AEPI Report

Sustain the Mission Project: Energy and Water Costing Methodology and Decision Support Tool

Final Technical Report

July 2008

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The purpose of the “Sustain the Mission Project 2” (SMP-2) is to further develop and expand the SMP energy and water costing methodology; update SMP-generated life-cycle energy and water cost factors for contingency operations and training; design and test a user-friendly decision support tool for cost-benefit analysis of energy and water investments; and work with appropriate Army agencies to apply the SMP cost-benefit tool to energy and water technologies considered by the Army for further development and fielding.

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Preface

This report was prepared under contract for the Army Environmental Policy Institute (AEPI) by the National Defense Center for Energy and Environment (NDCEE), operated by Concurrent Technologies Corporation (*CTC*), with additional support from Energy and Security Group (ESG). The views expressed do not necessarily reflect the official policy or position of the Department of Defense, Department of the Army, or the United States Government.

The mission of AEPI is to assist the Army Secretariat in developing forward-looking policies and strategies to address environmental issues that may have significant future impacts on the Army. In the execution of this mission, AEPI is further tasked with identifying and assessing the potential impacts on the Army of emerging environmental issues and trends.

This report discusses the efforts conducted under Contract Number W74V8H-04-D-0005, Task Number 0484, "Sustain the Mission Project 2" (SMP-2). The purpose of the SMP-2 is further develop and expand the SMP energy and water costing methodology; update SMP-generated life-cycle energy and water cost factors for contingency operations and training; design and test a user-friendly decision support tool for cost-benefit analysis of energy and water investments; and work with appropriate Army agencies to apply the SMP cost-benefit tool to energy and water technologies considered by the Army for further development and fielding.

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List of Acronyms

AEPI	Army Environmental Policy Institute
AEWRS	Army Energy and Water Reporting System
ASA	Assistant Secretary of the Army
ASE	Army Strategy for the Environment
CE	Cost and Economics
CFH	Army Cost and Factors Handbook
CH-47	Chinook Helicopter
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CONOPS	Contingency Operations
CONUS	Continental United States
CTC	Concurrent Technologies Corporation
DASA	Deputy Assistant Secretary of the Army
DASA-CE	Deputy Assistant Secretary of the Army for Cost and Economics
DESC	Defense Energy Support Center
DFSP	Defense Fuel Supply Point
DG	Distributed Generation
DLA	Defense Logistics Agency
DoD	Department of Defense
DSB	Defense Science Board
ESG	Energy and Security Group
ESOH	Environment, Safety, and Occupational Health
FAC	Facilities Analysis Category
FM&C	Financial Management and Comptroller
FORCES	Force and Organization Cost Estimation System
FORSCOM	United States Army Forces Command
FY	Fiscal Year
G-4	Deputy Chief of Staff - Logistics
G8	Deputy Chief of Staff - Resource Management
HEMTT	Heavy Expanded Mobility Tactical Truck
HMMWV	High Mobility Multipurpose Wheeled Vehicle
HQ	Headquarters
HQDA	Headquarters, Department of the Army
I&E	Installations and Environment
JP 8	Jet Propellant 8
kW	Kilowatt
Lbs	Pounds
MNF-I R&S	Multi-National Force - Iraq , Resource and Sustainment
MRAP	Mine Resistant Ambush Protected
MTON	Measurement Ton
NO_x	Nitrogen Oxides
NPV	Net Present Value
OCONUS	Outside the Continental United States
OSD	Office of the Secretary of Defense
OSMIS	Operating and Support Management Information System
PM PAWS	Product Manager, Petroleum and Water Systems
PREPO	Pre-Positioned Material
ROI	Return on Investment

ROWPU	Reverse Osmosis Water Purification Unit
SBCT	Stryker Brigade Combat Team
SMP	Sustain the Mission Project
SO_x	Sulfur Oxides
STON	Short Ton
TAADS	Theater Army Authorization Document System
TRADOC	US Army Training and Doctrine Command
TSC	Theater Support Command

Executive Summary

Without sustainable supplies of fuel and drinking water, the Army cannot perform its missions. About 50% of the load carried by supply convoys in theaters of operation is fuel, and about 20% is drinking water according to Headquarters Department of the Army (HQDA) Office of the Deputy Chief of Staff, G-4 (Logistics) estimates. These two commodities—fuel and drinking water—are essential to sustain Army missions. This report discusses the Army Environmental Policy Institute's (AEPI) Sustain the Mission Project (SMP), which developed an analytic methodology for calculating the total ownership or fully burdened costs of fuel and water (FBCF and FBCW) in theater and the training base. The SMP methodology is an important step towards enabling Army analysts, planners, and decision makers to more fully understand and evaluate the economic, operational, logistical and environmental impacts of investing in alternative energy and water technologies and practices. A user-friendly *alpha-version* SMP Decision Support Tool was recently developed based on the SMP methodology and will soon be available Army-wide. This SMP tool enables users to calculate the FBCF and FBCW for different theater and training base scenarios; to perform "what if" analyses by changing input assumptions or parameters; and to conduct cost-benefit analyses of alternative energy or water investments. The *alpha-version* of the SMP Decision Support Tool is expected to be issued Army-wide in late fiscal year (FY) 08.

This report lays out the foundation of the *alpha-version* of the SMP Decision Support Tool; the cost components by which the FBCF and FBCW are calculated; and the assumptions used in the base case scenarios included in the Alpha SMP Tool. The SMP methodology cost components include (1) Force Protection, (2) Transport, (3) Military Energy/Water Support Personnel, (4) Energy/Water Support Materiel, (5) Sustainment Brigade/Theater Support Command, (6) Energy/Water Commodity, and (7) Garrison Facilities. The cost factors for each of these components were derived from existing Army and Department of Defense (DOD) sources. The assumptions used to derive the base case scenarios related to these cost components were developed in conjunction with HQDA, G-4.

The base case scenarios in the Alpha SMP Tool were derived to calculate the FBCF and FBCW for a Stryker Brigade Combat Team (SBCT) in a mature theater (Iraq), an immature theater, and in the training base. The assumptions in the base case scenarios can be modified in the Tool to calculate new FBCF or FBCW values based upon user requirements. For example, in the base case scenario for a mature theater (Iraq), the FBCF was calculated to be $14.13 per gallon. This FBCF value can be used for planning or analysis purposes; or the user can modify the base case assumptions (e.g., number of convoy miles) to calculate a new FBCF for a different Iraq scenario of interest.

Based upon the FBCF or FBCW calculated by the SMP Tool, the user can also conduct a cost-benefit analysis of alternative energy and water technologies. For example as a case study, the Alpha SMP Tool includes a cost-benefit analysis of investing in the Rapidly Installed Fluid Transfer System (RIFTS) for the first fuel resupply leg in the Iraq Base Case Scenario. The RIFTS Case Study reduces the FBCF by $2.79 per gallon (from $14.13 to $11.34 per gallon) – a reduction of about 20%. This equates to an FBCF reduction of about $6.5 million per year for an SBCT in this scenario. The Alpha SMP Tool allows users to define specific scenarios based on their needs and perform quick- turnaround cost-benefit analysis of alternatives to increase sustainable energy and water security in support of Army missions.

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1 Introduction

In July 2005, the Army Environmental Policy Institute (AEPI) initiated the Sustain the Mission Project (SMP) to develop and apply an analytic methodology for calculating the fully-burdened cost of fuel and water (FBCF and FBCW) to sustain Army missions in theaters of operation and in the training base. The SMP was based upon the *Army Strategy for the Environment*: *Sustain the Mission—Secure the Future*, which was signed into effect on 1 October 2004 by the Secretary of the Army and the Army Chief of Staff. The *Army Strategy for the Environment* (ASE) established sustainability policy in the Army and laid the foundation for achieving "an enduring Army enabled by sustainable operations, installations, systems, and communities."[1] The ASE's goals include: (1) Foster a Sustainability Ethic; (2) Strengthen Army Operations; (3) Meet Test, Training and Mission Requirements; (4) Minimize Impacts and Total Ownership Costs; (5) Enhance Well-Being; and (6) Drive Innovation. The SMP was originally initiated to support the fourth goal of managing and accounting for the total ownership costs of resources to sustain Army missions, but over the course of the project, it became apparent that it also tangibly supports the other 5 goals as well. Fuel and water were selected as case study resources given their criticality across mission areas.

The SMP methodology includes the costs of fuel and drinking water, equipment, personnel, inter and intra-theater transportation, and other costs related to providing fuel and drinking water to a consuming Army unit. The SMP methodology uses Army and Department of Defense (DoD) databases and processes which enable the fully burdened costs of fuel and water to be updated as data inputs are updated on a recurring basis. The SMP methodology was first demonstrated in February 2006 with illustrative calculations of FBCF and FBCW for a Stryker Brigade Combat Team (SBCT) in Southwest Asia and at a military installation in the U.S. The SMP methodology has been validated by the Office of the Deputy Assistant Secretary of the Army for Cost and Economics (DASA-CE) and complies with OSD policy on the FBCF.

1.1 Sustain the Mission Project 2 (SMP-2)

The SMP-2 project was initiated in August 2007 to use the SMP Methodology to develop a user-friendly decision support tool for calculating the FBCF and FBCW and for conducting cost-benefit analyses of energy and water investments. The "*alpha-version*" of the SMP Decision Support Tool is expected to be employed Army-wide by the Army G-4 in late FY 08. Proponency of the Sustain the Mission Project is also planned to be transferred from AEPI to HQDA G-4 in late fiscal year (FY) 2008.

1.2 Purpose

The purpose of the SMP-2 is to develop a user-friendly decision support tool for calculating and analyzing the FBCF and FBCW to support Army missions both in theater and in the training base. The *alpha-version* of the SMP Decision Support Tool also allows users to conduct FBCF- and FBCW-based cost-benefit analysis of investments in energy and water technologies and practices; and it generates outputs such as payback, net present value, reduction in supply convoys (to include force protection), and reductions in fuel consumption and greenhouse gas emissions. The SMP tool allows the user to develop and compare operational scenarios, considering the costs and benefits of technology substitution, and thereby enabling more informed decisions in planning for and investment in sustainable energy and water technologies that provide essential support to Army missions.

[1] See the full ASE document at http://www.asaie.army.mil/Public/ESOH/doc/ArmyEnvStrategy.pdf.

The *alpha-version* of the SMP tool provides a capability to analyze the FBCF and FBCW for an SBCT. This capability allows for the evaluation of base case scenarios developed during this project and allows users to modify assumptions and develop their own scenarios. The *alpha-version* also enables users to conduct cost-benefit analyses of energy- and/or water-related investments using either the base case or modified scenarios. The base case scenario assumptions and values were developed in coordination with HQDA G-4. The *alpha-version* of the SMP Tool includes the following base case scenarios:

1. Fully-burdened Cost of Fuel in Iraq;
2. Fully-burdened Cost of Fuel in an Immature Theater;
3. Fully-burdened Cost of Fuel in the Training Base;
4. Fully-burdened Cost of Drinking Water in Iraq;
5. Fully-burdened Cost of Drinking Water in an Immature Theater;
6. Fully-burdened Cost of Drinking Water in the Training Base.

Section 3 details the base case scenario assumptions and parameters.

1.3 Report Structure

The remainder of this report is organized into three sections. Section 2 provides an overview of the SMP methodology employed in the SMP Decision support Tool. Section 3 outlines all of the Base Case scenarios to include their default assumptions and values. Section 4 provides a Results Summary for all six base case scenarios developed and incorporated in the SMP tool. Appendix A illustrates the tool's capabilities with three examples: (1) calculating the FBCF in the Base Case Scenario for Iraq; (2) a cost-benefit analysis of an investment in a fuel-related technology (based on the Iraq Base Case); and (3) calculating the FBCW in the Base Case Scenario for the Training Base.

2 SMP Methodology and Cost Components

The seven cost components or categories that compose the SMP methodology are summarized in Figure 1. The SMP cost components include the materiel, personnel, commodity, transportation, and garrison resources needed to provide fuel and drinking water to sustain a Brigade Combat Team (BCT) in theater and training base missions. In the alpha-version of the SMP Decision Support Tool, these cost components were calculated to derive the FBCF and FBCW in the case of a SBCT. The FBCF and FBCW outputs of the SMP methodology are expressed in terms of dollar per gallon, per soldier and per Army unit.

