CDTM Document Number: 11110808578 - v 2

Initial Capabilities Document
For
(U) United States Marine Corps Expeditionary Energy, Water, and Waste

Validation Authority: JCB
Approval Authority: JCB
Milestone Decision Authority: TBD
Designation: JCB Interest

Prepared for: N/A

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(U) Executive Summary

In response to the growing strategic and operational risk of energy dependence, the Commandant of the Marine Corps (CMC) declared energy a top priority beginning in 2009 and, in February 2011, signed the Marine Corps Expeditionary Energy Strategy and Implementation Plan. In this document, he stated that:

> "*The current and future operating environment requires an expeditionary mindset geared toward increased efficiency and reduced consumption, which will make our forces lighter and faster. We will aggressively pursue innovative solutions to reduce energy demand in our platforms and systems, to increase our self-sufficiency in our sustainment, and reduce our expeditionary foot print on the battlefield. Transforming the way we use energy is essential to rebalance our Corps and prepare it for the future.*"[1]

As one of the Commandant's six pillars of modernization of the force,[2] increasing our combat effectiveness through the way we use energy requires focused participation in the requirements,[3] acquisition,[4] and technology development processes. The Expeditionary Energy, Water and Waste (E2W2) Capabilities Based Assessment (CBA) forms the analytical basis for requirements that will drive development and fielding of a comprehensive E2W2 capability set that supports the CMC vision, "***To be the premier self-sufficient expeditionary force, instilled with a warrior ethos that equates the efficient use of vital resources with increased combat effectiveness.***"[5]

This Initial Capabilities Document (ICD) codifies the CBA and describes E2W2 capabilities, gaps, and solution approaches that support Marines across the range of military operations (ROMO) through 2025. The ICD seeks to resolve the military problem presented by current and future operational energy, water, and waste logistics demand and the resulting maneuver limitations and vulnerability to attacks on ever more critical and extended supply lines. This problem is evident in current, distributed operations and in applying the future Enhanced Marine Air Ground Task Force (MAGTF) Operations (EMO) concept; thus, the intent is for capabilities identified in this ICD to: (1) Achieve resource self-sufficiency on the battlefield; (2) Reduce energy demand in platforms and systems; (3) Reduce the overall footprint in current and future expeditionary operations.

The ICD identifies 152 gaps across 29 tasks in six E2W2 capability areas (***Planning, Production, Storage, Distribution, Disposal, Management***) that affect every warfighting consumer or producer of energy, water, and waste. E2W2 capabilities are inherent to all aspects of MAGTF operations; solutions span the range of materiel and non-materiel approaches. Non materiel changes will significantly improve E2W2 planning, employment, and oversight, and can be implemented in the near term without materiel development or new technology. However, these approaches will not completely close the E2W2 gaps and many gaps can only be adequately mitigated by incorporating materiel solutions—the ICD calls out 87 materiel solutions approaches, applicable to 27 tasks.

Identifying a broad set of needs, this ICD is a starting point for development of multiple Materiel Development Decisions, each requiring additional analysis to clearly identify specific solutions. Through this ICD, we will dramatically increase our combat effectiveness by reducing the Marine Corps' demand for liquid and battery logistics, and increasing energy and water self-sufficiency. Marines and MAGTFs will travel lighter, move faster, and stay longer, at less risk.

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[1] *United States Marine Corps Expeditionary Energy Strategy and Implementation Plan*, (Washington, DC: CMC, 2011), 23 Feb 2011, 3

[2] *General James F. Amos, Commandant of the Marine Corps, 2012 Report to the House Armed Services Committee on the Posture of the United States Marines Corps, February 16, 2012*.

[3] Chairman of the Joint Chiefs of Staff, *Joint Capabilities Integration and Development System (CJCSI 3170)*, (Washington, DC: CJCS, 2009), 1

[4] DoDI 5000.02, USD(AT&L), dated 2 December 2008

[5] *United States Marine Corps Expeditionary Energy Strategy and Implementation Plan*, (Washington, DC: CMC, 2011), 23 Feb 2011, 17

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1 (U) Concept of Operations Summary

1.1 (U) Background

Over 70 percent of the logistics required to sustain Marine Corps expeditionary forces ashore is liquid, fuel and water. This demand for energy and water increases the logistics sustainment requirements of the operating forces and limits the operational reach of Marines on the battlefield. Driving the demand for "liquid logistics" is the ability and necessity for Marines to distribute throughout the battle-space while bringing increasingly effective capabilities to bear at smaller unit levels. This ability is enabled by increased capability and capacity in precision weapons, force protection, and command, control, communications, computer, intelligence, surveillance, and reconnaissance (C4ISR) technology. Examples of growth in the Marine Air Ground Task Force (MAGTF) since 2001 include a 250% increase in radios, a 300% increase in computers, and the introduction of new types of systems (e.g. counter-IED jammers, persistent surveillance, position location/reporting and situational awareness, etc.) [6]

To provide distributed mobility, Marine infantry battalions have increased the number of vehicles on-hand by more than 200%. To protect vehicles armor has been added, resulting in a greater than a 75% increase in vehicle weight and a 30% decrease in miles per gallon across the tactical vehicle fleet.

The demand for liquid fuel, batteries, and bottled water has become a soft underbelly to the enemy. To reverse the growth in liquid and battery logistics demand, reduce risk to Marines, and enable the force envisioned in the *Marine Corps Vision and Strategy 2025* the Commandant of the Marine Corps (CMC) stated that the Marine Corps will:

- Achieve resource self-sufficiency in our battlefield sustainment
- Reduce energy demand in our platforms and systems
- Reduce our overall footprint in current and future expeditionary operations. [7]

Marine Corps Operating Concepts 2010 translated the CMC's vision into future operating concepts:

> "*As requirements to fight in more austere conditions and in a dispersed manner become more frequent, a central enhancement required across elements is reducing energy consumption. Less dependency on energy allows the MAGTF to travel lighter—with less fuel and batteries. It allows us to move faster, through the reduction in bulk supplies and the reduction in size and amount of equipment. New technologies and techniques that reduce our cube and weight as well as our dependency on energy allow the MAGTF the ability to conduct operations in the most austere of environments—where excess and luxury is not practical.*" [8]

In response to this military and institutional challenge, the Expeditionary Energy Office (E2O) and the Deputy Commandant for Combat Development and Integration (Capabilities Development Directorate) initiated Joint Capabilities Integration and Development System (JCIDS) planning by jointly sponsoring the Capabilities Based Assessment (CBA) documented in this Initial Capabilities Document (ICD). The CBA was conducted by a cross-functional Integrated Planning Team (IPT), which included participants from the other Services and across the Marine Corps operating forces, Headquarters Marine Corps, and the Supporting Establishment. CBA details and results are documented in Appendices E through H.

1.2 (U) Objective

This ICD forms the intellectual foundation for deliberate, capabilities-based planning to achieve the mission set forth in the USMC Expeditionary Energy Strategy:

> "*By 2025 we will deploy Marine Expeditionary Forces that can maneuver from the sea and sustain C4I and life support systems in place; the only liquid fuel needed will be for mobility systems which will be more energy efficient than systems are today.*"

[6] Director, Energy Systems, Systems Engineering Interoperability, Architectures and Technology, Marine Corps Systems Command, July 2010.

[7] 35th Commandant of the Marine Corps, Commandant's Planning Guidance 2010. p.9.

[8] Marine Corps Operating Concepts, Third Edition 2010.

Non-materiel and materiel approaches proposed in this ICD outline a means for achieving the overarching E2 Strategy goal, a 50% increase in operational energy efficiency on the battlefield by 2025, while increasing operational water self-sufficiency and more effectively managing waste. The approaches represent solution paths to achieving the mission by guiding planners, advocates, and combat developers in defining requirements and adapting or developing enabling programs along three lines of operation: procurement of more efficient equipment and efficiency upgrades to legacy equipment, increased renewable energy use, an ethos that equates energy and water efficiency with combat effectiveness.[9] Most importantly, application of these approaches is necessary to increase operational effectiveness and reduce the risk to Marines. Increasing self-sufficiency and lightening the individual and MAGTF load will shrink the threat-exposure created by logistical demands and increase maneuverability at all levels. These improvements are imperatives to the future operating concepts and will save lives.

1.3 (U) Scope

The attached Concept of Operations (CONOPS) summarizes the Expeditionary Energy, Water, and Waste (E2W2) CONOPS. E2W2 refers to the capabilities that produce or consume energy or water, or could benefit from the ability to better manage waste or use waste to produce energy. This definition includes the associated materiel and non-materiel support required to organize, train, equip, and deploy a force that uses energy and water efficiency and self-sufficiency to increase combat effectiveness in all phases of operations and to levels demanded by future expeditionary operations as described in the *Marine Corps Operating Concepts*. An "efficient E2W2" capability is defined as self-sufficient C4ISR and life support capabilities, and energy efficient mobility and weapons systems that minimize the need for external (higher, adjacent, or supporting unit) energy (fuel and batteries) and water logistics.

E2W2 capabilities are inherently cross-functional. This ICD considers E2W2 enabling capabilities as they apply across the warfighting functions (WFFs) and the full range of expeditionary capabilities from individual Marine to Marine Expeditionary Forces (MEFs).

While capabilities addressed in the ICD have application across all operational phases, the identified gaps and solution approaches are focused on expeditionary capabilities that support operations from the sea during the first 120 days of operations ashore. This temporal limit drives metrics and measures that ensure approaches are consistent with the Marine Corps' expeditionary ethos and naval character and distinguish capabilities having unique MAGTF considerations from those in the Army's Operational Energy and Base Camp ICDs, which focus on sustained operations ashore. Although it is assumed that the joint force will provide theater sustainment after the first 120 days of operations, compatibility with joint capabilities and the ability to smoothly transition to sustained operations is within the ICD scope.

1.4 (U) E2W2 Capability Contributions

As the Marine Corps develops the force to conduct highly dispersed MAGTF operations in austere environments, reduced energy consumption and more efficient, more decentralized energy and potable water production are key capability enhancements required across the MAGTF Command, Ground, Aviation, and Logistics Combat Elements (CE, GCE, ACE, and LCE). Less energy demand allows the MAGTF to travel lighter and faster through less fuel, battery, and water load, and less dependence on theater- and MAGTF-level resupply. Less demand also reduces the MAGTF footprint by reducing bulk storage and distribution requirements and the size and quantity of power production and energy storage equipment. Establishing more effective and efficient E2W2 capabilities provides the commander an increased ability to respond to changes in dynamic and often chaotic operational environments, increases task organization alternatives, increases his operational reach for unit of energy consumed and reduces the exposure of his supply lines to attack. Enhancements in energy, water, and waste capability sets increase MAGTF capacity to support coalition partners and host nations in operations other than war, such as

[9] *United States Marine Corps Expeditionary Energy Strategy and Implementation Plan*, (Washington, DC: CMC, 2011), 23 Feb 2011, 16

humanitarian assistance and disaster relief efforts, by creating unique capabilities that can be directly applied to these missions while minimizing the footprint ashore and the impact to host nation resources.

1.5 (U) Operational Outcomes

The USMC Expeditionary Energy Strategy envisions a self-sufficient expeditionary force instilled with an ethos that considers efficient use of vital resources essential for combat effectiveness. Developing an E2W2-efficient capability set enables several desirable operational outcomes:

- A lighter, faster, more maneuverable, and more resilient maneuver force
- Increased ability for the MAGTF to operate in austere environments
- Reduced operational risk through reduced logistics footprint and threat exposure
- Increased autonomy and tactical mobility, particularly at the Company-level and below
- Increased MAGTF agility, reach, endurance, freedom of action, and operational tempo

1.6 (U) Operational Effects

Efficient E2W2 capabilities contribute to these outcomes in several ways:

- Decreased energy demand across the force and its materiel.
- Ability to provide power and life support at fixed bases and on-the-move through sufficient quantities of smaller, lighter systems that demand less power.
- Ability to maximize the use of available materials and renewable energy sources.
- Increased efficiency in mobility systems and associated subsystems (e.g. radios, sensors).
- Better resource usage information to aid planning and enable efficient E2W2 management.

1.7 (U) Complementing the Joint Force

Marine Corps enhancements in E2W2 capabilities support and complement the Joint warfighter by reducing the USMC demand for naval ship-to-shore sustainment and joint theater sustainment. Reduced demand for joint resources enables greater logistics flexibility, adaptability, and responsiveness, which significantly increases operational effectiveness. A MAGTF that more efficiently provides and uses energy and water and more efficiently manages waste gives the Joint force commander better options and increased agility to operate across the theater and the ROMO. The MAGTF ensures Joint force interoperability through common systems, supplies, standards, and procedures by leveraging the other Services' enhancements in power, water production and distribution, and waste management capabilities.

1.8 (U) Required Enabling Capabilities

Near- and far-term improvements in overall E2W2 efficiency and unit self-sufficiency rely on establishing a permanent ethos throughout the Marine Corps that considers energy and water to be constrained resources and key combat enablers with operational "costs." As a result, awareness, education, and training form a center of gravity to this capability set. Materiel and non-materiel improvements must apply to all WFFs and MAGTF elements as they affect or are affected by enabling capabilities in six E2W2 capabilities areas, defined in Attachment F.

DOTMLPF improvements in these six capability areas require synchronization by supporting E2W2 architectures and standards focused on interoperability and a systems approach. Capabilities must comply with applicable DOD, joint, national, and international policies and regulations. Materiel solutions should make use of international industrial standards to the maximum extent practical.

2 (U) Joint Capability Area

2.1 (U) Relevant Joint Capability Areas

Table 2-1 identifies the JCAs supported by the E2W2 tasks outlined in this ICD.

2.2 (U) Relevant Combatant Commander- Identified Capabilities

Joint Logistics capability attributes that are relevant to the E2W2 capability set:

- Deployment and Distribution - Visibility, Reliability, Velocity, Precision, Capacity
- Supply - Responsiveness, Sustainability, Flexibility, Survivability, Attainability, Economy
- Maintain - Sustainability, Responsiveness, Attainability, Flexibility, Economy, Survivability
- Logistics - Responsiveness, Attainability, Sustainability, Flexibility, Economy, Survivability

Table 2-1. JCAs Relevant to USMC E2W2 Capabilities

Tier 1	Tier 2
Force Application	Maneuver, Engagement
Command & Control	Organize, Understand, Planning, Decide, Direct, Monitor
Battlespace Awareness	Intelligence, Surveillance, & Reconnaissance (ISR), Environment
Net-Centric	Information Transport, Enterprise Services, Net Management, Information Assurance
Protection	Prevent, Mitigate
Logistics	Deployment & Distribution, Supply, Maintain, Logistics Services, Engineering
Force Support	Force Management, Force Preparation, Human Capital Management, Health & Readiness

2.3 (U) Timeframe

This ICD examines capability gaps and potential solutions to support the USMC Expeditionary Energy Strategy and Implementation Plan through 2025.

2.4 (U) Relevant Defense Planning Scenarios

Defense Planning Scenarios approved by the Marine Requirements Oversight Council (MROC) were used in the CBA Mission and Capabilities Identification described in Attachment F:

- (U) Major Combat Operation-1
- (U) Irregular Warfare-1
- (U) Humanitarian Assistance / Disaster Relief Steady State Security Posture

2.5 (U) Capability Attributes

The following JCA attributes are prioritized as they apply to USMC E2W2 capabilities in an expeditionary environment, and as defined in Attachment G:

- Expeditionary
- Agile
- Interoperable
- Scalable
- Lethal

3 (U) Required Capability

3.1 (U) Capability Overview

In order to foster a common understanding of enhanced E2W2 capabilities and tasks and to guide actions along the three E2 Strategy lines of operation, the following section and the associated appendices describe the operational relationships between the E2W2 enabling capabilities and tasks, and their application to each WFF. Appendices E through H describe the E2W2 CBA methodology and the resulting capability to task to gap hierarchy. These relationships provide a means to focus effort, identify mutually supportive solutions, and monitor progress.

The E2W2 CBA defined 29 constituent tasks and the standards necessary to achieve E2 Strategy goals and enable current and future operating concepts. The tasks comprise necessary institutional and operational E2W2 actions, to include the procedures, policies, and materiel systems. **Table F-1** provides task descriptions and associated E2W2 thrust areas (energy, water, or waste), capability areas, and WFFs.

3.2 (U) Enhanced E2W2 Capabilities and Tasks

Figure A-1 (Appendix A) depicts the future operational view (OV-1) of an E2W2-efficient MAGTF. In this OV-1, enhanced E2W2 capabilities are employed concurrently and sequentially through all

operational phases and across the MAGTF elements. In Attachment F, the six E2W2 capability areas are described in the context of the OV-1 as enhanced E2W2 capabilities within each WFF.

E2W2 capabilities are often viewed as exclusively logistics functions; however, decentralized MAGTF operations that demand more energy-intensive technology and self-sufficiency, within human, technological, and operational constraints, make it clear that every WFF is affected. **Table F-2** summarizes the distribution of the 29 E2W2 tasks as they apply to each capability area and WFF. This summary illustrates the need for DOTMLPF integration across functions and a systems design approach that includes both energy consumer and producer systems.

4 (U) Capability Gaps and Overlaps or Redundancies

4.1 (U) Capability Gap Overview

The growth in energy demand and the need for self-sufficiency related to the Marine concept of operations in Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) is consistent with the Marine Corps' future Enhanced MAGTF Operations (EMO) concept and an indicator of the associated materiel and non-materiel requirements. This future concept, OIF and OEF lessons learned, and the goals and objectives of the E2 Strategy were applied in determining standards for gap and risk assessment. The E2W2 CBA Gap and Risk Assessment method and results are detailed in Attachment G.

The CBA identified **152** capability gaps. The top 10 E2W2 capability requirements with associated attributes and standards are summarized in **Table 4-1** in gap priority order. **Table G-3** lists all 152 capability gaps, grouped by task in gap priority order. Gaps are categorized as policy, sufficiency, proficiency, lack of capability, need for replacement, or recapitalization of an existing capability. Attachment G also describes more specific tasks within each WFF that cannot be performed.

Table 4-1. Top 10 Capability Requirements by Gap Priority

Gap Priority	Task / Capability Requirements	Attributes	Metrics	Min Value
1	Plan to supply Energy (conventional, renewable, alternative) to the MAGTF; integrated throughout the supply chain and withJoint/Coalition and HNS	Agile	Units / Commanders have visibility into resource and equipment energy requirements.	Yes
		Expeditionary	Energy considerations factor into planning and operations.	Yes
		Expeditionary	Fuel considerations factor into planning and operations.	Yes
		Interoperable	Energy considerations factor into training and education curriculum.	Yes
2	Provide the capability to Manage Energy, Water, and Waste Resources in an Expeditionary Environment	Interoperable	% units at Battalion / Squadron level and above with an E2W2 data management system enabled	100%
		Scalable	Usage and monitoring and metering controls established	Yes
		Expeditionary	Units/ Commanders have visibility into resource use, efficiency and requirements through the use of monitoring and tracking technologies	Yes
		Scalable	Monitor amount of waste (energy harvestable and non-energy harvestable including hazardous) generated per Marine per day during expeditionary ops	Yes
		Scalable	Energy capabilities are aligned with energy requirements	Yes
		Interoperable	% of equipment certified to run on alternative fuels/energy	100%
		Scalable	% of units managing energy demand	100%
		Expeditionary	Doctrine and policies incorporate E2W2 efficiency as a Warfighting enabler	Yes
		Expeditionary	MAGTF units have documented waste management plans	Yes
		Agile	% of personnel trained in E2W2 management and awareness	100%

Gap Priority	Task / Capability Requirements	Attributes	Metrics	Min Value
3	Conduct Combat Operations across the MAGTF with minimal energy and energy related logistics requirements	Scalable	% reduction of individual equipment using unique power source	75%
		Scalable	% reduction of MAGTF equipment using unique power source	75%
		Expeditionary	Number of days a MAGTF is power self sufficient for C4ISR and life support systems	120 days
		Agile	% reduction in the amount of energy required to sustain a MAGTF ashore	50%
4	Produce Energy Efficient Climate Control environments to maintain Personnel and Equipment operating efficiency	Expeditionary	Adequate heating and cooling to optimize personnel performance and endurance with zero fuel requirements across operating climates.	Yes
		Expeditionary	Adequate heating and cooling to optimize equipment performance with zero fuel requirements across operating climates.	Yes
		Expeditionary	MAGTF shelters are thermally efficient across operating climates	Yes
5	Provide the capability to Measure Energy, Water, and Waste Resources in an Expeditionary Environment	Expeditionary	Units / Commanders have visibility into resource use, efficiency and requirements through the use of monitoring and tracking technologies	Yes
		Agile	% of equipment that is metered for power production and consumption	100%
		Agile	% of equipment that is metered for fuel consumption	100%
		Agile	% of equipment that is metered for water production and consumption	100%
		Agile	% of equipment that is metered for waste generation and reuse	85%
6	Conduct "smart" expeditionary Electrical Distribution	Scalable	Energy production is aligned with energy consumption	Yes
		Scalable	% continuous power produced matched to consumption	85%
		Scalable	Energy distribution enables efficient integration of multiple energy sources.	Yes
7	Develop Plans to Support Efficient, Scalable Expeditionary Forward Operating Base Water Systems and Hygiene Service	Expeditionary	Water considerations factor into planning and operations	Yes
		Expeditionary	Planners factor waste management (biological and non-biological) into mission planning	Yes
8	Design Efficient, Scalable, and Interoperable, Expeditionary Energy Producing and Consuming Warfighting	Agile	% of personnel trained in energy effectiveness	100%
		Scalable	Scalability and energy performance considered in planning and design	Yes
		Expeditionary	Trained personnel available and on hand to support plan and design of efficient FOBs at the unit/HQ level	Yes
		Expeditionary	Appropriate doctrine and training provided for scalable FOB design	Yes
9	Plan for reductions in energy demands of current and future capability sets without reducing combat / mission effectiveness	Agile	Requirements reduce MAGTF equipment using unique power sources	Yes
		Scalable	Power generation equipment systems are scalable and interoperable	Yes
		Lethal	Requirements increase energy performance of fielded powered equipment	Yes
		Expeditionary	Energy performance is incorporated as an analysis criteria early in the requirements process	Yes
10	Plan to produce all C4ISR energy and power requirements organically in place	Expeditionary	Number of days a MAGTF is power self sufficient for C4ISR and sustainment systems	120 days

5 (U) Threat and Operational Environment

5.1 (U) General

While the potential for conventional conflict remains, threats in the 21st century will most-likely be unconventional, unforeseen, and unpredictable state and non-state adversaries using asymmetric

approaches and irregular warfare. Potential adversaries will be adaptive, creative, and increasingly sophisticated using lessons learned from encounters with American weapons and tactics. They will apply those lessons learned with complexity, adaptability, and skill using non-linear, irregular TTPs.

5.2 (U) Threat Capabilities

Potential adversaries possess increasingly sophisticated sensors, C2 systems, platforms, and weapons capable of inflicting losses and impacting how MAGTF E2W2 capabilities are distributed and protected. Asymmetric tactics are being combined with threat weapons that are increasingly accurate and easy to employ. This makes it more difficult for the MAGTF commander to protect and position C4ISR and life support assets at optimal locations to support maneuver.

5.3 (U) Threats to E2W2 Capabilities

Threats to E2W2 capabilities may range from irregular and asymmetric to conventional force attacks on E2W2 production, distribution, and storage materiel and personnel, and cyber-attacks on networked E2W2 systems. Low-technology weapons pose significant threats to air- and ground-based resupply. The proliferation of mines and IEDs increases that threat, especially in counter-terrorist and -insurgency operations where small units operate autonomously and tactical logistics missions are employed. Future E2W2 systems will leverage real- and near-real-time information to monitor and accelerate logistics support and decision-making. This information may be vulnerable to interception and exploitation.

5.4 (U) Operational Environment

Events of today and projections of the future require Marine forces to operate in widely varying, hostile, often access-denied, environments across extended battlefields. This places an emphasis on gaining access to contested areas and establishing persistent presence with expeditionary maneuver forces that engage in decisive maneuver and conduct concurrent and subsequent stability operations. In many cases, these operations require forces to project from a joint sea-base and to self-sustain for extended periods. Crisis responses are likely to occur in areas that present challenges due to distance, rough terrain, and climatic extremes. These environments will also vary in energy and water resources and infrastructure.

5.5 (U) Threat Documents

This analysis used the MCIA Marine Corps Long Range Threat Assessment: 2008-2025, 2008 (U/FOUO), produced by the Marine Corps Intelligence Activity, Quantico, Virginia.

6 (U) Assessment of Non-Materiel Approaches (DOTMLPF Analysis)

6.1 (U) General Comments

Significant non-materiel solutions to E2W2 gaps exist. If implemented, these solutions would partially mitigate many of the **152** E2W2 capability gaps but would not completely eliminate any of them. Below is a overview of the non-materiel approaches identified. Attachment H describes the E2W2 CBA Solutions Assessment method and more detailed solution approach recommendations.

6.2 (U) Policy

All of the gaps require some degree of policy as part of a solution strategy. Much of this policy will be provided by the Expeditionary Energy Strategy and Implementation Plan, and doctrine approaches.

