



NATIONAL ENDOWMENT FOR THE

Humanities

DIVISION OF PRESERVATION AND ACCESS

Narrative Section of a Successful Application

The attached document contains the grant narrative and selected portions of a previously funded grant application. It is not intended to serve as a model, but to give you a sense of how a successful application may be crafted. Every successful application is different, and each applicant is urged to prepare a proposal that reflects its unique project and aspirations. Prospective applicants should consult the Preservation and Access Programs application guidelines at <http://www.neh.gov/grants/preservation/sustaining-cultural-heritage-collections> for instructions. Applicants are also strongly encouraged to consult with the NEH Division of Preservation and Access Programs staff well before a grant deadline.

Note: The attachment only contains the grant narrative and selected portions, not the entire funded application. In addition, certain portions may have been redacted to protect the privacy interests of an individual and/or to protect confidential commercial and financial information and/or to protect copyrighted materials.

Project Title: Winterthur Sustainable Preservation Environment Project

Institution: Winterthur Museum

Project Director: Lois O. Price

Grant Program: Preservation and Access Sustaining Cultural Heritage Collections

WINTERTHUR



Abstract

Winterthur Museum, Garden & Library is committed to lifelong learning in the humanities and to the sustainable preservation of the collections that support this mission. To this end, Winterthur requests a \$350,000 NEH SCHC implementation grant as part of an \$873,338 project to enhance the preservation of the collections and reduce collection-related energy costs. Installation of a new HVAC control system will effectively manage energy and the preservation environment in Winterthur's three major collection buildings—the Museum, Galleries, and Research Building. These buildings house one of America's outstanding collections of decorative arts and research material related to material culture as well as extensive programming, exhibitions, conservation and scientific research facilities, and two graduate programs critical to training cultural heritage professionals.

The new HVAC controls and associated upgrades will replace Winterthur's antiquated, inflexible system with sophisticated controls and the advanced monitoring and analytical capacity necessary to take advantage of recent research proving that daily and seasonal temperature and humidity can safely vary over a broad range without damaging collections. Implementing this energy saving variability safely in a complex physical plant requires a flexible system that allows the significant operational control provided by this system. The project will be managed by a collaborative team of engineers, consultants, conservators, facilities, and collection staff.

The project will have two significant outcomes. The first is a major improvement in the energy efficiency and quality of the preservation environment in Winterthur's collection areas with savings from mechanical upgrades estimated at \$194,350 per year, 12.7% of its current utilities costs, and significant additional savings from operational changes made possible by the new control system. These savings will allow Winterthur to improve the sustainability of its collection preservation and humanities-related research and program activities by redirecting resources to initiatives that enhance public and scholarly access to the collections. The second significant outcome is the information derived from installation of an innovative control/monitoring interface developed by the Image Permanence Institute (IPI) and systematic implementation of operational protocols that will benefit other cultural heritage institutions facing similar sustainability issues. IPI will make the control/eClimate Notebook interface available to all users and Winterthur's careful documentation of the process used to develop and document operational protocols and energy savings will be disseminated to the field through lectures, websites and publications.

This project addresses key components of the mission statement and strategic plan. As an extension of Winterthur's historic environmental consciousness, it will improve sustainability of the extensive physical plant and enhance preservation of collections—issues important to key donors and our core audience. A reduction in operating costs will improve financial performance and make more funds available to educational, exhibition, and collection-based activities that help build audiences, build on excellence, and increase revenue. The innovative components of this project in environmental control and energy saving operational protocols reflect Winterthur's culture and commitment to research, leadership, and excellence.

Introduction

Winterthur Museum, Garden & Library is committed to lifelong learning in the humanities and the sustainable preservation of the collections that support this mission. To this end, Winterthur requests a \$350,000 NEH SCHC implementation grant as part of an \$873,338 project to enhance the preservation of our collections and reduce collection-related energy costs. Winterthur is a large, complex enterprise encompassing almost 1,000 acres and over 100 buildings with utility systems that have been installed, modified, and repaired repeatedly over many decades, resulting in antiquated, incompatible, and poorly documented mechanical and control systems. Concern with growing energy costs and environmental impact motivated a major study of Winterthur's energy consumption and a strong commitment to make significant changes. The size and complexity of the systems present a formidable challenge, but Winterthur is a unique institution with resources and expertise to make obvious improvements and to explore new options that will help Winterthur and other institutions facing similar problems.

The focus of this project is the installation of a new HVAC control system that will effectively manage energy and the preservation environment in Winterthur's three major collection buildings—the Museum, Galleries, and Research Building. This system is designed with the sophisticated controls necessary to take advantage of recent research proving that daily and seasonal temperature and humidity can safely vary over a broad range, within safe parameters, without damaging collections. The capacity to allow this energy saving variability in a complex physical plant depends upon a system that allows significant operational control. With an advanced wireless control system enhanced by an integrated monitoring and analysis program, Winterthur can safely implement daily and seasonal operational changes that promise significant energy savings. To achieve this goal, the project brings together a collaborative team of engineers, consultants, conservators, facilities, and collection staff. This new HVAC control system will allow Winterthur to enhance the sustainability of its collection preservation, humanities-related research, and program activities by reducing energy consumption and redirecting resources to initiatives that enhance public and scholarly access to the collections.

Significance and Use of Collections

Created by Henry Francis du Pont and opened to the public in 1951, Winterthur is a multifaceted, internationally recognized institution consisting of a world-class museum with extensive educational and exhibit programming, a well-documented 60-acre naturalistic garden, an extraordinary research library, analytical laboratory, two graduate programs, and a visiting research fellowship program. The museum's unparalleled collection of nearly 90,000 fine and decorative arts objects made or used in America between 1640 and 1860 is considered to be the finest and most comprehensive in existence. The Winterthur Library, a leading center for the study of material culture, is the center of research activity at Winterthur. Well known for the maturity and variety of its plant collections, as well as the sophistication of its composition, Winterthur's garden has been called the greatest "wild garden" in North America. The museum collection and garden represent the best of American design and craftsmanship, while the library and analytical laboratory provide unparalleled research opportunities.

Three major buildings—the Museum, the Galleries, and the Research Building—display and house Winterthur's collections (see image in Appendix). The 175 rooms in the *Museum*, exhibit Winterthur's extraordinarily rich and varied fine and decorative arts collection in a domestic

setting. The 35,000 sq. ft. **Galleries** provide visitors with a self-guided tour experience through American decorative arts and changing exhibits that present innovative interpretations of American art and culture. The five-story **Research Building** houses the library, academic programs, analytical, and conservation laboratories.

The Museum rooms, Henry Francis du Pont's former home, provide a unique context for objects and architecture; they reflect du Pont's very particular aesthetic and the early twentieth century, a period receiving increasing attention from historians. Interpreters use them to illustrate the culture of that period and life on a country estate such as Winterthur. Rooms range from those with iconic features like the 1822 two-story spiral stair from Montmorenci, to elegantly intimate rooms like Chestertown, to those like the Fraktur room featuring imaginatively faux-grained woodwork in a Pennsylvania vernacular style. The furnishings in each room setting complement the architecture and the garden, a key component of du Pont's aesthetic.