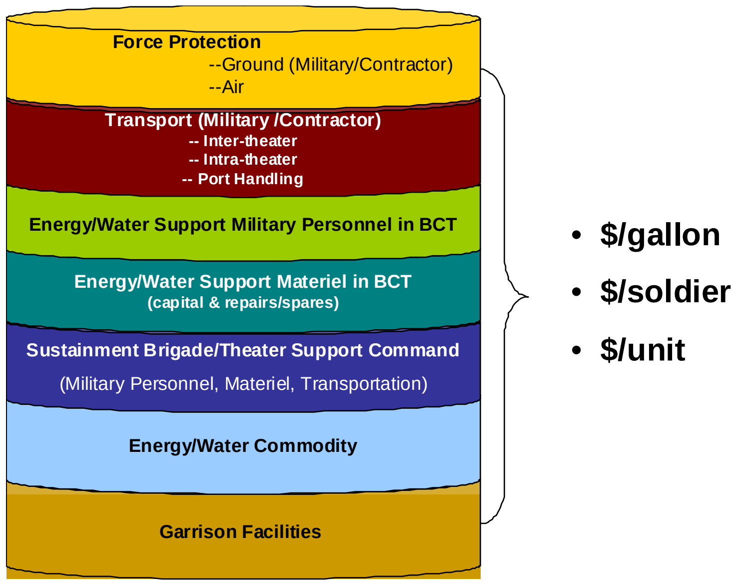


Figure 1. SMP Cost Components

2.1 Force Protection

This cost component refers to the resources needed to protect the fuel and drinking water resupply convoys in theater. For both fuel and water this component includes costs such as gun trucks (e.g., Mine Resistant Ambush Protected (MRAPs)), personnel, fuel costs, and Apache flying hours. The key data sources used to calculate this component are: gun truck costs (fuel and repairs and spares) from the Force and Organization Cost Estimation System – Cost Factors Handbook (FORCES CFH, DASA-CE); Apache fuel cost per hour (FORCES CFH); Crew pay and military pay per hour (FORCES CFH); Military pay per hour (FORCES CFH); Speed, distance, composition of convoy, and percent of convoy needing force protection are based on data from HQDA G-4, Office of Director of Supply.[2]

2.2 Transport (Military/Contractor)

2.2.1 Port Handling

Port handling costs are calculated for transferring either fuel or water support equipment, and are calculated on a per measurement-ton basis. For both fuel and water, support equipment and port handling fees are charged both at the point of embarkation (POE) and at the point of debarkation (POD). The key data sources used to calculate this cost are: total weight of water or fuel support equipment from the Operating and Support Management Information System (OSMIS) and port handling rates from FORCES CFH.

2.2.2 Inter- and Intra-Theater Transport

Inter-theater transport costs apply only to contingency operations and include the delivery of support equipment from the training base or pre-positioned inventories to the POD in theater. Intra-theater transport costs refer to resupplying units with drinking water and fuel on a recurring basis within a theater of operations. The key data sources used to calculate this cost are: total weight of water or fuel support equipment (OSMIS); shipping by sea rates (FORCES CFH); shipping by truck rates (FORCES CFH); scenario resupply mileage (HQDA G-4, Office of Director of Supply); contractor resupply truck rate

[2] These data elements were developed in conjunction with HQDA G-4, Office of Director of Supply, and provided in data sheets to the project team to include in the SMP Decision Support Tool.

(FORCES CFH); Military flying hour rate (FORCES CFH); and total commodity transported (calculated by scenario).

2.2.3 Relocation

The relocation cost component includes the costs associated with the movement of the unit within a theater after the initial deployment phase has ended. Only transport of equipment is costed out for relocation. The key data sources used to calculate this cost are: total weight of water or fuel support equipment (OSMIS) and shipping by truck rates (FORCES CFH).

2.3 Energy/Water Support Military Personnel in Brigade Combat Team (BCT)

This cost component includes the costs of military personnel in the SBCT that provide energy and drinking water services. For both fuel and water related military personnel, this component includes items such as: basic pay and allowances (BPA) and Special, Incentive, and Hazardous Duty Pays (SIH). The key data sources used to calculate this cost component are: unloaded base salary for the SBCT (FORCES CFH); Percent of Sustainment Brigade equivalent to support an SBCT from Army Training and Doctrine Command (TRADOC) SBCT Primer; loading factors (FORCES CFH Deployment pay factors); other pay adjustments (DASA CE); and number of soldiers in the SBCT from the Theater Army Authorization Document System (TAADS).

2.4 Energy/Water Support Materiel in BCT

This cost component includes the cost of materiel in the SBCT (as the case study) used to provide the fuel or drinking water commodity. For fuel this includes materiel such as refueling equipment, pipeline construction equipment, filters, hoses, storage drums, tanker trucks, and pumps and generator sets. For water this includes items such as well-drilling equipment, Reverse Osmosis Water Purification Units (ROWPUs), water quality analysis kits, pumps, chilling tanks, storage drums, and forward area distribution systems. The key data sources used to calculate are the water or fuel related support equipment in the SBCT (weight, capital and operating costs, useful life) (FORCES CFH) and fuel cost from the Defense Energy Support Center (DESC).

2.5 Sustainment Brigade/Theater Support Command

This cost component includes the military personnel and materiel resources that provide theater-level fuel and drinking water logistics support to an SBCT unit in theater. This support is provided by Sustainment Brigade and Theater Support Command (TSC) units. The key data sources used to calculate this are: Total Cost of TSC (HQDA G-4, Office of Director of Supply, and DASA-CE), Sustainment Brigade Materiel (OSMIS), and Military Personnel (TAADS);

2.6 Energy/Water Commodity

This component includes the cost per gallon of Jet Propellant 8 (standard kerosene jet fuel [JP-8]), or diesel fuel purchased by the Army from the DESC. It also includes the cost of bottled water and garrison-supplied tap water. An additional charge per gallon is added to the cost of the fuel commodity to account for environmental costs (per guidance from OSD–PAE Memo; Subject: Fully Burdened Cost of Fuel; dated July 16, 2007). The key data sources used to calculate are: Fuel Cost (DESC); commercially bottled water cost from the Multi-National Force-Iraq, Resource and Sustainment (MNF-I R&S) Food Advisor/ Oasis International Waters Inc, Product Manager, Petroleum and Water Systems (PM PAWS); Garrison water cost from the United States Forces Command (FORSCOM) Army Energy and Water Reporting System (AEWRS); and Water Bottling plant costs (operating, capital, personnel) (HQDA G-4, Office of Director of Supply, 164th Quartermaster Corps Support Group).

2.7 Garrison Facilities

The Garrison Facilities cost component applies only to the training base and includes the infrastructure used to provide fuel and drinking water services. For fuel, this includes facilities such as: Vehicle Fueling Facilities, Operating Fuel Storage, and POL (Petroleum, Oil and Lubricants) Pipelines. For drinking water, this includes facilities such as wells, water treatment facilities, and water distribution lines. The key data sources used to calculate this cost component include: DoD 2007 Facilities Pricing Guide for installation cost factors by Facility Analysis Category (FAC); Installation quantity of facilities/lines by FAC (FORSCOM, HQDA G-4, Office of Director of Supply); and Installation Fuel/Water Commodity Consumption (FORSCOM, HQDA G-4, Office of Director of Supply).

3 SMP Base Case Assumptions and Parameters

The Base Case scenario assumptions detailed below were developed and provided in data sheets in conjunction with HQDA G-4 (Director of Supply) and ODASA-CE (Unit Mission Costing Division). The Base Case scenarios reflect typical operations and conditions for an SBCT in theater and in the training base. Two theater-level Base Case Scenarios were developed: Iraq and an Immature Theater (first year of operations in a theater with little infrastructure support and no contractual support are assumed). In all theater-level scenarios (for both fuel and drinking water), Force Protection (Ground) is provided over the entire convoy distance (roundtrip); whereas Force Protection (Air) varies by scenario as shown below. The Training Base Case Scenario refers to training at Fort Lewis. Details are provided below on the individual scenario assumptions included in the Alpha SMP Tool.

3.1 Fully Burdened Cost of Fuel (FBCF) Assumptions

3.1.1 Base Case: Iraq

1. The consuming unit is a SBCT comprised of 3,972 soldiers.
2. Soldier and contractor costs are fully-loaded.
3. 1.7% of SBCT (68 soldiers within Distribution Company of the Brigade Support Battalion (BSB)) provides fuel support to SBCT.
4. One Sustainment Brigade (480 soldiers) provides theater logistics support to 10 Brigade Combat Teams (or equivalent); 5% of Sustainment Brigade personnel (24 soldiers) provide theater logistics fuel support to the SBCT.
5. 10% of fuel support equipment in Sustainment Brigade supports SBCT.
6. Fuel support equipment in SBCT and Sustainment Brigade deploy from Ft Lewis to Iraq (one-way).
7. Fuel Consumption for SBCT (2.5 mil gallon per year, 6,850 gal per day)

Fuel re-supply distances and convoy characteristics are shown for the Iraq Base Case Scenario in Table 1.

Table 1. Fuel Convoy Assumptions - Base Case Iraq

Re-supply Trip Legs	Capacity of Fuel Trucks	Type of Supply Truck Personnel	% of Trip Protected by Air	Miles (roundtrip)	Type of Gun Truck
Leg 1: Kuwait to Cedar II	8,000 gallons	100% contractor	20%	450	HMMWV [M1114]
Leg 2: Cedar II to Expeditionary Sustainment Command (ESC)	5,000 gallons	50% contractor 50% military	40%	500	HMMWV [M1114]
Leg 3: ESC to Brigade Support Battalion (BSB)	5,000 gallons	50% contractor 50% military	40%	100	MRAP
Leg 4: BSB to Consuming Unit	2,500 gallons	100% military	40%	50	MRAP

1. Fuel re-supply every other day (182 trips per year).
2. Ground convoy consists of 20 vehicles:
   a. 16 supply trucks
   b. 4 gun trucks; (4 soldiers per truck)
   c. 1 gunman per fuel truck
   d. Percent of convoy cost applied to SBCT varies by leg

   Example for Leg 1:
   - 8,000 gal x 16 trucks = 128,000 gal capacity
   - Daily fuel consumption for SBCT is 6,850 gal/day x 2 days = 13,700 gallons per trip
   - 13,700 gal/128,000 gal = 10.7% of Leg 1 cost to be allocated to SBCT
3. Air support to convoy includes 2 Apaches (AH-64D), 2 soldiers per Apache.
4. Average speed of the convoy is 35MPH.
5. SBCT relocates once within theater per year – distance is 200 miles.

3.1.2 Base Case: Immature Theater

The assumptions for the Iraq Base Case Scenario hold for the immature theater with the following exceptions:

1. Fuel support equipment in SBCT and Sustainment Brigade deploys from Ft Lewis to a port in an Immature Theater[3].
2. Re-supply is conducted 100% by military (using 5,000 gal fuel trucks, 40% of trip with air protection, and ground protection by MRAP).
3. All of the fuel is transported by ground convoys.
4. Fuel Re-supply Distances – 1,700 miles roundtrip (Port to Consuming Unit).

3.1.3 Base Case: Training Base

1. The consuming unit is comprised of 3,972 soldiers (SBCT).
2. The unit is training at Ft. Lewis.
3. All fuel consumed is provided by installation infrastructure.

[3] Note that the location of this port is notional.

3.2 Fully Burdened Cost of Water (FBCW) Assumptions

3.2.1 Base Case: Iraq

1. The consuming unit is a (SBCT) comprised of 3,972 soldiers.
2. Soldier and contractor costs are fully-loaded.
3. 1.7% of SBCT (68 soldiers within Distribution Company of the Brigade Support Battalion) provides water support to SBCT.
4. One Sustainment Brigade (480 soldiers) provides theater logistics support to 10 Brigade Combat Teams (or equivalent); 5% of Sustainment Brigade personnel (24 soldiers) provide theater logistics water support to the SBCT.
5. 10% of water support equipment in Sustainment Brigade supports SBCT.
6. Water support equipment in SBCT and Sustainment Brigade deploy from Ft Lewis to Iraq (one-way).
7. Drinking water consumption for SBCT – 31,776 liters per day at 8 liters consumed per day.