6.3 (U) Doctrine

There is a lack of sufficient energy-, water-, and waste -specific doctrine to enable MAGTF E2W2 planning and employment to the standards required by future concepts and scenarios.

6.4 (U) Organization

Updates to organizational structure are necessary to ensure that E2W2 is properly considered in mission planning and decision making, and to provide operational flexibility and self-sufficiency on the distributed battlefield. Approaches center on conducting manpower and training analysis to identify

changes in structure and organization that allow E2W2 capabilities to be integrated throughout the MAGTF most effectively.

6.5 (U) Training

Training is essential to shaping the E2W2 ethos, planning, and management and to ensuring efficient employment of current and future E2W2 capabilities. Other than individual E2W2 systems training, there is no current formal or informal instruction that establishes a culture of awareness for E2W2. Approaches include training that spans across administrative and operational requirements.

6.6 (U) Leadership

Instilling an ethos that values energy and considers E2W2 efficiency to be critical to combat effectiveness requires behavior change at all levels of the Marine Corps. The magnitude of this change requires strong and consistent leadership. Educating leadership spans the full range of instruction at the formal schools from entry level to career and command level courses.

6.7 (U) Personnel

Personnel approaches address changes in end-strength and assignment within applicable MOSs.

6.8 (U) Facilities

This ICD is predicated on the Marine Corps' expeditionary focus and, as such, limits discussion of permanent or base camp facilities. The only recommendation in this area was to establish core design models that support scalable FOBs and Forward Arming and Refueling Points (FARPs) for various mission requirements and enable efficient transitions to enduring operations and joint force sustainment. The Marine Corps will partner with Army programs and the other Services to ensure interoperability and assurance of USMC capabilities for enduring E2W2 sustainment and base camp operations.

7 (U) Final Recommendations

Establishing or changing policy, doctrine, TTPs, organization and personnel structure and training will significantly improve E2W2 planning, employment, and oversight. With a concerted effort, many of these non-materiel approaches can be implemented in the near term without materiel development or new technology. Nevertheless, no combination of non-materiel approaches will completely close E2W2 capability gaps, and there are significant gaps that can only be adequately mitigated through new or enhanced materiel solutions. Increasing battlefield energy efficiency and integrating renewable energy systems demands a coordinated, system of systems approach to achieve maximum operational energy performance within resource constraints.

The USMC Expeditionary Energy Strategy and Implementation Plan is the first key policy step. It establishes the Commandant's intent to focus materiel and non-materiel capability development on increasing E2W2 efficiency and self-sufficiency, reducing logistics vulnerabilities, and enabling a lighter, more maneuverable MAGTF that is ready to respond across the ROMO. The E2W2 ICD recommendations build on this intent and map the path to capabilities development.

The E2W2 CBA validated the premise that achieving the USMC Expeditionary Energy Strategy objectives, and conducting EMO, requires a change to the way Marines and their leaders value energy and water resources in training and on the battlefield. Policy, doctrine, training and leadership approaches can have the most immediate impact and it is recommended that these be applied without delay. Several next steps are recommended upon approval of this ICD:

- Begin policy issuance and leadership engagement immediately.
- Convene a DOTMLPF working group, consisting of the MAGTF and Functional Advocates, program offices, operating forces, and MOS and PME school participants, to plan and synchronize DOTMLPF changes.

- Begin doctrine changes by creating an overarching E2W2 publication and continue by incorporating E2W2 elements into existing publications during scheduled doctrine reviews.
- Implement updates to entry level, MOS, and PME school curricula. Training development must be coordinated with doctrine writing to ensure unity of effort and curricula must be updated as new materiel solutions are fielded.
- Conduct a detailed E2W2 organizational structure and manpower analysis to define necessary changes, and to schedule funding and implementation.

Non-materiel approaches need to be coordinated with materiel solution development to create the necessarily robust and efficient E2W2 capabilities. For example, policy will change the way energy is considered in requirements and acquisition processes, changes to training and organization will affect equipping needs, and new materiel generates non-materiel changes that require synchronization.

Current efforts are applying new E2W2 materiel capabilities to support forces conducting enhanced company operations on a distributed battlefield in Afghanistan. The Marine Corps should continue these efforts and build upon them through materiel development decisions focused on improvements across all energy, water, and waste producing and consuming systems. Materiel approaches are identified in three groups: ***information technology (IT)***, ***evolutionary development***, and ***transformational approaches***.

The IPT identified 87 materiel solution approaches across all three categories and applicable to 27 of the 29 tasks. The assessment indicates that the majority of materiel solution approaches are within the Evolutionary (Recapitalization) and Transformational (Breakout) categories. This suggests that current and programmed capabilities can support gap mitigation, but in several key areas new technology is needed. For Evolutionary approaches, system proficiency (i.e. how well a capability performs) and sufficiency (i.e. how much of a capability is required) need to be assessed further. The need for improved information technology to support mission planning, execution and management is evident by the number of tasks requiring a solution approach within the IT category.

USMC E2W2 capabilities support an expansive and dynamic mission set. Although there are programmed efforts underway in each of the materiel approach categories, they are not comprehensive enough to mitigate future gaps and are not focused by a common requirements and acquisition strategy or materiel standards architecture across the warfighting functions. The near- to mid-term approaches summarized above and detailed in Attachment H include systems that focus on expanding information technology for improved planning and management (e.g. monitoring and metering) and the evolution of existing E2W2 capabilities to improve MAGTF operational energy and water performance. Finally, transformational technology breakthroughs in the mid- to far-term are necessary to achieve the USMC Expeditionary Energy Strategy and Implementation Plan goals and to enable effective enhanced MAGTF operations across the range of military operations.

Appendix A
E2W2 Operational Overview-1

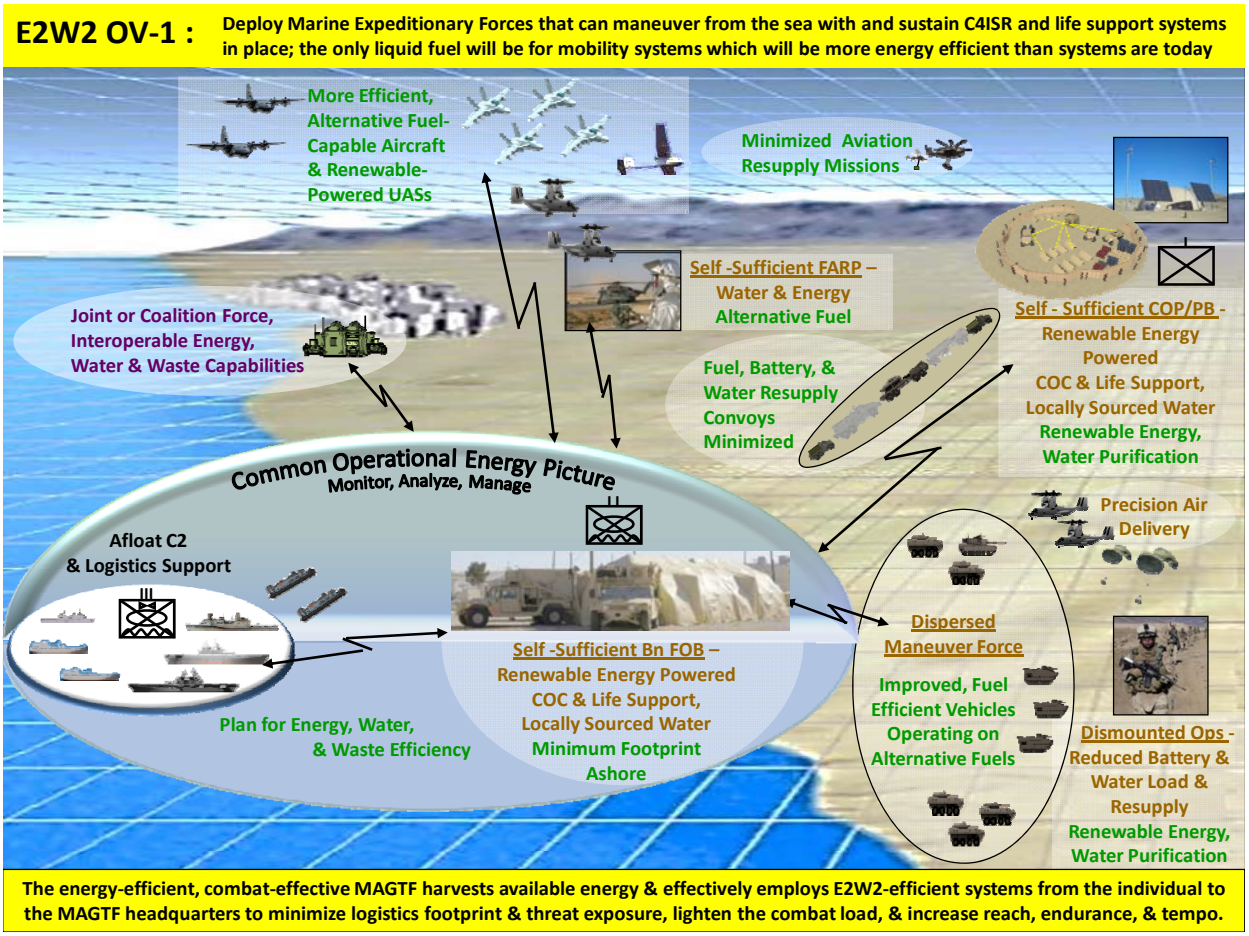

Figure A-1. USMC E2W2 OV-1

Figure A-1 depicts an operational view (OV-1) of a MAGTF employing the full complement of efficient Expeditionary Energy, Water and Waste (E2W2) capabilities in 2025. The MAGTF arrives from the sea, receives sea-based sustainment logistics support, and operates with only essential forces ashore. The force is distributed, with self-sufficient forward operating bases (FOBs), combat outposts (COPs), patrol bases (PBs), and Forward Arming and Refueling Points (FARPs). The OV-1 characterizes key operational nodes in terms of their E2W2 efficiency attributes and depicts the interactions between E2W2 architecture, the environment, and joint capabilities. The MAGTF effectively employs E2W2-efficient systems from the individual to the MAGTF headquarters level to enable operational node self-sufficiency and minimize ground and aviation resupply; increasing mobility, reducing exposure events, and freeing transportation assets for other missions. Self-sufficient operational nodes harvest all available energy (solar, thermal, kinetic, etc) to power energy-efficient C4ISR and life support equipment, and to produce potable water from local sources wherever available. Vehicles and individuals harvest and store energy on-the-move and share energy to power weapons and C4ISR systems, and to augment fixed-base renewable power.

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Appendix C
Acronym List

CBA	Capabilities Based Assessment
CBA&P	Capability-Based Assessment and Planning
CCJO	Capstone Concept for Joint Operations
CCDR	Combatant Commander
CCMD	Combatant Command
CJCSI	Chairman of the Joint Chiefs of Staff Instruction
CJCSM	Chairman of the Joint Chiefs of Staff Manual
COCOM	Combatant Command (command authority)
CONOPS	Concept of Operations
COP	Combat Outpost
C/S/A	COCOM / Service / Agency
C4I	Command, Control, Communications, Computers, and Intelligence,
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance
DCR	DOTMLPF Change Recommendation
DOD	Department of Defense
DOTMLPF	Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities
DPG	Defense Planning Guidance
DPS	Defense Planning Scenario, also Defense Planning Strategy
DSCA	Defense Support to Civilian Authorities
E2	Expeditionary Energy
E2O	Expeditionary Energy Office
E2W2	Expeditionary Energy, Water and Waste
EEA	Essential Elements of Analysis
EMO	Enhanced MAGTF Operations
FARP	Forward Arming and Refueling Point
FOB	Forward Operating Base
GAO	Government Accountability Office
GCC	Geographic Combatant Commanders
HADR	Humanitarian Assistance / Disaster Relief
ICD	Initial Capabilities Document
IOC	Initial Operational Capability
IPT	Integrated Process Team
ISR	Intelligence, Surveillance and Reconnaissance
IT	Information Technology
IW	Irregular Warfare
JCA	Joint Capability Area
JCB	Joint Capabilities Board
JCD	Joint Capabilities Document

Appendix C
Acronym List

JCIDS	Joint Capabilities Integration and Development System
JFC	Joint Force Commander or Joint Functional Concept
JFCC	Joint Force Component Commander
JIC	Joint Integrating Concept
JMETL	Joint Mission Essential Task List
JOC	Joint Operating Concept
JOpsC	Joint Operations Concept
JROC	Joint Requirements Oversight Council
JROCM	Joint Requirements Oversight Council Memorandum
MAGTF	Marine Air Ground Task Force
MCO	Major Combat Operations
MOE	Measures of Effectiveness
MOS	Military Occupational Specialty
MRB	Marine Requirements Board
NDS	National Defense Strategy
OV	Operational View
PB	Patrol Base
POI	Program of Instruction
POL	Petroleum, oil, and lubricants
POM	Program Objective Memorandum
QDR	Quadrennial Defense Review
ROMO	Range of Military Operations
SASO	Stability and Support Operations
SOF	Special Operations Forces
T/C/S	Tasks, Conditions and Standards
UCP	Unified Command Plan
UJTL	Universal Joint Tasks List
USA	United States Army
USAF	United States Air Force
USCG	United States Coast Guard
USMC	United States Marine Corps
USN	United States Navy

CONOPS

USMC Expeditionary Energy, Water, & Waste Concept of Operations

1. Overview
    - Purpose: To set the operational context for the Expeditionary Energy, Water, and Waste (E2W2) Capabilities Based Assessment / Initial Capabilities Document.
    - The E2W2 Concept of Operations (CONOPS) is a top level description of Expeditionary Energy, Water and Waste considerations for Marine forces in varied operating environments.
    - Each scenario describes a set of tasks typical in the type of operation and sets the foundation for E2W2 support requirements.
    - As a top level document the tasks and challenges depicted are illustrative of the E2W2 concept and are not intended to address all possible scenario details or issues.
2. E2W2 Problem Statement
    - Asset constraints are inherent to the expeditionary environment.
    - Energy and water comprise the bulk of gross tonnage required to support a forward deployed MAGTF.
    - The increasing support demands of forward deployed MAGTF elements present severe operational risk in terms of exposing Marines to enemy attack and the materiel drain on transportation and support equipment.
    - Energy and water are often treated as unconstrained resources by Marines, needlessly driving consumption beyond requirements.
    - These conditions of unconstrained resource demand in a constrained resource, high threat environment drive the demand for efficiency improvements in energy, water, and waste management in the expeditionary environment.
    - Improvements in the E2W2 domain must not negatively impact combat effectiveness.
3. E2W2 CONOPS Themes
    - Better resource usage visibility will aid planning and management of energy, water and waste.
    - The nature of MAGTF operations in an expeditionary environment demands a high degree of resource self-sufficiency to include energy and water.
    - The combination of maneuver warfare tactics and a hybrid threat environment challenge bulk distribution of energy and water.
    - Proliferation of electronics equipment throughout the MAGTF has greatly increased demand for electric power, from the Command Element down to the individual Marine.
    - Improvements in energy consumption efficiency will reduce user demand and associated logistical support requirements.
    - Improved energy and water production capabilities will increase unit self-sufficiency and reduce the requirement to transport energy and water resource.
4. E2W2 CONOPS Assumptions
    - The chosen MROC-approved scenarios are reflective of likely future (out to 2025 timeframe) warfighting environments and MAGTF missions:
        i. Hybrid threats – lack of secure areas and LOCs
        ii. Rapid response and maneuver
        iii. Requirements for sea-based operations and logistics support
        iv. Austere environments with limited infrastructure and non-MAGTF organic resources
    - Proliferation of electronics equipment throughout the MAGTF is likely to continue the growth in C4ISR energy demands.
    - An increased standard of vehicle protection will continue in the future, with a likely impact on vehicle energy consumption.

- Efforts to improve energy efficiency must not negatively impact warfighting capabilities or MAGTF combat effectiveness.

