DEPARTMENT OF THE ARMY
SAVANNAH DISTRICT, CORPS OF ENGINEERS

SUSTAINABLE DESIGN STUDY
FOR
COMBAT AVIATION BRIGADE
SEPARATE BATTALIONS COMPLEXES

FT. BRAGG, N.C.

Final Submittal-March 30, 2000

KNIGHT
ARCHITECTS

Prepared By:
KNIGHT Architects, Inc.

In Cooperation With:

Donald Prowler & Associates, Philadelphia, PA

Benya Lighting Design, West Linn, OR
CTG Energetics, Inc., San Diego, CA
Design Harmony, Inc., Wake Forest, NC
ENSAR Group, Boulder, CO
Laubmann-Reed & Associates, Inc., Atlanta, GA
Steven Winter Associates, Norwalk, CT

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SUSTAINABLE DESIGN…

- *Meets the needs of the present without compromising the quality of life of future generations.*

- *Maintains economic growth while producing an absolute minimum of pollution, repairing environmental damages of the past, producing less waste, and extending opportunities to life in a pleasant and healthy environment.*

- *Meets human needs by maintaining a balance between development, social equity, ecology, and economics.*

- *Demands systematic consideration of environmental impact, energy use, natural resources, economy, and quality of life.*

- *Has optimal benefit only when addressed at the inception of the project, and throughout the entire life cycle of the project ¾ from concept to planning to programming, design, construction, and ownership.*

SUSTAINABLE DESIGN CHARETTE

Charrette (shuh-RET): A final intensive effort to finish a project, especially an architectural design project, before a deadline.

—Source: *Random House Dictionary of the English Language*

The Savannah District of the Army Corps of Engineers directed Knight Architects to assemble a team of architects and civil, electrical, and mechanical engineers to make sustainable design recommendations for two projects planned at Fort Bragg. The Combat Aviation Brigade Barracks Complex and Separate Battalions Barracks Complex will consist of eighty-four buildings totaling $244 million, funded over four years.

The team met in Savannah, Georgia, from 31 January to 2 February 2000, for a three-day charrette, a sustained and intensive gathering of individuals working both separately and corporately toward a larger objective. Using a format that combined presentations with discussion and breakout work sessions, the group reviewed the design and worked toward the formulation of specific recommendations for the facilities.

FOLLOW-UP REPORT

PRESENTATION ON THE REPORT AT FT. BRAGG, NC: For three days between 31 January and 2 February 2000, a team assembled by Knight Architects prepared recommendations for changes to the design of the Combat Aviation Brigade (CAB) and Separate Battalions Complexes at Fort Bragg, North Carolina. Knight Architects presented its report to the Department of the Army on 14 February.

A month later, on 17 March, representatives of the Sustainable Design Team—Don Prowler, Gail Lindsey, and Joe Knight—met with personnel from the Combat Aviation Brigade, Fort Bragg Master Planner, and the Savannah District, Corps of Engineers. The purpose of the meeting, held at Fort Bragg's Normandy House, was to review the Sustainable Design Study.

Knight began with a brief introduction in which he described the method of the charrette, or, the gathering at which the team developed its recommendations. He went on to discuss the evolution of the study itself; then all three representatives of the Sustainable Design Team reviewed important features of the report's various sections.

Central to the study, and to the efforts undertaken by the Sustainable Design Team, was the Site Analysis (please see Section II of this report). After Knight and Prowler enumerated improvements to the site design offered in the study, Savannah District Senior Project Manager Diego Martinez discussed aspects of the proposed redesign that the Savannah District Design Team had chosen to incorporate. Among these were:

a. Reducing the overall size of the barracks building footprint.
b. Creating a central greenspace on the Separate Battalions site.
c. Re-orienting the CAB barracks to terminate the natural axis created by the Airborne Mile jogging path.

Fort Bragg representatives commented that they would prefer to have the running path from the CAB site to Keerans Street detour around the wetlands—a route adjacent to Longstreet Road—rather than use the footbridge recommended in the site plan. Members of the Sustainable Design Team responded by pointing out that Longstreet is a heavily trafficked thoroughfare (see Section II, Site Analysis, p. 1), and that the Airborne Mile provides a direct, pleasant, and highly usable link between the CAB site and Keerans Street.

Asked how they would compare the current design's relative impact on the wetlands area to that of the site plan proposed in the Sustainable Design Study, members referred to the fold-out drawing that shows the proposed site plan redesign (see Section II, Site Analysis, p. 7 and 8). The dashed lines indicate building locations in the original design. Even a cursory glance reveals that the redesign has pulled buildings in from the edge of the wetlands. Thus construction will take place at a substantial remove from the wetlands

area, and extensive use of retaining walls at the edge of the wetlands will no longer be required.

Other observations by Fort Bragg and Savannah District representatives reiterated written comments made earlier by Savannah District Design Branch personnel who reviewed the study. These comments are included, along with responses of the Sustainable Design Team, in the section that follows.

In addition, Judy Winfrey of the Savannah District Design Branch created a matrix identifying the agencies responsible for action on specific matters relative to the redesign effort. The Sustainable Design Study defines over one hundred initiatives in the areas of site design, energy use, water quality, use of materials, and indoor environmental quality—initiatives with application not only to the two Fort Bragg projects, but to future Department of the Army undertakings. Given the wide scope of the study, it is important for the numerous entities involved to understand their roles, and for no aspect of the effort to fall between the cracks.

A version of the matrix is included on the following three pages. Also included are annotated review comments received by the Sustainable Design Team at the 17 March presentation.

SUSTAINABLE DESIGN ACTION MATRIX

RECOMMENDATION	Cross-Ref.	POTENTIAL ACTION/ SUPPORT LEVELS (Funding, Criteria, Standard Designs, CEGS, Planning, Design) DA	USACE	SAS	FT. BRAGG	CAB/S.B.	Comments
01. Add sustainable design statement, checklist requirement to 1391	ES1,PA1						
02. 25% recycled content design goal	ES1,R39						
03. Construction waste reduction spec	R51						
04. Establish LEED bronze rating requirement for new construction	LA1						
05. Modify LEED for Army projects	ES2						
06. Incorporate BIPV systems (200kW target)	ES2						
07. Incorporate solar thermal hot water systems	LA7						
08. Use single duct VAV in barracks	ES2						
09. Occupancy sensors at thermostats	ES2						
10. Revise std designs to add daylighting	ES2						
11. Insulated wall sheathing	R32						
12. Heat recovery from shower drains	ES2,EA10						
13. Low-flow fixtures	LA6,PA10						
14. Sunshading	ES2						
15. Solar bldg orientation	PA9						
16. Annual bldg energy analysis @ programming	ES2						
17. Annual bldg energy analysis @ post-occupancy	ES2						
18. Improve life-cycle costing models	ES2,PA1						
19. Incorporate LEED into std designs	ES2,PA2						
20. Incorporate LEED into Installation Design Guide	ES2,PA2						
21. Incorporate LEED into CEGS	ES2,PA2						
22. Incorporate LEED into design criteria	LA3,PA2						
23. Revise site plan to avoid wetlands	LA4						
24. Provide bus shelters	LA4						
25. Coordinate/provide bus transportation on installation	LA4						
26. Create carpool-only parking spaces	LA2						
27. Provide bike paths & shelters	LA4						
28. Indigenous/drought-tolerant landscaping	LA6,R50						
29. Combine barracks buildings	R34						
30. Re-use demolition rubble	LA8						
31. Add dimming controls	R2,R9						
32. High-efficiency pulse boilers for domestic water	EA10						
33. Enhanced roof insulation	LA5						
34. Shade parking lots	LA5						
35. Open-grid pavement	LA5						
36. White/light color roofing	LA5						
37. Low/height/minimal FC exterior lighting	LA6						

Cross-Reference Legend (Section Name & Page #)

SUSTAINABLE DESIGN ACTION MATRIX

RECOMMENDATION **POTENTIAL ACTION/ SUPPORT LEVELS**

(Funding, Criteria, Standard Designs, CEGS, Planning, Design)

	Cross-Ref	DA	USACE	SAS	FT. BRAGG	CAB/S.B.	Comments
38. Drip irrigation	LA6						
39. Grey water landscape irrigation system	R17						
40. 2.5gal/min faucet aerators	LA6,PA10						
41. 2gal/min shower heads	LA6,PA10						
42. Measurement/Verification of Energy Use	LA7						
43. Whole Building commissioning	LA7						
44. Green Power program participation	LA7						
45. Recycling storage/collection – Site	LA8,R39						
46. Recycling storage/collection – Std Designs	LA8,R39						
47. Certified wood	LA9						
48. Low-VOC emitting adhesives/sealants	LA9,R37						
49. Low-VOC emitting paints/coatings	LA9,R37						
50. Low-VOC emitting carpet	LA9,R37						
51. Low-VOC emitting board products	LA9,R37						
52. Entrance mats/grilles	LA10						
53. Sustainable design training	LA10,R27						
54. Demonstration projects	PA3						
55. Energy and Environment Awards Program category	PA3						
56. Encourage in-house sustainable design expertise	PA3						
57. Hire AEs with sustainable design expertise	PA3						
58. Share case studies	PA3						
59. Establish sustainable design team	PA3						
60. Incorporate Executive Orders	PA4						
61. Create energy monitoring/feedback/improvement loops	PA6						
62. Minimize project footprint	SA1,R34						
63. Pre-treat surface runoff	PA8						
64. Implement PV Panels	R29						
65. Demountable partitions (w/project funds)	R27,R31						
66. Raised floor system	R31						
67. 20% lighting reduction – barracks	R1						
68. 15% lighting reduction – Food Prep	R3						
69. Low ballast factor electronic ballast	R4,R6						
70. BTN HQ soffit lights- compact fluorescent	R7						
71. Change T-8 lamps to 835	R8						
72. Dining Facility kitchen skylights	R10						
73. Dining Facility clerestory, dormers at dining areas	R10						

Cross-Reference Legend (Section Name & Page #)

ES- Executive Summary **SA**- Site Analysis **PA**- Project Analysis **LA**- LEED Analysis **R**- Reference Sheets

SUSTAINABLE DESIGN ACTION MATRIX

RECOMMENDATION **POTENTIAL ACTION/ SUPPORT LEVELS**

(Funding, Criteria, Standard Designs, CEGS, Planning, Design)

	Cross-Ref	DA	USACE	SAS	FT. BRAGG	CAB/S.B.	Comments
74. BDE HQ clerestory daylighting	R11						
75. Revise SCB storage lamps	R13						
76. BTN HQ clerestory daylighting	R12						
77. Use independent ESCO including cogeneration	R14,R45						
78. Reduce exterior lighting criteria to IESNA RP-33	R15						
79. BTN HQ open office at exterior wall	R16						
80. BDE HQ open office at exterior wall	R16						
81. Co-locate chillers, use recovered heat	R19						
82. Central plant - Use CHW delta-T at 20-25degrees F	R20,R41						
83. Use dessicant dehumidification	R21						
84. Barracks – exhaust heat recovery to pretreat outdoor	R22						
85. Store/re-use demolition materials	R23						
86. Landscaping maintenance instructions	R23						
87. Use CERL for design assistance	R24						
88. Contractor incentive program	R25						
89. Spec for future recyclability	R26						
90. Energy savings performance contracting	R27						
91. Rent carpeting	R28						
92. Combine COF mech rooms	R28						
93. Light troffers for supply air	R31						
94. Barracks – raise clg ht/simplify ductwork	R33						
95. Maximize local materials	R35						
96. Revisit central plant VE	R41						
97. Cogeneration	R14,43						
98. Delete vinyl tile	R47						
99. Reduce particle board usage	R47						
100. Metal roofing	R48						
101. Insulated window covering	R48						
102. Decrease Force Protection	R49						
103. Waterless urinal	R52						
104. Lower toxic cleaning product usage	R53						

Cross-Reference Legend (Section Name & Page #)

ES- Executive Summary **SA**- Site Analysis **PA**- Project Analysis **LA**- LEED Analysis **R**- Reference Sheets

COMMENTS FROM SAVANNAH DISTRICT PERSONNEL

Name: Judy Winfrey
Discipline: Architecture
Section: Energy Analysis

In the last paragraph on page 1 of this section, "Fort Bragg" should be changed to "the project."
Response: The correction has been made.

Name: Judy Winfrey
Discipline: Architecture
Section: Energy Analysis

The charts refer to a combination scenario, which I think is described in the fifth paragraph on page 1 of this section. Recommend that a clear description of each element charted be added to the report immediately preceding the charts. Recommend also that some discussion of first-cost implications of these measures be added and that life-cycle costs be addressed.
Response: This is a good comment inasmuch as a person not familiar with the design charrette and specific energy saving initiative discussed there is at a loss to understand the specifics of how, for example, we reduce total kBtu use from 544,949 to 458,203. Given the time constraints of the charrette and the general nature of the report, it must suffice to say that the Sustainable Design Professionals feel that these energy saving implementation goals can be achieved. The Energy Analysis section by no means presents a fully documented and comprehensive energy analysis of the project or even of a specific building. The cost and complexity of such a study would be comparable to the effort expended on this entire report.
The same general response can be made to the request for life-cycle costing information. First cost and life cycle cost information on each recommendation will be essential to implementation strategy. However, that level of detail is beyond the scope of this report. This report is a conceptual presentation that is based on not only specific calculation made at the charette but on overall experience with sustainable design initiatives and their overall effect on a project.

Name: Judy Winfrey
Discipline: Architecture
Section: Executive Summary

Recommend that a list or chart be compiled of all recommendations in the report to identify the party (or parties) whose action is required for implementation þy Dept of Army action, USACE action, SAS action, Installation action, and CAB/SB project action. Organizing the recommendations by principal action offices will facilitate decision-making and improve the possibility that recommendations will actually bear fruit. The current format requires each entity to sort through the whole report to find the recommendations that are within their implementation domain.

Response: The Sustainable Design Action Matrix included in this revised report was originally developed by Judy Winfrey.

Name: Judy Winfrey
Discipline: Architecture
Section: Executive Summary, Site Analysis Observation

The development of the 1391 does include site selection and evaluation in order to capture anticipated infrastructure costs in the funding request. The statement that 1391 development occurs without site evaluation is not correct. An appropriate revision to this statement is that sustainable design opportunities are not systematically considered in the project initiation/site evaluation/1391 development phase, and are therefore not planned for and funded.

Response: Have revised Executive Summary comment to reflect this wording.

Name: Judy Winfrey
Discipline: Architecture
Section: LEED Analysis

The LEED chart was mistakenly placed in the Energy Analysis section. Please correct this at next report.
Response: Actually the single 11" X 17" sheet following page 9 is the DOE-2 analysis of the typical barracks building. It has been labeled as such and given page number 10 in the Energy Analysis section.

Name: Judy Winfrey
Discipline: Architecture
Section: Process Analysis, p. 1, para. 1(b)

In addition to Army Corps of Engineers employees, it is critical that Master Planning and Public Works personnel at the installations receive training. Please add that to this paragraph.

Response: Have revised Process Analysis summary to reflect this comment.

Name: Judy Winfrey
Discipline: Architecture
Section: Site Analysis

If the Force Protection noncompliance issues at the COFs relate to the distance between the COF buildings, recommend combining COFs into single larger buildings housing more than two COFs each.

Response: Agreed. The current COF standard for only 2 companies in each building was implemented before the current Force Protection criteria relative to separation between buildings.

Name: Haught
Discipline: Civil Engineering
Section: Site Analysis (Layout)

We prefer the buildings across the street instead of a large block of parking to minimize the distance any barracks resident would have to walk to get to his vehicle.

Response: The Sustainable Design team chose to redesign the site based more on sustainable design principles including limiting the development of land. By limiting development to the area south of Butner Rd., site redesign also allows the project to be built out of the restricted flight path area. The design is not based primarily on design for the convenience of the automobile. A comment was made at the March 17th meeting that we should recommend the construction of parking garages. These have been non-starters in the past, but a parking garage would solve the distance problem as well as limiting the development of land.

Name: Haught
Discipline: Civil Engineering
Section: Site Analysis (Layout)

Doesn't appear that Keerans St. is wider. Higher traffic counts may require that it be widened to 4 lanes.

Response: We were unaware of the widening at the time of the Charrette.

Name: Haught
Discipline: Civil Engineering
Section: Site Analysis (Layout)

Stormwater management: I think by dealing with each project individually, rather than addressing the problem in terms of the net effect of all the projects planned in the area, we're delaying resolution of the problem. This will ultimately push the price up.

Response: This comment must be addressed by Savannah District and Ft. Bragg.

Name: Mark Kolasinski
Discipline: Civil Engineering
Section: Site Analysis (Layout)

Force protection distances not met for Dining Facility and
Battalion Headquarters. (Separates.)

Response: In general, we have maintained 50' between buildings and 80' between parking and buildings. The Dining Facility, like the COF's, has a loading area. This makes the Force Protection separation criteria a bit unclear. Also, since the charrette, 200+ soldier housing has been added to the program. This makes for a much more difficult site planning exercise!

Name: Mark Kolasinski
Discipline: Civil Engineering
Section: Site Analysis (Layout)

Fire trucks do not have easy access from existing pavement to the
barracks courtyards. (Separates.)

Response: This is true, but the problem could be solved by increasing distance between SCB and barracks wing.

Name: Mark Kolasinski
Discipline: Civil Engineering
Section: Site Analysis (Layout)

Site should be adjusted for the widening of Keerans Street to four lanes from two lanes. All widening will be to the side adjacent to the Separates site.

Response: Again, the proposed widening of Keerans St. was not a known issue at the time of the charrette.

Name: Mark Kolasinski
Discipline: Civil Engineering
Section: Site Analysis (Layout)

Possible site layout revisions due to increase in billet requirements and unit integrity. (Separates.)

Response: The increase in soldier billeting was not a known issue at the time of the charrette.

Name: Mark Kolasinski
Discipline: Civil Engineering
Section: Site Analysis (Layout)

I like the idea of placing all the buildings on one side of the street and using the area north of Butner Road for POV parking.

Response: This initiative allows for us to test whether Ft. Bragg really requires as much parking as has been assumed. Given the funding process it may be difficult to do this, but the most logical move would be to build a gravel lot and pave it later if the lot is actually needed.

Name: Mark Kolasinski
Discipline: Civil Engineering
Section: Site Analysis (Layout)

Site cost could be more, not less, by revising the site layout of the CAB. Less land will be disturbed, but the site will require extensive retaining walls with railing to prevent the site from impacting the wetlands. If site were spread out more, the need for retaining walls could be removed. The additional area could be replanted, and would still remain a green area.

Response: We don't really understand this comment inasmuch as by pulling the buildings further away from the wetlands we are left with more room to grade thereby lessening the need for retaining walls.

Name: Mark Kolasinski
Discipline: Civil Engineering
Section: Site Analysis (Layout)

Parking requirement as shown is approximately 290 spaces short for the CAB complex.

Response: We would suggest the parking shortfall be made up in the area north of the C.A.B. barracks building(s).

Name: Mark Kolasinski

Discipline: Civil Engineering
Section: Site Analysis (Layout)

The 75-POV parking lot to the southwest of the CAB dining facility and access drive cannot be constructed. This area is presently a large (+0.5 acre) permanent erosion-control detention basin. Thus there is an additional 75-slot shortfall in the parking allocation for the CAB.

Response: Agreed. The redesign showed no reclamation of wetlands for parking- perhaps it will be necessary to do this to provide adequate parking for the site.

Name: Mark Kolasinski
Discipline: Civil Engineering
Section: Site Analysis (Layout)

CAB COF access drives must be revised to tie into Longstreet opposite from Honeycutt Road. A traffic light is programmed to be installed at this location.

Response: We agree that the CAB COF access drives should be relocated to align with Honeycutt.

Name: Mark Kolasinski
Discipline: Civil Engineering
Section: Site Analysis (Layout)

I like the idea of placing POV parking in the center of the COF area in the CAB.

Response: As we mentioned at March 17th meeting, it should not be too difficult to control POV access to parking area with COF 'compound'.

Name: Mark Kolasinski
Discipline: Civil Engineering
Section: Sustainability Resource Nos. 14, No. 18

Due to site constraints, room for the suggested energy services facility may not be available.
Response: This is an issue for Ft. Bragg and Savannah District to decide.

Name: Mark Kolasinski
Discipline: Civil Engineering
Section: Sustainability Resource No. 17

Location of storage facilities must be in accordance with force protection requirements. May require separate collection basins and pumps for each building.

Response: This is an issue for Ft. Bragg and Savannah District to decide.

Name: Mark Kolasinski
Discipline: Civil Engineering
Section: Sustainability Resource No. 19 top

Siting must be within force protection requirements. Open site areas may not be available, or location may be in front of site.

Response: This is an issue for Ft. Bragg and Savannah District to decide. The original (10%) site plan had a Central Energy Plant. Couldn't this house the chillers?

Name: Mark Kolasinski
Discipline: Civil Engineering
Section: Sustainability Resource No. 23 top

Agree, if space on the installation is available for the different type of materials to be recycled.

Name: Mark Kolasinski
Discipline: Civil Engineering
Section: Sustainability Resource No. 29 top

Yes. Life of product Constructibility Maintenance Change in use of site Frequency of POV passes Durability to oil products.

Name: Mark Kolasinski
Discipline: Civil Engineering
Section: Sustainability Resource No. 34

Agree. Fire trucks must have access to the courtyard. User may have problems with unit integrity. Design going this way to reduced square-footage cost to be within cost limits.

Name: Mark Kolasinski
Discipline: Civil Engineering
Section: Sustainability Resource No. 49

Force protection required. Protection should be looked at being the same as factories and corporate offices that have restricted entrances, not a sport facility.

Name: RANDALL
Discipline: Civil Engineering
Section: Site Analysis (Layout)

Does the new proposed layout fit the area indicated? How will this affect the wetlands? Need to consider leaving Bigler as a through street. (KJH note: on the latter issues, I would like for the traffic study to determine if traffic counts dictate that we must have another thruway in addition to Keerans).

Response: The proposed layout (we assume you are talking about the Separate Battalions site) fits on the site based on the number of billets programmed for the site at the time of the charrette. We would have to restudy given the new program. Have addressed wetlands question on page 1 of this section. Recommend against taking Bigler thru the site as it breaks down the neighborhood that could be created. These soldiers don't need to live on a large traffic island.

Name: RANDALL
Discipline: Civil Engineering
Section: Site Analysis (Layout)

When and what kind of traffic analysis had been done on the layout? (KJH note: we have requested a traffic analysis in Phase

3). The major concern here is daily military vehicle operational traffic. Yes, there are access roads to each of the battalions' COFs, which provide access for daily traffic to and from the COFs. However, what about airborne operations, FTXs, alerts, etc.? Where are we going to line up 6 x 80 PAX tractor-trailers, or eight or ten FMTVs? I am not familiar with the dimensions of the COF parking lots, but my guess is they will be filled daily with other vehicles. This limits other military vehicles to movement only along the access roads to the COFs. They cannot drive or park in the POV parking lots because this would open up liability issues of military vehicles hitting POVs. Need to include PT areas in design. (KJH note: lack of real estate will likely preempt designing for mobilization functions to the extent mentioned, but we will consider these issues in layoutdiscussions.)

Name: WRIGHT
Discipline: Civil Engineering/Environmental
Section: Sustainability Resource No. 17

EN-DG does not recommend the use of gray water. The following disadvantage are:

1. Requires plumbing redesign. ***Agreed.***
2. Increases cost. ***Agreed.***
3. Increases maintenance because gray water is being used to help clean the plumbing lines and keep the lines from becoming clogged. ***We do not understand the comment.***
4. Gray water, when sprayed, may cause eye infection from shower drains, or skin rash from detergents and cleaning agents. ***Graywater could also be used for flushing toilets only, which would avoid the possible rashes when it is used for landscape watering.***
5. The amount of gray water is small compared to the rainfall accumulation. There is plenty of rainfall in this area to support plant life once the plants have been established. ***See previous comment. Is this true about the rainfall versus accumulated gray water for this type of facility?***

ENDG recommends only considering Rainwater runoff collection to be used for irrigation.

Name: Michael Brennan
Discipline: Electrical Engineering
Section: Sustainability Resource No. 1

Concur, except as noted: The recommended reduction in lamp wattage will reduce the general illumination level. If the reduced illumination level is still within the IES recommendation for residential environments, lamp wattages will be reduced. The

age group expected in the barracks complex will be considered in determining the applicable IES recommendations.
Name: Michael Brennan
Discipline: Electrical Engineering
Section: Sustainability Resource Nos. 10-12

Concur, except as noted: Recommendation will reduce life cycle cost, but will increase initial cost. Recommendation may negatively effect building aesthetics.

Name: Michael Brennan
Discipline: Electrical Engineering
Section: Sustainability Resource No. 13

Concur.

Name: Michael Brennan
Discipline: Electrical Engineering
Section: Sustainability Resource No. 15

Calculated lighting levels in parking areas are 25 lux (average) and 6 lux (minimum). These closely match the recommended maintained horizontal illuminances for parking facilities listed in IES Handbook Figure 24-23. The IES recommended lighting levels are 22 lux (average) and 10 lux (minimum) in high-activity parking areas, and 11 lux (average) and 6 lux (minimum) in medium-activity parking areas. Instead of reducing general lighting levels in the parking areas, it may be advisable to provide controls to reduce lighting levels only during low activity times, such as between midnight and pre-dawn.

Name: Michael Brennan
Discipline: Electrical Engineering
Section: Sustainability Resource No. 2

Concur, except as noted: Recommendation will reduce life cycle cost, but will increase initial cost.

Name: Michael Brennan
Discipline: Electrical Engineering
Section: Sustainability Resource No. 3

Concur, except as noted: The recommended reduction in lamp quantity will reduce the general illumination level. If the reduced illumination level is still within the IES recommendation for commercial kitchen areas, lamp quantities will be reduced. Specular reflectors will be included in the lighting calculations.

Name: Michael Brennan
Discipline: Electrical Engineering
Section: Sustainability Resource No. 4

Concur.

Name: Michael Brennan
Discipline: Electrical Engineering
Section: Sustainability Resource No. 5

Concur, except as noted: Recommendation will provide lighting flexibility, but will increase initial cost.

Name: Michael Brennan
Discipline: Electrical Engineering
Section: Sustainability Resource No. 6

Concur.

Name: Michael Brennan
Discipline: Electrical Engineering
Section: Sustainability Resource No. 7

Concur.

Name: Michael Brennan
Discipline: Electrical Engineering
Section: Sustainability Resource No. 8

Concur, except as noted: Recommendation will increase lighting efficiency, but will also increase initial cost.

Name: Michael Brennan
Discipline: Electrical Engineering
Section: Sustainability Resource No. 9

Concur, except as noted: Recommendation will provide lighting flexibility, but will increase initial cost.

Name: WELCH
Discipline: Landscape Architecture
Section: LEED Analysis

Provide a manual for landscape maintenance. There is a corps spec on that: Section 02935, Exterior Plant Material Maintenance. But it can be greatly improved with photos and more detailed information. I will check into that.

Response: This is an issue to be decided by the Savannah District.

Name: WELCH
Discipline: Landscape Architecture
Section: LEED Analysis, p. 6

Using drought resistant plants: I try always to use hardy native and non native plants that don't require too much water. The water problem is in getting the plants established in their first year after planting. During this critical time, if the plants are not watered, enough they will die. No one is available to do watering at the bases. Once established, most shrubs (with a few exceptions like our well-loved azalea) will survive with the rainfall we get in the South, unless there is a prolonged, severe drought. Irrigation helps assure that the plants will survive and become well-established. I do agree that we could use drip irrigation more, but keep in mind it is very labor-intensive in setting down all the many emitters.

Response: We have sent a listing of drought-tolerant plants for North Carolina landscapes as a possible appendix item to be issued as a follow-up to this report.

Name: WELCH
Discipline: Landscape Architecture
Section: LEED Analysis, p. 6 and Sustainability Resource No. 50

I have always tried to use native plants, and in my review of AE have always requested from them to use more native plants. So I do agree with this principle.

Response: See response to above comment.

Name: GOBIN
Discipline: MEC EMC
Section: Sustainability Resource Nos. 10, 11, 12

The use of more daylighting in these facilities has the potential for significant energy savings as well as improvement of indoor environmental quality. However, this would require significant redesign efforts. To be done correctly and provide maximum benefit,

the design process would require: (1) the use of analysis tools we don't currently have, (2) time, and (3)training.

Response: The sustainable design professionals who participated in the study are available to help with items 1 and 3. Item 2 is outside of our purview.

Name: GOBIN
Discipline: MEC EMC
Section: Sustainability Resource Nos. 14, 18, 45

The use of an ESCO to furnish thermal energy via a central plant would have several advantages. No additional DPW personnel would be required to operate/maintain plant. Cost of the plant could be eliminated from the project, and these savings might possibily be available for implementation of other sustainabily strategies. FEMP has programs and contracts in place to help government agencies evaluate and implement this type of proposal.

Name: GOBIN
Discipline: MEC EMC
Section: Sustainability Resource No. 29

The use of photovoltaics for peak shaving could reduce operating costs. Would probably be a significant first cost increase, even with incentives/rebates from power company.

Name: KING
Discipline: Mechanical Engineering
Section: Energy Analysis, p. 2

VAV [variable air-volume HVAC] systems in barracks will probably become a thing of the past due to current intensive efforts to greatly reduce costs of building barracks.

Response: It was understood at the March 17th meeting that decision has been made that VAV system will not be used in the barracks.

Name: KING
Discipline: Mechanical Engineering
Section: Energy Analysis, p. 2

Recovery from showers in barracks won't be cost-effective in barracks. It could prove cost-effective, however, in a facility employing gang showers, where the heat recovery could be centralized.
Agreed that the economics will be better for gang showers. However, there are relatively inexpensive heat traps that are designed for single shower units. They have

proven to be economic in residential application in California (and in fact are required by code in certain cities now). I suggest that a more detailed cost effectiveness study be performed under a separate scope of work.

