CHAPTER 1. INTRODUCTION

Volumes 2 through 6 of this Environmental Impact Statement (EIS) presented project-specific impacts and proposed mitigation measures for the proposed actions and alternatives. In contrast to the previous volumes, Volume 7 (this volume) addresses the impacts of *all* components of the preferred alternatives, in total, for both Guam and Tinian. The purpose of this volume is to list best management practices (BMPs) and proposed mitigation measures identified throughout the EIS (Chapter 2), present the combined impacts of the preferred alternatives (Chapter 3), and present the cumulative impacts of the preferred alternatives in combination with other past, present, and reasonably foreseeable future actions (Chapter 4).

The information provided in Volume 7 is organized into four chapters:

- Chapter 1, Introduction, summarizes the preferred alternatives described in previous volumes for Guam and Tinian. An overview of key natural events and human actions that have influenced the resources on both islands since World War II (WWII) is presented to provide an historical context for the current environmental setting of each island.
- Chapter 2, Overview of Best Management Practices and Proposed Mitigation Measures, summarizes the mitigation and BMPs that were identified in previous volumes of this EIS. Mitigation measures are measures that are proposed to avoid, minimize, rectify, reduce/eliminate, or provide compensation for an impact resulting from implementation of an alternative. Chapter 2 also presents a discussion of force flow reduction and adaptive program management techniques that could be used to further mitigate construction and operations impacts, and minimize impacts to public infrastructure and resources due to increased population.
- Chapter 3, Preferred Alternatives: Summary of Impacts, describes the impacts of the preferred alternatives for achieving the proposed Marine Corps, Navy and Army objectives identified on Guam and Tinian. Volumes 2 through 6 focused on the potential impacts of the numerous proposed actions and alternatives by action proponent and geography. However, there may be impacts generated by the preferred alternatives that are not apparent when independently assessing project-specific impacts from the Marine Corps relocation, Navy transient aircraft carrier berthing, and Army Air Missile Defense Task Force (AMDTF). This is especially true for Guam where there are many different projects proposed under the preferred alternatives. Since fewer actions are proposed for Tinian, the summary of impacts in Volume 3 suffices as the summary analysis; therefore, an additional summary analysis is not provided in this volume. Tinian is located approximately 135 miles (mi) (217 kilometers [km]) from Guam and is not expected to be influenced by environmental impacts on Guam resulting from implementation of the preferred alternatives.

  "No action" is defined as the affected environment without any of the projects proposed in this EIS to support the Marine Corps relocation, Navy transient aircraft carrier berthing, and Army AMDTF. The summary of impacts associated with the preferred alternatives is compared by resource to no action. The preferred alternatives' impacts are compared to resource trends and stressors for each island under no action to assess whether the preferred alternatives would influence island-wide trends in resource health.

Chapter 3 also summarizes secondary impacts of the preferred alternatives and provides a summary of potential Clean Water Act (CWA) Section 404 actions under all alternatives, as described in Volumes 2 through 6.

- Chapter 4, Cumulative Impacts, assesses impacts on the environment resulting from the incremental impact of the preferred alternatives when added to other past, present, and reasonably foreseeable future actions (cumulative projects) regardless of what agency (federal or non-federal) or person undertakes the action. A cumulative project list was generated for the time period between 2004 and 2019. A determination was made whether reasonably foreseeable actions would have an additive effect when combined with the effects of the proposed actions included in the preferred alternatives. For each resource area with a potential for an additive effect, an assessment of severity (e.g., adverse, beneficial and low, moderate, or strong) of those potential cumulative impacts is presented.

1.1 PREFERRED ALTERNATIVES

The term "preferred alternatives" is a collective term that encompasses all components of the preferred alternatives described in previous volumes for the Marine Corps relocation, Navy transient aircraft carrier berthing, and Army AMDTF.

1.1.1 Geographic Boundaries

The geographic boundaries of analyses in Volume 7 are the islands of Guam and Tinian. They are sufficiently distant from each other as to have minimal aggregate effects on each other.

1.1.2 Guam Preferred Alternatives

The proposed actions consist of: 1) constructing facilities and infrastructure to support the relocation of approximately 8,600 Marines and their dependents from Okinawa (Japan) to Guam, 2) constructing a Navy deep-draft wharf with shoreside infrastructure improvements for transient aircraft carriers, and 3) constructing facilities and infrastructure on Guam to support relocation of approximately 600 military personnel and their dependents in order to establish and operate an Army AMDTF.

In summary, implementation of the proposed actions would include the following major components:

- Temporary increase in population associated with the construction-related workforce.
- Permanent increase in the number of military and civilian personnel and dependents on Guam with a transient presence during training on Tinian.
- Increase in number and types of major equipment to support military personnel and operations (e.g., aircraft, ships, amphibious watercraft).
- Increase in number and types of training activities.
- Construction of new facilities and improvements to existing facilities (main cantonment, training, waterfront, airfield, family housing, community support).
- Improvements to existing and construction of new infrastructure (including roads, utilities, etc.).
- Acquisition or long-term leasing of additional land.

Table 1.1-1 lists the key functions requiring new or improved facilities by proponent. The development areas are shown on Figure 1.1-1.

