APPENDIX G

Evaluation of Greenhouse Gas Emissions

LIGHT BROWN APPLE MOTH ERADICATION PROGRAM

Draft
Programmatic Environmental Impact Report

EVALUATION OF
GREENHOUSE GAS EMISSIONS

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Abbreviations & Acronyms

AB	Assembly Bill
CAFE	Corporate Average Fuel Economy
CARB	California Air Resources Board
CDFA	California Department of Food and Agriculture
CEQA	California Environmental Quality Act
CFCs	chlorinated fluorocarbons
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalents
CH_4	methane
EF	emission factor
EISA	Energy Independence and Security Act of 2007
EMFAC	EMission FACtors (model)
GHG	greenhouse gas
Gt	giga ton(s)
GWP	global warming potential
H_2O	water vapor
HFCs	hydrofluorocarbons
IPCC	Intergovernmental Panel on Climate Change
LBAM	light brown apple moth
LCA	Life Cycle Analysis
LCFS	Low Carbon Fuel Standard
mph	miles per hour
N_2O	nitrous oxide
OPR	Office of Planning and Research
PEIR	Programmatic Environmental Impact Report
ppb	parts per billion
ppm	parts per million
Program	Light Brown Apple Moth Eradiation Program
SB	Senate Bill
URBEMIS	URBan EMISsions
USEPA	United States Environmental Protection Agency

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SECTION G1

Introduction

The Light Brown Apple Moth Eradiation Program (the Program) is a compilation of alternatives aimed at eradicating the nonnative light brown apple moth (LBAM) that has been detected in numerous counties within California. A greenhouse gas (GHG) emissions inventory has been prepared for the Program, based on the Program descriptions of the proposed treatment activities throughout California that would contribute to GHG emissions.

G1.1 PROGRAM BACKGROUND

The LBAM is a native moth of Australia. It has been detected in California since 2007. According to the California Department of Food and Agriculture (CDFA), it poses a significant threat to California's agricultural and native plant species. In addition, the potential presence of the LBAM threatens to reduce California growers' ability to export their crops. The goal of the CDFA and the United States Department of Agriculture is to eradicate the LBAM in California.

The immediate Program area is located in the following 13 counties of the state where LBAM infestations presently occur (January 2009): Alameda, Contra Costa, San Francisco, Napa, Marin, Sonoma, Solano, San Mateo, Santa Clara, San Benito, Monterey, Santa Cruz, and Santa Barbara. The areas proposed for eradication activities in the short term cover approximately 1,280,000 acres (2,000 square miles). Within the 13 counties, eradication activities will be focused in the areas with the infestation problems.

However, as explained in the Notice of Preparation of a Draft Programmatic Environmental Impact Report (PEIR)(July 17, 2008), the LBAM infestation has spread and may continue to spread until full scale eradication and treatment activities are implemented. The CDFA decided to expand the Program area description for the PEIR to include all portions of the state in which climatic conditions are suitable to the LBAM. Without a diapause (resting) stage, LBAM can only survive in areas where it can continuously breed and where sufficient hosts are available. Areas not expected to harbor LBAM are desert areas with sparse vegetation including most of Imperial County and the eastern portions of Santa Barbara, Riverside, and Inyo counties and areas of extensive cold, including elevations above 5,000 feet in the Sierra Nevada Mountains and the eastern portions of Modoc and Lassen counties. The threat is greatest along the coast from the Oregon border to the Mexican border. LBAM is expected to survive in the Central Valley and foothills below 5,000 feet. This expanded Program area is shown on Figure 2-1, LBAM Expanded Program Area, in PEIR Section 2.2 and includes portions or all of the 58 counties within California.

G1.2 PROGRAM ALTERNATIVES

To accomplish the stated goal of eradicating the LBAM, the CDFA is considering several different treatment alternatives. Each treatment alternative is briefly discussed below:

- **Mating Disruption.** Pheromones would be applied to disrupt the mating process. The pheromones could be applied aerially in essentially unpopulated areas and by various ground application techniques in urban or suburban areas.
- **Male Moth Attractant.** This alternative involves vehicle-based treatment with the LBAM-specific pheromone to attract the male moths plus permethrin to kill male moths.

- **Organic-Approved Insecticides.** Pesticidal control alternatives include the use of *Bacillus thuringiensis* (Alternative Btk) and Spinosad (Alternative S) that may be used in targeted populated areas. Both of these treatments would be applied by hydraulic spraying using either truck-based or backpack-based equipment.
- **Sterile Insect Technique.** This technique will be the primary tool for the eradication of the LBAM in the state of California when it becomes fully operational. The Program would release sterile moths into the environment to disrupt mating and eradicate the population.
- **Inundative Parasitic Wasp Release.** Inundative Trichogramma species (stingless parasite wasp) releases may be made in areas with detections. This form of biological control would use native, commercially available parasitic wasps. Wasp eggs are attached to index cards with Elmer's® glue and attached to foliage where LBAM has been detected.

The above Program alternatives are summarized from the detailed discussions of the Program alternatives that are provided in PEIR Section 2. This assessment focuses on the GHG emissions associated with treatment options that may be implemented by the CDFA. As such, all of the treatment alternatives, except the "No Program" alternative,[1] are included in this analysis.

As indicated in Table G-1, GHG emission sources associated with the Program and assessed in this analysis include:

1. Offroad Sources
   - Spray pump mounted on hydraulic spray vehicles
2. Onroad Sources
   - Passenger vehicles for workers commuting to and from central congregation points
   - Transportation trucks to transport ground-based and vehicle-based crews to and from Program sites
   - Trucks used in vehicle-based treatment applications (including the SPLAT spray vehicles and the hydraulic spray trucks)
   - Trucks used for vendor delivery of compounds/supplies to Program sites
3. Aerial Sources
   - Airplanes used for spraying of mating disruption pheromones
   - Airplanes used for the Sterile Insect Technique Alternative

To determine which GHG emission source would be assessed for each treatment option, refer to Table G-1. For example, the Twist Ties Alternative MD-1 has a check mark in the twist ties column. Following that column upward indicates the GHG emission sources to be assessed include the worker commute vehicles, the vendor delivery vehicles, and the worker transportation vehicles. Alternatively, for the Aerial Application (MD-3) Alternative, the worker commute vehicles, the vendor delivery vehicles, and the airplanes were included in the GHG emission estimates.

[1] **No Program Alternative.** The CDFA does not institute an eradication program and various individuals and businesses must respond to the LBAM infestations using traditional and registered pesticides and regulatory controls.

Table G-1 Program Alternatives: Application Methods and Corresponding Greenhouse Gas Emissions Sources

GHG Emissions Source	Application Method								
	Aerial		Vehicle		Ground				
	Spray	Populated Release	Hydraulic	SPLAT	Hydraulic Backpack	Caulk Gun	Pod Gun	Twist-Ties	Index Cards
Worker Commute Vehicles[1]	X	X	X	X	X	X	X	X	X
Vendor Delivery Vehicles[2]	X	X	X	X	X	X	X	X	X
Worker Transportation Vehicles[3]					X	X	X	X	X
Spray Vehicles[4]			X	X					
Airplanes	X	X							
Portable Offroad Equipment[5]			X						
Program Alternative									
Mating Disruption[6]									
Twist Ties (MD-1)								X	
Ground Application (MD-2)				X		X	X		
Aerial Application (MD-3)	X								
Male Moth Attractant (MMA)				X					
Organic Approved Insecticides (Btk and S)[6]			X		X				
Sterile Insect Technique (SIT)		X							
Innundative Parasitic Wasp Release (Bio-P)									X

Notes:

1. Worker commute vehicles include workers travelling to/from home to a specific location, such as an airport or congregation point for worker transport vehicles.
2. Vendor delivery vehicles include transportation of materials/supplies (such as treatment compound, parasitic wasps, sterile insects, etc.) to job sites.
3. Worker transportation vehicle include transportation of ground-based crews from central congregation points to job sites.
4. Spray vehicles include transportation of vehicle-based crews from central congregation points to job sites as well as vehicle usage for treatment application.
5. Portable offroad equipment includes vehicle-mounted pump engines.
6. For the Program treatment alternative that include both vehicle and ground application methods (MD-2 and Btk and S), typically only one will be used in an area.

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SECTION G2

State of Science

This section of the report summarizes the scientific issues surrounding climate change and global warming. It also provides a discussion of what types of things contribute to climate change and puts into context global, national, and state emissions of GHGs.

G2.1 GLOBAL CLIMATE CHANGE

Global warming and global climate change are both terms that describe changes in the earth's climate. *Global climate change* is a broader term used to describe any worldwide, long-term change in the earth's climate. This change could be, for example, an increase or decrease in temperatures, the start or end of an ice age, or a shift in precipitation patterns. The term *global warming* is more specific than global climate change and refers to a general increase in temperatures across the earth. Though global warming is characterized by rising temperatures, it can cause other climatic changes, such as a shift in the frequency and intensity of rainfall or hurricanes. Global warming does not necessarily imply that all locations will be warmer. Some specific, unique locations may be cooler even though the world, on average, is warmer. All of these changes fit under the umbrella of global climate change.

While global warming can be caused by natural processes, general scientific consensus concurs that most current global warming is the result of human activity on the planet (IPCC 2007a). This human-made, or anthropogenic, warming is primarily caused by increased GHG emissions that keep the earth's surface warm, known as "the greenhouse effect." The greenhouse effect and the role GHGs play in it are described below.

G2.2 THE GREENHOUSE EFFECT

Greenhouses allow sunlight to enter and then capture some of the heat generated by the sunlight's impact on the earth's surface. The earth's atmosphere acts like a greenhouse by allowing sunlight in, and trapping some of the heat that reaches the earth's surface. When solar radiation from the sun reaches the earth, much of it penetrates the atmosphere to ultimately reach the earth's surface; this solar radiation is absorbed by the earth's surface and then re-emitted as heat in the form of infrared radiation.[2] Whereas the GHGs in the atmosphere let solar radiation through, the infrared radiation is trapped by greenhouses gases, resulting in the warming of the earth's surface.[3]

The earth's greenhouse effect has existed far longer than humans have and has played a key role in the development of life. Concentrations of major GHGs, such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and water vapor (H_2O) have been naturally present for millennia at relatively stable levels in the atmosphere, adequate to keep temperatures on Earth hospitable. Without these GHGs, the earth's temperature would be too cold for life to exist.

As human industrial activity has increased, atmospheric concentrations of certain GHGs have grown dramatically. Figure G-1 shows the increase in concentrations of CO_2 and CH_4 over time. In the absence of major industrial human activity, natural processes have maintained atmospheric concentrations of GHGs, and,

[2] All light, be it visible, ultraviolet, or infrared, carries energy.
[3] Infrared radiation is characterized by longer wavelengths than solar radiation. GHGs reflect radiation with longer wavelengths. As a result, instead of escaping back into space, GHGs reflect much infrared radiation (i.e., heat) back to earth.

therefore, global temperatures at constant levels over the last several centuries.[4] As the concentrations of GHGs increase, more infrared radiation is trapped, and the earth is heated to higher temperatures. This process is described as human-induced global warming.

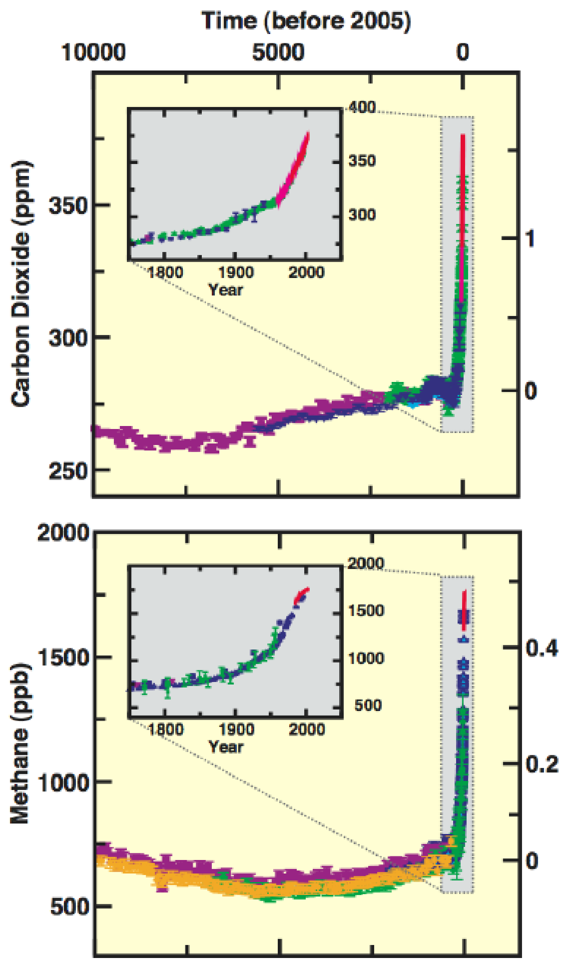

Figure G-1 Carbon Dioxide and Methane Concentrations Have Increased Dramatically Since the Industrial Revolution (IPCC 2007a)

In 2007, the Intergovernmental Panel on Climate Change (IPCC)[5] began releasing components of its Fourth Assessment Report on Climate Change. In February 2007, the IPCC provided a comprehensive assessment of climate change science in its Working Group I Report (IPCC 2007a). It stated that a scientific consensus concurs that the global increases in GHGs since 1750 are mainly due to human activities such as fossil fuel use, land use change (e.g., deforestation), and agriculture. In addition, the report stated that it is likely that these changes in GHG concentrations have contributed to global warming. Confidence levels of claims in this report have increased since 2001 due to the large number of simulations run and the broad range of available climate models.

