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Comprehensive Preservation Environments: Site-wide Resource Management and Conservation Outcomes for ReCAP

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Abstract:

ReCAP is engaged in a multi-year project to improve its total preservation impact by providing an excellent preservation environment for library and archival collections in tandem with a reduction in total energy usage, a shift of power consumption towards sustainable sources, reduction of waste materials, and good stewardship of the land under its care. The presentation will review the outcomes of a first phase of work and the planning process underway for an ongoing program. Both efforts focus on the need for keeping costs low and predictable, and aim to achieve this through reduced peak-demand commodity power usage, solar power implementation, water management, soil remediation, and landscape management. This effort builds on the sustainable preservation environments research conducted by Image Permanence Institute and the University of Texas at Austin Gray Areas to Green Areas symposium.

Keywords: Preservation, Conservation, Storage, Sustainability, Economics

1 INTRODUCTION

ReCAP operates a preservation repository for library and archives materials. The facility follow the Harvard Depository plan, with books sorted by size for their height and width, with no more than 2” of variation between each size grouping, and then set into trays to control for their depth. Materials are then arranged on shelves of matching height, in a racking system approximately 30 feet tall. This arrangement provides a number of preservation benefits.

- Oxygen exposure is limited, so that fire ignition is highly unlikely.
- Light exposure is extremely limited.
- Security and inventory control are easily maintained and readily audited.

- Materials are physically well supported on all sides, so that large books do not deform around smaller adjacent items, a problem in stacks that are not arranged by size.
- Materials insulate one another, so that changes in the ambient environment propagate very slowly through the materials in storage.

This paper focuses on the preservation opportunities that emerge from this last item, the self-insulating profile of high density storage, to allow for reduced energy consumption together with exceptionally good preservation outcomes.

To examine the scope of this opportunity, ReCAP engaged in a series of tests and reviewed its collected environmental data to determine the effects of HVAC system shutdowns, measure the rate of environmental change between the ambient and the in-stacks environment, and to compare these results against power utilization. This work serves as the preparatory stage of a formal project to reset ReCAP's environmental management standards and establish a new site-wide master plan for HVAC operations and building design for ReCAP in the future. This process will seek to establish an optimal balance between the conservation outcomes we seek for the materials in our care, and good stewardship of the resource systems that we are depend on to provide that care long into the future.

2 LITERATURE REVIEW

The work described in this paper was conducted based on two primary bodies of research. The first is the Image Permanence Institute's work on sustainable preservation environments. The second is the collection of research presented at "Gray Areas to Green Areas," a conference hosted by the University of Texas at Austin's Kilgarlin Center, where a variety of conservators, engineers, and scientists presented work on various aspects of the problem of achieving longevity for collections while also minimizing the resource consumption required for preservation of culture heritage materials.

The Image Permanence Institute (IPI) has developed a set of metrics for evaluating preservation environments based on the science of chemical kinetics, which deals with the rates of chemical reactions. IPI's work is based upon the theory of isopermance developed by Donald Sebera, and advances this research through support from additional laboratory and field testing that have resulted in a concept of preservation metrics that ReCAP has adopted to measure the efficacy of its environmental operations.

Preservation Index (PI) and Time Weighted Preservation Index (TWPI) are the principle metrics that ReCAP uses to evaluate the preservation outcomes of its storage environments. PI indicates the "preservation quality" of an environment at a given time of measurement, to show the combined effect of temperature and RH on the decay rate of vulnerable organic materials found in library and archive collections. PI values are given in years, and we were designed so that the PI value at 68°F (20°C) and 45% RH is 50 years, to reflect the useful life of fragile materials such as acid papers when kept in those conditions.

If a storage area has a PI of 100 years, it means that collections in that storage area would require 100 years to reach a significant state of decay, compared to 50 years in storage at room temperature and moderate RH. PI values can also be used in a relative sense. If a storage condition has a PI of 200 years, then organic materials would last four times longer in that area than they would in storage where the PI is only 50 years. This relativistic use is especially important for ReCAP, because many of the materials located at our facility are well over 50 years old already and began aging in a sub-optimal environment. An improved PI multiples the remaining useful life of the collections and provides more time before items that already show significant deterioration become severely decayed or unusable.

Preservation index ratings can be helpful in planning new storage areas, but their main practical use is for calculating Time Weighted Preservation Index (TWPI) values. Because the conditions in nearly every storage environment change over time, from seasonal effects or daily operating fluctuations, TWPI is used to evaluate the ongoing effect of a series of PI measurements. If PI values are obtained at regular time intervals, a relatively simple recursive calculation is able to produce a single number that accurately expresses the average rate of deterioration for the time period. This number is the TWPI. Because it is an averaged value, TWPI can be used to compare the outcomes of various plans for managing changes in environmental conditions over time.

Of particular interest for ReCAP is using TWPI to find the optimal fit between beneficial preservation outcomes and low energy usage. For example, ReCAP seeks a TWPI of at least 150, roughly three times as beneficial as conventional human-comfortable library stacks. Annual average conditions of 55ºF (13ºC) at 35% RH yields a TWPI of 163, 60ºF (15.5ºC) at 25% RH gives a TWPI of 167, and 50ºF (10ºC) at 50% results in TWPI 158. All of these average conditions provide acceptable TWPI outcomes, but they could be achieved through a variety of HVAC designs and operating schedules for the HVAC plant.