Table 1.1-1. Summary of Preferred Alternatives - Guam

Volume(s)	*2 and 6*	*4*	*5*
Proponent	*Marine Corps*	*Navy*	*Army-Air Missile Defense Task Force*
Function	*Primary Geographic Area- New facilities or existing*		
Main Cantonment	NCTS Finegayan - new facilities	-	-
Family housing and community support	South Finegayan/Former FAA - new facilities	-	-
Waterfront Operations	Inner Apra Harbor - improve existing plus new facilities	Outer Apra Harbor (Polaris Point) - new facilities	-
Airfield operations/ training	Andersen Air Force Base (AFB) - new facilities at existing airfield	-	Andersen AFB –new facilities
Live fire training	East of Andersen South - new facilities	-	-
Non-firing training	Andersen South - new facilities at existing training area	-	Northwest Field – new facilities
Munitions storage	Naval Munitions Site/Andersen AFB - new facilities at existing storage area	-	Andersen AFB – new facilities
Utilities			
Power	Recondition up to 5 existing GPA permitted facilities to provide peaking power/reserve capacity	-	-
Water	Andersen AFB and Navy Barrigada- new wells, storage and distribution facilities	-	-
Wastewater	Northern District Wastewater Treatment Plant - upgrade existing facilities to secondary treatment	-	-
Solid waste	Apra Harbor - Navy landfill - existing facility	-	-
Roadways	Across island - improve existing roadways and build new roadways	-	-

Legend: - = Not applicable
Note: While the Army and Navy missions would share many of the new facilities and roadways, the Marine Corps requirements generate most of the infrastructure construction and improvements.

1.1.3 Tinian Preferred Alternative

The proposed actions on Tinian are for the development and operation of four firing ranges; each range is located within the Military Lease Area (MLA). Volume 3 describes the proposed actions. The proposed ranges are:

1. Rifle known distance range.
2. Automated combat pistol/multipurpose firearm qualification course.
3. Platoon battle course.
4. Field firing range.

The preferred alternative for firing ranges is shown on Figure 1.1-2.

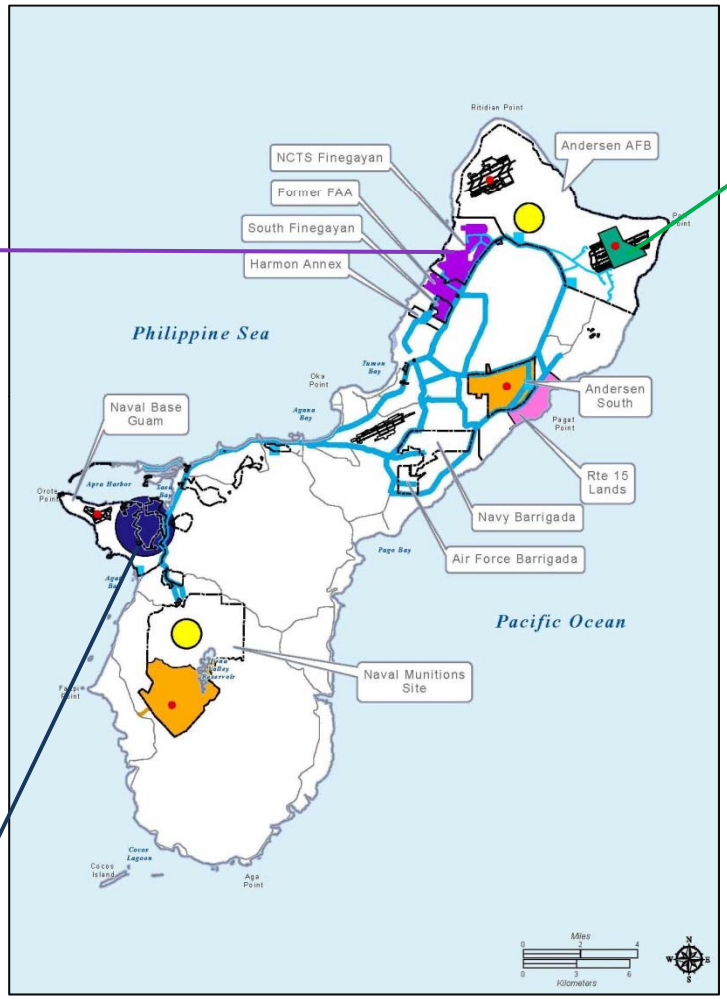
Figure 1.1-1 Overview of Preferred Alternatives on Guam

Main Cantonment Functions

- Headquarters (HQ) and Administrative:
  - Administrative offices
  - Vehicle maintenance
  - Communications
  - Security
  - Warehousing
  - Armory
  - Fuel storage
  - HAZMAT, DRMO, Recycling
- Base Operations:
  - Administrative offices
  - Police/fire facilities
  - Base Access
  - Warehousing
  - Legal services, dental services, family services, and MWR support
- Bachelor's Quarters and Temporary Lodging
- Family Housing
- Educational Facilities
- Quality of Life Functions:
  - Community center, commissary, exchange, post office, theater, recreational, etc.
  - Applied instruction and auditorium
  - Services: restaurant, bank, gas station

Waterfront Functions

- Amphibious task force ship berthing
- Embarkation and cargo inspection and staging area
- LCAC/AAV laydown area
- Apra Harbor medical/dental clinic
- Relocations: Military Working Dog Kennels, USCG wharf and support facilities
- Aircraft carrier wharf and navigation channel



Interim Utilities & Roadways

- Roadways [new & existing]
- Solid waste, water, wastewater, & power

Airfield Functions

- Air embarkation
- ACE beddown:
  - Hangars/aprons
  - Administrative
  - Maintenance
  - Fire and rescue

Training Functions

- Training Range Complex:
  - Live-firing ranges
  - Indoor small arms range
  - Demolition range
- Ammunition storage
- Non-firing Ranges:
  - Obstacle course
  - Hand-to hand combat
  - Gas chamber
  - Advanced motor vehicle course
  - Rappelling
  - Engineer equipment and decontamination training facility
  - Maneuver training
  - Range support buildings
- Aviation Training:
  - Tactical air operations training
  - Improved airfield
  - Landing zones
  - Air traffic control
- Command, Control and Simulation:
  - Battle Staff Training
  - Combined arms training
  - Audio visual and simulation training

