disrupt reproductive cycles of pests) rather than via damaging chemicals.

Historic Preservation Impact

These measures generally do not negatively impact the significant architectural or cultural landscape features of historic properties.

7.8 Alternative Energy Sources, or "Green Power"

"Green power" is electricity supplied in whole or in part from renewable energy sources, such as wind and solar power, geothermal, hydropower, various forms of biomass or low-impact small hydroelectric sources. Using green power reduces the use of fossil fuels, which both reduces pollution and increase self-reliance.

According to Drexel Kleber, Director of the Department of Defense's Strategic Operations Power Surety Task Force, several measures are currently being contemplated to reduce the DoD's reliance on the commercial grid and thereby to increase energy security, including:

- Reducing installation energy use by 30% by 2015 from its 2003 baseline;
- Attaining at least 25% of electricity at installations from renewable sources by 2025;
- Using solar power to heat water in 30% of new and renovated buildings by 2015;
- Using 10-year contracts to buy renewable electricity; and
- Metering all electricity usage by 2012.

7.8.1 The Pentagon

Sustainability Measures

The Pentagon uses solar photovoltaic collectors, some of which have been in operation since 2000, to generate electricity for the facility and to reduce several thousand pounds of pollutants by reducing emissions from conventional energy sources. At the time of installation, reductions were estimated at 241,180 pounds of carbon dioxide, 605 pounds of nitrogen oxide, and 1,675 pounds of sulphur dioxide. These collectors were arranged in different locations around the Pentagon grounds, including parking areas and rooftops. They are highly visible but do not appear to be in locations where they can compromise historic character-defining features of the Pentagon building itself.

The Solar Energy Farm at the Pentagon also includes a 258,000/BTU/hour hot water system, which supplements domestic hot water requirements for the sections of the Pentagon that were renovated after September 11, 2001. In addition, evacuated tube solar collectors are used on the roof of the Pentagon to heat service water. These were installed by Capital Sun and Thermal Technologies in the early 2000s on the roof of Wedge 1. According to the Capital Sun website describing this project, "Following approval of the final piping design and array locations in April 2003, Capital Sun completely installed 1080 solar collector tubes in June. The solar arrays were placed in six rooftop locations to make a 75-kilowatt-thermal system that offset natural gas in the central boiler plant." Features of the system included the following:

- Use of existing water heating system infrastructure;
- Quick real-time response due to low solar piping mass and instantaneous heating design;
- Fewer square feet of collector area per therm delivered due to higher efficiency vacuum collectors;
- Array held on roof with ballast system, avoiding any building penetrations for support that would compromise roof integrity;
- Only penetrations to and from the roof for solar water supply and return pipes were through existing openings;
- Each of six array locations ties piping directly to hot water re-circulation loop in the shortest possible distance, minimizing heat losses;
- Multiple collector arrays connected to separate hot water risers, expanding potential for solar savings;
- Tube collectors and mounting hardware all boxed and easily transported to roof for assembly; and
- Freeze protection assured by pulsed flow.

A simple definition for evacuated tube collector systems is as follows, according to the Green Terra Firma company:

> *An evacuated-tube collector contains several rows of glass tubes connected to a header pipe. Each tube has the air removed from it (evacuated) to eliminate heat loss through convection and radiation. Inside the glass tube, a flat or curved aluminum or copper fin is attached to a metal pipe. The fin is covered with a selective coating that transfers heat to the fluid that is circulating through the pipe.*

Historic Preservation Impact

While there was a minor visual impact as a result of placing the solar collectors on the flat roof, there was a minimal impact on the existing structure, since the piping used existing entrance and exist pipe penetrations in the roof, and the system was integrated with the building's existing

hot water heating system to supplement the hot water that it provided and reduce the energy that it expends.

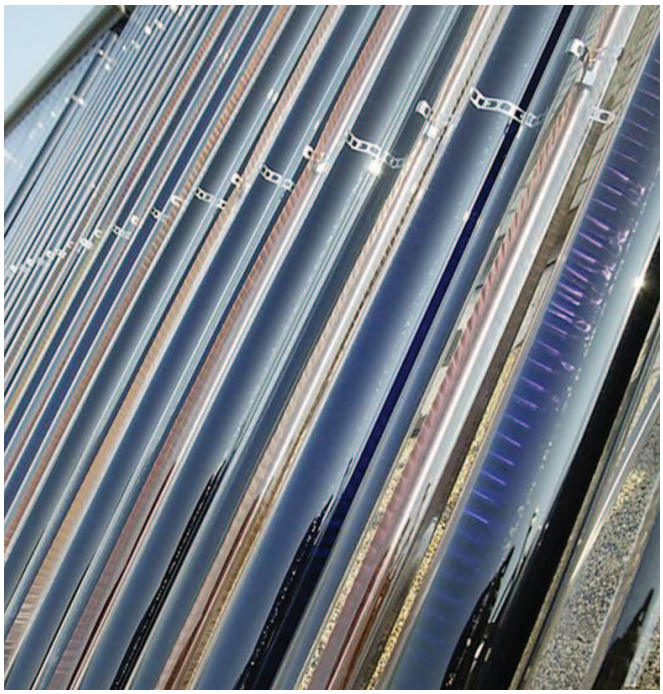

Figure 51: Solar service water heating system, The Pentagon

Source: Courtesy CapitalSunGroup

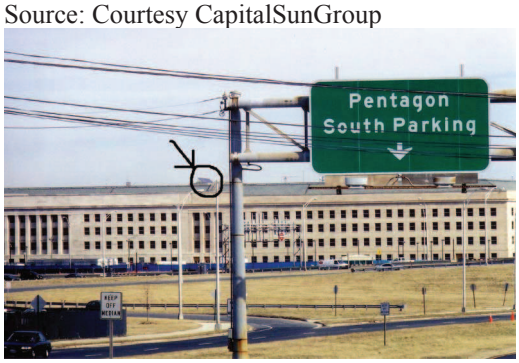

Figure 52: Location of solar tube array on The Pentagon

Source: Courtesy CapitalSunGroup

7.8.2 The Presidio/Thoreau Center

Sustainability Measures

The Center features a building-integrated solar array in the Thoreau Center for Sustainability's main building, which was one of the central facilities of the Letterman Hospital Complex at the old Army post. The solar array is built into the skylights in the building entryway. The Presidio Trust is also using photovoltaics on streetlights, remote kiosks, and way-finding signs. The strategy helps the Presidio avoid digging and trenching to lay "underground conduit and cables" to power the lighting and signage.

Historic Preservation Impact

As long as the photovoltaics do not affect the character of the historic landscape or building (hidden from primary views), using them can actually reduce visual impacts on the building and landscape, reducing the need to drape cables throughout an historic area.

7.8.3 New Mexico Villagra Building

Sustainability Measures

100% clean, renewable wind power was purchased to offset carbon emissions (CO_2) from electricity use for 2 years. Carbon emissions were reduced by approximately 192,000 lbs. annually for two years.

Historic Preservation Impact

Since the purchased wind energy was generated off-site, it had no negative impact on the historic building.

7.8.4 46 Blackstone South, Harvard University

Sustainability Measures

The equivalent of 100% of the site's energy use is covered using Renewable Energy Certificates.

Historic Preservation Impact

Renewable Energy Certificates are purchased and the energy is produced off-site, therefore, they do not negatively impact the building's historic character.

7.8.5 The Gerding Theater at the Armory (Annex)

Sustainability Measures

100% of the building's regulated electric usage is supplied by renewable power that meets the definition of Green-e. A two year electricity contract was purchased.

Historic Preservation Impact

Since the purchased power is off site, there is no negative impact to the building's historic character.

7.8.6 Cambridge City Hall Annex

Sustainability Measures

The Annex installed a 26.5kW solar photovoltaic system on the roof which meets approximately 10% of the building's electricity needs.

Figure 53: PV panels on the roof

Source: Photo by Alyson Reece

Steel frames were constructed over HVAC units to maximize all available surface area for panel installation. The Renewable Energy Trust Fund granted the City $337,500 to subsidize the cost.

Historic Preservation Impact

The project received approval from the Cambridge Historical Commission, who reviewed the design in terms of visual impact. This Historical Commission asked that the angle of the panels be decreased so to minimize the visibility of the panels. The steel structures can be visible from a few angles on the street level and from surrounding buildings. However, the panels and structures are not visible from the building's main façade on Broadway.

7.9 Maintenance

Good maintenance means routine maintenance, catching glitches before they become problems and ensuring that the systems operate as designed, thus allowing the system to operate at maximum efficiency. This includes keeping the indoor environment clean using cleaning products that do not contribute to compromised indoor environmental quality (IEQ).

Historic Preservation Impact

Maintenance practices related to housekeeping generally do not have an impact on historic buildings or landscapes.

7.9.1 Washington Navy Yard, Building 33

Sustainability Measures

Operations and Maintenance manuals were produced and supplied to the Navy by both the equipment manufacturers and subcontractors. The Navy performs preventive maintenance inspections regularly to address functional maintenance. They also have a yearly cyclic maintenance program to address aesthetic upkeep, i.e., maintaining the historic appearance of the building and managing the upkeep of character-defining features of the building (WDBG).

7.9.2 The Pentagon

Sustainability Measures

Low VOC, non-toxic cleaning supplies are used. These practices allow building occupants to remain healthy and to avoid such consequences of contact with toxic chemicals as absenteeism. The use of these approaches at the Pentagon is in keeping with efforts to improve employee health and productivity and to avoid such consequences as sick building syndrome.

7.9.3 New Mexico Villagra Building

Sustainability Measures

The Villagra Green Housekeeping Program was instituted including:

- Use of non-toxic cleaning products and methods.
- Environmentally Preferable Purchasing policy for housekeeping paper products made with high recycled content and non-chlorine bleach.

The Green Housekeeping Program became policy for all New Mexico state buildings as a result of this LEED project.

7.9.4 46 Blackstone South, Harvard University

Sustainability Measures

The 46 Blackstone South building is using organic, non-toxic, environmentally friendly products on both the interior and exterior of the building. The groundskeepers use only organic, pesticide free fertilizers.

Blackstone employs Harvard's Facilities Maintenance Operations, which uses a green cleaning program to minimize fumes from solvents and other cleaning supplies.

Figure 54: Landscaping sign

Source: Photo by Alyson Reece

7.9.5 The Gerding Theater at the Armory (Annex)

Sustainability Measures

The intent of a green housekeeping policy is to reduce exposure of occupants and maintenance personnel to potentially hazardous chemical, biological, particle contaminants and anything else that would adversely impact air quality, occupant health, building finishes, building systems and the environment. This project is implementing a green housekeeping policy.

7.10 Tenancy Management

Good management practices that are also environmentally efficient offer incentives for tenants to remain in a given facility. Low tenant turnover leads to lower economic and ecological costs, since building interiors will usually be refurbished or remodeled for each new tenant (for example, in terms of reorganizing dividers, painting interior walls, etc.).

Historic Preservation Impact

Good tenancy management practices generally do not have an impact on the historic qualities of the building.

7.10.1 The Presidio/Thoreau Center

Sustainability Measures

At the Presidio, the Thoreau Center for Sustainability, as the pilot sustainability organization within the National Historic Landmark, leases spaces within 12 different historic buildings in the former Letterman Hospital complex mainly to non-profit organizations devoted to sustainability and environmental justice. The tenant model is a unique one in which each tenant not only occupies space but also participates in the life and goals of the Thoreau Center for Sustainability, thus building a connective network with the parent organization and with other organizations within the Center devoted to common goals.

The Center has approximately 60 tenants that share its sustainability initiatives. The tenants are primarily "nonprofit organizations and individuals committed to promoting a diverse and sustainable world", which range in size from a staff of 2 to over 100.

This interactive approach between the Thoreau Center's tenants and the Thoreau Center's management (Equity Community Builders) provides an active interchange that helps promote the Center and the tenants' common goals, particularly as they relate to sustainability goals. Tenants sign a "community charter" in addition to signing a lease with the Center, and are actively integrated into the Center community. The 60 or so tenant organizations have collective buying programs that emphasize both cost savings and use of sustainable materials, and they also take part in bringing community and educational programs. All of these measures are designed to increase tenants' long term investment in the Thoreau Center as a whole, which reduces tenant turnover and the associated financial and environmental costs (transportation, renovation of spaces and associated waste production, etc.).

7.10.2 New Mexico Villagra Building

Sustainability Measures

The building has been dedicated as offices for the State Attorney General for ten years. Long-term leases reduce the frequency of relocating and associated construction activities, thereby conserving resources by reducing impacts related to materials, manufacturing, and transportation.

7.11 Integrated Pest Management

A "low impact" form of pest management is one that does not use poisonous substances in or around the building,

and can be both cost effective and an ecologically sound practice. The intent of such an approach is to reduce the exposure of building users to harmful substances, and to minimize the amount of contaminants that can deteriorate building finishes and systems. A sustainable approach to pest control can also contribute to an overall healthier indoor building environment. The LEED Existing Building Operations and Maintenance version 3 rating system (LEED EB-OM v3) outlines steps necessary to ensure that both the indoor and outdoor environments are protected as well as offering potential strategies to achieve the desired quality. Reducing exposure of building occupants and maintenance personnel, as well as building finishes, building systems, and the environment in general, is one of the areas that LEED covers in its Existing Buildings guidelines.