The Gray Areas to Green Areas conference, held at the University of Texas at Austin’s Kilgarlin Center in 2007, brought together several strands of work in culture heritage preservation in search of a more comprehensive approach to preservation, focused not only on achieving good outcomes for collections in storage, but also integrating this objective into a comprehensive view of stewardship that considered the environmental impact of cultural heritage preservation effort.

James Reilly, the founder and director of IPI, presented his work on the TWPI model in a paper titled “Specifying Storage Environments in Libraries and Archives.” This work was counterpointed and enlarged on by several others. William P. Lull’s paper, “Sustainable Practices for Conservation Environments,” along with Peter L. Pfeiffer’s “Real and Relevant Green Building,” places museum energy usage in the context of physical site characteristics and site usage, including decisions about occupancy hours, the employment of other energy systems such as lighting or computers, whole-building envelope integrity, landscape design and water usage. Richard L. Kerschner’s paper, “Providing Safe and Practical Environments for Cultural Property in Historic Buildings...and Beyond” provided further examples of modified use of HVAC systems beyond the flat-line, single set point approach that was the expectation n 20th century preservation.

Michael C. Henry, in “What Will the Cultural Record Say About Us? The stewardship of culture and the mandate for environmental sustainability,” and Paul Himmelstein and Barbara Appelbaum, in “Going Green in Museums: A Conservator's View” all situate the project of creating beneficial storage environments for cultural heritage collections in the context of prevailing concerns about the overall environmental impact of human activity. Henry reviews leading indicators and major points of consensus about climate change and questions the ethics of insisting on preservation practices that require a high consumption of resources, especially fossil fuel energy that entails substantial pollution. Himmelstein and Applebaum echo these concerns and join Henry in situating art conservation within a myriad of environmental concerns, including air quality, waste management, and energy usage.

Kazuko Hioki provides a set of studies that are central to ReCAP's current direction in "From Japanese Tradition: Is *Kura* a Model for a Sustainable Preservation Environment?" Hioki reports on the buffering impact of storage enclosures used in traditional Japanese document storage practices. Hikoi shows that equilibration time for the microclimate affecting the documents in storage is significantly longer than the period of deviation from the average condition in the ambient environment. Consequently, the materials themselves experience very little of the change present in the ambient environment.

Joachim Huber's paper, "Sustainability Means Less is More," raises a series of fundamental questions for the process of transferring objects from so-called "low-tech," but stable, environments to high-tech museum environments. In the short term, Huber argues that these museum environments may be a benefit to transferred objects, as long as the technical equipment works properly and financial resources are available to run the sophisticated systems, but he raises questions about the risk of technical dependencies for these systems. Laurie Zapalac's contribution, "From Institutional Mission to Sustainable Outcome: Cultivating Stewardship Through the Planning and Design Process," provides one sort of answer to Huber's question. Zalapac presents the stewardship model for the Pioneer Museum, located in Fredericksburg, Texas, in the Gillespie County Hill Country west of Austin, and explores the interdependent and even recursive influences that site selection, resource usage, preservation practices, and curatorial goals can have on one another, and the way they intertwine with social, economic, and political factors in their locality.

3 ENVIRONMENTAL TESTS AND DATA REVIEW

ReCAP's facility has several important features that influence the obtainable environmental outcomes. The facility is designed with 12" exterior masonry walls lined with 1" closed-cell foam covered in interior metal paneling. The smaller of the seven extent modules (1 through 4) have a floor plan of approximately 14,700 square feet (1,366 square meters), and the larger modules (5, 8, and 9), have a floorplan of approximately 28,000 ft^2 (2,600 m^2). With a clear height of approximately 32 feet (10 m), this gives interior volumes of about 470,000 cubic feet (13,310 cubic meters) for the smaller modules and 864,000 ft^3 (24,465 m^3) for the larger structures. Very little air exchange occurs with the outside environment; whole building air testing of Module 9 showed only .125 cfm of air exchange. This is in range of standards such as the United Kingdom's TS-1Commercial Tight (0.14 cfm), Canada's R-2000 (0.13 cfm), and the United States' ASHRAE 90.1 Tight (0.10 cfm).

The collections themselves carry substantial environmental inertia. Standard size books weigh between 1-2 pounds, and are stored in 12" or 18" trays, averaging 12 books per tray, and 12 to 14 trays per shelf. Each aisle of shelving in ReCAP, with 250-350,000 volumes, can easily contain 250 tons of closely-packed paper. Fully loaded, the smaller modules contain about 1,500 tons of books, and the larger modules can hold nearly 4,000 tons.

Although ReCAP's facility is surrounded by a continuous exterior façade, each storage module is in fact an independent building with no shared walls, separated by an air space and fire doors to create maximum foreseeable loss zones, and each module is supplied by its own independent HVAC system. These systems were designed and built by Harris Andover, Inc., and each unit is a package system with condensers, refrigerant chilling coil, desiccant dehumidification, electric heating, and steam humidification in series, allowing precise control of both temperature and relative humidity. The original operating plan called for constant supply of conditioned air from these systems at 55ºF (13ºC) and 35% RH.