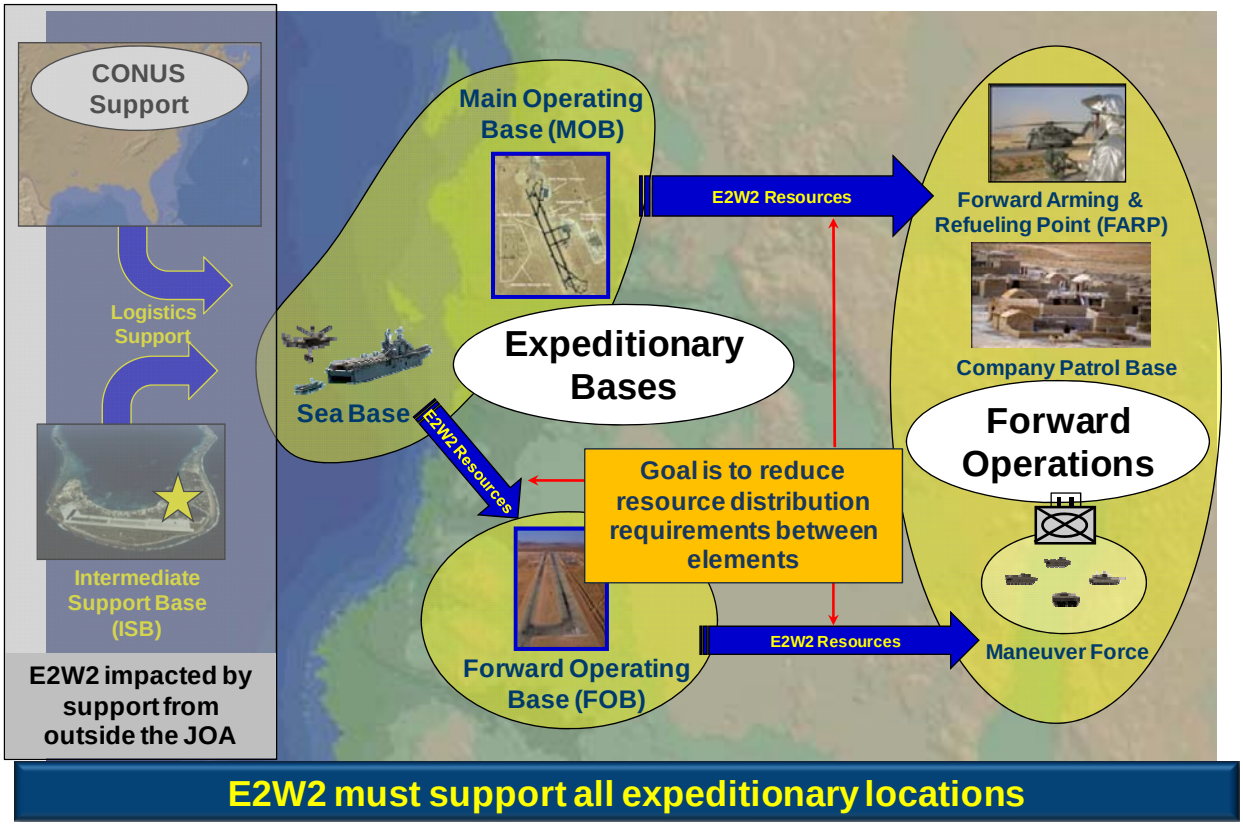


Figure 1. E2W2 Operating Area

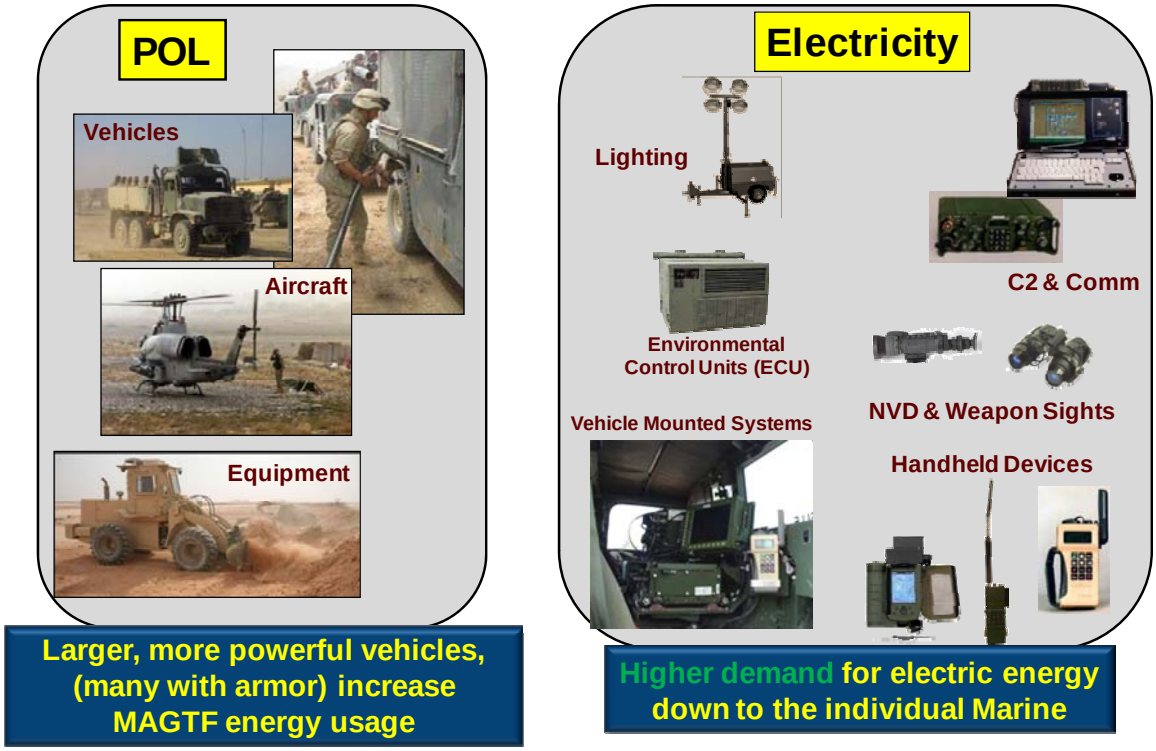


Figure 2. Energy Consumers

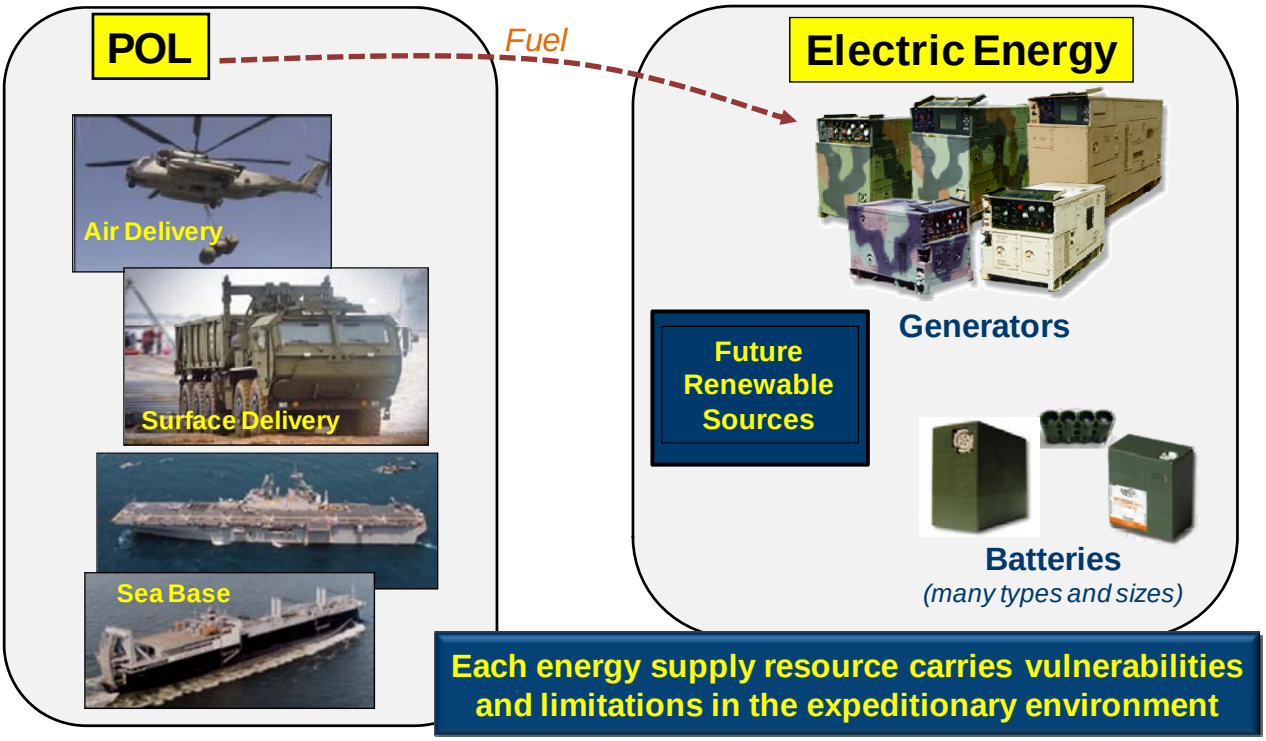


Figure 3. Energy Supply

USMC Expeditionary Energy, Water, & Waste Concept of Operations

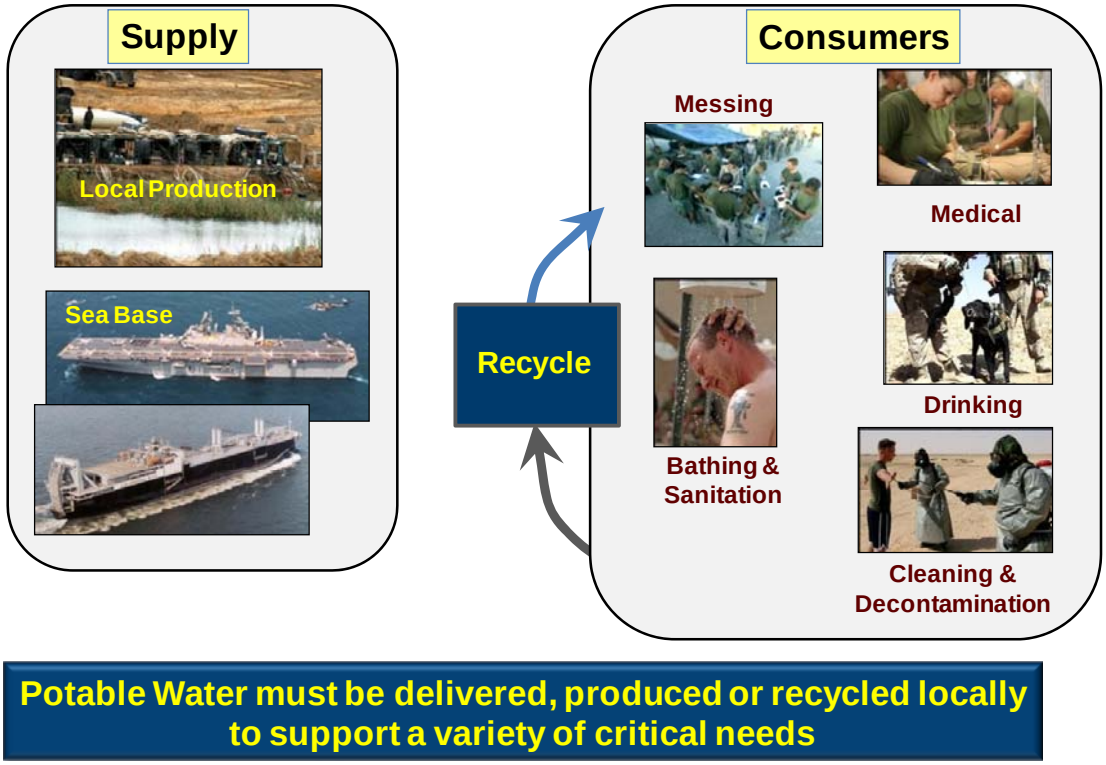


Figure 4. Water Supply - Consumption & Recycle

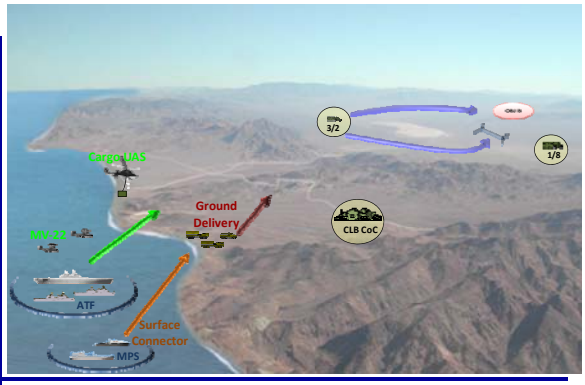
5. E2W2 Scenarios

- Task
  - i. Present three scenarios that illustrate plausible MAGTF operations and a vision for how expeditionary energy, water, and waste management requirements can be met more efficiently.
- CONOPS overview
  - i. CONOPS scenarios span the operating spectrum to highlight the need for greater efficiency in the delivery and use of energy and water for the MAGTF.
- Three scenarios chosen
  - i. (U) Major Combat Operation-1
  - ii. (U) Irregular Warfare-1
  - iii. (U) Humanitarian Assistance / Disaster Relief Steady State Security Posture

USMC Expeditionary Energy, Water, & Waste Concept of Operations

Overview

- 1st MEB is in the Assault Echelon of a JFEO against an adversary state threatening regional stability *(Amphibious MEB)*
  - Ship-To-Objective Maneuver (STOM) landing
  - Employs Enhanced MAGTF Operations (EMO) to cover an expanded battlespace
- Enemy will employ hybrid warfare tactics – few secure areas or Main Support Routes (MSR)



Blue Forces

- Marine
  - 2 x MEB (AE)
  - 1 x MEB (MPF)
- Army
  - Stryker Brigade Combat Team (SBCT)
  - Airborne Bde

Red Forces

- Mix of mechanized, armor, irregular infantry and air defenses
- Operate in company- to division-size formations
- Focused on access denial and defending critical infrastructure

E2W2 Challenges

- Capabilities to support speed and dispersion of operations
- Reliance on seabased resources challenges responsive sustainment to tactical locations ashore
- Pace of maneuver ops limits ability to develop local energy & water resources
- Lack of secure areas and routes challenges overland delivery options

Figure B-5. Major Combat Operations (MCO) Scenario

6. MCO Amphibious Operations

- Focus of scenario: Forcible entry by 1st MEB as an element of a larger JFEO
- Scenario has following lines of operation:
  - i. Close: Amphibious Force and MPF movement
  - ii. Assemble: Forces flow to the sea base from CONUS and intermediate staging bases (ISBs). The sea base is established.
  - iii. Employ: Assault phase (amphibious and vertical)
    1. Planned logistics support to enable rapid seizure of objectives and swift transition to follow-on phases
  - iv. Sustain:
    1. Primary source of logistics support is the sea base
    2. Requirement to support numerous dispersed company size units
    3. Establish limited basing ashore
    4. Establish expeditionary arrival and assembly capability for AFOE and other follow-on forces
  - v. Reconstitute:
    1. Forces redeploy to Amphibious and Maritime Prepositioning Ships
    2. Equipment is repaired in anticipation of follow-on missions

USMC Expeditionary Energy, Water, & Waste Concept of Operations

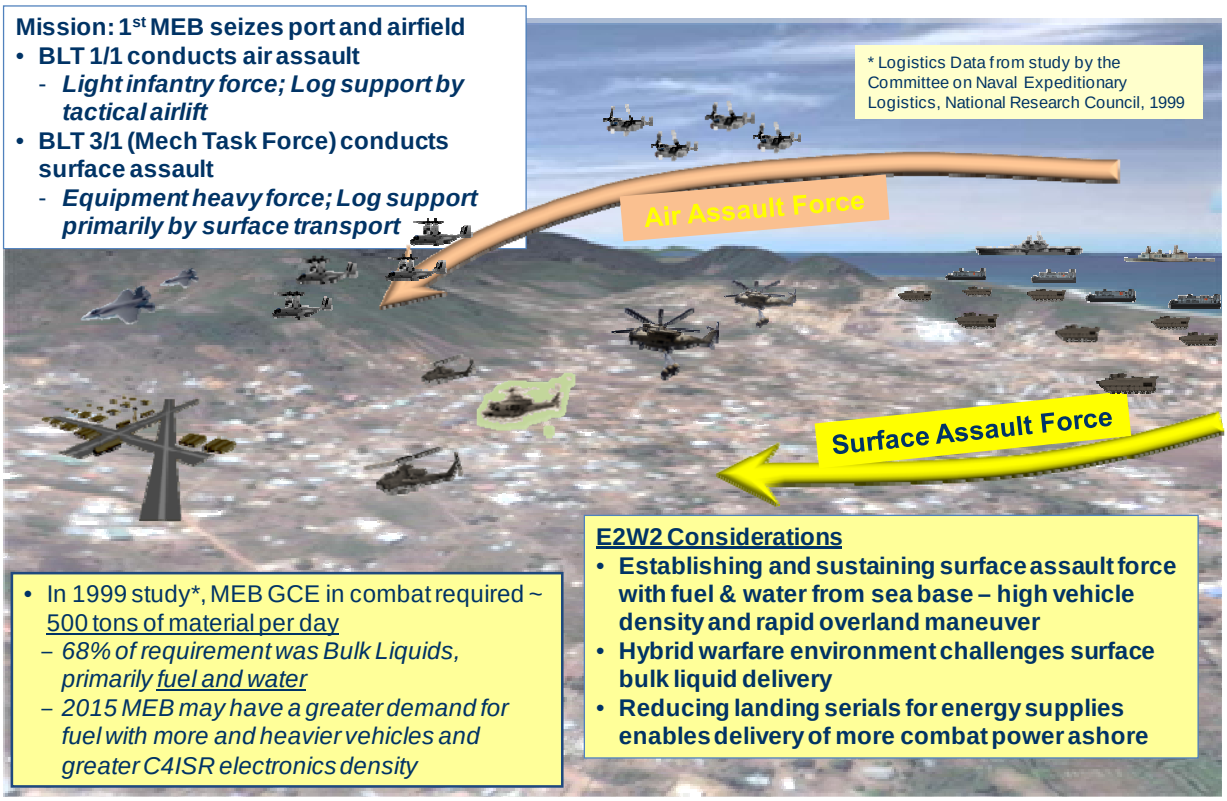


Figure 6. MCO Initial Assault

7. Resourcing the MAGTF
    - Modern and future MAGTF features a high density of vehicles and electronics
        i. Force cannot operate effectively without adequate fuel and electric power
        ii. Maneuver warfare places great demands on vehicle movements and C2 capabilities - requires consistent energy supply
    - Provision of adequate fuel and water to a maneuver force presents significant logistics challenges
        i. Maneuver in a hybrid threat environment limits secure LOCs
        ii. Storage and distribution requirements create vulnerabilities
    - Greater efficiency in energy usage and delivery reduces overall MAGTF vulnerability

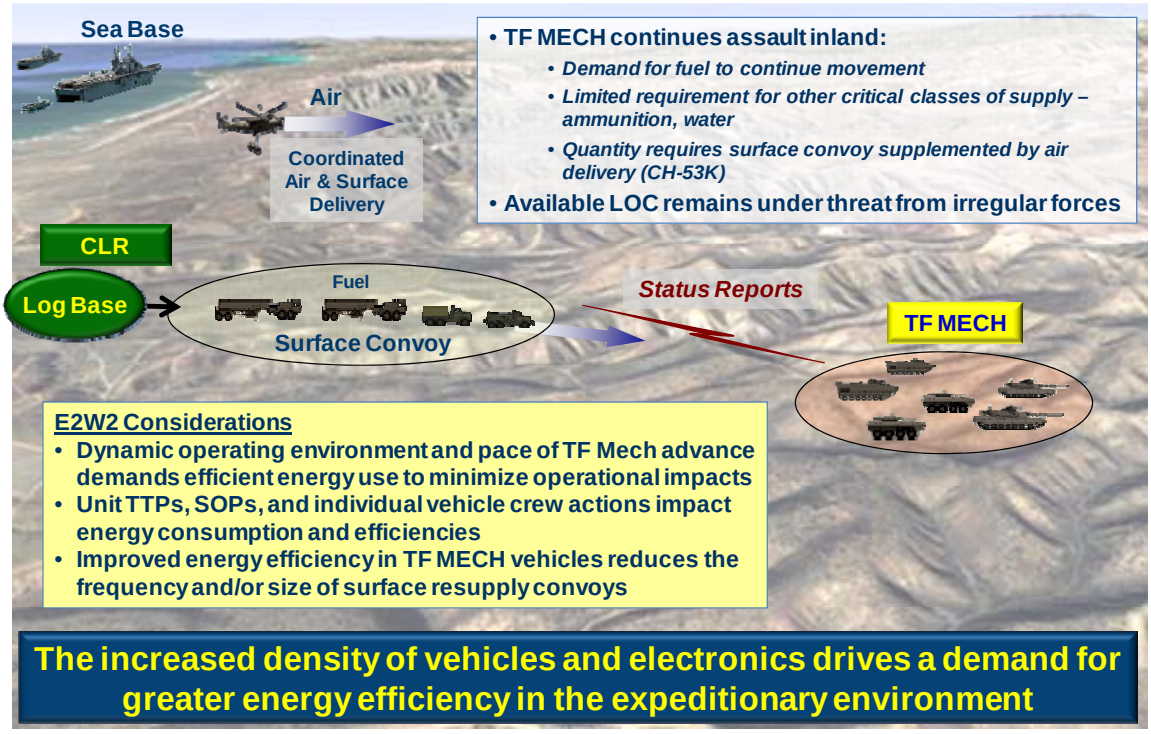


Figure 7. Surface Assault Force

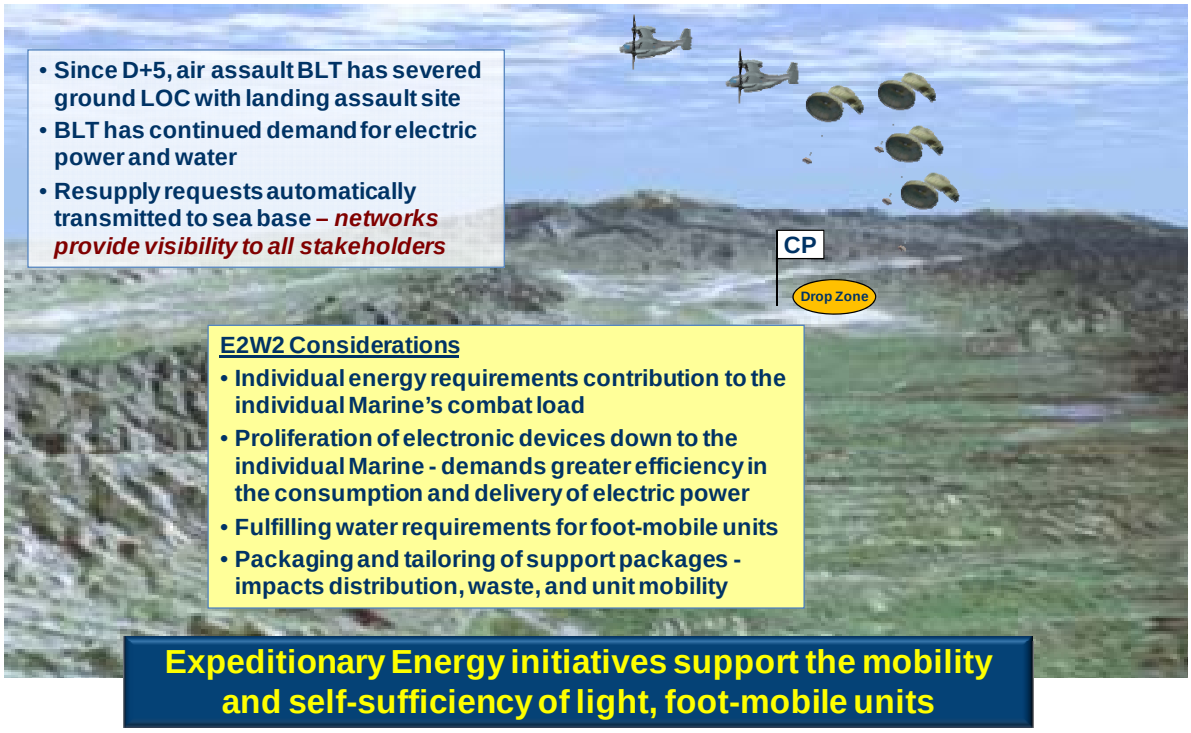
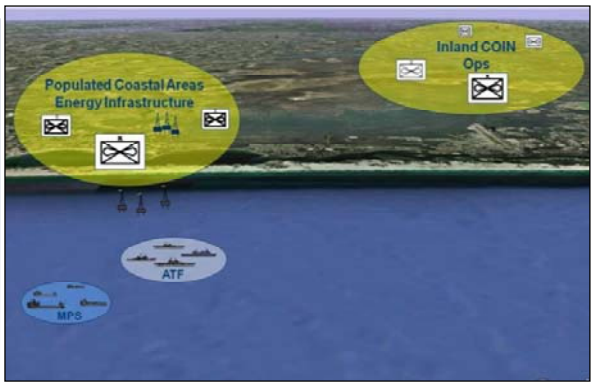


Figure 8. Air Assault Force

USMC Expeditionary Energy, Water, & Waste Concept of Operations

Situation

- Nation experiencing internal turmoil and threats to critical economic infrastructure from radical elements
- Corrupt local governments and organized crime
- Insurgent operations threaten economic development and human security
- Government requests U.S. and other international assistance
- U.S. agrees and orders forces to the area



U.S. Forces

- JTF formed with MEF CG tasked as CJTF
- MEF(-) composited from 2 MEBs
  - 1 Amphibious MEB
  - 1 MPF based MEB
- USN
  - Amphibious Group
  - Carrier Strike Group
- USAF airlift forces
- JSOTF

Threat

- Widely dispersed irregular/guerilla forces

E2W2 Challenges

- Distributed forces: 6 x Bn deployed over large area, compounded by dispersed company ops
- Meeting distributed force requirements for energy, water, and waste infrastructure
- Austere environment provides minimal host nation support infrastructure for energy or potable water
- Limited inland road networks, challenges overland logistics; threat of ambush in some OPAREAS

Figure 9. Irregular Warfare (IW) Scenario

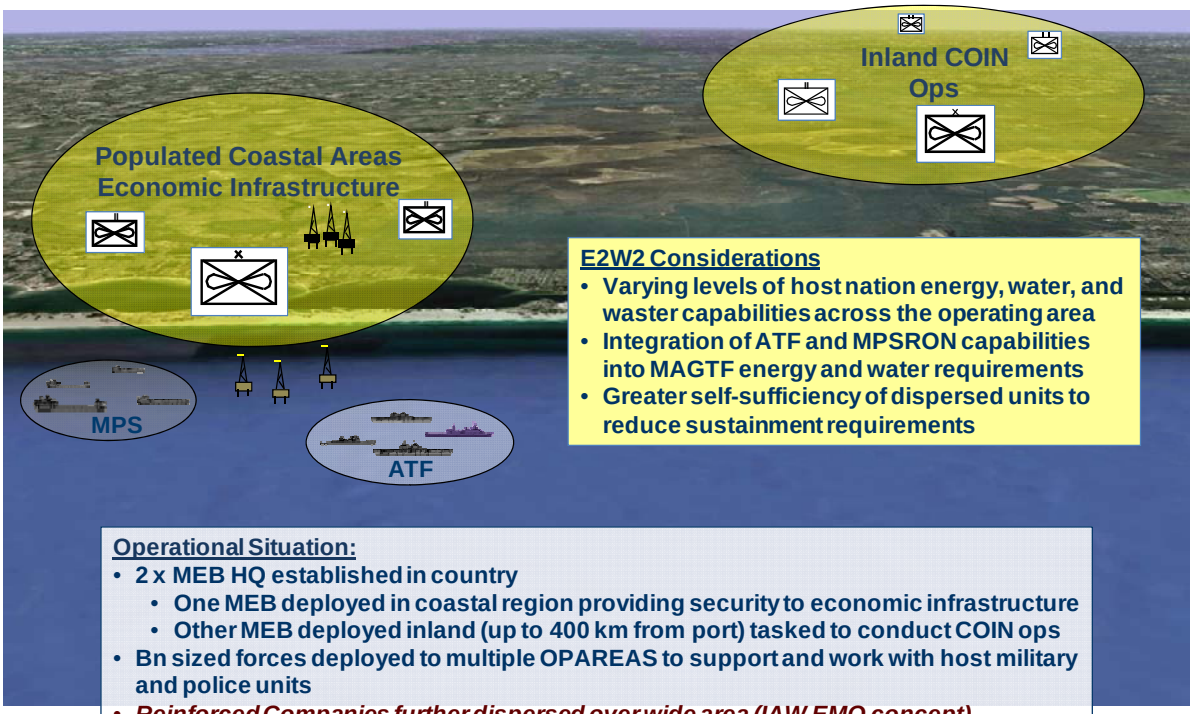


Figure 10. IW Mission Overview

8. Enhanced MAGTF Operations (EMO)
    - Improved Self-Sufficiency at Forward Operating Bases
        i. Improves battlespace "tooth to tail" ratio increasing combat effectiveness and efficiency
        ii. Reduces force protection challenge by reducing demand for resupply convoys
    - Increase efficiency, reduce consumption, and use local resources
        i. Improved water self-sufficiency
            1. Organic water production capabilities
            2. Leverage existing local sources for fuel/water and waste management
        ii. Improved energy usage efficiency
            1. Renewable energy sources
            2. Improved insulation for shelters and tents reduces cooling & heating demand
            3. Improved vehicle & equipment fuel efficiency
            4. Use of energy dense materials

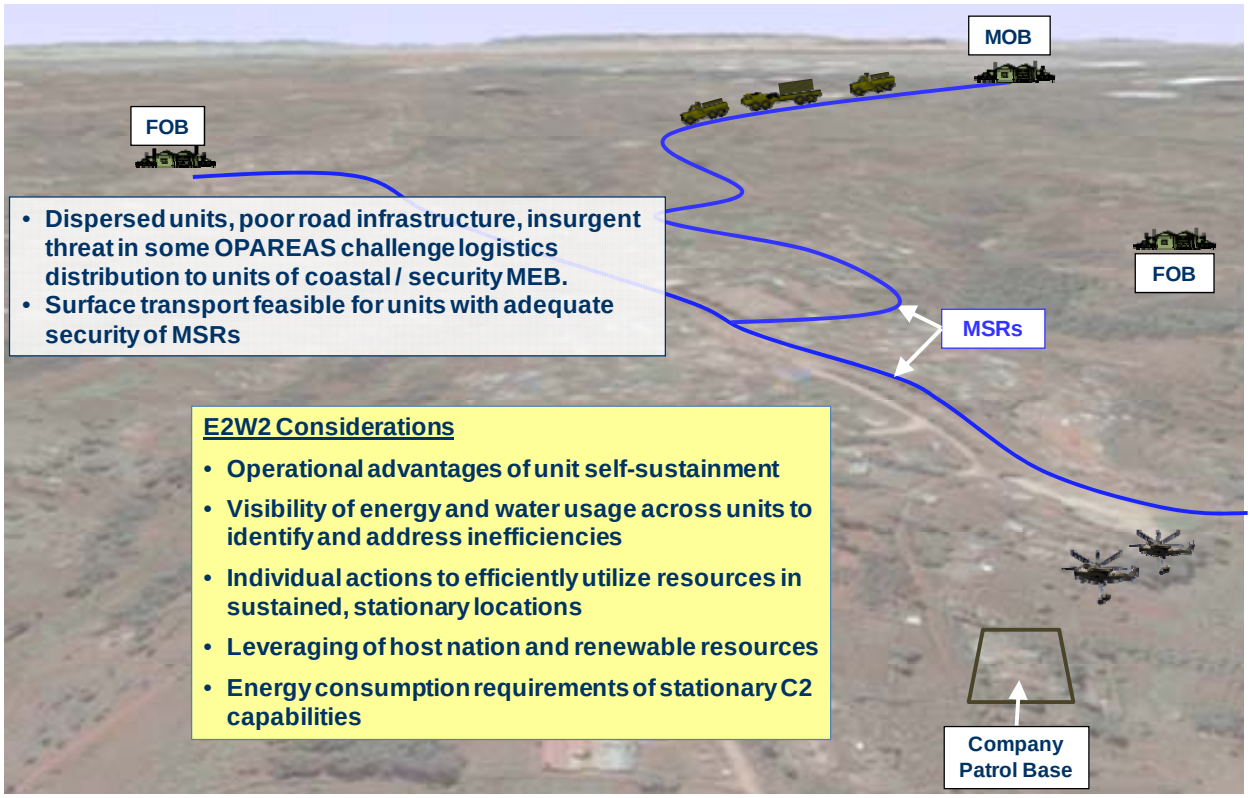


Figure 11. Ground E2W2 in IW Operations

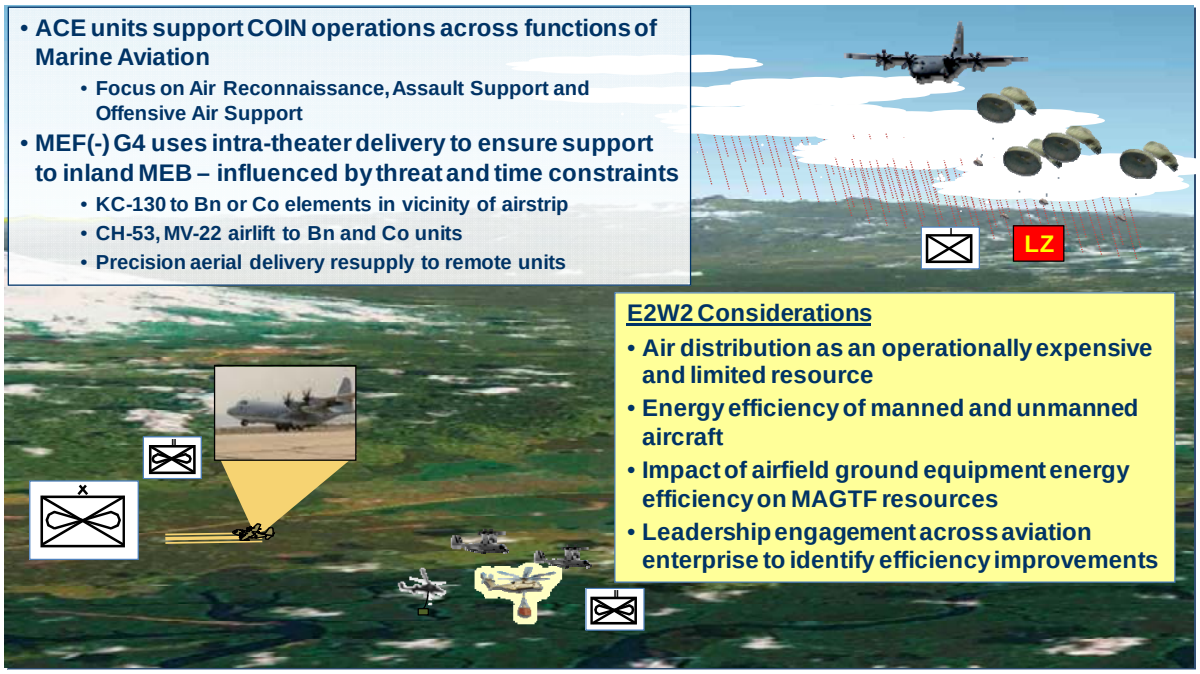


Figure 12. Air E2W2 in IW Operations

Figure 13. Waste as Energy in IW Operations

USMC Expeditionary Energy, Water, & Waste Concept of Operations

Situation

- An undersea earthquake off the coast of a small island nation causes tidal wave and severe flooding
- Mass casualties, many dead
- Key rail, air and port facilities damaged with most being rendered useless
- Water and fuel supplies contaminated
- U.S. asked to provide financial and direct assistance to humanitarian relief efforts
- MEU ordered to support JTF relief operations

U.S. Forces

- ARG/MEU en route anticipating arrival in 48 hrs
  - LHD, LSD, LPD,
  - Composite ACE
  - 2 x C-130 en route from CONUS to suitable airfield on neighboring island
    - On alert for tasking
  - 3 x Cargo UAS
- 2 x JHSV
  - Transporting DART

E2W2 Challenges

- Infrastructure damage challenges host nation energy and water capabilities
- Urgent needs for relief supplies, including water and energy, to population concurrent to internal MAGTF energy and water requirements
- Damaged road networks and air delivery capabilities and extensive engineer capabilities to facilitate surface distribution routes
- Limit negative impact by the MAGTF on an already strained energy and water infrastructure

Figure 14. Humanitarian Assistance / Disaster Relief (HADR) Vignette

9. HADR Mission Outline

Mission: Conduct relief operations in order to locate and evacuate survivors, provide immediate medical relief and deliver emergency subsistence.

