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Cost–Benefit Analysis of Marine Corps Search and Rescue (SAR): A Study of Alternatives for Marine Corps Air Stations at Cherry Point and Yuma

21 November 2013

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Abstract

Local base search and rescue (SAR) units were established to provide support for military operations. Civilian communities have also benefited from SAR units, often utilizing the Marine Corps' SAR capabilities to support local requests. However, SAR is not a core competency of the Marine Corps or a function of Marine aviation.

The current fiscal climate demands that the Marine Corps seek ways to achieve cost savings while maintaining its core competencies. The divestiture of functions that do not support the Corps' execution of its Title 10 responsibilities is a possible solution. Local base SAR units bear significant operations and support costs. Moreover, the Marine Corps faces additional modernization costs because of the age of its SAR aircraft. At the same time, the commercial helicopter industry has increased its ability to provide capable SAR services around the globe.

Our research provides a current analysis of SAR costs to the Marine Corps and presents a cost projection for a 10-year time horizon. Our research also conducts an analysis of outsourcing; the main findings of our analysis show that the Marine Corps can achieve annual savings of approximately $14 million (FY 2014) through the use of commercially contracted SAR services at Marine Corps Air Station (MCAS) Cherry Point and MCAS Yuma.

Keywords: Search and Rescue, SAR, Cost Benefit Analysis, Cost Effectiveness Analysis, Marine Corps Aviation, Analysis of Alternatives, UH-1Y Helicopter, Commercial Outsourcing

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Major Clint Collins graduated from Benedictine College in Atchison, KS, in 1996 with a degree in biology. After graduation, he enlisted in the Marine Corps and served as a helicopter mechanic for HMH-465 before being accepted into the Enlisted Commissioning Program (ECP). In December 2000, he was commissioned as a 2ndLT. In April 2002, he completed flight training at Naval Air Station Pensacola, FL, and was winged as a naval aviator. Maj Collins served as a CH-53D pilot with Marine Air Group 24 (MAG-24) MCAS Kaneohe Bay, HI, at both HMH-362 and HMH-363. During his time at MAG-24, Maj Collins deployed to Iwakuni, Japan, in 2003; Okinawa, Japan, in 2005 in support of the 31st ME; Iraq in 2007; and Afghanistan in 2010. In addition, Maj Collins completed resident Expeditionary Warfare School in Quantico, VA, in 2009. After graduation, Maj Collins will report to MARCORSYSCOM in Quantico, VA, where he will work for the command's Cost and Analysis Branch.

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List of Acronyms and Abbreviations

AFB	Air Force Base
AP	Aviation Procurement
APP	Aviation Plans and Policies
APUC	Average Procurement Unit Cost
AVPLAN	Aviation Plan
BHL	Bristow Helicopters Limited
BOM	Bill of Materials
CAP	Civil Air Patrol
CBA	Cost–Benefit Analysis
CEA	Cost-Effectiveness Analysis
CES	Cost-Element Structure
CHC	Canadian Holdings Company
CNA	Center for Naval Analyses
CPH	Cost Per Flight Hour
DCA	Deputy Commandant for Marine Aviation
DCMA	Defense Contract Management Agency
DHS	Department of Homeland Security
DAMIR	Defense Acquisition Management Information Retrieval
DoD	Department of Defense
DoN	Department of the Navy
DOT	Department of Transportation
DFT	Department for Transportation
FAA	Federal Aviation Administration
FFP	Firm Fixed Price
FEMA	Federal Emergency Management Agency
FOC	Full Operational Capability
FRS	Fleet Replacement Squadron
FY	Fiscal Year

GCE	Ground Combat Element
H&HS	Headquarters and Headquarters Squadron
HAZMAT	Hazardous Materials
HMH	Marine Heavy Helicopter Squadron
HQMC	Headquarters, United States Marine Corps
Kts	Knots
I-level	Intermediate Level
JIC	Joint Inflation Calculator
LCC	Life-Cycle Cost
LCE	Logistics Combat Element
MAD	Mean Absolute Deviation
MAGTF	Marine Air–Ground Task Force
MAGTFTC	Marine Corps Air–Ground Task Force Training Center
MATS	Marine Aviation Transition Strategy
MCAGCC	Marine Corps Air–Ground Combat Center
MAPE	Mean Absolute Percentage Error
MAWTS	Marine Aviation Weapons and Tactics Squadron
MCAS	Marine Corps Air Station
MCWP	Marine Corps Warfighting Publication
MDAP	Major Defense Acquisitions Program
MEDEVAC	Medical Evacuation
MILCON	Military Construction
MILPERS	Military Personnel
MSE	Mean Squared Errors
MSHARP	Marine Corps Sierra Hotel Aviation Readiness Program
NAS	Naval Air Station
NATOPS	Naval Aviation Training and Operating Procedures Standardization
NAVAIR	Naval Aviation Systems Command
NCCA	Naval Center for Cost Analysis
NPS	Naval Postgraduate School

NPV	Net Present Value
O&M	Operations and Maintenance
O&S	Operations and Support
O-level	Operational Level
OMB	Office of Management and Budget
OPNAV	Naval Operations Instruction
OSA	Operational Support Aircraft
OSVAT	Operations and Support Visual Analysis Tool
PHi	Petroleum Helicopters Incorporated
PV	Present Value
R&D	Research and Development
RAF	Royal Air Force
RCC	Rescue Coordination Center
RDT&E	Research, Development, Testing, and Evaluation
RFP	Request for Proposal
ROM	Rough Order of Magnitude
RQS	Rescue Squadron
SAR	Search and Rescue
SRR	Search and Rescue Region
SRU	Search and Rescue Unit
T/O	Table of Organization
TAD	Temporary Additional Duty
TMR	Total Mission Requirement
T/M/S	Type/Model/Series
TRWG	Thesis Research Working Group
TO&E	Table of Organization and Equipment
TY	Then Year
UK	United Kingdom
USAF	United States Air Force
USCG	United States Coast Guard

USMC	United States Marine Corps
VAMOSC	Visibility and Management of Operations and Support Costs
VIP	Very Important Person
VMR-1	Marine Transport Squadron 1

I. OVERVIEW

> Search and rescue: "The use of aircraft, surface craft, submarines, and specialized rescue teams and equipment to search for and rescue distressed persons on land or at sea in a permissive environment. Also called SAR" ("Search and Rescue," 2010).

A. INTRODUCTION

Search and rescue (SAR) operations provide enormous value to both military and civilian agencies, yet these services come with significant costs. Obtaining the most efficient use of Marine Corps resources in an environment where cost savings have become increasingly important, while maintaining a commitment to support hazardous training operations, requires a thorough analysis of current and alternative SAR methods.

The value of local base SAR operations to the USMC stems from the number of lives saved because of decreased exposure time to hazardous conditions and the ability of SAR personnel to administer medical attention to wounded persons. Additionally, local base SAR units have added value to the overall National SAR Plan, providing support to local civilian municipalities. As a result, lives of both uniformed service members and civilians have been saved. These actions have enabled the retention of knowledge and skill within the Marine Corps and have generated goodwill within the communities where Marines serve. The value of SAR operations is illustrated by the following examples.

On March 29, 2011, a Marine CH-53D helicopter carrying four aircrew from HMH-363 took off from Marine Corps Base Kaneohe Bay on a training mission. Within four minutes of takeoff, the aircrew experienced a catastrophic mechanical failure. Unable to return to shore, the pilot-in-command made a mayday call. Seconds later, the CH-53D crashed into a sand bar in shallow water about a mile off shore. The crash killed one Marine and injured three others. The recovery effort consisted of rescue aircraft from the Coast Guard and the Honolulu Fire Department, which combined efforts to recover and transport the aircrew to emergency vehicles located nearby (Kakesako & Shikina, 2011). As a result of the quick response from local rescue crews, the lives of three Marines were saved.

Equally impressive was the emergency transport of a civilian by Marine Corps SAR assets two years later. On July 14, 2013, a woman experienced a cardiac arrest while aboard the cruise ship *Norwegian Gem* off the coast of Morehead City, NC. Cruise ship personnel requested immediate assistance to transport the patient back to shore and enable her to receive medical attention. Within minutes, locally based search and rescue (SAR) Marines from Marine Corps Air Station (MCAS)

Cherry Point responded in the HH-46E "Pedro" helicopter. Using a hoist and litter, rescue personnel recovered the patient and her husband, and flew them to the Carolina East Medical Center, where she received medical attention (Roberts, 2013, p. A3). This is one of numerous examples of military support to the National Search and Rescue Plan of the United States (hereafter National SAR Plan, 2007; United States Coast Guard [USCG], 2007) that demonstrates how effective interagency cooperation can enable the preservation of life. Both the rescue of the woman on the cruise ship and the rescue of the Marine helicopter crew illustrate the value of SAR operations. Additionally, these cases bring attention to the fact that while search and rescue operations take place under difficult circumstances, SAR responses often involve multiple agencies coordinating available assets to accomplish the task of saving lives.

This thesis seeks to determine a more efficient way for the Marine Corps to carry out SAR operations. To this end, we employ several cost-estimating techniques such as learning curve theory, forecasting, and analogous methods based on historical data to derive the expected future costs of possible alternatives which are then normalized. Finally, we present a comparison of these alternatives and answer our research questions regarding the most cost-effective means.

B. BACKGROUND

The purpose of the National SAR Plan of the United States is to establish "the effective use of all available resources in all types of civil SAR missions to enable the United States to satisfy its humanitarian and national and international legal obligations" (USCG, 2007, p. 1). The National SAR Plan (USCG, 2007) establishes the framework and sets "the policy … for coordinating search and rescue services to meet domestic needs" (p. 1). The Department of Defense (DoD) is a participant of and signatory on the National SAR Plan, along with the Federal Aviation Administration (FAA), the Department of Homeland Security (DHS), the Department of Transportation (DOT), and various other government entities. These agencies work in concert to achieve greater efficiency and meet the nation's domestic SAR needs.

Under the plan, the DHS has the primary obligation of carrying out "responsibilities to protect against and respond to hazards and distress situations affecting the nation and its people" (USCG, 2007, p. 4). The DHS has two resources that enable it to accomplish this task: the Coast Guard and the Federal Emergency Management Agency (FEMA). The Coast Guard is the primary means by which the department "establishes, maintains and operates civil SAR resources for the promotion of safety on, under and over international waters and waters subject to United States jurisdiction" (USCG, 2007, p. 4). Furthermore, the Coast Guard serves as the SAR coordinator for the maritime environment of the United States (USCG, 2007, p. 7). FEMA, on the other hand, is tasked with coordinating the response between government agencies and conducting the oversight responsibilities of the interagency system and its ability to respond to SAR events. As such, the DHS serves as the cornerstone of the nations' SAR network.

In order to meet its obligation to provide national defense, the DoD maintains tremendous capabilities and resources. The National SAR Plan (USCG, 2007) leverages DoD capabilities to maximize the efficiency of government resources in support of its objectives. However, the plan recognizes the paramount nature of the DoD's mission to maintain national security by stating that DoD "resources may be used for civil SAR needs to the fullest extent practicable on a non-interference basis with primary military duties" (USCG, 2007, p. 4). One caveat to this overarching guidance is that the United States Air Force "provides and uses resources for the efficient organization and coordination of civil SAR operations, within its assigned SRR [search and rescue region]" (USCG, 2007, p. 5). Moreover, the Air Force serves as the SAR coordinator for the continental United States (USCG, 2007, p. 7). To meet its obligations, the Air Force relies on its organic assets to provide specialized SAR capability and extensive use of the civil air patrol (CAP) to cover large geographic regions in the fulfillment of its mission (National Search and Rescue Committee, 2000, p. 2-6).

As SAR coordinators, both the Coast Guard and the Air Force have "overall responsibility for establishing and providing civil SAR services for a U.S. SRR" (National Search and Rescue Committee, 2000, p. 1-4). SAR coordinators are also responsible for establishing Rescue Coordination Centers (RCCs) to support SAR missions as required (USCG, 2007, p. 6). Military operations are specifically not included under the National SAR Plan, but each service is still responsible to provide its own SAR for military operations (USCG, 2007, p. 11). Non-military participants, like state and local police and fire departments, are mandated to cooperate with RCC requests, mutually support other search and rescue regions (SRRs), and pool resources to support SAR missions as requested (USCG, 2007, p. 12). The responsibility of responding to emergencies over such large distances across many diverse environments is a challenging task. As a result, the helicopter has become the primary mode of execution for many SAR missions because of its speed and ability to access remote locations relatively quickly.

The Marine Corps has historically retained its own local base SAR to support its high-risk training. However, because of the service's relatively low demand for SAR, the increasing costs associated with maintaining dedicated SAR assets, and the increasingly redundant capabilities associated with the availability of adjacent federal government agencies and local municipalities, the Marine Corps has sought to divest its organic SAR capabilities in ways that will achieve financial savings while allowing the Corps to maintain its commitment to service members and local communities. As a result, the Marine Corps has deactivated three local base SAR units since 1998. The SAR unit at MCAS Miramar was deactivated in 1998; SAR service there is now provided by the Coast Guard, Navy, and San Diego County Sheriff. The SAR unit located at MCAS Iwakuni was deactivated in 2002. According to message traffic from Headquarters Marine Corps, dated August 27, 2001, local base SAR at Iwakuni was deactivated because of the availability of redundant host nation capabilities. MCAS Beaufort followed in 2005, shifting SAR service responsibilities to nearby Coast Guard stations at Charleston and Savannah (Thompson, 2013). In all three instances, other government assets were deemed capable of accomplishing the SAR mission with minor degradations to service, which were accepted in lieu of low demand for SAR, and the exorbitant operations and support (O&S) and modernization (or procurement) costs associated with maintaining the local base SAR units.

Although the number of Marine Corps SAR assets has decreased over the past two decades, there has been a large increase in the number and capability of other government SAR assets and of commercial helicopter service providers. Today, competitors in the global helicopter industry compete for regional and national contracts to provide SAR service to state and national parks, ocean-based gas and oil platforms, and local municipalities. Companies in the commercial helicopter industry, such as Bristow, Petroleum Helicopters Incorporated (PHi), Cougar, Canadian Holdings Company (CHC), and Evergreen now have the capability to provide high-end SAR services (such as hoist and over-water rescue capability) that previously were only to be carried out by government agencies with special training. Because private companies can often provide these services at a lower cost than the Marine Corps, a shift may be possible that will enable the Marine Corps to reduce its costs and reallocate manpower while maintaining its commitment to rescue downed aircrew and injured Marines in remote locations. In its submission to the House of Commons Finance Committee in 2011, CHC posited the following:

> As a general rule, outsourced SAR services are delivered with a more efficient manpower model offering significant savings to the government. As an example, Ireland's helicopter SAR service, which consists of four helicopter bases, has a total of 110 staff. This team provides robust, 24-hour coverage for the country. (Nagel, 2011, p. 4)

C. MARINE CORPS SEARCH AND RESCUE UNITS

Cherry Point and Yuma are the only two Marine Corps Air Stations that continue to maintain local base SAR units. These units are unique in that they do not support combat missions or Marine Corps deployment operations, but are entirely dedicated to the SAR mission at their respective installations. As a result, these units have been designed to meet this specific purpose. The units' aircraft have been modified to meet SAR requirements in accordance with Naval Operations Instruction 3710.7U (Department of the Navy [DoN], 2009), and aircrew training has been altered to reflect its unique assignment.

MCAS Cherry Point was commissioned in 1942, and today encompasses 29,000 acres on the North Carolina coast. The air station is home to the 2nd Marine Aircraft Wing, which includes thousands of Marines, sailors, and civilian personnel and various tactical aircraft, including the AV-8B Harrier, the KC-130 Hercules, and the EA-6B Prowler (United States Marine Corps [USMC], 2013a). It is also home to Marine Transport Squadron 1 (VMR-1). Flying Pedro, the HH-46E SAR helicopter, VMR-1 "provides Search and Rescue support to MCAS Cherry Point based aircraft" (USMC, 2013c). The HH-46E is based on the CH-46E Sea Knight airframe. Table 1 provides some of the basic performance characteristics of the CH-46E aircraft. Figure 1 shows VMR-1 conducting rescue training in the event that an over-water rescue is required.

Table 1. CH-46E Performance Capabilities
(Boeing, 2013)

CH-46E	"Sea Knight"
Function	Assault Support
Prime Contractor	Boeing
Crew	4
Speed	Maximum 145 knots
Range	365 nautical miles
Useful Load	8,763 lbs / 15 litters

Figure 1. Photograph of VMR-1 Conducting Training Mission With HH-46E
(Colon, 2010)

According to the unit's table of organization (T/O), the unit is composed of as many as 190 Marines and maintains a 24-hour SAR capability while also supporting the mission of the UC-35B and C-9B operational support aircraft (OSA; USMC, 2013c). The majority of aircrew within the squadron is qualified to fly on both SAR and OSA aircraft. Maintenance Marines are also dual-qualified to work on the HH-46E and the C9B; however, maintenance for the UC-35B is accomplished by means of a commercial contract with M7 Aerospace, LP (A. Smith, personal communication, July 16, 2013). See Appendix C for the unit T/O.

The SAR capability at MCAS Cherry Point currently provides local commanders with the ability to reduce the response time of SAR to USMC assets operating in the tactical training areas surrounding Cherry Point. The Coast Guard maintains HH-60 helicopters at Elizabeth City, NC, and HH-65 helicopters at Charleston, SC; however, the increased distance of each location to Marine Corps training areas results in a significant response delay and reduced on-station time. Because of this and the potential exposure risk to aircrew associated with cold Atlantic Ocean water temperatures, local base SAR at MCAS Cherry Point has been retained (Headquarters, United States Marine Corps [HQMC], 1994). Helicopters from Elizabeth City require approximately 45 minutes more to transit to areas in the W-122 when compared to helicopters based at MCAS Cherry Point. Figure 2 depicts the distances of these local SAR assets to Marine Corps aviation training areas located adjacent to MCAS Cherry Point.

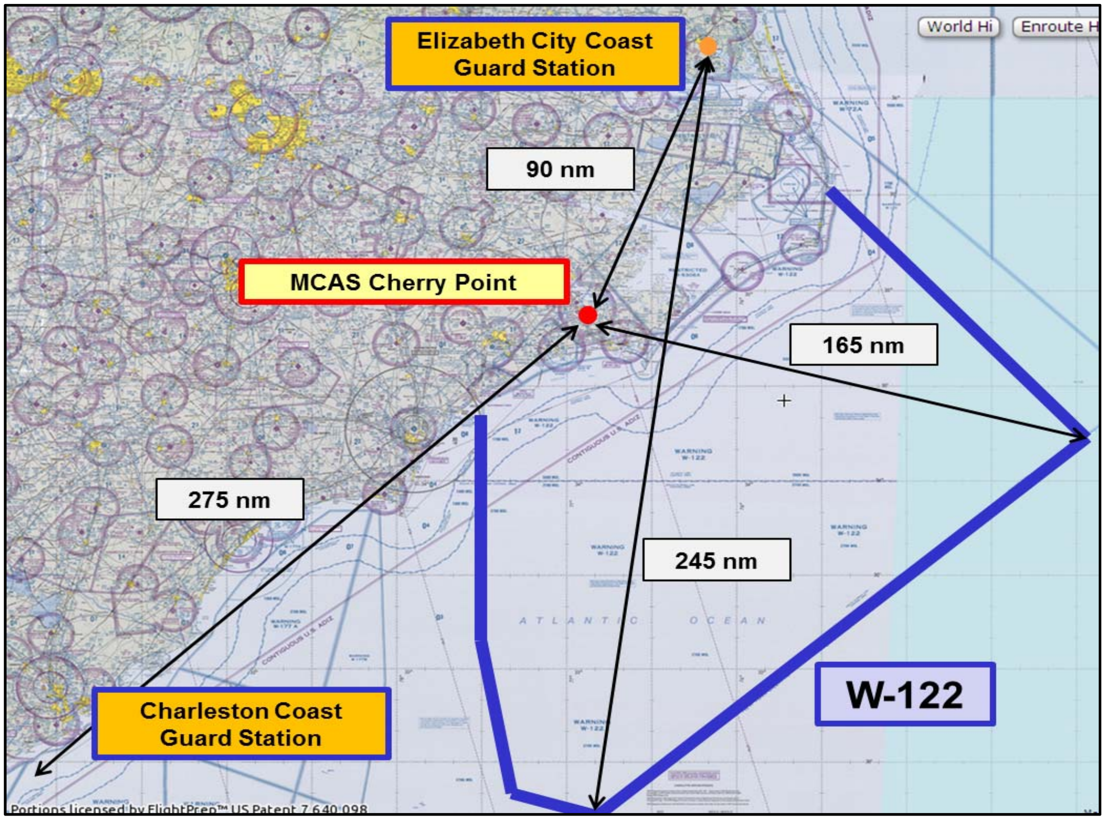

Figure 2. Map of Cherry Point Training Areas and Distances From SAR Assets

Located near the geographic junction of Arizona, California, and Mexico, MCAS Yuma began as Fly Field in 1928 and was used sparingly for training until 1941 when it was formally developed as a training air field for WWII pilots. After being shut down for a brief period in the 1950s, it was re-opened and designated a Marine Corps Air Station in 1962. Today, it shares its large runway with Yuma International Airport and supports some of the Marine Corps' best training areas, along with thousands of square miles of adjacent airspace used by Marine aviation for advanced, tactical training. The air station is currently home to Marine Aviation Weapons and Tactics Squadron One (MAWTS-1), Marine Aircraft Group-13 (comprised of multiple AV-8B Harrier squadrons), Marine Wing Support Squadron-371, and Marine Air Control Squadron One. The MCAS Yuma SAR unit (SRU), organized under Headquarters and Headquarters Squadron (H&HS), operates the HH-1N helicopter, with the "primary mission … to provide support for military flight operations within a 100 nautical mile radius of MCAS Yuma" (USMC, 2013b). Table 2 provides some of the basic performance characteristics of the UH-1N. Figure 3 shows the SRU conducting SAR training in Yuma, AZ, utilizing the HH-1N's hoist capability.