4 Examples of natural processes include the addition of GHGs to the atmosphere from respiration, fires, and decomposition of organic matter. The removal of GHGs is mainly from plant and algae growth and absorption by the ocean.

5 The World Meteorological Organization and the United Nations Environment Programme established the Intergovernmental Panel on Climate Change (IPCC) in 1988; it is open to all members of the United Nations and World Meteorological Organization.

G2.3 GREENHOUSE GASES AND THEIR EMISSIONS

The term “greenhouse gases” includes gases that contribute to the natural greenhouse effect, such as CO_2, CH_4 and N_2O, and H_2O, as well as gases that are only man-made and that are emitted through the use of modern industrial products, such as hydrofluorocarbons (HFCs), chlorinated fluorocarbons (CFCs), and sulfur hexafluoride. These last two families of gases, while not naturally present, have properties that also cause them to trap infrared radiation when they are present in the atmosphere, thus making them GHGs. These six gases comprise the major GHGs that are recognized by the Kyoto Accords.[6] Other GHGs are not recognized by the Kyoto Accords, due, chiefly to the smaller role that they play in climate change or the uncertainties surrounding their effects. One GHG not recognized by the Kyoto Accords is atmospheric H_2O concentrations because an obvious correlation does not exist between H_2O and specific human activities. H_2O appears to act in a feedback manner; higher temperatures lead to higher H_2O concentrations, which in turn cause more global warming (IPCC 2003).

The effect each of these gases has on global warming is a combination of the volume of their emissions and their global warming potential (GWP). GWP indicates, on a pound for pound basis, how much a gas will contribute to global warming relative to how much warming would be caused by the same mass of CO_2. CH_4 and N_2O are substantially more potent than CO_2, with GWPs of 21 and 310, respectively. However, these natural GHGs are nowhere near as potent as sulfur hexafluoride and fluoromethane, which have GWPs of up to 23,900 and 6,500 respectively (California Climate Action Registry 2008). GHG emissions are typically measured in terms of mass of carbon dioxide equivalents (CO_2e). CO_2e are calculated as the product of the mass of a given GHG and its specific GWP.

The most important GHG in human-induced global warming is CO_2. While many gases have much higher GWPs than the naturally occurring GHGs, CO_2 is emitted in such vastly higher quantities that it accounts for 85 percent of the GWP of all GHGs emitted by the United States (USEPA 2006). Fossil fuel combustion, especially for the generation of electricity and powering of motor vehicles, has led to substantial increases in CO_2 emissions and thus substantial increases in atmospheric CO_2 concentrations. In 2005, atmospheric CO_2 concentrations were about 379 parts per million (ppm), over 35 percent higher than the pre-industrial concentrations of about 280 ppm (IPCC 2007a). In addition to the sheer increase in the volume of its emissions, CO_2 is a major factor in human-induced global warming because of its long lifespan in the atmosphere of 50 to 200 years.

The second most prominent GHG, CH_4, has also increased due to human activities such as rice production, degradation of waste in landfills, cattle farming and natural gas mining. In 2005, atmospheric levels of CH_4 were more than double pre-industrial levels, up to 1774 parts per billion (ppb) as compared to 715 ppb (IPCC 2007a). CH_4 has a relatively short atmospheric lifespan of only 12 years, but has a higher GWP than CO_2.

N_2O concentrations have increased from about 270 ppb in pre-industrial times to about 319 ppb by 2005 (IPCC 2007a). Most of this increase can be attributed to agricultural practices (such as soil and manure management), as well as fossil-fuel combustion and the production of some acids. N_2O’s 120-year atmospheric lifespan increases its role in global warming.

Besides CO_2, CH_4, and N_2O, several gases and categories of gases were not present in the atmosphere in pre-industrial times but now exist and contribute to warming. They include CFCs, used often as refrigerants, and their more stratospheric-ozone-friendly replacements, HFCs. Fully fluorinated species, such as sulfur hexafluoride and tetrafluoromethane, are present in the atmosphere in relatively small concentrations, but have extremely long lifespans of 50,000 and 3,200 years each, making them potent GHGs.

[6] This Kyoto Accord sets legally binding targets and timetables for cutting the GHG emissions of industrialized countries. The U.S. has not ratified the Kyoto treaty.

G2.4 THE EFFECTS OF GLOBAL WARMING

Scientific consensus concurs that global climate change will increase the frequency of heat extremes, heat waves, and heavy precipitation events. Currently accepted models predict that continued GHG emissions at or above current rates will induce more extreme climate changes during the 21st century than were observed during the 20th century. A warming of about 0.2°C per decade is projected. Even if the concentrations of all GHGs and aerosols are kept constant at year 2000 levels, a further warming of about 0.1°C per decade would be expected. A faster temperature increase will lead to more dramatic, and more unpredictable, localized climate extremes. Other likely direct effects of global warming include an increase in the areas affected by drought, an increase in tropical cyclone activity and higher sea level, as well as the continued recession of polar ice caps. Already some identifiable signs exist that global warming is taking place. In addition to substantial ice loss in the Arctic, the top seven warmest years since the 1890s have been after 1997 (IPCC 2007a, 2007b). Figure G-2 shows the rise of global temperatures, the global rise of sea level, and the loss of snow cover from 1850 to the present.

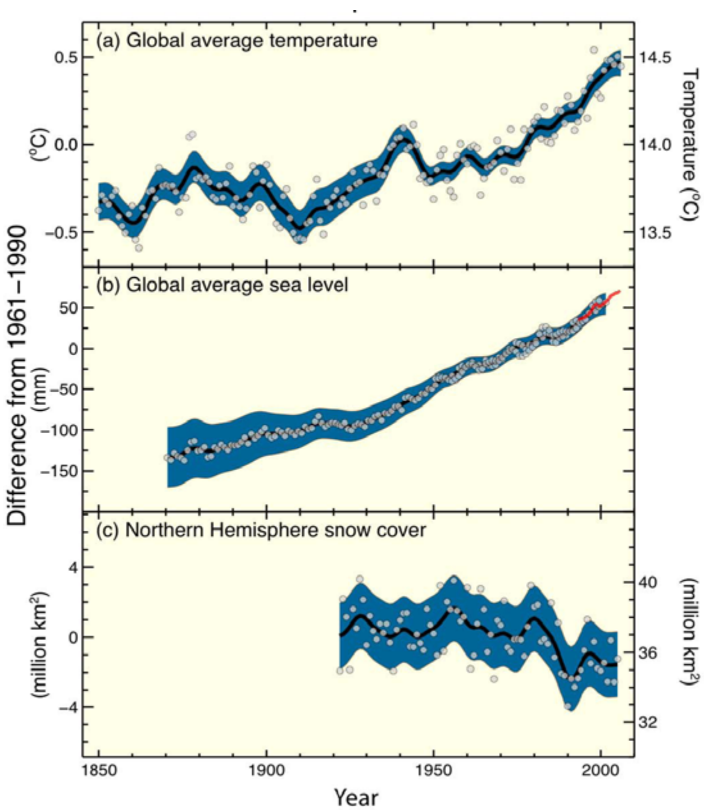

Figure G-2 Global Warming Trends and Associated Sea-Level Rise and Snow Cover Decrease (IPCC 2007a)

In April 2007, the IPCC provided an assessment of the "current scientific understanding of impacts of climate change on natural, managed and human systems, the capacity of these systems to adapt and their vulnerability" in its Working Group II Report (IPCC 2007b). Here, the IPCC states that although some people will gain and some will lose because of global climate change, the overall change will be of social and economic losses. These negative effects will likely be disproportionately shouldered by the poor who do not have the resources to adapt to a change in climate. Some of the main ecosystem changes anticipated are that biodiversity of terrestrial and freshwater ecosystems could be reduced and that the ranges of infectious diseases will likely increase.

G2.5 CALIFORNIA CLIMATE IMPACTS

Global temperature increases may have a series of significant negative impacts on the health of California residents and the California economy. One result of the higher temperatures caused by global warming may be compromised air quality. Warmer temperatures can cause more ground-level ozone, a pollutant that causes eye irritation and respiratory problems. California relies primarily on snowmelt for its drinking water and much of the water used in irrigation during the summer. Global warming could alter the seasonal pattern of snow accumulation and snowmelt and affect water supplies. Climatic changes would also affect agriculture, a major California industry, which could result in economic losses. For example, the heat wave in July 2006 is estimated to have cost the California dairy industry in excess of one billion dollars (California Office of the Governor 2006).

G2.6 GLOBAL, NATIONAL, AND CALIFORNIA-WIDE GHG EMISSIONS INVENTORIES

Worldwide emissions of GHGs in 2004 were over 20 billion metric tons (where one metric ton is equivalent to 1,000 kilograms) of CO_2e per year (United Nations Framework Convention on Climate Change 2004).[7] In 2004, the United States emitted about 7 billion metric tons of CO_2e or about 24 metric tons/year/person (USEPA 2007). Over 80 percent of the GHG emissions in the United States are comprised of CO_2 emissions from energy related fossil fuel combustion. In 2004, California emitted approximately 0.524 billion tons of CO_2e, or about 8 percent of the US emissions. If California were a country, it would be the 16th largest emitter of GHGs in the world (California Energy Commission 2006).[8] This large number is due primarily to the sheer size of California. Compared to other states, California has one of the lowest per capita GHG emission rates in the country. This low rate is due to California's higher energy efficiency standards, its temperate climate, and the fact that it relies on substantial out-of-state energy generation.

In 2004, 81 percent of GHG emissions (in CO_2e) from California were comprised of CO_2 emissions from fossil fuel combustion. CH_4 and N_2O accounted for 5.7 and 6.8 percent of total CO_2e respectively, and high GWP gases[9] accounted for 2.9 percent of the CO_2e emissions. Transportation is by far the largest end-use category of GHGs. Transportation includes that used for industry (i.e., shipping) as well as residential use (USEPA 2006).

G2.7 POTENTIAL FOR MITIGATION

In May 2007, the IPCC produced its Working Group III Report on the "scientific, technological, environmental, economic and social aspects" of mitigating climate change (IPCC 2007c). The report concluded that, with current climate mitigation and sustainable development practices and policies left unchanged, global GHG emissions will continue to grow over the next several decades. The amount of mitigation that will be economically achievable in the future will be tied to carbon prices. A summary of both bottom-up and top-down studies indicates that the global economic potential to mitigate GHGs by 2030 will range from 5 to 7 metric gigatons (Gt) CO_2e per year (bottom-up estimate) if no carbon price exists, 9 to 18 metric Gt CO_2e per year (top-down estimate) if the carbon price is set at $20 per metric ton CO_2e, or 17 to 26 metric Gt CO_2e per year (top-down estimate) if the carbon price is set at $100 per metric ton CO_2e. The effects of significant GHG mitigation on global economic productivity could have a positive or negative effect. To stabilize atmospheric concentrations of GHGs in the range of 445 to 710 ppm CO_2e by 2050, the associated macroeconomic costs of multigas mitigation are estimated to be between a 1 percent gain in global gross domestic product and a 5.5 percent fall in global gross domestic product. If a lower GHG stabilization concentration is desired in the long term, mitigation activities in the next 2 to 3 decades will be the most crucial.

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7 Annex I countries without counting Land-Use, Land-Use Change and Forestry.
8 Anywhere between the 12th and 16th depending upon methodology.
9 Such as HFCs and CFCs.

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SECTION G3

Regulatory Setting

Climate change is now widely recognized as a threat to the global climate, economy, and population. As a result, the climate change regulatory setting – federal, state, and local – is complex and evolving. This section identifies key legislation, executive orders, and seminal court cases related to climate change germane to the Program GHG emissions. Regulations relating to GHG emissions and fuel combustion are the focus of this section, as regulations pertaining to energy conservation and land use are not relevant to this Program.