Drinking Water re-supply distances and convoy characteristics are shown for the Iraq Base Case Scenario in Table 2.

Table 2. Water Convoy Assumptions – Base Case Iraq

Re-supply Trip Legs	Capacity of Water Trucks	Type of Supply Truck Personnel	% of Trip Protected by Air	Miles (roundtrip)	Type of Gun Truck
Leg 1: Anaconda/ESC to BSB	8,400 1 liter bottles on palettes	50% contractor 50% military	40%	100	MRAP
Leg 2: BSB to Consuming Unit	8,400 1 liter bottles on palettes	100% military	40%	50	MRAP

1. Water re-supply every other day (182 trips per year).
2. Ground convoy consists of 20 vehicles:
   a. 16 supply trucks.
   b. 4 gun trucks; (4 soldiers per truck).
   c. 1 gunman per water truck.
   d. Percent of convoy cost applied to SBCT varies by leg (similar to fuel).
3. Air support to convoy includes 2 Apaches (AH-64D), 2 soldiers per Apache.
4. Average speed of the convoy is 35MPH.
5. SBCT relocates once within theater per year – distance is 200 miles.
6. Bottled drinking water is supplied by a commercial plant in theater (Anaconda); continuous operation of plant at peak load, 18 hours/day, 365 days/year.
7. Army supports commercial bottling plant with:
   a. Two 2MW diesel generators and fuel (17 year economic life).
   b. 2 water pumps.
   c. 7 MPs to protect bottling plant.
   d. Construction of 7 new wells (3 year life).
8. Each soldier consumes 8 liters of drinking water per day.

3.2.2 Base Case: Immature Theater

1. Water support equipment in SBCT and Sustainment Brigade deploys from Ft Lewis to a port in Immature Theater.
2. One half of the commercially-bottled water is transported on a C 17 and one half in ground convoys (commercially-bottled water is acquired at port).

3. Ground convoy re-supply is conducted 100% by military (using 8,400 1 liter bottles per truck, 40% of trip with air protection, and ground protection provided by MRAP).
4. Water Re-supply Distances – 1,700 miles roundtrip (Port to Consuming Unit).
5. Re-supply is conducted 100% by military.
6. SBCT (and sustainment brigade) water consumption - 90% provided by commercially-bottled water, 10% ROWPU.

3.2.3 Base Case: Training Base

1. The consuming unit is comprised of 3,972 soldiers (SBCT).
2. The unit is training at Ft. Lewis.
3. All water consumed is provided by installation infrastructure.

4 Illustration of SMP Tool Calculations and Analyses

4.1 Case Study - Fully Burdened Cost of Fuel in Iraq (Base Case)

To illustrate the types of output produced by the Alpha SMP Tool, the fully burdened cost of fuel (FBCF) results for the Base Case Scenario (Iraq) are shown below as an example. This scenario is based on the assumptions outlined in Section 3.1.1 and is included in the Alpha SMP Tool. Table 3 presents a summary of the FBCF cost component outputs in the Iraq Base Case Scenario. Appendix A describes the steps used to calculate the FBCF in the Iraq Base Case. The total FBCF calculated in the Iraq Base Case Scenario is $14.13 per gallon.

Table 3. Base Case FBCF in Theater (in Iraq)

Cost Components	Annual Cost Base Case	% of FBCF	$ Per Gallon
Force Protection (Air)	$ 5,163,788.99	15.5%	$ 2.19
Force Protection (Ground)	$ 2,823,413.83	8.5%	$ 1.20
Transport	$ 11,189,210.80	33.6%	$ 4.75
Resupply	$ 10,564,739.00	31.7%	$ 4.48
Initial Deployment	$ 579,656.31	1.7%	$ 0.25
Relocation	$ 44,815.50	0.1%	$ 0.02
Return		0.0%	$ -
Fuel Support Military Personnel in SBCT	$ 5,737,231.63	17.2%	$ 2.43
Fuel Support Equipment in SBCT	$ 432,488.07	1.3%	$ 0.18
Sustainment Brigade/TSC	$ 571,155.90	1.7%	$ 0.24
Fuel Commodity	$ 7,402,829.15	22.2%	$ 3.14

Summary Statistic	Value
FBCF Annual Cost for SBCT	$ 33,320,118
Annual Gallons Consumed by SBCT	2,357,589
FBCF per Soldier	$ 8,389
FBCF per SBCT	$ 33,320,118
FBCF per Gallon	$ 14.13

4.2 Results Discussion

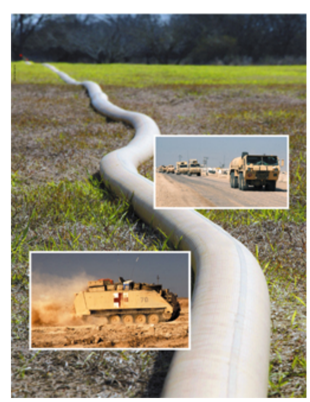
The results of the Iraq Base Case Scenario illustrate the different kinds of costs associated with delivering a gallon of fuel in Iraq. They also enable the SMP Tool user to identify the areas with the greatest potential for cost avoidance which could be tapped by deploying new technologies. In this scenario, less than one-quarter of the FBCF comes from the fuel commodity itself, whereas more than half of the FBCF (about 58%) comes from the re-supply convoys including force protection. This highlights the value added of investing in energy technologies that get "trucks off the road" to save both money and lives. The Alpha SMP Tool allows the user to modify the assumptions that compose the Iraq Base Case Scenario to derive their own scenarios based on their needs. It also allows users to conduct "what if" analysis to assess the impacts or sensitivities of changing input assumptions and parameters upon the FBCF in the Iraq Base Case Scenario. These capabilities are available for the other base case scenarios in the Alpha SMP Tool as well.

5 Cost Benefit Analysis

The cost-benefit analysis capability in the Alpha SMP Decision Support Tool allows users to evaluate either a fuel- or water-related investment using fully-burdened costs. Benefit measures include net change in FBCF or FBCW, commercial cost avoidance; reductions in logistic and force protection footprint (i.e., fuel supply trucks freed up per year, ground convoy equivalents freed up per year, Apache/C 17 hours freed up per year, gun trucks freed up per year, and reductions in fuel consumption by military/commercial resource), and reductions in greenhouse gas emissions due to reductions in fuel consumption both in the convoy and in the SBCT. In the Alpha SMP Tool, emission reductions based on a reduction in fuel consumption in the SBCT are calculated as the quantity of gallons reduced multiplied by 5.4mpg, based on diesel engine combustion of JP8 fuel (from SwRI). As data on weapon and support system fuel consumption and corresponding greenhouse gas emissions becomes available, it will be incorporated into the SMP Tool. For drinking water, impacts on the amount of waste generated from water bottle resupply are also calculated in terms of pounds of: empty bottles, shrink wrap, and pallets.

In addition to the benefit measures shown above, the Alpha SMP Tool calculates the payback (in number of years) and net present value of the investment over its useful life. The Alpha SMP Tool indicates payback and net present value results based on two approaches: 1) Commercial Cost Avoidance, and 2) Net Change in FBCF (or FBCW). The Alpha SMP Tool only shows one of these two approaches at a time in order to avoid giving the impression that benefits are counted twice.

The Commercial Cost Avoidance approach shows non-monetized and monetized commercial benefits, as well as non-monetized military benefit metrics (e.g., Apache flying hours freed up). That is, this approach does not monetize the benefits of freed-up military assets in terms of commercial cost avoidance, but rather it calculates them in terms of the quantity of military assets and services being freed up - which can be applied to other missions. The Net Change in FBCF approach shows non-monetized and monetized benefits for both commercial and military resources. Monetized values represent changes in FBCF. That is, this approach monetizes reductions in both commercial and military assets and services. In both approaches the monetized and non-monetized forms of the results characterize the same benefit – they are not additive. In other words, benefits are not double counted; they are just presented in monetized and non-monetized terms.



5.1 Case Study: Cost-Benefit Analysis of an Energy Investment - Rapidly Installed Fluid Transfer System (RIFTS) in Iraq

To illustrate the cost–benefit analysis capability in the Alpha SMP Tool, a fuel-related investment - the Rapidly Installed Fluid Transfer System (RIFTS) - was selected as a case study. The cost-benefit analysis of

RIFTS was conducted using the Iraq Base Case Scenario as a point of departure. The total FBCF in the RIFTS Scenario is $11.34 per gallon, about 20 percent less than the Iraq Base Case scenario FBCF of $14.13 dollars per gallon.

5.2 Rapidly Installed Fluid Transfer System (RIFTS)

For this case study, an alternative fuel distribution system is used to illustrate the cost-benefit capabilities of the Alpha SMP Tool. The investment evaluated is the RIFTS pictured to the right, which is a flexible conduit pipeline system possessing a throughput bulk petroleum distribution capacity of 850,000 gallons for about 100 miles per day.

In this example, RIFTS replaces the first 225 miles of the resupply convoy in the Iraq Base Case Scenario. The key investment inputs for the RIFTS Case Study included in the Alpha SMP tool were provided by HQDA G-4 (Office of the Director of Supply) and are shown in Table 4. The percent of investment allocated to the SBCT (1.52% or $3,617,135) was derived by dividing the number of gallons of fuel the SBCT consumes per day (6,459 gallons) by the daily RIFTS throughput for the first leg (425,000 gallons). Also as a result of RIFTS investment, four Petroleum Pipeline and Terminal Operating (PPTO) Companies would be replaced by four RIFTS companies. PPTO and RIFTS companies have similar force structure (military personnel and equipment) and force structure costs. Therefore, it is assumed for the purposes of this analysis, that there is no change in force structure costs between the PPTO and the RIFTS companies. However, the establishment of the RIFTS companies requires investing in the RIFTS itself, as well as several Heavy Expanded Mobility Tactical Trucks (HEMTTs). Therefore, the investment cost for the RIFTS Scenario is comprised of the costs of acquiring the RIFTS and the HEMTTs.

Table 4. RIFTS Scenario Inputs

Economic life of RIFTS	20 years
Capital Cost (includes RIFTS plus 40 HEMTTs)	$238,000,793
Percent of Capital Investment Allocated to SBCT	1.52%
Capital Cost Allocated to SBCT	3,617,135
Percent RIFTS Utilization	100.00%
Annual Operations and Maintenance Cost	$ 76,172.56

Table 5 shows the FBCF by cost component for the Iraq Base Case after installing the RIFTS. In this case the total FBCF is $11.34 per gallon compared to the total FBCF of $14.13 per gallon in the Iraq Base Case.