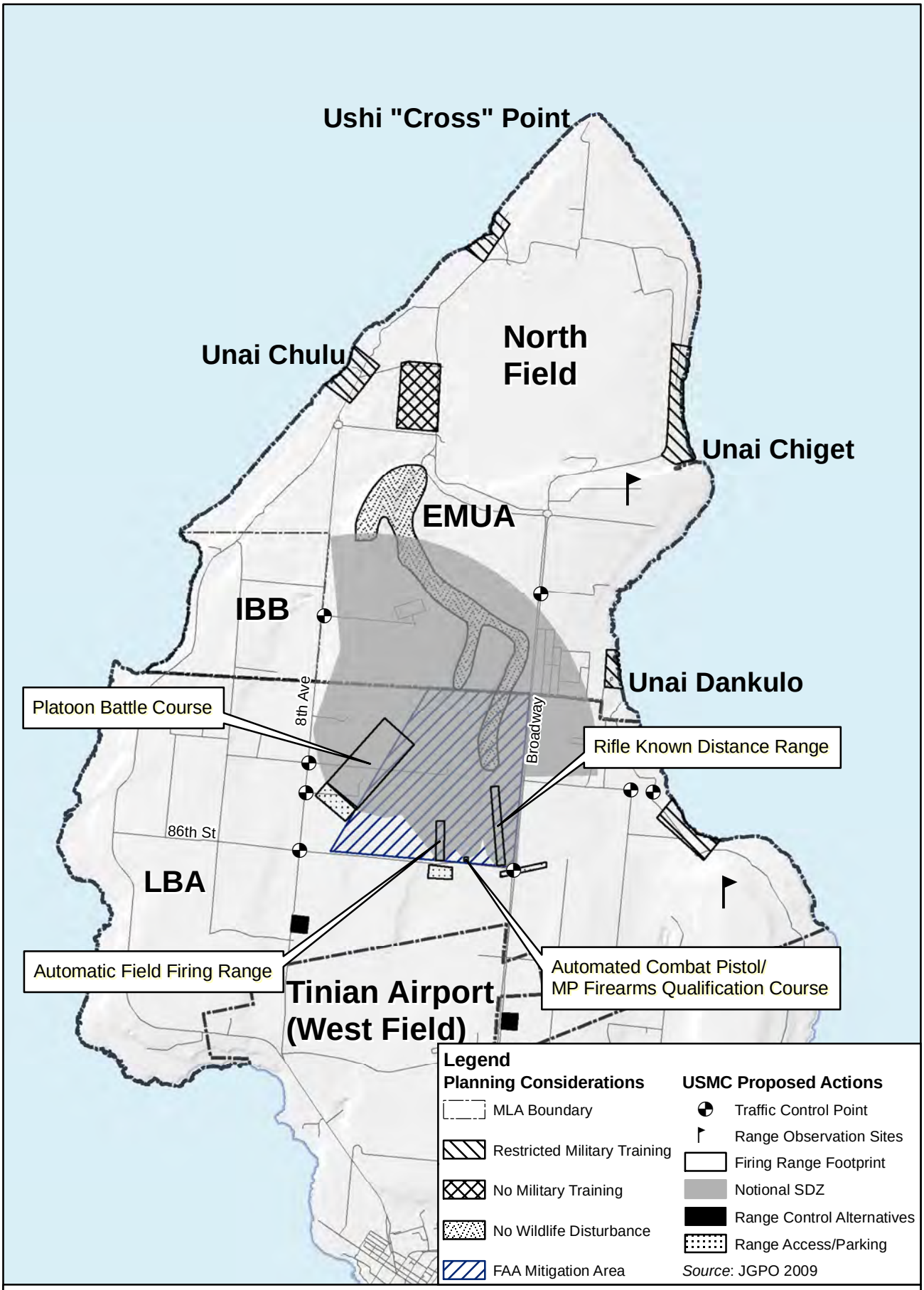


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Figure 1.1-2
Range Training Area Alternative 1

1.2 NO ACTION

"No action" as it is used in Volume 7, represents the island-wide (Guam and Tinian) status quo, assuming none of the proposed actions in this EIS are implemented. The resources would be subject to the same influences (stressors) that they are today. Chapter 3 describes no action by resource. The current trends in the conditions of resources are assumed to proceed at the same rate into the future for most resources.

1.3 HISTORICAL PERSPECTIVE - GUAM

The proposed actions on Guam would result in significant changes to the natural and built environments. Historically, there have been events – both naturally occurring and the result of man's actions (anthropogenic) – that have also resulted in significant impacts to the island environment. This section provides a brief overview of Guam and the events that have shaped its history and altered the ecology of the island. The individual resource assessments in Chapter 3 provide more detail.

1.3.1 Location and Brief Social History

Guam is an island in the western Pacific Ocean and is an organized, unincorporated territory of the U.S. It is one of five U.S. territories with an established civilian government (Office of Insular Affairs 2007). The island's capital is Hagatna (formerly Agana). Guam is the largest and southernmost of the Mariana Islands. It is 30 mi (48 km) long and 4 mi (6 km) to 12 mi (19 km) wide. Guam lies between 13.2°N and 13.7°N and between 144.6°E and 145.0°E; it has an area of 212 square miles [mi^2] (549 square kilometers [km^2]) making it the 32nd largest island of the U.S. Guam is the closest land mass to the Mariana Trench, a deep subduction zone that lies beside the island chain to the east. Challenger Deep, the deepest surveyed point in the Western Pacific Ocean, is southwest of Guam at 35,797 feet [ft] (10,911 meters [m]) deep. The highest point on Guam is Mount Lamlam, which is 1,332 ft (406 m) above sea level. Since it extends into the Mariana Trench, it is also considered the tallest mountain in the world (measured from below sea level).

Guam, which was formed by an uplift of undersea volcanoes, is surrounded by coral reefs near the shore. The island is composed of two distinct geologic areas of about equal size. The northern part of the island is a high coralline limestone plateau rising 850 ft (259 m) above sea level. This area contains the northern water lens, which is the main source of fresh water for Guam. The southern region is mountainous with elevations from 700 ft (213 m) to 1,300 ft (396 m) above sea level.