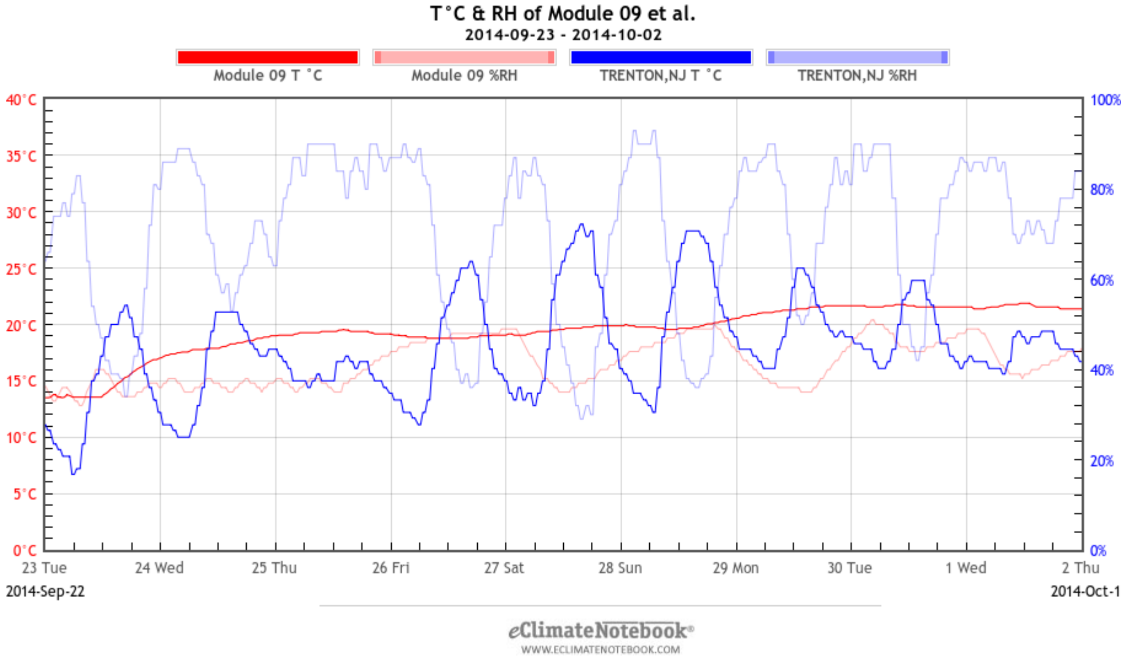
Over the past two years, ReCAP has conducted a series of simple tests and reviewed its collected environmental data to explore the potential for a more energy-efficient preservation environment plan and more sustainable power sourcing. This paper presents results from several of these tests: a long term shutdown of a vacant storage module (Module 9) that is benchmarked against an adjacent module (Module 8) of identical design; a three-day managed shutdown and progressive restart of HVAC systems in those modules during warm summer weather; and observations about the rate of environmental equilibration for materials in high density storage, based on data collected from a Preservation Environment Monitor (PEM2) placed inside a book that was moved through different environmental zones. Finally a review of power usage based on more flexible set points is given, to demonstrate the benefits realized and the potential for further cost reductions and preservation improvements possible under a more flexible environmental management plan.

3.1 Extended Shutdown of Module 9

During the majority of the past two years, Module 9 has been empty, with the first collection load-in scheduled for September 2016. We have used this period to run a comparison between Module 9 and Module 8, directly adjacent and built to identical specifications. From the date of the initial shutdown, September 24, 2014, it took approximately 4 days for the interior temperature to rise to meet the outside prevailing temperature, an approximately 4 additional days for the temperature to be in equilibrium, so that it trailed the outside temperature at a consistent pace. Throughout the next 18 months, the interior temperature trails the exterior temperature by several hours, and with enough delay that the interior temperature never fully equilibrates to the maximum or minimum outdoor conditions. During this time, very little energy was added to the storage module. The only consistent sources of heat were the motor from one air handler that was operating to provide some air exchange, and the fluorescent bulbs in the overhead safety lights.

