APPENDIX G
AIR QUALITY TECHNICAL MEMO

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1.0 INTRODUCTION

This technical memo supports discussions in Sections 3.4 and 4.4, *Air Quality Affected Environment* and *Environmental Consequences*, respectively, of the Commonwealth of the Northern Mariana Islands Joint Military Training (CJMT) Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS). In this technical memo, a more detailed discussion of the resource definition, regulatory framework approach used to evaluate potential impacts, and determination of impact significance is presented. This approach to National Environmental Policy Act (NEPA) documentation is taken to allow the layperson to read the EIS/OEIS unencumbered by information of interest to resource specialists and regulators; however, anyone can read this technical memo and be assured that the resource was thoroughly examined and that a hard look was taken to identify potential impacts.

Air quality can be affected by air pollutants produced by mobile sources, such as vehicular traffic, aircraft, or non-road equipment used for construction activities, and by operational activities, such as training with aircraft, vessels, and vehicles, and fixed or immobile facilities, referred to as "stationary sources." Stationary sources can include stationary combustion sources such as a power plant.

This Appendix is organized as follows:

- Introduction
- Air Quality Standards and Regulations. Discusses U.S. National, and Commonwealth of the Northern Mariana Islands (CNMI) air quality standards and regulations and their application to the proposed action.
- Air Emissions Analysis. This section contains the analyses performed for this study. It is divided into the following sections:
    - Construction Activity Emissions. Describes various construction activities associated with different components of the proposed action and how associated air emissions were estimated for components such as equipment, vehicles, and generators. Construction estimates for all parts of the proposed action are referenced.
    - Operational Activity Emissions. Discusses and provides references to the summary impact to air quality resources from aircraft, vessels, live-fire, training vehicles, and Range and Training Areas (RTAs).

1.1 AIR QUALITY STANDARDS AND REGULATIONS

Air quality can be affected by air pollutants produced by mobile sources, such as vehicular traffic, aircraft, or non-road equipment used for construction activities, and by fixed or immobile facilities, referred to as "stationary sources." Stationary sources can include combustion and industrial stacks and exhaust vents.

1.1.1 National Ambient Air Quality Standards

The U.S. Environmental Protection Agency (USEPA), under the requirements of the 1970 Clean Air Act (CAA), as amended in 1977 and 1990 (Clean Air Act Amendments), has established National Ambient Air Quality Standards (NAAQS) for six contaminants, referred to as criteria pollutants (40 Code of Federal Regulations [CFR] 50). These six criteria pollutants are:

- Carbon monoxide (CO)
- Nitrogen dioxide (NO_2)
- Ozone (O_3), with nitrogen oxides (NO_x) and volatile organic compounds (VOCs) as precursors
- Particulate matter (PM_{10}—less than 10 microns in particle diameter; $PM_{2.5}$—less than 2.5 microns in particle diameter)
- Lead (Pb)
- Sulfur dioxide (SO_2)

Table 1 presents a description of the criteria pollutants and their effects on public health and welfare.

Table 1. Criteria Pollutants - Sources and Impacts

Pollutants and Their Sources	***Health and Environmental Impacts***
Ozone (O_3): a gas composed of three oxygen atoms. It is not usually emitted directly into the air, but is created at ground level by a chemical reaction between nitrogen oxides (NO_x) and volatile organic compounds (VOC) in the presence of heat and sunlight. Ground-level O_3 is known as smog. O_3 has the same chemical structure whether it occurs miles above the earth or at ground level and can have positive or negative effects, depending on its location in the atmosphere. Most O_3 (about 90%) occurs naturally in the stratosphere approximately 10 to 30 miles above the earth's surface. It forms a layer that protects life on earth by absorbing most of the biologically damaging ultraviolet sunlight. In the earth's lower atmosphere, O_3 comes into direct contact with living organisms. High levels of ground-level O_3 can cause toxic effects, detailed in the adjacent column. VOC + NO_x + Heat + Sunlight = O_3: Motor vehicle exhaust and industrial emissions, gasoline vapors, and chemical solvents are some of the major sources of NO_x and VOC that help to form O_3. Sunlight and hot weather cause ground-level O_3 to form in harmful concentrations in the air. As a result, it is considered an air pollutant, particularly in summer. Many urban areas tend to have high levels of O_3, but even rural areas are also subject to increased O_3 levels because wind carries O_3 and associated pollutants hundreds of miles away from their original sources.	**Health Problems:** O_3 can irritate lung airways and cause inflammation much like sunburn. Other symptoms include wheezing, coughing, pain when taking a deep breath, and breathing difficulties during exercise or outdoor activities. People with respiratory problems are most vulnerable, but even healthy people that are active outdoors can be affected when O_3 levels are high. Repeated exposure to O_3 pollution for several months may cause permanent lung damage. Anyone who spends time outdoors in the summer is at risk, particularly children and other people who are active outdoors. Even at very low levels, ground-level O_3 triggers a variety of health problems including aggravated asthma, reduced lung capacity, and increased susceptibility to respiratory illnesses like pneumonia and bronchitis. **Plant and Ecosystem Damage:** Ground-level O_3 interferes with the ability of plants to produce and store food, which makes them more susceptible to disease, insects, and harsh weather. O_3 damages the leaves of trees and other plants, injuring them and impacting the appearance of cities, national parks, and recreation areas. O_3 reduces crop and forest yields and increases plant vulnerability to disease, pests, and harsh weather.

Table 1. Criteria Pollutants - Sources and Impacts

Pollutants and Their Sources	***Health and Environmental Impacts***
Carbon Monoxide (CO): a colorless, odorless gas that is formed when carbon in fuel is incompletely burned. It is a component of motor vehicle exhaust, which contributes about 56% of all CO emissions nationwide. Non-road engines and vehicles (such as construction equipment and boats) contribute about 22% of all CO emissions nationwide. Higher levels of CO generally occur in areas with heavy traffic congestion. In cities, 85 to 95% of all CO emissions may come from motor vehicle exhaust. Other sources of CO emissions include industrial processes (e.g., metals processing and chemical manufacturing), residential wood burning, and natural sources such as forest fires. Woodstoves, gas stoves, cigarette smoke, and unvented gas and kerosene space heaters are sources of CO indoors. The highest levels of CO in the outside air typically occur during the colder months of the year when inversion conditions are more frequent. The air pollution becomes trapped near the ground beneath a layer of warm air.	**Health Problems**: CO can cause harmful health effects by reducing oxygen delivery to the body's organs (e.g., heart, brain) and tissues. **Cardiovascular Effects** – The health threat from lower levels of CO is most serious for those who suffer from heart disease (e.g., clogged arteries, congestive heart failure). For a person with heart disease, a single exposure to CO at low levels may cause chest pain and reduce their ability to exercise; repeated exposures may contribute to other cardiovascular effects. **Central Nervous System Effects** – Even healthy people can be affected by high levels of CO. People who breathe high levels of CO can develop vision problems, reduced ability to work or learn, reduced manual dexterity, and difficulty performing complex tasks. At extremely high levels, CO is poisonous and can cause death. **Smog** – CO contributes to the formation of smog (ground-level O_3), which can trigger serious respiratory problems.

Table 1. Criteria Pollutants - Sources and Impacts

Pollutants and Their Sources	*Health and Environmental Impacts*
Sulfur Dioxide (SO_2): SO_2 belongs to the family of sulfur oxide gases (SO_x). These gases dissolve easily in water. Sulfur is prevalent in raw materials, including crude oil, coal, and ore that contains common metals like aluminum, copper, zinc, lead, and iron. SO_x gases are formed when fuel containing sulfur, such as coal and oil, is burned, when gasoline is extracted from oil, or when metals are extracted from ore. SO_2 dissolves in water vapor to form acid, and interacts with other gases and particles in the air to form sulfates and other products that can be harmful to people and their environment. Over 65% of SO_2 released to the air, or more than 13 million tons per year, comes from electric utilities, especially those that burn coal. Other sources of SO_2 are industrial facilities that derive their products from raw materials like metallic ore, coal, and crude oil, or that burn coal or oil to produce process heat. Examples are petroleum refineries, cement manufacturing, and metal processing facilities. Also, locomotives, large ships, and some non-road diesel equipment currently burn high sulfur fuel and release SO_2 emissions to the air in large quantities.	SO_2 causes a wide variety of health and environmental impacts because of the way it reacts with other substances in the air. Particularly sensitive groups include people with asthma who are active outdoors, and children, the elderly, and people with heart or lung disease. **Health Problems**: **Respiratory Effects from Gaseous SO_2** – High levels of SO_2 in the air can cause temporary breathing difficulty for people with asthma who are active outdoors. Longer-term exposures to high levels of SO_2 gas and particles cause respiratory illness and aggravate existing heart disease. **Respiratory Effects from Sulfate Particles** – SO_2 reacts with other chemicals in the air to form tiny sulfate particles. When these are breathed, they gather in the lungs and are associated with increased respiratory symptoms and disease, difficulty in breathing, and premature death. **Plant and Ecosystem Damage**: **Acid Rain** – SO_2 and NO_x react with other substances in the air to form acids, which fall to earth as rain, fog, snow, or dry particles. Some may be carried by the wind for hundreds of miles. **Plant and Water Damage** – Acid rain damages forests and crops, changes the makeup of soil, and makes lakes and streams acidic and unsuitable for fish and other aquatic life. Continued exposure over a long time changes the community of plants and animals in an ecosystem. **Visibility Impairment:** Haze occurs when light is scattered or absorbed by particles and gases in the air. Sulfate particles are the major cause of reduced visibility in many parts of the United States. **Aesthetic Damage:** SO_2 accelerates the decay of building materials and paints, including irreplaceable monuments, statues, and sculptures that are part of our cultural heritage.

Table 1. Criteria Pollutants - Sources and Impacts

Pollutants and Their Sources	*Health and Environmental Impacts*
Nitrogen Oxides (NO_x): the generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying amounts. Many of the NO_x are colorless and odorless. However, one common pollutant, nitrogen dioxide (NO_2), along with particles in the air can often be seen as a reddish-brown layer over many urban areas. NO_x forms when fuel is burned at high temperatures, as in a combustion process. The primary sources of NO_x are motor vehicles, electric utilities, and other industrial, commercial, and residential sources that burn fuels.	NO_x causes a wide variety of health and environmental impacts because of various compounds and derivatives in the family of NO_x, including NO_2, nitric acid, nitrous oxide (N_2O), nitrates, and nitric oxide. **Health Problems**: **Ground-level O_3 (smog)** is formed when NO_x and VOCs react in the presence of heat and sunlight. Children, people with lung diseases (e.g., asthma), and people who work or exercise outside are susceptible to adverse effects such as damage to lung tissue and reduction in lung function. O_3 can be transported by wind currents and cause health impacts far from original sources. Millions of Americans live in areas that do not meet the health standards for O_3. **Particles** – NO_x reacts with ammonia, moisture, and other compounds to form nitric acid and related particles. Human health concerns include effects on breathing and the respiratory system, damage to lung tissue, and premature death. Small particles penetrate deeply into sensitive parts of the lungs and can cause or worsen respiratory diseases such as emphysema and bronchitis, and aggravate existing heart disease. **Toxic Chemicals** – In the air, NO_x reacts readily with common organic chemicals and even O_3, to form a wide variety of toxic products. Examples of these chemicals include the nitrate radical, nitroarenes, and nitrosamines.

Table 1. Criteria Pollutants - Sources and Impacts

Pollutants and Their Sources	*Health and Environmental Impacts*
Nitrogen Oxides (NO_x) - continued	**Plant and Ecosystem Damage**: **Acid Rain** – NO_x and SO_2 react with other substances in the air to form acids that fall to earth as rain, fog, snow, or dry particles, which can be carried by wind for hundreds of miles. Acid rain causes lakes and streams to become acidic and unsuitable for many fish and other aquatic life. **Water Quality Deterioration** – Increased nitrogen loading in water bodies, particularly coastal estuaries, upsets the chemical balance of nutrients used by aquatic plants and animals. Additional nitrogen accelerates "eutrophication," which leads to oxygen depletion and reduces fish and shellfish populations. **Global Warming** – One of the NO_x, N_2O, is a greenhouse gas. It accumulates in the atmosphere with other greenhouse gasses causing a gradual rise in the earth's temperature. This leads to increased risks to human health, a rise in sea level, and other adverse changes to plant and animal habitat. **Visibility Impairment**: Nitrate particles and NO_2 can block the transmission of light, reducing visibility in urban areas and on a regional scale in other areas. **Aesthetic Damage:** Acid rain damages cars, buildings, and historical monuments.

Table 1. Criteria Pollutants - Sources and Impacts

Pollutants and Their Sources	***Health and Environmental Impacts***
Particulates (PM_{10} and $PM_{2.5}$): Particulate matter (PM) is the term for particles found in the air, including dust, dirt, soot, smoke, and liquid droplets. Particles can be suspended in the air for long periods of time. Some particles are large or dark enough to be seen as soot or smoke. Others are so small that individually they can only be detected with an electron microscope. Some particles are directly emitted into the air. They come from a variety of sources such as cars, trucks, buses, factories, construction sites, tilled fields, unpaved roads, stone crushing, and burning of wood. Other particles may be formed in the air from the chemical change of gases. They are indirectly formed when gases from burning fuels react with sunlight and water vapor. These can result from fuel combustion in motor vehicles, at power plants, and in other industrial processes.	**Health Problems**: Many scientific studies have linked breathing PM to a series of significant health problems, including: Aggravated asthma. Increases in respiratory symptoms (e.g., coughing; difficult or painful breathing etc.). Chronic bronchitis. Decreased lung function. Premature death. **Plant and Ecosystem Damage:** PM can be carried over long distances by wind, settling on ground or water. The effects of this atmospheric deposition include: Contributing to acidification of water bodies. Changing the nutrient balance in coastal waters and large river basins. Depleting the nutrients in soil. Damaging sensitive forests and farm crops. **Visibility impairment:** PM is the major cause of reduced visibility (haze) in parts of the United States. **Aesthetic damage:** Soot, a type of PM, stains and damages stone and other materials, including culturally important objects such as monuments and statues.

Legend: CO = carbon monoxide; NO_x – nitrogen oxides; NO_2 = nitrogen dioxide; N_2O = nitrous oxide; O_3 = ozone; PM = particulate matter; SO_2 = sulfur dioxide; SO_x = sulfur oxides; VOC = volatile organic compound.
Source: USEPA 2012b.

The NAAQS are comprised of primary and secondary standards, as in Table 2. The primary standards were established to protect human public health. Typical sensitive land uses and associated sensitive receptors protected by the primary standards include publicly accessible areas, such as residences, hospitals, libraries, churches, parks, playgrounds, and schools. The secondary standards were established to protect the environment, including plants and animals, from adverse effects associated with pollutants in the ambient air.

The CNMI Air Pollution Control Regulations require compliance with NAAQS and permitting for stationary sources of air emissions. The CNMI Bureau of Environmental and Coastal Quality reviews air permit applications and issues air permits for stationary sources.

Table 2. National and CNMI Ambient Air Quality Standards for Criteria Pollutants

Pollutant		***Primary/ Secondary***	***Averaging Time***	***Level***	***Form***
Carbon Monoxide		Primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead		primary and secondary	Rolling 3-month average	0.15 μg/m$^{3(1)}$	Not to be exceeded
Nitrogen Dioxide		primary	1-hour	100 ppb	98th percentile, averaged over 3 years
		primary and secondary	Annual	53 ppb$^{(2)}$	Annual mean
Ozone		primary and secondary	8-hour	0.075 ppm$^{(3)}$	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particulate Matter	$PM_{2.5}$	primary	Annual	12 μg/m$^{3(4)}$	Annual mean, averaged over 3 years
		secondary	Annual	15 μg/m^3	Annual mean, averaged over 3 years
		primary and secondary	24-hour	35 μg/m^3	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24-hour	150 μg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide		primary	1-hour	75 ppb$^{(5)}$	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

Legend: ppm = parts per million; ppb = parts per billion; μg/m^3=micrograms per cubic meter.

Notes: [1]Final rule signed October 15, 2008. The 1978 lead standard (1.5 μg/m^3 as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978 standard, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.

[2]The official level of the annual nitrogen dioxide standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of a clearer comparison to the 1-hour standard.

[3]Final rule signed March 12, 2008. The 1997 ozone standard (0.08 ppm, annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years) and related implementation rules remain in place. In 1997, the USEPA revoked the 1-hour ozone standard (0.12 ppm, not to be exceeded more than once per year) in all areas, although some areas have continued obligations under that standard ("anti-backsliding"). The 1-hour ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.

[4]Final rule signed January 15, 2013. The primary annual fine particle ($PM_{2.5}$) standard was lowered from 15 to 12 μg/m^3.

[5]Final rule signed June 2, 2010. The 1971 annual and 24-hour sulfur dioxide standards were revoked in that same rulemaking. However, these standards remain in effect until one year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.

Source: USEPA 2012c.

The air emissions that may result from the proposed action are addressed in this study for all criteria pollutants with the exception of lead. Lead emissions have been reduced significantly over years as a result of federal programs to control vehicle emissions by eliminating the use of lead-containing fuel. Ozone is a regional pollutant that normally is not addressed on a project basis; however, its precursor's emissions (NO_x and VOCs) are quantified in this study.

1.1.2 Attainment Status and Area Classification and Clean Air Act Conformity

Areas where concentration levels are below the NAAQS for a criteria pollutant are designated as being in "attainment." Areas where a criteria pollutant level equals or exceeds the NAAQS are designated as being in "nonattainment." Based on the severity of the pollution problem, nonattainment areas are categorized as marginal, moderate, serious, severe, or extreme. Where insufficient data exist to determine an area's attainment status, it is designated as either unclassifiable or in attainment.

The CAA, as amended in 1990, mandates that state agencies adopt State Implementation Plans that target the elimination or reduction of the severity and number of violations of the NAAQS in a nonattainment area. State Implementation Plans set forth policies to expeditiously achieve and maintain attainment of the NAAQS. For those nonattainment areas that are redesignated attainment, the state is required to develop a 10-year maintenance plan to ensure that the areas remain in attainment status for the same pollutant.

The CAA, as amended in 1990, also expands the scope and content of the act's conformity provisions in terms of their relationship to the State Implementation Plan. Under Section 176(c) of the CAA, a project is in "conformity" if it corresponds to State Implementation Plans' purpose of eliminating or reducing the severity and number of violations of the NAAQS and achieving their expeditious attainment. Conformity further requires that such activities would not:

- Cause or contribute to any new violations of any standards in any area
- Increase the frequency or severity of any existing violation of any standards in any area
- Delay timely attainment of any standard or any required interim emission reductions or other milestones in any area

The USEPA published final rules on general conformity (40 CFR Parts 51 and 93) in the Federal Register on November 30, 1993 and subsequently revised the rules on March 24, 2010. The rules apply to federal actions in nonattainment or maintenance areas for any of the applicable criteria pollutants. The rules specify *de minimis* emission levels by pollutant to determine the applicability of conformity requirements for a project. A conformity applicability analysis is the first step of a conformity evaluation and assesses if a federal action must be supported by a conformity determination. However, the rules do not apply in unclassifiable/attainment areas for the NAAQS.

Both Tinian and Pagan are unclassifiable and are considered in attainment for all criteria pollutants; therefore, the rules do not apply to the proposed action and a general conformity applicability analysis is not required.

1.1.3 Stationary Source Permitting Regulation

Stationary sources of air emissions include combustion turbines, boilers, generators, and fuel tanks. The 1990 amendments to the CAA set permit rules and emission standards for pollution sources of certain sizes. An air permit application is submitted by the prospective owner or operator of an emitting source in order to obtain approval of the source construction permit. A construction permit generally specifies a time period within which the source must be constructed. Permits are reviewed for any modifications to the site or the air emissions sources to determine permit applicability.

The USEPA oversees the programs that grant stationary source operating permits (Title V of the CAA) and new or modified major stationary source construction and operation permits. The New Source Review program requires new major stationary sources or major modifications of existing major stationary sources of pollutants to obtain permits before initiating construction. The New Source Performance Standards apply to sources emitting criteria pollutants, while the National Emission Standards for hazardous air pollutants apply to sources emitting hazardous air pollutants.

Hazardous air pollutants, also known as toxic air pollutants, are chemicals that can cause adverse effects to human health or the environment. The 1990 amendments to the CAA directed the USEPA to set standards for all major sources of air toxics. Thus, the USEPA established a list of 188 hazardous air pollutants. This list includes substances that cause cancer, neurological, respiratory, and reproductive effects.

The Title V major source thresholds for pollutant emissions that are applicable to Tinian and Pagan are:

- 100 tons per year for any criteria pollutant
- 25 tons per year total hazardous air pollutants
- 10 tons per year for any one hazardous air pollutant

The USEPA also established Prevention of Significant Deterioration (PSD) regulations to ensure that air quality in attainment or unclassified areas does not significantly deteriorate as a result of construction and operation of major stationary sources. A PSD increment is the maximum allowable increase in concentration of a pollutant that is allowed to occur above a baseline concentration. A typical major PSD source is classified as any source of air pollutant emissions with the potential to emit 250 tons per year of any regulated pollutant in an attainment area. However, for several types of major source operations, including fossil fuel-fired steam electric plants of more than 250 million British Thermal Units per hour heat input, 100 tons per year is the major PSD threshold.

Because the proposed activities would not affect the permitted operational capacity of existing power facilities on Tinian and would not involve installation of any permanent stationary sources on Pagan, no adverse air quality impacts from stationary sources (i.e., new or modified fixed or immobile facilities) would occur. Therefore, an impact analysis for stationary sources is not warranted. However, several backup emergency diesel generators that are exempt from above permitting regulations would be installed on Tinian and the potential operating emissions from these generators were quantified.

1.1.4 Mobile Sources Regulation

Mobile sources would result from the following operational components of the proposed action:

- Aircraft around airport
- Aircraft around training ranges
- Marine vessels along shoreline
- Ground vehicles within and around training ranges
- Supporting equipment emissions within the base camp and training ranges
- Weapons firing within training ranges
- Construction equipment and vehicles within project areas

The emissions from these mobile sources are regulated under Title II of the CAA, which establishes emission standards that manufacturers must achieve. Therefore, unlike stationary sources, no permitting requirements exist for operating mobile sources.

1.2 GREENHOUSE GAS EMISSIONS

Greenhouse gases are gas emissions that trap heat in the atmosphere. These emissions occur from natural processes and human activities. The primary long-lived greenhouse gases directly emitted by human activities are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).

Scientific evidence indicates a trend of increasing global temperature over the past century due to an increase in greenhouse gas emissions from human activities. The heating effect from these gases is considered the probable cause of the global warming observed over the last 50 years (Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the CAA; Final Rule 2009). The climate change associated with this global warming is predicted to produce negative economic and social consequences across the globe. Under Section 202(a) of the CAA, the USEPA Administrator has recognized potential risks to public health or welfare and signed an endangerment finding regarding greenhouse gases (USEPA 2009a). This finding indicates that the current and projected concentrations of greenhouse gases in the atmosphere threaten the public health and welfare of current and future generations.

To estimate global warming potential (GWP), all potential greenhouse gas contributions are expressed relative to a reference gas, CO_2, which is assigned a GWP equal to one. All six greenhouse gases are multiplied by their GWP and the results are added to calculate the total equivalent emissions of carbon dioxide (CO_2e). However, the dominant greenhouse gas emitted is CO_2, mostly from fossil fuel combustion. This EIS/OEIS considers CO_2 as the representative greenhouse gas emission.

On a national scale, federal agencies are addressing emissions of greenhouse gases by reductions mandated in federal laws and Executive Orders. Most recently, Executive Order 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*, and Executive Order 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*, were enacted to address greenhouse gases, including greenhouse gas emissions inventory, reduction, and reporting. The Department of the Navy has implemented a number of renewable energy projects in an effort to reduce energy consumption, reduce greenhouse gases, reduce dependence on petroleum, and increase the use of renewable resources in accordance with the goals set by Executive Order 13123 (subsequently replaced by Executive Order 13423) and the Energy Policy Act of 2005.

This CJMT EIS/OEIS follows the *Draft NEPA Guidance on Consideration of the Effects of Climate Change and Greenhouse Gas Emissions* issued by the Council on Environmental Quality (CEQ) (2010). Although greenhouse gas emissions occur locally, the potential effects of greenhouse gas emissions are by nature global in scale, and accumulate geographically and over time. As individual sources of greenhouse gas emissions are not large enough to have an effect on global climate change, this CJMT EIS/OEIS predicts CO_2 levels as appropriate for disclosure purposes.

1.3 Volcano Emissions

The composition of volcanic gases erupted at a volcano vent is, in general, controlled by the equilibrium between a hydrous fluid at the top and the silicate melt in the magma chamber below. It varies widely between volcanoes depending on the magma type, and is also dependent on the individual volcano's state of activity.

Sulfur dioxide is one of the most common gases released in volcanic eruptions (following water and CO_2 with 2 to 35% by volume of volcanic gas emissions) and is of concern on the global scale due to its potential to influence climate. Sulfur dioxide is a colorless gas with a characteristic and irritating smell. This odor is perceptible at different levels, depending on the individual's sensitivity, but is generally perceived between 0.3 to 1.4 parts per million and is easily noticeable at 3.0 parts per million. On contact with moist membranes, SO_2 forms sulfuric acid, which is responsible for its severe irritant effects on the eyes, mucous membranes, and skin. On the local scale, SO_2 is a hazard to humans in its gaseous form, and also because it oxidizes to form sulfate aerosol.

Typically, the concentration of SO_2 in dilute volcanic plumes is less than 10 parts per million at 6.6 miles (10 kilometers) downwind of the source. Assuming that the gas has a half-life of 6 to 24 hours, only about 5% of the emitted gas is present in the lower atmosphere after 1 to 4 days.

1.4 Criteria Pollutant and Greenhouse Gas Emissions Analysis

The air emissions analysis was performed for both construction and operational phases under each alternative. All reasonably foreseeable emissions (both direct and indirect) associated with the implementation of the proposed action were quantified and compared to the 250 tons per year threshold on an annual basis to determine potential air quality impacts. If the total emissions exceed this threshold, a further evaluation of the emissions resulting from each activity element was conducted to assess the emissions impact on sensitive land uses on a local basis to determine the potential significance of the air quality impacts.

1.4.1 Construction Emissions

Increased direct and indirect criteria pollutants and greenhouse gas emissions would result from the following potential construction activities:

- Use of diesel and gas-powered demolition and construction equipment
- Movement of trucks containing construction and removal materials
- Commuting of construction workers

1.4.1.1 Construction Activity Forecasts

On Tinian, the proposed work includes the construction of various training ranges and support facilities throughout the islands of Tinian and Pagan, within the CNMI. Table 3 and Table 4. Construction Elements on Pagan summarize the construction elements at Tinian and Pagan, followed by a description of prototype elements (whose use is described in the tables and detailed in the following sections).

