), (g)

$ANDOCadded_{Year(i)}$ = ANDOC added during inventory year i, (g)

M = Assumed delay before newly deposited waste begins to undergo anaerobic decomposition (months), default value = 6 months

k = Assumed rate constant for anaerobic decomposition; k = ln2/half-life (years); the half-life being the number of years required for half of the original mass of carbon to degrade (Table 7).

This calculation is performed iteratively for all subsequent years, starting with the landfill opening year and ending with the inventory year of interest.

Table 7: Assumed rate constant values for anaerobic decomposition (k)

Average Rainfall (Inches/Year)	***k value***
<20	*0.02*
20-40	*0.038*
>40	*0.057*

Source: USEPA

(c) Methane Generation

Equation 4; Methane generation in landfills

$$G_{CH4} = F_{CH4} \bullet \left\{ \begin{array}{l} ANDOCstock_{year(i)} \bullet (1 - e^{-k}) \\ + ANDOCadded_{year(i-1)} \bullet [\frac{1}{k} \bullet (e^{-k \bullet [1 - \frac{M}{12}]} - e^{-k}) - \frac{M}{12} \bullet e^{-k}] \\ + ANDOCadded_{year(i)} \bullet [1 - \frac{M}{12} - \frac{1}{k} \bullet (1 - e^{-k \bullet [1 - \frac{M}{12}]})] \end{array} \right\}$$

Where,

G_{CH4}	= CH_4 generated during inventory year i (g)
F_{CH4}	= Fraction of decomposing carbon that is converted into CH_4, default value = 0.5
$ANDOCstock_{Year(i)}$	= Stock of ANDOC present in the landfill at the beginning of inventory year i (g)
$ANDOCadded_{Year(i-1)}$	= ANDOC added during the previous inventory year (year i-1)
$ANDOCadded_{Year(i)}$	= ANDOC added during inventory year i (g)
M	= Assumed delay before newly deposited waste begins to undergo anaerobic decomposition (months), default value = 6 months
k	= Assumed rate constant for anaerobic decomposition; k = ln2/half-life (years); the half-life being the number of years required for half of the original mass of carbon to degrade (Table 7).

(d) Emissions Estimates

Equation 5: CH_4 emissions from landfills

$$E_{CH4} = G_{CH4} \bullet CE_{LFG} \bullet (1 - DE_{LFG}) + G_{CH4} \bullet (1 - CE_{LFG}) \bullet (1 - O_{CH4})$$

Where,

E_{CH4}	= Emissions of CH_4 from landfill (g)
G_{CH4}	= Amount of CH_4 generated by the landfill during the inventory year (g)
CE_{LFG}	= Landfill Gas Collection Efficiency, the fraction of generated landfill gas captured by the collection system (default value = 0.75)
DE_{LFG}	= Landfill Gas Destruction Efficiency, the fraction of CH_4 in the captured landfill gas oxidized to CO_2 (default values = 0.99 for combustion/thermal oxidation, and 0.01 for carbon filtration)
O_{CH4}	= Fraction of uncollected CH_4 that is oxidized to CO_2 in the landfill cover (default value = 0.1)

CIWMB staff provided information about which landfills have gas collection systems and what control method they use, if any. Responses to an ARB survey allowed staff to update a portion of the CIWMB numbers. For years where CIWMB data was lacking on the year of collection system installation (primarily years 1991 - 2003), staff used existing regulatory requirements to help estimate the installation dates. Staff intends to improve the accuracy of collection system installation dates in the future.

Staff assumed that a landfill gained the full benefits of gas collection beginning with the year in which the system was first installed. In the future, as the exact month of installation and start-up operation becomes available, it will be factored in and the collection efficiency for that year may be prorated.

CIWMB staff also provided the type of control landfills are using, including: simple venting to the atmosphere, carbon adsorption, or combustion (flaring, engines, thermal oxidizers, etc.). In the case of combustion, ARB staff assumed that 99 percent of the CH_4 was converted into CO_2 and 1 percent escaped as CH_4. For carbon adsorption, 1 percent of the CH_4 was assumed captured and 99 percent released. For venting 100 percent of the CH_4 was assumed released.

Each site with a gas collection system was assigned a default of 75% percent collection efficiency and a default of 10 percent oxidation for the uncollected landfill gas as it migrates through the landfill cover into the air. Using these default valuesThe defaults of 75 percent for collection efficiency and 10 percent for oxidation fraction has been the object of some debate. Staff recognizes that many values can be found for these factors in the literature and that some site-specific measurements and local estimates do exist. However, given the current lack of rigorous, scientifically-based measurement data, staff chose to use the default values established by USEPA. As better data become available through current and future research, staff will update the collection efficiency and oxidation factors for estimating landfill gas emissions.

(d.i) Use of Site Specific Survey Data

Using the First Order Decay model from the IPCC guidelines, staff estimated the amount of carbon sequestered and the amount of CH_4 emitted by each of the 372 landfills of interest in California.

ARB staff also surveyed landfill operators and some landfills provided site-specific landfill gas collection data for certain years of operations (30 of the 372 landfills submitted site specific survey data). These data were used either to replace or to improve the model's estimates for that landfill.

When staff received landfill survey data for a particular year, it used the survey information in place of the model estimate. However, survey data included only the amount of gas collected, and not the amount generated since landfill operators only know what is measured at the point of collection. To estimate the amount of gas generated, a default collection efficiency of 75 percent was used and the amount of collected gas was divided by 0.75 to obtain an estimate of the generated gas. Then, the estimate of gas generated—based on the amount of gas collected—was used to replace the model estimate for that year.

When an actual value for the CH_4 fraction in landfill gas was reported in the survey, staff used it instead of the general default landfill gas composition assumption of 50 percent CH_4 and 50 percent CO_2. However, because CO_2 specific fractions were not obtained from the site specific survey data (only CH_4 fractions were obtained), it was assumed that whatever was not reported as CH_4 was CO_2. Staff recognizes that N_2 gas and small amounts of O_2 are expected to be present, and therefore not all of the remaining gas (i.e., the fraction that is not CH_4) is CO_2. Nevertheless, the amounts of these other gases were considered to be negligible for the purpose of estimating the CO_2 emissions from landfills. As data improves, this conservative assumption may be revisited.

When landfill survey data was provided for some of the years and not others, staff used the provided years to improve the model estimates for the missing years by interpolating or extrapolating using the model predicted trend for that landfill. For example, if the years 1990-1993 were missing from a set of survey data for a particular landfill, but the year 1994 was available, then the years 1990-1993 were extrapolated from this 1994 data point by following the trend the model showed for that landfill. So if the model indicated that the CH_4 generation in 1993 was 3 percent lower than the 1994 predicted value, the available 1994 value from the survey was multiplied by 97 percent to estimate the 1993 point, and so on. This method of filling missing data preserves a consistent trend that smoothly joins the survey data. The same methodology was used to estimate CO_2 emissions when missing survey data were encountered.

An exception was made to these procedures in the case of survey-reported first years of operation of a collection system. These reported values were not used as a substitute for model estimates, as it was not known if the indicated first year represented a full year of operation. Staff assumed that the second year of reported data was a complete year and used that year as the starting point, ignoring data from the first year. For surveys with collection system data dating back to 1990, staff assumed that the 1990 value represented a full year of operations and always made use of it. Staff made this assumption since data was not available to indicate if 1990 was the first year of operation and no survey data was available for 1989.

(d.ii) Emissions from Landfill Gas Combustion

Emissions of N2O from the combustion of landfill gas are included in the inventory. These emissions are a function of the BTU content of the landfill gas being burned. The amount of landfill gas burned (LFG) is determined from model output for the amount of gas collected and from CIWMB data indicating which landfills burn their captured gas.

Equation 6: N_2O emissions from landfill gas combustion

$$E_{N2O} = LFG \bullet F_{CH4} \bullet HC_{CH4} \bullet EF_{CH4}$$

Where,

E_{N2O}	= N_2O emissions from landfill gas combustion (grams)
LFG	= Landfill gas captured and burned (standard cubic feet)
F_{CH4}	= CH_4 fraction of landfill gas (unitless)
HC_{CH4}	= Heat content of CH_4 (BTU / standard cubic foot)
EF_{CH4}	= N_2O emission factor of CH_4 (grams per BTU)

3. Data Sources

The First order decay model is from the 2006 IPCC guidelines (IPCC, 2006b). Waste characterization data was obtained from studies made by the California Integrated Waste Management Board (CIWMB, 2007d) and by the USEPA (USEPA, 2007b). Degradable Organic Carbon (DOC) content and values for Decomposable Anaerobic Fraction (DANF) were taken from USEPA (USEPA, 2002). DANF data for lumber comes from the California Energy Commission (CEC, 2006). Default values used for DANF and DOC content of waste in place, and CH_4 combustion emission factors were taken from the 2006 IPCC Guidelines (IPCC, 2006b). Default collection capture efficiency and CH_4 oxidation factor values were obtained from the USEPA through personal correspondence (Weitz, 2007). Landfill gas collection, geographic coordinates and control data for California landfills were provided by CIWMB staff through personal communication (Walker, 2007). Average precipitation data for the landfills was extracted from a map published by the NRCS (NRCS, 2007). Methane and nitrous oxide emissions factors are from IPCC Guidelines (IPCC, 2006a).

For a list of yearly activity and parameter values used in the equations, please consult the online documentation annex at:
http://www.arb.ca.gov/cc/inventory/doc/methods_v1/annex_4a_landfills.pdf

4. Future Improvements

More complete, California-specific landfill survey data on landfill gas collection and composition will help improve outputs from the IPCC model. Improved survey data should also establish actual opening dates for landfills and perhaps provide better data on the percent CO_2 content of landfill gas. Better information on the cover types present at landfills and further details on gas collection systems will allow for better collection and oxidation factor estimates. Ongoing research and other studies will be followed closely by staff to improve estimates of landfill gas emissions.

References for Appendix C

CEC, 2006. Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2004. CEC Publication CEC-600-2006-013-SF. Available online: http://www.energy.ca.gov/2006publications/CEC-600-2006-013/CEC-600-2006-013-SF.PDF

CIWMB, 2007d. Solid Waste Characterization Database, California Integrated Waste Management Board, Sacramento. Accessed online, fall 2007, at: http://www.ciwmb.ca.gov/WasteChar/

IPCC, 2006a. 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T., and Tanabe K. (eds). Volume 2, Chapter 2: Stationary Combustion. <http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf>

IPCC, 2006b. 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston HAS., Biennia L., Miwa K., Negara T. and Tanabe K. (eds). Volume 5: Waste. Published: IGES, Kanagawa, Japan. http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol5.html

NRCS, 2007. Map of Average precipitation data for California, US Department of Agriculture National Resources Conservation Service's Geospatial Data Gateway. Accessed online, fall 2007, at: http://datagateway.nrcs.usda.gov/

U.S. EPA, 2002. Solid Waste Management and Greenhouse Gases – A Life Cycle Assessment of Emissions and Sinks. 2nd Edition, May 2002. Exhibit 7.3 page 107. US Environmental Protection Agency, EPA publication 530-R-02-006.

U.S. EPA, 2007b. Municipal Solid Waste Characterization Reports (various years), US Environmental Protection Agency. Accessed online, Fall 2007, at: http://www.epa.gov/epawaste/inforesources/pubs/municipal_sw.htm

Walker, 2007. Personal communication (Collection, Lat/Lon, and Control Data for Landfills) between Larry Hunsaker of CA Air Resources Board and Scott Walker, California Integrated Waste Management Board. Fall 2007.

Weitz, 2007. Personal communication between Larry Hunsaker of CA Air Resources Board and Melissa Weitz, US Environmental Protection Agency. Fall 2007.

Appendix D

Evaluation of Landfill Gas Collection Efficiency

Appendix D

Evaluation of Landfill Gas Collection Efficiency

A. Introduction

This appendix provides a brief overview of the methodology used to estimate the expected collection efficiency that can be reasonably achieved by a well-controlled landfill subject to the proposed regulation to reduce methane emissions from municipal solid waste landfills. As discussed in this staff report, the proposed regulation will provide enhanced control of methane emissions from municipal solid waste landfills by requiring the installation of gas collection and control systems at smaller and other uncontrolled landfills. The control measure also includes requirements for all affected landfills to ensure that gas collection and control systems are operating optimally and that fugitive emissions are minimized.

In order to better understand the proposed regulation's impact on collection efficiency, ARB staff evaluated the collection efficiency values for a well-controlled landfill in Palos Verdes, California by performing air dispersion modeling coupled with actual landfill surface gas measurements conducted by District staff. This landfill is owned and operated by the Los Angeles County Sanitation District (District). The District had previously evaluated the gas collection efficiency at this same landfill using actual surface gas measurements and U.S. EPA's air dispersion model – Industrial Source Complex (ISCST3). However, since U.S. EPA phased out the use of the ISCST3 model in 2006, ARB staff conducted the air dispersion modeling using U.S. EPA's new approved replacement model - AERMOD. Below a brief overview of the approach used to determine the landfill collection efficiency using AERMOD modeling and the previously collected landfill gas measurements at the Palos Verdes landfill.

B. Methodology

1. <u>Data Processing</u>

The following data were obtained from the District:

- Methane (CH_4) concentration measurements from the Palos Verdes landfill surface in irregular time periods, in parts per million (ppm)
- Landfill gas emission rate (as estimated from the collection system)
- Various modeling parameters (area dimension, emission rates, etc.)

ARB staff evaluated the data sets to ensure there were no outliers. Because the measurements were not taken continuously over a one-hour period, staff used the average of any measurements that occurred within the same hour, date, and month and to represent the entire hour for that specific day.

2. AERMET Modeling

The AERMOD model requires meteorological parameters to characterize air dispersion dynamics in the atmosphere. These parameters are estimated by AERMOD's supporting meteorological processing model, AERMET. The meteorological data used in the model were selected on the basis of representativeness and availability. Representativeness is determined primarily on whether the wind speed/direction distributions and atmospheric stability estimates generated through the use of a particular meteorological station (or set of stations) are expected to mimic those actually occurring at a location where such data are not available. Typically, the key factors for determining representativeness are proximity of the meteorological station and the presence or absence of nearby terrain features that might alter airflow patterns. For this study, 2003 meteorological data from the Los Angeles International Airport (LAX) was used. LAX is about one mile away from the Palos Verdes landfill. For the upper air conditions, San Diego-Miramar and Oakland International Airport are two full-time and reliable stations in California. As the Miramar station is much closer to the landfill, it was used in this study. After running AERMET, the hourly meteorological data for the full year of 2003 were created. The processed meteorological data, including surface and upper air, were filtered to retain only hours corresponding to times of the measurements. The filtered meteorological files were rearranged into a time period with consecutive hours.

3. AERMOD Modeling

The recently U.S. EPA approved air dispersion model - AERMOD, rather than ISCST3 (phased out on November 9, 2006), was used to estimate the CH_4 hourly concentrations within the landfill in the same time series order as the measurements. Key model parameters are as follows:

Model:	AERMOD
Run Mode:	hourly concentrations (in $\mu g/m^3$)
Model Option:	area source (polygons)
Dispersion Coefficients:	Urban and Rural
Modeling Domain:	800 m x 800 m
Modeling Resolution:	50 m x 50 m for 256 receptors
Receptor Setting:	Placing on center of each area source (1.5 in)
Meteorological Data:	Surface station - LAX (2003), Upper air - San Diego-Miramar (2003)

4. Calculations of CH_4 Gas Collection Efficiency Based on AERMOD

The modeled CH_4 concentration by AERMOD can be regarded as an equivalent concentration reduction in the landfill surface achieved by gas collection (CH_r) where the model estimates the emissions that are captured through the landfill extraction wells. Gas generation is expressed as the sum of the modeled reduction at the surface due to collection and the measured surface CH_4 (CH_m) due to emissions. Gas collection efficiency is then calculated by Equation 1:

$$E = \frac{CH_r}{CH_r + CH_m} \qquad (1)$$

5. Conversion of Mass Concentration to Volume Concentration

The outputs from AERMOD are reported as mass concentrations for CH_4 (in µg/m^3), while the measured CH_4 were reported as volume concentrations (in ppm). The conversion of mass concentration into volume concentration can be made by Equation 2 at a standard air pressure of one atm condition for CH_4:

$$C_{mass} = \frac{1.95 * 10^5}{T} x C_{ppm} \qquad (2)$$

where C_{mass} is the CH_4 mass concentration (in µg/m^3), C_{ppm} is the CH_4 volume concentration (in ppm), and T is the atmospheric air temperature (in Kevin). Note that all terms are also a function of time.

C. Results

1. Gas Collection Efficiency Derived from AERMOD Modeling

Table 1 presents the gas collection efficiency determined following Equation 1 and using the AERMOD modeled outputs and CH_4 measurements as inputs to the equation. Any hour with modeled zero concentration was not included in the analysis and the corresponding measurement during that hour was also not included. In addition, because there were hours in which there resulted negative CH_4 concentrations after subtracting the background concentration and being corrected for instrument bias, two sets of collection efficiency values are reported in Table 1 - the “collection efficiency” and the “corrected collection efficiency.” “Collection efficiency” represents the results without removing any hours that had negative concentrations of CH_4 and “corrected collection efficiency” represents the results after removing any hours that had negative CH_4 concentrations. As shown in Table 1, the results demonstrate a collection efficiency of about 85 percent for the gas collection system in the Palos Verdes landfill.

Table 1. Gas Collection Efficiency Derived from AERMOD Modeling

	CH4 Conc (ppm)	
	Urban	**Rural**
Measured LF Surface	2.498	2.498
Bias Correction	0.059	0.059
Actual LF Surface	2.557	2.557
Air Background	1.835	1.835
LF Conc (CHm)	0.722	0.722
Corrected LF Conc (CHm)*	**0.879**	**0.879**
Modeled Conc (CHr)**	4.873	4.748
Total Conc (CHr+CHm)	5.595	5.470
Corrected Total Conc (CHr+CHm)	**5.752**	**5.627**
Collection Efficiency	87.10%	86.80%
Corrected Collection Efficiency	**84.72%**	**84.38%**

Note:

1. The hours with measurements being less than the background were excluded for the analysis;
2. The hours with modeled zero concentrations were excluded for the analysis.

2. Distribution of Methane Concentrations over the Landfill

Figure 1 shows the spatial distribution of the modeled CH_4 concentrations over the landfill. The concentrations are averaged over the monitoring time period or all monitoring hours. The distribution is nearly uniform except near the landfill boundaries. This implies that the results are not sensitive to the locations of receptors within the landfill, and that the gas collection efficiency approach presented above based on the overall average measurements and average modeled concentrations is reasonable. In fact, a grid-by-grid analysis versus the overall average analysis showed a difference of about 1 percent (analysis not shown).

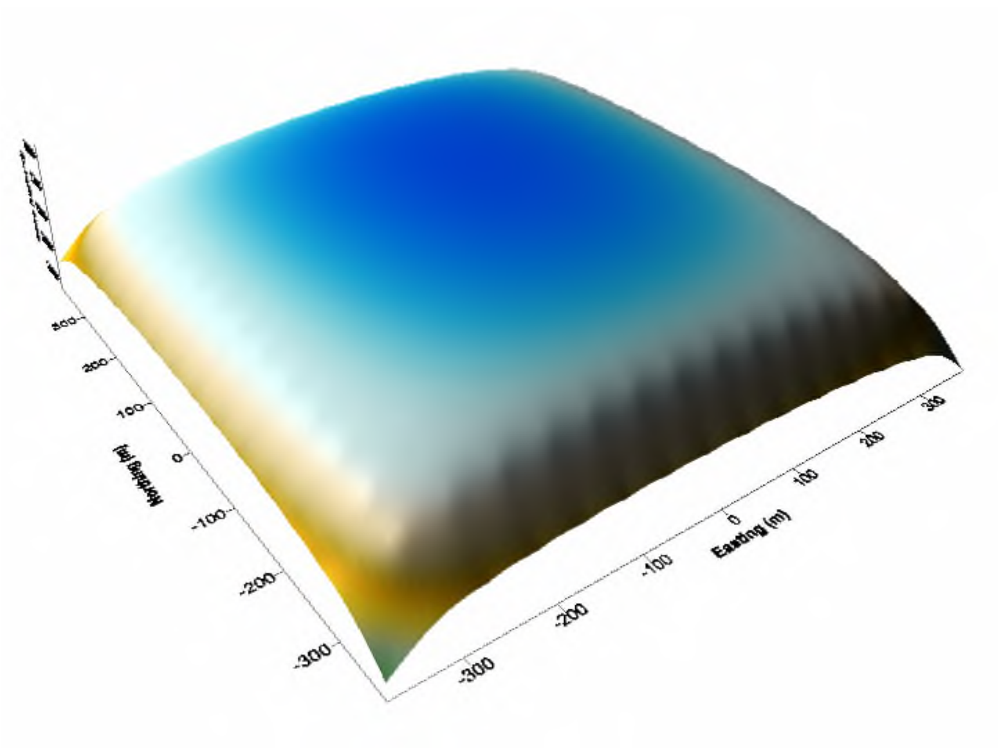


Figure 1. Spatial Distribution of the Modeled CH_4 Concentration over the Landfill Surface

3. Distribution of Methane Concentrations Beyond the Landfill

To investigate how the CH_4 concentrations change with downwind distance outside of the landfill, a modeling run was conducted by placing the receptors along the central line of the domain in the predominate wind direction at distances of 0, 1, 5, 10, and 20 m from the landfill boundary. The modeled CH_4 concentrations are normalized to those that are located on the boundary and on the center of the modeling domain, respectively. The results are summarized in Figure 2. As shown in Figure 2, the CH_4 concentrations decrease with the downwind distance rapidly. At 10 meters, the CH_4 concentrations have decreased by about 40 percent and at 20 meters by about 60 percent compared with those at the boundary.

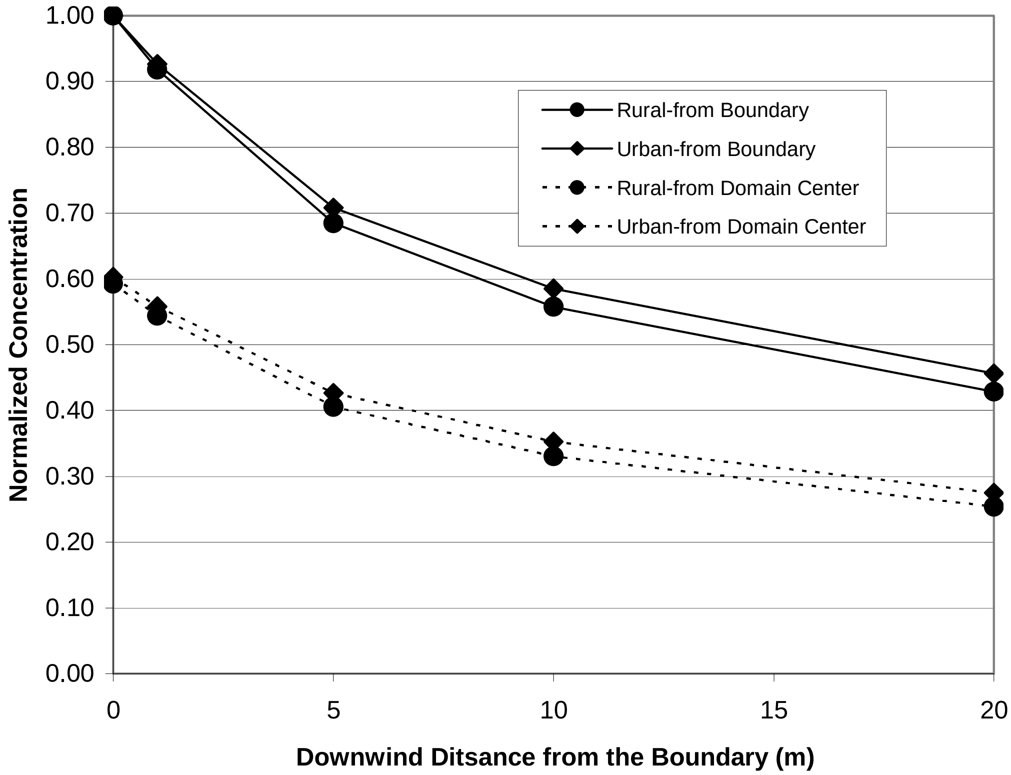


Figure 2. Normalized CH_4 Concentrations vs. Downwind Distances

4. Distribution of Methane Concentrations over Receptor Heights

To see how the modeled CH_4 concentrations change with receptor heights, we conducted a sensitivity study using AERMOD by placing receptors on the center of the modeling domain with different heights – 0, 0.5, 1, 2.5, 5, and 10 meters above the landfill surface. The results are normalized and presented in Figure 3. It is apparent that the setting of receptor heights plays an important role in determining the gas collection efficiency. For this study, the height of all receptors was placed in a height of 1.5 inches which was identical to the measurement height.

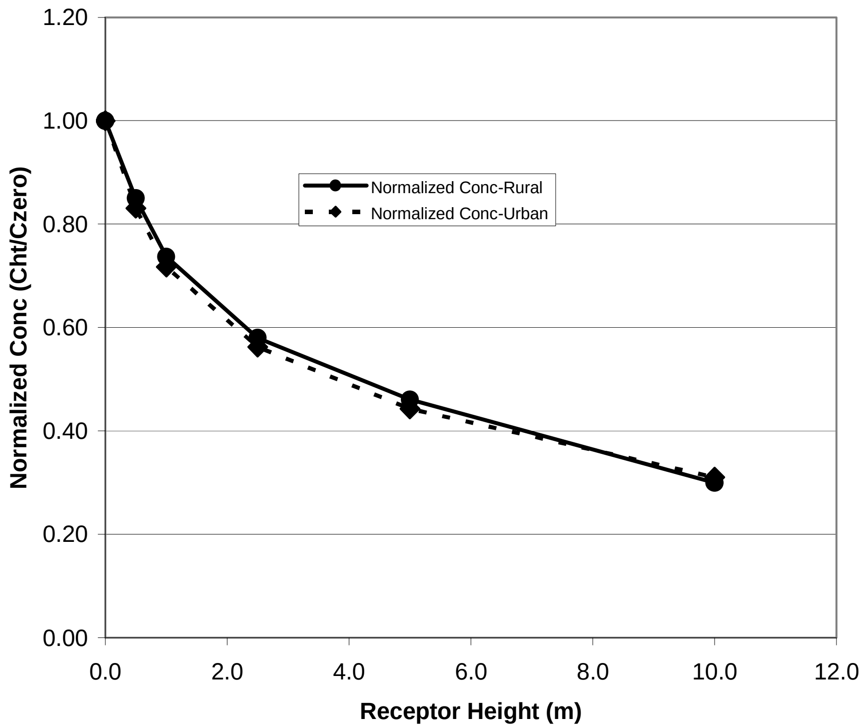


Figure 3. Normalized CH_4 Concentrations vs. Receptor Heights

Appendix E

AB 32 Requirements and Criteria

Appendix E

AB 32 Requirements and Criteria

This appendix provides a discussion of why staff believes the proposed regulation meets the limited criteria applicable to discrete early action measures, as well as furthers the later requirements of State law applicable to GHG measures generally.

- **The State Board shall adopt rules and regulations in an open public debate process to achieve the maximum technologically feasible and cost effective greenhouse gas emission reduction from sources or categories of sources.**

  Staff developed the proposed regulation to reduce methane emissions from MSW landfills in consultation with stakeholders in an open, public process through three public workshops and seven landfill workgroup meetings. See Chapter V of this report for additional details.

  The proposed regulation is technologically feasible and is similar to existing federal and district landfill gas rules for NMOCs and VOCs. It was developed based on information obtained from ARB's landfill inventory, and from discussions with representatives from industry, federal, State, and local agencies, and environmental organizations. Many MSW landfills that are already using gas collection and control systems to minimize NMOC emissions are familiar with the requirements in the proposed regulation, except in the areas of enhanced surface emissions monitoring, component leak testing, and methane destruction efficiency requirements for the control devices. Control devices that are subject to and complying with existing federal requirements for MSW landfills would meet the destruction efficiency requirements for methane in the proposed regulation. A detailed discussion of requirements of the proposed regulation is included in Chapter V.

  The proposed regulation is cost-effective, with an estimated cost-effectiveness of about $9 per metric ton of CO_2E reduced. The cost estimates used to calculate the cost-effectiveness are based on discussions with industry, local air districts, CIWMB staff, and landfill gas control equipment manufacturers. A detailed discussion of the economic impacts is included in Chapter VII.

- **Design the regulations, including the distribution of emissions allowances where appropriate, in a manner that is equitable, seeks to minimize costs and maximize the total benefits to California, and encourages early action to reduce greenhouse gas emissions.**

  The proposed regulation was designed to achieve the maximum GHG reduction benefit while minimizing the cost to the affected industry. Data on 367 landfills known to contain waste that is biodegradable was provided by CIMWB and used to develop ARB's landfill inventory. The landfill inventory was used to develop requirements for MSW landfills that considered the landfill's size, age, methane generation rate, and ability to support the continuous operation of a gas control device without the use of supplemental fuel, and the ability to reduce emissions in a cost-effective manner.

In order to exclude landfills that are not likely to generate landfill gas in sufficient quantities to be collected and controlled (e.g., older, closed landfills or low emission landfills located in arid areas of the state), the proposed regulation establishes thresholds for landfill size, landfill gas heat input capacity (or methane generation flow rate). In addition, the proposed regulation applies only to MSW landfills that received (or will receive) solid waste after January 1, 1977. Hazardous waste landfills and landfills containing only inert waste, like ash and masonry from demolition sites, are exempt.

To further reduce costs to MSW landfill owners and operators, the proposed regulation contains an incentive to increase the walking space pattern (from 25 feet to 100 feet) if there are no exceedances of the surface emissions standards after four consecutive monitoring periods. In addition, closed or inactive MSW landfills would be allowed to decrease their surface monitoring from quarterly to annually.

- **Ensure that activities undertaken to comply with the regulations do not disproportionately impact low-income communities.**

The decrease in methane emissions will occur statewide where MSW landfills are located, which is typically far from residential areas. Any residents living near a MSW landfill will receive the benefit of lower GHG emissions; lower exposure to toxic contaminants and odorous compounds contained in landfill gas, as well as a potential decrease in possible explosions caused by offsite gas migration.

- **Ensure that entities that have voluntarily reduced their greenhouse gas emissions prior to the implementation of this section receive appropriate credit for early voluntary reductions.**

The proposed regulation provides labor-saving incentives for landfills that can demonstrate compliance with the surface emission standards for four consecutive quarters (see Chapter V). However, there are a few landfills which may be able to demonstrate that they have been compliant with the surface emission standards for the previous three years. The proposed regulation allows these landfills to take advantage of the labor-saving incentives when the regulation becomes effective if the appropriate documentation can be provided.

- **Ensure that activities undertaken pursuant to the regulations complement, and do not interfere with, efforts to achieve and maintain federal and state ambient air quality standards and to reduce toxic air contaminant emissions.**

The proposed GHG emissions limits are not expected to cause an increase in the emissions of criteria pollutants or toxic air contaminants (TAC) with the possible exception of a slight increase in oxides of nitrogen (NO_x) emitted from certain types of gas control devices such as internal combustion engines (IC engines). The proposed regulation will not interfere with local air district requirements for controlling VOC and TAC emissions from MSW landfill operations because GHG emission limits are not required by local air district rules and the control technologies are complementary.

- **Consider cost-effectiveness of these regulations.**

  The cost-effectiveness of the proposed regulation is about $9 per metric ton of CO_2E reduced, which is equivalent to an increase of about 10 cents per month to the waste disposal cost per California household. See Chapter VII and Appendix F for further discussion.

- **Consider overall societal benefits, including reductions in other air pollutants, diversification of energy sources, and other benefits to the economy, environment, and public health.**

  The proposed requirements for MSW landfills are not expected to cause any significant adverse impacts to society or the environment. California will benefit from the reduction of methane emissions. The proposed regulation will not cause a significant increase in VOC or TAC emissions, however, a slight increase in NO_x emissions may occur in the unlikely event a landfill owner or operator selects an IC engine for gas control and energy recovery purposes. ARB staff has concluded that no adverse environmental impacts should occur from adoption of and compliance with the proposed regulation.

  Reducing methane emissions from MSW landfills will also remove NMOCs that would have otherwise been emitted. The potential benefits of the proposed regulation on reducing explosive gas migration, odors, and water quality impacts have not been quantified. See Chapter VI for further discussion.

- **Minimize the administrative burden of implementing and complying with these regulations.**

  The administrative burden to landfill owners or operators complying with the proposed regulation is reduced by minimizing duplication of reporting efforts. For reporting purposes, owners or operators may submit equivalent documents (e.g., district permits or compliance plans) in place of the documents required in the proposed regulation provided that they contain the necessary information required by the proposed regulation and the information is clearly identified in the equivalent documents. ARB staff expects that most local air districts will request delegation from ARB to implement and assist with the enforcement of the proposed regulation and incorporate that effort in conjunction with their existing landfill programs.

Additionally, ARB is developing a landfill gas tool to assist owners and operators in estimating their landfill's fugitive methane emissions, potential landfill gas generation rate, and landfill gas heat input capacity.