Winterthur's American furniture collection is the largest and arguably the finest in the country. With a wide range of regional and stylistic forms, the collection of more than 9,000 objects spans the mid-1600s to the 1870s. The collection boasts a rich variety of furniture forms from Windsor chairs, painted chests, and simple pine and maple pieces to high-style Philadelphia rococo furniture, such as the Turner-Van Pelt family high chest. Not only does Winterthur steward some of the choicest Philadelphia furniture dating from the 1730s to the 1770s, but other furniture collection highlights include representative pieces of the finest New England furniture, especially from Newport, Boston, Salem, and Portsmouth. Works by well-known urban cabinetmakers such as Samuel McIntire, Thomas Seymour, and Thomas Affleck join examples from less urban makers like the Dunlaps of New Hampshire and Christian Seltzer of Lebanon County, Pennsylvania. Neoclassical furniture from the early 1790s to the 1830s also has an important place in the collection including objects such as an exceptional Philadelphia sideboard attributed to Joseph Barry and once owned by Andy Warhol, an important dolphin-supported pier table, and a pair of Philadelphia armchairs with dolphin arm supports.

The outstanding ceramics collection, a major resource for scholars, includes some 19,000 objects made in or imported into America from the 1600s through the mid-1800s. The earthenware, stoneware, and porcelain in the collection represent an unusually broad range of manufacturing and design types and have special strengths among American, English, and Chinese wares. Highlights of American manufacture include pieces by Virginia's Samuel Bell and Sons and Anthony Wise Baecher, iconic work by sgraffito (incised) slipware potters from Pennsylvania, and American stoneware by the African-American potter, Dave, of South Carolina. Chinese export porcelain comprises 5,000 objects, many produced for the American market, as well as special-order wares once owned by famous historical figures such as 70 pieces of George Washington's Order of Cincinnati dinner service. European ceramics include a comprehensive English collection rivaling the best collections in Britain as well as significant collections of early Dutch delftware (tin-glazed earthenware) and Meissen porcelain.

The glass collection of nearly 4,000 objects represents types known to have been used in early America as well as superb individual examples chosen for their color and design. The work of important early American manufacturers includes glass by John Frederick Amelung (Maryland), Caspar Wistar (New Jersey), and Henry Williem Steigel (Pennsylvania).

Metalsmiths who settled in colonial America and trained successive generations of craftsmen left a legacy important to all aspects of life. American-made and imported metalwork encompasses more than 21,000 objects of gold, silver, silverplate, iron, pewter, copper, and alloys of copper such as brass, bronze, and paktong. Collection strengths include domestic and ecclesiastical pewter, ornamental and utilitarian wrought iron hardware and implements; lighting and lamps, many incorporating François Pierre Ami Argand's design; Kentucky rifles; and colonial American silver. The silver collection includes many rare objects such as six matching Paul Revere tankards as well as a critical research collection of approximately 9,000 examples of maker's marks on flat silver such as spoons and sugar tongs.

The 450 American paintings in the collection represent a carefully selected survey of early American portraiture and genre painting that both complement the Museum rooms and enhance the understanding of early American dress, customs, and changing identity. Works by artists such as John Singleton Copley, Robert Feke, John Smibert, John Breckenridge and James Earl represent the development of the artistic tradition in early America. Icons of American history include Benjamin West's unfinished *American Commissioners of the Preliminary Peace Negotiations with Great Britain*, and John Trumbull's *Washington at Verplanck's Point*, a work that had hung at Mount Vernon and was Martha Washington's favorite likeness.

Winterthur's collection of over 4,000 works on paper serves a similar function, providing detailed images of American and European personalities, events, scenes, and interiors. In addition to American and European mezzotints, engravings, etchings, and lithographs, Winterthur's holdings include important 18th and 19th-century maps, watercolors, drawings, silhouettes, fraktur, and other paper arts. The collection features rare works by notable American engravers Nathaniel Hurd, Paul Revere, Peter Pelham, and Amos Doolittle as well as a rich array of popular images known to have been available to American consumers prior to 1840.

Winterthur's 20,000 item textile collection includes some of the finest textiles made or used in America where they were a major expression of wealth and status. Furnishing textiles in Museum rooms include outstanding English, French, and Indian printed cottons as well as French silks, such as the magnificent curtains made from silk designed in the 1760s by Philippe de Lasalle (1723–1804). Significant to studies of gender and female education, Winterthur's extensive collection of American samplers and needlework pictures includes one of the earliest samplers known to have been worked in America, Sarah Stone's band sampler, dated 1678, as well as a unique Berlin woolwork picture embroidered by Olevia Rebecca Parker in 1852 at the public Lombard Street School for African-American children. Quilts and bedcovers feature Mary Foot's 1778 embroidered bed rug from southeastern Connecticut and Sophia Myers Pearce's chintz appliqué quilt, made in Baltimore about 1840. The extensive printed cottons and linen collection is consulted by international textile scholars and features one of three counterpanes printed by early Philadelphia printer John Hewson, numerous examples of fashionable 18th-century indigo-resist printed cottons, and a set of bed hangings plate-printed with portraits of George Washington and Benjamin Franklin in the 1780s.

An unequalled research facility, the Louise du Pont Crowninshield Research Building at Winterthur opened in 1969. It houses the library, academic programs, conservation and science laboratories, and various study collections. The library is dedicated to the study of America's

artistic, cultural, social, and intellectual history from the colonial period to the 20th century and is recognized as one of the leading centers for the study of American art and material culture. The resources have grown to more than 100,000 volumes and over one million manuscripts, printed ephemera, and photographs. As a member of the Independent Research Libraries Association (IRLA), the library supports an extensive roster of funded research fellowships, including NEH fellowships, as well as independent scholars and Winterthur staff and students.

The library holdings are comprehensive in the following areas of material culture studies, broadly defined: architecture and design pattern books; American and British manufacturers' and retailers' trade catalogues; material on American decorative arts and crafts techniques; advice literature on household management; interior design; etiquette; holdings on the Arts and Crafts Movement; material on the Colonial Revival; early travel literature; and city directories and guidebooks published before 1880. Together these resources offer an important place to study the material and visual aspects of life in the North American colonies and United States.

This unique confluence of collecting goals—objects that meet the highest standards of both connoisseurship and material culture research value—has created an extraordinary repository of material for humanities research and exhibition. Many visiting scholars, students, and staff use both Museum and Library collections to pursue their research, exhibition, and publication goals.

Exhibitions

The 35,000 sq. ft. Galleries provide a venue for self-guided, in-depth tours of furniture, glass and ceramics, textiles, metals, paintings and prints and related programming as well as expansive spaces for changing exhibitions. Since this building opened in 1991, Winterthur has mounted over 75 highly-acclaimed exhibits, many based on new research that helped place objects in a broad historic, cultural, or art historical context. *Betsy Ross: The Life behind the Legend*, which opened in October 2010, was based on the work of Marla Miller, an NEH-funded research fellow who consulted Winterthur's resources in writing her book and developing the show. The exhibition highlighted new scholarship on the life of this legendary American figure and explored the role of working women from the Revolutionary War until the War of 1812 and beyond. Because of its many themes, the exhibition appealed to a broad and diverse audience.