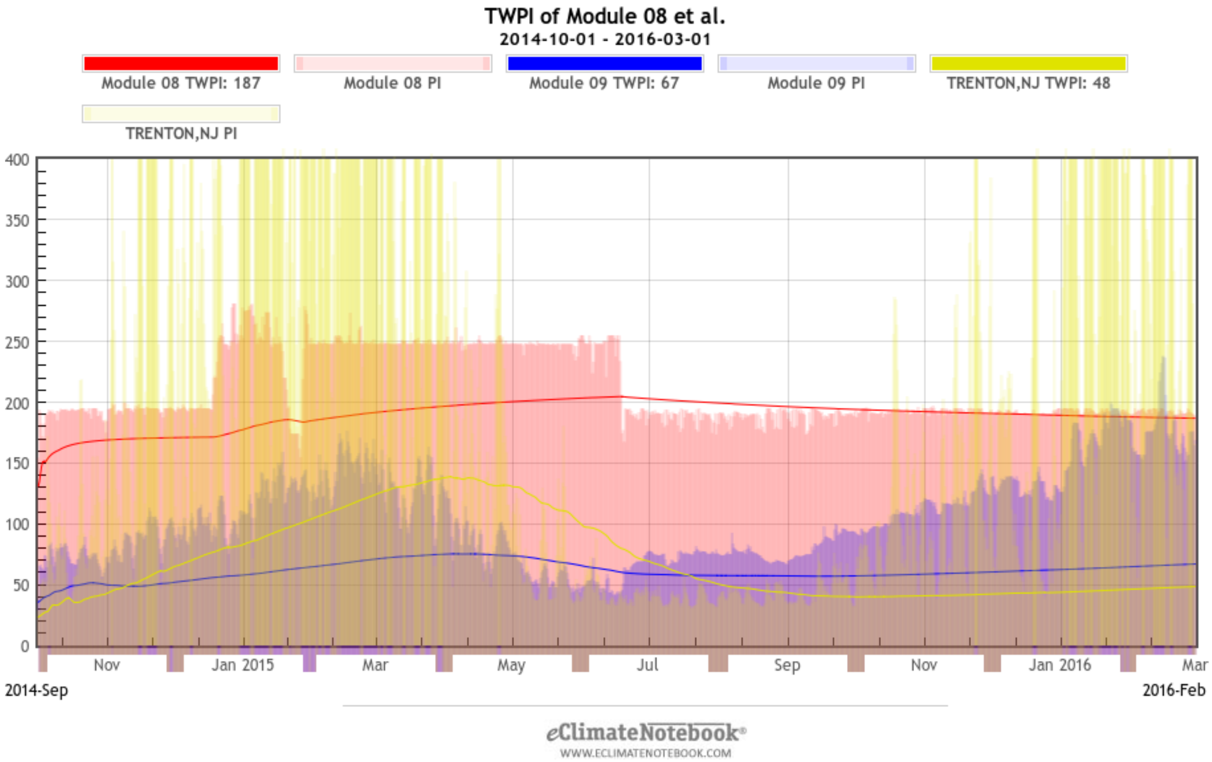
During this same period, the relative humidity makes a similar equilibration, overall, although the specific details here are worth observation. The relative humidity immediately begins to climb, but also to cycle up and down, possibly a spillover effect from the adjacent module, which is separated by a fire door that was not routinely closed during the first few days of the shutdown. The relative humidity does not show the same long cycles of change as the temperature until three to four days after shutdown, after which, isolated from Module 8, the relative humidity begins to trail the outside air conditions by a substantial amount of time and provide a fairly moderate day-to-day fluctuation in the modules.

Figure 1. Initial Equilibration of Module 9 to Prevailing Weather.



With almost no power added during the shutdown period from October 1, 2014 to March 1, 2016, Module 9 achieved a TWPI of 67, show in Figure 2. This is a significant improvement over the outdoor TWPI of 41, and better than many library stacks that are deliberately controlled for human comfort, at a TWPI of 40 to 60. With a better understanding of how temperature and humidity changes impact materials in storage, and more refined tests of the rate of equilibration between inside and outside conditions, we expect to obtain excellent preservation results for drastically lower power utilization.

Figure 1. TWPI of Modules 8, 9, and Prevailing Weather



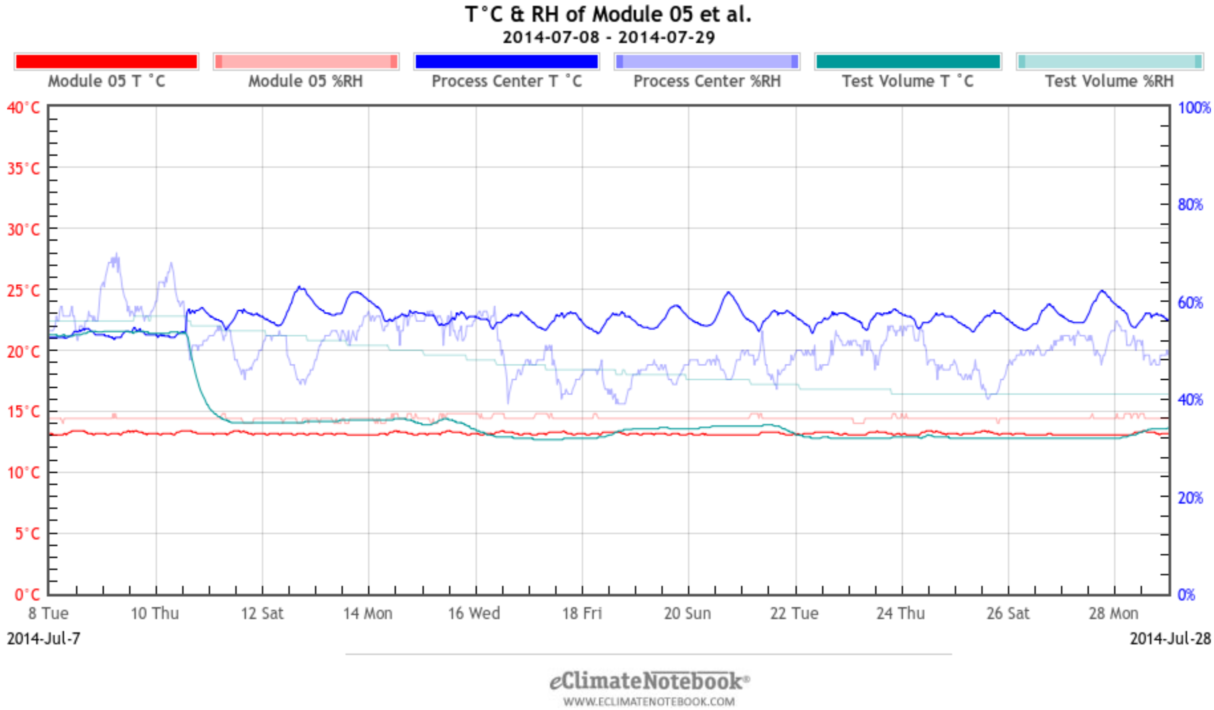
3.2 Equilibration Rates within High Density Storage

To see how the self-insulating properties of the stacks perform, we created a dummy book with a PEM2 datalogger inside. This book was inserted into the center mass of three trays of bound volumes, to provide some environmental inertia that would simulate the effect of the adjacent materials on the shelves in ReCAP. The entire assembly of trays was moved throughout various environmental zones in the facility with an adjacent PEM2 to read the ambient external conditions.