Table 2. HH-1N Performance Capabilities
(Naval Air Systems Command [NAVAIR], 2013)

UH-1N	Huey
Function	Utility
Prime Contractor	Bell Helicopter
Crew	4
Speed	Maximum 130 knots
Range	286 nautical miles
Useful Load	3,500 lbs / 2 litters

Figure 3. Photo of H&HS Conducting Training With HH-1N
(Fry, 2010)

According to the T/O, the Yuma SRU is composed of up to 48 Marines (MCAS Yuma, Headquarters and Headquarters Squadron (H&HS), 2013). Many members of the aircrew within the H&HS are qualified to fly on both SAR and OSA aircraft. However, Marines perform maintenance on the HH-1N only; maintenance for the C-12F (OSA aircraft) is accomplished by a commercial contract with Raytheon (C. Danford, personal communication, July 19, 2013). See Appendix C for the unit T/O.

The SRU at MCAS Yuma has also been retained due to the lack of other nearby SAR assets (HQMC, 1994). The San Diego Coast Guard Station and the Air

Force 55th Rescue Squadron (RQS) located at Luke Air Force Base (AFB), which both operate the HH-60 helicopter, and the air ambulance from Marine Corps Air Ground Combat Center, located at Twentynine Palms, CA, all require approximately one additional hour of transit time compared to helicopters based at MCAS Yuma. Figure 4 depicts the distances of each SAR unit to Yuma.

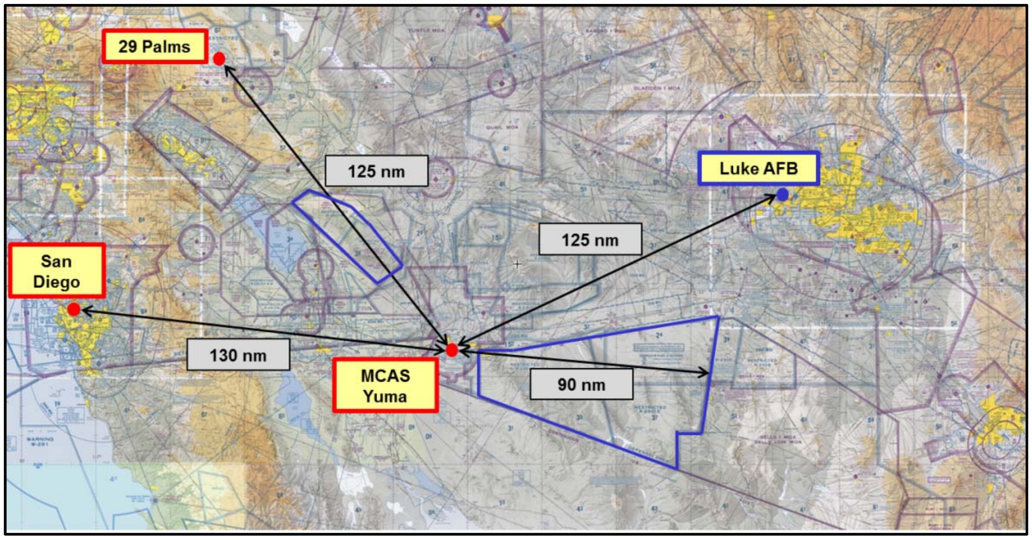

Figure 4. Map of Yuma Training Areas and Distances From SAR Assets

D. MARINE CORPS SEARCH AND RESCUE ACTIVITY

Data on operations from both SAR units was captured via the Marine Sierra Hotel Aviation Readiness Program (MSHARP). "M-SHARP is Marine Aviation's web-based application for scheduling, training management, operational risk management, and reporting of training readiness" (MSHARP, n.d.). Our research used flight mission data from the MSHARP to obtain historical flight information of the HH-1N and HH-46E helicopters by fiscal year beginning in fiscal year (FY) 2008. Because the MSHARP fielding was ongoing throughout the Marine Corps during FY2008, no flight mission data was available for either airframe prior to that time. Data for each fiscal year was downloaded into Microsoft Excel and parsed by unit, airframe, date, flight times, mission type, aircrew, flight hours, launch and recovery bases, and other data for each mission from FY2008 to FY2012. We then sorted missions by total mission requirement (TMR) codes. TMR codes are three-character codes assigned to every mission in naval aviation that denotes a given, general, and specific purpose of a flight (DoN, 2009). See Appendix E for a complete list of TMR codes. TMR codes were grouped into "SAR," "Training," and "Miscellaneous Support" categories and flight hours were aggregated according to those categories over the five-year period from FY2008 to FY2012. Of note, the SAR category included medical evacuation (MEDEVAC) and patient transport, along with missions specifically designated by TMR codes as SAR. SAR mission data was aggregated over a five-year period, and analyzed to determine the percentage of support to both DoD and non-DoD personnel.

1. Yuma

MSHARP data reflected more than 5,000 total flight hours for the HH-1N conducted by SRU from FY2008 to FY2012. Of this, 82% of the hours were training hours, 15% were for miscellaneous support, and 3% were flight hours that supported missions related to SAR. Table 3 shows the breakdown of flight hours for SRU Yuma by mission category. Figure 5 shows the percentage of flight hours flown by SRU Yuma in support each mission requirement.

Table 3. SRU Yuma Flight Hours, 2008–2012

SRU Yuma Flight Hours FY2008–FY2012 by Mission Requirement	
Training	4,134.9
Miscellaneous Support	752.1
SAR	144.6
Total Flight Hours	5,031.6

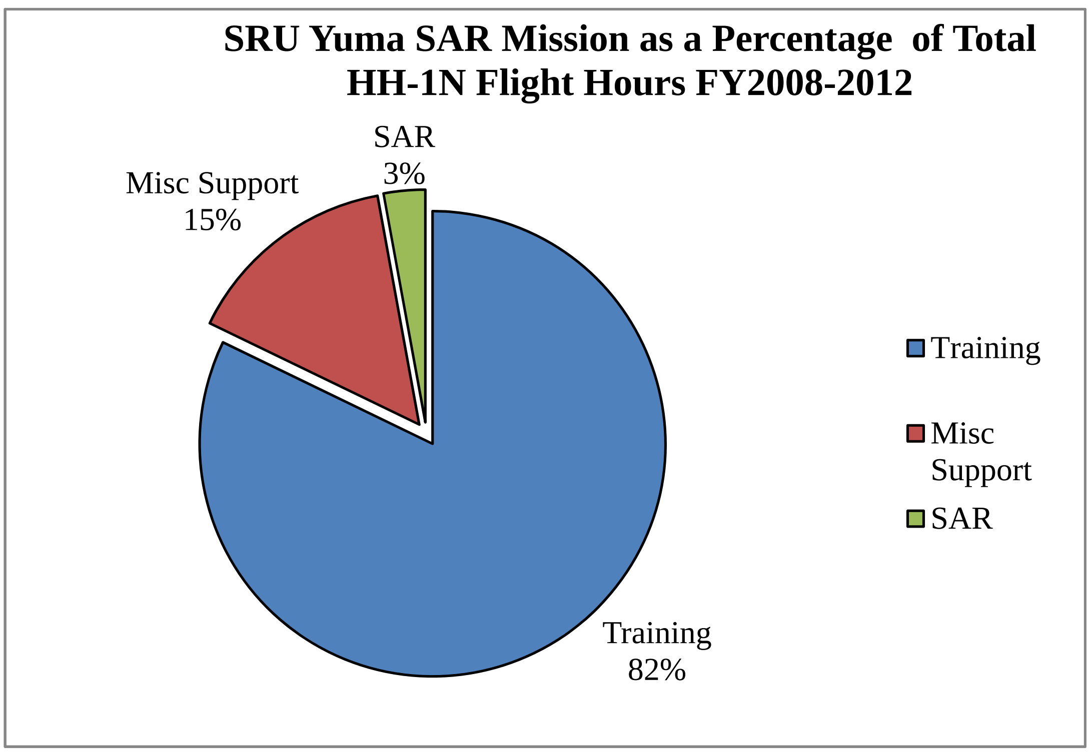

Figure 5. SRU Yuma SAR Mission as a Percentage of Total Flight Hours, 2008–2012

There were a total of 65 SAR missions conducted by the SRU from FY2008 to FY2012; 58% of the SAR missions flown went to support non-DoD personnel, with the remaining 42% used in support of the DoD. Figure 6 shows the amount of support given by SRU Yuma to DoD and non-DoD personnel by year from 2008 to 2012. Figure 7 shows the percentage of support to each over that same period.

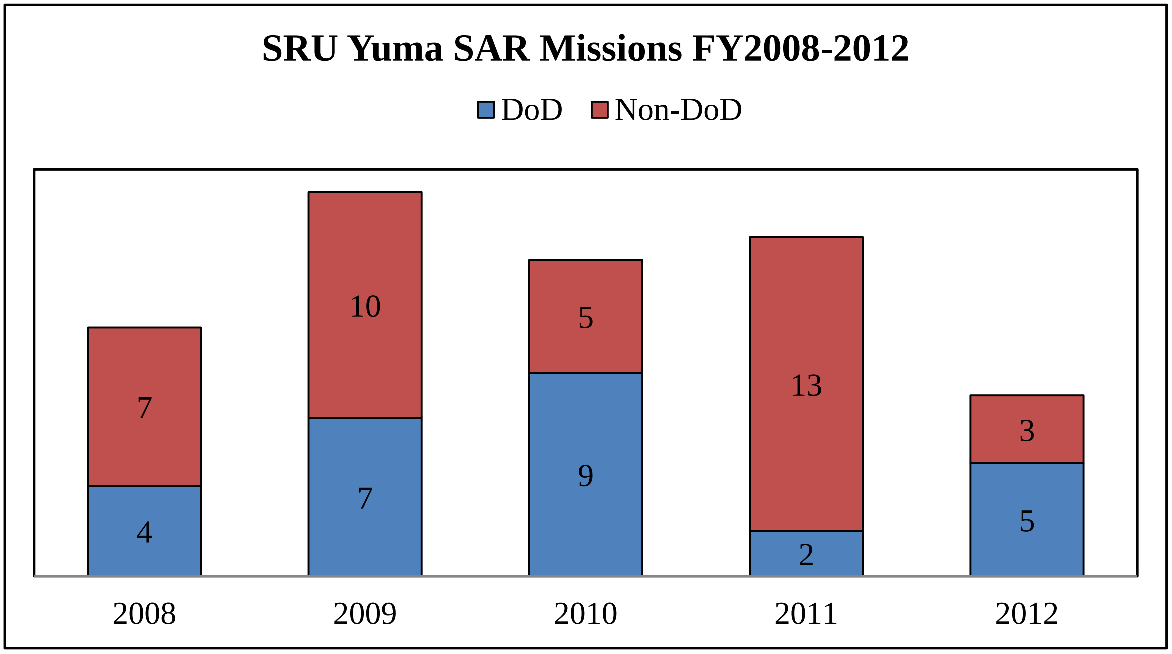

Figure 6. SRU Yuma Number SAR Missions Supporting DoD and Non-DoD Personnel, 2008–2012

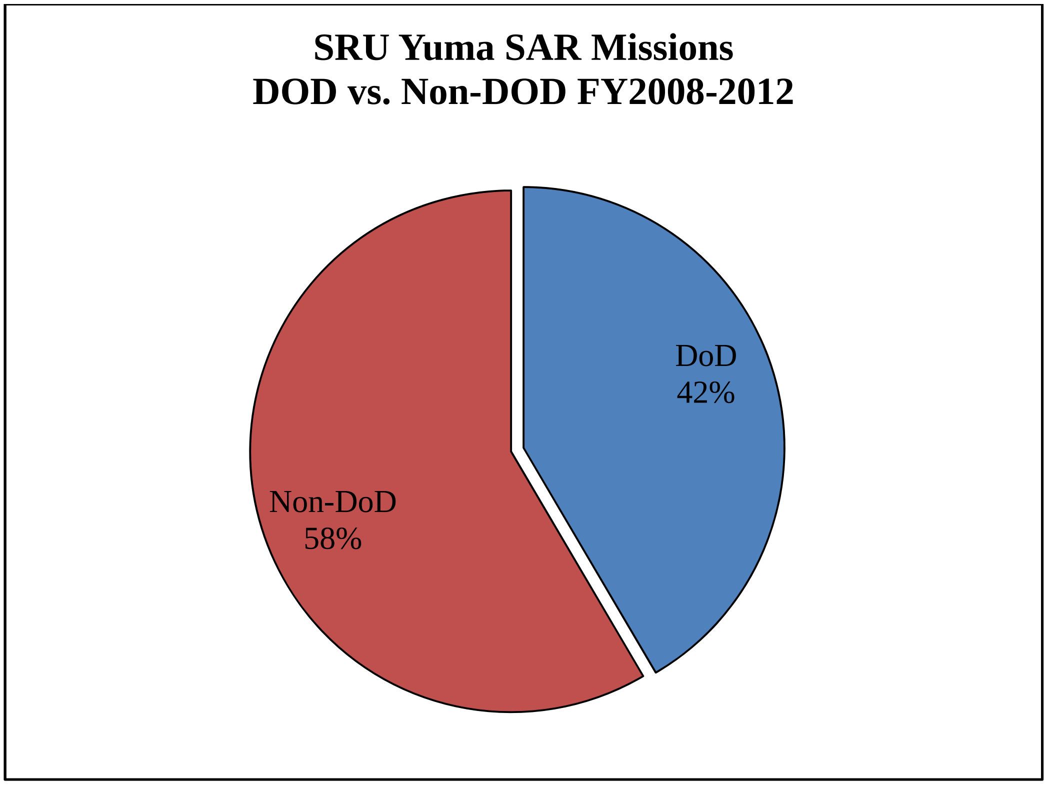

Figure 7. Percentage of SRU Yuma SAR Missions Supporting DoD and Non-DoD Tasking, 2008–2012

2. Cherry Point

MSHARP data reflected more than 4,500 total flight hours for VMR-1's HH-46E aircraft from FY2008 to FY2012. Of this, 69% were training hours, 23% were for miscellaneous support, and 8% of flight hours supported SAR related missions. Table 4 shows the breakdown of flight hours for VMR-1 by mission category. Figure 8 shows the percentage of flight hours flown by VMR-1 in support each mission requirement, and Figure 9 breaks down SAR missions between DoD and non-DoD missions.

Table 4. VMR-1 Flight Hours, 2008–2012

VMR-1 Flight Hours FY2008-FY2012 By Mission Requirement	
Training	3,105.60
Miscellaneous Support	1,034.80
SAR	378.3
Total Flight Hours	4,518.70

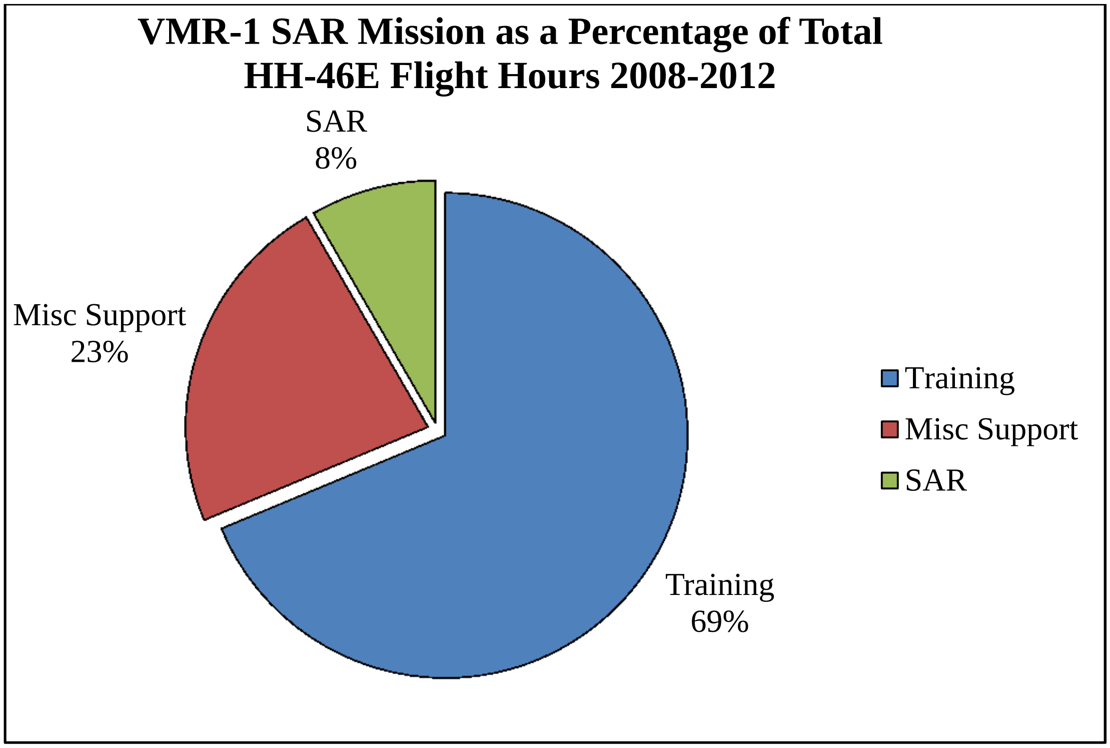

Figure 8. VMR-1 SAR Mission as a Percentage of Total Flight Hours for 2008–2012

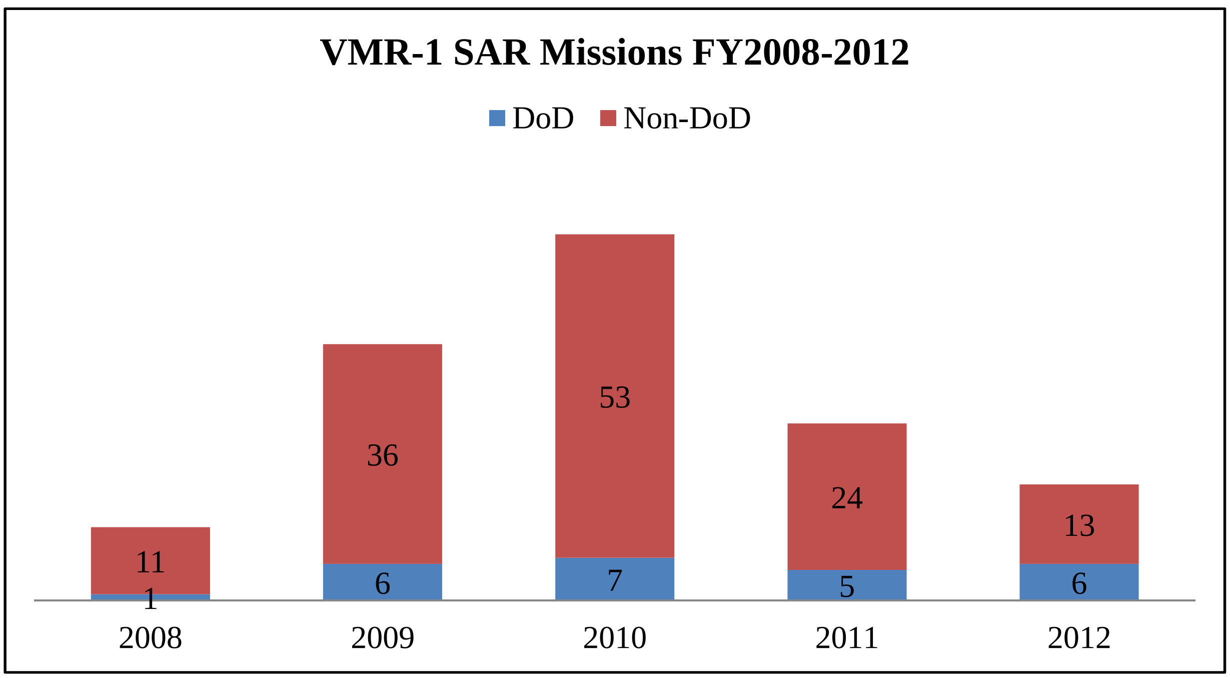

Figure 9. VMR-1 Number SAR Missions Supporting DoD and Non-DoD, 2008–2012.

