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Bulk Liquid Transportation Options Study

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Agenda

- Background
- Methodology
- Baseline Results
- Alternatives
- Conclusions

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Background

Study Sponsor

Brigadier General Robert E. Schmidle, Jr.

Director, Expeditionary Force Development Center

Study Team

Team Lead – Captain Jonathan Drexler, USMC

Team Member – Mr. Cortez Stephens

Team Member – Ms. Lori Taylor

Team Member – Ms. Launa Zaffram

Study Objective

Address the Marine Corps capability to provide bulk fuel and water transportation support for (Marine Air Ground Task Force) MAGTF operations:

- Examine the capability of current equipment and processes to transport bulk fuel and water.

- Examine the capability of other equipment and processes, not currently employed by the Marine Corps, to transport bulk fuel and water.

This brief will focus on the fuel transportation piece of the study.

Agenda

- Background
- Methodology
- Baseline Results
- Alternatives
- Conclusions

Methodology - Overview

- Notional Marine Expeditionary Force (MEF)
- Mature theater distribution network
- Demand is calculated using Marine Corps planning factors
- Only ground forces and equipment are taken into account
- Network optimization Excel model uses Solver to optimize truck routes among nodes
- Discrete event simulation Extend model builds on results

Methodology – MEF Organization

MEF COMMAND ELEMENT		
	MEF CE	
	MEF HQ GROUP	
	RADIO BN	
	COMMUNICATIONS BN	
	INTELLIGENCE BN	
	ANGLICO	
	CIVIL AFFAIRS GROUP	
	FORCE RECON COMPANY	
GRND CMBT ELEMENT	**AVN CMBT ELEMENT**	**CMBT SVC SPT ELEMENT**
HEADQUARTERS BN	MARINE WING HQ SQDN	H&S BN
INFANTRY REGIMENT	MARINE AIR CONTROL GROUP	TRANS SUPPORT BN
INFANTRY REGIMENT	MARINE WING SUPPORT GROUP	ENGR SUPPORT BN
INFANTRY REGIMENT	MARINE AIRCRAFT GROUP (FW)	MEDICAL BN
ARTILLERY REGIMENT	MARINE AIRCRAFT GROUP (FW)	SUPPLY BN
AAV BN	MARINE AIRCRAFT GROUP (FW)	MAINT BN
TANK BN	MARINE AIRCRAFT GROUP (RW)	DENTAL BN
LAR BN	MARINE AIRCRAFT GROUP (RW)	
COMBAT ENGR BN		
RECON BN		

Methodology – Operational Context

FCSSA – Forward Combat Service Support Area

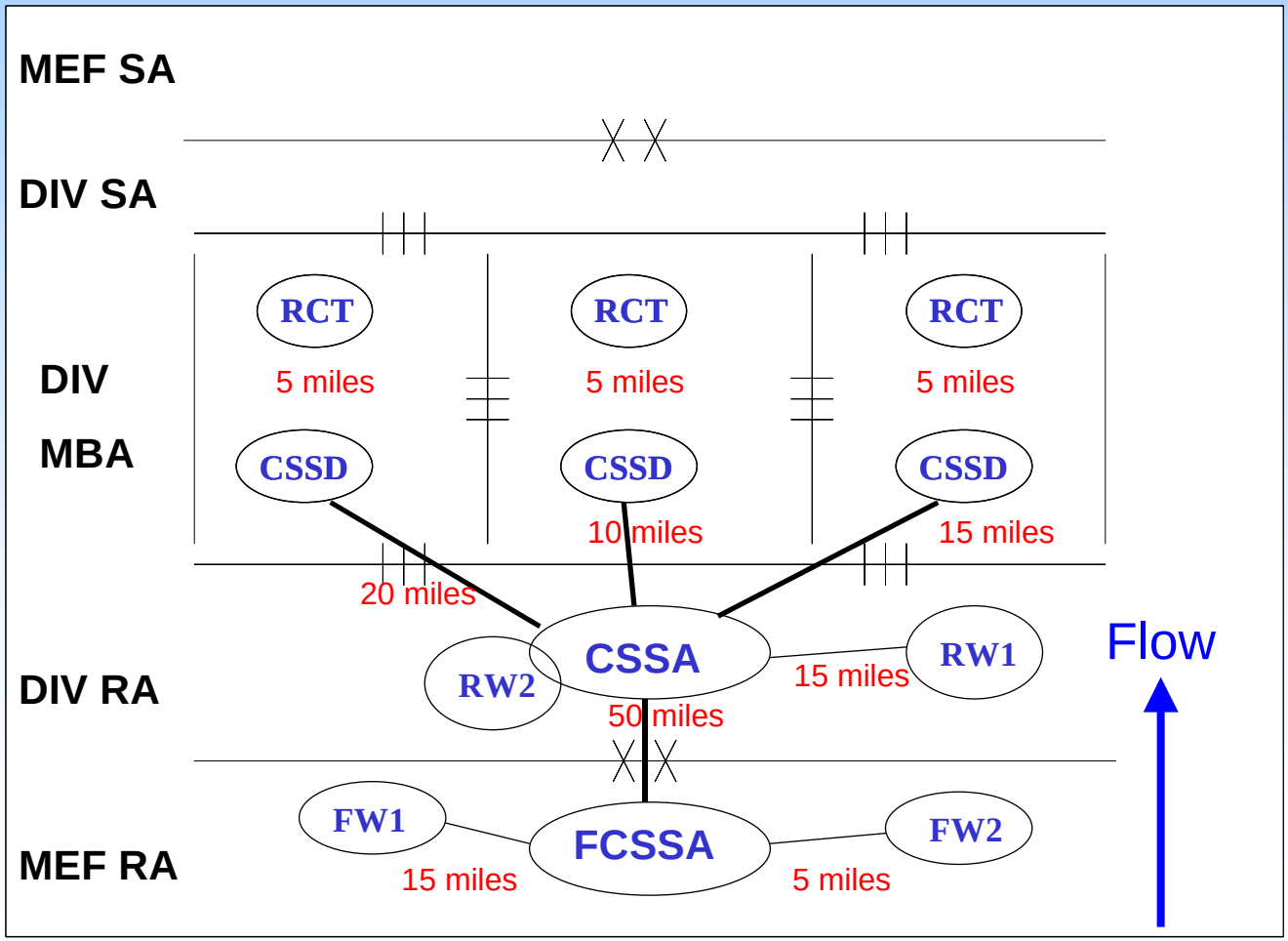
FW – Fixed Wing (Aircraft)

RW – Rotary Wing (Aircraft)