The equipment, material, and manpower requirements for the construction associated with the CJMT facilities on Tinian and Pagan were estimated to calculate construction-related emissions. Estimates of construction crew and equipment requirements and productivity are based on data presented in:

- *2003 RSMeans Facilities Construction Cost Data* (RSMeans 2002)
- *2011 RSMeans Facilities Construction Cost Data* (RSMeans 2010)

The assumptions and calculations presented below are based on information provided in the EIS/OEIS that provides planning-level descriptions of the proposed action associated construction/earth disturbance layouts under each alternative. The construction duration is anticipated to be 8 to 10 years.

Many of the training elements identified above are similar in terms of primary construction elements. To that end, several prototype elements are used to extrapolate to the overall construction effort.

Table 3. Construction Elements on Tinian

	Tinian Elements	*Common Elements*	*Alternative-Specific Options*
1	Base Camp	1,500 trainees in 15 open-bay barrack buildings (est. at 112,500 SF), and various other buildings (HQ, dining, medical aid, security & fire protection, utilities, fuel storage, etc. – estimated at total of 195,000 SF) plus 20 ac. of vehicular pavement. Total area of disturbance is 253 ac.	
2	Munitions Storage	Permanent munitions storage area; 8 acres is new impervious surface. Assume building space totals 140,000 SF and the remaining impervious surface is vehicular pavement (4.5 ac).	
3	Airport Improvements	41 acres of new impervious space created; approximately 30 acres is aircraft pavement and remainder vehicular pavement.	
4	Port of Tinian Improvements	5 acres of new impervious surface. Assume 1 acre is for a new building and the remainder is vehicular pavement. Assume remaining two acres is general stormwater pond (2 ac., general clearing & grading)	
5	Bulk Fuel Storage	Assume 25,000 SF of vehicular pavement to create base for the storage tanks, but that tanks themselves are prefab and installation effort is incidental.	
6	Access Road Improvements	133 ac. total of ground disturbance, of which 83 ac. is new impervious surface. Assume remaining 50 ac. represents replacement pavement, so 133 ac. of vehicular pavement to be installed.	
7	Utilities	Utilities would be installed in a number of different configurations, including underground along roadways and above ground. Assume a utility prototype for complete underground installation of water, sewer, electric, etc. utilities along roadways is a conservative overestimate, and that approximate 30 miles of utility are to be constructed. For solid waste transfer building, add a 20,000 SF new building.	

Table 3. Construction Elements on Tinian

	Tinian Elements	*Common Elements*	*Alternative-Specific Options*
8	Range Complex A	Includes 527 acres, which would require clearing for target placement, requiring general clearing.	
9	Range Complex B	Includes 47 acres, which would require clearing for target placement, requiring general clearing.	
10	Range Complex C	Includes 80 acres, which would require clearing for target placement, requiring general clearing. In addition, 20 open-roof target structures would be constructed. For estimate purposes, it is assumed that these have a total footprint of 40,000 SF.	
11	Range Complex D		For alternatives 1 and 2, 486 ac. would be cleared. For alternative 3, 453 ac. would be cleared.
12	Field Artillery Indirect Range	85 acres to be cleared for firing points.	
13	Convoy Course		For alternative 1, 97 acres of ground disturbance. For alternatives 2 and 3, 143 acres.
14	Tracked Vehicle Drivers' Course	100 acres to be cleared for driving courses.	
15	Tactical Amphibious Beach Landing	22,600 cu. meters of dredging, and require installation of an estimated 520 piles, 1,300 LF of sheeting to 40-ft depth and temporary trestles.	
16	Observation Posts	Assume eight 2,000 SF pre-engineered structures to be built (so 16,000 SF total) as equivalent measure to the elevated unprotected structures, and that 0.5 acres would require clearing.	
17	Surface Radar Sites	Assume six 4,000 SF pre-engineered structures to be built (so 24,000 SF total) as equivalent measure to the radar stations, and that 1 acre would require clearing.	
18	International Broadcasting Bureau		For alternative 1, no change. For alternatives 2 and 3, assume a new 20,000 SF structure.

Table 4. Construction Elements on Pagan

	Pagan Elements	*Common Elements*	*Alternative-Specific Options*
1	Base Camp	Bivouac area for 2,000, with surge capacity of 4,000; no permanent facilities, only prepared ground for camping. Total area is 42 acres.	
2	Expeditionary Airfield	Approximately 41 acres of ground disturbance; assumed this is entirely new aircraft pavement.	
3	Munitions Storage	Assumes a 10-acre pad (vehicular pavement, grading and clearing) and an additional 9 acres of clearing to create access, but no new roads to be constructed.	
4	Training Trails	39 acres would be cleared and graded.	
5	North Range Complex	A total of 319 acres would be cleared.	
6	South Range Complex		For alternative 1, 167 acres would be cleared.

1.4.1.1.1 General Range Clearing and Grading

On a per acre basis, for basic removal and grading:

- Clear and grub, cut and chip light trees to 6 inches (15 centimeters)

  Grade subgrade for base course, roadways, and finish grade slopes over 1 acre (0.40 hectare)

1.4.1.1.2 Open-Roof Training Structures

Assume each structure occupies a 1,000-square foot footprint (40 feet x 25 feet). Buildings are assumed to not have any utility services.

- Foundation, assumes a mat foundation, 40-feet x 25-feet (12 meters x 7.6 meters)
- Finishing grade slopes, gentle 1,000 square feet (93 square meters)
- Footprint site preparation, gravel placed over entire building footprint, 12-inch thick lift x 111 square feet = 1,000 cubic feet (28 cubic meters)
- Concrete slab, 130 linear feet (40 meters), 24 inches (0.6 meter) high
- Rebar, 8 linear feet per square-foot of slab = 21.36 pounds/square foot; total = 11 tons
- Concrete, 15-inch thick slab. 1,000 square feet x 15 inches = 1,250 cubic feet (35 cubic meters)
- Enclosure, precast concrete panels (8-foot high x 16 feet x 4 feet), total perimeter per structure is 130 linear feet (40 meters), wall area of 1,040 square feet (93 square meters)

1.4.1.1.3 Base Camp

1.4.1.1.3.1 Tinian

For permanent base camp installations, it is assumed that the general construction prototypes developed above or for similar purposes on Guam represent an equivalent or conservative measure. On Tinian, a basic “austere” camp is to be provided, while at Pagan an expeditionary bivouac area is to be provided.

The base camp at Tinian is designed to support up to 1,500 trainees in 15 permanent, open-bay barracks. Tent pads and a temporary mess hall would also be constructed to support an additional 1,500 surge trainees, providing a total capacity of to accommodate 3,000 personnel at the base camp.

It is assumed that a 200-square feet per trainee space allowance is required in the camp accommodations (i.e., approximately 600,000 square feet or 14 acres [5.7 hectares]).

For other base camp installations on Tinian (ammunition storage, range control), it is assumed that the industrial and commercial building prototypes employed in the Guam and the CNMI Military Relocation EIS are comparable. Sizes are not specified, but based on a maximum mobilization of 3,000 personnel and an assumption that 10% of this number act in a command or logistics capacity, it is assumed that the range control complex must accommodate 300 people in a commercial-type building, with a space requirement of 200 square feet (19 square meters) per command personnel (60,000 square feet [5,575 square meters] total); similarly, assuming a 20 square feet (19 square meters) per trainee requirement for ammunition storage, a 60,000-square feet (5,575 square meters) industrial building is required.

1.4.1.1.3.2 Pagan

On Pagan, an expeditionary base camp/bivouac area would be provided with space for up to 2,200 personnel, with additional surge capacity to accommodate up to 4,000 personnel. There would be no permanent buildings; only minimal facilities (e.g., established tent pads). A bivouac area would consist of crushed and compacted lava rock. This is assumed to be entirely in a camp (bivouac) setting, with an allowance of 200 square feet (19 square meters) per person (200,000 square feet or 1,860 square meters total), using general site clearing prototype, above, for 5 acres (2 hectares).

A munitions storage area would be established north of the airfield. It would consist of: (1) security fencing; (2) open magazines; (3) a munitions assembly pad; (4) a munitions storage area; (5) a load/unload dock (pad); and (6) a biosecurity pad. Exact size is not specified in Chapter 2, but it is assumed that 2,000 square feet (185 square meters) would be sufficient.

1.4.1.1.4 Airfield Improvements

Airfield improvements at Tinian consist primarily of providing new paved areas for taxiways, cargo pads, parking, etc. While some other incidental structures are to be constructed, it is assumed that in general new pavement with a 21-inch (53-centimeter) typical cross-section is used. The prototype, per acre, is defined as follows:

- Grading – Grade subgrade for base course, roadways and finishing grade slopes, gentle, 4,840 square yards (1 acre) each.

- Base Courses – 8-inch (20-centimeter) deep and 6-inch (15-centimeter) deep, 4,840 square yards (1 acre) each.
- Pavement – Asphaltic concrete, 4-inch (10-centimeter) thick binder course and asphaltic concrete, 3-inch (7.5-centimeter) thick wearing course, 4,840 square yards (1 acre) each.
- For Tinian, an aerial extent of 5 acres (2 hectares) substantively represents the extent of airfield construction. The areal extent of airfield improvements at Pagan is not specified; however, 10 acres (4 hectares) is assumed.

1.4.1.1.5 Roadway Construction

Roadway construction requirements were not quantified but were estimated from the EIS/OEIS figures based on approximate measuring of roadway lengths. The per-acre prototype for roadway pavement is as follows:

- Grading – grade subgrade for base course, roadways and finishing grade slopes, gentle, 4,840 square yards (1 acre).
- Base Course – 8-inch (20-centimeter) deep, square yards (1 acre).
- Pavement – Asphaltic concrete, 4-inch (10-centimeter) thick binder course and 1.5-inch (4-centimeter) thick wearing course, 4,840 square yards (1 acre).

It is assumed that all roadways are 25-feet (7.6-meters) wide. Based on scaling from EIS/OEIS figures, it is estimated that approximately 20 miles (61 acres) of roadways are required on Tinian. Also required is a 5-mile (16-acre) stretch of roadway on Tinian for convoy course live-fire training exercises.

On Pagan, roadway improvements consist of gravel roadways without pavement. The extent of new roadways is estimated at approximately 22 miles (35 kilometers). All roads are assumed to be 16-feet (5-meters) wide.

- Grading –Grade subgrade for base course, roadways and finishing grade slopes, gentle 4,840 square yards (1 acre).
- Base Course – 8-inch (20-centimeter) deep, 4,840 square yards (1 acre).

1.4.1.2 Construction Emissions Forecasts

Estimates of the emissions from construction equipment were developed based on the estimated hours of equipment use and the emission factors for each type of equipment. Given the lack of specific construction schedule for individual projects as summarized in Table 5, the total construction emissions were evenly distributed in each construction year. Emission factors were taken from USEPA's NONROAD emission factor model (USEPA 2009b) for Tier 2 engines associated with the national default model database for non-road engines. The quantity and type of equipment necessary were determined based on the activities necessary to implement the proposed action as described above. All equipment was assumed to be diesel-powered unless otherwise noted. Pieces of equipment to be used include, but are not limited to:

- Backhoes
- Compressors
- Cranes
- Dozer
- Dredges
- Excavators
- Front end loaders
- Gas engine vibrators
- Grader
- Concrete pumps
- Hammers
- Construction trucks

The USEPA recommends the following formula to calculate hourly emissions from non-road engine sources including cranes, front end loaders, and other machines:

- M_i = N x HP x LF x EF_i where:
- M_i = mass of emissions of i^{th} pollutants during inventory period;
- N = source population (units);
- HP = average rated horsepower;
- LF = typical load factor; and
- EF_i = average emissions of i^{th} pollutant per unit of use (e.g., grams per horsepower-hour).

Truck and commuting vehicle operations would result in indirect emissions. It is assumed each truck or commuting vehicle trip would take a 20-mile (32-kilometer) round trip to and from the project area. USEPA's Motor Vehicle Emission Simulator (MOVES) program was used to predict truck and commuter vehicle running emission factors for all criteria pollutants and CO_2 (USEPA 2012a). The national default input parameters available for Virgin Islands were used in emissions factor modeling per USEPA recommendation. Samples of MOVES input and output printout are shown in Attachment 1. Detail construction emissions estimate worksheets are included in Attachment 2.

1.4.1.2.1 Construction Emissions on Tinian

The total predicted annual air emissions resulting from potential construction activities on Tinian under Alternatives 1 through 3 are evenly divided over the likely nine years as summarized in Table 5. The annual emissions are well below the 250 tons (227 metric tons) per year threshold; therefore, construction under each Tinian alternative would result in less than significant impacts to air quality.

Table 5. Annual Construction Emissions on Tinian

Construction Year	*Pollutant (tons per year)*						
	SO_2	*CO*	*PM_{10}*	*$PM_{2.5}$*	*NO_x*	*VOC*	*CO_2*
1-9	**Alternative 1**						
	0.19	9.25	0.69	0.65	8.09	1.71	1207.57
	Alternative 2						
	0.19	9.49	0.70	0.66	8.20	1.75	1223.55
	Alternative 3						
	0.19	9.30	0.69	0.65	8.12	1.72	1210.85

Legend: CO = carbon monoxide; CO_2 = carbon dioxide; NO_x = nitrogen oxides; PM_{10} = particulate matter with an aerodynamic diameter of less than or equal to a nominal 10 micrometers; $PM_{2.5}$ = particulate matter with an aerodynamic diameter of less than or equal to a nominal 2.5 micrometers; SO2 = sulfur dioxide; VOC = volatile organic compound.

Note: 250 tons per year comparative impact threshold does not apply to CO_2.

1.4.1.2.2 Construction Emissions on Pagan

The total annual emissions on Pagan under Alternatives 1 and 2 are evenly but conservatively divided over the first four years assuming construction activities on Pagan would be front loaded as summarized in Table 6. Total emissions are well below the 250 tons (227 metric tons) per year threshold; therefore, construction activities under Pagan Alternatives 1 and 2 would result in less than significant impacts to air quality.

Table 6. Annual Construction Emissions on Pagan

Construction Year	*Pollutant (tons per year)*						
	SO_2	*CO*	*PM_{10}*	*$PM_{2.5}$*	*NO_x*	*VOC*	*CO_2*
1-4	**Alternative 1**						
	0.07	5.76	0.33	0.31	3.00	1.14	369.53
	Alternative 2						
	0.05	4.21	0.24	0.23	2.22	0.84	273.91

Note: 250 tons per year comparative impact threshold does not apply to CO_2.

1.4.2 Operational Emissions

The equipment horsepower values were provided by the training personnel and equipment power load factors were obtained in association with the NONROAD emission factors.

1.4.2.1 Aircraft Airport Emissions

Operational category emissions would remain the same for each alternative. Although the alternatives are located in different areas, the number of operations would remain the same based on training requirements. The detail-calculated aircraft emissions at the airports are shown in Attachment 3 of this report.

Aircraft and helicopter engines emit criteria pollutants during all phases of operation whether climb out, approach, touch and go, Ground Control Approach Box, or cruise. Aircraft emissions were estimated based on the number of additional flight operations at Tinian on an annual basis as described in the noise section of the Supplemental EIS and the aircraft emissions factors provided primarily by the Navy Aircraft Environmental Support Office (AESO) (AESO 1999-2002).

Under the Tinian action alternatives, the estimated aircraft trip numbers associated with the notional airlift requirements are considered. The rotary-wing sorties would be between Andersen Air Force Base North Field on Guam and Tinian International Airport (West Field). A biosecurity quarantine protocol would be developed for other tactical and training requirements.

Marine Corps rotary-wing (CH-53), tilt-rotor aircraft (MV-22), and fixed-wing aircraft (C-130) are planned to provide personnel and equipment lift to Tinian. These aircraft may use either Tinian International Airport (also termed West Field) or North Field. Other modes of aviation movement include Air Force C-17 and/or C-130 aircraft.

Under the Pagan action alternatives, the estimated aircraft trip numbers associated with the airlift requirements are used for emissions estimate. The rotary-wing sorties would be between Andersen Air Force Base North Field on Guam, Tinian International Airport (West Field), and Pagan. Rotary- and fixed-wing aircraft would provide personnel and equipment lift to Pagan. In-flight or ground refueling would be required for organic rotary-wing (CH-53) and tilt-rotor aircraft (MV-22) transiting between Pagan and Guam. Marine fixed-wing aircraft (C-130) may also provide personnel and equipment lift to Pagan.

Air pollutants would be emitted during all phases of these operations, including on-ground parking and engine idling, maintenance testing, and flight. Future annual emissions of criteria pollutants were estimated using:

- *Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources* (USEPA 1992)
- Navy aircraft engine emission factors developed by the Navy's Aircraft Environmental Support Office (AESO 1999-2002)
- Joint Strike Fighter (JSF) emission factor worksheets (Joint Strike Fighter Work Force 2009)
- *Air Emissions Guide for Air Force Mobile Sources* (Air Force Civil Engineer Center 2013) and *Federal Aviation Administration Emissions and Dispersion Modeling System (Version 5.0.1)* for other non-naval aircraft emissions factors (Federal Aviation Administration 2014)

The airfield operations types for the no-action and proposed action scenarios include departures, straight-in (non-break) arrivals, overhead break arrivals, touch-and-go patterns, and ground controlled approach patterns.

Procedures to calculate emissions for each aircraft type typically include the following steps:

- Obtain emission factors for each aircraft engine type
- Consider the range of operation types for each aircraft
- Apply the applicable aircraft operating mode associated with annual flight operations
- Calculate the emission rates for each aircrafts' type and operating mode by multiplying the respective emissions rates by annual flight operation numbers
- Determine the total annual emissions by combining the emissions from all operations for all aircraft types

Although air pollutant emissions occur during all phases of aircraft operation (parking, idling, and in-flight), only those emissions emitted in the lower atmosphere's mixing layer have the potential to result in ground-level ambient air quality impacts. The mixing layer is the air layer extending from ground level up to the point at which the vertical mixing of pollutants decreases significantly. The USEPA recommends that a default mixing layer of 3,000 feet (914 meters) be used in aircraft emission calculations (USEPA 1992). Consistent with this recommendation, aircraft emissions released above 3,000 feet (914 meters) were not included in this study. Emissions results for aircraft operations at the airport/airfield are summarized in Table 7 and detailed in Attachment 3.

Table 7. Annual Aircraft Emissions around Airports

Pollutant (tons per year)						
SO_2	*CO*	*PM_{10}*	*$PM_{2.5}$*	*NO_x*	*VOC*	*CO_2*
Aircraft Sorties around Tinian International Airport						
8.12	256.27	42.69	42.69	89.02	75.18	25048.85
Aircraft Sorties around Pagan Airport						
2.98	74.22	17.16	17.16	42.66	29.71	7607.25

1.4.2.2 Aircraft Emissions during Training Exercise

Annual training flight missions and flight hours within 3,000 feet (914 meters) above ground defined in both Tinian and Pagan were based on information described in Chapter 2, *Proposed Action and Alternatives*, of this EIS/OEIS. The annual training hours for each aircraft type during the exercise were forecasted based on the scale of training event and the number of events on an annual basis. The emissions from aircraft flight operations were estimated using the same references as described in Section 1.4.4.1.

The emissions from aircraft training at existing airfields were estimated using the same methods and emission factors guidance described previously. The annual aircraft training flight emissions are summarized in Table 8 and detailed in Attachment 3.

Table 8. Training Annual Emissions

Pollutant (tons per year)						
SO_2	*CO*	*PM_{10}*	*$PM_{2.5}$*	*NO_x*	*VOC*	*CO_2*
Aircraft Training Exercises on Tinian						
2.74	3.25	11.29	11.29	28.70	0.37	3740.83
Aircraft Training Exercises on Pagan						
2.29	2.31	8.00	8.00	42.64	0.28	4810.82

1.4.2.3 Marine Vessel Training Emissions

Administrative and non-tactical logistics movement of equipment and personnel would be by commercial or military vessels including, but not limited to, High Speed Vessels, commercial high-speed ferry, other ferry, or other passenger/cargo vessel. Marine emissions come primarily from diesel engines operating on oceangoing vessels, tugs and tows, and other vessels operating near the shoreline around training ranges.

The emissions from training vessels, including barges, were calculated using vessel type and number during each event, associated engine power levels for each vessel, operational hours per event and number of event per year provided by the training team. Vessel emissions were calculated using the methodologies, emission factors, and load factors related to diesel marine vessels obtained from *Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories* (USEPA 2009c).

Potential ship transportation to Tinian includes U.S. Navy Dock Landing Ships and High Speed Vessels or contracted commercial shipping. All units (personnel and equipment) moving to Tinian via ship would disembark at Tinian's commercial pier.

A total running time was calculated by adding any additional idling time that may occur. The marine vessel operational running times are detailed in Attachment 4.

The total running time was then multiplied by the emission factor for each vessel. The marine vessel training operational emissions are summarized in Table 9. These emissions are considered to be the same for all action alternatives.

Table 9. Marine Vessel Annual Emissions

Pollutant (tons per year)						
SO_2	*CO*	*PM_{10}*	*$PM_{2.5}$*	*NO_x*	*VOC*	*CO_2*
Marine Vessels on Tinian						
31.61	8.85	3.75	3.43	106.28	4.02	5144.48
Marine Vessels on Pagan						
2.18	0.84	0.27	0.25	10.22	0.36	353.86

1.4.2.4 Ground Training Vehicles Emissions

Training operations associated with the action alternative would generate emissions from ground vehicle training operations on both paved and unpaved roadways.

Ground transportation would be provided by each unit transporting its own organic equipment required for training. These would include high mobility multipurpose wheeled vehicles, medium tactical vehicle replacements, 7-ton trucks, battalion landing team artillery, amphibious assault vehicles, and light armored vehicles.

In addition to the above, various types of military and commercial vehicles are planned for permanent support of administrative and range maintenance functions. These include approximately eight buses, two cars, and five commercial flat-bed trucks. Also, forklifts, dump trucks, fire trucks, firefighting water supply trucks, commercial 4-wheel drive trucks, and mowers would be dedicated to base functions.

Ground training vehicle exhaust emissions from trucks, high mobility multipurpose wheeled vehicles, and buses used during training exercises were estimated with the same method used to predict construction vehicle emissions. The USEPA MOVES emission factor model (USEPA 2012a) was used to predict emissions factors associated with each type of training vehicle. The model-established emission factors that are based on the average weight and fuel type of each type of training vehicle. The emission factors were then multiplied by the annual vehicle running hours to determine exhaust emissions on an annual basis.

In addition, because most of these training vehicles would maneuver on paved roads, unpaved roads and military training trails with potential to generate fugitive dust, the USEPA AP-42, *Compilation of Air Pollution Emission Factors* (USEPA 1995) was used to predict fugitive dust emissions from training vehicles. Given the lack of inputs to divide the time for training vehicle running on paved or unpaved roads, it is conservatively assumed that roadway surface fugitive dust emissions would be all generated from unpaved roadways. Total training vehicle operational exhaust emissions and fugitive dust emissions are shown in Table 10 for activities on Tinian and Pagan and detailed in Attachment 4.

Table 10. Ground Vehicle Annual Emissions

Pollutant (tons per year)						
SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
Ground Vehicles on Tinian						
13.38	42.31	109.13	19.38	141.71	9.11	1192.42
Ground Vehicles on Pagan						
32.80	94.12	155.51	35.46	335.45	20.41	1421.42

1.4.2.5 Supporting Equipment Emissions

It is anticipated that during the training exercises, other supporting mobile equipment such as water and fuel trucks, forklift, etc. would be required and operational hours during annual training events were estimated by the training team. The supporting mobile equipment emission factors are based on the NONROAD model database (USEPA 2009b) and the methodologies used are the same as those used for construction equipment emissions as described in Section 1.4.2. The emission factors were multiplied by the annual mobile equipment running hours to determine emissions on an annual basis. The estimated annual supporting equipment emissions are summarized in Table 11 and detailed in Attachment 4.

Table 11. Training Support Equipment Annual Emissions

Pollutant (tons per year)						
SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
Support Equipment on Tinian						
0.17	3.43	16.48	2.12	7.50	0.64	794.05
Support Equipment on Pagan						
0.02	0.49	1.24	0.20	0.92	0.09	102.75

1.4.2.6 Mobile and Stationary Generator Emissions

To support the training exercises, multiple mobile power generators would be implemented and several back-up stationary generators would be installed at the Base Camp and a total of six Surface Radar sites. The USEPA AP-42, *Compilation of Air Pollution Emission Factors* (USEPA 1995) and the anticipated training associated mobile diesel generator parameters in terms of number, size, and operating hours on an annual basis were used to predict mobile generator emissions. For permanent stationary emergency diesel generators, a maximum of 500 hours of emergency operational capacity was assumed for each stationary generator in predicting emissions. The generator emissions predicted are summarized in Table 12 and detailed in Attachment 5.

Table 12. Mobile and Stationary Generator Annual Emissions

Pollutant (tons per year)						
SO_2	***CO***	***PM_{10}***	***$PM_{2.5}$***	***NO_x***	***VOC***	***CO_2***
Generators on Tinian						
0.35	4.71	0.34	0.29	20.57	0.60	994.00
Generators on Pagan						
0.30	4.04	0.29	0.25	17.61	0.52	851.20

Note: 250 tons per year comparative impact threshold does not apply to CO_2.

1.4.2.7 Solid Waste Transfer Emissions

Solid waste generated as part of training exercises would be processed and recycled in a new waste transfer station and a recycling center to be constructed at Tinian and then transferred from Tinian to a regulatory compliant facility off-island through a barge. The waste quantity generated is approximately 7 pounds per person per day and the daily generation rate on Tinian is 21,700 pounds per day (i.e., under 11 tons per day). This quantity of waste could be handled by a single loader and a grapple at the proposed transfer station & recycling center. The recycling center is anticipated to have a baler and shredder that would be powered by electricity. The tug with a barge transport, assuming a typical transport speed of 16 knots on open ocean for a large tug, the trip time from Tinian to Saipan is about one hour one way trip and it is anticipated that one tug trip per week would be sufficient to haul 77 tons of baled waste material.

The equipment and barge (tug) emission factors are based on the same references used previously for construction non-road equipment and training barges. Solid waste processing and transfer activity associated emissions with potential to occur at Tinian are summarized in Table 13 and detailed in Attachment 6. The solid waste generated during training operations on Pagan would be minimal and the associated waste storage containers transfer emissions are negligible.

Table 13. Solid Waste Transfer Annual Emissions

Pollutant (tons per year)						
SO_2	***CO***	***PM_{10}***	***$PM_{2.5}$***	***NO_x***	***VOC***	***CO_2***
Tinian						
0.10	0.31	0.06	0.06	0.95	0.07	84.56

Note: 250 tons per year comparative impact threshold does not apply to CO_2.