G3.1 FEDERAL ACTION ON GREENHOUSE GAS EMISSIONS

In 2002, former President George W. Bush set a national policy goal of reducing the GHG emission intensity (tons of GHG emissions per million dollars of gross domestic product) of the U.S. economy by 18 percent by 2012. No binding reductions were associated with the goal. Rather, the U.S. Environmental Protection Agency (USEPA) administers a variety of voluntary programs and partnerships with GHG emitters in which the USEPA partners with industries producing and utilizing synthetic GHGs to reduce emissions of these particularly potent GHGs. Since taking office, the Obama administration has announced its intent to implement a cap-and-trade system to reduce GHG emissions 80 percent by 2050 (White House 2009); however, no cap-and-trade legislation has been passed at this time.

G3.1.1 April 2007 Supreme Court Ruling

In *Massachusetts et al. vs. Environmental Protection Agency et al.* (April 2, 2007) the U.S. Supreme Court ruled that the Clean Air Act authorizes the USEPA to regulate CO_2 emissions from new motor vehicles. The Court did not mandate that the USEPA enact regulations to reduce GHG emissions, but found that the only instances where the USEPA could avoid taking action were if it found that GHGs do not contribute to climate change or if it offered a “reasonable explanation” for not determining that GHGs contribute to climate change. On July 11, 2008, the USEPA released an Advanced Notice of Proposed Rulemaking inviting comments on options and questions regarding regulation of GHGs under the Clean Air Act. This notice announced a 120-day public comment period that concluded on November 28, 2008.

G3.1.2 USEPA Proposed “Endangerment Finding”

On April 17th, 2009, the USEPA issued a proposed determination that GHGs contribute to air pollution to the extent that may endanger public health or welfare. The 60-day public comment period on the finding ends June 23, 2009, after which, the USEPA will issue its final determination. An “endangerment finding” does not of-itself trigger USEPA regulation of GHGs; rather, it would enable the USEPA to regulate GHGs under the Clean Air Act. There is current debate as to whether climate change should be regulated by the USEPA under the Clean Air Act or by legislation. The Obama administration has indicated its preference for comprehensive legislation to address climate change.

G3.1.3 Corporate Average Fuel Efficiency Standards

The Obama administration announced on May 19, 2009 a new national policy that would increase the fuel economy and reduce the GHG emissions from cars and trucks in the U.S. The proposed standards would require new cars to achieve an average emissions standard of 250 gram/mile CO_2 by 2016, with interim standards for models sold between 2012 and 2016.[10] The new corporate standards will be issued through collaboration between the U.S. EPA and the Department of Transportation (DOT). This policy addresses California's request to set its own GHG regulations. In effect, the nation will adopt California's fuel economy standards by 2016. The new policy would exceed previous Corporate Average Fuel Economy (CAFE) established by the Energy Independence and Security Act of 2007 (EISA), which required an average fuel economy of 35 mpg by model year 2020.

G3.1.4 Energy Independence and Security Act of 2007

In addition to setting increased CAFE standards for motor vehicles, the EISA includes other provisions:

- Renewable Fuel Standard (Section 202)
- Appliance and Lighting Efficiency Standards (Section 301–325)
- Building Energy Efficiency (Sections 411–441)

Additional provisions of the EISA address energy savings in government and public institutions, promoting research for alternative energy, additional research in carbon capture, international energy programs, and the creation of "green jobs."

G3.1.5 Reporting Requirements

On March 10, 2009, USEPA signed a proposed rule that would require mandating GHG reporting "for all sectors of the economy." The proposal was signed in response to a requirement in the 2008 Consolidated Appropriations Act, enacted in December 2007, that USEPA use its authority under the Clean Air Act to establish a mandatory GHG reporting system by June 26, 2009. Industries targeted by the USEPA's proposed rule generally include: 1) facilities operating stationary combustion equipment units, 2) all phases of fossil fuel procurement and processing, 3) manufacturers and processors of iron, steel, aluminum, pulp and paper, chemicals, and industrial gases, 4) manufacturers of mobile sources, and 5) agriculture and waste management, including landfills, wastewater treatment, ethanol production, manure management, and food processing. Depending on the industry, the obligation to report may be triggered at different thresholds. In general, reporting is not necessary unless a facility or entity emits greater than or equal to 25,000 ton CO_2e. For 19 source categories, consisting mostly of large manufacturing operations like petroleum refineries, chemical manufactures, and cement production, reporting is required regardless of whether the 25,000 CO_2e threshold is met. Facilities with stationary combustion units would not have to report unless the aggregate maximum rated heat input capacity of the stationary combustion units is greater than or equal to 30 million British thermal units per hour.

The 60-day public comment period ended on June 9, 2009. Although the 2008 Consolidated Appropriations Act imposes a deadline of June 26, 2009, the USEPA will not be able to complete rulemaking by that date and anticipates finalizing by the end of 2009.

[10] If the automotive industry were to achieve this standard purely through fuel economy, this would be equivalent to 35.5 miles per gallon. However, it is expected that companies will achieve this emissions standard with GHG savings from air conditioning improvements as well. Thus, expected fuel economy is expected to be somewhat below 35.5 miles per gallon.

G3.2 REGIONAL AGREEMENTS

G3.2.1 Western Regional Climate Action Initiative

The Western Regional Climate Action Initiative is a partnership among seven states, including California, and four Canadian provinces, that is implementing a regional, economy-wide cap-and-trade system to reduce global warming pollution. This initiative will cap the region's electricity, industrial, and transportation sectors with the goal of reducing the heat-trapping emissions that cause global warming 15 percent below 2005 levels by 2020. California is working closely with the other states and provinces to design a regional GHG reduction program that includes a cap-and-trade approach. As mentioned in its Assembly Bill (AB 32) Scoping Plan, the California Air Resources Board (CARB) plans to develop a cap-and-trade program that will link California and the other member states and provinces.

G3.3 CALIFORNIA LEGISLATION

California has enacted a variety of legislation that relates to climate change, much of which sets aggressive goals for GHG reductions within the state. However, none of this legislation provides definitive direction regarding the treatment of climate change in environmental review documents. As discussed below, the Office of Planning and Research (OPR) has been directed to develop guidelines for the mitigation of GHG emissions and their effects; CARB must adopt regulations by January 1, 2010. OPR recently released a guidance document, discussed below, for treatment of GHG under the California Environmental Quality Act (CEQA), but this document is purely advisory and serves as guidance only. In addition, on October 24, 2008, CARB released a draft staff proposal entitled "Recommended Approaches for Setting Interim Significance Thresholds for Greenhouse Gases under the California Environmental Quality Act" (Draft CARB Thresholds). A draft framework document, revised based on comments received, was expected in mid-February, 2009, but has not yet been produced. The Draft CARB Thresholds provide a framework for developing CEQA significance thresholds for industrial, commercial, and residential projects. But as of the release date of this document, many details remain unresolved and the CARB Thresholds document is still in draft form.

No local, state, or regional agency has promulgated binding regulations for the treatment of GHG analysis or mitigation in CEQA documents. However, some air districts are developing guidance on the analysis of GHGs for CEQA, including South Coast Air Quality Management District, Bay Area Air Quality Management District, Sacramento Metro Air Quality Management District, and San Joaquin Valley Air Pollution Control District. The discussion below provides a brief overview of the CARB and OPR documents and of the primary legislation that relates to climate change that may affect the emissions associated with the Proposed Program.

G3.3.1 Assembly Bill 32 (Statewide GHG Reductions)

The California Global Warming Solutions Act of 2006, widely known as AB 32, requires CARB to develop and enforce regulations for the reporting and verification of statewide GHG emissions. CARB is directed to set a GHG emission limit, based on 1990 levels, to be achieved by 2020. The bill sets a timeline for adopting a scoping plan for achieving GHG reductions in a technologically and economically feasible manner.

The heart of the bill is the requirement that statewide GHG emissions must be reduced to 1990 levels by 2020. California needs to reduce GHG emissions by approximately 25 percent below business-as-usual predictions of year 2020 GHG emissions to achieve this goal. The bill requires CARB to adopt rules and regulations in an open public process to achieve the maximum technologically feasible and cost-effective GHG reductions. Key AB 32 milestones are as follows:

- **June 30, 2007.** Identification of discrete early action GHG emissions reduction measures. On June 21, 2007, CARB satisfied this requirement by approving three early action measures. These were later supplemented by adding six other discrete early action measures.
- **January 1, 2008.** Identification of the 1990 baseline GHG emissions level and approval of a statewide limit equivalent to that level. Adoption of reporting and verification requirements concerning GHG emissions; the regulation was finalized in December 2008. On December 6, 2007, CARB approved a statewide limit on GHG emissions levels for the year 2020 consistent with the determined 1990 baseline.
- **January 1, 2009.** Adoption of a scoping plan for achieving GHG emission reductions. CARB adopted the Proposed Scoping Plan at its December 11, 2008, meeting. The Proposed Scoping Plan outlines a suite of measures that the CARB intends to implement to reach its 2020 and 2050 goals. These measures include the cap-and-trade program, energy efficiency, vehicle GHG standards, and water efficiency programs. The final Scoping Plan was approved by the CARB Executive Officer on May 7, 2009.
- **January 1, 2010.** Adoption and enforcement of regulations to implement the “discrete” actions.
- **January 1, 2011.** Adoption of GHG emissions limits and reduction measures by regulation.
- **January 1, 2012.** GHG emissions limits and reduction measures adopted in 2011 become enforceable.

G3.3.2 Executive Order S-3-05 (Statewide GHG Targets)

California Executive Order S-03-05 (June 1, 2005) mandates a reduction of GHG emissions to 2000 levels by 2010, to 1990 levels by 2020, and to 80 percent below 1990 levels by 2050. Although the 2020 target is the core of AB 32, and has effectively been incorporated into AB 32, the 2050 target remains the goal of the Executive Order.

G3.3.3 Low Carbon Fuel Standard (LCFS)

Executive Order S-01-07 (January 18, 2007) requires a 10 percent or greater reduction in the average fuel carbon intensity for transportation fuels in California regulated by ARB. CARB identified the LCFS as a Discrete Early Action item under AB 32, and the draft regulation was released on October 10, 2008. The ARB approved the LCFS on April 23, 2009.

G3.3.4 Assembly Bill 1493 (Mobile Source Reductions)

AB 1493 requires CARB to adopt regulations by January 1, 2005, to reduce GHG emissions from noncommercial passenger vehicles and light-duty trucks of model year 2009 and thereafter. The bill requires the California Climate Action Registry to develop and adopt protocols for the reporting and certification of GHG emissions reductions from mobile sources for use by CARB in granting emission reduction credits. The bill authorizes CARB to grant emission reduction credits for reductions of GHG emissions prior to the date of enforcement of regulations, using model year 2000 as the baseline for reduction.

In 2004, CARB applied to the USEPA for a waiver under the federal Clean Air Act to authorize implementation of these regulations. The waiver request was formally denied by the USEPA in December 2007 after California filed suit to prompt federal action. In January 2008 the State Attorney General filed a new lawsuit against the USEPA for denying California’s request for a waiver to regulate and limit GHG emissions from these automobiles. . In January 26, 2009, President Obama issued a directive to the USEPA to reconsider California’s request for a waiver. While the decision is not yet overturned, the USEPA is expected to approve the waiver to implement AB 1493.

G3.3.5 Senate Bill 375 (Land Use Planning)

Senate Bill (SB) 375 provides for a new planning process to coordinate land use planning and regional transportation plans and funding priorities to help California meet the GHG reduction goals established in AB 32. SB 375 requires regional transportation plans, developed by Metropolitan Planning Organizations, to incorporate a "sustainable communities strategy" in their regional transportation plans that will achieve GHG emission reduction targets set by ARB. SB 375 also includes provisions for streamlined CEQA review for some infill projects such as transit oriented development. SB 375 will be implemented over the next several years.

SB 375 is similar to the Regional Blueprint Planning Program, established by the California Department of Transit, which provides discretionary grants to fund regional transportation and land use plans voluntarily developed by Metropolitan Planning Organizations working in cooperation with Council of Governments.