CSSA – Combat Service Support Area

CSSD – Combat Service Support Detachment

RCT – Regimental Combat Team

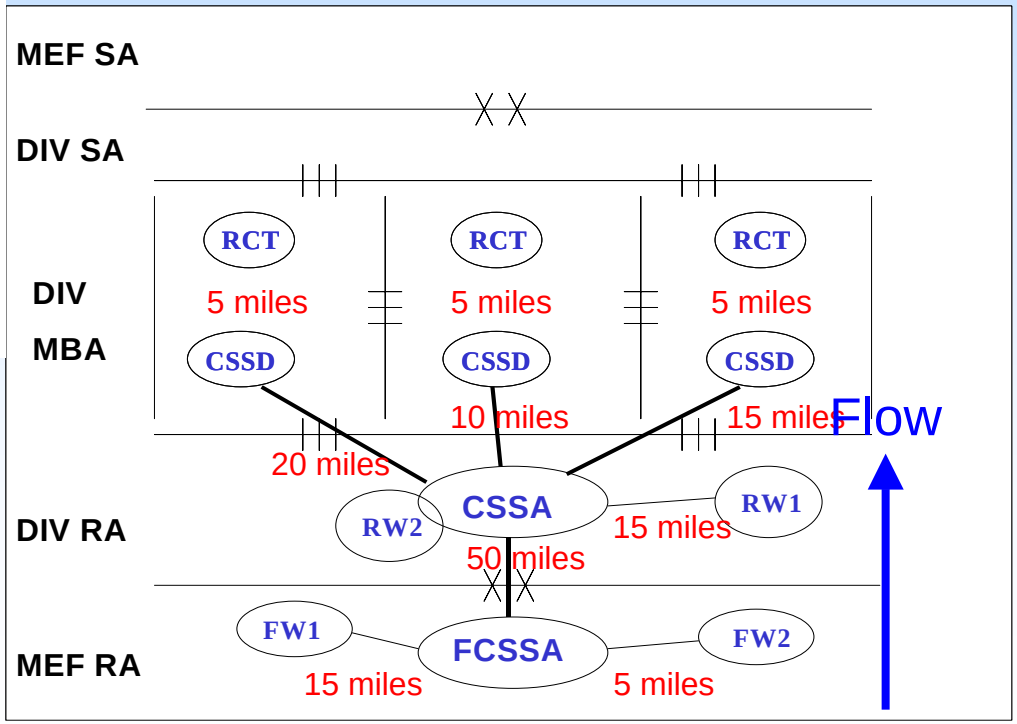


Methodology – Demand

Node	Fuel	Consumption Rate
MEF CP/FCSSA	61,299	Sustained
FW 1	253,121	Sustained
FW 2	159,653	Sustained
RW2/CSSA/DIV CP	357,863	Sustained
RW 1	103,258	Sustained
FARP	15,695	Assault
CSSD 1	19,689	Assault
CSSD 2	19,531	Assault
CSSD 3	19,411	Assault
RCT 1	28,642	Assault
RCT 2	28,695	Assault
RCT 3	28,695	Assault
Total	1,095,552	

Demand is calculated using Marine Corps planning factors

Demand is in gallons.



Methodology – Equipment

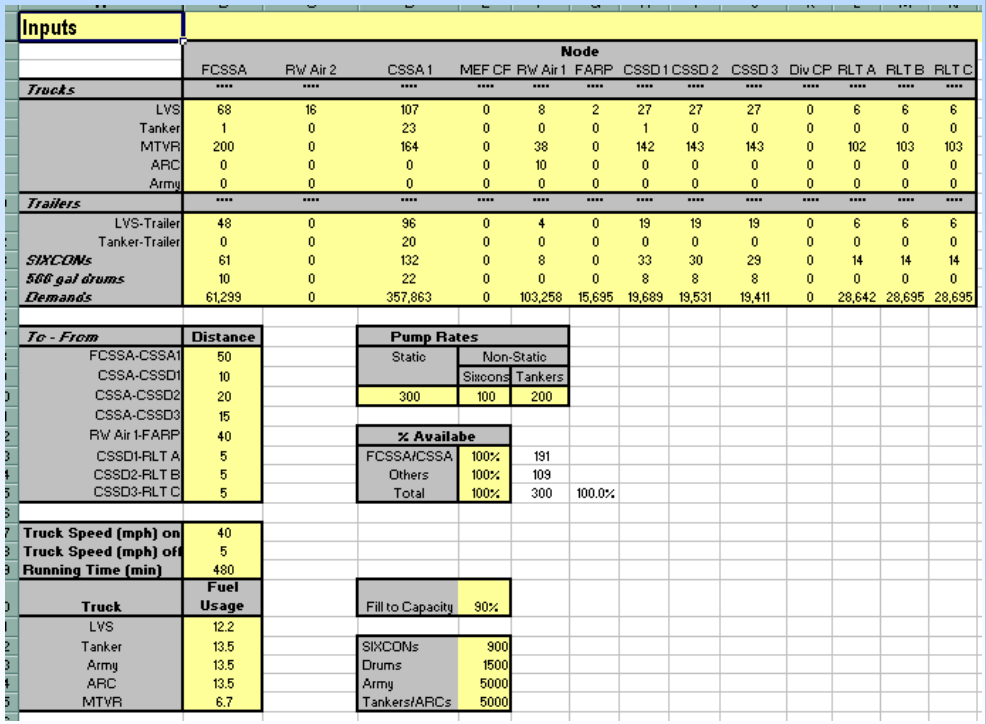
- **300** Logistics Vehicle System (LVS)
- **60** Refeulers (20 M970s, 40 Aviation Refueling Capability (ARC) Systems)
- **231** LVS Flatbed Trailers
- **309** Water Trailers (aka: Water Bull)
- **1222** Medium Tactical Vehicle Replacement (MTVR)
- **671** SIXCONs
  - **351** Fuel and **141** Pumps
  - **320** Water and **112** Pumps

Methodology – Excel Model

Network optimization model using Solver

Inputs –

- Equipment Starting Locations
- Distance Between Nodes
- Pump Rates
- % of Equipment Available For Use
- Truck Speed
- Truck Running Time
- Fill Capacity
  - By Percentage
  - By Gallons
- Truck Fuel Usage



Inputs

	Node												
	FCSSA	RW Air 2	CSSA 1	MEF CP	RW Air 1	FARP	CSSD 1	CSSD 2	CSSD 3	Div CP	RLT A	RLT B	RLT C
Trucks	····	····	····	····	····	····	····	····	····	····	····	····	····
LVS	68	16	107	0	8	2	27	27	27	0	6	6	6
Tanker	1	0	23	0	0	0	1	0	0	0	0	0	0
MTVR	200	0	164	0	38	0	142	143	143	0	102	103	103
ARC	0	0	0	0	10	0	0	0	0	0	0	0	0
Army	0	0	0	0	0	0	0	0	0	0	0	0	0
Trailers	····	····	····	····	····	····	····	····	····	····	····	····	····
LVS-Trailer	48	0	96	0	4	0	19	19	19	0	6	6	6
Tanker-Trailer	0	0	20	0	0	0	0	0	0	0	0	0	0
SIXCONs	61	0	132	0	8	0	33	30	29	0	14	14	14
566 gal drums	10	0	22	0	0	0	8	8	8	0	0	0	0
Demands	61,299	0	357,863	0	103,258	15,695	19,689	19,531	19,411	0	28,642	28,695	28,695