Table 5. Fuel in Theater (Iraq) with RIFTS Investment

Cost Components	Annual Cost Energy Investment RIFTS Analysis Case		% of FBCF	FY08 $Per Gallon	
Force Protection (Air)	$	4,299,958.12	16.1%	$	1.82
Force Protection (Ground)	$	2,067,077.83	7.7%	$	0.88
Transport	$	6,049,608.05	22.6%	$	2.57
- Resupply	$	5,425,136.24	20.3%	$	2.30
- Initial Deployment	$	579,656.31	2.2%	$	0.25
- Relocation	$	44,815.50	0.2%	$	0.02
- Return	$	-	0.0%	$	-
Fuel Support Military Personnel in SBCT	$	5,737,231.63	21.5%	$	2.43
Fuel Support Equipment in SBCT	$	432,488.07	1.6%	$	0.18
Sustainment Brigade/TSC	$	571,155.90	2.1%	$	0.24
Fuel Commodity	$	7,402,829.15	27.7%	$	3.14
Investment Cost Component	$	182,014.41	0.7%	$	0.08

Summary Statistic	Value	
FBCF Annual Cost for SBCT	$	26,742,363
Annual Gallons Consumed by SBCT		2,357,589
FBCF per Soldier	$	6,733
FBCF per Unit	$	26,742,363
FBCF per Gallon	$	11.34

5.3 Cost/Benefit Results: RIFTS Example

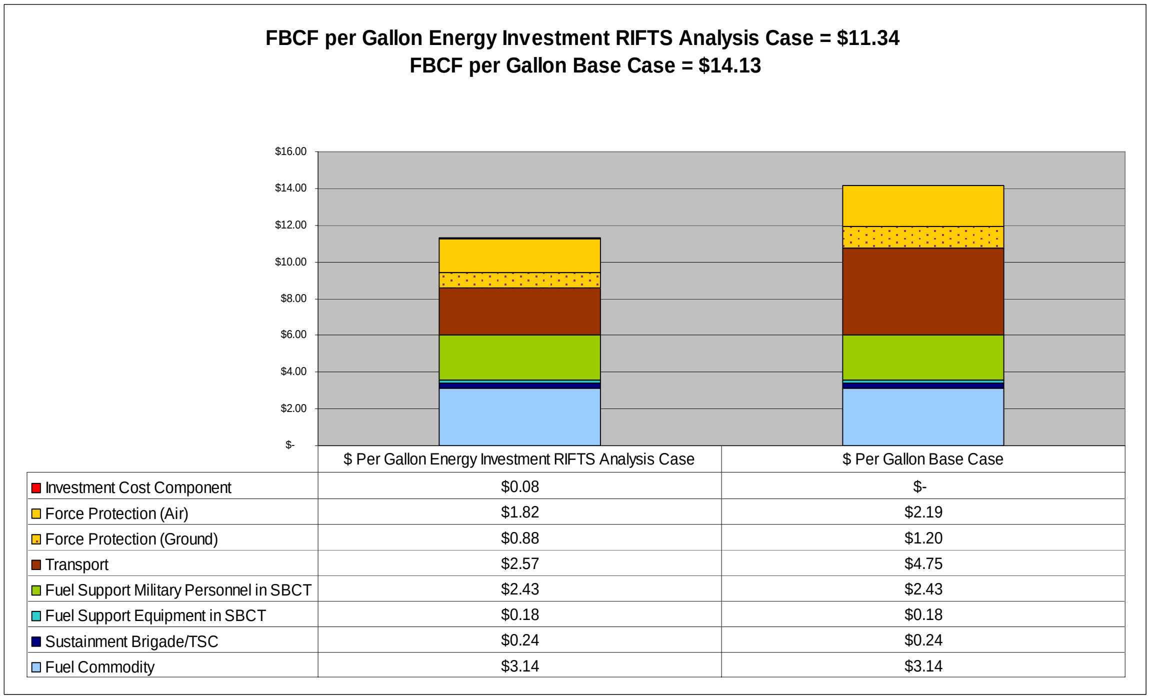
Table 6 compares the FBCF results (in terms of dollars per unit, soldier, and gallon) for the Iraq Base Case and the RIFTS Case. Figure 2 illustrates this difference graphically by cost component. In the Iraq Base Case, the FBCF is $14.13 per gallon and in the RIFTS case the FBCF is $11.34 per gallon – the reduction in FBCF is $ 2.79 per gallon (about a 20% decrease) as a result of RIFTS investment. This decrease equates to an FBCF reduction of about $6.5 million per year for an SBCT. Of the $2.79 per gallon decrease, 78% ($2.18) relates to Transport, 25% ($0.69) relates to Force Protection, and -3% ($-0.08) is due to the Investment Cost Component (which increases the FBCF).

The Alpha SMP Tool allows users to quickly compare the value added of alternative technologies using various scenarios. Based on the Commercial Cost Avoidance approach, the annual commercial cost avoidance from the RIFTS Investment is $5.1 million. The associated payback period is 0.704 years and the net present value is $69.4 million. Military benefits include 132,251 contractor fuel supply truck miles freed up, 33,063 gun truck miles freed up, and 94 Apache flying hours freed up per year. Based on the Net Change in FBCF approach, the annual Net Change in FBCF due to the RIFTS Investment is $6.6 million. The associated payback period is 0.535 years and the net present value is $92.4 million (based on monetizing both commercial and military resources).

The value added of the RIFTS investment can also be expressed in terms of ground convoy equivalents freed up, which are provided as an alternative metric to estimate the number of ground convoys (pre-investment) that would be removed from the road per year – about 18 in the RIFTS Case Study. Additionally, the annual reduction in fuel consumption due to the investment is provided; in the RIFTS example, this is the total reduction in convoy fuel consumption (53,022 gallons).

Table 6. Investment Analysis Summary – RIFTS Investment

Summary Metric	Energy Investment RIFTS Analysis Case	Base Case	Net Change
FBCF Annual Cost for SBCT	$26,742,363	$33,320,118	$(6,577,755)
Annual Gallons Consumed by SBCT	2,357,589	2,357,589	-
FBCF per Soldier	$6,733	$8,389	$(1,656)
FBCF per Unit	$26,742,363	$33,320,118	$(6,577,755)
FBCF per Gallon	$11.34	$14.13	$(2.79)



	$ Per Gallon Energy Investment RIFTS Analysis Case	$ Per Gallon Base Case
Investment Cost Component	$0.08	$-
Force Protection (Air)	$1.82	$2.19
Force Protection (Ground)	$0.88	$1.20
Transport	$2.57	$4.75
Fuel Support Military Personnel in SBCT	$2.43	$2.43
Fuel Support Equipment in SBCT	$0.18	$0.18
Sustainment Brigade/TSC	$0.24	$0.24
Fuel Commodity	$3.14	$3.14

Figure 2. Comparison of Base Case FBCF in Theater (in Iraq) to Base Case FBCF in Theater (in Iraq) with RIFTS Investment

5.4 Air Emissions Avoidance

The environmental impact of reducing the re-supply convoys for fuel delivery results in 654,644 pounds of carbon dioxide (CO_2) emissions avoided annually. These avoided emissions come from convoy miles reduced as a result of the RIFTS investment. The reduction in air emissions from resupply calculations are based on the number of miles reduced through resupply (168,620) and the factors shown in Table 7. The air emission factors shown in Table 7 are from an analysis of diesel engine combustion by the Southwest Research Institute (May 2002) and are based on a 2001 Cummins ISL 8.9 liter diesel engine. The average fuel economy of this type of engine using JP-8 was found to be 5.4 miles per gallon (MPG).

Table 7. Air Emission Factors JP-8

Pollutant	Measure	JP-8 Factor
HC	Grams/mile	1.35
CO	Grams/mile	3.0
NOX	Grams/mile	12.8
PM	Grams/mile	0.56
CO_2	Grams/mile	1,761

Source: Southwest Research Institute

6 Case Study – Fully Burdened Cost of Water in the Training Base

6.1 Overview of the FBCW Base Case Scenario for the Training Base

Table 8 illustrates the FBCW in the Base Case Scenario for the training base. For this example the training base location is Fort Lewis, Washington. The assumptions used to derive this scenario can be found in Section 3.2.3. The table contains a summary of the FBCW in the training base by cost component. The total FBCW in the training base (Ft Lewis) in this scenario is $1.66 per gallon. About 97 percent of the FBCW in this scenario is related to the SBCT personnel that provide water support services to the soldiers in their unit. Since the drinking water provided to the soldiers is from the tap (as opposed to bottled water) the commodity cost is very inexpensive. The cost to sustain the SBCT's share (about .2% as shown in the Tool) of the installation infrastructure cost for supplying drinking water is also very low. Water infrastructure in this scenario includes water pump facilities, distribution lines, storage and wells.

Table 8. Base Case FBCW Scenario (Training Base)

Cost Components	Annual Cost Modified Case (Training Base)	% of FBCF	$ Per Gallon
Water Support Military Personnel in SBCT	$ 4,963,470.48	97.329%	$ 1.6200
Water Support Equipment in SBCT	$ 132,665.28	2.601%	$ 0.0432
Installation Infrastructure	$ 1,125.28	0.022%	$ 0.0004
Water Commodity	$ 2,403.72	0.047%	$ 0.0008

Summary Statistic	Value
FBCW Annual Cost for SBCT	$ 5,099,665
Annual Gallons Consumed by SBCT	3,063,931
FBCW per Soldier	$ 1,284
FBCW per SBCT	$ 5,099,665
FBCW per Gallon	$ 1.66

7 Results Summary: Alpha SMP Tool Base Case Scenarios

As described above, each base case scenario is based on a unique set of default parameters and assumptions; and each scenario generates unique results as shown in Table 9. For example, the FBCF in an Immature Theater Scenario is $17.44/gallon as compared with the FBCF of $14.13/gallon in the Iraq Theater Scenario. The Immature Theater Scenario assumes a longer resupply trip; and as a result, its Force Protection (both Air and Ground) cost component is greater than in the Iraq theater scenario. The increase in the Force Protection cost component accounts for the majority of the difference between the two scenarios. The FBCF in the Training Base is $15.27. This is higher on a per gallon basis when compared to the FBCF in Iraq primarily because there is a large fixed cost associated with fuel related services (e.g. personnel) that is allocated over a significantly smaller number of gallons consumed.

Table 9. Summary of SMP Tool Results for Fuel and Water ($/gallon)

Commodity	In Theater (Iraq)	In Theater (Immature Theater)	Training Base
Fully-Burdened Cost of Fuel	$14.13	$17.44	$15.27
Fully-Burdened Cost of Drinking Water	$5.42	$16.76	$1.66

Similarly, the fully-burdened cost of drinking water in the Iraq scenario is $5.42/gallon. One key assumption underlying this cost is that 90 percent of the drinking water consumed by the SBCT comes from the Anaconda bottling plant at a commodity cost of $1.38/gallon. Additionally, the resupply distance from the bottling plant to the consuming unit is 550 miles round trip. However, in the Immature Theater scenario, the commodity cost of water is assumed to be purchased in 1-liter bottles at a cost of $1.25/liter (or $4.26/gallon). Another difference is that the resupply distance in the Immature Theater scenario is assumed to be 1,700 miles round trip. The increase in commodity cost coupled with the increase in miles (which increases both transport and force protection costs) results in a FBCW of $16.76.

The particular steps used to calculate fully burdened costs for fuel and drinking water are shown in Appendix A for the following three examples:

1. Case Study - Fully Burdened Cost of Fuel in Iraq (Base Case)
2. Case Study - Cost-Benefit Analysis of Energy Investment (Rapidly Installed Fluid Transfer System (RIFTS) Analysis Case-Iraq)
3. Case Study - Fully Burdened Cost of Water in the Training Base

8 Recommendations

The Alpha SMP Decision Support Tool developed during the SMP II Project provides an operational capability to calculate the FBCF and the FBCW and conduct cost-benefit analysis for energy and water investments. The Alpha Tool is limited to calculating the FBCF and FBCW in the case of an SBCT for selected scenarios. It also includes only one example of a cost-benefit analysis - RIFTS. Based upon discussions with Army personnel, there is interest in expanding the capabilities of the SMP Tool to include the following features:

- Model additional Army units in addition to the SBCT (derive and incorporate data on other units such as the Heavy BCT and Infantry BCT)
- Include additional Army installations and ports (besides Fort Lewis and Seattle)

- Add capability to calculate FBCF per weapon system (express FBCF and FBCW results in terms of dollars per weapon system, currently only dollars per gallon, soldier, and SBCT are generated)
- Collect and incorporate data on additional energy and water investments (develop an inventory of existing and emerging energy and water technology data that could be shared Army-wide)
- Develop additional scenarios (include small, medium and large scale combat and non-combat contingency operations – both overseas and in the U.S)

Furthermore, potential users of the SMP Tool have expressed interest in more formalized training on how to use the Tool; exploring the different kinds of analysis that could be done; and providing feedback on areas for improvement and additional capabilities that should be added to the Tool.

