

# To Build or Not to Build Quantifying Environmental Value



*A Presentation by Cherilyn Widell, Seraph LLC  
for NESEA Boston, Massachusetts  
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# Our Study:

## Demonstrating the Relative Cost-Benefits of Reusing Historic & Non-Historic DoD Properties

Funded by:

Department of Defense  
Environmental Security Technology  
Certification Program (ESTCP)



# **Legal and Policy Framework**

- **National Historic Preservation Act of 1966 ( Amended)**
- **Energy Policy Act of 2005**
- **Energy Independence and Security Act of 2007**
- **Executive Order 13423: Federal Environment, Energy, and Transportation Management (2007)**
- **Executive Order 13514: Federal Leadership in Environment, Energy, Economic Performance (2009)**

# Facilities Context

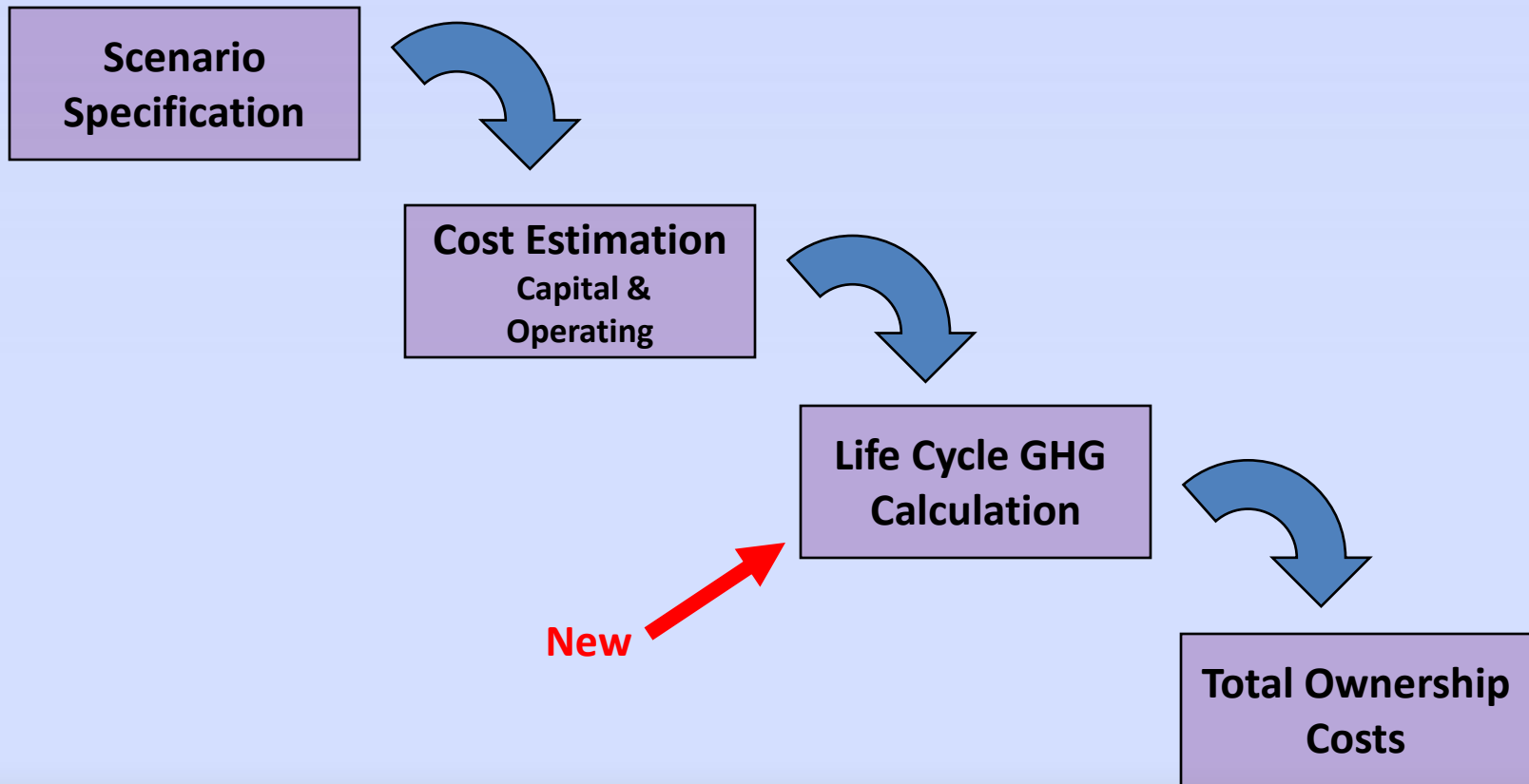
- The Department of Defense owns 345,000 buildings
- 105,000 of them are over fifty years old
- 42 % of US carbon emissions come from existing buildings (DOE)