In our first test, we equilibrated the trays in the standard ReCAP storage module, before relocating them to the processing center floor, which has standard human comfortable conditions. The temperature equilibrated quickly, generally reaching ambient temperature within 24 hours, and then trailing the ambient conditions. This trailing effect is very important when we turn out attention to energy savings in high density facilities. In any particular day, despite excursions of almost 10ºF (5.6ºC) in the ambient temperature, the test volume rarely showed changes of more than 2 degrees. This suggests that there is less need for a tightly controlled ambient environment, and that a substantial amount of ambient fluctuation can occur without real impact on well-packed materials.

The insulating effect is even more pronounced on relative humidity. From the initial shift out of the module into the process center, approximately 22 days elapsed before the relative humidity equilibrated. The way that paper slowly takes in and releases moisture works to our advantage here. During the entire trial, with four shifts between the tightly controlled storage modules, the process center, and a loading dock with very little environmental control, relative humidity rarely varied by more than 1-2% within the center of the test book.

Figure 3. Equilibration of Test Volume Temp. and RH



Our next step was to relocate the materials from the process center to the storage modules, which are kept at 55F (13ºC) and 35% RH. The equilibration pattern here was similar, with the temperature changing to the new condition in approximately one day, and the relative humidity trailing by several weeks. A similar pace of equilibration was observed on the next relocation of the materials to a set of racking adjacent to a loading dock entry day. Here, the materials are exposed to a minimally controlled environment that essentially follows the outside conditions, with a barrier wall and minimal heating and cooling to avoid freezing or extreme heat. Finally, the materials have been moved from this near-exterior environment back to the storage modules. In all tests, there was a 1 to 2 day equilibration period for temperature and several weeks passed before relative humidity reached the levels of the ambient environment.

This insulating effect does not provide any significant TWPI advantage on its own. In the nine-month period from October 2015 to July 2016, the test volume was in our loading dock. The outside environment and the recorded ambient conditions from the control monitor rated a TWPI 64, while the test volume scored marginally higher at TWPI 67. There may be preservation benefits from reducing the rate of mechanical change caused by changes in the environment but for the majority of library and archives materials, paper records and paper or cloth bound volumes from the mid-20th century or later, these risks are already very small.

The real advantage is not the direct benefit of the insulation, but the flexibility for environmental management that the insulating effect enables. This flexibility creates two critical paths for success in long-term, sustainable preservation. One is the potential for sequences of operations in HVAC systems that are less dependent on constant system operation but are still optimized for excellent preservation outcomes. The other is a reduced financial cost for any particular level of preservation outcome and in a similar vein, the ability to manage costs more effectively. This makes preservation more immediately attainable, through lowering the required cost for good outcomes, and more sustainable, by making costs more predictable and containable into the future.

3.3 Shutdown and Progressive Restart of Modules 8 and 9

On July 11, 2016, ATI Inc. conducted whole building air testing of ReCAP Module 9 to evaluate the effectiveness of the module design and construction process. This test measures how well the building envelope performs as an air barrier by forcing air or out to pressurize or depressurize the building and using sensors to track the rate at which the building returns to its baseline pressurization. To conduct these tests, all doors and other openings to the outside environmental are sealed to establish the test perimeter and of course, all HVAC systems must be shot down. Module 8 also had to be shut down, separated from Module 9 at the fire door, and its egress doors opened to equalize its pressure to the surrounding environment and avoid creating an artificial pressure wall alongside Module 9.

These test conditions are a worrisome scenario in traditional preservation environmental management: a warm and humid summer day, with no HVAC operating, and outside air entering through an open door in one area and being actively forced in by the pressurizing fans in another. Although ReCAP took ample precautions to watch for potentially harmful changes and microclimates within the larger building envelope, we went into the test fairly confident that it presented no significant risk based on the observations described above about the slow rate of equilibration and the stability of conditions in the large air volume and heavily insulated perimeter of the storage modules.