- **Minimize leakage.**

  Leakage occurs when an emission limit set by the State causes manufacturing or other activities and their associated GHG emissions to be displaced outside of California. If leakage were to occur, jobs and other economic benefits to California would be lost. No leakage is expected from the proposed regulation. ARB staff believes that the regulation would not create a situation where MSW landfills located in California would be placed in a competitive disadvantage compared to MSW landfills located out-of-state. In most cases, it is infeasible to transport wastes very long distances.

- **Consider the significance of the contribution of each source or category of sources to statewide emissions of GHGs.**

  In California, MSW landfills are the second largest anthropogenic source of methane (ARB, 2009). ARB staff estimates that fugitive emissions of methane from MSW landfills represent about 1 percent of the statewide gas GHG inventory. The total projected reductions that will be achieved from landfills subject to the proposed regulation are about 1.2 $MMTCO_2E$ in 2010, 1.4 $MMTCO_2E$ in 2015, and 1.5 $MMTCO_2E$ in 2020. While this reduction is somewhat modest, it is necessary in order to achieve the long-term GHG emission reduction goals. When the reduction is considered in conjunction with current and future GHG emission reductions in other sectors, the total reductions are significant.

- **The GHG gas emissions reductions achieved are real, permanent, quantifiable, verifiable and enforceable by the state board.**

  ARB staff believes that the emissions and emission reductions for MSW landfills operations are real. The emissions and emission reductions were determined using the Mathematically Exact First-Order Decay model from the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines (IPCC, 2006) and through landfill surveys requesting site-specific landfill gas collection data from landfill owners and operators. The GHG reductions are verifiable through annual reporting and recordkeeping requirements included in the proposed regulation. These requirements also support enforcement efforts. Sources installing gas control devices to comply with the proposed regulation are also subject to local air district permitting requirements. Once the proposed regulation is approved by the Office of Administrative Law, the proposed regulation will become State law and enforceable by the Board.

- **For regulations, the reduction is in addition to any GHG emission reduction otherwise required by law and regulation, and any other greenhouse gas emission reduction that otherwise would occur.**

  The proposed regulation for reducing methane emissions from MSW landfills is the first GHG regulation affecting this industry. No other local, State, federal, or other requirements, specific to reducing methane emissions from MSW landfills in California, are known to exist. While there are federal and local requirements applicable to MSW landfills, the proposed state regulation demonstrates GHG emission reductions beyond what can be expected from existing requirements.

- **If applicable, the GHG emission reduction occurs over the same time period and is equivalent in amount to any direct emission reduction required pursuant to this division.**

  This requirement is not applicable to the proposed regulation for MSW landfills because it achieves its emission reductions as direct reductions.

- **The state board shall rely upon the best available economic and scientific information and its assessment of existing and projected technological capabilities when adopting the regulations required by the law.**

  ARB staff used the best available economic and scientific information to develop the proposed regulation for reducing methane emissions from MSW landfills. Chapter VII includes a detailed description of the economic impacts of the proposed regulation. Chapter III discuses the management of MSW, the methane generation process, methods for optimizing collection efficiencies, and control technologies for reducing methane emissions from MSW landfills.

Appendix F

Economic Impact Analysis Methodology

Appendix F

Economic Impact Analysis Methodology

A. Limitations and Scope of This Analysis

Landfills vary in size, geometry, deposited waste composition, type of cover, topography, surrounding area geological characteristics, and local climate. These factors and others act in dynamic combination to affect both the rate of landfill gas production and its duration.

Due to the complex interaction of the above-mentioned factors, comprehensive site assessments are performed as a preliminary step in developing a design plan for installation of a landfill gas collection and control system. A site assessment includes on-site measurement and analyses of the above-mentioned factors that influence collection and control system design. ARB staff acknowledges that these steps are critical in designing and implementing a collection and control system. When examining landfills as an entire statewide emission source category, ARB does not have the resources to perform individual site assessments and prepare comprehensive design plans for all of the affected landfills in order to develop cost estimates.

ARB cost estimates are based on average or typical costs for the operations or actions necessary to comply with the proposed regulation, with the caveats and limitations inherent in using average or typical cost information; it is acknowledged that the actual costs to an affected landfill may be lower or higher than estimated, but the total cost to all affected landfills is expected to be consistent with stated estimates.

The individual landfill compliance threshold trigger dates stated in this analysis are generated for cost estimation purposes only and are not intended to indicate actual compliance dates. Actual compliance dates for individual landfills should be determined by the methods specified in the proposed regulation.

It should be noted that this analysis assumes the scenario where the sole compliance control method used is enclosed flare technology. Many landfills, especially larger ones, successfully employ various alternative technologies to use the captured landfill gas to generate energy for use at the landfill or for other purposes. Due to the specialized nature and objectives of these projects and their costs, no attempt was made to include these projects in the cost analysis nor predict the future rate at which landfills operators may choose this compliance option. To the extent that these projects produce a profit, compliance costs may be reduced for those landfill operations that choose this type of compliance option.

The analysis approach method used for this proposed regulation is consistent with methodologies used for other air quality regulations, but differs from the traditional analysis approach typically used in engineering economic analyses. In traditional engineering economic analyses, analysis methods are used to determine the point at which a selected parameter is maximized while the cost is minimized (highest cost/benefit ratio). This approach is not used in this analysis. For this and other air quality regulations, the setting of air quality standards or levels are primarily based upon technical feasibility determinations and maximizing public health protection, with compliance costs being a secondary concern.

This analysis is an estimate of the incremental cost of the proposed regulation to both businesses (private) and government agencies (local, State, federal, tribal, and military). Incremental costs are the costs (or savings) to an affected landfill resulting from compliance actions required by the proposed regulation. These costs do not include the normal cost of operation ("cost of doing business") encountered without the proposed regulations' requirements.

B. Methodology

Using individual landfill data obtained from the California Integrated Waste Management Board (CIWMB) (CIWMB, 2009), the 218 affected California landfills were separated into two categories, those that are estimated to be subject to reporting requirements only, and those that would be subject to reporting requirements as well as monitoring and possibly control requirements. The data used to determine the appropriate cost category included: waste-in-place (WIP) in tons projected for the year 2020 (target year for emission reductions for this proposed regulation under the AB 32 guidelines), landfill opening and closing (projected if still open) dates, existing control type (if any), local air district location (used to determine appropriate monitoring costs), and design size (acres). Costs for these two categories were calculated separately.

Table F-1 (next page) shows the cost categories and the parameters that place landfills into those categories.

Table F-1. Landfill Cost Categories (with > 450,000 Tons WIP and >= 3.0 MM Btu/hr)

Cost Category	Applicability
Capital (initial)	- Uncontrolled Landfills - Landfills w/ Open Flares[1]
Operation and Maintenance	- Uncontrolled Landfills - Landfills w/ Open Flares
Monitoring	- Controlled Landfills - Uncontrolled Landfills - Landfills w/ Open Flares
Reporting	- All Affected Landfills

1. Treated as a separate category because these landfills are required to install enclosed flares (with associated costs) by 2018.

C. Costs to Landfills Subject to Reporting Only Requirements

For the landfills forecast to be subject only to the reporting requirements of the proposed regulation (72 landfills), the costs were determined based on forecast waste-in-place data and calculated annual gas heat capacity. This group of landfills was further divided into two subgroups, those expected to need to file waste-in-place reports only (32 landfills) and those expected to file both report types (40 landfills). Neither subgroup is projected to need to comply with the monitoring requirements nor install gas collection and control systems.

The cost calculations for both the waste-in-place and landfill gas heat input capacity reports are shown on Worksheet 3 (Cost Subtotals) under Items 1 and 2. The labor rates selected are the mean hourly rates from the United States Bureau of Labor Statistics, for the San Francisco-Oakland-Fremont, California area (highest cost area of California) (USDL, 2009a). Since these labor rates are the latest available (May 2007), they are adjusted to year 2008 dollars using Adjustment Factor 1 in Table F-2 on the next page. An adjustment for benefits, etc., is made using Adjustment Factor 2, an assumed 50 percent markup of labor costs to estimate the cost to an employer of an employee (USDL, 2009b). The markup was based on observed labor markup rates of 37 percent to 46 percent for federal, State, and local government employment, as well as for the private sector. The Adjusted Rates are used for hourly labor costs in this analysis.

Table F-2. Adjusted Hourly Labor Rates

Occupation	Unadjusted Rate ($/hr)	Adjustment Factor 1	Adjustment Factor 2	Adjusted Rate ($/hr)
Civil Engineer[1]	39.22	1.05	1.5	61.77
Civil Engineering Technician[2]	30.10	1.05	1.5	41.41
Secretaries, Exc. Legal, Medical, and Exec.[1]	27.84	1.05	1.5	43.85

1. These rates are used to calculate the reporting costs.
2. This rate is used to calculate monitoring costs.

For preparation and submittal of both types of reports, it is assumed that the services of both a Civil Engineer and a Secretary will be needed. The waste-in-place reports required by the proposed regulation are also required by CIWMB on a less frequent basis than ARB; it is expected that the same report (with suitable updating) can be submitted to satisfy the waste-in-place requirement.

The per-report cost is used along with the operational status (open or closed/inactive) data for the affected landfills to determine the total reporting cost per landfill and also by owner/operator status (private and government) categories.

D. Costs to Landfills Subject to Reporting, Monitoring, and Control Requirements

Affected landfills in this group are potentially subject to incur compliance costs in all four of the cost categories listed in Table F-1.

Each affected landfill is listed in Worksheet 2 (MSW-Accepting Landfills Forecast to be Subject to Control Requirements); under each listing are four rows, each corresponding to one of the cost categories. (Unit costs are itemized and calculated on Worksheet 3 (Cost Subtotals.)) These rows are used to calculate the cost for that category for the landfill, if it is expected to incur expenses in that category. These calculations are as follows:

First Row: Used to calculate lump-sum and uniform annual payments for capital expenditure for landfills that will: 1) Need to install collection/control systems (landfills with no existing controls or carbon adsorption control), or 2) Those that will need to install enclosed flares (those currently equipped with open flares) by 2018, per the proposed regulation's requirements. Landfills with existing combustion control systems are expected to meet the proposed regulation's control efficiency requirements without incurring any additional costs, so for these landfills this row is blank.

1) Collection and control system costs for landfills with no existing collection and control systems are calculated using the maximum waste footprint (expressed in acres) supplied by CIWMB and multiplied by a per-acre cost (USEPA, 2009). The per-acre

cost is adjusted to year 2008 dollars under Heading 5a (Installation of New Collection and Control System--Capital Cost Landfills) on Worksheet 3 (Cost Subtotals).

2) For landfills that will need to install enclosed flares, the predicted maximum heat input (in MMBtu/hr) is used to look up the appropriate enclosed flare cost information on Worksheet 3 under Heading 4, Upgrade of Existing Collection/Control System--Capital Cost. It should be noted that these costs are approximate, given the instability of material and labor costs, as well as site specific issues such as electrical service costs. It is assumed that none of the landfills with open flares will be able to continue operating them after the year 2018 (though under certain conditions it may be permissible to do so), and that all open flares will be replaced with enclosed flares in the year 2018.

For both control scenarios listed under 1) and 2) above, a 15-year amortization period is assumed, and the costs are expressed as a series of uniform payments starting in the compliance year. These costs are for the design, siting, and initial equipment costs only; annual operation and maintenance costs are discussed in the next section.

Second Row: Used to calculate annual operation and maintenance (O&M) costs. For landfills that will need to install collection and control systems or upgrade to an enclosed flare, operation and maintenance costs are considered a compliance cost. This is due to the assumption that these costs were either previously not incurred by the landfill or were at a significantly lower level, in the case of open flares. O&M costs are calculated as the product of the maximum waste footprint of the landfill (expressed in acres) multiplied by a per-acre cost (U.S. EPA, 2009) adjusted to year 2008 dollars. Also included in the total O&M cost is an allowance ($25,000/yr) for an annual emissions source test, which is typically required by a local air district as a permit condition.

As with the capital costs discussed in the First Row above, landfills with existing combustion control systems are expected to meet the proposed regulation's control efficiency requirements without incurring any additional O&M costs, so for these landfills this row is labeled "Existing".

Third Row: This row is used to calculate monitoring costs. Costs for emission monitoring are calculated using the rates on Worksheet 3, under Item 3b, Surface Emissions/Control & Collection System Monitoring--Cost per Landfill-Acre. Emission monitoring work may be performed by landfill operations staff or outsourced. Due to the lack of data on the current extent of outsourced monitoring work as well as the recognition that the extent may change over time (as landfills decide to outsource the work or bring it in-house, or vice-versa), this analysis assumes that all landfills will perform their own monitoring work, and that the work will be performed by a Civil Engineering Technician (see Table F-2 for hourly rate).

Note that two different per-landfill acre rates are used, one for landfills located in the SCAQMD, and a second for all others. Different rates are used due to the differences in expected compliance actions.

Landfills in the SCAQMD are currently performing surface and collection/control equipment emission monitoring that is substantially equivalent to the requirements of the proposed regulation. Compliance for these SCAQMD landfills also includes landfill surface integrity repair work (landfill cover repairs) to mitigate emissions and meet the emission limits under SCAQMD Rule 1150.1. For these reasons, the additional or incremental cost for monitoring and surface integrity work to comply with the proposed regulation is expected to be significantly less than that for non-SCAQMD landfills.

The monitoring cost rate for non-SCAQMD landfills takes into account an increased amount of monitoring time per acre to meet a more stringent standard than either local air district (non-SCAQMD) or U.S. EPA standards. In addition to a higher monitoring cost rate, a $50/acre average allowance for increased landfill surface integrity work (landfill cover repairs) is included. This allowance is included to account for increased landfill surface repair work necessary to meet the emission standards of the proposed regulation. It is an assumption based on landfill cover repair cost allowances submitted in selected reviewed landfill closure plans; there are several variables influencing the actual cost, which cannot be predicted with any degree of certainty. These variables include: availability of on-site heavy equipment such as loaders, graders, etc. (availability more common for open landfills); need to contract out surface repair work, i.e., bring in equipment and personnel to do work; availability of fill material; and present and future condition of the landfill cover.

Monitoring costs for all landfills include a one-time, upfront $48,000 allowance for purchasing monitoring and related calibration equipment, though it is recognized that many landfills already subject to emission monitoring requirements may already possess monitoring equipment or have contracts in place for monitoring work.

Fourth Row: Used to calculate the reporting costs incurred by a landfill. The same methodology is used as for the landfills in the Reporting Only cost category, please see Section C above for an explanation of the calculation process.

The compliance costs in each of the four categories described above are summed by category at the bottom of Worksheet 2 for all affected landfills and also by ownership status (for businesses and government agencies).

E. Total Cost of Proposed Regulation to Businesses and Government Agencies

The total cost of the proposed regulation (except for enforcement and related costs to ARB) to directly-affected businesses and government agencies is summarized in Worksheet 9.

Costs to State agencies (other than those related to compliance by affected landfills) are outlined and calculated in Sections 6a through 6e of Worksheet 3 (Cost Subtotals.) These non-landfill related State agency costs are only expected to be incurred by ARB in activities related to the enforcement, monitoring, compliance, and outreach efforts related to the proposed regulation.

References for Appendix F

CIWMB, 2009. California Integrated Waste Management Board. Solid Waste Information System file downloaded from: http://www.ciwmb.ca.gov/SWIS/Search.aspx#DOWNLOAD January 7, 2009.

Ford, 2009. April 21, 2009 e-mail correspondence from Leslie Ford, ARB to Jon Manji, ARB.

Judge, 2009. Personal Communication, Hardip Judge, ARB, to Jon Manji, ARB. April 7, 2009.

Locke, 2009a. April 7, 2009 e-mail correspondence from Tim Locke, John Zink Company, to Jon Manji, ARB.

Locke, 2009b. April 8, 2009 e-mail correspondence from Tim Locke, John Zink Company, to Jon Manji, ARB.

USDL, 2009a. United States Department of Labor, Bureau of Labor Statistics. Occupational Employment Statistics. May 2007 Metropolitan and Nonmetropolitan Area Occupational Employment and Wage Estimates. Website Accessed, March 22, 2009. http://www.bls.gov/oes/2007/may/oes_41860.htm

USDL, 2009b. United States Department of Labor, Bureau of Labor Statistics. News Release: Employer Costs for Employee Compensation--December 2008. USDL: 09-247. March 12, 2009.

U.S. EPA, 2009. United States Environmental Protection Agency, Landfill Methane Outreach Program. LFG Energy Project Development Handbook, Chapter 4, Project Economics and Financing, pg. 4-3. Online Publication: Website Accessed, March 23, 2009. http://epa.gov/lmop/res/pdf/pdh_chapter4.pdf

This Excel file with 5 spreadsheets, is part of Appendix F, STAFF REPORT: INITIAL STATEMENT OF REASONS
FOR THE PROPOSED REGULATION TO REDUCE METHANE EMISSIONS FROM MUNICIPAL SOLID WASTE LANDFILLS

California Air Resources Board, Sacramento, CA

Description of Terms and Columns (also see Excel comment boxes on worksheets)

Name	**Description**
CO	County Number
AB	Air Basin Abbreviation
DIS	District Abbreviation
CIWMB SWIS File Number	California Integrated Waste Management Board (CIWMB) Solid Waste Information System (SWIS) ID
#	A number to indicate how many landfills are in that row (usually 1, but sometimes 2 or 3 may be grouped into a single row)
Facility/Site Name	From SWIS
Open Year	From SWIS or Survey, where it is red and in parenthesis, it means this was not available and ARB estimated it.
Close Year	From SWIS or Survey
1990 WIP (Tons)	Cumulative Waste-In-Place (WIP) for all years up to 1990 in short tons (Tons)
2005 WIP (Tons)	Cumulative Waste-In-Place (WIP) for all years up to 2005 in short tons (Tons)
"Current" 2006 Control Type	Type of control for captured LFG (based on the most current 2006 CIWMB data or Survey data)
2020 Reductions	Estimate of reductions from each landfill if they install gas collection with combustion as the control method

File Index	(Worksheet Tab Name)/Worksheet Title
	(Read Me)/This is the worksheet that you are now reading.
Worksheet 1	(Landfills_(All)/Total Number of CA MSW-Accepting Landfills
Worksheet 2	(Landfills_Controlled)/MSW-Accepting Landfills Forecast to be Subject to Control Requirements
Worksheet 3	(Cost_Subtotals)/Cost Subtotals
Worksheet 4	(Cost-Effectiveness)/Estimated Cost-Effectiveness
Worksheet 5	(Cost_Summary)/Cost Summary

Worksheet 1

Total Number of CA MSW-Accepting Landfills

3/19/2009

Source: California Integrated Waste Management Board

Landfill Model CH_4 Emissions (April 3, 2008)

CO	AB	DIS	CIWMB SWIS File Number	Count [a]	Facility/Site Name	Max. Waste Footprint (acres)	Open Year [b]	Close Year	1990 WIP (Tons)	2006 WIP (Tons)	2020 WIP (Tons)	Year LFG Capture	"Current" 2006 Control Type
19	SC	SC	19-AK-0084	1	Paramount Dump	17.4	**1921**	1948	250,000	250,000	250,000	2004	Venting
19	SC	SC	19-AA-0580	1	Blanchard Street Dump	20	**1931**	1958	250,000	250,000	250,000		
19	SC	SC	19-AQ-0005 19-AQ-0014	2	BKK Carson	300	1948	1959	500,000	500,000	500,000		
37	SD	SD	37-AA-0026	1	Mission Bay Landfill #1	115	1952	1959	750,000	750,000	750,000		
19	SC	SC	19-AA-0581	1	Cogen	28	1951	1959	750,000	750,000	750,000		
19	SC	SC	19-AQ-0010	1	Garden Valley 1 and 2	29	**1932**	1959	3,000,000	3,000,000	3,000,000		
36	SC	SC	36-CR-0059	1	Waterman LF	24	**1933**	1960	300,000	300,000	300,000	2006	Combustion
30	SC	SC	30-AB-0356 30-AB-0359	2	Longsdon Pit	12	1957	1960	400,000	400,000	400,000		
19	SC	SC	19-AK-5004	1	City Dump & Salvage 2	8	**1934**	1961	75,000	75,000	75,000	2004	Venting
19	SC	SC	19-AK-5017	1	City Dump & Salvage 4	9	**1934**	1961	80,000	80,000	80,000	2004	Venting
30	SC	SC	30-AB-0166	1	Sparks-Rains LF	18	**1934**	1961	258,300	258,300	258,300	1999	Combustion
19	SC	SC	19-AR-1199	1	Branford LF	160	1957	1961	435,000	435,000	435,000		
19	SC	SC	19-AK-5003	1	City Dump & Salvage 1 & 3	100	1940	1961	1,000,000	1,000,000	1,000,000	1995	Combustion
37	SD	SD	37-AA-0027	1	Hillsborough	16	**1935**	1962	350,000	350,000	350,000	1996	Combustion
30	SC	SC	30-AB-0014	1	Gothard Street Landfill	11	1956	1962	813,200	813,200	813,200	2000	Venting
37	SD	SD	37-AA-0017	1	Duck Pond	2.5	**1936**	1963	25,000	25,000	25,000	1996	Combustion
19	SC	SC	19-CR-5517	1	Gaffey St.	17	1955	1963	900,000	900,000	900,000	2000	Carbon
19	SC	SC	19-AA-0778	1	Russell Moe Landfill	20	**1937**	1964	250,000	250,000	250,000		
30	SC	SC	30-CR-0063	1	Lane Road Disposal Station 21	106	1961	1964	584,000	584,000	584,000		
34	SV	SAC	34-CR-5047	1	Elvas Avenue DS	10	**1938**	1965	75,000	75,000	75,000		
19	SC	SC	19-AQ-0016	1	Gardena Valley #6 (Don Kott Ford)	7.7	**1938**	1965	165,000	165,000	165,000	2000	Combustion
19	SC	SC	19-AR-5036	1	Gregg Pit/Pick-Your-Part	100	**1938**	1965	500,000	500,000	500,000	1993	Combustion
19	SC	SC	19-AQ-0012	1	Cal Compact/Metro LF	157	1959	1965	3,000,000	3,000,000	3,000,000	2000	Combustion
19	SC	SC	19-AA-5321	1	Torrance Municipal Dump	15	**1939**	1966	150,000	150,000	150,000		
30	SC	SC	30-CR-0020	1	Villa Park		1962	1966	200,000	200,000	200,000	1996	Combustion
37	SD	SD	37-CR-0088	1	Bell Jr. High/Sweetwater II	9	**1939**	1966	250,000	250,000	250,000	1994	Combustion
30	SC	SC	30-AB-0168	1	Newport Terrace LF	17	**1940**	1967	150,000	150,000	150,000	2004	Venting
19	SC	SC	19-AQ-0009	1	Southwest Conservation District LF	24	**1941**	1968	400,000	400,000	400,000	1995	Combustion
37	SD	SD	37-AO-0009	1	Old San Marcos	24	**1941**	1968	400,000	400,000	400,000		
42	SCC	SB	42-CR-0015	1	Ballard Canyon	10	**1942**	1969	50,000	50,000	50,000		
21	SF	BA	21-AA-0047	1	Horst Hanf Landfill/Bayview Park	13.5	**1942**	1969	50,000	50,000	50,000	2004	Venting
37	SD	SD	37-AK-0006	1	Maxon St.	15	**1942**	1969	150,000	150,000	150,000	1990	Combustion
37	SD	SD	37-AK-0001	1	Mission Ave. SLF	15	**1942**	1969	200,000	200,000	200,000	1990	Combustion
30	SC	SC	30-CR-0096	1	Cannery Street Disposal Station #16	20	1957	1969	496,584	496,584	496,584		
19	SC	SC	19-AR-5068	1	Bishop Canyon LF	45	1966	1969	1,660,000	1,660,000	1,660,000	2004	Venting
19	SC	SC	19-AA-5560	1	Industry Hills Sheraton Resort	101	1960	1969	3,500,000	3,500,000	3,500,000	1990	Combustion
31	SV	PLA	31-AA-0624	1	Rocklin Pit	3.9	**1943**	1970	10,000	10,000	10,000	2004	Venting
42	SCC	SB	42-CR-0014	1	Santa Ynez Airport LF	10	**1943**	1970	50,000	50,000	50,000	2006	Combustion
43	SF	BA	43-AN-0011	1	Hellyer Park LF	16	**1943**	1970	400,000	400,000	400,000	1998	Combustion
34	SV	SAC	34-AA-0023	1	Gerber Road LF	75	**1944**	1971	460,000	460,000	460,000		
56	SCC	VEN	56-AA-0125	1	Tierra Rejada	25	**1945**	1972	400,000	400,000	400,000		
41	SF	BA	41-AA-0003	1	Sierra Point	80	**1945**	1972	400,000	400,000	400,000	2004	Venting

Landfill Model CH_4 Emissions (April 3, 2008)

CO	AB	DIS	CIWMB SWIS File Number	Count [a]	Facility/Site Name	Max. Waste Footprint (acres)	Open Year [b]	Close Year	1990 WIP (Tons)	2006 WIP (Tons)	2020 WIP (Tons)	Year LFG Capture	"Current" 2006 Control Type
9	LT	ED	09-CR-0015	1	Meyers LF	7.4	**1946**	1973	50,000	50,000	50,000		
34	SV	SAC	34-AA-0016	1	14th Avenue Landfill (East/West Pits)	27	**1946**	1973	250,000	250,000	250,000	2004	Venting
37	SD	SD	37-AA-0033	1	South Miramar Sanitary Landfill	122	1950	1973	3,000,000	3,000,000	3,000,000	1993	Combustion
37	SD	SD	37-AA-0429	1	Arizona St.	64	1952	1974	2,000,000	2,000,000	2,000,000	1993	Combustion
19	SC	SC	19-AA-0835	1	Sheldon-Arleta	42	1962	1974	5,500,000	5,500,000	5,500,000	1990	Combustion
21	SF	BA	21-AA-0049	1	Hamilton AFB Landfill #26	20	**1948**	1975	100,000	100,000	100,000	2004	Venting
37	SD	SD	37-AA-0018	1	Poway	12	**1948**	1975	165,000	165,000	165,000	1997	Combustion
37	SD	SD	37-AA-0019	1	Gillespie	12	**1948**	1975	165,000	165,000	165,000	1997	Combustion
19	SC	SC	19-AA-5350	1	City Of Santa Monica LF #2	15	**1948**	1975	200,000	200,000	200,000	1999	Carbon
37	SD	SD	37-AA-0434	1	Paradise Park/Sweetwater III	20	**1948**	1975	200,000	200,000	200,000		
37	SD	SD	37-AH-0002	1	Palomar Airport	70	1962	1975	1,000,000	1,000,000	1,000,000	1995	Combustion
31	SV	PLA	31-AA-0220	1	Lincoln Disposal Site	6.3	**1949**	1976	50,000	50,000	50,000		
30	SC	SC	30-AB-0366	1	Forster Canyon Landfill	50	1958	1976	1,350,000	1,350,000	1,350,000		
19	SC	SC	19-AA-0011	1	Compton Disposal Site	17.9	**1950**	1977	200,000	200,000	200,000		
12	NC	NCU	12-AA-0022	1	Table Bluff LF	20	**1950**	1977	200,000	200,000	200,000		
37	SD	SD	37-AA-0016	1	Encinitas	30	1967	1977	585,000	585,000	585,000	1997	Combustion
37	SD	SD	37-AA-0002	1	Valley Center	25	**1951**	1978	130,000	130,000	130,000	1998	Combustion
19	SC	SC	19-AA-0587	1	Longden Ave Disposal Site	54	1955	1978	1,000,000	1,000,000	1,000,000	1991	Venting
37	SD	SD	37-AA-0001	1	Jamacha	46	1960	1978	1,800,000	1,800,000	1,800,000	1998	Combustion
19	SC	SC	19-AA-5100	1	City of Duarte LF	17.2	**1952**	1979	200,000	200,000	200,000	1990	Combustion
36	SC	SC	36-AA-0005	1	Upland LF	34	**1952**	1979	550,000	550,000	550,000	1993	Combustion
55	MC	TUO	55-AA-0005	1	Sierra Conservation Center	8	**1953**	1980	50,000	50,000	50,000		
31	MC	PLA	31-AA-0520	1	Meadow Vista LF	15	1965	1980	100,000	100,000	100,000	1997	Combustion
36	SC	SC	36-AA-0312	1	Norton AFB LF	25	**1953**	1980	250,000	250,000	250,000	2002	Combustion
31	SV	PLA	31-AA-0110	1	Roseville LF	21	**1953**	1980	300,000	300,000	300,000	2004	Venting
31	SV	PLA	31-AA-0310	1	Auburn Sanitary Landfill	37	**1953**	1980	375,000	375,000	375,000		
34	SV	SAC	34-AA-0004	1	Elk Grove LF	37	**1953**	1980	450,000	450,000	450,000	1993	Combustion
31	SV	PLA	31-AA-0140	1	Loomis Landfill	25	1959	1980	500,000	500,000	500,000	1997	Combustion
1	SF	BA	01-AA-0006	1	Davis Street	194	1965	1980	4,800,000	4,800,000	4,800,000	1990	Combustion
19	SC	SC	19-AE-0001	1	Palos Verdes	291	1957	1980	23,600,000	23,600,000	23,600,000	1990	Combustion
19	SC	SC	19-AR-0003	1	Ascon Sanitary LF	62	1960	1981	2,000,000	2,000,000	2,000,000	1995	Combustion
37	SD	SD	37-AA-0022	1	South Chollas	120	1952	1981	3,000,000	3,000,000	3,000,000	1990	Combustion
19	SC	SC	19-AA-0821 19-AA-0822 19-AA-0823	3	Mission Canyon/ Mountaingate	375	1958	1981	26,800,000	26,800,000	26,800,000	1990	Combustion
30	SC	SC	30-AB-0026	1	City Of Huntington Beach Landfill	22	**1955**	1982	400,000	400,000	400,000	2004	Venting
31	MC	PLA	31-AA-0540	1	Foresthill Sanitary Landfill	4	**1956**	1983	50,000	50,000	50,000		
10	SJV	SJU	10-AA-0018	1	Rice Road Disposal Site	14.2	**1956**	1983	350,000	350,000	350,000	1998	Combustion
41	SF	BA	41-AA-0007	1	Junipero Serra Solid Waste DS	9	**1956**	1983	450,000	450,000	450,000	1991	Combustion
33	SC	SC	33-AA-0002	1	West Riverside	74	1965	1983	1,000,000	1,000,000	1,000,000	1990	Combustion
1	SF	BA	01-AC-0001	1	Berkeley LF/Waterfront Park	90	1960	1983	1,000,000	1,000,000	1,000,000	1990	Combustion
15	SJV	SJU	15-AA-0044	1	Bakersfield	115	1956	1983	2,000,000	2,000,000	2,000,000	2003	Combustion
37	SD	SD	37-AA-0901	1	Box Canyon LF	120	**1957**	1984	500,000	500,000	500,000		
1	SF	BA	01-AA-0011	1	Albany LF/East Shore Park	60	1964	1984	1,000,000	1,000,000	1,000,000	2000	Combustion
41	SF	BA	41-AA-0011 41-AA-0012	2	Marsh Road	146	1961	1984	3,500,000	3,500,000	3,500,000	1991	Combustion
19	SC	SC	19-AA-0836	1	Operating Industries (OII) (NPL Site)	190	1948	1984	22,000,000	22,000,000	22,000,000	1995	Combustion
33	SC	SC	33-AA-0001	1	Tequesquite/City of Riverside	120	1958	1985	2,400,000	2,400,000	2,400,000	1995	Combustion
19	SC	SC	19-AR-0006	1	Penrose Pit	72	1960	1985	9,000,000	9,000,000	9,000,000	1990	Combustion
1	SF	BA	01-AA-0001	1	Turk Island Landfill	66	1965	1986	1,200,000	1,200,000	1,200,000	1990	Combustion
33	SC	SC	33-AA-0005	1	Elsinore Landfill		1953	1986	1,900,000	1,900,000	1,900,000	1993	Combustion

Landfill Model CH4 Emissions (April 3, 2008)