- Phase I Assess the situation and deploy
  i. ARG/MEU first responders
  ii. MEF establishes JTF HQ and Civil Military Operations Center (CMOC)
- Phase II:
  i. Begin immediate relief operations
    1. Locate and evacuate survivors
    2. Provide food, water and medical assistance
- Phase III:
  i. Deliver humanitarian aid from the sea base
    1. Air Delivery main focus
    2. SSC over the beach and LCU to the beach

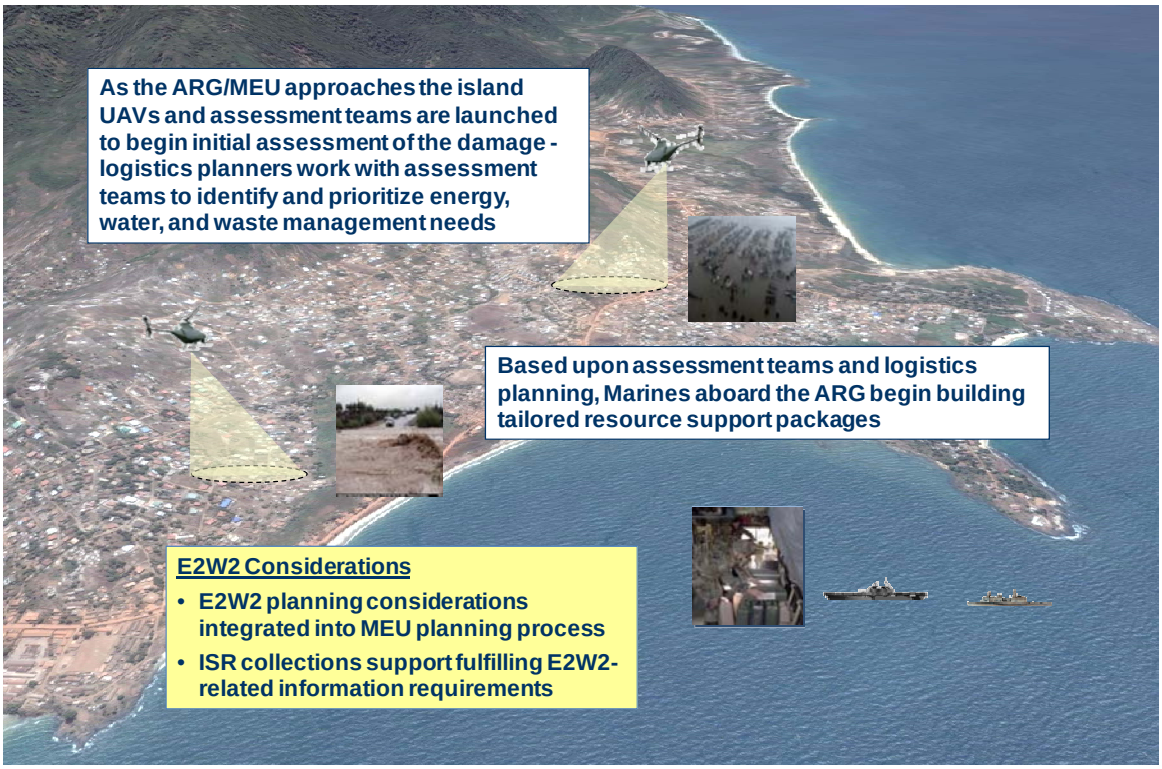


Figure 15. HADR Assessment and Preparation

Figure 16. HADR Efforts Underway

Attachment E

Attachment E

E2W2 Capabilities Based Assessment Overview

E.1 Objective

The E2W2 CBA initiated the deliberate, capabilities-based planning to achieve the mission set forth in the USMC Expeditionary Energy Strategy:

> *"By 2025 we will deploy Marine Expeditionary Forces that can maneuver from the sea and sustain its C4I and life support systems in place; the only liquid fuel needed will be for mobility systems which will be more energy efficient than systems are today."*

E2W2 CBA outputs provide a foundation for meeting the Marine Corps' energy goals: forging an ethos that equates energy efficiency with combat effectiveness; increasing energy efficiency of expeditionary systems; and increasing the use of renewable energy in battlefield operations.[1] The non-materiel and materiel approaches identified within this assessment establish a means for achieving the overarching USMC Expeditionary Energy Strategy goal, a 50% increase in operational energy efficiency on the battlefield, while increasing operational water self-sufficiency and more effectively managing waste. Most importantly, application of these approaches is necessary to increase operational effectiveness and reduce the risk to Marines. By increasing self-sufficiency and lightening the individual and MAGTF load, the MAGTF will shrink its threat-exposure, as created by logistical demands, and increase maneuverability at all levels. These improvements are imperatives to future Marine operating concepts and will save lives.

E.2 Scope

E2W2 capabilities are inherently cross-functional. As such, this CBA considered E2W2 enabling capabilities as they apply across the warfighting functions (WFFs) and the full range of expeditionary capabilities from individual Marine to Marine Expeditionary Forces. Capabilities are assessed in the context of Joint concepts and the E2 Strategy, and across the Range of Military Operations (ROMO) as represented by appropriate operational scenarios and the Marine Corps' expeditionary missions within those scenarios. Specifically considered are capabilities that produce or consume energy or water, or could benefit from the ability to better manage waste or use waste to produce energy.

The E2W2 CBA focused on operations from the sea during the first 120 days of operations ashore in order to focus on expeditionary capabilities and to deconflict with a complementary assessment being conducted by the U.S. Army that is focused on sustained operations ashore. The E2W2 IPT reviewed the Army's draft Operational Energy Initial Capabilities Document (ICD) and included several subject matter experts (SMEs) participating in both assessments.

E.3 Task

The E2W2 CBA applied a collaborative capabilities-based planning approach:

- to identify gaps in the ability of current, and projected future, E2W2 capabilities to adequately support the future Marine Corps missions in the context of the E2 Strategy;
- to assess risk;
- to recommend materiel and non-materiel solution approaches to closing identified gaps.

E.4 Assumptions

- Equipment to support Enhanced MAGTF Operations (EMO) will continue to increase MAGTF energy and weight demands.
- EMO implementation requires an increase in energy and water self-sufficiency.

[1] *United States Marine Corps Expeditionary Energy Strategy and Implementation Plan*, (Washington, DC: CMC, 2011), 23 Feb 2011

- Marines will continue to operate in austere environments, with no E2W2 infrastructure, and be exposed to complex, hybrid threats.
- Funding will be available to fully implement the non-material and material solutions identified in this CBA to include the necessary research and development.
- Renewable, alternative, and energy efficient technologies will evolve to meet future MAGTF demands.

E.5 Constraints

- The USMC will meet all SECNAV Goals for alternative energy consumption by 2020.
- The USMC will support DON "Green Strike Group" deployment by 2016.

E.6 Methodology Overview

The E2W2 CBA was guided by the CJCSI 3170.01G (*Joint Capabilities Integration and Development System),* the *Manual for the Operation of the Joint Capabilities Integration and Development System,* and the *Joint Staff Capabilities-Based Assessment (CBA) User's Guide* and applied a three-phase, six-step process (Figure D-1):

- Phase 1: Mission and Capabilities Identification (Steps 1 & 2)
- Phase 2: Gap and Risk Assessment (Steps 3 & 4)
- Phase 3: Solution Assessment and Recommendations (Steps 5 & 6)

Based on available time and resources the E2W2 IPT conducted the assessment using a consensus based methodology. This approach leveraged SME understanding of the varied and complex issue(s) associated with E2W2 capabilities and used collaborative decision support, multi-criteria decision making (MCDM) and an analytical hierarchy process (AHP) tools.

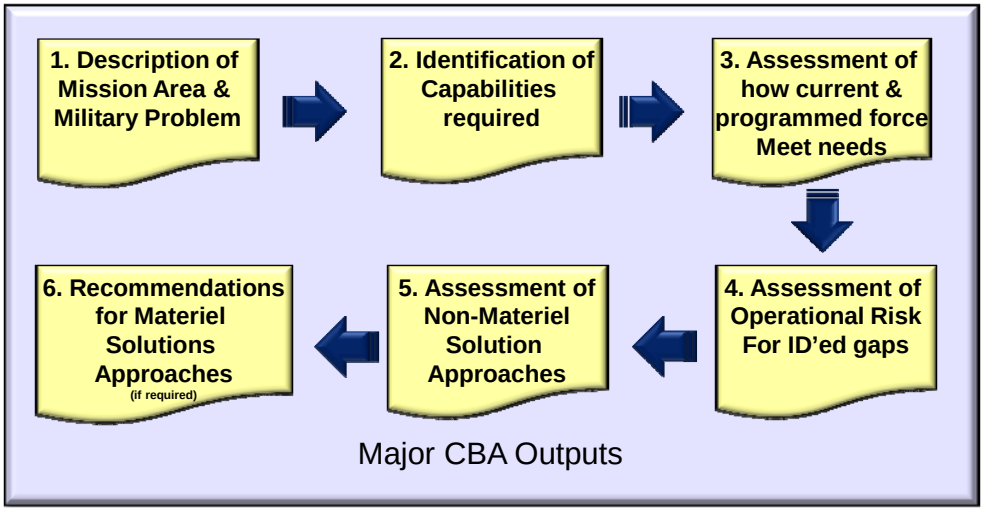


Figure E-1. CBA Process Flow

Attachment F

Attachment F

E2W2 CBA Mission and Capabilities Identification

F.1 Assessment Method

During Mission and Capabilities Identification, the IPT examined MAGTF missions in reference to a set of defense planning scenarios approved by the Marine Requirements Oversight Council for Programming Objective Memorandum 14 (POM-14) use. These scenarios include:

- (U) Major Combat Operation-1
- (U) Irregular Warfare-1
- (U) Humanitarian Assistance / Disaster Relief Steady State Security Posture

In order to identify relevant E2W2 capabilities and the associated Tasks, Conditions, and Standards (T/C/S), the IPT referenced numerous joint and Service strategy documents, concepts and doctrine. See Appendix D for a comprehensive list of references.

In order to represent the logical relationships between E2W2 capabilities and the flow of E2W2 activities in the operational environment, and to ensure a systems view of potential gaps, the IPT defined and prioritized six functional capability areas in which to group tasks (in priority order):

1) *Energy, Water and Waste Planning.* The ability to plan all aspects of operational energy, water, and waste, to include planning for their efficient production, distribution, storage, consumption, and disposal. This capability includes the means to ensure adequate oversight through policy, efficiency planning guidelines, and materiel standards (e.g. Operational Energy Performance Key System Attributes and Key Performance Parameters); and adequate standardization through doctrine and tactics, techniques, and procedures (TTPs).

2) *Production of Energy and Water.* The ability to produce energy and water, to include the use of alternative and renewable energy production capabilities. Production includes the generation of power to meet both unit and individual requirements, and the purification and testing of potable water. Production shall maximize self-sufficiency.

3) *Energy, Water and Waste Storage.* The ability to store energy, water, and waste. Storage includes systems to store potential energy until needed. Storage also includes the purification and testing of stored water, and energy monitoring for quality control.

4) *Energy and Water Distribution.* The ability to deliver energy and water resources to the proper location at the required time, in support of the MAGTF Commander. Distribution operations establishes, manages and integrate distribution services associated with the functions of movement and delivery of materiel, personnel and services to support the MAGTF while not hampering the MAGTF's inherent speed, flexibility and agility.

5) *Waste Disposal*. The ability to dispose of liquid and solid waste generated in the production and consumption of energy and water. Disposal includes packaging, handling, and transport of refuse, waste water, sewage, and contaminated POLs. Sewage and waste treatment, and recycling are elements of disposal.

6) *Energy, Water and Waste Management*. The ability to manage all aspects of operational energy, water, and waste, to include efficient production, distribution, storage, consumption, and disposal. This process employs policy, doctrine, and TTPs to ensure efficient use of E2W2 capabilities.

Attachment F

E2W2 CBA Mission and Capabilities Identification

The six capability areas may be further described in the context of the E2W2-efficient MAGTF depicted in the E2W2 OV-1:

1) *Energy, Water and Waste Planning.* E2W2 requirements must be thoroughly addressed in mission planning in order to ensure efficient employment of E2W2 assets in a manner that supports MAGTF combat effectiveness. Effective planning requires inclusion of appropriate, experienced, and trained SMEs to identify requirements and efficient solutions across the MAGTF elements as appropriate to each operational phase. Production is planned to occur as close to the point of use as technically feasible and operationally practical. Planning includes combat development efforts to plan and design energy efficient expeditionary systems within each WFF to include legacy and new equipment, vehicles, and aircraft.

2) *Production of Energy and Water.* With planning complete, close coordination is established between MAGTF elements to meet energy and water demands throughout mission execution. Critical tasks involve harvesting energy and water as close as practical to the intended point of use, efficiently producing power for C4ISR, mobility and life support systems, and potable water production.

3) *Energy, Water and Waste Storage.* As energy, water and waste are produced by efficient and distributable systems, metering, monitoring, testing and certification, or other quality assurance mechanisms coupled with procedures enable scalable storage and quality preservation.

4) *Energy and Water Distribution.* Fuel and other sources of stored energy, and water are distributed over the minimum distance necessary and with minimal exposure to the threat. Effective distribution is critical to maintaining operational tempo. Tactical electrical distribution occurs efficiently through detailed load assessments; right-sized power sources; adequate distribution equipment; “smart” power systems that integrate and autonomously control multiple power sources, storage devices, and loads; and prudent power conservation measures. Fuel is efficiently distributed for mobility systems. Smaller, more efficient power sources are capable of integrating with renewable sources. Distribution and consumption are measured. Water is distributed locally using efficient packaging that is tailorable to mission requirements.

5) *Waste Disposal.* The force generates waste products as it executes the mission within the operational environment. Packaging enables reuse, recycling, or conversion to energy to the maximum extent practical and technically feasible to minimize disposal and waste retrograde requirements. Expeditionary systems that convert waste to usable energy are deployed with the MAGTF and positioned where most effective as determined by mission analysis.

6) *Energy, Water and Waste Management.* Energy and water system status and usage data are continually collected, analyzed, and provided to commanders in order to enable timely decisions that ensure efficient management. Sensors and data management systems automate collection and reporting from the unit to enterprise levels. Visibility and decision support tools enable timely intervention that optimizes logistics support and enables operational decision making.

By decomposing the capability areas and examining the Universal Joint Task List (UJTL), Universal Naval Task List (UNTL), Marine Corps Task List (MCTL), joint and Service doctrine, and through IPT discussion, 29 tasks were identified as critical to the expeditionary mission across all scenarios. All 29 tasks were aligned to a task from the current MCTL and to applicable Joint Capability Areas (Tier I and II). The IPT prioritized tasks according to the perceived degree of importance to achieving the E2 Strategy goals and objectives and enabling future (Enhanced MAGTF) operations.

Vision and Strategy 2025, Marine Corps Operating Concepts (Third Edition, June 2010), the *USMC Expeditionary Energy Strategy and Implementation Plan* goals and objectives, and the *Center for Naval Analyses Report on Reducing Energy Footprint on the Battlefield* were consulted in order to identify appropriate metrics and measures, which were then refined through IPT input and discussion.

F.2 Results

Table F-1 lists the 29 E2W2 tasks, with description, in priority order from highest to lowest. This task list represents the institutional and operational imperatives (policies, procedures, and systems) for developing a more effective and efficient E2W2 capability set.

Appendix F
E2W2 CBA Mission and Capabilities Identification

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Table F-1. E2W2 Task Descriptions in Task Priority Order

Task Number	Thrust Area	E2W2 Capability Area	Supporting Warfighting Function(s)	Task	Task Description
1	Energy	Planning (Deployed)	C2 Log	Plan to supply/harvest Energy (conventional, renewable, alternative) to the MAGTF; integrated throughout the supply chain and with Joint/Coalition and HNS	Develop plans for the supply/harvest of conventional, renewable, alternative energy, waste-to-energy, with joint, coalition, and HNS in the Joint Operations Area. Plan for integration of energy systems, to include bulk liquid energy, into the supply chain to point of use in order to sustain expeditionary operations.
2	Energy, Water, & Waste	Management	C2 Log	Provide the capability to Manage Energy, Water, and Waste Resources in an Expeditionary Environment	Manage the supply, demand, and usage of energy and water in the operating environment. Assess usage data to determine energy efficiency. Employ sensors, software data management systems to process, analyze, and report E2W2 demand and consumption information at the unit and enterprise level.
3	Energy	Production	All	Conduct Combat Operations across the MAGTF with minimal energy and energy related logistics requirements	Reduce the need for fuel resupply by harvesting the required energy, in place, from natural and manmade sources, to power command, control, computer, and communications, intelligences and surveillance systems, and life support systems.
4	Energy	Planning	All	Plan for reductions in energy demands of current and future capability sets without reducing combat/mission effectiveness	Employ tailored T/O and T/E to achieve mission objectives, and optimize T/E using an energy system of systems approach. Provide the right personnel with the right equipment to optimize energy employment across the ROMO.
5	Water	Planning (Deployed)	Log C2	Develop Plans to Support Efficient, Scalable Expeditionary Water Systems and Hygiene Service	Develop plans to provide water and hygiene support. Includes provision for tactical water support to create, recycle, purify, certify, store, surveillance, and distribution of water; includes billeting, messing, shower, and laundry services, and incorporate waste water required to support expeditionary operations.
6	Energy	Planning	All	Design Efficient, Scalable, and Interoperable, Expeditionary Energy Producing and Consuming Warfighting Capabilities	Plan and design energy efficient expeditionary systems to include efficient shelter design, energy harvesting, power distribution systems, and all energy consuming equipment to minimize energy consumption to the degree possible without impacting operational effectiveness. Require an Energy Performance Key Performance Parameter in new and upgraded legacy equipment and vehicles.
7	Energy, Water, & Waste	Management	C2 Log	Provide the capability to Measure Energy, Water, and Waste Resources in an Expeditionary Environment	Employ sensors, meters, and other monitoring technology to gather real time /near real time data on energy, fuel, and water demand and consumption, and waste management processes. Include software data management systems to process, analyze, and report E2W2 demand/consumption information at the unit and enterprise level.
8	Energy	Distribution	Log	Conduct "smart" expeditionary Electrical Distribution	Conduct efficient tactical electrical distribution operations and provide electric distribution to expeditionary units through a tactical distribution grid system that could be metered and monitored from a central location. This distribution system will have the capability to integrate AC/DC generation and loads to include renewables.
9	Energy	Planning	Log, C2, Intel, FP	Plan to produce all C4ISR energy and power requirements organically in place	Operate and sustain C4ISR with harvested energy and power resources from natural and manmade sources.
10	Water	Distribution	Log	Conduct Expeditionary Water Distribution	Distribute water to operating locations as necessary to support expeditionary operations in all environments. Includes certification, surveillance, metering and monitoring. Water support may be provided to U.S. Forces, other nation armed forces or civilians as directed.

Appendix F

E2W2 CBA Mission and Capabilities Identification

Task Number	Thrust Area	E2W2 Capability Area	Supporting Warfighting Function(s)	Task	Task Description
11	Water	Production	Log Maneuver FP	Provide efficient production of Potable/Non-Potable water in an expeditionary environment	Produce potable and non-potable water on site. Maintain water generation and distribution, including purification, certification, and quality surveillance of water. Include the ability to cool and heat water as required for health and comfort needs. These systems shall be energy efficient and where possible leverage renewable energy sources.
12	Energy	Distribution	All	Conduct Expeditionary Bulk Fuel Distribution	Expeditionary bulk fuel distribution operations includes support for forward arming and refueling point (FARP) for aircraft and vehicles at locations near or beyond the forward edge of battle area (FEBA); Aviation-Delivered Ground Refueling (use of aircraft to deliver fuel to austere, remote expeditionary locations); and distributing fuel in an expeditionary environment; and the ability to monitor and meter distribution.
13	Energy	Production	C2, Intel, Maneuver, Fires, Log	Provide a Power Source appropriate to the individual user's required capability	Produce power for individual Warfighting systems that includes common power sources and energy harvesting systems.
14	Energy, Water, & Waste	Management	All	Provide the capability to Analyze data on Energy, Water, and Waste Resources in an expeditionary environment	Employ operational energy management data and analyses at the unit level to optimize logistic support and operational decision making.
15	Energy	Production	All	Produce Energy Efficient Climate Control environments to maintain Personnel and Equipment operating efficiency	Provide energy efficient climate control to provide comfort sensation for personnel and maintains operating temperature for equipment.
16	Water	Storage	Log, Maneuver, FP	Provide Expeditionary Water Storage	Water storage includes metering, purification, certification, and quality surveillance of water. Man portable containers or the storage system must be capable of distributing water into man pack containers (camel backs, canteens, etc).
17	Energy	Storage	Log, C2, FP	Provide Expeditionary Bulk Fuel Storage	Storage includes metering, monitoring, testing, and certification and quality assurance.
18	Waste (Operations)	Planning	All	Develop Plans to Manage, recycle and dispose of Waste (Water, Solid, Biological) and Hazardous Waste	Develop plans to reduce waste and hazardous materials: develop plans to minimize the generation of pollution, waste, and hazardous waste to minimize operational impact, avoid exposing friendly personnel to human health hazards, and minimize impact on host nation populations and environment, and plans to use waste for the production of onsite energy generation.
19	Energy	Planning	Log	Develop migration plan for FOB to transition from expeditionary to enduring base	Develop migration plans for the transition from FOBs to enduring bases that account for energy, water and waste requirements associated with a more enduring presence.
20	Waste	Disposal	Log	Provide Efficient/Effective Disposal of Non Reusable Solid Waste in an Expeditionary Environment	Provide waste management for disposal of solid waste in expeditionary base camp environment. Disposal includes recycling where feasible. Includes wastewater collection and treatment systems, refuse collection, and disposal.
21	Waste	Disposal	Log	Provide Efficient/Effective Disposal of Non Reusable Hazardous Waste in an Expeditionary Environment	Provide waste management for disposal of hazardous waste in expeditionary base camp environment. Disposal includes recycling where feasible.