Name: KING
Discipline: Mechanical Engineering
Section: Energy Analysis, p. 2

Good idea to have Army criteria updated in terms of a sustainable design approach.

Name: KING
Discipline: Mechanical Engineering
Section: Energy Analysis, p. 5

Based on the bar graphs, seems as though we would want to evaluate the savings of daylighting on buildings with high lighting loads and large cooled areas.

Name: KING
Discipline: Mechanical Engineering
Section: Energy Analysis, p. 7

We can do better in the area of renewable energies; but generally, these increase first cost, and it appears we are moving more and more to a first-cost approach at the expense of life-cycle cost concerns.

Name: KING
Discipline: Mechanical Engineering
Section: Sustainability Resource No. 10

Resources 10 through 12 are architectural as well as mechanical concerns. Mechanically, this item is OK.

Name: KING
Discipline: Mechanical Engineering
Section: Sustainability Resource No. 14

If we go design-build, the contractor will have the liberty to determine the mechanical systems. If we go the conventional route, what is being proposed is mostly a base call, since the proposal is one of an operational nature.

Name: KING
Discipline: Mechanical Engineering
Section: Sustainability Resource No. 17

The long-term effects of this proposal would need to be addressed.

Name: KING
Discipline: Mechanical Engineering
Section: Sustainability Resource No. 19

Would have to look at the cost-effectiveness of trying to centralize a decentralized scheme. Even if the chillers could be centralized, the hot water generated through recovered waste heat would have to be piped to the otherwise decentralized mechanical systems.
Generally, we find that cost effectiveness of heat recovery from the chiller condenser bundle is iffy in most cases. My suggestion would be to consider heat recovery from the chillers only if a central chiller/boiler plant is installed, to facilitate getting the waste heat to the central point of hot water generation.

Name: KING
Discipline: Mechanical Engineering
Section: Sustainability Resource No. 20

Don't recommend. This carries some unique O and M challenges, and the claim to additional dehumidification is questionable.
Agreed- on the O&M side of things, as deeper coils are trickier to clean than standard 2- or 4-row coils. Assuming that good filters are used, and that they are changed regularly, however, we usually don't find that too much gunk accumulates on the inner rows of the coils. If maintenance practice is seriously lax, however, accumulation of dirt that impinges on the coils will be aggravated by the deeper coil configuration. Regarding dehumidification, assuming that the chilled water coil is controlled to provide a constant leaving db temperature then there will not be much of a dehumidification effect, as stated. What can improve dehumidification is (1) the lower chilled water supply temperature that is usually used in large temperature differential systems, and (2) more coil surface area available for moisture removal, and reduced bypass of hot, humid air.
All of these things considered, the advantages of doubling or tripling the temperature differential is formidable. Pipe sizes are drastically reduces, as are sizes of valves, actuators, pumps, motors, and electrical feeders.

Name: KING
Discipline: Mechanical Engineering
Section: Sustainability Resource No. 21

Need to see if fan coil units can handle additional sensible load from outside air.

Most dessicant systems include an integral cooling coil to removal sensible heat that is added by the dessicant wheel. Thus, the air leaving the dessicant system is relatively cool dry. It is not expected that the fan coils will be impacted in any meaningful way.

Name: KING
Discipline: Mechanical Engineering
Section: Sustainability Resource No. 22

The low temperature of the waste heat will probably not pay off.
Agreed. Assuming exhaust is 75 to 85 degrees, there probably isn't too much we can do with it. In cafeteria and laundry spaces, however, this might not be the case.

SECTION I- EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

In early 2000, planning for the Combat Aviation Brigade (CAB) Barracks Complex and Separate Battalions Barracks Complexes at Fort Bragg, North Carolina, had reached a stage of completion known within the architectural and engineering professions as a "10 percent design." In other words, the broad outlines of the project had been defined, but the overall design was only about 10 percent complete, making it possible to change specifics as they related to environmental sustainability. It was at that point that Knight Architects organized and conducted a sustainable design charrette to critique the 10 percent design. The goal of this activity was to:

- Identify opportunities for incorporating sustainable design principles into the project;
- Suggest strategies to better integrate sustainable design concerns within the existing Army design and procurement process.

Based on site design, energy consumption, and materials analyses conducted in the course of the charrette, the sustainable design team makes the following major observations and recommendations, both for Fort Bragg and for the Army as a whole, in each of four areas:

SITE ANALYSIS

- **OBSERVATION:** The existing Army building procurement process, (through DD Form 1391) does not systematically consider state-of-the-art environmental and sustainable site design issues in the project initiation and site evaluation. Therefore, sustainable site design is not planned for or funded.

- **RECOMMENDATIONS:** *At Fort Bragg*, we recommend a redesign of the site plan to reduce the footprint of development by 20 to 25 percent. This will decrease project first cost; maintain force protection; improve quality of life at the brigade level by establishing a greater sense of community; and reduce degradation of the existing wetlands. *From an Army perspective*, we recommend that steps be taken to incorporate sustainable site planning concerns within the DD Form 1391 process.

LEED™ ANALYSIS

- **OBSERVATION:** The Army has not yet aggressively incorporated the spirit of Executive Orders related to sustainable design, such as EO No. 12873 ("Federal Acquisition, Recycling and Waste Prevention"), which mandates the use of recycled-content material and recyclable materials and assemblies in new construction.

- **RECOMMENDATIONS:** *At Fort Bragg,* we recommend that a target of 25 percent recycled content be set, as described in the LEED™ Green Building Rating System, and that aggressive construction and demolition (C&D) waste specifications be employed. *From an Army perspective,* we recommend that model specifications be created and adopted to guide both materials selection and C&D practices.

ENERGY ANALYSIS

- **OBSERVATION:** Compared to other aspects of sustainable design, the Army has been more aggressive at capturing energy efficiency opportunities. However, Executive Orders mandating the use of renewable energy sources and reduced emissions, most notably No. 13123 ("Greening the Government through Efficient Energy Management"; superseded No. 12902, "Energy Efficiency and Water Conservation at Federal Facilities"), have not received similar attention.

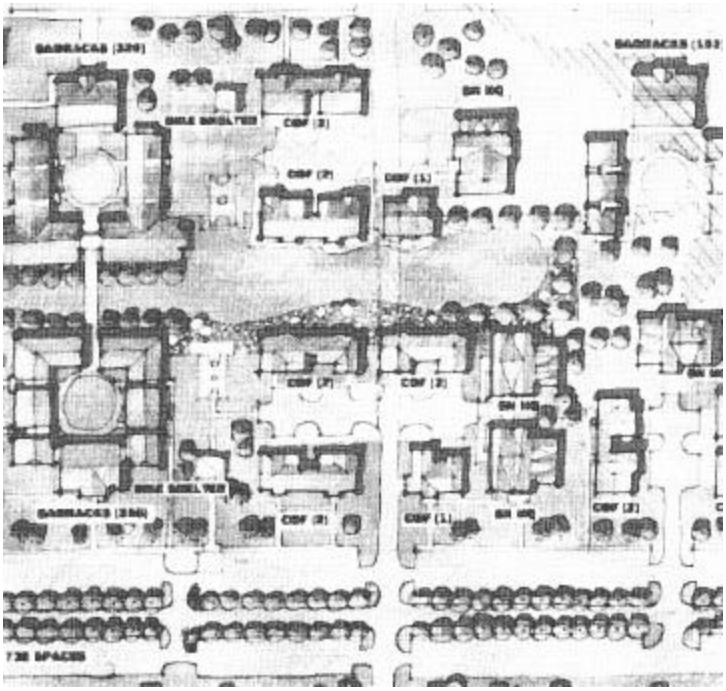
- **RECOMMENDATIONS:** *At Fort Bragg,* we recommend the adoption of modest-sized renewable energy systems, including building integrated photovoltaics (BIPV) and solar thermal hot water. We also recommend the inclusion of a number of energy conservation, water, and high-efficiency system strategies including single duct VAV systems in barracks; occupancy sensors to control thermostats; daylighting; improved barrack lighting and controls; enhanced wall and floor assemblies; heat recovery from shower drains; low-flow fixtures; and sunshading where appropriate. *From an Army perspective,* we recommend that annual building energy analysis be incorporated earlier in the design process; carried through design completion; and verified after occupancy begins.

PROCESS ANALYSIS

- **OBSERVATION:** There is currently no explicit mechanism by which sustainable design considerations can be evaluated at any step within the traditional Army design and procurement process.

- **RECOMMENDATIONS:** *At Fort Bragg,* we recommend that the current project seek to achieve the equivalent of a Certified (formerly Bronze) LEED™ rating while acknowledging the deficiencies of the LEED™ system in the military, residential context. *From an Army perspective,* we recommend that steps be taken to incorporate sustainable concerns—including objective goals and improved life-cycle costing models—into standard prototype designs, base installation manuals, and discipline-based criteria documents.

SECTION II- SITE ANALYSIS



SITE PLAN OVERVIEW

OVERALL CONSIDERATIONS: The original site plan for the Combat Aviation Brigade and Separate Battalions Complexes took into account the traditional concerns of architecture, function and form. In the twenty-first century environment, however, the scope of *function* has broadened to include concerns over sustainability and quality of life; hence the reconsideration and reconfiguration of the site plan with those issues in mind.

The site plan redesign team approached its work with two principal objectives: to reduce the overall site footprint, and to make other improvements to the overall quality of life for those who live or work in or near the two complexes.

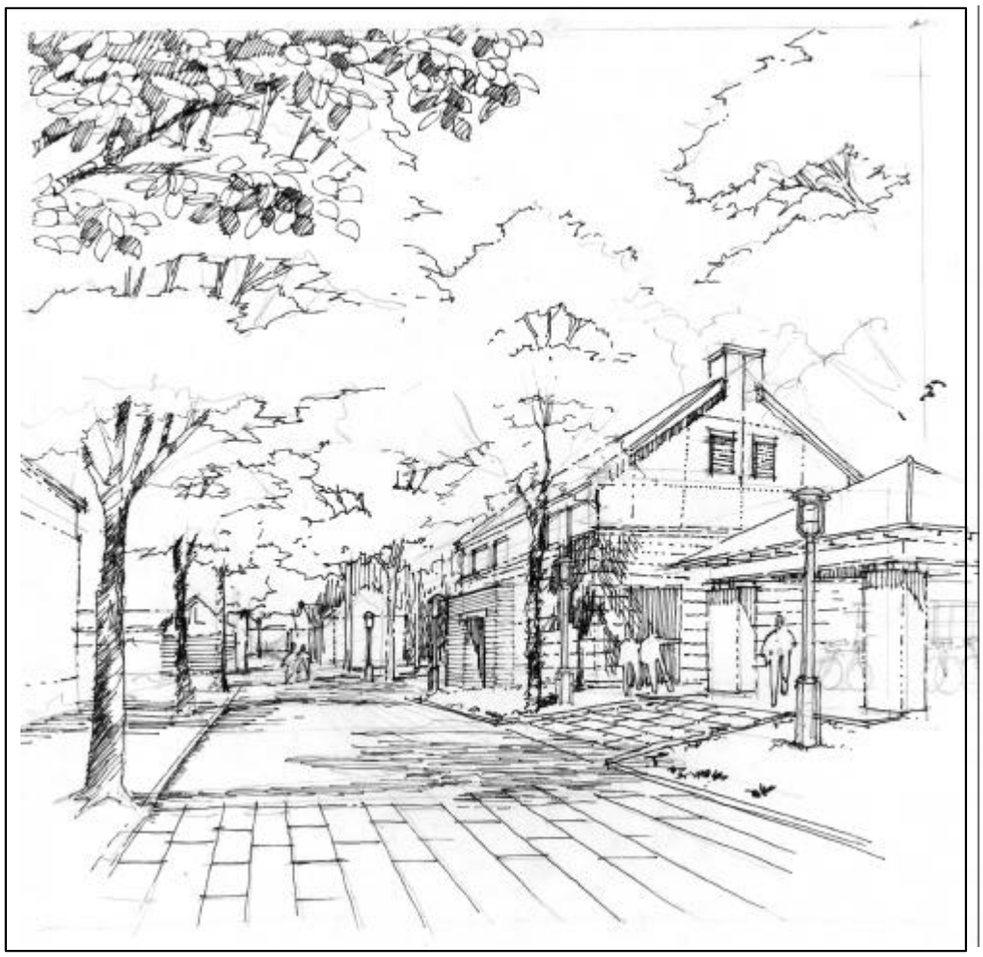
SITE FOOTPRINT REDUCTION: The size of the Combat Aviation Brigade and Separate Battalions Complexes is roughly the same as that of the historic downtown district in Savannah, Georgia. The two brigade complexes comprise about 2 million square feet, but whereas the Savannah downtown is home to over forty thousand people—and temporary home, during the day, to many thousands more—the two Fort Bragg complexes will provide housing for 1,700 and work space for 3,500 soldiers.

The point is that even with the large building-to-building and building-to-parking separations required by force protection criteria, Ft. Bragg is sacrificing a very generous amount of real estate to house the two complexes. Consequently, the site redesign team established an objective of reducing the overall site coverage in order to leave as much land undisturbed as possible. In particular, the team sought to decrease the amount of impervious surface as much as was feasible in an effort to reduce pollution of groundwater and allow for replenishment of the aquifer.

The first step in reducing total site coverage was a redesign of the barracks building prototype. *Please see Section VI, Sustainable Resources, Resource Sheet 34, for the "attached U" barracks design.*

Right: *Afternoon traffic on Longstreet. At present, the route to the nearest physical training (PT) sites takes personnel along this busy thoroughfare.*

Initially the team considered combining the two complexes on a single site, the one originally identified for the Separate Battalions Complex. After initial review, however, it became apparent that force protection requirements for building and parking separation made this impractical. Yet the team was able, in its redesign efforts, to bring the Barracks, Battalion HQ's, and Company Operations Facilities formerly sited north of Butner Road onto the main Separate Battalions site. This freed up approximately 10.5 acres on the site north of Butner, between Cole Street on the west and Ogden Street on the east.



Left: *The "Airborne Mile" in the company operations facility complex of the Combat Aviation Brigade. This pedestrian route would replace the Longstreet sidewalk as the principal conduit between barracks and PT areas.*

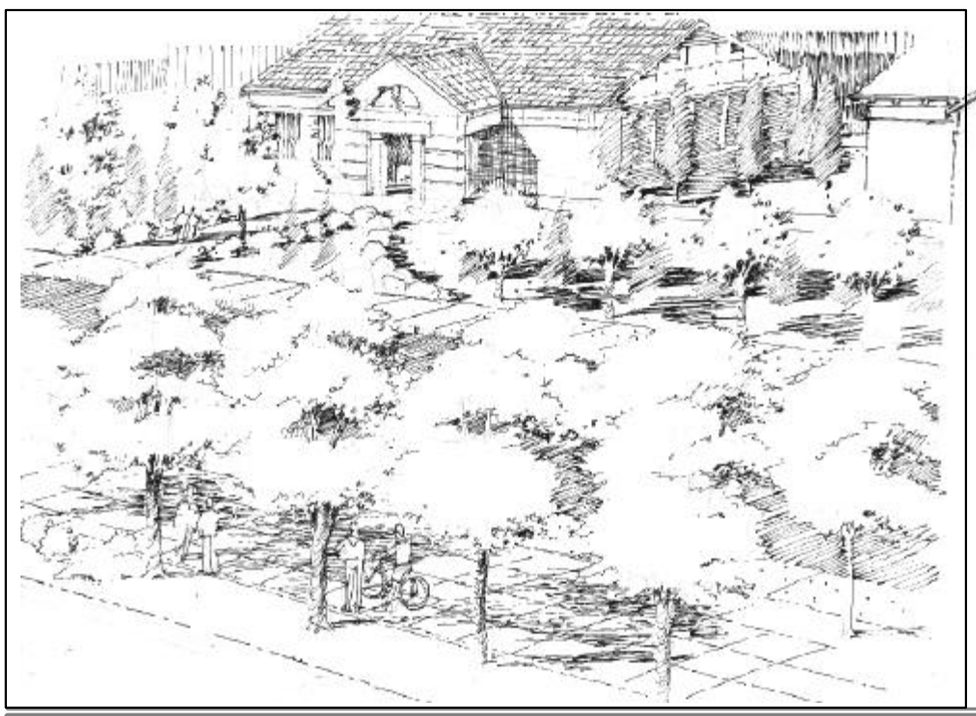
On the 10.5-acre site north of Butner Road, the redesign team proposed a gravel lot for as many as 1,160 cars. This lot could later be paved if paving proves essential to the function of the Separate Battalions Complex; in the meantime, keeping it unpaved would further limit the amount of impervious surface.

QUALITY OF LIFE IMPROVEMENTS: In its larger effort to improve quality of life for the personnel living and working in the two complexes, the site redesign team took into account a number of specific objectives. These include enhancing the air quality, establishing a comfortable relationship between the built environment and the surrounding natural environment, and providing a space compatible to both physical and psychological needs.

Right: *A view from Butner Road looking south, toward the future site of the Separate Battalions Complex.*

Hence the team set out to:

- Encourage the use of mass transportation.
- Direct privately owned vehicles (POVs) to large existing and potentially underutilized parking lots at locations other than the site in question.
- Encourage the use of bicycles by appropriately siting bike paths, bike shelters, and access to showers for personnel on their way to work.
- Protect wetlands by preventing the built environment from encroaching on those areas as much as possible.
- Use indigenous plantings as much as possible.
- Site buildings with particular attention to walking distances and separation of parking and living spaces.



Left: *The "Airborne Mile" runs between rows of trees in the south parking lot of the Separate Battalions Complex.*

With these objectives in mind, the team incorporated a number of general and specific design elements, among them the following:

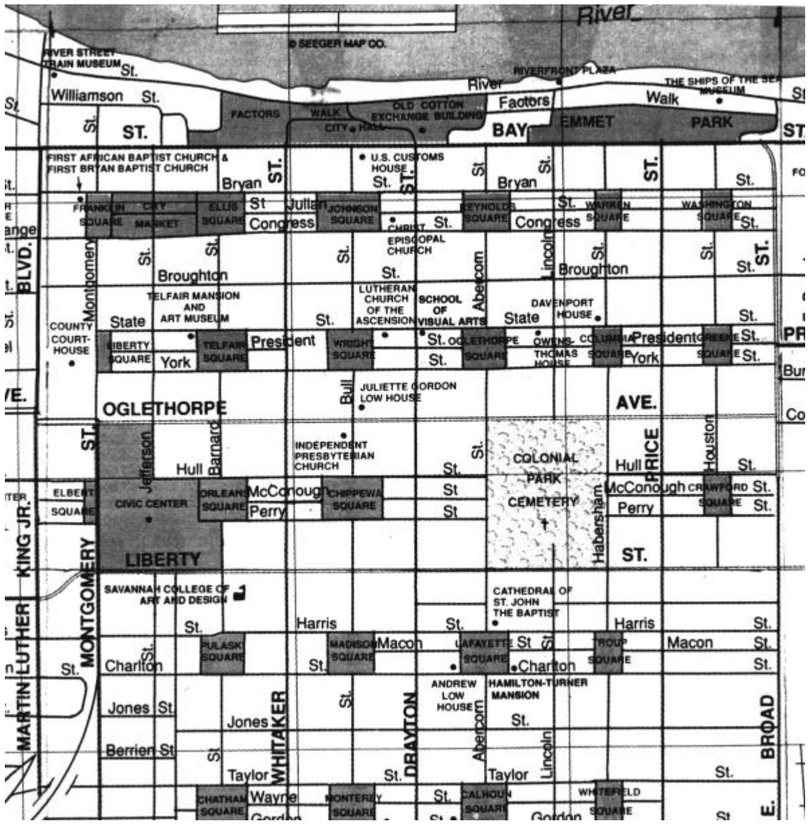
1. A master plan that maintains the unit integrity central to the original, while incorporating aspects of the linear Beaux Arts master planning prevalent in other recent large barracks complexes in the 82nd Airborne Division area.

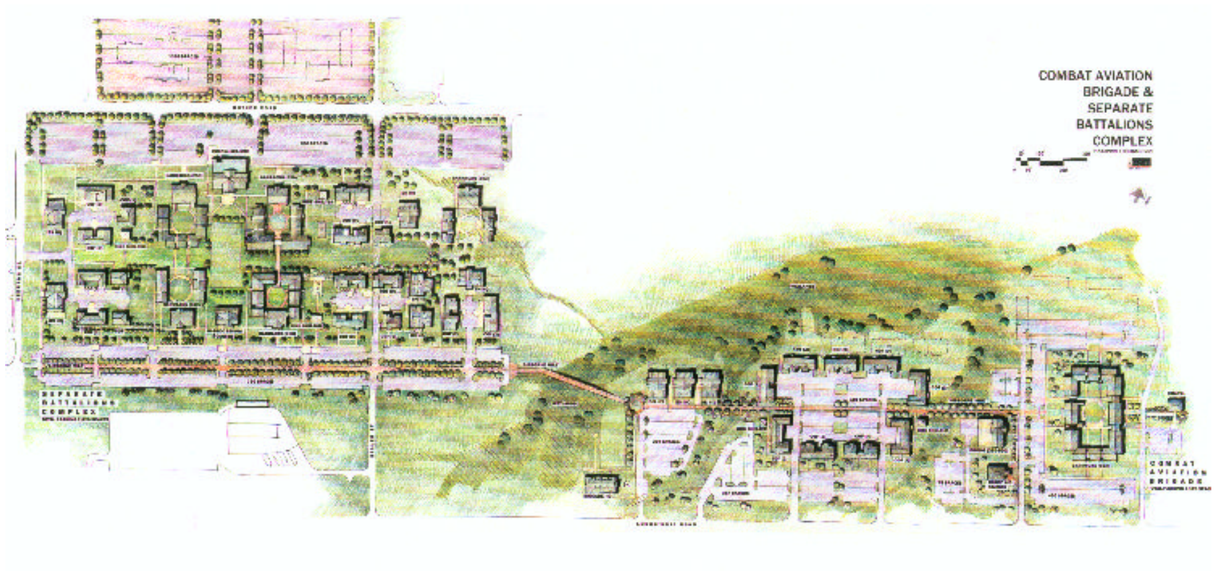
2. A walking/running/ bicycling path called the "Airborne Mile," a pedestrian "main street" that originates at the Combat Aviation Brigade barracks; passes by the dining facility and between the company operations facilities; bridges the wetlands; and, with a border of regularly spaced trees, passes through the south parking lot of the Separate Battalions Complex.

3. A "Central Green," a linear park heavily landscaped with indigenous planting and bordered by barracks, COFs, and battalion headquarters buildings.

4. A reduction in the visual impact of parking facilities as seen from Longstreet Road, achieved by siting large parking areas behind buildings in the Combat Aviation Brigade complex.

Above: *View to the northeast along the Central Green.* ***Below:*** *Existing retention basin.*





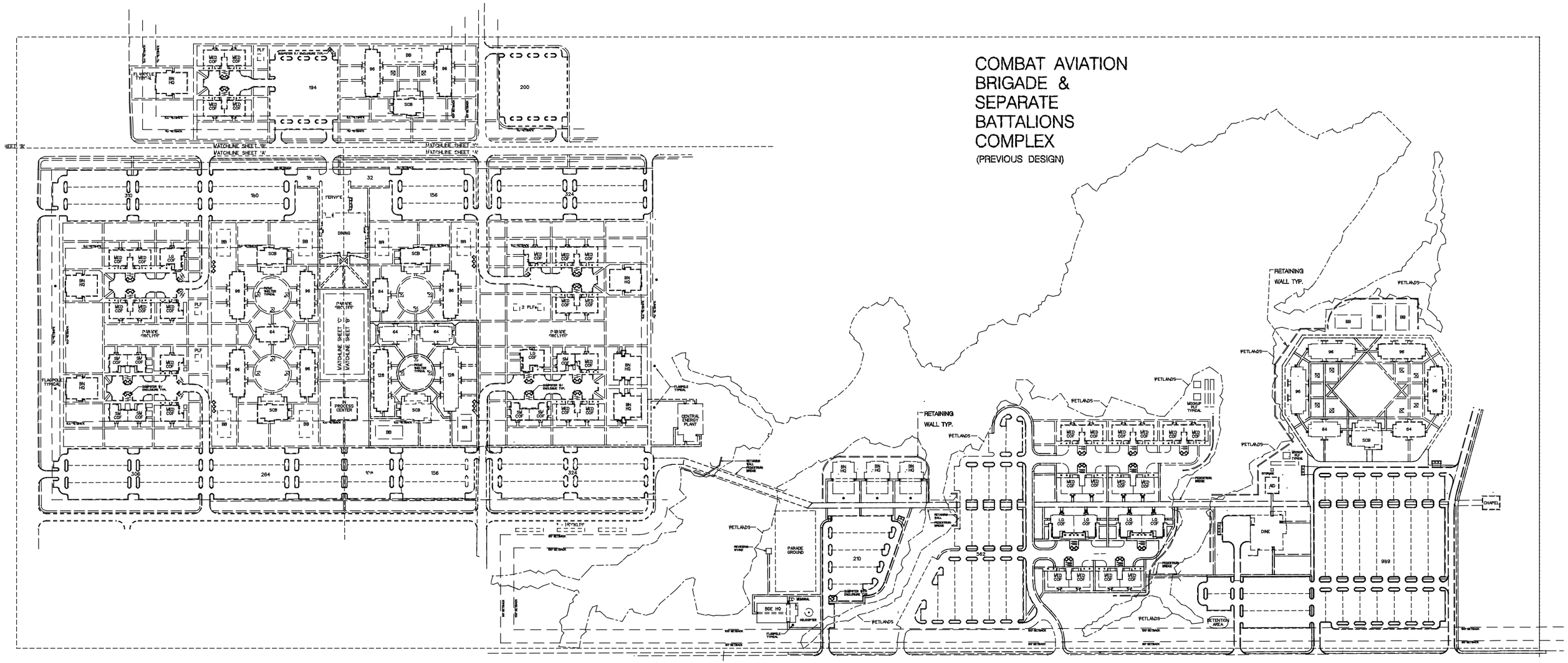
CITY PLAN OF SAVANNAH, GEORGIA

REDESIGNED SITE PLAN
C.A.B. AND SEPARATE BATTALIONS COMPLEXES

The Combat Aviation Brigade Complex and Separate Battalions Complexes (right) together occupy approximately the same area as the historic downtown district of Savannah, Georgia (left). The proposed Fort Bragg development stretches over one mile in length.

COMBAT AVIATION BRIGADE & SEPARATE BATTALIONS COMPLEX

(PREVIOUS DESIGN)



COMBAT AVIATION BRIGADE & SEPARATE BATTALIONS COMPLEX

SUSTAINABLE DESIGN STUDY

KNIGHT ARCHITECTURE

0' 50' 100' 200' 300'

BUTNER ROAD

1160 SPACES

930 SPACES

DINING (501-800)

BARRACKS (256)

BARRACKS (320)

BARRACKS (192)

BIKE SHELTER

COF (1)

COF (2)

COF (3)

BN HQ

KEERANS ST.

BARRACKS (192)

IN-PROCESSING CENTER

BARRACKS (256)

'AIRBORNE MILE'

730 SPACES

SEPARATE BATTALIONS COMPLEX

TOTAL PARKING 2,620 SPACES

BIGLER ST.

WETLANDS

BRIGADE HQ

206 SPACES

167 SPACES

180 SPACES

DINING (251-500)

TROOP AID STATION

75 SPACES

BARRACKS (512)

400 SPACES

CHAPEL

COMBAT AVIATION BRIGADE

TOTAL PARKING 1,120 SPACES

LONGSTREET ROAD

ADVANTAGES AND DISADVANTAGES

COMBAT AVIATION BRIGADE COMPLEX

ADVANTAGES

- The area for the barracks has been significantly reduced.
- The barracks have been relocated closer to Longstreet, and their negative impact on the wetlands has been virtually eliminated.
- The parking for POVs in the COF area has been relocated into the service area. Furthermore, the POV parking is visually removed from view on Longstreet.
- The "Airborne Mile," a troop walkway, has become the central spine of the site, providing pedestrian access to barracks, COF, and administrative areas. It also encourages troops to walk inside the complex, and builds a sense of community.
- The revised layout reduces by 25 percent the amount of land used, and reduces site development costs.

DISADVANTAGES

- The COF area will not meet force protection criteria for separation distance, which is stipulated at 80 feet. A vehicle gate could be used to control access.
- There will be additional design costs to implement building and site redesign.

SEPARATE BATTALIONS BARRACKS COMPLEXES

ADVANTAGES

- The revision of the barracks design to the "attached U" shape allows the site to be compressed to fit between Longstreet and Butner. The area north of Butner can either be left undeveloped, or used as a gravel parking lot.
- The U-shaped barracks design provides a more human scale, and a more intimate courtyard area.
- Access to the COF service area is more controlled, and does not conflict with POV parking.
- The buildings north of Butner required sound attenuation because of their location near Pope Air Force Base flight path. The revised site relocates these buildings

south of Butner so no sound attenuation is required, which will result in significant cost savings.

- The entry road to the east COF areas reuses asphalt paving from the existing north-south street.

- Bike shelters close to the COF showers encourage the use of bicycles as on-post transportation.

- The redesign allows for a large (100 by 900 feet) linear green space on the central east-west axis of the complex. This landscaped park is bordered by barracks and, on the pedestrian side, by company operations buildings.

- By using rubble, obtained from the demolition of other structures, as gravel for the parking lot on the site north of Butner, materials will be recycled. Furthermore, if this parking lot can be maintained unpaved, it could replace planned paved parking on a separate site.