To - From	**Distance**
FCSSA-CSSA1	50
CSSA-CSSD1	10
CSSA-CSSD2	20
CSSA-CSSD3	15
RW Air 1-FARP	40
CSSD1-RLT A	5
CSSD2-RLT B	5
CSSD3-RLT C	5

Pump Rates		
Static	Non-Static	
	Sixcons	Tankers
300	100	200

% Availabe			
FCSSA/CSSA	100%	191	
Others	100%	109	
Total	100%	300	100.0%

Truck Speed (mph) on	40
Truck Speed (mph) off	5
Running Time (min)	480

Truck	**Fuel Usage**
LVS	12.2
Tanker	13.5
Army	13.5
ARC	13.5
MTVR	6.7

Fill to Capacity	90%

SIXCONs	900
Drums	1500
Army	5000
Tankers/ARCs	5000

Methodology – Excel Model

Fictional trucks carrying 5,000 gallons are used as placeholders to quantify the known shortfall in organic Marine Corps capability.

Outputs –

- Trucks used along each arc
- Payload used to transport
- Fuel used to transport
- Remaining trucks
- Supply to each node

The trucks used along each arc are then fed into an Extend discrete event simulation model…

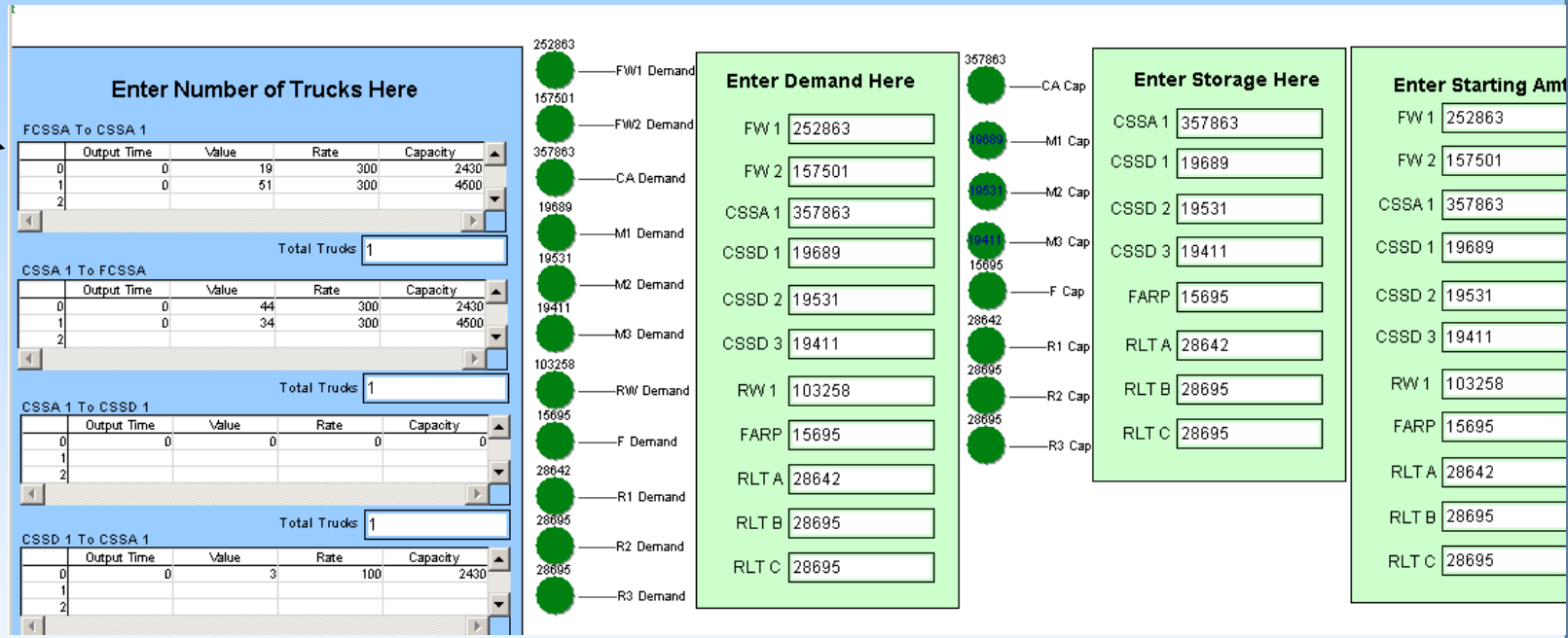
Trucks Used	130.0	8.8%
Shortfall Trucks Used	65.0	33.3%
Remaining Trucks	1343.0	91.2%
Fuel Used	8,502	
Payload Available	19,093	
Payload Used	2,978	15.6%

Node	Supply
CSSA 1	642,708
CSSD 1	56,133
CSSD 2	52,245
CSSD 3	53,460
FARP	17,550
RLT 1	28,674
RLT 2	29,160
RLT 3	29,160
Total	909,090

Trucks and Fuel Used	LVS	Tanker	Shortfall	MTVR - Sixcons	MTVR - Drums	ARC	Runs
FCSSA - CSSA 1	19.0	0.0	51.0	0.0	0.0	0.0	1.2
CSSA 1 - FCSSA	44.0	20.0	14.0	0.0	0.0	0.0	1.2
CSSA 1 - CSSD 1	0.0	0.0	0.0	0.0	0.0	0.0	7.7
CSSA 1 - CSSD 2	0.0	0.0	0.0	0.0	0.0	0.0	4.3
CSSA 1 - CSSD 3	0.0	0.0	0.0	0.0	0.0	0.0	5.5
CSSD 1 - CSSA 1	3.0	0.0	0.0	0.0	0.0	0.0	7.7
CSSD 1 - RLT 1	2.0	0.0	0.0	0.0	1.0	0.0	1.8
CSSD 2 - CSSA 1	5.0	0.0	0.0	0.0	0.0	0.0	4.3
CSSD 2 - RLT 2	3.0	0.0	0.0	0.0	0.0	0.0	1.8
CSSD 3 - CSSA 1	4.0	0.0	0.0	0.0	0.0	0.0	5.5
CSSD 3 - RLT 3	4.0	0.0	0.0	0.0	0.0	0.0	1.8
RW Air 1 - FARP	0.0	0.0	0.0	0.0	0.0	3.0	1.3
FARP - RW Air 1	0.0	0.0	0.0	0.0	0.0	0.0	1.3
RLT 1 - CSSD 1	6.0	0.0	0.0	2.0	0.0	0.0	1.8
RLT 2 - CSSD 2	6.0	0.0	0.0	2.0	0.0	0.0	1.8
RLT 3 - CSSD 3	6.0	0.0	0.0	0.0	0.0	0.0	1.8

Methodology – Extend Model

The results of the Excel model are entered in here.