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E2W2 CBA Mission and Capabilities Identification

Task Number	Thrust Area	E2W2 Capability Area	Supporting Warfighting Function(s)	Task	Task Description
22	Water	Production	Log Maneuver	Provide for the efficient production of recycled Potable/Non-Potable water in an expeditionary environment	Produce potable and non-potable water on site. Maintain water generation and distribution, including purification, certification, and quality surveillance of water. Include the ability to cool and heat water as required for health and comfort needs. These systems shall be energy efficient and where possible leverage renewable energy sources.
23	Energy, Water & Waste	Management	Log C2	Management of additional tasks to comply with higher guidance (i.e. DODI regarding burn pits, etc.) in an expeditionary environment	Manage guidance related to the use of energy, water and waste from higher, adjacent and joint commands, when required.
24	Energy	Storage	All	Provide Storage for Collection of Energy Sources Other than Liquid Fuels	Provide storage for harvested energy sources, other than liquid fuel and POL, to include the storage of solar, thermal, kinetic, ect. energy sources that provide for lightweight mobile energy storage in an expeditionary environment.
25	Water	Storage	Log Maneuver	Provide Expeditionary Water Packaging	Water packaging includes metering, purification, certification, & quality surveillance. Man portable containers or the storage system must be capable of distributing water into man pack containers (camelbacks, canteens, etc).
26	Energy & Waste	Planning	Log	Plan and Design Waste-to-Energy Systems	Plan and design expeditionary waste systems: Plan and design systems that recycle waste to include energy harvesting and safe removal of hazardous waste streams from the battlefield.
27	Energy & Waste	Production	Log	Convert waste products into energy during expeditionary operations	Produce energy from various waste streams that can be harvested in expeditionary operations.
28	Waste	Storage	Log	Provide Hazardous Waste Storage in an expeditionary environment	Provide storage for hazardous waste that cannot be converted to useable energy on the battlefield until it can be disposed of or recycled.
29	Waste	Storage	Log	Provide Waste Storage in an expeditionary environment	Provide storage for waste that cannot be converted to useable energy on the battlefield, until it can be disposed of or recycled.

Appendix F
E2W2 CBA Mission and Capabilities Identification

92 **Table F-2. E2W2 Task Cross-Reference by Task Number**

		Supporting Warfighting Function					
		Fires	**Maneuver**	**Command & Control (C2)**	**Intelligence (Intel)**	**Logistics (Log)**	**Force Protection (FP)**
E2W2 Capability Area	**Planning**	4, 6, 8,18	4, 6, 8, 18	1, 4, 5, 6, 8, 9,10, 18	4, 6, 8, 9, 10, 18	1, 4, 5, 6, 8, 9, 10, 18, 19, 26	4, 6, 8, 9, 10, 18
	Production	3, 13, 15	3, 11, 13, 15, 22	3, 13, 15	3, 13, 15	3, 11, 13, 15, 22, 27	3, 11, 15
	Storage	24	16, 24, 25	17, 24	24	16, 17, 24, 25, 28, 29	16, 17, 24
	Distribution	12	12	12	12	12	12
	Disposal					20, 21	
	Management	14	14	2, 7, 14, 23	14	2, 7, 14, 23	14

93 **Table F-2** summarizes the distribution of the 29 E2W2 tasks as they apply to each capability area and
94 WFF. Enhanced E2W2 capabilities across the WFFs will include the following characteristics:

95 **Fires.** Fires capabilities consume energy through direct and indirect fire weapons, mobility systems, and
96 aircraft. Integrating E2W2 improvements will increase the mobility and sustainability of sensor- and fire-
97 control system-supported fires, and increase aircraft range, endurance, and power options. Future fires
98 capabilities must enable:

99 • Energy efficient fire support that minimizes fuel use and battery resupply requirements.

100 • Increased employment flexibility and mobility for weapons systems that function in both
101 mounted and dismounted modes.

102 • Energy source flexibility, to include alternative fuels.

103 **Maneuver**. Maneuver capabilities consume energy and water for individual equipment, life support, and
104 mobility systems. Integrating E2W2 improvements will contribute to assured mobility and freedom of
105 maneuver. Future capabilities must enable:

106 • Greater dismounted endurance and mobility through the elimination of battery resupply
107 associated with communication, sensors, optics, and weapons to the squad level.

108 • Individual water purification capabilities that further reduce the water load for the dismounted
109 Marine and free maneuver units from water resupply.

110 • Greater vehicle endurance, reach, and protected mobility while increasing fuel efficiency and
111 reducing fuel consumption.

112 • More efficient and scalable power supplies to onboard and off-board systems.

113 • Greater aircraft fuel efficiency and more economical employment to increase time-on-station,
114 range, and reduce the need for fuel logistics.

115 **Command and Control (C2).** Requirements to power and cool C2 systems drive the battlefield demand
116 for generated power and stored energy. Improving C2 system energy efficiency will increase individual
117 and unit mobility, range and endurance. Future capabilities must enable:

- Effective operational energy planning and data collection; including environmental and climatic conditions and considerations.
- Real-time monitoring and decision support to commanders and staff in all MAGTF elements for E2W2 planning, management, and operational decision-making.
- Self-sufficient, MAGTF C2 without requirements for fuel and battery resupply.
- Renewable and alternative power sources and rapidly rechargeable, high endurance energy storage to sustain man portable equipment and reduce battery resupply requirements.

Intelligence (Intel). Intel capabilities consume energy through ISR collection, processing, and dissemination systems. Integrating E2W2 improvements will increase autonomy and endurance of ground and airborne ISR systems. Future capabilities must enable:

- Static ISR collection, processing, and dissemination, to include persistent surveillance and unattended ground sensors, without the need for battery or fuel resupply.
- Self-sufficient ISR operations by dismounted, small unit patrols.
- Self-sufficient ISR operations at platoon and above operating bases.

Logistics (Log). Logistics operations affect all E2W2 capabilities. Future capabilities must enable:

- Expeditionary logistics and sustainment for individuals, small units (company and below), and larger forces up to the battalion level.
- Efficient, scalable power generation, storage and distribution that support all C4ISR and life support requirements.
- Scalable renewable power that can be tailored to the needs of all non-mobility systems.
- Scalable, autonomous potable water production, packaging, storage, and distribution from the individual Marine to the Marine Expeditionary Force.
- Optimal energy, water and waste planning and management that minimizes operational risk and operational energy performance costs (e.g. combat load and resupply).
- Efficient growth and contraction of base camp sustainment power.

Force Protection (FP). FP systems consume energy through ground and air defense, persistent surveillance, counter-IED, and explosive ordnance disposal systems, and are also a means of preserving precious energy and water assets on the battlefield. Integrating E2W2 improvements will increase FP system mobility and decrease risk to vital energy and water assets. Future capabilities must enable:

- Elimination of fuel requirements for static FP and sensor systems through efficiency increases and integration with renewable power sources.
- Protection for energy and water sources and distribution mechanisms.
- Increased self-sufficiency and mobility FP systems through reduced fuel and battery demand.

Attachment G

Attachment G

E2W2 CBA Gap and Risk Assessment

G.1 Assessment Method

During the **Gap and Risk Assessment**, the IPT considered the ability of the expeditionary MAGTF, through existing or currently programmed capabilities, to perform the E2W2 tasks to the measures established in the **Mission and Capabilities Assessment**, and assessed the resulting unmitigated operational and institutional risk of any gaps. The IPT identified current capabilities and known gaps using Marine Corps Center for Lessons Learned (MCCLL) documentation and information on current materiel and non-materiel programs (e.g. acquisition requirements and program documentation, USMC Training and Readiness (T&R) Manuals, Military Occupational Specialist (MOS) Manual), Urgent and Deliberate Universal Need Statements (U-UNS and D-UNS), Joint Urgent Operational Needs (JUONs) and subject matter expert experience.

The IPT then compared current and programmed capabilities to the T/C/S identified in the **Capabilities Assessment** in order to identify E2W2 capability gaps and shortfalls. If MAGTF assets were determined to be unable to meet all (or a portion) of the task to the identified standard under the specified conditions then a capability gap (or shortfall) was identified. Gaps and shortfalls were characterized as policy, sufficiency, proficiency, lack of (i.e. absence of) capability, or as the need for replacement or recapitalization of an existing capability and were prioritized in relation to their associated E2W2 task priority. Given the characterized gaps, the Gap Severity (impact on the MAGTF's ability to effectively and efficiently meet E2W2 requirements) for each of the 29 tasks was then rated by each IPT member on a one to nine scale (**Table G-1**). The Gap Severity provided an estimate of the size of the gap in completing the E2W2 task, which was then combined with the Task Priority and Gap Severity to establish a Gap Priority and also applied as a weighting factor in the risk assessment.

Table G-1. Gap Severity Assessment

Criteria \ Gap	Low	Moderate	Significant	High
Rating	2	4	6	8
Gap Severity Measured against identified standards in the context of the Gap Characterization	No identified capability gap that would preclude mission execution to E2W2 Standards	Moderate gap in capability; does not preclude mission execution, but may not achieve E2W2 Standards	Significant gap in capability that adversely effects mission execution, and Fails to achieve E2W2 Standards	Significant gap in capability that precludes mission execution and Fails to achieve E2W2 Standards

Finally, the IPT performed a **Risk Assessment** to identify the operational and institutional risk of not closing the identified E2W2 capability gaps and shortfalls to identified standards. Risk assessment scores provide decision makers with the impact of not mitigating the highest priority gaps. Since this assessment began with already-determined gaps, the probability of the gap not being closed was assumed to be 100% (P = 1.0). First, each IPT member ranked five risk categories by relative importance: risk to mission, risk to force, risk to other resources, risk to institutional capacity, risk to operational timelines. This prioritization combined with Gap Severity provided weights for the ensuing risk rating. Every IPT member then rated each task for risk to each of the five risk categories. **Table G-2** depicts the risk definitions applied to this assessment. The previously identified weights were then applied to these risk ratings to determine the weighted relative risk of the 29 E2W2 tasks. In other words:

[*Probability that a gap occurs*] **x** [*Relative severity of a task's gaps*]
x [*(Relative importance of risk categories)* **x** *(Relative importance of a task to a risk category)*]
= ***Weighted relative risk of not closing a specific E2W2 task's gaps.***

Table G-2. E2W2 Risk Assessment Matrix.

Criteria \ Risk	Low	Moderate	Significant	High
Rating	2	4	6	8
Risk to Mission	Near certain achievement	Very likely achievement	Likely achievement	Significant risk of non-achievement
Risk to Force	Full capacity to source requirements	Sourcing requires limited duration capability gaps	Sourcing requires extended duration capability gaps	Requires full mobilization to cover capability gaps
Risk to other Resources	As planned	Requires resources from other plans or operations	Requires resources that create significant shortfalls	Requires resources that preclude other plans or operations
Risk to Institutional Capacity	Full capacity to source requirements	Requires shifts within DOD components to meet requirements	Requires shifts among DOD components to meet requirements	Requirements exceed capacity of the Joint force
Risk to Operational Timeline	As Planned	Minor Extension	Significant Delay	Delays with significant risk of non-achievement

G.2 Results

Several critical Lessons Learned documents and operational after action reports revealed known gaps in current energy, water and waste activities. These identified gaps provided the foundation for conducting the gap assessment and are listed below.

- Most Marines have limited to no awareness of their energy and water demands and the impacts on logistics support.
- There is increasing demand and reliance on fossil fuel for expeditionary forces.
- The force is too heavy; must lighten the combat load.
- Overall footprint has become too large in current and future expeditionary operations
- USMC units cannot achieve energy self-sufficiency in expeditionary environments with today's technology and current TTPs.
- The Marine Corps has not fostered a mindset that recognizes energy and water efficiency as a critical combat enabler.
- The Marine Corps is more lethal today, but has deviated from its center (i.e., fast and austere) in the way it employs energy and resources.
- Legacy equipment was not developed with energy efficiency as a requirement.
- Marine Expeditionary forces cannot autonomously produce or adequately harvest their own energy and water required for C4ISR and sustainment.
- There is no automated organizational ability to track expeditionary energy and water use.
- Waste is not considered in the planning process nor is it considered a potential source of energy.
- Local sources of energy and water are seldom considered in planning.
- Training regarding employment of energy for combat effectiveness for deployed forces is insufficient.
- Marines are at risk hauling fuel and water.

The gap assessment identified 152 E2W2 capability gaps distributed across the E2W2 functional capability areas:

- Planning (38 gaps)
- Production (38 gaps)
- Storage (20 gaps)
- Distribution (15 gaps)
- Disposal (10 gaps)
- Management (31 gaps)

Specific tasks within each WFF that cannot be performed or are unacceptably limited are outlined below.

Fires. The force lacks sufficient capability to:

- Deliver lethal and non-lethal fires using highly energy efficient weapon systems and sub-systems that also integrate renewable energy sources as part of an energy efficient system of systems architecture.

Maneuver. The force lacks sufficient capability to:

- Provide efficient, individual power and water, which reduces the dismounted Marine combat load and is sustainable at the tactical level.
- Adapt and scale small unit E2W2 capabilities that enable mission versatility and flexibility to the small unit commander.
- Extend the range and endurance of mobility systems through efficient energy consumption, while maintaining the protection of speed, maneuverability, and materials.
- Efficiently provide power to on-board vehicle systems and exportable power for off board systems.

Command and Control. The force lacks the sufficient capability to:

- Operate command, control, communication, and computer equipment without fuel and battery resupply in expeditionary environments.
- Employ command and control systems that are part of a highly energy efficient system of systems architecture.
- Conduct decentralized, on the move communications without battery and fuel resupply and with minimal battery combat loadout.
- Provide commanders with adequate visibility, analysis, and management tools to control expeditionary energy, water and waste usage.

Intelligence. The force lacks sufficient capability to:

- Plan for the use of existing energy and water (to include micro-terrain water sources) capability within the operations area.
- Conduct intelligence functions using highly energy efficient information, network, and communications systems that also integrate renewable energy sources as part of an energy efficient system of systems architecture.
- Conduct energy self-sufficient intelligence collection, processing, and dissemination in distributed operations.

Logistics. The force lacks sufficient capability to:

- Establish and maintain self-sufficiency in meeting energy and water needs.
- Efficiently harvest renewable energy and efficiently generate, store, and distribute power.
- Provide scalable expeditionary shelter systems with energy efficient components that minimize heating, cooling, and other electrical power demands and enable the integration of renewable power sources.
- Conduct in-place, small unit (Company and below) potable water production, certification, storage, and quality monitoring for long-term consumption.
- Provide integrated, renewable and hybrid (renewable + non-renewable) energy to support small unit and spot-generation power requirements.
- Provide commanders with adequate visibility to, and management controls for, expeditionary energy, water and waste usage.
- Provide planners with adequate planning tools for efficient, effective expeditionary energy, water and waste operations.

Protection. The force lacks sufficient capability to:

- Reduce convoy exposure events through reduced bulk liquid logistics requirements.
- Employ highly energy efficient force protection systems (e.g. surveillance, electronic countermeasures, surface-based air defense) that also integrate renewable energy sources as part of an energy efficient system of systems architecture.
- Protect highly decentralized, small unit water sources.
- Conduct energy self-sufficient biometric collection in distributed operations.

Table G-3 lists the gap descriptions in Gap Priority order with the associated tasks, standards, JCAs, and JCA attributes, as defined in the context of E2W2:

Expeditionary. The Marine Corps is an expeditionary, sea-based force. To the Marine Corps, expeditionary means being *fast, lethal, and austere*. Marine forces require capabilities that allow rapid global deployment to a wide range of environments and a high degree of self-sufficiency for operations in ungoverned spaces. The desired outcome is to employ task organized MAGTFs with E2W2 capabilities that increase combat effectiveness by reducing the need for logistics support to forces ashore and the logistics burden on those forces within their area of responsibility. Measures include reduction in the amount of energy required to sustain a MAGTF ashore, and time to gain and maintain water self-sufficiency.

Agile. Expeditionary forces must adapt to dynamic combat situations and physical environments, and exercise control through a flexible, adaptable decision process. E2W2 capabilities that reduce the MAGTF load, minimize the logistics burden, and maximize autonomy enable commanders to quickly exploit opportunities in multifaceted and ever-changing environments. Measures include energy considerations factoring into materiel requirements and planning and operations, reduction in individual equipment using unique power sources, improved fuel efficiency, and doctrine and policies that incorporate energy efficiency as an enabler of combat effectiveness.

Interoperable. Interoperable systems and doctrine are critical to joint operations. The Marine Corps must build E2W2 capabilities that can efficiently transition from MAGTF expeditionary operations to joint and commercial operational energy capability sets in enduring operations, and/or to host nation support. The desired outcome is continuity of operations and unity of effort when transitioning from early to later operational phases, which is accomplished through the development of both an interoperable

mindset and technologies. Measures include coordinated, scalable planning and design to supply conventional, renewable and alternative energy, waste-to-energy, and water capabilities that optimize inter- and intra-Service capabilities.

Scalable. Highly decentralized operations demand mobile forces that employ scalable E2W2 systems, and that provide commanders the ability to adjust up or down the capability scale depending on the size and application of the force, or the specific operational environment. The desired outcome is an E2W2 capability set that possesses task organized, multi-purpose capabilities with sufficient capacity to accomplish the broad range of tasks across the ROMO. Measures include the ability to rapidly transition across the ROMO and to efficiently employ E2W2 capabilities at all levels of the MAGTF, the flexibility to adjust those capabilities to changes in task organization and operational plans, and the versatility to utilize multiple power sources and indigenous energy and water sources.

Lethal. Marine forces must deliver precise lethal and nonlethal effects in all operating environments in order to dictate combat effects with minimized collateral damage. Systems that provide situational awareness, targeting data, and weapon precision consume power. Water sustains the life and performance of working dogs and the Marine Corps' most lethal weapon, the individual Marine. Measures include the ability to efficiently power weapon systems from the individual to the MEF level, lighten the individual and MAGTF energy and water load (equipment and consumables), and increase the commander's visibility on E2W2 to enhance operational speed, agility and freedom to apply maneuver principals at all levels of warfare.

Appendix G
E2W2 CBA Gap and Risk Assessment
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Table G-3. E2W2 Capability Gaps by Gap Priority

Gap Priority	E2W2 Functional Area	Task	Joint Capability Area (Tier I / •Tier II)	Attribute	Metric	Measure	Gap Statements	Gap ID (Pri.Cat.#)
1	**Planning**	**Plan to supply Energy (conventional, renewable, alternative) to the MAGTF; integrated throughout the supply chain and with Joint/Coalition and HNS**	**Command & Control** • Organize • Understand • Planning • Decide • Direct • Monitor **Battlespace Awareness** • Intelligence • Environment **Net-Centric** • Information Transport • Information Assurance **Protection** • Prevent • Mitigate **Force Support** • Force Management • Force Preparation	Agile	Units / Commanders have visibility into resource and equipment energy requirements.	Yes / No	**Sufficiency: Lack of sufficient utilities planners involved in the overall planning process**	**1.S.1**
							Policy: Lack of doctrine requiring utility planners in the Operations Department for planning.	**1.P.1**
							Policy: Lack of standardization of the location of planners at the MEF level	**1.P.2**
				Expeditionary	Energy considerations factor into planning and operations.	Yes / No	**Sufficiency: Lack of sufficient utilities planners involved in the overall planning process**	**1.S.1**
							Policy: Lack of doctrine requiring utility planners in the in the Operations Department for planning	**1.P.1**
							Policy: Lack of standardization of the location of planners at the MEF level	**1.P.2**
				Expeditionary	Fuel considerations factor into planning and operations.	Yes / No	**Sufficiency: Lack of sufficient utilities planners involved in the overall planning process**	**1.S.1**
							Policy: Lack of doctrine requiring utility planners in the in the Operations Department for planning	**1.P.1**
							Policy: Lack of standardization of the location of planners at the MEF level	**1.P.2**
				Interoperable	Energy considerations factor into training and education curriculum.	Yes / No	**Policy: Insufficient training and PME on alternative and renewable energy**	**1.P.3**
2	**Management**	**Provide the capability to Manage Energy, Water, and Waste Resources in an Expeditionary Environment**	**Command & Control** • Organize • Understand • Planning • Decide • Direct • Monitor **Battlespace Awareness** • Intelligence • Environment **Net-Centric** • Information Transport • Enterprise Services • Net Management • Information Assurance **Logistics** • Deployment & Distribution • Supply • Logistics Services • Engineering **Force Support** • Force Management • Human Capital Management	Interoperable	% units at Battalion / Squadron level and above with an E2W2 data management system enabled	100% (T = O)	**Lack of capability: No existing E2W2 data management system capability**	**2.LC.1**
							Policy: No existing E2W2 data management doctrine and policy	**2.P.1**
				Scalable	Usage and monitoring and metering controls established	Yes / No	**Proficiency: Lack of training of personnel in optimum energy, water, and waste employment**	**2.PR.1**
							Lack of capability: No existing E2W2 monitoring and metering capability	**2.LC.2**
							Policy: No existing E2W2 monitoring and metering doctrine and policy	**2.P.2**
				Expeditionary	Units/ Commanders have visibility into resource use, efficiency and requirements through the use of monitoring and tracking technologies	Yes / No	**Proficiency: Lack of training of personnel in optimum energy, water, and waste employment**	**2.PR.1**
							Lack of capability: No existing E2W2 data management system capability	**2.LC.1**
							Policy: No existing E2W2 monitoring and metering doctrine and policy	**2.P.2**
							Proficiency: Lack of training to conduct expeditionary energy use reviews	**2.PR.2**
				Scalable	Monitor amount of waste (energy harvestable and non-energy harvestable including hazardous) generated per Marine per day during expeditionary ops	Yes / No	**Lack of capability: No existing waste monitoring capability**	**2.LC.3**
							Policy: No existing waste monitoring doctrine and policy	**2.P.3**
				Scalable	Energy capabilities are aligned with energy requirements	Yes / No	**Policy: No existing doctrine and policy for alignment of energy capabilities with energy requirements**	**2.P.4**
							Policy: Lack of a MAGTF sustainment energy baseline	**2.P.5**
				Interoperable	% of equipment certified to run on alternative fuels/energy	100% (T=O)	**Policy: No existing doctrine or policy regarding equipment alternative fuel use**	**2.P.6**
				Scalable	% of units managing energy demand	100% (T=O)	**Policy: No existing E2W2 management doctrine and policy**	**2.P.7**

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Gap Priority	E2W2 Functional Area	Task	Joint Capability Area (Tier I / •Tier II)	Attribute	Metric	Measure	Gap Statements	Gap ID (Pri.Cat.#)
				Expeditionary	Doctrine and policies incorporate E2W2 efficiency as a Warfighting enabler	Yes / No	**Proficiency: Lack of training of personnel in optimum energy, water, and waste employment**	**2.PR.1**
							Policy: No existing doctrine on optimizing energy, water, waste employment	**2.P.8**
				Expeditionary	MAGTF units have documented waste management plans	Yes / No	**Policy: Lack of policy regarding expeditionary waste management plans**	**2.P.9**
				Agile	% of personnel trained in E2W2 management and awareness	100% (T=O)	**Proficiency: Lack of training of personnel in optimum energy, water, and waste employment**	**2.PR.1**
							Policy: No existing E2W2 management doctrine and policy	**2.P.7**
3	**Production**	**Conduct Combat Operations across the MAGTF with minimal energy and energy related logistics requirements**	**Force Application** • Maneuver • Engagement **Command & Control** • Organize, • Understand • Planning • Decide • Direct • Monitor **Battlespace Awareness** • Intelligence • ISR • Environment **Net-Centric** • Information Assurance Protection • Prevent • Mitigate **Logistics** • Deployment & Distribution • Supply • Logistics Services • Engineering **Force Support** • Force Management	Scalable	% reduction of individual equipment using unique power source	75% (T) / 100% (O)	**Lack of capability: Lack of existing capability to automatically match load to demand**	**3.LC.1**
							Lack of capability: Lack of a standardized individual power source	**3.LC.2**
							Policy: Lack of standardized procedures and doctrine	**3.P.1**
							Policy: No established individual energy production baseline	**3.P.2**
				Scalable	% reduction of MAGTF equipment using unique power source	75% (T) / 100% (O)	**Lack of capability: Lack of existing capability to automatically match load to demand**	**3.LC.1**
							Policy: Lack of standardized procedures and doctrine	**3.P.1**
							Policy: No established MAGTF energy production baseline	**3.P.3**
				Expeditionary	Number of days a MAGTF is power self sufficient for C4ISR and life support systems	120 days (T) Indefinite (O)	**Policy: No established MAGTF energy consumption baseline**	**3.P.4**
							Lack of capability: Lack of existing capability to automatically match load to demand	**3.LC.1**
							Lack of capability: Lack of capability to harvest energy from renewable or waste sources in place to power C4ISR and life support systems	**3.LC.3**
				Agile	% reduction in the amount of energy required to sustain a MAGTF ashore	50% (T=O)	**Lack of capability: Lack of existing capability to automatically match load to demand**	**3.LC.1**
							Policy: Lack of standardized procedures and doctrine	**3.P.1**
							Policy: No established MAGTF energy consumption baseline	**3.P.4**
4	**Production**	**Produce Energy Efficient Climate Control environments to maintain Personnel and Equipment operating efficiency**	**Force Application** • Maneuver • Engagement **Command & Control** • Organize • Understand • Planning • Decide • Direct • Monitor **Battlespace Awareness** • Intelligence • ISR • Environment **Protection**	Expeditionary	Adequate heating and cooling to optimize personnel performance and endurance with zero fuel requirements across operating climates.	Yes / No	**Policy: No doctrine for climate control for personnel**	**4.P.1**
							Policy: No energy baseline for individual cooling	**4.P.2**
							Policy: No defined requirement for personnel heating and cooling	**4.P.3**
							Lack of capability: No capability to optimize personnel performance across operating climates	**4.LC.1**
				Expeditionary	Adequate heating and cooling to optimize equipment performance with zero fuel requirements across operating climates.	Yes / No	**Policy: No doctrine for climate control for equipment**	**4.P.4**
							Policy: No energy baseline for equipment heating and cooling	**4.P.5**