DISADVANTAGES

- The change of the barracks to the "attached U-shaped" building may reduce the amount of unit integrity provided in the barracks buildings. This is ameliorated somewhat, however, by the relocation of the barracks, SCB, COFs, and battalion headquarters from the north side of Butner Road to the main site.

- There will be additional design costs to implement building and site design.

SECTION III- LEED ™ ANALYSIS

LEED ™ ANALYSIS

LEED GREEN BUILDING RATING SYSTEM™: A priority program of the U.S. Green Building Council, LEED ™ (Leadership in Energy and Environmental Design) is a self-certifying system designed for rating new and existing commercial, institutional, and multi-family residential buildings. It is a voluntary, consensus-based, market-driven rating system, based on existing, proven technology, which evaluates environmental performance from a "whole building" perspective.

The LEED™ Green Building Rating System™ was designed for use in a civilian rather than a military context. Nonetheless, the system proved highly useful in the sustainable design team's evaluation of the Combat Aviation Brigade (CAB) and Separate Battalions Complexes.

Although the criteria included in LEED™ are discrete elements, the process of building to the LEED™ standard is best accomplished by an interdisciplinary team working together to understand and take advantage of the synergies and trade-offs among the various criteria. This collaborative process will result in an integrated design that optimizes environmental and economic factors.

The sustainable design team used LEED ™ Version 2.0, scheduled for public release on 31 March 2000, during its sustainable design study. This version contains prerequisites and credits in five main categories: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, and Indoor Environmental Quality. Credits may also be obtained for Innovation and Design Process.

Under the current LEED ™ Rating System, an applicant can earn up to sixty-four core points, along with an additional five credits for innovation and design process. Different levels of green building certification are awarded to applicants who meet all the prerequisites and earn specified numbers of credits. Levels of certification include:

- LEED ™ Certified Level: 32-38 points (50-60% of Core Points)
- LEED ™ Certified Silver Level: 39-45 points (61-70% of Core Points)
- LEED ™ Certified Gold Level: 46-51 points (71-80% of Core Points)
- LEED ™ Certified Platinum Level: 52 or more points (81%+ of Core Points)

A detailed description of the LEED ™ application and certification process can be found on the U.S. Green Building Council's Web site (www.usgbc.org). Since the collective knowledge regarding green buildings continues to increase, LEED™ is unquestionably an ever-changing system requiring the input, scrutiny, and involvement of a great diversity of players. Future directions being explored for LEED™ by the Council include Interiors, Base Building, Operations and Maintenance, and Residential.

LEED ™ is currently being used by the U.S. Navy, the U.S. Environmental Protection Agency, and the City of Seattle (among others) to require that their projects meet or exceed a Certified LEED™ certification level. The Navy's Great Lakes BEQ was selected as a LEED™ Pilot Project and has spurred on other LEED ™ efforts in the Navy.

LEED ™ DEFICIENCIES/REVISIONS FOR MILITARY USE: Because it was originally developed to address concerns relating to civilian populations in an urban setting, aspects of the LEED™ System are understandably deficient in a military context. During its study of the CAB and Separate Battalions Barracks Project at Fort Bragg, the sustainable design team noted a number of such deficiencies, including areas in which LEED™ simply makes no provision for a military setting. Deficiencies focused primarily on large life-cycle issues and coordination with sustainable design Executive Orders, while revisions concerned site reworking.

DEFICIENCIES

- Site Credit 4: Alternative Transportation
  Add preference parking for carpool vehicles.

- Energy Credit 4: Elimination of HCFCs and Halons
  Other emissions need to be addressed–not just ozone
  Incorporation of Executive Order reduction targets should be addressed

- Energy Credit 5: Measurement and Verification
  Must address early coordination with utility companies and state deregulation rules

- LEED™ does not address sustainable design considerations associated with master planning, operations & maintenance, and post-occupancy. (Full life cycle issues)

- LEED ™ does not address sustainable design considerations associated with contractor incentives. (These could be incorporated into strategies)

- LEED ™ does not address (to the extent needed for military purposes) sustainable design considerations associated with hazardous waste generation and disposal.

- LEED™, for military purposes, should be coordinated with Executive Orders and statutes.

REVISIONS

- Site Credit 2: Urban Redevelopment
  Under “Requirement,” delete “minimum development density…” and add “developed area.”

- Site Credit 3: Brownfield Redevelopment
  Under “Technologies/Strategies,” delete paragraph regarding community support.

- Site Credit 4: Alternative Transportation
  Under last "Requirement," delete "local zoning requirements" and add "criteria."

- Site Credit 5: Reduced Site Disturbance
  Under last "Requirement," delete "local zonings" and add "programmed."

- LEED ™: Accredited Professional
  Establish different expertise requirement for the military

USE OF LEED ™ INSIGHTS: Using LEED™ during the sustainable design study for the CAB and Separate Battalions Barracks Project yielded the following three observations:

- The initial LEED ™ accounting of the project yielded close to zero points in ***all*** the five categories except indoor environmental quality. Without a focus on the LEED ™ sustainable design considerations, very few were addressed.
- With moderate effort and cost, the Army Corps of Engineers could meet at least half of all the LEED™ criteria requirements in all categories and obtain a Certified level LEED™ certification; however, almost all the moderate measures suggested would need to be implemented.
- To reach a LEED ™ certification level higher than Ceritified, aggressive sustainable design measures in tandem with the moderate measures would need to be implemented.

CONCLUSION: Overall, an explicit mechanism is needed to evaluate sustainable considerations during the traditional Army Corps of Engineers design and procurement process. Whether LEED™, a variation of LEED™, or an altogether different assessment tool or set of criteria is used, there is a critical need to benchmark and evaluate current levels of sustainable design in the Army Corps of Engineers' projects.

FORT BRAGG SUSTAINABLE DESIGN CHARRETTE
LEED CREDITS EVALUATION

The following table presents an initial evaluation of a standard Fort Bragg Barracks building using the U.S. Green Building Council's LEED Rating System (Version 2.0). The table lists all of the available LEED credits in condensed form (first column), followed by the number of credits obtained in the current Barracks building design (second column). In the other columns, an evaluation has been made to determine the level of effort necessary to earn each LEED credit that is not achieved in the current design. The level of effort is classified as either Moderate or Aggressive. For each evaluation, a brief set of comments identifies possible strategies reviewed by the Charrette team. The comments also reference the revised Brigade Site Plan developed during the charrette, as well as the Energy Analysis and Resource Pages which were developed as detailed studies of certain strategies. The final column notes cost impacts of the "Moderate Effort" strategies and provides additional comments for some of the issues noted. The "Low-to-Moderate-to-High" Cost Impact designations refer to each material or system category, not to the cost of the entire building.

BARRACKS BUILDING

Item	**# of Possible Credits**	**# of Projected Credits (Current Design)**	**Additional Credits (w/ comments)**		**Cost Implications (for Moderate Effort Strategies) and Other Comments**
			(Moderate Effort)	**(Aggressive Effort)**	
Sustainable Sites (Note: Site Credits have been considered for the entire Brigade development)					
Prerequisite: Erosion and Sedimentation Control	**REQ'D**	**Meets Reqmnt.** – Note that State of NC regulations should be compared to EPA Standard referenced in LEED			**No Cost Impact –** criteria are met in current USACE practice
Site Credit 1: Site Selection	**1**	**0**	**1** Redesign of site (see revised Site Plan) can avoid disruption of existing wetlands. USACE is currently sensitive to endangered species impacts.		**Potential Cost Savings -** Avoidance of the wetlands will eliminate mitigation costs.
Site Credit 2: Urban Redevelopment	**1**	**0**	**n/a** Not applicable to Ft. Bragg	**n/a**	**n/a**
Site Credit 3: Brownfield Redevelopment	**1**	**0**	**n/a** Not applicable to current Ft. Bragg development. May be applicable to other USACE sites.	**n/a**	**n/a**
Site Credit 4A: Alternative Transportation – Locate near public transportation (bus lines, subway, light rail)	**1**	**0**	**1** Currently no bus access to site. Adding bus waiting station and coordinating site access can achieve credit.		**Low to Moderate Cost Impact –** Bus Shelters are estimated at approximately $3500 per unit (3' x 9' x 8' high)
Site Credit 4B: Alternative Transportation – Suitable means for securing bicycles, provide shower facilities	**1**	**0**	**1** Additional bicycle racks on-site can achieve credit. Showers are currently provided.		**Low to Moderate Cost Impact –** Secure bicycle racks are estimated at approximately $60 per slot installed. Based on the total Brigade population of approx. 1700 persons, a total of 85 racks are required to meet the LEED credit.

Site Credit 4C: Alternative Transportation – Install alternate-fuel refueling stations	**1**	**0**	**0**	**1** Possible consideration for future – perhaps for on-site use vehicles.	**n/a (Aggressive Effort)** Comment: A small number of electric vehicle recharging stations can be integrated into designated parking areas at a low to moderate cost.
Site Credit 4D: Alternative Transportation – Size parking to minimum local zoning requirements	**1**	**0**	**1** Requires re-examination of parking needs and use. See Revised Site Plan.		**Potential Cost Savings –** Depends on final determination of parking needs
Site Credit 5A: Reduced Site Disturbance – Limit site disturbance to 40' beyond building OR restore minimum of 50% of open area on previously developed sites	**1**	**0**	**0**	**1** Requires evaluation of site planning, increased density. May not be practical for base (for new construction) because of Force Protection setbacks.	**n/a (Aggressive Effort)**
Site Credit 5B: Reduced Site Disturbance – Reduce development footprint to exceed zoning requirements by 25%	**1**	**0**	**1** Redesign of site (see revised Site Plan) can achieve reduction in development area by 25%.		**Potential Cost Savings –** Increased density can save costs through reduced site work, less paving, and shared building elements (stairwells, etc.)
Site Credit 6A: Stormwater Management – Stormwater runoff management plan	**1**	**1** No net stormwater runoff is reqmnt of current design.			**No Cost Impact –** criteria are met in current USACE practice
Site Credit 6B: Stormwater Management – Treatment systems for collected runoff	**1**	**0**	**0**	**1** Water treatment systems can be incorporated as part of water recycling effort (See Resource Page on Water Recycling).	**n/a (Aggressive Effort)**
Site Credit 7A: Landscape and Exterior Design to Reduce Heat Islands – Shading/High Albedo materials/Underground parking/open-grid pavement	**1**	**0**	**1** Increased tree planting in parking areas, use of "grass-pave" units for overflow parking can achieve credit. (See Resource Page on Pervious Paving)		**Low to Moderate Cost Impact –** Grass-pave units for overflow parking are approx. 2.5 – 3 times more expensive than standard asphalt paving.
Site Credit 7B: Landscape and Exterior Design to Reduce Heat Islands – Energy star roofing, Vegetated roofing	**1**	**0**	**1** Use of white or very light colored roofing – cement tiles, metal roofing, white single ply roofing – can achieve credit		**Moderate to High Cost Impact –** Metal roof panels or concrete tile roofing is approx 3 to 5 times more expensive than “standard” 3- tab asphalt shingle roofing. White roofing membranes (such as PVC, Polyolefin) are approx 20-30% more expensive than black EPDM roofing.

Site Credit 8: Light Pollution Reduction	**1**	**0**	**0**	**1** Requires evaluation of current lighting schemes for parking lots, grounds, and for building exteriors. In general, preference for low-height exterior lighting (poles, bollards) and minimal footcandle levels is needed to achieve credit.	**n/a (Aggressive Effort)** Comment: The use of a greater number of lower-height exterior fixtures would likely have a moderate cost impact.
Credit Sub-Total for Sustainable Sites	**14**	**1**	**7**	**4**	
Water Efficiency					
Water Credit 1: Water-Efficient Landscaping – High efficiency irrigation and drought-resistant planting to reduce potable irrigation water by 50% (1 credit) or 100% (2 credits)	**1 - 2**	**0**	**1** Installing drip irrigation or moisture-sensing irrigation system; utilizing recycled water (rain water, gray water); and/or using native drought-resistant planting can achieve credit (See Water Recycling Resource Page)	**1 additional** (2 total) Same strategies as in Moderate, implemented throughout the Brigade can achieve credit.	**Low to Moderate Cost Impact –** Specifying native, drought-resistant plantings is the most economical way to meet this credit. Water recycling from a retention basin is potentially the most cost-effective strategy for re-used irrigation water. Drip-irrigation systems are typically cheaper than sprinkler irrigation systems, but are used for shrubbery and planter beds. Gray water systems will need sub-surface irrigation.
Water Credit 2: Innovative Wastewater Technologies – Gray water/black water waste treatment to reduce sewage conveyance water by 50%. Also includes 100% on-site wastewater treatment	**1**	**0**	**1** Gray-water recycling of shower waste water can achieve credit		**Moderate Cost Impact –** For irrigation purposes, gray water recycling would involve holding tanks, sand filters, and tie-ins to sub-surface drip-irrigation system.
Water Credit 3: Water Use Reduction – Reduce water use by 20% or 30% below EPACT	**1 - 2**	**0**	**1** Requires use of low-flow shower heads (less than 2.0 gal/min), aerators at lavatory faucets (less than 2.5 gal/min) to achieve credit (See Water-Efficiency Resource Page)	**1 additional** (2 total) Dual-flush toilets or pressure-assisted toilets (less than 1.6 gal/flush) are needed to achieve credit (See Water-Efficiency Resource Page)	**No to Low Cost Impact –** Ultra-low flow showerheads and faucet aerators are available in the same cost range as typical fixtures. These fixtures can save significant energy as well as water. Comment: Dual-flush toilets (aggressive effort) are typically available only as imported fixtures.
Credit Sub-Total for Water Efficiency	**5**	**0**	**3**	**2**	
Energy and Atmosphere					
Prerequisite 1: Fundamental Building Systems Commissioning	**REQ'D**	**Meets Reqmnt**. – HVAC systems are currently commissioned per USACE specs			**No Cost Impact –** criteria are met in current USACE practice

Prerequisite 2: Minimum Energy Performance	**REQ'D**	**Meets Reqmnt**. – Current design is estimated to use approx. 15% less energy than ASHRAE/IES 90.1-1999 Standard			**No Cost Impact –** criteria are met in current USACE practice
Prerequisite 3: CFC Reduction in HVAC&R Equipment	**REQ'D**	**Meets Reqmnt**. – CFC equipment not allowed in new construction projects			**No Cost Impact –** criteria are met in current USACE practice
Energy Credit 1: Optimize Energy Performance	**2 - 10**	**0** Current design is estimated to use approx. 15% less energy than ASHRAE/IES 90.1-1999 Standard	**2** Measures to improve energy efficiency include improved lighting, tighter envelope, and efficient equipment. Details are provided in Energy Report.	**3 additional** (5 total) Details are provided in Energy Report.	**Low to Moderate Cost Impact –** See Energy Report for details
Energy Credit 2: Renewable Energy	**1 - 3**	**0**	**0**	**2** The use of building-integrated photovoltaic panels (BIPVs), solar water heating, and/or geothermal heat pumps can be employed to achieve 1 or 2 credits (See BIPV Resource Page)	**n/a (Aggressive Effort)** Comment: The cost for BIPVs typically ranges from $40 -$70 per square foot. Note that the cost of the building material replaced (e.g. roofing, glazing) should be subtracted from this cost.
Energy Credit 3: Best Practice Commissioning	**1**	**0**	**1** Full commissioning is possible if revisions are made to DD1391		**Moderate Cost Impact –** Full commissioning can be budgeted at approximately 3-4% of the building HVAC construction cost.
Energy Credit 4: Elimination of HCFC's and Halon	**1**	**1** HCFC refrigerants and Halons are not currently used in USACE projects			**No Cost Impact –** criteria are met in current USACE practice
Energy Credit 5: Measurement and Verification	**1**	**0**	**1** Sensors and sub-metering are typically installed in USACE HVAC systems. IPMPV protocol may require addtl sensors and will require reporting of data to achieve credit.		**Low Cost Impact –** Additional sensors/meters needed to supplement existing standards
Energy Credit 6: Green Power	**1**	**0**	**1** Deregulation in near future may allow green power options. USACE has own hydro-electric power sources; the installation of BIPVs at Fort Bragg can also be initiated by utilities as part of their Green Power programs.		**Moderate to High Cost Impact –** Green Power programs in other states have shown a $0.01 – $0.03 /kwh increase in the price of electricity to accommodate green power sources.

Credit Sub-Total for Energy and Atmosphere	**17**	**1**	**5**	**5**	
Materials and Resources					
Prerequisite: Storage and Collection of Recyclables	REQ'D	**Does not Meet Reqmnt**.	**Meets Reqmnt**. – Provisions for recycling bins and additional storage dumpsters		**Low Cost Impact –** Recycling bins and additional storage dumpsters are low cost items for a project of this size
Materials Credit 1: Building Reuse	**1 - 3**	**n/a** No Building reuse in current project. May apply to other USACE sites.	**n/a**	**n/a**	**n/a**
Materials Credit 2: Construction Waste Management	**1 - 2**	**0**	**1** Construction recycling can be achieved through contractor incentives, contract requirements, and elimination of free landfilling to contractors. (See Waste Recycling Resource Page)	**1 additional (2 total)** Additional products and quantities of recycling can achieve credit (See Waste Recycling Resource Page)	**Low to Moderate Cost Impact –** Costs for construction recycling depend on the resale value of the materials being recycled and the tipping fees charged for landfill. Fees normally added to General Conditions of the contract.
Materials Credit 3: Resource Reuse	**1 – 2**	**0**	**0**	**1** Reuse of masonry and other valuable materials is required to achieve credit. Materials salvaged from site and sold or donated to others can be counted. Salvaged materials purchased from off-site sources can be counted.	**n/a (Aggressive Effort)** Comment: The use of salvaged materials can potentially save costs, depending upon the material type.
Materials Credit 4: Recycled Content	**1 - 2**	**0**	**1** Many standard products contain high amounts of recycled content (steel, fiberglass). Additional recycled-content products can be specified to achieve credit. (See Recycled Materials Resource Page)	**1 additional (2 total)** Additional recycled content materials needed to achieve 2nd credit. (See Recycled Materials Resource Page)	**Low to Moderate Cost Impact –** The use of recycled content materials at the first level mandated by the LEED program (25%) may add approximately 2-4% to the overall cost of the materials selected. This number is based on the fact that many of the recycled materials have no premium, while some have a premium in the 10-20% range.
Materials Credit 5: Local/Regional Materials	**1 - 2**	**1** Materials such as brick, concrete, and steel are typically purchased from local manufacturers. (See Local Materials Resource Page)	**1 additional (2 total)** Additional materials (roofing, insulations, etc.) can be sourced from local manufacturers. May require incentives or contract requirements to ensure. (See Local Materials Resource Page)		**No to Low Cost Impact –** Most local materials have no cost premium.
Materials Credit 6: Rapidly Renewable Materials	**1**	**0**	**0**	**1** Possible materials include wheat-straw substrate board for cabinetry	**n/a (Aggressive Effort)** Comment: Straw-based substrate boards are approximately 15% more

				units in rooms.	expensive than standard mdf board.
Materials Credit 7: Certified Wood	**1**	**0**	**1** Requires certification for framing lumber, plywood, and/or wood base.		**Low to Moderate Cost Impact –** Certified wood can be priced from 0-20% higher than non-certified products, depending upon the wood species, product type, and quantity.
Credit Sub-Total for Materials and Resources	**13**	**1**	**4**	**4**	
Indoor Environmental Quality					
Prerequisite 1: IAQ Problem Avoidance	**REQ'D**	**Meets Reqmnt.** – ASHRAE 62-1989 is used in USACE designs.			**No Cost Impact –** criteria are met in current USACE practice
Prerequisite 2: Environmental Tobacco Smoke Control	**REQ'D**	**Meets Reqmnt.** – No smoking allowed in barracks.			**No Cost Impact –** criteria are met in current USACE practice
IEQ Credit 1: CO_2 Monitoring	**1**	**n/a** Unlikely system for barracks facility.	**n/a**	**n/a**	**n/a**
IEQ Credit 2: Increase Ventilation Effectiveness	**1**	**1** Barracks design has good air distribution.			**No Cost Impact –** criteria are met in current USACE practice
IEQ Credit 3: Construction IAQ Management Plan	**1 - 2**	**2** Duct cleaning and building flush-out are required in USACE specifications			**No Cost Impact –** criteria are met in current USACE practice
IEQ Credit 4A: Select Low-Emitting Materials – Adhesives and sealants	**1**	**0**	**1** Require specifications for VOC limits – many products will already meet criteria (See Low-VOC Products Resource Page)		**No to Low Cost Impact –** Most manufacturers offer low-VOC adhesives as standard products or as equal-priced alternates
IEQ Credit 4B: Select Low-Emitting Materials – Paints and coatings. Must meet GreenSeal standards.	**1**	**0**	**1** Require specifications for Green Seal compliant products. (See Low-VOC Products Resource Page)		**Low Cost Impact –** Low-VOC paints are priced 0-20% more than standard paints. The higher premiums are normally for "zero-VOC" products.
IEQ Credit 4C: Select Low-Emitting Materials – Carpet systems. Must have CRI Green Label rating	**1**	**1** Most carpets meet this standard; should be required in specs (See Low-VOC Products Resource Page)			**No to Low Cost Impact –** Carpets meeting the Green Label standard are available in all cost ranges.
IEQ Credit 4D: Select Low-Emitting Materials – Composite wood products without urea or phenol formaldehyde binders	**1**	**0**	**0**	**1** Requires board products with MDI binders, substitution of solid wood for some products (cabinetry), door selection for solid-core wood doors.	**n/a (Aggressive Effort)** Comment: Board products with non-formaldehyde binders will generally cost between 20-150% more than products with formaldehyde.

				(See Low-VOC Products Resource Page)	
IEQ Credit 5: Indoor Chemical and Pollutant Source Control – entryways, ventilate chemical storage areas, plumbing for chemical wastes	**1**	**0**	**1** Requires permanent architectural entryways (grates or grilles) at major entries. Other criteria are met.		**Low to Moderate Cost Impact –** Permanent architectural entryways are estimated at approx. $20-25/s.f. Recessed slabs are also required.
IEQ Credit 6A: Controllability of Systems – Operable windows, lighting control zones (perimeter spaces)	**1**	**1** Criteria are met intrinsically in barracks design.			**No Cost Impact –** criteria are met in current USACE practice
IEQ Credit 6B: Controllability of Systems – Controls for airflow, temperature, lighting (interior spaces)	**1**	**n/a** Not applicable to barracks facility	**n/a**	**n/a**	**n/a**
IEQ Credit 7A: Thermal Comfort – Comply w/ ASHRAE 55-1992	**1**	**1** ASHRAE 55 criteria are used in USACE designs.			**No Cost Impact –** criteria are met in current USACE practice
IEQ Credit 7: Thermal Comfort – Permanent temperature/humidity monitoring	**1**	**n/a** Humidity monitoring unlikely for this building type.	**n/a**	**n/a**	**n/a**
IEQ Credit 8: Daylight and Views – Diffuse sunlight reaches 90% of regularly occupied spaces	**1**	**1** Criteria are met intrinsically in barracks design.			**No Cost Impact –** criteria are met in current USACE practice
IEQ Credit 8: Daylight and Views – Direct line of sight to vision glazing for 90% of regularly occupied spaces	**1**	**1** Criteria are met intrinsically in barracks design.			**No Cost Impact –** criteria are met in current USACE practice
Credit Sub-Total for IEQ	**15**	**8**	**3**	**1**	
Innovation Credits and Design/Build Process					
LEED Innovation Credits Flexible credits for sustainable strategies that are not part of the current LEED rating system. Judged on a project-specific basis.	**1 - 4**	**0**	**TBD** To be determined on a project-specific basis	**TBD** To be determined on a project-specific basis	Determined on a project-specific basis
LEED Accredited Professional Design professionals have been accredited from LEED Training courses	**1**	**0**	**1** USACE Staff designers can obtain LEED training to achieve credit		**No to Low Cost Impact –** Costs are for training staff.
Credit Sub-Total for Innovation & Dsgn/Bld	**5**	**0**	**1**	**0**	
TOTALS	**69**	**11**	**23**	**16**	

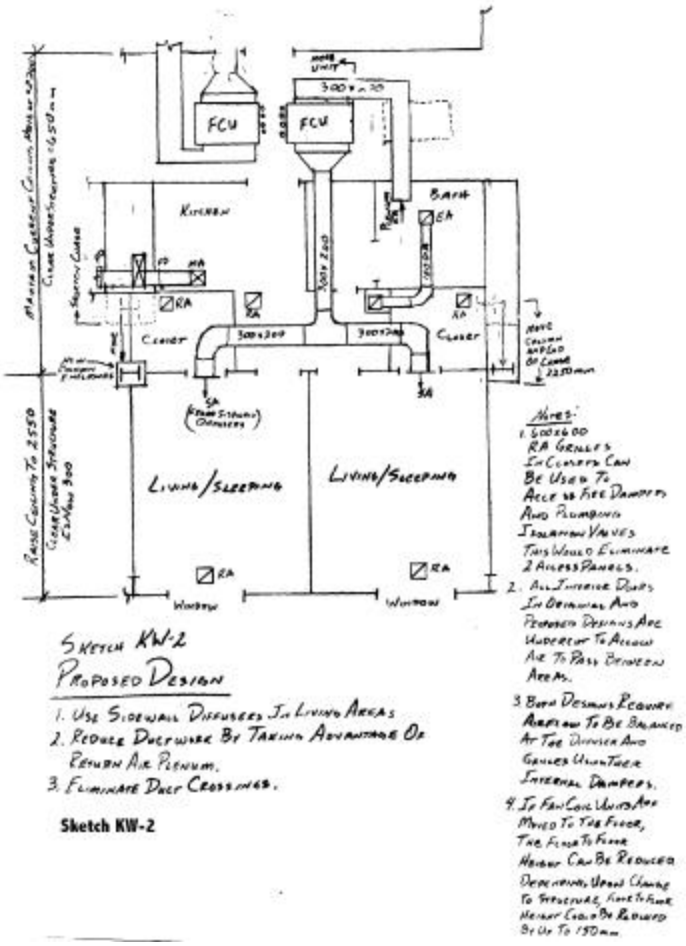
LEED RATINGS:

Certified:	32-38 Credits
Silver:	39-45 Credits
Gold:	46-51 Credits
Platinum:	52 or more Credits

CONCLUSION FOR BARRACKS BUILDING:
Although relatively few credits are earned in the existing design, the number of credits possible in the "Moderate" category is substantial. If all measures in the Moderate category were implemented, a Certified Rating (formerly called Bronze) is possible with 34 credits. The "Aggressive" measures identified would allow the building to be rated as high as Gold.

VERIFICATION - LEED EVALUATION OF DINING HALL AND HEADQUARTERS FACILITIES:
A LEED Evaluation similar to the one performed on the Barracks building was also performed on a typical Dining Hall and Headquarters Facility. Although some of the individual credits varied (energy strategies, availability of daylighting and views, potential for water conservation or reuse, types of local or recycled materials), the resulting ratings were similar to the Barracks building. In all cases, the existing building designs did not capture a substantial number of LEED credits, although a large number of “Moderate Effort” credits were identified (most of them being the same as those noted for the Barracks building). The conclusion is therefore the same for these representative buildings – if sustainability considerations are instituted in the earliest stages of the project, the potential exists to achieve a significant number of environmental improvements. Without this effort, a number of potential opportunities are lost. As the cost analysis indicates, a number of the LEED measures can be achieved at no, low, or moderate cost. In some cases, there is the potential for first cost savings. By examining the full cost impacts (trading cost savings and cost increases) with operational cost savings a comprehensive and cost-effective sustainability plan can be developed for the Fort Bragg Brigade development.

SECTION IV- ENERGY ANALYSIS



Sketch KW-2

ENERGY ANALYSIS

METHODOLOGY: With planning for the Combat Aviation Brigade (CAB) Barracks Complex and Separate Battalions Barracks Complexes at a "10 percent design" stage of completion—i.e., the broad outlines of the project had been defined, but the overall design was only about 10 percent complete—the sustainable design team addressed the issue of maximizing energy efficiency.

Two building types at the CAB were evaluated for potential opportunities to implement cost-effective Energy Efficiency Measures (EEMs). The brigade headquarters was evaluated using Energy-10, a computer-based tool used to provide quick analysis of the magnitude of various strategies that can improve energy efficiency. A typical barracks building was modeled using DOE-2, which is another computer program typically used for energy analysis.

For each of the building types considered, the current 10 percent design was modeled, in order to define a "base case" against which EEMs could be compared. Though not exact, we consider the 10 percent design to be roughly equivalent to minimal compliance with ASHRAE/IES Standard 90.1-1999. This new ASHRAE/IES standard has not been officially released; however, we understand that it is substantially more aggressive than ASHRAE/IES Standard 90.1-1989 in the areas of allowed lighting power density, and also contains more stringent requirements for controls applied to larger HVAC systems.

The more aggressive lighting requirements are intended to reflect the fact that high-efficiency T8 lamps and electronic ballasts have reached the stature of "standard practice," and thus the allowed lighting power densities for different buildings now assume that T8 lamps/electronic ballasts are used. Certain state energy codes (California, for one) that have made similar LPD adjustments now allow about 1.3 W/SF for lighting in office buildings, where 1.6 W/SF formerly was allowed.

From here, different EEMs were modeled individually, and then the most promising measures were modeled together so that overall level of performance could be assessed.

The brigade headquarters was easily modeled, since it is a simple one-story building, but the recommendations made for this building also apply to the other office-type facilities, since they have similar structure and systems. Among the EEMs studied for this building were daylighting, which involved the addition of eighteen diffuse skylights over the core area of the building, as well as dimming controls to reduce the electric lighting levels when sufficient daylight is present. Other EEMs included sun shading on the south elevation of the building; increased insulation in the walls and roofs to R-20 and R-30 respectively; decreased infiltration through the building envelope; and increased HVAC efficiency.