Inputs:

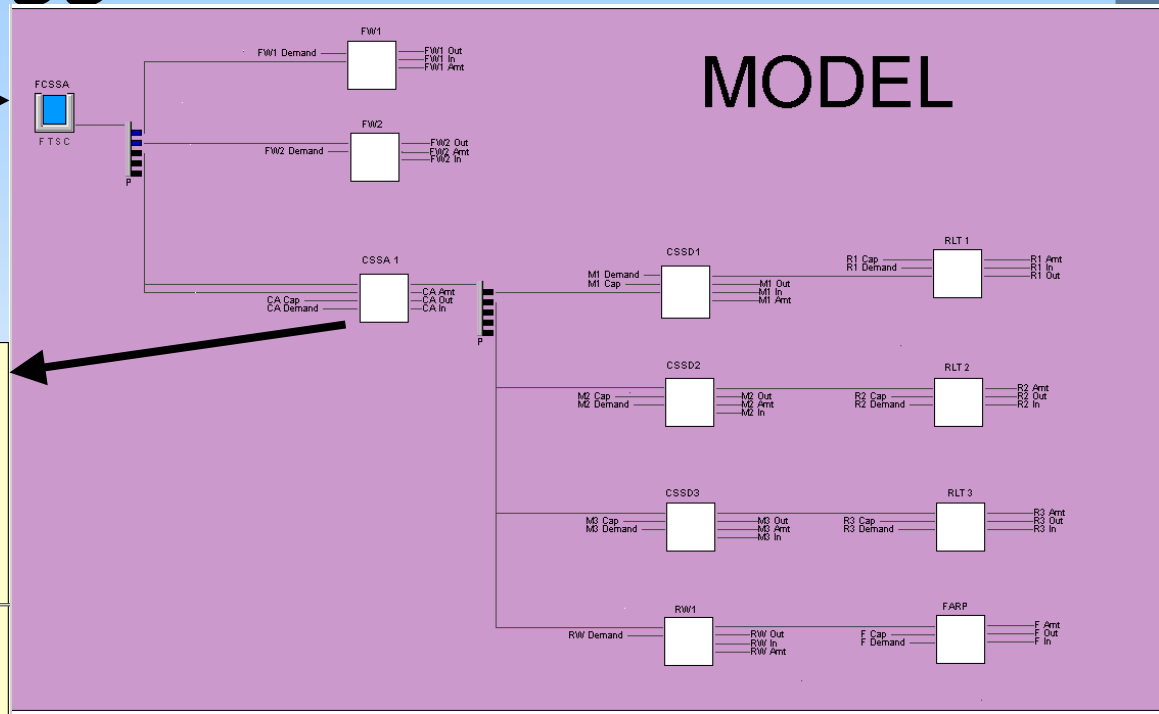
- Trucks along each arc
- Demand at each node
- Storage at each node
- Starting storage amount

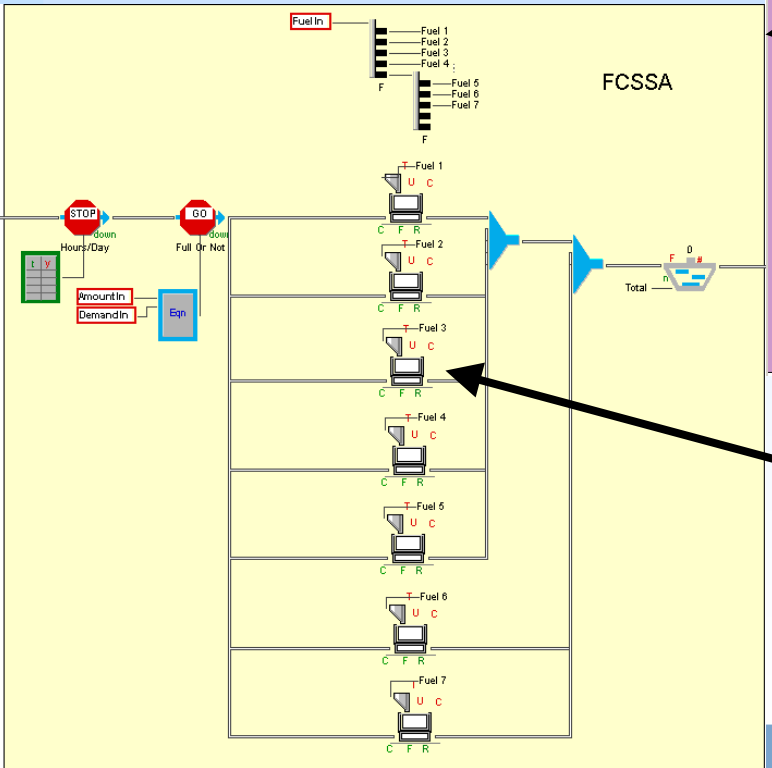
Extend model:

- Discrete event simulation
- Simulation time is 15 days
- Validates the results of the Excel model
- Stochastic variables can be added for sensitivity analysis

Methodology – Extend Model

Extend Distribution Network





FCSSA Pumps

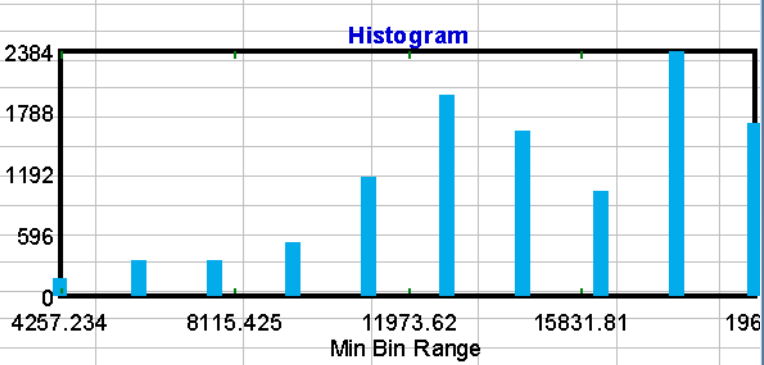
Methodology – Extend Model

Outputs:

Fuel levels are tracked at each node for all 15 days.

CSSD 1
Total Capacity 19,689

	Fuel Levels	Instances	Percentages
At	4,257	180	7.8%
Between	4,257	352	
And	6,186		
Between	6,186	343	
And	8,115		
Between	8,115	515	4.6%
And	10,045		
Between	10,045	1167	87.6%
And	11,974		
Between	11,974	1967	
And	13,903		
Between	13,903	1605	
And	15,832		
Between	15,832	1019	
And	17,761		
Between	17,761	2383	
And	19,690		
At	19,690	1678	
	Total	11209	



Fuel levels at CSSD 1

Agenda

- Background
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Baseline Results - Overall

- Cannot Deliver Required Amount of Fuel
- Captured the Difference in Terms of “Shortfall Trucks”
- Require an Additional 65 Shortfall Trucks
  - Lack the capability to move 292,500 gallons
- MEF Organic Equipment Cannot Support Fuel Requirements
  - Contract, Army, host nation support?
  - Organic capability?