Since both pests and pesticides can pose health concerns for building occupants and maintenance personnel, balancing control of pests with use of environmentally sensitive pest control approaches is essential to a good IPM program. This means minimizing the use of chemical pesticides and adopting an approach that employs a variety of approaches, including mechanical, chemical, biological, cultural and regulatory techniques. These approaches include such techniques as using mechanical trapping devices, natural predators, insect growth regulators, pheromones that disrupt mating (pheromones), and if necessary, chemical pesticides. The use of biological pesticides is an important component of IPM.

Historic Preservation Impact

Pest management generally does not have an impact on historic properties.

7.11.1 The Pentagon

Sustainability Measures

The Pentagon employs IPM practices, including minimization of toxic pesticides, and employs other measures such as use of plants and foliage that are resistant to insects and fungi. The horticultural department of the Pentagon has also "effectively" reduced pesticide usage through reduction of habitats attractive to pests and through maintaining cleanliness on the grounds.

7.11.2 The Presidio

Sustainability Measures

The Presidio practices IPM, whereby pest control is practiced as much as possible using chemical-free methods. These techniques are practiced at the building and at the landscape levels; for example, at the Presidio Golf Course, the Arnold Palmer Golf Management Company uses non-chemical pest control techniques wherever possible to maintain its grounds, and uses 75% fewer chemical pesticides than other golf courses in the San Francisco Bay Area. The Presidio's web site claims that more than half of all "work orders" from tenants – i.e., orders to the Presidio management to deal with pests at Presidio buildings – were successfully completed without resorting to conventional chemical pesticides. The Presidio also mentions that it does not use poisons to eliminate rodents, preferring to use mechanical traps instead, in order to avoid contaminating the food chain with chemicals that might kill natural predators of rodents. When the Presidio does employ chemical pesticides, it uses only low-risk pesticides that have been approved for use at the facility. The low-risk pesticides are selected for their lower level of impact upon the food chain and upon groundwater and riparian systems.

7.11.3 New Mexico Villagra Building

Sustainability Measures

State of New Mexico Building Services Division created an IPM Plan to manage pests without requiring the use of harmful chemicals or insecticides.

8. Optimize Energy Performance

Optimizing energy performance through lighting upgrades, modifications to the building envelope, and the installation of modern HVAC systems can pose a wide variety of impacts to an historic building. Unless the building has architecturally or historically significant interior features (check with your installation CRM to determine whether this is the case), installing updated lighting and sensors will not have an adverse effect on the building.

However, alterations to a building's envelope (installing insulation, window replacement, roof modifications, etc.) or the installation of a new HVAC system do have the potential to have significant impact to a building's historic characteristics. Although installing insulation within a wall cavity will probably have a minimal impact, other types of insulation projects may pose a threat to significant architectural characteristics. Window replacement on historic buildings almost always raises a "red flag" in the historic preservation community, since window style and material are one of the primary character-defining features of a building. The repair or replacement of historic windows should be carefully considered and involve discussion with the installation CRM as early as possible in the project planning process.

Similarly, HVAC systems can be an intrusive element on a historic building and its location on or adjacent to the building should be carefully thought out early in the planning stage. Exterior units should be hidden behind parapets or other features, or placed at the rear of a building. In addition, ductwork, grilles, and other interior features can cause adverse effects to building characteristics, so it is important to look for existing chases or ways to hide the new equipment. Commissioning of an HVAC system ensures energy efficiency and does not affect a building's character. If the design and construction integrate the new systems into the historic fabric, the commissioning will have no negative impact on the historic character.

When planning any of these energy efficient measures, it is critical to work closely with the installation CRM at the earliest project stage to determine how your proposed alterations will affect the historic qualities of the building.

8.1 Lighting

Lighting is an essential element of architecture. It not only provides illumination for tasks and activities, but it can improve the aesthetics of indoor spaces. An efficient lighting strategy, including natural daylighting (see Indoor Environmental Quality), can provide proper levels of illumination while reducing energy costs. It requires planning and integration of daylighting and electrical lighting solutions early in the design process to achieve this. Both lighting strategies can affect loads required for HVAC and result in significant energy savings in that category. Lighting techniques that can improve lighting and lower energy costs include:

- Task lighting,
- Lower foot-candle lighting for some interior areas, and
- Reflective lighting

8.1.1 Washington Navy Yard, Building 33

Sustainability Measures

The Navy used a number of lighting strategies at Building 33 to provide for greater energy efficiency, which in turn reduced the HVAC loads and positively affected the IEQ. The electrical lighting strategy included task lighting, occupancy sensors, photovoltaic sensors, and high-efficiency indirect lighting (uplighting).

Figure 62: Previous lighting fixtures provided poor ambient lighting and did not take advantage of reflective surfaces to distribute light more evenly

Source: Photo by Karen Van Citters

Task lighting was used to illuminate individual occupants' work area, rather than relying on brighter ambient lighting, which would require more energy and be less effective. As a result, the ambient lighting was reduced from 50 foot-candles to 35 foot-candles. Energy use was reduced by 4% in overhead ambient lighting (using a neighboring building, Building 36 within the Navy Yard Quadrangle, as a basis for comparison), and ambient lighting was provided using T8 fluorescent bulbs rather than the standard T12 bulbs, which resulted in both greater energy efficiency and in better color recognition (using the Color Rendering Index) than can be attained with T12 bulbs.

Photovoltaic sensors were used to control exterior lighting based on the amount of ambient light; at dusk, or if skies are grey, the lights automatically turn on. These sensors are also used on the interior to control the amount of electrical light used in the building based on the intensity of available daylight. This reduces overall energy costs, by only using electrical lighting when it is needed.

Uplighting was used to increase the range of ambient lighting in work areas by diffusing the light off of reflective ceiling and wall surfaces. This lighting also reduces the glare that can be associated with direct downlighting. New fluorescent ballast T8 bulbs were employed, which provides greater energy efficiency than the standard T12 bulbs while also providing better color recognition than the standard T12 bulbs.

Figure 63: Green lighting strategy at south end of fourth floor

Source: Photo by Karen Van Citters

Figure 64: Photovoltaic sensors such as these help control lighting based on the amount of ambient light

Source: Photo by Karen Van Citters

Figure 65: Fixtures added after sustainable renovation. Located in same space at opposite end of building

Source: Photo by Karen Van Citters

Historic Preservation Impact

None of the electrical lighting had a negative impact on the character-defining features of the building.

8.1.2 The Pentagon

Sustainability Measures

The Pentagon has implemented pilot test project to reduce energy consumption by reducing ambient lighting needs in corridors. This test project involved a 4,000 square foot corridor area. Ambient lighting was reduced from 75 foot-candles to 50 foot-candles. Annual cost savings in this single 4,000 square foot area was $2,100, and 4.08 MBTUs (million BTUs) were saved.

This has, according to the Engineering and Technical Services Division, already resulted in savings of $2,100 over the course of a year. Given the enormous amount of square footage in the Pentagon, the facility-wide application of such a reduction would save large amounts of energy and money. In addition, during the PENREN planning process, planners specified that T5 and T8 fluorescent lighting was to be used throughout the Pentagon in conjunction with task lighting in order to reduce the amount of energy being used for ambient lighting. An additional benefit of the Pentagon's historic floor plans is the relatively small distances from one side of an office wing to another, which results in opportunities to take advantage of daylighting that can reach to the middle of the floors from both sides of the wings.

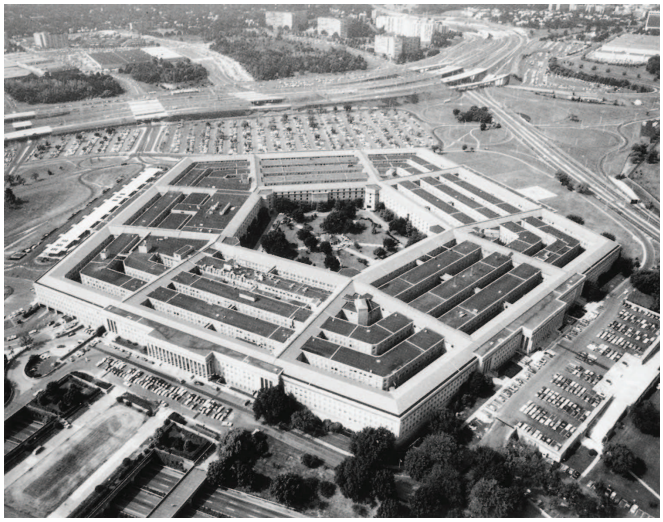

Figure 66: Early aerial shows Pentagon narrow floor plan and daylighting opportunities

Source: National Register nomination, photo by M. Sgt. Ken Hammond, USAF, 1985

Historic Preservation Impact

This test project did not have a negative impact on the character-defining features of the building.

8.1.3 The Presidio/Thoreau Center

Sustainability Measures

The electrical fixtures at the Center are fitted with high efficiency, long-lasting fluorescent T-8 bulbs. In addition, lights are operated by occupancy and photovoltaic sensors. Using high-efficiency bulbs and turning on fixtures only when lights are needed have resulted in significant energy savings. At the Presidio as a whole, more than a million kilowatt hours have been saved each year as a result of these measures. The use of indirect lighting in much of the Thoreau Center main building, in addition to the advantages afforded by the high windows of the historic buildings, which were designed to provide "borrowed" daytime ambient lighting to the interior, has resulted in a reduced need to expend energy for electrical ambient lighting.
Tenants in the building have also been encouraged to employ task lighting in their work areas as necessary.

Historic Preservation Impact

The narrow width of the Thoreau Center's main building, combined with the height of its historic windows, allows application of "borrowed daylight," which reduces the need for electrical ambient lighting to the interior. It does so through the advantages afforded by the historic high windows built into the original building design.

8.1.4 New Mexico Villagra Building

Sustainability Measures

The building has been retrofitted with:

- High efficient lighting to achieve a 28% reduction below the ASHRAE 62.1-2004 baseline
- Lighting occupant sensor controls that switch off lights for unoccupied spaces, reducing energy needs for light and associated cooling. This feature reduced the lighting power density from 0.659 watts per square foot to 0.593 watts per square foot.
  Offices are individually switched rather than having banks of lights serving in multiple offices, thereby reducing wasted energy for unoccupied spaces.
- High-efficiency lighting system that includes auto-dimming feature when natural daylight is sufficient. The lights nearest the windows will dim without dimming the lights further to the interior.

- Light fixtures that are farthest away from windows can be turned on separately from those near the windows using daylight sensors.

Historic Preservation Impact

These efficient lighting features were added with no negative impact on the historic qualities of the building.

8.1.5 Charleston Navy Yard, Building 7

Sustainability Measures

High-efficiency lighting fixtures with low-energy Ultramar electronic ballasts by General Electric were used. The fixtures are designed to direct 40% of the light towards the white ceiling to maximize indirect light. This reduces energy costs and heat emission, and provides a high-quality light without flickering seen in standard systems

Historic Preservation Impact

The fixtures were added on the interior and had no impact on the historic character.

8.1.6 46 Blackstone South, Harvard University

Sustainability Measures

Occupancy and daylight sensors are built into the lighting fixtures to increase energy efficiency. White ceilings further brighten the space by reflecting the direct/indirect light.

Historic Preservation Impact

The fixtures were added on the interior and had no impact on the historic character of the building.

8.1.7 The Gerding Theater at the Armory (Annex)

Sustainability Measures

The project uses more efficient lighting and occupancy sensors. The dressing rooms use compact fluorescent mirror lights instead of incandescent. Fluorescents use less energy, reduce the heating load, and provide a cooler quality of light. The use of indirect/direct fixtures bounce light off of the lighter reflectant surfaces, thus widening the effect of the lighting and highlighting the historic roof structure.

Taking advantage of daylighting where windows are available also allows for energy savings. Occupancy sensors are used in most spaces to turn off lights and save energy when no one is occupying the space.

Historic Preservation Impact

The use of energy efficient lighting within the theater and office space had no negative impact on the historic building.

Figure 67: Occupancy sensor

Source: Photo by Tina Reames

Figure 68: Fluorescent bulbs instead of incandescent bulbs used at dressing tables

Source: Photo by Tina Reames

8.1.8 Cambridge City Hall Annex

Sustainability Measures

The Annex utilizes occupancy and daylight sensors throughout the building. However, upon occupancy it was noticed that the switching of some of the lights resulted in lights being on in the corridors when it was not necessary.

A commissioning study done after the building was occupied found that many aspects of the electric lighting were not properly calibrated. For example, controls for the florescent lights in the office were set to "open office" instead of "private office" resulting in only 2/3 of the available energy saving from having occupancy sensors in private offices. The daylight dimming function on the office lighting was also disabled. The facility manager conveyed that the most important "lesson learned" in the renovation process was to contract commissioning at the beginning of the process. If this had been done, many of the problems that were found would have been fixed earlier and for less expense.

Historic Preservation Impact

The lighting improvements had no impact on the building's historic character.

