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TITLE:

**FORWARD FROM THE PAST:
MARINE CORPS ENGINEER OPERATIONS IN WORLD WAR II ARE PATHWAYS
TO THE EABO CHALLENGES OF TODAY**

SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
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Sample Executive Summary

Title: Forward from the Past: Marine Corps Engineer Operations in World War II are Pathways to the EABO Challenges of Today.

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Thesis: The successful integration of Marine Corps engineers during World War II, focused on task organization, bridge operations, horizontal construction, and bulk liquid operations, has specific application to the present-day EABO concept.

Discussion: The 2019 Commandant's Planning Guidance specifically directs a focus on the preparation for confronting a peer threat centered on the USINDOPACOM area of operations. While impossible to predict the next war or the exact character of the conflict, an argument can be made that the next war will be waged over great distances, through multiple domains, and in a dispersed manner. The current proliferation of long-range precision-guided munitions, vast detection and tracking networks, information capabilities, and communication technology indicate that US forces will not be able to mass at a single location or have unopposed movement within an AO. For the Marine Corps engineer community, the application of lessons learned from the Guadalcanal Campaign and Battle of Okinawa provide valuable insight into the potential application of engineer forces in future conflicts particularly in the Indo-Pacific region. This paper examines four critical components within each case study and looks at how task organization, bridging operations, horizontal construction, and bulk fuel operations impacted the execution of the battle. Relating these same four components to modern and future conflict issues this paper examines how lessons learned from World War II are still relevant to engineer operations in support of EABO, mobility in a high threat environment, and bulk liquid storage and distribution in a distributed environment.

Conclusion: The application of lessons learned from the Guadalcanal Campaign and Battle of Okinawa remain relevant to the employment of engineer forces during future conflicts. Specifically, the current task organization of the Marine Corps will enable the effective engineer support to maneuver forces operating within the EABO concept. Mobility operations will remain a critical capability for engineer forces, but the size of engineer bridging equipment will create both logistical and operational challenges in a distributed environment. Finally, bulk liquid operations, while glossed over in many World War II accounts, are essential to support and sustain maneuver forces in an EABO scenario. Marine Corps engineers will play a critical role in future near-peer conflicts, and learning from the past will help set the engineer community up for success in the future.

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Table of Contents

	Page
Executive Summary	I
Disclaimer	II
List of tables.....	IV
Acknowledgments.....	V
Preface.....	VI
Introduction.....	1
Definitions.....	2
Background	3
Case Study 1: Ill-Equipped Engineer Support to a Critical Operation	5
Summary	10
Case Study 2: Robust Engineer Support to a Joint Operation	11
Summary	14
Historical context.....	16
EABO Application.....	16
1) Task Organization, Operational Employment, and Logistical Support.....	17
2) Mobility in a Distributed, High-Threat Environment.....	22
3) Bulk Liquid Storage and Distribution	25
Conclusion	31
Bibliography	34

Tables

	Page
Table 1. Engineer Tasks from Tentative Landing Operations Manual of 1935	3
Table 2. Engineer Core Mission Essential Task List (METL)	5
Table 3. Captured Japanese engineer equipment at Henderson Air Field	9
Table 4. Task Organization of engineer units at Okinawa.....	11
Table 5. Marine Engineer Battalion table of equipment, 1939.....	20
Table 6. Marine Seperate Engineer Battalion table of equipment, 1944	20
Table 7. 7th Engineer Support Battalion table of equipment, 2018.....	21
Table 8. Daily water production estimates	26

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Preface

The Marine Corps is at a crossroads in its history. For eighteen years the Marine Corps has been consumed with supporting the Global War on Terror, which has resulted in an intense focus on counter-insurgency operations (COIN) in Afghanistan and Iraq. The ascent of the Islamic State of Iraq and Syria (ISIS) gave rise to a new task of maintaining COIN operations while combating violent extremist organizations (VEOs) in Iraq and Syria. In both COIN and VEO operations, the Marine Corps has entered combat significantly better trained and equipped with a massive technological overmatch compared to that of the adversaries. The 2019 Commandant's Planning Guidance provides a picture in stark contrast to that of COIN operations and places a renewed emphasis on preparing for great power competition. The United States (US) is faced with growing near-peer challengers in the People's Republic of China (PRC) and Russia that seek to exert both regional and global influence. The further rise in capacity and capability of the rogue nation states of the Democratic People's Republic of Korea (DPRK) and Iran provide unique challenges within the U.S. Central Command (USCENTCOM) and US Indo-Pacific Command (USINDOPACOM) areas of operations. Given these four adversaries, the 2019 Commandant's Planning Guidance specifically directs a focus on the preparation for a near-peer conflict centered on the USINDOPACOM area of operations (AO)¹ while the 2018 National Defense Strategy identifies the PRC as the specific pacing threat.²

While the geo-political environment and potential adversaries have changed, the challenges associated with combat operations in the Pacific remain the same. This study examines the historical context of Marine Corps engineer innovation and integration in support of the Fleet Marine Force (FMF) during World War II. Specifically focusing on the Guadalcanal Campaign and the Battle of Okinawa, this paper examines how lessons learned from World War II potential pathways to future combat operations in the Pacific.

¹ United States Marine Corps, *Commandant's Planning Guidance* (Washington, DC, July 16, 2019) 3.

² US Department of Defense, *2018 National Defense Strategy* (Washington, DC, January 19, 2018) 2.

“Those that do not learn from history are doomed to repeat it.”¹
George Santayana (Philosopher, 1863-1952)

Introduction:

The Marine Corps is in a unique position to capitalize on the lessons learned from one of the largest and most intense conflicts of the modern era. The current geo-political climate of the United States Indo-Pacific Command (USINDOPACOM) area of operations has set the stage in a manner that is eerily similar to that of the inter-war period of 1920-1937. To say that we are currently in an inter-war period suggests that war in the future is inevitable. While it is impossible to predict the exact time, location, or character of a future conflict, the Marine Corps is certainly well served to develop new operational concepts and equipment to prepare for war in the Pacific. As the 2019 Commandants Planning Guidance directs a renewed focus on preparing for great power conflict in the USINDOPACOM area of operation it is increasingly important to examine the lessons learned from World War II. While equipment and technology have certainly advanced, the Marine Corps and engineer community are faced with the same challenges that plagued the Marines of World War II. Namely, how do you task organize, equip, logistically support, and operationally employ engineer forces against a near-peer adversary in a distributed environment on the far side of the world’s largest ocean. Concepts such as Expeditionary Advance Base Operations (EABO) provide operational blue prints for the prosecution of a Pacific Theater campaign, but do not specifically dictate how engineer operating forces will be employed. The successful integration of Marine Corps engineers during World War II, focused on task organization, bridge operations, horizontal construction, and bulk liquid operations, has specific application to the present-day EABO concept. Studying the lessons taken from World War II leads to a better understanding of the essential nature of engineer operations in a great power conflict, the alignment of engineer forces, mobility challenges in a distributed high-threat

environment, and the need to prioritize bulk liquid operations. Collectively, these lessons provide direction on solving present-day challenges associated A2/AD and distributed operations in the USINDOPACOM Area of operations.

