ANDREW JOHNSON HOMESTEAD
HISTORIC STRUCTURE REPORT
-AMENDMENT-



Cultural Resources, Southeast Region
National Park Service

2001

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Southeast Region
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2001
Historic Structure Report
Andrew Johnson Homestead
Andrew Johnson National Historic Site
Greeneville, Tennessee
LCS#: 00023

The historic structure report presented here exists in two formats. A traditional, printed version is available for study at the park, the Southeastern Regional Office of the National Park Service (NPS SERO), and at a variety of other repositories. For more widespread access, the historic structure report also exists in a web- based format through the SERO intranet, which includes links to individual files for a variety of photographs, documents, plans and other material used in compilation of the printed report. To access any section of this report, use the intranet adresses located in the black bars of each right-hand page.

Recommended by: Kirk A Cordell 10/12/01

Chief, Cultural Resources Stewardship, Southeast Regional Office — Date

Concurred by: Mark Corey 10/18/01

Superintendent, Andrew Johnson National Historic Site — Date

Concurred by: Patricia A. Hooks 10/29/01

Regional Director, Southeast Region — Date

Foreword

We are pleased to make available this Historic Structure Report, part of our ongoing effort to provide comprehensive documentation and management guidelines for the cultural resources of National Park Service units in the Southeast Region. Many individuals contributed to the successful completion of this work. In particular we would like to thank Superintendent Mark Corey, Andrew Johnson National Historic Site, for the time and interest he gave to this project as the senior manager of the site. This study was made possible through a cooperative agreement with the Georgia Trust for Historic Preservation. We hope it will prove valuable to park management in understanding the history of the Homestead and in providing for its long- term preservation and maintenance.

Kirk A. Cordell
Chief, Cultural Resources Stewardship
National Park Service, Southeast Region
November 2001

http://crs.sero.nps.gov/historic/hsar/anjo/default.htm

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http://crs.sero.nps.gov/historic/hsar/anjo/e_summary.htm

Executive Summary

The Andrew Johnson Homestead was constructed in multiple phases between 1848 and 1869. Much altered after Johnson's death in 1875, the house was acquired by the NPS in 1942 and, fifteen years later, underwent a thorough restoration under the direction of Henry Judd, AIA. The Homestead was listed on the National Register in 1977, and, as the fiftieth anniversary of its restoration approaches, it remains in good condition overall. Concerns have recently emerged about the integrity of parts of the building and its systems, however. In order to deal with these concerns, the present report has been compiled. Because of the exhaustive nature of the original HSR (1956) and its "Supplement" (1959), this report is being presented as an amendment to those earlier studies.

Investigative Site Visits

In addition to a review of the original HSR, a series of investigative site visits was conducted between August 1999 and Novem-

ber 2000. These visits included interviews with park staff and a thorough investigation of the building to determine its existing condition.

August 12, 1999

Dan Scheidt- Historical Architect
Christian Bookter- Exhibit Specialist
Steve Sherwood- Engineer
Bill Russell- Structural Engineer
Allen Bohnert- Curator

May 18, 2000

Dan Scheidt- Historical Architect
Jon Buono- Historical Architect
Christian Bookter- Exhibit Specialist
Bill Russell- Structural Engineer

October 25, 2000

Jon Buono- Historical Architect
John Gopaul- Mechanical/Electrical/ Hydrological Engineer

November 15- 16, 2000

Jon Buono- Historical Architect
Allen Bohnert- Curator
Michael Henry- Architect/Specialist in Interior Environmental Control

These investigations were primarily visual in nature, i.e., only nondestructive means were used to examine the condition of the building's fabric and the causes of material failures.

Problems of Repair

The Homestead is located in a temperate- forest environment with cold, wet winters and hot, humid summers. As a result, progressive decay of exterior wood elements from moisture penetration is an ongoing problem. Furthermore, freeze/thaw cycles within the valley in which Greeneville is located contribute significantly to deterioration of masonry joints, flashing, and other elements of the building. Like any historic building in such a climate, the Homestead requires a high level of routine maintenance in order to be properly preserved. Since the greater Andrew Johnson National Historic Site is primarily a cultural resource consisting of similar historic structures in need of the same level of maintenance, the park staff should be expanded to include an exhibit specialist with experience in preservation and maintenance of historic buildings.