The current exhibition and publication *Paint, Pattern & People: Furniture of Southeastern Pennsylvania, 1725–1850*, was organized by Wendy A. Cooper, the Lois F. and Henry S. McNeil Senior Curator of Furniture, and Lisa M. Minardi, assistant curator of furniture. Although the region's distinctive and colorfully-decorated furniture is often associated exclusively with its German-speaking residents, the area was inhabited by a diverse mix of people and not dominated by furniture from a homogenous cultural group. The exhibition debunks several longstanding myths about the artistic heritage of this region and vastly expands the understanding of decorative arts of the area and the people who made and used them. For example, extensive research involving paint cross-sections, pigment analysis, wood identification, and reconstruction of missing elements has contributed significantly to the interpretation of this material. Important information about several groups of objects also emerged from the analysis undertaken by the Scientific Research and Analysis Laboratory, expanding our understanding of materials and techniques and answering ongoing questions about the decorative arts of the region. Specifically, according to early scholars, craftsmen producing painted Pennsylvania furniture and fraktur routinely used the homemade materials readily

available to the Pennsylvania farmer. The scientific analysis of pigments and binding media conducted at Winterthur revealed a different scenario, however, documenting the use of imported Asian and Middle Eastern materials. In essence, the scientific findings have revolutionized how current scholars interpret 18th- and 19th-century southeastern Pennsylvania folk art.

Public Programs

Winterthur provides an array of educational opportunities for children and adults through exhibitions, programs, and events that appeal to a traditional visitor as well as a diverse and intergenerational audience. Museum tours introduce visitors to American decorative arts and their social and cultural context as well as Winterthur's history and life on a large, self-sufficient estate. Special focus tour participants spend their visit with a curator or specialist concentrating on collections such as Federal-era furniture, tall case clocks, pewter, quilts or hooked rugs to understand the history, fabrication, and social and cultural contexts in which the objects were created and used. Events such as the annual Sewell C. Biggs Furniture Forum, Ceramics Conference, Winterthur Institute, and semi-annual Needlework Conference, bring together collectors, scholars, cultural heritage professionals, and members of the public who all share a common interest. School offerings include eighteen interactive, curriculum-based, and developmentally appropriate programs for nearly 10,000 students, preschool through the 12th grade, at Winterthur and in classrooms throughout the Delaware Valley.

Exhibitions often provide the inspiration for educational programming. *Betsy Ross, the Life behind the Legend*, provides a typical example. A visit to the exhibition was incorporated into several of Winterthur's most popular school programs, including *Plain and Fancy*, which explores how textiles are decorated, and *Maker and Marketplace*, which looks closely at the role of the craftsman in the early American economy. Winterthur also hosted a workshop for teachers that looked more deeply at the role of women in the early American economy, at some of the objects they produced, and at the myths associated with Betsy Ross, to help teachers find ways to incorporate the facts about her life into their classroom teaching. The *Hands on History Cart*, popular with both adults and children, helped visitors examine the skills involved in flag-making, and also enabled them to discover some of the materials used in early upholstery. Adult programming for this exhibit was also extensive and provided a lecture series by nationally-recognized scholars including: Dr. Michael Leja, Professor of American Art, University of Pennsylvania; Dr. Bruce Cole, Former President & CEO, American Revolutionary Center; and Dr. Marla Miller, Professor of History, University of Massachusetts.

For more than fifty years, school programs and teachers workshops have been at the core of children's programming with the goal of interpreting collections through enticing programs that help young visitors understand people, art, and landscapes—past and present. Winterthur offers an extensive list of school programs for a growing and diverse audience, which includes traditional school groups; childcare centers, home school groups, and involves a significant percentage of underserved children. Currently, ten of Winterthur's school programs are designed to take place onsite, the remaining eight travel to individual classrooms throughout the Delaware Valley. Workshops invite teachers to discover ways they can incorporate Winterthur's collection and history as an estate into their classroom teaching. Winterthur has partnered with the University of Delaware to provide workshops and primary source materials to teachers participating in the Historical Literacy Project. These workshops have focused on variety of

topics, including the Age of Roosevelt and the experiences of Winterthur patriarch H.A. du Pont during the Civil War.

Research and Publications

A leader in the field of object-based research and lifelong learning, Winterthur hosts unique programs that focus on developing a greater understanding of the physical nature of objects as well as the intellectual framework and methodology for using those objects as primary source material for wider historical study. Currently known as the study of material culture, this multi-disciplinary field involves curators, conservators, librarians, educators, historians, and scientists as well as scholars in fields from English literature to chemistry. Crucial to this study is the close examination of the object itself, which may include a variety of imaging and analytical techniques. When this information is combined with documentary sources, provenance, an understanding of craft practices and materials, and contemporary social and marketing norms, a complete and compelling story of an object can be told. Winterthur's extraordinary resources—its museum, library, conservation laboratories, and science facilities—uniquely complement and support one another in achieving a deeply integrated approach to the study of material culture.

Winterthur awards approximately two dozen research fellowships annually to academics, independent scholars, museum and public history professionals, and graduate students to conduct research in American cultural and social history using art and artifacts as evidence with the goal of furthering humanities scholarship. The main source fields comprise history, anthropology, archaeology, architectural history, art history; among other topics, studies have focused on artifacts in literary studies, Caribbean history, celebrations and holidays, children's literature and toys, decorative arts, family life, folklore and folklife, foodways, history of religion, history of art conservation, history of collecting and the antiques trade, historic preservation, preindustrial technology, the Shakers, theatre arts history, travel history, urban studies, and women's history.

Winterthur supports an active publications program that contributes significantly to the literature on American material culture and is an important vehicle for research undertaken at Winterthur. In addition to outside researchers, Winterthur's curatorial, conservation, and education staff is actively engaged in research and publication. For example, the aforementioned catalogue of the 2011 exhibition, *Paint, Pattern & People: Furniture of Southeastern Pennsylvania 1725-1850* (320-page, all color) contains current scholarship on the migration, community life, and distinctive furniture forms of the numerous ethnic groups living in the Pennsylvania area, and has broadened understanding of the material cultural history of this period. Additionally, the highly regarded *Winterthur Portfolio* is a quarterly journal committed to fostering knowledge of American art and material culture, published in cooperation with the University of Chicago Press.

The ability to share collections digitally is an important research and outreach tool. Winterthur recently embarked on a campaign to open its collections to visitors onsite as well as around the world through technologies that include iPod tours of exhibitions; an online catalogue of the museum collection that will be available through the website; Wintercat, the library's online catalog; and an accelerating program of digitization for library resources including the 70,000 title trade catalog collection mounted on Internet Archives. A project using KeEmu, a collection management program, has re-cataloged over 50,000 objects and added almost 100,000 images to the database; these images and the updated cataloging information will soon be available online.

Making its holdings available to the widest possible audience allows Winterthur to provide access to the wealth of information embedded in the collections.

Graduate Education

Although best known by the public for its museum and garden, Winterthur is an academic institution where the spirit of education and intellectual inquiry permeates almost every activity. Winterthur co-sponsors two complementary graduate-level programs with the University of Delaware—the Winterthur Program in American Material Culture (WPAMC), established in 1952, and the Winterthur/University of Delaware Program in Art Conservation (WUDPAC), established in 1974. These programs are unparalleled in their emphasis of object-based learning and train professionals for positions in academic and cultural heritage institutions throughout the United States, where many Winterthur alumni fill leadership positions that profoundly influence the role and study of the humanities in American culture. Some notable positions filled by program graduates include: Chairman of the American Wing and Head of Photograph Conservation, Metropolitan Museum of Art; Executive Director, Thomas Jefferson Foundation; Curator of American Decorative Arts, Philadelphia Museum of Art; Director of Collections and Head Curator, Los Angeles County Museum of Art; Director of the Strauss Conservation Center, Harvard University; Director of Conservation, MOMA; Vice President of Collections, Mount Vernon; Director of Preservation Programs, National Archives; Vice President of Research, Colonial Williamsburg; Head of Paper Conservation, Harvard Library; and Head of Paper Conservation, MFA Boston.