CO	AB	DIS	CIWMB SWIS File Number	Count [a]	Facility/Site Name	Max. Waste Footprint (acres)	Open Year [b]	Close Year	1990 WIP (Tons)	2006 WIP (Tons)	2020 WIP (Tons)	Year LFG Capture	"Current" 2006 Control Type
19	SC	SC	19-AI-0001	1	Norwalk Dump	13	**1959**	1986	100,000	563,842	3,135,162	2004	Venting
33	SC	SC	33-AA-0004	1	Corona Disposal Site	95	1961	1986	4,000,000	4,000,000	4,000,000	1990	Combustion
19	SC	SC	19-AA-0819	1	Toyon	90	1957	1986	16,000,000	16,000,000	16,000,000	1990	Combustion
21	SF	BA	21-AA-0003	1	San Quentin Disposal Site	42	**1960**	1987	500,000	500,000	500,000	2004	Venting
48	SF	BA	48-AA-0001	1	Solano Garbage Company	36	**1960**	1987	750,000	750,000	750,000		
10	SJV	SJU	10-AA-0005	1	City of Fresno LF	145	1937	1987	4,700,000	4,700,000	4,700,000	2000	Combustion
16	SJV	SJU	16-AA-0011	1	Corcoran LF	21	**1961**	1988	300,000	300,000	300,000		
40	SCC	SLO	40-AA-0009	1	Camp San Luis Obispo	8	**1962**	1989	50,000	50,000	50,000		
41	SF	BA	41-AA-0010	1	San Mateo Composting (3rd Ave.)	44	**1962**	1989	400,000	400,000	400,000		
54	SJV	SJU	54-AA-0002	1	Exeter DS	34	**1962**	1989	400,000	400,000	400,000		
56	SCC	VEN	56-AA-0004	1	Coastal LF (including Santa Clara LF)	120	1962	1989	4,000,000	4,000,000	4,000,000	1991	Combustion
31	MC	PLA	31-AA-0530	1	Clipper Creek LF	2	**1963**	1990	10,000	10,000	10,000		
5	MC	CAL	05-AA-0014	1	Red Hill SLF	15	**1963**	1990	100,000	100,000	100,000		
45	SV	SHA	45-AA-0021	1	Simpson Paper Company	20	**1963**	1990	400,000	400,000	400,000	2004	Venting
50	SJV	SJU	50-AA-0002	1	Geer Road LF	144	**1963**	1990	500,000	500,000	500,000	1991	Combustion
10	SJV	SJU	10-AA-0011	1	Southeast Regional	67	1970	1990	1,300,000	1,300,000	1,300,000	1998	Combustion
30	SC	SC	30-AB-0017	1	Coyote Canyon SLF	325	1963	1990	27,000,000	27,000,000	27,000,000	1990	Combustion
36	MD	MOJ	36-AA-0318	1	Mountain Pass Mine and Mill	4	**1964**	1991	20,000	20,000	20,000		
27	NCC	MBU	27-AA-0012	1	Lake San Antonio South Shore LF	5.5	**1964**	1991	25,000	25,000	25,000		
36	MD	MOJ	36-AA-0039	1	Newberry	4	**1964**	1991	25,000	25,000	25,000		
56	SCC	VEN	56-AA-0008	1	Pacific Missile TC LF	6	**1964**	1991	50,000	50,000	50,000		
15	SJV	SJU	15-AA-0056	1	Lebec LF	14.2	**1987**	1991	59,064	75,000	75,000	2004	Venting
50	SJV	SJU	50-AA-0003	1	Bonzi LF	35	**1951**	1991	536,258	773,200	966,220	1995	Combustion
19	SC	SC	19-AA-0013	1	Azusa LF (Zone I)	77	1958	1991	4,980,097	5,331,470	7,167,957	1990	Combustion
18	NEP	LAS	18-AA-0003	1	Bieber LF	8	**1951**	1992	49,815	50,000	50,000		
28	SF	BA	28-AA-0003	1	Berryessa Garbage	7	**1951**	1992	47,955	50,000	50,000		
31	SV	PLA	31-AA-0120	1	Berry Street Mall LF	13	**1965**	1992	100,000	100,000	100,000		
48	SV	YS	48-AA-0004	1	Rio Vista	12	**1951**	1992	92,103	100,000	100,000		
7	SF	BA	07-AA-0003	1	Contra Costa SLF (aka GBF LF)	74	1943	1992	656,050	897,051	897,051	1995	Combustion
15	SJV	SJU	15-AA-0063	1	McFarland-Delano LF	40	1971	1992	918,766	1,000,000	1,000,000	2005	Combustion
15	SJV	SJU	15-AA-0048	1	China Grade SLF	58	1978	1992	1,561,931	2,000,000	2,000,000	2002	Combustion
25	NEP	MOD	25-AA-0002	1	Eagleville	1.56	**1966**	1993	10,000	10,000	10,000		
25	NEP	MOD	25-AA-0003	1	Fort Bidwell	0.8	**1966**	1993	10,000	10,000	10,000		
25	NEP	MOD	25-AA-0004	1	Lake City	2.83	**1966**	1993	10,000	10,000	10,000		
25	NEP	MOD	25-AA-0021	1	Cedarville	2.09	**1966**	1993	10,000	10,000	10,000		
45	SV	SHA	45-AA-0022	1	Intermountain LF	4	**1987**	1993	13,466	25,000	25,000		
36	MD	MOJ	36-AA-0062	1	Lucerne Vlly	6	**1977**	1993	39,582	50,000	50,000		
19	SC	SC	19-AA-0057	1	Pitchess Detention Cntr	15	**1975**	1993	57,060	75,000	75,000		
36	MD	MOJ	36-AA-0026	1	Oro Grande	5	**1966**	1993	100,000	100,000	100,000		
49	NC	NS	49-AA-0004	1	Healdsburg	27	**1966**	1993	400,000	400,000	400,000	1994	Combustion
43	SF	BA	43-AO-0001	1	All Purpose LF	25	1965	1993	1,637,887	2,000,000	2,000,000	1990	Combustion
43	SF	BA	43-AA-0006	1	Shoreline-Mtn. View (Vista)	150	1968	1993	1,973,885	2,000,000	2,000,000	1990	Combustion
47	NEP	SIS	47-AA-0030	1	Cecilville LF	1	**1967**	1994	10,000	10,000	10,000		
47	NEP	SIS	47-AA-0045	1	Hotelling Gulch LF	3	**1967**	1994	10,000	10,000	10,000		
47	NEP	SIS	47-AA-0029	1	Kelly Gulch LF	1	**1967**	1994	10,000	10,000	10,000		
47	NEP	SIS	47-AA-0044	1	Rogers Creek LF	1	**1967**	1994	10,000	10,000	10,000		
36	MD	MOJ	36-AA-0059	1	Needles Sanitary LF	50	**1964**	1994	83,646	100,000	100,000		
23	NC	MEN	23-AA-0003	1	Casper Refuse DF	16	**1964**	1994	136,365	150,000	150,000	2004	Venting
31	MC	PLA	31-AA-0560	1	Eastern Regional LF	36	**1978**	1994	341,816	500,000	500,000	1994	Combustion
45	SV	SHA	45-AA-0019	1	Redding SLF (Benton)	71	**1967**	1994	750,000	750,000	750,000	1994	Combustion
44	NCC	MBU	44-AA-0003	1	Ben Lomond WDS	24	1942	1994	580,311	750,000	750,000	1994	Combustion
10	SJV	SJU	10-AA-0025	1	Chestnut Ave DS	32	1969	1994	670,038	1,000,000	1,000,000	1998	Combustion

Landfill Model CH4 Emissions (April 3, 2008)

CO	AB	DIS	CIWMB SWIS File Number	Count [a]	Facility/Site Name	Max. Waste Footprint (acres)	Open Year [b]	Close Year	1990 WIP (Tons)	2006 WIP (Tons)	2020 WIP (Tons)	Year LFG Capture	"Current" 2006 Control Type
41	SF	BA	41-AA-0009	1	Burlingham LF	41	1960	1994	1,000,000	1,000,000	1,000,000	1991	Combustion
39	SJV	SJU	39-AA-0003	1	Harney Lane LF	97	1948	1994	1,902,280	2,000,000	2,000,000	1993	Combustion
43	SF	BA	43-AA-0007	1	Sunnyvale LF	92	1960	1994	1,889,967	2,300,000	2,300,000	1991	Combustion
34	SV	SAC	34-AA-0018	1	Sacramento City LF	130	1960	1994	3,410,394	4,000,000	4,000,000	1991	Combustion
47	NEP	SIS	47-AA-0031	1	Lava Beds LF	1.24	**1968**	1995	10,000	10,000	10,000		
47	NEP	SIS	47-AA-0019	1	Weed SWDS	6.2	**1987**	1995	11,144	25,000	25,000		
19	SC	SC	19-AA-0062	1	Two Harbors LF	2	**1951**	1995	24,975	25,000	25,000		
47	NEP	SIS	47-AA-0035	1	New Tenant SWDS	10	**1968**	1995	50,000	50,000	50,000		
47	NEP	SIS	47-AA-0001	1	McCloud	12.5	**1951**	1995	45,733	50,000	50,000		
15	SJV	SJU	15-AA-0051	1	Glennville LF	4	**1951**	1995	49,238	50,000	50,000		
49	NC	NS	49-AA-0002	1	Annapolis LF	5	**1951**	1995	64,663	75,000	75,000		
58	SV	FR	58-AA-0002	1	Ponderosa SLF	10	**1951**	1995	73,069	75,000	75,000		
6	SV	COL	06-AA-0001	1	Evans Rd LF-P1	14	1979	1995	153,269	200,000	200,000		
39	SJV	SJU	39-AA-0005	1	Corral Hollow	43	**1983**	1995	435,764	750,000	750,000	2003	Combustion
33	SC	SC	33-AA-0008	1	Double Butte DS	100	1973	1995	2,732,052	3,000,000	3,000,000	1994	Combustion
47	NEP	SIS	47-AA-0026	1	Happy Camp SWDS	3.4	**1969**	1996	10,000	10,000	10,000		
14	GBV	GBU	14-AA-0016	1	Furnace Creek	9.5	**1951**	1996	42,277	50,000	50,000		
18	NEP	LAS	18-AA-0011	1	Herlong DF	8	**1951**	1996	47,133	50,000	50,000	1996	Venting
36	MD	MOJ	36-AA-0058	1	Morongo DS	11.55	**1982**	1996	52,945	100,000	100,000		
36	MD	MOJ	36-AA-0041	1	Trona Angus LF	22	**1951**	1996	167,271	200,000	200,000		
55	MC	TUO	55-AA-0002	1	Tuolumne Central (Jamestown)	16	**1951**	1996	650,370	750,000	750,000	1996	Venting
10	SJV	SJU	10-AA-0002	1	Chateau Fresno LF	75	1950	1996	2,132,332	3,800,000	3,800,000	1993	Combustion
56	SCC	VEN	56-AA-0011	1	Bailard LF	120	1989	1996	1,879,583	4,000,000	4,000,000	1991	Combustion
30	SC	SC	30-AB-0018	1	Santiago Canyon SLF	130	1968	1996	8,936,769	13,284,221	13,284,221	1991	Combustion
19	SC	SC	19-AA-0820	1	Lopez Canyon LF	166	1975	1996	14,616,276	19,000,000	19,000,000	1990	Combustion
19	SC	SC	19-AF-0001	1	BKK West Covina (Class I and III LFs)	370	1962	1996	29,126,627	45,800,000	45,800,000	1990	Combustion
18	NEP	LAS	18-AA-0004	1	Madeline DF	1	**1970**	1997	10,000	10,000	10,000		
18	NEP	LAS	18-AA-0005	1	Ravendale DF	1	**1970**	1997	10,000	10,000	10,000		
40	SCC	SLO	40-AA-0014	1	California Valley LF	6	**1970**	1997	25,000	25,000	25,000		
42	SCC	SB	42-AA-0010	1	New Cuyama	5	**1970**	1997	50,000	50,000	50,000		
23	NC	MEN	23-AA-0008	1	Laytonville LF	7	**1951**	1997	49,309	50,000	50,000		
36	MD	MOJ	36-AA-0049	1	Baker RDS	10	**1951**	1997	74,727	75,000	75,000		
58	SV	FR	58-AA-0006	1	Yuba Sutter Disposal Area LF (YSDA)	12	**1951**	1997	139,306	150,000	150,000		
58	SV	FR	58-AA-0001	1	Beale AFB LF	88	**1951**	1997	178,392	200,000	200,000	2004	Venting
15	MD	KER	15-AA-0055	1	Kern Valley LF	31	**1984**	1997	115,494	250,000	250,000	2004	Combustion
23	NC	MEN	23-AA-0021	1	City of Willits DS	18.5	**1980**	1997	144,672	250,000	250,000	2004	Venting
36	MD	MOJ	36-AA-0061	1	Lenwood-Hinkley	54	**1951**	1997	194,800	250,000	250,000		
36	MD	MOJ	36-AA-0060	1	Twentynine Palms DS	44.26	**1983**	1997	140,531	300,000	300,000		
29	MC	NSI	29-AA-0001	1	McCourtney Rd LF	36	1972	1997	943,465	1,000,000	1,000,000	1991	Combustion
33	SS	SC	33-AA-0012	1	Coachella Valley DS	75	1972	1997	1,494,459	2,500,000	2,500,000	2000	Combustion
58	SV	FR	58-AA-0005	1	Yuba Sutter Disposal Inc. LF (YSDI)	33	1967	1997	909,422	2,500,000	2,500,000	1999	Combustion
33	SC	SC	33-AA-0009	1	Mead Valley DS	60	1974	1997	1,315,088	2,528,951	2,528,951	1995	Combustion
37	SD	SD	37-AA-0008	1	San Marcos LF	107	1979	1997	2,483,568	6,000,000	6,000,000	1990	Combustion
36	MD	MOJ	36-AA-0084	1	Echo Gold	7	**1971**	1998	25,000	25,000	25,000		
54	SJV	SJU	54-AA-0010	1	Balance Rock DS	10	**1971**	1998	100,000	100,000	100,000		
15	SJV	SJU	15-AA-0047	1	Buttonwillow SLF	8	**1951**	1998	78,478	100,000	100,000		
21	SF	BA	21-AA-0002	1	West Marin SLF	15	**1980**	1998	113,958	200,000	200,000		
54	SJV	SJU	54-AA-0001	1	Earlimart DS	16	**1951**	1998	149,620	200,000	200,000	2005	Combustion
16	SJV	SJU	16-AA-0009	1	Hanford LF	79	1973	1998	1,159,295	1,750,000	1,750,000	2000	Combustion
33	SC	SC	33-AA-0003	1	Highgrove LF	71	1947	1998	1,284,218	3,002,920	3,002,920	1997	Combustion

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CO	AB	DIS	CIWMB SWIS File Number	Count [a]	Facility/Site Name	Max. Waste Footprint (acres)	Open Year [b]	Close Year	1990 WIP (Tons)	2006 WIP (Tons)	2020 WIP (Tons)	Year LFG Capture	"Current" 2006 Control Type
34	SV	SAC	34-AA-0007	1	Dixon Pit LF	29.75	**1983**	1999	42,893	100,000	100,000	2004	Combustion
33	SC	SC	33-AA-0013	1	Anza DS	20	**1977**	1999	55,456	100,000	100,000		
36	MD	MOJ	36-AA-0047	1	Yermo DS	12	**1951**	1999	83,254	100,000	100,000		
39	SJV	SJU	39-AA-0002	1	French Camp LF	60	**1976**	1999	230,325	517,575	517,575		
23	NC	MEN	23-AA-0018	1	South Coast Rd LF	5	**1973**	2000	28,186	50,000	50,000		
13	SS	IMP	13-AA-0012	1	Pichacho C&F	14	**1951**	2000	63,723	101,534	114,633		
28	SF	BA	28-AA-0001	1	American Canyon LF	97	1940	2000	1,667,136	2,500,000	2,500,000	1990	Combustion
19	SC	SC	19-AA-0015	1	Spadra LF	173	1957	2000	10,144,050	17,536,915	17,536,915	1990	Combustion
47	NEP	SIS	47-AA-0027	1	Tulelake SWDS	8.8	**1951**	2001	52,216	75,172	75,172		
36	MD	MOJ	36-AA-0056	1	Big Bear RDS	26	**1988**	2001	103,590	450,000	450,000		
42	SCC	SB	42-AA-0011	1	Foxen LF	18.4	**1968**	2001	430,090	750,000	750,000	2006	Combustion
36	MD	MOJ	36-AA-0050	1	Hesperia RDS	50	**1980**	2001	432,133	750,000	750,000	2005	Combustion
23	NC	MEN	23-AA-0019	1	City of Ukiah SWDS	40	**1967**	2001	466,712	750,000	750,000	2004	Venting
36	SC	SC	36-AA-0054	1	Milliken	140	1956	2001	8,339,070	12,011,629	12,011,629	1990	Combustion
55	MC	TUO	55-AA-0001	1	Big Oak Flat LF	5	**1972**	2002	15,153	25,000	25,000	2002	Venting
54	SJV	SJU	54-AA-0011	1	Kennedy Meadows DS	6	**1975**	2002	25,000	25,000	25,000		
31	MC	PLA	31-AA-0550	1	Colfax LF	3	**1975**	2002	25,000	25,000	25,000		
47	NEP	SIS	47-AA-0003	1	Black Butte SWDS	27	**1979**	2002	67,285	149,564	149,564		
8	NC	NCU	08-AA-0006	1	Crescent City LF	23	**1969**	2002	270,268	505,963	665,340	2004	Venting
26	GBV	GBU	26-AA-0002	1	Bridgeport SLF	36.5	**1951**	2003	95,584	100,377	103,036		
27	NCC	MBU	27-AA-0003	1	Lewis Rd. LF	14	**1978**	2003	236,855	501,122	501,122	1997	Combustion
7	SF	BA	07-AA-0002	1	Acme Sanitary LF	109	1954	2003	6,429,329	7,050,842	7,488,750	1991	Combustion
32	MC	NSI	32-AA-0007	1	Portola LF	8	**1951**	2004	62,497	75,000	75,000	2004	Venting
27	NCC	MBU	27-AA-0006	1	Jolon Rd LF	24	**1979**	2004	116,370	200,000	200,000		
36	MD	MOJ	36-AA-0048	1	Apple Valley DS	38	**1987**	2004	103,544	300,000	300,000		
36	MD	MOJ	36-AA-0044	1	Phelan RDS	30	**1983**	2004	143,007	300,000	300,000		
3	MC	AMA	03-AA-0001	1	Amador Co. LF	29	**1967**	2004	401,174	737,602	742,369	2002	Combustion
43	SF	BA	43-AA-0004	1	Pacheco Pass LF	91	1963	2004	862,677	2,064,554	2,581,707	1994	Combustion
33	SS	SC	33-AA-0011	1	Edom Hill DS	148	1967	2004	1,681,856	6,983,228	12,733,398	2001	Combustion
13	SS	IMP	13-AA-0005	1	Ocotillo C&F	5.3	**1951**	2005	19,588	25,000	25,006		
45	SV	SHA	45-AA-0058	1	Twin Bridges	21	**1981**	2005	88,291	200,000	200,000		
13	SS	IMP	13-AA-0008	1	Brawley LF	34.3	**1984**	2005	122,389	430,327	699,366		
43	SF	BA	43-AN-0007	1	Zanker Rd. LF	47.1	1956	2005	746,341	1,022,263	1,233,861	1995	Combustion
10	SJV	SJU	10-AA-0013	1	Orange Ave.	29	1941	2005	534,399	1,122,053	1,983,341	2006	Combustion
54	SJV	SJU	54-AA-0004	1	Teapot Dome DS	71	1972	2005	679,732	1,646,300	2,810,691	2005	Combustion
1	SF	BA	01-AA-0008	1	Tri-Cities LF	115	1968	2005	4,217,879	9,325,621	14,655,691	1990	Combustion
37	SD	SD	37-AA-0005	1	Ramona LF	46	1969	2006	791,182	1,642,804	2,883,292	1997	Combustion
19	MD	AV	19-AA-0009	1	Antelope Valley	57	1952	2006	269,364	3,743,346	9,607,924	2004	Combustion
36	SC	SC	36-AA-0051	1	Colton LF	82	1964	2006	1,587,376	6,062,952	11,840,853	2001	Combustion
7	SF	BA	07-AA-0001	1	W Contra Costa LF	160	1953	2006	4,483,715	9,410,067	15,665,749	1992	Combustion
36	MD	MOJ	36-AA-0067	1	USMC- 29 Palms	38.5	**1951**	2007	94,772	163,838	273,517		
12	NC	NCU	12-AA-0005	1	Cummings Road LF	38	1969	2007	750,650	1,500,177	1,500,955	1997	Combustion
15	MD	KER	15-AA-0062	1	Tehachapi SLF	32	1973	2007	526,883	1,115,907	2,030,714		
36	MD	MOJ	36-AA-0046	1	Barstow RDS	47	1963	2007	835,445	1,645,120	2,949,622		
19	SC	SC	19-AR-0008	1	Bradley Ave East & West	171	1959	2007	12,983,834	33,518,023	38,729,613	1990	Combustion
13	SS	IMP	13-AA-0009	1	Niland C&F	13.9	**1951**	2008	46,552	51,211	60,735		
15	SJV	SJU	15-AA-0050	1	Arvin SLF	143	1971	2008	1,669,202	3,519,658	3,520,296	2001	Combustion
19	SC	SC	19-AR-0002	1	Sunshine Canyon City (Inactive Unit and Unit 2-I)	289	1958	2008	802,887	2,865,249	11,819,433	1992	Combustion
19	SC	SC	19-AA-0853	1	Sunshine Canyon Extension	215	1996	2008	0	12,656,411	36,856,158	1992	Combustion
24	SJV	SJU	24-AA-0002	1	Billy Wright LF	40	1973	2009	274,746	1,124,901	2,158,303		
27	NCC	MBU	27-AA-0007	1	Crazy Horse LF	72	1960	2009	1,189,474	4,000,135	7,943,988	1993	Combustion
41	SF	BA	41-AA-0008	1	Hillside LF	43	1968	2010	864,199	1,794,183	2,252,899	2002	Combustion

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CO	AB	DIS	CIWMB SWIS File Number	Count [a]	Facility/Site Name	Max. Waste Footprint (acres)	Open Year [b]	Close Year	1990 WIP (Tons)	2006 WIP (Tons)	2020 WIP (Tons)	Year LFG Capture	"Current" 2006 Control Type
13	SS	IMP	13-AA-0019	1	Republic-Imperial	73	1971	2010	279,924	1,856,219	4,708,951		
33	MD	SC	33-AA-0016	1	Desert Center DS	7	**1951**	2011	136,083	150,088	150,817		
33	SS	SC	33-AA-0071	1	Mecca Landfill II	19	**1983**	2011	65,942	205,591	252,464		
43	SF	BA	43-AM-0001	1	Palo Alto RDS	126	1954	2011	893,847	1,548,051	1,913,153	1993	Combustion
37	SD	SD	37-AA-0020	1	Miramar SWLF	470	1959	2011	6,156,512	27,951,838	52,513,559	1995	Combustion
13	SS	IMP	13-AA-0006	1	Holtville DS	24.5	**1951**	2012	100,652	150,014	150,358		
15	MD	KER	15-AA-0059	1	Ridgecrest SLF	91	1968	2012	734,267	1,632,378	2,660,395	2002	Combustion
40	SCC	SLO	40-AA-0004	1	Cold Canyon	88	1965	2012	1,321,918	3,827,673	6,599,415	1994	Combustion
19	MD	AV	19-AA-0050	1	Lancaster Waste Mgt.	209	1954	2012	1,253,944	4,921,267	12,577,703	1993	Combustion
15	MD	KER	15-AA-0045	1	Boron SLF	14	**1965**	2013	115,269	206,829	261,924		
36	MD	MOJ	36-AA-0057	1	Landers DS	42	**1986**	2013	201,694	936,892	2,324,132		
45	SV	SHA	45-AA-0043	1	West Central (Phase 2)	100	1990	2013	106,919	2,101,253	4,581,004		
34	SV	SAC	34-AA-0020	1	L & D LF	157	1977	2013	1,239,834	3,565,900	7,739,980	2004	Venting
30	SC	SC	30-AB-0035	1	Olinda Alpha SLF	420	1960	2013	14,557,799	45,305,372	86,102,427	1990	Combustion
19	SC	SC	19-AA-0053	1	Puente Hills LF	640	1957	2013	55,110,679	116,141,687	185,036,763	1990	Combustion
15	MD	KER	15-AA-0058	1	Mojave-Rosamond SLF	27	**1967**	2014	279,771	521,676	689,218		
19	SC	SC	19-AA-0012	1	Scholl Canyon LF	440	1961	2014	19,443,400	27,791,673	36,374,233	1990	Combustion
40	SCC	SLO	40-AA-0002	1	Camp Roberts SWDS	11.7	**1951**	2015	67,395	100,000	100,000		
9	MC	ED	09-AA-0003	1	Union Mine DS	21.8	1962	2015	1,101,623	1,502,320	1,523,377	1997	Combustion
32	MC	NSI	32-AA-0008	1	Gopher Hill LF	13	**1974**	2016	43,553	75,000	75,000		
36	SC	SC	36-AA-0087	1	San Timoteo SWDS	114	1978	2016	773,034	3,200,222	6,832,341	2000	Combustion
1	SF	BA	01-AA-0010	1	Vasco Road LF	222	1962	2016	3,990,878	11,845,745	21,368,916	1996	Combustion
43	SF	BA	43-AN-0003	1	Newby Island	313.2	1932	2016	2,409,383	15,746,481	28,339,271	1992	Combustion
37	SD	SD	37-AA-0023	1	Sycamore SW LF	324	1976	2016	2,984,513	14,111,841	31,614,977	1999	Combustion
42	SCC	SB	42-AA-0016	1	City of Santa Maria LF	245	1940	2017	1,217,394	3,247,271	5,338,263	1998	Combustion
33	SC	SC	33-AA-0006	1	Badlands DS	150	1966	2018	674,139	6,768,638	19,976,773	2001	Combustion
13	SS	IMP	13-AA-0011	1	Salton City C&F	7.8	**1951**	2019	47,770	50,740	61,849		
33	SS	SC	33-AA-0015	1	Oasis DS	26	**1951**	2019	61,554	100,005	100,056		
50	SJV	SJU	50-AA-0001	1	Fink Rd LF	216	1973	2019	706,220	2,793,994	5,158,987	2004	Combustion
49	SF	BA	49-AA-0001	1	Central LF	172	1972	2019	4,585,243	11,192,029	14,126,201	1990	Combustion
19	SC	SC	19-AA-0052	1	Chiquita Canyon	257	1972	2019	4,310,480	22,074,046	50,973,493	1995	Combustion
28	SF	BA	28-AA-0002	1	Clover Flat LF	44	**1984**	2020	226,887	836,580	1,589,315		
16	SJV	SJU	16-AA-0004	1	Avenal LF	123.2	**1980**	2020	341,069	1,136,419	4,003,699		
43	SF	BA	43-AN-0015	1	Guadalupe SLF	115	1929	2020	1,034,929	4,469,114	7,922,634	1990	Combustion
42	SCC	SB	42-AA-0015	1	Tajiguas LF	118	1967	2020	2,654,471	6,235,959	10,283,897	1996	Combustion
39	SJV	SJU	39-AA-0015	1	Forward LF (+ Austin Rd LF -0001)	354.5	1973	2020	1,973,144	15,264,704	37,950,388	1991	Combustion
37	SD	SD	37-AA-0006	1	Borrego Springs LF	29	**1951**	2021	195,604	264,301	373,372		
15	MD	KER	15-AA-0150	1	Edwards AFB Main LF	64	**1978**	2021	127,252	319,450	476,764		
11	SV	GLE	11-AA-0001	1	Glenn County LF	50	**1976**	2021	342,393	797,154	1,189,403		
44	NCC	MBU	44-AA-0004	1	Buena Vista DS	61	1966	2021	1,321,475	3,250,261	5,415,161	1991	Combustion
37	SD	SD	37-AA-0010	1	Otay SWLF	230	1963	2021	7,065,578	21,650,229	50,092,469	1991	Combustion
13	SS	IMP	13-AA-0001	1	Imperial SWS	18	**1951**	2022	96,720	152,424	172,869		
13	SS	IMP	13-AA-0004	1	Calexico DS	38	**1951**	2022	344,144	502,436	524,483		
56	SCC	VEN	56-AA-0007	1	Simi Valley LF	185.61	1970	2022	4,946,498	13,739,823	27,823,257	1991	Combustion
30	SC	SC	30-AB-0360	1	Frank R. Bowerman	341	1989	2022	6,541,179	36,445,683	75,897,049	1993	Combustion
26	GBV	GBU	26-AA-0004	1	Benton Crossing	71.51	**1988**	2023	58,764	382,077	1,005,138		
44	NCC	MBU	44-AA-0002	1	City of Watsonville	31	1962	2023	583,714	1,080,517	1,734,443	1997	Combustion
52	SV	TEH	52-AA-0001	1	Red Bluff LF	33.6	1956	2023	400,561	1,111,250	2,013,981	2005	Combustion
16	SJV	SJU	16-AA-0021	1	Kettleman Hills SLF	43	1998	2023	0	1,685,025	5,488,215	2005	Combustion
33	SC	SC	33-AA-0007	1	Lamb Canyon DS	144.6	1970	2023	1,350,362	5,092,563	14,048,887	2002	Combustion
41	SF	BA	41-AA-0002	1	Corinda Los Trancos LF (Ox Mtn)	191	1976	2023	3,102,621	16,593,446	29,255,388	1991	Combustion
35	NCC	MBU	35-AA-0001	1	John Smith Road SWDS	44	1968	2024	712,443	1,667,101	2,905,134	1998	Combustion
54	SJV	SJU	54-AA-0009	1	Visalia DS	247	1952	2024	786,444	2,967,791	4,782,022	2004	Combustion

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CO	AB	DIS	CIWMB SWIS File Number	Count [a]	Facility/Site Name	Max. Waste Footprint (acres)	Open Year [b]	Close Year	1990 WIP (Tons)	2006 WIP (Tons)	2020 WIP (Tons)	Year LFG Capture	"Current" 2006 Control Type
43	SF	BA	43-AN-0008	1	Kirby Canyon LF	311	1986	2025	1,775,249	6,608,275	11,149,364	1996	Combustion
40	SCC	SLO	40-AA-0008	1	Chicago Grade	36.25	**1986**	2026	203,666	920,660	2,305,490	2006	Combustion
54	SJV	SJU	54-AA-0008	1	Woodville DS	153	1970	2026	1,258,544	2,644,186	3,755,863	2004	Combustion
13	SS	IMP	13-AA-0010	1	Hot Spa C&F	6	**1951**	2027	45,381	50,699	56,431		
18	NEP	LAS	18-AA-0010	1	Westwood DF	9	**1951**	2027	38,440	52,494	78,294		
17	LC	LAK	17-AA-0001	1	Eastlake SLF	35	1960	2027	364,723	1,104,817	1,935,182		
15	SJV	SJU	15-AA-0057	1	Shafter-Wasco SLF	135	1972	2027	1,141,979	3,043,121	5,665,322	2002	Combustion
56	SCC	VEN	56-AA-0005	1	Toland Rd. LF	92	1970	2027	675,668	4,692,098	11,982,793	1997	Combustion
25	NEP	MOD	25-AA-0001	1	Alturas	27.5	**1984**	2028	46,952	100,000	100,000		
18	NEP	LAS	18-AA-0009	1	Bass Hill LF	32	**1986**	2028	79,828	348,082	737,637		
19	SC	SC	19-AA-0056	1	Calabasas LF	416	1961	2028	13,172,817	22,479,153	31,874,338	1990	Combustion
1	SF	BA	01-AA-0009	1	Altamont LF	443	1980	2028	14,967,744	39,772,442	63,607,251	1990	Combustion
13	SS	IMP	13-AA-0007	1	Palo Verde C& F	9.4	**1951**	2029	49,728	50,010	50,132		
10	SJV	SJU	10-AA-0006	1	Coalinga DS	52	**1970**	2029	270,061	525,688	758,692		
10	SJV	SJU	10-AA-0004	1	Clovis LF	50	1969	2029	454,816	1,102,938	1,934,418	2006	Combustion
33	SC	SC	33-AA-0217	1	El Sobrante SWLF	495	1983	2030	1,619,035	19,711,183	59,173,030	1994	Combustion
40	SCC	SLO	40-AA-0001	1	Paso Robles LF	66	1970	2031	974,622	1,597,969	2,416,280	1997	Combustion
36	SC	SC	36-AA-0017	1	California St. LF	106	1963	2031	760,853	1,627,494	2,670,268	2001	Combustion
10	SJV	SJU	10-AA-0009	1	American Ave.	361	1971	2031	2,260,008	8,990,687	16,983,923	2000	Combustion
19	SC	SC	19-AA-0063	1	US Navy LF (San Clemente Island)	13	**1951**	2032	35,407	51,662	64,244		
18	NEP	LAS	18-AA-0013	1	Sierra Army Depot	32	**1951**	2032	78,230	100,000	100,000		
46	MC	NSI	46-AA-0001	1	Loyalton LF	29	**1974**	2032	37,536	82,007	134,022		
57	SV	YS	57-AA-0004	1	UC Davis LF	53	**1974**	2032	149,286	325,625	539,213	1996	Combustion
5	MC	CAL	05-AA-0023	1	Rock Creek LF	57	1990	2032	5,326	576,705	1,452,714		
19	SC	SC	19-AA-0061	1	Pebbly Beach	5.6	**1982**	2033	17,751	56,903	113,846		
33	MD	MOJ	33-AA-0017	1	Blythe DS	78	**1969**	2033	415,345	795,266	1,190,551	1997	Combustion
20	SJV	SJU	20-AA-0002	1	Fairmead LF	77	1958	2033	661,128	2,309,543	4,781,653	1998	Combustion
39	SJV	SJU	39-AA-0022	1	North County LF	185	1990	2033	94,996	2,161,867	5,090,525		
4	SV	BUT	04-AA-0002	1	Neal RD LF	140	1970	2033	493,221	3,100,082	6,086,556	2002	Combustion
36	SC	SC	36-AA-0055	1	Fontana RDS (Mid-Valley)	408	1958	2033	2,466,265	9,786,714	25,197,761	1995	Combustion
34	SV	SAC	34-AA-0001	1	Kiefer LF	667	1967	2035	4,882,713	17,499,572	30,055,405	1994	Combustion
26	GBV	GBU	26-AA-0003	1	Pumice Valley	20	**1951**	2036	123,153	150,755	156,182		
31	SV	PLA	31-AA-0210	1	Western Regional LF	231	1980	2036	1,201,867	4,538,046	9,086,821	1993	Combustion
44	NCC	MBU	44-AA-0001	1	City of Santa Cruz LF	57.5	1966	2037	793,897	1,869,373	2,844,784	1991	Combustion
7	SF	BA	07-AA-0032	1	Keller Canyon LF	244	1992	2037	0	7,678,238	22,690,827	1993	Combustion
15	SJV	SJU	15-AA-0052	1	Lost Hills SLF	25	**1951**	2038	72,069	100,000	100,000		
14	GBV	GBU	14-AA-0004	1	Independence DS	18.42	**1951**	2038	91,998	104,469	131,998		
15	SJV	SJU	15-AA-0273	1	Bakersfield SLF (Bena)	229	1992	2038	0	4,757,447	13,408,350	2000	Combustion
19	SC	SC	19-AH-0001	1	Whittier- Savage Canyon	132	1963	2039	3,027,749	6,176,012	7,618,193	1993	Combustion
21	SF	BA	21-AA-0001	1	Redwood SLF	195	1958	2039	1,960,908	8,286,636	15,476,521	1990	Combustion
27	NCC	MBU	27-AA-0005	1	Johnson Cnyn LF	80	1976	2043	148,946	993,345	2,254,724	2000	Combustion
24	SJV	SJU	24-AA-0001	1	Hwy 59 DS	255	1972	2043	1,322,411	3,973,714	7,847,858		
32	MC	NSI	32-AA-0009	1	Chester LF	28	**1973**	2045	27,272	50,221	52,389		
57	SV	YS	57-AA-0001	1	Yolo Co. Central LF	473	1975	2045	2,777,248	5,833,578	9,244,718	1992	Combustion
42	SCC	SB	42-AA-0017	1	Lompoc LF	39	1962	2047	259,256	1,119,417	2,068,142	2002	Combustion
45	SV	SHA	45-AA-0020	1	Anderson LF	165	1976	2049	550,274	2,063,459	4,647,695	2006	Combustion
14	GBV	GBU	14-AA-0007	1	Tecopa DS	9.3	**1978**	2050	50,000	50,000	50,000		
53	NC	NCU	53-AA-0013	1	Weaverville LF	16.6	**1976**	2050	85,831	150,000	150,000		
14	GBV	GBU	14-AA-0006	1	Shoshone DS	4.7	**1978**	2052	25,000	25,000	25,000		
19	SC	SC	19-AA-0040	1	Burbank LF #3	49	1971	2053	611,532	1,330,610	2,003,218	1995	Combustion
14	GBV	GBU	14-AA-0005	1	Bishop Sunland	69.2	**1983**	2054	82,061	299,731	597,518		
39	SJV	SJU	39-AA-0004	1	Foothill LF	50	1965	2054	551,014	4,123,926	9,158,468		
36	MD	MOJ	36-AA-0045	1	Victorville RDS	341	1955	2059	1,067,804	4,348,479	10,626,492	2003	Combustion