The Chamorros, Guam's indigenous people, first populated the island approximately 4,000 years ago (Tasi 2009). The island has a long history of European colonialism and was controlled by Spain until 1898 when it was surrendered to the U.S. as part of the Treaty of Paris following the Spanish American War. As the largest island in Micronesia, and the only American-held island in the region before WWII, Guam was captured by the Japanese shortly after the attack on Pearl Harbor, Hawaii, and was occupied for two and a half years. Guam was subject to fierce fighting when American troops recaptured the island on July 21, 1944, a date commemorated every year as Liberation Day.

1.3.2 Guam Today

Guam's economy depends primarily on tourism, DoD installations, and locally-owned businesses. Residents of Guam pay federal income tax; they do not vote in federal elections, and their representative in Congress cannot vote.

Guam is a popular destination for Japanese and other east-bound tourists since it requires a relatively shorter flight from Asia or Australia (as compared to Hawaii). Tumon, the tourist hub, features more than 20 large hotels, accommodating over a million tourists per year and providing access to seven public golf

courses. Although 75% of Guam's tourists are Japanese, Guam also receives a sizable number of tourists from South Korea, the U.S., the Philippines, and Taiwan.

1.3.3 Historical Events That Have Affected Guam

1.3.3.1 Key Natural Events and Occurrences Affecting the Ecology of Guam

Earthquakes

Guam experiences occasional earthquakes due to its location on the western edge of the Pacific Plate and near the Philippine Sea Plate. In recent years, earthquakes with epicenters near Guam have had magnitudes ranging from 5.0 to 7.8.

- On October 30, 1936 (October 29, Universal Time), a magnitude 6.7 shock occurred about 80 mi (125 km) southwest of Guam resulting in cracked walls and fallen tile and plaster for Guam households and businesses. The seismic observer at Guam reported 25 tremors during the day of October 30.
- Another earthquake originated in the same area as the 1936 shock on September 16, 1970. The magnitude 6.2 tremor also caused minor damage on Guam.
- A similar occurrence on November 1, 1975 (magnitude 6.2) produced damage on Guam that reached $1 million. The earthquake was felt strongly on many parts of the island.
- On January 27, 1978, a magnitude 5.2 earthquake centered near the east coast of Guam caused considerable damage on the island.
- On August 8, 1993, the largest earthquake (magnitude 7.8) recorded on Guam occurred south of the Mariana Islands, injuring 48 people on Guam and causing extensive damage to hotels in the Tumon Bay area. Many landslides and rockslides were reported mainly in the southern half of the island. The estimate of loss from damage to commercial buildings was placed at $112 million with loss from damage to private residences estimated at several million dollars.

Unlike the Anatahan volcano in the Northern Mariana Islands, Guam is not volcanically active (Official Site of Guam 2007). However, due to its proximity to Anatahan, vog ("volcanic" and "smog") does occasionally affect Guam (USGS-CNMI 2007). Vog is a form of air pollution that results when sulfur dioxide and other gases and particles emitted by an erupting volcano react with oxygen and moisture in the presence of sunlight. Vog contains chemicals that can damage the environment and the health of plants, humans and other animals.

Typhoons

Guam is located in what has been nicknamed "Typhoon Alley" and it is common for the island to be threatened by tropical storms and typhoons during the wet season. An average of three tropical storms and one typhoon pass within 180 nautical miles (nm) (330 km) of Guam each year. In the last decade, Guam has been hit directly by four typhoons with sustained winds of greater than 150 miles per hour (mph) and has suffered high waves and winds from large systems passing close to Guam.

The most intense typhoon to pass over Guam within the last decade was Super Typhoon Pongsona; with sustained winds of 144 mph and gusts peaking at 173 mph, it slammed into Guam on December 8, 2002 resulting in massive destruction islandwide. Typhoon Pongsona maintained a 40-mi (65-km)-wide eye upon crossing the northern populated portion of Guam; Andersen Air Force Base (AFB) was in the eye for two hours.

Due to the high winds, Typhoon Pongsona left the entire island of Guam temporarily without electrical power or phone service. The winds collapsed several walls at the Guam Memorial Hospital resulting in

major damage throughout the northern two-thirds of the facility; several hotels, churches, and schools also received moderate damage. 65% of the island's water wells were also inoperable resulting in most of Guam being without water service following the storm (FEMA 2003a). Officials estimate the typhoon destroyed 1,300 homes, severely damaged 1,825 homes, and lightly damaged 4,800 homes (Gillespie 2002).

Pongsona produced storm surge flooding of up to 20 ft (6 m) at some locations, with 9-13 ft (3-4 m) recorded near the eyewall. Considerable storm surge flooding occurred from Tumon southward to Piti, leaving some buildings on the west coast of the island flooded with 4 ft (1 m) of water. The combination of strong storm surge and rough waves caused considerable beach erosion and severe coastal damage, including impacts to coral (NCDC 2003).

Typhoon Pongsona was the last typhoon of the 2002 Pacific typhoon season and was the most expensive U.S. disaster in 2002 with damage estimated at $700 million (FEMA 2003b). The public also considers Pongsona to be the worst typhoon to ever strike Guam (Kelly 2003).

Wildfires

Wildfires plague the forest areas of Guam every dry season despite the island's humid climate. Most fires are caused by man with 80% resulting from arson (Neill and Rea 2004). Poachers often start fires to attract deer to the new growth. Invasive grass species that rely on fire as part of their natural life cycle grow in many regularly burned areas. These grasslands and barrens have replaced previously forested areas, leading to greater soil erosion.

During the rainy season, sediment is carried by the heavy rains into the Fena Lake Reservoir and Ugum River, thereby leading to water quality problems for southern Guam. Eroded silt also destroys the marine life in reefs around the island.