Current Conditions and Preservation Challenges

Winterthur's collections occupy three primary buildings—the Museum, the Galleries, and the Research Building. Although each was constructed at a different time and each has unique problems, all three are linked to the same inadequate control systems and need to be addressed as a unit. The three disparate control systems are totally obsolete or only partially supported by the manufacturer; only one allows remote monitoring and adjustment of the system.

The existing HVAC system controls and equipment were sized and designed to maintain an environment set to a very narrow range $70^{\circ}\text{F} \pm 2^{\circ}$ and $50\% \text{ RH} \pm 3\%$ —a “set it and forget it” system. This has made energy saving operational adjustments that allow significantly broader daily and seasonal ranges for temperature and relative humidity complicated, time consuming and sometime impossible for a Facilities staff with limited resources. In addition, sparse, antiquated, and poorly placed sensors in collection spaces provide inadequate and sometimes conflicting information—information critical to informing safe and effective operational adjustments.

The Museum consists of 175 period rooms and seven study/storage areas spread over nine floors of a structure built into the side of a hill; some of the rooms are below grade. The northern “T” encloses the original 1840 Greek revival structure as well as pre-1929 additions. Construction on the southern wing, about two-thirds of the building, began in 1929. An administrative and storage wing was added in 1959. The building is brick/masonry and concrete with steel beams in the 1929 and 1959 additions with a stucco exterior and tile roof throughout. The Museum has a long history of year round climate control dating from the 1960's when H.F. du Pont installed a central air conditioning system. Parts of that original system, particularly the induction units in the museum rooms, are still in service.

The museum is served by three large air handler systems responsible for all 175 rooms. Each system divides into numerous sub systems and reheat zones, but there is no map documenting the extent and location of each zone. Each air handler has only three sensors wired to the HVAC control system so a total of nine must serve all 175 rooms. Each air handler serves one vertical nine-floor zone; rooms under the eaves on the eighth floor have the same overall control as those at ground level; those with a northern exposure have the same general control as those with a southern exposure. Overlapping areas served by more than one air handler, multiple unmapped reheat zones and an inadequate number of poorly located systemic sensors make identifying and solving the causes of unacceptable temperature and humidity conditions in some museum rooms and collection storage areas a frustrating exercise in trial and error. In addition, eight collection areas in the Museum such as Curtain Storage, Needlework Study, Glass & Ceramics Study, and Memorial Library have their own separate air handlers that must be individually monitored and controlled.

Individual induction units that adjust the temperature and humidity of the air received from air handlers and reheat units are installed below almost every window in the Museum. Induction units in above grade rooms cool air and reduce RH by condensing moisture from the air into pans below each unit. Induction units in below grade areas, where there are no moisture barriers in the exterior walls, warm the air, supplying somewhat drier air to these more humid rooms. Each of these 300 units, dating from the original HVAC installation in the 1960's, has its own separate pneumatic controls that are not centrally wired and must be adjusted and calibrated individually. The pan under each above-grade unit collects the condensate from the cooling coils and allows it to drain. Corroded pans, malfunctioning units or blocked ducts can cause the pans to leak or overflow resulting in water damage that affects objects next to the window and/or window treatments and objects on the floor below. In spite of intensified maintenance efforts, these units are the single greatest internal cause of water damage in the collection. An integrated control system would significantly increase the efficiency of these units and initial assessments suggest that better controls and seasonal operational adjustments would reduce or even eliminate the need for induction units in the Museum.

The Research Building consists of the Library (three levels of reading rooms, offices, and five stack levels), Academic Programs offices, and Conservation laboratories and offices occupying the top two floors. Constructed in 1969, the building is a concrete structure with steel beams, faced with exterior stucco, and a tile and neoprene rubber roof.

The Library is served by three basement level air handlers replaced in 2003. They are not integrated into the control system for the rest of the three building complex because the existing control system was too antiquated to work with the new air handlers; they operate in a stand-alone manner with a user interface in the mechanical room. Although the air handlers and controls are relatively new (2003), system sensors and documentation of the whole system of airflow and reheat zones is inadequate. The 2003 project provided a dedicated system with a glycol chiller for the Library stacks that has lowered the temperature to $65^{\circ}\text{F} \pm 3^{\circ}$ and $40\% \text{ RH} \pm 5\%$ year round. This initiative raised the Time Weighted Preservation Index (TWPI) from 41 years to 83 years in a particularly vulnerable collection of immense research value to humanities scholars. The TWPI is a measure developed by the Image Permanence Institute (IPI) to quantify the amount of time it takes particularly vulnerable material in a collection to show signs of deterioration. During a recent visit to consult on the development of this project, Jim Reilly of

IPI suggested turning off the glycol chiller when the dew point temperature falls below 40°F, since at this dew point super cooling is not necessary to provide adequate dehumidification. This simple adjustment will save chiller/reheat costs during an estimated 35% of the year. This is precisely the type of operational modification Winterthur seeks to implement once there is an adequate control system.

Conservation is served by an air handler on the roof that shares the same issues as those in the museum—lack of documentation and inadequate controls and sensors compounded by its interface with the fume hood ventilation system. The fan coil units throughout the Research Building heat or cool and dehumidify, as necessary, the air delivered by the air handlers; they have also been a source of periodic leaks. They date to the building's construction in 1969 and, like the induction units in the Museum, periodically malfunction and create areas of excessively high or low humidity. They have highly inefficient, stand-alone pneumatic controls that are in need of repair or replacement.

The Galleries consist of 35,000 square feet of exhibition space spread over two floors. Constructed in 1991, the building is a concrete structure with steel beams, a stucco exterior, and a tile roof. It is served by three air handlers that lack variable frequency drives, and it suffers from the same obsolete controls and inadequate sensors as the Museum and Research Building. Variable frequency drives save energy by allowing the volume of air moved to match the system demand; without them, systems run at a constant speed regardless of demand. Although the Gallery is the newest and best documented of the three buildings, it suffers from some of the most unpredictable environmental swings because the open spaces and sparser array of collection materials provide less buffering and the inflexible system cannot respond readily to changing exterior conditions.

Preventive Conservation at Winterthur

As technology has advanced and use of the Museum, Galleries, and Research Building has evolved with a growing roster of educational programs, public tours, activities and events, Winterthur has consistently maintained and upgraded its environmental parameters and preventive conservation practices to meet the needs of the collection. Winterthur is a recognized leader in the field of preventive conservation and has maintained an extensive preventive conservation program for many years. It is an integral part of the conservation training program (WUDPAC) and became a recognized minor in 2002. Strategies to preserve the research value of humanities collections by slowing damage and reducing the need for treatment intervention has long been a key component of the conservation program. The institution's leadership in this area was recognized in 2003 with the Heritage Preservation/AIC Award for Outstanding Commitment to the Preservation and Care of Collections.