1.4.2.8 Munitions Emissions

Air emissions are potentially released during each weapon firing a round. Potential emission releases occur during the launching of a projectile, from the propellant charge at the firing position, and from the detonation explosion of the projectile in the target vicinity. The USEPA has published draft emission factors for ordnance in the AP-42 handbook. These emission factors for weapons firing and explosive detonation were used to predict munitions emissions. The munition emission factors for each applicable weapon expenditure were multiplied by the number of rounds anticipated during firing to predict munitions emissions. The munitions emissions predicted are summarized in Table 14 and detailed in Attachment 7.

Table 14. Munitions Annual Emissions

Pollutant (tons per year)						
SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
Munitions on Tinian						
0.03	56.01	38.68	13.80	1.72	0.01	82.21
Munitions on Pagan						
0.04	6.63	24.92	23.05	0.19	0.06	315.34

Note: 250 tons per year comparative impact threshold does not apply to CO_2.

1.4.2.9 Combined Operational Emissions

Combined operational emissions are evaluated in this section.

1.4.2.9.1 Tinian

The combined training emissions from each training source element discussed previously were calculated for the Tinian alternatives. The training-related combined emissions for Tinian alternatives (Table 15) are below the comparative impact threshold of 250 tons (227 metric tons) per year for all criteria pollutants, except CO and NO_x. The training-related CO and NO_x emissions would occur across a large geographic area that consists of the airspace around the airport and training facilities where aircraft would operate, the proposed RTA where training vehicles and aircraft would operate, and coastal areas where aircraft and marine vessels would operate.

More than 70% of CO and 50% of NO_x emissions would be generated by aircraft and marine vessels. Consequently, the total ground level CO and NO_x emissions (where there are sensitive receptors) would be well below the 250 tons (227 metric tons) per year comparative impact threshold. Furthermore, the dominant trade winds in the region blowing from the east and northeast would quickly disperse emissions towards the ocean. Therefore, operational activities under each of the Tinian alternatives would result in less than significant impacts to air quality.

1.4.2.9.2 Pagan

Military training operational emissions were estimated using the same methodologies implemented for Tinian alternatives. The annual emissions for the combined operational elements and training exercises are summarized in Table 16 and are below the comparative impact threshold of 250 tons (227 metric tons) per year for all criteria pollutants, except for NO_x. Approximately 75% of NO_x emissions would be generated by ground training vehicles. Since no sensitive land uses are located close to the proposed RTA, and the dominant trade winds in the region blowing from the east and northeast would quickly disperse emissions towards the ocean, operational activities under the Pagan alternatives would result in less than significant impacts to air quality.

Table 15. Training Annual Emissions - Tinian Alternatives 1, 2, and 3

Pollutant (tons per year)						
SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
Aircraft Sorties around Tinian International Airport						
8.12	256.27	42.69	42.69	89.02	75.18	25048.85
Aircraft Training Exercises						
2.74	3.25	11.29	11.29	28.70	0.37	3740.83
Marine Vessels						
31.61	8.85	3.75	3.43	106.28	4.02	5144.48
Ground Vehicles						
13.38	42.31	109.13	19.38	141.71	9.11	1192.42
Support Equipment						
0.17	3.43	16.48	2.12	7.50	0.64	794.05
Generators						
0.35	4.71	0.34	0.29	20.57	0.60	994.00
Solid Waste Transfer						
0.10	0.31	0.06	0.06	0.95	0.07	84.56
Munitions						
0.03	56.01	38.68	13.80	1.72	0.01	82.21
Total						
56.45	375.14	222.42	93.06	396.45	90.00	37081.40

Note: 250 tons per year comparative impact threshold does not apply to CO_2.

Table 16. Training Activity Annual Emissions- Pagan Alternatives 1 and 2

Pollutant (tons per year)						
SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
Aircraft Sorties around Pagan Airport						
2.98	74.22	17.16	17.16	42.66	29.71	7607.25
Aircraft Training Exercises						
2.29	2.31	8.00	8.00	42.64	0.28	4810.82
Marine Vessels						
2.18	0.84	0.27	0.25	10.22	0.36	353.86
Ground Vehicles						
32.80	94.12	155.51	35.46	335.45	20.41	1421.42
Support Equipment						
0.02	0.49	1.24	0.20	0.92	0.09	102.75
Generators						
0.30	4.04	0.29	0.25	17.61	0.52	851.20
Munitions						
0.04	6.63	24.92	23.05	0.19	0.06	315.34
Total						
40.61	182.65	207.39	84.37	449.69	51.43	15462.64

Note: 250 tons per year comparative impact threshold does not apply to CO_2.

1.5 CUMULATIVE REGIONAL EMISSIONS UNDER PREFERRED ALTERNATIVES

The preferred alternatives were evaluated for potential air quality impacts to Tinian and Pagan. Regional emissions occurring under the combined alternatives from the proposed action at both islands were analyzed. The criterion used to determine potential air quality impacts is based on PSD major source threshold of 250 tons (227 metric tons) per year as a comparative impact threshold. It should be noted that this level is used as an indication of a potentially significant impact that would need to be further evaluated based on geographic coverage of these emissions and the close proximity of sensitive land uses to the emission sources generating these emissions.

1.5.1 Criteria Pollutants

The cumulative regional emissions under the preferred alternatives with training activities on Tinian and Pagan combined (Table 17) would exceed the comparative impact threshold of 250 tons (227 metric tons) per year for CO, PM_{10}, and NO_x on a regional basis. However, these emissions would occur across a large geographic area that consists of the airspace around the airport and training facilities where aircraft would operate, the proposed RTAs where training vehicles and aircraft would operate, and coastal areas where aircraft and marine vessels would operate. Consequently, the total ground level CO, PM_{10}, and NO_x emissions (where there are sensitive receptors) are anticipated to be well below the 250 tons (227 metric tons) per year comparative impact threshold. Furthermore, the dominant trade winds in the region blowing from the east and northeast would quickly disperse emissions towards the ocean. Therefore, cumulative operational activities under the preferred combined alternative would result in less than significant impacts to air quality.

Table 17. Regional Combined Annual Emissions

Pollutant (tons per year)						
SO_2	*CO*	*PM_{10}*	*$PM_{2.5}$*	*NO_x*	*VOC*	*CO_2*
Aircraft Sorties around Tinian International Airport and Pagan Airport						
11.1	330.49	59.85	59.85	131.68	104.89	32656.1
Aircraft Training Exercises						
5.03	5.56	19.29	19.29	71.34	0.65	8551.65
Marine Vessels						
33.79	9.69	4.02	3.68	116.5	4.38	5498.34
Ground Vehicles						
46.18	136.43	264.64	54.84	477.16	29.52	2613.84
Support Equipment						
0.19	3.92	17.72	2.32	8.42	0.73	896.8
Generators						
0.65	8.75	0.63	0.54	38.18	1.12	1845.20
Solid Waste Transfer						
0.10	0.31	0.06	0.06	0.95	0.07	84.56
Munitions						
0.07	62.64	63.6	36.85	1.91	0.07	397.55
Total						
97.06	555.20	429.09	177.41	849.47	141.48	52544.04

Note: 250 tons per year comparative impact threshold does not apply to CO_2.

1.5.2 Greenhouse Gases and Global Warming

Greenhouse gas emissions in the atmosphere are of concern because they contribute to global warming by trapping re-radiated energy. The total quantity of greenhouse gas emissions was expressed in terms of CO_2 emissions resulting under the preferred alternative. CO_2 is not a criteria pollutant and the 250 tons (227 metric tons) per year comparative impact threshold is not applicable to CO_2. Therefore, greenhouse gases in terms of CO_2 emissions are presented only for disclosure purposes.

Since the proposed action would mostly involve the military training exercises that are currently occurring in various regions in the U.S., energy consumption from activities in the region are unlikely to change significantly and the overall global greenhouse gas emissions associated with the proposed action are likely to remain at the current levels on a regional scale.

1.5.2.1 Background and Regulatory Framework

This section provides the background and regulatory framework for greenhouse gases and a quantitative evaluation of the increase in greenhouse gas emissions from cumulative emissions from the proposed alternatives.

Greenhouse gases trap heat in the atmosphere by absorbing infrared radiation. These emissions occur from both natural processes and human activities. The primary long-lived greenhouse gases directly emitted by human activities are CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6. Although CO_2, CH_4, and N_2O occur naturally in the atmosphere, their concentrations have increased by 38, 149, and 23%, respectively, from the preindustrial era (1750) to 2007/2008 (USEPA 2009d).

Federal agencies address emissions of greenhouse gases by reporting and meeting reductions mandated in laws, Executive Orders, and policies. The most recent of these are Executive Order 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*, of October 5, 2009 and Executive Order 13423, *Strengthening Federal Environmental, Energy, and Transportation Management* of January 26, 2007.

Executive Order 13514 shifts the way the government operates by: (1) establishing greenhouse gases as the integrating metric for tracking progress in federal sustainability; (2) requiring a deliberative planning process; and (3) linking to budget allocations and Office of Management and Budget scorecards to ensure goal achievement.

The targets for reducing greenhouse gas emissions discussed in Executive Order 13514 for Scope 1 - direct greenhouse gas emissions from sources that are owned or controlled by a federal agency; Scope 2 - direct greenhouse gas emissions resulting from the generation of electricity, heat, or steam purchased by a federal agency - have been set for the Department of Defense at a 34% reduction of greenhouse gas from the 2008 baseline by 2020 and; Scope 3 targets - greenhouse gas emissions from sources not owned or directly controlled by a Federal agency but related to agency activities such as vendor supply chains, delivery services, and employee travel and commuting – have been proposed to set for the Department of Defense at a 13.5% reduction. The Executive Order 13514 Strategic Sustainability Performance Plan (SSPP) was submitted to the CEQ on June 2, 2010 and contains a guide for meeting these goals.

Greenhouse gases for the proposed action would be reduced by incorporating the Leadership in Energy and Environmental Design (LEED) program into the proposed action. LEED is an internationally recognized green building certification system, providing third-party verification that a building or community was designed and built using strategies aimed at improving performance across all the metrics that matter most: energy savings, water efficiency, CO_2 emissions reduction, improved indoor environmental quality, and stewardship of resources and sensitivity to their impacts. There are four levels of certification in LEED and buildings constructed for action associated with this EIS would aim to attain a rating of LEED silver. Low-impact land development would also be used during design in order to save water and energy to meet the targets established under Executive Order 13514.

Executive Order 13423 established a policy that Federal agencies conduct their environmental, transportation, and energy-related activities in support of their respective missions in an environmentally economic way. It included a goal of improving energy efficiency and reducing greenhouse gas emissions of the agency, through reduction of energy intensity by 3% annually through the end of fiscal year 2015, or 30% by the end of fiscal year 2015, relative to the baseline of the agency's energy use in fiscal year 2003.

CEQ Draft NEPA Guidance on Consideration of the Effects of Climate Change and Greenhouse Gas Emissions (CEQ 2010) states that "*if a proposed action would be reasonably anticipated to cause direct emissions of 25,000 metric tons or more of CO_2-equivalent greenhouse gas emissions on an annual basis, agencies should consider this an indicator that a quantitative and qualitative assessment may be meaningful to decision makers and the public.*" These recommendations are consistent with the Mandatory Reporting of Greenhouse Gases rule (40 CFRs Parts 86, 87, 89 et al.) effective December 29, 2009 and applies to fossil fuel suppliers and industrial gas suppliers, direct greenhouse gas emitters and manufacturers of heavy-duty and off-road vehicles and engines. Under the rule, suppliers of fossil fuels or industrial greenhouse gases, manufacturers of vehicles and engines, and facilities that emit 25,000 metric tons per year of greenhouse gas emissions are required to submit annual reports to USEPA. The Mandatory Reporting rule for the proposed action applies to the Department of Defense stationary sources. However, because the proposed action would not result in any modification or construction of new stationary sources other than exempted emergency generators, these rules do not apply. This analysis provided here follows the recent Draft NEPA Guidance on Consideration of the Effects of Climate Change and Greenhouse Gas issued by the CEQ (CEQ 2010).

1.5.3 Proposed Action and Cumulative Greenhouse Gas Impacts

The potential effects of proposed greenhouse gas emissions are by nature global and cumulative impacts, as individual sources of greenhouse gas emissions are not large enough to have an appreciable effect on climate change. In keeping with CEQ guidance, the focus of the cumulative air quality greenhouse gas analysis is on greenhouse gas emissions that are affected by the proposed action and its significance on climate change as compared to the no-action alternative. The impact of proposed greenhouse gas emissions as they pertain to climate change is discussed in the context of the combined impacts as compared to the total amount of greenhouse gas emissions that the U.S. produces.

To estimate total greenhouse gas emissions, each greenhouse gas is assigned a GWP. The GWP is the ability of a gas or aerosol to trap heat in the atmosphere. The GWP rating system is standardized to CO_2, which has a value of one. For example, CH_4 has a GWP of 21, which means that it has a global warming effect 21 times greater than CO_2 on an equal-mass basis (Intergovernmental Panel on Climate Change 2007). To simplify greenhouse gas analyses, total greenhouse gas emissions from a source are often expressed as CO_2 equivalents (CO_2e). The CO_2e is calculated by multiplying the emissions of each greenhouse gas by its GWP and adding the results together to produce a single, combined emission rate representing all greenhouse gases. While CH_4 and N_2O have much higher GWPs than CO_2, CO_2 is emitted in much higher quantities, so that CO_2 is the overwhelming contributor to CO_2e from both natural processes and human activities. GWP-weighted emissions are presented in terms of equivalent emissions of CO_2, using units of teragrams (1 million metric tons or 1 billion kilograms) of carbon dioxide equivalents (Tg CO_2e).

The total greenhouse gas emissions in terms of CO_2e for the proposed alternatives were predicted for the mobile fossil fuel combustion sources.

Among the primary long-lived greenhouse gases directly emitted by human activities, only CH_4 and N_2O have potential to be produced from fossil fuel combustion sources (USEPA 2009a).

Although the USEPA final rule on Mandatory Reporting of Greenhouse Gases (October 30, 2009) provides various methodologies to estimate CO_2 equivalencies based on fuel test and consumption data, this rule is essentially designed for specific stationary facility reporting purposes and cannot be directly implemented in this EIS to address various source categories. Most of the USEPA tools that are widely used for NEPA study purposes (e.g., AP-42 [USEPA 1995], NONROAD [USEPA 2009b]) do not provide emission factors for CO_2e other than for CO_2. Therefore, given the lack of regulatory tools to provide reasonable estimates of CO_2e, this appendix utilizes the inventory ratios among CO_2, CH_4, and N_2O summarized in the most recent USEPA inventory report (USEPA 2014) and provided in the introduction to this section as the basis for approximating and prorating CH_4 and N_2O emission levels.

The most recent 2012 inventory data (USEPA 2014) shows that CO_2, CH_4, and N_2O contributed from fossil fuel combustion process from mobile and stationary sources include approximately:

- 5,072 teragrams (Tg) (or million metric tons) of CO_2
- 7 Tg CH_4
- 39 Tg N_2O

The ratios among CO_2, CH_4, and N_2O based on above inventory levels were used to predict CH_4 and N_2O equivalencies from mobile combustion sources as follows:

$$CH_4 = (\text{tons per year [TPY] of } CO_2) * (7 / 5{,}072) = 0.14\% \text{ TPY of } CO_2.$$

$$N_2O = (\text{TPY of } CO_2) * (39/ 5{,}072) = 0.77\% \text{ TPY of } CO_2.$$

Based on these ratios, the greenhouse gas contribution from CH_4 and N_2O is less than 1% of the total CO_2 equivalency for fossil fuel combustion sources.

In 2012, the U.S. generated about 6,526 Tg (million metric tons) CO_2e (USEPA 2014). However, the U.S. inventory does not provide a baseline for Tinian or Pagan; therefore, using the U.S. baseline condition for a comparison is considered appropriate for current conditions. The total maximum quantity of greenhouse gas emissions from the preferred alternatives (i.e., 52,544 short tons as shown in Table 17 which is equivalent to 47,709 metric tons) comprises less than 0.00073% of the annual U.S. emissions.

The change in climate conditions caused by greenhouse gas resulting from the burning of fossil fuels from proposed mobile sources is a global effect, and requires that the emissions be assessed on a global scale. Therefore, the disclosure of localized incremental emissions has limited or no weight in addressing climate change. The proposed action mainly involves the military operations that are already occurring in the U.S.; therefore, fossil fuel burning activities in the U.S. are unlikely to change significantly. Consequently, overall global greenhouse gas emissions are likely to remain near the current level on a regional or global scale under the proposed condition, resulting in an insignificant cumulative impact to global climate change. No specific greenhouse gas emission mitigation measures are warranted.

1.6 VOLCANIC IMPACTS ON OPERATION

Existing volcanic gases would continue to be released from Pagan volcano eruptions as part of natural geological processes. SO_2, a criteria pollutant, is one of the most common gases released in volcanic eruptions and is hazardous to humans. During the training operations, periodic SO_2 releases due to volcanic eruptions could have adverse air quality impacts. Table 18 summarizes human health effects as a function of SO_2 exposure concentration levels. Table 19 shows the permissible occupational exposure level of SO_2 for multiple averaging periods. An advisory table used at the Hawaii Volcanoes National Park to protect public health from high concentrations of SO_2 is provided in Table 20.

Table 18. Health Effects of Respiratory Exposure to Sulfur Dioxide

Exposure Limits (parts per million)	***Sulfur Dioxide Health Effects***
1 – 5	Threshold for respiratory response in healthy individuals upon exercise or deep breathing.
3 – 5	Gas is easily noticeable. Fall in lung function at rest and increased airway resistance.
5	Increased airway resistance in healthy individuals.
6	Immediate irritation of eyes, nose, and throat.
10	Worsening irritation of eyes, nose, and throat.
10 – 15	Threshold of toxicity for prolonged exposure.
20+	Paralysis or death occurs after extended exposure.
150	Maximum concentration that can be withstood for a few minutes by healthy individuals.

Source: International Volcanic Health Hazard Network 2013.

Table 19. Occupational Guidelines for Sulfur Dioxide

Sulfur Dioxide Level (parts per million)	*Averaging Period*	*Relevant Law*	*Ref.*
5	15 minutes	NIOSH/ ACGIH	B
5	8-hour	OSHA Regulations[1] (Standards - 29 CFR)	A
2	8-hour	NIOSH/ ACGIH	B
0.3	1-hour	Emergency Response Planning Guideline-1[2]	C
3	1-hour	Emergency Response Planning Guideline-2[3]	C
25	1-hour	Emergency Response Planning Guideline-3[4]	C

Notes [1.] Parts per million by volume at 25ºC.
[2.] The Emergency Response Planning Guideline-1 is the maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing other mild transient adverse health effects or without perceiving a clearly defined objectionable odor.
[3.] The Emergency Response Planning Guideline-2 is the maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or serious health effects or symptoms that could impair an individual's ability to take protective action.
[4.] The Emergency Response Planning Guideline-3 is the maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing life threatening health effects.

Legend: ACGIH = American Conference of Governmental Industrial Hygienists; CFR = Code of Federal Regulations; NIOSH = National Institute for Occupational Safety and Health; OSHA = Occupational Safety and Health Administration.

Sources: a. Occupational Safety and Health Administration 2013.
b. National Institute for Occupational Safety and Health 1994.
c. American Industrial Hygiene Association (AIHA) 2013.
Table adapted from the International Volcanic Health Hazard Network (2013).

Table 20. The Hawaii Volcanoes National Park and Hawaiian Volcano Observatory's Sulfur Dioxide Advisory

Hawaii Volcanoes Sulfur Dioxide Response Plan	
Condition	***Response***
GREEN (Good) sulfur dioxide <300 parts per billion 15-min average	Business as usual
YELLOW (Moderate) sulfur dioxide >300 parts per billion 30-minute average	Basic Protective Actions Dispatcher alerts staff Inform visitors of hazard
ORANGE (Unhealthy for sensitive groups) sulfur dioxide >500 parts per billion 15-minute average	Moderate Protective Actions Relocate/cancel nature walks and other outdoor work
RED (Unhealthy) sulfur dioxide >1,000 parts per billion 15-minute average	Extended Protective Actions Consider closing entrance station and Visitor Centers

Source: U.S. Geological Survey 2008.

In order to compare the advisory limit for a typical volcanic eruption shown in Table 20, it is assumed that approximately 5% of the emitted gas is present in the lower atmosphere 1-4 days after a volcanic eruption (International Volcanic Health Hazard Network 2013), resulting in likely SO_2 concentration levels less than 1,000 parts per billion. In addition, the color in the air could be an indicator of the concentration of SO_2. Caution should be used during operation activities to minimize personnel from potential exposure to high SO_2 air concentrations (e.g., avoiding training activities for 1-4 days after a volcanic eruption). High SO_2 concentrations could result in human health risks; however, with implementation of planning procedures to limit or avoid training activities during periods of high SO_2 concentration, Pagan Alternatives 1 and 2 would result in less than significant impacts to human health.

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Attachments-Calculation Backups

Attachment 1 - MOVES Sample Input/Output

CJMT MOVES Inputs

MOVES Run Summary

Vehicle Types	Time			Location	Road Type
Gasoline Passenger Vehicle Diesel Combination Short Haul Truck	2016	Weekdays	January & July	Virgin Islands - St. Thomas	Rural Unrestricted Access

Fuel Supply

CountyID	FuelYearID	MonthGroupID	FuelFormulationID	MarketShare	MarketShareCV
78030	2012	1	9172	1	0.5
78030	2012	7	9190	1	0.5
78030	2012	1	20011	1	0.5
78030	2012	7	20011	1	0.5

Hour VMT Fraction

SourceTypeID	RoadTypeID	DayID	HourID	HourVMTFraction
21	3	2	1	0.016421
21	3	2	2	0.011192
21	3	2	3	0.008542
21	3	2	4	0.006793
21	3	2	5	0.007219
21	3	2	6	0.010762
21	3	2	7	0.01768
21	3	2	8	0.026875
21	3	2	9	0.038659
21	3	2	10	0.052239
21	3	2	11	0.063174
21	3	2	12	0.069944
21	3	2	13	0.072933

Hour VMT Fraction

SourceTypeID	RoadTypeID	DayID	HourID	HourVMTFraction
21	3	2	14	0.073122
21	3	2	15	0.073616
21	3	2	16	0.074461
21	3	2	17	0.074217
21	3	2	18	0.070009
21	3	2	19	0.061404
21	3	2	20	0.050504
21	3	2	21	0.041207
21	3	2	22	0.033637
21	3	2	23	0.026224
21	3	2	24	0.019167
61	3	2	1	0.016421
61	3	2	2	0.011192
61	3	2	3	0.008542
61	3	2	4	0.006793
61	3	2	5	0.007219
61	3	2	6	0.010762
61	3	2	7	0.01768
61	3	2	8	0.026875
61	3	2	9	0.038659
61	3	2	10	0.052239
61	3	2	11	0.063174
61	3	2	12	0.069944
61	3	2	13	0.072933
61	3	2	14	0.073122
61	3	2	15	0.073616
61	3	2	16	0.074461
61	3	2	17	0.074217

Hour VMT Fraction

SourceTypeID	RoadTypeID	DayID	HourID	HourVMTFraction
61	3	2	18	0.070009
61	3	2	19	0.061404
61	3	2	20	0.050504
61	3	2	21	0.041207
61	3	2	22	0.033637
61	3	2	23	0.026224
61	3	2	24	0.019167

Road Type Distribution

SourceTypeID	RoadTypeID	RoadTypeVMTFraction
21	1	0
21	2	0.083421
21	3	0.289053
21	4	0.209684
21	5	0.417842
61	1	0
61	2	0.324692
61	3	0.294068
61	4	0.207526
61	5	0.173714

Source Type Age Distribution

SourceTypeID	YearID	AgeID	AgeFraction
21	1999	0	0.0646
21	1999	1	0.0602
21	1999	2	0.061
21	1999	3	0.0624
21	1999	4	0.0626
21	1999	5	0.0642
21	1999	6	0.0597
21	1999	7	0.0562
21	1999	8	0.0543
21	1999	9	0.0596
21	1999	10	0.0608
21	1999	11	0.0622
21	1999	12	0.0549
21	1999	13	0.0522
21	1999	14	0.0419
21	1999	15	0.032
21	1999	16	0.0226
21	1999	17	0.0155
21	1999	18	0.0129
21	1999	19	0.0105
21	1999	20	0.008
21	1999	21	0.006
21	1999	22	0.0045
21	1999	23	0.0034
21	1999	24	0.0026
21	1999	25	0.0019
21	1999	26	0.0014

Source Type Age Distribution

SourceTypeID	YearID	AgeID	AgeFraction
21	1999	27	0.0008
21	1999	28	0.0006
21	1999	29	0.0005
21	1999	30	0
61	1999	0	0.084252
61	1999	1	0.067209
61	1999	2	0.057562
61	1999	3	0.050629
61	1999	4	0.0693
61	1999	5	0.056228
61	1999	6	0.048773
61	1999	7	0.037878
61	1999	8	0.045255
61	1999	9	0.053548
61	1999	10	0.056029
61	1999	11	0.054994
61	1999	12	0.059676
61	1999	13	0.05284
61	1999	14	0.048713
61	1999	15	0.040034
61	1999	16	0.016687
61	1999	17	0.014696
61	1999	18	0.013335
61	1999	19	0.017959
61	1999	20	0.011167
61	1999	21	0.00904
61	1999	22	0.009914
61	1999	23	0.003839

Source Type Age Distribution

SourceTypeID	YearID	AgeID	AgeFraction
61	1999	24	0.004789
61	1999	25	0.004765
61	1999	26	0.004
61	1999	27	0.003639
61	1999	28	0.002622
61	1999	29	0.000628
61	1999	30	0

Zone Month Hour

MonthID	ZoneID	HourID	Temperature	RelHumidity
1	780300	1	73.7	81.8
7	780300	1	79.5	81.7
1	780300	2	73	82.9
7	780300	2	79	82.2
1	780300	3	72.6	83.5
7	780300	3	78.3	83.3
1	780300	4	72	84.3
7	780300	4	77.7	83.8
1	780300	5	71.6	84.6
7	780300	5	77.4	84
1	780300	6	71.3	84.8
7	780300	6	77	84.9
1	780300	7	70.9	85.4
7	780300	7	76.7	84.9
1	780300	8	70.9	85.4
7	780300	8	78.6	82.4
1	780300	9	73.1	82.6
7	780300	9	82.1	77.6
1	780300	10	78.1	75.4
7	780300	10	85.1	72.4
1	780300	11	81.1	71
7	780300	11	87	69.3
1	780300	12	82.7	67.4
7	780300	12	88.5	67.8
1	780300	13	83.7	65.7
7	780300	13	89.2	66.6
1	780300	14	84.4	64.5