Figure 69: Private office light fixture off in an occupied office during the day

Source: Photo by Alyson Reece

8.2 Building Envelope

For the purposes of this document, the building envelope includes all external building elements that have a direct bearing on energy performance and efficiency of the building, including:

- Insulation
- Windows
- Roofs
- Walls
- Foundation
- Doors

Including accurate descriptions of building envelope materials is critical to creating an accurate energy model as used in the LEED for New Construction and Major Renovations (LEED NC v3) rating system. Additionally, comprehensive knowledge of the building envelope influences changes made under the LEED for Existing Building Operations and Maintenance (LEED EB-OM v3) rating system both in terms of energy efficiency and cost feasibility.

The use of insulation in walls and under the roof can markedly affect the building's energy performance, and can reduce heating and cooling energy expenditure. In some cases, insulation can be installed with minimal effect on historic features. Historic windows and doors can likewise be retained with energy efficient adjustments such as application of internal films to existing window panes.

8.2.1 Washington Navy Yard, Building 33

Sustainability Measures

As a part of adapting this historic structure for reuse, walls and ceilings were furred out from the original walls and roof, and insulation was added or greater thermal efficiency.

The historic common bond brick walls, the tall, multi-lite wood windows, arched doors, window openings and fanlights in the historic shell were all retained. Within the inner layer of furred-out walls, anodized aluminum windows were added corresponding to the existing historic wood windows on the original building envelope, some of them operable to allow access to the historic windows set in the building's outer shell.

The fixed historic windows helped create a "super window" effect. Double glazed insulating glass was installed inside of the existing glazing creating a high thermal performance with over 12" of overall thickness. A suspended coated film glazing product (heat mirror) was used in the link building windows and skylights. In both cases, between the new glazing and the retrofit, high performance was achieved. Historic wood doors were retained.

Figure 70: Note historic wood window on exterior with anodized aluminum window unit in furred-out interior

Source: Photo by Karen Van Citters

Figure 71: New windows as they appear on interior

Source: Photo by Karen Van Citters

Historic Preservation Impact

The focus was to preserve the historic character of the exterior. The high, open bay space was turned into four floors of office space; skylights were added to the gable roof on the courtyard side so there was no negative impact visible on the primary elevation. Walls were furred out on the interior to provide a new four-floor interior structure and to allow for an insulated space between the new and the historic walls. All of the above features helped to achieve sustainability goals without having a negative impact on the historic character of the exterior shell.

In addition, a rail line used to run through the center of the building to allow for transport of materials. Although the rails were not left in place, the design team did turn this area into a multi-story entry that runs through the building (from the street and courtyard). This helped to retain some of the original openness, and feeling.

8.2.2 The Pentagon

Sustainability Measures

The Pentagon's historic shell has been retained during the decade-long renovation process that began in 1998. Much of the interior of each wedge of the Pentagon has been replaced, and much of Wedge One has been rebuilt since the attack of September 11, 2001, a consequence of the fact that the damage occurred almost entirely within this Wedge.

Even before the 2001 attack, blast resistant windows had been installed; these were selected also to be historically sensitive replacements for the original steel windows. These new windows featured panes that were nearly two inches thick, and cost $10,000 per unit. They were credited with keeping substantial portions of Wedge One standing for a time following the attack, allowing surviving Pentagon employees time to escape.

Approximately 2.5 inches of insulation is being used in all exterior walls under PENREN. Vestibules have been added to most doorways; glass doors are automatic, double-pane glass. The blast-resistant exterior vestibules in many cases were added to preserve existing historic doors that needed to be retained in the building.

In addition, several other aspects of the renovation had hardened the wall system prior to the 2001 attack. Exterior walls were reinforced with steel and backed with Kevlar, and automatic fire doors were installed. These renovations came about because of the recognition that the 1943 building, which consists of a thin limestone façade over a brick infill between reinforced concrete floors, was constructed under the terms of wartime material constraints, and before architects had envisioned modern terrorist attacks.

Historic Preservation Impact

The PENREN project has of necessity removed most if not all of the interior historic fabric.

Figure 72: Pentagon, new windows in wall prior to adding insulation

Source: www.defense.gov

The exterior shell has retained its original historic appearance, although in some places – notably where the terrorist attack occurred, in Wedge One – much of the original exterior shell has been replaced; this replacement was carried out in a historically sensitive fashion. While the historic windows were replaced, their replacements were carefully selected to duplicate the appearance and materials of the original steel windows, and they are more ecologically friendly, since they replaced windows that were painted with lead-based paint.

8.2.3 The Presidio

8.2.4 Sustainability Measures

Building renovations here are preserving as much as possible the historic character-defining features of the buildings. Buildings awaiting renovation are having their building envelopes "sealed," that is, their roofs, windows and doors are being protected from the elements, premises are being secured against vandalism, and the masonry is being tuck-pointed to prevent further decay. Overall, an attempt is being made to preserve the essential character-defining features of Presidio buildings while upgrading their infrastructure to support modern office technology. The building envelopes are being repaired as closely as possible to the original appearance of the buildings.

Historic Preservation Impact

As the Presidio Trust is following a strict preservation-first approach to saving and reusing buildings as much as possible, while "mothballing" others that are not yet slated for immediate renovation and reuse, it is expected that the buildings are being saved in their original form and materials to the greatest extent possible, particularly in respect to historic character-defining features.

8.2.5 New Mexico Villagra Building

Sustainability Measures

The following measures were taken to improve the energy performance of the building envelope.

- R-30 insulation in the roof was achieved by adding 2" (R-14) insulation layers to the top floor ceiling interior.
- R-11 insulation was added to the interior surface of exterior concrete walls. Insulation was covered with gypsum board.
- Original 1934 double-hung single glazed windows' thermal performance was enhanced with high-tech ceramic film (Huper Sech) while retaining historic character. The film reflects up to 70% of the outside solar heat to reduce cooling energy demand in summer, while blocking up to 98% of all infra-red radiation for retaining interior heat in winter.
- Original windows were refurbished to be made operable allowing control by occupants.

Historic Preservation Impact

The addition of the insulation to the interior of walls increased the frame section at the windows and doors. This addition did not have a negative impact on the building's exterior historic character. The ceramic film added to the windows does not have the metallic look of some films, and does not detract from the historic qualities of the windows.

Figure 73: Historic windows with ceramic film on glazing

Source: Photo by Cynthia Figueroa-McInteer

8.2.6 46 Blackstone South, Harvard University

Sustainability Measures

The following changes were made to the building envelope.

- Two buildings, a store house and office building which had originally been separated by a narrow alley approximately five feet wide, were connected by a glass enclosure, thus minimizing the amount of exterior wall space susceptible to air infiltration.
- Blackstone was able to reduce the size of its mechanical system by optimizing the insulation. Standard board-type insulation was installed at foundations, and a spray-applied Icynene foam insulation (which provides a vapor barrier and is vapor permeable) and sprayed-in-place insulation were applied at exterior door frames.
- The original windows no longer existed in the buildings. However, the team worked with the Cambridge Historical Commission to create energy-efficient windows that replicated the original aesthetic. Windows are operable, with double pane, argon-filled low-e glass, with a U-value of 0.25.
- The Ecospace elevator is 60% more efficient than a conventional hydraulic elevator. The new elevator uses the Diary Building's original elevator shaft. The new elevator uses energy effectively through a variable frequency microprocessor which drives motor control of its gearless machine. Though it does not require a machine room as a traditional hydraulic elevator would, the space for a mechanical room is required by Massachusetts code.

Historic Preservation Impact

The added insulation did not have a visual impact to the building's exterior, the look of the historic windows was restored and the new elevator used an existing elevator shaft. Thus the project did not have a negative impact on the building's historic character.

Figure 74: Diary building façade - note historically appropriate replacement windows

Source Photo by Alyson Reece

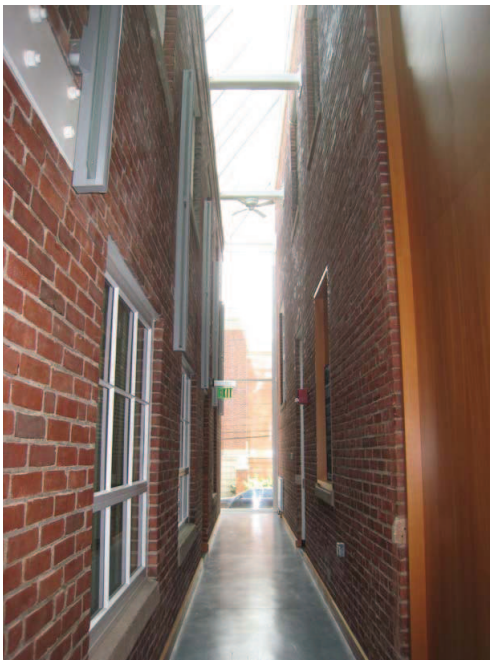

Figure 75: Glass enclosure connecting the buildings

Source: Photo by Alyson Reece

8.2.7 Cambridge City Hall Annex

Sustainability Measures

The existing building had noticeable air infiltration prior to the remodel. Much of the mortar had severely deteriorated, requiring that most of the exterior be repointed. New insulation, in some cases the first insulation, was installed throughout the building. Windows were replaced with new, low-e, double-glazed windows designed to replicate the historic windows.

Historic Preservation Impact

The brick was repointed with historically compatible mortar. Additionally, great care was taken to rebuild the parapets to resemble the 1899 renovation, which enhanced the historic character of the building. Under the supervision of the Cambridge Historical Commission, windows were selected to match the historic windows in order to minimize or eliminate the negative impact on the building's historic character.

Figure 76: Close up of repointing at The Annex.

Source: Photo by Alyson Reece

Figure 77: New Window

Source: Photo by Alyson Reece

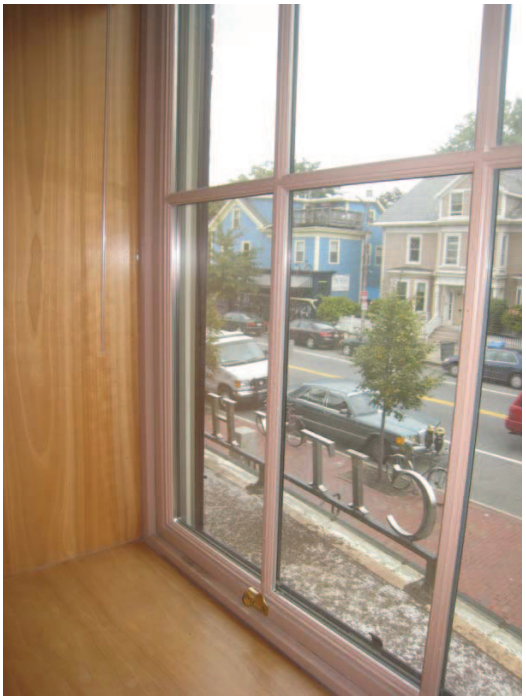

Figure 78: Close-up of window corner

Source: Photo by Alyson Reece

8.3 Heating, Ventilation, and Air Conditioning

HVAC is another area in which DoD facilities have sought to realize energy efficiency and savings in recent years. HVAC account for nearly 40% of total energy costs in commercial buildings in the United States, and therefore it makes sense to maximize the efficiency of HVAC systems in installing, commissioning and operating them. According to the Consortium for Energy Efficiency, many benefits accrue to HVAC operations that pursue energy efficient installation practices, including:

- Energy cost savings of up to 40% through properly selecting and sizing equipment;
- Savings of up to 11% through proper duct installation and sealing;
- Up to 20% less energy used through effective commissioning, which can lead to correction of installation and operations problems;
- Construction savings by avoiding equipment oversizing, installation errors, and excessive ductwork; and
- Markedly decreased impact upon the environment through proper equipment selection, commissioning, and operations, which results in reduced energy consumption and fewer waste products of energy, materials and refrigerants.

Other "green" factors that can be taken into consideration are part of a "whole building" approach that not only takes into account the size and efficiency of the HVAC system itself, but also the building shell (including walls, insulation, windows, and doors), daylighting, a state of the art lighting system, all of which should be considered together rather than in isolation. The amount of energy used by an HVAC system will be affected by the lighting system and the use of appliances throughout the building (affecting plug-load), in addition to other factors such as passive lighting and ventilation (such as that provided by operable windows in many historic buildings).

8.3.1 Washington Navy Yard, Building 33

Sustainability Measures

Heating efficiencies at Building 33 were achieved through light efficiencies and envelope upgrades. Light efficiencies reduce the overall internal heat load, and envelope upgrades work to retain the heating or cooling that is generated within the building. The light efficiency methods included bringing daylight to the interior, reducing ambient electrical lighting from 50 to 35 foot-candles, and using sensors to operate electrical lights. Insulation was added to ceilings and walls, and the installation of interior window units created a "super-window" effect that lowered the overall U-factor, or energy loss, incurred by windows. The measures listed here also resulted in a reduction of chiller sizes from 500 to 330 tons, thus further reducing the building's energy use. Variable speed motors were also employed, resulting in greater energy efficiency for the HVAC units.