Using a Preventive Conservation Manual first developed in 2001 to codify policies and procedures (see Appendix), the Conservation Department takes a comprehensive approach to implementing preventive measures ranging from pest control protocols to guidelines for photography in the collection. Preventive conservation aides, who regularly monitor the environment, clean floors, dust the collection, respond to emergencies, and check for pests are valued members of the conservation team and work closely with staff in evaluating protocols and products. Conservation staff is currently engaged in a lighting survey in the Museum in preparation for a project that will upgrade the filtration capacity of all 320 windows.

Conservators, registrars, curators, and librarians jointly monitor object storage areas as well as objects on exhibition to identify housing, mount, or stabilization needs. Smoke detectors and a sprinkler system, augmented by Winterthur's on-site fire brigade, provide fire protection. The Public Safety Department provides 24/7 security including complete collection walkthroughs every few hours. An interdepartmental Collection Emergency Team is led by the Conservation Department and engages in a drill or educational session twice a year.

Environmental monitoring is the foundation for preventive conservation and planning for this implementation project. The HVAC system at Winterthur depends upon two independent but complementary monitoring systems. The first uses sensors hard wired to the current HVAC control system; the second uses portable independent monitors. As noted above, there are not enough hard-wired sensors and many are antiquated and poorly placed, but the information they provide is the primary source for adjusting the HVAC system. Data can only be stored for up to 30 days and it cannot be manipulated to explore optional settings and scenarios.

Winterthur has several decades of data from portable independent monitors, including paper charts from hygrothermographs and generations of data loggers. Winterthur served as a test site for IPI's development of its data loggers and Climate Notebook software, and this system has been extremely helpful in understanding and documenting environmental conditions in the collection. Winterthur currently has 4 PEM2 monitors, 20 Hobo U12 and U14 data loggers to monitor 175 museum/period rooms, 11 collection storage/study areas, 35,000 sq. ft. of Gallery space, five levels of Library stacks and two floors of Conservation labs. The monitors are downloaded quarterly into the online PEM data system developed by IPI and moved annually to different areas, but there are not enough units to give the staff a full picture of changing conditions or issues caused by HVAC system failures. This data is used to gain a retrospective picture of environmental conditions and to alert facilities staff to needed repairs or control corrections, but it often lags up to 2-3 months behind the onset of a problem.

To offset this time lag, a preventive conservation aid takes daily readings in 30 locations with a Traceable Hygrometer. These readings are recorded in a notebook, and the Conservation Preventive Team and facilities staff are notified whenever readings outside accepted parameters are identified. These readings provide an 11am snapshot five days a week and identify acute problems or calibration issues with the wired sensors, but they often miss trends.

Within the last decade Winterthur has moved from attempting to maintain conditions at $70^{\circ}\text{F} \pm 2^{\circ}$ and $50\% \text{ RH} \pm 3\%$ to a more flexible system reflecting current research with winter ranges of $70^{\circ}\text{F} \pm 2^{\circ}$, $40\% \pm 5\% \text{ RH}$ and summer ranges of $73^{\circ}\text{F} \pm 2^{\circ}$ and $50\% \pm 5\% \text{ RH}$. These standards were set after reviewing recent research that revealed that while objects react fairly rapidly to temperature changes, they take extended periods of time to react to changes in RH and can safely tolerate much broader environmental changes than previously thought, particularly when these changes are gradual. Current standards at Winterthur have also taken into account the variables of age and construction methods in the Museum, Galleries, and Research Building as well as the challenges of a mid-Atlantic temperate climate that is experiencing widening extremes of temperature and humidity and more frequent power outages. As such, environmental conditions are allowed to move outside these ranges during periods of extreme weather—values for winter may not fall below 60°F and $30\% \text{ RH}$ and in summer they may not rise above 80°F and $60\% \text{ RH}$.

Even with these investments in environmental controls over many years, Winterthur faces significant challenges in controlling temperature and relative humidity. Increasingly detailed and sophisticated monitoring of temperature and relative humidity at Winterthur by conservators has revealed problematic microclimates throughout collection areas and conservation labs that the current systems are unable to adequately mitigate due to antiquated and inflexible controls. A few intractable examples include (see Appendix for images):

- In curtain storage the relative humidity hovers near 70% in the summer resulting in rusty curtain hooks that can stain fabrics and contribute to an ongoing silverfish problem.
- In the adjacent rug storage room, the winter relative humidity descends to 30% and contributes to a deposit of fiber dust on the floor from the breakage of dry, brittle fibers.
- The Tappahannock and China Trade rooms in the Museum experience a winter relative humidity near 30% that has exacerbated serious deterioration of lacquered objects. Repeated trial and error efforts to lower the temperature to raise the relative humidity have been unsuccessful.
- In iron and brass metal storage and an adjacent silver display area, the relative humidity reads well over 60% from April to October creating a serious risk of corrosion.
- The second floor of the Galleries, a changing exhibit area frequent filled with loan objects, has a relative humidity that plunges to 30% during the winter and experiences highs near 70% for much of the summer. Repair of one air handler may have solved the problem, or the improved readings may be due to seasonally lower exterior humidity. Given the current system, the Facilities staff will not know if the problem is solved until next summer.
- Objects in the conservation labs are there because they are in particularly vulnerable and unstable condition—overly dry or humid environments can exacerbate problems and complicate treatment techniques that rely on a moderate environment.
- Library materials brought from very stable stack conditions to reading or workrooms are generally retrieved for use by researchers or for temporary exhibition as part of a special subject tour, educational, or public programs. Unpredictable environmental conditions place some objects, such as those with vellum bindings, at increased risk as they are handled and used.

Administrative and Intellectual Control of Collections

Winterthur's Library collections are recently inventoried, fully cataloged, and available through Wintercat, Winterthur's online catalog; online finding aids are also available for many manuscript and archives collections. The Museum is in the midst of a two-year IMLS funded inventory project for the entire collection. The collection is fully cataloged, but a current project to upgrade entries and improve intellectual control, has re-cataloged over 50,000 objects and added almost 100,000 images to the data base. These images and the updated cataloging information will soon be available online.

History of Project

Limbach Facility Services, LLC is a large specialty engineering and facilities service company with a specialization in energy solutions. Winterthur began working with Limbach as a vendor in the mid-1990's and awarded them the contract for all HVAC equipment maintenance in 2005.

Limbach has been very responsive and effective in solving HVAC problems and suggesting cost effective performance upgrades. In 2010, after checking references with other cultural institutions that used their services, Winterthur contracted with Limbach to conduct a mechanical system and energy conservation assessment. Like other institutions, Winterthur's budget has been squeezed by energy costs that have risen to over 7% of Winterthur's \$19 million operating budget. Reducing costs is complicated by the size of the 1,000 acre estate, which, in addition to the core museum complex, has over 100 structures including a train station, visitors' center, water and waste water treatment facilities, museum store, fire house, post office, barns, garages, and farm houses now used as offices or residences.

The initial report, submitted in January 2011, was reviewed by Winterthur's senior management team, and Limbach was asked to proceed to the next phase and develop a budget, implementation plan, and energy saving/payback schedule. Directors from conservation, collections, and registration requested the addition of a consultant with expertise in assessing monitoring data, collection impact, and operational system modifications and controls. Lois Olcott Price, Director of Conservation, contacted James Reilly of the Image Permanence Institute (IPI), a nonprofit, university-based laboratory devoted to preservation research with whom Winterthur has worked in the past. In the last few years IPI has partnered with Herzog/Wheeler & Associates, an energy cost management consulting firm to address the operational control and sustainability issues raised by widening environmental control ranges for collections and growing energy costs. After talking to colleagues at the Library of Congress and the Folger Shakespeare Library, who have used their services, and after reading sample reports IPI provided, they were asked to join the planning team.