9 Conclusion

The Army developed and demonstrated the SMP Methodology in FY06 to calculate the fully burdened costs of fuel and water to sustain Army missions. This methodology uses existing Army and DoD sources of data; readily allows cost updates and “what if” drills; and has been validated by ODASA-Cost and Economics. It also facilitates implementation of the Army Strategy for the Environment; complies with OSD policy on FBCF; and has been acknowledged for its advances in fully-burdened cost of fuel analysis in the recently published DSB Report on Energy Strategy.

A user friendly Alpha SMP Decision Support Tool was recently developed and is expected to be issued for Army-wide use in late fiscal year (FY) 2008. The Alpha SMP Tool calculates the FBCF and FBCW for selected theater and training base scenarios (already incorporated in the Tool); and can also be used to calculated FBCF and FBCW for user-defined scenarios. The Alpha Tool also enables cost-benefit analysis of investments in alternative energy and water technologies – an example of an energy technology cost-benefit analysis is incorporated in the Tool. As indicated in the section above, the capabilities of the Alpha Tool should be expanded to meet the growing analytical and planning needs of the Army regarding energy and water decisions.

OSD has directed DoD agencies to use FBCF in support of trade-off analysis and planning for acquisition, logistics, and other resource decision making processes. Using FBCF is also recommended by the Defense Science Board Task Force on Energy Strategy. The Alpha SMP Decision Support Tool is an existing way to consistently implement DoD FBCF policy; while allowing users to tailor their analysis to meet their individual needs.

Appendix A
Illustration of Alpha SMP Tool Calculations and Analyses

Preface

This appendix provides an illustration of the Alpha SMP Tool calculations and analyses. To illustrate the SMP methodology, the steps used to calculate the fully burdened costs of fuel and drinking water; and to conduct a cost-benefit analysis are shown below for the following examples:

1. Case Study - Fully Burdened Cost of Fuel in Iraq (Base Case)
2. Case Study - Cost-Benefit Analysis of Energy Investment (Rapidly Installed Fluid Transfer System (RIFTS) in Iraq)
3. Case Study - Fully Burdened Cost of Drinking Water in the Training Base

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1 Illustration of Alpha SMP Tool Calculations and Analyses: Fully Burdened Cost of Fuel

1.1 Case Study - Fully Burdened Cost of Fuel in Iraq (Base Case)

To illustrate the SMP methodology, the steps used to calculate the fully burdened cost of fuel (FBCF) in the Base Case Scenario for Iraq are shown below as an example. This scenario is based on the assumptions outlined in Section 3.1.1 in the main body of the report. Table 1 below contains a summary table of the FBCF results by cost component in the Iraq Base Case. Figure 1 below contains the same data as Table 1 in graphical form. The total FBCF in Theater (Iraq) in this case study is $14.13 per gallon.

Table A-1. Base Case FBCF in Theater (in Iraq)

Cost Components	Annual Cost Base Case	% of FBCF	$ Per Gallon
Force Protection (Air)	$ 5,163,788.99	15.5%	$ 2.19
Force Protection (Ground)	$ 2,823,413.83	8.5%	$ 1.20
Transport	$ 11,189,210.80	33.6%	$ 4.75
Resupply	$ 10,564,739.00	31.7%	$ 4.48
Initial Deployment	$ 579,656.31	1.7%	$ 0.25
Relocation	$ 44,815.50	0.1%	$ 0.02
Return		0.0%	$ -
Fuel Support Military Personnel in SBCT	$ 5,737,231.63	17.2%	$ 2.43
Fuel Support Equipment in SBCT	$ 432,488.07	1.3%	$ 0.18
Sustainment Brigade/TSC	$ 571,155.90	1.7%	$ 0.24
Fuel Commodity	$ 7,402,829.15	22.2%	$ 3.14

Summary Statistic	Value
FBCF Annual Cost for SBCT	$ 33,320,118
Annual Gallons Consumed by SBCT	2,357,589
FBCF per Soldier	$ 8,389
FBCF per SBCT	$ 33,320,118
FBCF per Gallon	$ 14.13

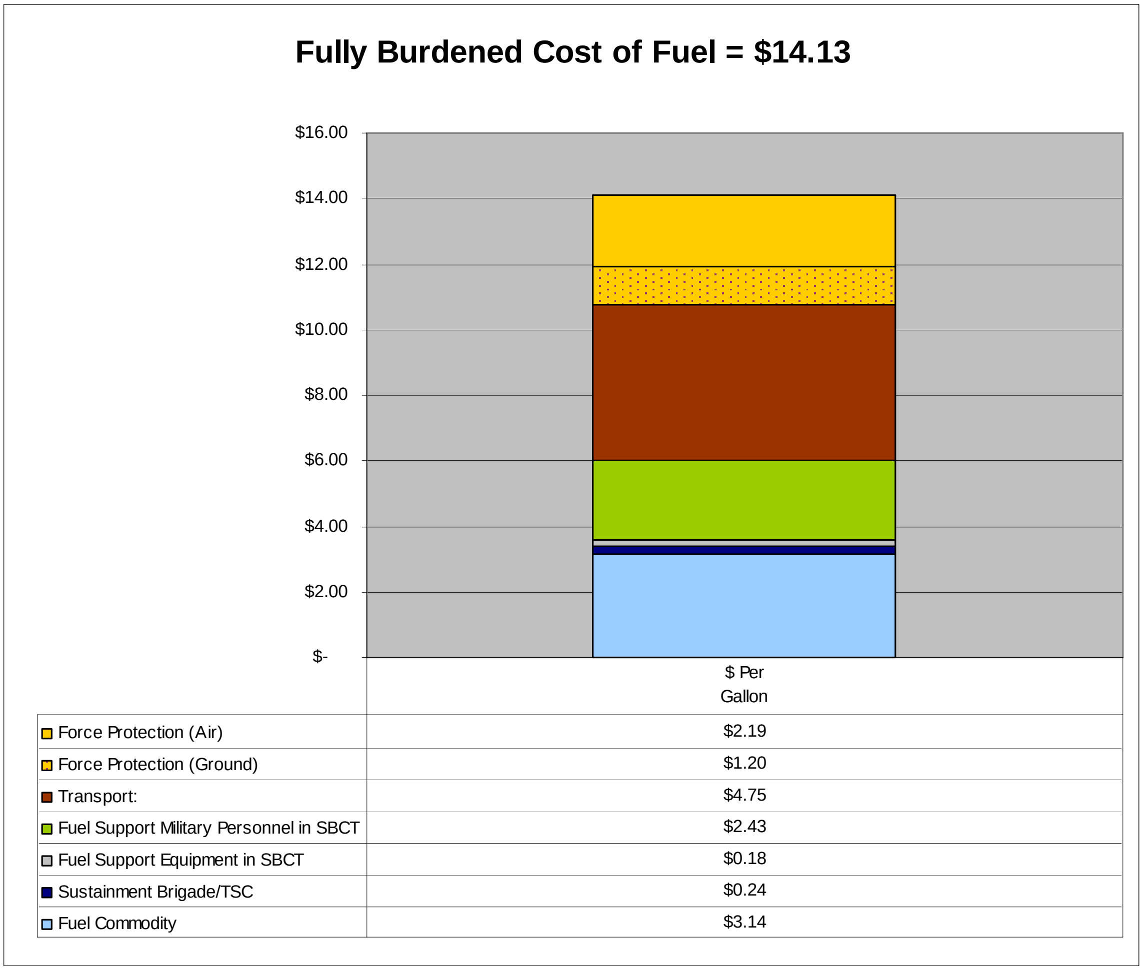


Figure A-3. Base Case FBCF in Theater (in Iraq)

Below is an explanation of the key steps and calculations by cost component for this scenario.

1.1.1 Force Protection (Air)

Force Protection (Air) costs are calculated by taking the hours per convoy per year (convoy speed is assumed to be 35 mph) times the sum of 1) the fuel cost per hour of escort, and 2) the DOD rate for Other Flying Costs per Hour of escort (excluding fuel). For Leg 1 this is [4,680 * (256.00 + 8,131)]. Personnel costs, the product of hours per convoy per year (assume convoy speed is 35 mph), crew pay per hour, and the number of air personnel or [4,680 * 136 * 4], are then added. The results represent the total Force Protection (Air) costs associated with 100% protection over each leg of the resupply, or $41,797,080 for Leg 1. This calculation is repeated for all of the other legs in this scenario. Then, for each leg, the value from the previous calculation (where Force Protection (Air) is assumed to provide 100% of the hours per convoy per year) is multiplied by the percent of trip protected (20% of the hours per convoy per year in this scenario) and the percent of convoy costs allocated to the SBCT (10%), resulting in $843,667 for Leg 1. All 4 legs sum to the value $5,043,255. The total is then multiplied by an inflation factor to show FY08$, resulting in the value $5,163,789.

The Force Protection (Air) cost component divided by FBCF Annual Cost for SBCT results in a percentage, 15.5%. This is then multiplied by FBCF per Gallon, $14.13, to yield the $/gallon associated with this metric, $2.19.

1.1.2 Force Protection (Ground)

Force Protection (Ground) costs are calculated as the sum of 1) total gun-truck fuel and O&M costs per mile, multiplied by both the number of miles and by the number of gun-trucks, and 2) the total convoy truck force protection personnel salary cost per year for each resupply leg, calculated as crew pay per hour times the number of convoy hours per year times the number of people. In Leg 1 these values are as [$1,497,132 + $5,822,040] respectively, for a total of $7,319,172. This value is then multiplied by the percent of convoy allocated to the SBCT (10%), resulting in the value of $738,682 for Leg 1. All 4 legs sum to the total $2,757,509. The total is then multiplied by an inflation factor to show FY08$, resulting in the value $2,823,414.

The Force Protection (Ground) cost component divided by FBCF Annual Cost for SBCT results in a percentage, 8.5%. This is then multiplied by FBCF per Gallon, $14.13, to yield the $/gallon associated with this metric, $1.20.

1.1.3 Transport

This metric is calculated as the sum of 4 other metrics (Resupply, Initial Deployment, Relocation, and Return). The Transport cost component divided by FBCF Annual Cost for SBCT results in a percentage, 33.6%. This is then multiplied by FBCF per Gallon, $14.13, to yield the $/gallon associated with this metric, $4.75. See below for details:

Resupply

This metric measures the cost of transporting fuel by Contractors and/or the Military to resupply an SBCT in theater . For Leg 1, the percent of the resupply trip contractors are used (100%) is factored in, as is the percent military resources relied upon (0%). This calculation also factors in fuel commodity weight required for a two-day supply, the resupply distance, and shipping rates. The calculation then determines the costs allocated to Contractors and the Military by taking the product of the following factors: 1) weight of a 1-day fuel supply in short tons; 2) the number of miles roundtrip; 3) the contractor truck rate; 4) 2 days; and 5) the percent contractor use; and the product of 1) the weight of a 1-day fuel supply in short tons; 2) the number of miles roundtrip; 3) the military truck rate; 4) 2 days; and 5) the percent military use, respectively. The values for leg 1 are [26.93 * 450 * 1.110 * 2]*100% + [26.93 * 450 * 0.555 * 2]*0%, resulting in the values $26,907 and $0, respectively. Both values are then multiplied by the number of roundtrips per year (182) and are added together, resulting in the value $4,897,203. The sum for all 4 legs is $10,318,135. The total is then multiplied by an inflation factor to show FY08$, resulting in the value $10,564,739.

The Resupply cost component divided by FBCF Annual Cost for SBCT results in a percentage, 31.7%. This is then multiplied by FBCF per Gallon, $14.13, to yield the $/gallon associated with this metric, $4.48.

Initial Deployment

This calculation aggregates transport costs for all petroleum, oil, and lubricant (POL) and generator set (GEN-SETS) items deployed from the U.S. to the point of usage in the Iraq theater. For each item, the calculation is the sum of 1) port handling costs in the U.S. plus port handling costs in the Persian Gulf, multiplied by an inflation factor, the 2) the total inter-theater deployment transport cost from the U.S. to Iraq (excluding port handling costs), and 3) the total intra-theater initial deployment transport cost in Iraq. For Leg 1, the calculation is [(24.67 + 19.49)*1.025 + 1727.40 + 769.23]. The total for all 4 POL item legs is $530,770. The total for all 4 GEN-SETS legs is $35,355. The grand total is $566,125. That grand total is then multiplied by an inflation factor to show FY08$, resulting in the value $579,656.