Baseline Results - Sensitivity Analysis

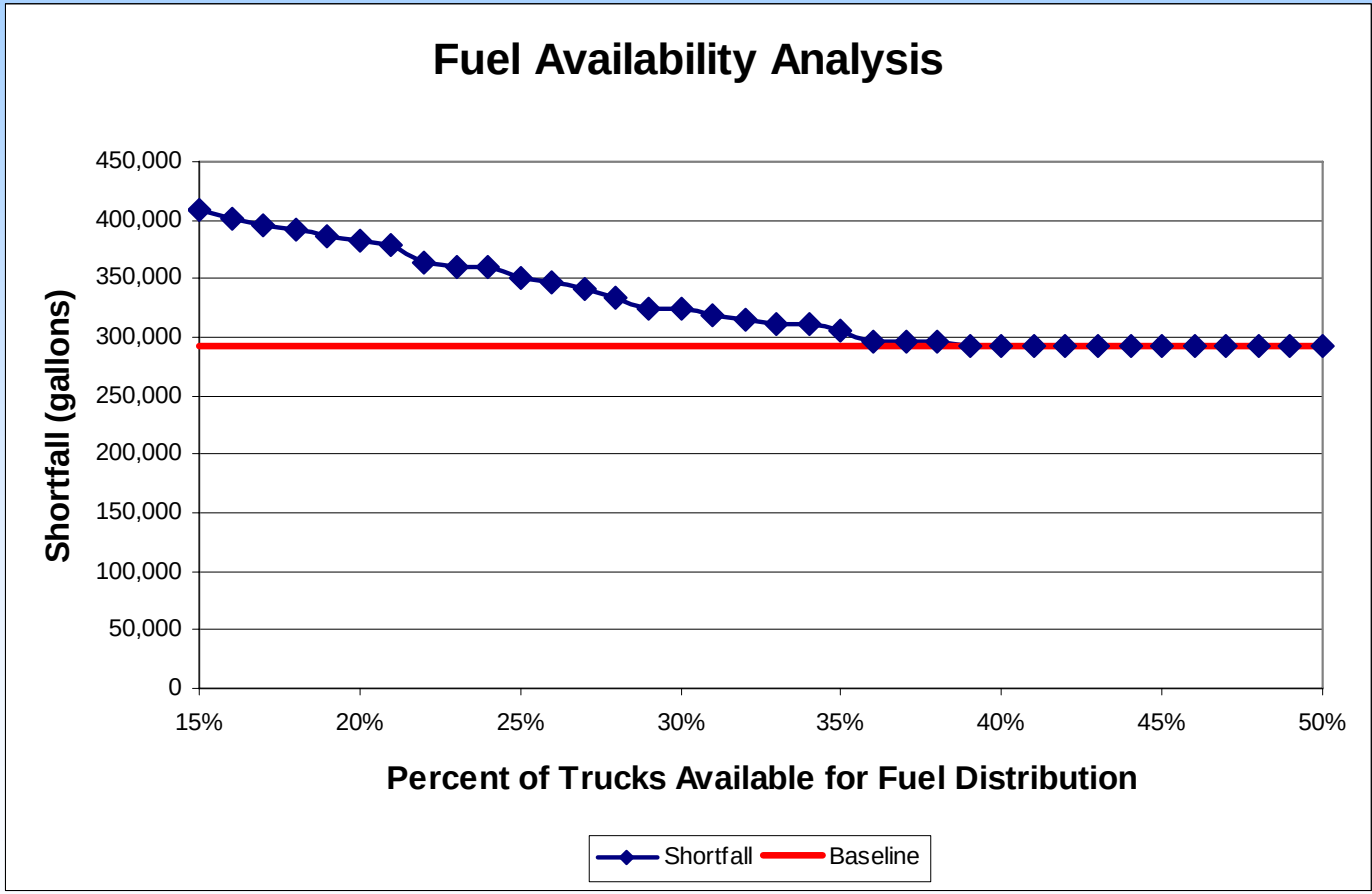
- How a solution changes with slight changes to the parameters
- Show:
  - Useful information
  - Unknown relationships
- Better understanding of current capabilities

Baseline Results - Sensitivity Analysis

Use of ground assets is allowed up to 35%.

We varied that percentage from 15% – 50%.

The shortage is worsened by a lower percentage, but little is gained by an increase.