There were 162 SAR missions conducted by VMR-1 from FY2008 to FY2012; 85% of those missions supported persons outside of the DoD, while only 15% of missions were flown in support of DoD personnel. Figure 10 shows the percentage of support to each group over the 2008–2012 period.

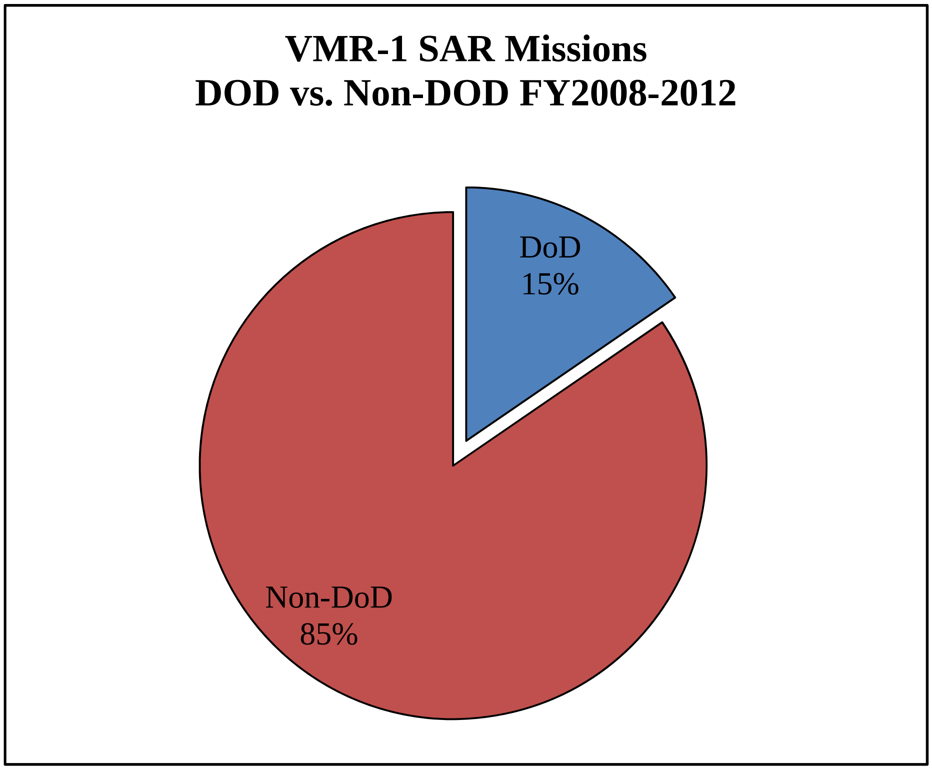

Figure 10. VMR-1 Percentage of SAR Missions Supporting DoD and Non-DoD Tasking, 2008–2012

E. PROBLEM

According to Marine Corps Warfighting Publication 3-2 *Aviation Operations* (HQMC, 2000), the six functions of Marine Aviation are assault support, anti-air warfare, offensive air support, electronic warfare, control of aircraft and missiles, and aerial reconnaissance. These doctrinally mandated functions complement the functions of the ground combat element (GCE) and logistics combat element (LCE) and enable the Marine Air–Ground Task Force (MAGTF) to carry out the execution of its assigned missions. Each function can be subdivided into several categories of doctrinal missions that are organic to Marine Aviation. SAR is not one of these six functions, nor does it exist as a doctrinal mission category within Marine Aviation (HQMC, 2000, pp. 2-1–2-6). Since 2008, however, the Marine Corps has executed nearly 200 SAR missions, rescuing hundreds of military personnel and civilians. This means that the Marine Corps continues to invest resources each year in a capability that is not a core competency. Assuming the Marine Corps will continue to invest in

SAR in order to provide decreased response time for personnel in the event it is needed, is there a more efficient way to do so that would allow the Marine Corps to achieve cost savings and redirect those resources toward its critical warfighting functions or reductions in spending?

Divesture of local base SAR units has been identified in various reports over the past two decades as an option that could produce cost savings for the Marine Corps. With on-going fiscal constraints and the prospect of future budget cuts, the Marine Corps has been seeking to reduce unnecessary spending. At the Marine Corps Thesis Research Group (TRWG) hosted at the Naval Postgraduate School (NPS) in April 2013, representatives from Headquarters Marine Corps, Aviation Plans and Policies (APP-51) presented a research proposal from the Deputy Commandant for Marine Aviation (DCA) to study the costs and alternatives for Marine Corps local base SAR, specifically whether or not a commercially contracted SAR service would be more cost effective than continuing to maintain the SRUs at MCAS Cherry Point and MCAS Yuma.

F. RESEARCH QUESTIONS

Primary Research Question: Would a commercial contract for SAR service at MCAS Cherry Point and MCAS Yuma be a more cost-effective alternative than continuing to maintain local base SRUs at each location?

Secondary Research Questions: What are the estimated future costs of SRUs at MCAS Cherry Point and MCAS Yuma? What is the estimated future cost associated with a contract for Marine Corps local base SAR service?

G. ORGANIZATION OF STUDY

In Chapter II, we review the most relevant and current studies that address the costs of SAR service for the DoN.

In Chapter III, we discuss the methodology used in our analysis, provide an overview of the steps of a cost–benefit analysis (CBA), and explain our use of the Office of Management and Budget (OMB; 1992) Circular A-94 *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs.* We then lay out our methodology approach, specifically addressing the CBA steps for our cost-based analysis of local base SAR at MCAS Cherry Point and MCAS Yuma.

We begin Chapter IV by examining the cost associated with the status quo, along with a discussion about the sources of our data. We then present our assumptions and considerations for analysis and lay out our findings of the current and projected costs associated with local base SAR units at MCAS Cherry Point and MCAS Yuma. Following our discussion of the current situation, we present the modernization costs associated with the procurement of the HH-1Y per the aviation plan (AVPLAN). Lastly, we provide an estimate of the costs associated with a commercial contract for SAR services.

In Chapter V, we compare the cost of each alternative, draw conclusions and make recommendations based on our analysis, and offer suggestions for further research.

II. LITERATURE REVIEW

A. OVERVIEW OF SCHOLARLY RESEARCH

The majority of scholarly research into Marine Corps local base SAR has come from the Center for Naval Analyses (CNA). Several studies into Navy base SAR in the late 1990s evoked interest from the Marine Corps Chief of Staff for Aviation and led to additional analyses on SAR for the Marine Corps by the CNA in 2000 and 2003. Although these reports are somewhat dated (more than a decade old), we examined the methodology and assumptions in the analyses and used the reports as a starting point for our study. Outside the CNA, only a handful of students at NPS have broached the topic of SAR costs and alternatives. We also examined those students' theses.

B. STUDIES BY THE CENTER FOR NAVAL ANALYSES

1. *Outsourcing Helicopters for Land-Based Search and Rescue* by W. B. Boning, J. G. Ebert, J. D. Keenan, & P. C. Pedrick (1999)

In a 1999 report published by the CNA, Boning et al. (1999) analyzed costs and alternatives to land-based SAR service for the Navy. The report served as the predecessor to several subsequent reports that were tailored to the Marine Corps. The CNA report (Boning et al., 1999) also provided a significant amount of historical and contextual information regarding SAR service throughout the DoD and the military's relationship to the National SAR Plan. Although Boning et al. (1999) acknowledged the benefits of Navy SAR service for local communities, their report repeatedly returned to the sole justification for Navy land-based SAR service, which is to "provide SAR for Navy operations" (p. 2). As a result, the scope of their study focused on SAR service for the Navy and on the associated costs and viable alternatives to provide comparable SAR service. For simplicity, their report ignored any impact for SAR coverage for external governments or municipalities.

The CNA report (Boning et al., 1999) analyzed SAR at 14 naval air stations (NAS). For each location, the report considered the SAR requirements (based on the commanders' mandates for availability, coverage, and capabilities), historical demand for services, and the SAR units (manning, airframes, flight hours, and mission data). Alternatives for each location included other DoD assets, local government services, and contracts with commercial helicopter services. Cost calculations were derived from data taken from visibility and management of operations and support costs (VAMOSC), survey data from 13 of the 14 SAR units, and records of contracted maintenance costs from NAS Meridian and NAS Pensacola (Boning et al., 1999, p. 99). Using VAMOSC data, Boning et al. (1999)

broke down average cost and organizational personnel cost per helicopter and by type (p. 100). They also used survey data to determine then-current manning levels rather than using an actual T/O to make these determinations because actual manning often differed greatly from that authorized in the T/O. Finally, the report included contract maintenance costs (four of the 14 locations used contracted maintenance support instead of military personnel to conduct aircraft maintenance; Boning et al., 1999, p. 100).

In estimating costs for alternatives, Boning et al. (1999) used estimates from two commercial helicopter service providers, as well as prices for existing contracted helicopter services with the Department of the Interior. The contract price estimates they used in their report also considered then-current annual fixed costs as well as variable costs associated with actual flying hours. Their report incorporated special over-water aircrew considerations and partial fulfillment of SAR aircrew requirements by Navy rescue swimmers (Boning et al., 1999, p. 102). All of the cost estimates they used were adjusted to FY1998 dollars. None of their cost estimates projected future costs, and only then-present value per year amounts were used.

When other DoD (or Coast Guard) assets were not viable alternatives, Boning et al. (1999) recommended outsourcing SAR services because cost estimates for outsourcing were significantly cheaper than maintaining the SAR units and still provided comparable capability. Of the 14 locations, Boning et al. (1999) recommended that only one, NAS Meridian, eliminate its SAR capability and rely instead on local civilian and government helicopter service (p. 3).

We frame our analysis differently than Boning et al (1999). First, in the case of a commercial SAR contract, we do not assume any fulfillment of rescue swimmer responsibilities by the Navy. Rescue swimmer capabilities are now commonly available in the commercial SAR industry. As a result, the Navy would not be required to provide rescue swimmer capability to a commercial provider. Second, we project costs for 10 years instead of seven. Third, we do not make any assumptions about flight hours on the part of the commercial provider. We contrived cost estimates for the SAR contracts based on SAR capability and availability. Lastly, we used manpower cost data from VAMOSC instead of surveys.

2. *Outsource Land-Based SAR?* by P. C. Pedrick & J. D. Keenan (2000b)

In March 2000, the CNA published a briefing by Pedrick and Keenan as a follow-on analysis to a similar 1999 report. In this report, Pedrick and Keenan (2000b) expanded cost projections of Navy land-based SAR to FY2012 (in FY2000 year dollars). By extending this timeframe, Pedrick and Keenan (2000b) were able to include the acquisition, remanufacturing, and disposal costs and contrasted these with commercially contracted SAR alternatives. In their briefing, Pedrick and Keenan (2000b) considered an option to follow the Navy's plan, which did not include a commercial contract for SAR. They also considered an option to retain SAR units and airframes but to reorganize to an operational model that mirrored that of a commercial provider, which would mean only a single helicopter would be available for SAR per location instead of three helicopters. The last option they posed was a commercial contract of all SAR services, to include aircraft, pilots, aircrew (except rescue swimmers), and maintenance (Pedrick & Keenan, 2000b, p. 5).

Pedrick and Keenan (2000b) highlighted that the Navy had planned to purchase large quantities of CH-60Ss, to remanufacture existing SH-60 variants into SH-60Rs, and to phase out all other type/model/series (T/M/S) helicopters between FY2000 and FY2012. The acquisition and remanufacturing costs comprised the majority of the overall costs associated with the Navy's plan as compared to contracted alternatives (Pedrick & Keenan, 2000b, p. 4).

The briefing provided detailed assumptions on commercial options that would have included contracting SAR service to a commercial helicopter provider. Pedrick and Keenan (2000b) considered three different civilian helicopters, based on purchase and operating costs, range, loiter time, speed, and passenger capacity. All three helicopters met or greatly exceeded performance requirements for SAR based on historical SAR mission data, average distances to rescues, response times, and the number of people rescued per mission. Pedrick and Keenan (2000b) chose the Bell 412EP for its low operating costs, although its purchase price was marginally the highest (p. 10). They assumed that the Navy would provide hangars and workspace to a commercial SAR provider, as well as continue to provide rescue swimmers for SAR service. The commercial SAR service provider would provide pilots and maintenance crews. Pedrick and Keenan (2000b) estimated costs using flying hour assumptions based on data from the four SAR units with the highest usage (p. 7).

They compared costs between maintaining one, two, or three SH-60R helicopters, and between contracting for a commercial service. The commercial service was estimated to have significantly lower yearly annual costs through FY2012 than maintaining the SAR units within the Navy (Pedrick & Keenan, 2000b, p. 12). However, the analysis did not consider qualitative costs and benefits, such as positive public relations or mutually beneficial intergovernmental agreements; or manpower assignment policies, such as highly desirable shore duty or dwell time ratios (Pedrick & Keenan, 2000b, p. 16). Although our analysis likewise does not consider these types of qualitative costs or benefits, we do recommend a thorough exploration of these factors in order to calculate a true net present value (NPV) or support any change with regard to the future of Marine Corps local base SAR.

3. *Alternatives for the USMC's Local Base SAR* by P. C. Pedrick & J. D. Keenan (2000a, 2003).

In 2000, the CNA began research on alternatives for Marine Corps SAR at the request of the Marine Corps Deputy Chief of Staff for Aviation. Pedrick and Keenan published their report first in 2000, and then updated the report in 2003. Their 2000 report considered the four Marine Corps air stations (MCAS) that, at that time, still operated their own base SAR: Beaufort, Cherry Point, Iwakuni, and Yuma (Pedrick & Keenan, 2000a, p. 2). Since the publication of their 2000 report, the Marine Corps has closed the base SAR units at Beaufort and Iwakuni. Despite this, their report provides a starting point for updating their analysis of base SAR at Cherry Point and Yuma.

Pedrick and Keenan's 2000 report provided a thorough breakout of descriptive statistics of SAR unit activity, mission data, and flight hours, and also SAR unit composition including airframes and personnel. Their report first considered cost estimates (in FY2001 dollars) for continued SAR operations of three HH-46D helicopters at Cherry Point and three HH-1N helicopters at Yuma. They considered this as a baseline for comparison to other alternatives but purposefully excluded acquisition and upgrading costs. Using FY2001 costs in both reports, Pedrick and Keenan considered operations and maintenance (O&M), military personnel (MILPERS), and aviation procurement (AP) budget projections to estimate base SAR costs through FY2010 (Pedrick & Keenan, 2000a, p. 17).

The first alternative offered by Pedrick and Keenan (2000a) was to upgrade all SAR aircraft to HH-46E or HH-1Y. The HH-46Ds at Cherry Point would be upgraded in 2004, and the HH-1N in Yuma would be upgraded in 2008. The second alternative Pedrick and Keenan (2000a) presented was to upgrade all SAR assets to HH-46Es at both Cherry Point and Yuma. Both of these alternatives resulted in increased cost estimates from the baseline $361.8 million to $394.9 million and $375 million, respectively, through FY2010 (pp. 18–19).

Pedrick and Keenan's (2000a) third estimate used the same aircraft make-up as in the second alternative, but included the use of a commercial contract for organizational-level maintenance that would begin in FY2004. Their last alternative was to use a commercial provider for both maintenance and SAR operations including aircraft, aircrew, and pilots. The SAR contract would provide for 24-hour service with one helicopter continuously available for immediate operations and one helicopter available as a back-up. No other specifics regarding the assumed contractual agreement (such as over-water rescue or all-weather capabilities) were mentioned. In both the third and fourth alternatives, Pedrick and Keenan (2000a) estimated a significant cost reduction, with a savings of approximately $90 million and $180 million, respectively, through FY2010 (pp. 19–20).

Pedrick and Keenan (2000a) retrieved data for this report from the Naval Center for Cost Analysis (NCCA), maintenance contracts from NAS Meridian and Pensacola, and cost estimates from Petroleum Helicopters Incorporated (PHi; Pedrick & Keenan, 2000a, p. 19). Their report does not forecast or attempt to predict future demand for SAR. The report also omits any analysis of effects on the community, political implications, impacts to the National SAR Plan, or other qualitative costs or benefits. Their report concludes with a specific recommendation that the Marine Corps outsource its SAR mission to a commercial firm at an annual savings of $25 million per year (Pedrick & Keenan, 2000a, p. 2).

In 2003, the CNA published an updated follow-on report to Pedrick and Keenan's 2000 analysis. The 2003 report was almost identical to their work from 2000. The only significant difference was that MCAS Iwakuni SAR was omitted from the analysis because it had been closed. This change yielded different numerical estimations but an identical succession of cost magnitude and, as a result, identical conclusions with regards to alternatives. Pedrick and Keenan (2003) again showed that outsourcing commercial SAR would yield a significant cost savings to the Marine Corps. The Deputy Commandant for Marine Aviation (DCA) has recently requested an updated analysis, similar to the Pedrick and Keenan reports, to be used to support decisions regarding the future of Marine Corps base SAR.

Although our analysis most closely mirrors Pedrick and Keenan's 2003 report, there are some key differences in our analysis. According to the FY2013 Marine Aviation Plan, all SAR helicopters will transition to the new HH-1Y by FY2016; however, this had not yet been planned when Pedrick and Keenan formulated alternatives for Marine Corps SAR in 2000 and 2003. This was a significant factor in our analysis with regards to estimating procurement cost. Moreover, we found significant changes to the procurement cost and fielding schedule of the HH-1Y. Thus, our estimates provide an updated and more complete analysis regarding these costs to Marine Corps SAR. Additionally, we include modernization cost estimates and found significant costs associated with modifying the HH-1Y that were previously not considered in any CNA report.

Lastly, instead of using budget numbers, we estimated the procurement and O&S cost of the first 10 years for the HH-1Y (based on a 30-year life cycle cost [LCC]) and projected costs using the UH-1N annual O&S costs as an analogy to determine total cost of SAR to the Marine Corps over 10 years. We compared this estimate with three different SAR contract estimates (each with unique capabilities and costs) instead of only one (as in Pedrick and Keenan's 2003 report).

C. STUDIES BY THE NAVAL POSTGRADUATE SCHOOL

1. *Comparative Analysis of Benefits Received From Naval Air Station Search and Rescue (SAR) Mission* by R. K. Brodin (1998)

The first NPS thesis relevant to our research is a thesis by R. K. Brodin (1998). His thesis was designed to complement a then-forthcoming CNA report, which was subsequently published in 1999, on outsourcing Navy local base SAR. He approached the issue of outsourcing (Office of Management and Budget [OMB], 1999, para. 4) and addressed whether Navy SAR was a core function, whether Navy SAR was an inherently governmental function, and whether there was commercial competition among private sector firms to provide SAR service for the government (Brodin, 1998, p. 2).

Brodin's (1998) thesis then sought to find the non-direct economic costs and benefits to outsourcing SAR (p. 2). He considered only non-direct benefits and costs, or those gross benefits that are difficult to quantify. He grouped these benefits into four broad categories: personnel experience, personnel rotation, service performed, and public relations. He sought to evaluate whether these should be included in a best-value determination for the government (Brodin, 1998, p. 1).

Brodin (1998) created questionnaires for various personnel from two SAR units. The questionnaires were designed to gather data on the qualitative costs and benefits of local base SAR as compared to a commercial SAR service. Brodin (1998) then used Decision Support Software Expert Choice Pro to analyze chosen qualitative factors (p. 67). He concluded that SAR was not established as an inherently governmental function and provided analysis of two examples of commercial outsourcing to support this conclusion. Overall, his analysis was not conclusive as to whether to outsource, nor did it quantify benefits of maintaining local base SAR units. However, Brodin (1998) did posit that those qualitative factors contribute to the government's best-value calculation and should therefore be included in future analyses (p. 86). His analysis did reveal that outsourcing would have potential impacts to unit-level manpower. For example, he found that SAR aircrew, ground crew, and pilots spent a significant portion of their time on the job performing collateral assignment duties like legal administration, security, and logistics (Brodin, 1998, p. 81).

Brodin (1998) focused on qualitative costs and benefits, and relied on questionnaire data for his analysis. He exposed a few qualitative factors that may be appropriate for further research; however, these factors are outside the scope of our analysis. Our research focuses solely on cost analysis and comparison, and relies on historical expenditure data and cost projections.

Brodin does, however, question the Navy's requirement for SAR by examining whether SAR is a core competency. This facet of his analysis is directly related to our research, as we examine Marine Corps local base SAR in the context of the National SAR Plan, which mandates that the Air Force and the Coast Guard provide SAR service. We posit the fact that SAR is not a doctrinal responsibility for the Marine Corps and suggest further research into repositioning existing governmental assets to meet required coverage and response times for the Marine Corps.