Historic Preservation Impact

In order to minimize the negative impact to the historic character, care was taken when adding daylighting, insulation, and HVAC. All possible attempts were made to reduce the visual impact of these actions, such as minimizing HVAC duct sizes and placing units at the rear of buildings or hidden on roofs.

8.3.2 The Pentagon

Sustainability Measures

A "state-of-the-art computer-controlled facility" provides steam not only to the Pentagon, but also to the Navy Annex and Henderson Hall. In addition, chilled water is provided to the Pentagon and the Navy Annex by the new system.

During a PENREN project, the DoD installed a "state of the art" heating and refrigeration plant to replace a coal-fired HVAC unit, which ceased operations in the mid-1980s. The new HVAC system is computer-controlled, uses natural gas as its primary fuel source, is 30% more efficient, and maintains the historical architectural features of the building.

The facility also installed an energy savings performance contract (ESPC) Water Side Economizer to generate 4,250 tons of cooling using river water during the winter months, to eliminate the use of an electric chiller. The facility saved 1,050 MBTUs at an annual savings of $540,000. In exchange for not having to pay for the energy equipment and its installation, the federal agency passes on a portion of the savings it achieves on the ESPC equipment to the energy services company.

Historic Preservation Impact

Because the Pentagon's new energy efficiency heating and refrigeration systems require a significant downsizing in the need for ducting and plants within the building, it was installed with little or no negative impact on the historic features of the building.

8.3.3 The Presidio

Sustainability Measures

The Presidio uses, as much as possible, natural ventilation and daylighting to help with energy conservation, as well as to complement their historic preservation goals. Many of the buildings also use highly efficient package boilers. Every building rehabilitated at the Presidio receives an upgrade to its lighting, heating and other systems, in such a way that historic preservation goals are complemented rather than negatively impacted.

Historic Preservation Impact

Some elements of this measure take advantage of existing features of historic buildings, such as high double-hung windows which allow daylighting and natural ventilation. Others involve necessary upgrades to existing systems such as HVAC. As the Presidio Trust has made an effort to combine preservation of historic character-defining features with energy efficiency, HVAC system upgrades were installed and sited in such a way as to have a minimal impact upon the historic character of the buildings.

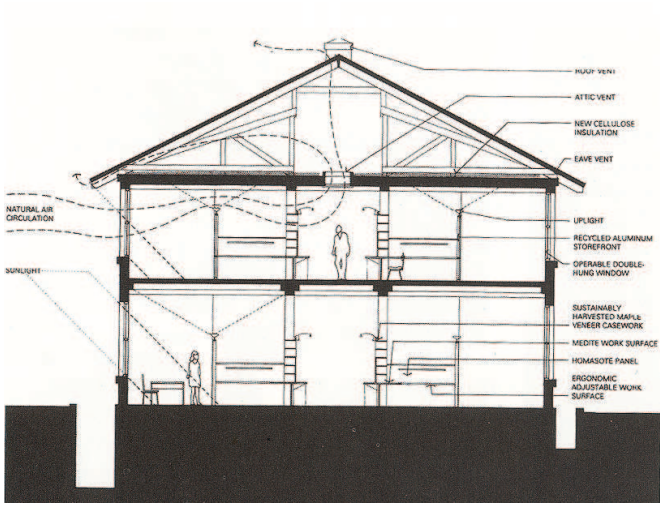

Figure 79: Energy Conservation at the Thoreau Center

Source: Courtesy of National Park Service

8.3.4 New Mexico Villagra Building

Sustainability Measures

High-performance energy-related equipment and envelope improvements resulted in energy performance that is 31% better than the American Society of Heating, Refrigeration, and Air Conditioning (ASHRAE) 90.1-2004 baseline.

- Four-pipe fan coil HVAC system with heat recovery, variable speed drives on ventilators, and a complete Direct Digital Control (DDC) system. The DDC controls room temperature and ventilation and responds to CO_2 sensors to elevate air supply.
- Capacity to operate in "economizer" mode, which provides space conditioning using 100% outside air when outdoor conditions are suitable.
- HVAC operates only when occupancy sensor determines that the room is occupied, saving heating and cooling energy
- Variable speed fans save energy over typical single speed fans
- New high efficiency boiler installed
- Fan coil units are used for heating and cooling. Chilled water from the chiller plant provides cooling, and heated water from the boiler plant provides heating. Ventilation is provided through an outside air distribution system which supplies air directly to the return air ducts for each fan coil unit.
- An independent commissioning agent monitored the HVAC performance to be sure that the system delivered the performance expected.
- Efficiency measures decreased the carbon footprint by 58,000 lbs. annually.
- 61% savings of natural gas through efficiency measures translates to saving 25,000 lbs of CO_2 annually.
- No ozone-depleting chlorofluorocarbon (CFC)-based refrigerants were used in the existing 10 year old chiller system.

Historic Preservation Impact

The use of a four pipe system reduces the amount of space required for ducts, thereby minimizing the effects of HVAC upgrades on historic building characteristics.

Initial HVAC design called for a large air handling unit on the roof. At the SHPO's request, this approach was changed to conceal some units within the building and have smaller energy recovery units located on the roof, reducing their visual impact.

8.3.5 Charleston Navy Yard, Building7

Sustainability Measures

The energy-saving HVAC strategies included:

- Do not condition the entire interior space; just the occupied portions.
- Individually heat and cool the artist spaces, office suites and restaurant with highly efficient central

chilled water system. Condensing units were consolidated to minimize their visual intrusion.

- Non-conditioned open space: large, twelve-foot diameter ceiling fans were installed to provide constant airflow during summer months. Radiant heaters were hung in key locations providing warmth for special events during cooler months.

Historic Preservation Impact

The new equipment is hidden on the exterior and therefore, has no negative impact on the building's historic characteristics.

8.3.6 46 Blackstone South, Harvard University

Sustainability Measures

The building was designed as an integrated system by using the energy model as a design tool to optimize efficiency.

Energy use in the summer is reduced by over 42% better than code requirements. Heating is supplied by the steam plant next door.

Ground-source heat pumps are used to cool the building. Two 6"-diameter wells, 1500 feet deep utilize the nearly constant temperature of the ground to reject heat from the building. A wide loop of polyvinyl chloride piping pumps room temperature water into the earth, where it is naturally cooled. The pumps are located in the parking lot and are covered with standard manhole covers.

Valance units containing coils cool and heat the space through convection. As warm air rises, it passes over the cool coils, and sinks to the floor. This system is decoupled from the ventilation system, providing significant energy savings. There are various heating and cooling zones throughout the building, so that an office with southern exposure will be heated by the sun with no additional heat provided, while an office with northern exposure can be heated with mechanical heat alone.

The ventilation system provides up to 5100 cubic feet per minute 100% outside air, with an enthalpy wheel for latent and sensible heat recovery (heat and humidity). This system allows exhaust air to closely interact with incoming fresh air. In the winter, exhaust air warms cold incoming air, and in the summer it cools it. Efficiency of this exchange is close to 80%, which greatly reduces the amount of energy needed to heat or cool incoming air.

Demand control ventilation increases or decreases the supply of outside air in conference rooms, using carbon dioxide monitors to gauge occupancy.

Figure 80: Ground source heat plumbing supply and return

Source: Photo by Alyson Reece

Figure 81: Connection to ground source heat pump

Source: Photo by Alyson Reece

Figure 82: Power unit for ground source heat pump.

Historic Preservation Impact

The valance units are visible from some rooms inside the buildings as seen in the picture below. The piping for the groundsource heat pump is also visible on the ceilings since there was not any mechanical chase space in the original buildings. This is not ideal, but it is reversible and not an overall negative impact.

Figure 83: Valance unit

Source: Photo by Alyson Reece

8.3.7 The Gerding Theater at the Armory (Annex)

Sustainability Measures

The signed LEED Letter Template, summary tables, and energy modeling output demonstrate a 29.7% savings between the design case and the budget case based on ASHRAE 90.1-1999. Energy efficiency measures include economizers, efficient lighting, chilled beams, underfloor air distribution, displacement ventilation and high efficiency boiler.

The Armory building shell was not affected by the insertion of the 55,000 square foot multi-floor theater. As part of the design, the space between floors was used for mechanical air distribution, see Building Section. The result of energy modeling and design indicates 29.7% savings between the design case and a standard building. Energy efficiency measures include economizers, efficient lighting, chilled beams, underfloor air distribution, displacement ventilation and high efficiency boiler.

The design of the theater incorporated an open lobby space to capture the historic feeling of the large open volume of the armory. The use of underfloor air distribution and providing return air grills inconspicuously freestanding against the walls allowed for the ceiling and roof structure to remain open and visible.

Figure 84: Each seat includes diffusers for underfloor air distribution system

Source: Photo by Tina Reames

Historic Preservation Impact

The historic structure was not negatively impacted by the energy efficient measures used in the new theater

construction. All the components fit within the building shell. While the programmed spaces of the theater used the majority of the building space, the large front lobby and upper office spaces allowed for visibility of the original roof structure and a sense of the volume of the space. The use of underfloor air distribution and providing return air grills inconspicuously freestanding against the walls allowed for the ceiling and roof structure to remain open and visible.

8.4 Commissioning, Measurement, and Verification

Building commissioning is a practice that needs to be encompassed in the early stages of planning a construction/rehabilitation process, and should be part of integrated planning. According to the National Institute of Building Sciences (NIBS), "Commissioning is an all inclusive process for all the planning, delivery, verification, and managing risks to critical functions performed in, or by, facilities." Commissioning is also a "quality assurance-based process that delivers preventive and predictive maintenance plans, tailored operating manuals, and training procedures for all users to follow." Done correctly, commissioning can lead to "higher energy efficiency, environmental health, and occupant safety and improves indoor air quality by making sure the building components are working correctly and that the plans are implemented with the greatest efficiency."

Commissioning requires a cooperative effort among owners, designers, construction managers, and the commissioning providers to achieve the optimum result from the commissioning process. Sound commissioning practices can lead to up to 30% improved energy performance in new and rehabilitated building facilities, according to the NIBS.

ASHRAE and NIBS cover various requirements for building systems in several guidelines covering heating, ventilation, air conditioning and refrigeration commissioning; requirements for exterior enclosures; and commissioning requirements for structure, electrical, lighting, interiors, and plumbing, etc. These are covered in the following guidelines:

- ASHRAE guideline 0
- ASHRAE guideline 1-200X, HVAC & R commissioning requirements
- NIBS guideline 3-2205 covers commissioning requirements for exterior enclosures
- ASHRAE/NIBS Guidelines 2-200X & 4-200X through 14-200X, Technical commissioning guidelines for structure, electrical, lighting, interiors, and plumbing.

Design solutions are only part of the equation. Building occupants play a major role in energy performance by keeping thermostats at reasonable levels, turning off lights, and making use of daylight.

8.4.1 Washington Navy Yard, Building 33

Sustainability Measures

According to a final report by the NIBS done on a 1999 energy efficiency study undertaken at Building 33, "The only systems commissioned were the HVAC, elevator and uninterruptable power supply. The contractor was required to submit a plan for commissioning, based on the ASHRAE standard, far in advance of project completion. This was not done, and the actual commissioning fell short of what the client expected." The report concluded that ongoing commissioning needed to be carried out on all building systems in order to maintain energy efficiency standards and to ensure that systems were delivering the optimum thermal comfort and occupant safety standards.

Historic Preservation Impact

This building's renovation included removal of the entire interior of the building and preservation only of its historic shell. Commissioning would therefore have taken into account the existing historic shell of the building as part of the overall equation of commissioning of the building's systems; therefore, commissioning per se has a minimal effect on historic preservation at the rehabilitated building.

Figure 85: The exterior shell of Building 33 was retained

Source: Photo by Karen Van Citters

8.4.2 46 Blackstone South, Harvard University

Sustainability Measures

The building is metered to monitor energy use. UOS is responsible for calibrating the simulation and calculating the projected savings between the actual energy use of the facility and the simulated energy use of the baseline building. The primary item which is monitored and verified is the whole building's energy use, specifically to verify the savings which are documented by the ASHRAE 90.1 comparison between the designed building and the baseline building. However, with the use of sub-metering, they have the ability to monitor the energy use and the energy savings associated with various systems and components. Both consumption and demand of all utilities are monitored. Blackstone installed metering equipment for lighting systems and controls, constant and variable motor loads, variable frequency drive operation, chiller efficiency at variable loads, cooling load, air distribution static pressures and ventilation air volumes, building-specific energy efficiency systems and equipment, indoor water risers.

Historic Preservation Impact

While utility meters were not part of the original buildings, they are necessary to monitor use. These do not have a negative impact on the historic property.

8.4.3 The Gerding Theater at the Armory (Annex)

Sustainability Measures


Metering equipment has been installed for all utility systems; electric, gas and water. The commissioning agent ensured that all system equipment was designed and installed according to Owner's requirements.

Historic Preservation Impact

The metering equipment does not negatively impact the building's historic qualities.

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9. Protect and Conserve Water

In general, water efficiency measures have little or no impact on a building's historic character. Unless the building has architecturally or historically significant interior features (check with your installation CRM to determine whether this is the case), it is very unlikely that changing floor plans to install new rest rooms would adversely effect an historic building. Simple projects, such as switching out toilets, sinks and adding aerators, will generally have no effect.