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Gap Priority	E2W2 Functional Area	Task	Joint Capability Area (Tier I / •Tier II)	Attribute	Metric	Measure	Gap Statements	Gap ID (Pri.Cat.#)
			• Prevent• Mitigate **Logistics** • Deployment & Distribution • Supply • Logistics Services • Engineering **Force Support** • Force Management • Human Capital Management				**Lack of capability: No capability to optimize equipment performance across operating climates**	**4.LC.2**
				Expeditionary	MAGTF shelters are thermally efficient across operating climates	Yes / No	**Need to replace: Replace existing shelters with energy efficient capability**	**4.NR.1**
							Policy: No established standard for shelter thermal efficiency	**4.P.6**
5	**Management**	**Provide the capability to Measure Energy, Water, and Waste Resources in an Expeditionary Environment**	**Command & Control** • Organize • Understand • Planning • Decide • Direct • Monitor **Battlespace Awareness** • Intelligence • Environment **Net-Centric** • Information Transport • Enterprise Services **Logistics** • Deployment & Distribution • Supply • Logistics Services • Engineering **Force Support** • Force Management	Expeditionary	Units / Commanders have visibility into resource use, efficiency and requirements through the use of monitoring and tracking technologies	Yes / No	**Proficiency: Lack of training of personnel in optimum energy employment**	**5.PR.1**
							Policy: No existing E2W2 measurement doctrine and policy	**5.P.1**
				Agile	% of equipment that is metered for power production and consumption	100% (T=O)	**Lack of capability: Power producing and consuming equipment not metered**	**5.LC.1**
							Policy: No existing E2W2 measurement doctrine and policy	**5.P.1**
				Agile	% of equipment that is metered for fuel consumption	100% (T=O)	**Sufficiency: Fuel consumption not monitored on all fuel dispensing or fuel-consuming equipment**	**5.S.1**
							Policy: No existing E2W2 measurement doctrine and policy	**5.P.1**
				Agile	% of equipment that is metered for water production and consumption	100% (T=O)	**Lack of capability: All water production and storage equipment not metered**	**5.LC.2**
							Policy: No existing E2W2 measurement doctrine and policy	**5.P.1**
				Agile	% of equipment that is metered for waste generation and reuse	85% (T) / 100% (O)	**Lack of capability: No existing waste-metering capability**	**5.LC.3**
							Policy: No existing E2W2 measurement doctrine and policy	**5.P.1**
6	**Distribution**	**Conduct "smart" expeditionary Electrical Distribution**	**Force Application** • Maneuver • Engagement **Command & Control** • Organize • Understand • Planning • Decide • Direct • Monitor **Battlespace Awareness** • Intelligence • ISR • Environment **Net-Centric** • Information Transport • Enterprise Services	Scalable	Energy production is aligned with energy consumption	Yes / No	**Policy: No baseline**	**6.P.1**
				Scalable	% continuous power produced matched to consumption	85%(T) / 100%(O)	**Lack of capability: Lack existing capability to autonomously and automatically match power production to consumption**	**6.LC.1**

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Gap Priority	E2W2 Functional Area	Task	Joint Capability Area (Tier I / •Tier II)	Attribute	Metric	Measure	Gap Statements	Gap ID (Pri.Cat.#)
			• Net Management • Information Assurance **Protection** • Prevent • Mitigate **Logistics** • Deployment & Distribution • Supply • Logistics Services • Engineering	Scalable	Energy distribution enables efficient integration of multiple energy sources.	Yes / No	**Lack of capability: Lack existing capability to efficiently integrate multiple energy sources**	**6.LC.2**
7	**Planning**	**Develop Plans to Support Efficient, Scalable Expeditionary Forward Operating Base Water Systems and Hygiene Service**	**Command & Control** • Organize • Understand • Planning • Decide • Direct • Monitor **Battlespace Awareness** • Intelligence • ISR **• Environment** **Net-Centric** • Information Transport • Enterprise Services • Net Management • Information Assurance **Protection** • Prevent • Mitigate **Logistics** • Deployment & Distribution • Supply • Logistics Services • Engineering	Expeditionary	Water considerations factor into planning and operations	Yes / No	**Proficiency: Lack of ability to scale FOB water systems and Hygiene Service**	**7.PR.1**
							Sufficiency: Lack of sufficient utilities planners involved in FOB planning & design	**7.S.1**
							Sufficiency: Lack of appropriate trained personnel	**7.S.2**
							Lack of capability: No existing planning and design tools for scalable FOB design	**7.LC.1**
							Policy: Insufficient doctrine and policy on the planning for scalable FOB design	**7.P.1**
							Policy: Lack of standardized training across the MAGTF on scalable FOB design	**7.P.2**
							Sufficiency: Insufficient training and PME on scalable FOB design	**7.S.3**
				Expeditionary	Planners factor waste management (biological and non-biological) into mission planning	Yes / No	**Sufficiency: Lack of sufficient utilities planners involved in the overall planning process**	**7.S.4**
							Policy: Lack of doctrine requiring utility planners in the in the Operations Department for planning	**7.P.3**
							Policy: Lack of standardization of the location of planners at the MEF level	**7.P.4**
8	**Planning**	**Design Efficient, Scalable, and Interoperable, Expeditionary Energy Producing and Consuming Warfighting Capabilities**	**Force Application** • Maneuver • Engagement **Command & Control** • Organize • Understand • Planning • Decide • Direct **Battlespace Awareness** • Intelligence • Environment **Net-Centric** • Information Transport • Enterprise Services	Agile	% of personnel trained in energy effectiveness	100% (T = O)	**Sufficiency: Lack of appropriate trained personnel**	**8.S.1**
							Proficiency: Lack of ability to use renewable or alternative power sources on the battlefield	**8.PR.1**
							Lack of capability: No existing planning and design tools for alternatives and renewables	**8.LC.1**
							Policy: Insufficient training and PME on alternative and renewable power sources	**8.P.1**
				Scalable	Scalability and energy performance considered in planning and design	Yes / No	**Sufficiency: Lack of sufficient utilities planners involved in the FOB scalability planning & design**	**8.S.2**
							Lack of capability: No existing planning and design tools for alternatives and renewables	**8.LC.1**
							Policy: Insufficient doctrine and policy on planning and design for scalability and interoperable energy performance in warfighting capabilities	**8.P.2**

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Gap Priority	E2W2 Functional Area	Task	Joint Capability Area (Tier I / •Tier II)	Attribute	Metric	Measure	Gap Statements	Gap ID (Pri.Cat.#)
			• Net Management • Information Assurance **Logistics** • Deployment & Distribution • Supply • Logistics Services • Engineering **Force Support** • Force Preparation				**Policy: Lack of standardized training across the MAGTF on scalability and energy performance**	**8.P.3**
				Expeditionary	Trained personnel available and on hand to support plan and design of efficient FOBs at the unit/HQ level	Yes / No	**Sufficiency: Lack of appropriate trained personnel**	**8.S.1**
							Policy: Lack of standardized training across the MAGTF on scalability and energy performance	**8.P.3**
				Expeditionary	Appropriate doctrine and training provided for scalable FOB design	Yes / No	**Sufficiency: Lack of appropriate trained personnel.**	**8.S.1**
							Policy: No existing doctrine on scalability and energy performance in FOB design	**8.P.4**
							Policy: Lack of standardized training across the MAGTF on scalability and energy performance	**8.P.3**
9	**Planning**	**Plan for reductions in energy demands of current and future capability sets without reducing combat / mission effectiveness**	**Command & Control** • Organize • Understand • Planning • Decide • Direct • Monitor **Battlespace Awareness** • Intelligence • Environment **Net-Centric** • Information Transport • Enterprise Services • Net Management • Information Assurance **Logistics** • Deployment & Distribution • Supply • Logistics Services • Engineering **Force Support** • Force Preparation	Agile	Requirements reduce MAGTF equipment using unique power sources	Yes / No	**Policy: No established standard for power sources**	**9.P.1**
				Scalable	Power generation equipment systems are scalable and interoperable	Yes / No	**Policy: No established standard for power sources**	**9.P.1**
				Lethal	Requirements increase energy performance of fielded powered equipment	Yes / No	**Policy: No established standard for power sources**	**9.P.1**
				Expeditionary	Energy performance is incorporated as an analysis criteria early in the requirements process	Yes / No	**Policy: No established energy performance requirements criteria**	**9.P.2**
10	**Planning**	**Plan to produce all C4ISR energy and power requirements organically in place**	**Command & Control** • Organize, • Understand • Planning • Decide • Direct **Battlespace Awareness** • Environment **Net-Centric** • Information Transport • Enterprise Services • Net Management • Information Assurance **Logistics** • Deployment & Distribution • Logistics Services • Engineering **Force Support** • Force Preparation	Expeditionary	Number of days a MAGTF is power self sufficient for C4ISR and sustainment systems	120 days (T=O)	**Sufficiency: Lack of sufficient utilities planners involved in planning**	**10.S.1**
11	**Distribution**	**Conduct Expeditionary Water Distribution**	**Force Application** • Maneuver	Scalable	Autonomous and automatic capability to monitor water distribution across the MAGTF	Yes / No	**Lack of capability: No autonomous and automatic capability**	**11.LC.1**

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Gap Priority	E2W2 Functional Area	Task	Joint Capability Area (Tier I / •Tier II)	Attribute	Metric	Measure	Gap Statements	Gap ID (Pri.Cat.#)
			• Engagement **Command & Control** • Organize • Understand • Planning • Decide • Direct • Monitor **Battlespace Awareness** • Intelligence • ISR • Environment **Protection** • Prevent • Mitigate **Logistics** • Deployment & Distribution • Supply • Logistics Services • Engineering **Force Support** • Force Management • Human Capital Management				**Sufficiency: Limited capabilities exist to efficiently distribute water**	**11.S.1**
							Need to replace: Replace/upgrade existing water distribution capability	**11.NR.1**
				Agile	Grey wastewater reclaimed / reused as potable water	Yes / No	**Lack of Capability: No capability to reclaim and reuse grey water**	**11.LC.2**
							Sufficiency: Limited capabilities exist to efficiently distribute water	**11.S.2**
							Need to replace: Replace/upgrade existing capability to manage grey water	**11.NR.2**
							Policy: No policy exists for reclaim and reuse of grey water.	**11.P.1**
				Lethal	Self-sufficient water distribution conducted at the Battalion / Squadron level and below	Yes / No	**Policy: Limited doctrine for water distribution at the Battalion / Squadron level and below**	**11.P.2**
							Sufficiency: Limited capabilities exist to efficiently distribute water	**11.S.1**
							Need to replace: Replace/upgrade existing water distribution capability	**11.NR.1**
				Scalable	Adequate water distribution equipment on hand to enable water self-sufficiency at the Battalion / Squadron level and below	Yes / No	**Policy: Limited doctrine for water distribution at the Battalion / Squadron level and below**	**11.P.2**
							Sufficiency: Limited capabilities exist to efficiently distribute water	**11.S.1**
							Need to replace: Replace/upgrade existing water distribution capability	**11.NR.1**
12	**Management**	**Provide the capability to Analyze data on Energy, Water, and Waste Resources in an expeditionary environment**	**Command & Control** • Understand • Decide • Direct • Monitor **Battlespace Awareness** • Intelligence **Net-Centric** • Information Transport • Net Management • Information Assurance **Logistics** • Deployment & Distribution • Engineering **Force Support** • Force Management	Interoperable	% units at the Battalion / Squadron level and above with an E2W2 data management system enabled	100% (T=O)	**Proficiency: Lack of trained personnel to analyze E2W2 data**	**12.PR.1**
							Lack of capability: No existing E2W2 data management capability	**12.LC.1**
							Policy: No existing E2W2 data management doctrine or policy	**12.P.1**
				Expeditionary	Units have adequate analytical / decision support tools for assessment of energy, water and waste management	Yes/No	**Proficiency: Lack of training of personnel in optimum energy employment**	**12.PR.2**
							Lack of capability: No existing E2W2 analysis or decision support capability	**12.LC.2**
							Policy: No existing E2W2 analysis doctrine or policy	**12.P.2**
							Policy: Lack of an E2W2 baseline for all MAGTF variants	**12.P.3**
				Expeditionary	Units / Commanders have visibility into waste and hazardous waste streams	Yes/No	**Policy: Insufficient doctrine and policy for expeditionary recycling and disposal of non-hazardous waste**	**12.P.4**
							Policy: Insufficient doctrine for monitoring amount of waste generated	**12.P.5**
13	**Production**	**Provide for the efficient production of Potable/Non-Potable water in an expeditionary environment**	**Force Application** • Maneuver • Engagement **Command & Control** • Organize, • Understand • Planning • Decide • Direct	Scalable	Distributed potable water production capability to the Company level and below	Yes/No	**Sufficiency: Lack of small unit water purification assets**	**13.S.1**
							Proficiency: Lack of trained personnel to conduct distributed potable water production to the Company level and below	**13.PR.1**
							Policy: No doctrine or policy exists regarding small unit (Company and	**13.P.1**

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Gap Priority	E2W2 Functional Area	Task	Joint Capability Area (Tier I / •Tier II)	Attribute	Metric	Measure	Gap Statements	Gap ID (Pri.Cat.#)
			• Monitor **Battlespace Awareness** • Intelligence • ISR • Environment **Net-Centric** • Information Assurance **Protection** • Prevent • Mitigate **Logistics** • Deployment & Distribution • Supply • Logistics Services • Engineering **Force Support** • Force Management				**below) water purification systems**	
				Expeditionary	Days a MAGTF is able to sustain water self-sufficiency at the individual Battalion / Squadron unit level and below	120 days	**Lack of capability: Minimal capability to allow units to obtain and maintain water self-sufficiency**	**13.LC.1**
							Sufficiency: Lack of small unit water purification assets	**13.S.1**
							Proficiency: Lack of trained personnel to conduct distributed potable water production to the Company level and below	**13.PR.1**
							Policy: No doctrine or policy exists regarding small unit (Company and below) water purification systems	**13.P.1**
				Expeditionary	Dismounted water self-sufficiency at the squad level	7 days (T) / 21 days (O)	**Lack of capability: No ability to maintain dismounted water self-sufficiency**	**13.LC.2**
							Policy: No policy or doctrine addressing dismounted rifle squad level water self-sufficiency	**13.P.2**
							Policy: Military testing and preventive medicine policy does not address use of small unit water purification systems (e.g. low pressure reverse osmosis), that meet short-term (<30 days) potability standards, for repeated short intervals that may aggregate to greater than 30 days over some time period	**13.P.3**
14	**Production**	**Provide a Power Source appropriate to the individual user's required capability**	**Force Application** • Maneuver • Engagement **Command & Control** • Organize • Understand • Planning • Monitor **Battlespace Awareness** • Environment **Logistics** • Deployment & Distribution • Supply • Logistics Services • Engineering **Force Support** • Force Management	Agile	Reduction of individual personal equipment using unique power source	Yes / No	**Lack of capability: Lack of common and/or renewable power source**	**14.LC.1**
							Need to replace: Need to replace/modify legacy equipment to accept common power source	**14.NR.1**
							Policy: No established standard for individual power sources	**14.P.1**
							Policy: No doctrine or policy exists for individual power sources (e.g. batteries)	**14.P.2**
				Lethal	% of energy requirements met with renewable sources	100% (T=O)	**Lack of capability: Lack of individual renewable power systems**	**14.LC.2**
							Need to replace: Need to replace/modify legacy equipment to accept renewable power source	**14.NR.2**
							Policy: No policy requiring individual renewable power source	**14.P.3**
				Expeditionary	Power and energy requirements aligned with operational requirements	Yes / No	**Policy: No established standards for individual power sources**	**14.P.1**
15	**Distribution**	**Conduct Expeditionary Bulk Fuel Distribution**	**Force Application** • Maneuver **Command & Control** • Decide • Direct • Monitor Protection • Prevent • Mitigate **Logistics** • Deployment & Distribution • Supply • Logistics Services	Expeditionary	Units/ Commanders have visibility into fuel use, efficiency, energy performance, and requirements at the unit and end item level through the use of monitoring and tracking technologies	Yes / No	**Proficiency: Lack of training to conduct metering and maintain data**	**15.PR.1**
							Policy: No policy for comprehensive fuel data management across the MAGTF and to the MARFOR and HQMC level	**15.P.1**
							Sufficiency: Inadequate / Incomplete monitoring and data management tools	**15.S.1**
				Agile	Equipment is metered for fuel consumption	Yes / No	**Sufficiency: Incomplete metering capability**	**15.S.2**
				Expeditionary	Fuel distribution is tailored to demand in operations	Yes / No	**Policy: No policy for assessing unit fuel demand profiles**	**15.P.2**
							Policy: No established standard fuel demand planning profiles	**15.P.3**
				Agile	% reduction in the requirement to transport fuel in an expeditionary environment	25% (T) / 50% (O)	**Proficiency: Lack of training to conduct tailored fuel planning and distribution**	**15.PR.2**
							Proficiency: Lack of training to mitigate distribution with allocation of renewable energy assets	**15.PR.3**

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Gap Priority	E2W2 Functional Area	Task	Joint Capability Area (Tier I / •Tier II)	Attribute	Metric	Measure	Gap Statements	Gap ID (Pri.Cat.#)
			• Engineering **Force Support** • Force Management				**Policy: No MAGTF fuel consumption baseline**	**15.P.4**
16	**Storage**	**Provide Expeditionary Water Storage**	**Force Application** • Maneuver • Engagement **Command & Control** • Organize • Understand • Planning • Decide • Direct • Monitor **Protection** • Prevent • Mitigate **Logistics** • Supply • Logistics Services • Engineering **Force Support** • Force Management	Expeditionary	Water usage, monitoring and metering established	Yes / No	**Lack of capability: No autonomic metering capability on existing storage equipment**	**16.LC.1**
							Policy: No policy that directs adherence to Service and Joint water doctrine	**16.P.1**
				Expeditionary	Units / Commanders have visibility into resource use, efficiency and requirements through the use of monitoring and tracking technologies	Yes / No	**Lack of capability: No autonomic metering capability on existing storage equipment**	**16.LC.1**
				Expeditionary	Product water storage considerations factor into planning and operations	Yes / No	**Policy: No policy that directs adherence to Service and Joint water doctrine**	**16.P.1**
				Agile	% of bulk storage equipment that is metered for water consumption	100% (T=O)	**Lack of capability: No autonomic metering capability on existing storage equipment**	**16.LC.1**
				Agile	Self-sufficient water storage conducted at the Battalion / Squadron level and below	Yes / No	**Policy: Lack of doctrine regarding water self-sufficiency at the Battalion / Squadron level and below**	**16.P.2**
							Lack of capability: Lack of capability to efficiently heat or cool product water	**16.LC.2**
				Expeditionary	Number of days for a MAGTF ashore to transition to locally purified water	30 days (T) 0 days (O)	**Policy: No policy that directs adherence to Service and Joint water doctrine**	**16.P.1**
							Policy: Lack of doctrine regarding water self-sufficiency at the Battalion / Squadron level and below	**16.P.2**
							Sufficiency: Limited expeditionary water capabilities at the Battalion / Squadron level and below	**16.S.1**
17	**Production**	**Provide for the efficient production of recycled Potable/Non-Potable water in an expeditionary environment**	**Force Application** • Maneuver • Engagement **Command & Control** • Organize, • Understand • Planning • Decide • Direct • Monitor **Battlespace Awareness** • Intelligence • ISR • Environment **Net-Centric** • Information Assurance **Protection** • Prevent • Mitigate **Logistics** • Deployment & Distribution • Supply • Logistics Services • Engineering **Force Support** • Force Management	Expeditionary	Grey wastewater reclaimed / reused as potable water	Yes / No	**Need to replace: Current capability inefficient and limited in ability to reclaim and purify grey water**	**17.NR.1**
							Policy: No policy directing grey water reclaim and reuse	**17.P.1**
				Lethal	Water self-sufficiency achieved to the Battalion / Squadron level and below	Yes / No	**Need to replace: Current capability inefficient and limited in ability to reclaim and purify grey water**	**17.NR.1**
				Agile	Hygiene and laundry equipment is metered for water recycling	Yes / No	**Lack of capability: No metering capability for recycled water**	**17.LC.1**

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Gap Priority	E2W2 Functional Area	Task	Joint Capability Area (Tier I / •Tier II)	Attribute	Metric	Measure	Gap Statements	Gap ID (Pri.Cat.#)
18	**Disposal**	**Provide Efficient/Effective Disposal of Non Reusable Solid Waste in an Expeditionary Environment**	**Command & Control** • Organize • Understand • Planning • Decide • Direct • Monitor **Battlespace Awareness** • Environment **Logistics** • Supply • Logistics Services • Engineering **Force Support** • Force Management	Agile	Reduced weight of solid waste generated per day	25% (T) 50% (O)	**Policy: No solid waste generation baseline**	**18.P.1**
							Policy: Lack of doctrine regarding expeditionary non-reusable solid waste management	**18.P.2**
							Policy: Lack of policy regarding documented expeditionary non-reusable solid waste management plans	**18.P.3**
							Lack of capability: Lack of materiel capabilities to reduce non-reusable solid waste	**18.LC.1**
19	**Planning**	**Develop Plans to Manage, recycle and dispose of Waste (Water, Solid, Biological) and Hazardous Waste**	**Command & Control** • Organize • Understand • Planning • Decide • Direct • Monitor **Battlespace Awareness** • Intelligence • ISR • Environment **Logistics** • Deployment & Distribution • Supply • Logistics Services • Engineering **Force Support** • Force Management • Human Capital Management	Expeditionary	Planners factor waste management (biological and non-biological) into mission planning	Yes / No	**Policy: Lack of policy on employment of utilities planners in the planning process to adequately address recycling and waste disposal**	**19.P.1**
							Policy: Insufficient doctrine and policy for recycling and disposal of non-hazardous waste	**19.P.2**
							Policy: Lack of standardization of the location of planners at the MEF level.	**19.P.3**
				Expeditionary	MAGTF units have documented waste management plans	Yes / No	**Policy: Lack of policy regarding expeditionary waste management plans**	**19.P.4**
				Scalable	Waste streams monitored and measured	Yes / No	**Lack of Capability: No capability to monitor and measure waste production and to manage waste data**	**19.LC.1**
							Policy: Insufficient doctrine for waste generation monitoring	**19.P.5**
20	**Planning**	**Develop migration plan for FOB to transition from expeditionary to enduring base**	**Force Application** • Maneuver • Engagement **Command & Control** • Organize • Understand • Planning • Decide • Direct • Monitor **Logistics** • Deployment & Distribution	Scalable	Personnel trained in scalable FOB transition planning	Yes / No	**Policy: Lack of policy on employment of utilities planners in the transition planning process**	**20.P.1**
							Policy: Insufficient doctrine and policy on transitioning from an expeditionary to an enduring base	**20.P.2**
				Agile	Trained personnel available and on hand to support plan and design of efficient FOBs at the Battalion / Squadron headquarters level and above	Yes / No	**Policy: Lack of policy on employment of utilities planners in the transition planning process**	**20.P.1**

Appendix G
E2W2 CBA Gap and Risk Assessment

Gap Priority	E2W2 Functional Area	Task	Joint Capability Area (Tier I / •Tier II)	Attribute	Metric	Measure	Gap Statements	Gap ID (Pri.Cat.#)
			• Supply • Logistics Services • Engineering **Force Support** • Force Management • Human Capital Management				**Policy: Insufficient doctrine and policy on transitioning from an expeditionary to an enduring base**	**20.P.2**
				Expeditionary	Appropriate doctrine and training provided for scalable FOB design	Yes / No	**Policy: Insufficient doctrine and policy on scalable FOB planning and design**	**20.P.3**
21	**Storage**	**Provide Expeditionary Bulk Fuel Storage**	**Force Application** • Maneuver • Engagement **Command & Control** • Organize • Understand • Planning • Decide • Direct • Monitor **Protection** • Prevent • Mitigate **Logistics** • Supply • Logistics Services • Engineering **Force Support** • Force Management	Scalable	Fuel usage, monitoring and metering established	Yes / No	**Lack of capability: Need for autonomic metering capability on bulk fuel storage systems**	**21.LC.1**
				Expeditionary	Units / Commanders have visibility into fuel use, efficiency, energy performance, and requirements at the unit and end item level through the use of monitoring and tracking technologies	Yes / No	**Lack of capability: Need for fuel data management and decision support capabilities**	**21.LC.2**
				Expeditionary	Fuel storage and consumption factor into operational	Yes / No	**Policy: Lack of doctrine and policy requiring fuel planning that efficiently matches ground power demands through optimized storage**	**21.P.1**
				Agile	% of fuel storage equipment that is metered	100% (T=O)	**Lack of capability: Need for autonomic metering capability on bulk fuel storage systems**	**21.LC.1**
22	**Storage**	**Provide Storage for Collection of Energy Sources Other than Liquid Fuels**	**Force Application** • Maneuver • Engagement **Command & Control** • Organize • Understand • Planning • Decide • Direct • Monitor **Protection** • Prevent • Mitigate **Logistics** • Supply • Logistics Services • Engineering **Force Support** • Force Management	Scalable	Scalable energy storage matched to demand	Yes / No	**Lack of capability: No scalable expeditionary energy storage capability**	**22.LC.1**
							Policy: No policy established for harvesting and storing energy sources other than liquid fuel	**22.P.1**
				Expeditionary	Energy harvesting and storage factored into planning and operations	Yes / No	**Policy: No policy established for harvesting and storing energy sources other than liquid fuel**	**22.P.1**
				Agile	Units have the ability to harvest and store energy from available sources	Yes / No	**Lack of capability: No current capability to harvest available potential and kinetic energy**	**22.LC.2**
23	**Storage**	**Provide Expeditionary Water Packaging**	**Force Application** • Maneuver • Engagement **Command & Control**	Agile	Adequate water packaging equipment available to enable water self-sufficiency at the Battalion / Squadron level and below	Yes / No	**Lack of capability: No capability to package water at the Battalion / Squadron level and below**	**23.LC.1**