Accelerated rates of upland erosion due to wildfires, clearing and grading forested land, recreational off-road vehicle use, and wild populations of introduced mammals continue to result in increased rates of sedimentation in southern Guam. Estimates suggest that between 1975 and 1999, Guam lost nearly a quarter of its tree cover, while an increase in badlands acreage (bare soil with extremely high erosion rates) and other erosion-prone surface cover types have been observed. The numerous fires set each year and the popular use of off-road vehicles are believed to be major contributors to the development and persistence of these erosion-prone surface cover types (Burdick et al. 2008).

According to the Guam Department of Agriculture's Forestry and Soil Resources Division, more than 750 fires were reported annually between 1979 and 2001, burning over 155 mi^2 (401 km^2) during this time period (Burdick et al. 2008). The acreages of the largest fires (>1,000 acres [ac] {405 hectares [ha]}) during the years 1979 - 2002 are shown in Table 1.3-1.

Table 1.3-1. Wildfires on Guam

Date	*Size (ac)*	*Cause*
May 1998	1,970	Incendiary
March 1995	1,000	Navy Incendiary
March 1987	1,000	Incendiary
Feb 1983	1,446	Debris Burning
Jun 1983	1,108	Incendiary
April 1979	1,000	Debris Burning

Source: Neill and Rea 2004.

A Wildland Fire Management Plan currently is in place that has been developed by the U.S. Forest Service (USFS) for DoD lands (USFS 2008). The plan currently includes a series of recommended actions to develop and implement an effective wildland fire management plan, covering such topics as staffing, equipment, training, and development and implementation of fire management strategies, prevention, suppression methods, preparedness, impacts, and management techniques.

Invasive Species

An invasive species is often defined as an introduced species that spreads widely and causes harm. On Guam, invasive species have caused significant alteration of wildlife and vegetation populations. Some of these species are discussed below.

Brown Tree Snake (BTS)

Shortly after WWII, and before 1952, the BTS was accidentally transported from its native range in the South Pacific to Guam, probably as a stowaway on a ship cargo (Fritts and Leasman-Tanner 2001). The snake was first detected on Guam in the 1950s near the Naval Port (central Guam), but may not have become conspicuous away from the port area until the early 1960s. By the mid 1960s, the snake had colonized over half of the island. In 1968, BTS had reached the extreme northern end of the island and was present throughout the island, although its densities varied widely from region to region (U.S. Pacific Command 2006). As a result of abundant prey resources on Guam and the absence of natural predators that rely on the snake as a part of their diet, BTS populations have reached very high densities unknown outside of their range (Fritts and Leasman-Tanner 2001).

With the high density of BTS, the disappearance of birds on the island soon followed. By 1963, several formerly abundant species of native birds had disappeared from the central part of the island where snakes were most populous. By the late 1960s, birds had begun to decline in the central and southern parts of the island and remained abundant only in isolated patches of forest on the northern end of the island. Snakes began affecting the birds in the north-central and extreme northern parts of the island in the 1970s, and most native forest species were virtually extinct when they were listed as threatened or endangered by the USFWS in 1984. The native bird species remaining on Guam are extremely patchy in distribution, occurring only in special habitats where some protection from snakes exists.

Currently, small mammals are extremely rare in most forested habitats of Guam. Predation by the BTS is the most likely primary factor preventing recruitment to the single population of native Mariana fruit bats remaining on Guam. Lizard densities, particularly of introduced species with high reproductive rates, remain high, thereby supporting the snake population. Although larger snakes are showing signs of stress, exhibited by low fat reserves, the ability to shift from birds to rodents or lizards has enabled the snake to reach and maintain extraordinarily high densities of as many as 13,000 per mi^2 (5.019 per km^2). This is higher than snake densities in the rainforests of the Amazon Basin of Ecuador where 51 different snake species occupy the same habitat (U.S. Pacific Command 2006).

This predator has caused the disappearance of nearly all of the native forest birds on Guam including the extinction of the Guam rail and the Micronesian kingfisher. The snake's decimation of the bird population and resultant loss of avian seed dispersers has also caused declines in the reproductive rate of introduced plants and shrubs.

The abundance of the BTS has also caused far reaching secondary ecological impacts. The snake is responsible for the decline of the fruit bat - a crucial species for the pollination and seed dispersal of tropical trees. Also, without the presence of certain avian insectivores, insect populations may have experienced population booms which negatively impacted local agriculture. The cultural fabric of the

island communities are negatively impacted by the BTS as well. Fruit bats, an important part of indigenous rituals and celebrations on the Mariana Islands, have shown great declines since the introduction of the BTS. In addition to these negative biological impacts, the BTS impacts the economy of the island through damages to equipment causing large-scale electrical power outages. Since 1978, over 1,200 power outages have occurred as a result of the BTS shorting high voltage electrical lines and transformers. Moreover, continuously increasing populations of the BTS are responsible for predation of farm animals, poultry, and pets, leading to further economic consequences. The snakes are mildly venomous to humans and their non-fatal bite can cause severe sickness in young children (Hodgson et al. 1998).

Because Guam is a major transportation hub in the Pacific, numerous opportunities exist for BTS on Guam to be introduced accidentally to other Pacific islands as passive stowaways on ship and air traffic from Guam. Numerous sightings of this species have been reported on other islands including Wake Island, Tinian, Rota, Okinawa, Diego Garcia, Hawaii, and even Texas in the continental U.S. An incipient population is probably established on Saipan (Fritts and Leasman-Tanner 2001). The chemical compound para-acetylaminophenol (in some contexts, it is simply abbreviated as APAP) has been used to help eradicate the snake on Guam (Avis 2007). The Guam Customs & Quarantine Agency is also training detector dogs to seek out BTS throughout Guam in an effort to further mitigate and reduce their escalating population.

Coconut Rhinoceros Beetle

An infestation of the coconut rhinoceros beetle (CRB), *Oryctes rhinoceros*, was detected on Guam on September 12, 2007. CRB is not known to occur in the U.S., except in American Samoa. CRB is native to southern Asia and is distributed throughout Asia and the Western Pacific including in Sri Lanka, Samoa, American Samoa, Palau Islands, New Britain, West Irian, New Ireland, Pak Island and Manus Island (New Guinea), Fiji, Cocos (Keeling) Islands, Mauritius, and Reunion.