# What the Study Looked at

1. Modernization costs of Pre-World War II Masonry Buildings compared to new construction
2. Life cycle energy costs achieved through modernization at a LEED Silver level compared to new construction
3. Scope 1,2 and 3 GHG savings associated with the reuse of Pre-World War II Buildings
4. Impact on project Net Present Value (NPV) of monetizing Greenhouse Gas Emissions (GHG) in Total Cost of Ownership analysis
5. Project cost and GHG differences by varying historic preservation and anti-terrorism force protection intervention
6. Challenges associated with replicating our approach

# A New Step for TOC Analysis



# PROJECT TEAM MEMBERS

## CO-PRINCIPAL INVESTIGATORS:

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Economics (BAE) and  
**Cherilyn Widell**, Seraph LLC

## Study Team:

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**Roger Catlett**, P.E. Comfort  
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# **Applicable design standards include:**

- ✓ **Whole Building Design Guide**
- ✓ **UFC 1-200-01 General Building Requirements**
- ✓ **UFC 4-610-01 Administrative Facilities**
- ✓ **UFC 1-900-01 Selection of Methods for the Reduction, Reuse and Recycling of Demolition Waste**
- ✓ **UFC 3-310-04 Seismic Design for Buildings**
- ✓ **DoD Minimum Antiterrorism Force Protection Standards for Buildings**
- ✓ **Secretary of Interior's Standards for Rehabilitation of Historic Buildings**



# **BUILDING SELECTION CRITERIA**

- ✓ **Non-residential**
- ✓ **“Typed” historic/non-historic  
DoD buildings**
- ✓ **Pre- World War II**
- ✓ **Masonry**
- ✓ **Cohesive technology (avoid  
buildings with additions)**
- ✓ **Climate variability**



# ORIGINAL DESIGN INTELLIGENCE

*Built-in green design characteristics which contribute to an ability to naturally conserve energy*

- ✓ **Durable materials**
- ✓ **Natural lighting and ventilation**
- ✓ **Heat wells**
- ✓ **Open floor plans**
- ✓ **Site orientation**
- ✓ **Basements**
- ✓ **Tall ceilings**
- ✓ **Plaster walls**



# FORT BLISS BUILDINGS 1 AND 115



**Building 115**  
**1911 Barracks**



**Building 1**  
**1906 Hospital**

# ST. JULIENS CREEK ANNEX

## Buildings 61 and 168



**Building 61**  
**1917 Warehouse**



**Building 168**  
**1941 Warehouse**

# F.E.WARREN AIR FORCE BASE (NHL) BUILDINGS 222 AND 323



**Building 222**  
**1906-1909 Barracks**



**Building 323**  
**1906-1909 Stables**

# ***DoD Building Treatment Terms***

- “Adaptive reuse & rehabilitation” are terms of art outside DoD
- The DoD term for “major rehabilitation” is “modernization”
- Modernization means: *“the alteration or replacement of facilities solely to implement new or higher standards to accommodate new functions or to replace a building component that typically lasts more than 50 years.”*
- This study compares the costs and GHG of modernization with new construction

# Building Scenarios

## **Sustainment/Status Quo**

- Formulated for measuring baseline energy consumption

## **Demolition and New Construction**

- LEED Silver certifiable construction – 2009 LEED for New Construction and Major Renovations

## **Full Modernization with Strict Application of Historic Preservation Standards (HPS)**

- Full modernization with a strict application of the Secretary of the Interior Standards for Rehabilitation and other DoD facility design standards including
- LEED Silver

## **Full Modernization with Strict Application of ATFP**

- Full rehabilitation/modernization but with strict application of Anti-terrorism Force Protection requirements , seismic and other DoD facility design standards
- LEED Silver