Zone Month Hour

MonthID	ZoneID	HourID	Temperature	RelHumidity
7	780300	14	89.5	66.4
1	780300	15	84.3	64.9
7	780300	15	89.4	66.8
1	780300	16	83.7	65.5
7	780300	16	88.8	67.6
1	780300	17	83	66.1
7	780300	17	87.9	68.4
1	780300	18	81.2	68.6
7	780300	18	86.7	69.9
1	780300	19	78.8	72.5
7	780300	19	85	72.6
1	780300	20	76.9	76.1
7	780300	20	82.8	76.1
1	780300	21	76.2	77.4
7	780300	21	81.5	78.1
1	780300	22	75.5	78.6
7	780300	22	80.9	79.1
1	780300	23	74.9	79.7
7	780300	23	80.5	80.1
1	780300	24	74.4	80.5
7	780300	24	79.9	81.4

CJMT MOVES Output

MOVESScenarioID	MOVESRunID	yearID	monthID	dayID	hourID	linkID	pollutantID	processID	sourceTypeID	SCC	fuelTypeID	modelYearID	roadTypeID	avgSpeedBinID	temperature	relHumidity	ratePerDistance
Guam_EF_AllPop	1	2016	1	5	1	780300302	3	1	21		1	0	3	2	73.7	81.8	0.324642
Guam_EF_AllPop	1	2016	1	5	1	780300302	3	15	21		1	0	3	2	73.7	81.8	6.49284E-06
Guam_EF_AllPop	1	2016	1	5	2	780300302	3	1	21		1	0	3	2	73	82.9	0.314503
Guam_EF_AllPop	1	2016	1	5	2	780300302	3	15	21		1	0	3	2	73	82.9	6.29006E-06
Guam_EF_AllPop	1	2016	1	5	3	780300302	3	1	21		1	0	3	2	72.6	83.5	0.308652
Guam_EF_AllPop	1	2016	1	5	3	780300302	3	15	21		1	0	3	2	72.6	83.5	6.17306E-06
Guam_EF_AllPop	1	2016	1	5	4	780300302	3	1	21		1	0	3	2	72	84.3	0.299878
Guam_EF_AllPop	1	2016	1	5	4	780300302	3	15	21		1	0	3	2	72	84.3	5.99757E-06
Guam_EF_AllPop	1	2016	1	5	5	780300302	3	1	21		1	0	3	2	71.6	84.6	0.294259
Guam_EF_AllPop	1	2016	1	5	5	780300302	3	15	21		1	0	3	2	71.6	84.6	5.88517E-06
Guam_EF_AllPop	1	2016	1	5	6	780300302	3	1	21		1	0	3	2	71.3	84.8	0.290003
Guam_EF_AllPop	1	2016	1	5	6	780300302	3	15	21		1	0	3	2	71.3	84.8	5.80007E-06
Guam_EF_AllPop	1	2016	1	5	7	780300302	3	1	21		1	0	3	2	70.9	85.4	0.283777
Guam_EF_AllPop	1	2016	1	5	7	780300302	3	15	21		1	0	3	2	70.9	85.4	5.67554E-06
Guam_EF_AllPop	1	2016	1	5	8	780300302	3	1	21		1	0	3	2	70.9	85.4	0.283777
Guam_EF_AllPop	1	2016	1	5	8	780300302	3	15	21		1	0	3	2	70.9	85.4	5.67553E-06
Guam_EF_AllPop	1	2016	1	5	9	780300302	3	1	21		1	0	3	2	73.1	82.6	0.316202
Guam_EF_AllPop	1	2016	1	5	9	780300302	3	15	21		1	0	3	2	73.1	82.6	6.32404E-06
Guam_EF_AllPop	1	2016	1	5	10	780300302	3	1	21		1	0	3	2	78.1	75.4	0.41452
Guam_EF_AllPop	1	2016	1	5	10	780300302	3	15	21		1	0	3	2	78.1	75.4	8.29042E-06
Guam_EF_AllPop	1	2016	1	5	11	780300302	3	1	21		1	0	3	2	81.1	71	0.467609
Guam_EF_AllPop	1	2016	1	5	11	780300302	3	15	21		1	0	3	2	81.1	71	9.35221E-06

CJMT MOVES Output

MOVESScenarioID	MOVESRunID	yearID	monthID	dayID	hourID	linkID	pollutantID	processID	sourceTypeID	SCC	fuelTypeID	modelYearID	roadTypeID	avgSpeedBinID	temperature	relHumidity	ratePerDistance
Guam_EF_AllPop	1	2016	1	5	12	780300302	3	1	21		1	0	3	2	82.7	67.4	0.494102
Guam_EF_AllPop	1	2016	1	5	12	780300302	3	15	21		1	0	3	2	82.7	67.4	9.88205E-06
Guam_EF_AllPop	1	2016	1	5	13	780300302	3	1	21		1	0	3	2	83.7	65.7	0.509014
Guam_EF_AllPop	1	2016	1	5	13	780300302	3	15	21		1	0	3	2	83.7	65.7	1.01803E-05
Guam_EF_AllPop	1	2016	1	5	14	780300302	3	1	21		1	0	3	2	84.4	64.5	0.519041
Guam_EF_AllPop	1	2016	1	5	14	780300302	3	15	21		1	0	3	2	84.4	64.5	1.03808E-05
Guam_EF_AllPop	1	2016	1	5	15	780300302	3	1	21		1	0	3	2	84.3	64.9	0.517462
Guam_EF_AllPop	1	2016	1	5	15	780300302	3	15	21		1	0	3	2	84.3	64.9	1.03493E-05
Guam_EF_AllPop	1	2016	1	5	16	780300302	3	1	21		1	0	3	2	83.7	65.5	0.509167
Guam_EF_AllPop	1	2016	1	5	16	780300302	3	15	21		1	0	3	2	83.7	65.5	1.01834E-05
Guam_EF_AllPop	1	2016	1	5	17	780300302	3	1	21		1	0	3	2	83	66.1	0.499314
Guam_EF_AllPop	1	2016	1	5	17	780300302	3	15	21		1	0	3	2	83	66.1	9.98627E-06
Guam_EF_AllPop	1	2016	1	5	18	780300302	3	1	21		1	0	3	2	81.2	68.6	0.471862
Guam_EF_AllPop	1	2016	1	5	18	780300302	3	15	21		1	0	3	2	81.2	68.6	9.43725E-06
Guam_EF_AllPop	1	2016	1	5	19	780300302	3	1	21		1	0	3	2	78.8	72.5	0.431142
Guam_EF_AllPop	1	2016	1	5	19	780300302	3	15	21		1	0	3	2	78.8	72.5	8.62282E-06
Guam_EF_AllPop	1	2016	1	5	20	780300302	3	1	21		1	0	3	2	76.9	76.1	0.369763
Guam_EF_AllPop	1	2016	1	5	20	780300302	3	15	21		1	0	3	2	76.9	76.1	7.39527E-06
Guam_EF_AllPop	1	2016	1	5	21	780300302	3	1	21		1	0	3	2	76.2	77.4	0.360086
Guam_EF_AllPop	1	2016	1	5	21	780300302	3	15	21		1	0	3	2	76.2	77.4	7.20174E-06
Guam_EF_AllPop	1	2016	1	5	22	780300302	3	1	21		1	0	3	2	75.5	78.6	0.350461
Guam_EF_AllPop	1	2016	1	5	22	780300302	3	15	21		1	0	3	2	75.5	78.6	7.00919E-06

CJMT MOVES Output

MOVESScenarioID	MOVESRunID	yearID	monthID	dayID	hourID	linkID	pollutantID	processID	sourceTypeID	SCC	fuelTypeID	modelYearID	roadTypeID	avgSpeedBinID	temperature	relHumidity	ratePerDistance
Guam_EF_AllPop	1	2016	1	5	23	780300302	3	1	21		1	0	3	2	74.9	79.7	0.341924
Guam_EF_AllPop	1	2016	1	5	23	780300302	3	15	21		1	0	3	2	74.9	79.7	6.83847E-06
Guam_EF_AllPop	1	2016	1	5	24	780300302	3	1	21		1	0	3	2	74.4	80.5	0.334931
Guam_EF_AllPop	1	2016	1	5	24	780300302	3	15	21		1	0	3	2	74.4	80.5	6.69863E-06

Attachment 2 - Construction Emissions Estimate

CJMT Construction Emissions

Total Construction Equipment Emissions – Tinian Alternative 1

Tinian Alternative 1																				
Equipment Type	Number of Units	Days	Hours	Horsepower (hp)	Load Factor (%)	Emission Factor (grams/hp-hour)							Emission Rate (tons)							
						SO2	CO	PM10	PM2.5	NOx	VOC	CO_2	SO2	CO	PM10	PM2.5	NOx	VOC	CO_2
Construction Equipment Emissions																			
Asphalt paver, 130 HP	1	377	3016	130	59	0.12	1.60	0.33	0.32	4.54	0.37	536.21	0.03	0.41	0.08	0.08	1.16	0.09	136.61
Backhoe loader, 48hp	1	6759	54072	48	21	0.15	6.20	1.00	0.97	5.75	1.49	692.19	0.09	3.72	0.60	0.58	3.45	0.90	415.50
Chain saws, 36"	1	3066	24528	7	70	0.14	349.18	9.76	8.98	0.91	70.10	686.61	0.02	44.96	1.26	1.16	0.12	9.03	88.42
Chipping machine	1	1533	12264	144	43	0.12	2.46	0.45	0.43	5.98	0.59	550.61	0.10	2.05	0.37	0.36	5.00	0.49	460.15
Compressor, 250 cfm	1	238	1904	90	43	0.13	2.63	0.38	0.37	4.01	0.32	589.94	0.01	0.21	0.03	0.03	0.33	0.03	47.87
Concrete pump, small	1	121	968	53	43	0.12	3.03	0.57	0.56	6.18	0.75	567.14	0.00	0.07	0.01	0.01	0.15	0.02	13.71
Crane, 90-ton	1	242	1936	225	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.02	0.19	0.04	0.04	0.97	0.07	109.44
Crane, hydraulic, 33 ton	1	48	384	315	43	0.11	1.55	0.25	0.25	5.59	0.34	530.50	0.01	0.09	0.01	0.01	0.32	0.02	30.39
Crane, SP, 12 ton	1	5540	44320	175	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.42	3.46	0.77	0.75	17.23	1.21	1948.67
Crane, SP, 5 ton	1	1693	13544	175	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.13	1.06	0.24	0.23	5.26	0.37	595.51
Crane, 40 ton	1	10	80	282	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.00	0.01	0.00	0.00	0.05	0.00	5.67
Vibratory hammer and generator	1	10	80	503	59	0.12	2.75	0.39	0.37	5.60	0.42	537.08	0.00	0.07	0.01	0.01	0.15	0.01	14.04
Diesel hammer, 41k ft-lb	1	101	808	329	59	0.12	2.75	0.39	0.37	5.60	0.42	537.08	0.02	0.47	0.07	0.06	0.97	0.07	92.66
Dozer, 300 HP	1	263	2104	300	59	0.12	1.93	0.30	0.29	4.72	0.33	539.34	0.05	0.79	0.12	0.12	1.94	0.13	221.21
Front end loader, 1.5 cy,	1	263	2104	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.04	0.69	0.11	0.11	1.67	0.12	178.88
Front end loader, TM, 2.5cy	1	1533	12264	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.22	4.05	0.64	0.62	9.75	0.71	1042.67
Gas engine vibrator	1	242	1936	2	55	0.22	291.97	7.64	7.03	1.42	57.01	1053.35	0.00	0.56	0.01	0.01	0.00	0.11	2.04
Gas welding machine	1	68	544	17	68	0.21	642.74	0.11	0.10	3.24	11.35	996.20	0.00	4.53	0.00	0.00	0.02	0.08	7.02
Grader, 30,000 lb	1	3609	28872	204	59	0.12	1.45	0.28	0.27	4.26	0.32	537.25	0.44	5.57	1.07	1.03	16.33	1.22	2060.36
Pneumatic wheel roller	1	377	3016	99	59	0.16	2.37	0.24	0.23	4.70	0.37	559.00	0.03	0.46	0.05	0.05	0.91	0.07	108.45
Roller, vibratory	1	263	2104	92	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.02	0.31	0.05	0.05	0.60	0.05	70.51
Rollers, steel wheel	1	278	2224	92	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.02	0.33	0.05	0.05	0.64	0.06	74.53
Tandem roller, 10 ton	1	238	1904	70	59	0.12	2.64	0.44	0.42	5.00	0.47	555.84	0.01	0.23	0.04	0.04	0.43	0.04	47.84
Total Emissions													**1.68**	**74.32**	**5.65**	**5.42**	**67.44**	**14.91**	**7772.14**

Total Construction Equipment Emissions – Tinian Alternative 2

Tinian Alternative 2																				
Equipment Type	Number of Units	Days	Hours	Horsepower (hp)	Load Factor (%)	Emission Factor (grams/hp-hour)							Emission Rate (tons)							
						SO2	CO	PM10	PM2.5	NOx	VOC	CO_2	SO2	CO	PM10	PM2.5	NOx	VOC	CO_2
Construction Equipment Emissions																			
Asphalt paver, 130 HP	1	377	3016	130	59	0.12	1.60	0.33	0.32	4.54	0.37	536.21	0.03	0.41	0.08	0.08	1.16	0.09	136.61
Backhoe loader, 48hp	1	6759	54072	48	21	0.15	6.20	1.00	0.97	5.75	1.49	692.19	0.09	3.72	0.60	0.58	3.45	0.90	415.50
Chain saws, 36"	1	3158	25264	7	70	0.14	349.18	9.76	8.98	0.91	70.10	686.61	0.02	46.31	1.29	1.19	0.12	9.30	91.07
Chipping machine	1	1579	12632	144	43	0.12	2.46	0.45	0.43	5.98	0.59	550.61	0.10	2.12	0.39	0.37	5.15	0.51	473.96
Compressor, 250 cfm	1	255	2040	90	43	0.13	2.63	0.38	0.37	4.01	0.32	589.94	0.01	0.23	0.03	0.03	0.35	0.03	51.29
Concrete pump, small	1	126	1008	53	43	0.12	3.03	0.57	0.56	6.18	0.75	567.14	0.00	0.08	0.01	0.01	0.16	0.02	14.28
Crane, 90-tons	1	244	1952	225	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.02	0.20	0.04	0.04	0.98	0.07	110.35
Crane, hydraulic, 33 ton	1	48	384	315	43	0.11	1.55	0.25	0.25	5.59	0.34	530.50	0.01	0.09	0.01	0.01	0.32	0.02	30.39
Crane, SP, 12 ton	1	5540	44320	175	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.42	3.46	0.77	0.75	17.23	1.21	1948.67
Crane, SP, 5 ton	1	1693	13544	175	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.13	1.06	0.24	0.23	5.26	0.37	595.51
Crane, 40 ton	1	10	80	282	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.00	0.01	0.00	0.00	0.05	0.00	5.67
Vibratory hammer and generator	1	10	80	503	59	0.12	2.75	0.39	0.37	5.60	0.42	537.08	0.00	0.07	0.01	0.01	0.15	0.01	14.04
Diesel hammer, 41k ft-lb	1	101	808	329	59	0.12	2.75	0.39	0.37	5.60	0.42	537.08	0.02	0.47	0.07	0.06	0.97	0.07	92.66
Dozer, 300 HP	1	263	2104	300	59	0.12	1.93	0.30	0.29	4.72	0.33	539.34	0.05	0.79	0.12	0.12	1.94	0.13	221.21
Front end loader, 1.5 cy	1	263	2104	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.04	0.69	0.11	0.11	1.67	0.12	178.88
Front end loader, TM, 2.5cy	1	1579	12632	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.23	4.17	0.66	0.64	10.05	0.73	1073.96
Gas engine vibrator	1	252	2016	2	55	0.22	291.97	7.64	7.03	1.42	57.01	1053.35	0.00	0.59	0.02	0.01	0.00	0.11	2.12
Gas welding machine	1	72	576	17	68	0.21	642.74	0.11	0.10	3.24	11.35	996.20	0.00	4.80	0.00	0.00	0.02	0.08	7.43
Gradder, 30000 lb	1	3697	29576	204	59	0.12	1.45	0.28	0.27	4.26	0.32	537.25	0.45	5.71	1.09	1.06	16.73	1.25	2110.59
Pneumatic wheel roller	1	377	3016	99	59	0.18	2.37	0.24	0.23	4.70	0.37	559.00	0.04	0.46	0.05	0.05	0.91	0.07	108.45
Vibratory roller	1	263	2104	92	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.02	0.31	0.05	0.05	0.60	0.05	70.51
Rollers, steel wheel	1	278	2224	92	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.02	0.33	0.05	0.05	0.64	0.06	74.53
Tandem roller, 10 ton	1	238	1904	70	59	0.12	2.64	0.44	0.42	5.00	0.47	555.84	0.01	0.23	0.04	0.04	0.43	0.04	47.84
Total Emissions													**1.70**	**76.30**	**5.75**	**5.51**	**68.33**	**15.26**	**7875.52**

Total Construction Equipment Emissions – Tinian Alternative 3

Tinian Alternative 3																			
Equipment Type	Number of Units	Days	Hours	Horsepower (hp)	Load Factor (%)	Emission Factor (grams/hp-hour)							Emission Rate (tons)						
						SO2	CO	PM10	PM2.5	NOx	VOC	CO_2	SO2	CO	PM10	PM2.5	NOx	VOC	CO_2
Construction Equipment Emissions																			
Asphalt paver, 130 HP	1	377	3016	130	59	0.12	1.60	0.33	0.32	4.54	0.37	536.21	0.03	0.41	0.08	0.08	1.16	0.09	136.61
Backhoe loader, 48hp	1	6759	54072	48	21	0.15	6.20	1.00	0.97	5.75	1.49	692.19	0.09	3.72	0.60	0.58	3.45	0.90	415.50
Chain saws, 36"	1	3092	24736	7	70	0.14	349.18	9.76	8.98	0.91	70.10	686.61	0.02	45.35	1.27	1.17	0.12	9.10	89.17
Chipping machine	1	1546	12368	144	43	0.12	2.46	0.45	0.43	5.98	0.59	550.61	0.10	2.07	0.38	0.37	5.04	0.50	464.05
Compressor, 250 cfm	1	238	1904	90	43	0.13	2.63	0.38	0.37	4.01	0.32	589.94	0.01	0.21	0.03	0.03	0.33	0.03	47.87
Concrete pump, small	1	121	968	53	43	0.12	3.03	0.57	0.56	6.18	0.75	567.14	0.00	0.07	0.01	0.01	0.15	0.02	13.71
Crane, 90-ton	1	242	1936	225	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.02	0.19	0.04	0.04	0.97	0.07	109.44
Crane, hydraulic, 33 ton	1	48	384	315	43	0.11	1.55	0.25	0.25	5.59	0.34	530.50	0.01	0.09	0.01	0.01	0.32	0.02	30.39
Crane, SP, 12 ton	1	5540	44320	175	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.42	3.46	0.77	0.75	17.23	1.21	1948.67
Crane, SP, 5 ton	1	1693	13544	175	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.13	1.06	0.24	0.23	5.26	0.37	595.51
Crane, 40 ton	1	10	80	282	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.00	0.01	0.00	0.00	0.05	0.00	5.67
Vibratory hammer and generator	1	10	80	503	59	0.12	2.75	0.39	0.37	5.60	0.42	537.08	0.00	0.07	0.01	0.01	0.15	0.01	14.04
Diesel hammer, 41k ft-lb	1	101	808	329	59	0.12	2.75	0.39	0.37	5.60	0.42	537.08	0.02	0.47	0.07	0.06	0.97	0.07	92.66
Dozer, 300 HP	1	263	2104	300	59	0.12	1.93	0.30	0.29	4.72	0.33	539.34	0.05	0.79	0.12	0.12	1.94	0.13	221.21
Front end loader, 1.5 cy	1	263	2104	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.04	0.69	0.11	0.11	1.67	0.12	178.88
Front end loader, TM, 2.5cy	1	1546	12368	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.23	4.08	0.64	0.62	9.84	0.71	1051.51
Gas engine vibrator	1	242	1936	2	55	0.22	291.97	7.64	7.03	1.42	57.01	1053.35	0.00	0.56	0.01	0.01	0.00	0.11	2.04
Gas welding machine	1	68	544	17	68	0.21	642.74	0.11	0.10	3.24	11.35	996.20	0.00	4.53	0.00	0.00	0.02	0.08	7.02
Grader, 30,000 lb	1	3634	29072	204	59	0.12	1.45	0.28	0.27	4.26	0.32	537.25	0.45	5.61	1.07	1.04	16.45	1.23	2074.63
Pneumatic wheel roller	1	377	3016	99	59	0.18	2.37	0.24	0.23	4.70	0.37	559.00	0.04	0.46	0.05	0.05	0.91	0.07	108.45
Roller, vibratory	1	263	2104	92.3	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.02	0.31	0.05	0.05	0.60	0.05	70.51
Rollers, steel wheel	1	278	2224	92	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.02	0.33	0.05	0.05	0.64	0.06	74.53
Tandem roller, 10 ton	1	238	1904	70	59	0.12	2.64	0.44	0.42	5.00	0.47	555.84	0.01	0.23	0.04	0.04	0.43	0.04	47.84
Total Emissions													**1.69**	**74.80**	**5.68**	**5.44**	**67.68**	**15.01**	**7799.91**

Total Construction Equipment Emissions – Pagan Alternative 1

Pagan Alternative 1																			
Equipment Type	Number of Units	Days	Hours	Horsepower (hp)	Load Factor (%)	Emission Factor (grams/hp-hour)							Emission Rate (tons)						
						SO2	CO	PM10	PM2.5	NOx	VOC	CO_2	SO2	CO	PM10	PM2.5	NOx	VOC	CO_2
Construction Equipment Emissions																			
Asphalt paver, 130 HP	1	19	152	130	59	0.12	1.60	0.33	0.32	4.54	0.37	536.21	0.00	0.02	0.00	0.00	0.06	0.00	6.88
Chain saws, 36"	1	1234	9872	7	70	0.14	349.18	9.76	8.98	0.91	70.10	686.61	0.01	18.10	0.51	0.47	0.05	3.63	35.59
Chipping machine	1	617	4936	144	43	0.12	2.46	0.45	0.43	5.98	0.59	550.61	0.04	0.83	0.15	0.15	2.01	0.20	185.20
Crane, hydraulic, 33 ton	1	2	16	315	43	0.11	1.55	0.25	0.25	5.59	0.34	530.50	0.00	0.00	0.00	0.00	0.01	0.00	1.27
Dozer, 300 HP	1	11	88	300	59	0.12	1.93	0.30	0.29	4.72	0.33	539.34	0.00	0.03	0.01	0.00	0.08	0.01	9.25
Front end loader, 1.5 cy	1	11	88	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.00	0.03	0.00	0.00	0.07	0.01	7.48
Front end loader, TM, 2.5cy	1	617	4936	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.09	1.63	0.26	0.25	3.93	0.28	419.65
Grader, 30,000 lb	1	1220	9760	204	59	0.12	1.45	0.28	0.27	4.26	0.32	537.25	0.15	1.88	0.36	0.35	5.52	0.41	696.49
Pneumatic wheel roller	1	19	152	99	59	0.16	2.37	0.24	0.23	4.70	0.37	559.00	0.00	0.02	0.00	0.00	0.05	0.00	5.47
Roller, vibratory	1	11	88	92	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.00	0.01	0.00	0.00	0.03	0.00	2.95
Rollers, steel wheel	1	14	112	92	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.00	0.02	0.00	0.00	0.03	0.00	3.75
Tandem roller, 10 ton	1	12	96	70	59	0.12	2.64	0.44	0.42	5.00	0.47	555.84	0.00	0.01	0.00	0.00	0.02	0.00	2.41
Total Emissions													**0.30**	**22.59**	**1.30**	**1.23**	**11.85**	**4.56**	**1376.40**

Total Construction Equipment Emissions – Pagan Alternative 2

Pagan Alternative 2																				
Equipment Type	Number of Units	Days	Hours	Horsepower (hp)	Load Factor (%)	Emission Factor (grams/hp-hour)							Emission Rate (tons)							
						SO2	CO	PM10	PM2.5	NOx	VOC	CO_2	SO2	CO	PM10	PM2.5	NOx	VOC	CO_2
Construction Equipment Emissions																			
Asphalt paver, 130 HP	1	19	152	130	59	0.12	1.60	0.33	0.32	4.54	0.37	536.21	0.00	0.02	0.00	0.00	0.06	0.00	6.88
Chain saws, 36"	1	900	7200	7	70	0.14	349.18	9.76	8.98	0.91	70.10	686.61	0.01	13.20	0.37	0.34	0.03	2.65	25.95
Chipping machine	1	450	3600	144	43	0.12	2.46	0.45	0.43	5.98	0.59	550.61	0.03	0.60	0.11	0.11	1.47	0.15	135.07
Crane, hydraulic, 33 ton	1	2	16	315	43	0.11	1.55	0.25	0.25	5.59	0.34	530.50	0.00	0.00	0.00	0.00	0.01	0.00	1.27
Dozer, 300 HP	1	11	88	282	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.00	0.01	0.00	0.00	0.06	0.00	6.23
Front end loader, 1.5 cy	1	11	88	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.00	0.03	0.00	0.00	0.07	0.01	7.48
Front end loader, TM, 2.5cy	1	450	3600	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.07	1.19	0.19	0.18	2.86	0.21	306.07
Grader, 30,000 lb	1	899	7192	204	59	0.12	1.45	0.28	0.27	4.26	0.32	537.25	0.11	1.39	0.27	0.26	4.07	0.30	513.23
Pneumatic wheel roller	1	19	152	99	59	0.16	2.37	0.24	0.23	4.70	0.37	559.00	0.00	0.02	0.00	0.00	0.05	0.00	5.47
Roller, vibratory	1	11	88	92	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.00	0.01	0.00	0.00	0.03	0.00	2.95
Rollers, steel wheel	1	14	112	92	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.00	0.02	0.00	0.00	0.03	0.00	3.75
Tandem roller, 10 ton	1	12	96	70	59	0.12	2.64	0.44	0.42	5.00	0.47	555.84	0.00	0.01	0.00	0.00	0.02	0.00	2.41
Total Emissions													**0.22**	**16.51**	**0.95**	**0.91**	**8.75**	**3.33**	**1016.78**

Total Construction Vehicle Emissions – Tinian Alternative 1

On Site Vehicle Emission																
			Emission Factor (lb/hr)							Emissions (tons)						
	Days	Total Hours	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
On Site Vehicle[1]																
Trucks	526	8	0.00	0.07	0.02	0.01	0.15	0.02	60.71	0.00	0.14	0.05	0.03	0.32	0.04	127.74
Off Site Vehicle Emission																
			Emission Factor (lb/Miles)							Emissions (tons)						
	Number of Units	Total Miles	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
Off Site Vehicle[2]																
Trucks	36510	20	0.00	0.00	0.00	0.00	0.01	0.00	5.70	0.01	1.51	0.45	0.36	4.60	0.26	2080.56
Cars	109186	20	0.00	0.01	0.00	0.00	0.00	0.00	0.81	0.02	7.27	0.07	0.03	0.45	0.17	887.69
Total motor vehicle emissions										**0.03**	**8.93**	**0.58**	**0.41**	**5.37**	**0.46**	**3095.99**