2. *Cost and Operational Effectiveness Analysis of Alternative Force Structures for Fulfillment of the United States Marine Corps Operational Support Airlift and Search and Rescue Missions* by E. T. Chase (2000)

A second NPS thesis relevant to our research was written by E. T. Chase in 2000. In his thesis, Chase analyzed both the cost and effectiveness of various force structure alternatives for Marine Corps operational support aircraft (OSA) and SAR units. In his analysis of costs, Chase (2000) considered 20-year LCCs, which included research, development, testing, and evaluation (RDT&E); procurement; O&S; conversion and disposal; and manpower costs.

Chase (2000) analyzed four alternatives. The first alternative included the employment of 14 C-12 aircraft as OSA and the conversion of 12 CH-46E helicopters into HH-46E helicopters to support SAR (three HH-46Es at each base: Beaufort, Cherry Point, Yuma, and Iwakuni). The second alternative included upgrading from the C-12 to the C-35 for OSA and maintaining the same SAR assets as in the first alternative. The third alternative included the employment of the HV-609 tilt rotor aircraft for both OSA and SAR. However, this alternative is now outmoded because the Marine Corps has since changed its plan and no longer intends to use tilt rotor aircraft for OSA and SAR missions.

Using the Excel plug-in Crystal Ball and cost data (converted to FY1998 dollars) obtained from the NCCA, Chase (2000) concluded that the CH-46 (the second alternative) had the lowest LCC, making it the least expensive alternative for Marine Corps local base SAR operations (p. 51). However, he did not consider commercial SAR support as an alternative to provide local base SAR.

In its analysis of operational effectiveness, Chase (2000) chose aircraft speed, range, landing site requirements, payload, and time on station as measures of effectiveness in conducting SAR. These measures of effectiveness provided a quantitative baseline of aircraft capabilities and limitations for comparison between aircraft alternatives. Chase (2000) used Logical Decision for Windows to analyze measures of effectiveness and concluded that the most effective platform was the HV-609 tilt rotor aircraft (p. 81).

Chase's measures of effectiveness are similar to the criteria we used in comparing aircraft alternatives in our research. However, our research provides a more complete analysis of SAR costs. Instead of program office estimates (which Chase used), we used cost data from VAMOSC, which is the authoritative repository for Navy cost data. VAMOSC also provided us other data useful in calculating cost per flight hour and aircraft inventories. Additionally, we included SAR-specific modification costs, which we found to be significant with respect to the total cost of SAR modernization.

3. *Cost Analysis for a Dedicated Search and Rescue Capability for Commander Strike Fighter Wing U.S. Pacific Fleet* by R. Biros, N. Corpuz, C. Hines, and T. Riggs (2009)

In their thesis, Biros, Corpuz, Hines, and Riggs (2009) approached local base SAR from a different perspective by focusing their research specifically on SAR capabilities at NAS Lemoore. NAS Lemoore was the largest jet base on the west coast and the only jet base with no dedicated SAR capability. Despite having increased its number of flying squadrons and its offshore training airspace, its organic SAR capability was disbanded in 2004 as a cost-cutting measure, and no commercial SAR service was procured to replace it (Biros et al., 2009, p. 7). In their project, Biros et al. (2009) made a case for restoring local base SAR efforts to NAS Lemoore. The status quo would have been to allow NAS Lemoore to continue without organic SAR capability and rely on SAR service from the Coast Guard station in San Francisco. However, the status quo option was potentially fatal for downed aircrew because of cold water temperatures of the Pacific Ocean and the associated response times from San Francisco to retrieve survivors (Biros et al., 2009, p. 9). Biros et al. (2009) conducted a cost analysis of various alternatives to bring back a dedicated SAR capability to NAS Lemoore. In their analysis, they did not attempt to forecast future or long-term costs, but only considered the then-current costs of re-establishing organic SAR capability.

In four of their five alternatives, Biros et al. (2009) proposed solutions that would establish a SAR detachment at NAS Lemoore. Each of these four alternatives was modeled after other naval air stations with SAR capabilities (Whidbey, Fallon, and China Lake) and called for the use of existing Navy helicopters. This way, they avoided acquisitions costs because they assumed that the inventory of Navy helicopters was sufficient to stand up a detachment at NAS Lemoore (Biros et al., 2009, p. 10). Of these four alternatives, each had unique arrangements concerning the T/M/S of aircraft and manpower assignment policies. For example, one alternative (modeled after the SAR capability at NAS Fallon) would have assigned personnel to the SAR unit at NAS Lemoore under the category of temporary additional duty (TAD), whereas other alternatives permanently assigned personnel to the SAR unit at NAS Lemoore. Using 240 hours of annual flight time for all the alternatives, Biros et al. (2009) compiled cost per flight hour (CPH) data using maintenance and flight records from other SAR units. Biros et al. (2009) also used administrative and personnel costs from other SAR units, and scaled them to fit NAS Lemoore.

Ultimately, their recommendation was that their last alternative be adopted, which was for a commercial contracted service to provide SAR capabilities at NAS Lemoore, an alternative that was modeled after the air ambulance contract at Marine Corps Air–Ground Task Force Training Command (MAGTFTC) in Twentynine Palms, CA. Although this alternative was only marginally the second least expensive, Biros et al. (2009) concluded that the costs of future acquisitions and upgrades of Navy aircraft would have surely dwarfed the costs of the commercial alternative (p. 14).

This thesis was the only NPS thesis we found that considered a commercial contract to provide SAR service. However, the conclusion of Biros et al. (2009) failed to acknowledge significant differences between the capabilities of the air ambulance contract at MAGTFTC and actual SAR service. SAR capability would necessarily include high-end capabilities to conduct over-water rescues with rescue swimmers and hoist operations. We found that these capabilities significantly drive the cost of commercial SAR service and therefore should be included in any cost analysis of commercial SAR. Our research compares similar alternatives; that is, we sought estimates from commercial SAR providers that include these similar high-end capabilities.

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III. METHODOLOGY

A. OVERVIEW

In this chapter, we present the main steps of a cost–benefit analysis (CBA), which "is a policy assessment method that quantifies in monetary terms the value of all consequences of a policy to all members of society" (Boardman, Greenberg, Vining, & Weimer, 2011, p. 2). We then highlight the important elements of the Office of Management and Budget (OMB; 1992) Circular A-94 and discuss some different CBA formats, including the format we used in our research.

B. COST–BENEFIT ANALYSIS

A CBA can be conducted in one of three ways: The ex ante CBA is conducted prior to execution of a project; the ex post CBA comes at the end of a project; and the in medias res CBA is conducted during the life cycle of a project. In any of these cases, a CBA can be used to measure efficiency and provide data about how best to allocate resources (Boardman et al., 2011, p. 3). It provides policy-makers and resource managers with a "method for making direct comparisons among alternative policies" (Boardman et al., 2011, p. 27). According to Boardman et al. (2011, p. 6), there are nine basic steps of a CBA. In the following list, we outline these nine steps and explain how we applied them in our research.

1. *Specify the set of alternatives*. In Chapter IV, we discuss the status quo (SAR units' current costs) and then analyze costs associated with two alternatives: modernization and a commercial contract. These alternatives were proposed by representatives from HQMC APP-51 and are based on previous studies conducted by the CNA. We propose several additional alternatives as areas for further research in Chapter V.
2. *Decide whose benefits and costs count (known as standing)*. For the purposes of this thesis, we define standing in terms of interests to the United States Marine Corps. In particular, we focus on the best use of the Marine Corps' resources to execute its assigned war-fighting missions (Deputy, 2013). Therefore, we consider in this thesis only those costs and benefits that impact the Marines Corps and its ability to carry out its assigned war-fighting functions.
3. *Identify the impact categories, catalogue them, and select measurement indicators*. Ideally, all categories impacted by a policy could be captured and measured. However, social impacts and other

qualitative costs and benefits can be nearly impossible to definitively monetize. We limit our analysis to a comparison of costs only.

4. *Predict and monetize the impacts quantitatively over the life of the project.* We obtained cost data for the presented alternatives from VAMOSC and examined O&S costs associated with the SAR units at MCAS Cherry Point and MCAS Yuma. Additionally, we obtained acquisition and modernization costs from the Defense Acquisitions Management Information Retrieval (DAMIR) and the Naval Air Systems Command (NAVAIR) program office PMA-276. Lastly, we considered cost data from existing commercial helicopter services and aircraft maintenance contracts at various military installations. We considered a 30-year life cycle for SAR helicopters in our cost-based analysis.
5. *Discount benefits and costs to obtain present values (PVs)*. We normalized the data to FY2014 dollars and forecasted costs for each alternative 10 years into the future using the predictor function in Oracle's Crystal Ball plug-in for Microsoft Excel.
6. *Compute the net present value (NPV) of each alternative*. We ignored the benefits for each alternative in this analysis and thus did not calculate a true NPV. Instead, we considered only O&S, procurement, and contract costs.
7. *Perform a sensitivity analysis.* In our analysis, we considered specific sources of uncertainty, upper and lower bounds from procurement costs estimates, and confidence limits (10% and 90%) for yearly variances in O&S costs associated with SAR units.
8. *Make a recommendation*. In this thesis, we recommended only the alternative with the lowest cost. However, we also recommended that future analyses of qualitative impacts include both costs and benefits in order to more accurately assess the true NPV of each alternative.

C. COST-EFFECTIVENESS ANALYSIS

Although the CBA process can be applied universally across public and private sectors, OMB (1992) Circular A-94 *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs* provides guidance specifically geared to a national perspective and designed to "promote efficient resource allocation through well-informed decision-making by the federal government" (para. 1). Circular A-94 provides direction for the CBA of federal programs in order to make sound cost comparisons, and outlines the CBA process in four elements: policy rationale, explicit assumptions, evaluation of alternatives, and verification (OMB, 1992, para. 5.c).

The CBA encompasses a broad range of analysis; as a result, it can take different forms. One such form is a cost-effectiveness analysis (CEA). A CEA is “a less comprehensive technique [than CBA], but it can be appropriate when the benefits from competing alternatives are the same or where a policy decision has been made that the benefits must be provided” (OMB, 1992, para. 5). A CEA is often used in lieu of CBA in defense policy because of the common limitations associated with predicting the loss of life, or the difficulties associated with monetizing social impacts or public opinion. According to OMB (1992),

> A program is cost-effective if, on the basis of life cycle cost analysis of competing alternatives, it is determined to have the lowest costs expressed in present value terms for a given amount of benefits. Cost effectiveness analysis is appropriate whenever it is unnecessary or impractical to consider the dollar value of the benefits provided by the alternatives under consideration. This is the case whenever (i) each alternative has the same annual benefits expressed in monetary terms; or (ii) each alternative has the same annual effects, but dollar values cannot be assigned to their benefits. (para. 5.a.2.b)

D. COST-BASED ANALYSIS

In this thesis, we follow a CEA more closely than a CBA; however, we do not analyze benefits because we considered them to be outside the scope of our research questions. As such, we focus solely on a cost-based analysis between alternatives and ignore any benefits. We project future costs of alternatives and then discount these to a PV, allowing for a comparison. Our cost-based analysis stops short of deriving a true NPV, which would be “the discounted monetized value of expected net benefits” (OMB, 1992, para. 5.b), and focuses on investment and cost savings internal to the federal government.

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IV. ANALYSIS

A. INTRODUCTION

The cost-based analysis conducted in this thesis examines the current cost of USMC SAR operations at Cherry Point and Yuma using historical cost data from both units. In addition, we examine the cost of two alternatives discussed with representatives from Aviation Plans and Policy (APP-51) at Headquarters Marine Corps. Alternatives analyzed in this study include the costs for planned aircraft procurement along with estimations of the future O&S costs associated with those upgrades. We highlight recent changes in the availability of commercial helicopter service to provide SAR and present a cost estimate based on recent governmental outsourcing of SAR and related helicopter services. This outsourcing alternative is then compared to the current cost and estimated costs associated with the upgrade option to facilitate the readers ability to determine the most suitable alternative relative to cost and performance.

B. DATA

Our research combines data from the Marines Corps' current aviation plan (AVPLAN), the Navy's Visibility and Management of Operating and Support Costs (VAMOSC) database, and the Defense Acquisition Management Information Retrieval (DAMIR), along with publically available information regarding governmental outsourcing of SAR functions to various commercial firms. The Marine Corps' AVPLAN "supports the force structure initiatives approved under the Marine Aviation Transition Strategy (MATS) and the anticipated requirements resulting from the implementation of the Defense Policy Review Initiative FY16" (Deputy Commandant for Marine Aviation [DCA], 2012). VAMOSC is the management information system that

> collects and reports US Navy and Marine Corps historical operating and support (O&S) costs. VAMOSC provides the direct O&S costs of weapon systems, some indirect costs (e.g., ship depot overhead), and related non-cost information such as flying hour metrics, steaming hours, age of aircraft, etc. (Defense Acquisition University [DAU], 2011)

The DAMIR system is "a DoD initiative that provides enterprise visibility to Acquisition program information. DAMIR streamlines acquisition management and oversight by leveraging web services, authoritative data sources, data collection, and data repository capabilities" (DAMIR, 2013).

C. DESCRIPTION OF STATUS QUO AND ALTERNATIVES

1. Status Quo

Status quo offers a benchmark estimate of costs; however, the status quo is not a viable option for the future because current aircraft have reached the end of their service life. Our analysis of the status quo examines the current O&S cost of Marine Corps SAR. O&S includes MILPERS costs and O&M costs. A one-year forecast based on 10 years of historical data is provided.

2. HH-1Y Upgrade

The Marine Corps currently intends to replace all SAR aircraft with the HH-1Y. This alternative dictates that the Marine Corps execute the AVPLAN as currently written and calls for the HH-46E helicopters located at MCAS Cherry Point, and HH-1N helicopters located at MCAS Yuma, to be replaced by HH-1Y helicopters. Our analysis of this alternative assumes a 30-year life cycle for HH-1Y and no change to operational level (O-level) maintenance or existing support structures. The Life-Cycle Costs (LCCs) presented in this analysis consist of procurement costs associated with UH-1Y and both the RDT&E as well as the procurement costs associated with the necessary modifications to make it an HH-1Y. Additionally, the associated O&S costs will be added to the amortized procurement and modification costs to determine the total cost estimate of the platform. Our analysis provides both an annual cost estimate along with the estimated cost of the HH-1Y aircraft over a 10-year period.

3. Commercial Outsourcing

This alternative is to outsource SAR in one or both locations to a commercial provider who can perform the mission and meet Marine Corps criteria for capability and readiness. The nature of SAR operations makes aircraft performance increasingly important; however, costs are also highly correlated with this metric. Therefore, to ensure that alternatives presented in this analysis do not emphasize cost savings at the expense of capability (and assume unknown risk), our analysis focuses on commercial SAR providers that have similar or greater aircraft performance, and rescue and medical capabilities as current Marine Corps SAR. We provide relevant performance characteristics of each alternative aircraft later in this chapter. Through our provision of these capabilities, readers can better understand the trade space between cost and performance and make more accurate comparisons between alternatives. This alternative assumes that the contractor will provide the helicopters, pilots, maintenance support, medical personnel, and rescue technicians to conduct 24-7 SAR operations. This alternative also assumes that the Marine Corps will provide necessary facilities for the contactors to perform operations at each location, such as workspaces and hangars; however, no new military construction (MILCON) is considered.

D. ANALYSIS OF STATUS QUO

1. Current Cost of Marine Corps Search and Rescue

To determine the current cost of SAR to the Marine Corps, we used historical O&S costs associated with the HH-1N, HH46D, and HH46E. We assume that these aircraft have exceeded their expected service life and that all procurement costs have been depreciated. Therefore, we do not include the procurement of these legacy assets in our analysis of the current units' cost. To conduct our cost analysis, we obtained 10 years of historical cost data from VAMOSC for each T/M/S aircraft used by VMR-1 and SRU to conduct SAR operations. We normalized the cost data to FY2014 dollars and account for each HH-1N, HH-46D, and HH46E airframe within the Navy inventory from 2003 to 2012.

The cost data obtained from VAMOSC contained the complete breakdown of the cost element structure (CES) for all units operating the HH-1N, HH46D, and HH46E aircraft. Costs related to each T/M/S aircraft are separated into relevant elements that facilitate the identification of relevant O&S costs. The major cost elements accounted for in the VAMOSC data are unit level manpower, unit level operations, maintenance, sustaining support, and continuing system improvement. Table 5 briefly illustrates how this cost data is separated by element for each T/M/S. The complete CES from VAMOSC is given in Appendix B.

Table 5. Example of VAMOSC Cost Element Structure for SAR Squadrons

Element 1	Element 2	Element 3	Element 4	Element 5	Element 6	Element 7
Unit Level Manpower	- Operations - Unit Maint - Other Maint	- Marine - Navy - Other	- Officer - Enlisted	- Regular - FRS	- Basic pay - Allowances - Entitlements	
Unit Operations	- Material -TAD	- Energy -Transporta-tion - TAD	- Navy - Marine	- Regular - FRS	- Officer - Enlisted	- Basic pay - Allowances - Entitlements
Maintenance	- O-Level - I-Level - Contract	- Consumables - Gov. Labor - Contract	- Manpower - Maint - Other	- Navy - Marine	- Labor - Material - Other	
Sustaining Support	- Syst. Train - Program Mgmt	- Training - Tech Service - Pubs				
Continuing System Improvement	- Mods - Updates	- Kits - Installs - Spares				

We summed O&S costs in the data that could be directly attributed to VMR-1 and SRU by fiscal year. We allocated cost data that existed in the VAMOSC database as cost pools and that consisted of shared costs among units operating the same T/M/S aircraft to Marine SAR units via the following method. In these instances, we determined VMR-1 and SRU O&S costs by multiplying the specific fiscal year shared cost pool by the percentage of aircraft in the relevant Marine Corps SAR unit for that fiscal year. We then input the costs determined to be attributed to each Marine SAR unit into our cost data and used it to conduct further analysis. We used this method to estimate intermediate (I-level) maintenance, depot-level maintenance, sustainment and support, and continuing system improvement costs of SRU for the HH-1N data from 2003 to 2008 and of VMR-1 for the HH-46D in 2003 and 2004. Where pooled costs were predominantly determined to be driven by Navy units operating the same T/M/S and costs were not proportional to the percentage of Marine Corps SAR aircraft, our analysis used an average of later year costs, which could be directly linked to Marine SAR units. We then inputted the average of these direct costs from later years into our cost data and used them in our analysis. We used this method to determine the cost of I-level maintenance Navy manpower and I-level maintenance other Navy manpower in 2003 and 2004 for VMR-1.

2. Cost of VMR-1 and SRU

Once each of the Marine SAR unit O&S costs was separated from the rest of the raw data, we then used this cost data to construct cost models for each SAR unit. These models provide historical reference and a basis for comparison of future costs. Our analysis determined that the average O&S cost to conduct SAR operations each year for the Marine Corps from 2003 to 2012 in FY2014 dollars was $21,019,412. During that period, the average cost for VMR-1 to conduct SAR was $12,997,506; and the average cost for SRU Yuma to conduct SAR was $8,021,906. Additionally, during that period, costs varied between $10,456,699 and $17,968,689 for VMR-1 and between $4,946,344 and $10,308,786 for SRU. The primary cost driver for both units during this period was an increase in maintenance and support costs. Figures 11 and 12 depict the O&S costs for each unit. O&S costs are broken into continuing system improvements, sustainment and support, maintenance and support, unit-level operations, and unit-level manpower costs. Because RDT&E and procurement costs have been previously discounted for these legacy aircraft, the O&S costs represent the total cost to the Marine Corps for these units.