9.1 Water Efficiency

Water efficiency is critical in light of mounting data showing that clean and potable water resources are being quickly depleted, and is considered mandatory for any 'green' building project. According to the US Geological Survey "Summary of Estimated Water Use in the United States in 2005" (published October 2009), public water supply accounted for 11% of the total water consumption at 44.2 million gallons per day (Mgal/d), which is up from 43.3 Mgal/d in 2000. Water efficiency is arguably one the most important categories in the LEED rating systems, as well as being one of the easiest and least expensive individual credits to achieve.

Use of various control systems for bathroom fixtures such as low flush toilets, sensor-activated or self-controlling faucet fixtures, centralizing drinking fountains, and other measures, can greatly reduce water waste in the interior of a building. Among the strategies for reducing potable water usage in a building are grey water recapture strategies that use the grey water from showers and sinks, for use in toilets.

Historic Preservation Impacts

The installation of water efficiency measures generally does not have a negative impact on historic properties.

9.1.1 Washington Navy Yard, Building 33

Sustainability Measures

The Navy installed "low flow" toilets, urinals, showers, faucets, and drinking fountains. According to the Department of Energy, "federal regulations mandate that new showerhead flow rates can't exceed more than 2.5 gallons per minute (gpm) at a water pressure of 80 pounds per square inch (psi). New faucet flow rates can't exceed 2.5 gpm at 80 psi or 2.2 gpm at 60 psi. [Low-flow fixtures can] achieve water savings of 25%–60%."

Figure 91: Low flow fixtures such as this faucet in a bathroom in Building 33 help reduce water use significantly

Source: Photo by Karen Van Citters

9.1.2 The Pentagon

Sustainability Measures

The Pentagon centralized its many water fountains, installed water restrictors for showers, adjusted hot water temperatures, and installed low-flow urinals, sinks, and aerators. Sensors were used in bathrooms at faucet and toilet fixtures. The Energy and Technical Services Division estimates that the facility saved 90,492,000 gallons of water at annual savings of $443,118.

Centralizing plumbing allows for ease of access for repairs and can minimize water waste by reducing pipe runs. Centralized "plumbing manifolds" function much like electrical fuse box, helping to control water use from a centralized location.

9.1.3 The Presidio/Thoreau Center

Sustainability Measures

The Center installed waterless no-flush urinals, which work without water or flush valves. They are equipped with a Sloan touchless, battery-operated sensor-operating flushmeter that flushes automatically. The Sloan device allows for many years of metered flushing to control water use. The urinals are designed to stay odorless and because they are sensor-operated, they are sanitary and more

hygienic than traditional urinals. Their simple design lowers maintenance costs and the need to replace operating parts (Thoreau.org website).

9.1.4 New Mexico Villagra Building

Sustainability Measures

All interior plumbing fixtures were removed and replaced with low-usage fixtures.

9.1.5 Charleston Navy Yard, Building 7

Sustainability Measures

The following measures were taken to save water within the building:

- Water saving sink faucet.
- Optical faucets (user activated, no touch) and water saving diffusers.
- Two waterless urinals (not all urinals installed were waterless). Each one saves one gallon of water per use compared to conventional urinals.

9.1.6 46 Blackstone South, Harvard University

Sustainability Measures

Occupant water use is reduced by 43% compared to Energy Policy Act of 1992-compliant plumbing fixtures. Water reduction is achieved by using dual-flush toilets, waterless urinals, and low-flow sinks.

9.1.7 The Gerding Theater at the Armory (Annex)

Sustainability Measures

The Gerding Theater catches the roof rain water and stores it in a 16,000 gallon cistern underground. This water is then pumped, filtered and used to flush the toilets in the facility. No potable water is used for sewage conveyance.

The plumbing fixtures are low-flow and signage is present to educate the public. The ultimate result is 88% water use reduction.

Figure 92: Sensor activated faucet at lavatory

Source: Photo by Tina Reames

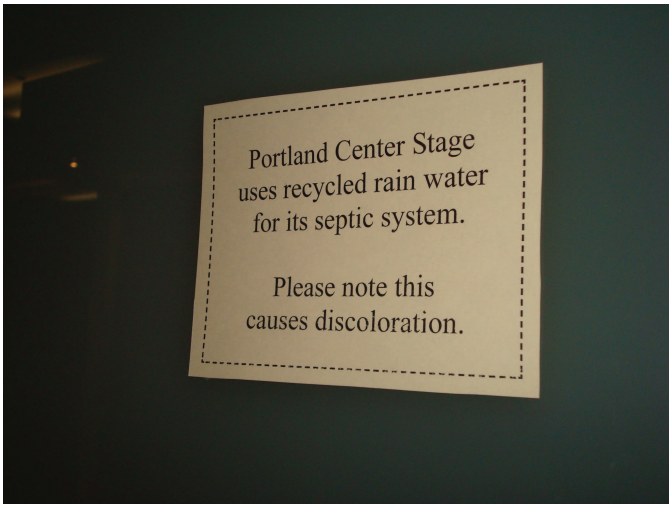

Figure 93: Informational signage about water reuse

Source: Photo by Tina Reames

Figure 94: Pump and piping for water reuse from underground cistern

Source: Photo by Tina Reames

Figure 95: Pipe showing rain drain capture and flow to underground cistern

Source: Photo by Tina Reames

9.1.8 Cambridge City Hall Annex

Sustainability Measures

Low-flow fixtures were installed throughout the building.

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10. Enhance Indoor Environmental Quality

In historic buildings, the use of natural light (daylighting) is typically a design element that conforms well to the existing structure. In many cases, historic buildings have a large ratio of window to wall which allows for more natural daylight to enter the building. Using the existing historic fenestration to allow this daylight is encouraged by preservationists and generally will have no adverse effect upon the building's historic character (note that window replacement can have an adverse effect, see Section 7). However, if it is necessary to create new wall or roof openings for additional fenestration or skylights, such action could have an adverse effect. In many cases, this can be mitigated by putting the new fenestration on the rear of the building or placing the skylights in a less visible location on the roof. It is important to work with the installation CRM early to resolve the need for additional daylight and how this might affect the building's architectural character.

Thermal comfort controls and operable windows typically have no adverse effect on historic character. The primary effect under thermal comfort is usually the installation of new HVAC systems ductwork and equipment. As noted in Section 7, the proper placement and integration of the HVAC components to avoid adverse effects is critical.

Unless the interior is historically significant or the treatment is visible from the exterior, acoustical treatments or the installation of low VOC materials will generally have minimal impact on the historic character of the building.

10.1 Daylighting

Daylighting is the use of passive lighting techniques to bring daylight into a building. Such techniques include windows, light shelves, skylights, and reflective surfaces. Use of daylight can reduce the need to provide electrical lighting and as a result can greatly reduce energy use. According to LEED for Existing Buildings v 3.0, "Daylighting can significantly reduce artificial lighting requirements and energy costs in many commercial and industrial buildings, as well as schools, libraries, and hospitals. In some facilities, daylighting has reduced energy use for interior lighting by 80%."

One of the great advantages in many historic buildings constructed before the widespread use of electric lighting is that they were designed to take advantage of natural daylighting. High window heights, building orientation, central light wells, skylights, and other techniques were in widespread use in historic designs. The continued use or adaptive reuse of historic buildings can revive these historic built-in advantages of historic buildings to conserve energy.

10.1.1 Washington Navy Yard, Building 33

Sustainability Measures

Natural light was brought into the interior via skylights and reuse of the exterior high-bay factory wood windows. The four-story office floors of the "building-within-a-building" are constructed of furred-out walls that now occupy the former open bay space of the building. The existing exterior shell of the building and the high, fixed historic wood windows were preserved in order to save the historic character-defining features of the building's exterior. The tall windows set within the historic shell's elevations admit light into the interior and reduce the need for ambient electrical lighting during daylight hours. An added benefit of the preservation of the tall windows that have been kept on the historic outer shell of the building has been that tenants experience a high degree of connection to the outdoors.

An additional layer of interior anodized windows supplemented the existing historic windows; these were installed in the shell of the interior "building-within-a-building" that allowed the designers to construct a four-story office structure within the existing shell of the brick masonry factory building. The anodized aluminum windows were aligned with the existing historic windows in such a way as to allow daylight to enter into the interior office spaces and provide borrowed illumination.

The rehabilitated building also included reduced levels of electric ambient lighting, as well as reduced plug loads from appliance use. This involved using increased insulation in the ceilings and walls, using insulated glass applications, high efficiency indirect lighting, and task lighting. Ambient lighting was reduced from 50 to 35 foot-candles, perforated blinds were employed to allow daylight in while keeping direct light/heat gain down and occupancy sensors and photoelectric dimming were also used. All of these resulted in a "substantially reduced electric load and reduced anticipated plug loads." HVAC equipment, piping, and ductwork could all be reduced as a result of these measures.

Figure 98: Lighting Building 33 Photo shows indirect and direct ambient lighting

Source: Photo by Karen Van Citters

Historic Preservation Impact

Daylighting was combined with historic preservation goals to help preserve character-defining features of the building, most specifically the tall windows of the open bay factory building. In the reconfiguration of the interior single open bay into four stories of office space, the tall windows were preserved in order to bring light into the office floors. Skylights were added to the side of the building that does not face the street, in order to minimize the effects of this change on visible historic features.

10.1.2 The Pentagon

Sustainability Measures

The Pentagon has taken advantage of its exterior windows to provide daylighting to the building's interior. Prior to the present remodeling project, drop ceilings were added which cut off the top of the windows, limiting the amount light that could enter the building. The new approach uses hung ceilings, but is designed to allow the full exposed window height to have two feet of clearance before the hung ceiling begins in front of it. The Pentagon daylighting strategy also takes advantage of the relatively narrow width of the building segments to bring daylight in from both sides of the building and uses open office seating with low partition walls so all occupants receive the benefits of natural lighting. This also allows for a greater connection to the exterior for the occupants of those spaces.

Historic Preservation Impact

This work did not have a negative impact on the character-defining features of the building.

10.1.3 The Presidio/Thoreau Center

Sustainability Measures

The Presidio has taken advantage of the high window heights and narrow floor plans of many of its historic buildings to provide daylighting to the interiors, as per the explicit policies in its planning documents to employ built-in sustainable features in its historic resources. At the Letterman Hospital complex, where the Thoreau Center for Sustainability and its tenants occupy several of the historic buildings, daylighting from high historic windows has been combined with various electrical lighting strategies, including indirect T-8 fluorescent lighting, task lighting, and occupancy sensors to create an interior environment in which less energy is expended on ambient lighting.

Historic Preservation Impact

The daylighting technique used in the historic buildings of the Presidio employ the already existing historic windows and the relatively narrow elevation-to-elevation width of the buildings to help promote energy efficiency in lighting building interiors. There is no negative impact on historic features due to this approach.

Figure 99: Use of historic windows to daylight the interior at the Thoreau Center

Source: www.parks.ca.gov

10.1.4 New Mexico Villagra Building

Sustainability Measures

The original building was intended to be day-lighted and was designed with many windows. The windows were refurbished and reused.

Historic Preservation Impact

The reuse of original windows resulted in no negative impacts to the historic character of the building.

10.1.5 Charleston Navy Yard, Building 7

Sustainability Measures

The rehabilitation for office space takes advantage of large existing windows and natural light throughout the workspace by having an open office floor plan.

Historic Preservation Impact

Since open office furniture is readily removable, there is no negative impact to the historic space.

10.1.6 46 Blackstone South, Harvard University

Sustainability Measures

Daylight and views have been emphasized in the historic building's re-design. Because the building has a relatively large footprint, the architects designed an insulated skylight to bring light through the center space of the fourth floor to the second and third floors via a new stairwell. Over 90% of occupants have access to daylight and views. The interior design allows light infiltration deep into the core. As discussed previously under 7.2.6, a glass enclosure was built to connect two of the buildings. By using glass, windows that had opened to the exterior still maintain a similar degree of natural daylight into the spaces.

Historic Preservation Impact

Connecting the building did eliminate some exterior windows, however, the openings were kept and the envelope of the connection is mostly glass so windows still maintain daylight. The new skylight is not visible from the end therefore does not have a negative visible impact on the building's exterior.

Figure 100: View from one of the removed windows into the glass enclosure

Source: Photo by Alyson Reece

Figure 101: View of skylight from lower level

Source: Photo by Alyson Reece

Figure 102: View of skylight

Source: Photo by Alyson Reece

10.1.7 The Gerding Theater at the Armory (Annex)

Sustainability Measures

The LEED requirement for natural daylight and indoor air quality was fulfilled with 42 skylights, 17 of them operable for natural ventilation. The roof had been replaced before the building was put on the National Register.

Figure 103: Note operable skylights between historic trusses

Source: Courtesy Gerding Theater

Historic Preservation Impact

It was deemed that only the roof structure, the laminated wood trusses, were historically significant, therefore the roof itself could be penetrated. There was some discussion and compromise that the skylights not be visible from the street. They are not visible from the same block, but are visible three blocks away.