James Reilly and Peter Herzog reviewed Limbach's preliminary report and five years of monitoring data Winterthur posted on PEM before they visited Winterthur for two days in June, 2011. They toured the collection areas and mechanical systems that serve them and then met with Winterthur facilities, collection, and Limbach staff. IPI/Herzog's initial findings paralleled Limbach's with an increased emphasis on operational and mechanical energy saving opportunities and added the object focus sought by the collections staff. Discussions during the visit were open, fruitful, and suggested several areas of beneficial collaboration in developing and implementing a system upgrade/energy conservation project for Winterthur that would also enhance environmental control in collection areas and potentially yield research of value to other institutions.

Limbach submitted their implementation proposal and cost estimates in August 2011 (see Appendix). Winterthur staff and IPI/Herzog reviewed the proposal and worked with Limbach to formulate an implementation schedule and funding plan. Winterthur plans to undertake **Stage I**, the major mechanical system and software upgrades, in early 2012, prior to the grant period. This \$692,813 project will result in far more efficient mechanical systems with integrated upgraded controls linked to a new unified web-based Building Automation System (BAS). These activities will lay the foundation necessary for Stage II and allow Winterthur to realize the significant energy savings and short payback times associated with these upgrades as soon as possible. **Stage II**, the subject of this proposal, will install a sophisticated sensor/control system with advanced monitoring capabilities and undertake associated mechanical upgrades. These activities require a more nuanced approach executed in phases to be effective and cannot be undertaken until major mechanical upgrades are complete.

Relationship to Strategic Plan

This project will improve preservation of the collections as mandated by the mission statement while also addressing several key components of the strategic plan (see Appendix). As an extension of Winterthur's historic environmental consciousness, this project will improve sustainability of the extensive physical plant and enhance preservation of collections—issues important to key donors and our core audience. Improvements in the physical plant and reduction of operating costs will improve financial performance and make more funds available to educational, exhibition, and collection-based activities that help grow audiences, build on excellence, and increase revenue. The innovative components of this project in environmental control and energy saving operational protocols reflect Winterthur's culture and commitment to research, leadership, and excellence.

Outcomes

This project will have two significant outcomes. The first is a major improvement in the energy efficiency and quality of the preservation environment in Winterthur's collection areas through HVAC mechanical and control upgrades. These improvements will allow the development of energy saving operational protocols that take advantage of wider preservation ranges for temperature and relative humidity, seasonal changes, and the inherent buffering capacity of buildings and collections. Winterthur anticipates annual savings estimated at \$194,350 per year, 12.7% of its current utilities costs, from mechanical upgrades to its three collection buildings. The average simple payback is estimated at 10.8 years using current energy costs. (When combined with projected savings in estate-wide, non-collection areas that are not part of this proposal, the overall project will cut energy costs by an estimated 21.7%). Significant additional savings will be realized and documented as operational protocols are implemented during Stage II of the project.

The second significant outcome is the information derived from installation of an innovative control/monitoring interface and systematic implementation of operational protocols that will benefit other cultural heritage institutions facing similar sustainability issues. The project will take advantage of IPI's launch of the new web-based eClimate Notebook, a significantly enhanced upgrade of the PEM data software, in early 2012. Working with Limbach, IPI/Herzog will create an interface between eClimate notebook and the new web-based Tridium control system that will provide integrated real time data that can be viewed simultaneously by engineers, facilities, and conservation staff. With the availability of real-time shared data, eClimate Notebook's powerful capacity to analyze data from the collection in concert with exterior weather conditions will allow the systematic implementation of operational protocols and assessment of their cost effectiveness. Over the course of a year, the project will document the effects of these operational changes during each season and determine what degree of energy/HVAC input is necessary to maintain a preservation environment; this information may allow mechanical systems to be turned back or off for significant periods of time without compromising the preservation environment. Since much of the research to date has been conducted with library and archives collections, Winterthur's experience and IPI's involvement as a consultant will expand the research to a museum environment and help inform future projects undertaken by museums. IPI will make the control/eClimate Notebook interface available to all users and Winterthur's careful documentation of the process used to develop and

document operational protocols and energy savings will be disseminated to the field through lectures, websites, and publications.

Methods and Standards

Justification and Explanation

This two stage project will focus on mechanical and control upgrades to major equipment and on installation of a new integrated web-based HVAC control system with advanced monitoring capacity that will significantly improve management of energy consumption and the preservation environment. The current inflexible HVAC system, designed to maintain narrow set specifications, does not allow the adjustments necessary to take advantage of new research broadening preservation parameters and is unable to address problematic environmental conditions in localized areas.

During **Stage I**, the pre-grant period, Limbach will make significant mechanical upgrades to air handlers, boilers and chillers including control/control logic and sensor upgrades to the equipment. They will also install a unified web-based Building Automation System (BAS) based on the open source Niagara framework product delivered by the Tridium Company and then perform control integration and systems analysis. Finally, they will conduct a detailed analysis of air handler system configurations and air flow to map the system in all three buildings. This analysis, using the upgraded Tridium control system, is necessary to fully understand the existing conditions and changes that have occurred over the many years the systems have been in service.

During **Stage II**, the subject of this proposal, IPI will install an interface to provide a live data connection between the Tridium control system and eClimate Notebook and train Winterthur and Limbach staff. Limbach will use the mapping accomplished in Stage I and the advanced monitoring and analytical capacity of the new interface to analyze and address control issues in collection spaces, including locations for additional sensors in all three buildings, and controls for the 300 Museum induction units and 80 Research Building fan coil units. They will also install variable frequency drives (VFD) on the Galleries air handlers and the Museum boiler draft inducer fan to allow better control of air flow and reduce energy consumption.

Finally, using data from the Tridium/eClimate Notebook control system, Limbach and Winterthur facilities staff, in consultation with collections staff and IPI/Herzog, will implement and test new operational protocols such as shutting down chillers during periods of moderate temperatures and low dew points when buildings are unoccupied. The addition of 20 new PEM2 monitors will allow independent monitoring of collection areas to verify the accuracy of sensor calibration and placement and to monitor areas most likely to be adversely affected by new operational protocols. This data will also be manually downloaded into the Tridium/eClimate Notebook system. The Collection Sustainability Committee, composed of Winterthur facilities and collection staff, with consultation from IPI/Herzog, will review the monitoring data and operational protocols and as they are developed and tested to insure the changes meet the goal of reducing energy consumption without compromising the preservation environment.

This scenario reflects Limbach's recommendation that Winterthur take a two-stage, carefully sequenced approach to maximize the efficiency of the HVAC systems while maintaining the preservation environment. The Stage I activities must be completed before the Stage II activities

begin. To maintain the preservation environment and assess the cost effectiveness of different operational changes, Stage II activities need to be implemented in a sequenced and carefully documented manner accompanied by rigorous assessment and review. The Tridium/eClimate Notebook control system is the critical tool that will monitor energy consumption, system performance and the preservation environment to allow the most informed and innovative decision making.