Definitions:

- Expeditionary Advanced Basing Operations (EABO): The Marine Corps Warfighting Laboratory (MCWL) defines the EABO concept as, “a naval operational concept that anticipates the presence and resiliency requirements of the next paradigm of joint expeditionary operations. The concept is predicated on the increasingly obvious need for US naval and joint forces to adapt the method for conducting expeditionary operations in light of significant adversary advances in the capability and capacity of their long-range precision fires.”²
- Anti-Access / Area-Denial (A2AD): In his book *Anti-Access Warfare*, Sam S. Tangredi defines A2/AD as “modern terms referring to warfighting strategies focused on preventing an opponent from operating military forces near, into, or within a contested region.”³ MCWL further defines A2/AD as the use of long-range precision munitions designed “to create new advantages, exploit regional geography, incite partner apprehension, inhibit US intervention and preclude American theater access.”⁴
- Stand-in Forces: In his article “Stand-in Forces”, Colonel Art Corbett (USMC, Retired) defines stand-in forces as forces that will “take advantage of partner geography to conduct an integrated maritime defense of the straits that control access to close and confined seas.”⁵ He further describes the concept of stand-in forces as, “smaller, less expensive, hard to find, risk worthy platforms in all domains.”⁶

Background:

The engineer community within the Marine Corps is relatively young in comparison to that of the United States Army Corps of Engineers (USACE). The USACE was established at the direction of General George Washington prior to the start of the American Revolution in 1776.⁷ The Marine Corps did not identify engineers as a requirement until 1899 after the conclusion of the Spanish-American War.⁸ The Marine Corps, while realizing the need for engineers, did not define specific roles or tasks for engineer units. As a result, engineer units endured a cyclic period of activation, deactivation, and realignment of forces between 1900-1935. Engineers proved their value during the interwar period as the Marine Corps experimented with amphibious landings against a contested objective. As early as 1914, engineers supported the preparation of gun pits for fixed artillery companies ashore, employed demolitions to create ammunition magazines, used hand tools to improve roadways off the beach, and provided manpower to move pack howitzers into the hillside.⁹ The Tentative Landing Operations Manual of 1935 defined ten tasks for engineers (see table 1) in support of amphibious operations.

Table 1: Engineer Tasks from Tentative Landing Operations Manual of 1935

Task	Description
1	Compilation, reproduction, and distribution of maps;
2	Assistance to the beach party in the removal of underwater obstructions at the beach, construction and maintenance of improvised landings and temporary wharves, and in the landing of heavy material;
3	Construction, shelter, and camouflage of important rear area establishments;
4	Repair, construction, and maintenance of traffic routes from the water's edge to combat units and, if necessary, assistance in the movement of heavy vehicles;
5	Construction and maintenance of facilities for the reception, stowage, and purification of water, the development of water supply ashore, and the organization and maintenance of water distributing points;
6	Construction of landing fields for aviation;
7	Furnishing technical assistance, and provision and distribution of tools and materiel for the construction of defensive position, artillery positions, and command and observation posts;
8	Demolition of enemy obstacles on shore, and roads and bridges which might be of assistance to the enemy;
9	Repair, maintenance, and operation of existing railways and, if necessary, other public utilities;
10	The execution of engineering work of a special character

Source: Headquarters, United States Marine Corps, *Tentative Landing Operations Manual*, 9 July 1935, Archives, Marine Corps History Division, Quantico Virginia, 289.

Despite the specific tasks listed in the Tentative Landing Operations Manual of 1935, the actual mission of the engineers depended upon the size and activity of the Marine Corps as a whole, which often saw their role reduced to base maintenance companies during peacetime operations.¹⁰ In preparation for perceived war with the Empire of Japan in the Pacific Ocean, the Marine Corps created the 1st and 2nd Engineer Battalions in March 1940, but subordinate companies were not fully activated until December 1941.¹¹ The engineer battalions were each aligned to a Marine Brigade and served in a hybrid capacity compared to that of the present-day Combat Engineer Battalions and Engineer Support Battalions. Serving in each of the major battles of the Marine Corps Pacific Campaign, combat engineer units expanded considerably from 1941 to 1945 both in quantity and capability. Beginning with the Guadalcanal Campaign and ending with the Battle of Okinawa, Marine Corps Combat Engineers played a critical role in developing infrastructure and provided essential engineer support to units throughout the war.

Today, combat engineer units are assigned to each of the three primary elements of the Marine Air Ground Task Force while engineer planners are assigned to key billets on Marine subordinate command (MSC) staffs. Reminiscent of the initial tasks assigned to engineers in the Tentative Landing Operations Manual of 1935, current engineer units are assigned a list of mission essential tasks (See table 2) that facilitate comprehensive engineer support to the assigned MSC. Present-day mission essential task lists (METLs) are a driving factor in how engineer forces are task organized, equipped, and trained for future operations. The current engineer METLs will be a critical factor in the employment of engineer forces in support of EABO and future operational concepts.

Table 2. Engineer Core Mission Essential Task List (METL)¹²

MARINE CORPS TASK LIST	ENGINEER UNITS CORE METL
MCT 1.1.2	Provide Task-Organized Forces
MCT 1.12.1	Conduct Amphibious Operations
MCT 1.4.1	Conduct Mobility Operations
MCT 1.4.2	Conduct Counter-Mobility Operations
MCT 2.2.2	Provide and Maintain Engineering Reconnaissance Operations
MCT 4.2.2.4	Conduct Repair
MCT 4.3.6	Conduct Material Handling Operations
MCT 4.4.1	Conduct Horizontal Construction
MCT 4.4.1.1	Conduct Limited Horizontal Construction
MCT 4.4.2	Conduct Vertical Construction
MCT 4.4.2.1	Conduct Limited Vertical Construction
MCT 4.4.3	Conduct Bulk Liquids Operations
MCT 4.4.3.1	Conduct Limited Bulk Liquids Operations
MCT 4.4.4	Conduct Tactical Electrical Supply
MCT 4.4.4.1	Conduct Limited Tactical Electrical Supply
MCT 6.1.4	Conduct Survivability Operations

Source: Headquarters, United States Marine Corps, *Engineer and Utilities Training and Readiness Manual*, Washington DC, 22 January 2014, 2-2.

Case Study #1: Ill-equipped engineer support to a critical operation

The Marine Corps organized the Fleet Marine Force to provide an array of critical capabilities to its operational units. The 1st Engineer Battalion deployed to Guadalcanal in support of the 1st Marine Division with the Headquarters and Service (H&S) and “D” Companies placed in general support (GS) to the division. “A” Company was attached to the Fifth Marine Combat Group, and “C” Company was attached to the First Marine Combat Group.¹³ Each of the combat groups within the division consisted of an infantry regiment and were supported by an artillery battalion and one company of tanks, engineers, pioneers, and amphibious tractors.¹⁴ Following the successful landing of the amphibious force on 7 August, 1942 and subsequent advance inland, all engineer forces were reconsolidated within the 1st Engineer Battalion on 8 August with the exception of one platoon from “A” Company, which remained attached to 2nd Battalion, 5th Marines.¹⁵ This consolidation was conducted for two reasons. First the 5th Marines captured the Japanese air field on 8 August and the immediate engineer priority shifted to repairing and completing the air field. Massing the battalion engineer

effort enabled the expedient completion of the air field despite the limited availability of engineer equipment. Secondly, the 1st Engineer Battalion was assigned a sector of the defensive line around the perimeter of the air field and massing engineer personnel enabled the continuous manning of defensive positions while still continuing work on the air field. Upon completion of the air field on 18 August, engineer platoons and companies were routinely attached/detached to division units to complete defensive, survivability, and mobility tasks. The collective task organization of the 1st Engineer Battalion demonstrates flexible engineer support to both the division and combat groups throughout the conduct of the battle. The ability to mass engineer forces enabled the division to prioritize tasks and complete them in the most efficient manner.

