

White Paper

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Title of Project: Milwaukee Public Museum Cultural Collections Master Plan

Name of Project Director: Ellen J. Censky

Name of Grantee Institution: Milwaukee Public Museum, Inc.

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Narrative Description

A. Project Activities

The Milwaukee Public Museum (MPM) received a \$40,000 NEH Sustaining Cultural Heritage Collections Planning Grant to develop a master plan for the collections stored in the basement of the museum's building. This includes the ethnology, archeology and history collections as well as non-cultural collections in of geology, botany and zoology collections. The master plan includes all collections in the basement in order to make the most efficient and effective use of all spaces. However it should be noted that the cultural collections utilize 68% of basement collection space. Hence the bulk of the master plan focuses on addressing the issues in the cultural collections. Currently, these collections are in conditions that are subpar, with temperatures that remain relatively consistent but with humidity that fluctuates daily and by season. We proposed to establish realistic environmental criteria on a room-by-room basis, determine how collections with similar needs could be co-located, and develop a program for improvements to the basement envelop based on actual environmental needs of specific co-located collections. In addition, we identified that the master plan would identify appropriate and space efficient storage units for each area – based on actual environmental needs of the specific collections. All of these requirements are consistent with the museum's Sustainability Policy and Plan. Our goal was to present a master plan that would include a five to ten year schedule for implementing the plan. We also proposed that we would have a draft of a NEH Sustaining Cultural Heritage Collections Implementation Grant proposal completed by the end of the 2016.

Our methods for developing the master plan were as follows:

1. Review past studies and changes to building envelop since the last report
2. Establish realistic environmental criteria on a room-by-room basis throughout the basement
3. Determine how collections with similar environmental needs could be co-located in the building
4. Research and determine best storage furniture for collections based on environmental needs and space
5. Develop a program for improvements to the building envelop based on the actual environmental needs of specific collections, including storage furniture
6. Analyze the actual heating, cooling and ventilation requirements throughout the basement
7. Evaluate the existing distribution system to identify ductwork modifications required to match actual individual room load requirements
8. Determine the size and quantity of air handlers necessary to support the load.
9. Develop a five-to-ten year schedule for implementing changes.
10. Draft NEH Sustaining Cultural Heritage Collections implementation grant proposal to address most immediate issue.

The Team was comprised of MPM's Registrar, Curator of Anthropology Collections and the Senior Vice President/Academic Dean as well as an Engineer from McGuire Engineers and a contract conservator. All

existing studies and documents about the museum's building envelope and collection storage, as well as the meeting agendas, were distributed to all team members prior to meeting. We had three full team meetings during the year and several one-on-one phone calls and consultations. We also had several in-house meetings to make sure that we were on track and to identify new issues that arose over the course of gathering data.

During the first meeting, we did a walkthrough of the entire basement and identified and cataloged all of the building issues that are affecting the collections. We noted the new issues that had arisen since the last study had been conducted (2001). We also assessed current HVAC and ductwork as well as reviewed all the temperature/humidity data for each of the collection spaces. In addition, we looked at spaces that are currently not used for collections but that might be used for either new HVAC systems or as swing space as needed for the project. In the second meeting, we assessed the collection storage conditions – the extent of crowding in the drawers and on the shelves, the condition of the cabinetry and the appropriateness of storage. We also looked at collections stored in other areas of the building to determine if some of them should be co-located with collections in the basement.

During the first two meetings, we established an initial task list and a schedule for completion. The first task was to identify what areas were 1) suitable with minor modifications, 2) suitable with major modifications and 3) not suitable for collection storage. These spaces were identified on a “heat map.” On a second map, we determined how much space per room was available after decommissioning spaces. These maps helped us to think about specific collections types and where they could go. The second task was to identify 1) the kinds of collection materials stored in the basement, 2) the environmental conditions needed for each of the different kinds of collection materials, 3) based on the environmental conditions, the collection materials that could be co-located together, and 4) how much space was needed for each of the collection material types. This last task included assessing the crowdedness of each collection and providing the space requirements (sq. ft.) to de-compress the collection. This was done by conducting a random review of drawers and shelves in each collection area – reviewing the contents and determining if and how much de-compressing was necessary in each collection. This was then extrapolated to the each collection space to give us an idea of what kind of space (sq. ft.) would be needed for a decompressed collection. Then we determined what kind of space (sq. ft.) these decompressed collections would need if they were put into compact storage. This gave us the total square footage for each collection area as it existed – without being co-located, but being put into compact storage.

Once we had all of these tasks done (which took the bulk of our time), we met as a team for a third time to discuss 1) best placement of collections into spaces, based on square footage of rooms and types of collections, 2) different ways to condition the spaces (based on collection type) that would be energy efficient and sustainable, and 3) the steps that would be needed to accomplish the project in 10 years (assuming all funds were available). See Appendix A for Master Plan.

The only task that we did not accomplish that we had planned to was to write a draft of the NEH Sustaining Cultural Heritage Collections implementation grant proposal. The reason we did not do this is because the very first thing that needs to be done in the collections – dealing with the mold in one of the history storage areas (BW4) -- is not covered under the NEH Sustaining Cultural Heritage Collections implementation Grant guidelines. We cannot do any other move until BW4 collections and space are cleaned and collections moved offsite. BW4 space then becomes the swing space for all other moves of collections and installation of equipment.

B. Accomplishments

We accomplished all of our goals, except the final one of preparing a draft of a proposal to NEH for implementation. We reviewed all past studies and updated our documents with the changes that had been made to the building in the intervening time between the studies. We reviewed all collections storage areas and determined the best types of materials to store together and the conditions that those materials should be stored in. We determined the amount of space and types of storage furniture that we will need for each space. We analyzed current heating, cooling and ventilation systems in the basement and determined that we should have a new, separate, energy-efficient system for collections in the basement. And we developed a 10-year plan for implementing changes. We believe our 10-year plan to improve collection conditions and storage in the MPM basement is a reasonable plan and can be accomplished with funding. We have begun conversations with a few local funding agencies and philanthropists in Milwaukee to secure funds for the first big task – assessing and cleaning collections in BW4 as well as the space.

C. Audiences – N/A

D. Evaluation – N/A

E. Continuation of Project

The plan to address all of the collection needs in the basement will take 10 years minimum when fully funded. We have defined an aggressive schedule that allows us to address some of the most pressing needs first and then proceeds based on a plan for where the objects will eventually end up – thus most objects should only have to be moved once. The plan also proceeds in a way that utilizes as little off-site storage as possible, this reducing our overall costs. This plan does not take into account the time to actually deaccession objects, should that need to be done. The plan is as follows.

Years 1-5 (steps may be done simultaneously):

1. Move typewriters offsite – these are already on rolling racks that are covered and can be moved with little work to do. This is needed as a first step because the space that the typewriters are in currently (BE2) is needed for step 2.
2. Move VZ storage (and possibly hide storage) to BE2 – this will be a permanent move.
 - Assess BE2 botany collection and cull materials (deaccession). Move rest offsite.
 - Determine storage units to be used for remaining VZ storage.
 - Install and move collections.
3. Box and move the Syrian materials (Ancient History), Glass Lantern slides and WPA paintings collection offsite
 - Box Syrian materials for offsite storage
 - Box other Ancient History materials and store for move into Anthropology space, once renovated
 - Assess lantern slide collections and dispose of most. Box rest for storage offsite.

- Box WPA paintings for offsite storage
- 4. Clean out BW4 storage
 - Determine type of mold (identified as *Cladosporium* (common mildew) in 1998.
 - Seal space
 - Understand airflow (survey tunnels/drawings)
 - Place data loggers in sealed room (see Appendix 1 for current conditions)
 - Assess collections to determine what remains part of MPM and what is deaccessioned
 - Deaccession and dispose of materials that will not remain part of MPM
 - Crate and move materials that will remain part of MPM offsite
 - Decontaminate room
 - Build walls
 - Seal floors, walls and ceiling (vapor barrier walls – this would be for all areas as part of renovation.)
 - Place data loggers
 - Install new system (Passive HVAC)
 - Monitor. Once satisfied – this space will be used as swing space

Years 6-7

- 5. Move Anthropology Collection (BC7, BE6, BE7) to BW4
 - Set up temporary shelving in BW4
 - Move collections drawer by drawer
- 6. Improve conditions in all Anthropology storage areas(BC7, BE6, BE7) and install compact storage equipment
 - Remove any pipes that are not active, if possible
 - Put drip pans under active pipes
 - Insulate ductwork and pipes
 - Seal floors, walls and ceiling (vapor barrier walls), as needed
 - Install ductwork for new HVAC system and run through hallways
 - Install compact storage units in all spaces
- 7. Move Anthropology collections back into spaces (BC7, BE6, BE7)
 - Move all anthropology collections into compact storage (except textiles that will be stored with History textiles).
 - Make sure osteology collection is separate from ethnology collection

Years 8-10 (Geology may be done at same time as BW4 storage)

- 8. Move guns to BW4
 - Use shelving that was set up for Anthropology, if possible (Now abandoned by move of Anthropology collections to new cabinetry.)
- 9. Improve gun space and install compact storage units
 - Decommission catch basin

- Seal floors, walls and ceiling (vapor barrier walls), as needed
 - Bring ductwork from HVAC through hallways
 - Install compact storage units
10. Move guns back
 11. Install compact storage in BW4
 12. Move Textiles to BW4 (including all Anthropology textiles)
 13. Move other History collections to BW4 or offsite
 14. Improve BE8 storage and install compact storage.
 15. Move some history collections back
 16. Install compactors in Geology (BC2)
 - Move geology collection to offsite storage
 - Build wall at back of room to isolate all pipes into a separate space
 - Seal floors, walls and ceiling (vapor barrier walls), as needed
 - Install compactor units in room
 - Move some of geology collections back (leave minerals offsite)

F. Long Term Impact

The MPM has one of the most significant collections of ethnographic, historic and archaeological objects in the state and the region. Addressing the storage conditions for these collections is of utmost importance. The Basement Master Plan will guide the museum over the next ten years or so to address the collection storage issues. Once the collections are in upgraded storage spaces and furniture, they will be protected for future generations and be more accessible for current generations. In addition, the HVAC system that is being proposed for collection space -- variable volume liquid desiccant dedicated outside air system (DOAS) with local cooling, heating and humidification -- will be a much more energy efficient, thus the Museum will be a more sustainable institution.

G. Grant Products

MPM Basement Master Plan (Appendix A).