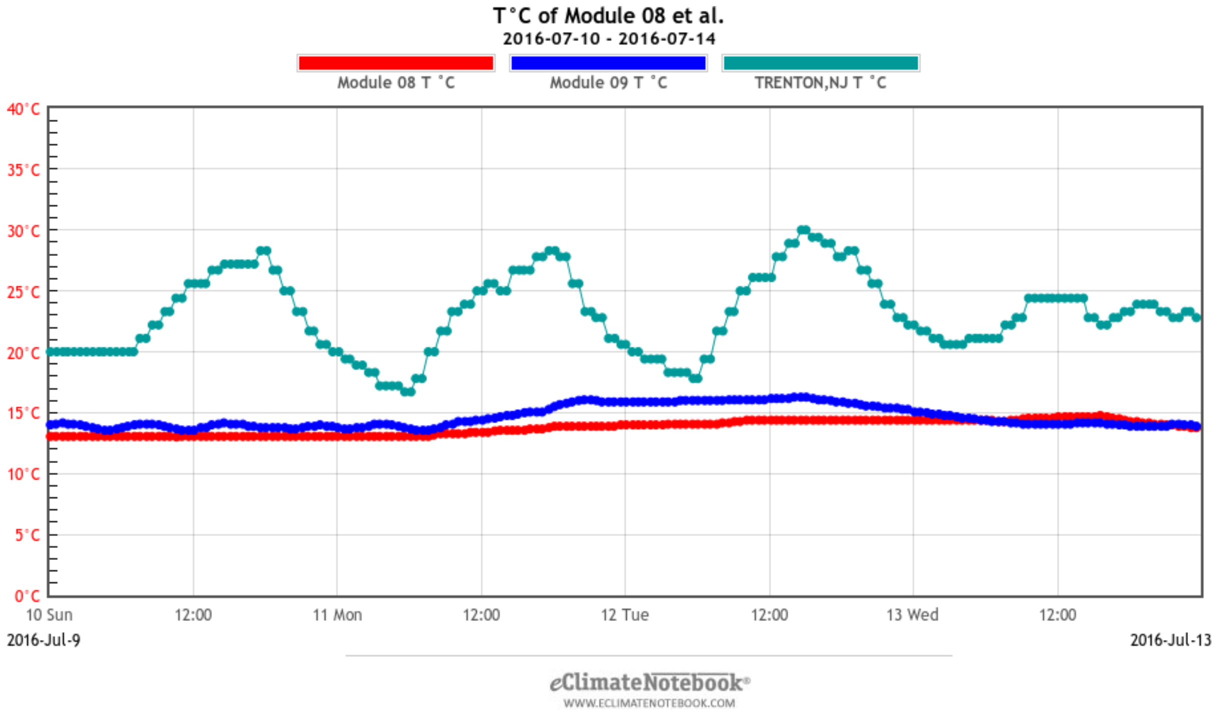
Module 8 and 9 are both large-plan modules with 12 aisles of shelving each, and they abut one another on one side with a connecting doorway between them so that they function as a continuous run of storage in normal operations. These modules each have roughly twice the interior air volume of the storage modules that are the norm in Harvard plan storage facilities in North America. Module 8 and 9 are each served by two complete HVAC systems, as described above, designated as 8a, 8b, 9a, and 9b. Unit 9b has not been in service, since that portion of the structure is not yet supplied with shelving and the in-rack ductwork the system is designed for, so current normal operations for the interior environment is conditioned by three HVAC systems, 8a, 8b, and 9a.

All systems were taken offline between 9 and 10am EST on July 11. With a mild weather forecast overnight, we decided to work into the evening to complete testing in one day and return to normal operations on July 12. The morning of Tuesday, July 12, we made an initial inspection and found a substantial amount of water around the base of unit 8b. After determining that there was no refrigerant mixed in, which would indicate a damaged coil or refrigerant leak, we concluded that the coil had iced over after shutdown and thawed overnight. The design assumes warm air is constantly passing over the coil, and the shutdown sequence should include a dry-out period. In this case, additional moisture may have been in the chamber following heavy rain and humidity over the preceding week, so that the shutdown sequence did not sufficiently dry the coil.

We took readings late in the morning of July 12 to determine if there was a pressing need for cooling, but found that temperatures had yet to rise about 60ºF (13ºC), and relative humidity was stable. (This was expected, of course, as a rise in temperature should always lower relative humidity.) We elected to leave 8a and 8b offline so they could thoroughly dry and have their drains cleaned. During the afternoon of the 12th, HVAC unit 9a was brought online to provide some cooling until 8a and 8b were restored to service the next day, July 13th, at approximately 2pm EST.

Figure 4 shows the temperature in the modules during this time, compared to outdoor conditions. As expected, the modules' temperature climbs towards the outside temperature but given the isolation provided by the facility envelope and the massive amount of air to equilibrate. During the first 12 hours, only 5ºF (2.3ºC) of change occurs inside the module while outside temperatures climbed three times as much, from 70ºF (21ºC) to 85F (29ºC). Overnight on the 12th, the outside temperature dropped into the mid-60s in degrees Fahrenheit (approximately 18ºC), low enough that the internal temperature did not climb any higher. This provides a strong indication that properly built facilities can ride out warm day time weather with little energy input and it further emphasizes the feasibility of overnight cooling to create cool/dry preservation environments efficiently.

Figure 4. Temperature of Modules 8 and 9 during shutdown, compared to outdoor conditions



A second rise in internal temperature is seen on Tuesday, July 12, as the outside temperature once again climbs over 80ºF (27ºC), but with HVAC unit 9a online, the temperature begins an immediate decline and within 12 hours it is restored to normal summer conditions at 55F (13ºC). This is already a notable result that points the way to a much more efficient sequence of HVAC operations. Using only half of the total chilling capacity of the module, and operating the HVAC in tandem with the declining afternoon temperature, we are able to restore the preservation environment within 12 hours. Extrapolating from these results, we might propose a scenario where we cool modules to 50F (10ºC) overnight in the summer, let them warm naturally into the afternoon, with solar power generation bringing online a single HVAC unit if temperatures rise above a set point, then begin cooling again in the afternoon, with solar giving way to clean and inexpensive commodity power overnight. Alternately, we might run daytime cooling off of solar power and let the modules coast during cooler evening periods. Either approach could reduce energy usage by 25-50% and require fewer working hours for the HVAC systems, extending their useful life.