The 1st Engineer Battalion was well organized, but poorly equipped to complete the tasks assigned to the engineers during the Battle for Guadalcanal. The 1st Engineer Battalion deployed with all of its assigned equipment in May 1942 and staged in New Zealand in July 1942 for final combat loading.¹⁶ The engineers prioritized water purification, bridging, and temporary “tubelox” docking assets, but were also well equipped with company and squad level demolition kits.¹⁷ Intelligence reports indicated to the US engineers that the Japanese airfield on Lunga Point (Henderson Air Field) would be completed prior to D-Day scheduled for 7 August, 1942. To this end, heavy equipment was embarked aboard the transport ship *Fomalhaut*, but was not made a priority for offload.¹⁸ Additionally, no major building construction or bridge construction was planned during the early phases of the landing and engineer companies were not equipped with construction material, tools, or tactical bridging assets. The grievous error to not prioritize heavy equipment and construction materials would have significant adverse consequences that nearly jeopardized the outcome of the battle. For almost immediately upon landing, “A” Company built an expedient bridge across the Ilu River to enable the advance of 5th Marines. This expedient

bridge was constructed by sinking two amphibious tractors in the river as supports and then laying lumber acquired from a US Navy (USN) transport across the top of the amphibious tractors. The engineers had planned for the employment of bridges, but had failed to prioritize the offload of bridges, construction material, construction tools, heavy equipment, and trucks to execute their assigned tasks. This pattern would repeat itself numerous times as engineers would overcome a problem through ingenuity and modification because they lacked the proper tools to accomplish the mission.

Water production on Guadalcanal was a critical task for the engineers as clean drinking water was an essential requirement to maintain the health of the fighting units. The specific table of equipment for the 1st Engineer Battalion indicates that in 1939 the battalion was assigned three water purification systems.¹⁹ Subsequent tables of equipment for Marine Corps engineer battalions as well as engineer activity reports indicate that the 1st Engineer Battalion was equipped with six water purification assets and twenty water distillation units during the Battle of Guadalcanal.²⁰ Collectively, this enabled the engineers to produce an average of 60,000 gallons of fresh water per day.²¹ The production of 60,000 gallons of water per day meets the standard planning factor of 3 gallons²² per day in a jungle environment for each of the 19,546 Marines²³ that landed on Guadalcanal. Throughout the operations the ability to distribute the water in a safe and efficient manner was a critical limiting factor. The Tentative Landing Operations Manual of 1935 recommended acquiring 10-gallon milk cans from the host country for the purpose of distributing freshwater.²⁴ This course of action is unfeasible on a remote tropical island. The method of distributing the freshwater was reduced to the use of used oil/gas drums. Despite washing the interior of the drum, the drums often fouled the water making it unfit for consumption.

The storage and distribution of bulk fuel was not a task assigned to the 1st Engineer Battalion as it is assigned to present-day Engineer Support Battalions and Marine Wing Support Squadrons. However, engineers were critical to building survivability positions to protect both supply and fuel dumps from enemy fire and bombing.²⁵

The jungle environment of Guadalcanal proved the necessity for military bridging capability. The steep slopes of the mountainous hillsides and dense rainfall turned numerous streams and rivers into impassible obstacles. The engineers were well suited for bridge operations, but ill equipped. Unit activity and after action reports reference the installation of Bailey bridges and manufactured floating bridges (both rubber and metal pontoons), but are not clear on the quantity of assets available or bridges installed. The Engineer Activities (Guadalcanal) report makes it clear that “a great deal in the nature of field expedients was necessary to carry out the simplest of jobs.”²⁶ The Engineer Activities (Guadalcanal) report further identifies that the “toughest part of any engineer assignment was the procurement of the necessary materials, particularly in the case of bridges.”²⁷

Horizontal construction was one of the primary and most critical missions for engineers. However, the 1st Engineer Battalion did not have any heavy equipment due to the failure to prioritize the offload prior to the untimely departure of the naval force from Guadalcanal on 9 August.²⁸ On 10 August, three days after landing on Guadalcanal the 1st Engineer Battalion began work on repairing and completing the unfinished Japanese air field. Renamed Henderson Air Field, the flight line became the sole life-line for the 1st Marine Division after the departure of the naval force. If the air field was not repaired and completed, the Marines on Guadalcanal would have no means of receiving air support or aerial resupply. Without assigned heavy equipment and tools the engineers used captured enemy equipment (see table 3) and hand tools

to move 6,700 cubic yards of soil²⁹ in an effort to extend the runway more than 1,400 feet.³⁰ It is important to note that the Japanese only attempted to deliberately destroy one piece of engineer equipment.³¹ The remaining destroyed equipment was attributed to US naval gun fire and aerial strafing. Had the Japanese effectively disabled more equipment, the Marine Corps would not have been able to complete the runway in such an expedient manner, if at all. Henderson Air Field was completed on 18 August, 1942, but subsequent bombing by the Japanese required almost continuous repairs to keep the air field in operation.

Table 3: Captured Japanese engineer equipment at Henderson Air Field on 9 August, 1942.

Quantity	Item	Note
9	Road Rollers	3 Damaged beyond repair
2	Gas engine powered locomotives with hopper cars	
6	Small 1-KW Homelite type generators	2 damaged beyond repair
50	Handcarts for hauling dirt	
75	Hand shovels	

Source: Headquarters, United States Marine Corps. *Engineer Activities (Guadalcanal)*. Archives, Marine Corps History Division, Quantico Virginia, 3.

The requirement for horizontal construction included extensive construction of combat roads and trails. The existing road network on Guadalcanal facilitated the initial advance of the 1st Marine Division and ultimate capture of Henderson Field. Subsequent roads were required to facilitate the movement of logistical support, connect operational units, and aid in command and control. On 6 September, 1942, the 1st Engineer Battalion cut a 600 yard road along the Lunga River using only captured Japanese equipment and hand tools.³² Upon receiving heavy equipment with the arrival of the 6th Naval Construction Battalion in late September, 1942, engineers made continuous improvement to existing roadways and cut numerous trails in support of 1st Marine Division operations.