Landfill Model CH4 Emissions (April 3, 2008)

CO	AB	DIS	CIWMB SWIS File Number	Count [a]	Facility/Site Name	Max. Waste Footprint (acres)	Open Year [b]	Close Year	1990 WIP (Tons)	2006 WIP (Tons)	2020 WIP (Tons)	Year LFG Capture	"Current" 2006 Control Type
48	SF	BA	48-AA-0075	1	Potrero Hills	190	1986	2059	574,163	8,521,148	24,710,972	1993	Combustion
6	SV	COL	06-AA-0002	1	Stonyford LF	3.3	**1951**	2064	9,381	10,788	17,296		
47	NEP	SIS	47-AA-0002	1	Yreka LF	52	**1984**	2065	65,086	231,038	451,072		
58	SV	FR	58-AA-0011	1	Ostrom Road SLF	225	1995	2066	0	1,663,897	6,125,580	2003	Combustion
30	SC	SC	30-AB-0019	1	Prima Descha SLF	699	1976	2067	12,035,917	21,893,121	36,376,606	1991	Combustion
48	SV	YS	48-AA-0002	1	B & J Drop Box	260	1964	2070	1,529,609	3,911,141	7,168,617		
22	MC	MPA	22-AA-0001	1	Mariposa Co. SLF	40	**1974**	2081	149,274	330,547	562,699		
42	SCC	SB	42-AA-0012	1	Vandenburg AFB	172	**1978**	2084	133,140	340,242	480,687		
27	NCC	MBU	27-AA-0010	1	Monterey Peninsula LF	315	1966	2084	3,981,093	7,517,740	11,570,780	1990	Combustion
14	GBV	GBU	14-AA-0003	1	Lone Pine DS	26.6	**1951**	2087	69,767	107,801	164,761		
15	SJV	SJU	15-AA-0061	1	Taft SLF	85	1972	2123	568,630	1,083,515	1,644,864	2005	Combustion
26	GBV	GBU	26-AA-0005	1	Chalfant SLF	6.6	**1951**	2155	49,934	50,000	50,000		
26	GBV	GBU	26-AA-0001	1	Walker SLF	38.4	**1951**	2162	45,942	50,324	52,343		
37	SD	SD	37-AA-0903	1	Las Pulgas LF	88.7	**1979**	2184	321,545	833,131	1,486,508		
26	GBV	GBU	26-AA-0006	1	Benton SLF	7.4	**1978**	2212	77,607	100,000	100,000		
37	SD	SD	37-AA-0902	1	San Onofre LF	31	**1951**	2257	100,406	151,309	158,618		
36	MD	MOJ	36-AA-0068	1	Fort Irwin	467	**1970**	2405	137,707	264,636	383,515		
			Total CA MSW Landfills by SWIS #	**372**	**367**	Landfills by Facility/Site Name			**618,564,139**	**1,231,428,174**	**1,970,372,763**		

[a] Some facilities are composed of more that one SWIS # and were evaluated as a single facility for emission inventory and cost analyis purposes.

[b] Open Year in **Bold** Indicates ARB Estimate

Worksheet 2

MSW-Accepting Landfills Forecast to be Subject to Control Requirements

5/7/2009

Analysis Year

CO	AB	DIS	CIWMB SWIS File Number	Count [a]	Facility/Site Name	Ownership Status	Max. Waste Footprint (acres) [d]	Average Rainfall (Inch/Yr)	Open Year [b]	Close Year	1990 WIP (Tons)	2006 WIP (Tons)	2020 WIP (Tons)	Year LFG Capture	Updated Control Type (2009) [e]	Year >= 450,000 Tons WIP	Effective Year of Control (WIP Criteria)	Gas Heat Rate Calc. Test?	New Hardware?	2010 Status	Gas Heat Cap. Calc	Final Gas Heat Calc. Year	Max. Gas Rate (MM BTU/HR)	Capital Cost of Control (lump sum)	Annualized Capital Cost [c]	Assumed Start Year for Cap Cost Amort.	Assumed End Year for Cap. Cost Amort.	Annual Operation & Mtce Cost	Surface Monitoring & Improved Cover Maintenance (Cost/Test)	Annual Monitoring Frequency	2010	2011	2012	2013	2014
23	NC	MEN	23-AA-0019	1	City of Ukiah SWDS	Local Govt.	40	39	**1967**	2001	466,712	750,000	750,000	2004	Venting	1989	2010	Controls F	Coll. + Cntl.	Closed	2010	2010	3.3	$781,000	$75,210	2011	2026					$75,210	$75,210	$75,210	$75,210
																												$193,000				$193,000	$193,000	$193,000	$193,000
																													$3,950	4	$63,802	$15,802	$15,802	$15,802	$15,802
																															$127				
7	SF	BA	07-AA-0003	1	Contra Costa SLF (aka GBF LF)	Private	74	15	1943	1992	656,050	897,051	897,051	1995	Combustion	1988	2010	Controls F	No	Closed	2010	2010	3.3	0	$0	2013	2028							$0	$0
																												Existing						Existing	Existing
																													$7,308	4			$77,233	$29,233	$29,233
																															$127				
10	SJV	SJU	10-AA-0025	1	Chestnut Ave DS	Private	32	11	1969	1994	670,038	1,000,000	1,000,000	1998	Combustion	1988	2010	Controls F	No	Closed	2010	2010	12.9	0	$0	2013	2028							$0	$0
																												Existing						Existing	Existing
																													$3,160	4			$60,641	$12,641	$12,641
																															$127				
41	SF	BA	41-AA-0009	1	Burlingham LF	Local Govt.	41	23	1960	1994	1,000,000	1,000,000	1,000,000	1991	Combustion	1975	2010	Controls F	No	Closed	2010	2010	3.2	0	$0	2013	2028							$0	$0
																												Existing						Existing	Existing
																													$4,049	4			$64,197	$16,197	$16,197
																															$127				
29	MC	NSI	29-AA-0001	1	McCourtney Rd LF	Local Govt.	36	53	1972	1997	943,465	1,000,000	1,000,000	1991	Combustion	1980	2010	Controls F	No	Closed	2010	2010	3.6	0	$0	2013	2028							$0	$0
																												Existing						Existing	Existing
																													$3,555	4			$62,221	$14,221	$14,221
																															$127				
11	SV	GLE	11-AA-0001	1	Glenn County LF	Local Govt.	50	19	**1976**	2021	342,393	797,154	1,189,403			1991	2010	Controls F	Coll. + Cntl.	Open	2021	2021	3.4	$970,000	$93,411	2012	2027						$93,411	$93,411	$93,411
																												$235,000					$235,000	$235,000	$235,000
																													$4,938	4		$67,752	$19,752	$19,752	$19,752
																															$127	$127	$127	$127	$127
33	MD	MOJ	33-AA-0017	1	Blythe DS	Local Govt.	78	3	**1969**	2033	415,345	795,266	1,190,551	1997	Combustion	1992	2010	Controls F	No	Open	2033	2033	3.2	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$7,703	4		$78,813	$30,813	$30,813	$30,813
																															$127	$127	$127	$127	$127
1	SF	BA	01-AA-0001	1	Turk Island Landfill	Private	66	17	1965	1986	1,200,000	1,200,000	1,200,000	1990	Combustion	1973	2010	Controls F	No	Closed	2010	2010	3.4	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$6,518	4		$74,073	$26,073	$26,073	$26,073
																															$127				
43	SF	BA	43-AN-0007	1	Zanker Rd. LF	Private	47.1	15	1956	2005	746,341	1,022,263	1,233,861	1995	Combustion	1981	2010	Controls F	No	Closed	2010	2010	3.3	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$4,652	4		$66,606	$18,606	$18,606	$18,606
																															$127				
10	SJV	SJU	10-AA-0011	1	Southeast Regional	Local Govt.	67	11	1970	1990	1,300,000	1,300,000	1,300,000	1998	Combustion	1977	2010	Controls F	No	Closed	2010	2010	4.0	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$6,617	4		$74,468	$26,468	$26,468	$26,468
																															$127				
5	MC	CAL	05-AA-0023	1	Rock Creek LF	Local Govt.	57	19	1990	2032	5,326	576,705	1,452,714			2003	2010	Controls F	Coll. + Cntl.	Open	2032	2032	4.3	$1,102,300	$106,151	2011	2026					$106,151	$106,151	$106,151	$106,151
																												$264,400				$264,400	$264,400	$264,400	$264,400
																													$5,629	4	$70,517	$22,517	$22,517	$22,517	$22,517
																															$127	$127	$127	$127	$127
37	SD	SD	37-AA-0903	1	Las Pulgas LF	Military	88.7	13	**1979**	2184	321,545	833,131	1,486,508			1993	2010	Controls F	Coll. + Cntl.	Open	2184	2033	4.3	$1,701,430	$163,848	2012	2027						$163,848	$163,848	$163,848
																												$397,540					$397,540	$397,540	$397,540
																													$8,760	4		$83,040	$35,040	$35,040	$35,040
																															$127	$127	$127	$127	$127
12	NC	NCU	12-AA-0005	1	Cummings Road LF	Local Govt.	38	49	1969	2007	750,650	1,500,177	1,500,955	1997	Combustion	1986	2010	Controls F	No	Closed	2010	2010	8.2	0	$0	2013	2028							$0	$0
																												Existing						Existing	Existing
																													$3,753	4			$63,012	$15,012	$15,012
																															$127				
9	MC	ED	09-AA-0003	1	Union Mine DS	Local Govt.	21.8	35	1962	2015	1,101,623	1,502,320	1,523,377	1997	Combustion	1973	2010	Controls F	No	Open	2015	2015	5.9	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$2,153	4	$56,612	$8,612	$8,612	$8,612	$8,612
																															$127	$127	$127	$127	$127
28	SF	BA	28-AA-0002	1	Clover Flat LF	Private	44	39	**1984**	2020	226,887	836,580	1,589,315			1997	2010	Controls F	Coll. + Cntl.	Open	2020	2020	6.9	$856,600	$82,491	2012	2027						$82,491	$82,491	$82,491
																												$209,800					$209,800	$209,800	$209,800
																													$4,345	4		$65,382	$17,382	$17,382	$17,382
																															$127	$127	$127	$127	$127
15	SJV	SJU	15-AA-0061	1	Taft SLF	Local Govt.	85	7	1972	2123	568,630	1,083,515	1,644,864	2005	Combustion	1980	2010	Controls F	No	Open	2123	2033	5.8	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$8,395	4		$81,578	$33,578	$33,578	$33,578
																															$127	$127	$127	$127	$127
44	NCC	MBU	44-AA-0002	1	City of Watsonville	Local Govt.	31	25	1962	2023	583,714	1,080,517	1,734,443	1997	Combustion	1985	2010	Controls F	No	Open	2023	2023	6.6	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$3,062	4	$60,246	$12,246	$12,246	$12,246	$12,246
																															$127	$127	$127	$127	$127
16	SJV	SJU	16-AA-0009	1	Hanford LF	Local Govt.	79	9	1973	1998	1,159,295	1,750,000	1,750,000	2000	Combustion	1980	2010	Controls F	No	Closed	2010	2010	6.1	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$7,802	4		$79,208	$31,208	$31,208	$31,208
																															$127				
37	SD	SD	37-AA-0001	1	Jamacha	Local Govt.	46	13	1960	1978	1,800,000	1,800,000	1,800,000	1998	Combustion	1964	2010	Controls F	No	Closed	2010	2010	4.3	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$4,543	4		$66,172	$18,172	$18,172	$18,172
																															$127				
33	SC	SC	33-AA-0005	1	Elsinore Landfill	Local Govt.	**44**	13	1953	1986	1,900,000	1,900,000	1,900,000	1993	Combustion	1963	2010	Controls F	No	Closed	2010	2010	4.9	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$1,073	4		$52,291	$4,291	$4,291	$4,291
																															$127				
43	SF	BA	43-AM-0001	1	Palo Alto RDS	Local Govt.	126	15	1954	2011	893,847	1,548,051	1,913,153	1993	Combustion	1982	2010	Controls F	No	Open	2011	2011	5.5	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$12,444	4		$97,775	$49,775	$49,775	$49,775
																															$127	$127			
10	SJV	SJU	10-AA-0004	1	Clovis LF	Local Govt.	50	13	1969	2029	454,816	1,102,938	1,934,418	2006	Combustion	1989	2010	Controls F	No	Open	2029	2029	5.6	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$4,938	4		$67,752	$19,752	$19,752	$19,752
																															$127	$127	$127	$127	$127
17	LC	LAK	17-AA-0001	1	Eastlake SLF	Local Govt.	35	29	1960	2027	364,723	1,104,817	1,935,182			1991	2010	Controls F	Coll. + Cntl.	Open	2027	2027	8.1	$686,500	$66,110	2012	2027						$66,110	$66,110	$66,110
																												$172,000					$172,000	$172,000	$172,000
																													$3,457	4		$61,826	$13,826	$13,826	$13,826
																															$127	$127	$127	$127	$127
10	SJV	SJU	10-AA-0013	1	Orange Ave.	Private	29	11	1941	2005	534,399	1,122,053	1,983,341	2006	Combustion	1985	2010	Controls F	No	Closed	2010	2010	5.4	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$2,864	4		$59,456	$11,456	$11,456	$11,456
																															$127				
19	SC	SC	19-AR-0003	1	Ascon Sanitary LF	Private	62	13	1960	1981	2,000,000	2,000,000	2,000,000	1995	Combustion	1964	2010	Controls F	No	Closed	2010	2010	5.0	0	$0	2013	2028							$0	$0
																												Existing						Existing	Existing
																													$1,512	4			$54,046	$6,046	$6,046
																															$127				
15	SJV	SJU	15-AA-0044	1	Bakersfield	Local Govt.	115	7	1956	1983	2,000,000	2,000,000	2,000,000	2003	Combustion	1963	2010	Controls F	No	Closed	2010	2010	5.0	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$11,357	4	$93,430	$45,430	$45,430	$45,430	$45,430
																															$127				
15	SJV	SJU	15-AA-0048	1	China Grade SLF	Local Govt.	58	7	1978	1992	1,561,931	2,000,000	2,000,000	2002	Combustion	1980	2010	Controls F	No	Closed	2010	2010	5.0	0	$0	2013	2028							$0	$0

																															Analysis Year				
CO	AB	DIS	CIWMB SWIS File Number	Count [a]	Facility/Site Name	Ownership Status	Max. Waste Footprint (acres) [d]	Average Rainfall (Inch/Yr)	Open Year [b]	Close Year	1990 WIP (Tons)	2006 WIP (Tons)	2020 WIP (Tons)	Year LFG Capture	Updated Control Type (2009) [e]	Year >= 450,000 Tons WIP	Effective Year of Control (WIP Criteria)	Gas Heat Rate Calc. Test?	New Hardware?	2010 Status	Gas Heat Cap. Calc	Final Gas Heat Calc. Year	Max. Gas Rate (MM BTU/HR)	Capital Cost of Control (lump sum)	Annualized Capital Cost [c]	Assumed Start Year for Cap Cost Amort.	Assumed End Year for Cap. Cost Amort.	Annual Operation & Mtce Cost	Surface Monitoring & Improved Cover Maintenance (Cost/Test)	Annual Monitoring Frequency	2010	2011	2012	2013	2014
																												Existing						Existing	Existing
																													$5,728	4			$70,912	$22,912	$22,912
																															$127				
43	SF	BA	43-AO-0001	1	All Purpose LF	Local Govt.	25	15	1965	1993	1,637,887	2,000,000	2,000,000	1990	Combustion	1976	2010	Controls F	No	Closed	2010	2010	6.7	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$2,469	4		$57,876	$9,876	$9,876	$9,876
																															$127				
43	SF	BA	43-AA-0006	1	Shoreline-Mtn. View (Vista)	Local Govt.	150	17	1968	1993	1,973,885	2,000,000	2,000,000	1990	Combustion	1972	2010	Controls F	No	Closed	2010	2010	6.0	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$14,814	4		$107,256	$59,256	$59,256	$59,256
																															$127				
39	SJV	SJU	39-AA-0003	1	Harney Lane LF	Local Govt.	97	17	1948	1994	1,902,280	2,000,000	2,000,000	1993	Combustion	1966	2010	Controls F	No	Closed	2010	2010	5.8	0	$0	2013	2028							$0	$0
																												Existing						Existing	Existing
																													$9,580	4			$86,319	$38,319	$38,319
																															$127				
19	SC	SC	19-AA-0040	1	Burbank LF #3	Local Govt.	49	19	1971	2053	611,532	1,330,610	2,003,218	1995	Combustion	1986	2010	Controls F	No	Open	2053	2033	5.8	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$1,195	4	$52,778	$4,778	$4,778	$4,778	$4,778
																															$127	$127	$127	$127	$127
52	SV	TEH	52-AA-0001	1	Red Bluff LF	Local Govt.	33.6	23	1956	2023	400,561	1,111,250	2,013,981	2005	Combustion	1991	2010	Controls F	No	Open	2023	2023	8.3	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$3,318	4		$61,273	$13,273	$13,273	$13,273
																															$127	$127	$127	$127	$127
15	MD	KER	15-AA-0062	1	Tehachapi SLF	Local Govt.	32	11	1973	2007	526,883	1,115,907	2,030,714		**Open Flare**	1991	2010	Controls F	Encl. Flare	Closed	2010	2010	5.5	$284,590	$27,406	2018	2033								
																												$159,400							
																													$3,160	4					
																															$127				
42	SCC	SB	42-AA-0017	1	Lompoc LF	Local Govt.	39	17	1962	2047	259,256	1,119,417	2,068,142	2002	Combustion	1994	2010	Controls F	No	Open	2047	2033	5.5	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$3,852	4	$63,407	$15,407	$15,407	$15,407	$15,407
																															$127	$127	$127	$127	$127
24	SJV	SJU	24-AA-0002	1	Billy Wright LF	Local Govt.	40	9	1973	2009	274,746	1,124,901	2,158,303			1995	2010	Controls F	Coll. + Cntl.	Closed	2010	2010	6.3	$781,000	$75,210	2011	2026					$75,210	$75,210	$75,210	$75,210
																												$193,000				$193,000	$193,000	$193,000	$193,000
																													$3,950	4	$63,802	$15,802	$15,802	$15,802	$15,802
																															$127				
41	SF	BA	41-AA-0008	1	Hillside LF	Private	43	23	1968	2010	864,199	1,794,183	2,252,899	2002	Combustion	1981	2010	Controls F	No	Closed	2010	2010	8.9	0	$0	2013	2028							$0	$0
																												Existing						Existing	Existing
																													$4,247	4			$64,987	$16,987	$16,987
																															$127				
27	NCC	MBU	27-AA-0005	1	Johnson Cnyn LF	Local Govt.	80	13	1976	2043	148,946	993,345	2,254,724	2000	Combustion	1998	2010	Controls F	No	Open	2043	2033	6.6	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$7,901	4	$79,603	$31,603	$31,603	$31,603	$31,603
																															$127	$127	$127	$127	$127
43	SF	BA	43-AA-0007	1	Sunnyvale LF	Local Govt.	92	15	1960	1994	1,889,967	2,300,000	2,300,000	1991	Combustion	1973	2010	Controls F	No	Closed	2010	2010	7.5	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$9,086	4		$84,344	$36,344	$36,344	$36,344
																															$127				
40	SCC	SLO	40-AA-0008	1	Chicago Grade	Private	36.25	19	**1986**	2026	203,666	920,660	2,305,490	2006	Combustion	1999	2010	Controls F	No	Open	2026	2026	6.8	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$3,580	4	$62,320	$14,320	$14,320	$14,320	$14,320
																															$127	$127	$127	$127	$127
36	MD	MOJ	36-AA-0057	1	Landers DS	Local Govt.	42	7	**1986**	2013	201,694	936,892	2,324,132			1998	2010	Controls F	Coll. + Cntl.	Open	2013	2013	6.9	$818,800	$78,850	2012	2027						$78,850	$78,850	$78,850
																												$201,400					$201,400	$201,400	$201,400
																													$4,148	4		$64,592	$16,592	$16,592	$16,592
																															$127	$127	$127	$127	
33	SC	SC	33-AA-0001	1	Tequesquite/City of Riverside	Local Govt.	120	11	1958	1985	2,400,000	2,400,000	2,400,000	1995	Combustion	1963	2010	Controls F	No	Closed	2010	2010	6.3	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$2,926	4	$59,702	$11,702	$11,702	$11,702	$11,702
																															$127				
40	SCC	SLO	40-AA-0001	1	Paso Robles LF	Local Govt.	66	13	1970	2031	974,622	1,597,969	2,416,280	1997	Combustion	1978	2010	Controls F	No	Open	2031	2031	6.7	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$6,518	4		$74,073	$26,073	$26,073	$26,073
																															$127	$127	$127	$127	$127
33	SS	SC	33-AA-0012	1	Coachella Valley DS	Local Govt.	75	3	1972	1997	1,494,459	2,500,000	2,500,000	2000	Combustion	1981	2010	Controls F	No	Closed	2010	2010	9.1	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$1,829	4	$55,314	$7,314	$7,314	$7,314	$7,314
																															$127				
58	SV	FR	58-AA-0005	1	Yuba Sutter Disposal Inc. LF (YSDI)	Private	33	21	1967	1997	909,422	2,500,000	2,500,000	1999	Combustion	1984	2010	Controls F	No	Closed	2010	2010	3.9	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$3,259	4	$61,036	$13,036	$13,036	$13,036	$13,036
																															$127				
28	SF	BA	28-AA-0001	1	American Canyon LF	Local Govt.	97	21	1940	2000	1,667,136	2,500,000	2,500,000	1990	Combustion	1978	2010	Controls F	No	Closed	2010	2010	11.5	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$9,580	4	$86,319	$38,319	$38,319	$38,319	$38,319
																															$127				
33	SC	SC	33-AA-0009	1	Mead Valley DS	Local Govt.	60	13	1974	1997	1,315,088	2,528,951	2,528,951	1995	Combustion	1982	2010	Controls F	No	Closed	2010	2010	9.4	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$1,463	4	$53,851	$5,851	$5,851	$5,851	$5,851
																															$127				
43	SF	BA	43-AA-0004	1	Pacheco Pass LF	Private	91	19	1963	2004	862,677	2,064,554	2,581,707	1994	Combustion	1983	2010	Controls F	No	Closed	2010	2010	10.2	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$8,987	4	$83,949	$35,949	$35,949	$35,949	$35,949
																															$127				
36	SC	SC	36-AA-0017	1	California St. LF	Local Govt.	106	13	1963	2031	760,853	1,627,494	2,670,268	2001	Combustion	1983	2010	Controls F	No	Open	2031	2031	7.6	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$2,584	4		$58,337	$10,337	$10,337	$10,337
																															$127	$127	$127	$127	$127
54	SJV	SJU	54-AA-0004	1	Teapot Dome DS	Local Govt.	71	11	1972	2005	679,732	1,646,300	2,810,691	2005	Combustion	1985	2010	Controls F	No	Closed	2010	2010	8.1	0	$0	2013	2028							$0	$0
																												Existing						Existing	Existing
																													$7,012	4			$76,048	$28,048	$28,048
																															$127				
44	NCC	MBU	44-AA-0001	1	City of Santa Cruz LF	Local Govt.	57.5	33	1966	2037	793,897	1,869,373	2,844,784	1991	Combustion	1983	2010	Controls F	No	Open	2037	2033	11.1	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$5,679	4	$70,715	$22,715	$22,715	$22,715	$22,715
																															$127	$127	$127	$127	$127
37	SD	SD	37-AA-0005	1	Ramona LF	Private	46	15	1969	2006	791,182	1,642,804	2,883,292	1997	Combustion	1981	2010	Controls F	No	Closed	2010	2010	5.0	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$4,543	4		$66,172	$18,172	$18,172	$18,172
																															$127				
35	NCC	MBU	35-AA-0001	1	John Smith Road SWDS	Local Govt.	44	13	1968	2024	712,443	1,667,101	2,905,134	1998	Combustion	1981	2010	Controls F	No	Open	2024	2024	8.2	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$4,345	4	$65,382	$17,382	$17,382	$17,382	$17,382
																															$127	$127	$127	$127	$127
36	MD	MOJ	36-AA-0046	1	Barstow RDS	Local Govt.	47	5	1963	2007	835,445	1,645,120	2,949,622			1977	2010	Controls F	Coll. + Cntl.	Closed	2010	2010	8.2	$913,300	$87,951	2013	2028							$87,951	$87,951
																												$222,400						$222,400	$222,400
																													$4,642	4			$66,567	$18,567	$18,567
																															$127				
37	SD	SD	37-AA-0022	1	South Chollas	Local Govt.	120	11	1952	1981	3,000,000	3,000,000	3,000,000	1990	Combustion	1957	2010	Controls F	No	Closed	2010	2010	7.1	0	$0	2013	2028							$0	$0

Analysis Year

CO	AB	DIS	CIWMB SWIS File Number	Count [a]	Facility/Site Name	Ownership Status	Max. Waste Footprint (acres) [d]	Average Rainfall (Inch/Yr)	Open Year [b]	Close Year	1990 WIP (Tons)	2006 WIP (Tons)	2020 WIP (Tons)	Year LFG Capture	Updated Control Type (2009) [e]	Year >= 450,000 Tons WIP	Effective Year of Control (WIP Criteria)	Gas Heat Rate Calc. Test?	New Hardware?	2010 Status	Gas Heat Cap. Calc	Final Gas Heat Calc. Year	Max. Gas Rate (MM BTU/HR)	Capital Cost of Control (lump sum)	Annualized Capital Cost [c]	Assumed Start Year for Cap Cost Amort.	Assumed End Year for Cap. Cost Amort.	Annual Operation & Mtce Cost	Surface Monitoring & Improved Cover Maintenance (Cost/Test)	Annual Monitoring Frequency	2010	2011	2012	2013	2014
																												Existing						Existing	Existing
																													$11,851	4			$95,405	$47,405	$47,405
																															$127				
33	SC	SC	33-AA-0008	1	Double Butte DS	Local Govt.	100	11	1973	1995	2,732,052	3,000,000	3,000,000	1994	Combustion	1975	2010	Controls f	No	Closed	2010	2010	9.8	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$2,438	4	$57,752	$9,752	$9,752	$9,752	$9,752
																															$127				
33	SC	SC	33-AA-0003	1	Highgrove LF	Local Govt.	71	13	1947	1998	1,284,218	3,002,920	3,002,920	1997	Combustion	1984	2010	Controls f	No	Closed	2010	2010	11.3	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$1,731	4		$54,924	$6,924	$6,924	$6,924
																															$127				
41	SF	BA	41-AA-0011 41-AA-0012	2	Marsh Road	Local Govt.	146	17	1961	1984	3,500,000	3,500,000	3,500,000	1991	Combustion	1963	2010	Controls f	No	Closed	2010	2010	9.2	0	$0	2013	2028							$0	$0
																												Existing						Existing	Existing
																													$14,419	4			$105,676	$57,676	$57,676
																															$127				
15	SJV	SJU	15-AA-0050	1	Arvin SLF	Local Govt.	143	7	1971	2008	1,669,202	3,519,658	3,520,296	2001	**Open Flare**	1978	2010	Controls f	Encl. Flare	Closed	2010	2010	4.0	$284,590	$27,406	2018	2033								
																												$625,600							
																													$14,123	4					
																															$127				
54	SJV	SJU	54-AA-0008	1	Woodville DS	Local Govt.	153	11	1970	2026	1,258,544	2,644,186	3,755,863	2004	Combustion	1978	2010	Controls f	No	Open	2026	2026	10.7	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$15,110	4		$108,441	$60,441	$60,441	$60,441
																															$127	$127	$127	$127	$127
10	SJV	SJU	10-AA-0002	1	Chateau Fresno LF	Private	75	11	1950	1996	2,132,332	3,800,000	3,800,000	1993	Combustion	1979	2010	Controls f	No	Closed	2010	2010	21.0	0	$0	2013	2028							$0	$0
																												Existing						Existing	Existing
																													$7,407	4			$77,628	$29,628	$29,628
																															$127				
33	SC	SC	33-AA-0004	1	Corona Disposal Site	Local Govt.	95	11	1961	1986	4,000,000	4,000,000	4,000,000	1990	Combustion	1963	2010	Controls f	No	Closed	2010	2010	10.8	0	$0	2013	2028							$0	$0
																												Existing						Existing	Existing
																													$2,316	4			$57,264	$9,264	$9,264
																															$127				
56	SCC	VEN	56-AA-0004	1	Coastal LF (including Santa Clara LF)	Local Govt.	120	15	1962	1989	4,000,000	4,000,000	4,000,000	1991	Combustion	1965	2010	Controls f	No	Closed	2010	2010	11.5	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$11,851	4	$95,405	$47,405	$47,405	$47,405	$47,405
																															$127				
34	SV	SAC	34-AA-0018	1	Sacramento City LF	Local Govt.	130	19	1960	1994	3,410,394	4,000,000	4,000,000	1991	Combustion	1967	2010	Controls f	No	Closed	2010	2010	12.7	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$12,839	4		$99,355	$51,355	$51,355	$51,355
																															$127				
56	SCC	VEN	56-AA-0011	1	Bailard LF	Local Govt.	120	15	1989	1996	1,879,583	4,000,000	4,000,000	1991	Combustion	1988	2010	Controls f	No	Closed	2010	2010	16.0	0	$0	2013	2028							$0	$0
																												Existing						Existing	Existing
																													$11,851	4			$95,405	$47,405	$47,405
																															$127				
16	SJV	SJU	16-AA-0004	1	Avenal LF	Local Govt.	123.2	7	**1980**	2020	341,069	1,136,419	4,003,699			1997	2010	Controls f	Coll. + Cntl.	Open	2020	2020	11.6	$2,353,480	$226,640	2011	2026					$226,640	$226,640	$226,640	$226,640
																												$542,440				$542,440	$542,440	$542,440	$542,440
																													$12,167	4	$96,669	$48,669	$48,669	$48,669	$48,669
																															$127	$127	$127	$127	$127
45	SV	SHA	45-AA-0043	1	West Central (Phase 2)	Local Govt.	100	37	1990	2013	106,919	2,101,253	4,581,004			1993	2010	Controls f	Coll. + Cntl.	Open	2013	2013	20.9	$1,915,000	$184,415	2012	2027						$184,415	$184,415	$184,415
																												$445,000					$445,000	$445,000	$445,000
																													$9,876	4		$87,504	$39,504	$39,504	$39,504
																															$127	$127	$127	$127	
45	SV	SHA	45-AA-0020	1	Anderson LF	Private	165	29	1976	2049	550,274	2,063,459	4,647,695	2006	Combustion	1988	2010	Controls f	No	Open	2049	2033	20.9	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$16,295	4		$113,182	$65,182	$65,182	$65,182
																															$127	$127	$127	$127	$127
10	SJV	SJU	10-AA-0005	1	City of Fresno LF	Local Govt.	145	11	1937	1987	4,700,000	4,700,000	4,700,000	2000	Combustion	1945	2010	Controls f	No	Closed	2010	2010	11.5	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$14,320	4	$105,281	$57,281	$57,281	$57,281	$57,281
																															$127				
13	SS	IMP	13-AA-0019	1	Republic-Imperial	Private	73	3	1971	2010	279,924	1,856,219	4,708,951			1993	2010	Controls f	Coll. + Cntl.	Closed	2010	2010	13.8	$1,404,700	$135,273	2012	2027						$135,273	$135,273	$135,273
																												$331,600					$331,600	$331,600	$331,600
																													$7,209	4		$76,838	$28,838	$28,838	$28,838
																															$127				
20	SJV	SJU	20-AA-0002	1	Fairmead LF	Local Govt.	77	11	1958	2033	661,128	2,309,543	4,781,653	1998	Combustion	1986	2010	Controls f	No	Open	2033	2033	13.8	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$7,605	4		$78,418	$30,418	$30,418	$30,418
																															$127	$127	$127	$127	$127
54	SJV	SJU	54-AA-0009	1	Visalia DS	Local Govt.	247	11	1952	2024	786,444	2,967,791	4,782,022	2004	Combustion	1987	2010	Controls f	No	Open	2024	2024	14.3	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$24,394	4		$145,575	$97,575	$97,575	$97,575
																															$127	$127	$127	$127	$127
1	SF	BA	01-AA-0006	1	Davis Street	Local Govt.	194	21	1965	1980	4,800,000	4,800,000	4,800,000	1990	Combustion	1965	2010	Controls f	No	Closed	2010	2010	12.5	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$19,159	4		$124,638	$76,638	$76,638	$76,638
																															$127				
39	SJV	SJU	39-AA-0022	1	North County LF	Local Govt.	185	17	1990	2033	94,996	2,161,867	5,090,525		**Combustion**	1993	2010	Controls f	No	Open	2033	2033	15.3	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$18,271	4		$121,082	$73,082	$73,082	$73,082
																															$127	$127	$127	$127	$127
50	SJV	SJU	50-AA-0001	1	Fink Rd LF	Local Govt.	216	11	1973	2019	706,220	2,793,994	5,158,987	2004	Combustion	1986	2010	Controls f	No	Open	2019	2019	15.1	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$21,332	4	$133,329	$85,329	$85,329	$85,329	$85,329
																															$127	$127	$127	$127	$127
42	SCC	SB	42-AA-0016	1	City of Santa Maria LF	Local Govt.	245	15	1940	2017	1,217,394	3,247,271	5,338,263	1998	Combustion	1981	2010	Controls f	No	Open	2017	2017	15.5	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$24,196	4	$144,785	$96,785	$96,785	$96,785	$96,785
																															$127	$127	$127	$127	$127
44	NCC	MBU	44-AA-0004	1	Buena Vista DS	Local Govt.	61	23	1966	2021	1,321,475	3,250,261	5,415,161	1991	Combustion	1977	2010	Controls f	No	Open	2021	2021	21.8	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$6,024	4	$72,097	$24,097	$24,097	$24,097	$24,097
																															$127	$127	$127	$127	$127
16	SJV	SJU	16-AA-0021	1	Kettleman Hills SLF	Private	43	7	1998	2023	0	1,685,025	5,488,215	2005	Combustion	2000	2010	Controls f	No	Open	2023	2023	16.2	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$4,247	4	$64,987	$16,987	$16,987	$16,987	$16,987
																															$127	$127	$127	$127	$127
15	SJV	SJU	15-AA-0057	1	Shafter-Wasco SLF	Local Govt.	135	7	1972	2027	1,141,979	3,043,121	5,665,322	2002	Combustion	1983	2010	Controls f	No	Open	2027	2027	6.5	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$13,333	4		$101,330	$53,330	$53,330	$53,330
																															$127	$127	$127	$127	$127
37	SD	SD	37-AA-0008	1	San Marcos LF	Local Govt.	107	13	1979	1997	2,483,568	6,000,000	6,000,000	1990	Combustion	1984	2010	Controls f	No	Closed	2010	2010	23.4	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$10,567	4		$90,269	$42,269	$42,269	$42,269
																															$127				
4	SV	BUT	04-AA-0002	1	Neal RD LF	Local Govt.	140	29	1970	2033	493,221	3,100,082	6,086,556	2002	Combustion	1989	2010	Controls f	No	Open	2033	2033	27.0	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$13,826	4	$103,306	$55,306	$55,306	$55,306	$55,306
																															$127	$127	$127	$127	$127
58	SV	FR	58-AA-0011	1	Ostrom Road SLF	Private	225	21	1995	2066	0	1,663,897	6,125,580	2003	**Open Flare**	2001	2010	Controls f	Encl. Flare	Open	2066	2033	30.1	$370,419	$35,671	2018	2033								