Appendix

A. MPM Basement Master Plan

Milwaukee Public Museum

Basement Storage Master Plan

November, 2016

Master Plan Committee

Ellen J. Censky, PhD, Senior Vice President and Academic Dean, MPM

Claudia Jacobson, Registrar, MPM

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INTRODUCTION

The Milwaukee Public Museum (MPM) received a \$40,000 NEH Sustaining Cultural Heritage Collections Planning Grant to develop a Basement Master Plan for the collections stored in the basement of the museum's building. These include ethnology, archeology and history collections as well as non-cultural collections in geology, botany and zoology. While this master plan includes all basement collection spaces to make the most efficient and effective use of all spaces, the cultural collections utilize 68% of that collection space. Hence the bulk of the master plan focuses on addressing the issues in the cultural collections. As of 2016, these collections are in conditions that are subpar, with temperatures that remain relatively consistent but with humidity that fluctuates daily and by season. This master plan establishes realistic environmental criteria on a room-by-room basis, determines how collections with similar needs will be co-located, and provides a program for improvements to the basement envelop based on actual environmental needs of specific co-located collections. In addition, the master plan identifies appropriate and space efficient storage units for each area – based on actual environmental needs of the specific collections. All of these requirements are consistent with the museum's Sustainability Policy and Plan. The master plan also includes a five to ten year schedule for implementing the plan.

The collections are under the oversight of the Senior Vice President/Academic Dean. Each collection has a dedicated collection manager or curator who oversees the organization and access to the collection. In addition, the registrar and assistant registrar oversee metadata for collection items as well as collection policy administration. The museum currently does not have a conservator. Day-to-day conservation issues are overseen by the registrar's office.

GOALS OF THE BASEMENT MASTER PLAN

- Establish realistic environmental criteria on a room-by-room basis.
- Determine how collections with similar needs will be co-located.
- Provides a program for improvements to the basement envelop based on actual environmental needs of specific co-located collections.
- Identify appropriate and space efficient storage units for each basement area – based on actual environmental and storage needs of the specific collections.
- Provide a ten year schedule for implementing the plan.

ASSESSMENT OF CURRENT SPACE CONDITIONS

The bulk of the ethnology/archaeology and history collections are stored in the basement along with geology and some botany and vertebrate zoology collections. The basement is about 45,000 sq ft in size with approximately 12,000 sq ft of non-collection space (mechanical/electrical /maintenance). Of the remaining space, 68% is dedicated to anthropology and history storage.

The building was constructed in the early 1960s with a thin exterior shell made of concrete block without a vapor barrier or insulation. As a result, temperature and humidity conditions are subject to wide fluctuations, especially as seasons change. Uncontrolled drainage or leakage around the perimeter of the building may also adversely contribute to high humidity. Relative humidity is more variable than temperature and, in some locations, experiences frequent, short duration swings as high as 30%.

Relative humidity also exceeds 65% in some areas, which is generally considered the threshold at which mold spores become active (see Appendix 1).

When the building was constructed, pipes carrying waste water and clear water were run through many collection rooms. In addition, in the early 1990s, the museum's café was moved to a space just above one of the history storage collection areas (BE8). As a result of this move, the ceiling in history storage was penetrated in several spaces with pipes that carry kitchen waste and water supplies. The location of pipes in the museum's collection areas is problematic as they invariably leak into the collections. There is also an air intake unit in the ethnology collection area (BC7). In the fall and spring, the difference in temperature between incoming air through the unit and the room causes condensation and dripping. Other modifications to the building (communication, security, fire and electrical lines) have also penetrated walls and ceilings in the basement, causing access for moisture and water from storm events. In addition, some storage areas (geology-BC2, history-BW4) lie below large walk-in freezers. These have the potential to thaw and leak. In the past 10 years, the museum has experienced 7 major incidents of leaking pipes and floods, the most recent in November of 2014.

A Johnson Controls Metasys System controls the building's air handling systems. It monitors temperature, humidity and CO₂ and adjusts the building environment accordingly. On the upper floors, the system includes air handlers, humidifiers, variable air volume boxes and return fans. This allows for more effective monitoring of above ground spaces. Unfortunately, the unit that serves the basement is a constant-volume air handling system which currently cannot handle segregating and conditioning specific rooms.

There are two existing centrifugal chillers that generate chilled water during cooling months. They are not operational during the winter. The steam is available year around via a central municipal steam system. Currently, the condensate from the steam exchanger must be cooled before it can be flushed into the sewer system.

CURRENT COLLECTION STORAGE ASSESSMENT

Anthropology Collections

Current storage consists of bank of 12 or more frames that hold up to 20 drawers. Each drawer is oak framed with masonite bottom that measures 20" wide by 36" long and 3 5/8" deep.

A random review of drawers was undertaken, reviewing the contents and determining if the contents require decompression to provide for the long-term stability of the collections. Decompressing would include un-stacking baskets, reducing the contents due to lack of space, separation of materials or items requiring more space than the drawer provides such as clothing or items that project beyond the face of the drawer.

Ethnology Collections (BC7)

A random review of drawers in Anthropology Storage BC7 was undertaken to determine the need for decompressing collections. The review was tallied by looking at the drawers within a single vertical section of rack storage. An example of the review for a single vertical rack, capable of holding up to 20 drawers, had 10 drawers with spacing between drawers to accommodate collection items that exceeded the depth of the drawers. Seven of the drawers required decompression of collections (stacked items,

objects on top of objects or items that required more individual space for proper long-term storage. Another single rack of drawers, 8 drawers on 20 spaces per, will require 14 drawers and will go require expanding into another rack. A third rack of shelving was examined and of the 8 drawers on the 20 space rack, the collections within the 8 drawers will need 13 drawers and will move into another shelving unit. Another rack of 11 drawers will need 20 drawers to accommodate the current collections. Another rack of 8 drawers will require expansion into 12 drawers. A rack containing 6 drawers will require 14 drawers to accommodate decompressing the baskets.

Currently there are garments (hide, leather, textiles) that are folded and compressed into the existing drawers. A review of 19 drawers of garments, leggings and the like when decompressed would take up the spacing for 47 drawers. The garments should be re-housed in oversized drawer systems (compact unit) and will need to be specified with an inventory of these items in all of the locations within Anthropology storage. Anthropology needs approximately 1,050 square feet of storage dedicated to drawer, hanging, open shelving and rolled textiles on compact storage.

A number of the rows of drawers have open shelving "end caps" that contain collections. One unit containing baskets has 5 shelves, each measuring 67" long by 17" deep and there is an 18" spacing between the shelves. Decompressing the shelving unit will require an additional 3 shelves, essentially adding another 2/3rds shelving unit. The hanging rolled textiles (rugs, blankets, woven material, North America) occupy an "end cap" of a paired, (back to back) row of racks. The rolled storage may have anywhere from 2 to 6 rugs rolled one on top of the other. There are currently 10 tubes and decompressing the textiles will take as many as 12-25 tubes. The rolled storage can be stored on rigid mounts within the compact storage units. There is a collection of pow wow outfits (James Howard Collection) that is currently housed on the mezzanine of the 6th floor Anthropology lab. This collection should be housed in the ethnology collection (BC7) and will require 450 sq. feet.

Decompressing collections will result in expanding current storage and it is necessary to determine the amount of decompression to extrapolate the future space needs when re-housing the collections. The use of compact storage can increase storage capacity in a given space by up to 50%. Given the random review of existing Anthro collection storage (Ethnology 3202 sq. ft) the current back to back drawer system, the need for oversized textile storage and expanding rolled storage, it is best estimated that one third to one half more square feet would be needed **4,800 square feet (5250 with the Howard Collection)**. The compact shelving would be a mix of drawers, open shelving and one to two oversized units with drawers and open shelving as well as a section of rolled storage to accommodate rolled textiles to accommodate collections.

Archeology and Old World collections (BE7 & BE6)

The collections contained within the drawer system in these two rooms can be re-housed in compact storage within the **1124 sq feet**. Maintain relative humidity at 40%-60% with gradual seasonal swings. The small collection of copper and iron archaeological material can be re-housed into tightly closed (micro-climate) containers with internal desiccant (desiccated silica gel packets) and visual monitors (Rh indicating cards) to maintain relative humidity below 15%.

Osteology collection storage environment: Mixed material collection storage environmental recommendations would be to maintain a seasonal range of 45-55% ($\pm 5\%$) relative humidity with 40% being the low RH for winter and 60% the high for summer, with gradual seasonal changes controlled by gradual and seasonal temperature changes to mitigate quick shifts in temperature and relative humidity. Lower temperatures (60°F) are best but should not exceed 77°F. Remember that many osteological collections have been assembled using older adhesives and higher temperatures will accelerate the deterioration of the old adhesives.

Ancient History (BE1)

Pottery storage in the lower level Ancient History Storage BE1 will need **1595 sq feet** space with compact storage to accommodate the holdings. If pottery contains salts re-house in tightly closed (microclimate) containers with internal desiccant (desiccated silica gel packets) and visual monitors (RH indicating cards) to maintain relative humidity below 15%¹.

History Collections (BW4, BE3, BE8)

Basement History Storage BW4 currently contains open metal frames (old Civil Defense beds) with wood shelves. Each shelf measures 6' long by 3' wide and each shelving unit has 4 shelves. The shelving units run 7-8 in line to form a row with an aisle between. Currently the aisles are filled with larger pieces limiting access to the collections. There are two stand alone industrial dehumidifiers (STEAMATIC T-6000) in the center of the room to reduce high relative humidity in spring to early fall. The other storage within this room include oak cabinets, doors removed housing a variety of smaller items including copper alloy sculpture. The collections stored within this room should be reviewed and culled by the History staff. The collections within BW 4.2 could have a level of intervention to address issues. If collections are culled, oversized items placed into oversized storage approximately **1480 sq feet**. History Collections currently located in BW 4.2, 4.3 and 4.1 could be stored on compact storage (mixed open shelving, drawers and closed cabinets) and the typewriter collection, currently stored on covered frames on wheels that could be located (without wheels) on compact storage trolleys would require **approximately 5,632 sq feet (including oversized storage)**.

Basement History Storage BE8 contains a textile collection (costumes, uniforms, etc), historic metal items (household / decorative arts), toys, small manufacturer and business equipment, clocks and textiles. The collections are stored in metal racks with wood drawers (like Anthropology), or hanging on pegboard mounted on wall. Clothing and uniforms are stored in Delta museum cabinets. The textiles are housed in rows of Delta metal museum cabinets. Smaller clothing items are stored in acid free boxed on top of the metal cabinets. Storage space for rolled textiles, decompressing existing hanging garments and boxed textiles will require an additional 1000 square feet. The collections in museum quality cabinets could be placed on compact storage systems and will require **5,046 sq. feet**. The remainder of the collections currently stored within this room will need re-housing into compacting storage within a **4000 sq foot** space that will need to be identified.