A variety of problems of repair was noted during the investigative site visits. Issues of concern included strength of the second floor and roof structure, instances of water penetration along the west wall, environmental hazards to the Homestead's museum collections, and the need for a fire- suppression system. The scope of the present report did not include an evaluation of the 1956- 58 restoration, although that project appears to have been well founded and well executed.

The results of these investigations are recommendations that aim to create a more stable environment for museum holdings within the Homestead and to address life/safety concerns related to building utilities. The recommended project includes replacement of the outdated radiant heating system, replacement of the electrical system, installation of a fire- suppression system, and correction of structural deficiencies in the framing of the entrance hall

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and roof.

Since each of these rehabilitative actions will require selective destruction of building fabric, they should be initiated in concert with one another in order to minimize adverse effects on the Homestead.

The project will require the supervision of an architecture and engineering firm with *demonstrated* experience in the rehabilitation of historic structures. Insensitive interpretation of modern building codes and application of standards such as NFPA #13 *Standard for the Installation of Sprinkler Systems* can quickly destroy the historic character of a building like the Homestead.

The restoration and rehabilitation efforts of 1957 have endured remarkably well. The present project seeks to ensure the continued preservation of the Homestead for the next generation of visitors.

Problems of Repair, Independent of Historic Fabric	Recommendations
Mechanical	Install new heating system: • Natural gas-fired boiler with small volume hot water storage tank (sized for 55° F interior temperature at exterior design low temperature) • Boiler located in ell cellar storeroom, with appropriate measures for fire prevention • Utility service for natural gas • Hot water coils in two air handlers • Perimeter hot water baseboard heat in Staff/Housekeeping zone Improve ventilation: • One air handler for low temperature first floor Collections zone, located in ell cellar storeroom, with ducted air supply and return in cellar and crawl spaces below first floor • One air handler for low temperature second floor Collections zone, located in ell attic, with ducted air supply and return in main block and ell attics above second floor • Controlled source of outside air for each air handler zone Intake(s) should be remote from street (to avoid vehicular emissions) and from finished grade/landscaped areas (to avoid excess moisture and microorganisms). • Exhaust fan for rest room Install climate controls: • Integral monitoring and control via direct digital control system, small local desktop computer and remote monitoring via dedicated data transmission line to the AJNHS office • Air handler fans recirculate and filter air continuously. Smoke detection stops fans. • Outside air is admitted when exterior humidity ratio is closer to desired interior humidity ratio than the existing actual humidity ratio (i.e., if interior relative humidity exceeds desired range, and exterior conditions are drier, then outside air is introduced). • Hot water to air handler coils is modulated to maintain low level (45° F to 70° F) space temperature.

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Problems of Repair, Independent of Historic Fabric	Recommendations
Mechanical *continued*	Temperature set point for heating is based on desired interior relative humidity level.
Electrical	• Retain existing underground service to house. • Replace main panel in utility room in ell cellar. • Remove existing radiant heating subpanels and control panels and circuits, including portable heater receptacles. • Add to subpanel for mechanical outbuilding, if necessary. • Remote controlled pre-set lighting for Collections zone, including service/housekeeping lighting level • Conventional lighting in Staff/Housekeeping zones and in Mechanical zones • Service/convenience receptacles throughout all zones • Power for mechanical systems • All power and control wiring in conduit • Limited site lighting for access and security • Manual transfer switch and tie in for portable generator connection for essential systems during power outage
Fire Protection	• Water service from off-site municipal water supply, assuming water pressure/volume is adequate for dry-pipe or pre-action system and no fire pump is required • Pre-action sprinkler system throughout building, possibly with on-off capability, such as "Fire-Cycle" system, or dry pipe system throughout building, zoned to correspond to use zones • Fire protection system water service, entry, and station in ell cellar utility room in storeroom • Siamese fire department connection located adjacent to service parking area