Summary:

Engineer efforts on Guadalcanal were essential to the success of the 1st Marine Division, and the campaign may not have succeeded if not for their tireless work. The engineers were task organized in a manner that enabled them to provide immediate support to the infantry regiments while maintaining an engineer capability in GS to the division. The task organization enabled flexibility, particularly the massing of engineer forces, to complete essential tasks, such as the air field, in an expedited manner. However, poor planning led to an ill-equipped engineer force incapable of executing their assigned mission of horizontal construction and bridging. While the untimely departure of the naval force is partially to blame, it is fair to say that the 1st Marine Division and particularly the 1st Engineer Battalion failed to anticipate an enemy response to the amphibious landing. Furthermore, the Tentative Landing Operations Manual of 1935 specifically addresses the engineer task to improve roads and trails upon landing in order to project combat power ashore. By not prioritizing heavy equipment and bridging assets the initial landing was in jeopardy of being unable to advance beyond the first natural obstacle. The decision to not unload construction kits and material indicates a lack of foresight into potential engineer requirements upon landing. Had the Japanese successfully destroyed their engineer equipment left on the air field, the 1st Engineer Battalion would have been completely without equipment to repair and finish Henderson Air Field. Without the air field, the Marines would not have had the air support or sole means of resupply, which may have produced disastrous results for the 1st Marine Division. It can be said that the engineers' ingenuity and adaptability for the construction of expedient bridges across the numerous rivers and jungle streams enhanced the maneuver of the 1st Marine Division and contributed to the successful defense of Henderson Air Field.

Case Study 2: Robust Engineer Support to a Joint Operation

The Battle of Okinawa stands in stark contrast to the perceived shoe string operation that was the Guadalcanal Campaign. Disorganization and poor planning gave way to deliberate planning and application of lessons learned during previous amphibious operations. The size of the amphibious landing dwarfed all other World War II landings, and the scope of the fighting was comparably some of the bitterest of the war. However, similar to the Guadalcanal Campaign, the contributions of Marine Corps engineers increased the capability of the supported division and expedited the successful conclusion of the battle.

The organization for the engineers during the Battle of Okinawa mirrored that of Guadalcanal in terms of support to combat groups, but on a much larger scale. The Marine Corps designated III Amphibious Group as the operational lead for the Battle of Okinawa and task organized an array of Marine Corps, Navy, and Army Air Corps engineer units under it (see table 4). This task organization provided engineer support at all tactical levels.

Table 4: Task organization of engineer units during Battle of Okinawa.

Headquarters	Group	Unit
III Amphibious Group	Corps Engineer Group	44th Naval Construction Regiment (less 58th, 130th, and 145th Naval Construction Battalion, and 11th Special Naval Construction Battalion)
		71st Naval Construction Battalion
		1st Separate Engineer Battalion (USMC)
		802d Aviation Engineer Battalion (USA)
1st Marine Division	Engineer Group	1st Engineer Battalion (less companies A, B, and C)
		145th Naval Construction Battalion
	Combat Group	Each Combat Group assigned (1) Engineer Company from 1st Engineer Battalion
6th Marine Division	Engineer Group	6th Engineer Battalion (less companies A, B, and C)
		58th Naval Construction Battalion
	Combat Group	Each Combat Group assigned (1) Engineer Company from 6th Engineer Battalion

Source: Major Chas S. Nichols Jr. and Henry I. Shaw, Jr., *Okinawa: Victory in the Pacific*, (Washington: Historical Branch, G-3 Division, Headquarters U.S. Marine Corps, U.S. Government Printing Office, 1955), 284-301.

As at Guadalcanal, engineers were not directly tasked with the storage and distribution of bulk fuel. However, engineers played a critical role in facilitating the receipt, storage, and protection of gas supply dumps. As identified in the Tentative Landing Operation Manual of 1935, fuel would be transported via tanker ships and then transported to the shore in individual fuel drums.³³ This process is extremely time consuming and has the potential to create delays in the availability of fuel for land based units. This became precisely the case on Okinawa as gas shortages, particularly for aviation units, became a major concern primarily due to the slow unloading and lack of bulk fuel storage facilities ashore.³⁴ Engineers were tasked to rectify this problem in late April, 1945 through the construction of gas tanks and fuel farms on shore.³⁵ The completion of the gas tanks increased the fuel storage capacity ashore, provided survivability measures against enemy attack, and significantly increased the operational capacity of land-based aviation units.

Water purification remained a primary mission for Marine Corps division and corps level engineer groups. The equipment utilized did not change from that employed at Guadalcanal. However, in the academic and primary sources reviewed during the research of the Battle of Okinawa there is little mention of Marine Corps engineer units performing water purification operations. Though essential to sustain combat operations, the lack of coverage can be attributed to the relative mundane nature of water purification operations when overshadowed by more interesting kinetic operations on a grand scale. The emphasis placed on recording such mundane operations can be summed up by an Engineer Activity Report on Guadalcanal that simply stated, “much routine work went on continually such as water supply.”³⁶

Bridging operations on Okinawa proved to be of vital importance in supporting the advance of combat forces. The topography of Okinawa is marked by steep ravines, jagged cliffs,

and numerous streams and rivers; all of which served as natural obstacles to armored and logistical units. Many of the existing bridges were damaged due to the extensive aerial and ground bombardment or were simply insufficient to support the weight of US trucks and tanks. Marine Corps engineers extensively employed both tactical bridging in the form of Bailey Bridges and ribbon bridges as well as non-standard expedient bridges.³⁷ An example of this was the installation of a 120-foot Bailey Bridges over the Asa River on 6 April by engineers from 6th Engineer Battalion in support of 4th Marines. It should be noted, however, that numerous accounts of bridge installation operations had to be delayed or canceled as enemy fire effectively suppressed all actions on the objective. One example of this was on 23 May, 1945, when engineers from 6th Engineer Battalion attempted to install a bridge across the Asato River. Under intense artillery and mortar fire engineers successfully installed two foot bridges, but attempts to install a Bailey bridge were beaten back by accurate enemy artillery fire.³⁸ This example can be recounted numerous times as enemy artillery fire prevent the installation or delayed completion of a bridge. In each of these examples the engineer operations were in support of a combat team or group advance, but the historical text does not indicate the level of coordination for the gap crossing. To the extent covered, it is unclear if friendly fire and obscuration was ineffective at suppressing the enemy force or if coordination was not completed for friendly fires in support of the gap crossing.

Horizontal construction projects remained a continuous effort for the Marine Corps engineers on Okinawa. Prior to the American landing on 1 April, 1945, the Okinawan countryside was mostly characterized by a patchwork of farms nestled into the steep hills. Very few modern roads existed outside the capital city of Naha with most dirt roads specifically designed for narrow ox carts. Immediately upon landing, Marine Corps engineers overcame

these narrow limiting trails by blasting holes in the coral seawall to improve and widen beach exits.³⁹ Once ashore, engineers led the way, often in front of combat troops, cutting new trails and widening existing roads in support of the US advance. During the month of April, the 6th Marine Division attacked north to seize the city of Nago and secured the northern Motobu peninsula. During this attack north, the engineers conducted what is described by Appleman, Burns, Gugeler, and Staevens in their book *United States Army in World War II, The War in the Pacific, Okinawa: The Last Battle*, as “vital work as the advancement up the isthmus was to be primarily a logistical effort. The 6th Marine Division’s hardest task was to move troops, vehicles, supplies, tanks, and guns over these one-way roads without losing the momentum that has been moving the division ahead at the rate of 7,000 yards a day.”⁴⁰ This herculean effort was continued during the subsequent attack beginning in May 1945. The intense rainfall during the Spring and Summer of 1945 on Okinawa saturated and often completely flooded the road network. Marine Corps engineers continuously improved existing roadways, cut drainage ditches, and provided recovery support for logistical trucks stuck in the mire. In total, engineers widened 164 miles of existing roads for two-lane traffic, constructed 37 miles of two, three, and four lane roads, and maintained a total of 339 miles of roads.⁴¹