¹ <http://resources.conservation-us.org/osg-postprints/wp-content/uploads/sites/8/2015/03/osg021-06.pdf>

The collections in the Arms Room (BE3), currently housing the firearms, edged weapons and armor are stored in oak cabinets with oak doors (locked) or oak drawers (locked) and some of the rack and wood drawer system. The oak is acidic and can damage some metals such as silver, copper, copper alloy and lead, materials that are associated with edged weapons, firearms and armor. The collection would require **1081 sq feet** if re-housed in compact storage with museum quality powder coated cabinetry (Delta Design, Viking, Spacesaver, etc.) or mobile shelving equipped for firearms with drawers and oversized items.

Summary for Anthropology and History Storage

Anthropology and History organic and composite (organic and metals) will require a total of **25,150** sq feet of storage space to accommodate collections on compact, open, drawer, closed cabinet and rolled storage systems.

Metals & archaeological ceramics with salts that need conditions of 15% humidity will need 60 square feet of space. That can be handled with specially-conditioned cabinets.

Geology Collection Storage (BC2)

Current Geology storage will require **3945 sq feet for storage**. The collections are currently housed in oak cabinetry with drawers, glass front oak cabinets and open wood cabinets with metal shelving. Collections within drawers are stored as loose items, item or items in open small boxes (not acid free), in polyethylene bags with some individual items isolated from the drawer with expanded polyethylene foam. Re-housing of collections would be into archival boxes, trays or polyethylene bags placed into archival compacting cabinetry (powder coated) metal drawers with expanded polyethylene foam, as needed. Or open shelving padded with expanded polyethylene foam for larger items. Field jacketed large-scale collections will require open storage shelving or individual rolling platforms as needed.

Botany and Zoology Storage (combined in BE2)

Botany and Zoology storage will require **1861 sq feet** for storage space using compact storage units. Botany collections are currently stored in metal cabinets. Zoology Storage (currently in BW4.4) presently consists of open wood shelving with metal framing/ supports for a variety of bone, turtle shell, skull/antler and Paleontology collections. Some taxidermy mounts are on wooden platforms (on wheels?) or wood frames/supports, skeletal material (wired together) are on expanded polyethylene sheeting directly on the concrete floor.

Invertebrate Zoology (BE5)

Invert Zoology Storage BE5 requires **1259 sq feet** of storage space. Collections are stored in older invert zoo metal faced wood cabinets, some on all metal cabinets and some items in wood insect cases on open wood and metal shelving. Installing compact storage and archival storage cabinetry would open floor space for other collections storage.

A summary of current collection spaces and future needs of collections once decompressed and

compacterized can be found in Appendix 2.

STRATEGIES TO ACHIEVE GOALS

STORAGE ENVIRONMENT

A survey of the materials in the collection determined that the bulk of the objects that are held by the museum in its anthropology and history collections are comprised of organic or mixed organic materials. Therefore most collection rooms will need to achieve the same standards. There are a few collections that would need other conditions and those could be met by using specially-conditioned cabinets. The following conditions need to be met to achieve the best practices for collection storage by type of material:

Current Average range of temperature 55°F-75°F

Current Average range of relative humidity: 15%-70%

Best Practice for mixed collections: Mixed organic material collection storage environmental recommendations would be to maintain a seasonal range of 40-60% relative humidity with 40% being the low RH for winter and 60% the high for summer, with gradual seasonal changes controlled by gradual and seasonal temperature changes to mitigate quick shifts in temperature and relative humidity.

Metals and ceramics that contain chlorides: Maintain a relative humidity below 15%.

All glass: 40-55 % RH or 45 % +/- 5 % (NOT above 55%!).

Temp: 50-75 (can even be wider, so long as it doesn't compromise RH. Open storage/ air movement.)*

Crizzling glass: 40-45% RH. + air movement (fans, if necessary).*

Light levels are generally irrelevant, except for adhesive repairs and contemporary glasses with modern media.

Paintings: Maintaining relative humidity between 40-60% year round is most important but not too cold for acrylics. Low temperature at 35° F can adversely affect acrylic paintings and no painting should be allowed to go to such low temperature.

Compact Storage: All compacting storage will have archival gaskets (silicone) to limit access of dust and reduce fluctuations of temperature and relative humidity. Cabinetry, drawers and open shelving will be powder coated and free of off gassing materials.

BUILDING MODIFICATIONS

An assessment was completed on the basement to determine the spaces best and least suited for collections areas. Spaces were rated on as follows: promising, less than ideal, compromised, and not applicable (Appendix 3). Then, the collection assessment was over-laid onto the building assessment to

determine where collections would ultimately be stored (Appendix 4). Finally, a scope of work was developed for each of the proposed collections spaces (Appendix 5).

In general, building spaces that will house collections will be modified as follows:

1. HVAC will be added to individually control the temperature and relative humidity in each space.
2. In some spaces, interior walls will be added to isolate one space from another. The walls will go from floor to deck and will be sealed with vapor barrier paint.
3. Exterior walls will be sealed with vapor barrier paint.
4. Where possible, a vestibule will separate the conditioned spaces from un-conditioned spaces.
5. Piping and ductwork unrelated to the spaces will be removed or provisions made to prevent damage to collections.
6. There is an existing underground tunnel that will need to be sealed where it communicates with collection storage spaces.
7. An existing underground settling basin under the armory storage will be decommissioned and sealed, if possible. We are still trying to determine what feeds into and out of the basin.
8. Some areas will be abandoned because the risk to collections cannot be easily mitigated.

ENVIRONMENTAL SYSTEM SCOPE

The environmental system will be responsible for maintaining temperature, relative humidity, and air filtration. There are several factors considered for the HVAC system. They are:

1. Cooling is not available year around. Therefore, dehumidification and cooling must be from an independent source other than the existing chiller.
2. A small amount of outside air will be introduced to reduce the building up of volatile organic compounds (VOC's) and to pressurize the spaces relative to non-artifact spaces. This will help reduce infiltration of air and moisture.
3. The cooling, heating, humidification and dehumidification must be simple to operate and maintain. It also should use the least amount of energy possible while maintaining temperature and relative humidity year around.

Each space will have slightly different criteria, but in general, the environmental and design criteria are as follows:

1. Duration of Storage: Long (50+ years)
2. Frequency of Access: Often
3. Public Access: Limited to none
4. Temperature: 70°F +/-2°F
5. Relative Humidity: 40% to 60%, +/- 5% in 24 hour period
6. Particulate Filtration: Minimum MERV 14 per ASHRAE 52.2
7. Gaseous Filtration²: Limits of SO₂, 1 part per billion (ppb)

²² Air Pollutant Limits, Appendix B, NARA 157`

NO2, 2.6 ppb
 O3, 2 ppb
 Formaldehyde, 4 ppb
 Acetic acid, 4 ppb
 8. Air Flow Rate: 8 changes per hour

The HVAC system considered will be a variable volume liquid desiccant dedicated outside air system (DOAS) with local cooling, heating and humidification (Figure 1). The local system will be a variable refrigerant flow (VRF) which will have simultaneous cooling and heating capabilities (Figure 2). The liquid desiccant DOAS will supply air at 56°F at 14 grains per pound of dry air. Each space will have a dedicated variable air volume (VAV) box that will operate to maintain each space’s maximum relative humidity. A local humidifier will supply moisture to the space to maintain the minimum relative humidity. Ducted VRF fan coils will operate to maintain the space temperature.

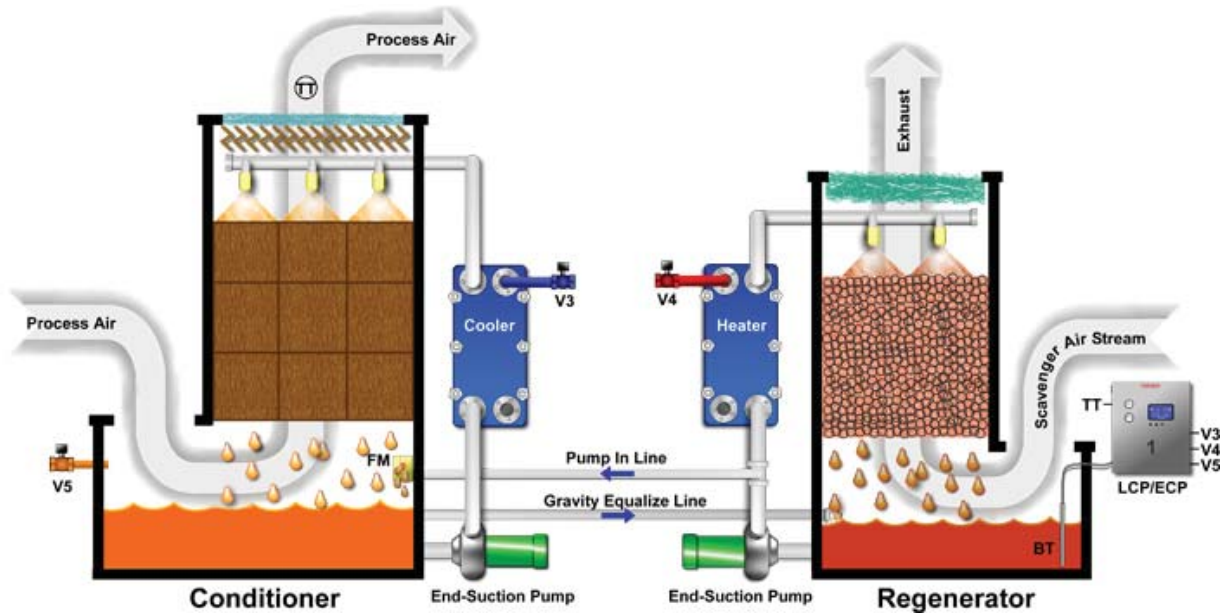


Figure 1 - Liquid Desiccant

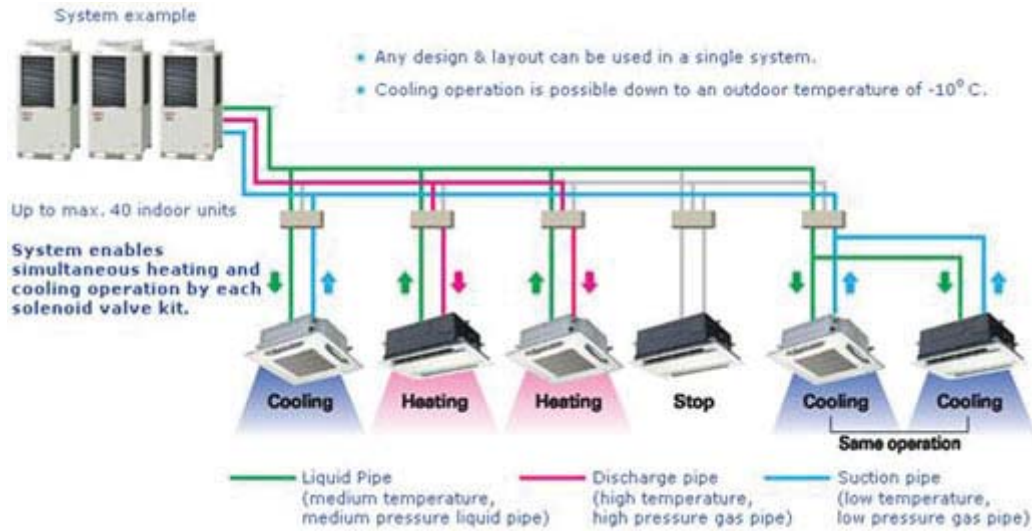


Figure 2 - Variable Refrigerant Flow (VRF)

Liquid desiccant is being considered because it uses less energy than cooling and heating, a typical dehumidification cycle. VRF is also a good candidate for heating and cooling because of its heat recovery capabilities. Additionally, the systems can operate at low speeds, saving fan energy.