Problems of Repair, Inherent to Historic Fabric	Recommendations
Structural Weakness	Stair Hall Framing at Second Floor • Correct for flexibility (approximately 15% greater stiffness). • Remove trim around stair, exposing joists and their attachment to flooring. • Ensure attachments to flooring and adjacent structural members, and/or • Increase the size of the joists. Roof Framing in the Ell • Maintain scabbed rafters. • Install 4 (span: 15 feet, width: 3.5", depth: 12") roof beams to relieve rafters. • Brace rafters by means of vertical supports.
Envelope Performance	• Reduce/control convective heat loss/gain by air infiltration/ex filtration: Repair/upgrade weatherstripping at windows and doors; Minimize duration of open exterior doors, especially if exterior temperature is extremely low; Control introduction of outside (make-up) air into ventilation system. • Reduce conductive heat/loss gain: Replace vermiculite insulation with fiberglass batt insulation in attic. • Control/reduce natural light at windows & doors: Use light-reducing window shades or material incorporated into window treatments; Close shutters on southwest ell and main block from April to October. • Minimize use of artificial lights that have heat-generating lamps or ballasts.

http://crs.sero.nps.gov/historic/hsar/anjo/e_summary.htm

Problem of Repair, Inherent to Historic Fabric	Recommendations
Water Penetration	• Improve roof water collection and drainage system: Verify correct gutter slope and function. Correct gutter overtopping above southwest wall of ell. Maintain rigorous and frequent cleaning schedule for gutters and trench drain. Inspect (with fiber optics) drain lines for damage/blockage and correct as necessary. • Reduce water infiltration at front sidewalk: Monitor vehicular splashing on front facade, especially in winter. If necessary, rebuild open-jointed brickwork with underdrain/water barrier, or, rebuild with mortared joints. Increase depth of trench drain along distance.

http://crs.sero.nps.gov/historic/hsar/anjo/ad.htm

Administrative Data

Locational Data:

Building Name: Andrew Johnson Homestead
Building Address: 209 South Main St.
Greeneville, TN 37743

Proposed Treatment:

Rehabilitate mechanical and electrical systems. Install fire protection system to secure historic furnishings. Correct structural deficiencies in entry hall and ell roof framing.

Related Studies:

Restoration of the Andrew Johnson Homestead 2nd Supplement to the Survey Report. Henry Judd, 1959.

Restoration of the Andrew Johnson Homestead. Ernest Allen Connally, 1956.

Cultural Resource Data:

ORG CODE: 5450
ID LCS: 00023
STRUCTURE NUMBER: HS- 3- 01

Period of Significance:

The Andrew Johnson Homestead was constructed in multiple phases between 1848 and 1869. An exhaustive restoration of the building was conducted by the National Park Service from 1956- 58, restoring the structure to its appearance at the time of Johnson's death in 1875. The Homestead was listed on the National Register in March 1977, with a national level of significance under Criterion B for its association with President Andrew Johnson and a local level of significance under Criterion C as a good example of the work of local mason James Brannon.

http://crs.sero.nps.gov/historic/hsar/anjo/hbc.htm

Historical Background & Context

Traditionally called the Johnson Homestead, the home of Andrew Johnson (1808- 75), seventeenth President of the United States (1865- 69), is a two- story brick house situated on South Main Street in Greeneville, Tennessee. It is one of several historical sites in Greeneville relating to the career of Andrew Johnson. It is not the only house Johnson lived in or owned in Greeneville, but it is the one most closely identified with his rise to fame and historical importance.