It should be noted here that the project already incorporates some strategies that would typically be recommended. Among these are high performance low-e insulated glazing in the window systems; efficient electric lighting yielding a lighting load of only

about 1.0 watts/sf; and HVAC controls that allow the temperature in a space to fluctuate out of the comfort range when unoccupied.

MODEL: The energy savings for the various strategies are illustrated in the graphs on pages 2 through 6. On page 1 is a table indicating the differences between the Base Case and Combination Case in terms of the building structure and systems, and the resultant modeled energy savings. Figures 1 through 5 show how the various individual strategies and the Combination Case performance relative to the Base Case for different aspects of energy usage, while figures 6 through 9 compare only the Base and Combination Cases.

The modeling indicates that by incorporating the strategies mentioned above, an energy savings of around 16 percent could be expected. It should be understood that this number is only a projection of potential savings, and not a prediction of exact operating costs.

It may also be noted that some strategies indicated greater energy use than the Base Case for certain aspects of energy use. For example, daylighting results in higher heating energy use, because skylights would lose heat faster than surrounding roof structure. But in the cooling energy use graph, daylighting saves energy, in part because of the decrease in energy from having the electric lights on, and additionally because of the associated cooling load from the lights. Ultimately, daylighting saves energy and money, and significantly improves the quality of the indoor environment. Several daylighting strategies are illustrated in the suggestions section later in this report.

Even though the energy savings is minimal in this model, sun shading is recommended because of the improved visual quality that results. Also, the headquarters building as modeled has few west-facing windows, but shading of these windows can yield significant energy savings. The effectiveness of both daylighting and sun shading could be increased even further if light shelves and taller windows are incorporated. These strategies are further defined in the suggestions section following. Decreased infiltration can be accomplished by following good construction practices to minimize air passage at building joints, cracks and penetrations.

For the barracks, an aggressive package of EEMs could potentially reduce energy consumption by 37 percent—an impressive level of performance. The following pages summarize the EEMs included in this package, among them high efficiency lighting; advanced lighting controls; adding insulated sheathing to the building envelope; installing a variable-air volume HVAC system; installing heat-recovery devices on shower drains; and using high-efficiency pulse boilers for domestic water heating.

It must be noted that these results are preliminary, and though they have been determined using advanced computer programs, they still contain a great number of assumptions about how each type of building is used. For this reason, these results should be interpreted as showing the relative differences in energy use between different approaches, but not as an absolute prediction of energy use.

Variant: Base/Combination

Weather file: charlott.et1

Description:	Base Case	Combination
Floor Area, ft²	10475.0	10475.0
Surface Area, ft²	26802.3	26802.3
Volume, ft³	141412.5	141412.5
Surface Area Ratio	1.65	1.65
Total Conduction UA, Btu/h-F	1597.3	1353.8
Average U-value, Btu/hr-ft²-F	0.060	0.051
Wall Construction	brick/2x6stl, R=12.4	brick/2x6stl rigid, R=20.6
Roof Construction	sip, r-22, R=21.8	flat, r-30, R=30.0
Floor type, insulation	Slab on Grade, Reff=26.8	Slab on Grade, Reff=26.8
Window Construction	6060 low-e al/b, U=0.29,etc	6060 double, low e, U=0.28,etc
Window Shading	None	40 deg latitude
Wall total gross area, ft²	5852	5852
Roof total gross area, ft²	10475	10475
Ground total gross area, ft²	10475	10475
Window total gross area, ft²	1008	1152
Windows (N/E/S/W:Roof)	11/2/13/2:0	11/2/13/2:18
Glazing name	double low-e, U=0.26	double low-e, U=0.26
Operating Parameters		
HVAC system	PTAC with Gas Boiler & HW Coil	PTAC with Gas Boiler & HW Coil
Rated Output (Heat/SCool/TCool),kBtuh	377/236/314	377/236/314
Rated Air Flow/MOOA,cfm	10475/1571	10475/1571
Heating thermostat	70.0 °F, setback to 45.0 °F	70.0 °F, setback to 45.0 °F
Cooling thermostat	75.0 °F, setup to 85.0 °F	75.0 °F, setup to 85.0 °F
Heat/cool performance	eff=80,EER=12.0	eff=90,EER=14.0
Economizer?/type	no/NA	no/NA
Duct leaks/conduction losses, total %	3/0	1/0
Peak Gains; IL,EL,HW,OT; W/ft²	1.05/0.33/0.15/1.00	1.05/0.33/0.15/1.00
Added mass?	none	none
Daylighting?	no	yes, 1 stepped
Infiltration, in²	ELA=778.4	ELA=194.6
Results:	(Energy cost: 0.295 $/Therm, 0.040 $/kWh, 0.003 $/kW)	
Simulation dates	01-Jan to 31-Dec	01-Jan to 31-Dec
Simulation status, Thermal/DL	valid/NA	valid/valid
Energy use, kBtu	544949	458203
Energy cost, $	5574	4925
Saved by daylighting, kWh	NA	8647
Total Electric, kWh	132508	119372
Internal/External lights, kWh	33400/14131	24769/14131
Heating/Cooling/Fan, kWh	0/21589/7817	0/18006/6945
Hot water/Other, kWh	NA	NA
Peak Electric, kW	47.1	37.6
Fuel, hw/heat/total, kBtu	NA/NA/92790	NA/NA/50871
Emissions, CO2/SO2/NOx, lbs	183295/1048/544	164737/944/490

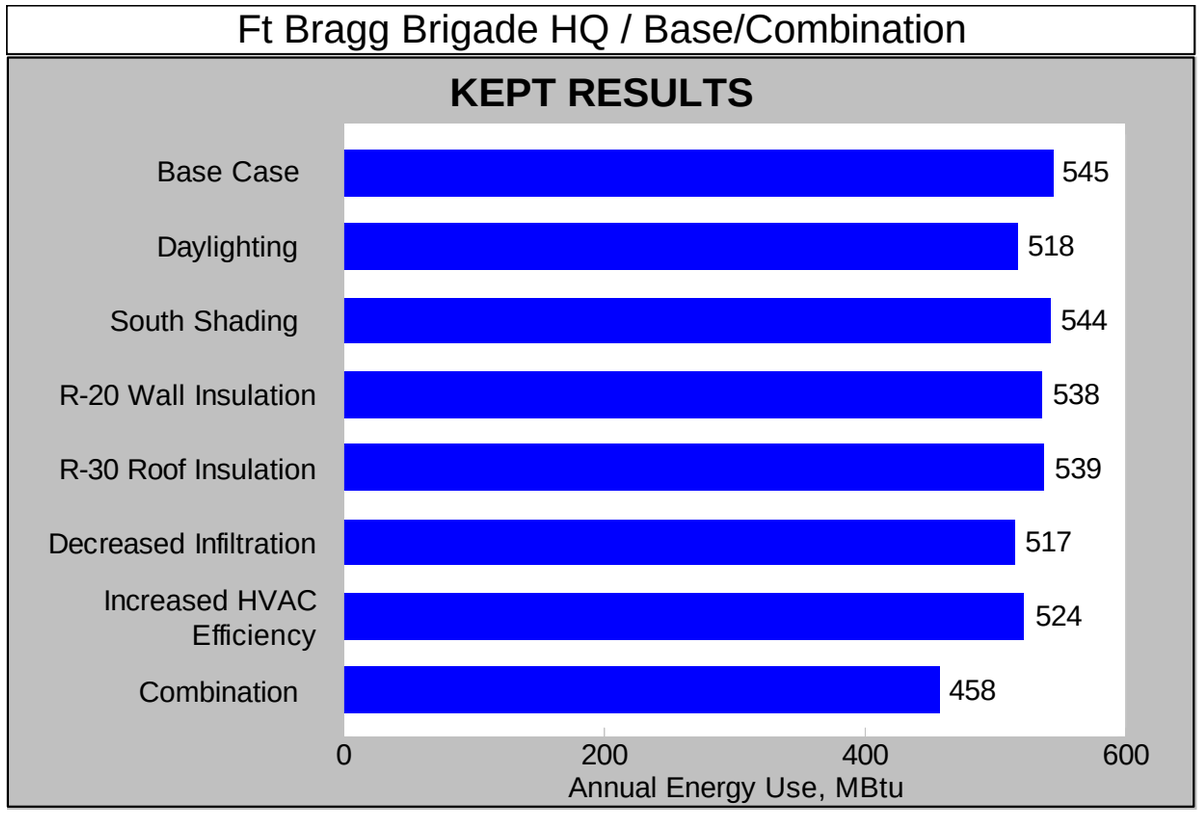


Fig.1 – Comparison of the Various Strategies' Annual Energy Use in Millions of BTUs

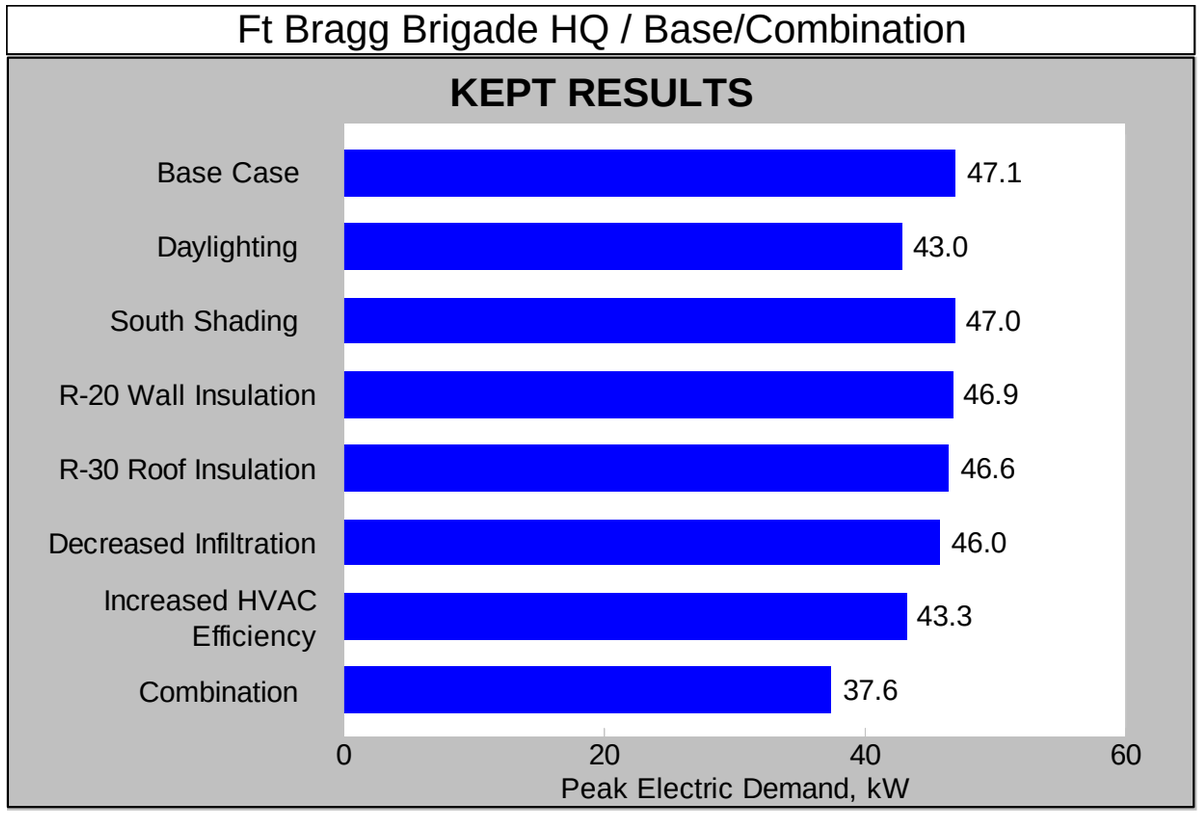


Fig. 2 – Comparison of the Various Strategies' Resultant Peak Electric Demand

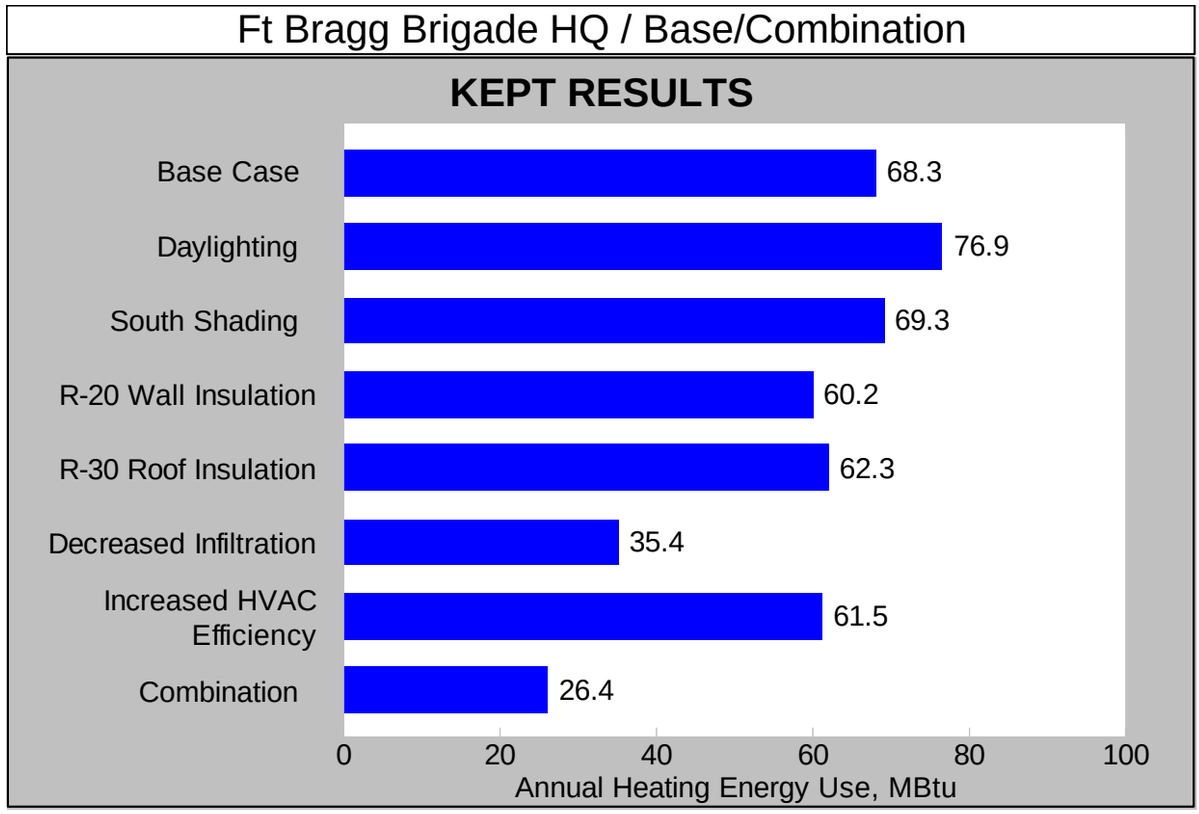


Fig. 3 – Comparison of the Various Strategies' Annual Heating Energy Use in Millions of BTUs

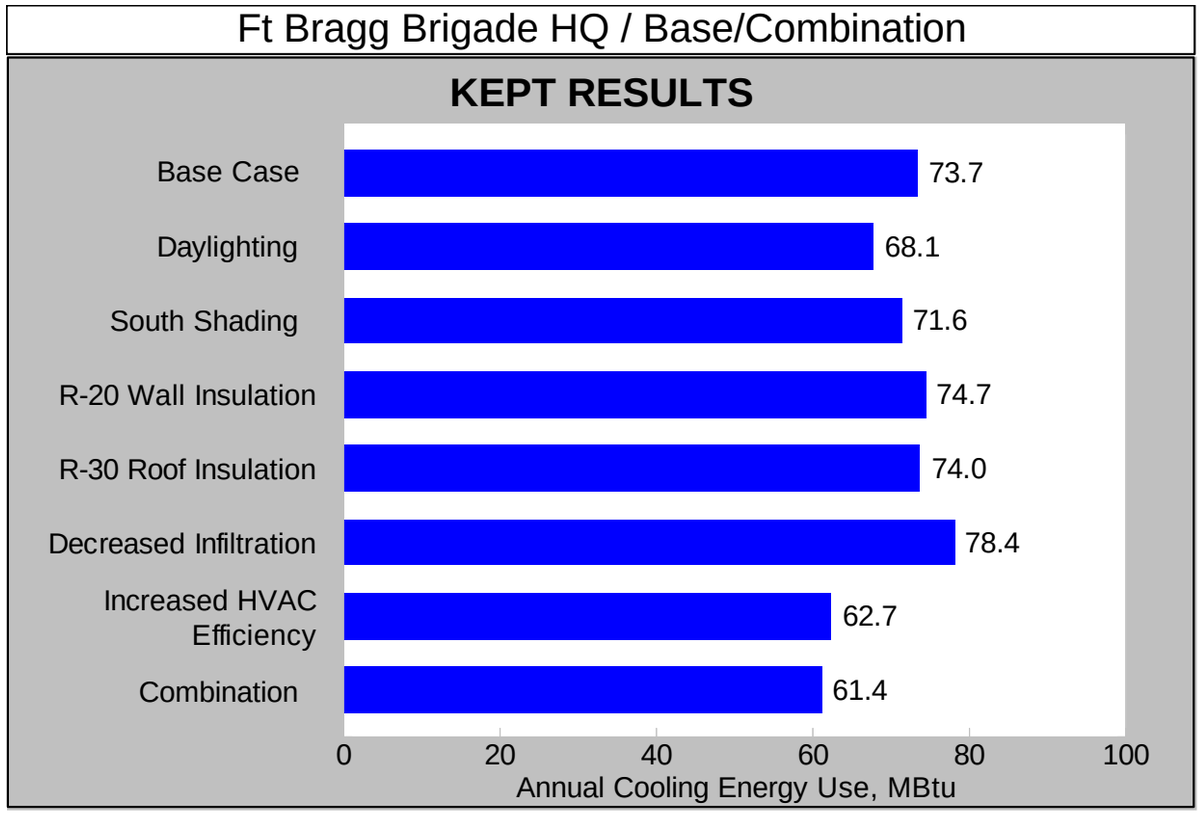


Fig. 4 – Comparison of the Various Strategies' Annual Cooling Energy Use in Millions of BTUs

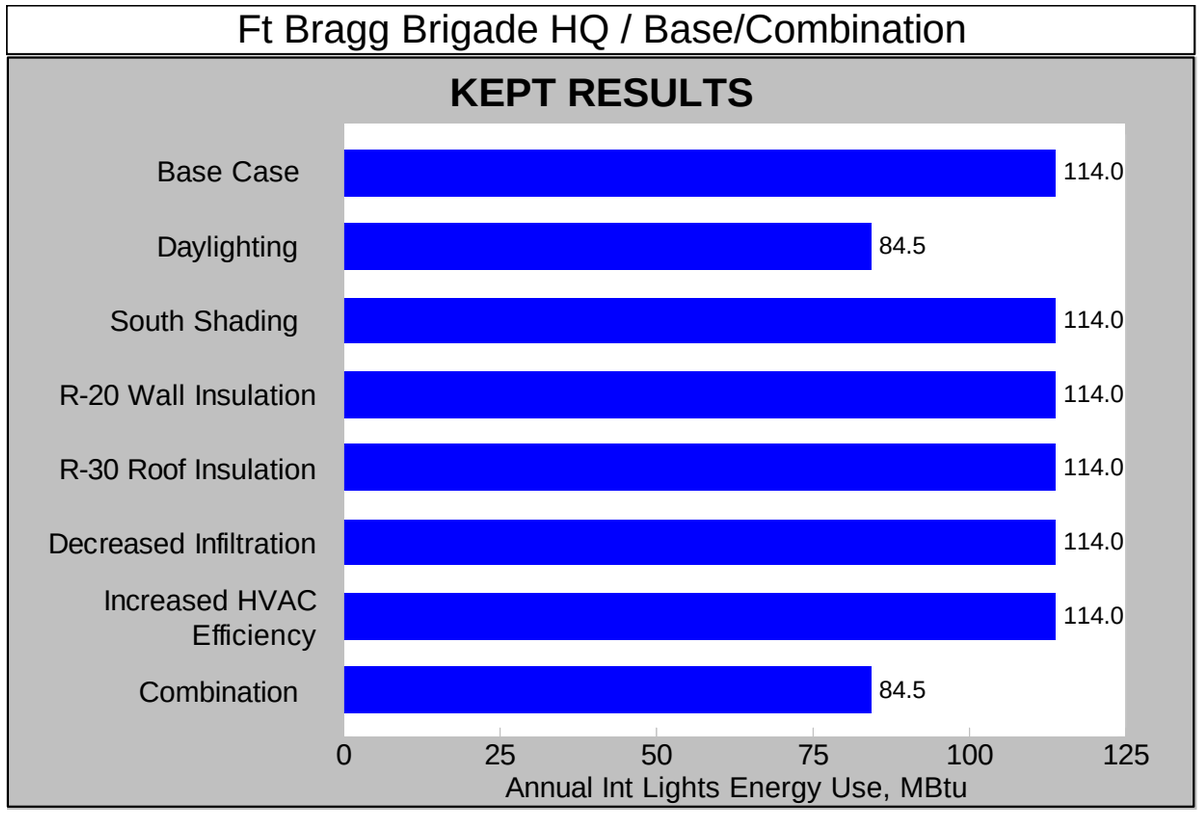


Fig. 5 – Comparison of the Various Strategies' Annual Interior Lighting Energy Use in Millions of BTUs

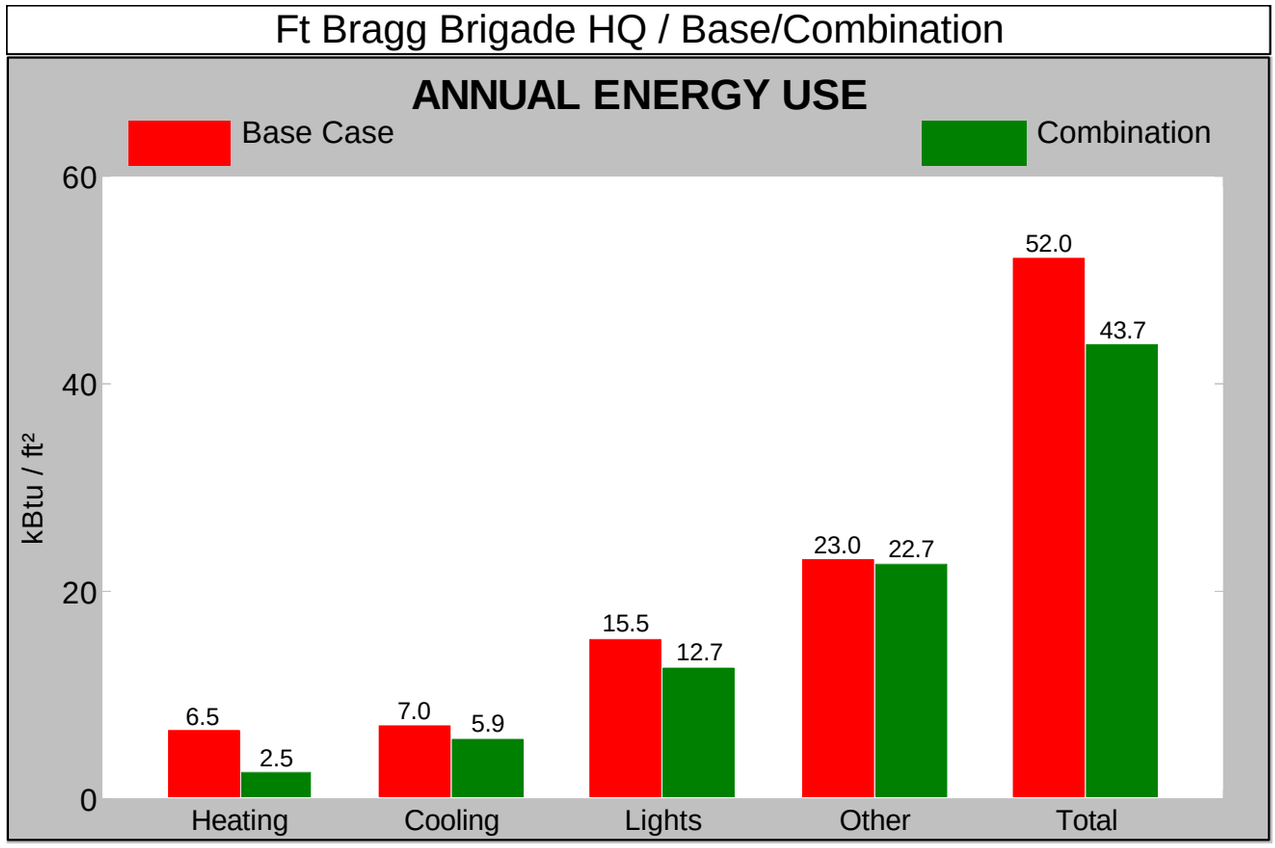


Fig. 6 – Comparison of the Energy Use of the Base Case (Existing Design) with the Combination Case (Implementing the Proposed Sustainable Strategies) in kBtu per Square Foot

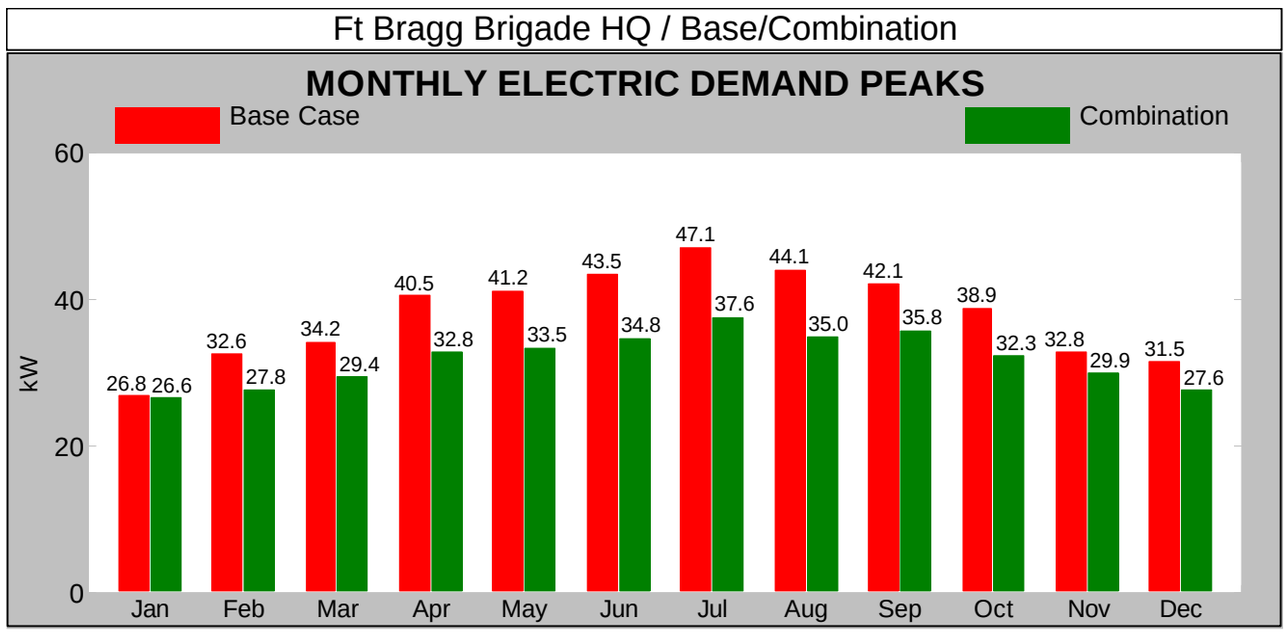


Fig. 7 – Comparison of the Monthly Electric Demand Peaks of the Base Case (Existing Design) with the Combination Case (Implementing the Proposed Sustainable Strategies) in kW

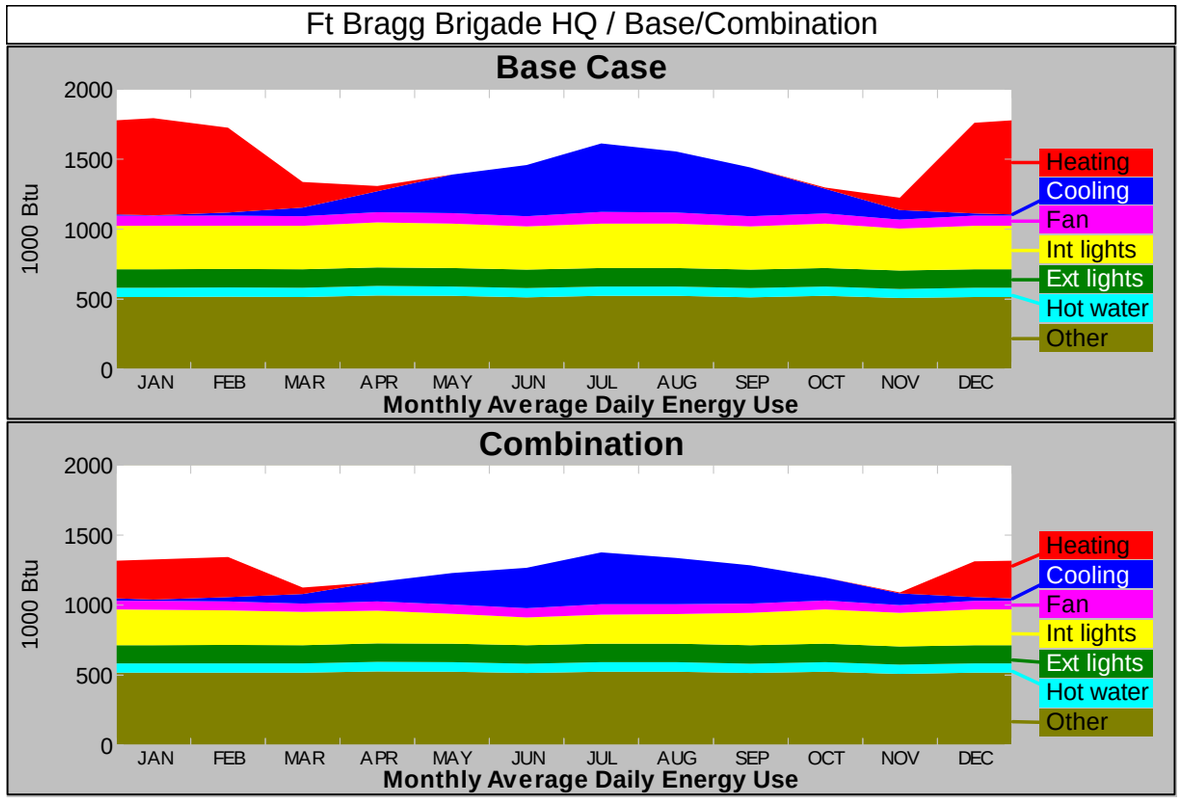


Fig. 8 – Comparison of the Monthly Average Daily Energy Use of the Base Case (Existing Design) with the Combination Case (Implementing the Proposed Sustainable Strategies) in kBtu.