CRBs in the adult stage cause the most harm; they are generally night-time fliers and when they alight on a host, they chew down into the folded, emerging fronds of coconut palms to feed on sap. V-shaped cuts in the fronds and holes through the midrib are visible when the leaves grow out and unfold. If the growing tip is injured, the palm may be killed, or severe loss of leaf tissue may cause decreased nut set. Feeding wounds may also serve as an infection pathway for pathogens or other pests. The effects of adult boring may be more severe on younger palm trees where spears are narrower. Mortality of young palms as a result of CRB damage has already been observed on Guam.

The description of the current situation is summarized from a progress report by Moore (2009). The beetle has spread along the northwest coast of Guam with the main infestation from Tumon Bay to Tanguisson Beach, south of NCTS Finegayan, with isolated breeding sites noted at Agana Bay and Uranao. A total of 739 beetles had been trapped as of May 2009. If the beetle is not controlled, it is estimated that half of the coconut palms on Guam could be killed based on experience on other islands. Eradication would require the following: (1) sanitation - the removal of breeding sites, (2) trapping adults, and (3) prophylactic tree treatment.

Tinangaja

Invasive animal species are not the only threat to Guam's native flora. Tinangaja, a virus affecting coconut palms, was first observed on the island in 1917 when copra (dried white flesh of coconut) production was still a major part of Guam's economy. Though coconut plantations no longer exist on the island, the dead and infected trees that have resulted from the epidemic are seen throughout the forests of Guam (Burdick et al. 2008).

Also during the past century, the dense forests of northern Guam have been largely replaced by thick tangantangan brush (*Leucaena* - native to the Americas). Most of Guam's foliage was lost during WWII, and in 1947, the U.S. military introduced tangantangan by seeding the island from the air to prevent erosion. In southern Guam, non-native grass species also dominate much of the landscape.

Fadang Tree – Alien Insects Species

Guam's fadang tree (*Cycas micronesica*) population is currently threatened by alien species that feed on its leaves. This tree has been growing in the Mariana Islands for thousands of years and was one of the most common garden plants in Guam homes about 200 years ago (UoG 2009). The UoG has completed the establishment of a conservation planting of Guam's endangered fadang tree on the island of Tinian. The DoD funded the conservation project and provided access to their lands in northern Tinian for implementing the effort to help stave off the ongoing threats to survival of the species.

Coral Reefs

The entire island of Guam is classified as a coastal zone consisting of 20 watersheds. It is surrounded by 116.5 mi (187.5 km) of shoreline divided into three distinct classifications: rocky coastline, sandy beaches, and mangrove mud flats. The rocky coastline classification surrounds the northern end of the island with a few isolated stretches in the south. It is approximately 72.5 mi (116.6 km) in length or 62% of the total shoreline. Sandy beaches are scattered intermittently around the island and comprise 35.9 mi (57.7 km) of shoreline, or 31% of the total. The remaining 8.1 mi (13.0 km) or 7% of the total shoreline are classified as mangrove mud flats and are centered mainly within Apra Harbor and Merizo.

There are also approximately 14.2 mi^2 (367.8 km^2) of coral reefs, 0.55 mi^2 (1.4 km^2) of seagrass beds, 1.43 mi^2 (3.7 km^2) of estuarine systems, and 21.73 mi^2 (56.3 km^2) of marine bays. Shallow fringing coral reefs with outer slopes and margins support live coral colonies surrounding most of Guam. The bordering fringing reefs in the south are broader than in the north. The width of these reefs range from very narrow benches (as narrow as 10 to 20 ft [3.05 to 6.09 m]) on the northeastern coast, to broad reef flats forming the popular recreational and fishing areas in Tumon, Hagatna, Agat, and Asan Bays and on the shore side of Cocos Island Lagoon. These reefs are extremely valuable in terms of marine life, aesthetics, food supply, recreation, and protection of Guam's highly erodible shorelines from storm waves, currents, and tsunamis. Two large barrier reef systems occur at Cocos Island Lagoon and at Apra Harbor. Cocos Island Lagoon and its reefs form an atoll-like environment about 4 mi^2 (10.3 km^2) in area, with a greatest lagoon depth of approximately 40 ft (12 m). The uplifted limestone plateau of Orote, Cabras Island and a large artificial breakwater, which was built on a shallow reef platform and adjacent submerged bank, bound the much deeper lagoon of Apra Harbor, with depths over 120 ft (36 m) (Burdick et al. 2008).

Guam's coral reefs are also an important component of Guam's tourism industry. The reefs and the protection that they provide make Guam a popular tourist destination for Asian travelers. According to the Guam Economic Development Authority, the tourism industry accounts for up to 60% of the government's annual revenues and provides more than 20,000 direct and indirect jobs.

In 1997, the Government of Guam established five marine preserves: Tumon Bay, Piti Bomb Holes, Sasa Bay, Achang Reef Flat, and Pati Point. They were established as a response to decreasing reef fish stocks, but fishing restrictions were not fully enforced until 2001. Fishing activity is restricted in the marine preserves with limited cultural take permitted in three of the five areas. While management practices are enforced in the five marine preserves, there is currently limited management and enforcement in the other areas.

The health of Guam's coral reefs varies considerably depending on a variety of factors including geology, human population density, level of coastal development, level and types of uses of marine resources, oceanic circulation patterns, and frequency of natural disturbances, such as typhoons and earthquakes (Burdick et al. 2008). Many of Guam's reefs have declined in health over the past 40 years. The average live coral cover was approximately 50% in the 1960s (Randall 1971 in Porter et al), but dwindled to less than 25% live coral cover by the 1990s with only a few reefs having over 50% live cover (Birkeland, 1997 in Porter et al.). In the past, however, Guam's reefs have recovered after drastic declines. For example, an outbreak of the crown-of-thorns starfish in the early 1970s reduced coral cover in some areas from 50-60% to less than 1%. Twelve years later, live coral cover was restored to pre-1970s conditions (Colgan 1987 in Porter et al.).