Born in Raleigh, North Carolina, in a working class family, Johnson was left fatherless at the age of three; as a runaway tailor's apprentice he crossed the mountains into East Tennessee in 1826, when he was seventeen years old. The following year he married Eliza McCardle, who helped him acquire the rudiments of an education, and about 1830 he purchased the Tailor Shop, where he established himself in trade and in politics. By 1829 he had been elected alderman; in 1834 he was mayor of Greeneville, proceeding rapidly to the state legislature, where he served in

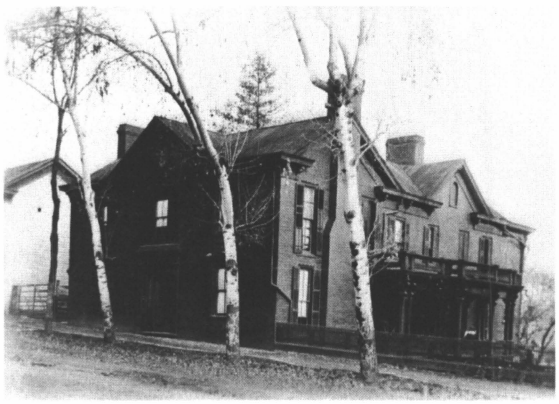
both houses, and in 1843 to the United States House Of Representatives. Across College Street from the Tailor Shop stands the small two- story brick early home.

Johnson owned the homestead from 1851 to 1875, and it was his residence when he was elected governor of Tennessee, United States senator, and vice president of the United States. Although not occupied by the family during the Civil War, the property remained in Johnson's ownership when he succeeded Lincoln to the presidency in 1865, and he returned there when he retired from office in 1869. He died in July 1875 and was buried at Greeneville on a hilltop of his own selection, which is now the Andrew Johnson National Cemetery.

After his death the house remained in family ownership. A major remodeling of the house was completed in 1885 by his daughter, Martha. Other additions and alterations were made in 1901 and later, including the addition of indoor plumbing, electricity, and gradual enclosure of the rear porches. The house was continuously occupied by three generations of Johnson's descendants, and, in spite of the changes to the house itself, they conscientiously preserved everything associated with the president, including much of his furniture, books, papers, official relics, and countless personal belongings. The family burial ground was given to the federal government in 1906 as a national cemetery, and in 1922, the family sold the Tailor Shop to the state of Tennessee..



Homestead, at President Johnson's death, 1875, Accession no. 231, ANJO Archives



Homestead, after President Johnson's death, 1885, Accession no. 231, ANJO Archives

An important presidential household that was virtually complete, the Homestead was acquired by the NPS from Johnson's great-granddaughter, Margaret Johnson Patterson, and, with the Tailor Shop and Cemetery, it became part of the "Andrew Johnson National

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Monument" that had been authorized by Congress in August 1935 (49 Stat. 958) and formally established by Presidential Proclamation (#2554) in April 1942

Large- scale work was postponed for some time because of the Second World War and its aftermath, and Mrs. Bartlett continued to occupy the house until 1956, when Congress finally made appropriations to begin restoration. The extraordinarily fortunate (and rare) set of circumstances that preserved so much made it possible to restore the interior with pieces of undoubted authenticity that had always been in the house. Several trunk- loads of papers and personal accounts assisted in planning the restoration of the building, with "an uncommon degree of accuracy," according to architect Ernest Allen Connally, who served as historian for the project. The actual restoration, which was completed in the fall of 1957, was directed by architect Henry Judd and was based on detailed examination of the structure and study of all available documents pertaining to the property. To guide the work, Connally prepared a "Survey Report" in the summer of 1956, and it was supplemented by Judd's volume of architectural data in the spring of 1959. Because of the thoroughness of their research and its presentation, these volumes may be seen as a historic structure report for the Homestead and should be consulted for historical and architectural details not covered in the present report.



Homestead, just prior to NPS restoration project, 1956, Accession no. 231, ANJO Archives

http://crs.sero.nps.gov/historic/hsar/anjo/cdu.htm

Chronology of Development & Use

As noted in the preceding historical overview, the Homestead underwent a variety of alterations and additions after its construction around 1850. The nature and extent of these changes were thoroughly documented in Henry Judd's *Restoration of the Andrew Johnson Homestead, Greeneville, Tennessee* in 1959, a copy of which is kept at the site. Because of the presence of so much of Johnson's furniture, books and papers, official relics, and personal belongings in the house, operation of the house as a house museum was and remains the NPS's primary use for the property. Based upon the work of Judd and Connally, the decision was made to restore the house to its appearance when Andrew Johnson died in 1875, thus preserving the first major addition to the house, the second- story ell and double gallery (around 1869- 1870), and other alterations that Johnson made to the house during his twenty- five- year ownership of the property.