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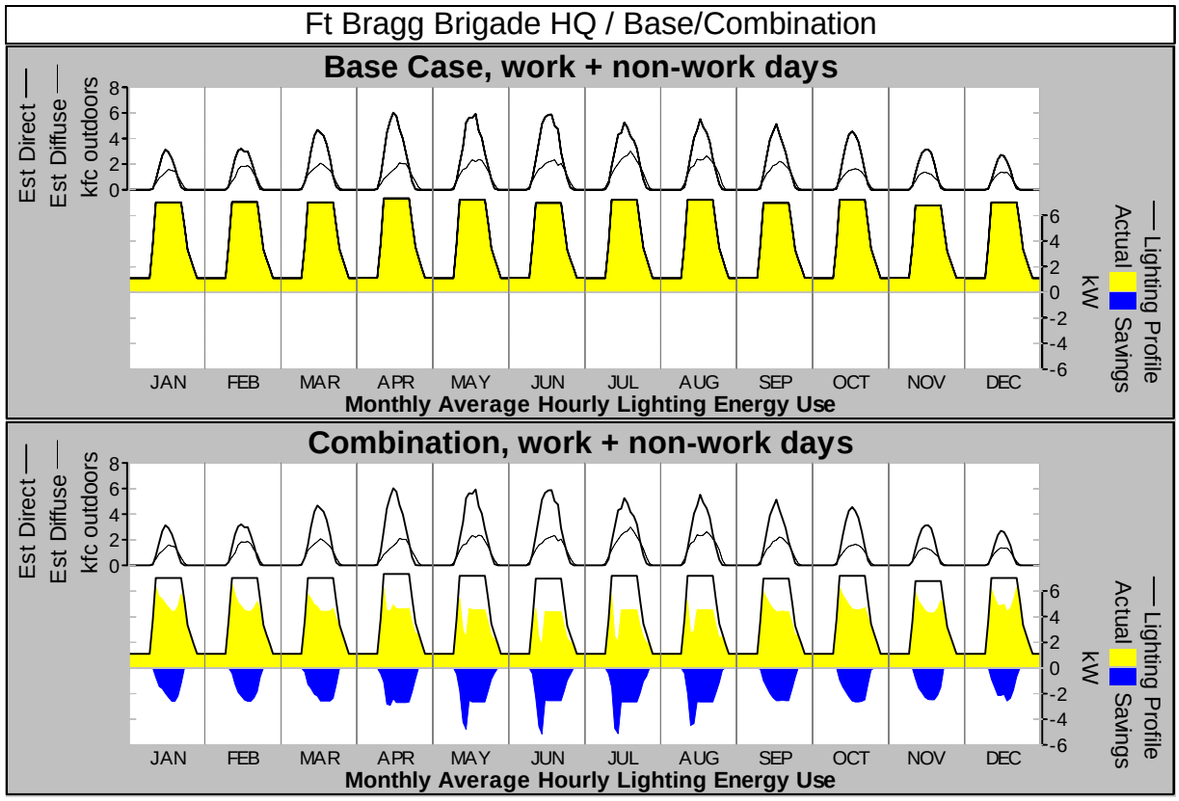
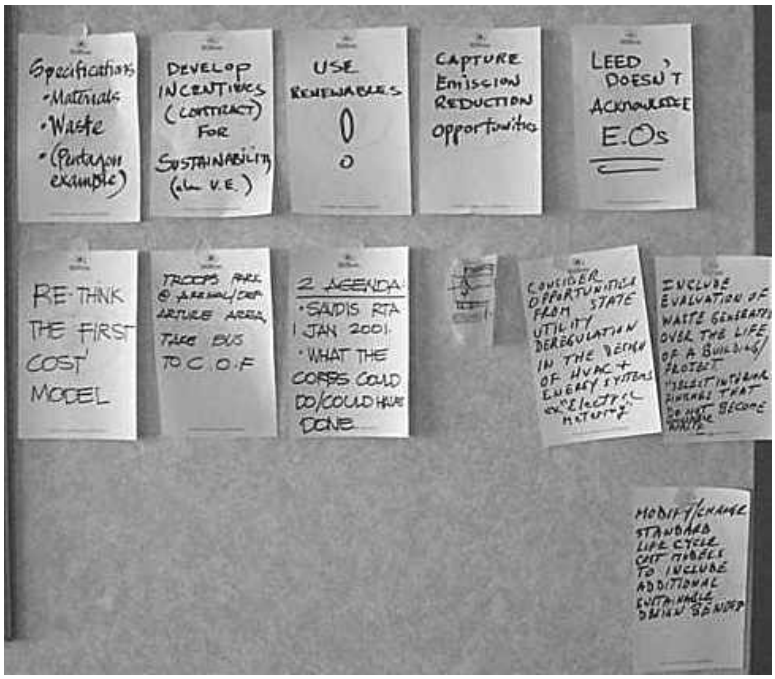


Fig. 9 – Comparison of the Monthly Average Hourly Lighting Energy Use of the Base Case (Existing Design) with the Combination Case (Implementing the Proposed Sustainable Strategies) in kW. The graph of the combination case indicates the savings of electric lighting energy resulting from the implementation of daylighting strategies

	TYPICAL BARRACKS	DOE-2 ANALYSIS							
Case	**Energy**	**Annual Energy Intensity**			**Peak Demand**	**Annual Electric Cons.**	**Annual Gas Cons.**	**Annual Energy Cost**	**Savings vs. Base**
#	**Scenario**	**Site (kBtu/sf-yr)**	**Source (kBtu/sf-yr)**	**% Reduction**	**(kW)**	**(kWh/year)**	**(therms/year)**	**($/year)**	**($/year)**
AD	As-Designed	215	345	0%	128	519,165	40,352	$ 42,852	$ -
1	Shade Windows with Overhangs	214	344	0%	127	514,451	40,495	$ 42,611	$ 241
2	Install Sheathing Behind Brick Façade to Reduce Thermal Bridges Across Metal Stud Walls	212	343	1%	126	518,098	39,695	$ 42,597	$ 255
3	Improve Lighting Efficiency	210	328	5%	116	467,732	40,831	$ 39,905	$ 2,947
4	Install Occupancy Sensors to Control Lighting in Individual Rooms	210	328	5%	116	467,732	40,831	$ 39,905	$ 2,947
5	Install Manual Wall Dimmers	210	328	5%	116	467,732	40,831	$ 39,905	$ 2,947
6	Install Dual-Pane Low-E Glazing with Moderate Tint	214	345	0%	128	516,087	40,432	$ 42,691	$ 161
7	Install Occupancy Sensors to Set Back HVAC.	204	324	6%	126	475,644	39,017	$ 39,854	$ 2,998
8	Install Single-Duct VAV System with Terminal Reheat and VFCs on Fans	220	320	7%	117	394,310	46,189	$ 37,053	$ 5,799
9	Install Local Pulse Boilers for Space and Domestic Water Heating	194	324	6%	128	519,165	34,668	$ 41,204	$ 1,648
10	Install heat recovery heat exchangers on shower drains.	180	311	10%	128	519,165	30,915	$ 40,115	$ 2,737
11	**Interactive Run**	**148**	**217**	**37%**	**82**	**272,783**	**30,872**	**$ 25,320**	**$ 17,532**

SECTION V- PROCESS ANALYSIS



PROCESS ANALYSIS

Opportunities exist to optimize the benefits of sustainable design and, in turn, the performance of Army buildings by revising and updating current design and development processes. This is not only desirable, but in light of numerous Executive Orders directing federal agencies and facilities to take steps towards sustainability, it is necessary. (For a summary of notable Executive Orders that focus on sustainable issues, see PROCESS ANALYSIS, Page 4.) In order to comply with these Executive Orders and optimize sustainable design, the sustainable design team recommends strongly that the following Army Corps of Engineers process components be targeted for revisions and updates:

1. REVISE AND UPDATE THE CURRENT POLICY DOCUMENTS:

Policy documents must address sustainable design. All levels of the Army and Army Corps personnel must be trained, educated, and made aware of sustainability issues.

(a) Provide DoD Top Management sustainable design briefings to inform policy makers about sustainable design. (DoD Top Management Sustainable Design Briefing materials have been developed and are available. Use STR video for an overall introduction to sustainable design.)

(b) Provide DoD Sustainable Design Training Regimen course to Army Corps of Engineers representatives, including Master Planning and Public Works personnel at the installations. (A Sustainable Design Training Regimen has been developed and is available as a two and a half day course.)

(c) Create directives to change life cycle cost models and the 1391 process.

2. REVISE AND UPDATE THE 1391 PROCESS:

State of the art sustainable design can only be achieved with a procurement process that begins early with a focus on sustainability.

(a) Incorporate sustainable site planning considerations in the 1391 process by creating a checklist of sustainable site planning issues.

(b) Revise and update life cycle costing and cost models to capture sustainable design considerations and use this information in the 1391 process. (Connect design decisions with life cycle costing–e.g. minimizing hazardous waste)

3. REVISE AND UPDATE THE DESIGN CRITERIA:

Technical guidance and standards (criteria) for building types and disciplines should address sustainable design.

(a) Hold Sustainable Design Studies to update the design criteria of standard Army building types. (LEED™, other green assessment tools, and checklists could be used to inform and guide the revisions.)

(b) Update District Design Guides by adding a new chapter on sustainable design and coordinating the new chapter material with new sustainable design entries in the existing chapters for the various disciplines.

(c) Create a task group to review LEED™ and other green assessment tools in order to establish an explicit mechanism to evaluate sustainable considerations within the traditional Army design and procurement process. This mechanism should describe "high performance/best sustainable design practices" for the Army Corps of Engineers.

(d) Create a task group to research and provide alternative specification language for sustainable design issues.

4. REVISE AND UPDATE INSTRUCTIONS FOR IN-HOUSE OR CONTRACTS DESIGN:

Sustainable design should be addressed in the design and construction contracts.

(a) Create contract incentives for sustainable design initiatives. Engage all parties in savings and innovation related to sustainable design.

(b) Include language in the contract regarding construction inspection process to address waste/hazardous materials.

(c) Create a task group to investigate the implications of privatization of both ownership and operations, and the implications of sustainable design.

5. REVISE AND UPDATE PROJECT/DESIGN REVIEWS AT 10 PERCENT AND 35 PERCENT:

Sustainable design criteria must be coordinated with design review considerations.

(a) Get customer involvement in sustainable design issues early.

(b) Set up sustainable design checklist for design reviews.

(c) Coordinate design criteria with checklists.

OPPORTUNITIES FOR KNOWLEDGE EXCHANGE: In addition to the revisions and updates to the current planning, design, and construction processes, the Sustainable Design Team recommends that the Army Corps of Engineers create the following "Opportunities for Knowledge Exchange" to further assist and enhance their sustainable design efforts:

1. Establish Sustainable Design Discussion Groups between the Army and the Army Corps of Engineers. Also, establish sustainable design teams at the various installations.

2. Create Demonstration Projects and explore the idea of "Green Bases of the Future." Coordinate with research labs. Also, share sustainable design case studies through presentations to district commanders and others—for example at the Training Center in Huntsville, AL.

3. Integrate sustainable design into the existing Energy and Environment Awards Program for Army bases. Also, investigate alternative programs to award both Army and Army Corps of Engineers personnel ("champions") for innovative sustainable design initiatives.

4. Invite Sustainable Design experts and consultants to participate in design assistance studies, training programs, and project charrettes. Encourage in-house sustainable design expertise.

5. Share Army Corps of Engineers knowledge of sustainable design on the Whole Building Design Guide website (Gateway to the CCB at http://www.wbdg.org)

EXECUTIVE ORDERS RELATING TO SUSTAINABLE DESIGN

Executive Order 12843: "Procurement Requirements and Policies for Federal Agencies for Ozone-Depleting Substances": This order requires Federal agencies to maximize the use of safe alternatives to ozone-depleting substances. This is to be accomplished by: (1) revising procurement practices; (2) modifying specifications and contracts that require the use of ozone-depleting substances; (3) substituting non-ozone-depleting substances to the extent economically practicable; and (4) disseminating information on successful efforts to phase out ozone-depleting substances.

Executive Order 12844: "Federal Use of Alternative Fueled Vehicles": This order requires the Federal government to adopt aggressive plans to acquire, subject to availability of funds and considering life-cycle costs, alternative fueled vehicles, in numbers that exceed by 50 percent the requirements for 1993 through 1995, set forth in the Energy Policy Act of 1992.

Executive Order 12873: "Federal Acquisition, Recycling, and Waste Prevention": This Executive Order addresses the government's purchasing power, incorporates environmental considerations into decision making, and encourages waste prevention and recycling in daily operations. Federal agencies: (1) must set goals for waste reduction; (2) must increase the procurement of recycled and other environmentally preferable products; and (3) can retain some of the proceeds from the sale of materials from recycling or waste-prevention programs.

Executive Order 12902: "Energy Efficiency and Water Conservation at Federal Facilities": For Federal Agencies, this order requires: (1) a 30 percent reduction in per gross square energy consumption by 2005 compared to 1985 to the extent that these measures are cost effective; (2) a 20 percent energy efficiency increase in industrial facilities by 2005 compared to 1990 to the extent that these measures are cost effective; (3) the implementation of all cost-effective water conservation projects; and, (4) the procurement of products in the top 25 percent of their class in energy-efficiency where cost-effective and where they meet the agency's performance requirements. In addition to available appropriations, agencies shall utilize innovative financing and contracting mechanisms including, but not limited to, utility DSM and ESPCs to meet the goals and requirements of EPACT and this order.

Executive Order 13101: "Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition": This order mandates procurement of recycled and "environmentally preferable products and services" by federal agencies. This includes requirements related to elimination of virgin material use, use of bio-based products, use of recovered materials, reuse of products, life cycle cost, recyclability, use of environmentally preferable products, waste prevention (including toxicity reduction or elimination), and ultimate disposal.

Executive Order 13123: "Greening the Government Through Efficient Energy Management": This order sets the following goals for: greenhouse gas reduction (30 percent by 2010 compared to 1990 emissions); energy efficiency improvements (per square foot reductions of 30 percent by 2005 and 35 percent by 2010 compared to 1985); use of renewable fuel sources (tripling of nonhydroelectric by 2010 and 2,000 solar installations on federal facilities by 2010); meeting Energy Star Building criteria for energy performance and indoor environmental quality to the maximum extent possible by 2002; and use of life cycle costing when making investment decisions.

This last Executive Order mandates the Department of Defense to develop sustainable design principles and apply those principles to siting, design, and construction of its facilities.

INTEGRATED PLANNING AND DESIGN

Principles/ Strategies	Traditional Practice	Minimal Measures	Moderate Measures	Extensive Measures
Use whole systems approach	Focus on individual elements of design and compliance with laws or codes	Recognize and take advantage of synergistic effects of different energy strategies	Recognize and take advantage of synergistic effects among energy, site, materials, water, IEQ strategies	Recognize and take advantage of synergistic effects among project strategies and broader community context
Create multidisciplinary teams	Teams focus on coordination rather than integration (disciplines function independently)	•Add sustainability consultant(s) with minor involvement •Educate customers – push toward sustainable design	•Conduct Green Charrette •Involve environmental consultants throughout the process	•Create a fully-functioning multi-disciplinary team from the beginning of the project •Select A-E firms that have extensive in-house sustainability knowledge and expertise
Create up-front environmental goals (e.g. energy targets, waste reduction targets, IAQ targets, etc.)	Projects establish energy targets but rarely establish environmental goals in other areas	Establish short-term targets for individual areas (e.g., energy reduction)	•Establish more Integrated, comprehensive goals through a green charrette •Integrate among phases, from planning through O&M	•Develop a shared team vision for the project •Relate project goals to sustainability goals •Develop benchmarks and measures
Improve implementation through documentation, commissioning, and monitoring	Manufacturers manuals are the only documentation; Mass metering is the only monitoring	Conduct training on individual systems	Develop whole building manual Perform energy commissioning	•Establish monitoring, feedback, and improvement loops •Conduct regular training and retraining •Perform whole building commissioning

Principles/ Strategies	Traditional Practice	Minimal Measures	Moderate Measures	Extensive Measures
Improve procurement practices	Selection of contractors is based on lowest bid, with no requirements regarding sustainability expertise	Select and contract with firms with sustainability knowledge	Use performance based contracts for sustainable design	Require contractors to have inhouse sustainability knowledge
Use building rating systems as tools	No use of these systems in most cases, although this is changing	•Use Energy Star •Use local systems	•Use LEED™ •Use local systems	•Use GBC 2000 Assessment Tool •Use local systems

SITE

Principles/ Strategies	Traditional Practice	Minimal Measures	Moderate Measures	Extensive Measures
Select the site carefully based on sustainability considerations	Site selection is based on considerations other than sustainability	•Avoid ecologically sensitive areas •Choose developed areas of the site •Avoid building in the center of the site •Cluster buildings to reduce impact	•Select sites with good access to public transportation •Provide preferred parking for carpools •Select sites that minimize need for new infrastructure •Check flight patterns, highways, and other noise when locating facilities	•Develop a brownfield site •Integrate military project site selection with larger community land use proposals •Provide bicycle ways and changing facilities •Install refueling facilities for alternative fuel vehicles
Understand the site ecological considerations	Focus is on compliance with laws and codes	•Identify and document ecologically sensitive areas •Identify hazards and contaminated areas	•Conduct a full ecological assessment •Conduct a solar and wind study	
Protect and restore the site	Focus is on compliance with laws and codes	•Protect ecologically significant areas •Preserve existing trees and topsoil •Use buffers and protection fences during construction	•Minimize building footprint and associated construction •Use effective stormwater and erosion controls (e.g., minimize impervious surfaces, use grass swales) •Minimize effects of construction (e.g., staging areas) •Install oil grit separators or water quality ponds for pre-treatment of surface runoff	•Use innovative approaches such as permaculture •Restore degraded habitat areas on site •Use high-albedo materials on non-parking impervious surfaces

Principles/ Strategies	Traditional Practice	Minimal Measures	Moderate Measures	Extensive Measures
Landscape sustainability	Minimal consideration of sustainability and wide use of standard lawns	•Use indigenous plants and trees •Reintroduce native plants and trees •Mulch plantings •Group plantings with similar water needs •Install drip irrigation	•Use integrated pest management rather than chemicals •Use landscaping to assist in energy efficiency	
Design with the site	Initial cost considerations dominate decision making	Avoid cut and fill	•Optimize solar orientation •Use natural features for natural heating, cooling, daylighting, drainage	

WATER

Principles/ Strategies	Traditional Practice	Minimal Measures	Moderate Measures	Extensive Measures
Limit landscape water use	Landscaping is relatively uniform nationwide – standard lawn and recreational grass Widespread use of irrigation and fertilizers/ chemicals	•Use indigenous plants and trees •Group plants that require similar irrigation •Mulch plantings to retain water	•Limit or eliminate lawns and grass that require irrigation •Use drip irrigation systems •Use irrigation system based on need	Install entire landscape that requires little or no irrigation after establishment
Use water-conserving plumbing fixtures and appliances	Low-flow (1.6 gallon) toilets are standard and there is moderate use of other low-flow plumbing fixtures	•Install low-flow showerheads and faucets •Install infrared sensors •Install low-flow drinking fountains	•Install toilets that are 20% better than code •Install waterless urinals •Install water-conserving appliances	•Install composting toilets •Install toilet-mounted hand washers
Incorporate water recovery and re-use systems	Use limited to isolated highly arid locations		•Install rainwater collection system •Install greywater recovery and re-use systems	Install on-site wastewater treatment system
Monitor and adjust water use; manage consumption	Water use is monitored for payment purposes only	Monitor trends in overall water use	•Install individual meters •Monitor water use on individual scale	Install computer-based systems in individual units
Educate building users and facility managers	Little or no education at this time	Install signs and distribute educational flyers	•Develop and display educational exhibits •Conduct workshops on water conservation	•Conduct workshops on sustainability •Facilitate community involvement on water issues
Use water-conserving industrial processes				

ENERGY

Principles/ Strategies	Traditional Practice	Minimal Measures	Moderate Measures	Extensive Measures
Optimize building siting, orientation, size, and form	Based on site availability with minimal consideration of energy issues	Use landscaping to optimize solar and wind	Locate and orient the building on the site to optimize solar and wind	Build the smallest building that will meet needs; use most efficient shape and form
Optimize building envelope	Minimum to meet codes	Specify optimal insulation levels for roofs, walls, and foundations	•Specify optimal glazing and windows; optimize their placement and size •Specify optimal roofing •Design optimal sun control and shading devices	•Coordinate all building envelope elements for maximum energy efficiency •Tune glazing–use best for each façade
Optimize lighting and appliances	Minimum to meet codes	•Use efficient appliances •Use efficient luminaires indoors and outdoors	•Use occupancy sensors and energy efficient lighting controls •Integrate daylighting with other strategies •Use efficient pumps and motors •Use task lighting	Establish O&M performance monitoring for lighting systems and appliances
Optimize mechanical systems	Use of minimal energy efficiencies as required by laws and codes	•“Right size” HVAC system •Plan for expansion but do not size for it •Keep systems simple and easy to maintain	•Commission HVAC system •Shift or shave electric loads during peak demand periods •Consider part-load performance •Use energy efficient HVAC controls •Install a waste heat recovery system	•Establish an O&M program for HVAC system •Use energy conserving technologies (e.g., dessicant cooling, micro cogeneration, thermal storage) •Consider evaporative cooling
Use renewable/ alternative systems	No consideration	Consider passive solar heating	•Consider active solar water heating •Consider natural ventilation	Consider building integrated photovoltaics

Principles/ Strategies	Traditional Practice	Minimal Measures	Moderate Measures	Extensive Measures
			•Consider building mass for natural heating/cooling •Consider evaporative cooling	
Integrate all decisions/ use iterative process	Limited use	•Recognize all components of energy efficiency – reduce energy use in all components •Set energy targets •Use computer modeling tools (e.g., DOE BLAST)	•Consider synergistic effects of energy choices •Use an iterative decision process •Surpass ASHRAE 90.1	Begin project with integrated design approach and diverse team members
Educate building users/ facility managers	Manufacturer's equipment manuals As-built drawings	Use signs/educational flyers to encourage efficient energy use	Install educational exhibits and conduct workshops on energy efficiency	•Conduct integrated systems/sustainability workshops •Adopt user-friendly manuals
Monitor and benchmark energy performance	Mass energy metering	•Monitor overall energy use •Use EPA/DOE Energy Star Benchmarking Tool •Use energy management control systems	•Install individual facility meters and monitor on a regular basis •Establish feedback loop to designers	•Document energy savings on real-time computer based user information •Use energy management control systems to optimize performance

MATERIALS

Principles/ Strategies	Traditional Practice	Minimal Measures	Moderate Measures	Extensive Measures
Reduce the amount of materials used	Limited attention given to reduction of material use except to reduce cost	•Eliminate materials (e.g., finishes) •Use materials that require less maintenance •Use durable, long-lasting materials •Reuse existing facilities	•Reduce overall size of building •Design building dimensions to optimize material use/reduce waste •Establish a routine maintenance schedule	•Document activities and uses of buildings - coordinate functions to reduce overall space requirements •Consider networking, flex-time for office sharing to reduce space requirements
Select environmentally preferable materials	Requirements for recycled content exist. Selection based on initial cost, appearance, and maintenance CFCs and halons being eliminated in equipment and fire suppression systems	•Use materials that have recycled content and are recyclable •Use materials that are durable and low maintenance •Use materials that are low or no emissions and non-toxic	•Use certified wood •Use locally produced materials •Use materials with low embodied energy •Use salvaged/re-used materials •Use environmentally preferable cleaning products for building maintenance •Phase out all ozone depleters	Consider environmental life-cycle assessments (LCA) of materials
Reduce waste during demolition, construction, and post-occupancy	Rely on contractor's decisions	•Reduce and re-use demolition waste •Recycle waste •Provide for storage and collection of recyclables •Use pre-cut/ pre-fabricated materials, standard lengths/sizes	•Create a waste management plan •Know and use local recycling and reuse programs	•Investigate "take back" programs with manufacturers •Monitor and document project waste

Principles/ Strategies	Traditional Practice	Minimal Measures	Moderate Measures	Extensive Measures
Plan and design for future renovation, reconfiguration, and adaptive reuse	Existing facilities are routinely renovated, but "plan and design for future renovation, reconfiguration, flexibility" is limited	•Create durable building shell •Use access floors	•Create long-lasting building shell and structural system •Create an adaptable, flexible design (open building, service corridors) •Use flexible systems (e.g., plug and snap ceilings, raised floors, etc.)	•Incorporate "office of the future" into master planning •Establish task force to coordinate flex time, etc. into planning •Incorporate personal environmental controls

INDOOR ENVIRONMENT QUALITY

Principles/ Strategies	Traditional Practice	Minimal Measures	Moderate Measures	Extensive Measures
Eliminate or reduce the sources of indoor pollutants	Minimum required by laws and codes	•Use readily available lower-emitting materials •Prohibit smoking in facilities •Use walk-off entry mats, tiled entries, or grates or grills •Test for radon and take remedial measures as indicated	•Control moisture to minimize mold and mildew •Avoid cleaning products with harmful air emissions	•Reduce or eliminate harmful interior pest control •Educate occupants on indoor pollutants •Monitor and document occupant feedback on IAQ
Manage remaining pollutants	Comply with ASHRAE 62-1989 and codes	•Locate outside air intakes away from pollution sources •Ensure that air supply and return grills are not obstructed •Designate areas for proper chemical storage and mixing •Sequence construction to minimize IAQ problems	•Assess need for and use higher performing filters •Develop and implement an IAQ management plan •Install CO2 monitors •Flush out the building using the building system	•Install overall air quality monitoring system to monitor and document IAQ •Locate building on master plan to minimize IAQ effects •Conduct periodic flushing cycle •Flush out using different system •Separately exhaust areas with high pollutants
Ensure thermal comfort	•Simple systems with large zones •Supplemental personal heaters and fans used •Comply with set points for heating and cooling •Comply with ASHRAE 55-1992	Use VAV smaller zoned systems	•Design easy access to HVAC equipment for maintenance •Install operable windows with appropriate systems •Add sun shading and glazing to reduce radiant heating	•Provide individual occupant controls •Check, monitor, and document thermal comfort,balance glazing, sunshading, etc. •Install system that automatically shuts down HVAC and opens windows at certain temperatures

Principles/ Strategies	Traditional Practice	Minimal Measures	Moderate Measures	Extensive Measures
Encourage daylighting and visual connection to outdoors (avoid glare and unwanted heat gain)	Reliance on electrical lighting	•Introduce more visual connection to the outdoors •Optimize lighting quality •Increase window sizes	•Avoid heat gain and glare •Integrate daylighting with energy efficiency measures	Rely on daylighting as main lighting source and combine with holistic energy efficiency approach
Reduce noise	Regulated, comply with recommended decibel levels	Consider noise levels when designing adjacent activity spaces	•Use adequate interior insulation levels •Isolate large HVAC equipment away from occupied areas •Use noise masking system	Monitor and document occupant feedback on noise levels

SUMMARY OF CASE STUDY STRATEGIES

On the following pages, four DoD case studies are used to illustrate minimal, moderate, and extensive sustainable design principles/strategies in the military. The four case studies include:

1. **Fort Lee:** Low-density housing for the Army in Virginia.
2. **Building 33:** Headquarters Building for the Navy in Washington, D.C.
3. **BEQ:** High-density housing for the Navy in Illinois.
4. **Edwards:** Tertiary Wastewater Plant for the Air Force in California.

	Minimal Measures	**Moderate Measures**	**Extensive Measures**
Integrated Planning and Design	Fort Lee: Energy Star designation with energy targets and training on new systems (i.e., blower door test)	Bldg 33: Greening charrette set integrated sustainable goals,added "green" consultants, found synergies among all sustainable areas Fort Lee: HVAC systems were balanced and each unit successfully completed the required blower door tests BEQ: Used USGBC's LEED Green Building Rating system for sustainability goals in all sustainable areas	BEQ: Created a multidisciplinary team from the onset with a shared vision. Developed sustainable benchmarks and measures in all sustainable categories. Realized synergistic effects among strategies. Conducted whole building commissioning.
Site	Bldg 33: reused a developed site near mass transit and planted indigenous vegetation. Fort Lee: site preservation strategies to meet Chesapeake Bay preservation requirements (wetlands preservation). Existing timber on site was harvested and sold. Site is pedestrian friendly with walkways connecting residents of the neighborhood. Edwards: protection of the desert tortoise and Joshua tree habitat were requirements of the project.	Bldg 33: established effective erosion control. Fort Lee: no "net" increase in storm water; landscape islands introduced to reduce paving Edwards: storm water runoff requirements were in effect during construction	

	Minimal Measures	Moderate Measures	Extensive Measures
Site	BEQ: Infill construction, which minimizes the impact on undeveloped land and takes advantage of the existing infrastructure and transportation. Many existing trees were relocated and new plantings are indigenous.	BEQ: new plant material was installed at the NTC site which before was gravel to help with erosion control as well as heat island reduction. Pedestrian traffic was encouraged.	
Water	Bldg 33: low-flow faucets and drinking fountains were installed. Periodic monitoring of water use established. Fort Lee: low-flow faucets and showerheads were installed. Edwards: low-flow faucets, showerheads, and drinking fountains were installed. BEQ: low-flow faucets and showerheads were installed	Edwards: implemented graywater recovery and reuse.	BEQ: indigenous plants requiring no irrigation after establishment were used.