G3.3.6 Senate Bill 97 (CEQA Guidelines)

SB 97 requires that OPR prepare guidelines to submit to the California Resources Agency regarding feasible mitigation of GHG emissions or the effects of GHG emissions as required by CEQA. The Resources Agency is required to certify and adopt these revisions to the State CEQA Guidelines by January 1, 2010. The Guidelines will apply retroactively to any incomplete environmental impact report, negative declaration, mitigated negative declaration, or other related document. On April 13, 2009, OPR submitted to the Secretary for Natural Resources proposed amendments to the state CEQA Guidelines for greenhouse gas emissions. As currently proposed, these amendments state that the lead agency may consider the following when assessing the significance of impacts from GHG emissions on the environment:

- Extent the project may increase or reduce GHG emissions as compared to the existing environmental setting
- Extent to which the project complies with regulations or requirements adopted to implement a statewide, regional, or local plan for the reduction or mitigation of GHG emissions
- Extent project impacts or emissions exceed any threshold of significance

No specific methodologies for performing an assessment are indicated, but rather it is left to the lead agency to determine the appropriate methodologies in context of a particular project.

The proposed amendments state that lead agencies should consider all feasible means of mitigating greenhouse gas emissions that substantially reduce energy consumption or GHG emissions. These potential mitigation measures may include carbon sequestration and use of off-site measures such as offsets. No threshold of significance or any specific mitigation measures are indicated.

G3.3.7 Office of Planning and Research Advisory on CEQA and Climate Change

In June 2008, the OPR published a technical advisory entitled *CEQA and Climate Change: Addressing Climate Change Through CEQA* (OPR Advisory). This guidance, which is purely advisory, proposes a three-step analysis of GHG emissions:

- **Mandatory Quantification of GHG Project Emissions.** The environmental impact analysis must include quantitative estimates of a project's GHG emissions from different types of air emission sources. These estimates should include both construction-phase emissions, as well as completed operational emissions, using one of a variety of available modeling tools.
- **Continued Uncertainty Regarding "Significance" of Project-Specific GHG Emissions.** Each Environmental Impact Report (EIR) document should assess the significance of the project's impacts on

climate change. The OPR Advisory recognizes uncertainty regarding what GHG impacts should be determined to be significant and encourages agencies to rely on the evolving guidance being developed in this area. According to the OPR Advisory, the environmental analysis should describe a "baseline" of existing (pre-project) environmental conditions, and then add project GHG emissions on to this baseline to evaluate whether impacts are significant.

- **Mitigation Measures.** According to the OPR Advisory, "all feasible" mitigation measures or project alternatives should be adopted if an impact is significant, defining feasibility in relation to scientific, technical, and economic factors. If mitigation measures cannot sufficiently reduce project impacts, the agency should adopt whatever measures are feasible and include a fact-based statement of overriding considerations explaining why additional mitigation is not feasible. OPR also identifies a menu of GHG emissions mitigation measures, ranging from balanced "mixed use" master-planned project designs to construction equipment and material selection criteria and practices.

In addition to this three-step process, the OPR Advisory contains more general policy-level guidance. It encourages agencies to develop standard GHG emissions reduction and mitigation measures. The OPR Advisory directs CARB to recommend a method for setting the GHG emissions threshold of significance, including both qualitative and quantitative options.

G3.3.8 CARB Preliminary Draft Proposal: Recommended Approaches for Setting Interim Significance Thresholds for Greenhouse Gases Under the California Environmental Quality Act (Draft CARB Thresholds)

In October 2008, ARB released a preliminary draft proposal for identifying CEQA thresholds of significance for industrial, commercial, and residential developments. These were updated in December 2008, by the release of draft preliminary guidelines on performance standards. The Draft CARB Thresholds propose a framework for developing thresholds of significance that rely upon the incorporation of a variety of performance measures to reduce GHG emissions associated with a project, as well as a numerical threshold of significance above which a project must include detailed GHG analysis in an EIR and incorporate all feasible mitigation measures. Although CARB proposed a 7,000 metric tons per year threshold for industrial projects, a numerical threshold for commercial and residential projects was not proposed, but is under development. In addition, the Draft CARB Thresholds incorporate SB 375 by providing that commercial and residential projects that comply with a previously approved plan, which, essentially, satisfies SB 375 and for which a certified final CEQA document has been prepared, is presumed to have a less than significant impact related to climate change. There have been no updates in the CARB thresholds since December, and their future development is unclear.

G3.4 LOCAL AIR QUALITY PLANS AND POLICIES

A number of California cities and counties have adopted or are in the process of adopting plans and initiatives to address climate change.[11] These plans typically include GHG emission reduction goals and provide specific implementation measures to achieve such goals. As mentioned above, some air districts are developing guidance on the analysis of GHGs emissions under the context of CEQA. These districts include South Coast Air Quality Management District, Bay Area Air Quality Management District, Sacramento Metro Air Quality Management District, and San Joaquin Valley Air Pollution Control District. Guidance from these air districts are under various stages of development and none has been finalized. Due to the large quantity of such plans, their evolving nature, and the fact that climate change is a regional/global issue rather than a local one, this analysis focuses on available statewide guidelines.

[11] A representative, noncomprehensive list of local government plans has been compiled by the State of California Governor's Office of Planning and Research. This list is available online. Website (http://www.cted.wa.gov/DesktopModules/CTEDPublications/CTEDPublicationsView.aspx?tabID=0&ItemID=6166&MId=944&wversion=Staging) accessed on March 3, 2009.

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SECTION G4

Emission Methodology

GHGs include a wide variety of pollutants that contribute to the greenhouse effect in the atmosphere. GHG emissions can be measured in CO_2e by using the GWP of each pollutant. According to European Environment Agency, the GWP is a metric used to compare emissions among GHGs. Million metric tons of carbon dioxide equivalent ($MMTCO_2$e) for a gas is derived by multiplying the metric tons of the gas by the associated GWP.

$MMTCO_2$e = (million metric tons of a gas) * (GWP of the gas)

For example, according to the IPCC Second Assessment Report in 1996, the GWP for CH_4 is 21 and the GWP for N_2O is 310. These GWPs mean that emissions of 1 million metric tons of CH_4 and N_2O are equivalent to emissions of 21 and 310 million metric tons of CO_2, respectively (European Environment Agency 2009).

GHG pollutants emitted by the Program during the time period of interest include CO_2 (GWP = 1), CH_4 (GWP = 21), N_2O (GWP = 310), and hydrofluorocarbons (HFCs) (GWP = 140 to 11,700) (USEPA 2002). The USEPA recommends assuming the CH_4, N_2O, and HFCs account for 5 percent of GHG emissions from onroad vehicles, taking into account their GWPs (USEPA 2005). Thus for the onroad sources in this assessment, CO_2 emissions from these sources were estimated and these emissions were scaled by 5 percent to account for non-CO_2 GHG emissions (i.e., CH_4, N_2O, and HFCs). For the portable offroad sources and aerial sources, CH_4 and N_2O emissions were estimated in addition to CO_2 emissions. For the remainder of this report, "GHG emissions" refer to the combined emissions of CO_2 and other non-CO_2 GHG gases (i.e., CH_4, N_2O, and HFCs (where applicable)).

Potential GHG emission sources likely to result from Program implementation were identified and are assessed in the remainder of this report. GHG emissions from "business as usual" operations—such as building energy and water consumption for the CDFA and all of its contractors and maintenance activities for equipment associated with the Program—are not included in this assessment, as these are assumed to occur regardless of Program implementation. Life-cycle emissions were not accessed. Because the full life-cycle of GHG emissions are not accounted for in available emissions models, the information needed to characterize the GHG emissions from the manufacture, transport, and end-of-life of the treatment compounds would be speculative at the CEQA analysis level; such analysis is not recommended (California Air Pollution Control Officers Association 2008). Construction activities are not anticipated for this Program, so GHG emissions associated with construction have not been estimated. Similarly, GHG emissions associated with field verification activities such as sampling and trapping were not included. These activities are assumed to have low GHG emissions associated with them and the emissions would be comparable to the emissions from the field activities (especially trapping) that would occur if no treatment alternatives were implemented. Thus, these activities would not represent a significant source of increased GHG emissions.

As indicated in Table G-1, GHG emission sources associated with the Program and assessed in this analysis include:

OFFROAD SOURCES

- Spray pump mounted on hydraulic spray vehicles

ONROAD SOURCES

- Passenger vehicles for workers commuting to and from central congregation points
- Transportation trucks to transport ground-based and vehicle-based crews to and from Program sites
- Trucks used in vehicle-based treatment applications (including the SPLAT spray vehicles and the hydraulic spray trucks)
- Trucks used for vendor delivery of compounds/supplies to Program sites

AERIAL SOURCES

- Airplanes used for spraying of mating disruption pheromones
- Airplanes used for the Sterile Insect Technique Alternative

G4.1 OFFROAD MODEL

The CARB developed the OFFROAD model to estimate the relative contribution of gasoline, diesel, compressed natural gas, and liquefied petroleum gas powered vehicles to the overall emissions inventory of the state (CARB 2009a).

OFFROAD generates emission inventories by equipment type, accounting for equipment age and calendar year. Equipment emissions are calculated using the following equation (CARB 2009b):

Equation 1	**Emissions = EF * Pop * AvgHp * Load * Activity**

Where:

Emissions	=	Annual emissions (tons/year)
EF	=	Emission factor in grams per horsepower-hour (grams/brake horsepower-hour)
Pop	=	Population (i.e., number of pieces of equipment)
AvgHp	=	Maximum rated average horsepower (horsepower)
Load	=	Load factor (percent)
Activity	=	Annual activity in hours per year (hours/year)

Emission factors are calculated using the following equation:

Equation 2	**EF = ZH + dr * CHrs**

Where:

EF	=	Emission factor, in grams per horsepower-hour (grams/brake horsepower-hour)
ZH	=	Zero-hour emission rate, when equipment is new (grams/brake horsepower-hour)
Dr	=	Deterioration rate (grams/brake horsepower-hour^2)
CHrs	=	Cumulative hours or total number of hours accumulated on equipment (hours)

Emission factors from OFFROAD were used to estimate CO_2, CH_4, and N_2O emissions from all gas-powered, portable offroad sources to be used in the Program.

G4.2 ONROAD SOURCES: EMFAC MODEL

The EMission FACtors (EMFAC) model is used to calculate emission rates from motor vehicles, such as passenger cars to heavy-duty trucks, operating on highways, freeways and local roads in California (CARB 2009c). EMFAC allows the user to specify a variety of inputs to best characterize emissions from motor vehicles. For the Program, ENVIRON made the following specifications in the EMFAC interface to estimate emissions of CO_2 from vehicles:

Parameter	User-Input
Geographic Area:	State
Calendar Year:	2010
Model Years:	All
Season or Month:	Annual
Scenario Type:	EMFAC – Area fleet average (grams/mile and grams/trip)
Output Hydrocarbons as:	Reactive organic gases (ROGs)
Temperature:	61 degrees Fahrenheit (statewide annual average for California)[1]
Relative Humidity:	66% (statewide annual average for California)[2]

1. Value obtained from EMFAC2007 and represents statewide annual average.
2. Value obtained from EMFAC2007 and represents statewide annual average.

Speed Intervals and Vehicle Type	Speed	Vehicle Class
Passenger vehicles for workers commuting to/from congregation points	35 mph	50% LDA (passenger cars) 25% LDT1 (light-duty trucks, 0-3,750 lbs GVW) 25% LDT2 (light-duty trucks, 3,751-5,750 lbs GVW)
Transportation trucks to transport ground-based and vehicle-based application crews to Program sites	35 mph	LHDT1 (light-heavy duty trucks, 8,501-10,000 lbs GVW)
Trucks used in vehicle-based treatment applications	5 mph	LHDT2 (light-heavy duty trucks, 10,001-14,000 lbs GVW)
Trucks used for vendor delivery of compound/supplies to Program sites	35 mph	MHDT (medium-heavy duty trucks, 14,001-33,000 lbs GVW)

GVW = Gross Vehicle Weight

The EMFAC model was run for calendar year 2010, the first full year in which Program alternatives may be implemented. Although Program alternatives will likely extend beyond 2010, future years will reflect improvements in fuel efficiency that will yield less conservative emissions estimates, so only the most conservative 2010 calendar year was used. The following emission types are used to determine GHG emissions from the Program: running exhaust and starting exhaust.

EMFAC can also calculate idle-exhaust emissions; however, negligible idling was assumed to be associated with this Program. SPLAT spray vehicles were assumed to travel continuously during spraying, so no idling would be required. Similarly, hydraulic spray vehicles as well as transport vehicles associated with the ground-based application crews (using hydraulic backpacks, caulk guns, pod guns, twist ties, and index cards) were assumed to travel to six to ten properties per day, but the ignition of these vehicles would be turned off while treatment is occurring, thus contributing negligible idling emissions.

An emission inventory can be summarized as the product of an emission rate (e.g., grams of pollutant emitted over a mile) and vehicle activity (e.g., miles driven per day). Based on the user inputs into EMFAC as well as roundtrip distance traveled by each vehicle and number of vehicle trips per day for each vehicle category, one can estimate total annual CO_2 emissions for the onroad fleet associated with the Program.