Summary:

The Battle of Okinawa demonstrates a significant improvement in the organization, operational support, and engineer activity compared to that of the Guadalcanal campaign. Historical accounts and primary sources indicated a marked improvement in the level of preparedness, training, and equipment resources of the engineers at Okinawa compared to that of the Marines at Guadalcanal. The task organization employed by the III Amphibious Corps at Okinawa reflects a thorough understanding of troop to task requirements and best application of

available forces. Unlike Guadalcanal where engineers were often massed to complete a specific task, the organization of the engineers largely remained intact throughout the course of the battle. This can be attributed to the presence of more engineer units, which enabled the spread loading of tasks and reduced the requirement to centralize engineer forces. Secondly, the presence of proper equipment increased the productivity of smaller engineer elements and reduced the requirement to complete tasks by hand.

In terms of bridging and horizontal construction, the significance of the engineer efforts is easily glossed over in historical accounts due to the focus on kinetic actions. The Battle of Okinawa is often viewed in terms of vicious small arms fighting at close range or by the enormous massed firepower in terms of artillery, naval bombardment, and aerial support. However, the extraordinary amount of ammunition fired by Marine Corps units during the battle was only possible because of the sustained engineer effort to build usable roads and bridges to support logistical movements. Furthermore, the presence of tanks on the front line, though ineffective at times due to the accuracy of enemy anti-tank fire, was made possible only by the installation of bridges across the numerous dry/wet gaps that cut through the Okinawan countryside. The one concerning aspect of engineer actions, particularly bridging, on Okinawa is the seeming disconnect between integration of engineer actions into regimental operations. The multiple bridge insertions that were delayed or canceled due to accurate enemy fire may be the result of a peer-to-peer conflict, or perhaps a lack of prioritization of fires in support of a gap crossing operation. Bridge operations are conducted to support the mobility of the maneuver force. This means that the engineer operation must be nested within the scheme of maneuver of the supported unit and that fires and obscuration are prioritized to support the gap crossing.

While the referenced material is unclear to what extent fires were applied in support of the gap crossing, the delay or cancelation of the operations indicate that they were ineffective at best.

Historical context and the application to present day challenges

The potential for a great power conflict places an emphasis on preparing for a near-peer conflict. While impossible to predict the next war or the exact character of the conflict, an argument can be made that the next war will be waged over great distances, through multiple domains, and in a dispersed manner. The current proliferation of long-range precision munitions, vast detection and tracking networks, information capabilities, and communication technology indicate that US forces will not be able to mass at a single location or have freedom of movement within an AO. However, that does not imply that changes in the character of war will eliminate or render mute the lessons learned from previous wars. For the Marine Corps engineer community, the application of lessons learned from the Guadalcanal Campaign and Battle of Okinawa provide valuable insight into the potential application of engineer forces in future conflicts particularly in the Indo-Pacific region. As examined in each of the case studies, the four critical components of task organization, bridging, horizontal construction, and bulk fuel will be examined through three applications in support of EABO: 1) task organization, operational employment, and logistical support; 2) mobility in a distributed, high-threat environment; and 3) bulk liquid storage and distribution.

EABO Application:

The EABO concept is naval in character and focused on maintaining access and freedom of navigation within an area. Similar to the coaling stations during the interwar period, advanced bases are needed to project combat power in support of the naval campaign. While the ground

forces will likely not be the main effort they provide a valuable capability and will significantly enhance the capability, protection, and projection of combat power for the naval force. However, due to the enemy's precision weapon systems and extended threat weapon engagement zone (WEZ), the Marine Corps will have to significantly alter the way it operates and executes missions. This is not unlike the Battle of Guadalcanal where the US did not possess control of the sea or have initial air superiority. This is reflected in the targeting of US forces ashore by Japanese naval, aviation, and artillery units. In the modern EABO environment sea control and air superiority will likely be contested and may not be taken for granted. Despite a contested operating environment, the engineer community will be tasked with building a network of landing zones, forward arming and fueling points (FARPs), and mobile air strips for the launching of aircraft and drones. However, the ability of enemy threat weapons to target massed forces will require that engineers facilitate the quick movement and relocation of multiple sites and establish survivability positions, all while supporting the mobility of the MEF. This will require a task organized engineer force that is postured to support this complex mission set in a contested environment.

1) Task organization, operational employment, and logistical support:

In terms of task organization, the Marine Corps engineer units are more advantageously postured to support the MEF than they were during the Guadalcanal Campaign or the Battle of Okinawa. At Guadalcanal, a single engineer battalion detached companies to the respective regimental combat groups, before recouping all companies and massing engineer forces in support of specific tasks. As identified during the first case study, this task organization provided limited engineer capabilities to the regimental combat groups while maintaining the ability to mass forces. At the Battle of Okinawa, this task organization evolved significantly as the

availability and quantity of engineer forces provided a significantly larger capability. As at Guadalcanal, engineer battalions were assigned to each division and engineer companies were in turn assigned to regimental combat groups. However, the distinction between combat groups and engineer groups within the division provide an attached engineer capability to combat units while maintaining a general support capability at the division level. Furthermore, the creation of the Corps Engineer Group provided a large engineer capability to the Amphibious Corps.

This same construct is mirrored in the present-day task organization of engineer forces in terms of the alignment of Combat Engineer Battalions within the Marine Division, Engineer Support Battalions within the Marine Logistics Group, and Engineer Detachments as part of Marine Wing Support Squadrons within the Marine Air Wings. This construct provides an assigned engineer capability within each of the elements for the MAGTF with the inherent ability to align engineer support at regimental down to squad levels. Additionally, it provides the MEF and MSC commanders the ability to mass engineer forces for the completion of a specific task.

The application to the EABO environment is that engineer forces are assigned to each MSC within the MEF and can be aligned to support any size element within that MSC. The present-day engineer force has more operational capability than ever before and may be the most scalable organization within the Marine Corps. The personnel detachment and equipment set is solely based on the identified mission, required completion timeline, and type of transportation available. Reminiscent of the engineers at Guadalcanal, present-day engineer units are equipped with scalable construction, pioneer, and carpenter kits that can be utilized to complete projects using only hand tools. The defining requirement being the specific timeline for the project as hand tools will increase the completion time of the project while engineer equipment and

motorized assets will decrease construction time, but increases the transportation requirement as well as visual signature. This is an essential requirement given the distributed and austere nature of EABO operations. As described in the operational concept design, units will be required to operate in an austere environment, in a distributed manner, and often at reduced size to mitigate detection and targeting by enemy forces.⁴² Thus possessing an engineer capability that can enhance survivability, mobility, and general engineering capabilities with a reduced signature will be essential to the success of the stand-in force. Similar to the engineer units at Okinawa, present-day engineer units have the ability to mass engineer forces and equipment on large-scale mobility, counter-mobility, or survivability projects.