# GHG Calculators

## **Scope 1: Direct energy use on site**

- World Resources Institute, GHG Protocol

## **Scope 2: Purchased energy not controlled onsite**

- World Resources Institute, GHG Protocol

## **Scope 3: New building materials**

- Building for Environmental and Economic Sustainability (BEES)
- Athena Institute, EcoCalculator
- Economic Input-Output Life Cycle Assessment Model (EIO-LCA)

## **Scope 3: Transportation for demolition and waste disposal**

- World Resources Institute, GHG Protocol



# GHG SCOPE CALCULATOR

## CO2 analysis for Building 222 Scenario 2: Demo and New Construction

FOUNDATIONS AND FOOTINGS						121,059
Foundation Wall	Cast-in-place concrete (R-7.5XPS Continuous insulation)	-	Sq ft	8.92	Athena	-
	Cast-in-place concrete (R-7.5EPS Continuous insulation)	5,130	Sq ft	8.73	Athena	44,785
	Concrete block (R-7.5XPS Continuous insulation)	-	Sq ft	15.33	Athena	-
	Concrete block (R-7.5EPS Continuous insulation)	-	Sq ft	15.14	Athena	-
Foundation Slab	4" Poured Concrete Slab	10,530	Sq ft	4.06	Athena	42,752
Footing	Poured Concrete Footing	99	Volume (yd3)	338.61	Athena	33,522
Concrete Repairs						
	Epoxy/adhesives for concrete repairs	-	\$	1.18	EO-LCA	-
	Concrete leveling	-	\$	1.190	EO-LCA	-

**Total kg CO2e for Building 222 Scenario #4 Full Modernization w/ appropriate design exceptions = 121,059 kg**

**Athena EcoCalculator was primary source; updated Athena tool is Impact Estimator**

# Demolition and Weight Analysis

Each scenario requires a demolition cost estimate with materials weight analysis, a sample for HVAC:

#	Description	Reference	Weight
1	Outdoor chiller	Trane	3900.00 lbs
2	Attic make up air unit	Trane	1900.00 lbs
3	12 heaters in attic for attic	100 lbs. ea.	1200.00 lbs
4	4 exhaust fans	50 lbs. ea.	200.00 lbs
5	Piping		5000.00 lbs
6	27 fan coil units	150 lbs. ea.	4050.00 lbs
7	Duct work metal		5626.00 lbs
8	Add 20% for small accessories		4375.20 lbs
9		<b>Total weight</b>	<b>26251.20 lbs</b>
10		<b>Total weight in tons</b>	<b>13.13 tons</b>
11		<b>lbs/SF for HVAC demo (30,876 SF)</b>	<b>0.85 lbs/SF</b>

Weight data translates into truck trips for GHG calculation for demolition related activities

# Findings: Cost Effectiveness

- ✓ Pre-War Buildings can be cost effective compared to new construction on a Total Cost of Ownership basis (w/ and w/o factoring GHG)
- ✓ Example: Building 115 at Fort Bliss:

<u>Installation/Building/Project Alternative</u>	<u>Life Cycle Cost</u>	
	<u>Net Present Value with GHG (a)</u>	<u>% Difference from New Construction</u>
<b>Fort Bliss</b>		
<i>Building 115</i>		
FTBL 115-02: Demolition and New Construction	\$ 4,956,278	NA
FTBL 115-03: Modernization with HPS	\$ 3,791,391	-23.5% (b)
FTBL 115-04: Modernization with Full AT/FP	\$ 4,009,546	-19.1% (b)

Notes:

(a) Incorporates CO<sub>2</sub>e monetary value on a per MT basis.

(b) Achieved 15% NPV Cost Reduction Target =

Sources: Seraph LCC; BAE Urban Economics, Inc., 2012.

# Findings: Energy Performance

- ✓ Modernization of Pre-War Buildings can achieve comparable levels of energy consumption as new construction at LEED Silver level
- ✓ “Original design intelligence” features contribute to existing building performance
- ✓ **Example: Building 222 at F.E. Warren:**

<u>Installation/Building/Project Alternative (b)</u>	<u>MT CO2e Emissions (a)</u>			
	<u>Scope 1</u>	<u>% Difference from New Construction</u>	<u>Scope 2</u>	<u>% Difference from New Construction</u>
<b>F.E. Warren</b>				
Building 222				
FEW 222-02: Demolition and New Construction	5.0	NA	6,121	NA
FEW 222-03: Modernization with HPS	3.2	-36.9%	6,063	-0.9%
FEW 222-04: Modernization with AT/FP	5.6	11.2%	6,072	-0.8%

Sources: Seraph LCC; BAE Urban Economics, Inc., 2012.