CO	AB	DIS	CIWMB SWIS File Number	Count [a]	Facility/Site Name	Ownership Status	Max. Waste Footprint (acres) [d]	Average Rainfall (Inch/Yr)	Open Year [b]	Close Year	1990 WIP (Tons)	2006 WIP (Tons)	2020 WIP (Tons)	Year LFG Capture	Updated Control Type (2009) [e]	Year >= 450,000 Tons WIP	Effective Year of Control (WIP Criteria)	Gas Heat Rate Calc. Test?	New Hardware?	2010 Status	Gas Heat Cap. Calc	Final Gas Heat Calc. Year	Max. Gas Rate (MM BTU/HR)	Capital Cost of Control (lump sum)	Annualized Capital Cost [c]	Assumed Start Year for Cap Cost Amort.	Assumed End Year for Cap. Cost Amort.	Annual Operation & Mtce Cost	Surface Monitoring & Improved Cover Maintenance (Cost/Test)	Annual Monitoring Frequency	Analysis Year 2010	2011	2012	2013	2014
																												$970,000							
																													$22,221	4					
																															$127	$127	$127	$127	$127
40	SCC	SLO	40-AA-0004	1	Cold Canyon	Private	88	19	1965	2012	1,321,918	3,827,673	6,599,415	1994	Combustion	1981	2010	Controls f	No	Open	2012	2012	19.3	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$8,691	4		$82,764	$34,764	$34,764	$34,764
																															$127	$127	$127		
36	SC	SC	36-AA-0087	1	San Timoteo SWDS	Local Govt.	114	15	1978	2016	773,034	3,200,222	6,832,341	2000	Combustion	1987	2010	Controls f	No	Open	2016	2016	20.1	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$2,779	4		$59,117	$11,117	$11,117	$11,117
																															$127	$127	$127	$127	$127
19	SC	SC	19-AA-0013	1	Azusa LF (Zone I)	Private	77	17	1958	1991	4,980,097	5,331,470	7,167,957	1990	Combustion	1960	2010	Controls f	No	Closed	2010	2010	17.4	0	$0	2013	2028							$0	$0
																												Existing						Existing	Existing
																													$1,877	4			$55,509	$7,509	$7,509
																															$127				
48	SV	YS	48-AA-0002	1	B & J Drop Box	Private	260	21	1964	2070	1,529,609	3,911,141	7,168,617		**Combustion**	1973	2010	Controls f	No	Open	2070	2033	28.2	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$25,678	4		$150,710	$102,710	$102,710	$102,710
																															$127	$127	$127	$127	$127
7	SF	BA	07-AA-0002	1	Acme Sanitary LF	Private	109	17	1954	2003	6,429,329	7,050,842	7,488,750	1991	Combustion	1955	2010	Controls f	No	Closed	2010	2010	19.4	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$10,765	4		$91,059	$43,059	$43,059	$43,059
																															$127				
19	SC	SC	19-AH-0001	1	Whittier- Savage Canyon	Local Govt.	132	15	1963	2039	3,027,749	6,176,012	7,618,193	1993	Combustion	1966	2010	Controls f	No	Open	2039	2033	20.5	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$3,218	4		$60,873	$12,873	$12,873	$12,873
																															$127	$127	$127	$127	$127
34	SV	SAC	34-AA-0020	1	L & D LF	Private	157	19	1977	2013	1,239,834	3,565,900	7,739,980	2004	Venting	1981	2010	Controls f	Coll. + Cntl.	Open	2013	2013	22.6	$2,992,300	$288,158	2011	2026					$288,158	$288,158	$288,158	$288,158
																												$684,400				$684,400	$684,400	$684,400	$684,400
																													$15,505	4	$110,021	$62,021	$62,021	$62,021	$62,021
																															$127	$127	$127	$127	
24	SJV	SJU	24-AA-0001	1	Hwy 59 DS	Local Govt.	255	13	1972	2043	1,322,411	3,973,714	7,847,858		**Carbon**	1980	2010	Controls f	Encl. Flare	Open	2043	2033	23.0	$347,872	$33,500	2012	2027						$33,500	$33,500	$33,500
																												$1,096,000					$1,096,000	$1,096,000	$1,096,000
																													$25,184	4		$148,735	$100,735	$100,735	$100,735
																															$127	$127	$127	$127	$127
43	SF	BA	43-AN-0015	1	Guadalupe SLF	Private	115	25	1929	2020	1,034,929	4,469,114	7,922,634	1990	Combustion	1984	2010	Controls f	No	Open	2020	2020	10.6	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$11,357	4	$93,430	$45,430	$45,430	$45,430	$45,430
																															$127	$127	$127	$127	$127
27	NCC	MBU	27-AA-0007	1	Crazy Horse LF	Local Govt.	72	15	1960	2009	1,189,474	4,000,135	7,943,988	1993	Combustion	1981	2010	Controls f	No	Closed	2010	2010	23.2	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$7,111	4	$76,443	$28,443	$28,443	$28,443	$28,443
																															$127				
19	SC	SC	19-AR-0006	1	Penrose Pit	Private	72	17	1960	1985	9,000,000	9,000,000	9,000,000	1990	Combustion	1960	2010	Controls f	No	Closed	2010	2010	23.8	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$1,755	4		$55,021	$7,021	$7,021	$7,021
																															$127				
31	SV	PLA	31-AA-0210	1	Western Regional LF	Local Govt.	231	21	1980	2036	1,201,867	4,538,046	9,086,821	1993	Combustion	1984	2010	Controls f	No	Open	2036	2033	39.9	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$22,814	4	$139,254	$91,254	$91,254	$91,254	$91,254
																															$127	$127	$127	$127	$127
39	SJV	SJU	39-AA-0004	1	Foothill LF	Local Govt.	50	17	1965	2054	551,014	4,123,926	9,158,468		**Open Flare**	1989	2010	Controls f	Encl. Flare	Open	2054	2033	27.2	$347,872	$33,500	2018	2033								
																												$235,000							
																													$4,938	4					
																															$127	$127	$127	$127	$127
57	SV	YS	57-AA-0001	1	Yolo Co. Central LF	Local Govt.	473	19	1975	2045	2,777,248	5,833,578	9,244,718	1992	Combustion	1977	2010	Controls f	No	Open	2045	2033	26.4	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$46,713	4	$234,854	$186,854	$186,854	$186,854	$186,854
																															$127	$127	$127	$127	$127
19	MD	AV	19-AA-0009	1	Antelope Valley	Private	57	9	1952	2006	269,364	3,743,346	9,607,924	2004	Combustion	1992	2010	Controls f	No	Closed	2010	2010	39.3	0	$0	2013	2028							$0	$0
																												Existing						Existing	Existing
																													$5,629	4			$70,517	$22,517	$22,517
																															$127				
42	SCC	SB	42-AA-0015	1	Tajiguas LF	Local Govt.	118	17	1967	2020	2,654,471	6,235,959	10,283,897	1996	Combustion	1974	2010	Controls f	No	Open	2020	2020	29.6	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$11,654	4	$94,615	$46,615	$46,615	$46,615	$46,615
																															$127	$127	$127	$127	$127
36	MD	MOJ	36-AA-0045	1	Victorville RDS	Local Govt.	341	7	1955	2059	1,067,804	4,348,479	10,626,492	2003	Combustion	1980	2010	Controls f	No	Open	2059	2033	30.7	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$33,677	4	$182,709	$134,709	$134,709	$134,709	$134,709
																															$127	$127	$127	$127	$127
43	SF	BA	43-AN-0008	1	Kirby Canyon LF	Private	311	23	1986	2025	1,775,249	6,608,275	11,149,364	1996	Combustion	1986	2010	Controls f	No	Open	2025	2025	26.3	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$30,714	4		$170,857	$122,857	$122,857	$122,857
																															$127	$127	$127	$127	$127
27	NCC	MBU	27-AA-0010	1	Monterey Peninsula LF	Local Govt.	315	15	1966	2084	3,981,093	7,517,740	11,570,780	1990	Combustion	1969	2010	Controls f	No	Open	2084	2033	32.0	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$31,109	4	$172,438	$124,438	$124,438	$124,438	$124,438
																															$127	$127	$127	$127	$127
19	SC	SC	19-AR-0002	1	Sunshine Canyon City (Inactive Unit and Unit 2-I)	Private	289	19	1958	2008	802,887	2,865,249	11,819,433	1992	Combustion	1989	2010	Controls f	No	Closed	2010	2010	394.7	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$7,046	4		$76,183	$28,183	$28,183	$28,183
																															$127				
36	SC	SC	36-AA-0051	1	Colton LF	Local Govt.	82	13	1964	2006	1,587,376	6,062,952	11,840,853	2001	Combustion	1982	2010	Controls f	No	Closed	2010	2010	34.4	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$1,999	4		$55,997	$7,997	$7,997	$7,997
																															$127				
56	SCC	VEN	56-AA-0005	1	Toland Rd. LF	Local Govt.	92	19	1970	2027	675,668	4,692,098	11,982,793	1997	Combustion	1983	2010	Controls f	No	Open	2027	2027	34.4	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$9,086	4	$84,344	$36,344	$36,344	$36,344	$36,344
																															$127	$127	$127	$127	$127
36	SC	SC	36-AA-0054	1	Milliken	Local Govt.	140	15	1956	2001	8,339,070	12,011,629	12,011,629	1990	Combustion	1960	2010	Controls f	No	Closed	2010	2010	39.8	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$3,413	4	$61,653	$13,653	$13,653	$13,653	$13,653
																															$127				
19	MD	AV	19-AA-0050	1	Lancaster Waste Mgt.	Private	209	7	1954	2012	1,253,944	4,921,267	12,577,703	1993	Combustion	1978	2010	Controls f	No	Open	2012	2012	10.6	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$20,641	4	$130,563	$82,563	$82,563	$82,563	$82,563
																															$127	$127	$127		
33	SS	SC	33-AA-0011	1	Edom Hill DS	Local Govt.	148	5	1967	2004	1,681,856	6,983,228	12,733,398	2001	Combustion	1980	2010	Controls f	No	Closed	2010	2010	36.7	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$3,608	4	$62,433	$14,433	$14,433	$14,433	$14,433
																															$127				
30	SC	SC	30-AB-0018	1	Santiago Canyon SLF	Private	130	15	1968	1996	8,936,769	13,284,221	13,284,221	1991	Combustion	1972	2010	Controls f	No	Closed	2010	2010	33.6	0	$0	2013	2028							$0	$0
																												Existing						Existing	Existing
																													$3,169	4			$60,678	$12,678	$12,678
																															$127				
15	SJV	SJU	15-AA-0273	1	Bakersfield SLF (Bena)	Local Govt.	229	9	1992	2038	0	4,757,447	13,408,350	2000	Combustion	1992	2010	Controls f	No	Open	2038	2033	31.2	0	$0	2012	2027						$0	$0	$0

																															Analysis Year				
CO	AB	DIS	CIWMB SWIS File Number	Count [a]	Facility/Site Name	Ownership Status	Max. Waste Footprint (acres) [d]	Average Rainfall (Inch/Yr)	Open Year [b]	Close Year	1990 WIP (Tons)	2006 WIP (Tons)	2020 WIP (Tons)	Year LFG Capture	Updated Control Type (2009) [e]	Year >= 450,000 Tons WIP	Effective Year of Control (WIP Criteria)	Gas Heat Rate Calc. Test?	New Hardware?	2010 Status	Gas Heat Cap. Calc	Final Gas Heat Calc. Year	Max. Gas Rate (MM BTU/HR)	Capital Cost of Control (lump sum)	Annualized Capital Cost [c]	Assumed Start Year for Cap Cost Amort.	Assumed End Year for Cap. Cost Amort.	Annual Operation & Mtce Cost	Surface Monitoring & Improved Cover Maintenance (Cost/Test)	Annual Monitoring Frequency	2010	2011	2012	2013	2014
																												Existing					Existing	Existing	Existing
																													$22,616	4		$138,464	$90,464	$90,464	$90,464
																															$127	$127	$127	$127	$127
33	SC	SC	33-AA-0007	1	Lamb Canyon DS	Local Govt.	144.6	17	1970	2023	1,350,362	5,092,563	14,048,887	2002	Combustion	1981	2010	Controls I	No	Open	2023	2023	40.6	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$3,525	4	$62,101	$14,101	$14,101	$14,101	$14,101
																															$127	$127	$127	$127	$127
49	SF	BA	49-AA-0001	1	Central LF	Local Govt.	172	29	1972	2019	4,585,243	11,192,029	14,126,201	1990	Combustion	1974	2010	Controls I	No	Open	2019	2019	59.8	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$16,987	4	$115,947	$67,947	$67,947	$67,947	$67,947
																															$127	$127	$127	$127	$127
1	SF	BA	01-AA-0008	1	Tri-Cities LF	Private	115	15	1968	2005	4,217,879	9,325,621	14,655,691	1990	Combustion	1971	2010	Controls I	No	Closed	2010	2010	49.5	0	$0	2013	2028							$0	$0
																												Existing						Existing	Existing
																													$11,357	4			$93,430	$45,430	$45,430
																															$127				
21	SF	BA	21-AA-0001	1	Redwood SLF	Private	195	29	1958	2039	1,960,908	8,286,636	15,476,521	1990	Combustion	1981	2010	Controls I	No	Open	2039	2033	82.3	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$19,258	4	$125,033	$77,033	$77,033	$77,033	$77,033
																															$127	$127	$127	$127	$127
7	SF	BA	07-AA-0001	1	W Contra Costa LF	Private	160	23	1953	2006	4,483,715	9,410,067	15,665,749	1992	Combustion	1960	2010	Controls I	No	Closed	2010	2010	59.6	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$15,802	4		$111,206	$63,206	$63,206	$63,206
																															$127				
19	SC	SC	19-AA-0819	1	Toyon	Local Govt.	90	17	1957	1986	16,000,000	16,000,000	16,000,000	1990	Combustion	1957	2010	Controls I	No	Closed	2010	2010	42.3	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$2,194	4		$56,777	$8,777	$8,777	$8,777
																															$127				
10	SJV	SJU	10-AA-0009	1	American Ave.	Local Govt.	361	9	1971	2031	2,260,008	8,990,687	16,983,923	2000	Combustion	1974	2010	Controls I	No	Open	2031	2031	49.2	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$35,652	4	$190,609	$142,609	$142,609	$142,609	$142,609
																															$127	$127	$127	$127	$127
19	SC	SC	19-AA-0015	1	Spadra LF	State Govt.	173	17	1957	2000	10,144,050	17,536,915	17,536,915	1990	Combustion	1961	2010	Controls I	No	Closed	2010	2010	100.1	0	$0	2013	2028							$0	$0
																												Existing						Existing	Existing
																													$4,218	4			$64,871	$16,871	$16,871
																															$127				
19	SC	SC	19-AA-0820	1	Lopez Canyon LF	Local Govt.	166	19	1975	1996	14,616,276	19,000,000	19,000,000	1990	Combustion	1974	2010	Controls I	No	Closed	2010	2010	65.8	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$4,047	4		$64,188	$16,188	$16,188	$16,188
																															$127				
33	SC	SC	33-AA-0006	1	Badlands DS	Local Govt.	150	15	1966	2018	674,139	6,768,638	19,976,773	2001	Combustion	1987	2010	Controls I	No	Open	2018	2018	57.8	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$3,657	4	$62,628	$14,628	$14,628	$14,628	$14,628
																															$127	$127	$127	$127	$127
1	SF	BA	01-AA-0010	1	Vasco Road LF	Private	222	15	1962	2016	3,990,878	11,845,745	21,368,916	1996	Combustion	1973	2010	Controls I	No	Open	2016	2016	59.4	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$21,925	4		$135,699	$87,699	$87,699	$87,699
																															$127	$127	$127	$127	$127
19	SC	SC	19-AA-0836	1	Operating Industries (OII) (NPL Site)	Private	190	17	1948	1984	22,000,000	22,000,000	22,000,000	1995	Combustion	1948	2010	Controls I	No	Closed	2010	2010	53.4	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$4,632	4	$66,529	$18,529	$18,529	$18,529	$18,529
																															$127				
7	SF	BA	07-AA-0032	1	Keller Canyon LF	Private	244	17	1992	2037	0	7,678,238	22,690,827	1993	Combustion	1994	2010	Controls I	No	Open	2037	2033	99.5	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$24,097	4	$144,390	$96,390	$96,390	$96,390	$96,390
																															$127	$127	$127	$127	$127
19	SC	SC	19-AE-0001	1	Palos Verdes	Local Govt.	291	13	1957	1980	23,600,000	23,600,000	23,600,000	1990	Combustion	1956	2010	Controls I	No	Closed	2010	2010	57.8	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$7,095	4	$76,378	$28,378	$28,378	$28,378	$28,378
																															$127				
48	SF	BA	48-AA-0075	1	Potrero Hills	Private	190	21	1986	2059	574,163	8,521,148	24,710,972	1993	Combustion	1989	2010	Controls I	No	Open	2059	2033	112.2	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$18,764	4	$123,058	$75,058	$75,058	$75,058	$75,058
																															$127	$127	$127	$127	$127
36	SC	SC	36-AA-0055	1	Fontana RDS (Mid-Valley)	Local Govt.	408	21	1958	2033	2,466,265	9,786,714	25,197,761	1995	Combustion	1974	2010	Controls I	No	Open	2033	2033	111.2	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$9,947	4	$87,788	$39,788	$39,788	$39,788	$39,788
																															$127	$127	$127	$127	$127
19	SC	SC	19-AA-0821 19-AA-0822	3	Mission Canyon/ Mountaingate	Local Govt.	375	19	1958	1981	26,800,000	26,800,000	26,800,000	1990	Combustion	1957	2010	Controls I	No	Closed	2010	2010	5.7	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$9,143	4	$84,570	$36,570	$36,570	$36,570	$36,570
																															$127				
30	SC	SC	30-AB-0017	1	Coyote Canyon SLF	Private	325	13	1963	1990	27,000,000	27,000,000	27,000,000	1990	Combustion	1962	2010	Controls I	No	Closed	2010	2010	105.6	0	$0	2013	2028							$0	$0
																												Existing						Existing	Existing
																													$7,924	4			$79,694	$31,694	$31,694
																															$127				
56	SCC	VEN	56-AA-0007	1	Simi Valley LF	Private	185.61	15	1970	2022	4,946,498	13,739,823	27,823,257	1991	Combustion	1971	2010	Controls I	No	Open	2022	2022	95.5	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$18,331	4	$121,323	$73,323	$73,323	$73,323	$73,323
																															$127	$127	$127	$127	$127
43	SF	BA	43-AN-0003	1	Newby Island	Private	313.2	15	1932	2016	2,409,383	15,746,481	28,339,271	1992	Combustion	1985	2010	Controls I	No	Open	2016	2016	58.6	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$30,932	4	$171,727	$123,727	$123,727	$123,727	$123,727
																															$127	$127	$127	$127	$127
41	SF	BA	41-AA-0002	1	Corinda Los Trancos LF (Ox Mtn)	Private	191	33	1976	2023	3,102,621	16,593,446	29,255,388	1991	Combustion	1983	2010	Controls I	No	Open	2023	2023	171.5	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$18,863	4	$123,453	$75,453	$75,453	$75,453	$75,453
																															$127	$127	$127	$127	$127
34	SV	SAC	34-AA-0001	1	Kiefer LF	Local Govt.	667	19	1967	2035	4,882,713	17,499,572	30,055,405	1994	Combustion	1976	2010	Controls I	No	Open	2035	2033	88.7	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$65,873	4	$311,492	$263,492	$263,492	$263,492	$263,492
																															$127	$127	$127	$127	$127
37	SD	SD	37-AA-0023	1	Sycamore SW LF	Private	324	13	1976	2016	2,984,513	14,111,841	31,614,977	1999	Combustion	1979	2010	Controls I	No	Open	2016	2016	143.2	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$31,998	4	$175,993	$127,993	$127,993	$127,993	$127,993
																															$127	$127	$127	$127	$127
19	SC	SC	19-AA-0056	1	Calabasas LF	Local Govt.	416	19	1961	2028	13,172,817	22,479,153	31,874,338	1990	Combustion	1961	2010	Controls I	No	Open	2028	2028	144.1	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$10,142	4	$88,568	$40,568	$40,568	$40,568	$40,568
																															$127	$127	$127	$127	$127
19	SC	SC	19-AA-0012	1	Scholl Canyon LF	Local Govt.	440	19	1961	2014	19,443,400	27,791,673	36,374,233	1990	Combustion	1960	2010	Controls I	No	Open	2014	2014	149.8	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$10,727	4		$90,909	$42,909	$42,909	$42,909
																															$127	$127	$127	$127	$127
30	SC	SC	30-AB-0019	1	Prima Descha SLF	Local Govt.	699	13	1976	2067	12,035,917	21,893,121	36,376,606	1991	Combustion	1975	2010	Controls I	No	Open	2067	2033	72.1	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$17,042	4		$116,166	$68,166	$68,166	$68,166
																															$127	$127	$127	$127	$127
19	SC	SC	19-AA-0853	1	Sunshine Canyon Extension	Private	215	21	1996	2008	0	12,656,411	36,856,158	1992	Combustion	1997	2010	Controls I	No	Closed	2010	2010	281.2	0	$0	2012	2027						$0	$0	$0

																															Analysis Year				
CO	**AB**	**DIS**	**CIWMB SWIS File Number**	**Count [a]**	**Facility/Site Name**	**Ownership Status**	**Max. Waste Footprint (acres) [d]**	**Average Rainfall (Inch/Yr)**	**Open Year [b]**	**Close Year**	**1990 WIP (Tons)**	**2006 WIP (Tons)**	**2020 WIP (Tons)**	**Year LFG Capture**	**Updated Control Type (2009) [e]**	**Year >= 450,000 Tons WIP**	**Effective Year of Control (WIP Criteria)**	**Gas Heat Rate Calc. Test?**	**New Hardware?**	**2010 Status**	Gas Heat Cap. Calc	**Final Gas Heat Calc. Year**	**Max. Gas Rate (MM BTU/HR)**	**Capital Cost of Control (lump sum)**	**Annualized Capital Cost [c]**	**Assumed Start Year for Cap Cost Amort.**	Assumed End Year for Cap. Cost Amort.	**Annual Operation & Mtce Cost**	**Surface Monitoring & Improved Cover Maintenance (Cost/Test)**	**Annual Monitoring Frequency**	**2010**	**2011**	**2012**	**2013**	**2014**
																												Existing					Existing	Existing	Existing
																													$5,242	4		$68,967	$20,967	$20,967	$20,967
																															$127				
39	SJV	SJU	39-AA-0015	1	Forward LF (+ Austin Rd LF - 0001)	Private	354.5	15	1973	2020	1,973,144	15,264,704	37,950,388	1991	Combustion	1978	2010	Controls F	No	Open	2020	2020	66.9	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$35,010	4	$188,042	$140,042	$140,042	$140,042	$140,042
																															$127	$127	$127	$127	$127
19	SC	SC	19-AR-0008	1	Bradley Ave East & West	Private	171	17	1959	2007	12,983,834	33,518,023	38,729,613	1990	Combustion	1960	2010	Controls F	No	Closed	2010	2010	144.1	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$4,169	4		$64,676	$16,676	$16,676	$16,676
																															$127				
19	SC	SC	19-AF-0001	1	BKK West Covina (Class I and III LFs)	Private	370	17	1962	1996	29,126,627	45,800,000	45,800,000	1990	Combustion	1963	2010	Controls F	No	Closed	2010	2010	162.7	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$9,021	4	$84,082	$36,082	$36,082	$36,082	$36,082
																															$127				
37	SD	SD	37-AA-0010	1	Otay SWLF	Private	230	11	1963	2021	7,065,578	21,650,229	50,092,469	1991	Combustion	1965	2010	Controls F	No	Open	2021	2021	237.8	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$22,715	4	$138,859	$90,859	$90,859	$90,859	$90,859
																															$127	$127	$127	$127	$127
19	SC	SC	19-AA-0052	1	Chiquita Canyon	Private	257	15	1972	2019	4,310,480	22,074,046	50,973,493	1995	Combustion	1975	2010	Controls F	No	Open	2019	2019	147.4	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$6,266	4	$73,063	$25,063	$25,063	$25,063	$25,063
																															$127	$127	$127	$127	$127
37	SD	SD	37-AA-0020	1	Miramar SWLF	Military	470	11	1959	2011	6,156,512	27,951,838	52,513,559	1995	Combustion	1979	2010	Controls F	No	Open	2011	2011	156.6	0	$0	2011	2026					$0	$0	$0	$0
																												Existing				Existing	Existing	Existing	Existing
																													$46,417	4	$233,669	$185,669	$185,669	$185,669	$185,669
																															$127	$127			
33	SC	SC	33-AA-0217	1	El Sobrante SWLF	Private	495	13	1983	2030	1,619,035	19,711,183	59,173,030	1994	Combustion	1984	2010	Controls F	No	Open	2030	2030	173.9	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$12,068	4		$96,272	$48,272	$48,272	$48,272
																															$127	$127	$127	$127	$127
1	SF	BA	01-AA-0009	1	Altamont LF	Private	443	15	1980	2028	14,967,744	39,772,442	63,607,251	1990	Combustion	1979	2010	Controls F	No	Open	2028	2028	141.3	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$43,751	4		$223,003	$175,003	$175,003	$175,003
																															$127	$127	$127	$127	$127
30	SC	SC	30-AB-0360	1	Frank R. Bowerman	Local Govt.	341	15	1989	2022	6,541,179	36,445,683	75,897,049	1993	Combustion	1988	2010	Controls F	No	Open	2022	2022	195.2	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$8,314	4		$81,254	$33,254	$33,254	$33,254
																															$127	$127	$127	$127	$127
30	SC	SC	30-AB-0035	1	Olinda Alpha SLF	Local Govt.	420	15	1960	2013	14,557,799	45,305,372	86,102,427	1990	Combustion	1961	2010	Controls F	No	Open	2013	2013	319.9	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$10,240	4		$88,958	$40,958	$40,958	$40,958
																															$127	$127	$127	$127	
19	SC	SC	19-AA-0053	1	Puente Hills LF	Local Govt.	640	17	1957	2013	55,110,679	116,141,687	185,036,763	1990	Combustion	1956	2010	Controls F	No	Open	2013	2013	970.5	0	$0	2012	2027						$0	$0	$0
																												Existing					Existing	Existing	Existing
																													$15,603	4		$110,413	$62,413	$62,413	$62,413
																															$127	$127	$127	$127	
							23,247													78	Open							$7,177,980		Ann. Tot.	$6,387,065	$11,348,948	$14,045,189	$13,299,285	$13,298,647
							Tot. # Acres													68	Closed							Private LFs:	Capital Costs		$0	$288,158	$505,922	$505,922	$505,922
																													O&M Costs		$0	$684,400	$1,225,800	$1,225,800	$1,225,800
																													Monitoring Costs		$2,141,857	$3,077,983	$2,860,346	$2,380,346	$2,380,346
																													Reporting Costs		$6,247	$3,060	$3,060	$2,805	$2,677
																												Govt. LFs:	Capital Costs		$0	$483,212	$1,103,346	$1,191,297	$1,191,297
																													O&M Costs		$0	$1,192,840	$3,739,780	$3,962,180	$3,962,180
					146																								Monitoring Costs		$4,226,595	$5,612,410	$4,600,306	$4,024,306	$4,024,306
																													Reporting Costs		$12,367	$6,884	$6,629	$6,629	$6,120
																												Subtotals:	Capital Costs		**$0**	**$771,371**	**$1,609,268**	**$1,697,218**	**$1,697,218**
																													O&M Costs		**$0**	**$1,877,240**	**$4,965,580**	**$5,187,980**	**$5,187,980**
																													Monitoring Costs		**$6,368,451**	**$8,690,393**	**$7,460,652**	**$6,404,652**	**$6,404,652**
Affected CA MSW Landfills (by SWIS #):																													Reporting Costs		**$18,614**	**$9,944**	**$9,689**	**$9,434**	**$8,797**
				149	**146**	**By Facility/Site:**					**551,129,547**	**1,153,801,723**	**1,885,065,570**											$18,911,752				Totals:			**$6,387,065**	**$11,348,948**	**$14,045,189**	**$13,299,285**	**$13,298,647**
																			146																
						Number of Affected Landfills by Ownership Type																													
																				5	New Encl. Flare (replacing 4 open flares and 1 carbon adsorption unit)														
						Private:			49											13	New Coll. + Cntl. Systems														
																				128	Existing LFs w/ Combustion Control														
						Local Govt:		94												146	Total														
						State Govt:		1																											
						Fed. Govt:		0																											
						Tribal Govt.:		0																				Landfills w/o Controls:							
						Military:		2																				(private & govt.)							
						All Govt:			97																				Capital Costs		$0	$771,371	$1,575,767	$1,663,718	$1,663,718
									Total:	**146**																			O&M Costs		$0	$1,877,240	$3,869,580	$4,091,980	$4,091,980
																													Monitoring Costs		$404,811	$671,744	$402,311	$354,311	$354,311
																													Reporting Costs		$1,657	$1,147	$1,147	$1,147	$765
[a] Some facilities are composed of more that one SWIS # and were evaluated as a single facility for emission inventory and cost analyis purposes.																													Total:		$406,468	$3,321,503	$5,848,806	$6,111,157	$6,110,775
[b] Open Year in **Bold** Indicates ARB Estimate																																			
[c] Using a Capital Recovery Factor of 0.0963, for n = 15 years, I = 5%																												Landfills w/ Controls:							
[d] Entry in **Bold** denotes updated information.																												(private & govt.)							
[e] Entries in bold denote 2009 update.																													Capital Costs		$0	$0	$33,500	$33,500	$33,500
																													O&M Costs		$0	$0	$1,096,000	$1,096,000	$1,096,000
																													Monitoring Costs		$5,963,641	$8,018,649	$7,058,341	$6,050,341	$6,050,341
																													Reporting Costs		$16,956	$8,797	$8,542	$8,287	$8,032
																													Total:		$5,980,597	$8,027,446	$8,196,383	$7,188,128	$7,187,873
																															$6,387,065	$11,348,948	$14,045,189	$13,299,285	$13,298,647