Assumption

1. Onsite vehicles speed: 5 mph
2. Offsite vehicles speed: 30 mph
3. Roadway type: Rural unrestricted
4. Offsite trucks includes material delivery trucks and dump trucks running 20 miles round trip
5. Offsite passenger cars are running 20 miles round trip
6. Onsite trucks includes water trucks and tractor trucks, running 8 hours per day

Total Construction Vehicle Emissions – Tinian Alternative 2

On Site Vehicle Emission																
			Emission Factor (lb/hr)							Emissions (tons)						
	Days	Total Hours	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
On Site Vehicle[1]																
Trucks	526	8	0.00	0.07	0.02	0.01	0.15	0.02	60.71	0.00	0.14	0.05	0.03	0.32	0.04	127.74
Off Site Vehicle Emission																
			Emission Factor (lb/Miles)							Emissions (tons)						
	Days	Total Miles	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
Off Site Vehicle[2]																
Trucks	36898	20	0.00	0.00	0.00	0.00	0.01	0.00	5.70	0.01	1.53	0.46	0.37	4.65	0.26	2102.67
Cars	111439	20	0.00	0.01	0.00	0.00	0.00	0.00	0.81	0.02	7.42	0.08	0.03	0.46	0.17	906.01
Total motor vehicle emissions										**0.03**	**9.09**	**0.58**	**0.42**	**5.43**	**0.47**	**3136.41**

Assumption

1. Onsite vehicles speed: 5 mph
2. Offsite vehicles speed: 30 mph
3. Roadway type: Rural unrestricted
4. Offsite trucks includes material delivery trucks and dump trucks running 20 miles round trip
5. Offsite passenger cars are running 20 miles round trip
6. Onsite trucks includes water trucks and tractor trucks, running 8 hours per day

Total Construction Vehicle Emissions – Tinian Alternative 3

On Site Vehicle Emission																
			Emission Factor (lb/hr)							Emissions (tons)						
	Days	Total Hours	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
On Site Vehicle[1]																
Trucks	526	8	0.00	0.07	0.02	0.01	0.15	0.02	60.71	0.00	0.14	0.05	0.03	0.32	0.04	127.74
Off Site Vehicle Emission																
			Emission Factor (lb/Miles)							Emissions (tons)						
	Days	Total Miles	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
Off Site Vehicle[2]																
Trucks	36523	20	0.00	0.00	0.00	0.00	0.01	0.00	5.70	0.01	1.51	0.45	0.36	4.61	0.26	2081.30
Cars	109314	20	0.00	0.01	0.00	0.00	0.00	0.00	0.81	0.02	7.28	0.07	0.03	0.45	0.17	888.73
Total motor vehicle emissions										**0.03**	**8.94**	**0.58**	**0.41**	**5.37**	**0.46**	**3097.77**

Assumption

1. Onsite vehicles speed: 5 mph
2. Offsite vehicles speed: 30 mph
3. Roadway type: Rural unrestricted
4. Offsite trucks includes material delivery trucks and dump trucks running 20 miles round trip
5. Offsite passenger cars are running 20 miles round trip
6. Onsite trucks includes water trucks and tractor trucks, running 8 hours per day

Total Construction Vehicle Emissions – Pagan Alternative 1

On Site Vehicle Emission																
			Emission Factor (lb/hr)							Emissions (tons)						
	Days	Total Hours	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
On Site Vehicle[1]																
Trucks	22	8	0.00	0.07	0.02	0.01	0.15	0.02	60.71	0.00	0.01	0.00	0.00	0.01	0.00	5.34
Off Site Vehicle Emission																
			Emission Factor (lb/Miles)							Emissions (tons)						
	Days	Total Miles	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
Off Site Vehicle[2]																
Trucks	769	20	0.00	0.00	0.00	0.00	0.01	0.00	5.70	0.00	0.03	0.01	0.01	0.10	0.01	43.82
Cars	6466	20	0.00	0.01	0.00	0.00	0.00	0.00	0.81	0.00	0.43	0.00	0.00	0.03	0.01	52.57
Total motor vehicle emissions										**0.00**	**0.47**	**0.02**	**0.01**	**0.14**	**0.02**	**101.73**

Assumption

1. Onsite vehicles speed: 5 mph
2. Offsite vehicles speed: 30 mph
3. Roadway type: Rural unrestricted
4. Offsite trucks includes material delivery trucks and dump trucks running 20 miles round trip
5. Offsite passenger cars are running 20 miles round trip
6. Onsite trucks includes water trucks and tractor trucks, running 8 hours per day

Total Construction Vehicle Emissions – Pagan Alternative 2

On Site Vehicle Emission																
			Emission Factor (lb/hr)							Emissions (tons)						
	Days	Total Hours	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
On Site Vehicle[1]																
Trucks	22	8	0.00	0.07	0.02	0.01	0.15	0.02	60.71	0.00	0.01	0.00	0.00	0.01	0.00	5.34
Off Site Vehicle Emission																
			Emission Factor (lb/Miles)							Emissions (tons)						
	Days	Total Miles	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
Off Site Vehicle[2]																
Trucks	602	20	0.00	0.00	0.00	0.00	0.01	0.00	5.70	0.00	0.02	0.01	0.01	0.08	0.00	34.31
Cars	4822	20	0.00	0.01	0.00	0.00	0.00	0.00	0.81	0.00	0.32	0.00	0.00	0.02	0.01	39.20
Total motor vehicle emissions										**0.00**	**0.35**	**0.01**	**0.01**	**0.11**	**0.01**	**78.85**

Assumption

1. Onsite vehicles speed: 5 mph
2. Offsite vehicles speed: 30 mph
3. Roadway type: Rural unrestricted
4. Offsite trucks includes material delivery trucks and dump trucks running 20 miles round trip
5. Offsite passenger cars are running 20 miles round trip
6. Onsite trucks includes water trucks and tractor trucks, running 8 hours per day

Annual Construction Emissions – Tinian Alternative 1

Construction Year	Pollutant (tpy)						
	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
1	0.19	9.25	0.69	0.65	8.09	1.71	1207.57
2	0.19	9.25	0.69	0.65	8.09	1.71	1207.57
3	0.19	9.25	0.69	0.65	8.09	1.71	1207.57
4	0.19	9.25	0.69	0.65	8.09	1.71	1207.57
5	0.19	9.25	0.69	0.65	8.09	1.71	1207.57
6	0.19	9.25	0.69	0.65	8.09	1.71	1207.57
7	0.19	9.25	0.69	0.65	8.09	1.71	1207.57
8	0.19	9.25	0.69	0.65	8.09	1.71	1207.57
9	0.19	9.25	0.69	0.65	8.09	1.71	1207.57

Legend: CO = carbon monoxide; CO_2 = carbon dioxide; NO_x = nitrogen oxides; PM_{10} = particulate matter with an aerodynamic diameter of less than or equal to a nominal 10 micrometers; PM2.5 = particulate matter with an aerodynamic diameter of less than or equal to a nominal 2.5 micrometers; SO2 = sulfur dioxide; VOC = volatile organic compound.

Annual Construction Emissions – Tinian Alternative 2

Construction Year	Pollutant (tpy)						
	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
1	0.19	9.49	0.70	0.66	8.20	1.75	1223.55
2	0.19	9.49	0.70	0.66	8.20	1.75	1223.55
3	0.19	9.49	0.70	0.66	8.20	1.75	1223.55
4	0.19	9.49	0.70	0.66	8.20	1.75	1223.55
5	0.19	9.49	0.70	0.66	8.20	1.75	1223.55
6	0.19	9.49	0.70	0.66	8.20	1.75	1223.55
7	0.19	9.49	0.70	0.66	8.20	1.75	1223.55
8	0.19	9.49	0.70	0.66	8.20	1.75	1223.55
9	0.19	9.49	0.70	0.66	8.20	1.75	1223.55

Legend: CO = carbon monoxide; CO_2 = carbon dioxide; NO_x = nitrogen oxides; PM_{10} = particulate matter with an aerodynamic diameter of less than or equal to a nominal 10 micrometers; PM2.5 = particulate matter with an aerodynamic diameter of less than or equal to a nominal 2.5 micrometers; SO2 = sulfur dioxide; VOC = volatile organic compound.

Annual Construction Emissions – Tinian Alternative 3

Construction Year	Pollutant (tpy)						
	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
1	0.19	9.30	0.69	0.65	8.12	1.72	1210.85
2	0.19	9.30	0.69	0.65	8.12	1.72	1210.85
3	0.19	9.30	0.69	0.65	8.12	1.72	1210.85
4	0.19	9.30	0.69	0.65	8.12	1.72	1210.85
5	0.19	9.30	0.69	0.65	8.12	1.72	1210.85
6	0.19	9.30	0.69	0.65	8.12	1.72	1210.85
7	0.19	9.30	0.69	0.65	8.12	1.72	1210.85
8	0.19	9.30	0.69	0.65	8.12	1.72	1210.85
9	0.19	9.30	0.69	0.65	8.12	1.72	1210.85

Legend: CO = carbon monoxide; CO_2 = carbon dioxide; NO_x = nitrogen oxides; PM_{10} = particulate matter with an aerodynamic diameter of less than or equal to a nominal 10 micrometers; PM2.5 = particulate matter with an aerodynamic diameter of less than or equal to a nominal 2.5 micrometers; SO2 = sulfur dioxide; VOC = volatile organic compound.

Annual Construction Emissions – Pagan Alternative 1

Construction Year	Pollutant (tpy)						
	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
3	0.07	5.76	0.33	0.31	3.00	1.14	369.53
4	0.07	5.76	0.33	0.31	3.00	1.14	369.53
5	0.07	5.76	0.33	0.31	3.00	1.14	369.53
6	0.07	5.76	0.33	0.31	3.00	1.14	369.53

Legend: CO = carbon monoxide; CO_2 = carbon dioxide; NO_x = nitrogen oxides; PM_{10} = particulate matter with an aerodynamic diameter of less than or equal to a nominal 10 micrometers; PM2.5 = particulate matter with an aerodynamic diameter of less than or equal to a nominal 2.5 micrometers; SO2 = sulfur dioxide; VOC = volatile organic compound.

Annual Construction Emissions – Pagan Alternative 2

Construction Year	Pollutant (tpy)						
	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
3	0.05	4.21	0.24	0.23	2.22	0.84	273.91
4	0.05	4.21	0.24	0.23	2.22	0.84	273.91
5	0.05	4.21	0.24	0.23	2.22	0.84	273.91
6	0.05	4.21	0.24	0.23	2.22	0.84	273.91

Legend: CO = carbon monoxide; CO_2 = carbon dioxide; NO_x = nitrogen oxides; PM_{10} = particulate matter with an aerodynamic diameter of less than or equal to a nominal 10 micrometers; PM2.5 = particulate matter with an aerodynamic diameter of less than or equal to a nominal 2.5 micrometers; SO2 = sulfur dioxide; VOC = volatile organic compound.

Attachment 3 - Aircraft Emissions Estimate

CJMT Airfield Emissions

Aircrafts, LTO and Operation at Tinian

Aircraft Type	Model	Percentage	Operation Mode	Pounds per LTO / Operation					
				CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	100	Vertical Takeoff (Conversion mode)	2.45	2578.9	6.79	0.04	0.32	1.13
			Short Takeoff (Airplane mode)	2.37	2216.1	5.38	0.03	0.28	0.95
			Short Landing (Airplane mode)	2.96	1934.8	3.87	0.05	0.24	0.78
			Vertical Landing (Conversion mode)	2.96	1934.8	3.87	0.05	0.24	0.78
			Landing w/ Break (Airplane mode)	3.07	2498.7	6.13	0.05	0.31	1.06
Transport Rotary Wing	CH-53E	100	LTO	22.9	-	8.9	11.2	0.7	3.8
Attack Helo	AH-1Y	50	LTO (AH-1W)	7.08	852.02	2.09	0.33	0.17	1.8
	UH-1Z	50	LTO (UH-1N)	3.32	893.27	1.28	0.67	0.11	1.18
Transport Fixed Wing	KC-130	50	Single KC-130 LTO with Straight In Arrival	14.8	7570	17.35	7.65	0.95	9.03
			Single KC-130 LTO with Break at Arrival	13.8	7896	19.17	7.39	0.99	9.42
	C-17	50	Idle (Taxi)	23.53	3371.76	3.90	0.38	1.10	11.06
			Approach	0.81	5136.61	24.46	0.08	1.67	8.73
			Takeoff	0.12	1206.01	12.99	0.00	0.39	0.02
Unmanned	RQ-7	100	no info	-	-	-	-	-	-
Fight Jet (not including FCLP)*	FA-18C/D*	25	APU Use	0.03	52.04	0.10	0.00	0.03	0.00
			Start/Warm up	42.85	857.06	0.36	18.15	0.64	4.30
			Unstick(s) per Dep: 1	0.71	46.11	0.05	0.09	0.03	0.15
			Taxi Out	14.28	285.69	0.12	6.05	0.21	1.43
			Engine Run-up	0.39	126.02	0.19	0.04	0.08	0.33
			Takeoff	12.24	1652.79	4.88	0.07	1.09	-
			Climbout	0.35	1031.59	6.41	0.10	0.67	1.10
			Approach to Break	0.27	676.65	2.35	0.07	0.44	1.02
			Break	1.68	38.24	0.03	0.60	0.03	0.17
			On Runway (WonW)	2.86	57.14	0.02	1.21	0.04	0.29
			Unstick(s) per Arr: 1	0.71	46.11	0.05	0.09	0.03	0.15
			Taxi In	22.85	457.10	0.19	9.68	0.34	2.29
			Hot Refuel %: 100	42.85	857.06	0.36	18.15	0.64	4.30
	FA-18E/F*	25	APU Use	0.03	52.04	0.10	0.00	0.03	0.00
			Start/Warm up	34.13	1033.58	1.10	22.71	0.72	4.39

			Unstick(s) per Dep: 1	0.26	54.87	0.10	0.03	0.04	0.18
			Taxi Out	11.38	344.53	0.37	7.57	0.24	1.46
			Engine Run-up	0.10	164.44	0.46	0.01	0.11	0.45
			Takeoff	163.89	1616.61	5.77	2.90	1.23	-
			Climbout	0.26	1199.63	13.69	0.05	0.78	1.11
			Approach to Break	0.18	843.92	6.27	0.03	0.55	1.20
			Break	1.07	41.60	0.05	0.58	0.03	0.17
			On Runway (WonW)	2.28	68.91	0.07	1.51	0.05	0.29
			Unstick(s) per Arr: 1	0.26	54.87	0.10	0.03	0.04	0.18
			Taxi In	18.20	551.24	0.59	12.11	0.38	2.34
			Hot Refuel %: 100	34.13	1033.58	1.10	22.71	0.72	4.39
	F-35B*	20	F-35B Conventional LTO Cycle	4.65	8757	22.51	0.25	1.08	13.78
			F-35B Short LTO Cycle	4.63	10687	41.34	0.22	1.32	14.69
			F-35B Vertical LTO Cycle	4.61	11101	45.69	0.22	1.37	14.87
	F-35C*	30	F-35C LTO Cycle	17.08	5584	14.65	0.2	0.69	9.52
Heavy Commercial Transport	Assumed C-17	100	Idle (Taxi)	23.53	3371.76	3.90	0.38	1.10	11.06
			Approach	0.81	5136.61	24.46	0.08	1.67	8.73
			Takeoff	0.12	1206.01	12.99	0.00	0.39	0.02

Note:
* All fight jets 100% afterburner departures.

Emission factors for following Navy aircraft are obtained from AESO reports as indicated:

KC-130 – (#2000-09, Revision B, January 2001)
AH-1 – (#9824, Revision B, November 2009)
UH-1 – (#9904, Revision B, November 2009)
F/A-18 – (F-18 Emissions Calculator-Version 1-Sep.27, 2013)
H-53 – (#9822, Revision C, February 2000)
MV-22 – (#9946, Revision E, January 2001)
F-35 – (JSF worksheet for F-135 engine)
C-17 – (Air Emissions Guide for Air Force Mobile Sources)

Aircrafts, LTO and Operation at Pagan

Aircraft Type	Model	Percentage	Operation Mode	Pounds per LTO / Operation					
				CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	100	Vertical Takeoff (Conversion mode)	2.45	2578.9	6.79	0.04	0.32	1.13
			Short Takeoff (Airplane mode)	2.37	2216.1	5.38	0.03	0.28	0.95
			Short Landing (Airplane mode)	2.96	1934.8	3.87	0.05	0.24	0.78
			Vertical Landing (Conversion mode)	2.96	1934.8	3.87	0.05	0.24	0.78
			Landing w/ Break (Airplane mode)	3.07	2498.7	6.13	0.05	0.31	1.06
Transport Rotary Wing	CH-53E	100	LTO	22.9	-	8.9	11.2	0.7	3.8
Attack Helo	AH-1Y	50	LTO (AH-1W)	7.08	852.02	2.09	0.33	0.17	1.8
	UH-1Z	50	LTO (UH-1N)	3.32	893.27	1.28	0.67	0.11	1.18
Transport Fixed Wing	KC-130	50	Single KC-130 LTO with Straight In Arrival	14.79	7570	17.35	7.65	0.95	9.03
			Single KC-130 LTO with Break at Arrival	13.78	7896	19.17	7.39	0.99	9.42
	C-17	50	Idle (Taxi)	23.53	3371.76	3.90	0.38	1.10	11.06
			Approach	0.81	5136.61	24.46	0.08	1.67	8.73
			Takeoff	0.12	1206.01	12.99	0.00	0.39	0.02
Unmanned	RQ-7	100							

Note:

Emission factors for following Navy aircraft are obtained from AESO reports as indicated:

KC-130 – (#2000-09, Revision B, January 2001)
AH-1 – (#9824, Revision B, November 2009)
UH-1 – (#9904, Revision B, November 2009)
MV-22 – (#9946, Revision E, January 2001)
H-53 – (#9822, Revision C, February 2000)
C-17 – (Air Emissions Guide for Air Force Mobile Sources)
RQ-7 – (EDMS)

Airfield Emissions - Tinian International Airport

Aircraft Type	Model	Annual # Take-offs Total	Annual # Landings Total	Annual # Closed Field Patterns Total	Total Annual LTOs per Aircraft Type	Total Annual LTOs per Aircraft Model	Operational Emissions (tons) CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	200	200	300	500	500	1.38	1269.4	3.23	0.0225	0.1575	0.5475
Transport Rotary Wing	CH-53E	180	180	300	480	480	5.496	-	2.136	2.688	0.168	0.912
Attack Helo	AH-1Y	80	80	300	380	190	0.6726	80.9419	0.19855	0.03135	0.01615	0.171
	UH-1Z					190	0.3154	84.86065	0.1216	0.06365	0.01045	0.1121
Transport Fixed Wing	KC-130	600	600	0	600	300	2.067	1184.4	2.8755	1.1085	0.1485	1.413
	C-17					300	3.67	1457.16	6.20	0.07	0.47	2.97
Unmanned	RQ-7	150	150	0	150	150	-	-	-	-	-	-
Fighter (not including FCLP)*	FA-18C/D*	1000	1000	0	1000	250	17.76	772.95	1.89	6.79	0.54	1.94
	FA-18E/F*					250	33.27	882.48	3.72	8.78	0.61	2.02
	F-35B*					200	0.461	1110.1	4.569	0.022	0.137	1.487
	F-35C*					300	2.562	837.6	2.1975	0.03	0.1035	1.428
Heavy Commercial Transport	Assumed C-17	12	12	0	12	12	0.15	58.29	0.25	0.00	0.02	0.12
Total							**67.80**	**7738.17**	**27.39**	**19.61**	**2.38**	**13.13**

Airfield Emissions - Tinian International Airport (FCLP)

Aircraft Type		Annual # Take-offs	Annual # Landings	Annual # Closed Field Patterns	Total Annual LTOs per Aircraft Type	Total Annual LTOs per Aircraft Model	Operational Emissions (tons)					
	Model	Total	Total	Total			CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	-	-	-	-	-	-	-	-	-	-	-
Transport Rotary Wing	CH-53E	-	-	-	-	-	-	-	-	-	-	-
Attack Helo	AH-1Y	-	-	-	-	-	-	-	-	-	-	-
	UH-1Z					-	-	-	-	-	-	-
Transport Fixed Wing	KC-130	-	-	-	-	-	-	-	-	-	-	-
	C-17					-	-	-	-	-	-	-
Unmanned	RQ-7	-	-	-	-	-	-	-	-	-	-	-
Fighter (not including FCLP)*	FA-18C/D*	-	-	3000	3000	750	53.28	2318.85	5.67	20.37	1.61	5.83
	FA-18E/F*					750	99.82	2647.43	11.16	26.34	1.83	6.07
	F-35B*					600	1.383	3330.3	13.707	0.066	0.411	4.461
	F-35C*					900	7.686	2512.8	6.5925	0.09	0.3105	4.284
Heavy Commercial Transport	Assumed C-17											
Total							**162.17**	**10809.38**	**37.14**	**46.87**	**4.17**	**20.65**

Airfield Emissions - Tinian FARP North Field

Aircraft Type		Annual # Take-offs	Annual # Landings	Annual # Closed Field Patterns	Total Annual LTOs per Aircraft Type	Total Annual LTOs per Aircraft Model	Operational Emissions (tons)					
	Model	Total	Total	Total			CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	200	200	0	200	200	0.552	507.76	1.292	0.009	0.063	0.219
Transport Rotary Wing	CH-53E	180	180	0	180	180	2.061	-	0.801	1.008	0.063	0.342
Attack Helo	AH-1Y	80	80	0	80	40	0.1416	17.0404	0.0418	0.0066	0.0034	0.036
	UH-1Z					40	0.0664	17.865	0.0256	0.0134	0.0022	0.0236
Transport Fixed Wing	KC-130	600	600	0	600	300	2.067	1184.4	2.8755	1.1085	0.1485	1.413
	C-17					300	3.67	1457.16	6.20	0.07	0.47	2.97
Unmanned	RQ-7	150	150	0	150	150	-	-	-	-	-	-
Fighter (not including FCLP)*	FA-18C/D*	-	-	-	-	-	-	-	-	-	-	-
	FA-18E/F*					-	-	-	-	-	-	-
	F-35B*					-	-	-	-	-	-	-
	F-35C*					-	-	-	-	-	-	-
Heavy Commercial Transport	Assumed C-17	-	-	-	-							
Total							**8.56**	**3184.22**	**11.24**	**2.22**	**0.75**	**5.01**

Airfield Emissions - Tinian LZ Base Camp

Aircraft Type		Annual # Take-offs	Annual # Landings	Annual # Closed Field Patterns	Total Annual LTOs per Aircraft Type	Total Annual LTOs per Aircraft Model	Operational Emissions (tons)					
	Model	Total	Total	Total			CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	200	200	0	200	200	0.552	507.76	1.292	0.009	0.063	0.219
Transport Rotary Wing	CH-53E	180	180	0	180	180	2.061	-	0.801	1.008	0.063	0.342
Attack Helo	AH-1Y	80	80	0	80	40	0.1416	17.0404	0.0418	0.0066	0.0034	0.036
	UH-1Z					40	0.0664	17.8654	0.0256	0.0134	0.0022	0.0236
Transport Fixed Wing	KC-130	-	-	-	-	-	-	-	-	-	-	-
	C-17					-	-	-	-	-	-	-
Unmanned	RQ-7	-	-	-	-	-	-	-	-	-	-	-
Fighter (not including FCLP)*	FA-18C/D*	-	-	-	-	-	-	-	-	-	-	-
	FA-18E/F*					-	-	-	-	-	-	-
	F-35B*					-	-	-	-	-	-	-
	F-35C*					-	-	-	-	-	-	-
Heavy Commercial Transport	Assumed C-17	-	-	-	-							
Total							**2.821**	**542.6658**	**2.1604**	**1.037**	**0.1316**	**0.6206**

Airfield Emissions - Tinian LZ MSA

Aircraft Type		Annual # Take-offs	Annual # Landings	Annual # Closed Field Patterns	Total Annual LTOs per Aircraft Type	Total Annual LTOs per Aircraft Model	Operational Emissions (tons)					
	Model	Total	Total	Total			CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	100	100	0	100	100	0.276	253.88	0.646	0.0045	0.0315	0.1095
Transport Rotary Wing	CH-53E	100	100	0	100	100	1.145	-	0.445	0.56	0.035	0.19
Attack Helo	AH-1Y	-	-	-	-	-	-	-	-	-	-	-
	UH-1Z					-	-	-	-	-	-	-
Transport Fixed Wing	KC-130	-	-	-	-	-	-	-	-	-	-	-
	C-17					-	-	-	-	-	-	-
Unmanned	RQ-7	-	-	-	-	-	-	-	-	-	-	-
Fighter (not including FCLP)*	FA-18C/D*	-	-	-	-	-	-	-	-	-	-	-
	FA-18E/F*					-	-	-	-	-	-	-
	F-35B*					-	-	-	-	-	-	-
	F-35C*					-	-	-	-	-	-	-
Heavy Commercial Transport	Assumed C-17		-	-	-							
Total							**1.421**	**253.88**	**1.091**	**0.5645**	**0.0665**	**0.2995**

Airfield Emissions - Tinian LZ OP 3

Aircraft Type		Annual # Take-offs	Annual # Landings	Annual # Closed Field Patterns	Total Annual LTOs per Aircraft Type	Total Annual LTOs per Aircraft Model	Operational Emissions (tons)					
	Model	Total	Total	Total			CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	200	200	0	200	200	0.552	507.76	1.292	0.009	0.063	0.219
Transport Rotary Wing	CH-53E	180	180	0	180	180	2.061	-	0.801	1.008	0.063	0.342
Attack Helo	AH-1Y	80	80	0	80	40	0.1416	17.0404	0.0418	0.0066	0.0034	0.036
	UH-1Z					40	0.0664	17.8654	0.0256	0.0134	0.0022	0.0236
Transport Fixed Wing	KC-130	-	-	-	-	-	-	-	-	-	-	-
	C-17					-	-	-	-	-	-	-
Unmanned	RQ-7	-	-	-	-	-	-	-	-	-	-	-
Fighter (not including FCLP)*	FA-18C/D*	-	-	-	-	-	-	-	-	-	-	-
	FA-18E/F*					-	-	-	-	-	-	-
	F-35B*					-	-	-	-	-	-	-
	F-35C*					-	-	-	-	-	-	-
Heavy Commercial Transport	Assumed C-17		-	-	-							
Total							**2.821**	**542.666**	**2.1604**	**1.037**	**0.1316**	**0.6206**