G4.3 AERIAL SOURCES: IPCC EMISSION FACTORS

The IPCC released its *Guidelines for National Greenhouse Gas Inventories* in 2006. Among other data, the IPCC guidance provides emission factors for various activities, including mobile sources and more specifically, civil aviation. IPCC Tier I CO_2 emission factors for civil aviation are based on fuel type and carbon content. Program airplanes were conservatively assumed to use jet kerosene, as the CO_2 emission factor for jet kerosene (71,500 kilograms/terajoule) is higher than the CO_2 emission for aviation gasoline (69,300 kilograms/terajoule). Although literature suggests that little or no N_2O or CH_4 emissions occur from modern gas turbines (IPCC 1999), IPCC has developed Tier I emission factors for these pollutants. Emission factors for CH_4 and N_2O are developed based on the assumption that emissions will be approximately constant based on fuel consumption across all aircraft types. An uncontrolled N_2O emission factor of 2 kilograms/terajoule and an uncontrolled CH_4 emission factor of 0.5 kilogram/terajoule would be used, based on IPCC Tier I guidelines.

SECTION G5

Greenhouse Gas Emissions

Annual GHG emissions were estimated for each Program alternative. A summary of the annual GHG emissions for each Program alternative, broken down by emissions source, is shown in **Table G-2**.

Table G-2 Summary of Greenhouse Gas Emissions

Program Treatment Alternative		Offroad Equipment	Onroad Vehicles	Airplanes	Total GHG Emissions[1]	Total GHG Emissions[2]
		[metric ton CO_2e/year]				[metric ton CO_2e/ day]
Mating Disruption[3]		--	--	--	--	--
Ground-based Application (Caulk Gun / Pod Gun)	MD-2		320		**320**	**1.0**
Ground-based Application (Twist-Ties)	MD-1		367		**367**	**1.2**
Vehicle-based Application	MD-2		653		**653**	**2.1**
Aerial Application	MD-3		100	6,117	**6,217**	**20**
Male Moth Attractant	MMA		653		**653**	**2.1**
Organic-Approved Insecticides		--	--	--	--	--
Ground-based Application	Btk and S		320		**320**	**1.0**
Vehicle-based Application	Btk and S	43	320		**363**	**1.2**
Inundative Parasitic Wasp Release	Bio-P		367		**367**	**1.2**
Sterile Insect Technique	SIT		100	6,117	**6,217**	**20**

Notes:
1. Total GHG emissions calculated as the sum of GHG emissions from offroad equipment, onroad vehicles, and airplanes.
2. Total GHG emissions per day is calculated by dividing the total GHG emissions (per year) by the number of days of treatment per year.
3. Aerial application for mating disruption may be conducted in conjunction with either ground-based application or vehicle-based application methods.

Where ever possible, information and data provided by the CDFA, its contractors, and others responsible for implementing the Program alternatives were utilized. This information is noted in both the report and accompanying calculations in Attachments G-1, G-2, and G-3. However, some of the information used in the GHG emission estimates is based on estimates and engineering judgment. The most appropriate estimates possible were made and an emphasis was made to be conservative (i.e., to overestimate emissions) whenever possible. This section provides additional details on some of these estimates.

G5.1 OFFROAD EQUIPMENT EMISSIONS

The Program is expected to have emissions from gas-powered, portable offroad equipment, including spray pumps mounted on hydraulic spray vehicles. Table G-3 details the GHG emissions breakdown for the equipment used in the Program. As indicated in Table G-3, only Alternatives Btk and S have emissions from offroad equipment.

Table G-3 Summary of Offroad Equipment Greenhouse Gas Emissions

Program Treatment Alternative	Application Method	Equipment	LBAM CO_2e Emissions [metric ton/ year]	LBAM CO_2e Emissions [metric ton/ day]
Organic-Approved Insecticides (Btk and S)	Vehicle Based - Hydraulic Spraying	Vehicle Mounted Pump Engine	43	0.1

Using the OFFROAD model, emission factors are generally based on the following pieces of information:

- Equipment Category
- Model Year
- Horsepower

For spray pumps mounted on hydraulic spray vehicles, emissions estimated assuming each pump is 10 horsepower and that the closest OFFROAD representation for this pump is a four-stoke gasoline powered commercial pump (ASC 2265006010). The horsepower was provided by CDFA. In addition, emissions were estimated assuming a load of 25 percent, as specified by CDFA (Rains and Schnabel 2009).

The OFFROAD model was employed to estimate emissions of CO_2, CH_4, and N_2O, according to Equation (3):

Equation 3	$$\mathbf{EM_{pollutant} = EF_{pollutant} * ER_{HP} * LF * AT * C}$$

Where:

$EM_{pollutant}$ = Emissions of pollutant (metric tons/day)

$EF_{pollutant}$ = OFFROAD emission factor (grams/brake horsepower-hour)

ER_{HP} = Engine-rated horsepower (brake horsepower)

LF = Engine load factor (percent)

AT = Operating time (hours/day)

C = Conversion (metric tons/gram)

Since OFFROAD incorporates default assumptions about horsepower, engine load, operating time, and equipment population, the output of the model was scaled to account for Program-specific information, according to Equation (4):

Equation 4	$$\mathbf{EM_{project} = EM_{pollutant} * [hp_{project}/hp_{default}] * [Activity_{project}/Activity_{default}] * [Pop_{project}/Pop_{default}] * [Load_{project}/Load_{default}] * C}$$

Where:

$EM_{project}$ = Project-specific emission rate (metric tons/day)

$EM_{pollutant}$ = Default emission rate calculated by OFFROAD (tons/day)

$hp_{project}$ = Horsepower required for LBAM project (horsepower)

$hp_{default}$ = Default horsepower assumed by OFFROAD (horsepower)

$Activity_{project}$ = Activity required for LBAM project (hour/day)

$Activity_{default}$ = Default activity assumed by OFFROAD (hour/day)

$Pop_{project}$ = Population required for LBAM project (pieces/day)

$Pop_{default}$ = Default population assumed by OFFROAD (pieces/day)

$Load_{project}$ = Engine load factor required for LBAM project (percent)

$Load_{default}$ = Default engine load factor assumed by OFFROAD (percent)

C = Conversion (metric tons/tons)

Emissions were summed across all pieces of equipment assuming 52 weeks per year 6 days per week (Schnabel 2009) to determine the annual GHG emissions for offroad equipment. Finally, CO_2 equivalent emissions were estimated by multiplying the emissions from each GHG gas by its respective GWP. Details for these calculations are provided in Attachment G-1.

G5.2 ONROAD SOURCES EMISSIONS

The Program has onroad source emissions from:

- Passenger vehicles for workers commuting to and from congregation points
- Transportation trucks to transport ground-based and vehicle-based application crews to and from Program sites
- Trucks used in vehicle-based treatment applications (including the SPLAT spray vehicles and the hydraulic spray trucks)
- Trucks used for vendor delivery of compound/supplies to Program sites

The EMission FACtors (EMFAC) model was used to determine CO_2 emission factors from onroad fleet vehicles for a calendar year (these estimates use 2010, see the discussion in Section 4.2). EMFAC was run for all model years, as discussed in Section 4.2. Emission factors from EMFAC output files are given either in grams/mile or grams/trip, depending on the emission type.[12] Equations (5) and (6) detail calculations with emission factors given in gram/mile and grams/trip, respectively.

Equation 5	$EM_P = EM_{gm} / 453.592 * RT * VT * AD * C / 2000$

Where:

EM_P = Emissions of pollutant (metric tons/year)

EM_{gm} = Emission factor of pollutant (grams/mile)

RT = Roundtrip distance (miles)

VT = Number of vehicle trips per day (trips/day)

AD = Number of days per year of treatment (days/year)

C = Conversion (metric tons/tons)

[12] EMFAC also provides emission factors for idling emissions in units of grams/idle-hr. However, idling associated with the Program was assumed to be negligible, so idling emissions were not estimated.

Equation 6	$EM_P = EM_{gt} / 453.592 * ST * VT * AD * C / 2000$

Where:

EM_P	=	Emissions of pollutant (metric tons/year)
EM_{gt}	=	Emission factor of pollutant (grams/trip)
ST	=	Starts per trip (start/trip)
VT	=	Number of vehicle trips per day (trips/day)
AD	=	Number of days per year of treatment (days/year)
C	=	Conversion (metric tons/tons)

Default values provided by the URBan EMISsions model (URBEMIS) were used to estimate trip distances and vehicle speeds for all four types of onroad sources. URBEMIS draws upon compiled trip data taken from within California to provide default values when Program-specific data are unavailable. For worker commute, transportation trucks, and vehicle-based application trucks travelling from the central congregation points to the Program sites, trip length (33.6 miles round-trip) and vehicle speed (35 mph) is based on the URBEMIS default values for a home-based work trip; the more conservative rural trip length was used as this value was larger than the urban trip length. For vendor deliveries, trip length (14.6 miles round-trip), and vehicle speed (35 mph) are based on the URBEMIS default value for a commercial-based customer trip; the more conservative urban trip length was used as this value was larger than the rural trip length.

URBEMIS default values were not used to estimate trip length and vehicle speed for the trucks used in vehicle-based treatment applications once the trucks have reached the Program site. Instead, distances traveled by the hydraulic spray trucks and the ground application crew trucks (0.3 mile round-trip) and SPLAT vehicles (60 miles round-trip) during a day of application were estimated using the vehicle-based application coverage rates (640 acres/day per crew for SPLAT vehicle-spraying, and 3 acres/day per crew for yard-based spraying (including hydraulic)), provided by the CDFA (Schnabel 2009), and a typical urban block size (400 feet by 320 feet) assumed to be traveled by the vehicles. The vehicles were assumed to travel at a much slower rate to accommodate the application of the compounds.

With the exception of hydraulic spray vehicles and transport vehicles associated with the ground-based application crews (using hydraulic backpacks, caulk guns, pod guns, twist ties, and index cards), all vehicles are assumed to have two starts per round-trip. Based on the assumption that hydraulic spray vehicles and vehicles used to transport ground-based application crews travel to approximately 6 to 10 properties per day, these vehicles were assumed to start approximately 10 times per round-trip. The startup emission factor depends on the settling period before driving, with longer settling periods generally resulting in higher emissions due to cold starting of the engine. Worker commute vehicles and worker transportation vehicles were assumed to remain idle 10 hours between starts, hydraulic spray vehicles and transport vehicles associated with the ground-based application crews were assumed to remain idle 50 minutes between starts (10 starts evenly spread out across an 8 hour workday), and vendor delivery vehicles were assumed to remain idle 4 hours between starts (2 starts evenly spread out across an 8 hour workday).

USEPA recommends assuming that CH_4, N_2O, and hydroflorocarbons account for 5 percent of GHG emissions from onroad vehicles, taking into account their GWPs (USEPA 2005). Thus, to estimate GHG emissions from onroad sources, CO_2 emissions were divided by 0.95 to obtain total GHG emissions (CO_2e) from onroad sources. Table G-4 presents the GHG emissions for the onroad sources used in the Program. Details for these calculations are provided in Attachment G-2.