	Minimal Measures	Moderate Measures	Extensive Measures
Energy	Bldg 33: set energy targets and used DOE BLAST tool for energy modeling	Bldg 33: used synergistic energy strategies: super window effect, high levels of insulation, maximized daylighting, occupancy sensors and efficient lighting controls, HVAC commissioning.	
	Fort Lee: set energy targets and used DOE BLAST tool for energy modeling along with LCCID and MEC-CHECK programs. Specified high insulation levels – R-24 walls and R-46 roofs. Energy efficient appliances were specified (e.g., water heater) as were effective ceiling fans.	Fort Lee: high efficiency heating and cooling systems installed with AC usage to avoid peak demand charges for the base. Mechanical engineers and architects worked closely on issues of insulation levels, selection and placement of windows and equipment.	
	BEQ: electric fixtures are T-8 fluorescents or compact fluorescents, offering good lighting with high performance. Exit lights are LED. Lights in public spaces are on a dual switch for efficiency.	BEQ: over half of the dwelling units optimize solar orientation. DDC controls were used with temperature setback for HVAC. Building components have relatively high performance: windows are low-e argon filled in thermally-broken frames; insulation levels are R-30/R-40 in roofs, R-23 in walls, and R-10 at the perimeter slab. The building shell has significant thermal mass.	BEQ: operations and maintenance manuals are being developed in order to assure the long-term durability of the project and the lower operating costs. Commissioning was performed according to ASHRAE standards and the Navy's Public Works Command.
		Edwards: uses the highest efficiency motors and pumps available. Pumping to storage is done during off-peak hours. Skylights are used to daylight several spaces. Occupancy sensors are used for seldom occupied spaces. Plant was operationally commissioned.	

	Minimal Measures	Moderate Measures	Extensive Measures
Materials	Bldg 33: C&D waste recycled and post-occupant recycling system established. Fort Lee: a cyclical and routine maintenance ensures continued level of quality for these units. Durable, low maintenance shell and materials were used. Demolition metals were recycled. BEQ: several recycled content materials were specified and installed. Use of local materials was stressed.	Bldg 33: Extensive use of salvaged and recycled content materials. Fort Lee: Uses R-22 for new refrigeration components; units that were demolished, the contractor removed and reclaimed all of the existing refrigerant. BEQ: Each individual project product was reviewed for sustainability. Field inspections were performed regularly, and mandated testing was performed on materials and systems. CFCs, HCFCs, and Halon were eliminated or minimized. Brick was reused from the demolition of a neighboring building. A C&D Waste management plan was created -- construction debris was sorted and landfill use was tracked. Edwards: Eliminated use of CFCs, HCFCs, and Halon	

	Minimal Measures	Moderate Measures	Extensive Measures
IEQ	Bldg 33: No-low VOC materials, walk-off mats, proper chemical storage, and attention to noise reduction/compliance with AHSRAE. Fort Lee: Entryways are tile for ease of cleaning and maintenance. BEQ: ASHRAE standards on IAQ and thermal comfort were followed. Low VOC adhesives, sealants and coatings were specified and used. All entryways have walk-off mats.	Bldg 33: Sequenced construction to minimize IAQ problems, installed CO2 sensors, and integrated natural daylighting. Fort Lee: "Active Ventilation Engineered IAQ Enhancement" was incorporated, as were several other strategies to optimize indoor air quality in these residential units. HVAC equipment is easily accessed from the outside for maintenance. Party walls have an assembly STC rating of 59 -- sound testing was required and performed to assure compliance. BEQ: No cleaning agents with toxic chemicals will be used. High quality lighting is achieved through daylighting and efficient and effective lighting fixtures. (Window sizes were increased from Navy standard to allow for more daylight.) Individual units have partitions with STC rating of 57 between modules.	

SECTION VI- SUSTAINABILITY RESOURCES

SUSTAINABILITY RESOURCES

During the course of the charrette, team members discussed a number of ideas that did not necessarily appear in the body of the report. Individuals from each represented discipline noted various initiatives that could make this a more "green" project.

In some cases, these recommendations involved a substitution of one product for another, or the use of an energy-saving appliance—for instance, dimmers at various electrically lighted locations.

A number of the comments concern modifications to the standard designs for various buildings. In the site plan redesign, the barracks buildings would be reconfigured to reduce the footprint, which is essential to a reduction in the total development area of the Separate Battalions Complex. Some daylighting concerns prompted a recommendation to relocate the offices in the battalion headquarters to the interior areas.

In many cases, revision to existing Department of the Army or Ft. Bragg standards made up the basis of a recommendation. Force protection requirements have a direct effect on land use and limit of development. Exterior lighting standards in force at Ft. Bragg could be modified to be more in keeping with sustainable design standards.

In a few instances, resource sheets refer to available material such as military guide specifications or technical papers. These have not been included in this report, but references indicating their location have been provided.

Sustainability Criteria
(check only one)

- ☐ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☐ Mechanical
- ☒ Electrical

Submitted by Jim Benya

Description of Resource-

Change downlights in barracks type BA from 32 to 26 watt compact fluorescent, triple tube.

The current design calls for lensed 32 watt compact fluorescent downlights providing general illumination in the common areas of the barracks units. The designed light levels were evaluated by the COE using point-by-point calculations. Upon review, the charrette team felt that a 20% reduction in light levels was acceptable given the age of the viewer and non-critical nature of the visual tasks.

The 26 watt lamp saves about 6 watts as compared to the 32 watt lamp, but due to optical efficiencies, will produce a little bit more efficiency in the luminaire, resulting in light levels that are not quite as low as the 25% light level reduction. There will not be any cost penalty of any kind, and energy savings will result. Lamp life and other maintenance factors remain the same as before.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

No first cost change.

Lower operating cost by 25%.

Reduced connected load by 25%.

Disadvantages of Resource

Reduced light levels by 20%.

Sustainability Criteria
(check only one)

- ☐ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☐ Mechanical
- ☐ Electrical

Submitted by Jim Benya

Description of Resource

Dining Room Type "A" luminaires - make dimming and employ a simple preset dimming system to encourage manual dimming and to execute automatic scene transistions based on astronomic time.

This design change will require the addition of dimming ballasts to all compact fluorescent fixtures, an approximate cost adder of about $35-$40 per fixture. Then, the cost of a dimming system consisting of a four scene preset dimming control with programmable time functions and manual switches must be added. Use of booster dimmers may be needed to handle the large dining rooms.

A separate set of controls may be needed for the private meeting room area.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Reduced energy costs.

Use of daylighting to reduce peak demand.

Improved indoor environmental quality.

Disadvantages of Resource

Increased first cost.

Requires commissioning.

Requires management activity to use properly.

Sustainability Criteria
(check only one)

- ☐ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☐ Mechanical
- ☐ Electrical

Submitted by Jim Benya

Description of Resource

Kitchen areas type "C" lens troffer, reduce 4 lamps to 3, add high performance reflector.

The use of a high performance specular reflector increases the performance of a luminaire by 3-7% (absolute). The resultant light levels will be 15% or so less than calculated. When reviewing the lighting calculations, this was an acceptable reduction permitting a signficant energy decrease.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Lower energy cost by approx 25 watts each.

Lower relamping costs.

Disadvantages of Resource

Reduced lighting levels by about 15%.

Possible slight increase in first cost.

Sustainability Criteria
(check only one)

- ☐ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☐ Mechanical
- ☐ Electrical

Submitted by Jim Benya

Description of Resource

In various utility luminaires, utilize low ballast factor electronic ballasts.

A low ballast factor ballast uses fewer watts and produces lower light levels with no change in luminaire type, lamp type, or any cost other than energy, which is reduced.

The typical application in various utility luminaires is warranted since light levels are seldom an issue. The drop in light levels, of about 10-15%, save 5 watts per lamp.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Reduce power approx. 8-10 watts per 2 lamps.

Disadvantages of Resource

Reduce lighting levels about 7-9%.

Sustainability Criteria
(check only one)

- ☐ Site
- ☐ Energy
- ☐ Materials
- ☐ Water
- ☒ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☐ Mechanical
- ☒ Electrical

Submitted by Jim Benya

Description of Resource

Battalion Headquarters - dim lighting in the classrooms using a manual dimming system.

This will save energy but is actually needed to permit the A/V uses of the space.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Improve usability of facility.

Improve lighting levels during specific uses of room.

Save energy

Disadvantages of Resource

Additional cost for ballasts and dimmers.

Sustainability Criteria
(check only one)

- ☐ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☐ Mechanical
- ☒ Electrical

Submitted by Jim Benya

Description of Resource

Battalion HQ - use low ballast factor ballasts on 2 lamp parabolics.

A low ballast factor ballast uses fewer watts and produces lower light levels with no change in luminaire type, lamp type, or any cost other than energy, which is reduced.

The typical application in various utility luminaires is warranted since light levels are seldom an issue. The drop in light levels, of about 10-15%, save 5 watts per lamp.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Save 8-10 watts per luminaire.

Disadvantages of Resource

Reduced lighting levels in ancilliary areas by 7-9%.

Sustainability Criteria
(check only one)

- ☐ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☐ Mechanical
- ☒ Electrical

Submitted by Jim Benya

Description of Resource

Battalion HQ - change soffit lights from lensed metal halide using ceramic metal halide to open compact fluorescent.

Due to the superior lumen maintenance of compact fluorescent lamps as compared to metal halide, a 42 watt compact fluorescent can produce the same maintained light output as a 70 watt ceramic metal halide.

In addition to saving energy, the compact fluorescent lamp costs much less, lasts longer, has equal or better color rendering, and has instant on/instant restrike capability. This decreases owning and operating costs and overall life cycle costs. And the initial cost is lower, too.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Save 40+ watts per luminaire

Reduce relamping costs by $50 per lamp per replacement.

Reduced maintenance - longer life lamp, easier to change..

Disadvantages of Resource

None.

Sustainability Criteria
(check only one)

- ☐ Site
- ☐ Energy
- ☐ Materials
- ☐ Water
- ☒ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☐ Mechanical
- ☒ Electrical

Submitted by Jim Benya

Description of Resource

Barracks - change T-8 lamps to 835.

The standard fluorescent, F32 T8 lamp is used extensively and particualrly as the general lighting source for the soldier's bedroom. By improving the specifcation from 735 to 835 (color rendering 75 to 85 at 3500 Kelvin), the lamp light output increases and the lamp lumen depreciation improves, providing 5% more light for the same watts.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Increase maintained lighting by 5%

Improved lighting color CRI from 75 to 86.

Keeps same lamps as used elsewhere (dining, offices, etc.)

Disadvantages of Resource

Increased lamp cost

Sustainability Criteria
(check only one)

- ☐ Site
- ☐ Energy
- ☐ Materials
- ☐ Water
- ☒ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☐ Mechanical
- ☒ Electrical

Submitted by Jim Benya

Description of Resource

Barracks - add dimming in soldier's sleeping room.

It is generally believed that in this application, soldiers will use the dimming feature to save 50% energy and in the process, gain a measure of improved interior environmental quality.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Improved usability and comfort.

Reduce energy comsumption by 50% (estimated).

Disadvantages of Resource

Increased first cost of lighting controls and ballasts.

Sustainability Criteria
(check only one)

- ☐ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☒ Architecture
- ☒ Structural
- ☒ Mechanical
- ☒ Electrical

Submitted by Jim Benya

Description of Resource

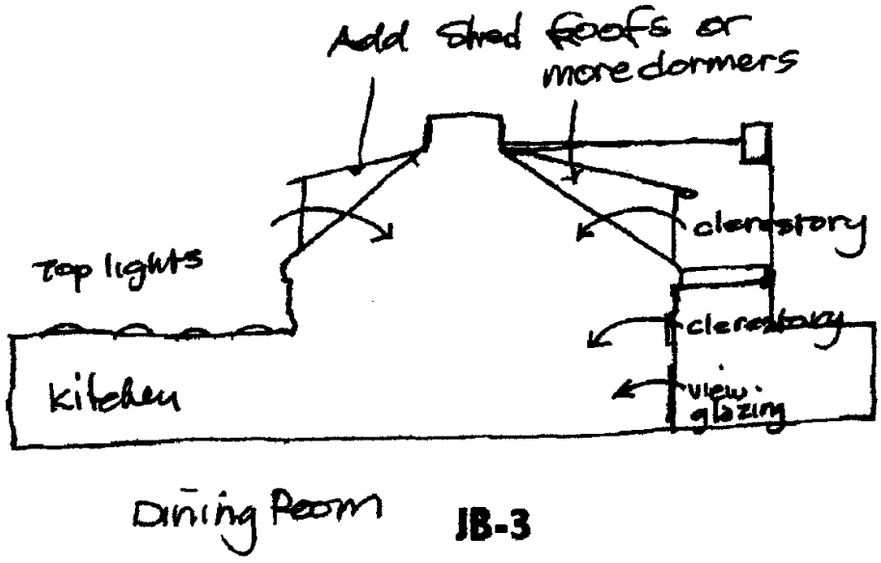
Daylighting for Large Dining Room as follows:

Add dormers or shed roof skylights to front of building to introduce daylight deeply into dining areas.

Add clerestory windows on building to introduce daylight into front area of dining areas.

Add modular skylights in flat roof over kitchen to introduce daylight into cooking areas.

This design will require revised architecture but is relatively easy to do and will gain great daylighting benefits. To realize the energy savings, dimming ballasts and daylight sensors must be employed in the daylighted spaces.



Attached Drawing or Sketch ☒ Reference Document Number or ID JB-3

Advantages of Resource

Reduced energy consumption for lighting and HVAC.

Improved indoor environmental quality.

Disadvantages of Resource

Additional first costs for daylight elements and electric lighting controls to permit dimming.

Sustainability Criteria
(check only one)

- ☐ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☒ Architecture
- ☒ Structural
- ☒ Mechanical
- ☒ Electrical

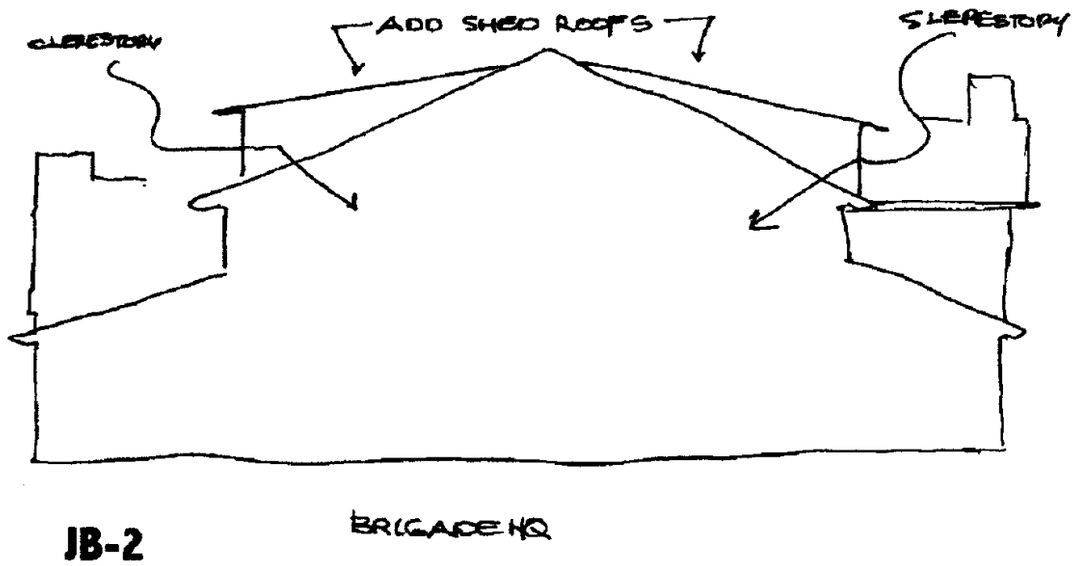
Submitted by Jim Benya

Description of Resource

Daylighting for Brigade HQ as follows:

Add shed roof skylights to front of building to introduce daylight deeply into office areas.

.
This design will require revised architecture but is relatively easy to do and will gain great daylighting benefits. To realize the energy savings, dimming ballasts and daylight sensors must be employed in the daylighted spaces.



Attached Drawing or Sketch ☒ Reference Document Number or ID JB-2

Advantages of Resource

Reduced energy consumption for lighting and HVAC.

Improved indoor environmental quality.

Disadvantages of Resource

Additional first costs for daylight elements and electric lighting controls to permit dimming.

Sustainability Criteria
(check only one)

- ☐ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☒ Architecture
- ☒ Structural
- ☒ Mechanical
- ☒ Electrical

Submitted by Jim Benya

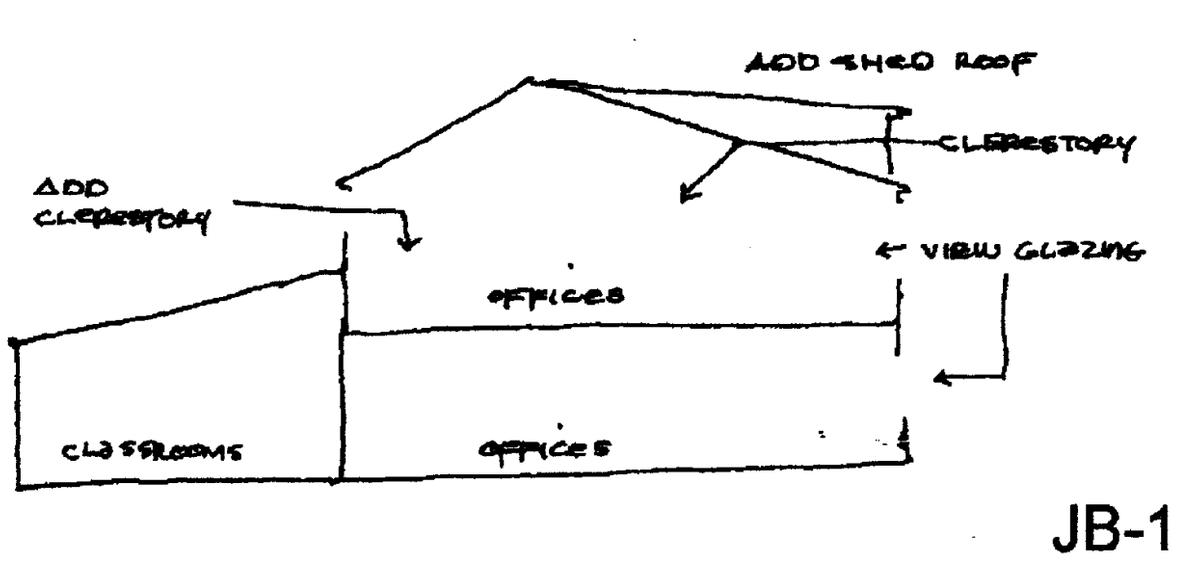
Description of Resource

Daylighting for Battalion HQ as follows:

Add shed roof skylights to front of building to introduce daylight deeply into office areas. This will require changing the elevation from dormers to a long shed/clerestory.

Add continuous clerestory on wall above meeting room roof to illuminate second story rooms along north side.

.
This design will require revised architecture but is relatively easy to do and will gain great daylighting benefits. To realize the energy savings, dimming ballasts and daylight sensors must be employed in the daylighted spaces.



Attached Drawing or Sketch ☒ Reference Document Number or ID JB-1

Advantages of Resource

Reduced energy consumption for lighting and HVAC.

Improved indoor environmental quality.

Disadvantages of Resource

Additional first costs for daylight elements and electric lighting controls to permit dimming.

Sustainability Criteria
(check only one)

- ☐ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☐ Mechanical
- ☒ Electrical

Submitted by Jim Benya

Description of Resource

Soldier Building second floor - change 2 lamp wraparound to single lamp strip. Control using digital timers, eliminate contactor.

This is more of a “VE” proposal because the space is seldom occupied. But in any event, reducing the lighting load from 2 lamps to one with a corresponding fixture efficiency increase assures minimum life cycle costs and lower first costs as well.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Save first cost

Save maintenance cost

Save energy

Disadvantages of Resource

None

Sustainability Criteria
(check only one)

- ☐ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☒ Civil/Landscape
- ☒ Architecture
- ☐ Structural
- ☒ Mechanical
- ☒ Electrical

Submitted by Jim Benya

Description of Resource

Eliminate energy conversion systems (boilers, water heaters, chillers) and related buildings. Provide site and permit an independent ESCO to provide energy services including the construction and operation of cogeneration.

See additional information on cogeneration from Tom.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Reduced first cost

Reduced annual energy costs

Eliminate need for maintenance and operation by Army

Disadvantages of Resource

Changes the way the Army operates facilities

Sustainability Criteria
(check only one)

- ☐ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☒ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☐ Mechanical
- ☒ Electrical

Submitted by Jim Benya

Description of Resource

Exterior lighting standards of Fort Bragg are twice or more applicable IESNA standards and do not meet IESNA Recommended Practice RP-33, Environmental Exterior Lighting. Reduce light levels to IESNA recommendations. Power savings will be about 50% or more as compared to current design, and exterior environment will be better.

All lighting standards revolve around IESNA standards and publications. As pointed out in RP-33, there is a trend towards unjustified exterior lighting levels. The cost per SF or acre is relatively small, and the existing belief is the more light the better, especially among security conscious personnel. However, high exterior light levels disrupt sleep and desensitize the eye to night vision, somewhat defeating the concept of security lighting.

To create the high exterior lighting levels, lamps are higher wattage than needed. A survey of design criteria for the project suggests that lighting levels about 50% of the current criteria would probably be suitable at a commensurate reduction in lighting power of 50%.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Lower first cost.

Lower energy cost.

Improved exterior environmental quality.

Disadvantages of Resource

Lower light levels, but adequate per IESNA.

Sustainability Criteria
(check only one)

- ☐ Site
- ☐ Energy
- ☐ Materials
- ☐ Water
- ☒ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☒ Architecture
- ☐ Structural
- ☒ Mechanical
- ☒ Electrical

Submitted by Ken Waldie

Description of Resource

Move offices in the Battalion and Brigade HQ buildings to the core to allow all of the occupants exposure to natural daylight

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Improved morale

Possible reduced energy use if daylighting is utilized.

Disadvantages of Resource

Redesign of floor plan.

Sustainability Criteria
(check only one)

- ☐ Site
- ☐ Energy
- ☐ Materials
- ☒ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☒ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☒ Mechanical
- ☐ Electrical

Submitted by Ken Waldie

Description of Resource

Use the following as sources of greywater for landscape irrigation:

Barracks lav and shower drains

COF shower and lav drains

Dining facilities all drains except sanitary

SCB washing machines

Also- consider collection of Rainwater runoff

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Re-uses water for lawn irrigation instead of wasting it.

Disadvantages of Resource

Requires plumbing redesign.

Could incur increased costs.

Sustainability Criteria
(check only one)

- ☐ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☒ Civil/Landscape
- ☒ Architecture
- ☒ Structural
- ☒ Mechanical
- ☐ Electrical

Submitted by Jim Benya

Description of Resource

Do not build any energy infrastructure, including boiler plants, chillers, etc.

Engage an ESCO to develop a cogeneration plant on site. Purchase electric, hot water and chilled water from the ESCO's plant. Leave the management and maintenance up to the ESCO. Employ backup electric service from the grid and permit the ESCO to sell excess electric energy. Require the ESCO to utilize high efficiency systems and meet basic sustainability criteria.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Dramatically reduced capital investment.

Eliminates problems of Army construction and acquistion process by privatizing the construction of the energy plant.

Permits use of natural gas and maximizes use of consumed fossil fuel.

Incentivizes ESCO to produce energy efficiently.

Tends to assure better qualified energy management and maintenance personnel..

Disadvantages of Resource

Major change in the manner in which Army facilities are designed, built and operated.

Sustainability Criteria
(check only one)
- ☒ Site
- ☐ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)
- ☒ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☒ Mechanical
- ☒ Electrical

Submitted by Ken Waldie

Description of Resource

Co-locate chillers for several buildings together along the back of the site. Use heat recovery in the chiller to preheat heating water for buildings with boilers such as SCB.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Energy savings potential.

Site planning advantages.

Disadvantages of Resource

Could cause problems with long runs from transformers if they are located with chillers.

Requires additional piping.

Sustainability Criteria
(check only one)
- ☐ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)
- ☐ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☒ Mechanical
- ☐ Electrical

Submitted by Ken Waldie

Description of Resource

Provide a means for data collection by DDC systems (temps, humidity, damper positions, meter readings) to be posted over a secure web site so we can monitor actual energy use and verify if the consumption estimates are accurate (ex. CellNET)

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Verification of energy consumption estimates

Providing data for troubleshooting field reported problems

Disadvantages of Resource

Additional cost

Requires user consent

Sustainability Criteria
(check only one)

- ☐ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☒ Mechanical
- ☐ Electrical

Submitted by Tom Lunneberg

Description of Resource

Base central plant VE study on large delta-T cooling system. We understand that VE assumed CHW delta-T at approx. 10ºF, but this can be increased to 20-25ºF, which reduces pipe sizes, central plant pump sizes, and CHW valve sizes. Must install deeper CHW coils to get high delta-T, which adds some cost. Big delta-T will improve dehumidification.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Lower installed cost

Lower operating cost

Better dehumidification

Disadvantages of Resource

Trickier engineering

Sustainability Criteria
(check only one)

- ☐ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☒ Architecture
- ☒ Structural
- ☒ Mechanical
- ☐ Electrical

Submitted by Ken Waldie

Description of Resource

Use dessicant dehumidification to pretreat outdoor air. Make up air handler could then be deleted for barracks. Pretreated air could then be ducted into RA duct at fan coil unit.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Reduced chilled water load.

Reduced energy use.

Dessicant units are nearly zero maintenance, especially as compared to make up air units.

Disadvantages of Resource

May require redesign of portions of barracks.

Sustainability Criteria
(check only one)

- ☐ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☒ Mechanical
- ☐ Electrical

Submitted by Ken Waldie

Description of Resource

Use heat recovery (air to air or wheel) in barracks to recover lost heating/cooling from central exhaust system. Use this unit to pretreat outdoor air.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Reduced energy use.

Low maintenance system.

Disadvantages of Resource

Additional cost.

Sustainability Criteria
(check only one)
- ☒ Site
- ☐ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)
- ☒ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☐ Mechanical
- ☐ Electrical

Submitted by Team

Description of Resource

Increase re-use of demolition materials on base and at project site.

Base should set aside usable recyclable materials for future use.

Project should then coordinate with base to store reusable materials for this or other projects.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Reduces landfill.

Maximizes use of recyclable materials such as rubble.

Disadvantages of Resource

Requires setting aside a separate recyclable materials facility.

Requires management efforts to be on-going.

Requires greater coordination between design and base management operations.

Sustainability Criteria
(check only one)
- ☒ Site
- ☐ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)
- ☒ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☐ Mechanical
- ☐ Electrical

Submitted by Team

Description of Resource

Provide maintenance instructions for landscaping.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Prevent loss of lansdcape materials, waste of water and use of fertilizers and chemical products.

Disadvantages of Resource

Cost of developing and implementing.

Sustainability Criteria
(check only one)
- ☐ Site
- ☐ Energy
- ☒ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)
- ☒ Civil/Landscape
- ☒ Architecture
- ☒ Structural
- ☒ Mechanical
- ☒ Electrical

Submitted by Team

Description of Resource

Better utilize sources of expertise and employ better communication links to project designers .

CERL is an example.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Better designs.

Disadvantages of Resource

Greater effort required.

Sustainability Criteria
(check only one)
- ☐ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)
- ☐ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☒ Mechanical
- ☒ Electrical

Submitted by John Krajewski

Description of Resource

Early coordination with energy providers and regulators on how energy is provided. Investigate energy opportunities e.g. interruptible service.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Lower life cycle cost.

Disadvantages of Resource

Change in how the Army views utility sources.

Sustainability Criteria
(check only one)
- ☐ Site
- ☐ Energy
- ☒ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)
- ☒ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☐ Mechanical
- ☐ Electrical

Submitted by John Krajewski

Description of Resource

Develop interior plans to utilize materials consistent with LEED and other standards.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Improve indoor environmental quality.

Reduce use of depletable resources.

Disadvantages of Resource

High cost.

More difficult procurement.

Sustainability Criteria
(check only one)
- ☐ Site
- ☐ Energy
- ☒ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)
- ☒ Civil/Landscape
- ☒ Architecture
- ☒ Structural
- ☒ Mechanical
- ☐ Electrical

Submitted by John Krajewski

Description of Resource

Include contractor incentives (design and construction) for sustainable design, products, systems and processes. VECP possible model.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Additional source of input.

Disadvantages of Resource

Requires greater project management and engineering time to evaluate proposals.

Sustainability Criteria
(check only one)
- ☒ Site
- ☒ Energy
- ☒ Materials
- ☒ Water
- ☒ Indoor Environmental Quality

Discipline Impact
(check all that apply)
- ☒ Civil/Landscape
- ☒ Architecture
- ☒ Structural
- ☒ Mechanical
- ☒ Electrical

Submitted by John Krajewski

Description of Resource

Require sustainable design experts for both design and construction teams.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Assures proper evaluation and implementation.