The Initial Deployment cost component divided by FBCF Annual Cost for SBCT results in a percentage, 1.7%. This is then multiplied by FBCF per Gallon, $14.13, to yield the $/gallon associated with this metric, $0.25.

Relocation

This calculation aggregates transport costs for all POL and GEN-SETS items relocated within the theater. For each item, the calculation is a product of the truck shipping rate per mile in the Persian Gulf and the distance in miles for one relocation, in theater, per year. The total for all POL items, $39,979, plus the total for all GEN-SETS, $3,790, represents the relocation cost for all materiel in the SBCT. The total is then multiplied by an inflation factor to show FY08$, resulting in the value $44,816.

The Relocation cost component divided by FBCF Annual Cost for SBCT results in a percentage, 0.1%. This is then multiplied by FBCF per Gallon, $14.13, to yield the $/gallon associated with this metric, $0.02.

Return

This element of the calculation was not applied in this scenario and does not influence any cost per gallon metrics.

1.1.4 Fuel Support Military Personnel in SBCT

The fully loaded base salary is calculated as full salary [($320,601,346) * 1.7%] to represent the fuel services allocation to an SBCT unit, resulting in $5,450,223. This value is increased by the CFH Military Pay Raise Factor for FY07 (2.2%) to yield a total salary of $5,570,128. The total is then multiplied by a pay raise factor to show FY08$, resulting in the value $5,737,232.

The Fuel Support Military Personnel in SBCT cost component divided by FBCF Annual Cost for SBCT results in a percentage, 17.2%. This is then multiplied by FBCF per Gallon, $14.13, to yield the $/gallon associated with this metric, $2.43.

1.1.5 Fuel Support Equipment in SBCT

The Fuel Support Equipment in SBCT is the sum of materiel capital costs and costs associated with repairs & spare parts for POL items and GEN-SETS. The value for POL items is calculated as the repairs/spares total value of $60,993 plus the total annual capital cost of $201,279 for a total of $262,273. Similar costs comprise the GEN-SETS value of $160,119. The sum of these two figures, $422,393, represents the total cost of fuel support equipment in the SBCT. That total is then multiplied by an inflation factor to show FY08$, resulting in the value $432,488.

The Fuel Support Equipment in SBCT cost component divided by FBCF Annual Cost for SBCT results in a percentage, 1.3%. This is then multiplied by FBCF per Gallon, $14.13, to yield the $/gallon associated with this metric, $0.18.

1.1.6 Sustainment Brigade/TSC

This calculation takes 10% of costs allocated to the Sustainment Brigade in support of the SBCT unit ($449,739) plus the TSC Cost ($108,084) for an annual cost of $557,824. The total is then multiplied by an inflation factor to show FY08$, resulting in the value $571,156.
The Sustainment Brigade/TSC cost component divided by FBCF Annual Cost for SBCT results in a percentage, 1.7%. This is then multiplied by FBCF per Gallon, $14.13, to yield the $/gallon associated with this metric, $0.24.

1.1.7 Fuel Commodity

The total annual cost fuel per SBCT unit is calculated by multiplying the fuel price for JP-8 fuel (including $0.10/gallon for environmental costs per OSD guidance) of $3.14 by the total gallons of fuel consumed per SBCT unit (2,357,589), yielding $7,402,829.

The Fuel Commodity cost component divided by FBCF Annual Cost for SBCT results in a percentage, 22.2%. This is then multiplied by FBCF per Gallon, $14.13, to yield the $/gallon associated with this metric, $3.14.

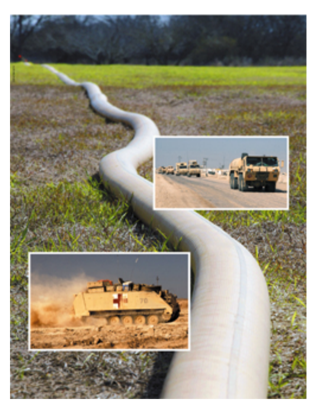
2 Cost-Benefit Analysis: Energy Investment

The cost-benefit analysis capability in the Alpha SMP Decision Support Tool allows users to evaluate either a fuel- or water-related investment using fully-burdened costs. Benefit measures include net change in FBCF or FBCW; commercial cost avoidance; reductions in logistic and force protection footprint (i.e., fuel supply trucks freed up per year, ground convoy equivalents freed up per year, Apache/C 17 hours freed up per year, gun trucks freed up per year, and reductions in fuel consumption by military/commercial resource); and reductions in greenhouse gas emissions due to reductions in fuel consumption both in the convoy and in the SBCT. In the Alpha SMP Tool, emission reductions based on a reduction in fuel consumption in the SBCT are calculated as the quantity of gallons reduced multiplied by 5.4mpg, based on diesel engine combustion of JP8 fuel (SwRI). As data on weapon and support system fuel consumption and corresponding greenhouse gas emissions become available, they will be incorporated into the SMP Tool. For drinking water, impacts on the amount of waste generated from water bottle resupply are also calculated in terms of pounds of: empty bottles, shrink wrap, and pallets.

In addition to the benefit measures shown above, the Alpha SMP Tool calculates the payback (in number of years) and net present value of the investment over its useful life. The Alpha SMP Tool indicates payback and net present value results based on two approaches: 1) Commercial Cost Avoidance, and 2) Net Change in FBCF (or FBCW). The Alpha SMP Tool only shows one of these two approaches at a time in order to avoid giving the impression that benefits are counted twice.

The Commercial Cost Avoidance approach shows non-monetized and monetized commercial benefits, as well as non-monetized military benefit metrics (e.g., Apache flying hours freed up). That is, this approach does not monetize the benefits of freed-up military assets in terms of commercial cost avoidance, but rather it calculates them in terms of the quantity of military assets and services being freed up - which can be applied to other missions. The Net Change in FBCF approach shows non-monetized and monetized benefits for both commercial and military resources. Monetized values represent changes in FBCF. That is, this approach monetizes reductions in both commercial and military assets and services. In both approaches the monetized and non-monetized forms of the results characterize the same benefit – they are not additive. In other words, benefits are not double counted; they are just presented in monetized and non-monetized terms.

2.1 Case Study - Cost-Benefit Analysis of Energy Investment (Rapidly Installed Fluid Transfer System (RIFTS) in Iraq)



To illustrate the cost –benefit analysis capability in the alpha SMP Tool, a fuel-related investment - the Rapidly Installed Fluid Transfer System (RIFTS) - was selected as a case study. The cost-benefit analysis of RIFTS was conducted using the Iraq Base Case Scenario as a point of departure. The total FBCF in the RIFTS Case Study is

$11.34 per gallon, about 20 percent less than the Iraq Base Case scenario FBCF of $14.13 dollars per gallon.

The assumptions and scenario inputs used to derive the RIFTS Case Study can be found in Table 2 below. Table 3 below contains a summary of the FBCF results in the RIFTS Case Study by cost component. Figure 2 below contains the same data as Table 3 shown in graphical form.

2.2 Rapidly Installed Fluid Transfer System (RIFTS)

For this case study, an alternative fuel distribution system is used to illustrate the cost-benefit capabilities of the Alpha SMP Tool. The investment evaluated is the RIFTS, which is a flexible conduit pipeline system possessing a throughput bulk petroleum distribution capacity of 850,000 gallons for about 100 miles per day. In this example, RIFTS replaces the first 225 miles of the resupply convoy in the Iraq Base Case Scenario. The key investment inputs for the RIFTS Case Study included in the SMP tool were provided by HQDA G-4 (Office of the Director of Supply) and are shown in Table 4. The percent of investment allocated to the SBCT (1.52% or $3,617,135) was derived by dividing the number of gallons of fuel the SBCT consumes per day (6,459 gallons) by the daily RIFTS throughput for the first leg (425,000 gallons). Also as a result of RIFTS investment, four Petroleum Pipeline and Terminal Operating (PPTO) Companies would be replaced by four RIFTS companies. PPTO and RIFTS companies have similar force structure (military personnel and equipment) and force structure costs. Therefore, it is assumed for the purposes of this analysis, that there is no change in force structure costs between the PPTO and the RIFTS companies. However, the establishment of the RIFTS companies requires investing in the RIFTS itself, as well as several Heavy Expanded Mobility Tactical Trucks (HEMTTs). Therefore, the investment cost for the RIFTS Scenario is comprised of the costs of acquiring the RIFTS and the HEMTTs. The key investment inputs used are shown in Table 2 below.

Table A-2. RIFTS Case Study Inputs

Economic life of RIFTS	20 years
Capital Cost (includes RIFTS plus 40 HEMTTs)	$238,000,793
Percent of Investment Allocated to SBCT	1.52%
Capital Cost Allocated to SBCT	3,617,135
Percent RIFTS Utilization	100.00%
Annual Operations and Maintenance Cost	$ 76,172.56

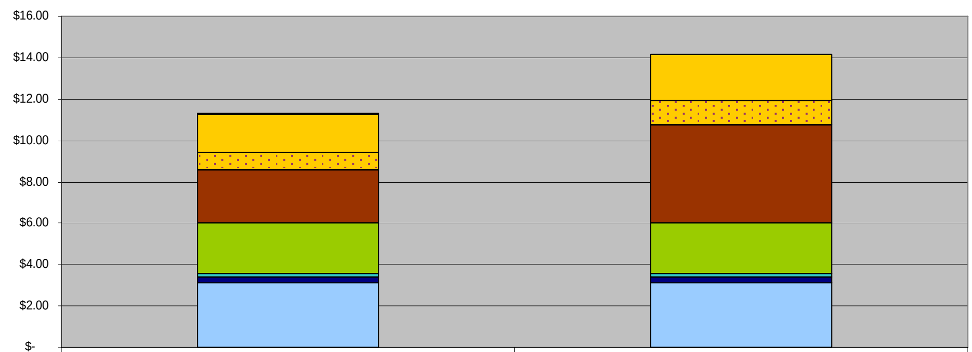
Table A-3. Base Case FBCF in Theater (in Iraq) with RIFTS Investment

Cost Components	Annual Cost Energy Investment RIFTS Analysis Case		% of FBCF	FY08 $Per Gallon	
Force Protection (Air)	$	4,299,958.12	16.1%	$	1.82
Force Protection (Ground)	$	2,067,077.83	7.7%	$	0.88
Transport	$	6,049,608.05	22.6%	$	2.57
- Resupply	$	5,425,136.24	20.3%	$	2.30
- Initial Deployment	$	579,656.31	2.2%	$	0.25
- Relocation	$	44,815.50	0.2%	$	0.02
- Return	$	-	0.0%	$	-
Fuel Support Military Personnel in SBCT	$	5,737,231.63	21.5%	$	2.43
Fuel Support Equipment in SBCT	$	432,488.07	1.6%	$	0.18
Sustainment Brigade/TSC	$	571,155.90	2.1%	$	0.24
Fuel Commodity	$	7,402,829.15	27.7%	$	3.14
Investment Cost Component	$	182,014.41	0.7%	$	0.08

Summary Statistic	Value	
FBCF Annual Cost for SBCT	$	26,742,363
Annual Gallons Consumed by SBCT		2,357,589
FBCF per Soldier	$	6,733
FBCF per Unit	$	26,742,363
FBCF per Gallon	$	11.34

Figure A-2. Comparison of Base Case FBCF in Theater (in Iraq) to Base Case FBCF in Theater (in Iraq) with RIFTS Investment

FBCF per Gallon Energy Investment RIFTS Analysis Case = $11.34
FBCF per Gallon Base Case = $14.13



	$ Per Gallon Energy Investment RIFTS Analysis Case	$ Per Gallon Base Case
Investment Cost Component	$0.08	$-
Force Protection (Air)	$1.82	$2.19
Force Protection (Ground)	$0.88	$1.20
Transport	$2.57	$4.75
Fuel Support Military Personnel in SBCT	$2.43	$2.43
Fuel Support Equipment in SBCT	$0.18	$0.18
Sustainment Brigade/TSC	$0.24	$0.24
Fuel Commodity	$3.14	$3.14

2.2.1 Force Protection (Air)

For the RIFTS Case Study, Force Protection (Air) costs are $0 for Leg 1 due to the addition of RIFTS. However, the other three legs still have Force Protection (Air) costs associated with them. Force Protection (Air) costs are calculated by taking the hours per convoy per year (convoy speed is assumed to be 35 mph) times the sum of 1) the fuel cost per hour of escort, and 2) the DOD rate for Other Flying Costs per Hour of escort (excluding fuel). For Leg 1 this is [0 * (256.00 + 8,131)]. Personnel costs, the product of hours per convoy per year (assume convoy speed is 35 mph), crew pay per hour, and the number of air personnel or [0 * 136 * 0] are then added.