The concern with massing engineer forces in an EABO scenario is the significant physical and visual signature that it creates. The size and quantity of engineer and motor transport equipment assigned to engineer battalions increased significantly during World War II and has only continued to increase since 1945. The 1st Engineer Battalion at Guadalcanal (see table 5) had less than a quarter of the equipment assigned to the Separate Engineer Battalion during the Battle of Okinawa (see table 6) just 2 years later.⁴³ Compared to the present-day Table of Equipment for an Engineer Support Battalion (see table 7), the Separate Engineer Battalion was considerably lighter in terms of quantity and variety of equipment. That is not to say that the robust equipment set of an Engineer Support Battalion is not necessary. On the contrary, the present-day equipment provides a wealth of capability and flexibility to engineer operations. However, the large equipment set of a consolidated engineer force is easily detectable and therefore easily targetable in an EABO environment. Furthermore, the transportation requirement to move an engineer battalion is significant and exceeds the assigned transportation capability of the unit. Thus in a distributed environment, particularly over numerous island separated by

hundreds of miles, it becomes nearly impossible to quickly shift engineer equipment from one location to another without substantial support from Marine and joint force naval and aviation assets.

Table 5. Marine Engineer Battalion Table of Equipment approved 23 August 1939.

Asset	Quantity
Tractor	6
Tractor Light	2
Trailer, Water, 300-gal	10
Truck, Machine Shop	1
Truck, 1/2 ton	10
Water Purification Unit	3

Source: Headquarters, United States Marine Corps, Table of Organization and Equipment Report: Marine Engineer Battalion approved 23 August 1939. Archives, Marine Corps History Division, Quantico Virginia.

Table 6. Marine Separate Engineer Battalion Table of Equipment approved 1 May 1944.

Asset	Quantity	Asset	Quantity
Bridge, Pontoon, 360 ft	1	Shovel, ¾ Cu Yd and 3/8 Cu Yd	4
Water Distillation Plant, 1500-2000 gal per day	20	Water Purification Unit, Portable	11
Dock, “Tubelox”	1	Tractor, Heavy	22
Grader, road	3	Tractor, Medium	9
Plow, Road	1	Truck, 1 Ton 4x4	16
Roller	3	Truck, 2.5 Ton 6x6, Dump	39
Scraper	6	Truck, 2.5 Ton, 6x6	12

Source: Headquarters, United States Marine Corps, Table of Organization and Equipment Report: Separate Engineer Battalion approved 1 May 1944. Archives, Marine Corps History Division, Quantico Virginia.

The significant disparity between the equipment quantities of engineer forces raises the question of movement of these engineer assets in theater. The most advantageous way to employ this equipment would be to forward stage these assets in a manner that would provide both responsive and flexible support. The Marine Preposition Force (MPF) is designed to support this requirement by transporting prior loaded equipment to a designated staging area. However, MPF ships provide only a platform for transporting equipment into theater and do not provide a realistic means of transporting equipment between islands within theater. Additionally, the MPF ships are precisely the type of lucrative targets that A2AD systems are designed to deny within the WEZ.

Table 7: 7th Engineer Support Battalion Table of Equipment approved 29 October, 2019.*

Nomenclature	Description	Total	Nomenclature	Description	Total
B0036	MAC-50	2	B2561	Fork Lift, EBFL	3
B0040	MTL	6	B2566	Truck, Fork Lift	7
B0060	MCT	12	B2605	TWPS	11
B0063	TRAM	16	D0002	Trailer, 870-E	3
B0071	LWPS	28	D0003	AMK23	8
B0078	Grader	7	D0005	AMK27	1
B0114	BEB	21	D0007	Truck, Armored Dump	31
B0119	Backhoe, Excavator	6	D0015	Wrecker, AMK36	1
B0120	Bridge Erection Set	3	D0022	Truck, Utility	2
B0121	IRB Interior	36	D0045	Truck, Utility	16
B0122	IRB Ramp	15	D0048	Truck, Utility	42
B0137	EWDS	4	D0198	MK23	6
B0152	MGB	4	D0235	Trailer, 870-S	11
B0589	M9 ACE	4	D0886	MKR18	40
B0685	AAFS	4	D0887	MKR16	13
B1720	MGB Link Rein	3	D1062	MK27	7
B1922	Scraper	8	D1073	Truck, Dump	20
B2460	Tractor, D6	10	D1214	Wrecker, MKR15	2
B2483	Loader, Backhoe	7			

Source: Headquarters, United States Marine Corps, Table of Organization and Equipment Report: 7th Engineer Support Battalion approved 29 October, 2019. Total Force Structure Management System (TFSMS), accessed on 20 January, 2020.

*Author's Note: 7th ESB Table of Equipment is summarized to reflect engineer and motor transport equipment principle end items. This table does not reflect individual equipment variants, associated subordinate equipment sets, or all non-engineer equipment.

A potential mitigation to large intra-theater movements is the concept of 21st Century foraging, which has the potential to minimize the military equipment footprints and may reduce transportation requirements. 21st Century foraging implies that an operational unit will either use local equipment identified upon arrival or work with local vendors to purchase/contract equipment. This concept has significant potential in an EABO scenario, but assumes that local vendors are willing to sell/rent to US forces, that equipment is available at a specific location, that equipment is operational, and that the equipment meets military requirements. The latter three points are particularly important as the existing quantity and quality of operational

equipment at many island locations may not meet military specifications or support the operational requirements. In many ways, this is reminiscent of the Tentative Landing Operations Manual directing the acquisition of milk cans at remote islands. While 21st Century foraging is certainly feasible if available, it should not be relied upon as the sole source of equipment or logistical support.

2) Mobility in a distributed, high-threat environment:

Mobility in a distributed environment during a near-peer, or peer-to-peer, conflict is a unique challenge that the Marine Corps has not faced since arguably World War II or the Korean War. While mobility operations during Operation Iraqi Freedom and Operation Enduring Freedom were certainly challenging in their own right, the Marine Corps maintained a significant operational, technical, training, and personnel overmatch that overcame most setbacks or challenges that arose. Certainly the Marine Corps enjoyed freedom of movement and air superiority, which enhanced the ability of engineers to complete mobility projects and missions. These luxuries will not be enjoyed during a great power conflict and success will not be guaranteed. There are three particular issues of concern regarding mobility in a distributed environment that draw upon lessons learned from Guadalcanal and the Battle of Okinawa. The size and quantity of engineer equipment, particularly bridging assets and heavy equipment, are a limiting factor in massing engineer forces during distributed operations. Furthermore, that lack of training or emphasis on deliberate breach operations at the regimental and division levels creates gaps in experience and integration during complex distributed operations. Finally, adapting engineer equipment to meet new logistic or mobility needs is beneficial in distributed operations, but comes with limitations that must be well understood.

For the purpose of this paper the topic of mobility equipment will be limited to standard tactical bridge assets, explosive breaching equipment, and engineer equipment to include heavy equipment assets. While not all missions in distributed operations will require the full complement of equipment, it must be identified that engineers are only as capable as the equipment that they have at their disposal. The concept of maintaining a low signature with mobile forces is contrary to the size and quantity of current engineer equipment. As such, engineer forces must be able to remain dispersed and concealed until the precise time to execute the breach or gap crossing mission. The ability to remain dispersed and then aggregate in an efficient manner will reduce the targeting of engineer forces and enhance survivability. This is certainly easier said than done as time/space and technology limitations make this a difficult task in a distributed high-threat environment.