Table G-4 Summary of Onroad Fleet Greenhouse Gas Emissions

Program Treatment Alternative	Emission Source	Application Method	Total CO_2e Emissions[1] [metric ton/ year]	[metric ton/day]
Mating Disruption	Worker Commute Vehicles	Aerial - Spray	95	0.3
		Vehicle - SPLAT	95	0.3
		Ground - Caulk Gun / Pod Gun	238	0.8
		Ground - Twist-Ties	286	0.9
	Worker Transport Vehicles - Transportation	Ground - Caulk Gun / Pod Gun / Twist-Ties	69	0.2
	Worker Transport Vehicles - Application		5	0.02
	Spray Vehicles - Spray	Vehicle - SPLAT	484	1.6
	Spray Vehicles - Transportation		67	0.2
	Vendor Delivery Vehicles	Aerial - Spray	4	0.01
		Vehicle - SPLAT	7	0.02
		Ground - Caulk Gun / Pod Gun / Twist-Ties	7	0.02
Total (assuming ground-based application [caulk gun / pod gun])			320	1.0
Total (assuming ground-based application [twist-ties])			367	1.2
Total (assuming vehicle-based application)			653	2.1
Total (assuming aerial-based application)			100	0.3
Male Moth Attractant	Worker Commute Vehicles	Vehicle - SPLAT	95	0.3
	Spray Vehicles - Spray	Vehicle - SPLAT	484	1.6
	Spray Vehicles - Transportation		67	0.2
	Vendor Delivery Vehicles	Vehicle - SPLAT	7	0.02
Total			653	2.1
Organic-Approved Insecticides	Worker Commute Vehicles	Vehicle - Hydraulic	238	0.8
		Ground - Hydraulic Backpack	238	0.8
	Worker Transport Vehicles - Transportation	Ground - Hydraulic Backpack	69	0.2
	Worker Transport Vehicles - Application	Ground - Hydraulic Backpack	5	0.02
	Spray Vehicles - Spray	Vehicle - Hydraulic	4	0.01
	Spray Vehicles - Transportation		70	0.2
	Vendor Delivery Vehicles	Vehicle - Hydraulic	7	0.02
		Ground - Hydraulic Backpack	7	0.02
Total (assuming ground-based application)			320	1.0
Total (assuming vehicle-based application)			320	1.0

Program Alternative	Emission Source	Application Method	Total CO_2e Emissions[1] [metric ton/year]	Total CO_2e Emissions[1] [metric ton/day]
				[redacted]
Inundative Parasitic Wasp Release	Worker Commute Vehicles	Ground - Index Cards	286	0.9
	Worker Transport Vehicles - Transportation	Ground - Index Cards	69	0.2
	Worker Transport Vehicles - Application		5	0.02
	Vendor Delivery Vehicles	Ground - Index Cards	7	0.02
Total			367	1.2
				[redacted]
Sterile Insect Technique	Worker Commute Vehicles	Aerial - Populated Release	95	0.3
	Vendor Delivery Vehicles	Aerial - Populated Release	4	0.01
Total			100	0.3

Notes:
1. CO2e = CO2 / 0.95: The United States Environmental Protection Agency (USEPA) recommends assuming that CH_4, N_2O, and HFCs account for 5% of GHG emissions from onroad vehicles, taking into account their global warming potentials (USEPA 2005).
2. For Mating Disruption, ground crew- based application includes either twist ties, caulk guns, pod-guns or other hand-held applicators.
3. For Mating Disruption, the vehicle-based ground application is the SPLAT spray truck.
4. For Organic Approved Insecticides, ground crew- based application is the hydraulic backpack sprayers
5. For Organic Approved Insecticides, the vehicle-based ground application is the hydraulic spray truck.

References: CARB 2007a, USEPA 2005

G5.3 AERIAL SOURCES EMISSIONS

The Program has aerial source emissions from the airplanes used for spraying and for populated release. Tier I emissions factors from the *2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories* (IPCC 2006) were used. The CO_2 emission factor is based on the combustion of jet kerosene, while the CH_4 and N_2O emission factors are based on combustion of all aviation fuels. Equations (7) and (8) detail the calculation of the aerial source GHG emissions.

Equation 7	$FC = P * A * H * AD * R$

Where:

FC = Fuel consumption (kilogram/year)

P = Density of fuel (kilogram/gallon)

A = Number of airplanes operating statewide per day (airplanes/day)

H = Hours of operation per day (hours/day)

AD = Number of days per year of treatment (days/year)

R = Average fuel consumption rate of airplane (gallons/hour)

Equation 8	$EM_P = SE * FC * EM_P * GWP_P / 1{,}000{,}000{,}000$

Where:

EM_P = Emissions of pollutant (metric ton/year)

SE = Specific energy of fuel (megajoule/kilogram)

FC = Fuel consumption of fuel (kilogram/year)

EM_P = Emission factor of pollutant for fuel (kilogram pollutant/terajoule)

GWP_P = Global warming potential for pollutant

To estimate emissions from the airplanes, the airplanes were assumed to consume 64 gallons per hour, which represents an average fuel consumption rate provided by Dynamic Aviation for the PT6A-20 Pratt & Whitney engines anticipated to be used in the Beechcraft King Air A90. For both mating disruption and sterile insect technique, four airplanes were assumed to operate statewide for 8 hours per day, 6 days per week, and 52 weeks per year (Schnabel 2009).

Emissions of CO_2, CH_4, and N_2O were summed for all airplanes operating throughout each year, and then multiplied by their respective GWPs to determine CO_2 equivalent emissions. Table G-5 presents the GHG emissions from aerial sources used in the Program. Details for these calculations are provided in Attachment G-3.

Table G-5 Summary of Airplane Greenhouse Gas Emissions

Program Treatment Alternative	Application Method	CO_2e Emissions [metric ton/year]	CO_2e Emissions [metric ton/day]
Mating Disruption (MD-3)	Aerial - Spray	6,117	20
Sterile Insect Technique (SIT)	Aerial - Populated Release	6,117	20

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SECTION G6

Uncertainties

The primary assumptions and uncertainties associated with the GHG assessment include the definition of the Program boundary and the assumptions required to determine the types and number of equipment used in the application processes. The first level of uncertainty lies in the selection of which sources to include in the GHG assessment, also known as defining the Program boundary. Potential GHG emission sources likely to result from Program implementation were identified as noted above. GHG emissions from "business as usual" operations—such as building energy and water consumption for the CDFA and all of its contractors and maintenance activities for equipment associated with the Program—are not included in this assessment, as these are assumed to occur regardless of Program implementation. In addition, life-cycle emissions were not accessed. Because the full life-cycle of GHG emissions are not accounted for in available emissions models, the information needed to characterize the GHG emissions from the manufacture, transport, and end-of-life of the treatment compounds would be speculative at the CEQA analysis level; such analysis is not recommended (California Air Pollution Control Officers Association 2008). The boundary for the various Program alternatives was set according to the best information available and best applicable methodology. However, either expanding or contracting the boundary (including or excluding emission sources) would change the magnitude of the estimated emissions and the resulting impacts.

In addition, as CDFA was not able to provide specific information for all parameters, several assumptions were made in determining the source characteristics and parameters. These assumptions are discussed in detail in the Sections above. Some of the key assumptions regarding parameters include:

- Although CDFA provided an estimate for the number of units (crews, planes, vehicles), there is uncertainty in the precise number of work crews and equipment that would be used state-wide . It was assumed that the number of people per crew ranged from two to six, depending on application method. If the number of units or the number of people per crew were adjusted up or down, GHG emissions would change accordingly.

- Equipment specifications for mobile sources were not provided, so assumptions were made to determine the vehicle sizes/types. For example, all work vehicles were assumed to be light heavy-duty trucks (8,501-10,000 pounds) while the hydraulic spray truck was modeled as a slightly heavier light heavy-duty truck (10,001 – 14,000 pounds). In addition, type of fuel consumed and age of the vehicle were determined using statewide fleet averages from EMFAC. If the vehicles are different than that assumed for this assessment, the GHG emissions would be affected, although it is not possible to determine if the resulting emissions would be higher or lower.

- Vehicle speeds and distances traveled were determined using a combination of default and site specific values. When Program-specific data were unavailable, default values were obtained from the URBan EMISsions model (URBEMIS), which draws upon compiled trip data taken from within California. Distances traveled by the hydraulic spray trucks, the ground application crew trucks, and SPLAT vehicles during a day of application were estimated using the vehicle-based application coverage rates, provided by the CDFA, and a typical urban block size assumed to be traveled by the vehicles.

- All application methods were assumed to occur for eight hours per day, six days per week, for 52 weeks per year. While this is considered a reasonable estimate of the time required, GHG emissions would change if these values were adjusted up or down.

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SECTION G7

Conclusions

G7.1 PROGRAM GHG EMISSIONS

This evaluation was prepared to estimate and assess the GHG emissions associated with the LBAM Eradication Program. The GHG evaluation considers three main sources of GHG emissions: offroad sources, onroad sources, and aerial sources. Annual and daily GHG emissions from these sources have been calculated.

A variety of methods were employed to develop the GHG emission estimates. GHG emissions from offroad sources were estimated using CARB's OFFROAD model. CO_2 emissions from onroad sources were estimated using CARB's EMission FACtors (EMFAC) model, and then scaled up to account for CH_4, N_2O, and HFC emissions using USEPA methods. GHG emissions from aerial sources were estimated using emission factors for aviation fuel combustion from the IPCC.

The GHG emissions from the various Program alternatives were previously summarized in Table G-2. Table G-6 summarizes the percentage contribution of various sources to GHG emissions for each Program treatment alternative. As the combination of different treatment alternatives has not yet been decided, the percentages are provided for each alternative separately. As indicated by Table G-6, emissions from aerial sources represent a significant fraction of GHG emissions when they are required in a treatment alternative.

Table G-6 Contribution of Various Sources to GHG Emissions for Each Treatment Alternative

Project Treatment Alternative		Percentage of Total GHG Emissions for Each Alternative		
		Offroad Equipment[1]	Onroad Vehicles[2]	Airplanes[3]
Mating Disruption		--	--	--
Twist Ties	MD-1	N/A	100%	N/A
Ground-crew based Application	MD-2	N/A	100%	N/A
Vehicle-based Application	MD-2	N/A	100%	N/A
Aerial Application	MD-3	N/A	2%	98%
Male Moth Attractant	MMA	N/A	100%	N/A
Organic-Approved Insecticides		--	--	--
Ground-crew based Application	Btk and S	N/A	100%	N/A
Vehicle-based Application	Btk and S	12%	88%	N/A
Inundative Parasitic Wasp Release	Bio-P	N/A	100%	N/A
Sterile Insect Technique	SIT	N/A	2%	98%

Notes:

1. Offroad sources include vehicle-mounted pump engines.

2. Depending on the treatment alternative, onroad sources can include worker commuting vehicles, vendor delivery vehicles, worker transportation vehicles, and spray vehicles.

3. Airplanes include airplanes used for spraying of pheromones (Mating Disruption) and airplanes used to release sterile moths (Sterile Insect Technique).

This GHG emission evaluation was prepared assuming that all emissions from the Program are "new," in the sense that, absent the occurrence of the Program, these emissions would not occur. It is also important to note that onroad source emissions are estimated without accounting for potential emission reduction measures—such as AB1493—resulting in estimates that may be higher than reality.

To place the estimated emissions due to the Program in context, GHG emissions from the various Program alternatives were compared to global, national, and statewide GHG emissions, as shown in Table G-7. The alternative with the highest GHG emissions (Mating Disruption with vehicle-based application) of approximately 7,000 metric tons of CO_2 equivalent per year was estimated, and represents approximately 0.00002 percent of the world-wide 2004 emissions, 0.0001 percent of the U.S. 2004 emissions, and 0.001 percent of California's 2004 annual GHG emissions.

Table G-7 Comparison of Program Greenhouse Gas Emissions to Relevant Benchmarks

	2004 World CO_2e Emissions	2004 USA CO_2e Emissions	2004 California CO_2e Emissions
Benchmark Emissions [metric ton CO_2e/year][1]	3.20E+10	6.38E+09	5.24E+08
	Percentage of Benchmark CO_2e Emissions		
Mating Disruption[2]	--	--	--
Ground-based Application (Caulk Gun / Pod Gun)	0.000001%	0.000005%	0.00006%
Ground-based Application (Twist-Ties)	0.000001%	0.000006%	0.00007%
Vehicle-based Application	0.000002%	0.00001%	0.0001%
Aerial Application	0.00002%	0.0001%	0.001%
Male Moth Attractant	0.000002%	0.00001%	0.0001%
Organic-Approved Insecticides	--	--	--
Ground-based Application	0.000001%	0.000005%	0.00006%
Vehicle-based Application	0.000001%	0.000006%	0.00007%
Inundative Parasitic Wasp Release	0.000001%	0.000006%	0.00007%
Sterile Insect Technique	0.00002%	0.0001%	0.001%

Notes:

1. World CO2e emissions from United Nations Framework Convention on Climate Change data (UNFCCC 2004, 2005). Value includes Annex I and non-Annex I countries, including Land-Use, Land-Use Change and Forestry.

USA CO2e emissions from USEPA's Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2005 (USEPA 2007). Value represents net USA emissions (including sources and sinks).

California CO2e emissions from CARB's Draft California Greenhouse Gas Inventory by IPCC Category (CARB 2007b). Value represents net California emissions (including sources and sinks).

2. Aerial application will be conducted in conjunction with either ground-based application or vehicle-based application methods. For Mating Disruption, the calculations presented in this table for "ground-based application" and "vehicle-based application" do not incorporate aerial application emissions. Similarly, the aerial application percentages shown in this table only consider the sources associated with the Mating Disruption aerial application method.