Supporting Research

Extensive planning over the last year supported by years of monitoring data, research widening acceptable environmental control parameters, and in-house experience with the buffering capacity of Winterthur's three major collection buildings informs the project design.¹ Current research, such as that now underway by IPI, *Methodologies for Sustainable HVAC Operation in Collection Environments* (2010-2013), will continue to help refine the project as Winterthur works through operational options to identify those that contribute most to energy savings without compromising the preservation environment.

Winterthur's Museum building has demonstrated its significant ability to buffer changes in the environment through two episodes. In winter of 1976-1977, Delmarva Power turned off all natural gas to non-essential institutions like Winterthur for several weeks as part of an energy emergency, depriving the entire complex of heat. Monitoring during that period showed a gradual drop in temperature without a significant change in relative humidity.

During a mild week in September 2009, Winterthur experimented with shutting down chillers and air handlers for 12 hours at night to see if the building could maintain an acceptable environment without energy input. Three storage areas and 20 rooms were monitored throughout each night by data loggers, staff, and conservation students. On average, the temperature in each rose a few degrees and the RH increased slightly above the set point, but remained within norms for each of the areas monitored. These results suggest that Winterthur could achieve significant energy savings by implementing this operational adjustment during mild weather conditions, saving an estimated \$752 nightly. An enhanced control and monitoring system will allow Winterthur to explore this and other operational options with the three collection buildings. The potential savings would be significant – for the Museum alone, if the systems can be shut down nightly for 40% of the year, the savings would be \$109,792 annually.²

Tridium/eClimate Notebook HVAC System

eClimate Notebook is a web-based, decision-making application developed expressly for preservation and climate management in libraries, archives, and museums where users can bring together temperature and RH data from real-time data sources as well as a variety of data

¹ James Reilly of IPI, Stefan Michalski of the Canadian Conservation Institute, and Rick Kerschner of Shelburne Museum have all published and lectured on the need for museums to widen their environmental parameters to improve collection preservation and make institutions more environmentally and financially sustainable.

² Rose Emily Cull, *Museum Collection Environment Parameters*, IIC, Lisbon, 2011. Rose is a recent graduate of WUDPAC who participated in this program as part of her minor in preventive conservation.

loggers. Working in parallel with the HVAC control system, eClimate Notebook analyzes the effects of observed conditions on collections. It gives fast access to graphs through a highly evolved interface, features a database-driven organizing scheme for monitored locations and the collection materials they contain, offers IPI's quantitative measures of the environment called *Preservation Metrics* and contains a notation system for incident tracking. As a secure, password-protected web application, it maximizes accessibility to the climate data for Winterthur staff and Limbach engineers. At large institutions like Winterthur, organizing and analyzing data for climate management is a major challenge, given the amount of spaces and data involved.

During planning sessions over the last few months, Limbach and IPI staff have thoroughly explored the proposed interface between the Tridium control system and eClimate Notebook. Although the proposed Tridium/Niagara Software HVAC controls would be completely independent of the eClimate Notebook web application, they would "expose" selected monitoring points from collection spaces to eClimate Notebook, where they can be graphed, analyzed, and reported on. eClimate Notebook has a variety of reports that can be generated automatically and sent via e-mail as pdf files. The new interface will allow real-time data transfer between eClimate Notebook and the Tridium/Niagara system using this feature. This capability of the Tridium/Niagara Software control system has been proven in practice and eClimate Notebook has been designed from the ground up to handle large amounts of real-time data efficiently.

Plan Components

Stage I (Pre-grant Activities funded by Winterthur)

The Stage I activities include significant mechanical and equipment control upgrades, system investigation, mapping, and installation of a Building Automation System. These activities provide the foundation for Stage II (**FIM** numbers key to specific parts of the Limbach proposal included in the Appendix):

1. Museum, Research Building (RB)—Upgrade controls for all museum air handlers and perform a detailed analysis of the system configuration and air flow paths in Museum and Library. Integrate Library air handlers into the control system. **FIM 5, 16**
2. Museum, Galleries, RB—Install a unified web-based control system based on the Niagara Framework product delivered by the Tridium Company. This system will utilize an open protocol to integrate with the existing control systems and replacement control panels. Install a wireless monitoring system from TRS Systems that will support an expanded network of sensors collecting and recording temperature and RH data in the Tridium control system. This web-based data will be accessible to Limbach engineers as well as Winterthur Facilities and Collection staff, significantly improving communication and the ability to respond promptly to problems. This open source, non-proprietary system can be upgraded and maintained by any HVAC management company should Winterthur decide to change vendors in the future. **FIM 2, 3**
3. Museum, Galleries, RB—Improve chiller efficiency by upgrading controls, control logic, and replacing/adding sensors that will allow performance tuning of the systems. Perform detailed analysis of system configuration, water flow, and system performance to identify additional opportunities to improve performance and efficiency. **FIM 14, 15**

4. Museum—Upgrade two boilers by installing new energy efficient burners with a control and management system that will improve fuel consumption, reduce emissions, and double the turn-down ratio to maintain high efficiency during low load periods. After a full season of operation and monitoring, replace, if possible, the third boiler with a small, high efficiency unit sized to handle the summer load, further reducing energy consumption by allowing a summer hiatus for the two larger boilers. Replace deteriorated condensate receiver with a new, high efficiency model coated with a thermal insulating protective finish. **FIM 8, 12**

Stage II (Grant activities funded by NEH and Winterthur)

Stage II consists of seven primary activities that affect improvements in the three collection buildings – the Museum, Galleries and Research Building (RB). These activities will significantly improve the sustainability of the preservation environment and develop energy saving protocols and innovations applicable in other institutions (**FIM** numbers key to specific parts of the Limbach proposal included in the Appendix).

1. Museum, Galleries, RB—Working with IPI, install a live data interface between the Tridium system and eClimate Notebook. Provide training to Winterthur and Limbach staff. **FIM 4**

2. Museum, Galleries, RB—Install an energy saving variable frequency drive (VFD) boiler draft inducer fan to replace the Museum’s constant volume unit. Install VFDs and new control panels/control logic systems and sensors in air handlers serving the Galleries and Conservation. With new controls in place, perform a detailed analysis of the system configuration, airflow and equipment performance in the Galleries and Conservation. **FIM 10, 13, 17**

3. Museum, RB—Improve efficiency and control in individual spaces by analyzing the air/water flow and temperature in each museum induction unit and each RB fan coil unit; specify adjustments and modifications to improve performance and efficiency. Link all induction and RB fan coil units, which currently have individual controls, to the institution wide automated control and monitoring system. These improved controls in the Museum and RB will also reduce risk to collections by reducing/eliminating the condensate that can leak from the pans under each unit. **FIM 7, 19**

4. Museum, Galleries, RB—Implement and test operational changes over the course of a year using data collected by the new Tridium/eClimate Notebook system. Data collected and analyzed in real time will allow adjustments to maintain a preservation environment while minimizing the use of the heating and cooling systems. Using experience gained, formulate operational protocols that enhance sustainability while maintaining or improving preservation conditions. **FIM 6**

5. Ten days of onsite training and consulting by James Reilly and Alex Bliss from Image Permanence Institute and Peter Herzog of Herzog/Wheeler Associates, plus 6 days of off-site consulting during the course of the project.

6. Ongoing oversight and assessment of the project by the Sustaining Collections Committee informed by Tridium/eClimate Notebook data on environmental conditions and energy consumption and by environmental monitoring in collection areas using existing equipment and 20 new PEM2 data loggers.