It is not difficult to conceptualize mobility requirements, specifically breach and gap crossing operations, in a distributed environment. While the size of the operational area (likely an island) may dictate the size and scope, the operation will likely be conducted in a contested environment within the WEZ. The implication is that all mobility operations must be closely coordinated with the supported. Drawing upon lessons learned from the Battle of Okinawa, it is evident that this is not always the case.

Bridging operations during the Battle of Okinawa provide a specific example of engineer operations that are not fully synchronized with infantry regiment operations. The Battle of Okinawa provides two specific examples of engineer forces attempting to emplace a bridge in support of an infantry attack, which had to be canceled or were significantly delayed because of the effects of enemy fire.⁴⁴ The lesson learned from these examples is that the supported unit did not task organize, integrate engineers, or provide appropriate support to facilitate the successful

outcome of the mission. A deliberate breach or gap crossing operation is not solely an engineer endeavor and must be fully integrated and executed by the tasked unit. Regardless of the location or scale of the mission, the tasked units must be organized into the doctrinal components of Assault Force, Breach Force, and Support Force. The tasked unit must coordinate or provide sufficient fires and obscuration to facilitate the breach or gap crossing.

Integration is especially important in distributed operations against a near-peer adversary that can utilize long-range precision guided munitions to adversely impact the success of the mission. That means that coordination will be required at Regimental and Division levels to support subordinate level operations with the appropriate fires, obscuration, and information assets. Perhaps even more critical is the requirement to conduct joint level planning and integration to support operations at the lowest levels. While prioritization of missions must be taken into consideration, even at the lowest levels the complex nature of a deliberate breach or gap crossing must tie into the available fires and information assets of the joint force. It is important to note that Marine Corps Infantry units (Regiment to Platoon level) are tasked with conducting breach operations incorporating elements of the MAGTF and joint/combined forces.⁴⁵ The Marine Corps would be well served to exercise higher level breach or gap crossing operations at the regimental or division level in a high-threat, distributed environment.

Engineer equipment is designed to provide a specific capability in fulfillment of a specific requirement. However, as demonstrated during the Guadalcanal Campaign, equipment can be adapted to fulfill evolving requirements. For example, the use of amphibious tractors as supports for bridges demonstrates a resourcefulness to overcome the lack of proper engineer equipment. Similarly, operations in a distributed environment may require the employment of equipment in a non-traditional manner. An example of such a scenario would be the use of

Improved Ribbon Bridges (IRB) as an inter-island connector or the employment of Bridge Erection Boats (BEBs) to move local procured barges. The IRB is designed to facilitate the crossing of all military vehicles and can be employed as a continuous span floating bridge or as a ferry. There are two significant limiting factors for the employment of the IRB. The first factor is the availability of bridge bays and BEBs used to maneuver the bridge and hold it in place during continuous operations or move the bridge during ferry operations. The second and less intuitive factor is the speed of the current during riverine operations and the sea state and tide factors during coastal operations. Understanding the limitations of the environmental factors is critical in the application of an IRB in distributed operations. In an EABO or distributed operations scenario, the requirement to move combat or logistical assets from one location to another will be critical. While the US Navy has numerous platforms well suited for this mission, the availability and quantity of assets may become a significant limiting factor. As such, the IRB is a potential platform that could be adapted from riverine crossing to an inter-island connector. While this application is possible in theory, the equipment is not designed to support such operations. This potentially creates a dangerous scenario and may place undue risk to crew and equipment. Still the use of BEB to move civilian barges has merit for further consideration.

3) Bulk liquid storage and distribution:

The engineer role in bulk liquid storage and distribution is somewhat limited as both case study 1 and 2 identified. Engineers are equipped with water purification assets which have been extensively used in amphibious operations. From the publishing of the Tentative Landing Operation Manual in 1935, engineer units have been tasked with purifying and supporting the distribution of fresh water. The storage and distribution of bulk fuel has been a different matter as engineer units in World War II were not tasked with this mission. However, since the addition

of bulk fuel company to Engineer Support Battalions, the receipt, storage, and distribution of bulk fuel is both a uniquely critical and yet challenging capability.

Water production, storage, and distribution in an EABO or distributed operations environment is critical. Unlike Operation Enduring Freedom and Operation Iraqi Freedom where mountains of bottled water was required to sustain operations, the proximity to water sources in the Pacific is significantly more plentiful. Employing the Tactical Water Purification System (TWPS) and the Lightweight Water Purification System (LWPS) the Marine Corps is well equipped to produce sufficient freshwater (see table 8) to meet the drinking water needs of the MEF⁴⁶ in a tropical environment.⁴⁷

Table 8: Daily water production estimates.

Asset	Production Factors	Quantity	Production Time	Production Estimates	Total Quantity
B0071 LWPS	225 GPH freshwater	28	18 hours per day	113,400 gal/day	410,400 gal/day (freshwater)
	135 GPH salt water			68,040 gal/day	
B2605 TWPS	1500 GPH freshwater	11		297,000 gal/day	305,040 gal/day (salt water)
	1200 GPH salt water			237,000 gal/day	

Source: Information derived from US Marine Corps Technical Manual: Principle Technical Characteristics of Marine Corps Power and Family of Expeditionary Fuel and Water Systems, TM 12359A-15/1, dated February 2017. Accessed 23 January, 2020. <https://mceits.usmc.mil/sites/pubs/180/18012359000.pdf#search=TM%2012359A>

The concerns in an EABO scenario are two-fold: first the physical and visual signature at the production point and secondly the distribution of water from point of production to the end user. In terms of the physical or visual signature of water purification equipment, the determining factor is solely based on the mission requirement. The relative small size of an LWPS, which can fit into the back of a high back HMMWV, produces a very small signature and is highly mobile. A standard mission for an LWPS team would be to move to a water source (likely a stream or small pond), pump 600-800 gallons to fill a water bull or SIXCON (6-8 hour in duration), and then move to a new location. In such a scenario, it is relatively easy to hide or camouflage 1-2

trucks in a wooded environment. The employment of the TWPS however is a significantly different matter. The large-scale production of a TWPS means that the system must be placed near a large water source such as a lake, large river, or ocean front. Furthermore, the TWPS system which will likely be used to fill multiple 20K-50K water bladders, which must have sufficient level space to layout and berm such bladders. Equally important is that the TWPS system requires a logistics vehicle system replacement (LVSR) flat-rack or Medium Tactical Vehicle Replacement (MTVR) with a Tractor, Rubber Tired, Articulated Steering, Multipurpose (TRAM) to on-load/off-load. TWPS are also notoriously maintenance intensive, but perform better when set up and run for extended periods of time. Thus, the TWPS should be employed at an identified location for an extended period versus moving to new locations every 6-8 hours. This creates a much larger visible signature for a longer duration. In an EABO scenario, the TWPS will likely only be operated at a location outside the WEZ or co-located with a unit that can provide sufficient coverage against enemy threat weapons.