Figure 104: Upper office space showing existing historic roof structure and new skylights for daylighting

Source: Photo by Tina Reames

10.1.8 Cambridge City Hall Annex

Sustainability Measures

90% of spaces at The Annex have views to the outside and most spaces have at least one window. For interior spaces, the original skylights were restored, and a new lightwell added between the third and forth stories. Transoms also allow borrowed light to enter into the interior spaces.

Historic Preservation Impact

The changes in daylighting accentuated the building's original design and did not result in any negative impacts to the building's historic characteristics.

Figure 105: View from an interior room looking through the corridor, a perimeter office and out the window

Source: Photo by Alyson Reece

Figure 106: Roof skylights were added in 1899 and a third was added during this renovation

Figure 107: View into a private office showing the transparent and translucent separation wall to the corridor

Source: Photo by Alyson Reece

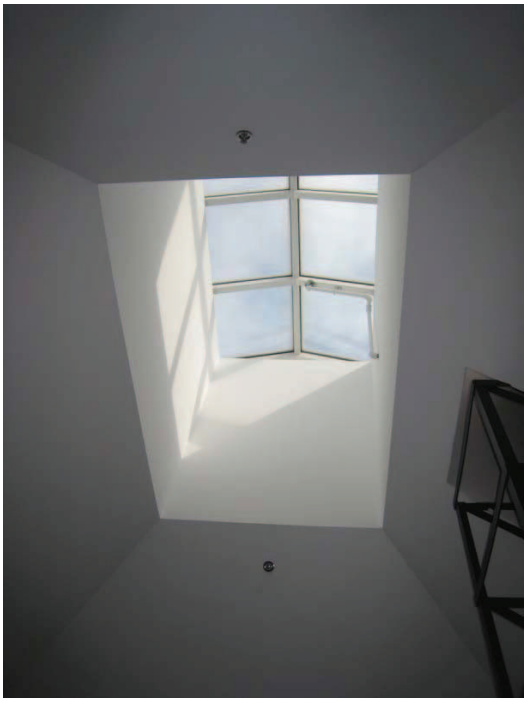

Figure 108: Interior view of roof skylight in stairwell

Source: Photo by Alyson Reece

Figure 109: New conference room skylight

Source: Photo by Alyson Reece

Figure 110: Views of windows from the new emergency stairwell that was added at the the Annex. The stair was held back to minimize impact on windows and to allow more daylight to penetrate the space

Source: Photo by Alyson Reece

10.2 Ventilation and Thermal Comfort

According to the USGBC, Americans spend an average of 90% of their time indoors, and therefore health and livability are primary concerns in ensuring proper ventilation and thermal comfort.

Thermal comfort is an important component in a building's long-term viability and usefulness, since ensuring that tenants are comfortable at all times of the year is conducive to the building retaining tenants in the long-term, thus reducing the turnover and resultant economic and environmental costs of renovations that tenant turnover entails. Air quality, similarly, can help maintain the long-term health and safety of tenants; it can be maintained by ensuring that there is adequate ventilation within a building and that HVAC systems are monitored and held to a high standard.

While energy efficiency and individual controllability of an occupant's thermal environment might seem to be at odds, thermal comfort can be provided with minimal impact upon the overall profile of energy usage within a building.

Historic Preservation Impact

Installation of individually adjusted thermal controls and interior air quality devices generally do not have an effect on historic properties.

10.2.1 The Presidio/Thoreau Center

Sustainability Measures

At the Presidio's Thoreau Center, individual tenants have individual controllability of heating and cooling for after-hours operations, and can also open widows for natural ventilation. This supplements the automatically controlled heating and cooling systems which are designed to respond to seasonal and day and night time climate variations, for greater energy efficiency as well as tenant comfort.

Figure 111: Tall, operable windows such as these at the Thoreau Center allow occupants to take advantage of available natural daylighting and ventilation

Source: Photo Courtesy National Park Service

10.2.2 New Mexico Villagra Building

Sustainability Measures

The following features enhance ventilation and thermal comfort:

- Ventilation is provided through an outside air distribution system which supplies air directly to the return air ducts for each fan coil unit.
- The DDC system controls room temperature and ventilation and responds to CO_2 sensors to elevate air supply.
- Refurbished windows are operable.

10.2.3 46 Blackstone South, Harvard University

Sustainability Measures

Operable windows give occupants local control over air flow and temperature during temperate conditions. See the discussion under Optimize Energy Performance for more in depth information on how the windows contribute to the overall HVAC systems.

Figure 112: Exterior view where several open windows are visible

Source: Photo by Alyson Reece

10.2.4 The Gerding Theater at the Armory (Annex)

Sustainability Measures

The new Armory design provides ventilation and thermal comfort with a series of mechanical devices. The HVAC design achieves an air-change effectiveness of 0.9 or greater in each mechanically ventilated zone, as determined by ASHRAE 129-1997.

A CO_2 monitoring system has been installed. The sensors are placed at the return air of each air handling unit. The system is set with a differential of 400 parts per million above ambient. The project provides all regularly occupied perimeter and non-perimeter spaces with operable windows and lighting controls, airflow and ventilation as required by the Controllability of Systems LEED credits.

The project also complies with and monitors the temperature and humidity in the spaces as required by the Thermal Comfort LEED credits and is in compliance with ASHRAE 55-1992.

Figure 113: Example of air exchanger discreet and streamline in appearance

Source: Photo by Tina Reames

10.2.5 Cambridge City Hall Annex

Sustainability Measures

CO_2 sensors are installed throughout the building to ensure air quality. The public meeting rooms are ventilated with 100% outside air. Natural ventilation (operable windows) are available in approximately 90% of rooms.

10.3 Acoustics

The acoustics of a given environment are also important to the occupants of a building. Distractions arising from poor acoustics – sounds carrying from one side of a work environment to another due to an open cubicle work environment, for example – are not conducive to worker productivity and in the long run affect an organization's bottom line through lost productivity.

10.3.1 Washington Navy Yard, Building 33

Sustainability Measures

The acoustics of the building have received "mixed reviews." Partial height partitions were used in the interior office spaces, and those tenants who had previously had private offices complained of not having "enough acoustic privacy." This was also partly attributed to the very quiet HVAC system, which allowed other, unmasked sounds to carry. But other occupants felt that there was an enhanced level of communication and flexibility due to the open plan of the offices.

Historic Preservation Impact

The use of an open work space plan was a purposeful attempt to make an adaptable, adjustable interior environment to suit the needs of tenants within Building 33. It also contributes to greater sharing of ambient lighting sources within the building while contributing to a greater reliance upon individual task lighting. A structure was built within this existing shell to accommodate the new office space, as such no historic fabric of the interior was negatively impacted.

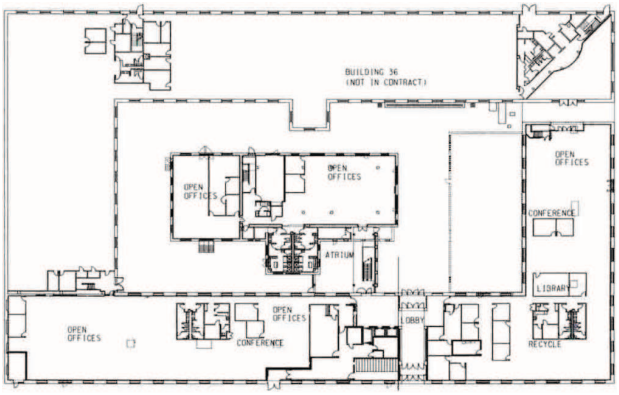

Figure 114: Building 33 renovation floor plan showing open offices

Source: US Navy, NAVFAC

Figure 115: Ceiling above open office plan

Source: Photo by Karen Van Citters

An open floor plan ("open offices") was employed to accommodate the new offices that replaced the open-bay factory space.

10.4 Low Emitting Materials

LEED for Existing Buildings 3.0 lists as a primary attribute of Indoor Environmental Quality the optimization of Indoor Air Quality (IAQ)-compliant products. The intent of these LEED credits is to reduce harmful and odorous indoor contaminants and to ensure proper maintenance and corrective actions are taken when needed. Reduction of emissions from paint and coatings, adhesives, sealants, carpet, composite panels, and agrifiber products, is key to enhancing the indoor air quality of buildings and thus protecting building occupants from VOCs.

Historic Preservation Impacts

The use of low emitting materials generally does not have negative impact on historic properties.

10.4.1 Washington Navy Yard, Building 33

Sustainability Measures

This building did not initially have an IAQ plan in place. Since the rehabilitation, carbon monoxide sensors have been added, and chemicals are stored in "appropriate containers." During construction, VOCs, CFCs, hydrochlorofluorocarbons, and halon were minimized. A pre-occupancy "purging" of the building was also conducted, without using the building's HVAC system.

10.4.2 46 Blackstone South, Harvard University

Sustainability Measures

Carpet tile, fabrics, adhesives, and paints in Blackstone are all non-toxic and emit zero or very low levels of VOCs. The carpet tiles are manufactured by Shaw and are also recyclable. ICI Lifemaster 2000 paints contain little or no VOCs.

During construction, the indoor air quality was controlled by implementing an IAQ Plan. This included storing ductwork in a dry and dust-free environment, sealing the open ends once installed, installing temporary filters and then replacing before start-up. Environmental control was achieved by keeping the building under negative pressure and again by providing temporary protection and installing temporary media filtration at start up. Another environmental control measure implemented was to establish a common space within the building for wood cutting activities after the building was enclosed (Bldg 7 Parking Office). This common space was vented via an exhaust fan, with high efficiency particulate air (HEPA) filter, through an operable window resulting in significantly less air borne wood dust.

10.4.3 The Gerding Theater at the Armory (Annex)

Sustainability Measures

As part of the LEED submittal and the required documentation, the Contractor submitted adhesives, sealants, paints, carpet and composite wood to meet the LEED criteria for Low-Emitting Materials.

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11. Reduce Environmental Impact of Materials

Perhaps the most effective sustainability action is the rehabilitation and re-use of an historic building. Using biobased or recycled materials in this effort will generally have little or no effect on the building's historic character, unless the historic materials are replaced with ones that are inappropriate with regard to style and type and which significantly alter the property's historic features or architectural design. In some cases, the recycling of historic materials can have a beneficial effect, such as when historic brick is removed from a part of the building that was selectively demolished and reused in an area of the building were the brick is severely deteriorated. This not only recycles the materials but it provides a source of matching brick that maintains the building's historic look.

Historic Preservation Impact

Construction recycling is an important element of sustainability—it puts waste from demolition back into the use cycle. Using construction waste recycling and materials made from recyclables typically will not negatively impact the historic property. Two exceptions are found in 11.2.3 and 11.2.5.

11.1 Recycled or Biobased Construction Materials

Use of biobased and recycled construction materials helps to reduce the impact of construction activities upon the environment by utilizing non-toxic, renewable materials, that have been harvested within the geographic vicinity of the project (thus reducing the transportation environmental impact of materials) and materials that have been salvaged from construction sites and reused in new and renovated buildings.

According to LEED 2009 for Exiting Buildings, use of regionally derived and produced materials is also major part of reducing the environmental impact of a sustainable construction project. Use of such materials "reduces pollution and transportation costs associated with delivery of the materials to the job site. Trucks, trains, ships, and other vehicles deplete finite resources of fossil fuels and generate air pollution. Selecting building materials that are produced from regional materials reduces transportation impacts and supports the regional economy". For the purposes of LEED-Existing Buildings, "regional materials" are defined as those that are extracted and manufactured within a 500-mile radius of the building or rehabilitation site, since some areas are relatively resource-poor.

11.1.1 Washington Navy Yard, Building 33

Sustainability Measures

Building 33, included the adaptive reuse of the historic exterior shell. Building 33's rehabilitation used recycled content throughout, and some materials were salvaged from the site and reused.

The use of recycled materials at Building 33 included the following:

- Recycled plastic
- Geo-textile and waterproofing materials, including recycled plastic
- Reused and refurbished bricks from the demolition project on the site
- Concrete masonry unit on-site used fly ash in cement mix (fly ash is toxic emissions from coal burning; recycling fly ash in Portland cement rather than releasing it into the atmosphere has both structural and sustainability benefits.)
- Carpet contained recycled plastic
- Gypsum wallboard incorporated recycled gypsum
- Joint filler
- Ceiling tiles included recycled newsprint

11.1.2 The Pentagon

Sustainability Measures

At the Pentagon, a major part of the PENREN program involved participation in the EPA Environmentally Preferable Purchasing program. This included identification of greener products, or "environmentally preferable materials," to use in the renovation.

The Pentagon also has an active and ongoing Affirmative Procurement program, whereby the Real Estate & Facilities Directorate gives preference to products containing recovered materials. Through this program the Pentagon purchases recycled-content products that meet the recycled materials guidelines issued by the EPA.

Over 50% of all building materials for the Pentagon were also purchased within a 500 mile radius of the project.