7. Cultural Heritage Community—Disseminate the project results through a white paper, presentations to professional groups, publications, and serve as a resource for anyone considering a similar project. IPI will make the eClimate Notebook HVAC interface available to all users.

The Collection Sustainability Committee, chaired by Lois Olcott Price, Director of Conservation and John Castle, Director of Facilities, will oversee and assess the project at each stage of its implementation. The committee includes Rob Necarsulmer, CFO, Bob McCue, Facilities Project Manager, Linda Eaton, McGraw Director of Collections, Beth Parker Miller, Registrar, Jeff Groff, Director of Public Programming and Dr. Joelle Wickens, Associate Textile Conservator and head of the Preventive Team. This committee is charged with ensuring that the project meets its goals, while continuing to protect the collections and maintain public services, humanities research, and educational programs. They will meet with engineers from Limbach as well as the energy consultants from IPI/Herzog to gather information on the project's progress and work through the inevitable scheduling, implementation, financial, and design challenges.

Collection Protection

During the project activities, collection protection will remain a high priority. Much of the activity will take place in mechanical rooms, but the Collection Sustainability Committee will work with Limbach to schedule the collection access necessary to install sensors and evaluate and modify induction units and fan coil controls. Paula DeStefano, Associate Registrar, and Matthew Stiles, Art Handler, will schedule and document object moves as necessary. Preventive conservation aids, under the supervision of Matthew Mickletz, Supervisor of Preventive Conservation, will assist Registration, as well as continue environmental monitoring activities and download portable independent monitors into the eClimate Notebook online system. Because Winterthur's three collection buildings have maintained a preservation environment for many years without damage to the building fabric, Winterthur does not anticipate any building issues.

Anticipated Results and Benefits

Winterthur anticipates that this project will significantly reduce energy consumption and improve conditions in collection areas. Installation of the new Tridium/eClimate Notebook control system with advanced monitoring capacity will allow Winterthur Facilities staff and Limbach, or any other contracted firm, to promptly identify and address systemic or local problems with environmental control, which will improve the overall preservation environment. The development of operational protocols keyed to seasonal changes, dew point, and building buffering capacity will significantly augment the energy savings achieved by mechanical upgrades alone. Limbach estimates savings from mechanical upgrades at 12.7% or almost \$200,000 per year and operational changes will significantly augment that figure. These savings not only create a more sustainable environment for the museum and library collections so critical to humanities research and programming, but allow Winterthur to increase its investment in the exhibitions, research, conservation, publications, and programming that make these collections accessible. The development of a process to test and develop operational protocols based on the best possible information and data analysis/decision making tools will be of value to many other institutions. IPI will make the web interface between environmental monitoring sensors and eClimate Notebook available to all other users.

Institutional Capacity and Ongoing Maintenance

Winterthur has adequate institutional capacity to operate and maintain its upgraded systems. The staff maintaining the HVAC system is supervised by Rick Medlock, an experienced mechanical supervisor with an HVAC license. Rick Medlock will be heavily involved in the project implementation and training from IPI and will train the two mechanics he supervises.

Winterthur intends to contract the control as well as the maintenance functions for the HVAC system to Limbach, replacing Honeywell, who currently provides a basic level control and monitoring service. Partnership with a responsive vendor and the new control and monitoring system will significantly improve communication and insure a more efficient and effective response to problems. The funded project includes training by the Image Permanence Institute staff for Winterthur and Limbach personnel to ensure that they can use the data analysis in eClimate Notebook to maximize the system's effectiveness.

Plan of Work

The goal of this plan is to improve the sustainability of the preservation environment in Winterthur's collection areas by upgrading the HVAC systems responsible for the collection environment through mechanical and operational modifications informed by a new web-based control system with advanced monitoring and analytical capacity. The project will be managed by Limbach, who has helped develop the project, and by John Castle, Director of Winterthur's Facilities Department with regular input from the Sustaining Collections Committee and consultants, IPI/Herzog. Limbach will solicit competitive bids for various components as appropriate.

January – September 2012 (pre-Award)

- FIM 2 Install BAS front-end user interface/system upgrade/power monitoring
- FIM 3 Museum & critical area monitoring system
- FIM 5 Museum air handler control upgrade and system investigation
- FIM 12 Museum condensate return tank replacement
- FIM 8 Museum boiler upgrade and control upgrade
- FIM 14 Gallery chiller plant control upgrade and performance tuning
- FIM 15 Tower Hill chiller plant (serves Museum) upgrade and performance tuning
- FIM 16 Research Building control integration and system analysis

October 2012 – March 2013

- FIM 13 Gallery air handling units VFD and control upgrade
- FIM 7 Museum induction unit mapping and control upgrade
- IPI installs eClimate Notebook interface with new Tridium/control system
- IPI/Herzog on-site consult and training
- Collection Sustainability Committee meets regularly

April 2013 – September 2013

- FIM 10 Museum boiler system draft inducer VFD
- Collection Sustainability Committee meets regularly

October 2013 – March 2014

- FIM 6 Museum air handler upgrade upgrades and corrections
- FIM 19 Research Building fan coil units control upgrade

- Research Building air handler 5 (serves Conservation) control upgrade and system analysis
- Collection Sustainability Committee meets regularly
- IPI/Herzog on-site consult

April 2014 – September 2014

- Collection Sustainability Committee meets regularly to review environmental and energy consumption data and evaluate operational changes
- Collection Sustainability Committee drafts Winterthur HVAC Operational Protocols codifying the most cost effective operational changes
- Final report and White Paper drafted for NEH
Planning and implementation of other dissemination activities

Project Results and Dissemination

Project results will benefit both Winterthur and other institutions struggling with similar sustainability issues. For Winterthur, installation of a new HVAC control system with advanced monitoring capacity and associated mechanical and equipment control upgrades will create a more sustainable preservation environment, while ensuring that damaging microclimates are remedied, and particularly vulnerable parts of the collection are exhibited or stored in areas that support their long-term preservation. Funds from significantly reduced energy costs will enhance humanities-based activities such as exhibits, collection research, conferences, school and family programming, and library acquisitions. For other institutions, development of a systematic process to evaluate energy-saving operational changes will be an important contribution. Additionally, the eClimate Notebook /HVAC control system interface, which IPI will make available to all users, is a powerful tool for organizing and evaluating this environmental and energy consumption data and the effect of operational changes on the collection environment. The interface is designed to function with the control systems commonly used by cultural institutions.

Winterthur will disseminate project results as widely as possible. The nonprofit Image Permanence Institute will feature the project on their website and disseminate the findings through the many seminars, educational programs and consultations they provide. Project results will also be posted as a white paper by NEH on their site. Winterthur's Director of Facilities, John Castle, is Vice President of the International Association of Museum Facilities Administrators (IAMFA) and has already discussed doing a joint paper and/or article with Lois Olcott Price, Director of Conservation, for this group as well as the American Institute for Conservation (AIC). They will also investigate other appropriate venues.

Winterthur's conservation graduate students in WUDPAC will be involved in the project and also serve as a key means of dissemination. As part of their graduate curriculum, both first- and second-year students undertake preventive conservation projects that contribute significantly to information about the collection environment and result in necessary improvements. During this project, they will assist with monitoring and assessment of environmental conditions and contribute to the final reports. They will take this knowledge and the methodologies into the institutions where they work after completing their degree. Students entering the program after completion of the project will learn about it as part of their training and continue to carry the information to new institutions.