The results represent the total Force Protection (Air) costs associated with 100% protection over each leg of the resupply, or $0 for Leg 1. This calculation is repeated for all of the other legs in this scenario. Then, for each leg, the value from the previous calculation (where Force Protection (Air) is assumed to provide 100% of the hours per convoy per year) is multiplied by the percent of trip protected (20% of the hours per convoy per year) and the percent of convoy costs allocated to the SBCT (10%), resulting in $0 for Leg 1. All 4 legs sum to the value $4,199,588. The total is then multiplied by an inflation factor to show FY08$, resulting in the value $4,299,958.

The Force Protection (Air) cost component divided by FBCF Annual Cost for SBCT results in a percentage, 16.1%. This is then multiplied by the total FBCF per Gallon, $11.34, to yield the $/gallon associated with this metric, $1.82.

2.2.2 Force Protection (Ground)

In the RIFTS Case Study, military personnel in the RIFTS companies provide security of the RIFTS, therefore there are no additional costs for Force Protection (Ground) that result from investing in RIFTS for the first leg. However, the other three legs still have Force Protection (Ground) costs associated with them. Force Protection (Ground) costs are calculated as the sum of 1) total gun-truck fuel and O&M costs per mile, multiplied by both the number of miles and by the number of gun-trucks, and 2) the total convoy truck force protection personnel salary cost per year for each resupply leg, calculated as crew pay per hour times the number of convoy hours per year times the number of people. In Leg 1 these values are $0 and $0, respectively, for a total of $0. This value is then multiplied by the percent of convoy allocated to SBCT (10%), resulting in the value of $0 for Leg 1. All 4 legs sum to the total $2,018,828. The total is then multiplied by an inflation factor to show FY08$, resulting in the value $2,067,078.

The Force Protection (Ground) cost component divided by FBCF Annual Cost for SBCT results in a percentage, 7.7%. This is then multiplied by FBCF per Gallon, $11.34, to yield the $/gallon associated with this metric, $0.88.

2.2.3 Transport

This metric is calculated as the sum of 4 other metrics (Resupply, Initial Deployment, Relocation, and Return). The Transport cost component divided by FBCF Annual Cost for SBCT results in a percentage, 22.6%. This is then multiplied by FBCF per Gallon, $11.34, to yield the $/gallon associated with this metric, $2.57. See below for details:

Resupply

This metric measures the cost of transporting fuel by Contractors and/or the Military to resupply the SBCT in theater. For Leg 1, the percent of the resupply trip contractors are used (0%) is factored in, as is the percent military resources relied upon (0%) in the RIFTS Case Study. This calculation also factors in commodity weight required for a two-day supply, the resupply distance, and shipping rates. The calculation then determines the costs allocated to Contractors and the Military by taking the product of the following factors: 1) weight of a 1-day fuel supply in short tons; 2) the number of miles roundtrip; 3) the contractor truck rate; 4) 2 days; and 5) the percent contractor use; and the product of 1) the weight of a 1-day fuel supply in short tons; 2) the number of miles roundtrip; 3) the military truck rate; 4) 2 days; and 5) the percent military use, respectively. The values for LEG 1 are [26.93 * 0 * 1.110 * 2] * 0% + [26.93 * 0 * 0.555 * 2] * 0%, resulting in the values $0 and $0, respectively. Both values are then multiplied by the number of roundtrips per year (182) and are added together, resulting in the value of $0. The sum for all 4 legs is $5,298,502. The total is then multiplied by an inflation factor to show FY08$, resulting in the value $5,425,136. This compares with the sum in the BASE case scenario of $10,564,739.

The Resupply cost component divided by FBCF Annual Cost for SBCT results in a percentage, 20.3%. This is then multiplied by FBCF per Gallon, $11.34, to yield the $/gallon associated with this metric, $2.30.

Initial Deployment

This calculation aggregates transport costs for all petroleum, oil, and lubricant (POL) and generator sets (GEN-SETS) items deployed from the U.S. to the point of usage in the Iraq theater. For each item, the calculation is the sum of 1) port handling costs in the U.S. plus port handling costs in the Persian Gulf, multiplied by an inflation factor, the 2) the total inter-theater deployment transport cost from the U.S. to Iraq (excluding port handling costs), and 3) the total intra-theater deployment transport cost in Iraq. For Leg 1, the calculation is [(24.67 + 19.49) * 1.025 + 1727.40 + 769.23]. The total for all 4 POL legs is $530,771. The total for all 4 GEN-SETS legs is $35,355. The grand total is $566,126. The total is then multiplied by an inflation factor to show FY08$, resulting in the value $579,656.

The Initial Deployment cost component divided by FBCF Annual Cost for SBCT results in a percentage, 2.2%. This is then multiplied by FBCF per Gallon, $11.34, to yield the $/gallon associated with this metric, $0.25.

<u>Relocation</u>

This calculation aggregates transport costs for all POL and GEN-SETS items relocated within the theater. For each item, the calculation is a product of the truck shipping rate per mile in the Persian Gulf and the distance in miles for one relocation, in theater, per year. The total for all POL items, $39,979, plus the total for all GEN-SETS, $3,790, represents the relocation cost for all materiel in the SBCT. The total is then multiplied by an inflation factor to show FY08$, resulting in the value $44,816.

The Relocation cost component divided by FBCF Annual Cost for SBCT results in a percentage, 0.2%. This is then multiplied by FBCF per Gallon, $11.34, to yield the $/gallon associated with this metric, $0.02.

<u>Return</u>

This element of the calculation was not applied in this scenario and does not influence any cost per gallon metrics.

2.2.4 Fuel Support Military Personnel in SBCT

The fully loaded base salary is calculated as full salary [($320,601,346) * 1.7%] to represent the fuel services allocation to an SBCT unit, resulting in $5,450,223. This value is increased by the CFH Military Pay Raise Factor for FY07 (2.2%) to yield a total salary of $5,570,128. The total is then multiplied by a pay raise factor to show FY08$, resulting in the value $5,737,232.

The Fuel Support Military Personnel in SBCT cost component divided by FBCF Annual Cost for SBCT results in a percentage, 21.5%. This is then multiplied by FBCF per Gallon, $11.34, to yield the $/gallon associated with this metric, $2.43.

2.2.5 Fuel Support Equipment in SBCT

The Fuel Support Equipment in SBCT is the sum of materiel capital costs and costs associated with repairs & spare parts for POL items and GEN-SETS. The value for POL items is calculated as the repairs/spares total value of $60,993 plus the total annual capital cost of $201,279 for a total of $262,273. Similar costs comprise the GEN-SETS value of $160,119. The sum of these two figures, $422,393, represents the total cost of fuel support equipment in the SBCT. That total is then multiplied by an inflation factor to show FY08$, resulting in the value $432,488.

The Fuel Support Equipment in SBCT cost component divided by FBCF Annual Cost for SBCT results in a percentage, 1.6%. This is then multiplied by FBCF per Gallon, $11.34, to yield the $/gallon associated with this metric, $0.18.

2.2.6 Sustainment Brigade/TSC

This calculation takes 10% of costs allocated to the Sustainment Brigade in support of the SBCT unit ($449,739) plus the TSC Cost ($108,084) for an annual cost of $557,824. The total is then multiplied by an inflation factor to show FY08$, resulting in the value $571,156.

The Sustainment Brigade/TSC cost component divided by FBCF Annual Cost for SBCT results in a percentage, 2.1%. This is then multiplied by FBCF per Gallon, $11.34, to yield the $/gallon associated with this metric, $0.24.

2.2.7 Fuel Commodity

The total annual cost fuel per SBCT unit is calculated by multiplying the fuel price for JP-8 fuel (including $0.10/gallon for environmental costs per OSD guidance) of $3.14 by the total gallons of fuel consumed per SBCT unit (2,357,589), yielding $7,402,829.

The Fuel Commodity cost component divided by FBCF Annual Cost for SBCT results in a percentage, 27.7%. This is then multiplied by FBCF per Gallon, $11.34, to yield the $/gallon associated with this metric, $3.14.

2.2.8 Investment Cost Component

The Investment Cost Component is calculated as the annualized capital investment plus annual O&M costs. The annualized capital investment is calculated as the total investment Capital Cost ($238,000,793) for the RIFTS and the HEMTTs, multiplied by the Percent of Capital Cost Allocated to the SBCT (1.52%) and divided by the economic life (20 years). The calculation is ($238,000,793 * 1.52% / 20 =$180,857). The Annual O&M Cost Allocated to the SBCT is found by taking the Annual O&M Cost multiplied by the Percent of Annual O&M Cost Allocated to the SBCT. The calculation is ($76,172.56 * 1.52% = $1,158). These are then added to yield the Investment Cost Component value of $182,014. This is divided by the FBCF Annual Cost for the SBCT post-investment which results in a percentage, 0.7%. This is then multiplied by FBCF per Gallon, $11.34, to yield the $/gallon associated with this metric, $0.08.

2.3 Cost/Benefit Results: RIFTS Case Study

Below are both the economic and logistic footprint impacts of the RIFTS investment analysis. Table 4 below summarizes the results of this analysis.

Table A-4. Investment Analysis Summary – RIFTS Investment

Summary Metric	Energy Investment RIFTS Analysis Case	Base Case	Net Change
FBCF Annual Cost for SBCT	$26,742,363	$33,320,118	$(6,577,755)
Annual Gallons Consumed by SBCT	2,357,589	2,357,589	-
FBCF per Soldier	$6,733	$8,389	$(1,656)
FBCF per Unit	$26,742,363	$33,320,118	$(6,577,755)
FBCF per Gallon	$11.34	$14.13	$(2.79)

2.3.1 Economics

The total investment capital cost to the SBCT is $3,617,135. The total annual operations & maintenance cost to the SBCT is $1,158. Payback period and net present value (NPV) are calculated for both the Commercial Cost Avoidance approach and the Net Change in FBCF approach.

Based on the Commercial Cost Avoidance approach, the annual commercial cost avoidance from the RIFTS Investment is $(5,139,603). To calculate the payback period, divide the Capital Cost Allocated to the SBCT $3,617,135 by the sum of the Annual Commercial Cost Avoidance $(5,139,603) and the Annual O&M Cost Allocated to the SBCT $1,158. This equals a payback period of 0.704 years. The calculation is [-$3,617,135/ [$(5,139,603) + $1,158] = 0.704]. NPV is calculated as the present value of the Commercial Cost Avoidance plus the Annual O&M Cost Allocated to the SBCT discounted at a real rate of 3.5% over 20 years, minus the Capital Cost Allocated to the SBCT, resulting in a net present value of $69,412,519.

To calculate the payback period based on the Net Change in FBCF approach, divide the Capital Cost Allocated to the SBCT $3,617,135 by the Annual Net Change in FBCF $(6,577,755) less the Annualized Capital Cost Allocated to the SBCT $180,857. This equals a payback period of 0.535 years. The calculation is [-$3,617,135/ [$(6,577,755) - $180,857] = 0.535]. NPV is calculated as the present value of the Net Change in FBCF less the Annualized Capital Cost Allocated to the SBCT discounted at a real rate of 3.5% over 20 years, minus the Capital Cost Allocated to the SBCT, resulting in a net present value of $92,438,984.