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Gap Priority	E2W2 Functional Area	Task	Joint Capability Area (Tier I / •Tier II)	Attribute	Metric	Measure	Gap Statements	Gap ID (Pri.Cat.#)
			• Organize • Understand • Planning • Decide • Direct • Monitor **Protection** • Prevent • Mitigate **Logistics** • Supply • Logistics Services • Engineering **Force Support** • Force Management				**Policy: Lack of doctrine for water packaging at the Battalion / Squadron level and below**	**23.P.1**
				Scalable	Scalable water packaging from the MEF to individual scale	Yes / No	**Lack of capability: Lack of bulk water packaging capability at all MAGTF levels**	**23.LC.2**
							Policy: Lack of policy on small unit (Company and below) and individual water packaging	**23.P.2**
24	**Management**	**Management of additional tasks to comply with higher guidance (i.e. DODI regarding burn pits, etc.) in an expeditionary environment**	**Command & Control** • Organize • Understand • Planning • Decide • Direct • Monitor **Logistics** • Deployment & Distribution • Supply • Logistics Services • Engineering **Force Support** • Force Management • Human Capital Management	Scalable	% of operational units conducting annual expeditionary energy use reviews	100% (T=O)	**Policy: Lack of policy on expeditionary energy use reviews**	**24.P.1**
				Expeditionary	Fuel and energy procedures are integrated across the MAGTF	Yes / No	**Policy: Lack of doctrine on expeditionary energy use**	**24.P.2**
					Doctrine and policies incorporate energy efficiency as a warfighting enabler	Yes / No	**Policy: Lack of doctrine on expeditionary energy use**	**24.P.2**
				Interoperable	USMC Expeditionary Energy requirements are synchronized with Joint and Coalition operations	Yes / No	**Policy: Lack of doctrine on expeditionary energy use**	**24.P.2**
25	**Planning**	**Plan and Design Waste-to-Energy Systems**	**Command & Control** • Organize • Understand • Planning • Decide • Direct • Monitor **Battlespace Awareness** • Intelligence • ISR • Environment **Protection** • Prevent • Mitigate **Logistics** • Deployment & Distribution	Expeditionary	Units / Commanders have visibility into waste streams	Yes / No	**Policy: Lack of doctrine and policy on measuring waste generation**	**25.P.1**
							Lack of Capability: No capability to monitor and measure waste production and to manage waste data	**25.LC.1**
				Expeditionary	Planners factor waste management (biological and non-biological) into mission planning	Yes / No	**Policy: Insufficient doctrine and policy on expeditionary waste planning and management**	**25.P.2**

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Gap Priority	E2W2 Functional Area	Task	Joint Capability Area (Tier I / •Tier II)	Attribute	Metric	Measure	Gap Statements	Gap ID (Pri.Cat.#)
			• Supply • Logistics Services • Engineering **Force Support** • Force Management • Human Capital Management	Scalable	Expeditionary waste-to-energy systems available	Yes / No	**Policy: No waste generation or composition baseline**	**25.P.3**
							Lack of capability: No material capability to convert waste-to-energy	**25.LC.2**
26	**Disposal**	**Provide Efficient/Effective Disposal of Non Reusable Hazardous Waste in an Expeditionary Environment**	**Command & Control** • Organize • Understand • Planning • Decide • Direct • Monitor **Battlespace Awareness** • Environment **Logistics** • Supply • Logistics Services • Engineering **Force Support** • Force Management	Expeditionary	Unit has developed a plan for hazardous waste management	Yes / No	**Need to replace: Need to upgrade current capabilities to meet policy requirements**	**26.NR.1**
							Policy: Lack of doctrine regarding expeditionary hazardous waste management	**26.P.1**
				Agile	Reduced weight of hazardous waste generated per day	Yes / No	**Policy: No hazardous waste generation baseline**	**26.P.2**
							Policy: Lack of doctrine regarding expeditionary hazardous waste management	**26.P.3**
							Policy: Lack of policy regarding documented expeditionary hazardous waste management plans	**26.P.4**
							Lack of capability: Lack of materiel capabilities to reduce expeditionary hazardous waste	**26.LC.1**
27	**Production**	**Convert waste products into energy during expeditionary operations**	**Force Application** • Maneuver • Engagement **Command & Control** • Organize • Understand • Planning • Decide • Direct • Monitor **Battlespace Awareness** • Intelligence • ISR • Environment **Protection** • Prevent • Mitigate **Logistics** • Deployment & Distribution • Supply • Logistics Services • Engineering **Force Support** • Force Management	Agile	Battlefield materials designed to maximize waste-to-energy conversion	Yes / No	**Lack of capability: No capability to convert waste products into energy**	**27.LC.1**
							Policy: No waste generation or composition baseline	**27.P.1**
							Policy: No established standards for battlefield materials to enable waste-to-energy conversion	**27.P.2**
				Agile	% of unit waste used to generate power	10% (T) / 25% (O)	**Lack of capability: No capability to convert waste products into energy**	**27.LC.1**
							Policy: No waste generation or composition baseline	**27.P.1**
				Scalable	Monitor amount of energy-convertible waste generated per Marine per day during expeditionary ops	Yes / No	**Lack of Capability: No capability to monitor and measure waste production and to manage waste data**	**27.LC.2**
							Policy: No existing waste monitoring doctrine and policy	**27.P.3**
				Scalable	Monitor amount of energy-convertible waste generated per Marine per day during expeditionary ops	Yes / No	**Lack of Capability: No capability to monitor and measure waste production and to manage waste data**	**27.LC.2**

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Gap Priority	E2W2 Functional Area	Task	Joint Capability Area (Tier I / •Tier II)	Attribute	Metric	Measure	Gap Statements	Gap ID (Pri.Cat.#)
28	**Storage**	**Provide Hazardous Waste Storage in an expeditionary environment**	**Force Application** • Maneuver • Engagement **Command & Control** • Organize • Understand • Planning • Decide • Direct • Monitor **Battlespace Awareness** • Intelligence • ISR • Environment **Protection** • Prevent • Mitigate **Logistics** • Deployment & Distribution • Supply • Logistics Services • Engineering **Force Support** • Force Management	Expeditionary	MAGTF units have a documented plan for expeditionary hazardous waste management	Yes / No	**Policy: Lack of policy for expeditionary hazardous waste management plans**	**28.P.1**
							Sufficiency: Lack of trained personnel in expeditionary hazardous waste management	**28.S.1**
				Scalable	Scalable expeditionary hazardous waste storage equipment that meets regulatory requirements is available	Yes / No	**Lack of capability: Lack of scalable expeditionary hazardous waste storage equipment**	**28.LC.1**
29	**Storage**	**Provide Waste Storage in an expeditionary environment**	**Command & Control** • Organize • Understand • Planning • Decide • Direct • Monitor **Battlespace Awareness** • Intelligence • ISR • Environment **Protection** • Prevent • Mitigate **Logistics** • Deployment & Distribution • Supply • Logistics Services • Engineering **Force Support** • Force Management	Agile	Scalable expeditionary waste storage equipment available	Yes / No	**Lack of capability: Lack of scalable expeditionary waste storage equipment**	**29.LC.1**
							Policy: Lack of policy for expeditionary hazardous waste management plans	**29.P.1**
				Expeditionary	MAGTF units have a documented plan for expeditionary waste management	Yes/No	**Policy: Lack of policy for expeditionary waste management plans**	**29.P.2**
							Sufficiency: Lack of trained personnel in expeditionary hazardous waste management	**29.S.1**

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E2W2 CBA Solutions Approach Assessment

H.1 Assessment Method

During the **Solutions Approach Assessment** the IPT examined the **Gap and Risk Assessment** results and identified non-materiel and materiel solution approaches to mitigate E2W2 gaps in order to make solution recommendations. The IPT first reviewed the previously defined E2W2 tasks and gaps and through iterative idea generation and group discussion identified non-materiel approaches across doctrine, organization, training, leadership and education, personnel, and facilities (DOTLPF). Using the same methodology, the IPT then identified materiel solution approaches to those gaps for which non-materiel solution approaches would not fully mitigate the gap. These proposed materiel solutions were further categorized as *Evolutionary*, *Transformational* (e.g. breakthrough technology), or *Information Technology (IT)*. A wide range of potential approaches were identified and prioritized based on the highest ability to fill a gap and/or mitigate a risk.

H.2 Results

Non-materiel

The **Solutions Approach Assessment** determined that non-materiel solutions are particularly important for both near-term mitigation and to guide mid- to long-term materiel solution development. 160 non-materiel approaches or solution alternatives were recommended for inclusion in the full analysis effort. Establishing doctrine and policy, updating Tactics, Techniques, and Procedures, developing and providing appropriate training, and minor organization and personnel adjustments can provide significant near-term mitigation of multiple gaps. Per JCIDS guidance, the best approach to integrating possible non-materiel and materiel approaches is to start with those non-materiel solutions that can have immediate impact on improving overall capability, and that is also the recommendation of the E2W2 IPT. Non-materiel approaches are summarized below.

Policy

All of the gaps require some degree of policy as part of a solution strategy. Much of this policy will be provided by the USMC Expeditionary Energy Strategy and Implementation Planning Guidance and the doctrine approaches suggested below. Still the assessment identified several key areas that require additional policy or guidance:

a) Publish guidance regarding Energy Key Performance Parameters and Key System Attributes in all requirements documents for systems that produce or consume energy, water, or waste.

b) Publish guidance on applying energy considerations to acquisition life cycle cost estimates and analyses of alternatives.

c) Publish a formal battery policy to guide requirements, engineering, and acquisition decisions and to standardize operating forces' battery procurement and management. This policy should focus on increasing battery commonality and the use of rechargeable media in order to maximize renewable energy storage and to lighten the individual and MAGTF load.

d) Publish a formal water policy that reinforces doctrine and provides commanders with clear intent on reducing the current dependency on bottled water on the battlefield and return to more self-sufficient potable water production using systems organic to the MAGTF.

e) Develop an evolutionary technology roadmap that addresses potential technological solutions to E2W2 in the near-, mid-, and far-term to inform requirements and acquisition.

f) Publish guidance directing the inclusion of energy efficient technologies where applicable during legacy equipment upgrades, during reset, recapitalization, and planned product improvements.

g) Require Program Managers to review and update the Total Force Management System data base to accurately capture power requirements of all USMC equipment.

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Doctrine

The non-materiel assessment identified a lack of sufficient energy-, water-, and waste -specific doctrine to enable MAGTF E2W2 planning and employment to the standards required by future concepts and scenarios. Several doctrine approaches to resolving this gap were identified:

a) Develop a Marine Corps Reference Publication that addresses MAGTF E2W2 operations across WFFs and MAGTF elements and provides comprehensive guidance to commanders, planners, and SMEs on efficient expeditionary Forward Operating Base (FOB) design.

b) Integrate E2W2 capabilities into existing and emerging Marine Corps doctrinal publications. Address E2W2 efficiencies and best practices and include updates to bulk liquid logistics doctrine that addresses small unit water self-sufficiency in support of EMO.

c) Develop standard procedures for employing utility planners at the MEB level and above.

d) Add renewable energy and waste-to-energy considerations and planning factors to existing logistics, engineering and utility doctrine and TTPs.

e) Promote development of joint E2W2 doctrine and standards.

Organization

Updates to organizational structure are necessary to ensure that E2W2 is properly considered in mission planning and decision making, and to provide operational flexibility and self-sufficiency on the distributed battlefield. Approaches center on conducting manpower and training analysis to identify changes in structure and organization that allow E2W2 capabilities to be integrated throughout the MAGTF most effectively:

a) Review all organizational structure that supports E2W2 capabilities.

- Include evaluation of Tables of Organization (T/O) requirements for utility planners for planning at the MEF and Major Subordinate Command (MSC) levels and ensure adequate quantities and appropriate assignment of utility planners for integrated E2W2 throughout MAGTF planning processes.

b) Evaluate Tables of Equipment (T/E) for opportunities to increase energy efficiency by "right-sizing" the T/E for energy producing or consuming equipment and to support integration and expanded use of energy efficient equipment.

- Evaluate T/E to support water self-sufficiency from the MEF to the rifle squad level.

Training

Training is essential to shaping the E2W2 ethos, planning, and management and to ensuring efficient employment of current and future E2W2 capabilities. Other than individual E2W2 systems training, there is no current formal or informal instruction that establishes a culture of awareness for E2W2. Approaches include training that spans across administrative and operational requirements:

a) Develop a flexible (entry to career level), scalable (individual to collective training standards) training continuum that addresses E2W2 ethos, planning, and management.

b) Modify officer and enlisted military occupational specialty (MOS) training, as determined by the Course Content Review Board (CCRB) and Training and Readiness (T&R) Manual Review processes, to reflect knowledge and skills required to understand, plan, coordinate, integrate, and maintain E2W2 capabilities.

a. Include training on efficient and scalable power and water production and distribution, renewable and alternative energy, and waste-to-energy systems.

c) Integrate E2W2 planning and execution (e.g. scalable FOB design) into standardized pre-deployment training and other training exercises to increase the proficiency and sufficiency of the deploying expeditionary energy, water, and waste operational capability.

d) Increase preventive medicine training for Corpsman for testing, certifying, and maintaining water standards at the small unit level.

e) Train personnel in expeditionary energy best practices ; conduct expeditionary energy use reviews during training exercises and deployments to identify and close training/awareness gaps.

f) Include resource (fuel/water) -limited and -constrained training events.

Leadership

Instilling an ethos that values energy and considers E2W2 efficiency to be critical to combat effectiveness requires behavior change at all levels of the Marine Corps. The magnitude of this change requires strong and consistent leadership. Educating leadership spans the full range of instruction at the formal schools from entry level to career and command level courses:

a) Educate every Marine in several areas - awareness of their individual and collective energy footprint; observing, analyzing, and acting on information regarding energy use; understanding the first, second and third order effects of energy and water use on operations; understanding tradeoffs in the operational decision space.

b) Develop and integrate E2W2 material into officer and enlisted professional military education (PME) that is tailored for entry, intermediate and advanced level programs.

- Include efficient employment of assets to reduce energy consumption.
- Include familiarization with water capabilities and employment best practices.
- Include familiarization with expeditionary power operations and alternative power systems and benefits to reducing demand and the overall logistical footprint.
- Emphasize the importance of planning for and using MAGTF water resources.
- Emphasize the importance of reducing and minimizing waste.
- Include planning and management of MAGTF organizational equipment/resources for appropriate billets/planners.

Personnel

Personnel approaches address changes in end-strength and assignment within applicable MOSs:

a) Evaluate rank, MOS, and population requirements to determine adequate numbers of trained planners at the MEFs and MSCs to enable effective E2W2 planning, to include efficient FOB utilities design, and management.

b) Evaluate rank, MOS, and population requirements to determine T/O revisions needed to support training on, and management of, E2W2 capability sets across the USMC operating forces.

c) Evaluate supporting establishment rank, MOS, and population requirements to manage E2W2 programs and determine initial user, maintainer, and train-the-trainer training.

d) Assess the need for additional utilities water technicians to conduct water system operation, testing, and maintenance and additional Corpsmen to conduct water sampling, field testing, certification, and preventive medicine training in direct support to the battalion level and below.

e) Evaluate the requirement for additional utilities MOS Marines and additional personnel trained in waste and hazardous waste management and storage in an expeditionary environment.

Modifications to existing manning will impact materiel, organization, and training changes and must be synchronized with the planning in these areas.

Facilities

This ICD is predicated on the Marine Corps' expeditionary focus and limits discussion of permanent or base camp facilities. The only recommendation in this area is to establish core design models that support scalable FOBs and Forward Arming and Refueling Points for different mission requirements and enable efficient transitions to enduring operations and joint force sustainment. The Marine Corps will partner with Army programs and with the other Services to ensure interoperability and assurance of USMC capabilities for enduring energy, water and waste sustainment and base camp operations.

Materiel

Taken alone, non-materiel solutions are insufficient to achieve the robust E2W2 capability directed by the E2 Strategy or demanded by expected future operational scenarios. Research identified over 22 relevant materiel programs, systems or approaches. Along with these potential programs, the IPT identified 87 materiel solution approaches across all three categories (IT, Evolutionary, Transformational) and applicable to 27 of the 29 tasks. The assessment indicates that the majority of materiel solution approaches are within the Evolutionary (Recapitalization) and Transformational (Breakout) categories. This suggests that current and programmed capabilities can support gap mitigation, but in several key areas new technology is needed. For Evolutionary approaches, system proficiency (how well a capability performs) and sufficiency (how much of a capability is required) need to be assessed further. The need for improved information technology to support mission planning, execution and management is evident by the number of tasks requiring a solution approach within the IT category. Recommended materiel solution approaches are detailed below.

Information Technology

a) Develop interoperability software for existing logistics systems and metering systems to provide commanders with real-time accessible, visible, and understandable information regarding their energy and water usage.

b) Establish an energy Community of Interest to develop a common data structure and taxonomy.

c) Develop Service-Oriented Architecture tools to support planning.

Evolutionary Development

a) Develop equipment modified from Commercial-Off-The-Shelf technology to meet expeditionary requirements across expected operating environments.

b) Develop ruggedized, lightweight, deployable alternative/renewable (e.g. solar harvesting) power systems for unit level and individual use that do not require climate control to operate effectively.

c) Apply a SOA data structure and taxonomy to current Programs of Record.

d) Update the AutoDISE software with power requirements associated with fielded equipment loads and operational use as a utility planning tool.

e) Develop deployable FOB modules in self-sustainable capability sets designed to provide efficient utilities support (power, water, Heating, Ventilation, & Air Conditioning), and which are inter-connectable for expansion and reduction.

f) Provide additional funding for advanced battery development to include standardized high energy, rechargeable batteries and increased battery commonality.

g) Evolve current communication systems to improve energy efficiency.

- Develop all systems to be compatible with rechargeable batteries

- Improve efficiency and compatibility of man-packable alternative power sources. (e.g. more efficient man-packable/wearable solar)
- Develop or procure C4ISR systems with the most efficient internal power and cooling technology available.

h) Evolve legacy system requirements to include operational energy performance parameters and system attributes.

i) Fund and accelerate fielding of the Advanced Medium-Sized Mobile Power Source (AMMPS), Enhanced Efficiency Environmental Control Unit (E3CU), and Integrated Trailer-Environmental Control Unit- Generator (Generation II) [ITEG II] families.

j) Develop and field vehicle on board exportable power / auxiliary power systems.

k) Increase tactical vehicle and aircraft energy efficiency.

l) Develop and field water test kits or expand or modify existing kits to enable expanded long- and short-term potability sampling and analysis capability.

Transformational Approach

a) Evaluate new technologies to improve efficiency beyond current Mobile Electric Power (MEP) and planned AAMPS, E3CU, and ITEG II capability.

b) Develop a modular rapidly assembled/disassembled energy common operating post capability.

c) Develop "hybrid" fuel burning generator sets that include renewable power and power storage to significantly reduce the need for liquid fuels. Storage capability must support fully renewable operations for non-mobility systems.

d) Develop component parts and systems that reflect a holistic utility systems relationship for power, water, waste, and force protection.

e) Develop expeditionary waste-to-energy systems for all terrains and climates.

f) Develop technology that enables future systems to be powered by the most efficient power sources with a footprint that is consistent with mission requirements and is embarkable aboard L-Class shipping.

g) Develop technologies with alternative energy functionality at the required scale (e.g. containerized energy power generation and storage system; solar laminates, photovoltaic solar, renewable energy systems; transportable hybrid electric power station).

h) Develop an integrated individual power production, management and monitoring system that uses common power sources and interfaces to power all individual equipment and allow users to accurately determine remaining battery life and selectively distribute power based on mission needs.

i) Develop technologies to provide enhanced water capabilities (e.g. atmospheric water-from-air technologies, waste water reuse systems, water from exhaust systems; collapsible water containment carriers), including man-portable and -packable systems.

j) Develop technology that integrates with common hardware, minimizing the requirement for specialized equipment for computers, and other such devices.

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Table H-1: Materiel and Non-materiel Solution Approaches

Task Information			Non-Materiel Solution Approaches						Materiel Solution Approaches		
Gap Priority	**Function**	**Task**	**Doctrine**	**Organization**	**Training**	**Leadership & Education**	**Personnel**	**Facilities**	**IT**	**Evolutionary**	**Transformational**
1	Planning	Plan to supply Energy (conventional, renewable, alternative) to the MAGTF; integrated throughout the supply chain and with Joint/Coalition and HNS	1. Develop E2W2 doctrinal publication and implement in MCPP and MSTP. Address E2W2 efficiencies and best practices and include updates to bulk liquid logistics doctrine that addresses small unit water self-sufficiency in support of EMO. 2. Develop standardized TTPs for utility planners at the MEF level. 3. Establish renewable energy and waste-to-energy doctrine within existing logistics, engineering and utility doctrine and TTPs. 4. Promote the development of joint E2W2 doctrine and standards. 5. Publish guidance on applying energy considerations to acquisition life cycle cost estimates and analyses of alternatives. 6. Establish policy for energy as a risk factor in planning, similar to ORM.	1. Establish appropriate T/O and T/E requirements for utility planners to support planning at all the MEF/MSC levels. 2. Assess organizational capabilities to support E2W2 initiatives and doctrine.	1. Develop a flexible (entry to career level), scalable (individual to collective training standards) training continuum that addresses E2W2 ethos, planning and management. 2. Modify officer and enlisted military occupational specialty (MOS) training, as determined by the Course Content Review Board (CCRB) and Training and Readiness (T&R) Manual Review processes, to reflect knowledge and skills required to understand, plan, coordinate, integrate, and maintain E2W2 capabilities.	1. Develop and incorporate E2W2 considerations in POIs for planning education activities into entry and career level schooling (boot camp-to-war college level). 2. Incorporate E2W2 planning considerations across the MAGTF within in the PME continuum. 3. Develop POIs for war gaming and sand table scenarios to train Marines on E2W2 initiatives and capabilities.	1. Evaluate personnel requirements to support E2W2 planning requirements.		1. Interoperability software for existing logistics systems and metering systems. 2. Energy COI to determine proper data structure and taxonomy.	1. Develop Energy Planning Tools. 2. Apply common data structure and taxonomy via a Service-Oriented Architecture (SOA) to current Programs of Record (POR). 3. Develop means to supply energy by reducing the power demand via more energy efficient equipment (reduced power requirements on computers/AC's/plasma/comm).	1. Evaluate new technologies to move beyond current Mobile Electric Power (MEP) capability.

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Task Information			Non-Materiel Solution Approaches						Materiel Solution Approaches		
Gap Priority	**Function**	**Task**	**Doctrine**	**Organization**	**Training**	**Leadership & Education**	**Personnel**	**Facilities**	**IT**	**Evolutionary**	**Transformational**
2	Management	Provide the capability to Manage Energy, Water, and Waste Resources in an Expeditionary Environment	1. Develop doctrine and policy regarding E2W2 data management systems. 2. Develop doctrine and policy regarding E2W2 monitoring and metering. 3. Establish baseline for amount of energy to sustain a MAGTF. 4. Develop doctrine and policy regarding alternative fuels/energy usage. 5. Establish baseline for the reduction of fossil fuel use. 6. Doctrine and policy regarding alignment of logistics and operational requirements for fuel and energy efficiency. 7. Develop policy concerning the management of waste. 8. Develop doctrine and policy regarding incorporation of energy efficiency as a warfighting enabler and a mission risk factor.		1. Train personnel in optimum energy, water, and waste employment. 2. Train personnel to conduct expeditionary energy use reviews.	1. Incorporate E2W2 considerations in planning and education at all levels. 2. Educate leadership in: holistic management of E2W2 resources; appropriate staffing/use of MOSs to achieve efficient/combat effective operations; T/O and T/E requirements to achieve efficiency and optimize resources to reduce logistic requirements; systems approach to managing sustainment operations 3. Develop small and large unit award incentives for expeditionary energy performance.	1. Evaluate approaches to optimize the use of trained MOS personnel to achieve efficient resource use.			1. Develop the capability to remotely monitor MEPDIS-R current readings to allow for re-wire / repower in low usage areas. 2. Develop “smart” power controls that automatically match power load to demand.	