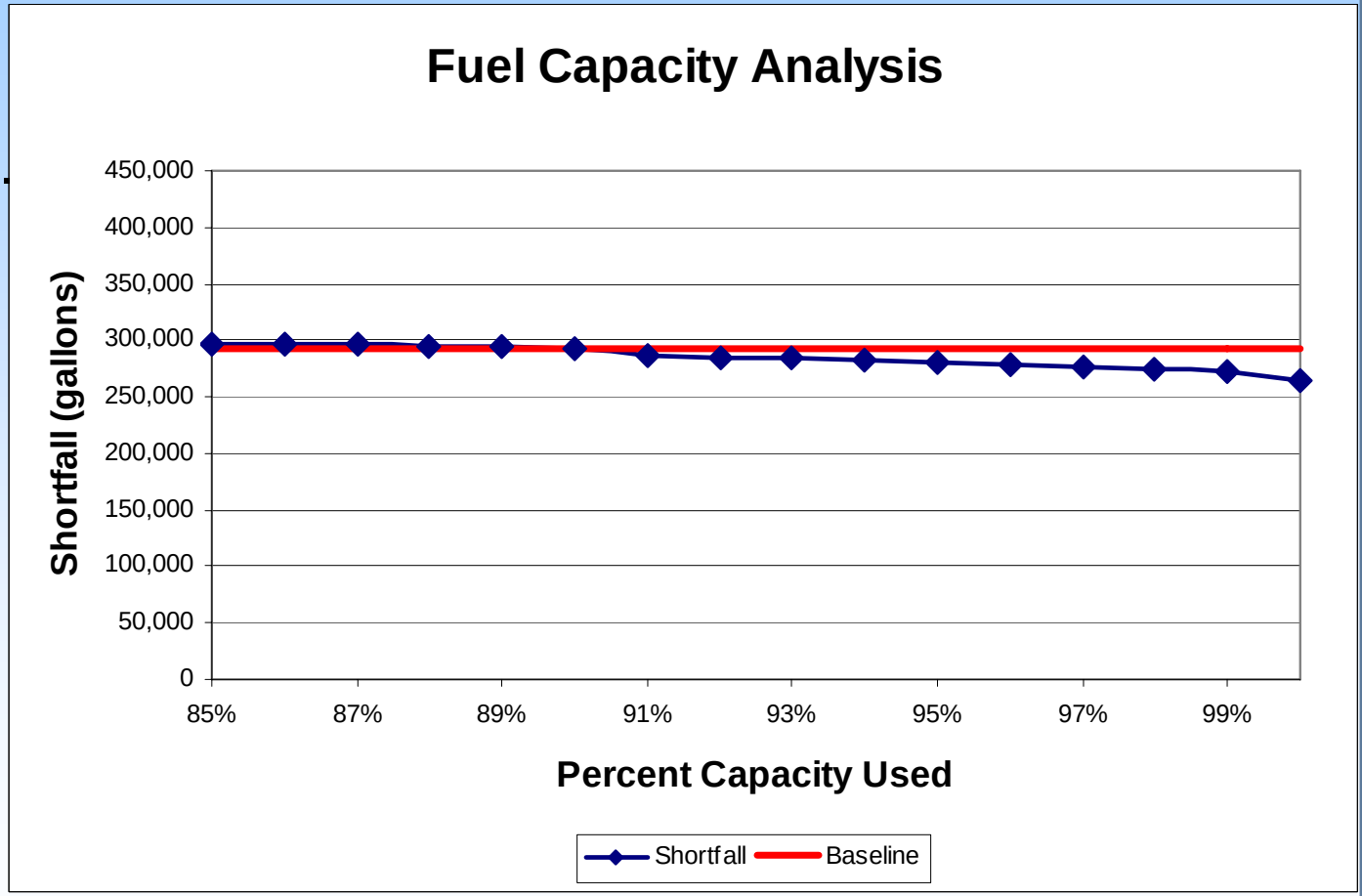


Baseline Results - Sensitivity Analysis

Fill capacity is allowed up to 90%.

We varied that percentage from 85% – 100%.

Little change is observed in shortfall.

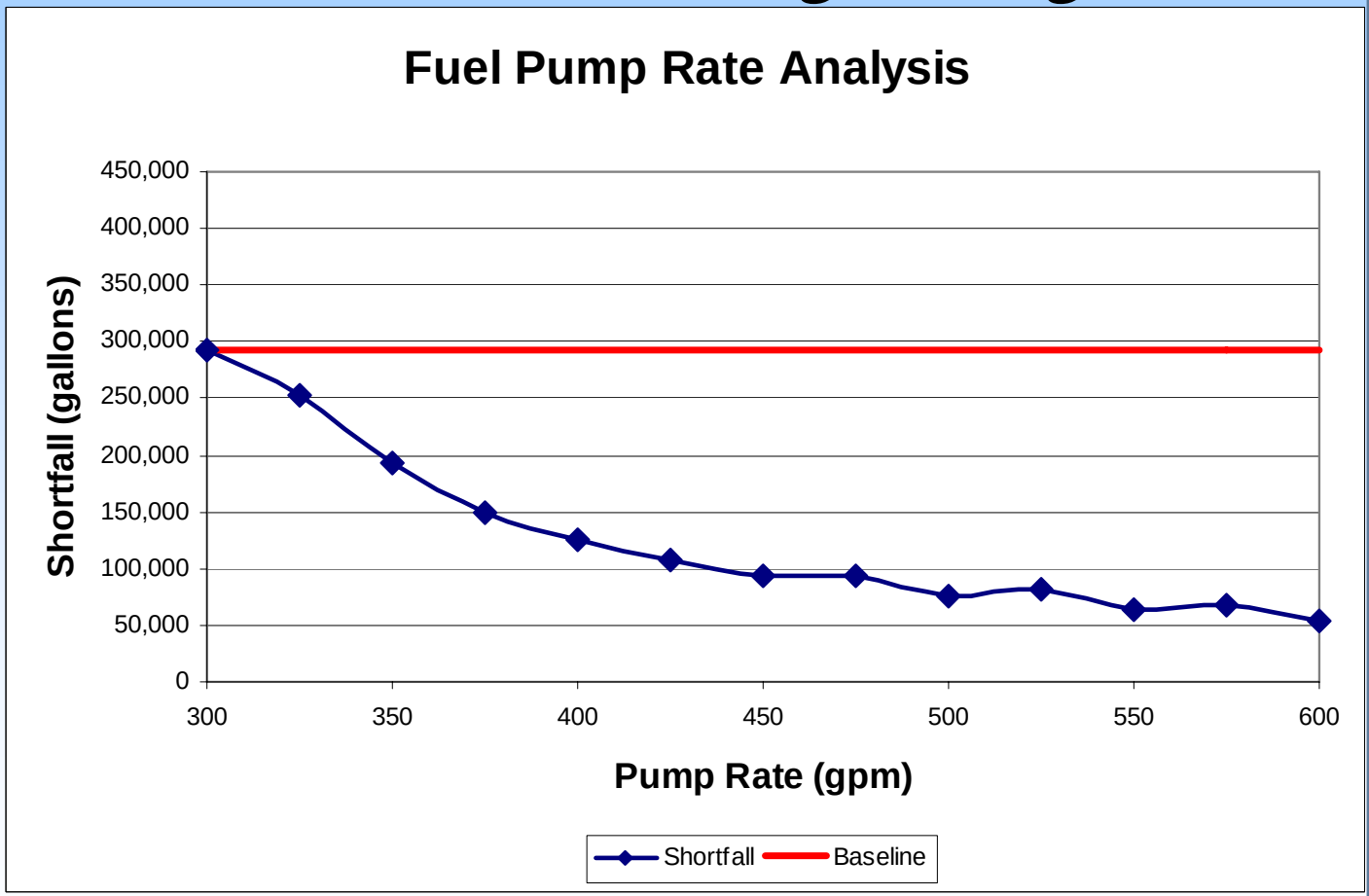


Baseline Results - Sensitivity Analysis

The static pump rate is 300 gpm.

We varied that rate from 300 – 600 gpm.

There appear to be significant gains in small increases in pump rate.