Anticipated state and federal regulatory developments will have various effects on GHG emission estimates for the Program. The LCFS is unlikely to have a large effect on the Program's GHG emissions because the inventory only accounts for tailpipe emissions from mobile sources whereas the LCFS addresses the life cycle emissions for each fuel. Tailpipe emissions would decrease as a result of LCFS only if a significant shift occurs from gasoline to alternative fuels that have a combination of fuel efficiency and carbon content that result in lower CO_2 emissions per mile driven. While the LCFS may not lead to a significant change in the vehicle tailpipe emissions, it will lead to a decrease in California GHG emissions because it also accounts for emissions from production, processing, and the transport of fuels. Both the Pavley vehicle emissions standards and the increased CAFE standards under EISA will result in a moderate decrease in the Program's GHG tailpipe emissions from onroad sources.

G7.2 LIFE CYCLE ANALYSIS

The assessment of GHG emissions for the LBAM Program did not include a full Life Cycle Analysis (LCA). LCA is a method developed to evaluate the mass balance of inputs and outputs of systems and to organize and convert those inputs and outputs into environmental themes or categories. A LCA would assess the GHG emissions from the processes used to manufacture and transport materials used for the Program, mainly the treatment formulations. The LCA field is still relatively new, and while there are general standards for goals and general practices for LCAs[13] the specific methodologies and, in particular, the boundaries chosen for the LCA introduce considerable uncertainty and makes inter-comparison of various studies difficult.

Recognizing the uncertainties associated with a life-cycle analysis, in January 2008, the California Air Pollution Control Officers Association (CAPCOA) released a white paper which states: "The full life-cycle of GHG emissions from construction activities is not accounted for in the modeling tools available, and the information needed to characterize GHG emissions from manufacture, transport, and end-of- life of construction materials would be speculative at the CEQA analysis level."[14] In April 2009, the Attorney General of California has stated that "CEQA does not require independent research to trace back to its source every single material used in construction, but there is no reason that existing, readily available information about lifecycle emissions should not be included in the CEQA analysis."[15]

Although the LBAM Program does not have any construction associated with the project, the concepts associated with these two statements remains relevant. That is, a LCA analysis would be speculative at the CEQA level and that independent research on every single material used in the Program is not required for a CEQA analysis. Given that no information on the GHG emissions associated with the manufacture of the specific treatment formulations was available and the uncertainty associated with a LCA, such an assessment was not included in the GHG emission analyses. However, information from existing, readily available sources indicates that LCA GHG emissions associated with the manufacturing of treatment formulations would be approximately one metric ton of CO_2 equivalent per $1,000 of treatment formulation manufactured, and LCA GHG emissions associated with the manufacturing of fuel would be approximately 2 metric tons of CO_2 equivalent per $1,000 of fuel manufactured.[16] Again, it is emphasized that these numbers are based on general studies that may not be representative of the Program (for example, the LCA GHG emissions for fuel manufacturing represents the petroleum refining sector, which includes not only aviation fuel and gasoline, but also items like kerosene, asphalt, and petroleum coke), but they are provided for comparative purposes.

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[13] ISO 14044 and ISO 14040

[14] California Air Pollution Control Officers Association. 2008. *CEQA & Climate Change*. Website (http://www.capcoa.org/CEQA/CAPCOA%20White%20Paper.pdf) accessed on March 2, 2009.

[15] Brown. 2009. Edmund G. Brown, Attorney General of California, Communication with Dave Warner, SJVAPCD. RE: Draft Document Entitled "Characterization of Greenhouse Gas Emissions." February 17, 2009.

[16] Carnegie Mellon University Green Design Institute. (2009) *Economic Input-Output Life Cycle Assessment (EIO-LCA) US Dept of Commerce 1997 Industry Benchmark (491) model.* Available online at: http://www.eiolca.net/. Accessed June 11, 2009. Pesticide and other agricultural chemical manufacturing is assumed to be representative of manufacturing of treatment formulations. Petroleum refining is assumed to be representative of fuel manufacturing.

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SECTION G8

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ATTACHMENT G-1

Greenhouse Gas Emission Calculations for Offroad Equipment

Attachment G-1
Greenhouse Gas Emissions Calculations for Offroad Equipment
Light Brown Applemoth Eradication Program
California

Program Treatment Alternative	Application Method	Equipment	OFFROAD Representation[1]	Population[2]		Activity[3]		Horsepower[4]		Load Factor[5]		OFFROAD Emissions[6]			LBAM Emissions[7]						GWP			LBAM CO_2e Emissions[8]	LBAM CO_2e Emissions[8]
				[pieces of equipment]		[hr/day]		[hp]		[--]		[tons/day]			[tons/day]			[tons/year]			[--]			[metric ton/ year]	[metric ton/ day]
				LBAM	OFFROAD	LBAM	OFFROAD	LBAM	OFFROAD	LBAM	OFFROAD	CO_2	N_2O	CH_4	CO_2	N_2O	CH_4	CO_2	N_2O	CH_4	CO_2	N_2O	CH_4		
Organic-Approved Insecticides (Btk and	Vehicle Based - Hydraulic Spraying	Vehicle Mounted Pump Engine	Commercial Pump (ASC 2265006010)	12	11,614	8	0.71	10	8	0.25	0.69	21.4	0.02	0.02	0.1	0.0001	0.0001	35	0.04	0.04	1	310	21	43	0.1

Notes:

1. This category is assumed to be the most representative within OFFROAD (CARB 2006) for the type of equipment required for the LBAM Eradication Program.
   ¯ASC code of 2260006010 corresponds to Gas (4 stroke) -> Commercial -> Pump.
2. Population for LBAM represents the population required statewide for the LBAM Program. Population for the vehicle mounted pump engine was estimated assuming 12 crews/day (Schnabel 2009) . Population from OFFROAD represents the statewide population for this type of equipment.
3. Activity for LBAM represents the daily activity for each piece of equipment required for the LBAM Program. Activity from OFFROAD represents the daily activity for each piece of equipment.
4. Horsepower for LBAM is estimated based on Program-specific requirements. Horsepower from OFFROAD is the average horsepower for the horsepower range required for the LBAM Program.
5. Load factor for LBAM is estimated based on Program-specific requirements. Load factor for OFFROAD was obtained from OFFROAD (CARB 2006).
6. OFFROAD emissions were obtained by running the OFFROAD model for statewide emissions of the equipment indicated.
7. LBAM emissions were calculated by scaling the OFFROAD emissions according to the following formula:

$$\text{LBAM Emissions} = \text{OFFROAD Emissions} * [hp_{LBAM}/hp_{OFFROAD}] * [Activity_{LBAM}/Activity_{OFFROAD}] * [Population_{LBAM}/Population_{OFFROAD}] * [Load_{LBAM}/Load_{OFFROAD}]$$

Daily emissions were then multiplied by the days of activity per year (312 days/year) to obtain the emissions on a per year basis (Schnabel 2009).

8. The CO_2e emissions are equal to the sum of the three pollutants' emissions multiplied by their GWPs.

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ATTACHMENT G-2

Greenhouse Gas Emission Calculations for Onroad Vehicles

Attachment G-2
Greenhouse Gas Emissions Calculations for Onroad Vehicles
Light Brown Applemoth Eradication Program
California

Program Treatment Alternative	Emission Source	Fleet Composition[1]	Application Method	Roundtrips[2]	VMT[3]	Starts per Roundtrip[4]	CO_2 EF_{LDA}[5]		CO_2 EF_{LDT1}[5]		CO_2 EF_{LDT2}[5]		CO_2 EF_{LHDT1}[5]		CO_2 EF_{LHDT2}[5]		CO_2 EF_{MHDT}[5]		CO_2 Emissions[6,7]		Total CO_2 Emissions	Total CO_2e Emissions[8]	Total CO_2e Emissions
							Running[5]	Startup[5]	Running[5]	Startup[5]	Running[5]	Startup[5]	Running[5]	Startup[5]	Running[5]	Startup[5]	Running[5]	Startup[5]	Running	Startup			
				[trips/ year]	[miles/ year]	[--]	[g/mile]	[g/trip]	(g/mile)	(g/trip)	(g/mile)	(g/trip)	(g/mile)	(g/trip)	(g/mile)	(g/trip)	(g/mile)	(g/trip)	[metric ton/year]				[metric ton/day]
Mating Disruption	Worker Commute Vehicles	50% LDA / 25% LDT1 / 25% LDT2	Aerial - Spray	7,488	251,597	2	310	188	384	222	386	232	--	--	--	--	--	--	88	3	91	95	0.3
			Vehicle - SPLAT	7,488	251,597	2	310	188	384	222	386	232	--	--	--	--	--	--	88	3	91	95	0.3
			Ground - Caulk Gun / Pod Gun	18,720	628,992	2	310	188	384	222	386	232	--	--	--	--	--	--	219	8	227	238	0.8
			Ground - Twist-Ties	22,464	754,790	2	310	188	384	222	386	232	--	--	--	--	--	--	263	9	272	286	0.9
	Worker Transport Vehicles - Transportation	LHDT1	Ground - Caulk Gun / Pod Gun / Twist-Ties	3,744	125,798	2	--	--	--	--	--	--	503	357	--	--	--	--	63	3	66	69	0.2
	Worker Transport Vehicles - Application			3,744	1,123	10	--	--	--	--	--	--	2,036	72	--	--	--	--	2	3	5	5	0.02
	Spray Vehicles - Spray	LHDT1	Vehicle - SPLAT	3,744	224,640	2	--	--	--	--	--	--	2,036	357	--	--	--	--	457	3	460	484	1.6
	Spray Vehicles - Transportation			3,744	125,798	0	--	--	--	--	--	--	503	357	--	--	--	--	63	0	63	67	0.2
	Vendor Delivery Vehicles	MHDT	Aerial - Spray	208	3,037	2	--	--	--	--	--	--	--	--	--	--	1,344	89	4	0.0	4	4	0.01
			Vehicle - SPLAT	312	4,555	2	--	--	--	--	--	--	--	--	--	--	1,344	89	6	0.1	6	7	0.02
			Ground - Caulk Gun / Pod Gun / Twist-Ties	312	4,555	2	--	--	--	--	--	--	--	--	--	--	1,344	89	6	0.1	6	7	0.02
Total (assuming ground-based application [caulk gun / pod gun])[9]																					**304**	**320**	**1.0**
Total (assuming ground-based application [twist-ties])[9]																					**349**	**367**	**1.2**
Total (assuming vehicle-based application)[9]																					**620**	**653**	**2.1**
Total (assuming aerial-based application)[9]																					**95**	**100**	**0.3**
Male Moth Attractant	Worker Commute Vehicles	50% LDA / 25% LDT1 / 25% LDT2	Vehicle - SPLAT	7,488	251,597	2	310	188	384	222	386	232	--	--	--	--	--	--	88	3	91	95	0.3
	Spray Vehicles - Spray	LHDT1	Vehicle - SPLAT	3,744	224,640	2	--	--	--	--	--	--	2,036	357	--	--	--	--	457	3	460	484	1.6
	Spray Vehicles - Transportation			3,744	125,798	0	--	--	--	--	--	--	503	357	--	--	--	--	63	0	63	67	0.2
	Vendor Delivery Vehicles	MHDT	Vehicle - SPLAT	312	4,555	2	--	--	--	--	--	--	--	--	--	--	1,344	89	6	0.1	6	7	0.02
Total																					**620**	**653**	**2.1**
Organic-Approved Insecticides	Worker Commute Vehicles	50% LDA / 25% LDT1 / 25% LDT2	Vehicle - Hydraulic	18,720	628,992	2	310	188	384	222	386	232	--	--	--	--	--	--	219	8	227	238	0.8
			Ground - Hydraulic Backpack	18,720	628,992	2	310	188	384	222	386	232	--	--	--	--	--	--	219	8	227	238	0.8
	Worker Transport Vehicles - Transportation	LHDT1	Ground - Hydraulic Backpack	3,744	125,798	2	--	--	--	--	--	--	503	357	--	--	--	--	63	3	66	69	0.22
	Worker Transport Vehicles - Application			3,744	1,123	10	--	--	--	--	--	--	2,036	72	--	--	--	--	2	3	5	5	0.02
	Spray Vehicles - Spray	LHDT2	Vehicle - Hydraulic	3,744	1,123	10	--	--	--	--	--	--	--	--	1,574	64	--	--	2	2	4	4	0.01
	Spray Vehicles - Transportation			3,744	125,798	2	--	--	--	--	--	--	--	--	513	298	--	--	65	2	67	70	0.2
	Vendor Delivery Vehicles	MHDT	Vehicle - Hydraulic	312	4,555	2	--	--	--	--	--	--	--	--	--	--	1,344	89	6	0.1	6	7	0.02
			Ground - Hydraulic Backpack	312	4,555	2	--	--	--	--	--	--	--	--	--	--	1,344	89	6	0.1	6	7	0.02
Total (assuming ground-based application)[9]																					**304**	**320**	**1.0**
Total (assuming vehicle-based application)[9]																					**304**	**320**	**1.0**
Inundative Parasitic Wasp Release	Worker Commute Vehicles	50% LDA / 25% LDT1 / 25% LDT2	Ground - Index Cards	22,464	754,790	2	310	188	384	222	386	232	--	--	--	--	--	--	263	9	272	286	0.9
	Worker Transport Vehicles - Transportation	LHDT1	Ground - Index Cards	3,744	125,798	2	--	--	--	--	--	--	503	357	--	--	--	--	63	2.7	66	69	0.2
	Worker Transport Vehicles - Application			3,744	1,123	10	--	--	--	--	--	--	2,036	72	--	--	--	--	2	2.7	5	5	0.02
	Vendor Delivery Vehicles	MHDT	Ground - Index Cards	312	4,555	2	--	--	--	--	--	--	--	--	--	--	1,344	89	6	0.1	6	7	0.02
Total																					**349**	**367**	**1.2**
Sterile Insect Technique	Worker Commute Vehicles	50% LDA / 25% LDT1 / 25% LDT2	Aerial - Populated Release	7,488	251,597	2	310	188	384	222	386	232	--	--	--	--	--	--	88	3	91	95	0.3
	Vendor Delivery Vehicles	MHDT	Aerial - Populated Release	208	3,037	2	--	--	--	--	--	--	--	--	--	--	1,344	89	4	0.0	4	4	0.01
Total																					**95**	**100**	**0.3**