																			Capital Costs							Annual Operation & Maintenance Costs			
2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Subtotal	Private	Local Govt.	State Govt.	Fed Govt.	Tribal Govt.	Military	Subtotal	Private	Local Govt.	State Govt.
$75,210	$75,210	$75,210	$75,210	$75,210	$75,210	$75,210	$75,210	$75,210	$75,210	$75,210									$1,128,155		$1,128,155								
$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000								$4,439,000		$4,439,000	
$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0							$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$29,233	$29,233	$29,233	$29,233	$29,233	$29,233	$29,233	$29,233	$29,233	$29,233	$29,233	$29,233	$29,233	$29,233	$29,233	$29,233	$29,233	$29,233	$29,233											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0							$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$12,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0							$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$16,197	$16,197	$16,197	$16,197	$16,197	$16,197	$16,197	$16,197	$16,197	$16,197	$16,197	$16,197	$16,197	$16,197	$16,197	$16,197	$16,197	$16,197	$16,197											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0							$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$14,221	$14,221	$14,221	$14,221	$14,221	$14,221	$14,221	$14,221	$14,221	$14,221	$14,221	$14,221	$14,221	$14,221	$14,221	$14,221	$14,221	$14,221	$14,221											
$93,411	$93,411	$93,411	$93,411	$93,411	$93,411	$93,411	$93,411	$93,411	$93,411	$93,411	$93,411								$1,401,165		$1,401,165								
$235,000	$235,000	$235,000	$235,000	$235,000	$235,000	$235,000	$235,000	$235,000	$235,000	$235,000	$235,000	$235,000	$235,000	$235,000	$235,000	$235,000	$235,000	$235,000								$5,170,000		$5,170,000	
$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752											
$127	$127	$127	$127	$127	$127	$127																							
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$30,813	$30,813	$30,813	$30,813	$30,813	$30,813	$30,813	$30,813	$30,813	$30,813	$30,813	$30,813	$30,813	$30,813	$30,813	$30,813	$30,813	$30,813	$30,813											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$18,606	$18,606	$18,606	$18,606	$18,606	$18,606	$18,606	$18,606	$18,606	$18,606	$18,606	$18,606	$18,606	$18,606	$18,606	$18,606	$18,606	$18,606	$18,606											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$26,468	$26,468	$26,468	$26,468	$26,468	$26,468	$26,468	$26,468	$26,468	$26,468	$26,468	$26,468	$26,468	$26,468	$26,468	$26,468	$26,468	$26,468	$26,468											
$106,151	$106,151	$106,151	$106,151	$106,151	$106,151	$106,151	$106,151	$106,151	$106,151	$106,151									$1,592,272		$1,592,272								
$264,400	$264,400	$264,400	$264,400	$264,400	$264,400	$264,400	$264,400	$264,400	$264,400	$264,400	$264,400	$264,400	$264,400	$264,400	$264,400	$264,400	$264,400	$264,400								$6,081,200		$6,081,200	
$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127												
$163,848	$163,848	$163,848	$163,848	$163,848	$163,848	$163,848	$163,848	$163,848	$163,848	$163,848	$163,848								$2,457,716						$2,457,716				
$397,540	$397,540	$397,540	$397,540	$397,540	$397,540	$397,540	$397,540	$397,540	$397,540	$397,540	$397,540	$397,540	$397,540	$397,540	$397,540	$397,540	$397,540	$397,540								$8,745,880			
$35,040	$35,040	$35,040	$35,040	$35,040	$35,040	$35,040	$35,040	$35,040	$35,040	$35,040	$35,040	$35,040	$35,040	$35,040	$35,040	$35,040	$35,040	$35,040											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0							$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$15,012	$15,012	$15,012	$15,012	$15,012	$15,012	$15,012	$15,012	$15,012	$15,012	$15,012	$15,012	$15,012	$15,012	$15,012	$15,012	$15,012	$15,012	$15,012											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$8,612	$8,612	$8,612	$8,612	$8,612	$8,612	$8,612	$8,612	$8,612	$8,612	$8,612	$8,612	$8,612	$8,612	$8,612	$8,612	$8,612	$8,612	$8,612											
$127																													
$82,491	$82,491	$82,491	$82,491	$82,491	$82,491	$82,491	$82,491	$82,491	$82,491	$82,491	$82,491								$1,237,359	$1,237,359									
$209,800	$209,800	$209,800	$209,800	$209,800	$209,800	$209,800	$209,800	$209,800	$209,800	$209,800	$209,800	$209,800	$209,800	$209,800	$209,800	$209,800	$209,800	$209,800								$4,615,600	$4,615,600		
$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382											
$127	$127	$127	$127	$127	$127																								
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$33,578	$33,578	$33,578	$33,578	$33,578	$33,578	$33,578	$33,578	$33,578	$33,578	$33,578	$33,578	$33,578	$33,578	$33,578	$33,578	$33,578	$33,578	$33,578											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$12,246	$12,246	$12,246	$12,246	$12,246	$12,246	$12,246	$12,246	$12,246	$12,246	$12,246	$12,246	$12,246	$12,246	$12,246	$12,246	$12,246	$12,246	$12,246											
$127	$127	$127	$127	$127	$127	$127	$127	$127																					
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$31,208	$31,208	$31,208	$31,208	$31,208	$31,208	$31,208	$31,208	$31,208	$31,208	$31,208	$31,208	$31,208	$31,208	$31,208	$31,208	$31,208	$31,208	$31,208											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$4,291	$4,291	$4,291	$4,291	$4,291	$4,291	$4,291	$4,291	$4,291	$4,291	$4,291	$4,291	$4,291	$4,291	$4,291	$4,291	$4,291	$4,291	$4,291											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$49,775	$49,775	$49,775	$49,775	$49,775	$49,775	$49,775	$49,775	$49,775	$49,775	$49,775	$49,775	$49,775	$49,775	$49,775	$49,775	$49,775	$49,775	$49,775											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127															
$66,110	$66,110	$66,110	$66,110	$66,110	$66,110	$66,110	$66,110	$66,110	$66,110	$66,110	$66,110								$991,649		$991,649								
$172,000	$172,000	$172,000	$172,000	$172,000	$172,000	$172,000	$172,000	$172,000	$172,000	$172,000	$172,000	$172,000	$172,000	$172,000	$172,000	$172,000	$172,000	$172,000								$3,784,000		$3,784,000	
$13,826	$13,826	$13,826	$13,826	$13,826	$13,826	$13,826	$13,826	$13,826	$13,826	$13,826	$13,826	$13,826	$13,826	$13,826	$13,826	$13,826	$13,826	$13,826											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127																	
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$11,456	$11,456	$11,456	$11,456	$11,456	$11,456	$11,456	$11,456	$11,456	$11,456	$11,456	$11,456	$11,456	$11,456	$11,456	$11,456	$11,456	$11,456	$11,456											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0							$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$6,046	$6,046	$6,046	$6,046	$6,046	$6,046	$6,046	$6,046	$6,046	$6,046	$6,046	$6,046	$6,046	$6,046	$6,046	$6,046	$6,046	$6,046	$6,046											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0							$0		$0								

																			Capital Costs							Annual Operation & Maintenance Costs			
2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Subtotal	Private	Local Govt.	State Govt.	Fed Govt.	Tribal Govt.	Military	Subtotal	Private	Local Govt.	State Govt.
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$22,912	$22,912	$22,912	$22,912	$22,912	$22,912	$22,912	$22,912	$22,912	$22,912	$22,912	$22,912	$22,912	$22,912	$22,912	$22,912	$22,912	$22,912	$22,912											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$9,876	$9,876	$9,876	$9,876	$9,876	$9,876	$9,876	$9,876	$9,876	$9,876	$9,876	$9,876	$9,876	$9,876	$9,876	$9,876	$9,876	$9,876	$9,876											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$59,256	$59,256	$59,256	$59,256	$59,256	$59,256	$59,256	$59,256	$59,256	$59,256	$59,256	$59,256	$59,256	$59,256	$59,256	$59,256	$59,256	$59,256	$59,256											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0							$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$4,778	$4,778	$4,778	$4,778	$4,778	$4,778	$4,778	$4,778	$4,778	$4,778	$4,778	$4,778	$4,778	$4,778	$4,778	$4,778	$4,778	$4,778	$4,778											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$13,273	$13,273	$13,273	$13,273	$13,273	$13,273	$13,273	$13,273	$13,273	$13,273	$13,273	$13,273	$13,273	$13,273	$13,273	$13,273	$13,273	$13,273	$13,273											
$127	$127	$127	$127	$127	$127	$127	$127	$127																					
			$27,406	$27,406	$27,406	$27,406	$27,406	$27,406	$27,406	$27,406	$27,406	$27,406	$27,406	$27,406	$27,406	$27,406	$27,406		$411,090		$411,090								
			$159,400	$159,400	$159,400	$159,400	$159,400	$159,400	$159,400	$159,400	$159,400	$159,400	$159,400	$159,400	$159,400	$159,400	$159,400	$159,400								$2,550,400		$2,550,400	
		$60,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641	$12,641											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$15,407	$15,407	$15,407	$15,407	$15,407	$15,407	$15,407	$15,407	$15,407	$15,407	$15,407	$15,407	$15,407	$15,407	$15,407	$15,407	$15,407	$15,407	$15,407											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$75,210	$75,210	$75,210	$75,210	$75,210	$75,210	$75,210	$75,210	$75,210	$75,210	$75,210									$1,128,155		$1,128,155								
$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000	$193,000								$4,439,000		$4,439,000	
$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802	$15,802											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0							$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$31,603	$31,603	$31,603	$31,603	$31,603	$31,603	$31,603	$31,603	$31,603	$31,603	$31,603	$31,603	$31,603	$31,603	$31,603	$31,603	$31,603	$31,603	$31,603											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$14,320	$14,320	$14,320	$14,320	$14,320	$14,320	$14,320	$14,320	$14,320	$14,320	$14,320	$14,320	$14,320	$14,320	$14,320	$14,320	$14,320	$14,320	$14,320											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127																		
$78,850	$78,850	$78,850	$78,850	$78,850	$78,850	$78,850	$78,850	$78,850	$78,850	$78,850	$78,850								$1,182,757		$1,182,757								
$201,400	$201,400	$201,400	$201,400	$201,400	$201,400	$201,400	$201,400	$201,400	$201,400	$201,400	$201,400	$201,400	$201,400	$201,400	$201,400	$201,400	$201,400	$201,400								$4,430,800		$4,430,800	
$16,592	$16,592	$16,592	$16,592	$16,592	$16,592	$16,592	$16,592	$16,592	$16,592	$16,592	$16,592	$16,592	$16,592	$16,592	$16,592	$16,592	$16,592	$16,592											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$11,702	$11,702	$11,702	$11,702	$11,702	$11,702	$11,702	$11,702	$11,702	$11,702	$11,702	$11,702	$11,702	$11,702	$11,702	$11,702	$11,702	$11,702	$11,702											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073	$26,073											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127													
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$7,314	$7,314	$7,314	$7,314	$7,314	$7,314	$7,314	$7,314	$7,314	$7,314	$7,314	$7,314	$7,314	$7,314	$7,314	$7,314	$7,314	$7,314	$7,314											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$13,036	$13,036	$13,036	$13,036	$13,036	$13,036	$13,036	$13,036	$13,036	$13,036	$13,036	$13,036	$13,036	$13,036	$13,036	$13,036	$13,036	$13,036	$13,036											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319	$38,319											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$5,851	$5,851	$5,851	$5,851	$5,851	$5,851	$5,851	$5,851	$5,851	$5,851	$5,851	$5,851	$5,851	$5,851	$5,851	$5,851	$5,851	$5,851	$5,851											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$35,949	$35,949	$35,949	$35,949	$35,949	$35,949	$35,949	$35,949	$35,949	$35,949	$35,949	$35,949	$35,949	$35,949	$35,949	$35,949	$35,949	$35,949	$35,949											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$10,337	$10,337	$10,337	$10,337	$10,337	$10,337	$10,337	$10,337	$10,337	$10,337	$10,337	$10,337	$10,337	$10,337	$10,337	$10,337	$10,337	$10,337	$10,337											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127													
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0							$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$28,048	$28,048	$28,048	$28,048	$28,048	$28,048	$28,048	$28,048	$28,048	$28,048	$28,048	$28,048	$28,048	$28,048	$28,048	$28,048	$28,048	$28,048	$28,048											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$22,715	$22,715	$22,715	$22,715	$22,715	$22,715	$22,715	$22,715	$22,715	$22,715	$22,715	$22,715	$22,715	$22,715	$22,715	$22,715	$22,715	$22,715	$22,715											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172	$18,172											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382	$17,382											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127																				
$87,951	$87,951	$87,951	$87,951	$87,951	$87,951	$87,951	$87,951	$87,951	$87,951	$87,951	$87,951	$87,951							$1,319,262		$1,319,262								
$222,400	$222,400	$222,400	$222,400	$222,400	$222,400	$222,400	$222,400	$222,400	$222,400	$222,400	$222,400	$222,400	$222,400	$222,400	$222,400	$222,400	$222,400	$222,400								$4,670,400		$4,670,400	
$18,567	$18,567	$18,567	$18,567	$18,567	$18,567	$18,567	$18,567	$18,567	$18,567	$18,567	$18,567	$18,567	$18,567	$18,567	$18,567	$18,567	$18,567	$18,567											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0							$0		$0								

																			Capital Costs							Annual Operation & Maintenance Costs			
2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Subtotal	Private	Local Govt.	State Govt.	Fed Govt.	Tribal Govt.	Military	Subtotal	Private	Local Govt.	State Govt.
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$9,752	$9,752	$9,752	$9,752	$9,752	$9,752	$9,752	$9,752	$9,752	$9,752	$9,752	$9,752	$9,752	$9,752	$9,752	$9,752	$9,752	$9,752	$9,752											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$6,924	$6,924	$6,924	$6,924	$6,924	$6,924	$6,924	$6,924	$6,924	$6,924	$6,924	$6,924	$6,924	$6,924	$6,924	$6,924	$6,924	$6,924	$6,924											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0							$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$57,676	$57,676	$57,676	$57,676	$57,676	$57,676	$57,676	$57,676	$57,676	$57,676	$57,676	$57,676	$57,676	$57,676	$57,676	$57,676	$57,676	$57,676	$57,676											
			$27,406	$27,406	$27,406	$27,406	$27,406	$27,406	$27,406	$27,406	$27,406	$27,406	$27,406	$27,406	$27,406	$27,406	$27,406		$411,090		$411,090								
			$625,600	$625,600	$625,600	$625,600	$625,600	$625,600	$625,600	$625,600	$625,600	$625,600	$625,600	$625,600	$625,600	$625,600	$625,600	$625,600								$10,009,600		$10,009,600	
		$104,491	$56,491	$56,491	$56,491	$56,491	$56,491	$56,491	$56,491	$56,491	$56,491	$56,491	$56,491	$56,491	$56,491	$56,491	$56,491	$56,491											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$60,441	$60,441	$60,441	$60,441	$60,441	$60,441	$60,441	$60,441	$60,441	$60,441	$60,441	$60,441	$60,441	$60,441	$60,441	$60,441	$60,441	$60,441	$60,441											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127																		
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0							$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$29,628	$29,628	$29,628	$29,628	$29,628	$29,628	$29,628	$29,628	$29,628	$29,628	$29,628	$29,628	$29,628	$29,628	$29,628	$29,628	$29,628	$29,628	$29,628											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0							$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$9,264	$9,264	$9,264	$9,264	$9,264	$9,264	$9,264	$9,264	$9,264	$9,264	$9,264	$9,264	$9,264	$9,264	$9,264	$9,264	$9,264	$9,264	$9,264											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$51,355	$51,355	$51,355	$51,355	$51,355	$51,355	$51,355	$51,355	$51,355	$51,355	$51,355	$51,355	$51,355	$51,355	$51,355	$51,355	$51,355	$51,355	$51,355											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0							$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405	$47,405											
$226,640	$226,640	$226,640	$226,640	$226,640	$226,640	$226,640	$226,640	$226,640	$226,640	$226,640									$3,399,602		$3,399,602								
$542,440	$542,440	$542,440	$542,440	$542,440	$542,440	$542,440	$542,440	$542,440	$542,440	$542,440	$542,440	$542,440	$542,440	$542,440	$542,440	$542,440	$542,440	$542,440								$12,476,120		$12,476,120	
$48,669	$48,669	$48,669	$48,669	$48,669	$48,669	$48,669	$48,669	$48,669	$48,669	$48,669	$48,669	$48,669	$48,669	$48,669	$48,669	$48,669	$48,669	$48,669											
$127	$127	$127	$127	$127	$127																								
$184,415	$184,415	$184,415	$184,415	$184,415	$184,415	$184,415	$184,415	$184,415	$184,415	$184,415	$184,415								$2,766,218		$2,766,218								
$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000								$9,790,000		$9,790,000	
$39,504	$39,504	$39,504	$39,504	$39,504	$39,504	$39,504	$39,504	$39,504	$39,504	$39,504	$39,504	$39,504	$39,504	$39,504	$39,504	$39,504	$39,504	$39,504											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$65,182	$65,182	$65,182	$65,182	$65,182	$65,182	$65,182	$65,182	$65,182	$65,182	$65,182	$65,182	$65,182	$65,182	$65,182	$65,182	$65,182	$65,182	$65,182											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$57,281	$57,281	$57,281	$57,281	$57,281	$57,281	$57,281	$57,281	$57,281	$57,281	$57,281	$57,281	$57,281	$57,281	$57,281	$57,281	$57,281	$57,281	$57,281											
$135,273	$135,273	$135,273	$135,273	$135,273	$135,273	$135,273	$135,273	$135,273	$135,273	$135,273	$135,273								$2,029,089	$2,029,089									
$331,600	$331,600	$331,600	$331,600	$331,600	$331,600	$331,600	$331,600	$331,600	$331,600	$331,600	$331,600	$331,600	$331,600	$331,600	$331,600	$331,600	$331,600	$331,600								$7,295,200	$7,295,200		
$28,838	$28,838	$28,838	$28,838	$28,838	$28,838	$28,838	$28,838	$28,838	$28,838	$28,838	$28,838	$28,838	$28,838	$28,838	$28,838	$28,838	$28,838	$28,838											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$30,418	$30,418	$30,418	$30,418	$30,418	$30,418	$30,418	$30,418	$30,418	$30,418	$30,418	$30,418	$30,418	$30,418	$30,418	$30,418	$30,418	$30,418	$30,418											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$97,575	$97,575	$97,575	$97,575	$97,575	$97,575	$97,575	$97,575	$97,575	$97,575	$97,575	$97,575	$97,575	$97,575	$97,575	$97,575	$97,575	$97,575	$97,575											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127																				
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$76,638	$76,638	$76,638	$76,638	$76,638	$76,638	$76,638	$76,638	$76,638	$76,638	$76,638	$76,638	$76,638	$76,638	$76,638	$76,638	$76,638	$76,638	$76,638											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$73,082	$73,082	$73,082	$73,082	$73,082	$73,082	$73,082	$73,082	$73,082	$73,082	$73,082	$73,082	$73,082	$73,082	$73,082	$73,082	$73,082	$73,082	$73,082											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$85,329	$85,329	$85,329	$85,329	$85,329	$85,329	$85,329	$85,329	$85,329	$85,329	$85,329	$85,329	$85,329	$85,329	$85,329	$85,329	$85,329	$85,329	$85,329											
$127	$127	$127	$127	$127																									
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$96,785	$96,785	$96,785	$96,785	$96,785	$96,785	$96,785	$96,785	$96,785	$96,785	$96,785	$96,785	$96,785	$96,785	$96,785	$96,785	$96,785	$96,785	$96,785											
$127	$127	$127																											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$24,097	$24,097	$24,097	$24,097	$24,097	$24,097	$24,097	$24,097	$24,097	$24,097	$24,097	$24,097	$24,097	$24,097	$24,097	$24,097	$24,097	$24,097	$24,097											
$127	$127	$127	$127	$127	$127	$127																							
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987	$16,987											
$127	$127	$127	$127	$127	$127	$127	$127	$127																					
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$53,330	$53,330	$53,330	$53,330	$53,330	$53,330	$53,330	$53,330	$53,330	$53,330	$53,330	$53,330	$53,330	$53,330	$53,330	$53,330	$53,330	$53,330	$53,330											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127																	
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$42,269	$42,269	$42,269	$42,269	$42,269	$42,269	$42,269	$42,269	$42,269	$42,269	$42,269	$42,269	$42,269	$42,269	$42,269	$42,269	$42,269	$42,269	$42,269											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$55,306	$55,306	$55,306	$55,306	$55,306	$55,306	$55,306	$55,306	$55,306	$55,306	$55,306	$55,306	$55,306	$55,306	$55,306	$55,306	$55,306	$55,306	$55,306											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
			$35,671	$35,671	$35,671	$35,671	$35,671	$35,671	$35,671	$35,671	$35,671	$35,671	$35,671	$35,671	$35,671	$35,671	$35,671		$535,070	$535,070									

																			Capital Costs							Annual Operation & Maintenance Costs			
2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Subtotal	Private	Local Govt.	State Govt.	Fed Govt.	Tribal Govt.	Military	Subtotal	Private	Local Govt.	State Govt.
			$970,000	$970,000	$970,000	$970,000	$970,000	$970,000	$970,000	$970,000	$970,000	$970,000	$970,000	$970,000	$970,000	$970,000	$970,000	$970,000								$15,520,000	$15,520,000		
		$136,884	$88,884	$88,884	$88,884	$88,884	$88,884	$88,884	$88,884	$88,884	$88,884	$88,884	$88,884	$88,884	$88,884	$88,884	$88,884	$88,884											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$34,764	$34,764	$34,764	$34,764	$34,764	$34,764	$34,764	$34,764	$34,764	$34,764	$34,764	$34,764	$34,764	$34,764	$34,764	$34,764	$34,764	$34,764	$34,764											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$11,117	$11,117	$11,117	$11,117	$11,117	$11,117	$11,117	$11,117	$11,117	$11,117	$11,117	$11,117	$11,117	$11,117	$11,117	$11,117	$11,117	$11,117	$11,117											
$127	$127																												
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0							$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$7,509	$7,509	$7,509	$7,509	$7,509	$7,509	$7,509	$7,509	$7,509	$7,509	$7,509	$7,509	$7,509	$7,509	$7,509	$7,509	$7,509	$7,509	$7,509											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$102,710	$102,710	$102,710	$102,710	$102,710	$102,710	$102,710	$102,710	$102,710	$102,710	$102,710	$102,710	$102,710	$102,710	$102,710	$102,710	$102,710	$102,710	$102,710											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$43,059	$43,059	$43,059	$43,059	$43,059	$43,059	$43,059	$43,059	$43,059	$43,059	$43,059	$43,059	$43,059	$43,059	$43,059	$43,059	$43,059	$43,059	$43,059											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$12,873	$12,873	$12,873	$12,873	$12,873	$12,873	$12,873	$12,873	$12,873	$12,873	$12,873	$12,873	$12,873	$12,873	$12,873	$12,873	$12,873	$12,873	$12,873											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$288,158	$288,158	$288,158	$288,158	$288,158	$288,158	$288,158	$288,158	$288,158	$288,158	$288,158									$4,322,377	$4,322,377									
$684,400	$684,400	$684,400	$684,400	$684,400	$684,400	$684,400	$684,400	$684,400	$684,400	$684,400	$684,400	$684,400	$684,400	$684,400	$684,400	$684,400	$684,400	$684,400								$15,741,200	$15,741,200		
$62,021	$62,021	$62,021	$62,021	$62,021	$62,021	$62,021	$62,021	$62,021	$62,021	$62,021	$62,021	$62,021	$62,021	$62,021	$62,021	$62,021	$62,021	$62,021											
$33,500	$33,500	$33,500	$33,500	$33,500	$33,500	$33,500	$33,500	$33,500	$33,500	$33,500	$33,500								$502,501		$502,501								
$1,096,000	$1,096,000	$1,096,000	$1,096,000	$1,096,000	$1,096,000	$1,096,000	$1,096,000	$1,096,000	$1,096,000	$1,096,000	$1,096,000	$1,096,000	$1,096,000	$1,096,000	$1,096,000	$1,096,000	$1,096,000	$1,096,000								$24,112,000		$24,112,000	
$100,735	$100,735	$100,735	$100,735	$100,735	$100,735	$100,735	$100,735	$100,735	$100,735	$100,735	$100,735	$100,735	$100,735	$100,735	$100,735	$100,735	$100,735	$100,735											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430											
$127	$127	$127	$127	$127	$127																								
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$28,443	$28,443	$28,443	$28,443	$28,443	$28,443	$28,443	$28,443	$28,443	$28,443	$28,443	$28,443	$28,443	$28,443	$28,443	$28,443	$28,443	$28,443	$28,443											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$7,021	$7,021	$7,021	$7,021	$7,021	$7,021	$7,021	$7,021	$7,021	$7,021	$7,021	$7,021	$7,021	$7,021	$7,021	$7,021	$7,021	$7,021	$7,021											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$91,254	$91,254	$91,254	$91,254	$91,254	$91,254	$91,254	$91,254	$91,254	$91,254	$91,254	$91,254	$91,254	$91,254	$91,254	$91,254	$91,254	$91,254	$91,254											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
			$33,500	$33,500	$33,500	$33,500	$33,500	$33,500	$33,500	$33,500	$33,500	$33,500	$33,500	$33,500	$33,500	$33,500	$33,500		$502,501		$502,501								
			$235,000	$235,000	$235,000	$235,000	$235,000	$235,000	$235,000	$235,000	$235,000	$235,000	$235,000	$235,000	$235,000	$235,000	$235,000	$235,000								$3,760,000		$3,760,000	
		$67,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752	$19,752											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$186,854	$186,854	$186,854	$186,854	$186,854	$186,854	$186,854	$186,854	$186,854	$186,854	$186,854	$186,854	$186,854	$186,854	$186,854	$186,854	$186,854	$186,854	$186,854											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0							$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517	$22,517											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$46,615	$46,615	$46,615	$46,615	$46,615	$46,615	$46,615	$46,615	$46,615	$46,615	$46,615	$46,615	$46,615	$46,615	$46,615	$46,615	$46,615	$46,615	$46,615											
$127	$127	$127	$127	$127	$127																								
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$134,709	$134,709	$134,709	$134,709	$134,709	$134,709	$134,709	$134,709	$134,709	$134,709	$134,709	$134,709	$134,709	$134,709	$134,709	$134,709	$134,709	$134,709	$134,709											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$122,857	$122,857	$122,857	$122,857	$122,857	$122,857	$122,857	$122,857	$122,857	$122,857	$122,857	$122,857	$122,857	$122,857	$122,857	$122,857	$122,857	$122,857	$122,857											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127																			
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$124,438	$124,438	$124,438	$124,438	$124,438	$124,438	$124,438	$124,438	$124,438	$124,438	$124,438	$124,438	$124,438	$124,438	$124,438	$124,438	$124,438	$124,438	$124,438											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$28,183	$28,183	$28,183	$28,183	$28,183	$28,183	$28,183	$28,183	$28,183	$28,183	$28,183	$28,183	$28,183	$28,183	$28,183	$28,183	$28,183	$28,183	$28,183											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$7,997	$7,997	$7,997	$7,997	$7,997	$7,997	$7,997	$7,997	$7,997	$7,997	$7,997	$7,997	$7,997	$7,997	$7,997	$7,997	$7,997	$7,997	$7,997											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344	$36,344											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127																	
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$13,653	$13,653	$13,653	$13,653	$13,653	$13,653	$13,653	$13,653	$13,653	$13,653	$13,653	$13,653	$13,653	$13,653	$13,653	$13,653	$13,653	$13,653	$13,653											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$82,563	$82,563	$82,563	$82,563	$82,563	$82,563	$82,563	$82,563	$82,563	$82,563	$82,563	$82,563	$82,563	$82,563	$82,563	$82,563	$82,563	$82,563	$82,563											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$14,433	$14,433	$14,433	$14,433	$14,433	$14,433	$14,433	$14,433	$14,433	$14,433	$14,433	$14,433	$14,433	$14,433	$14,433	$14,433	$14,433	$14,433	$14,433											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0							$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$12,678	$12,678	$12,678	$12,678	$12,678	$12,678	$12,678	$12,678	$12,678	$12,678	$12,678	$12,678	$12,678	$12,678	$12,678	$12,678	$12,678	$12,678	$12,678											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								