Funded by the Park Service's "Mission 66" program, restoration was completed in the fall of 1957. For the next twenty years, there were few if any real changes to the house beyond routine repairs and maintenance. By the late 1970s, more significant problems emerged as porches, mortar joints, and other features began to deteriorate. More recently, concerns have arisen over the internal environment and its suitability for the long- term preservation of the site's historic artifacts.

CONSTRUCTION TIME LINE			Feature #
Original Construction			
about 1849- 50		Original construction of the house by James Brannon	
1851	September 10	Congressman Andrew Johnson purchases house and completes finishes	
Historic Alterations (prior to 1875)			
1862- 1868		House occupied by Confederate and Federal troops and is neglected and abused	
1868- 1869		Johnson's daughter, Martha, refurbishes the house	
1869	March 20	Ex- President Johnson returns to the Homestead	
1869- 70		Additional alterations and improvements, including brick sidewalk and fence at front	
Later Alterations			
1884	December	Johnson's daughter Martha J. Patterson inherits the house	
1885		Johnson's daughter thoroughly remodels the house, including the addition of a bracketed cornice, gables on the front and south side, and a porch and bay window on the south side	
1899- 1900		New porch constructed across southern flank of house; first indoor bathroom installed on back porch; bay window added in dining room	
1901		New kitchen constructed on first floor of house	
1913		Oak flooring laid in several rooms	
1920		Rear portion of second floor converted to apartment; second bathroom built on first floor; french doors installed at several locations	
1931		Parlor porch enclosed for small bedroom	

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CONSTRUCTION TIME LINE			Feature #
1948		Stoop next to kitchen enclosed for breakfast room	
NPS Restoration			
1956	summer	Johnson's great- granddaughter vacates house; building investigation and historical documentation begun by NPS	
1957	fall	Restoration completed (see Judd's 1959 report for details)	
1965	April	PLASTER TREATMENT PAINT: EXT. TRIM DALE RANKIN 176.00	4117, 4140, 4147, 4148, 4153, 4210
1966	May	PAINT: EXT. TRIM, SHUTTERS, GUTTERS, TIN ROOF GRAIN FRONT DOOR WHITSON & SONS 345.00	4117, 4147, 4148, 4151, 4152, 4310, 4351
1966	June	REPAIRS TO SHUTTERS BOLES AND HITE 97.95	4147
1967	October	PAINT: EXT. AS NEEDED DALE RANKIN 259.09	un- specified
1971	June	PAINT: EXT. (EXCLUDING PORCH WINDOWS, DOORS, CEILING) DALE RANKIN 500.00	4115, 4117, 4133, 4160, 4351

CONSTRUCTION TIME LINE			Feature #
1972	November	DRAINAGE WORK EARL SHELTON 295.00	un-specified
1974	February	INSTALL SUMP PUMP WAITES PLUMBING 221.60	5821
1974	June	RE- PENCIL MORTAR JOINTS HILTON SNIPES 760.00 PAINT: KITCHEN, PORCH CEILING EXT. BRICK WALLS, INT. CEILINGS DALE RANKIN 920.00 REPOINT BRICK MORTAR HILTON SNIPES 1060.00	4110, 4132, 4160, 4210, 4220
1974	November	PAINT: TRIM ON WEST SIDE DALE RANKIN 382.50	4140, 4147, 4148
1975	June	REPAIR FLOOR JOISTS PORCH HENRY SEAVER 168.00 REPLACE 400 SQ. FT. PORCH DECK HENRY SEAVER 448.00	4131, 4132
1976	June	PAINT: EXT. BRICK WILLIS RANKIN 272.00	4160
1977		PAINT: EXT. WOODWORK, DOWNSPOUTS EXCEPT PORCH CEILING GEORGE TEMPLIN 805.25	4115, 4117, 4133, 4351
1978	November	REPAIRS TO PORCH RAYMOND TILSON 42.00	4132