The concept of stationary water sources leads directly into the concept of water distribution. While logistics units are specifically tasked with transporting water from an established water point to the end user, engineer units have a piece of the overall distribution system. Engineer Support Battalions are equipped with the Expeditionary Water Distribution System (EWDS, B0137) which has sufficient water pumps and 6-inch hoses to move water up to 1.4 miles. The use of additional hoses and water pumps can extend the distribution of water over five miles. The EWDS system provides a critical capability that was not present during World War II. Unfortunately, the quantity of hose sections required to transport water five miles is substantial and creates a visible signature prior to being laid or upon recovery. Additionally, it

also creates a burden of patrolling the hose line once laid to ensure that the product is moved uninterrupted and uncontaminated.

In a distributed operations environment, the goal of planners would be to employ water purification assets as close to the using unit as possible, which would help reduce transportation requirements and minimize the signature of large scale water points. Drawing upon lessons learned from Guadalcanal, a potential solution would be to invest in more LWPS or similar water production systems. Additionally, creating a Water Production Detachment assigned to a Combat Engineer Battalion would enhance the organic capabilities of the division engineers. The assignment of Water Support Technicians as part of a Utilities Platoon within a Combat Engineer Battalion has a historical precedent as Combat Engineer Battalion's maintained a water capability until the early 2000s. It was not until the 2004-2005 force realignment that all water capabilities were consolidated under the Marine Logistics Group and Marine Wing Support Squadron engineer units. Aligning water capabilities to the Combat Engineer Battalion will increase the internal capabilities of the division engineers and increase operational efficiency, while not detracting from the overall capability of the Engineer Support Battalion's general support to the Marine Expeditionary Force.

Bulk Fuel

In comparison with water purification equipment, the bulk fuel equipment set is highly mobile and scalable. Consisting of an infinite combination of collapsible fuel bladders, hoses, and fuel pumps the Amphibious Assault Fuel System (AAFS) is well designed to establish small (20,000 gallon) or large (1.2 million gallon plus) fuel farms. Perhaps the greatest capability of the AAFS is the ability to receive fuel from ships anchored up to 10,000 feet (approximately two

miles) off-shore using the Amphibious Bulk Liquid Transfer System (ABLTS)⁴⁸. The ABLTS is a US Navy operated system that facilitates the transfer of fuel from ship to shore using a buoyant hose reel system. This is a significant improvement in bulk fuel receipt and storage in comparison to the Guadalcanal Campaign and the Battle of Okinawa during which 55-gallon barrels of gas had to be individually moved to shore. It must be noted that the employment of the ABLTS inside the WEZ in an EABO scenario is highly unlikely due to high vulnerability to enemy threat weapon systems. The ABLTS system, while the most efficient way to transfer bulk fuel, will likely only be employed well outside the WEZ in support of forward deployed forces.

The scalability of the AAFS system is perfectly suited for providing bulk fuel support during distributed operations. Understanding that a large static fuel farm will likely be targeted by the enemy, the distribution of small scalable fuel points is much more survivable and adapted to an EABO scenario. Furthermore, unlike the TWPS which requires heavy equipment to load/off-load, the AAFS equipment may be loaded/unloaded entirely by hand. If correctly trained, a squad of 1391 Bulk Fuel Marines can unload and set up 40K-60K fuel system by hand and begin receiving fuel in under 60 minutes. This significantly increases the mobility and expeditionary employment of the AAFS.

The scalable nature of the AAFS and the ease of movement enables it to be used to fill the niche fuel point role in an EABO scenario. For example, in order to reduce the physical signature and targeting of fuel points, the Marine Corps can use rotary wing assets to insert a scalable AAFS package into a point, download fuel from the rotary wing asset into the fuel bladder and then distribute fuel for a set period of time before retrieving the asset. This capability will enable the Marine Corps to “leap frog” fuel points around multiple islands at set times to

provide critical fuel to operational units while significantly decreasing the ability of the enemy to detect and target the fuel point.

The receipt of fuel into the AAFS system can take many forms to include the employment of the ABLTS, downloading of fuel from aviation assets, or receipt of fuel from ground transportation assets. The AAFS is limited in that it requires a flat open area with sufficient area to fully lay out the fuel bladders. Additionally, if aviation assets are limited, movement between islands could be reduced. While the US Navy processes logistic connectors to move between islands, the availability and quantity may limited bulk fuel operations. Two innovative concepts that can help mitigate these challenges are 21st Century foraging, concealment of fuel bladders in civilian infrastructure, and the application of autonomous delivery systems.

Beginning with 21st Century Foraging, bulk fuel Marines could be used to test the quality of fuel identified at local national fuel points. While not all fuel will meet the military requirement for quality or quantity, it could be used to offset some of the bulk fuel requirement. The use of local national fuel would require significant coordination with contracting officers to purchase the fuel and have it delivered to required destinations if required. If deemed sufficient quality for use by military vehicles, the use of a civilian gas station will help minimize the footprint of the fuel point and decrease the EN ability to target fuel points. The use of civilian infrastructure such as warehouses, gyms, or large open barns will help disguise the location of fuel points and may enable fuel points to remain in one location for a longer duration. Finally, the use of autonomous or submersible fuel delivery systems perhaps provide the greatest opportunity to move fuel between islands in an EABO environment. While not fully realized that his point in time, an autonomous fuel delivery system will enable scalable fuel systems to receive

fuel at the water line and then transition the product in-land. This will significantly reduce the signature of aviation assets or large fuel trucks delivering fuel to established fuel points thus increasing survivability and application in a contested environment.

Conclusion

The concepts of A2/AD and EABO are not new paradigms in terms of military operations in the USINDOPACOM area of operations. The engineer operations during World War II provide a historical example of how the Marine Corps task organized, equipped, and employed engineer forces as the war in the Pacific Theater evolved. The same challenges faced by Marine engineers in 1942-1945 and their creative solutions are now more relevant than ever. Through the study of lessons learned from the Guadalcanal Campaign and the Battle of Okinawa it is possible to understand how the challenges associated with operating in a distributed high-threat environment can be overcome. Advancement in technology and equipment will certainly contribute to the success of future engineer operations in support of EABO. In many ways, future developments in autonomous delivery systems and weapon platforms will significantly enhance the success of EABO concepts and reduce the risk to stand-in forces. However, technology is not a complete solution to the challenges expected in a future Pacific conflict. Efficiently task organizing engineer forces, effectively nesting engineer operations in support of the maneuver force, leveraging joint capabilities, and prioritizing bulk liquid operations will undoubtedly contribute to the future success of EABO operations in the USINDOPACOM area of operations.

¹ Charles Gubert, "Heeding History." *Global Custodian*. (London: Tungsten Publishing, July 1, 2013). <http://search.proquest.com/docview/1432669950/>

² Headquarters US Marine Corps, Marine Corps Warfighting Lab, Concepts & Plans Division. *Expeditionary Advanced Base Operations (EABO) Handbook: Considerations for Force Development and Employment*, version 1.1 (Quantico Virginia, 1 June 2018), 9.

³ Sam J. Tangredi, *Anti-Access Warfare: Countering A2/AD Strategies*, (Annapolis, Maryland: Naval Institute Press, 2013), 1.

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