Disadvantages of Resource

Increased design and construction costs.

Sustainability Criteria
(check only one)
- ☒ Site
- ☒ Energy
- ☒ Materials
- ☒ Water
- ☒ Indoor Environmental Quality

Discipline Impact
(check all that apply)
- ☒ Civil/Landscape
- ☒ Architecture
- ☒ Structural
- ☒ Mechanical
- ☐ Electrical

Submitted by John Krajewski

Description of Resource

Address future recyclability of products in product requirements and specs.

Revise CEGS

Also need to educate designers for purposes of making product selections.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Plans for future sustainability.

Disadvantages of Resource

Costs of revising product requirements and specs.

Costs of educating personnel.

Sustainability Criteria
(check only one)
- ☐ Site
- ☐ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)
- ☐ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☐ Mechanical
- ☐ Electrical

Submitted by John Krajewski

Description of Resource

Use demountable partitions.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Little or no demolition materials when re-arranging space.

Rapid change of space layouts.

Disadvantages of Resource

More costly.

Currently included as furniture cost, penalizes customer's budget to employ.

Sustainability Criteria
(check only one)
- ☒ Site
- ☒ Energy
- ☒ Materials
- ☒ Water
- ☒ Indoor Environmental Quality

Discipline Impact
(check all that apply)
- ☒ Civil/Landscape
- ☒ Architecture
- ☒ Structural
- ☒ Mechanical
- ☒ Electrical

Submitted by John Krajewski

Description of Resource

In order to utilize sustainable products and systems, base maintenance resources will need to be improved. Included will be:

1. Enhanced training for operations and maintenance personnel
2. Contracting out maintenance
3. Contract both provision and maintenance e.g. energy savings performance contracting

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Improved sustainability

Improved acceptance of sustainable materials and systems

Realization of full life cycle cost benefits

Disadvantages of Resource

Will require new methods of contracting

Will increase training costs

Sustainability Criteria

(check only one)

- ☐ Site
- ☐ Energy
- ☒ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact

(check all that apply)

- ☐ Civil/Landscape
- ☒ Architecture
- ☐ Structural
- ☐ Mechanical
- ☐ Electrical

Submitted by John Krajewski

Description of Resource

Rent carpeting.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Assures recycling.

Lowers first cost

Disadvantages of Resource

Change in manner in which buildings are built and managed.

Discipline Impact

(check all that apply)

- ☐ Civil/Landscape
- ☒ Architecture
- ☒ Structural
- ☒ Mechanical
- ☒ Electrical

Sustainability Criteria

(check only one)

- ☐ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Submitted by John Krajweski

Description of Resource

COF- combine mechanical rooms

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Lower first costs.

Lower life cycle costs.

More efficient use of space.

Disadvantages of Resource

Invalidates modular/separable concepts.

Requires redesign.

Sustainability Criteria
(check only one)
- ☐ Site
- ☐ Energy
- ☒ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)
- ☒ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☐ Mechanical
- ☐ Electrical

Submitted by Team

Description of Resource

Are there alternatives to asphalt paving in parking lots?

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Unknown

Disadvantages of Resource

Unknown.

Discipline Impact
(check all that apply)
- ☐ Civil/Landscape
- ☒ Architecture
- ☒ Structural
- ☐ Mechanical
- ☒ Electrical

Sustainability Criteria
(check only one)
- ☒ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Submitted by Tom Lunneberg

Description of Resource

Opportunities for Photovoltaics at Fort Bragg CAB/Separate Batallions

The Federal Government has stated their desire to use renewable energy sources when feasible, and the proposed CAB/Separate Batallions site has certain characteristics that make it ideal for using photovoltaic (PV) panels to harvest electrical energy from the sun. Specifically, many of the barrack buildings feature extensive roof area that faces due South, with a roof pitch of 30 to 50 degrees. PV panels achieve their highest power production when oriented this way, so these barracks are an ideal site on which to install PV panels.

Photovoltaic panels are still expensive - about $5 to $7 per installed Watt - so they must be judiciously applied in order to maximize cost-effectiveness. To make best use of PV at the CAB, we suggest that the following approaches be considered:

(1) Use PV-harvested power for loads that peak in the middle of the day, when PV output is greatest. Electricity is usually most expensive during the middle of the afternoon, so it makes sense to use the PV power to offset much more expensive grid power when you can. It would not be a good idea to store the PV power in order to serve loads that must be served overnight, as power is less expensive from the grid during this time, limit it to serving emergency power loads (though the resource can be reallocated this way when necessary).

(2) Consider using PV-harvested power to serve loads that benefit from "clean" power. Specifically, clean power is free from harmonics, waveform distortion, is supplied at a constant voltage, and is not subject to any brown out, transient voltage spikes, or voltage drops that can exist with power obtained from a utility grid.

(3) As a target, consider installing 200 kW of PV at the site. Since modern PV panels can produce 10 to 12 Watts per square foot of panel surface under ideal conditions, this would require about 20,000 square feet of collector surface, mounted facing due South at an incline. This target was developed based upon the "naturally" occurring south-facing roof slopes and inclinations at the site.

(4) While the cost of installing a PV system may be prohibitive at this point, many utilities are now being asked to provide "green" power to their customers. These customers willingly pay a higher price for their power in order to influence their utility to secure renewable energy sources such as solar, wind, low-impact hydroelectric, and geothermal. It may be possible to partner with your local utility to have the panels installed at your site as a renewable resource for the utility. In exchange, the Army could ask for (1) preferential utility rates, (2) access to some of the PV power, or (3) eventually ownership of the the PV system.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Renewable Resource

Provides Clean Power

Meets DOD Goals of Promoting Renewable Energy

CAB is ideally suited for PV panel installation

Disadvantages of Resource

Cost is still high

Must figure out how to use the harvested power to best advantage

Public Works staff will need to learn about a new technology.

Sustainability Criteria
(check only one)
- ☐ Site
- ☐ Energy
- ☐ Materials
- ☐ Water
- ☒ Indoor Environmental Quality

Discipline Impact
(check all that apply)
- ☐ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☒ Mechanical
- ☒ Electrical

Submitted by Ken Waldie

Description of Resource

Use light troffers for supply air distribution in administration areas.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Provides better air distribution and ventilation effectiveness.

Allows smaller zones and tighter thermal control by occupants

Disadvantages of Resource

Lower airflow through troffers will require more duct and increased costs.

Sustainability Criteria
(check only one)
- ☐ Site
- ☐ Energy
- ☐ Materials
- ☐ Water
- ☒ Indoor Environmental Quality

Discipline Impact
(check all that apply)
- ☐ Civil/Landscape
- ☒ Architecture
- ☐ Structural
- ☒ Mechanical
- ☒ Electrical

Submitted by Ken Waldie

Description of Resource

Use raised floor system in office areas to allow underfloor supply of HVAC, power and computer wiring. Connect these supply to specially designed systems furniture that allows each person to control the temperature and lighting at their workstation. This could be applied to the classrooms in the Battalion HQ where we have been told the occupancy can involve systems furniture too.

Combine with demountable partitions for added flexibility.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Increased IAQ - increased ventilation effectiveness.

Increased flexibility of workstation relocation in the future.

Increased satisfaction and productivity of workers.

Disadvantages of Resource

Requires additional funds.

Limits furniture solution to a fewer number of systems.

Sustainability Criteria
(check only one)

- ☐ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

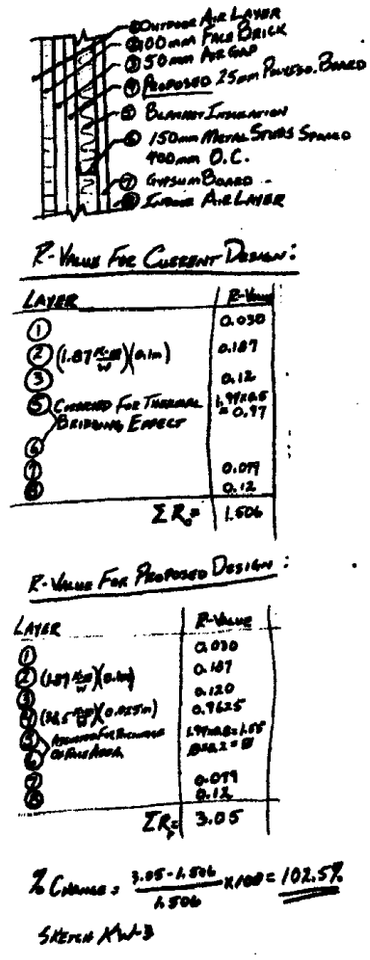
- ☐ Civil/Landscape
- ☒ Architecture
- ☐ Structural
- ☒ Mechanical
- ☐ Electrical

Submitted by Ken Waldie

Description of Resource

Add 25mm cellular polyisocyanurate board between brick and metal stud on exterior walls with metal studs.

Attached Drawing or Sketch ☒ Reference Document Number or ID KW-3



Advantages of Resource

Reduces energy comsumption by eliminating thermal bridging effect caused by metal stud. R-value of wall assembly increases by 102%.

Disadvantages of Resource

Increased first cost for wall construction. However, reduced HVAC loads may create savings to offset the additional cost.

Sustainability Criteria
(check only one)

- ☐ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☒ Architecture
- ☒ Structural
- ☒ Mechanical
- ☒ Electrical

Submitted by Ken Waldie

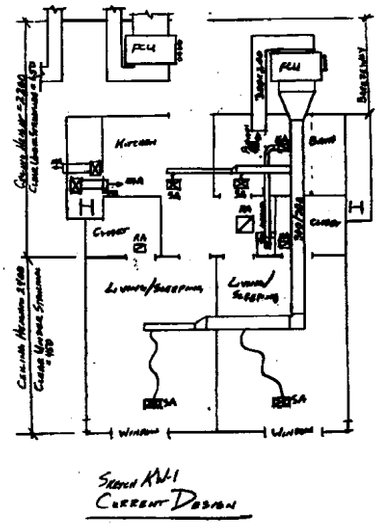
Description of Resource

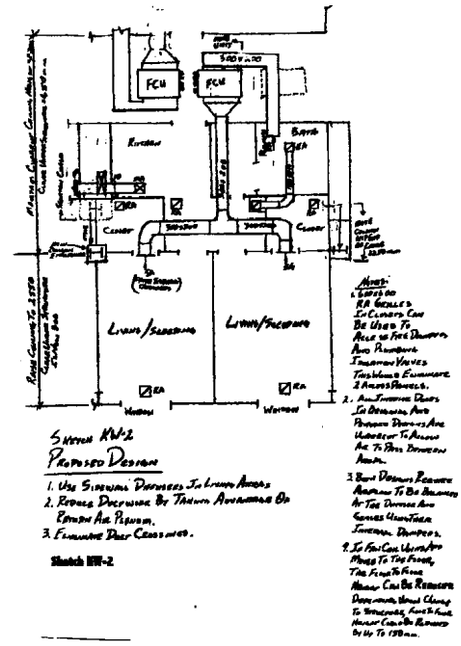
1. Increase ceiling height in living and sleeping rooms by 150 mm.

2. Simplify duct layout to eliminate duct crossings.

3. Supply air to living and sleeping areas by sidewall diffusers.

4. Move structural beam to living/sleeping area wall.





Attached Drawing or Sketch ☒ Reference Document Number or ID KW-1 and KW-2

Advantages of Resource

1. Less duct required.

2. If floor mounted units are used, floor to floor heights can be reduced. If structural beams do not get deeper, the floor to floor height might be reduced 150 mm.

3. Returns at windows move some of the heat load from the glass to the coil rather than room supply air.

4. Returns in the closet can be used to access fire dampers and plumbing isolation valves, reducing access panels.

Disadvantages of Resource

1. Requires structural redesign.

2. Requires relocating some lights.

Sustainability Criteria
(check only one)
- ☒ Site
- ☐ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

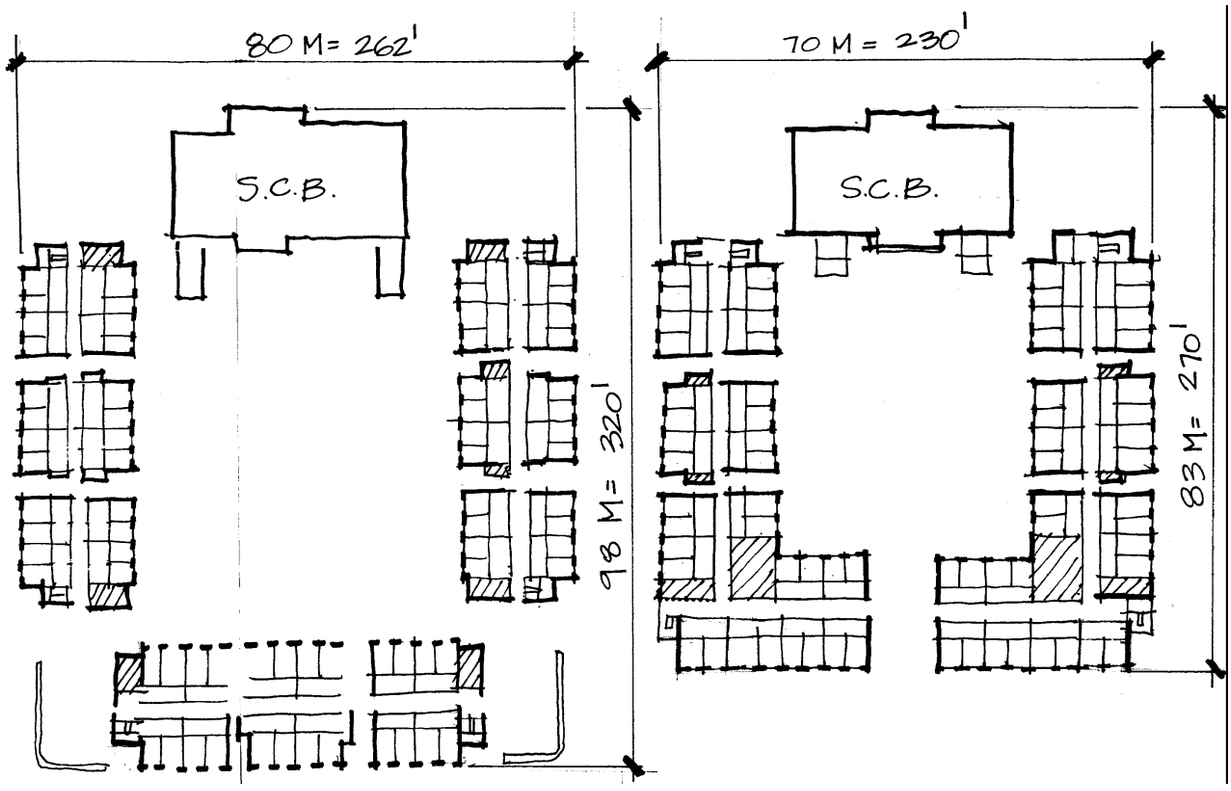
Discipline Impact
(check all that apply)
- ☐ Civil/Landscape
- ☒ Architecture
- ☒ Structural
- ☒ Mechanical
- ☒ Electrical

Submitted by Don Prowler, Joe Knight

Description of Resource

Compress the floor plan of the courtyard- style barracks from the design that is currently being used in the First Brigade complex.

Attached Drawing or Sketch ☒ Reference Document Number or ID



Previous (1st Brigade) Barracks design
72 Enlisted Personnel/floor

Proposed design-
72 Enlisted Personnel/floor

Advantages of Resource

The barracks building will take up much less area, allowing the site design to compress and lessen the site development.

Disadvantages of Resource

Requires total building re-design.

Sustainability Criteria
(check only one)

- ☐ Site
- ☐ Energy
- ☒ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☒ Civil/Landscape
- ☒ Architecture
- ☒ Structural
- ☐ Mechanical
- ☐ Electrical

Submitted by John Amatruda

Description of Resource

Local Materials -

The use of locally-manufactured materials is encouraged as part of the USACE's overall sustainabilty program. The use of local materials can reduce the "embodied energy" associated with construction materials, particularly by reducing the transportation energy needed to deliver finished materials to the construction site. Embodied energy is the energy required to fully produce a product from its constituent materials, and includes the energy used in extracting raw materials, refining/processing/manufacturing, and transporting the finished product to its final destination.

In addition to the embodied energy issue, the use of local materials supports local industry and communities, and can be seen as a "good neighbor" policy of Fort Bragg and the USACE to the surrounding communities. Finally, local materials such as brick, stone, wood, or tile can often be used to create a regional architectural character in a development, which promotes diversity in the USACE's wide range of building projects.

For the Fort Bragg Brigade development, it is recommended that local materials meeting the criteria outlined in the U.S. Green Building Council's LEED Rating System be specified and procured. The LEED standard states that:

A minimum of 20% of the architectural and structural building materials (measured by material costs) are to be manufactured regionally within a radius of 500 miles of the building site.

Materials identified for the Fort Bragg Brigade development include:

- Brick

- Concrete

- Structural Steel

- Ceramic Tiles

- Roofing

In a preliminary calculation performed during the charrette, it was determined that if the brick, concrete, and steel used in a typical barracks building came from local sources, these materials alone would constitute over 20% of the material costs (as defined in LEED) for the barracks building.

It is recommended that the USACE research the range of locally-manufactured products within the 500 mile radius of Fort Bragg. It is expected that a wider range of product types will be identified through this process.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

As noted above: Reduced embodied energy, support of local industry, development of regional architectural identity.

Many local materials do not have an associated cost premium, and may, in fact, be cheaper than materials from other sources.

Disadvantages of Resource

Identifying 3 local manufacturers of the same material type will not be possible for some materials. The USACE may therefore choose not to specify which materials must be from local sources, but rather mandate the overall percentage of local materials that must be utilized (thus letting the contractors choose which local materials are most cost-effective). As another possibility, the USACE can stipulate that for targeted materials (e.g. brick, roofing), at least one locally-manufactured product must be included as the base product or alternate in the contractor's bid.

Sustainability Criteria
(check only one)

- ☐ Site
- ☐ Energy
- ☒ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☒ Architecture
- ☐ Structural
- ☐ Mechanical
- ☐ Electrical

Submitted by John Amatruda

Description of Resource

Low Volatile Organic Compound (VOC) Products -

Low-VOC product selection is part of an integrated approach to improving indoor air quality in new and renovated facilities. The selection of low-VOC products is a “source control” strategy designed to reduce or eliminate hazardous compounds that may be introduced to a building during the construction process. Source control strategies are combined with ventilation measures, O&M procedures, and housekeeping strategies to form a comprehensive indoor air quality plan.

Volatile organic compounds are carbon-based chemicals that vaporize at normal atmospheric temperatures and pressures. Because they can be inhaled, or be directly exposed to eyes and skin, VOCs can potentially cause irritations or illnesses in building users that include headache, nausea, and eye/nose/throat irritation, as well as more serious disorders in some individuals. VOCs are common in many construction products, including “wet” materials such as paints and adhesives, and “dry” products including engineered wood, vinyl or rubber flooring, and carpets. Examples of VOCs found in construction products include toluene, xylene, and ethyl vinyl acetate, among many others. Formaldehyde, while not technically classified as a VOC (it does not contain carbon), is another volatile compound with potentially significant health impacts that should be minimized or eliminated as part of the overall IAQ plan.

There are now a number of “low-VOC” formulations available for many of the higher-emitting construction products. For the Fort Bragg Brigade development, it is recommended that these low-VOC materials be specified and procured. As a starting point, it is recommended that the standards referenced in the U.S. Green Building Council’s LEED Rating system be used to specify low-VOC materials. The standards are as follows:

Paints:

Paints and coatings must meet or exceed the VOC and chemical component limits of Green Seal requirements (see www.greenseal.org for detailed specifications).

Note: In a recent test program conducted at the Aberdeen Proving Grounds (see Green Seal website) low-VOC paints meeting the GreenSeal standards were found, on average, to cost less than non-compliant paints.

Adhesives and Sealants:

Adhesives must meet or exceed the VOC limits of South Coast Air Quality Management District Rule #1168, AND all sealants used as a filler must meet or exceed Bay Area Air Resources Board Reg. 8, Rule 51 (see www.usgbc.org for links to these VOC specifications).

Note: Many adhesive and sealant manufacturers offer low-VOC formulations as their standard product, or as alternate product choices.

Carpets:

Carpet systems must meet the Carpet and Rug Institute Green Label Indoor Air Quality Test Program (see www.carpet-rug.com for specifications).

Note: Most major carpet manufacturers are part of the Green Label program, and offer all or most of their product lines with the Green Label.

Composite wood products:

Composite wood products must contain no added urea-formaldehyde or phenol-formaldehyde resins.

Note: While the use of formaldehyde has been reduced in many composite wood products, materials including plywood and particleboard do contain formaldehyde-based binders. Medium density fiberboard (mdf) products are available that utilize a non-formaldehyde binder (typically MDI, a polyurethane-based binder) – of these products there are both wood-based and straw-based boards. The wood-based products currently have a moderate-to-high cost premium, while the straw-based products have a low premium.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Low-VOC materials are selected to promote the health and well-being of the soldiers, officers, and other users of the Fort Bragg Brigade complex. Low-VOC materials should be considered one part of a multiple-strategy indoor environmental quality plan.

As noted above, a number of these materials have no-to-low cost premiums.

Disadvantages of Resource

Some low-VOC materials currently carry a moderate to high cost premium. In some cases alternative strategies may be investigated. Example: the encapsulation of particleboard in millwork may be investigated as an option to using “formaldehyde-free” engineered wood products.

Performance standards and installation procedures for low-VOC materials should be carefully compared to those of the “standard” products they may replace. In some cases, performance or installation methods will vary.

Sustainability Criteria
(check only one)

- ☐ Site
- ☐ Energy
- ☒ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☒ Civil/Landscape
- ☒ Architecture
- ☒ Structural
- ☐ Mechanical
- ☐ Electrical

Submitted by John Amatruda

Description of Resource

Recycled Content Materials -

Recycled-content materials are new products which incorporate postconsumer or preconsumer (also called post-industrial) recovered materials. Postconsumer materials are products that have completed their "useful life" and have been diverted from the waste stream, usually through municipal recycling programs (e.g. newspaper, bottles, cans, etc.). Preconsumer materials are recovered materials which were generated in manufacturing and converting processes, and include manufacturing scrap, trimmings/cuttings, and process by-products. Recycled-content building products encompass a wide range of material types, including metals, paper and wood products, insulations, and carpeting.

The use of recycled content materials in Federal facilities has been encouraged and mandated through Section 6002 of the Resource Conservation and Recovery Act (RCRA) and Executive Order 13101. The EPA, through its Comprehensive Procurement Guideline (CPG) program , designates products that are or can be made with recovered materials, and recommends practices for buying these products. Once a product is designated, procuring agencies are required to purchase it with the highest recovered material content level practicable. A list of CPG products can be found at www.epa.gov/cpg.

In addition to incorporating EPA designated products, it is recommended that the USACE strive to incorporate a total quantity of recycled content material in each building in accordance with the guidelines of the U.S Green Building Council's LEED Rating System. The LEED Criteria mandates that 25% of the architectural and structural building materials (measured by cost) contain, in aggregate, a minimum of 20% post-consumer recycled content material, OR, a minimum of 40% post-industrial recycled content material.

Materials identified for the Fort Bragg Brigade development include the following:

Materials with no to minimal cost impact:

- Steel (structural framing, light-gage framing, rebar, pipe rails, etc.)
- Fiberglass Insulation (EPA Designated)
- Acoustical ceiling tile
- Brick (w/recycled oil-containing clays)
- PET Fiber carpet (EPA Designated)
- Fly-ash pozzolan (admixture in cement and concrete, EPA Designated)
- Porcelain tile w/feldspar tailings (mining waste)

Materials with moderate to high cost impact (see notes for each product):

- Recycled plastic toilet partitions (EPA Designated) - more expensive than painted steel partitions, but less maintenance required
- Recycled-content carpet tiles - more expensive than broadloom carpet, but similar price to other carpet tiles
- Recycled wood/polymer lumber and decking - more expensive than pressure treated wood, but durable and low maintenance

Additional cost impact information is included in the LEED Rating Summay sheets included in this report.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

As noted above, many "standard" materials have significant recycled content and do not have a cost premium.

Use of recycled content products meets Federal mandates.

By making use of materials diverted or recovered from the waste stream, recycled content products reduce waste, save valuable resources, and lessen pollution.

Disadvantages of Resource

Some materials have a cost premium versus "standard" product alternates, although many of these have improved durability or reduced maintenance.

For some recycled content products, there may be less than three manufacturers offering competitive products.

Sustainability Criteria
(check only one)

- ☒ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☒ Architecture
- ☐ Structural
- ☒ Mechanical
- ☒ Electrical

Submitted by Tom Lunneberg

Description of Resource

Central Heating and Cooling Plant

We understand that a central heating/cooling plant concept has been evaluated for the CAB project, and that preliminary conclusions are that this alternative is not the most cost-effective scenario considered. Though not official, we understand that a distributed plant concept, where multiple heating and cooling plants are installed to serve different regions of the site, has proven to be the most cost efficient alternative.

Before the conclusions of this study are finalized, we think that a peer review of the central plant study should be performed to ensure that the most sensible approach has been taken in the assumed central plant design. For example, piping costs for a central plant are likely the single largest cost component for the project, due to the long runs of large diamter piping that are necessary to distribute chilled and hot water to the extreme reaches of the site. The assumptions regarding the temperatures at which hot and cold water are supplied (and at what temperature they return) will have a profound impact on pipe sizes and costs. We understand that the chilled water distribution system, for example was based on a 10 degree temperature split, meaning that chilled water returns to the plant at a temperature ten degrees high than when it left the plant. If a plant is designed for a higher temperature split, a reduced amount of water will need to be pumped to the various buildings in order to meet the required cooling loads (because more cooling is extracted from each gallon of circulated fluid). This same 10 degree system could be designed as a 25 degree system, which would substantially reduce chilled water pipe sizes (as well as the size of valves, strainers, pumps, and pump motors), because flow requirements would be reduced by 150%.

This is just one example of how intelligent design concepts can minimize first cost and enhance the life cycle cost performance of the project. Other areas that should be considered include chiller type and system, in-plant piping/pumping configuration, cooling tower sizing and sequencing, and control system sequences of operation.

We suggest that the underlying assumptions for this value engineering study be reviewed by qualified parties to ensure that they reflect the current best thinking in this design area.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

For the best results, compare a modern, high-efficiency central plant with other alternatives.

A single central plant reduces the physical number of pieces of equipment to be maintained, minimizing impact on existing maintenance staff.

A central plant can be designed to provide substantially reduced operating costs, while using less useful space at the site.

Disadvantages of Resource

Sophistication of modern, high efficiency central plant equipment may be overwhelming for existing maintenance staff.

Sustainability Criteria
(check only one)

- ☐ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☒ Mechanical
- ☒ Electrical

Submitted by Tom Lunneberg

Description of Resource

Cogeneration

Cogeneration, which is defined as, "simultaneously producing electric power and useful thermal energy", can be a cost-effective way to meet the energy needs of a large commercial or industrial facility. Producing your own electric power enables you to meet some or all of your electrical needs, offsetting the amount of more expensive power that must be purchased from the local utility. In addition, cogeneration allows you to sell surplus power back to the utility at a rate equal to their avoided cost for not having to produce it themselves.

Typical cogeneration wisdom is that the electricity-producing capacity should be sized so that all generated waste heat can be put to some useful purpose. For this reason, facilities with large thermal loads (e.g. cafeterias, laundry facilities, domestic hot water for showers, process loads) are usually considered to be better candidates for cogeneration than facilities with small thermal needs.

Cogeneration is expensive to install ($1,000 to $2,000 per installed kW), and also requires a competent operating staff to ensure reliable, efficient operation. For these reasons, a detailed feasibility study should be performed before any commitments are made.

The generation equipment typically used for cogeneration can range from turbines to engine drives to fuel cells. In the case of Fort Bragg, fuel cells may be attractive because they are quiet, can be installed at ground level to meet loads for specific buildings, and they are non-polluting. Other than the prescribed major and minor service work that must be done, fuel cells may be worthwhile to investigate in greater detail. Microturbines in the 20-30 kW capacity may also be worth considering for small buildings.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Simultaneously provides electricity and thermal energy

Reduced reliance on utility-provided power

Can be used to "level" the electric profile of the facility, thus improving load factor and reducing power costs.

Disadvantages of Resource

Increased maintenance requirements versus purchasing power for the utility.

Qualifications of operators must be considered when assessing cogeneration.

Fuel cells and microturbines are still emerging technologies; their long-term reliability has not been proven yet.

Sustainability Criteria
(check only one)

- ☒ Site
- ☒ Energy
- ☐ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☒ Mechanical
- ☒ Electrical

Submitted by Tom Lunneberg

Description of Resource

Energy Service Companies ("ESCOs")

There has been much discussion regarding the ability and willingness of the existing maintenance staff at Fort Bragg to operate building systems that use state-of-the-art technology. Though it does not seem prudent to install outdated, inefficient system types strictly because the maintenance staff knows how to service them, it appears that this approach may be taken in certain areas.

An alternative that is available would be to partner with an Energy Service Company ("ESCO"), to maximize efficiency and minimize operating cost. Though there are myriad possibilities for how such a partnership could be arranged, one possibility would be to have the ESCO design, construct, own and operate a central heating and cooling plant at Fort Bragg, and then sell chilled and hot water back to the base at an agreed-to price. This ensures that Fort Bragg takes advantage of state-of-the-art equipment, skilled operators, and pricing security, while not having to hire additional maintenance staff (or retrain existing staff) to service new kinds of building systems.

An additional benefit of partnering with an ESCO is that the capital cost for a central plant would be provided by the ESCO (they recover it over time by selling the utilities to the base), which would free up this capital for other other areas of the project.