Humidification will be accomplished either with the district steam or with local distributed humidifiers. Potential humidifier types include immersion heater or ultrasonic.

Particulate filtration will be accomplished with MERV 14 high efficiency cartridge filter. There are several options for gaseous filtration. The first is to use absorbent media, like activated carbon, and/or chemical filtration, like potassium permanganate.



Figure 3 - Chemical Filtration

The system diagram would be as follows:

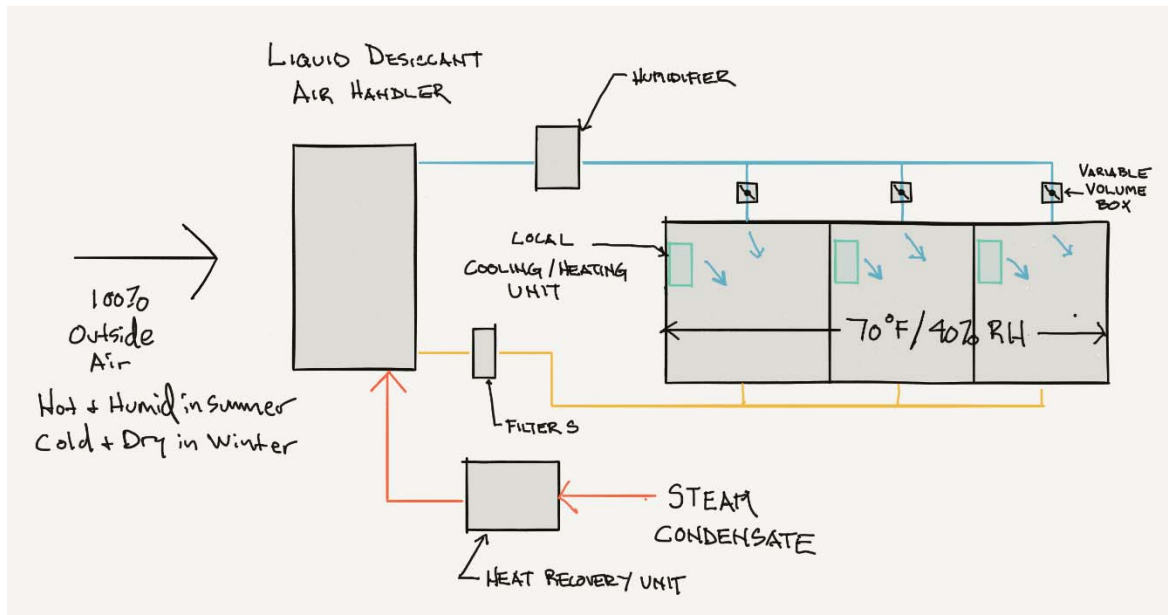


Figure 4 - System Diagram

STORAGE EQUIPMENT SCOPE

Storage of collections will fall into the following systems:

- Mobile compact metal storage shelving with silicone gaskets to seal out dust.
- All compact storage will be manually operated **not** electric.

General collections:

Mobile metal shelving, lined with expanded polyethylene foam or irradiated cross-linked foam (Volara) to isolate and cushion collections from metal shelving.

Open shelving – varying lengths and heights based on collection item sizes for baskets, pottery, decorative arts (using rings or custom made backer rod / tri rod rings) & drawer systems (varying depth of drawers) to accommodate smaller items isolated from one another using acid free boxes, trays or acid free corrugated board dividers.







Some History objects are currently stored in museum grade metal cabinetry while others are housed in acidic oak shelving. The cabinetry can be placed on compactor storage frames to gain floor space and reduce aisles. Collections within the cabinets may need rehousing, isolating pieces from one another using acid free corrugated board or Volara. Expanding open shelving and metal drawer systems on compactor shelving will be needed to rehouse the collections (Anthropology and History) currently stored in oak drawers.

Textiles that can be rolled will go onto acid free tubes (varying diameters), Volara, interleaved with acid free tissue or washed muslin and covered with clear polyester (Mylar) secured in place with cotton twill tape and housed on compactor units.



Smaller textiles can be stored on open shelving if housed in acid-free boxes and stacked or stored in draw systems on compactor shelving.



Costumes and associated materials in the History collection have been stored within museum grade metal cabinetry (Delta). The cabinets can be placed on compactor frames to allow compression of these collections and gain storage floor space. Expansion of this system and cabinetry with drawers and open shelving will provide storage for Anthropology textiles and costumes.



Oversized pieces such as furniture can be stored on open shelving protected by expanded polyethylene foam or irradiated cross-linked foam (Volara) to isolate and cushion collections from metal shelving.



Oversized, heavy pieces may be stored on fixed open shelving designed for excessive weight loads:



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Oversized pieces may need individual, custom crating or moving systems for storage, here is an example of a good system:



The storage of human osteology (Archaeology) best practice is isolating bone elements from one another using irradiated crossed linked expanded foam (Volara). Store on compacter shelving closed cabinetry with drawers.

Current storage



Best practice:





The storage of archaeological copper alloy or iron with chlorides, current storage



Best practice would be to rehouse the bagged items in acid free boxes into tight fitting poly containers with desiccated silica gel and a RH strip:



The rehousing items can be placed on shelving within compactor units to allow visual access to maintain the passive micro climates keeping the collections at or below 15% relative humidity.

Firearms are currently stored within oak cabinets or outside of cabinetry:



Best practice would be to rehouse the collection on closed compactor storage with padded supports and smaller items housed in metal drawers:



TEN YEAR

IMPLEMENTATION PLAN

The plan to address all of the collection needs in the basement will take 10 years minimum when fully funded. We have defined an aggressive schedule that allows us to address some of the most pressing needs first and then proceeds based on a plan for where the objects will eventually end up – thus most objects should only have to be moved once. The plan also proceeds in a way that utilizes as little off-site storage as possible, this reducing our overall costs. This plan does not take into account the time to actually deaccession objects. The plan is as follows.

Years 1-5 (steps may be done simultaneously):

1. Move typewriters offsite – these are already on rolling racks that are covered and can be moved with little work to do. This is needed as a first step because the space that the typewriters are in currently (BE2) is needed for step 2.
2. Move VZ storage (and possibly hide storage) to BE2 – this will be a permanent move.
 - Assess BE2 botany collection and cull materials (deaccession). Move rest offsite.
 - Determine storage units to be used for remaining VZ storage.
 - Install and move collections.
3. Box and move the Syrian materials (Ancient History), Glass Lantern slides and WPA paintings collection offsite
 - Box Syrian materials for offsite storage
 - Box other Ancient History materials and store for move into Anthropology space, once renovated
 - Assess lantern slide collections and dispose of most. Box rest for storage offsite.
 - Box WPA paintings for offsite storage
4. Clean out CD storage
 - Determine type of mold (identified as *Cladosporium* (common mildew) in 1998.
 - Seal space
 - Understand airflow (survey tunnels/drawings)
 - Place data loggers in sealed room (see Appendix 1 for current conditions)
 - Assess collections to determine what remains part of MPM and what is deaccessioned
 - Deaccession and dispose of materials that will not remain part of MPM
 - Crate and move materials that will remain part of MPM offsite
 - Decontaminate room
 - Build walls
 - Seal floors, walls and ceiling (vapor barrier walls – this would be for all areas as part of renovation.)
 - Place data loggers
 - Install new system (Passive HVAC)
 - Monitor. Once satisfied – this space will be used as swing space