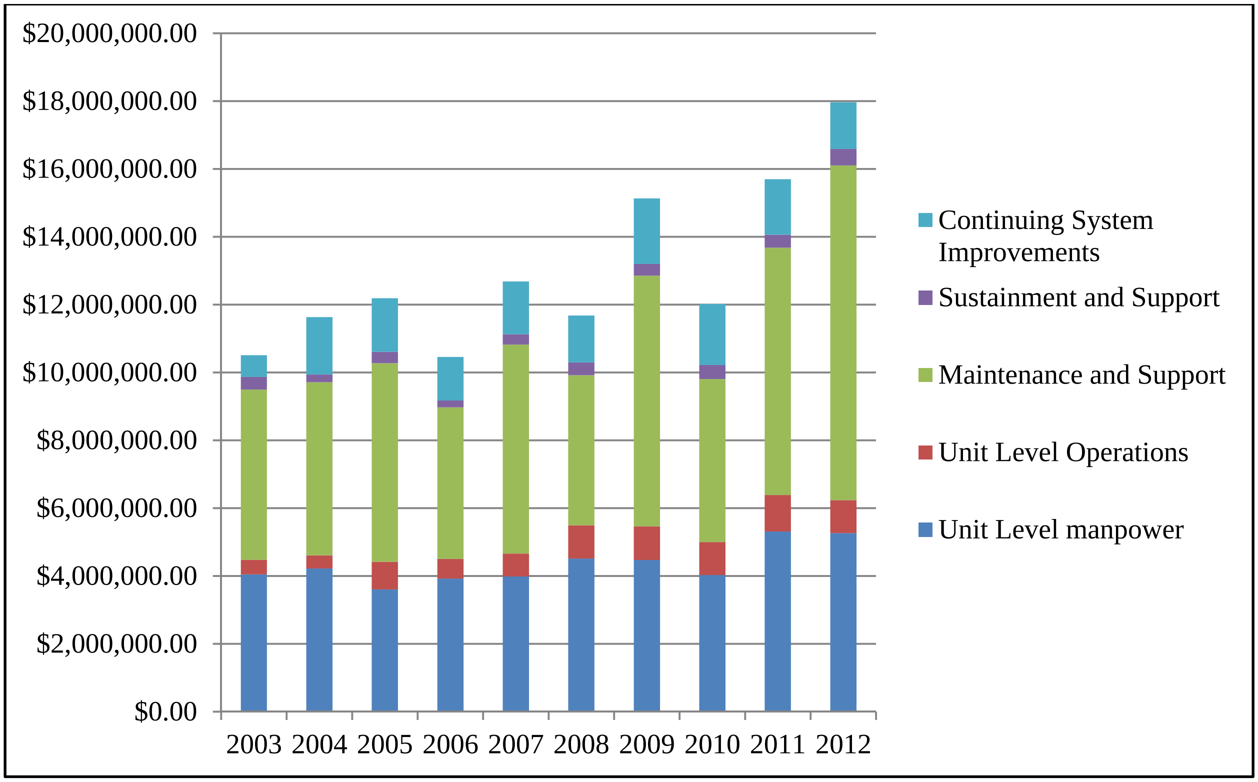

Figure 11. VMR-1 HH-46D/E Annual O&S Costs

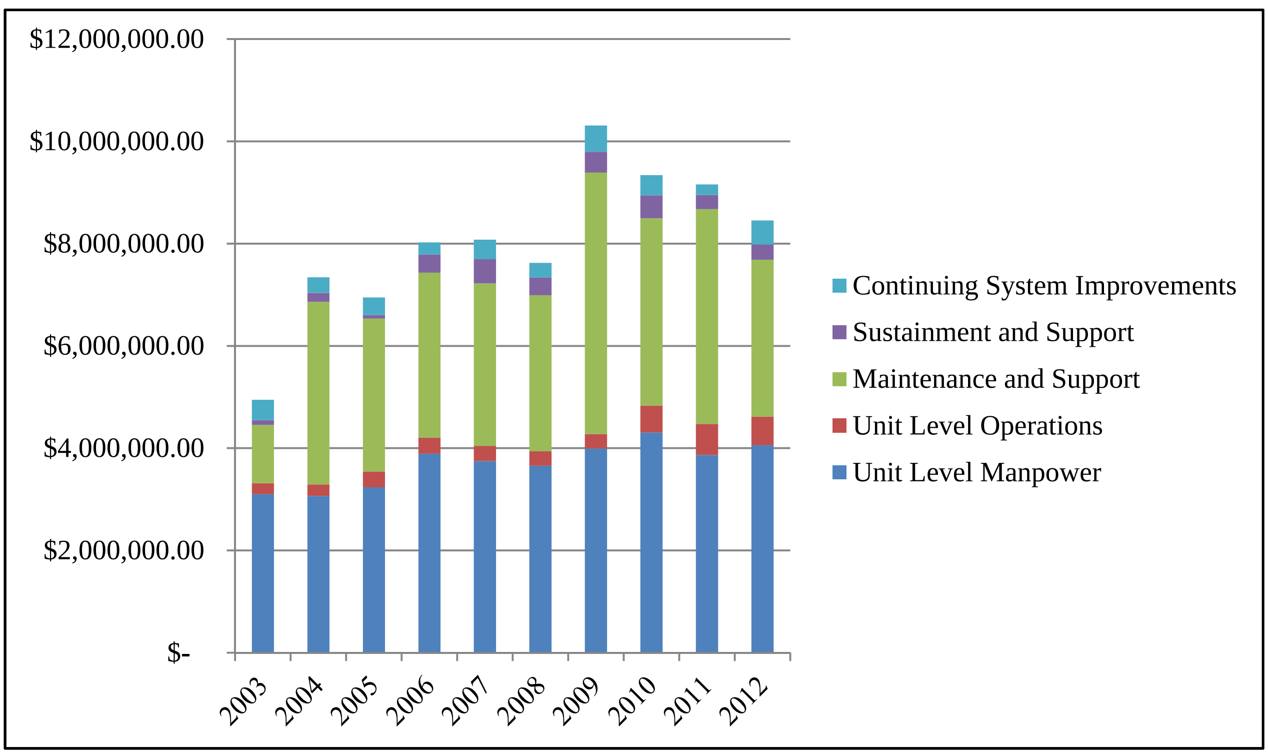

Figure 12. SRU HH-1N Annual O&S Costs

The Marine Corps annual cost to conduct SAR operations from 2003 to 2012 is presented in Figure 13. The total costs for both units range from a low of $15,456,468 in 2003 to a high of $26,421,551 in 2012. The average cost to the Marine Corps of conducting SAR during this period was $21,019,412. Figure 13 shows the total O&S cost of Marine Corps SAR from 2003 to 2012. Note that costs trended upward over the 10-year period.

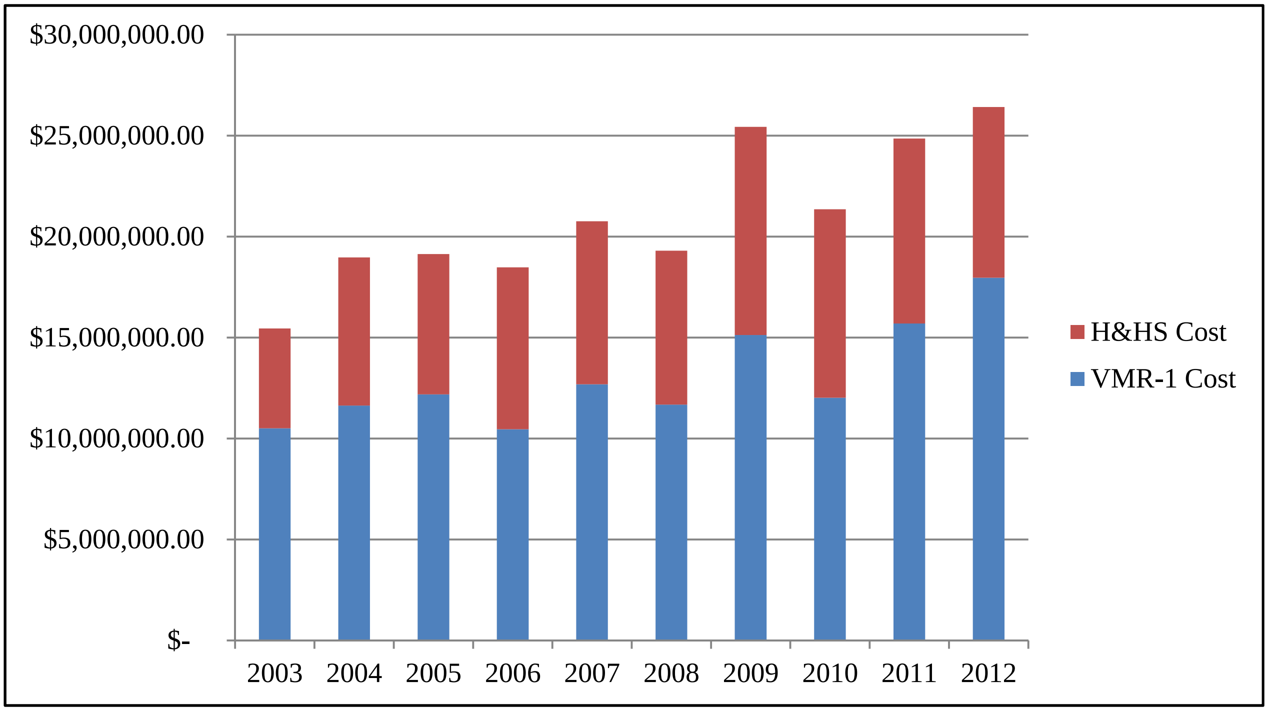

Figure 13. Total O&S Costs

E. ANALYSIS OF UPGRADE ALTERNATIVE

1. Transition to the HH-1Y

Transitioning SAR aircraft to the HH-1Y is the planned course of action for the Marine Corps. It involves the procurement of six HH-1Y helicopters, which are based on the UH-1Y airframe. The UH-1Y utility helicopter, manufactured by Bell Helicopter Incorporated, provides improved capabilities over the UH-1N. This four-bladed aircraft offers increased speed and payload carrying capacity, along with upgraded avionics and added safety features. Table 6 provides relevant performance characteristics of the UH-1Y aircraft.

Table 6. UH-1Y Performance Characteristics
(Naval Air Systems Command [NAVAIR], 2013)

UH-1Y	"Venom"
Function	Assault Support
Prime Contractor	Boeing
Crew	4
Speed	Maximum 170 knots
Range	258 nautical miles (combat load)
Useful Load / Litters	6,660 lbs / 6 litters

The program is currently in the operations and sustainment phase, and is being operated from both combat and shipboard environments (DoD, 2012, p. 4). These helicopters are expected to replace the fleet of legacy SAR helicopters. See figure 14.

Figure 14. UH-1Y Photo
(The Bell UH-1Y, 2013)

Six HH-1Y helicopters total are to be fielded to the SAR units at MCAS Cherry Point and Yuma, three aircraft at each location. The FY2013 AVPLAN reflects MCAS Yuma SAR unit beginning this transition to the HH-1Y in fourth quarter of FY2014; however, that transition has been delayed one year until fourth quarter of FY2015 (Deputy, 2013). The AVPLAN also reflects MCAS Cherry Point transitioning in second quarter of FY2016. Taken together, the updated plan will reflect Marine Corps SAR units receiving all six HH-1Ys in FY2016 (DCA, 2012). According to the Operations and Support Visual Analysis Tool (OSVAT) in VAMOSC, the service inventory count of UH-1Y helicopters was 61 as of FY2012, and the platform is being delivered to operational units throughout the Marine Corps at a rate of approximately

16 units per year. Aircraft are normally delivered about two years after procurement (J. Davis, personal communication, August 26, 2013). Using this data, we estimate the UH-1Y units to become SAR assets will be production numbers 120–125 and that these assets will be procured during FY2014. Table 7 depicts the UH-1Y procurement profile.

Table 7. Procurement Profile for the UH-1Y From PMA-276

FY	04	05	06	07	08	09	10	11	12	13	14	15	16	Total
Number of Aircraft	6	4	7	9	11	15	19	18	15	16	15	15	10	160

2. UH-1Y Costs

We obtained cost data for the UH-1Y from DAMIR and the cost team at NAVAIR (PMA-276). This program office is responsible for "cradle to grave procurement, development, support, fielding and disposal of the Marine Corps rotary wing close air support, anti-armor, armed escort, armed/visual reconnaissance and fire support program systems" (NAVAIR, 2013).

Our analysis uses total LCC as the basis to compare alternatives and determine the most cost effective SAR method. According to the Defense Acquisitions Guidebook (DAG; DoD, 2011), LCC include "research and development costs, investment costs, operating and support costs, and disposal costs over the entire life cycle" (p. 92). However, our analysis differs from this definition in that it considers only options that are capable of performing SAR with existing technology and proven aircraft. Additionally, we limited our cost analysis to a 10-year projection of future costs because of the uncertainty of O&S forecast models beyond that point.

We used cost data from the *H-1 Upgrades* Selected Acquisition Report in DAMIR (DoD, 2012) to estimate costs for units 120–125 (the program costs to USMC SAR). We used average procurement acquisition cost (APUC) to base our cost estimations. APUC captures fly-away, weapon system, and procurement costs; it does not include research and development (R&D) costs (which are sunk), MILCON costs, or O&S costs.

Because the UH-1Y has already been fully developed and is currently in service in the operating forces and supporting establishments throughout the Marine Corps, we treated RDT&E costs from the UH-1Y as sunk costs. Therefore, RDT&E costs of the UH-1Y program are not included as part of the analysis in this thesis. However, we consider the RDT&E costs associated modifications required to convert the UH-1Y to the HH-1Y relevant to SAR and include them. Additionally, we assume the disposal costs to be negligible and have omitted them.

We estimated the UH-1Y procurement costs to USMC SAR using two different APUC estimates. In the first estimate, we mathematically derived the APUC of the six UH-1Y aircraft that are to be used for SAR by taking the program APUC listed in the selected acquisition report, applying learning curve theory and some basic assumptions to derive the cost estimate for the first unit, and then deriving the cost of units 120–125.

Learning curve theory, specifically the Crawford Unit Theory, is a quantitative tool commonly used to estimate costs associated with repetitively produced products. It was introduced in the 1930s and was originally applied to calculate labor hour efficiency in the production of airplanes (Stewart, 1990, p. 51). The formula represents a proportional, curvilinear decrease in production costs as manufacturers improve labor, engineering, development, and assembly practices of a given product. The formula is as follows: $Y = AX^b$, where Y is unit cost; A is the cost of the first unit produced; X is the quantity number or “Xth” unit; and b is the learning curve (Stewart, 1990, p. 52). The learning curve exponent provides the slope to the formula and is equal to ln(.9)/ln(2).

Assuming a 90% learning curve, and using APUC as the cost of the 81st unit (the midpoint between 1 and 160), we estimated the cost of the first unit “A.” Then, using the derived A, we calculated the estimated cost of units 120–125 and converted to FY2014 dollars using the inflation indices in the Naval Center for Cost Analysis Joint Inflation Calculator. Using this method, we estimated the average unit cost of the six aircraft to be $29,607,360, and the total cost to be $177,644,150 (FY2014 dollars). Table 8 contains estimates derived from using this method.

Table 8. Learning Curve Estimated APUC of UH-1Y

Per Unit Cost Estimate UH-1Y	Cost FY2014 (thousands $)
120th unit	$29,699.79
121th unit	$29,662.35
122th unit	$29,625.27
123th unit	$29,588.53
124th unit	$29,552.13
125th unit	$29,516.08
Total	**$177,644.15**

In the second estimate, we obtained cost estimates directly from the cost team at NAVAIR PMA-276. The team was anticipating an overall cost increase for the UH-1Y program beginning in FY2014 because of a new cost accounting system at Bell called the “Business Modernization System,” which recently increased direct labor hours by combining various labor categories into indirect labor. Estimated labor rates were based on historical labor rates from previous lots of the UH-1Y. Estimates were then applied to a 98% learning curve and then multiplied by recommended labor rates from the Defense Contract Management Agency (DCMA). Materials were estimated similarly, using the bill of materials (BOM) from past lots, applying it to a learning curve, and multiplying by DCMA material rates (L. Davis, personal communication, August 26, 2013). Using this data and these methodologies, the cost team at PMA-276 estimated the APUC for UH-1Y in FY2014 to be $28,961,220 or $173,767,340 for all six aircraft (FY2014 dollars). Table 9 contains the program office estimates.

Table 9. Program Office Estimated APUC of UH-1Y

Program Office Estimate UH-1Y	Cost FY2014 (thousands $)
APUC	$28,961.22
Estimate for 6 units	**$173,767.34**

The program office estimate was approximately 2% lower than our estimate. The average of both estimates was used for our analysis. Table 10 contains the average of the two estimates.

Table 10. Average Estimated APUC of UH-1Y

Average Estimate UH-1Y	Cost FY2014 (thousands $)
Average APUC	$29,284.29
Estimate for 6 units	**$175,705.74**

3. UH-1Y to HH-1Y Conversion Costs

SAR helicopters must meet certain capabilities requirements as per the Naval Aviation Training and Operating Standardization (*NATOPS) General Flight and Operating Instructions* (DoN, 2009). As such, the UH-1Y helicopter is required to be retrofitted with specific modifications in order to be designated an HH-1Y and to be employed in a SAR capacity. The cost team at NAVAIR PMA-276 also provided the cost estimates for conversion of the UH-1Y to the HH-1Y.

Major modifications include a powerful searchlight, a landing light, and a coupled-hover capability. Costs estimates for the landing light and searchlight (the SX-16 “Nightsun”), taken from a rough order of magnitude (ROM) prepared by PMA-276 in 2012, are based on historical conversion costs from the HH-1N and include R&D, engineering and logistics, and retrofit costs. The landing light is required for visual reference during SAR missions and is installed directly below the fuselage system (L. Criley, personal communication, August 27, 2013). The 50 million candlepower Nightsun is mounted on the port-side of the fuselage, just above the landing skid, and oriented to the front. It is operated by the co-pilot to provide illumination during use technical rescues (Spectrolab, n.d). Figure 15 shows the lighting configuration for the HH-1Y.

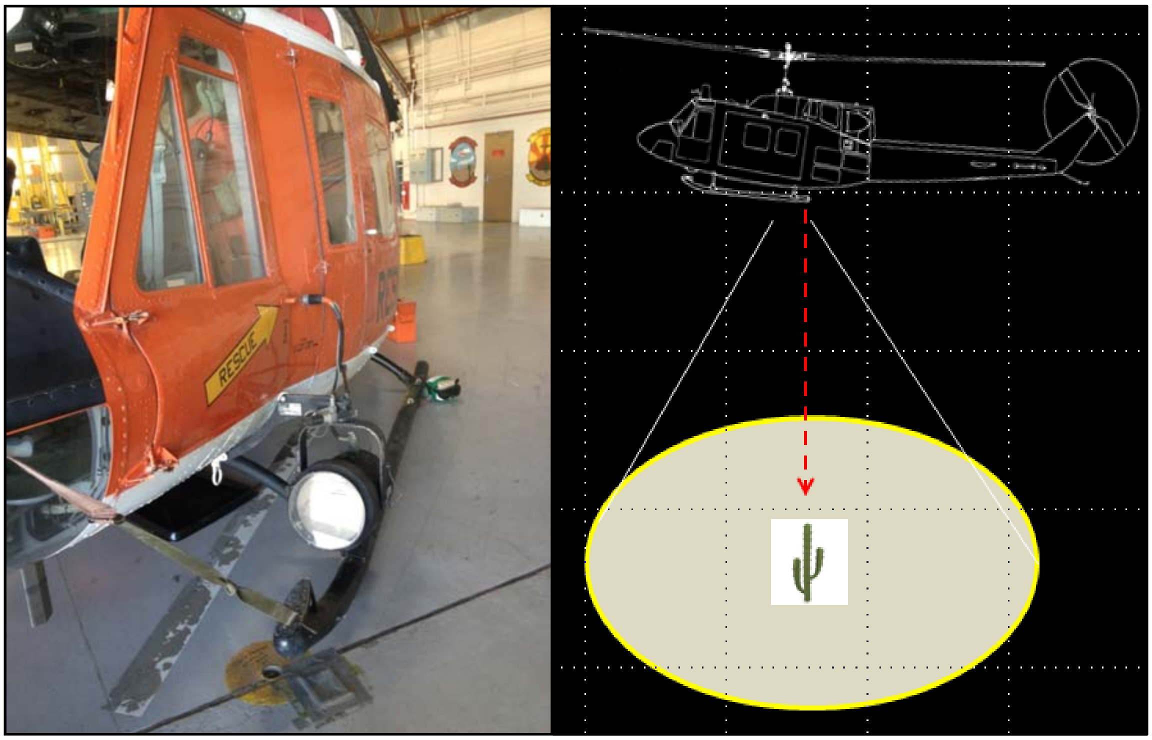

Figure 15. Photograph and Illustration of Nightsun
(H. Vanderborght and L. Criley, personal communication, August 27, 2013)

Coupled hover capability greatly increases the stability of the aircraft when hovering over a single point. The coupled hover requirement is specifically outlined in OPNAV 3710.7U (DoN, 2009):

> **Helicopter/Tiltrotor Night Hover Operation Over Water**
>
> Night/low visibility hover operations over water shall be conducted using aircraft equipped with operable automatic hover systems (i.e., coupler/Doppler/AFCS equipment) on all occasions when a natural horizon visible from the cockpit is not available to assist the pilot in establishing/maintaining a stable hover. (par. 5.4.3)

Coupled hover estimates included R&D, retrofit and O&S, cost increases, and were based on flight controls from the UH-60M upgrades program. Using an analogous cost method, we considered the previous flight control upgrades of other systems as a reference and used the upper and lower costs of these upgrades to provide a boundary for our analysis. In addition sensitivity analysis was conducted on the upper bound of $86.2 million, which was taken from the UH-60M fly-by-wire system, as well as the lower bound of $73.2 million, which was taken from a redesigned mechanical flight control system (H. Vanderborght, personal communication, July 31, 2013). All estimates reflect FY2014 dollars.