4 ENERGY USAGE

Using more flexible set point and managed HVAC shutdowns has reduced our power consumption by about 10% year over year, with annual savings well over $100,000 USD for each of the past two years. During that time, our TWPI results have remained in our desired range between TWPI 160 and 180 for all of the modules, including those served by older systems that have required extensive downtime for maintenance over this same period. In fact, our ad hoc results from the various offline periods required for maintenance have provided data that support the possibility of letting adjacent modules carry one another during mild weather, in effect cutting our total system power requirements in half during certain seasons of the year.

This part of the environmental optimization project provides obvious benefit: reduced cost for the same preservation outcomes, with no added risk to the materials. To make the transition from measures that are cost effective in the present to methods that are sustainable over time, we must also evaluate the costs of purchasing power and the factors that bear on the energy marketplace. For ReCAP, this means understanding the trends in commodity power purchased from the public utility.

At present, in the United States has plentiful natural gas reserves that are derived from hydraulic fracture mining in domestic oil fields. This outcome is a local exception to the global limits on fossil fuels reserves, however, derived from a particular application of technology in North America, and its long term viability is questionable. The short term result is unusually low energy prices, but it is conceivable that when these supplies are depleted, energy prices will climb at very least, and may spike upwards at a rapid rate. Neither of these scenarios is sustainable for a long-term preservation operation.

To mitigate this, ReCAP can take some action by further optimization, but this approach has diminishing returns and a limited window of effectiveness. In response to a particularly sharp price change, for example, we could alter our TWPI goals from 180 to 120 for a one or two-year period. This would soften the price impact with little effect on the collections' health over a short period. Repetition of this strategy would eventually undermine ReCAP's value proposition, however. The virtue of a dedicated preservation repository is to gain a positive return on one-time capital expenditures so that a long run preservation outcome can be achieved at dramatically lower per-unit costs than in conventional storage. If repository conditions are too close to conventional stacks, there is little return on the capital investment and that return takes longer to accrue, harming both the financial sustainability of the preservation effort and the sustainability of the collections themselves.

Our solution is to position our operation so that it can shift to renewable energy sources over time, and in a way that gives us an exit strategy when or if commodity energy prices climb too high. ReCAP has solar panels mounted on Modules 1-5 at present and these already meet 10% of our annual power needs. Given the current low fuel prices we have not expanded our solar plant but the remainder of the facility is designed to accommodate panels, so that ReCAP can double its solar collection capacity. Upgrading to new panel designs that already give a 20% improvement in energy yield over our current photovoltaics is possible, as well, and altogether, this means that 25% of ReCAP's annual power could shift to solar with our current site plan and existing technology. With another 10-20% reduction in our power requirements through the sort of optimized sequences of operations discussed above and another modest improvement in solar generation efficiency, supplying 30 or 40% of ReCAP's energy needs from solar power is possible.

Our business model for solar power is also a part of sustainability planning. The solar array is installed and maintained by a third-part company, Energy Power Partners, so that ReCAP bears no costs for the power generation infrastructure. In return, we have a contract that specifies that we will purchase all of the power generated at a pre-determined rate over a long period, 10 years in the current version. Even if prices escalate dramatically from other energy suppliers, our pre-established solar rate provides a check on runaway costs. This is self-governing, as well, since expanding the solar plant effectively increases the margin of safety against upward price shocks.

Finally, it is important to emphasize that our interest in solar energy has an alignment with our mission that goes beyond its strategic value for cost controls. ReCAP's reason for being is preservation, and the careful management of our power usage and attention to the sources of that power are one significant area where our direct mission of preserving library and archives collections aligns with a more general commitment to good stewardship.

Solar power is most available during peak demand periods, so relying on solar helps ReCAP shift its commodity power usage towards off peak hours. Those hours are also the cleanest, since the power is derived from baseline generation plants that operate constantly and are tuned for maximum efficiency. By contrast, peak-generation plants come online intermittently and run much less efficiently. So, by purchasing commodity power in quantities that are still notable, but increasingly off-peak, ReCAP exerts market pressure towards cleaner power and away from less efficient peak demand usage.

5 OTHER RESOURCE IMPACTS

ReCAP's primary environmental impact and our major costs centers are related to energy consumption, and this is the area where the health of library and archival collections and good environmental stewardship are most directly linked. It is important, however, that we are attentive to other areas where our operation consumes resources or creates impact, so that we can be sure that our immediate dollar costs and long term economic impact are positively aligned with our mission and stewardship goals.

ReCAP is built on a site previously used as in aerospace engineering and testing. This was prior to legislation proscribing the use and disposal of a variety of industrial solvents including trichloroethylene (TCE) and tetrachloroethylene (PCE). In developing our site, we had to execute a substantial remediation plan, developed with Princeton University, to meet the standards of the New Jersey Department of Environmental Protection and the Freehold Soil Conservation District. The process used bacteria that were introduced via a molasses substrate to break down the TCE and PCE and themselves be eliminated through natural biodegradation. This project shows two ways that a building project can fulfill a beneficial role in environmental management, first taking up the responsibility to remediate the site and then by selecting sounds means to accomplish that task, in line with the preservation ethic embodied in a library and archives storage facility.