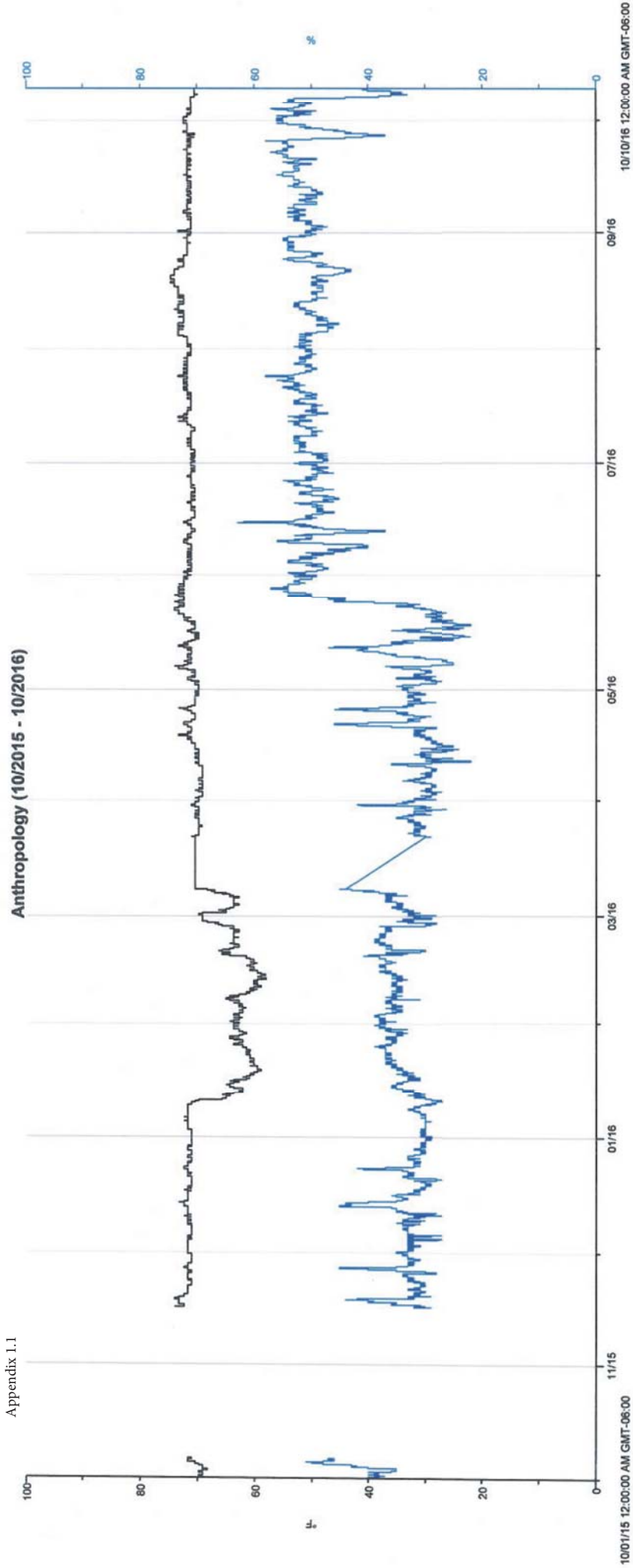
Years 6-7

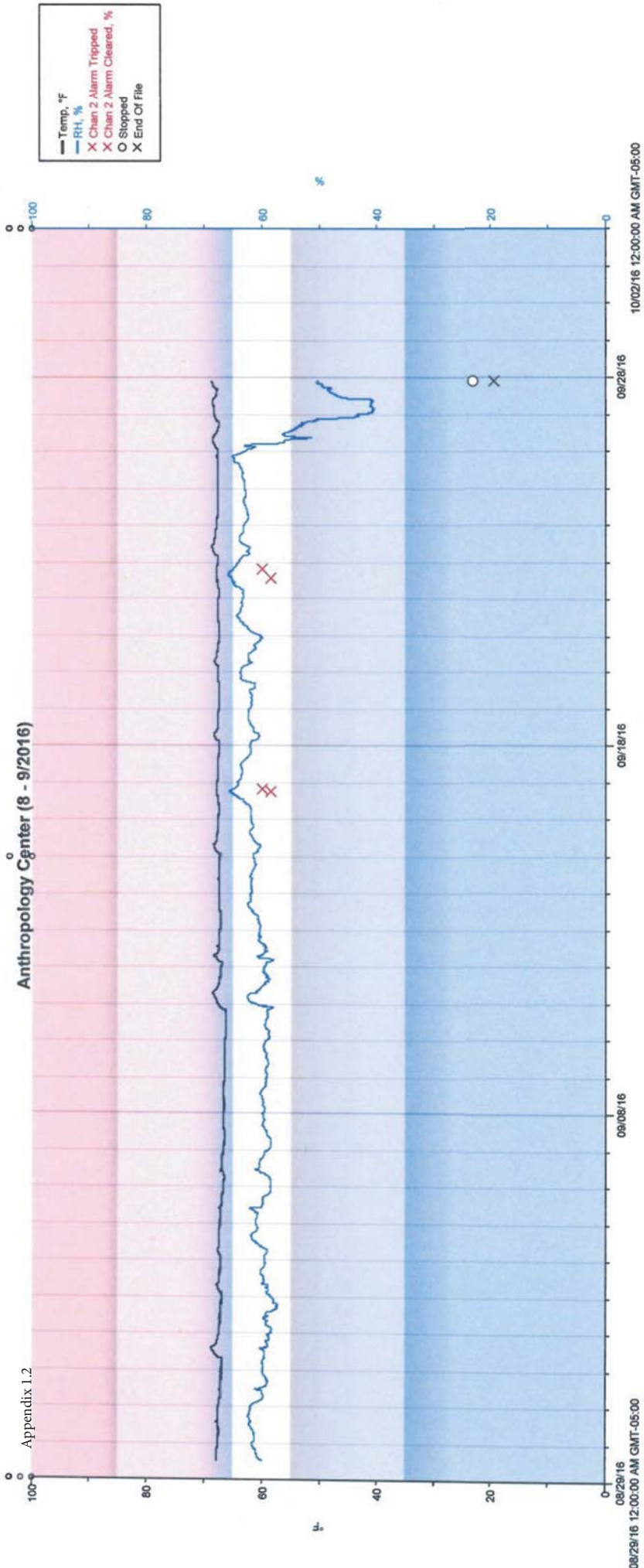
5. Move Anthropology Collection (BC7, BE6, BE7) to BW4
 - Set up temporary shelving in BW4
 - Move collections drawer by drawer
6. Improve conditions in all Anthropology storage areas(BC7, BE6, BE7) and install compact storage equipment
 - Remove any pipes that are not active, if possible
 - Put drip pans under active pipes
 - Insulate ductwork and pipes
 - Seal floors, walls and ceiling (vapor barrier walls), as needed
 - Install ductwork for new HVAC system and run through hallways
 - Install compact storage units in all spaces
7. Move Anthropology collections back into spaces (BC7, BE6, BE7)
 - Move all anthropology collections into compact storage (except textiles that will be stored with History textiles).
 - Make sure osteology collection is separate from ethnology collection

Years 8-10 (Geology may be done at same time as BW4 storage)

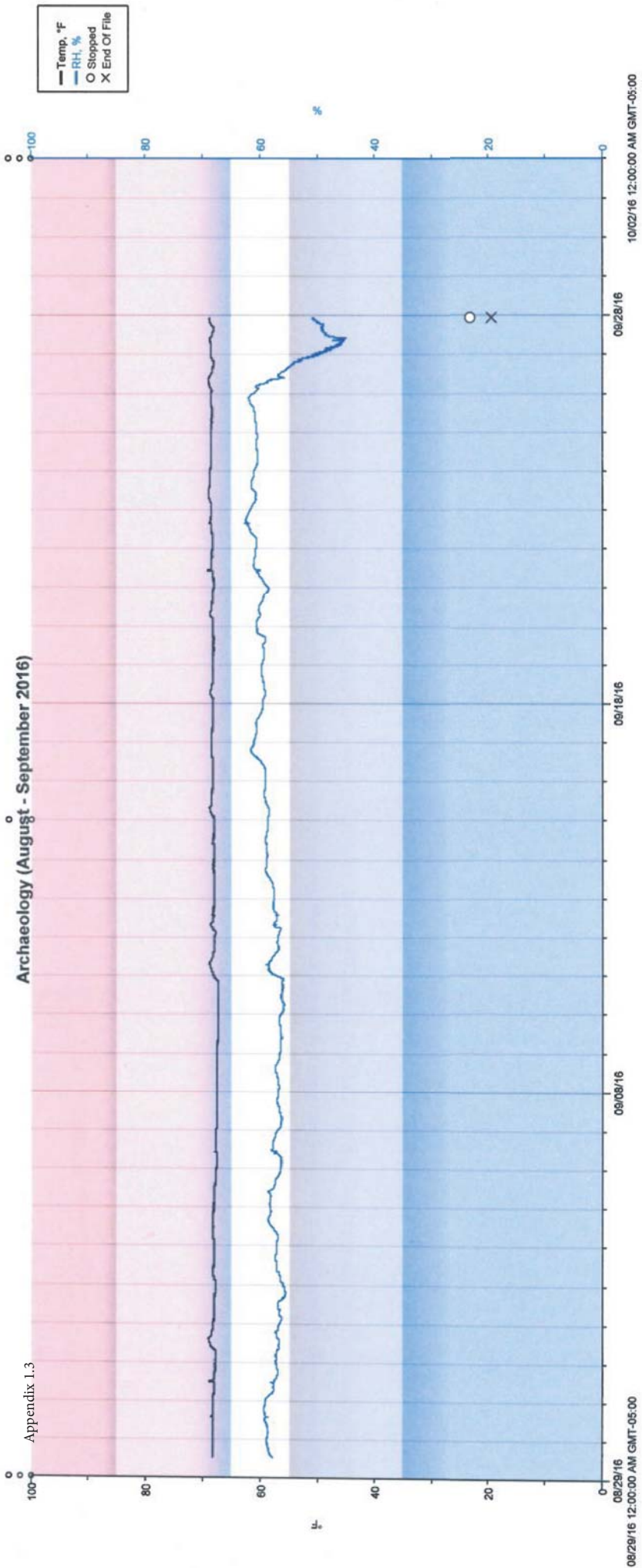
8. Move guns to BW4
 - Use shelving that was set up for Anthropology, if possible (Now abandoned by move of Anthro collections to new cabinetry.)
9. Improve gun space and install compact storage units
 - Decommission catch basin
 - Seal floors, walls and ceiling (vapor barrier walls), as needed
 - Bring ductwork from HVAC through hallways
 - Install compact storage units
10. Move guns back
11. Install compact storage in BW4
12. Move Textiles to BW4 (including all Anthropology textiles)
13. Move other History collections to BW4 or offsite
14. Improve BE8 storage and install compact storage.
15. Move some history collections back
16. Install compactors in Geology (BC2)
 - Move geology collection to offsite storage
 - Build wall at back of room to isolate all pipes into a separate space
 - Seal floors, walls and ceiling (vapor barrier walls), as needed
 - Install compactor units in room
 - Move some of geology collections back (leave minerals offsite)