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Task Information			Non-Materiel Solution Approaches						Materiel Solution Approaches		
Gap Priority	**Function**	**Task**	**Doctrine**	**Organization**	**Training**	**Leadership & Education**	**Personnel**	**Facilities**	**IT**	**Evolutionary**	**Transformational**
3	Production	Conduct Combat Operations across the MAGTF with minimal energy and energy related logistics requirements	1. Develop standardized procedures and doctrine on power use, power production, and usage of renewable energy from the individual to the MAGTF level. 2. Establish a MAGTF energy production and consumption baseline.		1. Develop and conduct training at all levels to conduct combat operations with minimal energy requirements. 2. Develop training materials for unit energy coordinators once this collateral duty is defined.	1. Education at all levels to conduct combat operations with minimal energy requirements. I\ 2. Educate Marines to know and be aware of their individual and collective energy footprint, and should include education on how to observe, analyze and act on information regarding energy use, and understand the first, second and third order effects of energy use on operational options, and trade-offs in the operational decision space.				1. Increase efforts to field the Advanced Medium-Sized Mobile Power Source (AMMPS). 2. Provide more Mobile Electric Power Distribution System - Replacement (MEPDIS-R) equipment. 3. Increase commonality of power equipment and batteries. 4. Develop more efficient and fewer battery types with an emphasis on rechargeable batteries. 5. Evolve current program of record systems with energy performance improvements.	1. Develop "smart" power distribution technologies with alternative energy functionality at the required scale (e.g.: Micro Grid Remote Hybrid Power Solutions; solar fields and lighting systems; containerized energy power generation and storage system; solar laminates, photovoltaics, renewable energy systems; transportable hybrid electric power station). 2. Develop Family of Systems (light, medium, heavy) approach for procuring equipment. 3. Better packaging, load configuration capability to maximize vehicle lift in fuel, water, cargo. Consider bustle racks, other racks. 4. Develop lighter tactical wheeled vehicle capabilities.
4	Production	Produce Energy Efficient Climate Control environments to maintain Personnel and Equipment operating efficiency	1. Develop doctrine and policy regarding climate control for personnel and equipment. [Doctrine should incorporate guidance on managing energy needed for completing missions, and associated QOL implications.]	1. Evaluate T/E for climate control equipment to ensure standardization and appropriate level of capability.	1. Include efficient climate control measures in appropriate training materials.	1. Educate leadership on the effective use of climate control systems / solutions.				1. Develop and field tent liners to reduce Environmental Control Units (ECU) load and duty cycle; durable, better insulated shelters. 2. Employ the same concept that solar paneled homes use; attach solar panel to each ECU to help off-set power draw on the grid.	1. Explore other technologies beyond A/C powered ECUs.
5	Management	Provide the capability to Measure Energy, Water, and Waste Resources in an Expeditionary Environment	1. Establish doctrine and policy regarding E2W2 data management systems. 2. Establish doctrine and policy regarding E2W2 monitoring and metering.		1. Train personnel in optimum energy employment. 2. Train personnel to conduct expeditionary energy use reviews.					1. Develop metering capability for all devices and power sources to more effectively deploy energy, water and waste assets. 2. Evolve current systems and create new systems with the ability to measure and transmit the data.	

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Task Information			Non-Materiel Solution Approaches						Materiel Solution Approaches		
Gap Priority	**Function**	**Task**	**Doctrine**	**Organization**	**Training**	**Leadership & Education**	**Personnel**	**Facilities**	**IT**	**Evolutionary**	**Transformational**
6	Distribution	Conduct "smart" expeditionary Electrical Distribution	1. Establish baseline for expeditionary electrical distribution (include scalability and interoperability). 2. Publish guidance on best practices for power distribution grid design, and water and hygiene services, and waste-to-energy operations.	1. Evaluate T/O and T/E to meet requirements for expeditionary electrical distribution planning.		1. Educate leaders to create awareness of expeditionary power systems operations and benefits to reducing logistical footprint and overall requirements.	1. Evaluate the requirement for additional Utility Marines to support small units.			1. Develop ”smart” power systems that automatically match load to demand at different scales. 2. Provide additional MEPDIS-R in the OPFOR. 3. Adapt available load management technology to generator sets to allow the small unit leaders to monitor output/usage. 4. Establish metering systems in all power production equipment. 5. Power management and monitoring system to allow small unit leaders to make energy decisions and allow logisticians to more accurately predict future requirements.	1. Develop a smart power controller. 2. Develop power storage and distribution solutions that integrate with common hardware, reducing the requirement for specialized equipment for computers, and other such devices.
7	Planning	Develop Plans to Support Efficient, Scalable Expeditionary Forward Operating Base Water Systems and Hygiene Service	1. Develop doctrine and policy on the scalability planning of FOB design specific to water systems and hygiene services. 2. Integrate all facets of E2W2 planning and execution into pre-deployment training and other training exercises to increase the proficiency and sufficiency of the deploying expeditionary energy, water and waste operational capability.	1. Evaluate T/O and T/E requirements for utility planners to support scalable FOB planning, and design specific to water and hygiene services. This includes examination of 1171 MOS and PMT requirements.	1. Develop a flexible (entry to career level), scalable (individual to collective training standards) training continuum that addresses E2W2 ethos, planning and management. 2. Modify officer and enlisted military occupational specialty (MOS) training, as determined by the Course Content Review Board (CCRB) and Training and Readiness (T&R) Manual Review processes, to reflect knowledge and skills required to understand, plan, coordinate, integrate, and maintain E2W2 capabilities. 3. Incorporate alternative and renewable energy and waste management training in appropriate courses. 4. Evaluate PMT training at the small unit level associated with water storage.	1. Incorporate water quality, safety, and considerations for sustainment across the ROMO within Professional Military Education. [Objective: to provide leadership the knowledge to direct Marines to use locally sourced/purified water.]	1. Evaluate personnel requirements to support E2W2 planning and FOB utilities design.	.	1. Common planning tool for water and waste that is application independent and can be added to DOD IT SOA		

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8	Planning	Design Efficient, Scalable, and Interoperable, Expeditionary Energy Producing and Consuming Warfighting Capabilities	1. Develop doctrine and policy on the scalable (define) power planning and design. [Note: energy employment doctrine that incorporates, or synchronizes with, expeditionary logistics doctrine.] 2. Develop and implement joint standards. 3. Develop standards for efficient FOB design. 4. Publish guidance on the inclusion of operational energy performance parameters and system attributes in all requirements documents for systems that produce or consume energy, water, or waste.	1. Evaluate Tables of Equipment (T/E) for opportunities to increase energy efficiency by "right-sizing" the T/E for energy producing or consuming equipment and to support integration and expanded use of energy efficient	1. Integrate E2W2 planning and execution (e.g. scalable FOB design) into standardized pre-deployment training and other training exercises to increase the proficiency and sufficiency of the deploying expeditionary energy, water and waste operational capability.	1. Develop and integrate E2W2 material into officer and enlisted professional military education (PME) that is tailored for entry, intermediate and advanced level programs.	1. Evaluate rank, MOS, and population requirements to provide adequate numbers of trained planners at the MEFs and MSCs to enable effective E2W2 planning, to include efficient FOB utilities (including distributed power systems).design, and management.	1. Establish core FOB design models for planners to support with additive elements related to mission requirements.	1. Utilize AutoDISE as a planning tool: update with power requirements of fielded loads. 2. Use SOA tools to support planning.	1. Develop a deployable FOB module in self-sustainable capability sets designed to make max use of utilities support (power, water, HVAC) and that are interconnectable for expansion and/or reduction. 2. Develop ruggedized lightweight, deployable alternative/renewable (solar, wind, geo-thermal, nuclear) power systems for unit level and individual use. 3. Provide additional funding for advanced battery work - new standardized high energy batteries. 4. Evolve current systems to improve energy efficiency. 5. Continue development of vehicle exportable power systems.	1. Develop "smart" systems that provide renewable power, power storage, and power control. 2. Develop component parts and systems that reflect the holistic utility systems relationship for power, water, waste, and force protection. 3. Develop future C4ISR and weapon systems with the most energy efficient internal components and that do not require heating or cooling. 4. Develop technologies that create the power required C4ISR systems in place.
9	Planning	Plan for reductions in energy demands of current and future capability sets without reducing combat/mission effectiveness	1. Establish baseline doctrine and policy for energy efficiency. 2. Publish guidance on the inclusion of operational energy performance parameters and system attributes in all requirements documents for systems that produce or consume energy, water, or waste.	1. Evaluate T/O and T/E structures and employment options for increases in energy efficiency.	1. Modify officer and enlisted military occupational specialty (MOS) training, as determined by the Course Content Review Board (CCRB) and Training and Readiness (T&R) Manual Review processes, to reflect knowledge and skills required to understand, plan, coordinate, integrate, and maintain E2W2 capabilities.	1. Education at all levels to reduce energy usage, when applicable, without impact to mission. 2. Educate planners and leaders to consider moving only the capabilities forward necessary for operations and leave "non-shooters" in the rear with the gear.	1. Evaluate options for removing "non-shooters" (contractors) from battlespace - operating from non-restricted environments.			1. Evolve current systems to include energy performance parameters. 2. Adapt energy-saving technologies to legacy systems. 3. Replace lighting and backlit systems with more efficient solutions (e.g. LED lights, screens, etc.) 4. Develop systems that tie in efficient equipment, renewable energy and generator sets.	1. Develop transformational technologies that are powered by most efficient power source and reduce demand for energy. 2. Examine potential for vehicles to efficiently harvest, store, and efficiently share mobile power to onboard and offboard systems.

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Gap Priority	**Function**	**Task**	**Doctrine**	**Organization**	**Training**	**Leadership & Education**	**Personnel**	**Facilities**	**IT**	**Evolutionary**	**Transformational**
10	Planning	Plan to produce all C4ISR energy and power requirements organically in place	1. Develop a Marine Corps Reference Publication that addresses MAGTF E2W2 operations across WFFs and MAGTF elements and provides comprehensive guidance to commanders, planners, and SMEs on efficient expeditionary Forward Operating Base (FOB) design. 2. Integrate E2W2 capabilities into existing and emerging Marine Corps doctrinal publications. Address E2W2 efficiencies and best practices and include updates to bulk liquid logistics doctrine that addresses small unit water self-sufficiency in support of EMO. 3. Develop standard procedures for employing utility planners at the MEB level and above. 4. Add renewable energy and waste-to-energy considerations and planning factors to existing logistics, engineering and utility doctrine and TTPs.	1. Review all organizational structure that supports E2W2 capabilities. 2. Evaluate Tables of Organization (T/O) requirements for utility planners to support planning at the MEF and Major Subordinate Command (MSC) levels. 3. Ensure adequate quantities and appropriate assignment of utility planners to support integrated E2W2 throughout MAGTF planning processes. equipment.	1. Establish training requirements on organic power production approaches and systems, including integrating across multiple power sources as well as load management.	1. Develop and integrate E2W2 material into officer and enlisted professional military education (PME) that is tailored for entry, intermediate and advanced level programs.	1. Evaluate rank, MOS, and population requirements to provide adequate numbers of trained planners at the MEFs and MSCs to enable effective E2W2 planning, to include efficient FOB utilities design, and management.		1. Develop interoperability software for existing logistics systems and metering systems to provide commanders with real-time accessible, visible, and understandable information regarding energy and water usage.		
11	Distribution	Conduct Expeditionary Water Distribution	1. Develop doctrine for water distribution (metering, reuse, self-sufficiency).	1. Evaluate T/E to support water self-sufficiency from the MEF to the rifle squad level.	1. Conduct training down to the small unit level to support capability and to instill confidence and habits of thought and action for water self-sufficiency.	1. Educate leadership and Marines to "drink what we make." Expeditionary water distribution should be distribution of water production not just trucking bottled water from point to point. 2. Develop and integrate E2W2 material into officer and enlisted professional military education (PME). Include familiarization with water capabilities and employment best practices. Emphasize the importance of planning for and using organic water resources.	1. Assess the need for additional utilities water technicians to conduct water system operation, testing, and maintenance 2. Assess the need for additional Corpsmen to conduct water sampling, field testing, certification, and preventive medicine training in direct support to the battalion level and below.		1. Develop systems that support autonomous and automatic monitoring of water distribution.	1. Develop small unit and individual water purification systems that increase the ability to distribute water production and decrease the demand for water distribution.	1. Develop man-portable small unit and individual water purification and testing technology that can be powered by renewable energy sources, is robust enough for long-term consumption and able to be operated and maintained with minimal training or specialization.

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Task Information			Non-Materiel Solution Approaches						Materiel Solution Approaches		
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12	Management	Provide the capability to Analyze data on Energy, Water, and Waste Resources in an expeditionary environment	1. Establish doctrine and policy regarding E2W2 data management systems. 2. Establish baseline for amount of fuel, batteries, and water to sustain a MAGTF.		1. Train personnel in optimizing energy performance. 2. Train personnel to conduct expeditionary energy use reviews.	1. Incorporate E2W2 considerations in planner education.				1. Develop metering capability for all devices and power sources to more effectively deploy energy, water and waste assets. 2. Evolve current systems and create new systems with the ability to measure and transmit the data.	
13	Production	Provide for the efficient production of Potable/Non-Potable water in an expeditionary environment	1. Establish baseline for the production of potable & non-potable water. 2. Develop policy specific to use of non-organically produced water (i.e. bottle water). 3. Develop TTPs for small unit water purification during pre-deployment training. 4. Publish a formal water policy that reinforces doctrine and provides commanders with clear intent to reduce the current dependency on bottled water on the battlefield and return to organic, more self-sufficient potable water production.	1. Assess MLG T/O and MAGTF T/O for appropriate alignment of 1171's. 2. Evaluate T/E to support water self-sufficiency from the MEF to the rifle squad level.	1. Develop training below the MAGTF level to support the production and distribution of water at the company and below level to augment the bulk water capability. 2. Increase preventive medicine training for Corpsmen for testing, certifying and maintaining water standards at the small unit level.	1. Develop and integrate E2W2 material into officer and enlisted professional military education (PME). Include familiarization with water capabilities and employment best practices. Emphasize the importance of planning for and using organic water resources.	1. Assess the need for additional utilities water technicians to conduct water system operation, testing, and maintenance 2. Assess the need for additional Corpsmen to conduct water sampling, field testing, certification, and preventive medicine training in direct support to the battalion level and below.			1. Vehicle and man-transportable, small unit water purifier that supports Platoon level operations. 2. Improve ruggedization (MIL-STD-810) of existing Commercial Off The Shelf (COTS) small unit water purifiers for military suitability. 3. Modify and expand availability of existing field testing kits and ruggedize for use by any MOS and without the need for field calibration.	1. Develop man-portable small unit and individual water purification and testing technology that can be powered by renewable energy sources, is robust enough for long-term consumption and able to be operated and maintained with minimal training or specialization.
14	Production	Provide a Power Source appropriate to the individual user's required capability	1. Establish policy on common power sources (define) for individual personal equipment. 2. Publish a formal battery policy to guide requirements, engineering, and acquisition decisions and to standardize operating forces' battery procurement and management. This policy should focus on increasing battery commonality and the use of rechargeable media in order to maximize renewable energy storage and to lighten the individual and MAGTF load.		1. Develop and conduct training on common power sources capability and usage.	1. Educate personnel on planning factors on how and when to resupply power sources for individual users need; should be included in leader's PME at the company level and below.				1. Developed equipment and systems that require less power. 2. Increase commonality across power source (battery). 3. Develop man-portable battery chargers (more efficient flexible solar panels, fuel cells) to reduce the individual battery load and need for resupply. 4. Provide individuals the ability to obtain power from vehicles and other mobility and non-mobility sources.	1. Power source (battery) duration needs to be measured in days or weeks rather than hours - might involve mechanical energy or alternative source such as nuclear/isotopes. 2. Future systems need to be constrained on the number of battery types. 3. Future systems must be forward compatible with future power sources. Requires common connector and/or interface. 4. Develop individual power management and monitoring capability that would allow user to accurately determine remaining battery life and selectively distribution of power based on mission needs.

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15	Distribution	Conduct Expeditionary Bulk Fuel Distribution	1. Develop and establish policy for the use of fuel monitoring and tracking applications. Policy that specifically states which distribution mediums should be metered and recorded. Policy should be to drive toward a common, reconcilable database for tracking fuel use, which is accessible to both planners and programmers. 2. Establish baseline for fuel usage metering.	1. Evaluate T/O and T/E requirements for Bulk Fuel support current/future missions.	1. Conduct training to properly conduct fuel usage metering.	1. Educate leadership on the direct linkage between fuel efficiency and combat effectiveness.				1. Expand family of tactical fuel flow metering systems. 2. Expand Embedded Platform Logistics System (EPLS). 3. Improve air delivery methods from seabases.	
16	Storage	Provide Expeditionary Water Storage	1. Evaluate current policy concerning bottled-to-bladder and bottle vice purified water. 2. Publish a formal water policy that reinforces doctrine and provides commanders with clear intent to reduce the current dependency on bottled water on the battlefield and return to organic, more self-sufficient potable water production, packaging, and storage.		1. Conduct training at the unit level regarding water storage, disinfection and potability requirements, and considerations.	1. Educate leaders to allow them to educate (teach) subordinates to safely use packaged /stored water that is organically produced / purified.	1. Assess the need for additional Corpsmen to conduct water sampling, field testing, certification, and preventive medicine training to store bulk water at the battalion level and below.				1. Develop a transformational capability that any MOS can employ to potable water standards.
17	Production	Provide for the efficient production of recycled Potable/Non-Potable water in an expeditionary environment	1. Establish policy and standards for reclaim and reuse of grey water.	1. Evaluate the T/O and T/E requirements associated with reclaiming and reusing gray water in an expeditionary operation environment.		1. Establish specific guidelines for leaders to routinely educate units on the use/reuse of gray water.					1. Consider development of technologies to provide the capabilities for waste water reuse systems; shower water reuse systems; laundry water reuse systems; supercritical Water Purification Units (WPUs); member bioreactor to ultraviolet disinfection WPUs; hollow-fiber membrane bioreactors to ultraviolet disinfection WPUs; membrane filtration WPUs; photo catalytic oxidation WPUs; membrane bioreactor WPUs; immobilized cell bioreactor WPUs; water from air; and water from exhaust systems.

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Gap Priority	**Function**	**Task**	**Doctrine**	**Organization**	**Training**	**Leadership & Education**	**Personnel**	**Facilities**	**IT**	**Evolutionary**	**Transformational**
18	Disposal	Provide Efficient/ Effective Disposal of Non Reusable Solid Waste in an Expeditionary Environment	1. Develop doctrine and policy regarding non-reusable solid waste management. Doctrine and policy should be focused on source reduction and disposal of non-reusable solid and hazardous waste in expeditionary environment. 2. Establish baseline for lbs/tons of solid waste/day disposed. 3. Waste management plans should be developed. This should cover all waste categories.		1. Conduct training at the small units on disposal of non-reusable solid and hazardous waste in expeditionary environment.	1. Educate leaders to incorporate planning for non-reusable solid and hazardous waste management (to include disposal) into mission planning.				1. Redesign packaging and nonmilitary materiel to be recyclable.	
19	Planning	Develop Plans to Manage, recycle and dispose of Waste (Water, Solid, Biological) and Hazardous Waste	1. Develop doctrine and policy on recycling and disposal of non-hazardous waste, and monitoring the amount of waste generated. [Consider 'greener' sustainable products that can be composted, reused, recycled or safely disposed.] 2. Evaluate current standards for determining what is hazardous.	1. Evaluate T/O and T/E requirements to enable planning for waste recycling, reuse, and disposal.	1. Evaluate, and if required, develop POIs on the recycling and disposal of waste and hazardous waste. [Integrate recycling, waste management at level of individual Marine in basic training.]		1. Evaluate incorporating recycling responsibilities and oversight into HAZMAT MOS.		1. Develop common IT data structure IAW with DOD SOA. 2. Develop systems to monitor and manage waste data.	1. Develop TO&Es for solid and hazardous (water, solid, biological, and hazardous) waste collection, segregation, recycling, packaging /crushing/baling, back loading, spill cleanup, and disposal equipment.	1. Packaging should be either muti-use (reusable box / container), compostable or if disposable-made of material which has a high energy return when burned (e.g. through gasification).
20	Planning	Develop migration plan for FOB to transition from expeditionary to enduring base	1. Develop doctrine and policy on transitioning from an expeditionary to an enduring (define) base that incorporates master planning in all operations and includes an annex with a checklist of standards and policies for Relief-in-Place / Transfer-of-Authority	1. Evaluate T/O and T/E to meet requirements for base transition planning process. 2. Coordinate all joint RDT&E efforts in this area.	1. Develop training materials for training individuals on planning for transitions from an expeditionary to an enduring base.	1. Include planning factors for transition of FOBs to enduring bases in PME at Officer and SNCO level schools.				1. Develop capability to tie in/transfer to another service's power production and distribution without loss of power - examine Joint implications and commonality of equipment issues.	
21	Storage	Provide Expeditionary Bulk Fuel Storage								1. Develop, optimize, and increase use of sea-based bulk fuel as we become more energy independent.	
22	Storage	Provide Storage for Collection of Energy Sources Other than Liquid Fuels	1. Establish policy for the collection of energy sources outside liquid fuels.							1. Adapt existing storage technology to increase endurance and commonality with interfaces for tactical system application.	1. Develop rugged, high-energy density storage that can adapt to multiple system form factors and acceptable weight and size requirements.

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23	Storage	Provide Expeditionary Water Packaging	1. Develop policy concerning expeditionary water packaging systems.			1. Educate leaders to allow them to educate (teach) subordinates to safely use packaged water that is organically produced / purified.				1. Develop a quick disconnect for water bull to 5 Gal jug to Camelback. Ease and speed of use promotes usage.	1. Develop rugged, lightweight collapsible water containment carriers (hold 400 - 500 gallons) used during the production and distribution. The container is folded up and put away.
24	Management	Management of additional tasks to comply with higher guidance (i.e. DODI regarding burn pits, etc.) in an expeditionary environment	1. Establish policy and doctrine on compliance with higher guidance in an expeditionary environment. 2. Support development on a joint policy on expeditionary energy use reviews. 3. Develop doctrine and policy regarding incorporation of energy efficiency as a warfighting enabler. 3. Develop doctrine and policy regarding USMC E2W2 requirement synchronization with Joint and Coalition operations. 4. Develop doctrine and policy regarding reduction of greenhouse gas emissions. 5. Establish policy for reducing solid waste packaging either by weight or volume.		1. Modify officer and enlisted military occupational specialty (MOS) training, as determined by the Course Content Review Board (CCRB) and Training and Readiness (T&R) Manual Review processes, to reflect knowledge and skills required to understand, plan, coordinate, integrate, and maintain E2W2 capabilities.	1. Incorporation of E2W2 considerations in planning education. 2. Educate leaders to incorporate waste, water and energy guidance into mission planning, implementation, and evaluation activities.				
25	Planning	Plan and Design Waste-to-Energy Systems	1. Develop doctrine and policy on converting waste to energy.	1. Additional utility planners involved in the overall planning process for energy production. 2. Additional utility planners involved in the overall planning process for energy production	1. Establish training requirements to support the changes in doctrine for converting waste to energy.					1. Develop equipment modified from Commercial-Off-The-Shelf technology to meet expeditionary requirements in all types of terrains and climates.	1. Develop kits with expeditionary waste-to-energy systems for all types of terrains and climates.
26	Disposal	Provide Efficient/Effective Disposal of Non Reusable Hazardous Waste in an Expeditionary Environment	1. Develop doctrine and policy regarding hazardous waste management.								

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27	Production	Convert waste products into energy during expeditionary operations	1. Establish baseline for weight and volume per day of re-usable solid waste produced by different units under different conditions. 2. Identify waste-to-energy conversion potential for different units under different conditions.							1. Develop means to conduct deliberate packaging (change of materials) for greater opportunity to maximize this strategy.	1. Develop capabilities to turn waste to energy for use during expeditionary operations.
28	Storage	Provide Hazardous Waste Storage in an expeditionary environment			1. Develop POIs and conduct training for Marines in hazardous waste storage in an expeditionary environment. 2. Develop POIs and conduct training and skills to reclaim HAZMAT.	1. Educate leaders to evaluate hazardous waste management plans and inspect storage sites.	1. Evaluate the requirement for additional personnel trained in hazardous waste storage in an expeditionary environment.			1. Develop scalable, expeditionary hazardous waste storage equipment.	1. New technologies in waste-to-energy will drive likely solutions in this area.
29	Storage	Provide Waste Storage in an expeditionary environment	1. Develop policy concerning the management of waste. This policy needs to address types of waste to be stored, length of storage, and procedures for disposal or conversion to energy.				1. Evaluate the need for the creation of an MOS to handle waste disposal and recycling.			1. Develop scalable, expeditionary waste storage equipment.	