Other minor modification costs include hoists and other ancillary equipment. Estimates for the hoist included the purchase of only two hoists because the Yuma SRU already has four of the six total hoists that will be required. Costs estimates for ancillary equipment, like litters and safety equipment, were considered negligible, as these items are to be taken from the existing SAR units HH-1N and HH-46E helicopters (L. Criley, personal communication, August 27, 2013). Table 11 lists both the per aircraft cost and total conversion costs for each modification.

Table 11. UH-1Y to HH-1Y Conversion Costs

UH-1 to HH-1 Modifications	Actions Required	Conversion Cost Per Aircraft (FY2014 $)	Total Conversion Cost for 6 Aircraft (FY2014 $)
Lighting	R&D, Engineering/Logistics	$426,000	$426,000
	Retrofit	$125,373	$752,238
	Total Lighting		$1,178,238
Coupled Hover	R&D	$52,478,500	$52,478,500
	Retrofit	$2,038,000	$12,228,000
	Additional O&S	$2,751,300	$16,507,800
	Total Coupled Hover		$81,214,300
Hoist	Quantity 2	$208,204	$416,408
Total Estimate			**$82,392,538**

Taken together, the total procurement estimate for the six HH-1Y helicopters is $258,098,280 or $43,016,380 per aircraft. Because the coupled hover capability was taken from a ROM that ranged from $73.2 million to $86.2 million (FY2014 dollars), this total could vary +/- $6.5 million or +/- $2.17 million per aircraft. Table 12 is the total cost of procuring the HH-1Y (to include the conversion costs). The variability shown is based on the ROM for the coupled hover given by the program office.

Table 12. HH-1Y Total Procurement Cost Estimate

Procurement Estimate (FY2014 $ thousands)	Lower-Bound	Mid-Range	Upper-Bound
Total Modifications	$75,892.54	$82,392.54	$88,892.54
Total SAR Procurement	**$251,598.28**	**$258,098.28**	**$264,598.28**
Total per Aircraft	**$41,933.05**	**$43,016.38**	**$44,099.71**

Assuming a 30-year life cycle for the HH-1Y, and applying straight line depreciation to these aircraft over that period, the estimated annual cost to be depreciated is $8,603,280 (FY2014 dollars) per year. Table 13 shows the estimated annual depreciation cost.

Table 13. Estimated Annual Depreciation Cost of HH-1Y Over 30-Year Life Cycle

30-Year Life Cycle (FY2014 $ thousands)	Low	Average	High
Estimated Annual Depreciation Cost	$8,386.61	**$8,603.28**	$8,819.94

4. Operations and Support Costs (O&S)

O&S Cost data for the UH-1Y were obtained using the same method as the HH-1N. Total O&S cost was severely skewed because of the growing inventory of UH-1Y from zero to 59 over the previous six years. To obtain an estimate that would better represent O&S costs, we broke down total O&S cost by flight hour for the UH-1Y, dividing total costs by total flight hours. We then separated cost per flight hour into five cost categories: continuing system improvements, sustainment and support, maintenance and support, unit level operations, and unit level manpower costs. Figure 16 provides an illustration of the cost per flight hour of the UH-1Y broken into these five categories.

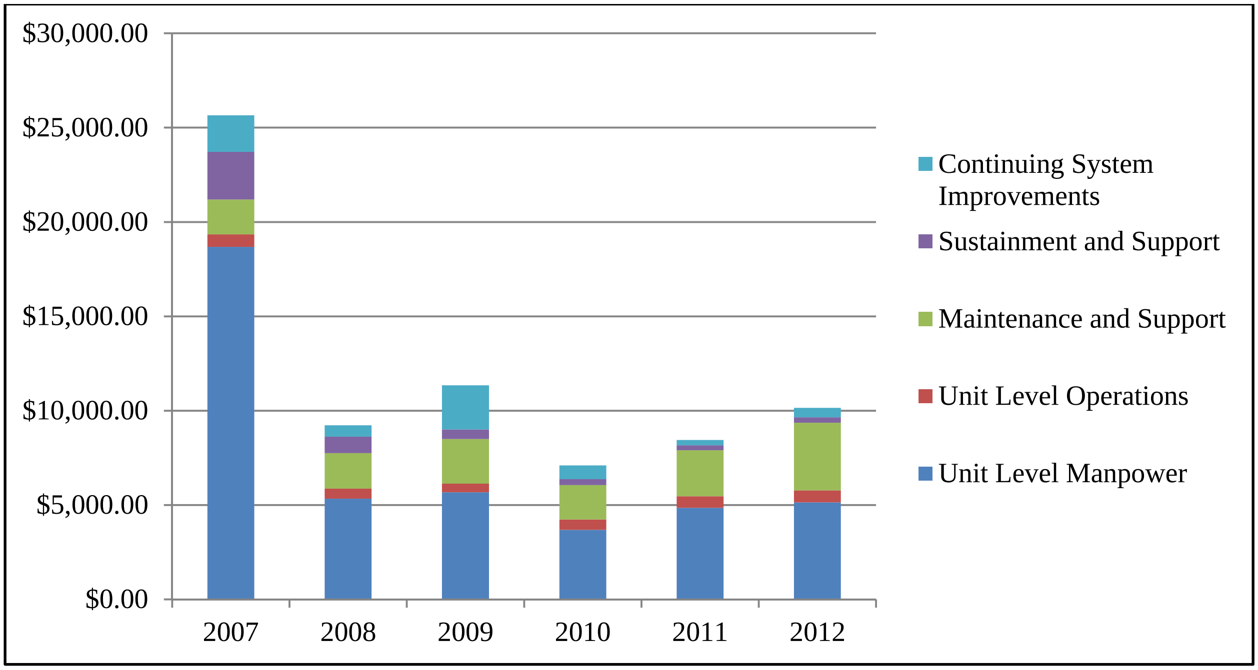

Figure 16. UH-1Y Cost per Flight Hour

This data represents the sum of all historical UH-1Y O&S cost data available in VAMOSC. Because the UH-1Y is a relatively new aircraft and has not yet reached full operational capability (FOC), the data from FY2008 to FY2012 reflects significant variability, specifically in its first year (service inventory was one aircraft). Additionally, in subsequent years many aircraft underwent initial fielding. Because of the limited observations (only six fiscal years), and the year-to-year differences in aircraft number, which created large cost variances, we did not use UH-1Y data to forecast the HH-1Y's O&S costs. Rather, we used the historical cost data associated with the HH-1N.

The UH-1N program is a much more established Major Defense Acquisitions Program (MDAP). Additionally, an examination of the O&S cost data from FY2010 to FY2012 reveals that the CPH three-year moving averages for the HH-1N and UH-1Y were within 2.9% at $8,817 and $8,562, respectively. Furthermore, there are overwhelming similarities between the two airframes, their cost, and employment. Because of the greater amount of historical cost data available to reference and the shared commonality between the UH-1N and the UH-1Y, we used the O&S cost data for the HH-1N to project future HH-1Y O&S costs.

Because of the significant similarities between the HH-1N and the UH-1Y, we assume that the direct maintenance manpower requirements will be the same for both aircraft. In contrast, there are organizational dissimilarities which exist between the two SAR units operating the HH-46E and the HH-1N. However, our analysis assumes no change to direct maintenance manpower requirements at VMR-1 based on communication with manpower representatives (A. Lavato, personal communication, July 15, 2013). Additionally, SAR pilot billets are assumed to be unaffected by the transition to the HH-1Y.

Using 10 years of historical O&S cost data from the UH-1N, we projected future costs by using Microsoft Excel and Oracle's Crystal Ball plug-in to forecast O&S CPH for the UH-1Y. The Predictor function in Crystal Ball provided us a time-series forecast based on the historical O&S cost data. Although a cursory analysis may have forecasted using a simple O&S average, we assumed that the more recent years' data may be more indicative of future costs. Thus, we used exponential smoothing as our model to forecast O&S costs for the HH-1Y over 10 years.

Exponential smoothing exponentially decreases the weights of a weighted moving average and "constructs forecast of future values as weighted averages of past observations, with the more recent observations carrying more weight in determining forecasts than observations in the more distant past" (Fomby, 2008, p. 1). The method then uses standard forecasting accuracy measures like the mean squared errors (MSE), mean absolute deviation (MAD), and the mean absolute percentage error (MAPE) to measure accuracy of the forecast. The time series CPH data for the HH-1N clearly shows a linear trend, increasing on average 6% per year over 10 years, and shows no discernible cyclic or seasonal activity. Because of these characteristics, we generated a forecast using double exponential smoothing, which assumes a trend but no seasonality. Double exponential smoothing uses two smoothing rates: a level smoothing rate, and a trend smoothing rate. The double exponential model equation is $y_t = \mu_t + \beta_t t + a_t$; where *t* is time or number of periods; *β* is the trend smoothing factor; and *a* is the level smoothing factor (Fomby, 2008, p. 8). Predictor chooses smoothing factors that minimize error. Figure 17 is a chart that depicts the forecasted O&S CPH, and Table 14 contains the descriptive statistics associated with the O&S forecast cost model.

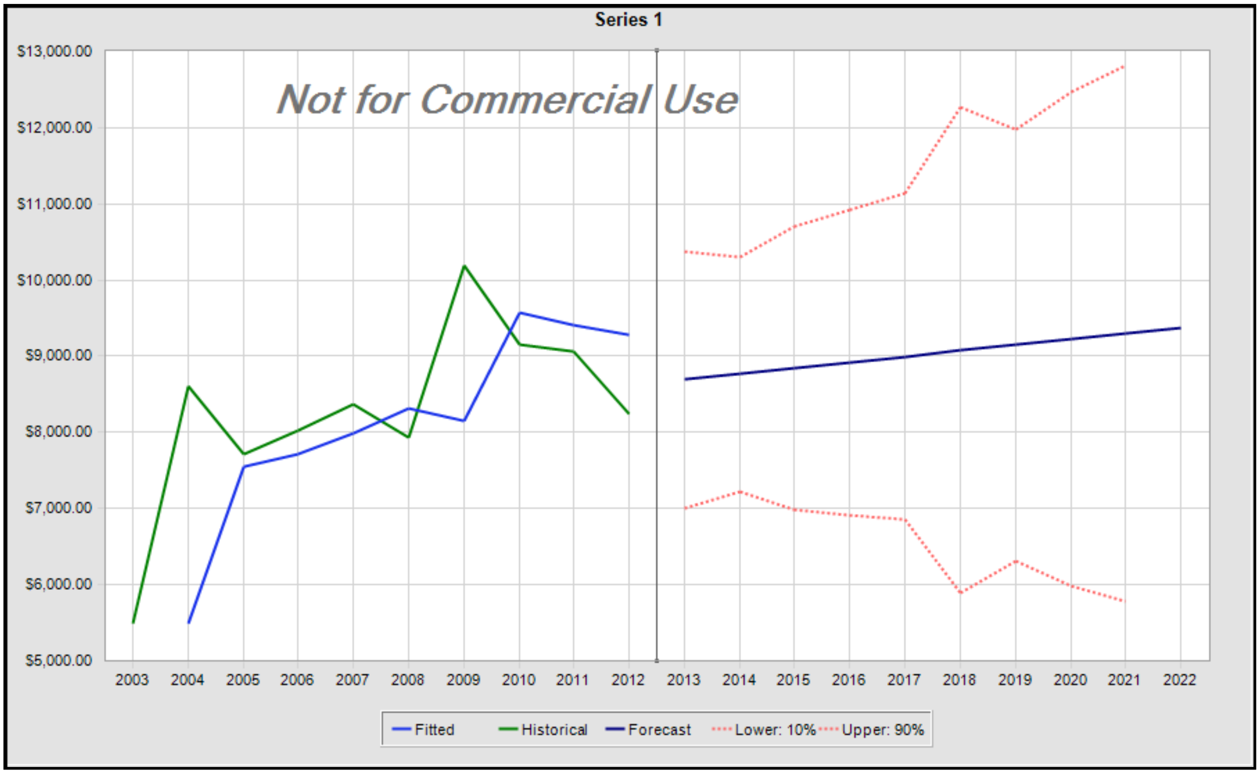

Figure 17. Forecasted O&S Costs at 90% Confidence Interval

Table 14. Descriptive Statistics Associated With Forecast O&S Cost Model

Descriptive Statistics	
Data Values	10
Minimum	$5,496
Mean	$8,270
Maximum	$10,197
Standard Deviation	$1,221
Accuracy	
RMSE	$1,320
MAD	$911
MAPE	10.28%
Method Parameters	
Alpha	0.6393
Beta	0.0312

Table 15 contains the forecasted O&S cost per flight hour for the UH-1Y with upper and lower confidence limits (90% and 10%). Both the MSHARP and VAMOSC reflected that each SAR unit flew approximately 1,000 hours annually. Thus, we assumed 1,000 flight hours annually for each HH-1Y SAR unit per year.

Table 15. HH-1Y O&S Forecast Cost for 10 Years

Year	Lower: 10% (FY2014 $)	Forecast (FY2014 $)	Upper: 90% (FY2014 $)
2013	$7,001	$8,693	$10,385
2014	$7,229	$8,770	$10,310
2015	$6,992	$8,846	$10,701
2016	$6,917	$8,923	$10,929
2017	$6,863	$8,999	$11,135
2018	$5,884	$9,076	$12,268
2019	$6,319	$9,153	$11,986
2020	$5,985	$9,229	$12,474
2021	$5,791	$9,306	$12,821
2022		$9,382	
10 YR O&S @ 1,000 flight hours per unit		$90,376,491	
10 YR O&S for Both SAR Units		**$180,752,982**	

5. HH-1Y 10-Year Cumulative Cost Estimates

Ten-year cumulative cost estimates were calculated by adding 10 years of lower-bound, mid-range, and upper-bound estimates for procurement, conversion and O&S costs. Procurement and conversion costs assumed a 30-year life cycle, straight line depreciation, and no salvage value; procurement and conversion costs were summed and then divided by 30 to derive annual depreciation. Table 16 shows the 10-year cost estimate for both Cherry Point and Yuma.

Table 16. HH-1Y 10-Year Total Cost Estimate for SAR

HH-1Y 10-Year Estimate for both Cherry Point and Yuma (FY2014 $)			
	Lower Bound	**Mid-Range**	**Upper Bound**
Procurement	$57,922,447	$58,568,580	$59,214,717
Conversion	$25,297,513	$27,464,180	$29,630,847
O&S Forecast	$130,025,259	$180,752,982	$230,867,885
Total: Two Locations	**$213,245,219**	**$266,785,742**	**$319,713,448**

We assumed the aircraft and units at each location to have identical costs. Therefore, we calculated procurement and O&S costs for a single location by dividing the estimate for both locations in half. Conversion costs for a single location assumed a procurement of three HH-1Y helicopters vice six and were derived by subtracting out variable costs (retrofit, and additional O&S) only. R&D was a fixed cost. Therefore, it is not a relevant cost. Table 17 shows the 10-year cost estimate for a single location.

Table 17. 10-Year Cost Estimate for a Single Location

HH-1Y 10-Year Estimate for a Single Location (FY2014$)			
	Lower Bound	**Mid-Range**	**Upper Bound**
Procurement	$28,961,223	$29,284,290	$29,607,358
Conversion	$20,382,840	$22,549,507	$24,716,174
O&S Forecast	$65,012,629	$90,376,491	$115,433,942
Total: Single Location	**$114,356,693**	**$142,210,288**	**$169,757,474**

6. HH-1Y First-Year Cost Estimates

First-year cost estimates were calculated using the same assumptions as the 10-year estimates; however, we considered only the costs of the first year in order to provide a more standard comparison to alternative II. Table 18 shows the first year cost estimate for both locations, and Table 19 shows first year cost estimates for a single location.

Table 18. First-Year Cost Estimate for Both Cherry Point and Yuma

HH-1Y First-Year Estimate (2014) Both Cherry Point and Yuma			
	Lower Bound	Mid-Range	Upper Bound
Procurement	$5,792,245	$5,856,858	$5,921,472
Conversion	$2,529,751	$2,746,418	$2,963,085
O&S Forecast	$13,833,481	$17,845,490	$21,857,500
Total: Two Locations	**$22,155,477**	**$26,448,766**	**$30,742,056**

Note. Assumes FY2014 Procurement and FY2016 Fielding.

Table 19. First-Year Cost Estimate for a Single Location

HH-1Y First-Year Estimate (2014) for a Single Location			
	Lower Bound	Mid-Range	Upper Bound
Procurement	$2,896,122	$2,928,429	$2,960,736
Conversion	$2,038,284	$2,254,951	$2,471,617
O&S Forecast	$6,916,740	$8,922,745	$10,928,750
Total: Single Location	**$11,851,147**	**$14,106,125**	**$16,361,103**

Note. Assumes FY2014 Procurement and FY2016 Fielding.

F. ANALYSIS OF CONTRACT ALTERNATIVES

Outsourcing SAR for one or both locations is another option considered in this analysis. This alternative involves the contracting of a commercial service provider to assume the SAR mission currently conducted by VMR-1 and SRU. To estimate a cost associated with this alternative, we examined existing contracts that involve a number helicopter services providers. Commercial solutions vary from more limited capability to advanced, high-end capability. An example of a low-end capability alternative is the Marine Corps air ambulance contract that services Twentynine Palms, CA. On the high end of the capability spectrum, we studied multi-helicopter regional SAR contracts, such as those that currently exist in the UK.

Commercial helicopter service providers in the United States currently do not perform extensive SAR operations for government agencies or the general public that involve elevated risk. The U.S. Coast Guard and other federal and state agencies, such as the Border Patrol, U.S. Parks Service, as well as state and local law enforcement, have historically provided these services to most areas of the country. This has resulted in little incentive for private industry to compete in this market. To estimate the cost of SAR, we consider a similar, but slightly less capable, market for helicopter service operations contracted by the U.S. military. Our analysis then compares these services to more capable SAR services that exist in other countries, such as the UK, Australia, and Ireland, where government agencies have outsourced this function to commercial service providers. By identifying the capabilities and costs associated with each, our analysis defines the borders that exist for this particular commercial helicopter service worldwide and provides an estimated price range for SAR in the United States.

Because of the nature of the competitive global market for helicopter services, commercial vendors did not disclose detailed price data. The information is generally considered sensitive by companies because of the need for each to protect its competitive advantage. Moreover, we were not provided with any data on contracted flight hours, or fixed or variable costs. This limitation precluded a detailed analysis of CPH (similar to the UH-1Y). Therefore, our analysis of this option focuses on data obtained from open source information provided in news releases and contained in periodicals, trade publications, and newspapers. Because of historically low demand for SAR, cost data in this alternative is based on coverage and capability versus flight hours. Therefore, we assume all costs associated with this alternative to be covered in a firm-fixed-price (FFP) contract; no additional incremental costs would be incurred outside of the FFP.

Some greater details were available in U.S. Army, Navy, and Marine Corps contracts that provide helicopter services at several locations. However, because of the requirement differences of these contracts and the performance differences of the aircraft and crew, these services do not match exactly the demand for high-end SAR sought at Cherry Point and Yuma by the Marine Corps. Our analysis uses the limited helicopter service industry data available to provide a spectrum of costs and capabilities that are currently seen in the global market. This methodology allows us to bracket the outsourced cost of SAR based on DoD contract data and information that has been released to the public. Capability and performance information is then given to facilitate decision-making.

1. Center for Naval Analyses Estimates

We first examined the commercial contract estimates provided in the 2003 CNA report “Alternatives for USMC’s Local Base SAR” (Pedrick & Keenan, 2003). Pedrick and Keenan (2003) obtained estimates for commercial contracts for SAR from Petroleum Helicopters Incorporated (PHi); however, details regarding the type of contract, fixed and variable costs, or specific capabilities (over-water, hoist, etc.) were absent. Furthermore, representatives at the CNA were not available for discussion on these estimates.

According to the report (Pedrick & Keenan, 2003), the estimated seven-year cost of a commercial SAR contract for three locations (Beaufort, Cherry Point, and Yuma) from FY2004 to FY2010 was $60.6 million (then-year [TY]2003 dollars; Pedrick & Keenan, 2003, p. 19). Assuming the cost of each location to be the same (dividing by 3), and also assuming costs to remain constant from year to year (dividing again by 7), and converting to FY2014 dollars (using the Joint Inflation Calculator from the NCCA), we estimate the average yearly contract cost per location to be $3.59 million (FY2014$). However, accounting for inflation, assuming year-to-year cost increases of 3.85% based on the inflation rate derived from the air ambulance contract at Twentynine Palms, we calculated the first-year cost estimate from the CNA report to be $3.03 million (FY2014$) and the final-year cost to be $3.95 million (FY2014$) for each location.