Notes:
1. Vehicle classes are defined as follows:

Abbreviation	Gross Vehicle Weight (lbs)	Description
LDA	All	Passenger Cars
LDT1	0-3750	Light-Duty Trucks
LDT2	3,751-5,750	Light-Duty Trucks
LHDT1	8,501-10,000	Light-Heavy-Duty Trucks
LHDT2	10,001-14,000	Light-Heavy-Duty Trucks
MHDT	14,001-33,000	Medium-Heavy-Duty Trucks

Fleet composition for worker commute vehicles estimated based on default composition in URBEMIS. Fleet composition for other vehicles estimated using engineering judgment based on Program requirements.

2. Number of roundtrips estimated based on the following:
   a. Worker Commute:
      i. Aerial - Spray assumes 4 airplanes/day, 312 days/year, and 6 people/airplane (including ground support).
      ii. Vehicle - SPLAT assumes 12 crews/day, 2 people/crew, and 312 days/year.
      iii. Ground - Caulk Gun / Pod Gun assumes 12 crews/day, 5 people/crew, and 312 days/year.
      iv. Ground - Twist-Ties assumes 12 crews/day, 6 people/crew, and 312 days/year.
      v. Vehicle - Hydraulic assumes 12 crews/county, 5 people/crew, and 312 days/year.
      vi. Ground - Index Card assumes 12 crews/day, 6 people/crew, and 312 days/year.
      vii. Aerial - Populated Release assumes 4 airplanes/day, 312 days/year, and 6 people/airplane (including ground support).
   b. Worker Transport Vehicles (transportation and application):
      i. Ground - Caulk Gun / Pod Gun / Twist Ties assumes 12 crews/day, 312 days/year, and that all members of a crew fit in one transport vehicle.
      ii. Ground - Index Cards assumes 12 crews/day, 6 people/crew, and 312 days/year.
   c. Spray Vehicles (transportation and application):
      i. Vehicle - SPLAT assumes 12 crews/day, 2 people/crew, and 312 days/year.
      ii. Vehicle - Hydraulic assumes 12 crews/day, 5 people/crew, and 312 days/year.
   d. Vendor Delivery Vehicles
      i. Aerial - Spray assumes one delivery per week for aerial application for each airplane (assume airplanes operate 6 days/week).
      ii. Vehicle - SPLAT assumes one delivery every two weeks for ground/vehicle application for each crew (assume ground/vehicle application occurs 6 days/week).
      iii. Ground - Caulk Gun / Pod Gun / Twist Ties assumes one delivery every two weeks for ground/vehicle application for each crew (assume ground/vehicle application occurs 6 days/week).
      iv. Vehicle - Hydraulic assumes one delivery every two weeks for ground/vehicle application for each crew (assume ground/vehicle application occurs 6 days/week).
      v. Ground - Index Card assumes one delivery every two weeks for ground/vehicle application for each crew (assume ground/vehicle application occurs 6 days/week).
      vi. Aerial - Populated Release assumes one delivery per week for aerial application for each airplane (assume airplanes operate 6 days/week).
3. Vehicle miles travelled was estimated based on the following:
   a. Commuting vehicles were assumed to travel 33.6 miles round-trip based on URBEMIS default for home-based work trip (CARB 2007a).
   b. Transportation trucks for ground-based crews were assumed to travel 33.6 miles round-trip based on URBEMIS default for home-based work trip (CARB 2007a).
   c. Vehicles used for SPLAT spraying were assumed to travel 60 miles round-trip. This value was determined using an estimate of total acreage covered per crew per day (640 acres/day) and the size of urban block (400' x 320'), assuming the vehicles drive on all four sides of each block.
   d. Vehicles used for hydraulic spraying were assumed to travel 0.3 miles round-trip. The value was determined using an estimate of total acreage covered per crew per day (3 acres/day) and the size of urban block (400' x 320'), assuming the vehicles drive on all four sides of each block.
   e. Vehicles used for transportation of treatment compound assumed to travel 14.6 miles round-trip based on URBEMIS default for commercial-based customer trip (CARB 2007a). This value was used for vendor deliveries to airports, ground-based crews, and vehicle-based crews.
4. Vehicle - Hydraulic is assumed to have 10 starts per roundtrip, based on the assumption that the vehicles spray 6-10 properties per day. Vehicle - SPLAT for transportation is assumed to have 0 starts per roundtrip, as the 2 starts per roundtrip associated with the entire SPLAT trip is already accounted for in the Vehicle - SPLAT for spraying.
All other emissions sources and application methods are assumed to have 2 starts per roundtrip.
5. These emission factors represent weighted averages of the emission factors for gas (catalytic and non-catalytic) and diesel vehicles in each vehicle class; these emission factors were estimated using EMFAC (CARB 2007b).

6. CO_2 running emission calculation formula:

Worker Commute Vehicles: CO_2 Emission = VMT x (0.5 x EF_{LDA} + 0.25 x EF_{LDT1} + 0.25 x EF_{LDT2})

Worker Transport Vehicles: CO_2 Emission = VMT x EF_{LHDT1}

Spray Vehicles (SPLAT): CO_2 Emission = VMT x EF_{LHDT1}

Spray Vehicles (Hydraulic): CO_2 Emission = VMT x EF_{LHDT2}

Vendor Delivery Vehicles: CO_2 Emission = VMT x EF_{MHDT}

CO_2 startup emission calculation formula:

Worker Commute Vehicles: CO_2 Emission = Roundtrips x Number of Starts per Roundtrip x (0.5 x EF_{LDT} + 0.25 x EF_{LDT1} + 0.25 x EF_{LDT2})

Worker Transport Vehicles: CO_2 Emission = Roundtrips x Number of Starts per Roundtrip x EF_{LHDT1}

Spray Vehicles (SPLAT): CO_2 Emission = Roundtrips x Number of Starts per Roundtrip x EF_{LHDT1}

Spray Vehicles (Hydraulic): CO_2 Emission = Roundtrips x Number of Starts per Roundtrip x EF_{LHDT2}

Vendor Delivery Vehicles: CO_2 Emission = Roundtrips x Number of Starts per Roundtrip x EF_{MHDT}

7. The running emission factor depends on the speed of the vehicle. The following speeds were assumed:

Worker Commute Vehicles: 35 mph	[based on URBEMIS average speed for home-based worker trip (CARB 2007a)]
Worker Transport Vehicles - Transportation: 35 mph	[based on URBEMIS average speed for home-based worker trip (CARB 2007a)]
Worker Transport Vehicles - Application: 5 mph	[assumed based on Program requirements]
Spray Vehicles (SPLAT) - Spray: 5 mph	[assumed based on Program requirements]
Spray Vehicles (SPLAT) - Transportation: 35 mph	[based on URBEMIS average speed for home-based worker trip (CARB 2007a)]
Spray Vehicles (Hydraulic) - Spray: 5 mph	[assumed based on Program requirements]
Spray Vehicles (Hydraulic) - Transportation: 35 mph	[based on URBEMIS average speed for home-based worker trip (CARB 2007a)]
Vendor Delivery Vehicles: 35 mph	[based on URBEMIS average speed for commercial-based customer trip (CARB 2007a)]

The startup emission factor depends on the settling period before driving. Worker commute vehicles and worker transportation vehicles were assumed to remain idle 10 hours between starts, while hydraulic spray vehicles and transport vehicles used by the ground-based application crews were assumed to remain idle 50 minutes between starts (10 starts evenly spread out across an 8-hour workday).

8. $CO_2e = CO_2 / 0.95$: The United States Environmental Protection Agency (USEPA) recommends assuming that CH_4, N_2O, and HFCs account for 5% of GHG emissions from onroad vehicles, taking into account their global warming potentials (USEPA 2005).

9. For Program treatment alternatives that includes both vehicle and ground application methods, only one method will be used if the alternative is chosen. For mating disruption, aerial-based application will be conducted in conjunction with either ground-based or vehicle-based application methods.

References:

California Air Resources Board (CARB). 2007a. *Urban Emissions Model (URBEMIS9), Version 9.2.4.* Website (http://www.urbemis.com/) accessed on February 15, 2009.
California Air Resources Board (CARB). 2007b. *EMFAC 2007 (Version 2.30) User's Guide (DRAFT).* April.
United States Environmental Protection Agency (USEPA). 2005. *Emission Facts: Greenhouse Gas Emissions from a Typical Passenger Vehicle*. Office of Transportation and Air Quality. February.

ATTACHMENT G-3

Greenhouse Gas Emission Calculations for Airplanes

Attachment G-3
Greenhouse Gas Emissions Calculations for Airplanes
Light Brown Applemoth Eradication Program
California

Program Treatment Alternative	Application Method	Airplane	Engine	Fuel Type	Population	Duration		Fuel Consumption[1]	CO_2 Emission Factor[2]	N_2O Emission Factor[3]	CH_4 Emission Factor[3]	CO_2 GWP	N_2O GWP	CH_4 GWP	CO_2e Emissions[4,5]	CO_2e Emissions[4,5]
					[airplanes/ day]	[hr/day]	[day/ year]	[gallons/hr]	[kg/TJ]			[--]			[metric ton/ year]	[metric ton/ day]
Mating Disruption (MD-3)	Aerial - Spray	Beechcraft King Air A90	Pratt & Whitney - PT6A-20	Jet Fuel A	4	8	312	64	71,500	2	0.5	1	310	21	6,117	20
Sterile Insect Technique (SIT)	Aerial - Populated Release	Beechcraft King Air A90	Pratt & Whitney - PT6A-20	Jet Fuel A	4	8	312	64	71,500	2	0.5	1	310	21	6,117	20

Notes:
1. Fuel consumption value provided by Dynamic Aviation and represents the average fuel burn rate for a Beechcraft King Air A90.
2. CO_2 emission factor for jet kerosene provided by IPCC (IPCC 2006).
3. N_2O and CH_4 emission factors for all aviation fuels provided by IPCC (IPCC 2006).
4. The emissions for each pollutant are calculated as follows:
   Pollutant Emissions = Population x Duration (hr/day) x Duration (day/year) x Fuel Consumption (gal/hr) x Fuel Density (kg/gal) x Fuel Specific Energy (TJ/kg) x Emission Factor (kg/TJ)
   Fuel density (3.07 kg/gal) and specific energy (43.28 MJ/kg) for jet kerosene obtained from online literature (Chevron 2006).
   Fuel density (3.10 kg/gal) and specific energy (43.02 MJ/kg) for jet fuel A obtained from online literature (Air BP 2000).
5. The CO_2e emissions are equal to the sum of the three pollutants' emissions multiplied by their GWPs.

References:

IPCC. *2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 2: Energy, Chapter 3: Mobile Combustion.* 2006. Website (http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html) accessed on February 15, 2009.
Chevron Corporation. 2006. *Aviation Fuels Techical Review. Website (* http://www.chevron.com/products/ourfuels/prodserv/fuels/documents/aviation_fuels.pdf) accessed on February 27, 2009.
Air BP. 2000. *Handbook of Products.* Website (http://www.bp.com/liveassets/bp_internet/aviation/air_bp/STAGING/local_assets/downloads_pdfs/a/air_bp_products_handbook_04004_1.pdf) accessed on February 27, 2009.