# Findings: Total GHG Impacts

- ✓ On a life-cycle GHG basis, Pre-War Buildings generate less total GHG compared to new construction
- ✓ GHG savings from initial construction (Scope 3) is the driver of this result
- ✓ **Example: Building 222 at F.E. Warren:**

<u>Installation/Building/Project Alternative (b)</u>	<u>MT CO2e Emissions (a)</u>			
	<u>Scope 3</u>	<u>% Difference from New Construction</u>	<u>TOTAL</u>	<u>% Difference from New Construction</u>
<b>F.E. Warren</b>				
Building 222				
FEW 222-02: Demolition and New Construction	2,320	NA	8,445	NA
FEW 222-03: Modernization with HPS	1,070	-53.9%	7,136	-15.5%
FEW 222-04: Modernization with AT/FP	1,446	-37.7%	7,524	-10.9%

Sources: Seraph LCC; BAE Urban Economics, Inc., 2012.

# Life Cycle Cost Analysis

- **While GHG tons significant, incorporating GHG monetary value has small effect: 1.5 to 2% on LCCA**

# Findings: Replication of Demonstration

- ✓ No off-the shelf carbon calculator that integrates Scope 1, 2, & 3 emissions
- ✓ Existing calculators oriented to new construction, not historic rehabilitation or modernization
- ✓ Need easy cross-walk between cost estimation systems and carbon calculators
- ✓ Conclusion: not ready for “prime time”

# Key Findings ESTCP SI 0931

1

- Modernization of DoD's Pre-War Buildings masonry buildings can be **significantly less expensive** than new construction.

2

- DoD's LEED Silver standard can be met at **less cost with modernization** and Pre-War Buildings can contribute significantly to DoD's goals of lowering GHG emissions.

3

- By leveraging original design features for thermal comfort ("original design intelligence") with new, energy-efficient buildings systems, DoD can modernize Pre-War Buildings to **match the energy performance of new construction**.

4

- **Mission critical facility requirements can be fulfilled** through the adaptive reuse and modernization of Pre-War Buildings.

5

- Historic buildings should be considered a **valuable asset** and their reuse and modernization should be integrated into installation master plans.

6

- Prescriptive and rigid application of AT/FP and progressive collapse standards can result in significantly **higher modernization costs and at the same time generate higher levels of Scope 3 GHG emissions** than carefully specified AT/FP treatments.

## Recommended Actions

1

- Military planners should explore modernization and repurposing of Pre-War Buildings **before** considering new construction to meet installation mission requirements.

2

- Military service procurement procedures should be reviewed and revised to ensure **selection and use** of contractors with experience and knowledge of historic structures.

3

- DoD's MILCON and SRM funding programs should be reviewed and revised to **avoid piece-meal improvements** to historic structures and instead provide for full modernization.

4

- Prescriptive and rigid application of AT/FP and progressive collapse standards should be avoided. Greater emphasis on installation-wide security measures can **lower** AT/FP compliance costs for historic, and other existing structures.



## Recommendations

- ✓ Incorporate life-cycle GHG emissions analysis into DoD Military Construction (MILCON) and Sustainment Restoration and Maintenance (SRM) programs
- ✓ Give more emphasis to existing buildings as a viable project alternative to meet mission requirements
- ✓ Give more emphasis to existing buildings as a viable project alternative to reduce GHG emissions



## More Recommendations

- ✓ Invest in formulation of carbon calculator system ; current process not yet ready for “prime time”
- ✓ Place more emphasis on existing buildings to meet energy reduction goals
- ✓ Avoid modernization treatments that result in loss of original energy saving design features in Pre-War Buildings ; original design intelligence contributes to energy savings



# MORE INFORMATION?

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**Report Website:** The full report, Demonstrating the Environmental & Economic Cost-Benefits of Reusing DoD's Pre-World War II Buildings can be found at the following link

<<http://www.serdp.org/Program-Areas/Energy-and-Water/Energy/Conservation-and-Efficiency/EW-200931/EW-200931>>

# QUESTIONS, PLEASE!