																			Capital Costs							Annual Operation & Maintenance Costs			
2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Subtotal	Private	Local Govt.	State Govt.	Fed Govt.	Tribal Govt.	Military	Subtotal	Private	Local Govt.	State Govt.
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$90,464	$90,464	$90,464	$90,464	$90,464	$90,464	$90,464	$90,464	$90,464	$90,464	$90,464	$90,464	$90,464	$90,464	$90,464	$90,464	$90,464	$90,464	$90,464											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$14,101	$14,101	$14,101	$14,101	$14,101	$14,101	$14,101	$14,101	$14,101	$14,101	$14,101	$14,101	$14,101	$14,101	$14,101	$14,101	$14,101	$14,101	$14,101											
$127	$127	$127	$127	$127	$127	$127	$127	$127																					
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$67,947	$67,947	$67,947	$67,947	$67,947	$67,947	$67,947	$67,947	$67,947	$67,947	$67,947	$67,947	$67,947	$67,947	$67,947	$67,947	$67,947	$67,947	$67,947											
$127	$127	$127	$127	$127																									
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0							$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430	$45,430											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$77,033	$77,033	$77,033	$77,033	$77,033	$77,033	$77,033	$77,033	$77,033	$77,033	$77,033	$77,033	$77,033	$77,033	$77,033	$77,033	$77,033	$77,033	$77,033											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$63,206	$63,206	$63,206	$63,206	$63,206	$63,206	$63,206	$63,206	$63,206	$63,206	$63,206	$63,206	$63,206	$63,206	$63,206	$63,206	$63,206	$63,206	$63,206											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$8,777	$8,777	$8,777	$8,777	$8,777	$8,777	$8,777	$8,777	$8,777	$8,777	$8,777	$8,777	$8,777	$8,777	$8,777	$8,777	$8,777	$8,777	$8,777											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$142,609	$142,609	$142,609	$142,609	$142,609	$142,609	$142,609	$142,609	$142,609	$142,609	$142,609	$142,609	$142,609	$142,609	$142,609	$142,609	$142,609	$142,609	$142,609											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127													
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0							$0			$0							
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0			$0
$16,871	$16,871	$16,871	$16,871	$16,871	$16,871	$16,871	$16,871	$16,871	$16,871	$16,871	$16,871	$16,871	$16,871	$16,871	$16,871	$16,871	$16,871	$16,871											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$16,188	$16,188	$16,188	$16,188	$16,188	$16,188	$16,188	$16,188	$16,188	$16,188	$16,188	$16,188	$16,188	$16,188	$16,188	$16,188	$16,188	$16,188	$16,188											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$14,628	$14,628	$14,628	$14,628	$14,628	$14,628	$14,628	$14,628	$14,628	$14,628	$14,628	$14,628	$14,628	$14,628	$14,628	$14,628	$14,628	$14,628	$14,628											
$127	$127	$127	$127																										
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$87,699	$87,699	$87,699	$87,699	$87,699	$87,699	$87,699	$87,699	$87,699	$87,699	$87,699	$87,699	$87,699	$87,699	$87,699	$87,699	$87,699	$87,699	$87,699											
$127	$127																												
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$18,529	$18,529	$18,529	$18,529	$18,529	$18,529	$18,529	$18,529	$18,529	$18,529	$18,529	$18,529	$18,529	$18,529	$18,529	$18,529	$18,529	$18,529	$18,529											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$96,390	$96,390	$96,390	$96,390	$96,390	$96,390	$96,390	$96,390	$96,390	$96,390	$96,390	$96,390	$96,390	$96,390	$96,390	$96,390	$96,390	$96,390	$96,390											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$28,378	$28,378	$28,378	$28,378	$28,378	$28,378	$28,378	$28,378	$28,378	$28,378	$28,378	$28,378	$28,378	$28,378	$28,378	$28,378	$28,378	$28,378	$28,378											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$75,058	$75,058	$75,058	$75,058	$75,058	$75,058	$75,058	$75,058	$75,058	$75,058	$75,058	$75,058	$75,058	$75,058	$75,058	$75,058	$75,058	$75,058	$75,058											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$39,788	$39,788	$39,788	$39,788	$39,788	$39,788	$39,788	$39,788	$39,788	$39,788	$39,788	$39,788	$39,788	$39,788	$39,788	$39,788	$39,788	$39,788	$39,788											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$36,570	$36,570	$36,570	$36,570	$36,570	$36,570	$36,570	$36,570	$36,570	$36,570	$36,570	$36,570	$36,570	$36,570	$36,570	$36,570	$36,570	$36,570	$36,570											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0							$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$31,694	$31,694	$31,694	$31,694	$31,694	$31,694	$31,694	$31,694	$31,694	$31,694	$31,694	$31,694	$31,694	$31,694	$31,694	$31,694	$31,694	$31,694	$31,694											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$73,323	$73,323	$73,323	$73,323	$73,323	$73,323	$73,323	$73,323	$73,323	$73,323	$73,323	$73,323	$73,323	$73,323	$73,323	$73,323	$73,323	$73,323	$73,323											
$127	$127	$127	$127	$127	$127	$127	$127																						
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$123,727	$123,727	$123,727	$123,727	$123,727	$123,727	$123,727	$123,727	$123,727	$123,727	$123,727	$123,727	$123,727	$123,727	$123,727	$123,727	$123,727	$123,727	$123,727											
$127	$127																												
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$75,453	$75,453	$75,453	$75,453	$75,453	$75,453	$75,453	$75,453	$75,453	$75,453	$75,453	$75,453	$75,453	$75,453	$75,453	$75,453	$75,453	$75,453	$75,453											
$127	$127	$127	$127	$127	$127	$127	$127	$127																					
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$263,492	$263,492	$263,492	$263,492	$263,492	$263,492	$263,492	$263,492	$263,492	$263,492	$263,492	$263,492	$263,492	$263,492	$263,492	$263,492	$263,492	$263,492	$263,492											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$127,993	$127,993	$127,993	$127,993	$127,993	$127,993	$127,993	$127,993	$127,993	$127,993	$127,993	$127,993	$127,993	$127,993	$127,993	$127,993	$127,993	$127,993	$127,993											
$127	$127																												
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$40,568	$40,568	$40,568	$40,568	$40,568	$40,568	$40,568	$40,568	$40,568	$40,568	$40,568	$40,568	$40,568	$40,568	$40,568	$40,568	$40,568	$40,568	$40,568											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127																
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$42,909	$42,909	$42,909	$42,909	$42,909	$42,909	$42,909	$42,909	$42,909	$42,909	$42,909	$42,909	$42,909	$42,909	$42,909	$42,909	$42,909	$42,909	$42,909											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$68,166	$68,166	$68,166	$68,166	$68,166	$68,166	$68,166	$68,166	$68,166	$68,166	$68,166	$68,166	$68,166	$68,166	$68,166	$68,166	$68,166	$68,166	$68,166											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0	$0									

																			Capital Costs							Annual Operation & Maintenance Costs			
2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Subtotal	Private	Local Govt.	State Govt.	Fed Govt.	Tribal Govt.	Military	Subtotal	Private	Local Govt.	State Govt.
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$20,967	$20,967	$20,967	$20,967	$20,967	$20,967	$20,967	$20,967	$20,967	$20,967	$20,967	$20,967	$20,967	$20,967	$20,967	$20,967	$20,967	$20,967	$20,967											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$140,042	$140,042	$140,042	$140,042	$140,042	$140,042	$140,042	$140,042	$140,042	$140,042	$140,042	$140,042	$140,042	$140,042	$140,042	$140,042	$140,042	$140,042	$140,042											
$127	$127	$127	$127	$127	$127																								
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$16,676	$16,676	$16,676	$16,676	$16,676	$16,676	$16,676	$16,676	$16,676	$16,676	$16,676	$16,676	$16,676	$16,676	$16,676	$16,676	$16,676	$16,676	$16,676											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$36,082	$36,082	$36,082	$36,082	$36,082	$36,082	$36,082	$36,082	$36,082	$36,082	$36,082	$36,082	$36,082	$36,082	$36,082	$36,082	$36,082	$36,082	$36,082											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$90,859	$90,859	$90,859	$90,859	$90,859	$90,859	$90,859	$90,859	$90,859	$90,859	$90,859	$90,859	$90,859	$90,859	$90,859	$90,859	$90,859	$90,859	$90,859											
$127	$127	$127	$127	$127	$127	$127																							
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$25,063	$25,063	$25,063	$25,063	$25,063	$25,063	$25,063	$25,063	$25,063	$25,063	$25,063	$25,063	$25,063	$25,063	$25,063	$25,063	$25,063	$25,063	$25,063											
$127	$127	$127	$127	$127																									
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0									$0						$0				
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0			
$185,669	$185,669	$185,669	$185,669	$185,669	$185,669	$185,669	$185,669	$185,669	$185,669	$185,669	$185,669	$185,669	$185,669	$185,669	$185,669	$185,669	$185,669	$185,669											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$48,272	$48,272	$48,272	$48,272	$48,272	$48,272	$48,272	$48,272	$48,272	$48,272	$48,272	$48,272	$48,272	$48,272	$48,272	$48,272	$48,272	$48,272	$48,272											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127														
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0	$0									
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0	$0		
$175,003	$175,003	$175,003	$175,003	$175,003	$175,003	$175,003	$175,003	$175,003	$175,003	$175,003	$175,003	$175,003	$175,003	$175,003	$175,003	$175,003	$175,003	$175,003											
$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127																
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$33,254	$33,254	$33,254	$33,254	$33,254	$33,254	$33,254	$33,254	$33,254	$33,254	$33,254	$33,254	$33,254	$33,254	$33,254	$33,254	$33,254	$33,254	$33,254											
$127	$127	$127	$127	$127	$127	$127	$127																						
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$40,958	$40,958	$40,958	$40,958	$40,958	$40,958	$40,958	$40,958	$40,958	$40,958	$40,958	$40,958	$40,958	$40,958	$40,958	$40,958	$40,958	$40,958	$40,958											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0								$0		$0								
Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing								$0		$0	
$62,413	$62,413	$62,413	$62,413	$62,413	$62,413	$62,413	$62,413	$62,413	$62,413	$62,413	$62,413	$62,413	$62,413	$62,413	$62,413	$62,413	$62,413	$62,413											
$13,298,520	$13,298,392	$13,667,650	$15,589,506	$15,589,379	$15,588,996	$15,588,359	$15,587,976	$15,587,721	$15,587,084	$15,586,829	$14,815,331	$13,977,179	$13,888,846	$13,888,591	$13,888,463	$13,888,336	$13,887,953	$13,763,842	$335,348,090										
$505,922	$505,922	$505,922	$541,593	$541,593	$541,593	$541,593	$541,593	$541,593	$541,593	$541,593	$253,435	$35,671	$35,671	$35,671	$35,671	$35,671	$35,671	$0	$8,123,895										
$1,225,800	$1,225,800	$1,225,800	$2,195,800	$2,195,800	$2,195,800	$2,195,800	$2,195,800	$2,195,800	$2,195,800	$2,195,800	$2,195,800	$2,195,800	$2,195,800	$2,195,800	$2,195,800	$2,195,800	$2,195,800	$2,195,800	$43,172,000										
$2,380,346	$2,380,346	$2,517,230	$2,469,230	$2,469,230	$2,469,230	$2,469,230	$2,469,230	$2,469,230	$2,469,230	$2,469,230	$2,469,230	$2,469,230	$2,469,230	$2,469,230	$2,469,230	$2,469,230	$2,469,230	$2,469,230	$59,626,482										
$2,677	$2,677	$2,295	$2,295	$2,295	$2,167	$1,785	$1,657	$1,530	$1,275	$1,275	$1,147	$1,020	$1,020	$892	$892	$765	$765	$765	$47,044										
$1,191,297	$1,191,297	$1,191,297	$1,279,609	$1,279,609	$1,279,609	$1,279,609	$1,279,609	$1,279,609	$1,279,609	$1,279,609	$796,396	$176,263	$88,312	$88,312	$88,312	$88,312	$88,312	$0	$19,194,131										
$3,962,180	$3,962,180	$3,962,180	$4,982,180	$4,982,180	$4,982,180	$4,982,180	$4,982,180	$4,982,180	$4,982,180	$4,982,180	$4,982,180	$4,982,180	$4,982,180	$4,982,180	$4,982,180	$4,982,180	$4,982,180	$4,982,180	$104,458,400										
$4,024,306	$4,024,306	$4,257,190	$4,113,190	$4,113,190	$4,113,190	$4,113,190	$4,113,190	$4,113,190	$4,113,190	$4,113,190	$4,113,190	$4,113,190	$4,113,190	$4,113,190	$4,113,190	$4,113,190	$4,113,190	$4,113,190	$100,604,768										
$5,992	$5,865	$5,737	$5,610	$5,482	$5,227	$4,972	$4,717	$4,590	$4,207	$3,952	$3,952	$3,825	$3,442	$3,315	$3,187	$3,187	$2,805	$2,677	$121,370										
$1,697,218	**$1,697,218**	**$1,697,218**	**$1,821,202**	**$1,821,202**	**$1,821,202**	**$1,821,202**	**$1,821,202**	**$1,821,202**	**$1,821,202**	**$1,821,202**	**$1,049,831**	**$211,934**	**$123,983**	**$123,983**	**$123,983**	**$123,983**	**$123,983**	**$0**	$27,318,026										
$5,187,980	**$5,187,980**	**$5,187,980**	**$7,177,980**	**$7,177,980**	**$7,177,980**	**$7,177,980**	**$7,177,980**	**$7,177,980**	**$7,177,980**	**$7,177,980**	**$7,177,980**	**$7,177,980**	**$7,177,980**	**$7,177,980**	**$7,177,980**	**$7,177,980**	**$7,177,980**	**$7,177,980**	$147,630,400										
$6,404,652	**$6,404,652**	**$6,774,420**	**$6,582,420**	**$6,582,420**	**$6,582,420**	**$6,582,420**	**$6,582,420**	**$6,582,420**	**$6,582,420**	**$6,582,420**	**$6,582,420**	**$6,582,420**	**$6,582,420**	**$6,582,420**	**$6,582,420**	**$6,582,420**	**$6,582,420**	**$6,582,420**	$160,231,250										
$8,669	**$8,542**	**$8,032**	**$7,904**	**$7,777**	**$7,394**	**$6,757**	**$6,375**	**$6,120**	**$5,482**	**$5,227**	**$5,100**	**$4,845**	**$4,462**	**$4,207**	**$4,080**	**$3,952**	**$3,570**	**$3,442**	$168,414										
$13,298,520	**$13,298,392**	**$13,667,650**	**$15,589,506**	**$15,589,379**	**$15,588,996**	**$15,588,359**	**$15,587,976**	**$15,587,721**	**$15,587,084**	**$15,586,829**	**$14,815,331**	**$13,977,179**	**$13,888,846**	**$13,888,591**	**$13,888,463**	**$13,888,336**	**$13,887,953**	**$13,763,842**	$335,348,090										
												Reporting Costs from "Landfills_Reporting_Only" worksheet:																	
												Subtotals	**Private**	**Local Govt.**	**State Govt.**	**Fed Govt.**	**Tribal Govt.**	**Military**											
												$139,178							$27,318,026							$147,630,400			
													$10,098							$8,123,895							$43,172,000		
														$87,994							$16,736,415							$95,712,520	
															$3,769							$0							$0
																$12,641							$0						
																	$0							$0					
																		$24,676							$2,457,716				
$1,663,718	$1,663,718	$1,663,718	$1,663,718	$1,663,718	$1,663,718	$1,663,718	$1,663,718	$1,663,718	$1,663,718	$1,663,718	$892,348	$87,951	$0	$0	$0	$0	$0	$0	$24,955,774										
$4,091,980	$4,091,980	$4,091,980	$4,091,980	$4,091,980	$4,091,980	$4,091,980	$4,091,980	$4,091,980	$4,091,980	$4,091,980	$4,091,980	$4,091,980	$4,091,980	$4,091,980	$4,091,980	$4,091,980	$4,091,980	$4,091,980	$91,678,400										
$354,311	$354,311	$354,311	$354,311	$354,311	$354,311	$354,311	$354,311	$354,311	$354,311	$354,311	$354,311	$354,311	$354,311	$354,311	$354,311	$354,311	$354,311	$354,311	$8,919,405										
$765	$765	$765	$765	$765	$765	$510	$382	$382	$382	$382	$382	$382	$255	$255	$255	$255	$255	$127	$14,661										
$6,110,775	$6,110,775	$6,110,775	$6,110,775	$6,110,775	$6,110,775	$6,110,520	$6,110,392	$6,110,392	$6,110,392	$6,110,392	$5,339,021	$4,534,625	$4,446,546	$4,446,546	$4,446,546	$4,446,546	$4,446,546	$4,446,419	$125,568,241										
$33,500	$33,500	$33,500	$157,483	$157,483	$157,483	$157,483	$157,483	$157,483	$157,483	$157,483	$157,483	$123,983	$123,983	$123,983	$123,983	$123,983	$123,983	$0	$2,362,252										
$1,096,000	$1,096,000	$1,096,000	$3,086,000	$3,086,000	$3,086,000	$3,086,000	$3,086,000	$3,086,000	$3,086,000	$3,086,000	$3,086,000	$3,086,000	$3,086,000	$3,086,000	$3,086,000	$3,086,000	$3,086,000	$3,086,000	$55,952,000										
$6,050,341	$6,050,341	$6,420,109	$6,228,109	$6,228,109	$6,228,109	$6,228,109	$6,228,109	$6,228,109	$6,228,109	$6,228,109	$6,228,109	$6,228,109	$6,228,109	$6,228,109	$6,228,109	$6,228,109	$6,228,109	$6,228,109	$151,311,844										
$7,904	$7,777	$7,267	$7,139	$7,012	$6,629	$6,247	$5,992	$5,737	$5,100	$4,845	$4,717	$4,462	$4,207	$3,952	$3,825	$3,697	$3,315	$3,315	$153,753										
$7,187,745	$7,187,618	$7,556,876	$9,478,732	$9,478,604	$9,478,222	$9,477,839	$9,477,584	$9,477,329	$9,476,692	$9,476,437	$9,476,309	$9,442,554	$9,442,299	$9,442,044	$9,441,917	$9,441,789	$9,441,407	$9,317,424	$209,779,849										
$13,298,520	$13,298,392	$13,667,650	$15,589,506	$15,589,379	$15,588,996	$15,588,359	$15,587,976	$15,587,721	$15,587,084	$15,586,829	$14,815,331	$13,977,179	$13,888,846	$13,888,591	$13,888,463	$13,888,336	$13,887,953	$13,763,842	$335,348,090	Total									
																		$335,348,090		All LFs Subj. to Control/Mon.									

			Monitoring Costs							LF Gas Heat Calc. Reporting Cost							Costs per Landfill				
Fed Govt.	Tribal Govt.	Military	Subtotal	Private	Local Govt.	State Govt.	Fed Govt.	Tribal Govt.	Military	Subtotal	Private	Local Govt.	State Govt.	Fed Govt.	Tribal Govt.	Military		Number of Reports	Review By ARB?	ARB LEA Acres	ARB Reviewed Reports
																			Yes	40	
			$427,238		$427,238																
										$127		$127						1			1
																	$5,994,520		No		
			$691,125	$691,125																	
										$127	$127							1			
																	$691,253		No		
			$326,108	$326,108																	
										$127	$127							1			
																	$326,236		No		
			$404,326		$404,326																
										$127		$127						1			
																	$404,454		Yes	36	
			$360,872		$360,872																
										$127		$127						1			1
																	$360,999		No		
			$502,296		$502,296																
										$1,530		$1,530						12			
																	$7,074,991		No		
			$756,702		$756,702																
										$3,060		$3,060						24			
																	$759,762		No		
			$647,671	$647,671																	
										$127	$127							1			
																	$647,798		No		
			$475,947	$475,947																	
										$127	$127							1			
																	$476,074		No		
			$656,757		$656,757																
										$127		$127						1			
																	$656,884		Yes	57	
			$588,415		$588,415																
										$2,932		$2,932						23			23
																	$8,264,819		No		
		$8,745,880																			
			$853,921						$853,921												
										$3,060						$3,060		24			
																	$12,060,576		Yes	38	
			$378,253		$378,253																
										$127		$127						1			1
																	$378,381		Yes	21.8	
			$254,685		$254,685																
										$765		$765						6			6
																	$255,450		No		
			$447,780	$447,780																	
										$1,402	$1,402							11			
																	$6,302,142		No		
			$820,303		$820,303																
										$3,060		$3,060						24			
																	$823,363		No		
			$341,910		$341,910																
										$1,785		$1,785						14			
																	$343,695		No		
			$765,788		$765,788																
										$127		$127						1			
																	$765,915		No		
			$465,952		$465,952																
										$127		$127						1			
																	$466,080		No		
			$146,690		$146,690																
										$127		$127						1			
																	$146,818		No		
			$1,192,826		$1,192,826																
										$255		$255						2			
																	$1,193,081		No		
			$502,296		$502,296																
										$2,550		$2,550						20			
																	$504,846		No		
			$366,007		$366,007																
										$2,295		$2,295						18			
																	$5,143,951		No		
			$311,492	$311,492																	
										$127	$127							1			
																	$311,619		No		
			$181,017	$181,017																	
										$127	$127							1			
																	$181,145		No		
			$1,138,310		$1,138,310																
										$127		$127						1			
																	$1,138,438		No		

			Monitoring Costs							LF Gas Heat Calc. Reporting Cost							Costs per Landfill				
Fed Govt.	Tribal Govt.	Military	Subtotal	Private	Local Govt.	State Govt.	Fed Govt.	Tribal Govt.	Military	Subtotal	Private	Local Govt.	State Govt.	Fed Govt.	Tribal Govt.	Military		Number of Reports	Review By ARB?	ARB LEA Acres	ARB Reviewed Reports
			$552,071		$552,071																
										$127		$127						1			
																	$552,199		No		
			$275,148		$275,148																
										$127		$127						1			
																	$275,275		No		
			$1,410,888		$1,410,888																
										$127		$127						1			
																	$1,411,015		No		
			$891,015		$891,015																
										$127		$127						1			
																	$891,143		No		
			$162,684		$162,684																
										$3,060		$3,060						24			
																	$165,743		No		
			$353,287		$353,287																
										$1,785		$1,785						14			
																	$355,072		No		
			$262,902		$262,902																
										$127		$127						1			
																	$3,224,520		No		
			$417,757		$417,757																
										$3,060		$3,060						24			
																	$420,817		No		
			$427,238		$427,238																
										$127		$127						1			
																	$5,994,520		No		
			$421,708	$421,708																	
										$127	$127							1			
																	$421,835		No		
			$806,477		$806,477																
										$3,060		$3,060						24			
																	$809,537		No		
			$883,905		$883,905																
										$127		$127						1			
																	$884,032		No		
			$391,685	$391,685																	
										$2,167	$2,167							17			
																	$393,852		No		
			$429,609		$429,609																
										$510		$510						4			
																	$6,043,675		No		
			$328,858		$328,858																
										$127		$127						1			
																	$328,985		No		
			$647,671		$647,671																
										$2,805		$2,805						22			
																	$650,476		No		
			$223,536		$223,536																
										$127		$127						1			
																	$223,663		No		
			$360,872	$360,872																	
										$127	$127							1			
																	$360,999		No		
			$967,653		$967,653																
										$127		$127						1			
																	$967,781		No		
			$188,429		$188,429																
										$127		$127						1			
																	$188,556		No		
			$910,767	$910,767																	
										$127	$127							1			
																	$910,895		No		
			$285,754		$285,754																
										$2,805		$2,805						22			
																	$288,559		No		
			$665,052		$665,052																
										$127		$127						1			
																	$665,180		No		
			$593,155		$593,155																
										$3,060		$3,060						24			
																	$596,215		No		
			$465,952	$465,952																	
										$127	$127							1			
																	$466,080		No		
			$465,162		$465,162																
										$1,912		$1,912						15			
																	$467,075		No		
			$456,471		$456,471																
										$127		$127						1			
																	$6,446,261		No		

			Monitoring Costs							LF Gas Heat Calc. Reporting Cost							Costs per Landfill				
Fed Govt.	Tribal Govt.	Military	Subtotal	Private	Local Govt.	State Govt.	Fed Govt.	Tribal Govt.	Military	Subtotal	Private	Local Govt.	State Govt.	Fed Govt.	Tribal Govt.	Military		Number of Reports	Review By ARB?	ARB LEA Acres	ARB Reviewed Reports
			$1,090,906		$1,090,906																
										$127		$127						1			
																	$1,091,033		No		
			$282,048		$282,048																
										$127		$127						1			
																	$282,175		No		
			$207,250		$207,250																
										$127		$127						1			
																	$207,378		No		
			$1,316,868		$1,316,868																
										$127		$127						1			
																	$1,316,996		No		
			$1,008,342		$1,008,342																
										$127		$127						1			
																	$11,429,160		No		
			$1,438,146		$1,438,146																
										$2,167		$2,167						17			
																	$1,440,313		No		
			$699,816	$699,816																	
										$127	$127							1			
																	$699,943		No		
			$251,817		$251,817																
										$127		$127						1			
																	$251,944		No		
			$1,185,715		$1,185,715																
										$127		$127						1			
																	$1,185,843		No		
			$1,229,170		$1,229,170																
										$127		$127						1			
																	$1,229,297		No		
			$1,090,906		$1,090,906																
										$127		$127						1			
																	$1,091,033		No		
			$1,216,054		$1,216,054																
										$1,402		$1,402						11			
																	$17,093,179		No		
			$956,592		$956,592																
										$510		$510						4			
																	$13,513,319		No		
			$1,547,177	$1,547,177																	
										$3,060	$3,060							24			
																	$1,550,237		No		
			$1,422,739		$1,422,739																
										$127		$127						1			
																	$1,422,867		Yes	73	
			$711,272	$711,272																	
										$127	$127							1			1
																	$10,035,689		No		
			$747,616		$747,616																
										$3,060		$3,060						24			
																	$750,676		No		
			$2,292,222		$2,292,222																
										$1,912		$1,912						15			
																	$2,294,135		No		
			$1,810,668		$1,810,668																
										$127		$127						1			
																	$1,810,796		No		
			$1,728,895		$1,728,895																
										$3,060		$3,060						24			
																	$1,731,955		No		
			$2,095,887		$2,095,887																
										$1,275		$1,275						10			
																	$2,097,162		No		
			$2,370,835		$2,370,835																
										$1,020		$1,020						8			
																	$2,371,855		No		
			$626,339		$626,339																
										$1,530		$1,530						12			
																	$627,868		No		
			$455,681	$455,681																	
										$1,785	$1,785							14			
																	$457,466		No		
			$1,274,599		$1,274,599																
										$2,295		$2,295						18			
																	$1,276,894		No		
			$1,020,193		$1,020,193																
										$127		$127						1			
																	$1,020,321		No		
			$1,375,334		$1,375,334																
										$3,060		$3,060						24			
																	$1,378,394		No		

			Monitoring Costs							LF Gas Heat Calc. Reporting Cost							Costs per Landfill				
Fed Govt.	Tribal Govt.	Military	Subtotal	Private	Local Govt.	State Govt.	Fed Govt.	Tribal Govt.	Military	Subtotal	Private	Local Govt.	State Govt.	Fed Govt.	Tribal Govt.	Military		Number of Reports	Review By ARB?	ARB LEA Acres	ARB Reviewed Reports
			$1,559,028	$1,559,028						$3,060	$3,060						$17,617,158	24	No		
			$847,561	$847,561						$382	$382						$847,943	3	No		
			$303,697		$303,697					$892		$892					$304,590	7	No		
			$213,199	$213,199						$127	$127						$213,326	1	No		
			$2,410,339	$2,410,339						$3,060	$3,060						$2,413,399	24	No		
			$1,038,365	$1,038,365						$127	$127						$1,038,493	1	No		
			$344,071		$344,071					$3,060		$3,060					$347,130	24	No		
			$1,536,511	$1,536,511						$510	$510						$21,600,598	4	No		
			$2,364,910		$2,364,910					$3,060		$3,060					$26,982,470	24	No		
			$1,138,310	$1,138,310						$1,402	$1,402						$1,139,713	11	No		
			$730,629		$730,629					$127		$127					$730,757	1	No		
			$209,493	$209,493						$127	$127						$209,621	1	No		
			$2,238,102		$2,238,102					$3,060		$3,060					$2,241,162	24	No		
			$383,784		$383,784					$3,060		$3,060					$4,649,344	24	No		
			$4,532,494		$4,532,494					$3,060		$3,060					$4,535,554	24	No		
			$543,380	$543,380						$127	$127						$543,508	1	No		
			$1,166,753		$1,166,753					$1,402		$1,402					$1,168,156	11	No		
			$3,281,007		$3,281,007					$3,060		$3,060					$3,284,067	24	No		
			$2,873,721	$2,873,721						$2,040	$2,040						$2,875,761	16	No		
			$3,034,502		$3,034,502					$3,060		$3,060					$3,037,562	24	No		
			$696,215	$696,215						$127	$127						$696,343	1	No		
			$231,923		$231,923					$127		$127					$232,050	1	No		
			$920,248		$920,248					$2,295		$2,295					$922,543	18	No		
			$375,667		$375,667					$127		$127					$375,795	1	No		
			$2,029,521	$2,029,521						$382	$382						$2,029,903	3	No		
			$394,391		$394,391					$127		$127					$394,519	1	No		
			$326,907	$326,907						$127	$127						$327,035	1	No		

			Monitoring Costs							LF Gas Heat Calc. Reporting Cost							Costs per Landfill				
Fed Govt.	Tribal Govt.	Military	Subtotal	Private	Local Govt.	State Govt.	Fed Govt.	Tribal Govt.	Military	Subtotal	Private	Local Govt.	State Govt.	Fed Govt.	Tribal Govt.	Military		Number of Reports	Review By ARB?	ARB LEA Acres	ARB Reviewed Reports
			$2,128,676		$2,128,676																
										$3,060		$3,060						24			
																	$2,131,735		No		
			$386,433		$386,433																
										$1,785		$1,785						14			
																	$388,218		No		
			$1,678,725		$1,678,725																
										$1,275		$1,275						10			
																	$1,680,000		No		
			$1,047,451	$1,047,451																	
										$127	$127							1			
																	$1,047,579		No		
			$1,896,787	$1,896,787																	
										$3,060	$3,060							24			
																	$1,899,847		No		
			$1,501,747	$1,501,747																	
										$127	$127							1			
																	$1,501,875		No		
			$249,866		$249,866																
										$127		$127						1			
																	$249,994		No		
			$3,470,627		$3,470,627																
										$2,805		$2,805						22			
																	$3,473,431		No		
			$419,161			$419,161															
										$127			$127					1			
																	$419,289		No		
			$420,331		$420,331																
										$127		$127						1			
																	$420,459		No		
			$399,072		$399,072																
										$1,147		$1,147						9			
																	$400,219		No		
			$2,065,074	$2,065,074																	
										$892	$892							7			
																	$2,065,967		No		
			$492,691	$492,691																	
										$127	$127							1			
																	$492,819		No		
			$2,361,354	$2,361,354																	
										$3,060	$3,060							24			
																	$2,364,414		No		
			$729,080		$729,080																
										$127		$127						1			
																	$729,207		No		
			$1,849,382	$1,849,382																	
										$3,060	$3,060							24			
																	$1,852,442		No		
			$1,002,916		$1,002,916																
										$3,060		$3,060						24			
																	$1,005,976		No		
			$925,680		$925,680																
										$127		$127						1			
																	$925,807		No		
			$745,268	$745,268																	
										$127	$127							1			
																	$745,395		No		
			$1,807,761	$1,807,761																	
										$1,657	$1,657							13			
																	$1,809,418		No		
			$3,017,437	$3,017,437																	
										$892	$892							7			
																	$3,018,329		No		
			$1,858,863	$1,858,863																	
										$1,785	$1,785							14			
																	$1,860,648		No		
			$6,371,800		$6,371,800																
										$3,060		$3,060						24			
																	$6,374,860		No		
			$3,119,831	$3,119,831																	
										$892	$892							7			
																	$3,120,723		No		
			$1,021,640		$1,021,640																
										$2,422		$2,422						19			
																	$1,024,062		No		
			$1,034,902		$1,034,902																
										$637		$637						5			
																	$1,035,540		No		
			$1,615,829		$1,615,829																
										$3,060		$3,060						24			
																	$1,618,889		No		

			Monitoring Costs							LF Gas Heat Calc. Reporting Cost							Costs per Landfill				
Fed Govt.	Tribal Govt.	Military	Subtotal	Private	Local Govt.	State Govt.	Fed Govt.	Tribal Govt.	Military	Subtotal	Private	Local Govt.	State Govt.	Fed Govt.	Tribal Govt.	Military		Number of Reports	Review By ARB?	ARB LEA Acres	ARB Reviewed Reports
			$530,236	$530,236																	
										$127	$127							1			
																	$530,364		No		
			$3,409,000	$3,409,000																	
										$1,402	$1,402							11			
																	$3,410,403		No		
			$431,546	$431,546																	
										$127	$127							1			
																	$431,674		No		
			$913,978	$913,978																	
										$127	$127							1			
																	$914,105		No		
			$2,228,621	$2,228,621																	
										$1,530	$1,530							12			
																	$2,230,151		No		
			$649,503	$649,503																	
										$1,275	$1,275							10			
																	$650,778		No		
		$0																			
			$4,504,051						$4,504,051												
										$255						$255		2			
																	$4,504,306		No		
			$1,158,265	$1,158,265																	
										$2,677	$2,677							21			
																	$1,160,942		No		
			$4,073,063	$4,073,063																	
										$2,422	$2,422							19			
																	$4,075,485		No		
			$812,849		$812,849																
										$1,657		$1,657						13			
																	$814,507		No		
			$990,043		$990,043																
										$510		$510						4			
																	$990,553		No		
			$1,483,494		$1,483,494																
										$510		$510						4			
																	$1,484,004		1321		33
																				265.8	
																		$335,348,090			
																			6	# for ARB Review	
																	$26,982,470		140	# for District Review	
																	$146,818				
			$160,231,250							$168,414							$335,487,268	Per-Category Subtotals (all sectors)			
				$59,626,482							$47,044						$110,979,519	Private Sector			
					$94,827,634							$117,928					$207,482,492	Local Govt. Sector			
						$419,161							$127				$423,058	State Govt. Sector			
$0							$0							$0			$12,641	Fed. Govt. Sector			
	$0							$0							$0		$0	Tribal Govt. Sector			
		$8,745,880							$5,357,972							$3,315	$16,589,559	Military Sector			
																	$335,487,268	**Total Reg. Cost**			

Worksheet 3

Cost Subtotals

5/7/2009

Note: See staff report (Appendix F) for additional discussion and more detailed information (including reference citations.)

1. Waste-in-Place (WIP) Report Preparation & Submittal

Assumptions:
1) Landfills are currently required to submit periodic WIP reports to the California Integrated Waste Management Board.
2)This cost estimate assumes that a recent CIWMB report will either be updated or copied and submitted to ARB.
3) No allowance is given for office overhead, supplies, etc., since these are minimal cost items given the short duration and scope of this work assignment.

Cost:

Engineering Staff Time:	2 hours @	61.77 $/hr. =	$124
Clerical Staff Time:	1 hours @	43.85 $/hr. =	$44
WIP Report Preparation & Submittal Cost:			**$167**

Ref.: USDL, 2009b

2. Calculation of Landfill Gas Heat Input Capacity

Assumptions:
1) Time needed to prepare and submit Calculation as outlined in proposed regulation.
2) No allowance is given for office overhead, supplies, etc., since these are minimal cost items given the short duration and scope of this work assignment.

Cost:

Engineering Staff Time:	1.5 hours @	65.14 $/hr. =	$98
Clerical Staff Time:	1 hours @	29.78 $/hr. =	$30
Calculation of Landfill Gas Heat Input Capacity Cost:			**$127**

Ref.: USDL, 2009b

3a. Surface Emissions/Contol & Collection System Monitoring--Capital Cost

Assumptions:
Monitoring equipment to be used by landfills will be the same as used by ARB for reg. enforcement.