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Alternatives

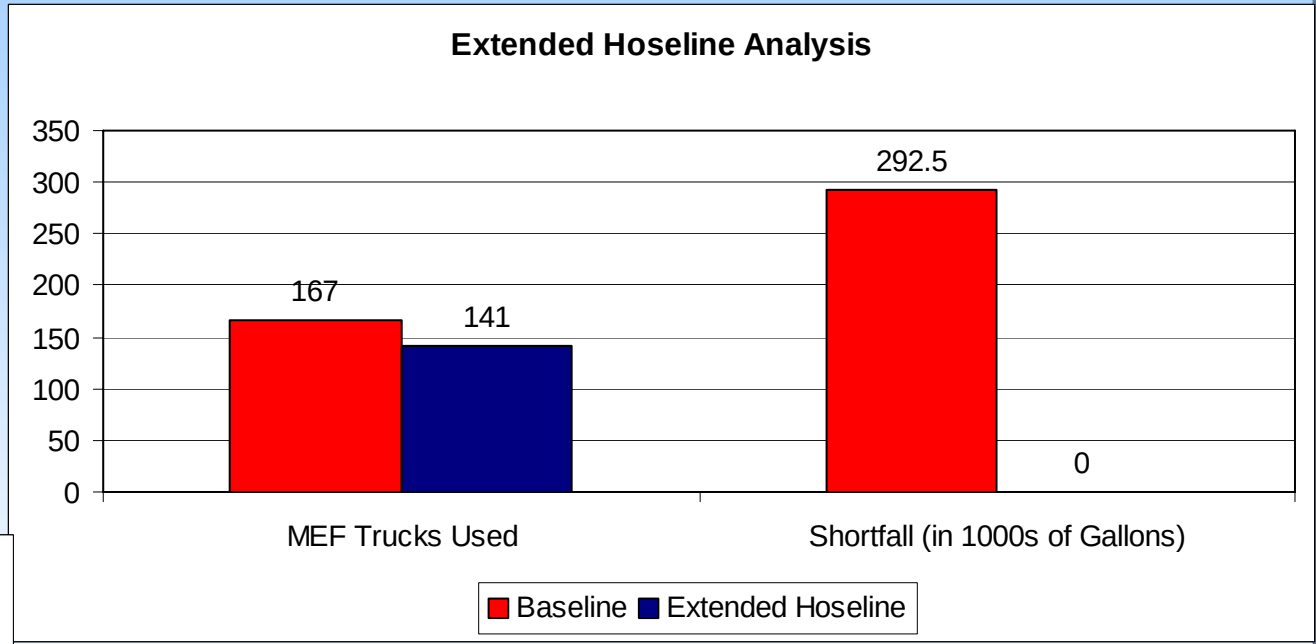
- **Three Alternatives:**
  1. Extended Hoseline
  2. Logistics Vehicle System Replacement (LVSR) and Flatrack Refueling Capability (FRC).
  3. LVSR, FRC and Expeditionary Fueling System (EFS).

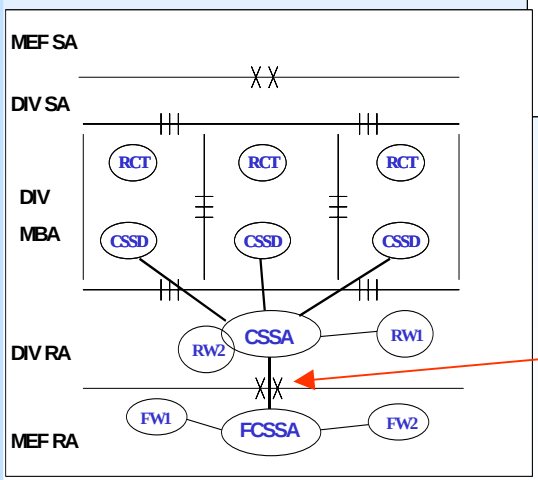
- **Each Compared Separately to Baseline Results**

Alternatives - Extended Hoseline

Changes:

- 50 miles of additional hoseline
- From FCSSA to CSSA
- Capacity: 425,000 gallons/day





Hoseline

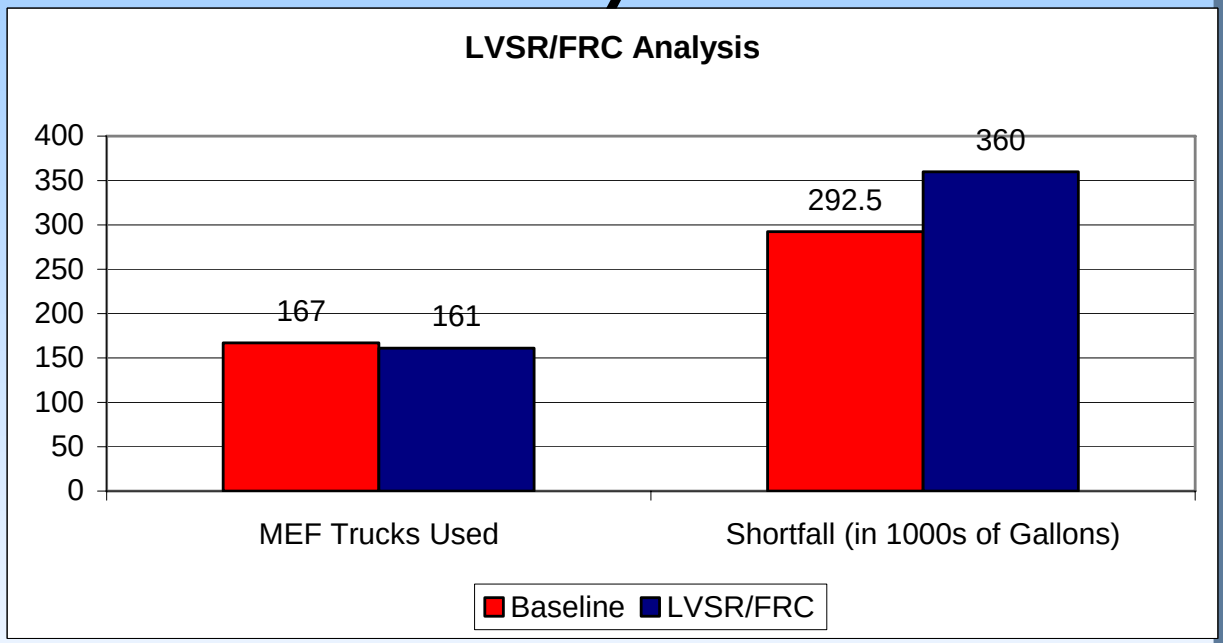
Conclusions:

- Hoseline may not always be possible.
- Whenever possible, it can be very effective.

Alternatives - LVSR/FRC

Changes:

- Replace LVS with LVSR
  - 300 LVS → 263 LVSR
- Replace M970 with FRC
  - 20 M970s → 40 FRCs
  - 2,750 gallon Capacity