In the *State of the Coral Reef Ecosystem on Guam*, Porter et al. evaluated a number of environmental and anthropogenic stressors on the reef ecosystem on Guam including:

- climate change and coral bleaching,
- disease,
- tropical storms,
- coastal development and runoff,
- coastal pollution,
- tourism and recreation,
- fishing,
- trade in coral and live reef species,
- ships, boats, and groundings,
- marine debris,
- aquatic invasive species,
- security training activities, and
- offshore oil and gas exploration.

The conclusion of this *State of the Coral Reef Ecosystem* assessment was that the health of Guam's coral reefs varies significantly. Reefs unaffected by sediment and nutrient loading, such as those in the northern part of the island and in between river outflows in the south, have healthy coral communities. Guam's reefs have been spared from large-scale bleaching events and coral diseases which are prevalent in so many parts of the world. Unfortunately, a number of Guam's reefs are impacted by land-based sources of pollution and heavy fishing pressure. Land-based sources of pollution on Guam were the number one priority focus area in 2002. Sedimentation, algal overgrowth due to decreased fish stocks, and low recruitment rates of both corals and fish continue to be important issues that must also be addressed.

1.3.3.2 Key Anthropogenic Events Affecting the Ecology of Guam

Historical events, most notably WWII, have dramatically altered the ecology of Guam. A brief summary of key historical events follows.

The U.S. Navy continued to use Guam as a refueling and communication station until 1941, when it fell to invading Japanese forces shortly after the attack on Pearl Harbor, Hawaii. The Japanese military occupation of Guam lasted from 1941 to 1944 and was a brutal experience for the Chamorro people, whose loyalty to the U.S. became a point of contention with the Japanese. All surviving American military personnel and civilians were evacuated to internment camps in Japan. Several American servicemen remained on the island and were hidden by the Chamorro people.

After weeks of pre-invasion bombardment by the U.S. Navy, the Battle of Guam began on July 21, 1944 with American troops landing on the western side of the island. After several more weeks of heavy fighting, the Japanese forces officially surrendered on August 10, 1944. Guam's two largest pre-war communities (Sumay and Hagatna) of central Guam were virtually destroyed during the Battle of Guam. Many Chamorro families were forced to live in temporary re-settlement camps near the American invasion beaches before moving to permanent homes constructed in the island's outer villages. Guam's southern villages largely escaped damage.

Guam was subsequently converted into a forward operations base for the U.S. Navy and the Army Air Force. Airfields were constructed in the northern part of the island (including Andersen AFB), the island's pre-WWII Naval Station was expanded, and numerous facilities and supply depots were constructed throughout the island.

In 1947, following the devastation of the war, a shrubby tree called tangantangan (*Leucaena*) was seeded from aircraft to protect the land from erosion. It now grows in impenetrable thickets over much of the north of the island, preventing erosion and supplying some fuel wood, but having forever altered native ecosystems (Holmes III 2001).

Other direct anthropogenic disturbances include deliberate damage to the marine environment by the human population on Guam, including military personnel; examples include destructive fishing methods such as dynamite fishing and the deliberate collection of corals and live rock for aquarium use.

1.4 HISTORICAL PERSPECTIVE - TINIAN

Historically, there have been a number of events – both naturally occurring and the results of man's actions – that have resulted in significant impacts to the environment of Tinian. This section is a brief overview of Tinian and the events and occurrences that have shaped its history as well as altered the ecology of the island.

1.4.1 Location and Brief History

Tinian is about 5 mi (8 km) southwest of Saipan, and is separated from it by the Saipan Channel. Tinian has a land area of 39 mi^2 (101.01 km^2). One of the four constituent municipalities of the Northern Marianas, the Tinian municipality consists of Tinian, Saipan, and the uninhabited island of Aguijan (2.74 mi^2, or 7.09 km^2). The total area of the municipality is 41.74 mi^2 (108.1 km^2).

Tinian is about the same size and shape as Manhattan (New York City), and when U.S. forces occupied it during WWII, they laid out a system of roads with the same general plan and orientation as Manhattan. The main north-south road was named Broadway, and it runs parallel to the other main north-south road named 8th Avenue. Tinian, one of the of the three principal CNMI islands, is perhaps best known for being the location from which the American atomic bomb attacks on Japan during WWII were launched. During the war, six airstrips were constructed on Tinian and two more on Saipan to accommodate the U.S. B-29 aircrafts (NCDC 2003).

1.4.2 Tinian Today

Tinian has a small resident population and therefore relies heavily on tourism. San Jose is Tinian's largest village. Tourism facilities on the island include the Dynasty Hotel (a luxury hotel and casino with shops, restaurants, etc.) as well as several other smaller hotels, restaurants and bars. Tinian's commuter airport is served by two airlines, Freedom Air, and Star Marianas Air, which operate daily scheduled flights and charter flights, respectively. There is also daily ferry boat service between Tinian and Saipan (Pacific Wrecks 2009).

1.4.3 Historical Events and Occurrences Affecting the Ecology of Tinian

1.4.3.1 Key Natural Events

Earthquakes

Tinian is located on the Mariana Ridge, a volcanic arc approximately 1 mi (1.6 km) west of the Mariana Trench. This ridge was formed as a result of subduction of the Pacific Plate under the Philippine Plate. Due to movement of these lithospheric plates, Tinian is vulnerable to earthquakes.

Volcanoes

Tinian is not volcanically active (Neill and Rea 2004). However, due to its proximity to Anatahan, vog ("volcanic" and "smog") does occasionally affect Tinian as described for Guam.

Typhoons

The CNMI is in what is known as weather condition *four* at all times, which means that 40-mph winds are possible within 72 hours. These cyclonic disturbances can quickly and unexpectedly develop into typhoon force winds of 120 mph or greater. The frequency of typhoons affecting Tinian is the same as for Guam.