Airfield Emissions - Tinian LZ BAX S

Aircraft Type		Annual # Take-offs	Annual # Landings	Annual # Closed Field Patterns	Total Annual LTOs per Aircraft Type	Total Annual LTOs per Aircraft Model	Operational Emissions (tons)					
	Model	Total	Total	Total			CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	200	200	0	200	200	0.552	507.76	1.292	0.009	0.063	0.219
Transport Rotary Wing	CH-53E	180	180	0	180	180	2.061	-	0.801	1.008	0.063	0.342
Attack Helo	AH-1Y	80	80	0	80	40	0.1416	17.0404	0.0418	0.0066	0.0034	0.036
	UH-1Z					40	0.0664	17.8654	0.0256	0.0134	0.0022	0.0236
Transport Fixed Wing	KC-130	-	-	-	-	-	-	-	-	-	-	-
	C-17					-	-	-	-	-	-	-
Unmanned	RQ-7	-	-	-	-	-	-	-	-	-	-	-
Fighter (not including FCLP)*	FA-18C/D*	-	-	-	-	-	-	-	-	-	-	-
	FA-18E/F*					-	-	-	-	-	-	-
	F-35B*					-	-	-	-	-	-	-
	F-35C*					-	-	-	-	-	-	-
Heavy Commercial Transport	Assumed C-17	-	-	-	-							
Total							**2.821**	**542.666**	**2.1604**	**1.037**	**0.1316**	**0.6206**

Airfield Emissions - Tinian LZ Chulu

Aircraft Type		Annual # Take-offs	Annual # Landings	Annual # Closed Field Patterns	Total Annual LTOs per Aircraft Type	Total Annual LTOs per Aircraft Model	Operational Emissions (tons)					
	Model	Total	Total	Total			CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	200	200	0	200	200	0.552	507.76	1.292	0.009	0.063	0.219
Transport Rotary Wing	CH-53E	180	180	0	180	180	2.061	-	0.801	1.008	0.063	0.342
Attack Helo	AH-1Y	80	80	0	80	40	0.1416	17.0404	0.0418	0.0066	0.0034	0.036
	UH-1Z					40	0.0664	17.8654	0.0256	0.0134	0.0022	0.0236
Transport Fixed Wing	KC-130	-	-	-	-	-	-	-	-	-	-	-
	C-17					-	-	-	-	-	-	-
Unmanned	RQ-7	-	-	-	-	-	-	-	-	-	-	-
Fighter (not including FCLP)*	FA-18C/D*	-	-	-	-	-	-	-	-	-	-	-
	FA-18E/F*					-	-	-	-	-	-	-
	F-35B*					-	-	-	-	-	-	-
	F-35C*					-	-	-	-	-	-	-
Heavy Commercial Transport	Assumed C-17	-	-	-	-							
Total							**2.821**	**542.666**	**2.1604**	**1.037**	**0.1316**	**0.6206**

Airfield Emissions - Tinian International Airport (LHD)

Aircraft Type		Annual # Take-offs	Annual # Landings	Annual # Closed Field Patterns	Total Annual LTOs per Aircraft Type	Total Annual LTOs per Aircraft Model	Operational Emissions (tons)					
	Model	Total	Total	Total			CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	0	0	300	300	300	0.828	761.64	1.938	0.0135	0.0945	0.3285
Transport Rotary Wing	CH-53E	0	0	300	300	300	3.435	-	1.335	1.68	0.105	0.57
Attack Helo	AH-1Y	0	0	300	300	150	0.531	63.9015	0.15675	0.02475	0.01275	0.135
	UH-1Z					150	0.249	66.9953	0.096	0.05025	0.00825	0.0885
Transport Fixed Wing	KC-130	-	-	-	-	-	-	-	-	-	-	-
	C-17					-	-	-	-	-	-	-
Unmanned	RQ-7	-	-	-	-	-	-	-	-	-	-	-
Fighter (not including FCLP)*	FA-18C/D*	-	-	-	-	-	-	-	-	-	-	-
	FA-18E/F*					-	-	-	-	-	-	-
	F-35B*					-	-	-	-	-	-	-
	F-35C*					-	-	-	-	-	-	-
Heavy Commercial Transport	Assumed C-17	-	-	-	-							
Total							**5.043**	**892.537**	**3.52575**	**1.7685**	**0.2205**	**1.122**

Airfield Emissions - Pagan Airfield

Aircraft Type		Annual # Take-offs	Annual # Landings	Annual # Closed Field Patterns	Total Annual LTOs per Aircraft Type	Total Annual LTOs per Aircraft Model	Operational Emissions (tons)					
	Model	Total	Total	Total			CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	300	300	0	300	300	0.828	761.64	1.938	0.0135	0.0945	0.3285
Transport Rotary Wing	CH-53E	1080	1080	0	1080	1080	12.366	-	4.806	6.048	0.378	2.052
Attack Helo	AH-1Y	480	480	0	480	240	0.8496	102.2424	0.2508	0.0396	0.0204	0.216
	UH-1Z					240	0.3984	107.1924	0.1536	0.0804	0.0132	0.1416
Transport Fixed Wing	KC-130	500	500	0	500	250	1.7225	987.0	2.39625	0.92375	0.12375	1.1775
	C-17					250	3.06	1214.30	5.17	0.06	0.40	2.48
Unmanned	RQ-7	150	200	0	150	150	-	-	-	-	-	-
No fighter aircraft operations on Pagan	-	Not applicable										
Total							**19.22**	**3172.37**	**14.71**	**7.16**	**1.03**	**6.39**

Airfield Emissions - Pagan LZ Mid

Aircraft Type		Annual # Take-offs	Annual # Landings	Annual # Closed Field Patterns	Total Annual LTOs per Aircraft Type	Total Annual LTOs per Aircraft Model	Operational Emissions (tons)					
	Model	Total	Total	Total			CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	100	100	0	100	100	0.276	253.88	0.646	0.0045	0.0315	0.1095
Transport Rotary Wing	CH-53E	300	300	0	300	300	3.435	-	1.335	1.68	0.105	0.57
Attack Helo	AH-1Y	200	200	0	200	100	0.354	42.601	0.1045	0.0165	0.0085	0.09
	UH-1Z					100	0.166	44.6635	0.064	0.0335	0.0055	0.059
Transport Fixed Wing	KC-130	Not applicable										
	C-17											
Unmanned	RQ-7											
No fighter aircraft operations on Pagan	-											
Total							**4.231**	**341.1445**	**2.1495**	**1.7345**	**0.1505**	**0.8285**

Airfield Emissions - Pagan LZ Gold East

Aircraft Type		Annual # Take-offs	Annual # Landings	Annual # Closed Field Patterns	Total Annual LTOs per Aircraft Type	Total Annual LTOs per Aircraft Model	Operational Emissions (tons)					
	Model	Total	Total	Total			CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	100	100	0	100	100	0.276	253.88	0.646	0.0045	0.0315	0.1095
Transport Rotary Wing	CH-53E	300	300	0	300	300	3.435	-	1.335	1.68	0.105	0.57
Attack Helo	AH-1Y	200	200	0	200	100	0.354	42.601	0.1045	0.0165	0.0085	0.09
	UH-1Z					100	0.166	44.6635	0.064	0.0335	0.0055	0.059
Transport Fixed Wing	KC-130	Not applicable										
	C-17											
Unmanned	RQ-7											
No fighter aircraft operations on Pagan	-											
Total							**4.231**	**341.1445**	**2.1495**	**1.7345**	**0.1505**	**0.8285**

Airfield Emissions - Pagan LZ West

Aircraft Type		Annual # Take-offs	Annual # Landings	Annual # Closed Field Patterns	Total Annual LTOs per Aircraft Type	Total Annual LTOs per Aircraft Model	Operational Emissions (tons)					
	Model	Total	Total	Total			CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	100	100	0	100	100	0.276	253.88	0.646	0.0045	0.0315	0.1095
Transport Rotary Wing	CH-53E	300	300	0	300	300	3.435	-	1.335	1.68	0.105	0.57
Attack Helo	AH-1Y	200	200	0	200	100	0.354	42.601	0.1045	0.0165	0.0085	0.09
	UH-1Z					100	0.166	44.6635	0.064	0.0335	0.0055	0.059
Transport Fixed Wing	KC-130	Not applicable										
	C-17											
Unmanned	RQ-7											
No fighter aircraft operations on Pagan	-											
Total							**4.231**	**341.1445**	**2.1495**	**1.7345**	**0.1505**	**0.8285**

Airfield Emissions - Pagan LZ Ring Road South

Aircraft Type		Annual # Take-offs	Annual # Landings	Annual # Closed Field Patterns	Total Annual LTOs per Aircraft Type	Total Annual LTOs per Aircraft Model	Operational Emissions (tons)					
	Model	Total	Total	Total			CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	100	100	0	100	100	0.276	253.88	0.646	0.0045	0.0315	0.1095
Transport Rotary Wing	CH-53E	300	300	0	300	300	3.435	-	1.335	1.68	0.105	0.57
Attack Helo	AH-1Y	200	200	0	200	100	0.354	42.601	0.1045	0.0165	0.0085	0.09
	UH-1Z					100	0.166	44.6635	0.064	0.0335	0.0055	0.059
Transport Fixed Wing	KC-130	Not applicable										
	C-17											
Unmanned	RQ-7											
No fighter aircraft operations on Pagan	-											
Total							**4.231**	**341.1445**	**2.1495**	**1.7345**	**0.1505**	**0.8285**

Airfield Emissions - Pagan LZ Ring Road North

Aircraft Type		Annual # Take-offs	Annual # Landings	Annual # Closed Field Patterns	Total Annual LTOs per Aircraft Type	Total Annual LTOs per Aircraft Model	Operational Emissions (tons)					
	Model	Total	Total	Total			CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	100	100	0	100	100	0.276	253.88	0.646	0.0045	0.0315	0.1095
Transport Rotary Wing	CH-53E	300	300	0	300	300	3.435	-	1.335	1.68	0.105	0.57
Attack Helo	AH-1Y	200	200	0	200	100	0.354	42.601	0.1045	0.0165	0.0085	0.09
	UH-1Z					100	0.166	44.6635	0.064	0.0335	0.0055	0.059
Transport Fixed Wing	KC-130	Not applicable										
	C-17											
Unmanned	RQ-7											
No fighter aircraft operations on Pagan	-											
Total							4.231	341.1445	2.1495	1.7345	0.1505	0.8285

Airfield Emissions - Pagan LZ Hill South

Aircraft Type		Annual # Take-offs	Annual # Landings	Annual # Closed Field Patterns	Total Annual LTOs per Aircraft Type	Total Annual LTOs per Aircraft Model	Operational Emissions (tons)					
	Model	Total	Total	Total			CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	100	100	0	100	100	0.276	253.88	0.646	0.0045	0.0315	0.1095
Transport Rotary Wing	CH-53E	300	300	0	300	300	3.435	42.601	1.335	1.68	0.105	0.57
Attack Helo	AH-1Y	200	200	0	200	100	0.354	44.6635	0.1045	0.0165	0.0085	0.09
	UH-1Z					100	0.166	-	0.064	0.0335	0.0055	0.059
Transport Fixed Wing	KC-130	Not applicable										
	C-17											
Unmanned	RQ-7											
No fighter aircraft operations on Pagan	-											
Total							**4.231**	**341.1445**	**2.1495**	**1.7345**	**0.1505**	**0.8285**

Airfield Emissions - Pagan LZ Hill North

Aircraft Type		Annual # Take-offs	Annual # Landings	Annual # Closed Field Patterns	Total Annual LTOs per Aircraft Type	Total Annual LTOs per Aircraft Model	Operational Emissions (tons)					
	Model	Total	Total	Total			CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	100	100	0	100	100	0.276	253.88	0.646	0.0045	0.0315	0.1095
Transport Rotary Wing	CH-53E	300	300	0	300	300	3.435	-	1.335	1.68	0.105	0.57
Attack Helo	AH-1Y	200	200	0	200	100	0.354	42.601	0.1045	0.0165	0.0085	0.09
	UH-1Z					100	0.166	44.6635	0.064	0.0335	0.0055	0.059
Transport Fixed Wing	KC-130	Not applicable										
	C-17											
Unmanned	RQ-7											
No fighter aircraft operations on Pagan	-											
Total							**4.231**	**341.1445**	**2.1495**	**1.7345**	**0.1505**	**0.8285**

Airfield Emissions - Pagan LZ Northeast

Aircraft Type		Annual # Take-offs	Annual # Landings	Annual # Closed Field Patterns	Total Annual LTOs per Aircraft Type	Total Annual LTOs per Aircraft Model	Operational Emissions (tons)					
	Model	Total	Total	Total			CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	100	100	0	100	100	0.276	253.88	0.646	0.0045	0.0315	0.1095
Transport Rotary Wing	CH-53E	300	300	0	300	300	3.435	-	1.335	1.68	0.105	0.57
Attack Helo	AH-1Y	200	200	0	200	100	0.354	42.601	0.1045	0.0165	0.0085	0.09
	UH-1Z					100	0.166	44.6635	0.064	0.0335	0.0055	0.059
Transport Fixed Wing	KC-130	Not applicable										
	C-17											
Unmanned	RQ-7											
No fighter aircraft operations on Pagan	-											
Total							**4.231**	**341.1445**	**2.1495**	**1.7345**	**0.1505**	**0.8285**

Airfield Emissions - Pagan LZ North Beach

Aircraft Type		Annual # Take-offs	Annual # Landings	Annual # Closed Field Patterns	Total Annual LTOs per Aircraft Type	Total Annual LTOs per Aircraft Model	Operational Emissions (tons)					
	Model	Total	Total	Total			CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	100	100	0	100	100	0.276	253.88	0.646	0.0045	0.0315	0.1095
Transport Rotary Wing	CH-53E	300	300	0	300	300	3.435	-	1.335	1.68	0.105	0.57
Attack Helo	AH-1Y	200	200	0	200	100	0.354	42.601	0.1045	0.0165	0.0085	0.09
	UH-1Z					100	0.166	44.6635	0.064	0.0335	0.0055	0.059
Transport Fixed Wing	KC-130	Not applicable										
	C-17											
Unmanned	RQ-7											
No fighter aircraft operations on Pagan	-											
Total							**4.231**	**341.1445**	**2.1495**	**1.7345**	**0.1505**	**0.8285**

Airfield Emissions - Pagan LZ Northwest

Aircraft Type		Annual # Take-offs	Annual # Landings	Annual # Closed Field Patterns	Total Annual LTOs per Aircraft Type	Total Annual LTOs per Aircraft Model	Operational Emissions (tons)					
	Model	Total	Total	Total			CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	100	100	0	100	100	0.276	253.88	0.646	0.0045	0.0315	0.1095
Transport Rotary Wing	CH-53E	300	300	0	300	300	3.435	-	1.335	1.68	0.105	0.57
Attack Helo	AH-1Y	200	200	0	200	100	0.354	42.601	0.1045	0.0165	0.0085	0.09
	UH-1Z					100	0.166	44.6635	0.064	0.0335	0.0055	0.059
Transport Fixed Wing	KC-130	Not applicable										
	C-17											
Unmanned	RQ-7											
No fighter aircraft operations on Pagan	-											
Total							**4.231**	**341.1445**	**2.1495**	**1.7345**	**0.1505**	**0.8285**

Airfield Emissions - Pagan LZ Ring Road Lake

Aircraft Type		Annual # Take-offs	Annual # Landings	Annual # Closed Field Patterns	Total Annual LTOs per Aircraft Type	Total Annual LTOs per Aircraft Model	Operational Emissions (tons)					
	Model	Total	Total	Total			CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	100	100	0	100	100	0.276	253.88	0.646	0.0045	0.0315	0.1095
Transport Rotary Wing	CH-53E	300	300	0	300	300	3.435	-	1.335	1.68	0.105	0.57
Attack Helo	AH-1Y	200	200	0	200	100	0.354	42.601	0.1045	0.0165	0.0085	0.09
	UH-1Z					100	0.166	44.6635	0.064	0.0335	0.0055	0.059
Transport Fixed Wing	KC-130	Not applicable										
	C-17											
Unmanned	RQ-7											
No fighter aircraft operations on Pagan	-											
Total							**4.231**	**341.1445**	**2.1495**	**1.7345**	**0.1505**	**0.8285**

Airfield Emissions - Pagan LZ Ring Road Eagle

Aircraft Type		Annual # Take-offs	Annual # Landings	Annual # Closed Field Patterns	Total Annual LTOs per Aircraft Type	Total Annual LTOs per Aircraft Model	Operational Emissions (tons)					
	Model	Total	Total	Total			CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	100	100	0	100	100	0.276	253.88	0.646	0.0045	0.0315	0.1095
Transport Rotary Wing	CH-53E	300	300	0	300	300	3.435	-	1.335	1.68	0.105	0.57
Attack Helo	AH-1Y	200	200	0	200	100	0.354	42.601	0.1045	0.0165	0.0085	0.09
	UH-1Z					100	0.166	44.6635	0.064	0.0335	0.0055	0.059
Transport Fixed Wing	KC-130	Not applicable										
	C-17											
Unmanned	RQ-7											
No fighter aircraft operations on Pagan	-											
Total							**4.231**	**341.1445**	**2.1495**	**1.7345**	**0.1505**	**0.8285**

Airfield Emissions - Pagan LZ Owl

Aircraft Type		Annual # Take-offs	Annual # Landings	Annual # Closed Field Patterns	Total Annual LTOs per Aircraft Type	Total Annual LTOs per Aircraft Model	Operational Emissions (tons)					
	Model	Total	Total	Total			CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	100	100	0	100	100	0.276	253.88	0.646	0.0045	0.0315	0.1095
Transport Rotary Wing	CH-53E	300	300	0	300	300	3.435	-	1.335	1.68	0.105	0.57
Attack Helo	AH-1Y	200	200	0	200	100	0.354	42.601	0.1045	0.0165	0.0085	0.09
	UH-1Z					100	0.166	44.6635	0.064	0.0335	0.0055	0.059
Transport Fixed Wing	KC-130	Not applicable										
	C-17											
Unmanned	RQ-7											
No fighter aircraft operations on Pagan	-											
Total							**4.231**	**341.1445**	**2.1495**	**1.7345**	**0.1505**	**0.8285**

Total Airfield Operation Emissions – Tinian (tons)

CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
256.27	25048.85	89.02	75.18	8.12	42.69

Total Airfield Operation Emissions – Pagan (tons)

CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
74.22	7607.25	42.66	29.71	2.98	17.16

CJMT Range Flight Aircraft Emissions

Range Flight Hours – Fighter Type Aircraft

Aircraft Type	Fighter Type (i.e., FA-18, F-35, AV-8, F-16)						
Airspace	Tinian MOA	Tinian R-7203N	Tinian R-7203S	Tinian R-7203E	Tinian R-7203W	Pagan R-7204	Pagan W-14
# Events/Year	7400	7400	7400	7400	7400	2350	2350
Avg # minutes in Airspace/Event	25	5	5	5	5	10	35
# Events/Year < 3,000 FT	0	1726.7	1726.7	1726.7	0	430.8	235
Total hr in Airspace < 3,000 FT	0	143.9	143.9	143.9	0	71.8	137.1
Total Combined Hours (<3,000 FT)	431.67					208.89	

Range Flight Hours – Transport Tilt-Rotor Type Aircraft

Aircraft Type	Transport Tilt-Rotor Type (i.e., MV-22)						
Airspace	Tinian MOA	Tinian R-7203N	Tinian R-7203S	Tinian R-7203E	Tinian R-7203W	Pagan R-7204	Pagan W-14
# Events/Year	200	200	200	0	0	100	100
Avg # minutes in Airspace/Event	20	20	30	5	5	10	35
# Events/Year < 3,000 FT	0	156.7	156.7	0.0	0	75.0	73.3
Total hr in Airspace < 3,000 FT	0	52.2	78.3	0.0	0	12.5	42.8
Total Combined Hours (<3,000 FT)	130.56					55.28	

Range Flight Hours – Transport Rotary Wing Type Aircraft

Aircraft Type	Transport Rotary Wing Type (i.e., CH-53)						
Airspace	Tinian MOA	Tinian R-7203N	Tinian R-7203S	Tinian R-7203E	Tinian R-7203W	Pagan R-7204	Pagan W-14
# Events/Year	NA	180	180	0	0	360	360
Avg # minutes in Airspace/Event	NA	25	25	5	5	20	5
# Events/Year < 3,000 FT	NA	150.0	150.0	0.0	0	252.0	252
Total hr in Airspace < 3,000 FT	NA	62.5	62.5	0.0	0	84.0	21.0
Total Combined Hours (<3,000 FT)	125.00					105.00	

Range Flight Hours – Attack Helo Type Aircraft

Aircraft Type	Attack Helo Type (i.e., AH-1, AH-64)						
Airspace	Tinian MOA	Tinian R-7203N	Tinian R-7203S	Tinian R-7203E	Tinian R-7203W	Pagan R-7204	Pagan W-14
# Events/Year	NA	80	80	80	80	160	160
Avg # minutes in Airspace/Event	NA	25	5	15	0	20	10
# Events/Year < 3,000 FT	NA	66.7	66.7	61.3	61	120.0	93.3
Total hr in Airspace < 3,000 FT	NA	27.8	5.6	15.3	0	40.0	15.6
Total Combined Hours (<3,000 FT)	48.67					55.56	

Range Flight Hours – Transport Fixed Wing Type Aircraft

Aircraft Type	Transport Fixed Wing (i.e., KC-130, C-17)						
Airspace	Tinian MOA	Tinian R-7203N	Tinian R-7203S	Tinian R-7203E	Tinian R-7203W	Pagan R-7204	Pagan W-14
# Events/Year	1500	600	200	200	200	900	900
Avg # minutes in Airspace/Event	10	10	5	5	5	35	10
# Events/Year < 3,000 FT	0	80.0	26.7	26.7	27	120.0	120
Total hr in Airspace < 3,000 FT	0	13.3	2.2	2.2	2	70.0	20.0
Total Combined Hours (<3,000 FT)	20.00					90.00	

Range Flight Hours – UAV Type Aircraft

Aircraft Type	UAV (i.e., RQ-7 Shadow)						
Airspace	Tinian MOA	Tinian R-7203N	Tinian R-7203S	Tinian R-7203E	Tinian R-7203W	Pagan R-7204	Pagan W-14
# Events/Year	200	200	200	200	200	400	400
Avg # minutes in Airspace/Event	0	90	90	30	30	200	40
# Events/Year < 3,000 FT	0	43.3	43.3	23.3	23	86.7	46.7
Total hr in Airspace < 3,000 FT	0	65.0	65.0	11.7	12	288.9	31.1
Total Combined Hours (<3,000 FT)	153.33					320.00	

Range Emissions – Tinian

		Total hr in Airspace < 3,000 FT	Percentage	Total hr in Airspace < 3,000 FT per Aircraft	Emission Factors for One hour of Cruise Time (lb/hr)*						Cruise Emissions (tons)					
Type	Model	Tinian		Tinian	CO	CO2	NOx	VOC	SO2	PM10 or PM2.5	CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	130.56	100	130.6	2.0	12258.4	53.8	0.0	1.5	6.0	0.13	800.20	3.51	0.00	0.10	0.39
Transport Rotary Wing	CH-53E	125.00	100	125.0	9.5	-	36.1	0.7	1.8	9.9	0.59	-	2.26	0.04	0.11	0.62
Attack Helo	AH-1Y	48.67	50	24.3	9.0	2734.5	4.7	0.5	0.3	3.6	0.11	33.27	0.06	0.01	0.00	0.04
	UH-1Z		50	24.3	0.7	2220.7	4.0	0.1	0.3	2.9	0.01	27.02	0.05	0.00	0.00	0.04
Transport Fixed Wing	KC-130	20.00	50	10.0	9.3	14458.0	36.7	2.1	1.8	17.9	0.05	72.29	0.18	0.01	0.01	0.09
	C-17		50	10.0	13.3	135406.4	1362.2	1.7	44.1	96.2	0.07	677.03	6.81	0.01	0.22	0.48
Unmanned	RQ-7	153.3	100	153.3	-	-	-	-	-	-	-	-	-	-	-	-
Fighter (not including FCLP)*	FA-18C/D*	431.67	25	107.9	19.2	-	53.0	3.5	3.1	50.1	1.04	-	2.86	0.19	0.17	2.70
	FA-18E/F*		25	107.9	7.5	-	152.5	1.2	21.3	67.8	0.40	-	8.23	0.07	1.15	3.66
	F-35B*		20	86.3	8.0	19898.7	44.6	0.5	2.5	30.5	0.34	858.96	1.92	0.02	0.11	1.32
	F-35C*		30	129.5	7.9	19645.7	43.5	0.5	2.4	30.2	0.51	1272.06	2.82	0.03	0.16	1.96
Total											3.25	3740.83	28.70	0.37	2.74	11.29

* Emission Factors obtained from the following:

MV-22: AESO Memorandum Report No. 9946 Revision E, January 2001

CH-53E: AESO Memorandum Report No. 9822 Revision C, February 2000

AH-1Y: AESO Memorandum Report No. 9824 Revision B, November 2009

UH-1: AESO Memorandum Report No. 9904 Revision B, November 2009

KC-130: AESO Memorandum Report No. 2000-10 Revision B, January 2001

C-17: Air Emissions Guide for Air Force Mobile Sources, AFCEE, August 2013, page 28, Emission -page 46

F/A-18: AESO Memorandum Report No. 9933 Revision D, circle emission factor

F-35: Joint Strike Fighter (JSF) emission factor worksheets (Joint Strike Fighter Work Force 2009)

Range Emissions – Pagan

		Total hr in Airspace < 3,000 FT	Percentage	Total hr in Airspace < 3,000 FT per Aircraft	Emission Factors for One hour of Cruise Time (lb/hr)						Cruise Emissions (tons)					
Type	Model	Pagan		Pagan	CO	CO2	NOx	VOC	SO2	PM10 or PM2.5	CO	CO2	NOx	VOC	SO2	PM10 or PM2.5
Transport Tilt-rotor	MV-22	55.28	100	55.3	2.0	12258.4	53.8	0.0	1.5	6.0	0.06	338.81	1.49	0.00	0.04	0.17
Transport Rotary Wing	CH-53E	105.00	100	105.0	9.5	-	36.1	0.7	1.8	9.9	0.50	-	1.90	0.04	0.09	0.52
Attack Helo	AH-1Y	55.56	50	27.8	9.0	2734.5	4.7	0.5	0.3	3.6	0.12	37.98	0.07	0.01	0.00	0.05
	UH-1Z		50	27.8	0.7	2220.7	4.0	0.1	0.3	2.9	0.01	30.84	0.06	0.00	0.00	0.04
Transport Fixed Wing	KC-130	90.00	50	45.0	9.3	14458.0	36.7	2.1	1.8	17.9	0.21	325.30	0.83	0.05	0.04	0.40
	C-17		50	45.0	13.3	135406.4	1362.2	1.7	44.1	96.2	0.30	3046.64	30.65	0.04	0.99	2.16
Unmanned	RQ-7	320.0	100	320.0	-	-	-	-	-	-	-	-	-	-	-	-
Fighter (not including FCLP)*	FA-18C/D*	208.89	25	52.2	19.2	-	53.0	3.5	16.2	50.1	0.50	-	1.39	0.09	0.08	1.31
	FA-18E/F*		25	52.2	7.5	-	152.5	1.2	21.3	67.8	0.19	-	2.45	0.03	0.08	1.33
	F-35B*		20	41.8	8.0	19898.7	44.6	0.5	2.5	30.5	0.17	415.66	0.93	0.01	0.05	0.64
	F-35C*		30	62.7	7.9	19645.7	43.5	0.5	2.4	30.2	0.25	615.56	1.36	0.01	0.08	0.95
Total											**2.31**	**4810.82**	**42.64**	**0.28**	**2.29**	**8.00**