These estimates assumed the use, operation, and maintenance of the Bell 412EP helicopter, one helicopter at each location (three locations plus one helicopter to be used as a maintenance back-up), and around-the-clock coverage seven days per week (Pedrick & Keenan, 2003, p. 18). We found these cost estimates to be comparable (however, at the low-end) of the current air ambulance contract at Marine Corps Air Ground Combat Center (MCAGCC) in Twentynine Palms, CA.

2. Twentynine Palms Air Ambulance

The contract for air ambulance services, at Twentynine Palms, CA, serves as an initial point of reference for our commercial cost analysis because it is currently the only helicopter services contract that exists in the Marine Corps. Although this contract does not provide all of the capabilities currently demanded by SAR squadrons at Cherry Point and Yuma, the contract does provide cost information about the helicopter services industry capable of serving DoD needs. Because of the limited scope and capability of the contracted service, we estimate that it will provide a lower boundary for our cost analysis. (The contract does not require the commercial provider to conduct over-water or hoist rescues.) The Marine Corps air ambulance contract at Twentynine Palms is a five-year FFP contract. The contract was renewed in January 2012 and covers calendar year 2012 through 2016. The purpose of the contact was to “obtain 24 hours a day, 7 days a week air ambulance services … and limited amounts of other air transport services, for the Marine Air-Ground Task Force (MAGTFTC), Marine Corps Air-Ground Combat Center (MCAGCC), Twentynine Palms, California” (USMC, 2012, p. 8). The cost of annual air ambulance services to the Marine Corps at Twentynine Palms is listed in Table 20. Our analysis calculated the inflation rate used over the contact period to be 3.85%. The total cost over the five-year period is $18.9 million with an average annual cost of $3.8 million. Table 20 shows a cost breakdown of the air ambulance contract at MCAGCC in Twentynine Palms, CA.

Table 20. Annual Twentynine Palms Air Ambulance Contract Service and Flight Hour Prices

Service	Year	Quantity	Unit Price
	2012		
Base Period Air Ambulance Service:		12	$ 245,248.34
Base Period Level IV Flight Hours:		200	$ 1,975.00
	2013		
Base Period Air Ambulance Service:		12	$ 254,691.34
Base Period Level IV Flight Hours:		300	$ 2,051.00
	2014		
Base Period Air Ambulance Service:		12	$ 264,497.93
Base Period Level IV Flight Hours:		300	$ 2,130.00
	2015		
Base Period Air Ambulance Service:		12	$ 274,682.11
Base Period Level IV Flight Hours:		300	$ 2,212.00
	2016		
Base Period Air Ambulance Service:		12	$ 285,258.43
Base Period Level IV Flight Hours:		300	$ 2,297.00

Then-year dollar amounts contained in the contract were then normalized by converting contact amounts to FY2014 dollar amounts using the joint inflation calculator (JIC). This adjustment resulted in the following FY2014 dollar amounts listed in Table 21.

Table 21. Twentynine Palms Air Ambulance Annual Contract Costs in FY2014$

Service by Year	Amount (CY)	Weighted Index	Amount (FY2014$)
2012		1.000512822	
Base Period Air Ambulance Service:	$ 2,942,980.08		$ 2,944,489.30
Base Period Level IV Flight Hours:	$ 395,000.00		$ 395,202.56
Total:	$ 3,337,980.08		**$ 3,339,691.87**
2013		1.019792888	
Base Period Air Ambulance Service:	$ 3,056,296.08		$ 3,116,789.01
Base Period Level IV Flight Hours:	$ 615,300.00		$ 627,478.56
Total:	$ 3,671,596.08		**$ 3,744,267.57**
2014		1.039168953	
Base Period Air Ambulance Service:	$ 3,173,975.18		$ 3,298,296.46
Base Period Level IV Flight Hours:	$ 639,000.00		$ 664,028.96
Total:	$ 3,812,975.18		**$ 3,962,325.42**
2015		1.058913163	
Base Period Air Ambulance Service:	$ 3,296,185.38		$ 3,490,374.08
Base Period Level IV Flight Hours:	$ 663,600.00		$ 702,694.77
Total:	$ 3,959,785.38		**$ 4,193,068.86**
2016		1.079032513	
Base Period Air Ambulance Service:	$ 3,423,101.13		$ 3,693,637.42
Base Period Level IV Flight Hours:	$ 689,100.00		$ 743,561.30
Total:	$ 4,112,201.13		**$ 4,437,198.72**
Total Cost 2012–2016:	**$ 18,894,537.85**		**$19,676,552.44**
Average Annual Cost:	**$ 3,778,907.57**		**$ 3,935,310.49**

3. United Kingdom Search and Rescue

On March 26, 2013, the United Kingdom announced that it had contracted with Bristow helicopters of Houston, TX, to conduct SAR at 10 locations using 22 aircraft. According to *Jane's Defence Weekly*, the "UK Department for Transportation (DFT) has signed a GBP 1.6 billion (USD 2.4 billion) contract with Bristow Helicopters Limited (BHL) to provide rotary-winged search and rescue (SAR) services for the next 10 years" (Jennings, 2013). The announcement marks the largest outsourcing of SAR by a government to date, and a landmark shift in how the UK government provides SAR services. According to *The Telegraph*, "The 10 year contract, launching in 2015, will end 70 years of search and rescue provided by the RAF [Royal Air Force] and Royal Navy" (Ebrahimi, 2013).

Exact dollar figures required to conduct an intense cost analysis were not available. However, our analysis extrapolates information from data sources that are then used to project an annual price estimate for each aircraft model. According to the *Defense Industry Daily*, the request for proposal (RFP) structure consists of two coverage zones. Each zone has specific aircraft performance requirements to meet the needs of a geographic region. The Lot 1 area "minimum rescue capacity per aircraft is 8 casualties/survivors (2 of which could be stretchered) and minimum radius of action is 200 nm/370 km, and 250 nm / 463 km" (Defense Industry Daily Staff, 2013, para. 1). The Lot 2 area "minimum rescue capacity per aircraft is just 4 casualties/survivors (2 of which could be stretchered), and minimum radius of action is just 170 nm / 315 km" (Defense Industry Daily Staff, 2013, para. 2).

The UK government estimated the total value range at GBP 2.0 billion–3.1 billion when constructing the request for proposal. The estimated value of the Lot 1 RFP was GBP 1.2 billion–1.8 billion. The estimated value range for Lot 2 was GBP 800 million to 1.3 billion. (Defense Industry Daily Staff, 2013, para. 2–3). These figures suggest that the UK government estimated Lot 1 to account for between 58.1% and 60% of the total and Lot 2 to account for between 40% and 41.9% of the total cost for the contract.

Bristow bid £1.6 billion ($2.4 billion) to service both Lot area 1 and Lot area 2. The company intends to meet the requirements for Lot 1 using the Sikorsky S-92 and the requirements for Lot 2 by using the Agusta Westland AW189 aircraft. According to the *Bristow Group Inc. Analyst Day 2013* report, the preliminary cost of the S-92 is $35–$40 million, and the preliminary cost of the AW189 is $20–$25 million. The aircraft cost figures from the company's analyst day report indicate that the S-92 accounts for 61.5%–63.6% of the aircraft purchase costs, and the AW189 accounts for 36.4%–38.5% of the aircraft purchase costs associated with the UK contract.

Our analysis uses the UK government's estimated Lot 1 and Lot 2 costs for SAR operations, as well as the reported preliminary purchase costs of each aircraft, to estimate the price of SAR provided by each aircraft. Using this method, we estimate that the operations of the S-92 aircraft account for between 58.1% and 63.6% of the total cost of the UK contract, and that the AW189 accounts for between 36.4%–41.9% of the total UK contract. Analysis of these figures yields the then-year dollar amounts in the Table 22.

Table 22. Estimated Average UK SAR Costs by Aircraft Type

		£	TY$
Total UK SAR Contact Price:		1,600,000,000	2,400,000,000
AW189			
	36.4%	£ 582,400,000.00	$ 873,600,000.00
Annual Cost:		£ 58,240,000.00	$ 87,360,000.00
Annual Cost per Aircraft:		£ 5,294,545.45	$ 7,941,818.18
	41.9%	£ 670,400,000.00	$ 1,005,600,000.00
Annual Cost:		£ 67,040,000.00	$ 100,560,000.00
Annual Cost per Aircraft:		£ 6,094,545.45	$ 9,141,818.18
Average Annual Cost per Aircraft:		£ 5,694,545.45	**$ 8,541,818.18**
S-92			
	58.1%	£ 929,600,000.00	$ 1,394,400,000.00
Annual Cost:		£ 92,960,000.00	$ 139,440,000.00
Annual Cost per Aircraft:		£ 8,450,909.09	$ 12,676,363.64
	63.6%	£ 1,017,600,000.00	$ 1,526,400,000.00
Annual Cost:		£ 101,760,000.00	$ 152,640,000.00
Annual Cost per Aircraft:		£ 9,250,909.09	$ 13,876,363.64
Average Annual Cost per Aircraft:		£ 8,850,909.09	**$ 13,276,363.64**

To account for cost growth over the 10-year period of the contract, our analysis assumed a 3.85% inflation rate. This assumption was made based on the inflation rate obtained from the FFP contract awarded last year to provide air ambulance services to MAGTFTC at Twentynine Palms, CA. Our analysis used the inflation rate from the Marine Corps contact, the known total price and estimated costs by aircraft type previously discussed from the UK SAR contract to project the TY annual cost for each aircraft over the 10-year period.

Then-year dollar amounts determined through our analysis were then normalized using the JIC and converted to FY2014 dollars. Using these figures, we estimate the first-year cost of SAR for the AW189 to be between $5.9 million and $6.7 million with an average of $6.2 million. The same method provides a first-year estimate of the S-92, with costs ranging between $9.3 million and $10.2 million with an average of $9.8 million. Table 23 provides the breakdown for the AW189 and S-92 aircraft along with the TY and FY2014 dollar amounts associated with the estimates derived from the UK SAR contract.

Table 23. Estimated UK SAR Estimated First-Year Cost (FY2014)

	% of Total Cost	Per Aircraft Cost
AW189		**2017**
	36.4%	
Estimated Cost per Aircraft TY:		$ 6,433,893.72
Estimated Cost per Aircraft (FY2014):		$ 5,851,472.50
	41.9%	
Estimated Cost per Aircraft TY:		$ 7,406,047.99
Estimated Cost per Aircraft (FY2014):		$ 6,735,623.56
	Average (FY14):	**$ 6,293,548.03**
S-92		**2017**
	58.1%	
Estimated Cost per Aircraft TY:		$ 10,269,484.21
Estimated Cost per Aircraft (FY2014):		$ 9,339,850.33
	63.6%	
Estimated Cost per Aircraft TY:		$ 11,241,638.48
Estimated Cost per Aircraft (FY2014):		$ 10,224,001.39
	Average (FY2014):	**$ 9,781,925.86**

Note. First-year costs calculated assuming 3.85% rate of inflation over contract life.

G. AIRCRAFT PERFORMANCE AND CHARACTERISTICS

Table 24 provides some notable performance data and characteristics associated with each aircraft presented in our alternative analysis. The performance data and characteristics of these aircraft are presented here to enable a relative comparison among alternatives. The comparison ensures that as alternatives are considered, each potential replacement is a viable option and provides capabilities necessary for performing the current mission, while identifying slight variations in performance between aircraft that may necessitate a tradeoff.

Table 24. Aircraft Performance Characteristics

	Bell 412EP	HH-1Y	AW189	S-92
Useful Load	5,100 lbs.	6,661 lbs.	9,646 lbs.	10,000 lbs.
Cabin Volume (cu.ft.)	220	220	395.5	700
Cruise Speed (Kts)	132 kts	147 kts	150 kts	151 kts
Mission Range	365 nm	310 nm	400 nm	476 nm
Crew/Passengers	1/14	2/10	2/18	2/19

To facilitate a comparison of alternatives, Figure 18 plots the costs associated with the recent commercial outsourcing alternatives analyzed in this thesis versus the capabilities of each alternative. Capability increases from left to right, beginning with the capabilities found in the Twentynine Palms air ambulance contract (Bell-412 helicopter) at the low end and extending to the more advanced UK SAR capability (S-92 helicopter) on the high end. Our basis for measuring capability is in terms of the SAR capability of the aircraft and crew only. Because of the recent demonstration of commercial SAR crews to complete complex and hazardous mission tasking, we assume the capability of the crew to be equal. Therefore, the separation between the HH-1Y and the commercial SAR alternatives is assumed to be aircraft performance. SAR performance was based on aircraft range, lift capability, and the number of passengers that can be transported. It does not account for factors such as the ability to utilize the assets to accomplish alternate missions, such as range sweeps, logistics runs, and miscellaneous support.

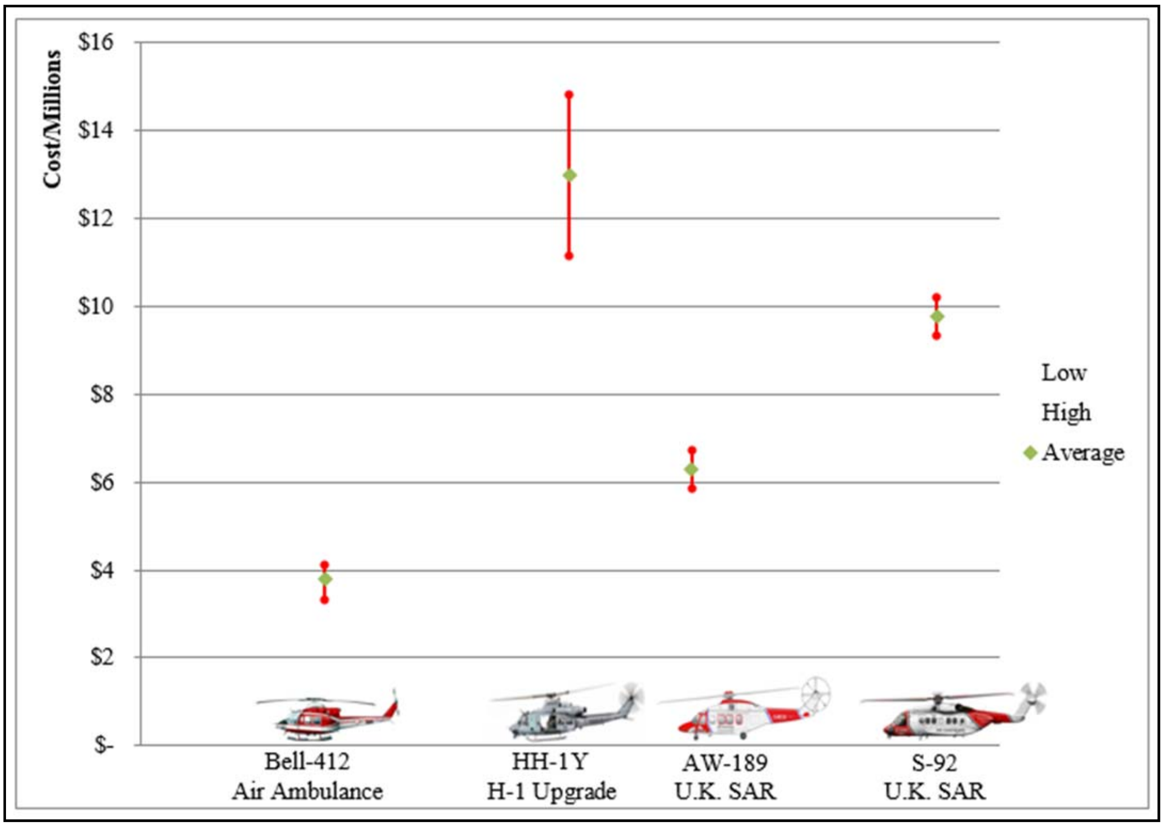

Figure 18. Annual Cost vs. Capability and Performance of SAR Alternatives

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V. CONCLUSION

A. SUMMARY

Since 1998, local base SAR units at several air stations have been divested as a result of cost cutting measures. Significant budgetary constraints and an austere fiscal environment have again spurred interest among senior leaders to examine ways to achieve cost savings for the Marine Corps while preserving the readiness of our core competencies. Our thesis is based on a request from APP-51 to compare the cost of future USMC local base SAR options with commercial outsourcing alternatives. Our analysis seeks to aid decision-makers by providing an estimate of the costs associated with these alternatives.

Our primary research question asked whether a commercial contract could provide SAR service to MCAS Cherry Point and MCAS Yuma more cost effectively than continuing to maintain the local base SAR units at each location. To answer this question, we utilized the CBA methodology as provided in the OMB Circular A-94 *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs* (OMB, 1992). However, for the purpose of our analysis, we specifically examined only fiscal dollar costs and did not analyze or compare qualitative cost or benefits between alternatives. Additionally, we did not address SAR policy but sought only to provide an accurate analysis of current and projected costs and a comparison to a commercial SAR contract with like capabilities.

To begin our research, we first analyzed SAR unit activity. Our data shows that over the past five years, a very small percentage of overall SAR unit activity was the actual conduct of SAR (or similar missions like MEDEVAC or patient transfer). For instance, only 8% of total flight hours flown by VMR-1 directly supported SAR missions, while only 3% of total flight hours flown by SRU directly supported SAR. Furthermore, we found that Cherry Point SAR averaged just 33 SAR missions annually over the past five years, while Yuma SAR averaged only 13 SAR missions annually over the same time period. We also found that of these SAR missions, only a minority actually supported DoD personnel. In fact, the preponderance of missions flown by Marine SAR units (85% and 58% for Cherry Point and Yuma, respectively) were flown in support of organizations or persons external to the DoD.

We then estimated the future costs to the Marine Corps for continuing local base SAR at both Cherry Point and Yuma. Our estimate is based on 10 years of historical O&S cost data, in addition to the projected procurement and conversion costs associated with upgrading Marine Corps SAR aircraft. As a result, we estimate the Marine Corps will spend between $213 and $319 million (FY2014; 90% confidence interval) on local base SAR for both locations over the next 10 years, with the mid-range estimate being approximately $267 million. First-year costs associated with the HH-1Y are estimated to be between $22 and $30 million (FY2014; 90% confidence interval), with the mid-range estimate of approximately $26 million. The first-year cost estimate for a single location, at either Cherry Point or Yuma, ranges between approximately $12 and $16 million (FY2014; 90% confidence interval), with a mid-range estimate of $14 million.

We then performed an analysis, based on existing DoD contracts and open-source information, of a commercial outsourcing alternative. In particular, we examined the existing air ambulance contract at MCAGCC, estimates provided to the CNA in its 2003 report, and open-source reports of other governmental SAR contracts (particularly the UK) that have contacted for high-end SAR capability from commercial service providers. Analysis of these information sources revealed a range of capabilities; from basic air ambulance services serving MCAGCC, to advanced SAR capabilities provided by Bristow Group Inc. to the UK. The cost estimate per location ranged between $3 million and $10 million (FY2014). However, we determined that the capability of the air ambulance service would not meet or exceed the capability of existing local base SAR units. Cost estimates for commercial services that meet or exceed current SAR capability range from $6 million (based on use of the AW189) to $10 million (based on use of the S-92) (FY2014) per location. Of note, both of the cost estimates for a commercial SAR option (the AW189 and S-92) represent aircraft performance improvements over existing and future Marine Corps local base SAR.

The option to use the AW189 represents the most similar comparison in our analysis to existing and future local base SAR capabilities. The estimated cost range for the AW189 to provide SAR is between $5.9 and $6.4 million, with a mid-range estimate of $6.15 million (FY2014) per location.

B. SUMMARY OF MAIN FINDINGS AND RECOMMENDATION

In order to meet the objective of our thesis, we first addressed our secondary research question, which was to determine the estimated future costs of local base SAR units and estimated future costs associated with a contract for SAR service. Based on our analysis, we estimate the future costs of local base SAR to be approximately $26 million per year (FY2014$) for both locations. We also estimate the future cost of commercial outsourcing for local base SAR to be approximately $12 million per year (FY2014$) for both locations.

We then answered our primary research question, which was to determine if a commercial contract for SAR service would be a more cost-effective alternative than continuing to maintain local base SAR units. Based on our research, analysis, and assumptions, we found the potential for significant cost savings with the commercial alternative. The Marine Corps could realize savings of approximately $14 million per year (FY2014) by utilizing a commercial contract for local base SAR at MCAS Cherry Point and MCAS Yuma.

As a result, we recommend the Marine Corps consider the use of commercial contracts for SAR at MCAS Cherry Point and MCAS Yuma, provided that further analysis does not obviate the findings in this thesis.

C. FUTURE RESEARCH

There are several areas recommended for further research that should be explored prior to a decision to change Marine Corps local base SAR. These areas could affect the feasibility of utilizing a commercial contract for SAR and could increase or decrease any proposed cost savings.