2.3.2 Force Protection and Logistics Impacts

To express impact in non-economic terms, the Alpha SMP Tool shows commercial and military resources freed up along with the associated monetized totals and reduction in fuel consumption by military/commercial resource. Ground Convoy Equivalents freed up are provided as an alternative metric to estimate the number of ground convoys (pre-investment) that are no longer needed to resupply the SBCT annually. The annual reduction in fuel consumption due to the investment is also provided; in the RIFTS example, this is the total reduction in convoy fuel consumption (53,022 gallons).

The Ground Convoy Equivalents freed up per year is calculated for each leg individually as the difference between the pre-investment annual convoy miles allocated to the SBCT and the post-investment annual convoy miles allocated to the SBCT. The pre-investment annual convoy miles allocated to the SBCT are calculated by taking the pre-investment Percent of Convoy Allocated to the SBCT [the 2-day fuel requirement (12,918 gallons) divided by the maximum convoy capacity (16 fuel supply trucks, 128,000 gallons total)] multiplied by the pre-investment annual resupply miles and the number of convoys per year (182). The calculation is [(12,918/128,000) * 450 * 182 = 8,266], Post-investment annual convoy miles allocated to the SBCT are calculated in a similar manner, except that the calculation uses the post-investment Percent of Convoy Allocated to the SBCT (in the RIFTS example, the pre- and post-investment percentages are equal) and is calculated as [(12,918/128,000) * 0 * 182 = 0]. The difference is then divided by the number of pre-investment miles for a single convoy carrying 100% fuel for the SBCT (450), resulting in approximately 18 ground convoy equivalents being freed up. This calculation is [(8,266 – 0) / 450 = 18.4].

Contractor Fuel Supply Truck miles freed up are calculated by first taking the difference between pre-investment ground convoy equivalent and the post-investment ground convoy equivalent multiplied by the number of fuel truck resupply miles driven for a single, 16-truck convoy carrying 100% SBCT fuel. The result is multiplied by the percent of commodity delivered by contractor trucks (100%). The calculation is [(18.4 – 0) * (450 * 16) * 100% = 132,251 miles]. The annual reduction in convoy fuel consumption is calculated by taking the number of miles freed up divided by the MPG (HEMTT, 3.4mpg), or (132,251 / 3.4 = 38,718 gallons). The monetized value of the Contractor Fuel Supply Truck miles freed up equals $5,139,603.

Gun Truck miles freed up are calculated by taking the difference between pre-investment ground convoy equivalent and the post-investment ground convoy equivalent multiplied by the number of gun truck miles driven for a single, 4-truck convoy protecting fuel supply trucks carrying 100% SBCT fuel. The calculation is [(18.4 – 0) * (450 * 4) = 33,063 miles]. The annual reduction in convoy fuel consumption is calculated by taking the number of miles freed up divided by the MPG (HMMWV, 11.0mpg), or (33,063 / 11.0 = 3,003 gallons). The monetized value of the Gun Truck miles freed up equals $756,336.

Apache hours freed up are calculated by first taking the difference between pre-investment ground convoy equivalent and the post-investment ground convoy equivalent multiplied by the number of Apache miles flown for a single, 2-helicopter convoy protecting fuel supply trucks carrying 100% SBCT fuel. The result is multiplied by the percent of force protection (Air) of 20%, which is then divided by the average speed of the convoy. The calculation is [(18.4 – 0) * (450 * 16) * 20% / 35 = 94.47 hours]. The annual reduction in convoy fuel consumption is calculated by taking the number of Apache hours freed up multiplied by the gallons per hour (Apache, 119.63gph), or (94.47 * 119.63 = 11,300 gallons). The monetized value of the Apache hours freed up equals $863,831.

2.3.3 Air Pollutant Emissions Avoided

The reduction in air emissions from resupply and force protection (in the RIFTS example SBCT fuel consumption does not change) calculations are based on the resources freed up due to the investment and the JP-8 air pollutant factors shown in Table 5. The air emission factors shown in Table 5 are from an analysis of diesel engine combustion by the Southwest Research Institute (May 2002) and are based on a 2001 Cummins ISL 8.9 liter diesel engine. The average fuel economy of this type of engine using JP-8 is 5.4 miles per gallon (MPG) according to the SwRI analysis.

Table A-5. Air Emission Factors JP-8

Pollutant	Measure	JP-8 Factor
HC	Grams/mile	1.35
CO	Grams/mile	3
NOX	Grams/mile	12.8
PM	Grams/mile	0.56
CO_2	Grams/mile	1,761

Source: Southwest Research Institute

For example, to calculate CO_2 reductions (654,644 pounds), the annual number of convoy miles reduced by the investment (168,620, including Apache hours converted to miles) are multiplied by the appropriate grams/mile factor shown in the table above [168,620 * 1,761 = 296,939,973 grams]. This is then converted to pounds (conversion factor of 453.59 g/lb), or [296,939,973/453.59 = 654,644 pounds of CO_2 per year).

3 Illustration of Alpha SMP Tool Calculations and Analyses: Fully burdened cost of drinking water

3.1 Case Study - Fully Burdened Cost of Drinking Water in the Training Base

3.2 Overview of the Training Base

To illustrate how the FBCW is derived, this section shows the steps used to calculate the FBCW in the Base Case Scenario for the training base. For this example the training base location is Fort Lewis, Washington. The assumptions used to derive this scenario can be found in Section 3.2.3 in the main body of the Report. Table 6 below contains a summary of the FBCW in the training base by cost component. Figure 3 below contains the same data as Table 6 shown in graphical form. The total FBCW in the training base (Ft Lewis) in this case study is $1.66 per gallon.

Table A-6. Base Case FBCW (in the Training Base)

Cost Components	Annual Cost Modified Case (Training Base)	% of FBCW	$ Per Gallon
Water Support Military Personnel in SBCT	$ 4,963,470.48	97.329%	$ 1.6200
Water Support Equipment in SBCT	$ 132,665.28	2.601%	$ 0.0432
Installation Infrastructure	$ 1,125.28	0.022%	$ 0.0004
Water Commodity	$ 2,403.72	0.047%	$ 0.0008

Summary Statistic	Value
FBCW Annual Cost for SBCT	$ 5,099,665
Annual Gallons Consumed by SBCT	3,063,931
FBCW per Soldier	$ 1,284
FBCW per SBCT	$ 5,099,665
FBCW per Gallon	$ 1.66

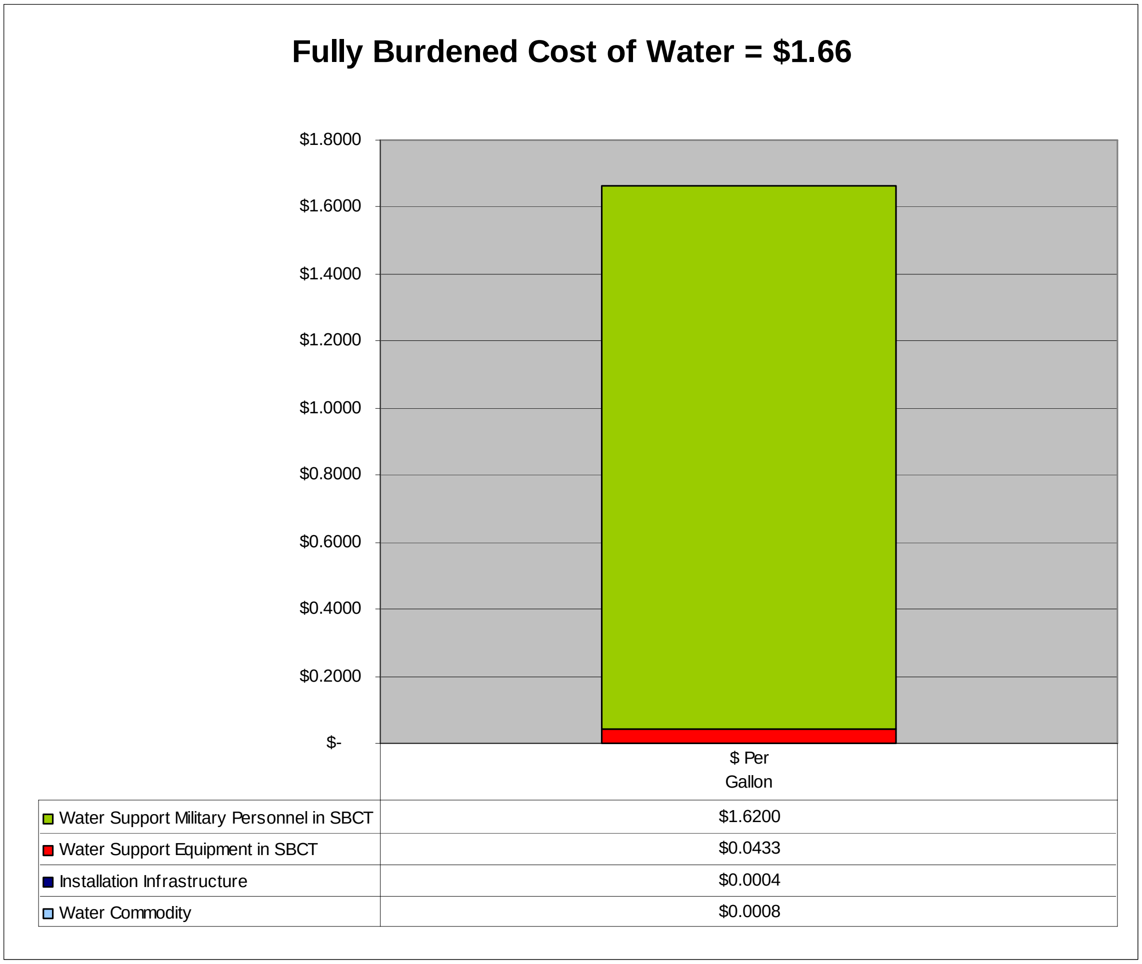


Figure A-3. Base Case FBCW (in the Training Base)

3.2.1 Water Support Military Personnel in SBCT

The fully loaded base salary is calculated by taking the value of SBCT military personnel pay at Fort Lewis ($277,362,920) multiplied by 1.7% to represent fuel services costs allocated to the SBCT unit ($4,715,170). This is then multiplied by 2.2%, the CFH Military Pay Raise Factor for FY07, resulting in the value $103,734. These figures are added together for a total salary value of $4,818,903. This value is then increased by the CFH Military Pay Raise Factor for FY08 of 3.9%, for a final value of $4,963,470.

The Water Support Military Personnel in SBCT cost component divided by FBCF Annual Cost for SBCT results in a percentage, 97.329%. This is then multiplied by FBCW per Gallon, $1.66, to yield the $/gallon associated with this metric, $1.6200.

3.2.2 Water Support Equipment in SBCT

The Water Support Equipment in SBCT is the sum of materiel capital costs and costs associated with repairs & spare parts. The water support equipment costs are $132,665.

The Water Support Equipment in SBCT cost component divided by FBCW Annual Cost for SBCT results in a percentage, 2.601%. This is then multiplied by FBCW per Gallon, $1.66, to yield the $/gallon associated with this metric, $0.0432.

3.2.3 Installation Infrastructure

Infrastructure costs are calculated by taking the Total Garrison Costs (for potable water) multiplied by the SBCT cost allocation factor (0.21%) yielding the SBCT share of costs ($1,099). This is then multiplied by the inflation factor for FY08$ of 2.39%, resulting in the value $1,125.

The Installation Infrastructure cost component divided by FBCW Annual Cost for SBCT results in a percentage, 0.022%. This is then multiplied by FBCW per Gallon, $1.66, to yield the $/gallon associated with this metric, $0.0004.

3.2.4 Water Commodity

Commodity cost multiplies the Garrison Water Cost Factor (0.0009), by the SBCT water consumption level (3,063,931 gallons), and takes into account the amount of water supplied by ROWPU [1 - (% supplied by ROWPU) = 10%], yielding $2,404.

The Water Commodity cost component divided by FBCW Annual Cost for SBCT results in a percentage, 0.047%. This is then multiplied by FBCW per Gallon, $1.66, to yield the $/gallon associated with this metric, $0.0008.