11.1.3 The Presidio

Sustainability Measures

The Presidio's Thoreau Center for Sustainability uses many recycled and sustainable materials in its renovation projects. These include:

- Sustainably harvested EcoPanels from Architectural Forest Enterprises and maple veneers from the Menominee Tribe.
- Formaldehyde-free medium density composite fiberboard panels manufactured from recycled wood.
- Homasote fiberboard panels made from 100% recycled paper.
- Wood finishes that are compliant with California's Air Quality Management District Regulations.
- Rest room tiles made with recycled windshield glass.
- Nontoxic, water-based tile adhesive.
- Linoleum flooring (a natural product).
- Insulation for walls and ceiling made from natural fibers (cellulose and cotton).
- Acoustic ceiling tiles with 85% recycled content.
- Minimal off-gassing carpet made of a percentage of recycled materials from Collins & Aikman Powerboard Carpet, a company committed to carpet recycling.
- Aluminum storefronts with 80% recycled content.
- High efficiency, long-lasting fluorescent bulbs for lighting.
- Formaldehyde-free paints with very low VOC content.

In addition, at the Presidio, re-refined lubricant is used for heavy machinery, and re-refined antifreeze and solvent are recycled in the heavy machinery shop.

11.2 Use of Sustainable Building Materials

The reuse of buildings in this study avoids enormous amounts of construction waste from going to the landfill had the buildings been demolished. In addition, new construction would have resulted in a certain amount of construction waste that would not be recyclable and would have also gone to the landfill.

11.2.1 New Mexico Villagra Building

Sustainability Measures

The following sustainable building materials were used:

- Gypsum in wall board is 6% recycled
- Paper on gypsum wall board is 100% recycled
- Medium density fiberboard (MDF), a composite wood product was used for door jambs, shelving, and other finish carpentry where appropriate.
- Steel studs contain 31% recycled content.
- Fiberglass insulation is 30% post-consumer content
- The original 1934 doors, windows, and some lighting fixtures were refurbished and reused. 83% of office furniture and furnishings were reused.

11.2.2 Charleston Navy Yard, Building 7

Sustainability Measures

The following strategies were used to reduce the environmental impact of materials:

- Furniture was designed using recycled and recyclable materials.
- All cabinetry was constructed using Woodstalk, a highly sustainable building material, also called "wheatboard". The product is manufactured with wheat stalks, a waste product from wheat harvesting. It is formaldehyde-free.
- Carpet is made with a high recycled content and is recyclable. Pattern allows for replacement of individual tiles.
- Gypsum board has a high recycled content

11.2.3 46 Blackstone South, Harvard University

Sustainability Measures

Beams and original tongue-and-groove floorboards were re-used to support the opening for the communicating stair. The shell of the existing building was preserved, along with many of its unique features.

Blackstone chose low-energy, renewable materials when possible. 17% of the materials cost includes materials with recycled content. Some of the materials with recycled content include Uni Ecostone Pavers, EFCO windows, Shaw carpet, and recycled rebar, steel, gypsum, and cubicle fabric, and rubber flooring.

The remodeling included renewable materials: Wood floors are made from bamboo, which grows much more quickly than hardwood species; and tiles are Marmoleum linoleum, which is made of linseed oil, instead of petrochemicals.

Almost 60% of the new wood used in the Blackstone Project is certified by the Forest Stewardship Council, an independent, international organization that certifies commercial forests if certain legal, cultural, economic, and environmental standards are met.

Historic Preservation Impact

It is not known whether the original tongue-and-groove floorboards were a character-defining feature of the building's interior. If they were a defining feature, then replacing and covering them with linoleum would be a negative impact. If they were not a character-defining feature, then using sustainable products is certainly the preferred alternative.

Figure 120: Re-used original beam and column

Source: Photo by Alyson Reece

Figure 121:

Source: Photo by Alyson Reece

Figure 122: Original brick and steel lintel

Source: Photo by Alyson Reece

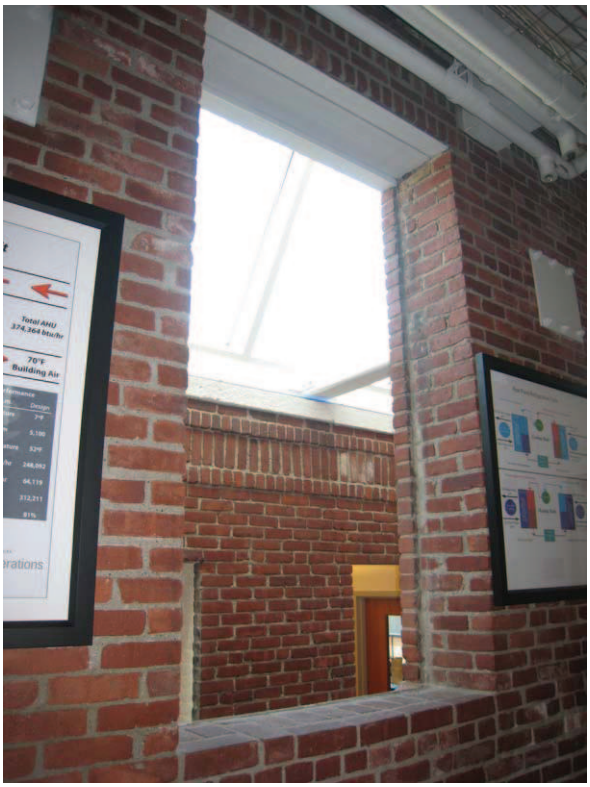

Figure 123: Opening with removed window

Source: Photo by Alyson Reece

11.2.4 The Gerding Theater at the Armory (Annex)

Sustainability Measures

The Gerding Theater reused at least 75% of the existing historic building's shell and structure. The parallel-chord wooden barrel trusses, brick turrets and arched doorways, the Columbia River basalt foundation and the original windows with their sandstone sills were saved and refurbished.

By restoring the historically significant features, the Gerding Theater in the Armory avoided additional construction waste. The demolition included roof deck, slab on grade and four openings on the south façade in order to restore the historically significant features. Drawings indicate only 240 square feet of wall area out of the 3,000 square feet on the south side was removed.

The new construction of the project has achieved a combined recycled content value of 25% of the total materials by cost.

Figure 124: Exterior view of front entry to armory showing restored facade

Source: Courtesy Creative Commons Attribution-Share Alike 3.0 Unported

Figure 125: Exterior view of rebuilt corner turret

Source: Photo courtesy Creative Commons

11.2.5 Cambridge City Hall Annex

Sustainability Measures

In addition to keeping the structural shell of the building, the Annex renovation project also sought the following to further reuse and sustainably harvest materials:

- Over 50% of the wood used in the building came from Forest Stewardship Council certified forests where sustainable forestry practices are used.
- Recycled content was specified in materials wherever possible including steel framing, carpet and ceiling tiles. The carpet manufacturer will take back the old carpet when it needs to be replaced.
- Brick used to rebuild the parapets was recycled from other historic buildings that had been demolished. The buildings were demolished prior to the Annex work.
- Low VOC-emitting materials were used for paints, adhesives, carpets and wood products.

Historic Preservation Impact

The increased reuse of historic buildings has reduced the stockpile of historic materials used to repair other historic structures. Materials made today, no matter how carefully, are not the same as materials made at the time the structure was built. The brick discussed in the Annex is a great example. The shape, color, texture of a brick is dependent on several factors including the type of clay used, location of the clay and the ovens used to bake the brick. In most cases the original clay deposit is gone thus rendering an exact color and sometimes texture match nearly impossible unless other brick made at the same time can be found.

Figure 126: Color differences in brick are noticeable

Source: Photo by Alyson Reece

The first two floors were built in 1871, the third floor in 1899, and the parapets were rebuilt with historic brick in 2002-2003. Even though historic brick was used, there is a noticeable color difference between the third story and parapet where none should exist.

11.3 Eliminate Use of Ozone Depleting Compounds

When applicable, all of the buildings discussed in these case studies used low-VOC emitting materials for paints, adhesives, carpets and wood products. This has been discussed in section 10.4.

11.3.1 The Gerding Theater at the Armory (Annex)

Sustainability Measures

The project has provided calculations to demonstrate that the R-123 refrigerant being used for the project will comply with the LEED requirements. This compliance path also requires that the fire suppression systems installed in the building are free of ozone depleting substances. In this case, the fire suppression systems used in the building are water based fire sprinkler systems. Also, chilled water is purchased by the project from a central plant. The chillers at the central plant also meet the credit requirements concerning refrigerants.

Historic Preservation Impact

The pipes are visible, but painted so that they blend in with the structure minimizing the visual impact.

11.4 Recycling Waste

LEED 3.0 points out that waste generation "plays a large role in the environmental impact of a building due to the negative environmental aspects of waste disposal through landfilling or incineration." Recycling programs have been identified by the EPA as a way of diverting waste from landfills and from incinerators, and thus helping to reduce the impact a building has upon the environment in its day to day operations. Recycling also has an impact upon the production of new products from newly harvested materials, in that it reduces the need for virgin materials by reusing materials that have already been used in products one or more times. Recycling construction waste is a point all projects go after and recycling for occupants is a prerequisite to even achieving any LEED certification.

Historic Preservation Impacts

Recycling programs generally do not have an effect on historic properties.

11.4.1 The Pentagon

Sustainability Measures

The Pentagon uses a daily operations recycling program to divert items that would end up in the waste stream and in landfills. This includes ledger paper, cardboard, plastic and glass containers, aluminum cans, newspapers, and telephone books. The facility also has a landscape waste recycling program; all landscaping waste is transported to an off-site composting facility and, following composting, reused in landscaping and grounds maintenance at the Pentagon Reservation. In addition, asphalt and paving waste generated in repair and re-surfacing of roadway and parking lots is recycled and reused as much as possible in road and pavement repairs at the Pentagon Reservation. Training and awareness raising programs keep Pentagon employees and visitors aware of recycling activities, and to encourage participation in these activities. (Defense Facilities Directorate, www.dtic.mil/ref/Pentagon/recycle.html.).

11.4.2 Washington Navy Yard, Building 33

Sustainability Measures

Recyclables collection takes place in coffee mess areas, and programs are in place in the Navy Yard for recycling of aluminum cans, white paper, newspapers, cardboard, wood, and metal.

Historic Preservation Impact

These measures can be pursued with no impact on historically significant building features.

11.5 Construction Waste Management

Construction Waste Management includes recycling of materials left over from renovation projects at historic buildings. LEED guidelines on construction waste management include measures to divert at least 50-75% of construction, demolition, and land-clearing waste from landfill and incineration disposal. According to LEED 3.0, 136 million tons of construction and demolition debris were generated in the U.S. in 1996; LEED states that most solid waste can be recycled, and that doing so would result in more available landfill space and a reduction in the rate of natural resource consumption, since fewer virgin resources would be needed to produce new construction materials.

LEED 2009 for Existing Buildings also recommends that construction, demolition, and renovation projects "develop and implement a Waste Management Policy covering any

future building retrofit, renovation or modification" on an existing building site. The intent of the policy is to "divert construction, demolition and land-clearing debris from landfill and incinerator disposal," "Redirect recyclable recovered resources back to the manufacturing process," and "Redirect reusable materials to appropriate sites".

According to the NIBS:

> *Responsibly managing waste on a construction job site is a vital component of sustainable building. In this context, managing waste means minimizing the construction waste or demolition debris (C&D) that leaves the job site for landfill disposal.*

11.5.1 Washington Navy Yard, Building 33

Sustainability Measures

Building 33 at the Washington Navy Yard involved a program to recycle demolition waste "to the fullest extent possible" (WBDG). For example, since this building project involved the renovation of an historic structure to "green" guidelines, a lean-to addition was demolished to open up daylighting from the Quadrangle and the demolition waste was recycled and reused in the rehabilitation project.

According to the WBDG, waste from demolition and construction was recycled, although the "specific materials recycled were not monitored by the owner nor reported by the contractor." Interior structure was removed as were "harmful materials that made up the building and site [i.e., petroleum contamination] beneath it." Efforts were made to minimize construction waste and to recycle demolition and waste materials.

Historic Preservation Impact

Construction waste management was carried out without any negative impacts on existing historic features. The removal of the lean-to structure was not an adverse effect since it was of later construction and thus outside the building's period of significance.

11.5.2 The Presidio

Sustainability Measures

Non-historic buildings at the Presidio, of which 200 are slated for demolition, are being used as part of a sustainability study project for the recycling of demolition waste. One of the buildings slated for demolition, Building 901, was a 1942 "temporary" wartime structure located at the west end of Crissy Field. The demolition of Building 901 and the recycling of the resulting construction waste were used as the focus of a case study by the California Integrated Waste Management Board. According to the Board, which conducted the 1996 case study on this project in conjunction with the Presidio Trust, "the intent of the 901 project was to show the amount of materials that can be salvaged using soft demolition techniques, while performing the operation at costs competitive with traditional demolition operations." The project's focus was to deconstruct and salvage the materials of the building, which were almost all wood – including "wood siding, wood flooring…..[and] wood slat roofing boards." Three salvaging firms performed the demolition and deconstruction in order to extract and recycle the building's wood content. Because the building was older, it contained a great deal of old growth lumber that has great value on the market due to its scarcity and its durability. Demolition was carried out by hand in order to salvage the greatest possible amount of wood without damaging it. The materials were salvaged "to the greatest extent possible and sold to the group(s) with the highest bids".