Appendix I.1



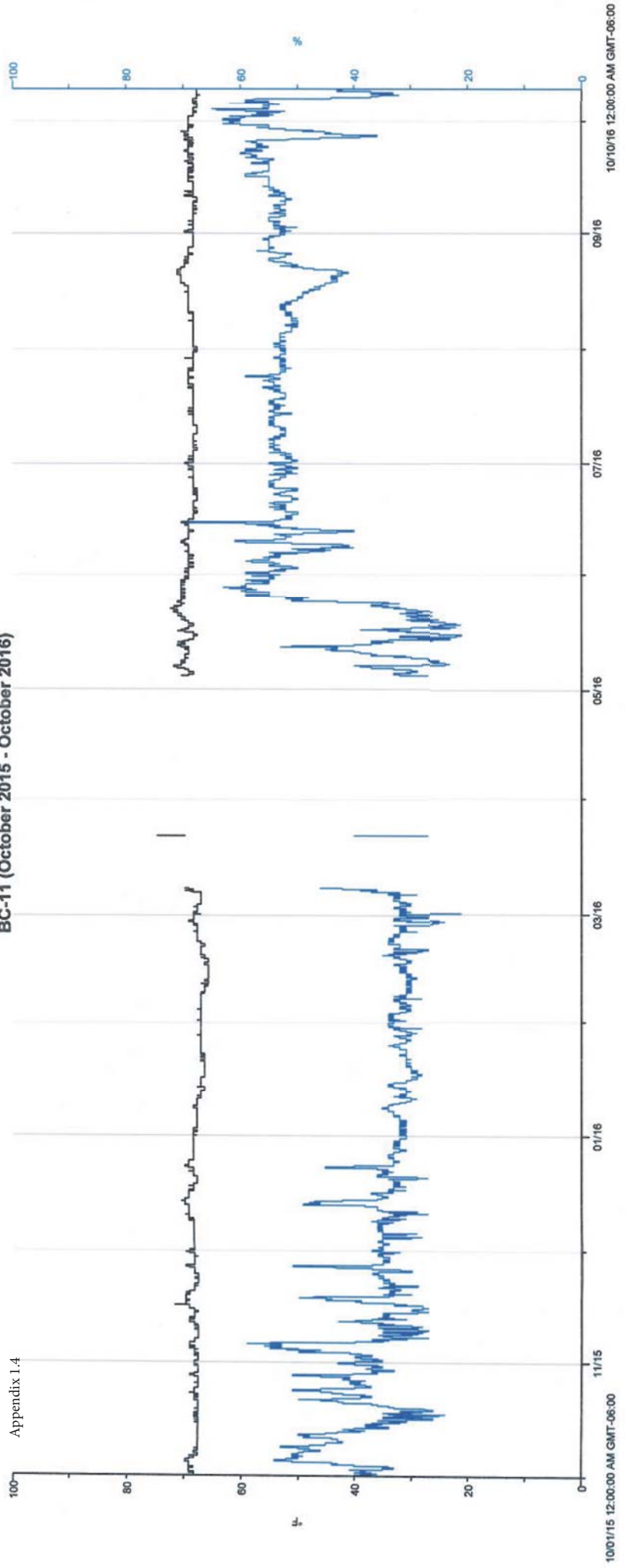


Appendix 1.2



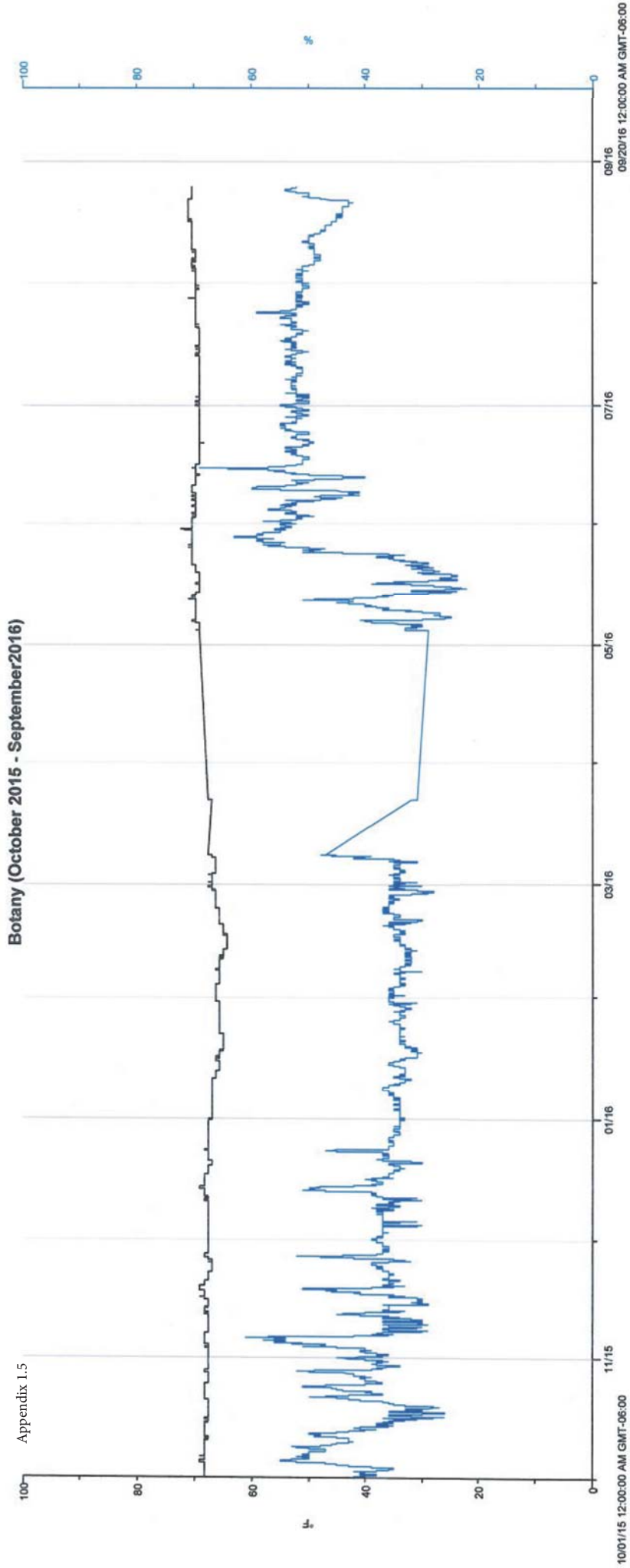
Appendix 1.3

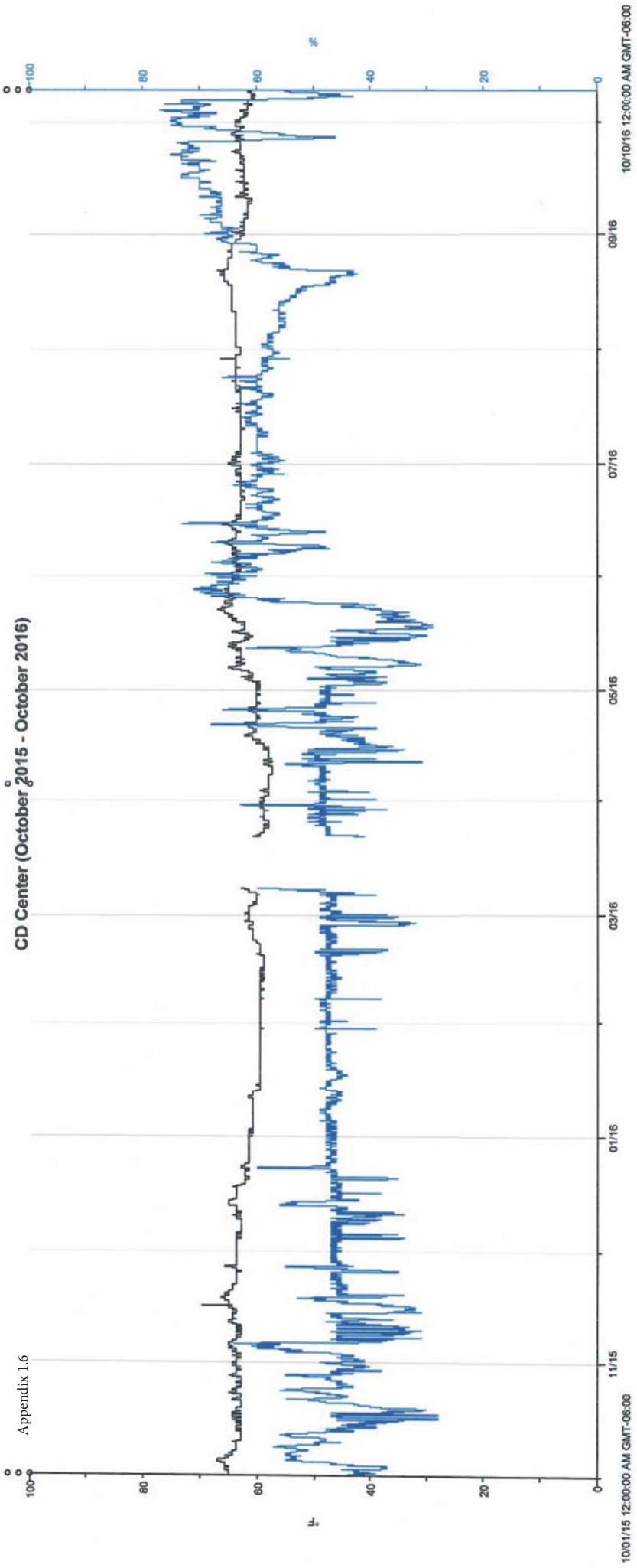
BC-11 (October 2015 - October 2016)