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CONSTRUCTION TIME LINE			Feature #
1979	August	RECONSTRUCT AND PAINT SHUTTERS MILLS FURNITURE REFINISHING 650.00 RESTORATION OF FRONT DOOR MILLS FURNITURE REFINISHING 365.00	4147, 4152
1979		REROOF HOMESTEAD	4310
1981	January	PAINT: TIN ROOF, EXT. WEST TRIM, ETC. WALLPAPER THOMAS DIER 1100.00 PAINT INT. CEILINGS THOMAS DIER 125.00	4117, 4220, 4260, 4310
1981	October	PAINT: NORTH AND EAST EXT. WOODWORK SHUTTERS, RAILINGS, FACIA, GUTTERS THOMAS DIER 420.00	4115, 4117, 4133, 4147, 4351
1982	August	REPAIRS TO PORCH RAIL, POST, CEILING LINCOLN BUILDERS 200.00	4115, 4120, 4133
1982		PAINT: EXT	4160
1984		REGRADE HOMESTEAD DRAINAGE	
1984	March	RESTORATION OF FRONT DOOR MILLS FURNITURE REFINISHING 435.00	4152
1984	April	PAINT: AS NEEDED EXT. WINDOWS, DOORS JAMES WHITE 385.00	4140, 4152
1984	May	PAINT: PORCH CEILING, RAILINGS JAMES WHITE 773.00	4120, 4133
1984	June	PAINT: TIN ROOF HOMESTEAD	4310

CONSTRUCTION TIME LINE			Feature #
1986	January	CEILING REPAIRED (LOWER HALL) (12/85CEILING COLLAPSE) BILL TEILMANN	4220
1986	January	INSULATION INSTALLED IN HALLWAY	4281
1986	February	WIRING INSTALLED (LOWER HALL) BOB REYNOLDS	5430
1986	April	PLASTER REPAIRS (LOWER HALL) CARL GOOD	4210
1986	November	SECTION OF PORCH REMOVED	4131, 4132
1987	February	STRIP, PAINT, REPAIR SHUTTERS JAMES WHITE 2200.00	4147
1987	March	REPAIR HOMESTEAD PORCHES JIM MORAN	4131, 4132
1987	March	PLASTER WORK IN KITCHEN CARL GOOD	4210
1987	March	PAINT: INT. WOOD TRIM, STAIR HALL REPAIRS TO PLASTER CONTRACTOR JAMES WHITE 2450.00	4210, 4213, 4260
1991	May	PAINT: EXT. TRIM, SHUTTERS, WINDOWS, TIN ROOF, BRICK WALLS, BANNISTERS, PORCH CEILINGS JAMES WHITE 940.00	4117, 4120, 4133, 4140, 4147, 4160, 4310
1992	May	FRONT DOOR GRAINED AND VARNISHED	4152
1992	July	INSTALL UV FILTERS ON WINDOWS BAILLYTON GLASS 540.00 REROOF RED CEDAR SHINGLE	4240

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CONSTRUCTION TIME LINE			Feature #
1993	April	REPOINT CHIMNEY SW REGION MASONRY PRESERVATION CREW	4110
1994	July	REPLACE NON- AUTHENTIC DOOR HANDLE	4154
1994	October	REPLACE SECTION OF PORCH DECK	4132
1995	February	REMOVE/REPLACE WALLPAPER ROBERT'S ROOM	4260
1995	September	PLASTER REPAIR JOHNSON BEDROOM	4210
1996	July	GRADE CHANGE TO IMPROVE DRAINAGE	
1997	September	FRONT DOOR GRAINED (SIMULATED OAK GRAIN) RICK ADAMSON	4152
1999	April	INSTALLATION DOOR VENTS EXHAUST FAN FOR BASEMENT, AND TWO ADDITIONAL ATTIC FANS	
1999	September	MORTAR JOINTS REPOINTED JAMES NUTTER J+T CONTRACTORS	4110

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Physical Description

Located on a two- acre site on S. Main Street in Greeneville, Tennessee, Andrew Johnson's "Homestead" is a two- story, brick house with a side- gable roof and a rear ell extension, all with Greek Revival details. The main block of the house, which was built with almost no setback from the street's sidewalk, faces west and measures approximately 39' by 20'. The rear ell, to which Johnson added a second floor, measures 30' by 18'. The house has eleven main rooms and a total square footage of just over 2600 s.f.