Historic Preservation Impact

Building 901 was not eligible for the National Register and thus was not a "historic property". The dismantling of 200 buildings at the Presidio in order to enhance the overall integrity of the historic landmark, while saving over 500 buildings at the park that have landmark status, has contributed to greater understanding of the market costs and benefits of recycling buildings, using hand-demolition techniques, and salvaging the wood materials out of which the building was constructed. While reducing the flow of materials into the waste stream, and hence the amount of virgin materials needed to produce new construction materials, it also reintroduces historic building materials back into the marketplace and has helped to demonstrate the utility and economic and ecological savings that can be derived from "soft" demolition practices, otherwise known as "deconstruction," to salvage reusable materials from buildings.

Photo shows Building 901 being disassembled and its materials being saved for recycling and resale on the market.

11.5.3 The Pentagon

Sustainability Measures


According to the Pentagon Renovation Program Management, C&D waste management has included "construction debris recycling. The Wedges 2–5 project has consistently diverted 50% of its construction waste from landfills through salvage and recycling". Approximately 70% of the demolition waste from Wedge 1 was recycled.

Approximately 15 million pounds of debris, including 600,000 pounds of steel, were recycled.

Historic Preservation Impact

Recycling construction waste at the Pentagon did not have an negative impact on its historic character.

11.5.4 New Mexico Villagra Building

Sustainability Measures

82% or 195 tons of demolition and construction waste was recycled or diverted from the landfill. Materials recycled or diverted included concrete and brick, metal and cardboard, plastic, copper, aluminum, interior doors, and asphalt.

Historic Preservation Impact

The demolished materials were not considered historically significant.

11.5.5 46 Blackstone South, Harvard University

Sustainability Measures

The project diverted 99.42% of its construction and demolition waste by weight from landfills, resulting in a net savings of 15% due to recycling instead of sending materials to the dump. Aggregate (brick, concrete and block) contributed a large part to the weight, and will be reused as rubble fill on other projects. Unpainted wood was ground into mulch. All the plumbing fixtures removed were sent to Guatemala, where a volunteer team from Shawmut construction erected a village water center for a small town of eighty-six residents. The windows were sent to Spanishtown, Jamaica, providing shelter for those whose homes suffered damage in summer hurricanes.

Historic Preservation Impact

The actual recycling of construction waste did not result in a negative impact; however, the replacement of functional windows in a historic building is a negative impact.

11.5.6 The Gerding Theater at the Armory (Annex)

Sustainability Measures

Project data indicates that 96% of project construction waste was diverted from the landfill.

Historic Preservation Impact

There was no negative impact as a result of recycling construction waste.

11.5.7 Cambridge City Hall Annex

Sustainability Measures

The General Contractor recycled about 85% of the construction waste.

Historic Preservation Impact

The recycling of construction waste resulted in no impact on the building's historic character.

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12. Summary

Historic buildings have character-defining features, which should be protected and maintained. However, caring for the historic integrity of such features does not preclude making improvements to the building's overall sustainability. As this study shows, with proper attention energy and other sustainability measures can be added to historic buildings while simultaneously protecting historic features. When original character-defining features cannot be preserved, replacements that are sympathetic to the original features can lessen the negative impact of projects on the overall historic character of the property. When considering projects that enhance an historic building's sustainability but may impact the historic character, consult with your CRM and SHPO, study the building's history and architectural character-defining features, and be familiar with the Secretary of the Interior's Standards for the Treatment of Historic Properties. When attention is paid both to historic integrity and sustainability, we protect our past and our future—historic buildings can be green!

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Appendix A: Other Sustainability Measures

Heat Island Effects

Conservation Consultants, Inc (CCI) Building

The CCI Building in Pittsburgh, PA, is not included in the case studies presented in this report because of the small size of the historic portion of the structure. It is included in the appendix under heat island effect to provide further example of the advantages of green roofs. Green roofs reduce the cooling load of the building by absorbing and therefore reducing the heat load through the roof. They also diminish the reflectance of heat toward other neighboring structures.

Another advantage of this particular green roof relates to the detention of storm water. The green roof retains some of the rain water that falls on the roof. Pittsburgh's storm water and sewer, like many older cities, run in the same lines. In order to treat this water prior to returning it to the river, the storm water must be treated as well. The roof garden minimizes that treatment expense.

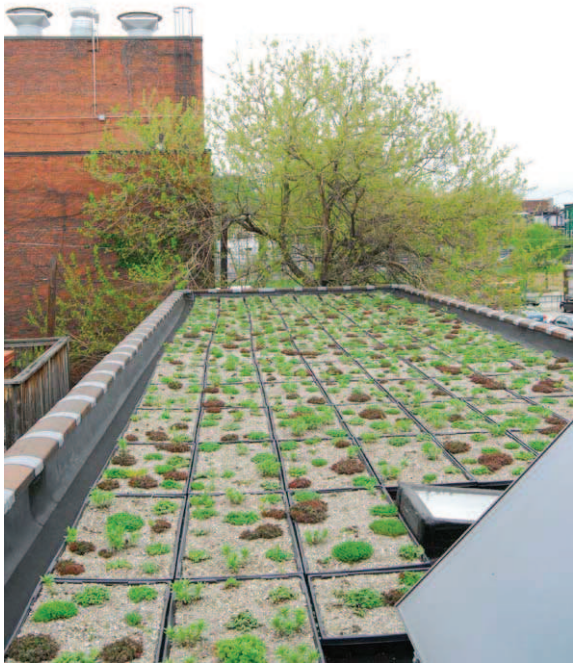

Figure 1: Green Roof

Source: Photo by Edith Cherry

Figure 2: Roof Plants

Source: Photo by Edith Cherry

The type of plants and the growth medium are specially selected for Pittsburgh's climate and plant growth in a shallow container.

Historic Preservation Impacts

The existing building upon which the green roof is constructed has a parapet wall that conceals the view of the green roof from the street. The roof load is somewhat greater than the original roof. It is not known for sure if the additional weight required additional structural reinforcement.

JW McCormack Building

The JW McCormack Building is not included in Section 5.2 Case Study Summaries but is included under heat island effect since the project added a green roof to a portion of the original roof. The JW McCormack building is a 22 story, Art Deco high rise in the financial district of Boston, Massachusetts. The footprint is square shaped and continues up four stories with the full footprint. The building then takes a 'C' shape up to the 17th story and the tower continues up to the 22nd story. The green roof is on the roof of the 4th story. The 4th story roof had been the location for rooftop mechanical units but was renovated into an outdoor gathering space for employees. Green roofs reduce the heat island effect by lowering the temperature of the roof. This in turn reduces the radiant heat emitting from the roofs onto surrounding buildings and surfaces.

Historic Preservation Impacts

Originally, the 4th story roof had been covered with rooftop units which negatively impacted the historic character since they were visible from surrounding buildings. The Historical Commission and surrounding tenants approved the green roof since it was more aesthetically pleasing than the roof top units.

Acoustics

Trinity Church

Trinity Church is not included in the case study summaries presented in this report, but is included as an appendix due to the unique considerations of the project. Trinity Church is an iconic structure built by H.H. Richardson in Boston, Massachusetts and dedicated in 1877. Through the decades, the function of the church has changed. Today it is not only a place of worship but also a community gathering space and tourist attraction. The out-dated mechanical system could not meet contemporary demands. The design team, lead by Goody Clancy Associates, the architect of record, researched several options to upgrade the mechanical system. The systems researched included conventional air-cooled chillers and water-cooled chillers. Ground source heat pumps were also researched as a non-conventional system. Several factors influenced the decision: cost (life cycle), space requirements, aesthetic impact, structural impact, noise levels, and energy efficiency.

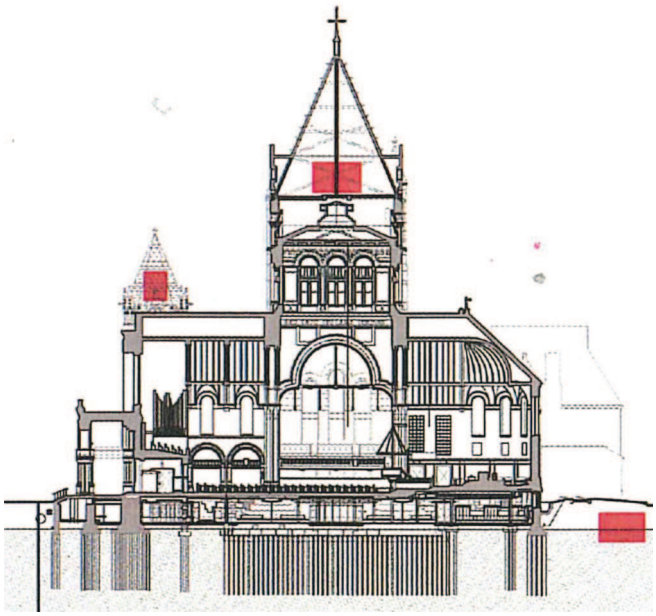

Figure 3: Water cooled chillers

Source: Courtesy Goody Clancy Associates

The ground source heat pump was ultimately chosen despite its higher initial cost because it was the quietest, had the smallest above-ground physical space requirements, and was the most energy efficient.

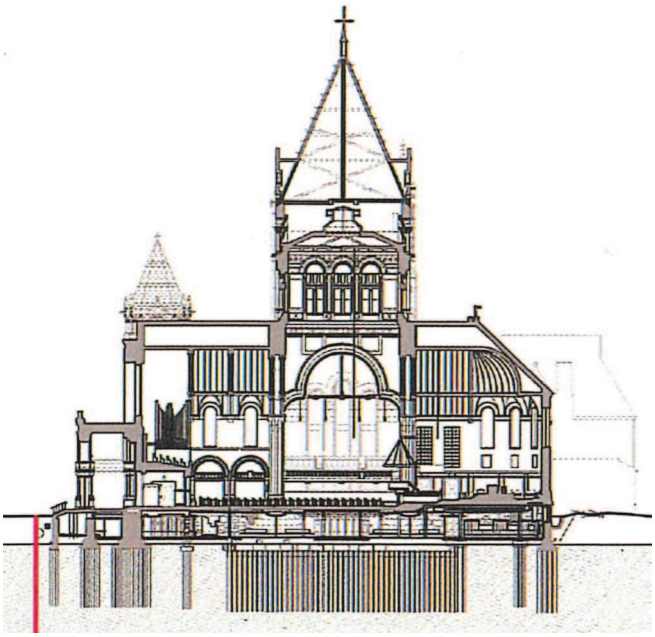

Figure 4: Ground-source heat pump

Source: Courtesy Goody Clancy Associates

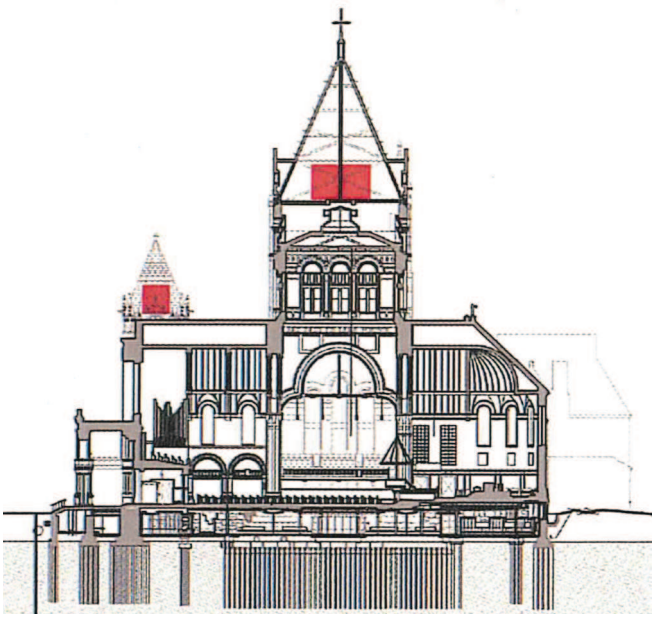

Figure 5: Air-cooled chiller

Source: Courtesy Goody Clancy Associates

Trinity Church diagrams by Clancy Associates. Used with permission.

Historic Preservation Impacts

This project is an example where the most sustainable choice, the use of ground source heat pumps, met the historic preservation considerations of acoustical integrity and minimal visual impact. These historic preservation aspects were paramount to the project and drove the decision making process.

Construction Waste Management

Eglin Air Force Base, Buildings 201 and 238

Building at Eglin Air Force Base are not included in the case studies presented in this report, but is included in the appendix to identify a cost-effective construction waste management.

Buildings 201 & 238, Eglin Air Force Base, involved replacement of single paned aluminum windows with historically sensitive double pane windows. According to Eglin Cultural Resources Management, each window was replaced and all construction and demolition waste recycled at a cost of $1,500 per window.

Figure 6: Historically sensitive double-hung replacement windows

Source: Photo by Karen Van Citters

Historic Preservation Impact

Construction and demolition waste recycling took place without any negative impact on existing historic features. Replacement of windows with historically sensitive windows improved the historic accuracy of the buildings' appearance.

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