* Emission Factors obtained from the following:

MV-22: AESO Memorandum Report No. 9946 Revision E, January 2001

CH-53E: AESO Memorandum Report No. 9822 Revision C, February 2000

AH-1Y: AESO Memorandum Report No. 9824 Revision B, November 2009

UH-1: AESO Memorandum Report No. 9904 Revision B, November 2009

KC-130: AESO Memorandum Report No. 2000-10 Revision B, January 2001

C-17: Air Emissions Guide for Air Force Mobile Sources, AFCEE, August 2013, page 28, Emission -page 46

F/A-18: AESO Memorandum Report No. 9933 Revision D, circle emission factor

F-35: Joint Strike Fighter (JSF) emission factor worksheets (Joint Strike Fighter Work Force 2009)

Attachment 4 - Vehicle and Other Mobile Source Emissions Estimate

Vessels – Tinian

Type	Number	Annual Total Operating Hours	Number of hours per training event	Total number of annual training events	Number of Engines	BHP / kW	Load Factor	Speed (mph)	Emission Factors (g/kWh, g/HP-hr or g/mi)							Emissions (tons)						
									NOx	PM10	PM2.5	VOC	CO	SOx	CO2	NOx	PM10	PM2.5	VOC	CO	SOx	CO2
Joint High Speed Vessel (JHSV)/ HSV (i.e., WPE)	1	180	12	15	4	12,203	80		13.2	0.47	0.43	0.5	1.1	3.97	646.08	102.27	3.64	3.33	3.87	8.52	30.76	5005.87
Barge	1	180	12	15	2	4,000	17		17	0.45	0.42	0.6	1.4	3.62	588.79	3.42	0.09	0.08	0.12	0.28	0.73	118.48
LCU (Landing Craft Utility)	1	180	12	15	2	680	17		17	0.45	0.42	0.6	1.4	3.62	588.79	0.58	0.02	0.01	0.02	0.05	0.12	20.14
Total																**106.28**	**3.75**	**3.43**	**4.02**	**8.85**	**31.61**	**5144.48**

Ground Vehicles – Tinian

Type	Number	Annual Total Operating Hours	Number of hours per training event	Total number of annual training events	Number of Engines	BHP / kW	Load Factor	Speed (mph)	Emission Factors (g/kWh, g/HP-hr or g/mi)							Emissions (tons)						
									NOx	PM10	PM2.5	VOC	CO	SOx	CO2	NOx	PM10	PM2.5	VOC	CO	SOx	CO2
Landing Vehicles																						
LAV-25	7	672	12	56	1	275	21		6.79	0.82	0.80	1.34	5.36	0.13	623.1	2.03	0.25	0.24	0.40	1.60	0.04	186.60
AAV	14	672	12	56	1	400	21		6.79	0.74	0.71	1.19	5.68	0.13	623.6	5.92	0.64	0.62	1.04	4.94	0.12	543.21
LCAC	4	672	12	42	4	5,500	80		4.44	0.29	0.29	0.25	1.15	0.45		129.50	8.46	8.46	7.29	33.54	13.12	0.00
Tactical Vehicles																						
HMMV	63	840	12	70	1	160	59		4.50	0.33	0.32	0.37	1.57	0.12	536.2	0.39	0.03	0.03	0.03	0.14	0.01	46.87
MTVR	30	840	12	70	1	440	59		4.97	0.29	0.28	0.31	2.26	0.12	536.4	1.20	0.07	0.07	0.07	0.54	0.03	128.93
D7 Bulldozer	3	840	12	70	1	200	59		4.16	0.26	0.25	0.32	1.29	0.12	536.38	0.45	0.03	0.03	0.03	0.14	0.01	58.61
Rough Terrain Forklift	2	840	12	70	1	81.6	59		5.15	0.63	0.61	0.60	4.22	0.13	594.90	0.23	0.03	0.03	0.03	0.19	0.01	26.52
MTVR Dump Truck	1	840	12	70	1	440	59		4.97	0.29	0.28	0.31	2.26	0.12	536.4	1.20	0.07	0.07	0.07	0.54	0.03	128.93
Logistics Vehicle System	4	840	12	70		600	21		6.79	0.74	0.71	1.19	5.68	0.13	623.6	0.79	0.09	0.08	0.14	0.66	0.02	72.75
Total																**141.71**	**109.13**	**19.38**	**9.11**	**42.31**	**13.38**	**1192.42**

Ground Vehicles (Fugitive Dust) – Tinian

Type	Number	Annual Total Operating Hours	Number of hours per training event	Total number of annual training events	Speed (mph)	Average Driving Time Percentage	Total Annual Miles	Emission Factors (lb/VMT)		Emissions (tons)	
								PM10	PM2.5	PM10	PM2.5
Landing Vehicles											
LAV-25	7	672	12	56	>5	NA	NA	NA	NA	-	-
AAV	14	672	12	56	>5	NA	NA	NA	NA	-	-
LCAC	4	672	12	42	>5	NA	NA	NA	NA	-	-
Tactical Vehicles											
HMMV	63	840	12	70	30	50%	793800	0.1611	0.0158	63.94	6.27
MTVR	30	840	12	70	30	50%	378000	0.1611	0.0158	30.45	2.99
D7 Bulldozer	3	840	12	70	>5	NA	NA	NA	NA	-	-
Rough Terrain Forklift	2	840	12	70	>5	NA	NA	NA	NA	-	-
MTVR Dump Truck	1	840	12	70	30	50%	12600	0.1611	0.0158	1.01	0.10
Logistics Vehicle System	4	840	12	70	30	50%	50400	0.1611	0.0158	4.06	0.40
Total										**99.46**	**9.76**

Support Equipment – Tinian

Type	Number	Annual Total Operating Hours	Number of hours per training event	Total number of annual training events	Number of Engines	BHP / kW	Load Factor	Speed (mph)	Emission Factors (g/kWh, g/HP-hr or g/mi)							Emissions (tons)						
									NOx	PM10	PM2.5	VOC	CO	SOx	CO2	NOx	PM10	PM2.5	VOC	CO	SOx	CO2
Buses (troop transport)	8	420	12	35				30	7.90	0.78	0.63	0.39	2.61	0.02	2188.50	0.00	0.00	0.00	0.00	0.00	0.00	0.27
Sedans (for staff use)	2	210	6	35				30	0.19	0.03	0.01	0.07	3.02	0.01	369.39	0.00	0.00	0.00	0.00	0.00	0.00	0.01
4WD truck (range maintenance)	15	1680	12	140		160	59		4.50	0.33	0.32	0.37	1.57	0.12	536.2	0.79	0.06	0.06	0.06	0.27	0.02	93.74
MTVR 7 ton truck (range maintenance)	5	840	6	140	1	440	59		4.97	0.29	0.28	0.31	2.26	0.12	536.4	1.20	0.07	0.07	0.07	0.54	0.03	128.93
Commercial flatbed truck	5	420	6	70				30	5.72	0.56	0.45	0.32	1.88	0.02	2586.72	0.00	0.00	0.00	0.00	0.00	0.00	0.20
D7 Bulldozer	2	420	6	70	1	200	59		4.16	0.26	0.25	0.32	1.29	0.12	536.38	0.23	0.01	0.01	0.02	0.07	0.01	29.30
Front End Loader	2	420	6	70		242.6	59		5.05	0.33	0.32	0.37	2.09	0.12	539.44	0.33	0.02	0.02	0.02	0.14	0.01	35.74
MTVR 7 ton Dump Truck	2	420	6	70	1	440	59		4.97	0.29	0.28	0.31	2.26	0.12	536.4	0.60	0.04	0.03	0.04	0.27	0.01	64.47
Rough Terrain Forklift	1	840	6	140	1	81.6	59		5.15	0.63	0.61	0.60	4.22	0.13	594.90	0.23	0.03	0.03	0.03	0.19	0.01	26.52
Material Handling Equipment (Rough Terrain)	1	840	6	140	1	81.6	21		7.91	1.25	1.21	1.82	7.62	0.15	691.22	0.13	0.02	0.02	0.03	0.12	0.00	10.97
Fire Trucks (Brush Trucks)	3	560	4	140				30	5.72	0.56	0.45	0.32	1.88	0.02	2586.72	0.00	0.00	0.00	0.00	0.00	0.00	0.16
Firefighting Water Supply Trucks	1	560	4	140				30	5.72	0.56	0.45	0.32	1.88	0.02	2586.72	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Extended Boom Forklift	1	840	6	140		93.9	59		4.16	0.37	0.36	0.37	2.88	0.12	573.48	0.21	0.02	0.02	0.02	0.15	0.01	29.42
4WD 4-Passenger Gators with dump bed	8	840	6	140		160	59		3.74	0.31	0.30	0.32	1.42	0.12	536.35	0.33	0.03	0.03	0.03	0.12	0.01	46.88

Support Equipment – Tinian

Type	Number	Annual Total Operating Hours	Number of hours per training event	Total number of annual training events	Number of Engines	BHP / kW	Load Factor	Speed (mph)	Emission Factors (g/kWh, g/HP-hr or g/mi)							Emissions (tons)						
									NOx	PM10	PM2.5	VOC	CO	SOx	CO2	NOx	PM10	PM2.5	VOC	CO	SOx	CO2
Gang Mowers w/Tractor	2	2160	12	180		145	59		5.66	0.46	0.45	0.53	2.53	0.12	535.75	1.15	0.09	0.09	0.11	0.52	0.02	109.13
Bush Hog w/Tractor	2	2160	12	180		145	59		5.66	0.46	0.45	0.53	2.53	0.12	535.75	1.15	0.09	0.09	0.11	0.52	0.02	109.13
Mower (John Deere 850)	4	2160	12	180		145	59		5.66	0.46	0.45	0.53	2.53	0.12	535.75	1.15	0.09	0.09	0.11	0.52	0.02	109.13
Total																**7.50**	**16.48**	**2.12**	**0.64**	**3.43**	**0.17**	**794.05**

Support Equipment (Fugitive Dust) – Tinian

Type	Number	Annual Total Operating Hours	Number of hours per training event	Total number of annual training events	Speed (mph)	Average Driving Time Percentage	Total Annual Miles	Emission Factors (lb/VMT)		Emissions (tons)	
								PM10	PM2.5	PM10	PM2.5
Buses (troop transport)	8	420	12	35	30	50%	50400	0.1611	0.0158	4.06	0.40
Sedans (for staff use)	2	210	6	35	30	50%	6300	0.1611	0.0158	0.51	0.05
4WD truck (range maintenance)	15	1680	12	140	>5	NA	NA	NA	NA	-	-
MTVR 7 ton truck (range maintenance)	5	840	6	140	30	50%	63000	0.1611	0.0158	5.07	0.50
Commercial flatbed truck	5	420	6	70	30	50%	31500	0.1611	0.0158	2.54	0.25
D7 Bulldozer	2	420	6	70	>5	NA	NA	NA	NA	-	-
Front End Loader	2	420	6	70	>5	NA	NA	NA	NA	-	-
MTVR 7 ton Dump Truck	2	420	6	70	30	50%	12600	0.1611	0.0158	1.01	0.10
Rough Terrain Forklift	1	840	6	140	>5	NA	NA	NA	NA	-	-
Material Handling	1	840	6	140	>5	NA	NA	NA	NA	-	-

Support Equipment (Fugitive Dust) – Tinian

Type	Number	Annual Total Operating Hours	Number of hours per training event	Total number of annual training events	Speed (mph)	Average Driving Time Percentage	Total Annual Miles	Emission Factors (lb/VMT)		Emissions (tons)	
								PM10	PM2.5	PM10	PM2.5
Equipment (Rough Terrain)											
Fire Trucks (Brush Trucks)	3	560	4	140	30	50%	25200	0.1611	0.0158	2.03	0.20
Firefighting Water Supply Trucks	1	560	4	140	30	50%	8400	0.1611	0.0158	0.68	0.07
Extended Boom Forklift	1	840	6	140	>5	NA	NA	NA	NA	-	-
4WD 4-Passenger Gators with dump bed	8	840	6	140	>5	NA	NA	NA	NA	-	-
Gang Mowers w/Tractor	2	2160	12	180	>5	NA	NA	NA	NA	-	-
Bush Hog w/Tractor	2	2160	12	180	>5	NA	NA	NA	NA	-	-
Mower (John Deere 850)	4	2160	12	180	>5	NA	NA	NA	NA	-	-
Total										**15.90**	**1.57**

Vessels – Pagan

Type	Number	Annual Total Operating Hours	Number of hours per training event	Total number of annual training events	Number of Engines	BHP / kW	Load Factor	Speed (mph)	Emission Factors (g/kWh, g/HP-hr or g/mi)							Emissions (tons)						
									NOx	PM10	PM2.5	VOC	CO	SOx	CO2	NOx	PM10	PM2.5	VOC	CO	SOx	CO2
Joint High Speed Vessel	1	0	0	0	4	12,203	80		13.2	0.47	0.43	0.5	1.1	3.97	646.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barge	1	252	6	42	2	4,000	17		17	0.45	0.42	0.6	1.4	3.62	588.79	4.79	0.13	0.12	0.17	0.39	1.02	165.87
LCU (Landing Craft Utility)	1	1680	24	70	2	680	17		17	0.45	0.42	0.6	1.4	3.62	588.79	5.43	0.14	0.13	0.19	0.45	1.16	187.99
Total																**10.22**	**0.27**	**0.25**	**0.36**	**0.84**	**2.18**	**353.86**

Ground Vehicles – Pagan

Type	Number	Annual Total Operating Hours	Number of hours per training event	Total number of annual training events	Number of Engines	BHP / kW	Load Factor	Speed (mph)	Emission Factors (g/kWh, g/HP-hr or g/mi)							Emissions (tons)						
									NOx	PM10	PM2.5	VOC	CO	SOx	CO2	NOx	PM10	PM2.5	VOC	CO	SOx	CO2
Landing Vehicles																						
LAV-25	7	936	12	78	1	275	21		6.79	0.82	0.80	1.34	5.36	0.13	623.1	2.83	0.34	0.33	0.56	2.23	0.06	259.90
AAV	14	936	12	78	1	400	21		6.79	0.74	0.71	1.19	5.68	0.13	623.6	8.24	0.89	0.87	1.44	6.89	0.16	756.62
LCAC	4	1248	12	104	4	5,500	80		4.44	0.29	0.29	0.25	1.15	0.45		320.66	20.94	20.94	18.05	83.05	32.50	0.00
Tactical Vehicles																						
HMMV	63		6	35	1	160	59		4.50	0.33	0.32	0.37	1.57	0.12	536.2	0.63	0.05	0.04	0.05	0.22	0.02	74.99
MTVR	30		6	35	1	440	59		4.97	0.29	0.28	0.31	2.26	0.12	536.4	1.02	0.06	0.06	0.06	0.47	0.02	110.51
D7 Bulldozer	3		6	35	1	200	59		4.16	0.26	0.25	0.32	1.29	0.12	536.38	0.39	0.02	0.02	0.03	0.12	0.01	50.23
Rough Terrain Forklift	2		6	35	1	81.6	59		5.15	0.63	0.61	0.60	4.22	0.13	594.90	0.20	0.02	0.02	0.02	0.16	0.00	22.73
MTVR Dump Truck	1		6	35	1	440	59		4.97	0.29	0.28	0.31	2.26	0.12	536.4	0.68	0.04	0.04	0.04	0.31	0.02	73.68
Logistics Vehicle System	4		6	35		600	21		6.79	0.74	0.71	1.19	5.68	0.13	623.6	0.79	0.09	0.08	0.14	0.66	0.02	72.75
Total																**335.45**	**155.51**	**35.46**	**20.41**	**94.12**	**32.80**	**1421.42**

Ground Vehicles (Fugitive Dust) – Pagan

Type	Number	Annual Total Operating Hours	Number of hours per training event	Total number of annual training events	Speed (mph)	Average Driving Time Percentage	Total Annual Miles	Emission Factors (lb/VMT)		Emissions (tons)	
								PM10	PM2.5	PM10	PM2.5
Landing Vehicles											
LAV-25	7	936	12	78	<5	NA	NA	NA	NA	-	-
AAV	14	936	12	78	<5	NA	NA	NA	NA	-	-
LCAC	4	1248	12	104	<5	NA	NA	NA	NA	-	-
Tactical Vehicles											
HMMV	63	1344	12	112	30	50%	1270080	0.1611	0.0158	102.31	10.03
MTVR	30	720	12	60	30	50%	324000	0.1611	0.0158	26.10	2.56
D7 Bulldozer	3	720	12	60	<5	NA	NA	NA	NA	-	-
Rough Terrain Forklift	2	720	12	60	<5	NA	NA	NA	NA	-	-
MTVR Dump Truck	1	480	12	40	30	50%	7200	0.1611	0.0158	0.58	0.06
Logistics Vehicle System	4	840	12	70	30	50%	50400	0.1611	0.0158	4.06	0.40
Total										**133.05**	**13.05**

Support Equipment – Pagan

Type	Number	Annual Total Operating Hours	Number of hours per training event	Total number of annual training events	Number of Engines	BHP / kW	Load Factor	Speed (mph)	Emission Factors (g/kWh, g/HP-hr or g/mi)							Emissions (tons)						
									NOx	PM10	PM2.5	VOC	CO	SOx	CO2	NOx	PM10	PM2.5	VOC	CO	SOx	CO2
4WD truck (range maintenance)	1	720	12	60		160	59		4.50	0.33	0.32	0.37	1.57	0.12	536.2	0.34	0.02	0.02	0.03	0.12	0.01	40.17
Rough Terrain Forklift	1	480	8	60	1	81.6	59		5.15	0.63	0.61	0.60	4.22	0.13	594.90	0.13	0.02	0.02	0.02	0.11	0.00	15.15
Material Handling Equipment (Rough Terrain)	1	480	8	60	1	81.6	21		7.91	1.25	1.21	1.82	7.62	0.15	691.22	0.07	0.01	0.01	0.02	0.07	0.00	6.27
Fire Trucks (Brush Trucks)	3	240	4	60				30	5.72	0.56	0.45	0.32	1.88	0.02	2586.72	0.00	0.00	0.00	0.00	0.00	0.00	0.07
Fire Fighting Water Supply Trucks	1	240	4	60				30	5.72	0.56	0.45	0.32	1.88	0.02	2586.72	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Extended Boom Forklift	1	480	8	60		93.9	59		4.16	0.37	0.36	0.37	2.88	0.12	573.48	0.12	0.01	0.01	0.01	0.08	0.00	16.81
Bush Hog w/Tractor	2	480	8	60		145	59		5.66	0.46	0.45	0.53	2.53	0.12	535.75	0.26	0.02	0.02	0.02	0.11	0.01	24.25
Total																**0.92**	**1.24**	**0.20**	**0.09**	**0.49**	**0.02**	**102.75**

Support Equipment (Fugitive Dust) – Pagan

Type	Number	Annual Total Operating Hours	Number of hours per training event	Total number of annual training events	Speed (mph)	Average Driving Time Percentage	Total Annual Miles	Emission Factors (lb/VMT)		Emissions (tons)	
								PM10	PM2.5	PM10	PM2.5
4WD truck (range maintenance)	1	720	12	60	<5	NA	NA	NA	NA	-	-
Rough Terrain Forklift	1	480	8	60	<5	NA	NA	NA	NA	-	-
Material Handling Equipment (Rough Terrain)	1	480	8	60	<5	NA	NA	NA	NA	-	-
Fire Trucks (Brush Trucks)	3	240	4	60	30	50%	10800	0.1611	0.0158	0.87	0.09
Firefighting Water Supply Trucks	1	240	4	60	30	50%	3600	0.1611	0.0158	0.29	0.03
Extended Boom Forklift	1	480	8	60	<5	NA	NA	NA	NA	-	-
Bush Hog w/Tractor	2	480	8	60	>5	NA	NA	NA	NA	-	-
Totals										**1.16**	**0.12**

Attachment 5 - Generator Emissions

CJMT Generator Emissions – Tinian

	Generator Power (kW)	Generator Power (HP)	Annual Hours	Diesel Generator Emission Factor (lb/hp-hr)[1]							Diesel Generator Annual Emissions (TPY)						
				VOC[3]	NOx[2]	CO	PM10	PM2.5	SOx	CO2	VOC	NOx	CO	PM10	PM2.5	SOx	CO2
Tinian																	
Emergency Generator w/ 153 Sub-Base Fuel Tank & 3,000 gal AST double-walled	200	268	1600	0.00071	0.024	0.0055	0.0004	0.00034	0.0004	1.16	0.15	5.15	1.18	0.09	0.07	0.09	248.9
Emergency Generator w/ 90 Sub-Base Fuel Tank & 2,000 gal AST double-walled	100	134	1600	0.00071	0.024	0.0055	0.0004	0.00034	0.0004	1.16	0.08	2.57	0.59	0.04	0.04	0.04	124.4
Emergency Generator w/ 54 Sub-Base Fuel Tank & 1000 gal AST double-walled	30	40	1600	0.00071	0.024	0.0055	0.0004	0.00034	0.0004	1.16	0.02	0.77	0.18	0.01	0.01	0.01	37.3
Back-up Generator for surface radar stations (6x100kw)	600	805	500	0.00071	0.024	0.0055	0.0004	0.00034	0.0004	1.16	0.14	4.83	1.11	0.08	0.07	0.08	233.3
Back-up Generator for Base Camp (2x250kw)	500	671	500	0.00071	0.024	0.0055	0.0004	0.00034	0.0004	1.16	0.12	4.02	0.92	0.07	0.06	0.07	194.4
Back-up Generator for Base Camp (2x200kw)	400	536	1600	0.00071	0.024	0.0055	0.0004	0.00034	0.0004	1.16	0.09	3.22	0.74	0.05	0.04	0.05	155.6
Total											**0.60**	**20.57**	**4.71**	**0.34**	**0.29**	**0.35**	**994.00**

Notes

1. USEPA AP-42 emission factors for large diesel engines
2. Uncontrolled NOx emission factor
3. VOC emissions use TOC (as CH_4) emission factor

4. Assumed Low Sulfur Diesel (500 ppm)
5. 7000 Btu/hp-hr

CJMT Generator Emissions – Pagan

	Generator Power (kW)	Generator Power (HP)	Annual Hours	# of Generators	Total Hours	Diesel Generator Emission Factor (lb/hp-hr)[1]							Diesel Generator Annual Emissions (TPY)						
						VOC[3]	NOx[2]	CO	PM10	PM2.5	SOx	CO2	VOC	NOx	CO	PM10	PM2.5	SOx	CO2
Pagan																			
30kW Generator (MEP-1060)	30	40	3648	10	36480	0.00071	0.024	0.0055	0.0004	0.00034	0.0004	1.16	0.52	17.61	4.04	0.29	0.25	0.30	851.20
Total													**0.52**	**17.61**	**4.04**	**0.29**	**0.25**	**0.30**	**851.20**

Notes

1. USEPA AP-42 emission factors for large diesel engines
2. Uncontrolled NOx emission factor
3. VOC emissions use TOC (as CH_4) emission factor
4. Assumed Low Sulfur Diesel (500 ppm)
5. 7000 Btu/hp-hr

Attachment 6 - Solid Waste Transfer Emissions

Solid Waste Transfer Emissions – Tinian

Solid Waste Transfer						Emission Factors (g/kWh, g/HP-hr or g/mi)							Emissions (tons)						
Type	Number of Units	Days	Hours	BHP / kW or Horsepower (hp)	Load Factor (%)	VOC	NOx	CO	PM10	PM2.5	SOx	CO2	VOC	NOx	CO	PM10	PM2.5	SOx	CO2
Barge	1	20	40	4000	17	0.60	17.00	1.40	0.45	0.42	3.62	588.79	0.01	0.38	0.03	0.01	0.01	0.08	13.16
Loader	1	140	1120	93	21	1.47	6.80	6.42	1.01	0.98	0.14	662.28	0.03	0.12	0.12	0.02	0.02	0.00	11.97
Grapple/Skidder	1	140	1120	203	59	0.30	4.02	1.45	0.27	0.26	0.12	537.81	0.03	0.44	0.16	0.03	0.03	0.01	59.43
Total													**0.07**	**0.95**	**0.31**	**0.06**	**0.06**	**0.10**	**84.56**

Attachment 7 - Annual Munitions Emissions

Representative Annual Munitions Estimate – Tinian

System Type	Ammunition Type	Annual Total Ordnance/ Ammunition Expenditure Estimate - Tinian
Field Artillery / Mortar / Rocket / Grenade		
Artillery	155 mm HE	13,600
Artillery	155 mm Illum	1,060
Artillery	155 mm Smoke	660
Mortar	120 mm HE	6,600
Mortar	120 mm Illum	1,670
Mortar	120 mm Smoke	1,670
Rocket (Personnel)	21 mm	4,100
	Shoulder Mounted Assault Weapon Practice Round	890
Grenade Launcher	40 mm TP	7,370
Mortar	60 mm HE	1,450
Mortar	60 mm Illum	340
Mortar	60 mm Smoke	170
Mortar	60 mm Inert	1,540
	66 mm HE	370
Mortar	81 mm HE	1,630
Mortar	81 mm Illum	610
Mortar	81 mm Smoke	340
Rocket (Personnel)	83 mm	400
Rocket (Personnel)	84 mm	370
Hand Grenade	Grenade (practice)	6,170
Hand Grenade	HE Fragmentation	3,190