An ESCO could also participate at a smaller scale, providing everything from project finanancing to service contracts. A beneficial characteristic of ESCOs is their flexibility and willingness to work with a client to find the best solution to a problem.

Though there are numerous ESCOs who would be interested in a project of this magnitude, it may make sense to start out by meeting with Duke Solutions (the non-regulated ESCO from Duke Power) to discuss your needs.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Ensures that the highest-efficiency plant configuration will be installed.

There will not be an additional burdon placed on existing maintenance staff, as plant operators will be provided by the ESCO.

Frees up capital for the project, which can then be used for other things.

Disadvantages of Resource

Purchase agreement must be carefully worded to avoid being locked-in to unrealistic pricing structures.

Military will not own the central plant (though provisions for buy-out can be made in contract)

On-going operating costs will be higher since the ESCO will be recovering the cost of building and operating the central plant.

Sustainability Criteria
(check only one)

- ☐ Site
- ☐ Energy
- ☒ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☒ Architecture
- ☐ Structural
- ☐ Mechanical
- ☐ Electrical

Submitted by Gail Lindsey

Description of Resource

Eliminate the vinyl tile flooring in Barracks sleeping rooms.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Reduced Pollution

Possible use of renewable resources.

Disadvantages of Resource

Sustainability Criteria
(check only one)

- ☐ Site
- ☐ Energy
- ☒ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☒ Architecture
- ☐ Structural
- ☐ Mechanical
- ☐ Electrical

Submitted by Gail Lindsey

Description of Resource

Do not use particle board in cabinetry and countertops. Kitchen and Bath cabinets in each Barracks room as well as miscellaneous cabinets and counter in other facility should also eliminate particle board.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Would reduce formaldehyde off gassing

Disadvantages of Resource

Sustainability Criteria
(check only one)
- ☐ Site
- ☐ Energy
- ☒ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)
- ☐ Civil/Landscape
- ☒ Architecture
- ☐ Structural
- ☐ Mechanical
- ☐ Electrical

Submitted by Gail Lindsey

Description of Resource

Use metal roofing in lieu of asphalt shingles, and use light-colored roofing to reduce heat island effect.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Reduce polluting runoff from roof areas. Greater life of roof system.

Disadvantages of Resource

More cost with standing seam metal roofing.

Sustainability Criteria
(check only one)
- ☐ Site
- ☐ Energy
- ☒ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)
- ☐ Civil/Landscape
- ☒ Architecture
- ☐ Structural
- ☐ Mechanical
- ☐ Electrical

Submitted by Gail Lindsey

Description of Resource

Provide insulated window covering in lieu of aluminum blinds.

Attached Drawing or Sketch ☐ Reference Document Number or ID

Advantages of Resource

Greater energy savings.

Disadvantages of Resource

Subject to damage.
More complicated cleaning requirements.

Sustainability Criteria

(check only one)

- [x] Site
- [ ] Energy
- [ ] Materials
- [ ] Water
- [ ] Indoor Environmental Quality

Discipline Impact

(check all that apply)

- [x] Civil/Landscape
- [ ] Architecture
- [ ] Structural
- [ ] Mechanical
- [ ] Electrical

Submitted by Gail Lindsey

Description of Resource

Use of native plants, trees, vegetation, etc.

A view from Butner Rd. looking south across the Separate Battalions Complex site.

Attached listing of NC native vegetation by Christine L. Hitt, ASLA (E-mail: clhdesign@horizons.net) Also- Knight Architects has Native Plant Material listing on file for possible future inclusion in this report when it is re-issued.

Advantages of Resource

Reduced water needs after establishment.

Reduced use of hazardous chemicals and pesticides.

Reduced O & M cost.

Disadvantages of Resource

Natural vegetation may take awhile to get established.

Does not have a manicured appearance.

Sustainability Criteria
(check only one)

- ☐ Site
- ☐ Energy
- ☒ Materials
- ☐ Water
- ☐ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☒ Architecture
- ☐ Structural
- ☐ Mechanical
- ☐ Electrical

Submitted by Gail Lindsey

Description of Resource

Incorporation of C&D (Construction and Demolition) waste reduction language into the project specifications.

Attached Drawing or Sketch ☐ Reference Document Number or ID Spec. Examples- EPA and Navy- Knight Architects has these specifications on file for possible future inclusion in this report when it is re-issued.

Advantages of Resource

Reduction in the amount of waste requiring landfill disposal.

More efficient use of construction materials.

Less pollution.

Disadvantages of Resource

Change in construction process may cause initial increase in time and labor.

Sustainability Criteria
(check only one)

- ☐ Site
- ☐ Energy
- ☐ Materials
- ☒ Water
- ☐ Indoor Environmental Quality

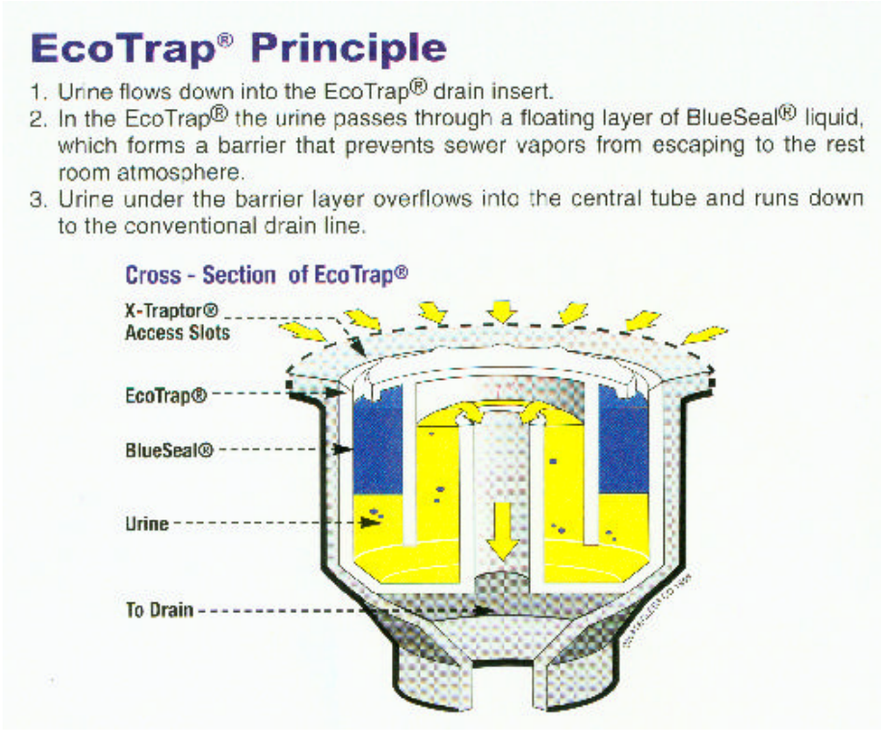
Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☐ Architecture
- ☐ Structural
- ☐ Mechanical
- ☒ Plumbing

Submitted by Gail Lindsey

Description of Resource

Use of waterless urinals



Attached Drawing or Sketch ☐ Website: www.waterless.com
Also- Knight Architects has waterless urinal product information on file for possible future inclusion in this report when it is re-issued.

Advantages of Resource

Water savings: 1.3 gal. Per flush.

Can be more hygenic than conventional urinals because they dry out between uses and do not support bacteria growth as readily.

Reduces maintenance costs (Annual savings between $80-120 per urinal have been demonstrated)

No water supply or valves are needed.

Disadvantages of Resource

Manufactured out of fiberglass- air pollution emissions may result during manufacturing.

Shipped from single manufacturing plant in California

Sustainability Criteria
(check only one)

- ☐ Site
- ☐ Energy
- ☐ Materials
- ☐ Water
- ☒ Indoor Environmental Quality

Discipline Impact
(check all that apply)

- ☐ Civil/Landscape
- ☒ Architecture
- ☐ Structural
- ☐ Mechanical
- ☐ Electrical

Submitted by Gail Lindsey

Description of Resource

Specify use of bio-degradable and least toxic (for workers and occupants) cleaning products- Both for cleaning before occupancy and post-occupancy.

Reduce the amount of chemical cleaning products to be used through material choices and early design choices.

Attached Drawing or Sketch ☐ EPA Website on Cleaning products:
http://www.epa.gov/opptintr/epp/cleaners/select
Also- Knight Architects has a Building Concerns Newsletter on file for possible future inclusion in this report when it is re-issued.

Advantages of Resource

Better indoor air quality

Less pollution (to air and water bodies)

Reduce O&M costs

Disadvantages of Resource

Creation of new requirements for cleaning contracts.

APPENDICES

SUSTAINABLE DESIGN CHARRETTE

Savannah, Georgia

31 January - 2 February 2000

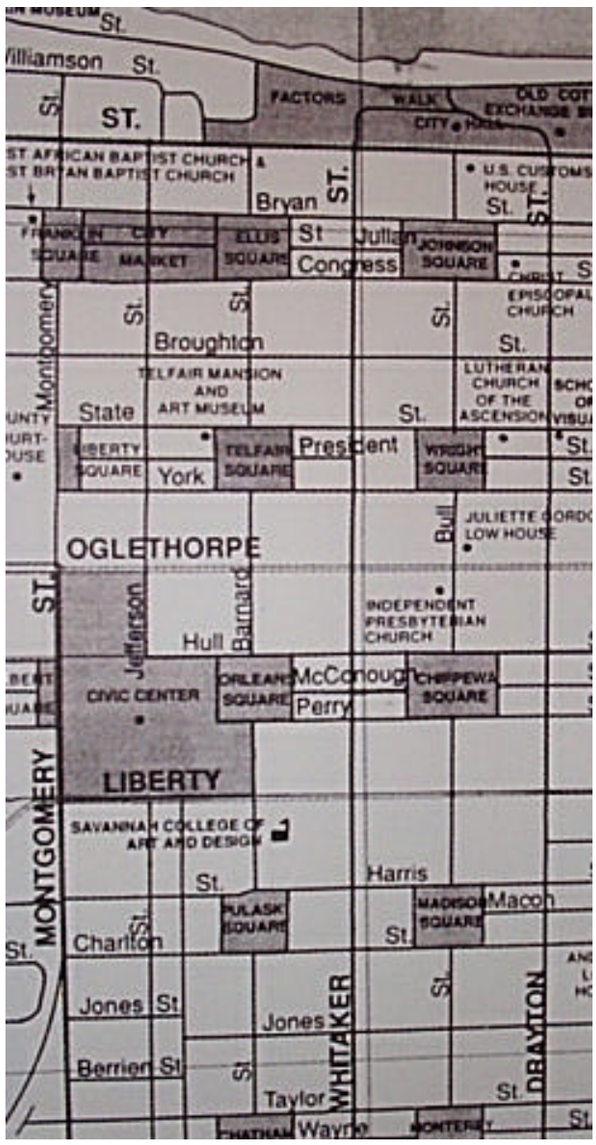
The Savannah District of the Army Corps of Engineers directed Knight Architects to assemble a team of architects and civil, electrical, and mechanical engineers to make sustainable design recommendations for two projects planned at Fort Bragg, North Carolina. The Combat Aviation Brigade Barracks Complex and the Separate Battalions Barracks Complexes will consist of eighty-four buildings totaling $244 million, funded over four years.

The team met at the De Soto Hilton in Savannah, Georgia, from 31 January to 2 February 2000, for a three-day charrette, a sustained and intensive gathering of individuals working both separately and corporately toward a larger objective. Using a format that combined presentations with discussion and breakout work sessions, the group reviewed the existing design and worked toward the formulation of specific recommendations for new facilities and possible standards implementation.

Sustainable:
Of, relating to, or being a method of harvesting or using a resource so that the resource is not depleted or permanently damaged.

Preceding page, Top: Members of the Sustainable Design Team, along with Savannah District personnel, at work. ***Below:*** the skyline of Savannah, an environment that has remained vital for over 250 years.

This page, ***Below:*** Detail of Savannah map. The two Fort Bragg barracks complexes would cover roughly the same area as Savannah's downtown



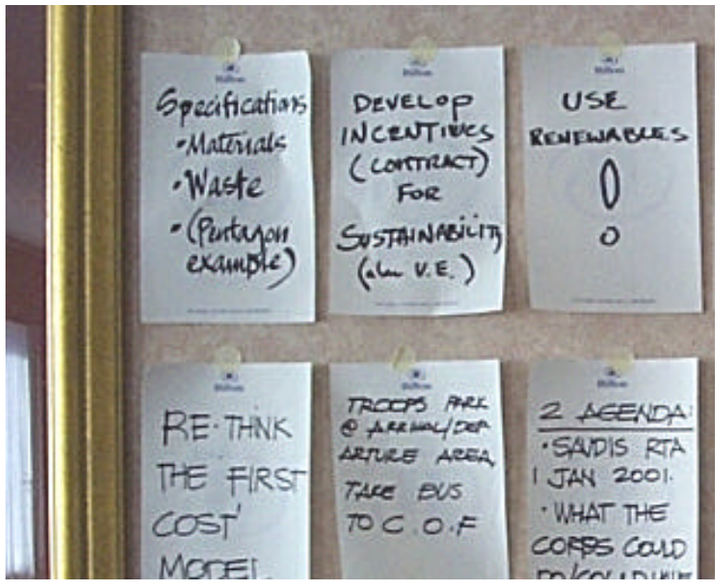
MONDAY

Following introductions of all participants, Bill Plunkett, Assistant Chief of Engineers for the Savannah District, gave a short talk in which he discussed his views on the overall project and the importance of adhering to sustainable design principles in future Corps of Engineers projects. He stressed the need to develop strategies for reducing life-cycle costs as a means of lowering the costs associated with implementing sustainable design principles.

Afterward, Savannah District architects and engineers presented the site plan for the two projects, along with individual building prototypes. They followed this with a question-and-answer session in which sustainable design team members clarified key issues.

Next, sustainable design team members introduced the LEED™ (Leadership in Energy and Environmental Design) concept. This they did in part through the presentation of a video entitled *Greening The Red, White, and Blue*, created largely by sustainable design team leader Don Prowler, with contributions by team member Gail Lindsey.

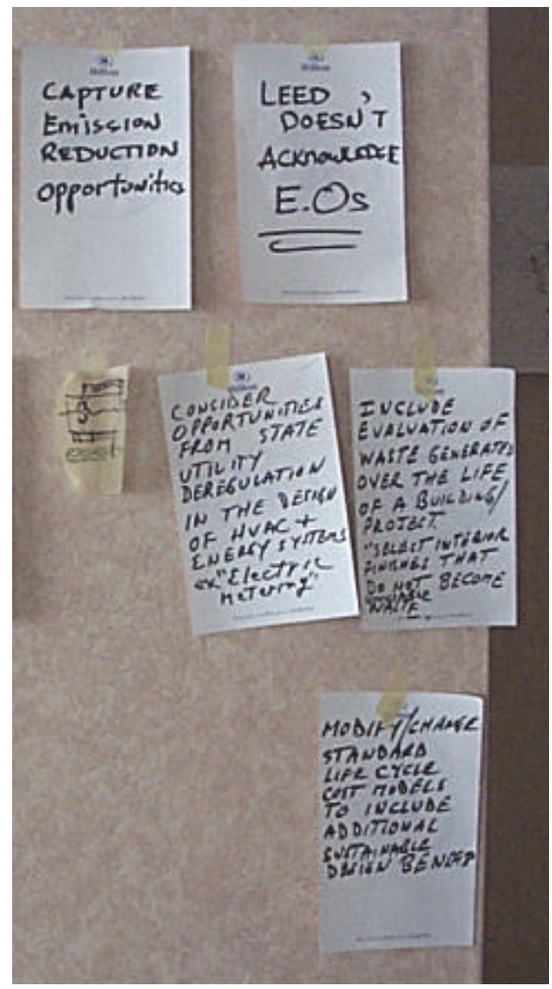
Following a lunch break, the larger group—sustainable design team members, representatives of the Savannah District, and Knight Architects personnel—split into smaller groups to study various aspects of the design. They examined specific building types, along with the revised site plan, as a means of discerning the LEED™ rating. In-depth analysis resulted in the formulation of specific strategies regarding how to increase the LEED™ rating to an acceptable threshold, and this initial LEED™ analysis became the basis for subsequent studies and strategic modeling.



TUESDAY

Ben Reed, ASLA, master planner for the original design of the complexes, joined the group on the second morning. Three teams were formed to study specific aspects of the larger project, and the first team took on the task of redesigning the site plan while the two other groups researched specific building types in order to formulate strategies for reducing energy use.

During the afternoon, groups established three levels of strategy for dealing with various building types: minimal, moderate, and extensive. Sustainable design team leader Don Prowler had developed a plan to reduce the overall footprint of the site by twenty to twenty-five percent. Now he, Ben Reed, Joe Knight of Knight Architects, and Savannah District engineers Keith Burr and Steve Winfrey devoted themselves to redesigning the site plan with this goal in mind. Together with sustainable design team member Tom Lunneberg, Wayne Dennis of Knight Architects worked on modeling analysis for reducing the footprint and energy use of the barracks/soldier community housing. John Krajewski and Judy Winfrey worked on analysis and redesign of the Department of the Army construction procurement process.



At intervals throughout the day, sustainable design team members presented their work on various designs, and other members of the group offered their comments. The afternoon session was devoted to a variety of activities: some group members worked on energy analyses, for instance, while others made parking and energy use calculations and plan revisions to building types initiated in the revised site plan.

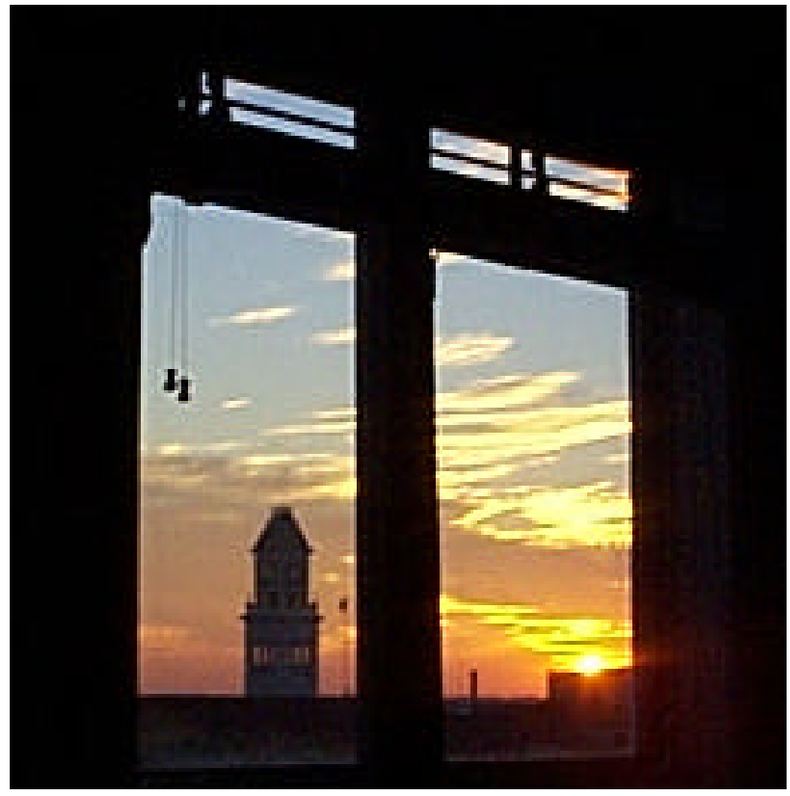
On Tuesday night, most of the group went out to dinner at Il Pasttichio in Savannah. Gail Lindsey and Don Prowler put together a "top-ten" list of resource pages they would use to capture sustainable design ideas for the final report, and over dinner, the group held an informal brainstorming session regarding what ideas would be appropriate for the resource pages.

WEDNESDAY

The final day of the sustainable design study saw the culmination of the previous two days' work. The morning began with a brief meeting to formulate a strategy for completion of the study, and the group began moving toward preparation of a final report on its activities and recommendations. To this end, Don Prowler prepared an overview of the final report, including a list of assignments for each group member. Over the days that followed, each would turn in documents via e-mail, and these would be incorporated in the final report.

Members of the team worked straight through lunch, crunching numbers, drawing up plans, and finalizing their observations. As on preceding days, the group reassembled periodically to assess their progress, and to coordinate the various aspects of work on the final report.

By afternoon, team members began catching shuttles for Savannah's airport, where they would catch flights to home bases around the United States. The sustainable design study work was not over, however: during the latter half of the week and the first days of the next one, team members would finalize their recommendations regarding specific areas of concern, and pass these on to Knight Architects for inclusion in the final report.



SUSTAINABLE DESIGN TEAM MEMBERS

JOHN AMATRUDA, RA, Senior Architect, Steven Winter Associates, Norwalk, CT: A specialist in environmentally conscious design and the evaluation of "green" materials and systems, John Amatruda has fourteen years' experience as an architect and building systems consultant. He has worked on projects featuring energy efficiency, detailed computer analysis of buildings and building details, and environmental material and system selections. In addition, Mr. Amatruda has developed computer programs and presentations for his firm. Among the "green" projects on which he has worked are Wal-Mart's Eco-Mart in Lawrence, Kansas; the Book Division Offices of Rodale Press in Emmaus, Pennsylvania; and the Heinz Family Foundation offices in Pittsburgh, Pennsylvania.

JAMES ROBERT BENYA, PE, FIES, IALD, LC, Principal, Benya Lighting Design, West Linn, OR: A professional lighting designer and consultant with over twenty-seven years' experience, Jim Benya has won numerous lighting design awards, including the Edison Award for Excellence and the International Illumination Design Award of Excellence. His work has appeared in *Architectural Record, Architectural Digest,* and every major lighting design and architectural journal. A registered professional engineer, lighting-certified by the National Council for Qualifications of the Lighting Profession, Mr. Benya has worked as a special consultant in over thirty cases of litigation involving lighting. He has assisted General Electric, Sylvania, and other companies in new-product development.

GAIL A. LINDSEY, AIA, Principal, Design Harmony, Inc., Wake Forest, NC: An environmental consultant for architectural projects around the country, Gail Lindsey is a national speaker and sustainable design trainer. She has been an instrumental part of numerous sustainable design charrettes, including *The Greening of the White House* and *The Greening of the Pentagon*. In 1998 Ms. Lindsey, along with three other consultants on "green" building issues, was contacted to review the U.S. Green Building Council's LEED™ (Leadership in Energy and Environmental Design) green building rating system. Later, she and one other consultant co-authored the LEED™ Reference Guide, which is currently part of a pilot test for this first green building rating system in the United States.

SUSTAINABLE DESIGN TEAM MEMBERS (CONT'D)

THOMAS A. LUNNEBERG, PE, CTG Energetics, Inc., San Diego, CA: A mechanical engineer and certified energy manager, Tom Lunneberg is responsible for project management and energy engineering activities at CTG Energetics. His activities include energy auditing, building energy simulation, and training for the company's mechanical, electrical, and energy engineering department. Mr. Lunneberg has extensive experience in the evaluation of energy projects for cost effectiveness and performance verification. He has provided analyses for numerous military, institutional, and commercial facilities, and has conducted over two hundred energy audits throughout southern California. Included in his experience are energy and water conservation studies for two U.S. Navy facilities.

JAMES PLAGMANN, AIA, Project Architect, ENSAR Group, Boulder, CO: An energy and daylighting analyst for a variety of projects, including a number for the military, James Plagmann has had extensive involvement with the U.S. Green Building Council's LEED™ (Leadership in Energy and Environmental Design) Green Building Rating System. He has served as project architect on facilities such as the Bachelor Enlisted Quarters at Great Lakes Naval Training Center in Chicago, and worked on the Sustainable Training Regimen for the Department of Defense. He also designed Prototype Sustainable Housing for the Yuma Proving Grounds in Yuma, Arizona. Since 1993, Mr. Plagmann has served on the National AIA (American Institute of Architects) Committee on the Environment.

DONALD PROWLER, FAIA, Principal, Donald Prowler & Associates, Philadelphia, PA: A consultant specializing in ecologically sound and energy-efficient design, Don Prowler divides his time between his architectural practice and his academic work. In the latter capacity, he is a member of the architectural faculty at Princeton University and the University of Pennsylvania, and serves as a visiting lecturer at Cornell University, the University of Virginia, and other institutions. Board chairman of the Sustainable Building Industries Council from 1994 to 1998, Mr. Prowler won the coveted Progressive Architecture Research Award in 1983. His ongoing work addresses a variety of sustainable design topics, including passive solar design, daylighting, pedestrian-oriented urban design, healthy buildings and materials, and affordable housing.

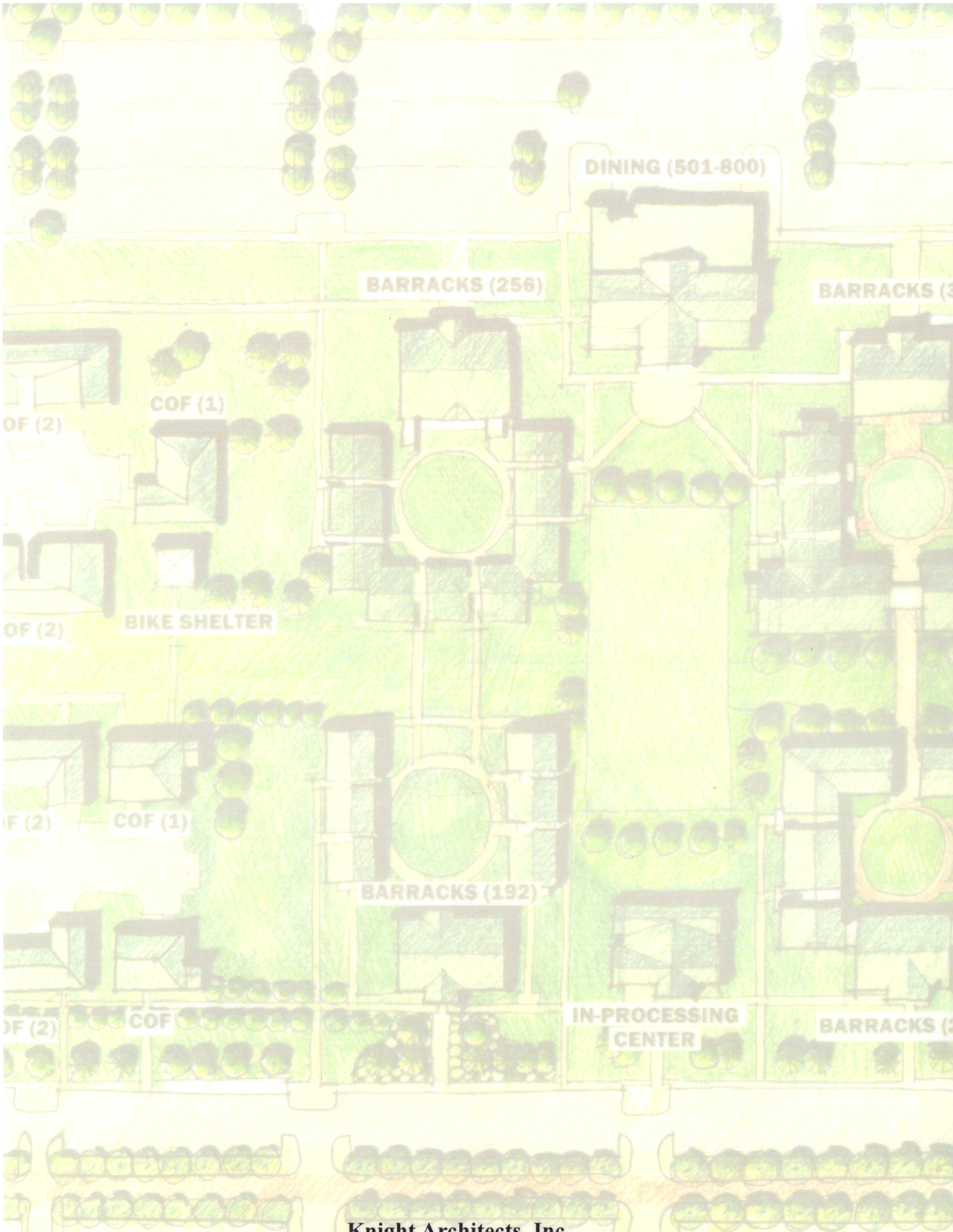
ACKNOWLEDGEMENTS

The sustainable design team would like to express their gratitude to the following individuals who attended and actively participated in the Sustainability Design Charette for the Separate Battalions and Combat Aviation Brigade complexes:

Ben Reed, ASLA, CSI, has worked on projects for the Savannah District for over twenty five years. His firm, Laubmann-Reed & Associates, plans large public- and private sector projects around the world.

Michael Brennan	U.S. Army Corps of Engineers, Savannah District
Phil Brinson	U.S. Army Corps of Engineers, Savannah District
Tom Brockbank	U.S. Army Corps of Engineers, Savannah District
Keith Burr	U.S. Army Corps of Engineers, Savannah District
J. Terry Dismukes	U.S. Army Corps of Engineers, Savannah District
Marion Harrison	U.S. Army Corps of Engineers, Savannah District
Mark Kolasinski	U.S. Army Corps of Engineers, Savannah District
John Krjewsky	HQ, Dept. of the Army
Bill Plunkett	U.S. Army Corps of Engineers, Savannah District
Kathren Santikos	U.S. Army Corps of Engineers, Savannah District
Robert Sauntry	U.S. Army Corps of Engineers, Savannah District
Ken Waldie	U.S. Army Corps of Engineers, Savannah District
Judy Winfrey	U.S. Army Corps of Engineers, Savannah District
Steve Winfrey	U.S. Army Corps of Engineers, Savannah District

Joseph C. Knight	Knight Architects
Wayne Dennis	Knight Architects
Judson Knight	The Knight Agency



Knight Architects, Inc.
2358 Perimeter Park Dr. Suite 325 Atlanta, GA 30341 (770) 452-0101 fax (770) 452-0980