Soil remediation is a one-time project, but watershed management is an ongoing responsibility. Whenever ReCAP expands its storage infrastructure, it covers over a significant piece of land and vegetation. The resulting hardscape does not retain water from rainfall and snowmelt, resulting in new flows of runoff and higher velocity water movement, without soil or vegetation to impede the water flow. In addition, for the safety of collections, ReCAP and similar facilities are logically situated on high ground, so that water runs away from the repository. To compensate for this, ReCAP has installed a bioswale, a landscape feature that directs surface runoff through a drainage channel filled with vegetation that slows and absorbs water and traps silt and pollution before it travels to other sites. This helps to keep water in its naturally occurring zones and buffer against shocks to adjacent lands and water management systems.

ReCAP owns a substantial parcel of land as an inevitable consequence of its operational need for storage space and we have the responsibilities that come with that ownership. Above and beyond our mandated duties, we have aspired to be good neighbors and good stewards of the land in our charge. In addition to the bioswale for water management, substantial parts of the ReCAP parcel are kept as open space and have been planted with New Jersey native grasses and wildflowers. These in turn provide important habitat, including butterfly milkweed (*Asclepius tuberosa*), various coneflowers like black-eyed Susans (*Rudbeckia hirta*), and other plants to support the pollinators that are required in a healthy ecosystem.

We consider good land and site stewardship to be an obligation of a preservation repository, but it is not as easy to advance this view in in the empirical terms that we use for our energy conservation strategy. In part, this is an outcome of the way our economic and legal systems are structured. The development of fair labor laws alongside societal expectations about worker safety and happiness have given us ways to frame compassionate human resource management as a sound investment that minimizes healthcare costs or offsets training and recruitment costs for replacing employees, for example, and maintains the long-term viability and productivity of the organization. As environmental law and economics evolve, similar arguments arguments may become more obvious in the realm of natural resource management, so that we reframe good land stewardship as part of a risk mitigation strategy against adverse costs or obligations under future policies or resource constraints.

Land stewardship can also serve as an adjunct area of our work, where we may learn valuable lessons that can apply in a cross-disciplinary fashion to our core work of library and archives preservation. For one example of this, we can look to a series of oak trees on ReCAP's site. Several of these trees are suffering from bacterial leaf scorch (*Xylella fastidiosa*) and at present, they are likely to die within a few years, or perhaps a decade, a very short time relative to the tree's potential lifespan. Treatment with the antibiotic Oxytetracyclin can extend the life of these oaks somewhat, but the symptoms reappear between treatments. In several cases, ReCAP is electing to extend the life of these trees while more efficacious treatments are developed. Working with professional arborists, we have reason to believe there are antibiotics currently used in cattle that may receive approval for usage in dosages appropriate to an oak tree and prove effective.

ReCAP itself does not have a business need for a full-time arborist or soil conservation expert, nor do we even employ our own HVAC engineers. Working with an expert in an allied discipline, however, and coming to understand how other conservation-minded professionals evaluate factors of time, cost, and risk is a valuable exercise for ReCAP. An arborist evaluating how the health of one individual oak relates to the surrounding trees, flora, fauna, and site can help us learn new frameworks and test our assumptions about how we conduct our own business.

6 CONCLUSION

ReCAP's library and archival preservation goals should be the exemplars of a complete conservation ethic that pervades our enterprise. To this end, questions of how to best deploy technology to achieve an optimal balance of preservation outcomes and energy consumption are of direct and immediate interest. These technical goals can be considered as part of a strategy to gracefully fail over and scale up, so that technical systems capable of providing pinpoint environmental control work in tandem with design that moderates the impact of the prevailing environment while also guarding against the most severe threats of extreme conditions. This holistic approach to the site, facility, and systems ensures that there are many complementary paths to successful preservation. When ReCAP the site and facility are understood as technological systems focused on achieving a series of mutually supportive preservation outcomes, it is possible to see ReCAP the corporation as an economic actor of a particular type, one that is focused on stewardship rather than consumption, and on optimal scale rather than maximal growth.

Our goals for operating a sustainable shared collection share many of their framing concerns with other conservation efforts, even though we realize those objectives in a different way. In both cases, we are faced with making a transition from one economic model to another. American libraries and universities, from their inception through the end of the 20th century, have functioned in an acquisitive mode. The primary method of achieving their goal of supporting research was to get as many works as possible and co-locate them with the scholars who would use those materials to create new intellectual or creative works. This is, in its essentials, a virtuous cycle when information is scarce and scholarly attention is relatively abundant. In the late 20th and early 21st century, the balance of information availability and researcher attention began to reverse. Now, libraries are under exceptional pressure to be curatorial, selecting and presenting the optimal information resources for use by limited scholarly resources, and to be transformative, offering services that support and amplify the value of all of the resources around any given intellectual project.

In this context, there is value to be realized in shifting from an acquisitive or consumptive economy to a commons model where stewardship is the primary activity. This change alters the period or range of evaluation, so that libraries engage in activities that will yield the greatest possible utility over the longest possible time, rather than the largest quantity of resources used or acquired over the shortest possible time. Implicit in this is a shift to mutual benefit and cooperation, so as to extend the potential scope of support, and away from competition and rivalrous activity. In this, operations like ReCAP have a vital role to play as laboratories for a new mode of common pool librarianship. Because preservation repositories are anchored in a fixed, measurable, and very tangible aspect of collection management, they can prove out the financial models required in a cooperative system, teach lessons about scale and diminishing returns, and in so doing, become a cooperative resource base that will serve as a foundation for further collective action in other area of library practice.

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