1. Policy

We recommend further study on SAR policies, including identification of Marine Corps SAR requirements, specifically capabilities and response times. This study will necessarily depend on changes to, or re-adoption of, portions of Marine Corps Order 3130.2, *Standard Operating Procedures for Marine Corps Air Station SAR Units and Helicopter Crewmember Evaluation and Training Program* (HQMC, 1987), which was rescinded in February 2013.

Additionally, we recommend further analysis on the impact of the loss of Marine Corps local base SAR to the National SAR Plan, and to the availability of air medical services in the local communities. Implied in this suggestion is the consideration of significant political factors that affect local base SAR units at both MCAS Cherry Point and MCAS Yuma. We also recommend further analysis of an alternative that would mandate the use (and/or repositioning) of adjacent governmental SAR assets (like the Coast Guard) to perform the SAR mission for the Marine Corps, versus utilizing local base SAR units or commercial contracts.

2. Economics

Our analysis assumed that there are no substantive differences in governmental regulation or policy between the U.S. and UK that would cause significant changes to our cost estimate. Furthermore, we assumed that the commercial vendor would not incur additional overhead expense that would require significant price adjustments, or that the commercial vendor uses variable costing vice absorption-based costing methods in its accounting. Therefore, we recommend that further study be conducted to determine the impact of governmental regulations and company accounting methods on industry pricing.

3. Market

While the commercial helicopter services industry has grown substantially over the last several decades, the SAR market in the U.S. has not evolved the way it has in other countries because of the extensive reliance on the U.S. Coast Guard. Additionally, use of commercial vendors for transport is restricted by DoDI 4500.53. Therefore, we recommend that further study be conducted to determine the nature of current market conditions for SAR in the U.S.

4. Facilities

Our analysis assumed no new military construction and that existing spaces would be available for a contract SAR provider. However, any changes to this assumption could increase or decrease associated cost savings. Therefore, we recommend a facilities impact study be completed to determine the availability of existing hanger and office spaces, hazardous materials (HAZMAT), and fuel support for a commercial SAR contractor.

5. Units and Manpower

We also recommend further research into the unit and manpower impacts associated with changes to local base SAR; specifically, the impact of commercial outsourcing to C-9B maintenance at VMR-1. Divesture of the SAR capability at VMR-1 could negatively impact the ability of the unit to perform maintenance on the C-9B because of significant cross-training within its maintenance department. A significant loss of T/O line numbers could have negative impacts on the unit's ability to maintain the C-9B. However, utilization of a commercial contract to perform maintenance on the C-9B (the squadron's UC-35 maintenance is already performed by contractors) could potentially alleviate this shortfall, but may decrease the projected cost savings associated with divesture of local base SAR at Cherry Point.

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APPENDIX A. NAVAL HELICOPTER AND TILT ROTOR AIRCRAFT INVENTORY CAPTURED IN VISIBILITY AND MANAGEMENT OF OPERATIONS AND SUPPORT COSTS, 1997–2012

Inventory Captured in VAMOSC

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
AH-1W	168	185	187	190	191	187	182	178	174	169	165	154	152	138	133	126
AH-1Z										2		3	3	8	16	24
CH-46D	27	27	25	26	25	11	3									
CH-46E	229	229	230	229	228	226	224	224	218	215	195	172	152	127	118	94
CH-53D	46	43	44	44	38	40	40	35	35	34	33	34	34	33	22	
CH-53E	146	146	148	150	152	150	147	147	144	144	144	144	147	148	151	149
HH-1N	22	22	22	22	21	24	23	18	15	15	14	15	5	5	4	4
HH-46D	42	42	41	41	41	38	24	7	3	3	2					
HH-46E											1	3	3	3	4	4
HH-60H	37	39	39	39	39	39	39	39	38	38	37	36	35	35	35	35
MH-53E	39	39	39	35	36	36	35	32	30	30	30	29	30	30	30	27
MH-60R							2	2	4	5	8	20	36	61	92	117
MH-60S					6	26	47	66	74	75	89	111	134	162	181	187
MQ-8B														1	2	1
SH-2G	15	13	12	12												
SH-3H	6	6	4	1	1											
SH-60B	162	158	156	154	150	147	147	147	146	146	145	144	139	130	102	79
SH-60F	73	71	72	72	72	71	71	72	71	71	70	67	55	51	40	26
UH-1N	103	97	96	97	96	91	90	86	86	86	83	84	85	73	46	25
UH-1Y										2	2	12	19	29	46	61
UH-3H	49	43	48	46	48	47	46	37	18	7	2			1	1	1
UH-46D	12	11	11	11	11	9	1									
VH-3A	4	3	2	2	2	2	2									
VH-3D	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
VH-60N	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
MV-22B				8	7	7	2	11	26	37	49	63	79	98	124	154
Total	**1,199**	**1,193**	**1,195**	**1,198**	**1,183**	**1,170**	**1,144**	**1,120**	**1,101**	**1,098**	**1,088**	**1,110**	**1,127**	**1,152**	**1,166**	**1,133**

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APPENDIX B. COST ELEMENT STRUCTURE FOR SAR AIRCRAFT (BOTH HH-46E AND HH-1N) FROM VISIBILITY AND MANAGEMENT OF OPERATIONS AND SUPPORT COSTS (VAMOSC)

1.0 - Unit-Level Manpower
1.1 - Operations Manpower
1.2 - Unit-Level Maintenance Manpower
1.3 - Other Unit-Level Manpower
2.0 - Unit Operations
2.1 - Operating Material
2.1.1 - Energy (POL, Electricity)
2.1.2 - Training Munitions and Expendable Stores
2.1.3 - Other Operational Material
2.2 - Support Services
2.3 - Temporary Duty
3.0 - Maintenance
3.1 - Organizational Maintenance and Support
3.1.1 - Organization-Level Consumables
3.1.2 - Organization-Level Repair Parts
3.1.3 - Organization-Level DLRs
3.1.4 - Contract Maintenance Services
3.1.5 - Other Unit Maintenance
3.2 - Intermediate Maintenance
3.2.1 - Intermediate Level Consumable Parts
3.2.2 - Intermediate Level Repair Parts
3.2.3 - Intermediate Level DLRs
3.2.4 - Government Labor
3.2.5 - Contractor Maintenance
3.2.6 - Other Intermediate Maintenance
3.3 - Depot Maintenance
3.3.1 - Government Depot Repair
3.3.2 - Contractor Depot Repair
3.3.3 - Other Depot Maintenance
4.0 - Sustaining Support
4.1 - System Specific Training
4.1.1 - System Specific Operator Training
4.1.2 - System Specific Non-Operator Training
4.2 - Support Equipment Replacement
4.3 - Operating Equipment Replacement
4.4 - Sustaining Engineering and Program Management
4.5 - Other Sustaining Support

5.0 - Continuing System Improvements
5.1 - Hardware Modifications or Modernization
5.2 - Software Maintenance & Modifications
5.2.1 - Correction of Deficiencies
5.2.2 - Software Enhancements
6.0 - Indirect Support
6.1 - Installation Support
6.2 - Personnel Support
6.2.1 - Personnel Administration
6.2.2 - Personnel Benefits
6.2.3 - Medical Support

APPENDIX C. VMR-1 TABLE OF ORGANIZATION

Billet Description	Pay Grade	BMOS	PMOS
HEADQUARTERS			
COMMANDING OFFICER	O5	7506	0000
EXECUTIVE OFFICER	O4	7551	0000
EXECUTIVE OFFICER	O4	7506	0000
SERGEANT MAJOR	E9	8999	8999
CAREER PLANNER	E5	4821	4821
AVN SAFETY/STAND			
DIR SAFETY/STAND	O4	7551	0000
AVN SAF OFF	O3	7596	0000
NATOPS OFF (C-9)	O4	7551	0000
NATOPS OFF (UC-35)	O4	7554	0000
NATOPS OFF (H-46)	O3	7562	0000
AVN OPERATIONS CLERK	E4	7041	0000
S-1			
ADMIN OFFICER	O4	7551	0000
ADMIN OFFICER	O4	7551	0000
LEGAL OFF	O3	7554	0000
ADMIN CHIEF	E8	O111	O111
PERSONNEL CHIEF	E4	O112	O111
S-3			
OPERATIONS OFFICER	O4	7551	0000
OPS OFFICER	O4	7551	0000
ASST OPS OFF	O4	7562	7562
ASST OPS OFFICER	O4	7506	0000
SCHED OFF	O3	7562	7562
AVN OPERATIONS CHIEF	E7	7041	7041
AVN OPERATIONS CLERK	E4	7041	7041
AVIATION OPERATIONS CLERK	E3	7041	7041
TRNG OFF	O3	7562	7562
TRNG OFF	O3	7562	7562
TRNG CHIEF	E6	6276	6276
C-9 BRANCH			
FLIGHT OFFICER	O4	7551	0000
FLIGHT OFFICER	O4	7551	0000
PILOT	O5	7551	0000
PILOT	O5	7506	0000
PILOT	O4	7506	0000

PILOT	O4	7551	0000
PILOT	O4	7551	0000
PILOT	O4	7551	0000
PILOT	O3	7551	0000
CREW MASTER	E5	6276	6276
CREW MASTER	E5	6276	6276
CREW MASTER	E5	6276	6276
CREW MASTER	E4	6276	6276
CREW MASTER	E4	6276	6276
FLIGHT ATTENDANT	E5	8014	0000
FLIGHT ATTENDANT	E5	8014	0000
CREW MASTER	E5	6276	6276
CREW MASTER	E5	6276	6276
CREW MASTER	E5	6276	6276
CREW MASTER	E3	6276	6276
CREW MASTER	E3	6276	6276
CREW MASTER	E3	6276	6276
CREW MASTER	E3	6276	6276
UC-35 BRANCH			
FLIGHT OFFICER	O4	7554	0000
FLIGHT OFFICER	O4	7554	0000
PILOT	O5	7506	0000
PILOT	O5	7506	0000
PILOT	O4	7506	0000
PILOT	O4	7506	0000
PILOT	O4	7506	0000
PILOT	O4	7506	0000
PILOT	O4	7506	0000
CREW MASTER	E5	6276	6276
CREW MASTER	E3	6276	6276
CREW MASTER	E3	6276	6276
SAR BRANCH			
SAR OIC	O4	7562	7562
SAR OIC	O4	7562	7562
PILOT	O3	7562	7562
PILOT	O4	7562	7562
PILOT	O3	7562	7562
PILOT	O3	7562	7562
PILOT	O3	7562	7562
PILOT	O3	7562	7562
PILOT	O3	7562	7562

PILOT	O4	7562	7562
PILOT	O4	7562	7562
PILOT	O4	7562	7562
PILOT	O4	7562	7562
CREW CHIEF	E5	6172	6172
CREW CHIEF	E5	6172	6172
CREW CHIEF	E5	6172	6172
CREW CHIEF	E5	6172	6172
CREW CHIEF	E5	6172	6172
CREW CHIEF	E5	6172	6172
CREW CHIEF	E4	6172	6172
CREW CHIEF	E4	6172	6172
CREW CHIEF	E4	6172	6172
CREW CHIEF	E4	6172	6172
SAR SWIMMER	E4	6172	6172
SAR SWIMMER	E4	6172	6172
SAR SWIMMER	E4	6172	6172
SAR SWIMMER	E3	6172	6172
SAR SWIMMER	E3	6172	6172
SAR TECH	E5	8401	8406
SAR TECH	E4	8401	8406
SAR TECH	E4	8401	8406
SAR TECH	E4	8401	8406
AIRCRAFT MAINT DIVISION			
A/C MAINT OFFICER	O4	7554	0000
ASST ACFT MAINT OFF	O3	6002	6002
ACFT MAINT CHIEF	E8	6019	6019
NALC ADMIN/ANALYST	E6	6049	6046
MAINT ADMIN SPEC	E5	6046	6046
MAINT/MAT CONT BRANCH			
M/M CONT CHIEF	E7	6112	6112
M/M CONT - AIRFRAMES	E5	6256	6256
M/M CONT - MECH	E5	6216	6216
M/M CONT - MECH	E5	6112	6112
M/M CONT - AVION	E5	6322	6322
IMRL			
IMRL MANAGER	E4	6042	6042
TOOL ROOM			
QUALITY ASSURANCE BRANCH			
Q/A OFFICER	O3	7506	0000
NCOIC	E6	6216	6216

Q/A - AIRFRAMES	E7	6152	6152
Q/A - AVION	E6	6322	6322
Q/A - AVION	E6	6316	6316
MAINT ADMIN SPEC - Q/A	E4	6046	6046
AIRCRAFT			
A/C OFFICER	O3	7562	7562
AIRFRAMES			
AIRFRAMES CHIEF	E7	6152	6152
AIRFRAMES MECH/HAZMAT	E6	6152	6152
AIRFRAMES MECH	E5	6152	6152
AIRFRAMES MECH	E5	6152	6152
AIRFRAMES MECH	E3	6152	6152
AIRFRAMES MECH	E3	6152	6152
AIRFRAMES MECH	E5	6256	6256
AIRFRAMES MECH	E4	6256	6256
AIRFRAMES MECH	E4	6256	6256
AIRFRAMES MECH	E3	6256	6256
CORROSION CONTROL			
SNCOIC	E6	6256	6256
C/C MECH	E4	6152	6152
C/C MECH	E3	6152	6152
C/C MECH	E3	6322	6322
SAF/SURV EQUIP			
SNCOIC	E7	6048	6048
FLT EQUIP MECH	E4	6048	6048
SAF EQUIP MECH	E7	6286	6286
SAF EQUIP MECH	E3	6286	6286
SAF EQUIP MECH	E3	6286	6286
AVIONICS BRANCH			
AVIONICS OFFICER	O3	7562	7562
AVIONICS CHIEF	E7	6322	6322
AVION TECH	E5	6322	6322
AVION TECH	E4	6322	6322
AVION TECH	E3	6322	6322
AVION TECH	E5	6316	6316
AVION TECH	E3	6316	6316
ELECT	E5	6336	6336
ELECT	E5	6336	6336
ELECT	E4	6336	6336
FLIGHT LINE BRANCH			
FLIGHT LINE OFFICER	O3	7562	7562

LINE CHIEF	E6	6216	6216
C-9 SECTION			
LINE MECH	E5	6216	6216
LINE MECH	E3	6216	6216
LINE MECH	E3	6216	6216
LINE MECH	E3	6216	6216
CREW MASTER	E5	6276	6276
CREW MASTER	E5	6276	6276
CREW MASTER	E4	6276	6276
CREW MASTER	E3	6276	6276
CREW MASTER	E3	6276	6276
UC-35 SECTION **CONTRACT MAINT**			
HH-46 SECTION			
SNCOIC	E6	6112	6112
LINE MECH	E5	6112	6112
LINE MECH	E3	6112	6112
LINE MECH	E3	6112	6112
LINE MECH	E3	6112	6112
CREW CHIEF	E5	6172	6172
CREW CHIEF	E5	6172	6172
CREW CHIEF	E4	6172	6172
CREW CHIEF	E4	6172	6172
CREW CHIEF	E4	6172	6172
CREW CHIEF	E4	6172	6172
CREW CHIEF	E4	6172	6172
CREW CHIEF	E4	6172	6172
GSE SECTION			
SNCOIC	E7	6072	6072
GSE MECH	E4	6072	6072
GSE MECH	E3	6072	6072
IMA BRANCH			
OIC	O3	7506	0000
PROD CONT			
SNCOIC	E7	6414	6414
MAINT ADMIN SPEC - P/C	E3	6046	6046
MAINTENANCE SECTION			
STR MECH/NDI	E5	6092	6092
COMM TECH	E4	6414	6414
NAV TECH	E4	6414	6414
ELECT/INST TECH	E5	6433	6433
GSE MECH	E7	6073	6073

GSE MECH	E5	6073	6073
GSE MECH	E4	6073	6073
CRYO EQUIP OPERATOR	E5	6074	6074
CRYO EQUIP OPERATOR	E4	6074	6074
SUPPLY/S-4 DIVISION			
SUPPLY OFFICER	W2	6604	6604
AVN SUPPLY CHIEF	E7	6672	6672
AVN FISCAL ACCT CHIEF	E6	6672	6672
AVN FISCAL ACCT SPEC	E4	6672	6672
SQUADRON SUPPORT CHIEF	E5	6672	6672
AVN REQ/EXPIDITER SPEC	E4	6672	6672
CUSTODY RECORDS CLERK	E3	3043	3043
AVN SUPPLY EXPEDITER	E3	6672	6672
AVN RPR MGNT UNIT SPEC	E3	6672	6672
AVN SUPPLY EXPEDITER	E3	3531	3531

APPENDIX D. YUMA SRU TABLE OF ORGANIZATION

Billet Description	Pay Grade	BMOS	PMOS	NOTES
UH-1 HUEY STANDARDS OFFICER	O3	7563	7563	HQ SAFETY
SEARCH AND RESCUE TECHNICIAN	HM2	8401	8406	SAR DET
SEARCH AND RESCUE TECHNICIAN	HM3	8401	8406	SAR DET
SEARCH AND RESCUE TECHNICIAN	HM3	8401	8406	SAR DET
SEARCH AND RESCUE TECHNICIAN	HM3	8401	8406	SAR DET
SEARCH AND RESCUE OFFICER IN CHARGE	O4	7563	7563	SAR DET
SEARCH AND RESCUE ASSISTANT OFFICER IN CHARGE	O4	7563	7563	SAR DET
PILOT	O3	7563	7563	SAR DET
PILOT	O3	7563	7563	SAR DET
PILOT	O3	7563	7563	SAR DET
PILOT	O3	7563	7563	SAR DET
PILOT	O3	7563	7563	SAR DET
PILOT	O3	7563	7563	SAR DET
CREW CHIEF	E5	6174	6174	SAR DET
CREW CHIEF	E5	6174	6174	SAR DET
CREW CHIEF	E5	6174	6174	SAR DET
CREW CHIEF	E5	6174	6174	SAR DET
CREW CHIEF	E4	6174	6174	SAR DET
CREW CHIEF	E4	6174	6174	SAR DET
CREW CHIEF	E4	6174	6174	SAR DET
CREW CHIEF	E4	6174	6174	SAR DET
SEARCH AND RESCUE PILOT	O3	7563	7563	SAR DET
AIRCRAFT MAINTENANCE OFFICER	O3	7506	0000	SAR DET
AIRCRAFT MAINTENANCE CHIEF	E8	6019	6019	SAR DET
MAINTENANCE ADMINISTRATIVE SPECIALIST	E4	6046	6046	SAR DET
HELOCOPTER MECHANIC	E7	6114	6114	SAR DET
INDIVIDUAL MAINTENANCE READINESS LIST MANAGER	E3	6042	6042	SAR DET
NCOIC	E6	8014	0000	SAR DET
TOOL ROOM ATTENDANT	E3	8014	0000	SAR DET
QUALITY ASSURANCE (QA) OFFICER	O3	7506	0000	SAR DET
QUALITY ASSURANCE (QA) CHIEF	E7	6114	6114	SAR DET
QUAILTY ASSURANCE (QA) AVIATION	E6	6154	6154	SAR DET
QUAILTY ASSURANCE (QA) AVIATION	E6	6324	6324	SAR DET

MAINTENANCE ADMINISTRATIVE SPECIALIST - Q/A	E3	6046	6046	SAR DET
NAVAL AVAITION LOG CMD INFO SYS (NALCOMIS) SPEC	E5	6046	6046	SAR DET
AIRFRAMES CHIEF	E6	6154	6154	SAR DET
AIRFRAMES MECHANIC	E5	6154	6154	SAR DET
AIRFRAMES MECHANIC	E3	6154	6154	SAR DET
AIRFRAMES MECHANIC	E3	6154	6154	SAR DET
HELICOPTER AIRFRAME MECHANIC A/UH-1	E6	6154	6154	SAR DET
HELICOPTER MECHANIC U/AH-1	E3	6114	6114	SAR DET
AIRCRAFT SAFETY MECHANIC	E5	6048	6048	SAR DET
AIRCRAFT SAFETY MECHANIC	E3	6048	6048	SAR DET
AVIONICS CHIEF	E7	6324	6324	SAR DET
AVIONICS TECHNICIAN	E3	6324	6324	SAR DET
AVIONICS TECHNICIAN	E3	6324	6324	SAR DET
AVIONICS TECHNICIAN	E3	6324	6324	SAR DET
LINE CHIEF	E6	6114	6114	SAR DET

APPENDIX E. SAR TOTAL MISSION REQUIREMENTS CODES

TMR Code	Description
2P1	SUPT SAR/WATER MIL SUPT
2P2	SUPT SAR/LAND MIL SUPT
2P3	SUPT SAR/WATER N-DOD
2P4	SUPT SAR/LAND N-DOD
2P5	SUPT SAR/MEDEVAC MIL SUPT
2P6	SUPT SAR/MEDEVAC N-DOD

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