Appendix 1.4

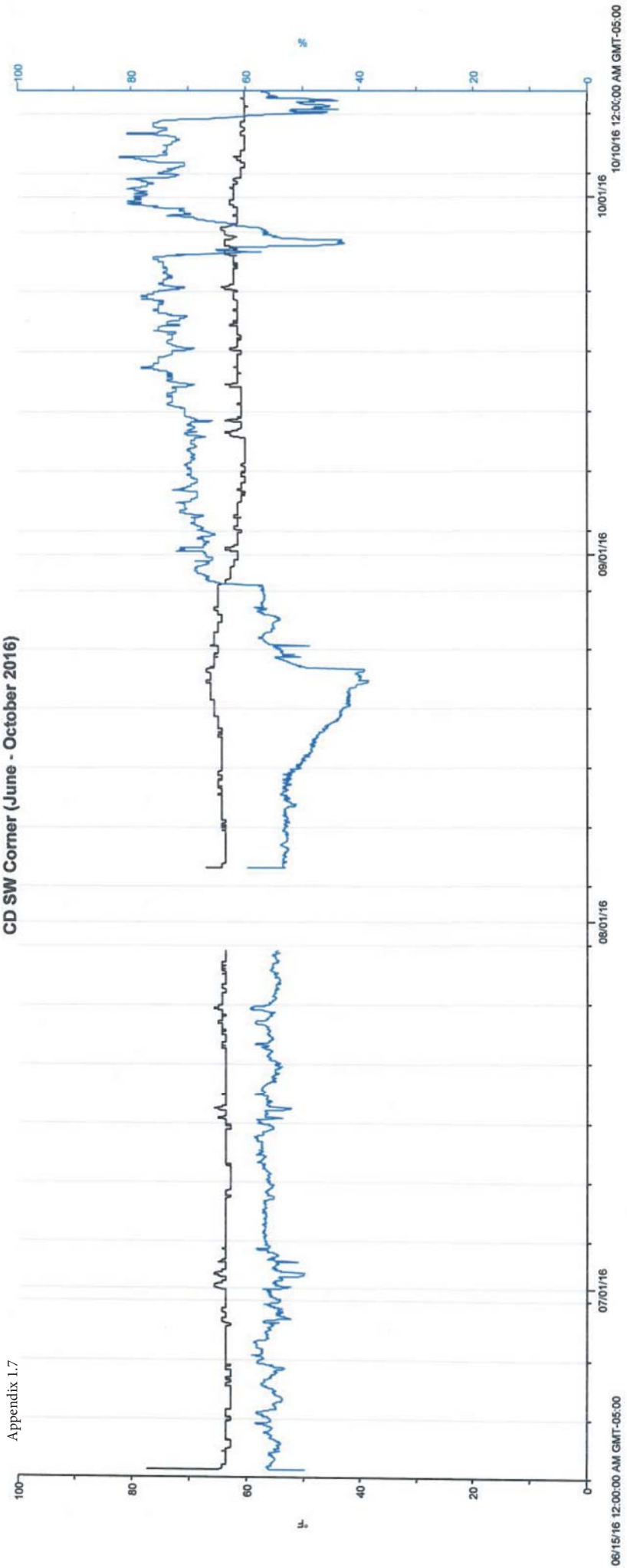
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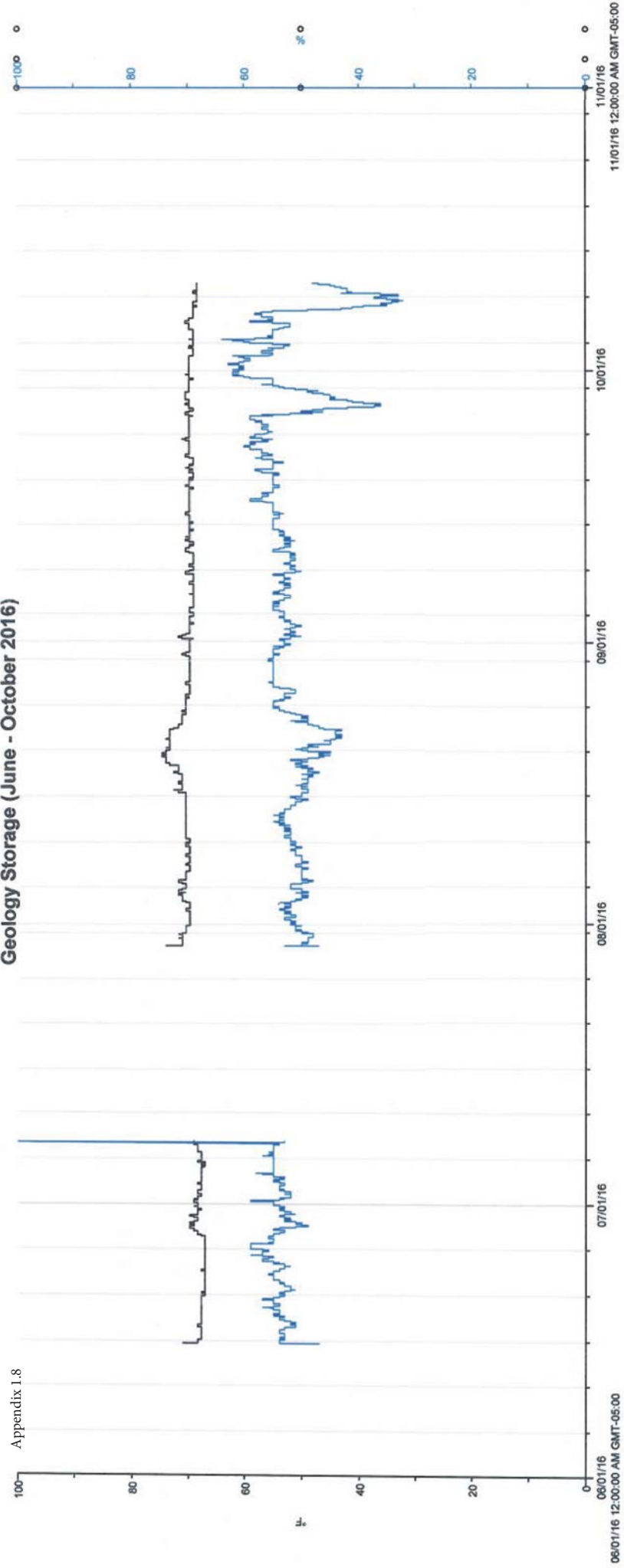


Appendix 1.6

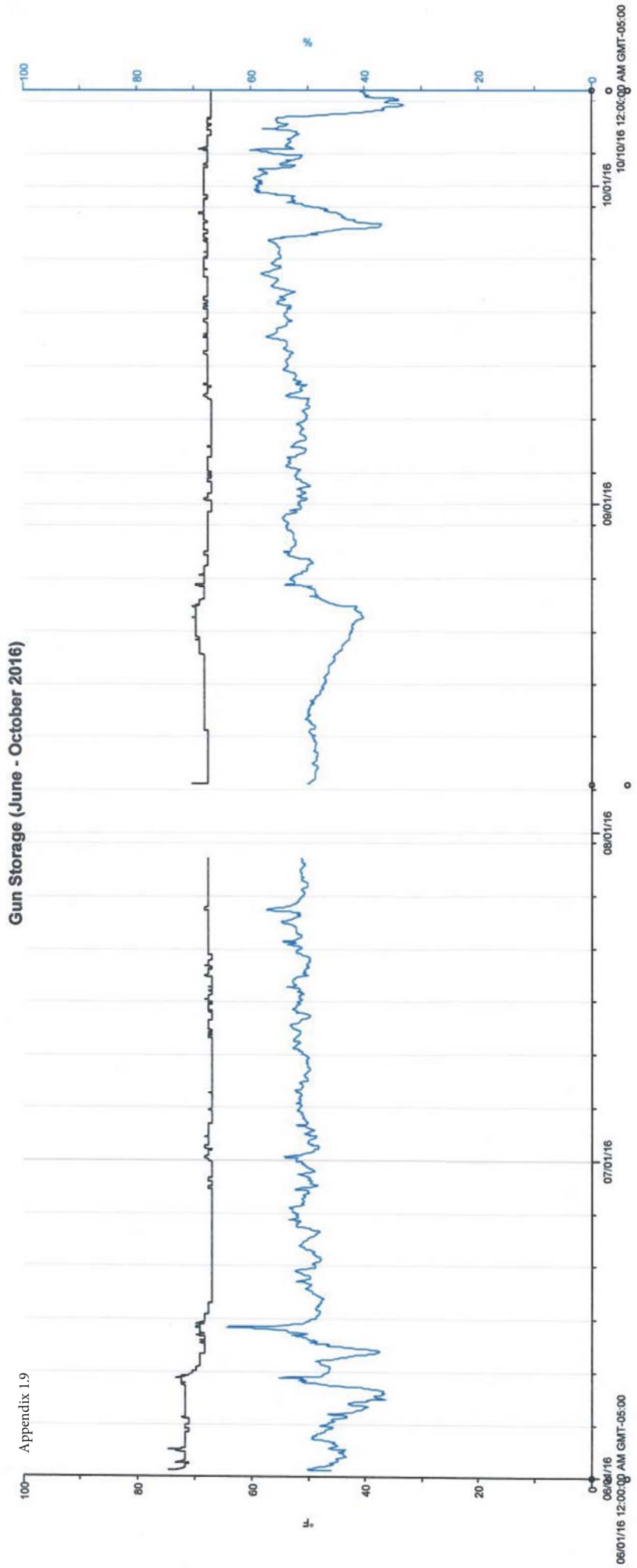
Appendix 1.7



Geology Storage (June - October 2016)



Appendix I.8



Appendix 1.9

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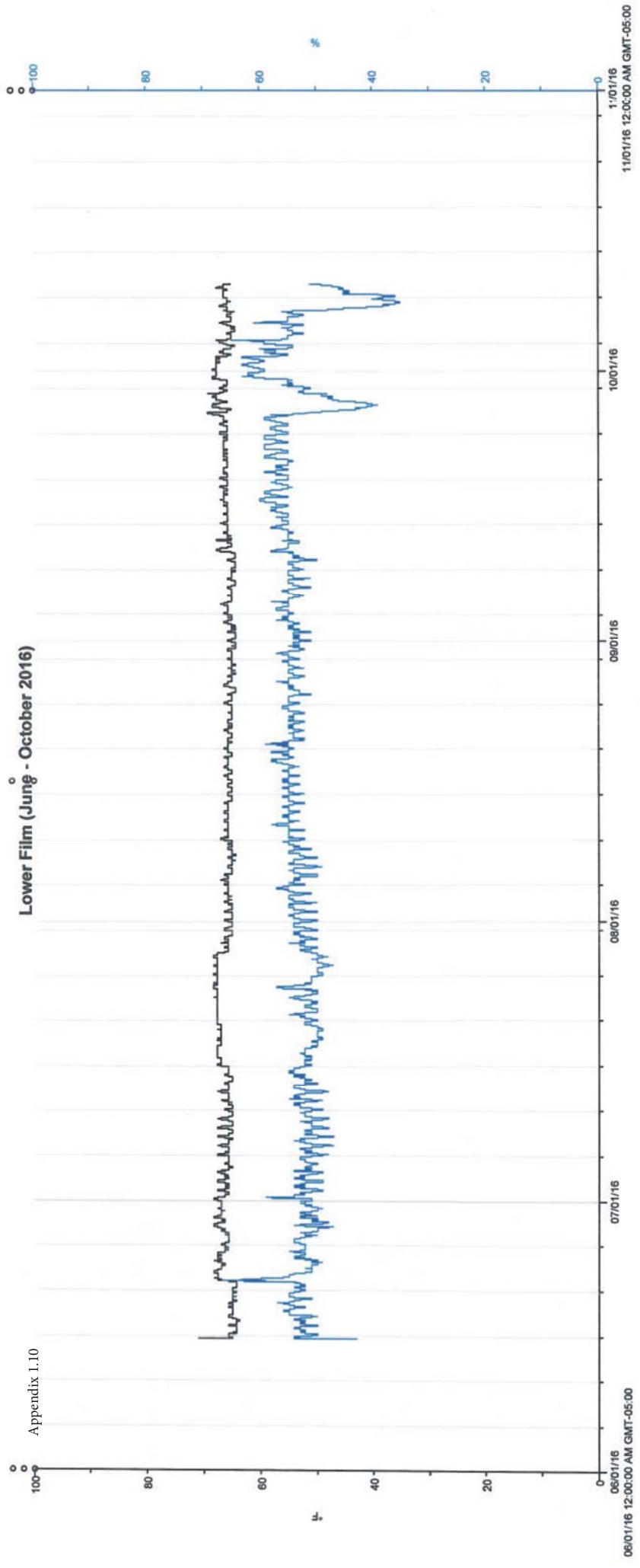
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Appendix 1.10