Monitoring Equipment Capital Cost: $48,000 **$48,000**

Includes the following:

(3) Portable Organic Vapor Analyzers	@	$5,000 ea. =	$15,000
(1) Calibration System	@	$3,000 ea. =	$3,000
(3) Vacuum Measuring Devices	@	$1,000 ea. =	$3,000
(3) Portable Oxygen Analyzers	@	$3,500 ea. =	$10,500
Spare Parts		$500 =	$500
Tools		$1,000 =	$1,000
(3) Datalogging Systems	@	$5,000 =	$15,000
			$48,000

3b. Surface Emissions/Contol & Collection System Monitoring--Cost per Landfill-Acre

Assumptions:
Includes calibration of monitor and downloading of monitoring data from datalogger.

Increased Monitoring Cost (SCAQMD only):

Engrg. Tech. Staff Time:	0.5 hours @	48.76	$/hr. =	**$24**	Per-Acre Cost:

Monitoring Cost + Surface Maintenance Allowance (non-SCAQMD landfills):

Engrg. Tech. Staff Time:	1 hours @	48.76	$/hr. =	$49	Per-Acre Cost:
Improved Surface Maintenance Cost Allowance:		50	$/AC =	$50	
				$99	Total Per-Acre Cost

Ref.: USDL, 2009b

4. Upgrade of Existing Collection/Control System--Capital Cost

Assumptions:
For landfills with existing open flare systems, work to be performed will consist of changeout of existing control device to a new enclosed flare.
Ref.: John Zink Co. "ZTOF" model

Enclosed Flare Cost Lookup Table [6]

Flare Size (MM Btu/Hr.)	Delivered Flare Cost [1]	Flare Installation [2]	Permits [3]	Start-up Source Test [4]	Misc. [5]	Total Cost
3.0	$174,590	$30,000	$5,000	$25,000	$50,000	**$284,590**
6.1	$189,405	$33,462	$6,000	$25,000	$50,000	**$303,867**
10.6	$207,490	$36,924	$7,000	$25,000	$50,000	**$326,414**
18.2	$224,486	$40,386	$8,000	$25,000	$50,000	**$347,872**
27.3	$242,571	$43,848	$9,000	$25,000	$50,000	**$370,419**
39.5	$265,016	$47,310	$10,000	$25,000	$50,000	**$397,326**
51.6	$285,281	$50,772	$15,000	$25,000	$50,000	**$426,053**
66.8	$305,546	$54,234	$20,000	$25,000	$50,000	**$454,780**
81.9	$325,812	$57,696	$25,000	$25,000	$50,000	**$483,508**
100.2	$346,077	$61,158	$30,000	$25,000	$50,000	**$512,235**
115.4	$366,342	$64,620	$35,000	$25,000	$50,000	**$540,962**
136.6	$386,607	$68,082	$40,000	$25,000	$50,000	**$569,689**
182.1	$596,090	$71,544	$45,000	$25,000	$50,000	**$787,634**
364.3	$1,001,430	$75,000	$50,000	$25,000	$50,000	**$1,201,430**
546.5	$1,001,430	$150,000	$55,000	$50,000	$50,000	**$1,306,430**
728.6	$1,406,770	$225,000	$60,000	$75,000	$50,000	**$1,816,770**
910.8	$1,812,110	$300,000	$65,000	$100,000	$50,000	**$2,327,110**
	$2,217,450	$375,000	$70,000	$125,000	$50,000	**$2,837,450**

Delivered Flare
Cost Construction Table

	Flare Stack & Controls	Propane Pilot Gas System	Blower Skid	Tranportation To Site	Delivered Flare Cost
3	$75,000	$1,000	$75,000	$10,000	$174,590
6	$80,000	$1,000	$80,769	$13,077	$189,405
11	$88,000	$1,000	$86,538	$16,154	$207,490
18	$95,000	$1,000	$92,307	$19,231	$224,486
27	$103,000	$1,000	$98,076	$22,308	$242,571
39	$115,000	$1,000	$103,845	$25,385	$265,016
52	$125,000	$1,000	$109,614	$28,462	$285,281
67	$135,000	$1,000	$115,383	$31,539	$305,546
82	$145,000	$1,000	$121,152	$34,616	$325,812
100	$155,000	$1,000	$126,921	$37,693	$346,077
115	$165,000	$1,000	$132,690	$40,770	$366,342
137	$175,000	$1,000	$138,459	$43,847	$386,607
182	$350,000	$1,000	$150,000	$50,000	$596,090
364	$525,000	$2,000	$300,000	$100,000	$1,001,430
546	$700,000	$3,000	$450,000	$150,000	$1,406,770
728	$875,000	$4,000	$600,000	$200,000	$1,812,110
911	$1,050,000	$5,000	$750,000	$250,000	$2,217,450
	$1,050,000	$6,000	$900,000	$300,000	$2,432,040

[1] Includes the following: enclosed flare cost (includes stack ,control panel, flame arrester, safety shutoff valve, flow meter, and chart recorder), $1,000 for propane pilot gas system, tranportation to CA (not taxed), and 9% sales tax.
[2] Includes site evaluation, application engineering, and actual installation work.
[3] Includes air district (application & authority-to-construct fees) and building permits.
[4] Source test for criteria pollutants and CH4 (EPA Method 18) to ensure permit compliance.
[5] Allowance for electrical service work, including line extension and service drop work, etc.
[6] 182 MM Btu/Hr. (about 6,000 SCFM) is the largest stock single enclosed flare size; larger sizes assume using multiple flares as required for control.

Ref.: Locke, 2009a, Locke 2009b

5a. Installation of New Collection and Control System--Capital Cost

Assumptions:
includes site assessment, design and installation of collection and control systems (enclosed flare assumed as control technology choice)

2007 $	2008 $
$18,000	$18,900

Cost/ LF acre: **$18,900**
Source Test: **$25,000**

Ref.: U.S. EPA, 2009

5b. Annual Operation & Maintenance Cost of New Collection and Control System

2007 $	2008 $
4,000	4,200

Cost/ LF acre: **$4,200**

$25,000 Source Test

$0 Misc.. **$25,000**

Ref.: U.S. EPA, 2009

6. Costs to ARB for Enforcement and Outreach Activities

Note: Items 6a through 6e are used to calculate the low end of the cost range, 6f through 6j are used to calculate the high end of the cost range.

Calculation of ARB Loaded Labor Rate Used for Estimation Purposes (includes benefits, overhead, etc.):
ARB Annual Employee Loaded Cost = $170,000[1] Number of Employee Production Hours/Yr.: 1,904
$170,000/1,904 = $89.29/hr.

Ref.: Ford, 2009[1]

6a. ARB Enforcement--Site Inspections & Associated Work (low end of cost range)

Assumptions:
1) Six landfills located in local air districts w/o delegated LEA authority from ARB will be inspected annually by ARB for enforcement purposes.
2) Three of the six landfills are remotely located, requiring additional travel time beyond that for a typical inspection.
3) A typical inspection is a one-day trip w/o overnight lodging, but includes limited (4hrs.) O/T. O/T = 1.5x normal pay rate.
4) A remote inspection includes two nights' lodging expenses + per-diem and two days for travel.
5) Landfill population is relatively stable over time-- no large increases in the number of landfills.

				Monitoring Equipment			One-Time Eq. Cost
				$48,000			**$48,000**
	# of Landfills	Travel (unit cost	Travel Cost Subtotal	Labor (hrs./insp.)	Labor Cost Subtotal		
Typical Inspection:	3	$80	$240	14	$3,750	Annual	Annual
Remote Inspection:	3	$520	$1,560	24	$6,429	Travel Cost	Labor Cost
			$1,800		$10,179	**$1,800**	**$10,179**

6b. ARB Enforcement--Design Plan Reviews (low end of cost range)

Assumptions:
1) Each intial Design Plan review by ARB staff includes 12 hrs. for a site visit.
2) 25% of Design Plans submitted will be updated and resubmitted annually.
3) Landfill population is relatively stable over time-- no large increases in the number of landfills.

Initial Design Plan Review[1]:

30 hours @	89.29 $/hr. =		$2,679
Travel Costs (avg.):			$240
		Total:	$2,919

Updated Design Plan Review[1]:

8 hours @	89.29 $/hr. =	$714

Cost Calculation:

	# of Affected Landfills	Labor Cost/Review	Review Cost Subtotal	One-Time Travel Cost	One-Time Labor Cost
Initial Review:	5	$2,679	$13,394	**$1,200**	**$13,394**
Update Review:	1	$714	$714		
					Annual Labor Cost
					$714

Ref.: Judge, 2009[1]

6c. ARB Enforcement--Monitoring Data Review (low end of cost range)

Assumptions:
1) Monitoring data review includes staff time to receive, review, and archive data.
2) Four monitoring reports per year are reviewed.
3) Landfill population is relatively stable over time-- no large increases in the number of landfills.
4) Report review workload is constant over the 23-year analysis period.

Review Cost per Reporting Cycle (expressed on a per-acre basis):

0.1 hours @	89.29 $/hr. =	$9

	Number of Affected Landfill-	Review Cost ($/acre)	Cost Subtotal	Annual Labor Cost
Report Review:	266	$9	$2,373	**$9,493**

6d. ARB Enforcement--Review of WIP and Heat Calculation Reports (low end of cost range)

Assumptions:
1) Report review workload is constant over the 23-year analysis period.
2) Landfill population is relatively stable over time-- no large increases in the number of landfills.

Number of Reports Expected From Affected Landfills

Landfills Subject to Reporting Only:		567
Landfills Subject to Reporting, Monitoring, & Controls:		33
	Total:	600 (over a 23-year period)

Estimated Review Time/Report

1 hour(s) @ 89.29 $/hr. = $89

Cost Calculation

	Number of Reports	Cost/Review	Cost Subtotal	Annual Labor Cost
Report Review:	600	$89	$53,574	**$2,329**

6e. ARB Implementation--Outreach and Compliance Assistance Activities (low end of cost range)

Assumptions:
1) Mailout audience is estimated at 218 x 1.25 = 273; this is the 218 potentially afffected CA landfills plus 25% additional to include associated regulatory agencies (local air districts (35), CIWMB, RWCB, and EPA), equipment and service providers, and other interested parties.
2) Preparation of 75-page outreach document for landfills is performed.

Preparation of Outreach Materials

(1) 75-page outreach document

ARB Staff Time: 120 hours @ 89.29 $/hr. = $10,715

	(# of units)	(cost/unit)	Quantity		
Reproduction Costs:					
400 copies = 273 + 127 extras	75	$0.04	400	$1,200	
Mailout:					
cover letter	2	$0.04	273	$22	
envelope	1	$0.72	273	$197	
postage (8 oz.) (after 5/09 rate increase)	1	$2.07	273	$565	
					$1,984

Informational Workshop(s)
(Outreach materials & staff time costs covered/absorbed in current budget allocation.)
Travel- one person/one week $1,200

Trade Show Attendance
(Staff time costs covered/absorbed in current budget allocation.)
Travel- one person/one week $1,200
Registration Fees $500

One-Time Non-Labor Expenses	One-Time Travel Exp.
$2,484	**$2,400**

One-Time Labor Cost
$10,715

Low-End of Cost Range Summary

	Cost ($)
Annual (Recurring) Costs:	
ARB Staff Time	$22,716
Travel	$1,800
	$24,516
"Low-End Annual Costs to ARB are approximately $24,500."	
One-Time Costs:	
ARB Staff Time	$24,108
Travel	$3,600
Monitoring Equipment + Mailout Expenses	$50,484
	$78,192
"Low-End One-Time Costs to ARB are approximately $78,000."	

6f. ARB Enforcement--Site Inspections & Associated Work (high end of cost range)

Assumptions:
1) All California landfills will be inspected annually by ARB for enforcement purposes.
2) Landfill population is relatively stable over time-- no large increases in the number of landfills.

Labor Cost
8 hrs./insp. + 1.3 hrs. travel allowance = 10 hrs./inspection
367 Landfills x 10 hrs. Staff Time/Landfill = 3,670 hrs.
3,670 hrs./1,904 hrs. ~ 2 PYs
2 PYs x $170,000/PY[1] = $340,000

Monitoring Equipment		One-Time Eq. Cost
$ 48,000		**$ 48,000**

Travel Cost
40% of Inspections on Per-Diem (~36.7 weeks/yr. for 2 PYs)

Travel	Labor Cost	Annual Travel Cost	Annual Labor Cost
$44,040	$ 340,000	**$44,040**	**$340,000**

Cost for One Week of Travel (5 days, 4 nights)

Lodging	$560
Round-Trip Airfare	$240
Car Rental (incl. gas.)	$200
Food and Incidentals	$200
	$1,200

36.7 Travel Weeks/yr. x $1,200/week = $44,040

Ref.: Ford, 2009[1]

6g. ARB Enforcement--Design Plan Reviews (high end of cost range)

Assumptions:
1) Each intial Design Plan review by ARB staff includes 12 hrs. for a site visit.
2) 25% of Design Plans submitted will be updated and resubmitted annually.
3) Landfill population is relatively stable over time-- no large increases in the number of landfills.

Initial Design Plan Review[1]:

30 hours @	89.29 $/hr. =	$2,679
Travel Costs (avg.):		$240
	Total:	$2,919

Updated Design Plan Review[1]:

8 hours @	89.29 $/hr. =	$714

Cost Calculation:

	# of Affected Landfills	Labor Cost/Review	Review Cost Subtotal	One-Time Travel Cost	One-Time Labor Cost
Initial Review:	146	$2,679	$391,090	**$35,040**	**$391,090**
Update Review:	37	$714	$26,073		

Annual Labor Cost
$26,073

Ref.: Judge, 2009[1]

6h. ARB Enforcement--Monitoring Data Review (high end of cost range)

Assumptions:
1) Monitoring data review includes staff time to receive, review, and archive data.
2) Four monitoring reports per year are reviewed.
3) Landfill population is relatively stable over time-- no large increases in the number of landfills.
4) Report review workload is constant over the 23-year analysis period.

Review Cost per Reporting Cycle (expressed on a per-acre basis):

0.1 hour(s) @	89.29 $/hr. =	$9

	Number of Affected Landfill-Acres	Review Cost ($/acre)	Cost Subtotal	Annual Labor Cost
Report Review:	23,247	$9	$207,573	**$830,292**

6i. ARB Enforcement--Review of WIP and Heat Calculation Reports (high end of cost range)

Assumptions:
1) Report review workload is constant over the 23-year analysis period.
2) Landfill population is relatively stable over time-- no large increases in the number of landfills.

Number of Reports Expected From Affected Landfills

Landfills Subject to Reporting Only:			888	
Landfills Subject to Reporting, Monitoring, & Controls:			1,321	
		Total:	2,209	

Estimated Review Time/Report

1 hour(s) @ 89.29 $/hr. = $89

Cost Calculation

	Number of Reports	Cost/Review	Cost Subtotal	Annual Labor Cost
Report Review:	2,209	$89	$197,242	**$8,576**

6j. ARB Implementation--Outreach and Compliance Assistance Activities (high end of cost range)

Assumptions:
1) Mailout audience is estimated at 372 x 1.25 = 465; this is all of the 372 potentially afffected CA landfills plus 25% additional to include associated regulatory agencies (local air districts (35), CIWMB, RWCB, and EPA), equipment and service providers, and other interested parties.
2) Preparation of 75-page outreach document for landfills is performed.

Preparation of Outreach Materials
(1) 75-page outreach document
ARB Staff Time: 120 hour(s) @ 89.29 $/hr. = $10,715

	(# of units)	(cost/unit)	Quantity		
Reproduction Costs:					
500 copies = 465 + 35 extras	75	$0.04	500	$1,500	
Mailout:					
cover letter	2	$0.04	465	$37	
envelope	1	$0.72	465	$335	
postage (8 oz.) (after 5/09 rate increase)	1	$2.07	465	$963	
					$2,835

Informational Workshop(s)
(Outreach materials & staff time costs covered/absorbed in current budget allocation.)
Travel- one person/one week $1,200

Trade Show Attendance
(Staff time costs covered/absorbed in current budget allocation.)
Travel- one person/one week $1,200
Registration Fees $500

One-Time Travel Exp.	One-Time Non-Labor Expenses
$2,400	**$3,335**

One-Time Labor Cost
$10,715

High-End of Cost Range Summary

	Cost ($)
Annual (Recurring) Costs:	
ARB Staff Time	$1,204,940
Travel	$44,040
	$1,248,980

"High-End Annual Costs to ARB are approximately 1.2 million dollars."

One-Time Costs:	
ARB Staff Time	$401,805
Travel	$37,440
Monitoring Equipment + Mailout Expenses	$50,835
	$490,080

"High-End One-Time Costs to ARB are approximately $490,000."

Worksheet 4

Estimated Cost-Effectiveness

(for the period 2010 to 2033, inclusive)

5/7/2009

This is the overall cost-effectiveness, where reporting requirement, collection and control system, and monitoring costs are summed and divided by the CO2 reductions attributable to the proposed regulation (emission benefits for landfills in the SCAQMD excluded from the emission reductions listed below.)

1) Cost-Effectiveness of Proposed Regulation

Year [1]	Annual Cost [2] ($)	Emission Red. [3] (MTCO2E)	Cost-Effectiveness ($/MTCO2E)	
2010	$6,404,217	1,163,439	**5.50**	**Low**
2011	$11,356,839	1,198,633	9.47	
2012	$14,052,745	1,234,336	**11.38**	**High**
2013	$13,306,546	1,270,563	10.47	
2014	$13,305,574	1,307,328	10.18	
2015	$13,305,151	1,344,646	9.89	
2016	$13,304,856	1,382,532	9.62	
2017	$13,673,947	1,421,002	9.62	
2018	$15,595,468	1,460,071	10.68	
2019	$15,595,341	1,499,756	10.40	
2020	$15,594,456	1,540,071	10.13	
2021	$15,593,819	1,581,034	9.86	
2022	$15,592,974	1,622,662	9.61	
2023	$15,592,424	1,664,971	9.36	
2024	$15,591,659	1,707,980	9.13	
2025	$15,591,404	1,751,704	8.90	
2026	$14,819,906	1,796,163	8.25	
2027	$13,981,754	1,841,375	7.59	
2028	$13,893,086	1,887,358	7.36	
2029	$13,892,536	1,934,132	7.18	
2030	$13,892,114	1,981,715	7.01	
2031	$13,891,986	2,030,127	6.84	
2032	$13,891,604	2,079,389	6.68	
2033	$13,766,863	2,129,520	6.46	
	$335,487,268	38,830,509	**8.64**	**Avg.**

[1] These are the individual years in the analysis period.

[2] Annual costs are the sum of the reporting, collection and control systems improvements, and monitoring costs for all affected CA landfills (including those in the SCAQMD.) Costs are from the Landfills_Reporting_Only and Landfills_Controlled worksheets in this file.

[3] Emission reductions are for all affected CA landfills except for those in the SCAQMD.

Worksheet 5 **Cost Summary**

5/4/2009

1) Costs for Landfills Subject to Reporting Requirements Only
(projected to have less than 450,000 tons WIP)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Private LFs:	$2,989	$462	$462	$462	$462	$462	$462	$462	$462	$462	$462	$462	$295	$295	$295	$295	$295	$295	$127
Government LFs (all):	$14,163	$7,428	$7,094	$6,799	$6,464	$6,169	$6,002	$5,834	$5,500	$5,500	$4,997	$4,997	$4,703	$4,408	$4,280	$4,280	$4,280	$4,280	$4,113
Local:	$11,055	$4,950	$4,615	$4,448	$4,113	$3,985	$3,985	$3,985	$3,818	$3,818	$3,316	$3,316	$3,316	$3,021	$2,893	$2,893	$2,893	$2,893	$2,726
State:	$295	$295	$295	$295	$295	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127	$127
Federal:	$1,387	$757	$757	$630	$630	$630	$630	$462	$462	$462	$462	$462	$462	$462	$462	$462	$462	$462	$462
Tribal:	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Military:	$1,427	$1,427	$1,427	$1,427	$1,427	$1,427	$1,259	$1,259	$1,092	$1,092	$1,092	$1,092	$797	$797	$797	$797	$797	$797	$797
	$17,152	$7,891	$7,556	$7,261	$6,926	$6,631	$6,464	$6,297	$5,962	$5,962	$5,460	$5,460	$4,997	$4,703	$4,575	$4,575	$4,575	$4,575	$4,240
LFs Subject to WIP Rep. Only:	$5,356	$5,356	$5,022	$4,854	$4,687	$4,687	$4,520	$4,352	$4,352	$4,352	$4,017	$4,017	$3,850	$3,683	$3,683	$3,683	$3,683	$3,683	$3,348
LFs Subject to Both WIP & Heat Calc. Rep'ting:	$11,795	$2,534	$2,534	$2,407	$2,239	$1,944	$1,944	$1,944	$1,610	$1,610	$1,442	$1,442	$1,147	$1,020	$892	$892	$892	$892	$892
Total by Year:	$17,152	$7,891	$7,556	$7,261	$6,926	$6,631	$6,464	$6,297	$5,962	$5,962	$5,460	$5,460	$4,997	$4,703	$4,575	$4,575	$4,575	$4,575	$4,240

2) Costs for Landfills Subject to Reporting, Monitoring, and Control Requirements
(typical businesses; projected to have greater than or equal to 450,000 tons WIP)

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Private LFs:	Capital Costs	$0	$288,158	$505,922	$505,922	$505,922	$505,922	$505,922	$505,922	$541,593	$541,593	$541,593	$541,593	$541,593	$541,593	$541,593	$541,593	$253,435	$35,671	$35,671
	O&M Costs	$0	$684,400	$1,225,800	$1,225,800	$1,225,800	$1,225,800	$1,225,800	$1,225,800	$2,195,800	$2,195,800	$2,195,800	$2,195,800	$2,195,800	$2,195,800	$2,195,800	$2,195,800	$2,195,800	$2,195,800	$2,195,800
	Monitoring Costs	$2,141,857	$3,077,983	$2,860,346	$2,380,346	$2,380,346	$2,380,346	$2,380,346	$2,517,230	$2,469,230	$2,469,230	$2,469,230	$2,469,230	$2,469,230	$2,469,230	$2,469,230	$2,469,230	$2,469,230	$2,469,230	$2,469,230
	Reporting Costs	$6,247	$3,060	$3,060	$2,805	$2,677	$2,677	$2,677	$2,295	$2,295	$2,295	$2,167	$1,785	$1,657	$1,530	$1,275	$1,275	$1,147	$1,020	$1,020
		$2,148,104	$4,053,602	$4,595,128	$4,114,873	$4,114,745	$4,114,745	$4,114,745	$4,251,247	$5,208,918	$5,208,918	$5,208,790	$5,208,408	$5,208,280	$5,208,153	$5,207,898	$5,207,898	$4,919,612	$4,701,721	$4,701,721
Govt. LFs:	Capital Costs	$0	$483,212	$1,103,346	$1,191,297	$1,191,297	$1,191,297	$1,191,297	$1,191,297	$1,279,609	$1,279,609	$1,279,609	$1,279,609	$1,279,609	$1,279,609	$1,279,609	$1,279,609	$796,396	$176,263	$88,312
	O&M Costs	$0	$1,192,840	$3,739,780	$3,962,180	$3,962,180	$3,962,180	$3,962,180	$3,962,180	$4,982,180	$4,982,180	$4,982,180	$4,982,180	$4,982,180	$4,982,180	$4,982,180	$4,982,180	$4,982,180	$4,982,180	$4,982,180
	Monitoring Costs	$4,226,595	$5,612,410	$4,600,306	$4,024,306	$4,024,306	$4,024,306	$4,024,306	$4,257,190	$4,113,190	$4,113,190	$4,113,190	$4,113,190	$4,113,190	$4,113,190	$4,113,190	$4,113,190	$4,113,190	$4,113,190	$4,113,190
	Reporting Costs	$12,367	$6,884	$6,629	$6,629	$6,120	$5,992	$5,865	$5,737	$5,610	$5,482	$5,227	$4,972	$4,717	$4,590	$4,207	$3,952	$3,952	$3,825	$3,442
		$4,238,961	$7,295,346	$9,450,061	$9,184,412	$9,183,902	$9,183,775	$9,183,647	$9,416,404	$10,380,588	$10,380,461	$10,380,206	$10,379,951	$10,379,696	$10,379,568	$10,379,186	$10,378,931	$9,895,719	$9,275,458	$9,187,124
Recurring Costs (all):		**$6,387,065**	$10,577,577	$12,435,921	$11,602,066	$11,601,429	$11,601,302	$11,601,174	$11,970,432	**$13,768,305**	$13,768,177	$13,767,795	$13,767,157	$13,766,775	$13,766,520	$13,765,882	$13,765,627	$13,765,500	$13,765,245	$13,764,862
Annualized Cap. Cost:		$0	**$771,371**	$1,609,268	$1,697,218	$1,697,218	$1,697,218	$1,697,218	$1,697,218	**$1,821,202**	$1,821,202	$1,821,202	$1,821,202	$1,821,202	$1,821,202	$1,821,202	$1,821,202	$1,049,831	$211,934	$123,983
Subtotals:	Capital Costs	$0	$771,371	$1,609,268	$1,697,218	$1,697,218	$1,697,218	$1,697,218	$1,697,218	$1,821,202	$1,821,202	$1,821,202	$1,821,202	$1,821,202	$1,821,202	$1,821,202	$1,821,202	$1,049,831	$211,934	$123,983
	O&M Costs	$0	$1,877,240	$4,965,580	$5,187,980	$5,187,980	$5,187,980	$5,187,980	$5,187,980	$7,177,980	$7,177,980	$7,177,980	$7,177,980	$7,177,980	$7,177,980	$7,177,980	$7,177,980	$7,177,980	$7,177,980	$7,177,980
	Monitoring Costs	$6,368,451	$8,690,393	$7,460,652	$6,404,652	$6,404,652	$6,404,652	$6,404,652	$6,774,420	$6,582,420	$6,582,420	$6,582,420	$6,582,420	$6,582,420	$6,582,420	$6,582,420	$6,582,420	$6,582,420	$6,582,420	$6,582,420
	Reporting Costs	$18,614	$9,944	$9,689	$9,434	$8,797	$8,669	$8,542	$8,032	$7,904	$7,777	$7,394	$6,757	$6,375	$6,120	$5,482	$5,227	$5,100	$4,845	$4,462
Totals:		$6,387,065	$11,348,948	$14,045,189	$13,299,285	$13,298,647	$13,298,520	$13,298,392	$13,667,650	**$15,589,506**	$15,589,379	$15,588,996	$15,588,359	$15,587,976	$15,587,721	$15,587,084	$15,586,829	$14,815,331	$13,977,179	$13,888,846

3) Reporting Costs for All Landfills

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Reporting Only LFs:																				
	Private	$2,989	$462	$462	$462	$462	$462	$462	$462	$462	$462	$462	$462	$295	$295	$295	$295	$295	$295	$127
	Government:	$14,163	$7,428	$7,094	$6,799	$6,464	$6,169	$6,002	$5,834	$5,500	$5,500	$4,997	$4,997	$4,703	$4,408	$4,280	$4,280	$4,280	$4,280	$4,113
		$17,152	$7,891	$7,556	$7,261	$6,926	$6,631	$6,464	$6,297	$5,962	$5,962	$5,460	$5,460	$4,997	$4,703	$4,575	$4,575	$4,575	$4,575	$4,240
Cntl/Monitoring LFs:																				
	Private	$6,247	$3,060	$3,060	$2,805	$2,677	$2,677	$2,677	$2,295	$2,295	$2,295	$2,167	$1,785	$1,657	$1,530	$1,275	$1,275	$1,147	$1,020	$1,020
	Government:	$12,367	$6,884	$6,629	$6,629	$6,120	$5,992	$5,865	$5,737	$5,610	$5,482	$5,227	$4,972	$4,717	$4,590	$4,207	$3,952	$3,952	$3,825	$3,442
		$18,614	$9,944	$9,689	$9,434	$8,797	$8,669	$8,542	$8,032	$7,904	$7,777	$7,394	$6,757	$6,375	$6,120	$5,482	$5,227	$5,100	$4,845	$4,462
Total (all):		$35,765	$17,835	$17,245	$16,695	$15,723	$15,301	$15,006	$14,328	$13,866	$13,739	$12,854	$12,217	$11,372	$10,822	$10,057	$9,802	$9,675	$9,420	$8,702

4) Total Cost of Regulation to Afffected Landfills

	Cost Category																			
	Capital Costs	$0	$771,371	$1,609,268	$1,697,218	$1,697,218	$1,697,218	$1,697,218	$1,697,218	$1,821,202	$1,821,202	$1,821,202	$1,821,202	$1,821,202	$1,821,202	$1,821,202	$1,821,202	$1,049,831	$211,934	$123,983
	O&M Costs	$0	$1,877,240	$4,965,580	$5,187,980	$5,187,980	$5,187,980	$5,187,980	$5,187,980	$7,177,980	$7,177,980	$7,177,980	$7,177,980	$7,177,980	$7,177,980	$7,177,980	$7,177,980	$7,177,980	$7,177,980	$7,177,980
	Monitoring Costs	$6,368,451	$8,690,393	$7,460,652	$6,404,652	$6,404,652	$6,404,652	$6,404,652	$6,774,420	$6,582,420	$6,582,420	$6,582,420	$6,582,420	$6,582,420	$6,582,420	$6,582,420	$6,582,420	$6,582,420	$6,582,420	$6,582,420
	Reporting Costs	$18,614	$9,944	$9,689	$9,434	$8,797	$8,669	$8,542	$8,032	$7,904	$7,777	$7,394	$6,757	$6,375	$6,120	$5,482	$5,227	$5,100	$4,845	$4,462
Annual Totals:		**$6,387,065**	**$11,348,948**	**$14,045,189**	**$13,299,285**	**$13,298,647**	**$13,298,520**	**$13,298,392**	**$13,667,650**	**$15,589,506**	**$15,589,379**	**$15,588,996**	**$15,588,359**	**$15,587,976**	**$15,587,721**	**$15,587,084**	**$15,586,829**	**$14,815,331**	**$13,977,179**	**$13,888,846**
		Lowest Yr.								**Highest Yr.**										

5) Cost Per California Household Calculation

Total Cost of Prop. Reg. Div. by # of CA Households: $26

Cost/ CA Household Div. by # of Months in Analysis Period: 0.09 $/mon/household

2029	2030	2031	2032	2033	Totals	
$127	$0	$0	$0	$0	$10,098	
$3,818	$3,650	$3,650	$3,650	$3,021	$129,080	
$2,559	$2,391	$2,391	$2,391	$2,224	$87,994	
$127	$127	$127	$127	$0	$3,769	
$335	$335	$335	$335	$335	$12,641	
$0	$0	$0	$0	$0	$0	
$797	$797	$797	$797	$462	$24,676	
$3,945	$3,650	$3,650	$3,650	$3,021	$139,178	
$3,180	$3,013	$3,013	$3,013	$2,511	$95,914	
$765	$637	$637	$637	$510	$43,264	
$3,945	$3,650	$3,650	$3,650	$3,021		$139,178

2029	2030	2031	2032	2033	Totals	
$35,671	$35,671	$35,671	$35,671	$0	$8,123,895	
$2,195,800	$2,195,800	$2,195,800	$2,195,800	$2,195,800	$43,172,000	
$2,469,230	$2,469,230	$2,469,230	$2,469,230	$2,469,230	$59,626,482	
$892	$892	$765	$765	$765	$47,044	
$4,701,594	$4,701,594	$4,701,466	$4,701,466	$4,665,795	$110,969,421	
$88,312	$88,312	$88,312	$88,312	$0	$19,194,131	
$4,982,180	$4,982,180	$4,982,180	$4,982,180	$4,982,180	$104,458,400	
$4,113,190	$4,113,190	$4,113,190	$4,113,190	$4,113,190	$100,604,768	
$3,315	$3,187	$3,187	$2,805	$2,677	$121,370	
$9,186,997	$9,186,869	$9,186,869	$9,186,487	$9,098,047	$224,378,669	
$13,764,607	$13,764,480	$13,764,352	$13,763,970	$13,763,842	$308,030,064	
$123,983	$123,983	$123,983	$123,983	$0	$27,318,026	
$123,983	$123,983	$123,983	$123,983	$0	$27,318,026	
$7,177,980	$7,177,980	$7,177,980	$7,177,980	$7,177,980	$147,630,400	
$6,582,420	$6,582,420	$6,582,420	$6,582,420	$6,582,420	$160,231,250	
$4,207	$4,080	$3,952	$3,570	$3,442	$168,414	
$13,888,591	$13,888,463	$13,888,336	$13,887,953	$13,763,842		$335,348,090
						$335,487,268

2029	2030	2031	2032	2033	Totals	
$127	$0	$0	$0	$0	$10,098	
$3,818	$3,650	$3,650	$3,650	$3,021	$129,080	
$3,945	$3,650	$3,650	$3,650	$3,021		$139,178
$892	$892	$765	$765	$765	$47,044	
$3,315	$3,187	$3,187	$2,805	$2,677	$121,370	
$4,207	$4,080	$3,952	$3,570	$3,442		$168,414
$8,153	$7,730	$7,603	$7,220	$6,463		$307,593

$123,983	$123,983	$123,983	$123,983	$0	**$27,318,026**	
$7,177,980	$7,177,980	$7,177,980	$7,177,980	$7,177,980	**$147,630,400**	
$6,582,420	$6,582,420	$6,582,420	$6,582,420	$6,582,420	**$160,231,250**	
$4,207	$4,080	$3,952	$3,570	$3,442	**$307,593**	(incl. reporting only LFs)
$13,888,591	**$13,888,463**	**$13,888,336**	**$13,887,953**	**$13,763,842**	**$335,487,268**	