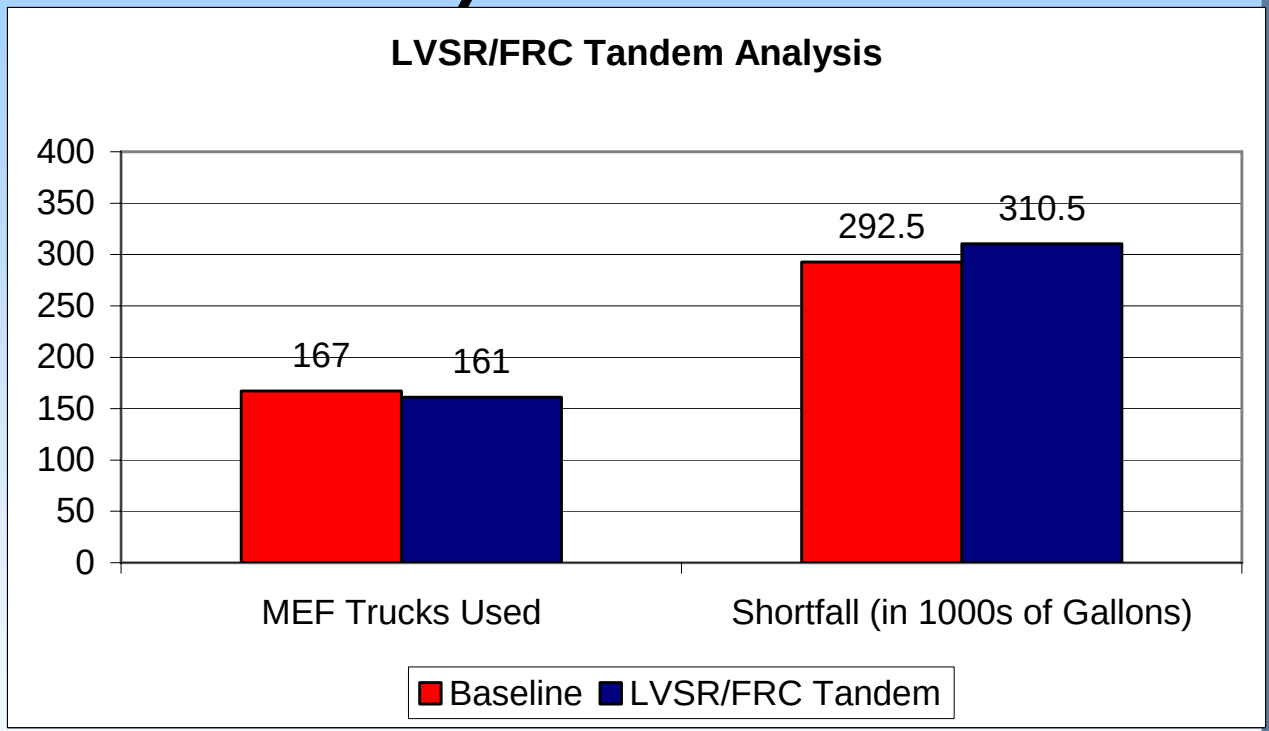
Conclusions:

- Fewer LVSRs as compared to LVS
- SIXCONs and FRC now compete for trailer space
  - No longer a dedicated fuel truck

Alternatives - LVSR/FRC Tandem

Changes:

- 45 tandem trailers
  - FCSSA: 15
  - CSSA: 30
- Capability to move twice the fuel
- Engineering issues not taken into account



Conclusions:

- Fewer LVSRs as compared to LVS
- SIXCONs and FRC now compete for trailer space
  - No longer a dedicated fuel truck
- Tandem trailers may help alleviate some shortfall

Alternatives – LVSR/FRC/EFS

Expeditionary Fuel System (EFS):

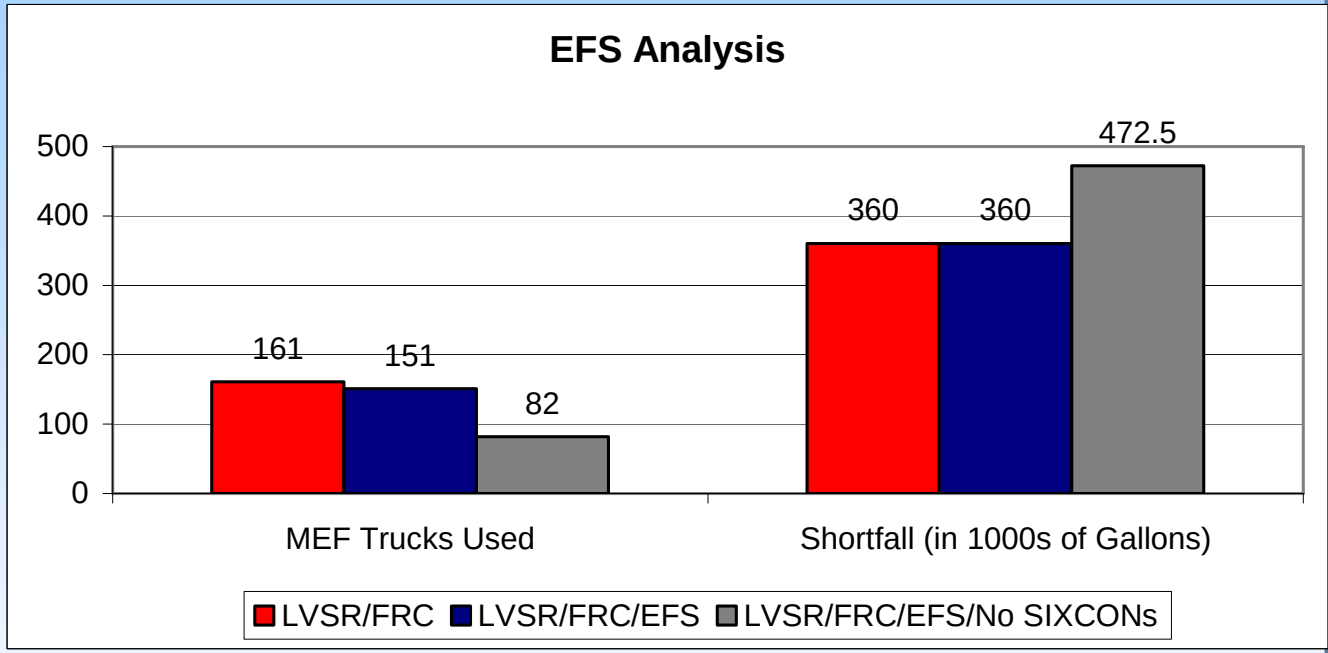
- Modular petroleum distribution system capable of being manhandled, self-pumping, refueling both ground vehicles and aircraft
- Consist of two variations (ORD)
  - Small: 20 – 50 gallons
  - Medium: 150 – 300 gallons
- Multiple, lightweight, collapsible tanks

Version	Small	Medium
Capacity (gal)	28	300
Full Weight	239	2245
Empty Weight	43	145
Length (inches)	47	85
Width (inches)	16	36
Height (inches)	16	36
Stacking Limit	4	2

Alternatives – LVSR/FRC/EFS

Change:

- Add EFS
  - 54 Small: 28 gallons
  - 54 Medium: 300 gallons
- Macro level – not adding a significant capability
- Comparison: No SIXCONs



Conclusion:

- As fielded, the EFS doesn't make a significant difference
- The removal of SIXCONs significantly complicates the situation
  - SIXCONs are an essential part of Bulk Fuel Transportation

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Conclusions

- Shortfall in transporting bulk fuel is 292,500 gallons per day
- Three ways to address the shortfall in the MEF's current capability:
  - Non-Marine Corps support - host nation or the U.S. Army
  - Obtain additional multi-use systems - LVS/SIXCON combination
  - Obtain single-use systems - ARC or the D1134 Tractor/M970 refueler combination
- Pump rates can have a significant effect on the results
- Extending the battlespace dramatically increases the shortfall
- When possible, extended hoseline can be very effective in reducing the fuel shortfall
- SIXCONs are an integral part of fuel distribution and are the limiting factor in the MEF's ability to satisfy its fuel requirements
- The FRC competes with SIXCONs for space on the LVSR and does not necessarily give the Marine Corps a greater capability
- The EFS shows some benefit when added to current equipment and processes

Questions?