Appendix 2.1 Current and Future Space Assessment

	Room	Current Use		Available Space		Space needs (decompressed and compacterize)			
		Sq Ft	Total	Sq Ft	Total	Sq Ft	Total		
History	BW 4.1	4996	13083	4996	10343	1480	17239		
	BW 4.2	500		500		5632			
	BW 4.3	660		660					
	BE 8	4946		3106		9046			
	BE 2	900		0					
	guns	1081		1081					
Ancient History	BE 1	3190	3190	0	0	1595	1595		
Anthropology	BC 7	3202	5796	3202	5796	4800	6368		26802 see Anth/Hist
	BE 7	1124		1124		1124			
	BE 6	1470		1470					
	Howard					444			
Geology	BC 2	3945	5247	2686	3788		3945		
	near BC 2	200		0					
	vert foss	434		434					
	cores	668		668					
Botany	BE 2	961	961	1861	1861		961		
VZ	BW 4.4	1366	1366	1366	1366		900	incl hides	
IZ	BE ?	1259	1259	1259	1259		1259	incl all storage	
Wet storage	BW 8	815	815	815	815		815		
workspace									
growth							700		
							900		
Total			31717		25228		34682		

Appendix 2.2 Anthropology and History Space needs by material

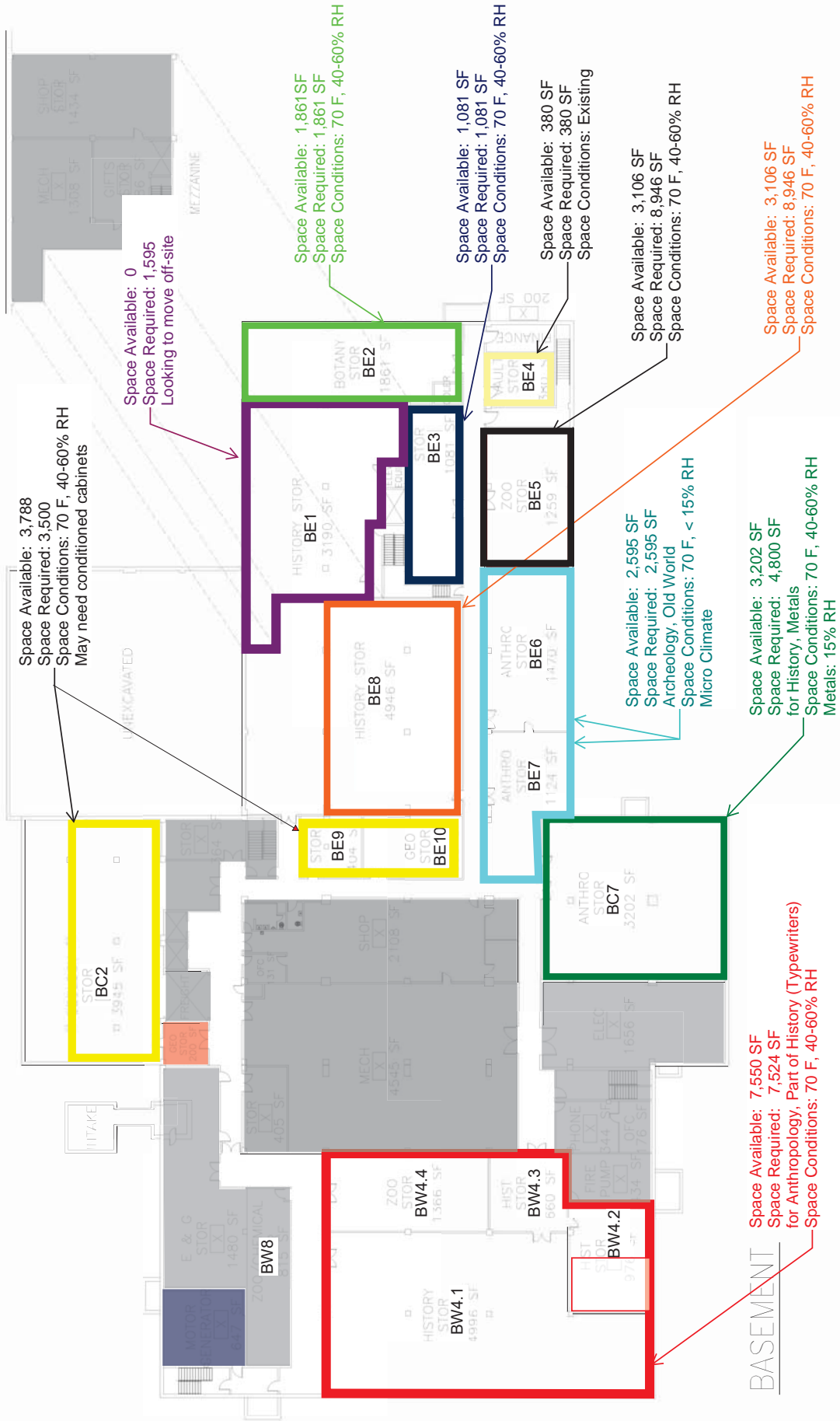
	Anthro	History	Growth	Aisles	WkSp	
Textiles	1184	3165	400	900	200	5849 see textiles
Celluloid		75				75
Human	172			200	100	472
Guns		1081				1081
other hist		12818		-800	200	12218
ancient Hist	1595					1595
other Anthro	5012		500	-300	200	5412
	7963	17139	900	0	700	26702

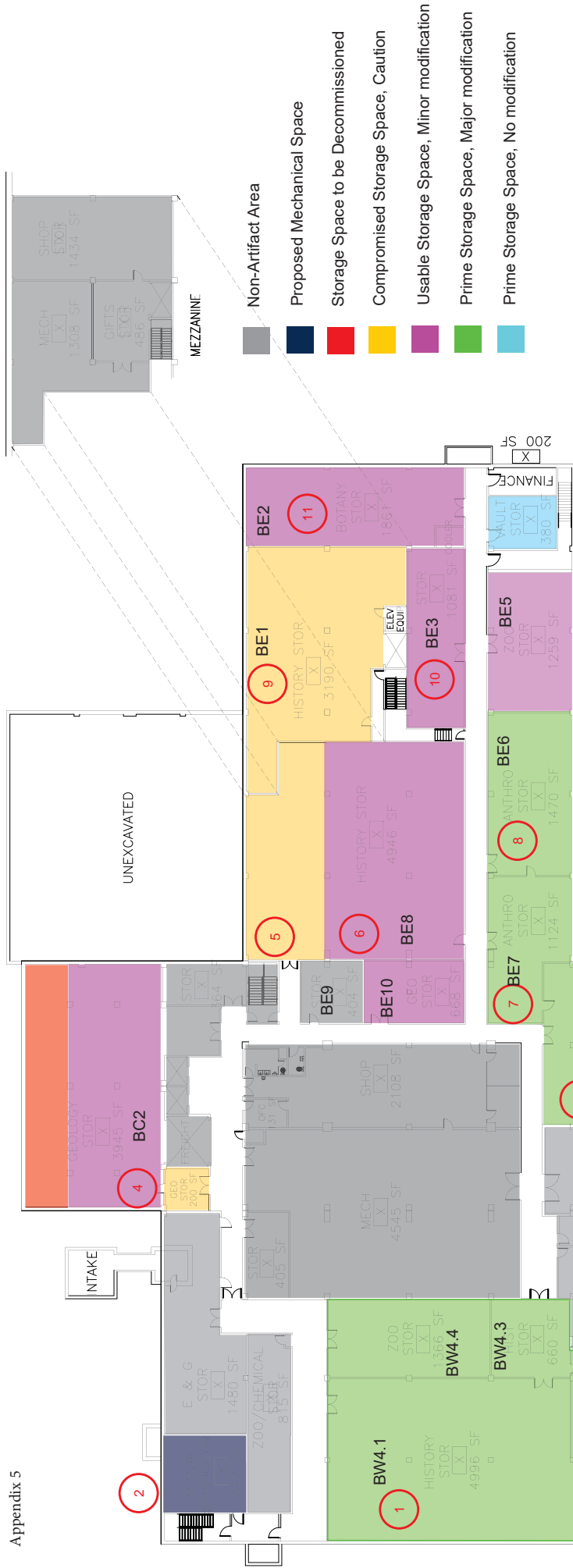
Appendix 2.3 Anthropology and History Textile needs

	Textiles current	Textiles ex +compact	Growth Aisles	workspace
History				
Tall Textiles	500	600		
Double Cab	660	1000		
Over Cab	255	510		
Carts	70	140		
Compact	840	840		
Celluloid	55	75		
Anthropology				
NA	298.74	600		
Howard	222	444		
AF/OC	32.62	60		
SA	44.6	80		
	2977.96	4349	400	200
			900	5849

Appendix 2.4 Anthropology and History future room placement

		BW4	BE6 BC7	BE7 BC8	BE3	offsite	
Hist/Anth	Textiles	5849					5849
History	Celluloid	75					75
	Other Hist	1626		3106	1081	7574	13387
Anthro	Osteology		172				172
	Osteology- additional		300				300
	Anthro (no textiles)		5412				5412
	Anthro growth		-88				-88
	Ancient Hist					1595	1595
	Total	7550	5796	3106	1081	9169	26702





Notes

- a) To prepare space: bag room, determine mold type, catalog, cull, and clean.
 - b) Add HVAC
 - c) Move organics from 5th floor
 - d) Add compact storage

- a) Prepare space: insulate duct, add dampers, etc.
 - b) Add compact storage
 - c) Decommission back of house space, build wall

- a) Move artifacts away from areas that have leak potential
 - b) Protect area with drip trays as required
 - c) Reorganize compact storage
 - d) Add drip trays as required
- a) Reorganize, add compact storage
 - b) Add drip trays as required
 - c) Add HVAC as required

- a) Add compact storage
 - b) Metals moved from history storage
 - c) Add drip trays as required
 - d) Add HVAC as required
- a) Decommission space as much as possible.
 - b) Avoid placing artifacts under mechanical room above
 - c) Consider gifting Hadidi artifacts
 - d) Move oversize paintings
- a) Secure firearm collection
 - b) Add HVAC
- a) Move typewriters
 - b) Use as swing space for west history storage
 - c) Add HVAC as required

BASEMENT