System Type	Ammunition Type	Annual Total Ordnance/ Ammunition Expenditure Estimate - Tinian
Small Arms		
Pistol	9 mm	27,620
Rifle	5.56 mm	3,244,920
Pistol	.45 cal	3,000
Rifle	.50 cal	196,760
Rifle	7.62 mm	1,138,690
Shotgun	12 gauge	32,520
Air-Delivered Ordinance		
Bomb (Aircraft)	25 lb Inert	1,000
Bomb (Aircraft)	500 lb Inert	175
Bomb (Aircraft)	1,000 lb Inert	175
Bomb (Aircraft)	Inert Laser Guided Training Round, 2.75, 5 inch	250
Rocket (Aircraft)	2.75 inch Inert	750
Rocket (Aircraft)	5 inch Inert	100
Machine Gun (Aircraft)	20 mm TP	11,250
Machine Gun (Aircraft)	25 mm TP	1,000
Machine Gun (Aircraft)	7.62 mm	45,000
Machine Gun (Aircraft)	.50 cal	30,000

Representative Annual Munitions Estimate – Pagan

System Type	Ammunition Type	Annual Total Ordnance/Ammunition Expenditure Estimate - Pagan
Field Artillery Fire Range		
Artillery	155 mm HE	592
Artillery	155 mm Illum	40
Artillery	155 mm Smoke	320
Mortar	120 mm HE	200
Mortar	120 mm Smoke	200
Mortar	81 mm Smoke	40
Small Arms		
Rifle	5.56 mm	382,575
Machine Gun	.50 cal	36,800
Rifle	7.62 mm	192,960
Grenade/Mortar/Rocket		
Grenade Launcher	40 mm HE	10,460
Mortar	60 mm HE	480
Mortar	60 mm Illum	80
Mortar	60 mm Smoke	40
Mortar	81 mm HE	1000
Mortar	81 mm Illum	80
Mortar	81 mm Smoke	40
Rocket (Personnel)	83 mm HE	8
Missile (Personnel)	TOW HEAT	4
Rocket (Personnel)	AT-4 HE	4
Machine Gun (Aircraft)	20 mm TP	160

System Type	Ammunition Type	Annual Total Ordnance/Ammunition Expenditure Estimate - Pagan
Air-Delivered Ordnance		
Bomb (Aircraft)	25 lb Inert	1,000
Bomb (Aircraft)	500 lb Inert	175
Bomb (Aircraft)	500 lb HE	175
Bomb (Aircraft)	1,000 lb HE	175
Bomb (Aircraft)	2,000 lb HE	175
Rocket (Aircraft)	2.75 inch HE	500
Rocket (Aircraft)	2.75 inch Illum	50
Rocket (Aircraft)	2.75 inch Smoke	75
Rocket (Aircraft)	5 inch HE	150
Machine Gun (Aircraft)	20 mm TP	11,250
Machine Gun (Aircraft)	25 mm TP	1,000
Machine Gun (Aircraft)	7.62 mm	45,000
Machine Gun (Aircraft)	.50 cal	30,000
Round (Aircraft)	LGTR Inert	250
System Type	Ammunition Type	Annual Total Ordnance/Ammunition Expenditure Estimate - Pagan
Naval Ship Delivered Ordnance		
Naval Gun (Ship)	5 inch HE	150
Air-to-Air Ordnance and Expendables (Warning Areas Only)		
	AIM 7	5
	AIM 9	5
	AIM 120	3
Dispenser (Aircraft)	Chaff	2,400
Dispenser (Aircraft)	Flares	2,400

Annual Munitions Emissions – Tinian

Ammunition Type	Annual Total Ordnance/ Ammunition Expenditure Estimate - Tinian	Emission Factors (lb/Round)							Emissions (tons)						
		SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
Field Artillery / Mortar / Rocket / Grenade															
155 mm HE	13,600	2.70E-03	6.03E+00	3.32E+00	1.40E-01	1.73E-01	1.50E-03	6.50E+00	1.84E-02	4.10E+01	2.26E+01	9.52E-01	1.18E+00	1.02E-02	4.42E+01
155 mm Illum	1,060	2.70E-03	6.03E+00	3.32E+00	1.40E-01	1.73E-01	1.50E-03	6.50E+00	1.43E-03	3.19E+00	1.76E+00	7.42E-02	9.17E-02	7.95E-04	3.45E+00
155 mm Smoke	660	2.70E-03	6.03E+00	3.32E+00	1.40E-01	1.73E-01	1.50E-03	6.50E+00	8.91E-04	1.99E+00	1.10E+00	4.62E-02	5.71E-02	4.95E-04	2.15E+00
120 mm HE	6,600	0.00E+00	4.70E-01	3.64E-01	1.90E-01	3.40E-02	0.00E+00	5.47E+00	0.00E+00	1.55E+00	1.20E+00	6.27E-01	1.12E-01	0.00E+00	1.80E+01
120 mm Illum	1,670	7.80E-04	5.15E-01	4.08E-01	2.01E-01	3.03E-02	2.10E-03	6.99E-01	6.51E-04	4.30E-01	3.41E-01	1.68E-01	2.53E-02	1.75E-03	5.84E-01
120 mm Smoke	1,670	8.40E-04	5.17E-01	1.23E+01	1.29E+01	1.93E-02	0.00E+00	9.19E-01	7.01E-04	4.32E-01	1.03E+01	1.08E+01	1.61E-02	0.00E+00	7.68E-01
21 mm	4,100	0.00E+00	3.30E-02	6.60E-04	4.60E-04	4.30E-04	0.00E+00	1.60E-02	0.00E+00	6.77E-02	1.35E-03	9.43E-04	8.82E-04	0.00E+00	3.28E-02
Shoulder Mounted Assault Weapon Practice Round	890	6.00E-04	3.30E-03	6.00E-03	6.00E-03	2.35E-03	2.05E-04	3.85E+00	2.67E-04	1.47E-03	2.67E-03	2.67E-03	1.05E-03	9.12E-05	1.71E+00
40 mm TP	7,370	0.00E+00	3.50E-04	2.60E-05	2.30E-05	3.60E-05	0.00E+00	2.60E-04	0.00E+00	1.29E-03	9.58E-05	8.48E-05	1.33E-04	0.00E+00	9.58E-04
60 mm HE	1,450	0.00E+00	6.71E-02	6.88E-02	3.31E-02	5.72E-03	0.00E+00	4.47E-01	0.00E+00	4.86E-02	4.99E-02	2.40E-02	4.15E-03	0.00E+00	3.24E-01
60 mm Illum	340	0.000151	0.00754	0.2088	0.4872	0.00812	0.005626	0.03886	2.56E-05	1.28E-03	3.55E-02	8.28E-02	1.38E-03	9.56E-04	6.61E-03
60 mm Smoke	170	0.00E+00	7.80E-03	1.40E-03	1.20E-03	9.80E-05	0.00E+00	6.30E-03	0.00E+00	6.63E-04	1.19E-04	1.02E-04	8.33E-06	0.00E+00	5.36E-04
60 mm Inert	1,540	0.00E+00	7.80E-03	1.40E-03	1.20E-03	9.80E-05	0.00E+00	6.30E-03	0.00E+00	6.01E-03	1.08E-03	9.24E-04	7.55E-05	0.00E+00	4.85E-03
66 mm HE	370	0.00E+00	6.71E-02	6.88E-02	3.31E-02	5.72E-03	0.00E+00	4.47E-01	0.00E+00	1.24E-02	1.27E-02	6.12E-03	1306E-03	0.00E+00	8.27E-02
81 mm HE	1,630	0.00E+00	2.74E-01	3.63E-01	1.99E-01	3.38E-02	0.00E+00	3.01E+00	0.00E+00	2.23E-01	2.96E-01	1.63E-01	2.75E-02	0.00E+00	2.45E+00
81 mm Illum	610	3.53E-05	5.08E-02	7.23E-02	5.48E-02	3.22E-03	1.39E-04	2.24E-01	1.08E-05	1.55E-02	2.21E-02	1.67E-02	9.82E-04	4.23E-05	6.83E-02
81 mm Smoke	340	1.50E-03	3.20E-03	3.50E+00	3.50E+00	1.50E-02	1.30E-04	3.40E-01	2.55E-04	5.44E-04	5.95E-01	5.95E-01	2.55E-03	2.21E-05	5.78E-02
83 mm	400	6.00E-04	6.03E-02	1.36E-01	7.20E-02	2.04E-02	2.05E-04	4.29E+00	1.20E-04	1.21E-02	2.72E-02	1.44E-02	4.07E-03	4.10E-05	8.58E-01
84 mm	370	6.00E-04	6.03E-02	1.36E-01	7.20E-02	2.04E-02	2.05E-04	4.29E+00	1.11E-04	1.12E-02	2.52E-02	1.33E-02	3.76E-03	3.79E-05	7.94E-01

Ammunition Type	Annual Total Ordnance/ Ammunition Expenditure Estimate - Tinian	Emission Factors (lb/Round)							Emissions (tons)						
		SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
Grenade (practice)	6,170	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HE Fragmentation	3,190	4.90E-05	1.40E-02	3.50E-02	2.00E-02	7.40E-03	0.00E+00	6.20E-01	7.82E-05	2.23E-02	5.58E-02	3.19E-02	1.18E-02	0.00E+00	9.89E-01
Small Arms															
9 mm	27,620	8.20E-08	3.10E-04	2.40E-05	2.00E-05	1.50E-05	0.00E+00	2.00E-04	1.13E-06	4.28E-03	3.31E-04	2.76E-04	2.07E-04	0.00E+00	2.76E-03
5.56 mm	3,244,920	0.00E+00	1.60E-03	3.90E-05	2.80E-05	8.50E-05	0.00E+00	8.70E-04	0.00E+00	2.60E+00	6.33E-02	4.54E-02	1.38E-01	0.00E+00	1.41E+00
.45 cal	3,000	0.00E+00	2.60E-04	3.70E-05	3.10E-05	8.10E-06	0.00E+00	2.20E-04	0.00E+00	3.90E-04	5.55E-05	4.65E-05	1.22E-05	0.00E+00	3.30E-04
.50 cal	196,760	0.00E+00	1.60E-02	9.70E-04	4.40E-04	3.30E-05	0.00E+00	9.20E-03	0.00E+00	1.57E+00	9.54E-02	4.33E-02	3.25E-03	0.00E+00	9.05E-01
7.62 mm	1,138,690	0.00E+00	3.00E-03	8.20E-05	5.80E-05	4.10E-05	0.00E+00	1.70E-03	0.00E+00	1.71E+00	4.67E-02	3.30E-02	2.33E-02	0.00E+00	9.68E-01
12 gauge	32,520	0.00E+00	1.50E-03	7.40E-05	6.70E-05	4.20E-05	0.00E+00	1.30E-03	0.00E+00	2.44E-02	1.20E-03	1.09E-03	6.83E-04	0.00E+00	2.11E-02
Air-Delivered Ordinance															
25 lb Inert	1,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
500 lb Inert	175	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,000 lb Inert	175	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Inert Laser Guided Training Round, 2.75, 5 inch	250	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.75 inch Inert	750	0.00E+00	1.50E+00	1.10E-01	1.00E-01	2.60E-02	0.00E+00	2.40E+00	0.00E+00	5.63E-01	4.13E-02	3.75E-02	9.75E-03	0.00E+00	9.00E-01
5 inch Inert	100	6.05E-02	2.31E-01	0.00E+00	0.00E+00	5.50E-02	0.00E+00	2.31E+01	3.03E-03	1.16E-02	0.00E+00	0.00E+00	2.75E-03	0.00E+00	1.16E+00
20 mm TP	11,250	0.00E+00	3.30E-02	6.60E-04	4.60E-04	4.30E-04	0.00E+00	1.60E-02	0.00E+00	1.86E-01	3.71-03	2.59E-03	2.42E-03	0.00E+00	9.00E-02
25 mm TP	1,000	0.00E+00	8.50E-02	3.30E-03	1.70E-03	1.50E-03	0.00E+00	4.30E-02	0.00E+00	4.25E-02	1.65E-03	8.50E-04	7.50E-04	0.00E+00	2.15E-02
7.62 mm	45,000	0.00E+00	3.00E-03	8.20E-05	5.80E-05	4.10E-05	0.00E+00	1.70E-03	0.00E+00	6.75E-02	1.85E-03	1.31E-03	9.23E-04	0.00E+00	3.83E-02
.50 cal	30,000	0.00E+00	1.60E-02	9.70E-04	4.40E-04	3.30E-05	0.00E+00	9.20E-03	0.00E+00	2.40E-01	1.46E-02	6.60E-03	4.95E-04	0.00E+00	1.38E-01
								Total	**0.03**	**56.01**	**38.68**	**13.80**	**1.72**	**0.01**	**82.21**

Annual Munitions Emissions – Pagan

Ammunition Type	Annual Total Ordnance/ Ammunition Expenditure Estimate - Pagan	Emission Factors (lb/Round)							Emissions (tons)						
		SO2	CO	PM10	PM2.5	NOX	VOC	CO2	SO2	CO	PM10	PM2.5	NOX	VOC	CO2
Field Artillery Fire Range															
155 mm HE	592	2.70E-03	6.03E+00	3.32E+00	1.40E-01	1.73E-01	1.50E-03	6.50E+00	7.99E-04	1.78E+00	9.83E-01	4.14E-02	5.12E-02	4.44E-04	1.92E+00
155 mm Illum	40	2.70E-03	6.03E+00	3.32E+00	1.40E-01	1.73E-01	1.50E-03	6.50E+00	5.40E-05	1.21E-01	6.64E-02	2.80E-03	3.46E-03	3.00E-05	1.30E-01
155 mm Smoke	320	2.70E-03	6.03E+00	3.32E+00	1.40E-01	1.73E-01	1.50E-03	6.50E+00	4.32E-04	9.64E-01	5.31E-01	2.24E-02	2.77E-02	2.40E-04	1.04E+00
120 mm HE	200	0.00E+00	1.02E+00	8.47E-01	4.31E-01	8.09E-02	0.00E+00	5.47E+00	0.00E+00	1.02E-01	8.47E-02	4.31E-02	8.09E-03	0.00E+00	5.47E-01
120 mm Smoke	200	8.40E-04	5.17E-01	1.23E+01	1.29E+01	1.93E-02	0.00E+00	9.19E-01	8.40E-05	5.17E-02	1.23E+00	1.29E+00	1.93E-03	0.00E+00	9.19E-02
81 mm Smoke	40	1.50E-03	3.20E-03	3.50E+00	3.50E+00	1.50E-02	1.30E-04	3.40E-01	3.00E-05	6.40E-05	7.00E-02	7.00E-02	3.00E-04	2.60E-06	6.80E-03
Small Arms															
5.56 mm	382,575	0.00E+00	1.60E-03	3.90E-05	2.80E-05	8.50E-05	0.00E+00	8.70E-04	0.00E+00	3.06E-01	7.46E-03	5.36E-03	1.63E-02	0.00E+00	1.66E-01
.50 cal	36,800	0.00E+00	1.60E-02	9.70E-04	4.40E-04	3.30E-05	0.00E+00	9.20E-03	0.00E+00	2.94E-01	1.78E-02	8.10E-03	6.07E-04	0.00E+00	1.69E-01
7.62 mm	192,960	0.00E+00	3.00E-03	8.20E-05	5.80E-05	4.10E-05	0.00E+00	1.70E-03	0.00E+00	2.89E-01	7.91E-03	5.60E-03	3.96E-03	0.00E+00	1.64E-01
Grenade Mortar/Rocket															
40 mm HE	10,460	0.00E+00	7.35E-03	1.30E-02	6.62E-03	1.64E-03	0.00E+00	6.63E-02	0.00E+00	3.84E-02	6.81E-02	3.46E-02	8.56E-03	0.00E+00	3.47E-01
60 mm HE	480	0	0.06705	0.068838	0.033078	0.0057216	0	4.47E-01	0.00E+00	1.61E-02	1.65E-02	7.94E-03	1.37E-03	0.00E+00	1.07E-01
60 mm Illum	80	1.51E-04	0.00754	0.2088	0.4872	0.00812	5.63E-03	0.03886	6.03E-06	3.02E-04	8.35E-03	1.95E-02	3.25E-04	2.25E-04	1.55E-03
60 mm Smoke	40	0.00E+00	7.80E-03	1.40E-03	1.20E-03	9.80E-05	0.00E+00	6.30E-03	0.00E+00	1.56E-04	2.80E-05	2.40E-05	1.96E-06	0.00E+00	1.26E-04
81 mm HE	1000	0.00E+00	2.74E-01	3.63E-01	1.99E-01	3.38E-02	0.00E+00	3.01E+00	0.00E+00	1.37E-01	1.81E-01	9.97E-02	1.69E-02	0.00E+00	1.50E+00
81 mm Illum	80	3.53E-05	5.08E-02	7.23E-02	5.48E-02	3.22E-03	1.39E-04	2.24E-01	1.41E-06	2.03E-03	2.89E-03	2.19E-03	1.29E-04	5.54E-06	8.96E-03
81 mm Smoke	40	1.30E-04	4.40E-03	1.70E-01	0.00E+00	5.70E-03	8.50E-05	3.80E-03	2.60E-06	8.80E-05	3.40E-03	0.00E+00	1.14E-04	1.70E-06	7.60E-05
83 mm HE	8	6.00E-04	6.03E-02	1.36E-01	7.20E-02	2.04E-02	2.05E-04	4.29E+00	2.40E-06	2.41E-04	5.44E-04	2.88E-04	8.14E-05	8.20E-07	1.72E-02
TOW HEAT	4	1.95E-03	6.29E-02	9.26E-01	9.26E-01	3.15E-03	2.91E-03	1.70E+01	3.91E-06	1.26E-04	1.85E-03	1.85E-03	6.30E-06	5.82E-06	3.40E-02
AT-4 HE	4	6.00E-04	6.03E-02	1.36E-01	7.80E-02	2.04E-02	2.05E-04	4.29E+00	1.20E-06	1.21E-04	2.72E-04	1.56E-04	4.07E-05	4.10E-07	8.58E-03
20 mm TP	160	0.00E+00	3.30E-02	6.60E-04	4.60E-04	4.30E-04	0.00E+00	1.60E-02	0.00E+00	2.64E-03	5.28E-05	3.68E-05	3.44E-05	0.00E+00	1.28E-03

Ammunition Type	Annual Total Ordnance/ Ammunition Expenditure Estimate - Pagan	Emission Factors (lb/Round)							Emissions (tons)						
		SO2	CO	PM10	PM2.5	NOX	VOC	CO2	SO2	CO	PM10	PM2.5	NOX	VOC	CO2
Air-Delivered Ordnance															
25 lb Inert	1,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
500 lb Inert	175	-	-	-	-	-	-	-	-	-	-	-	-	-	-
500 lb HE	175	5.00E-02	2.20E+00	3.40E+01	3.40E+01	2.95E-02	1.00E-01	4.85E+02	4.38E-03	1.93E-01	2.98E+00	2.98E+00	2.58E-03	8.75E-03	4.24E+01
1,000 lb HE	175	1.00E-01	4.40E+00	6.80E+01	6.80E+01	5.90E-02	2.00E-01	9.70E+02	8.75E-03	3.85E-01	5.95E+00	5.95E+00	5.16E-03	1.75E-02	8.49E+01
2,000 lb HE	175	2.00E-01	8.80E+00	1.36E+02	1.36E+02	1.18E-01	4.00E-01	1.94E+03	1.75E-02	7.70E-01	1.19E+01	1.19E+01	1.03E-02	3.50E-02	1.70E+02
2.75 inch HE	500	0.00E+00	1.90E+00	3.50E-01	2.20E-01	3.16E-02	0.00E+00	3.10E+00	0.00E+00	4.75E-01	8.75E-02	5.50E-02	7.90E-03	0.00E+00	7.75E-01
2.75 inch Illum	50	0.00E+00	1.50E+00	1.10E-01	1.00E-01	2.60E-02	0.00E+00	2.40E+00	0.00E+00	3.75E-02	2.75E-03	2.50E-03	6.50E-04	0.00E+00	6.00E-02
2.75 inch Smoke	75	0.00E+00	1.50E+00	1.10E-01	1.00E-01	2.60E-02	0.00E+00	2.40E+00	0.00E+00	5.63E-02	4.13E-03	3.75E-03	9.75E-04	0.00E+00	9.00E-02
5 inch HE	150	6.50E-02	4.29E-01	3.06E+00	3.06E+00	5.77E-02	9.00E-03	6.68E+01	4.88E-03	3.22E-02	2.30E-01	2.30E-01	4.32E-03	6.75E-04	5.01E+00
20 mm TP	11,250	0.00E+00	3.30E-02	6.60E-04	4.60E-04	4.30E-04	0.00E+00	1.60E-02	0.00E+00	1.86E-01	3.71E-03	2.59E-03	2.42E-03	0.00E+00	9.00E-02
25 mm TP	1,000	0.00E+00	8.50E-02	3.30E-03	1.70E-03	1.50E-03	0.00E+00	4.30E-02	0.00E+00	4.25E-02	1.65E-03	8.50E-04	7.50E-04	0.00E+00	2.15E-02
7.62 mm	45,000	0.00E+00	3.00E-03	8.20E-05	5.80E-05	4.10E-05	0.00E+00	1.70E-03	0.00E+00	6.75E-02	1.85E-03	1.31E-03	9.23E-04	0.00E+00	3.83E-02
.50 cal	30,000	0.00E+00	1.60E-02	9.70E-04	4.40E-04	3.30E-05	0.00E+00	9.20E-03	0.00E+00	2.40E-01	1.46E-02	6.60E-03	4.95E-04	0.00E+00	1.38E-01
LGTR Inert	250	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Naval Ship Delivered Ordnance															
5 inch HE	150	6.50E-02	4.29E-01	3.06E+00	3.06E+00	5.77E-02	9.00E-03	6.68E+01	4.88E-03	3.22E-02	2.30E-01	2.30E-01	4.32E-03	6.75E-04	5.01E+00
Air-to-Air Ordnance and Expendables (Warning Areas Only)															
AIM 7	5	1.78E-02	4.37E-01	6.07E+00	6.07E+00	4.04E-02	2.07E-02	1.43E+02	4.45E-05	1.09E-03	1.52E-02	1.52E-02	1.01E-04	5.17E-05	3.58E-01
AIM 9	5	1.11E-02	1.41E-01	1.50E+00	1.50E+00	3.65E-02	7.24E-03	7.79E+01	2.77E-05	3.53E-04	3.76E-03	3.76E-03	9.12E-05	1.81E-05	1.95E-01
AIM 120	3	2.00E-02	3.03E-01	3.55E+00	3.55E+00	6.17E-02	1.51E-02	1.45E+02	3.00E-05	4.54E-04	5.33E-03	5.33E-03	9.26E-05	2.27E-05	2.17E-01
Chaff	2,400	7.90E-06	1.30E-03	6.20E-03	6.20E-03	1.30E-04	4.00E-04	1.10E-02	9.48E-06	1.56E-03	7.44E-03	7.44E-03	1.56E-04	4.80E-04	1.32E-02
Flares	2,400	1.30E-04	4.40E-03	1.70E-01	0.00E+00	5.70E-03	8.50E-05	3.80E-03	1.56E-04	5.28E-03	2.04E-01	0.00E+00	6.84E-03	1.02E-04	4.56E-03
								Total	**0.04**	**6.63**	**24.92**	**23.05**	**0.19**	**0.06**	**315.34**

Attachment 8 - Total Annual Operational Emissions

Training Operational Annual Emissions - Tinian Alternatives 1, 2, and 3

Pollutant (tons per year)						
SO_2	***CO***	***PM_{10}***	***$PM_{2.5}$***	***NO_x***	***VOC***	***CO_2***
Aircraft Sorties around Tinian International Airport						
8.12	256.27	42.69	42.69	89.02	75.18	25048.85
Aircraft Training Exercises						
2.74	3.25	11.29	11.29	28.70	0.37	3740.83
Marine Vessels						
31.61	8.85	3.75	3.43	106.28	4.02	5144.48
Ground Vehicles						
13.38	42.31	109.13	19.38	141.71	9.11	1192.42
Support Equipment						
0.17	3.43	16.48	2.12	7.50	0.64	794.05
Generators						
0.35	4.71	0.34	0.29	20.57	0.60	994.00
Solid Waste Transfer						
0.10	0.31	0.06	0.06	0.95	0.07	84.56
Munitions						
0.03	56.01	38.68	13.80	1.72	0.01	82.21
Total						
56.45	375.14	222.42	93.06	396.45	90.00	37081.40

Legend: CO = carbon monoxide; CO_2 = carbon dioxide; NO_x = nitrogen oxides; PM_{10} = particulate matter with a particle diameter of less than or equal 10 microns; $PM_{2.5}$ = particulate matter with a particle diameter of less than or equal 2.5 microns; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Training Operational Annual Emissions - Pagan Alternatives 1 and 2

Pollutant (tons per year)						
SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
Aircraft Sorties around Pagan Airport						
2.98	74.22	17.16	17.16	42.66	29.71	7607.25
Aircraft Training Exercises						
2.29	2.31	8.00	8.00	42.64	0.28	4810.82
Marine Vessels						
2.18	0.84	0.27	0.25	10.22	0.36	353.86
Ground Vehicles						
32.80	94.12	155.51	35.46	335.45	20.41	1421.42
Support Equipment						
0.02	0.49	1.24	0.20	0.92	0.09	102.75
Generators						
0.30	4.04	0.29	0.25	17.61	0.52	851.20
Munitions						
0.04	6.63	24.92	23.05	0.19	0.06	315.34
Total						
40.61	182.65	207.39	84.37	449.69	51.43	15462.64

Legend: CO = carbon monoxide; CO_2 = carbon dioxide; NO_x = nitrogen oxides; PM_{10} = particulate matter with a particle diameter of less than or equal 10 microns; $PM_{2.5}$ = particulate matter with a particle diameter of less than or equal 2.5 microns; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Combined Regional Training Operational Annual Emissions – Tinian and Pagan Combined

Pollutant (tons per year)						
SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
Aircraft Sorties around Tinian International Airport and Pagan Airport						
11.1	330.49	59.85	59.85	131.68	104.89	32656.1
Aircraft Training Exercises						
5.03	5.56	19.29	19.29	71.34	0.65	8551.65
Marine Vessels						
33.79	9.69	4.02	3.68	116.5	4.38	5498.34
Ground Vehicles						
46.18	136.43	264.64	54.84	477.16	29.52	2613.84
Support Equipment						
0.19	3.92	17.72	2.32	8.42	0.73	896.8
Generators						
0.65	8.75	0.63	0.54	38.18	1.12	1845.20
Solid Waste Transfer						
0.10	0.31	0.06	0.06	0.95	0.07	84.56
Munitions						
0.07	62.64	63.6	36.85	1.91	0.07	397.55
Total						
97.06	555.20	429.09	177.41	849.47	141.48	52544.04

Legend: CO = carbon monoxide; CO_2 = carbon dioxide; NO_x = nitrogen oxides; PM_{10} = particulate matter with a particle diameter of less than or equal 10 microns; $PM_{2.5}$ = particulate matter with a particle diameter of less than or equal 2.5 microns; SO_2 = sulfur dioxide; VOC = volatile organic compound.

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