The Super Typhoon Pongsona that struck Guam on December 8, 2002 also struck Tinian with sustained winds of 78 mph and gusts up to 85 mph. The combination of winds and other effects from the typhoon destroyed 114 houses, severely damaged 154 homes, and caused minor damage to 306 homes; about 200 families were left homeless on Tinian. The typhoon produced a storm surge of 22 ft (6 m) at Songsong Village (FEMA 2003b).The winds damaged power lines causing two island-wide power outages. Major crop damage was reported (Kelly 2003).

Species of Interest

Tinian Monarch

The Tinian monarch, or "Chuchurican Tinian" in the Chamorro language, is a small forest bird found only on the island of Tinian in the CNMI. This small, six-inch bird is a member of the monarch flycatcher family. It has a light reddish chest and neck, olive brown back, dark brown wings and tail, white wing bars, white rump, and a white-tipped tail. Tinian monarchs forage and breed throughout the entire island in both the non-native tangantangan forests and the native limestone forests.

The Tinian monarch was originally listed as an endangered species on June 2, 1970, because the population was extremely small. The primary threat to the species was habitat loss. This resulted from forest clear-cutting prior to WWII for cattle grazing and sugarcane farming and from extensive construction during the war. The monarch began to thrive as soon as tangantangan forests grew back, replacing the native forests. A survey of the monarch population in 1982 showed that approximately 37,000 birds inhabited the island, and the species was subsequently reclassified to threatened status. A survey conducted in 1996 indicated that the population had increased to approximately 56,000 birds.

Because populations of the Tinian monarch have rebounded and habitat loss is no longer a threat, the USFWS removed Endangered Species Act (ESA) protections for this forest bird in 2004. Because of the threat of the BTS becoming established on Tinian, the USFWS will continue to monitor the status of the species for at least five years (Foote 2004).

Fadang Tree

The UoG completed the establishment of a conservation planting of Guam's endangered fadang tree on the island of Tinian. The DoD had funded the entire project and provided access to their lands in northern

Tinian for implementing the effort to help stave off the ongoing threats to survival of the species. The fadang tree is called *Cycas micronesica* by scientists, and belongs to a unique group of plants called cycads. It has grown for thousands of years in the forests on Guam and Rota with no real threats (UOG 2009), but two exotic insect species have recently invaded Guam and Rota, and their voracious appetite for fadang trees has pushed the tree into the endangered status. Fadang is the only plant of its kind in the Mariana Islands, and this extensive planting on Tinian has become a crucial component of the ongoing conservation efforts to save the species.

1.4.3.2 Key Anthropogenic Events Affecting the Ecology of Tinian

WWII and Its Effects on Tinian

The capture of Saipan, Tinian, and Guam in the Central Pacific in mid-1944 was one of the key actions in the Pacific during WWII. Air bases in the Marianas were essential in order to accommodate the new B-29 Superfortress, a U.S. bomber that was just beginning to be mass-produced in early 1944 and had a flying range equal to the distance from the Mariana Islands to Japan and back - about 1,500 mi (2,414 km).

Airfields were constructed on Guam, Saipan and Tinian. The construction of the airfields on Tinian was the largest building activity the U.S. Naval Construction Battalion (Seabees) had ever undertaken up to that time and the largest airport of WWII was on Tinian. Six runways, each 8,500 ft (2590 m) long, were constructed to support the B-29s. Barracks to accommodate 50,000 troops were built on Tinian, and Navy Seabees hauled, blasted and packed down enough coral to fill three times the volume of Boulder Dam - nearly 112 million cubic yards of fill (Global Security 2005).

Prior to WWII, Tinian was a major sugarcane growing and processing center, but the War left only a denuded forest.

Post WWII Utilization of Tinian

The 1976 Covenant (Public Law 94-241) creating the CNMI established jurisdiction of U.S. laws, agencies, and programs; provided for a CNMI Constitution, an elected government and defined self-rule; and granted U.S. citizenship to CNMI residents. The Covenant also brought to the CNMI substantial and extended financial support from the U.S. A major portion of this financial support came in the form of payments made to the CNMI for the leasing of about two-thirds of the island of Tinian. In 1983, a lease agreement covering these lands was signed, and DoD assumed control and possession over the northern two-thirds of Tinian. The lease agreement is for 50 years, with a renewal option for an additional 50 years.

Under the terms of the lease agreement, none of leased lands may be privately-owned, nor are any CNMI residents allowed to live or develop property there. Essentially, the DoD controls all land uses within the leased area. Any non-military uses within the leased area must be approved by the DoD. Presently, the U.S. military uses major portions of the leased land area for training exercises.

The 16,100 ac (6,515.4 ha) leased area is known as the Military Lease Area (MLA) and is divided into two sections. The northern half is the Exclusive Military Use Area (EMUA) and the southern half is referred to as the Leaseback Area (LBA). North Field and the national historic landmark are located within the EMUA. The EMUA is used for periodic military training exercises. It is open to the public for recreational purposes when it is not being used for military training. DoD uses of the EMUA include both large and small field exercises. Marine units hold large-scale amphibious assaults and joint training exercises within the EMUA, utilizing its beaches as entry points to inland areas for maneuvers and for landing fixed-wing aircraft and helicopters. The DoD uses abandoned buildings, some of which are historically related to WWII and North Field within the EMUA, for urban warfare practice. The roads that

connect the training area with Tinian's commercial harbor and airport to the south are used by the DoD during training exercises.

The LBA is a joint use area, where both military and non-military activities may take place. The LBA has been leased back to the CNMI for uses that are compatible with long-term DoD needs, primarily grazing and crop production.

The MLA remains largely undeveloped, with no permanent military installations or staffed facilities. At the present time, there are no major construction projects planned for the MLA. None of the roads are fenced or gated, and public access to North Field during non-maneuver times is not restricted.