During a series of investigative site visits in August 1999 and in May, October, and November 2000, the following historic feature inventory and condition assessment was developed by a team from the Cultural Resources Division of the NPS Southeastern Regional Office that included Jon Buono, historical architect, and Christian Bookter, exhibit specialist in architectural restoration.

Problems of Repair

The Homestead is located in a temperate- forest environment with cold, wet winters and hot, humid summers. As a result, progressive decay of exterior wood elements from moisture penetration is an ongoing problem. Furthermore, freeze/thaw cycles within the valley in which Greeneville is located contribute significantly to deterioration of masonry joints, flashing, and other elements of the building. Like any historic building in such a climate, the Homestead requires a high level of routine maintenance if it is to be properly preserved.

A variety of problems of repair emerged during the course of investigating the building and in talking with park staff about their experience with the building. These problems are outlined below along with recommendations for corrective measures.

Envelope Performance and Water Penetration

The Homestead site has periodically had problems with sub- surface moisture. To control moisture at its source, a number of routine maintenance and prevention exercises should be performed. The highest priority is maintenance of adequate means of collection and drainage of roof runoff; positive gutter slope and function should be verified and maintained. A rigorous regimen of gutter and trench drain cleaning should be enforced.

In addition to maintaining the gutters in good working order, the trench drain should be enlarged to increase in depth with distance to accommodate runoff. As the rate of vehicular traffic increases along Main Street, so does the volume of road splash and sidewalk runoff during heavy precipitation. If gutters and drains are functioning properly and there is a marked increase in the frequency or severity of moisture infiltration along the building's northwest elevation, the open- jointed brick sidewalk should be rebuilt to include an under drain or water barrier to prevent infiltration into the building.

Immediate caulking of cornice and trim at the front (west) door has been recommended to park staff. Caulked joints around all window and door openings should be routinely inspected and repairs made promptly to eliminate moisture penetration and air infiltration into the building.

Convective heat loss/gain by air infiltration/ exfiltration is a pervasive problem in the house; weatherstripping at windows and doors should be repaired or upgraded. To reduce radiant heat loss/gain, the vermiculite insulation in the attic should be replaced with fiberglass batt insulation.

Structural Integrity

Examination of the roof structure above the rear ell (about 1869) revealed the need for additional support. Since the present timbers are historic and were probably reused from the earliest construction of the home, they should be braced or otherwise stabilized and not re-

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moved or altered in any irreversible way. (See Appendix B, report by Bill Russell.)

Structural weakness was also detected in the second- floor framing of the entry hall, but the cause of that weakness has not been specifically identified. Future repairs must be coordinated with selective removal of finishes in the stair hall to determine the extent of any damage or deterioration.

The house's porch decks account for 40 percent of the structure's usable space but are almost fully exposed to the elements. As a result, numerous repairs have been necessary over the years. The climate and the nature of their historic design are such that constant vigilance will always be necessary to prolong the useful life of the materials.

Ambient Conditions

The Johnson Homestead represents a construction period from the mid to late nineteenth century, a period during which thermal insulation was rudimentary at best. The comfort level for occupants was low by today's standard, but the relatively small difference between internal and external temperatures and relative humidity allowed building materials to expand and contract with the seasons. Regional styles and architectural features reflected regional climates. The mountains of Tennessee, characterized by hot and humid summers, called for elevated living rooms, louvered grilles and shutters, balconies, and interior courtyards to help circulate air. The grand size of the Homestead porch figures prominently in this building philosophy, as does its northeast orientation, which effectively avoids the solar angle.

Although the Homestead furnishings have survived these premodern conditions for over a century, their historic significance and monetary value require an increased level of care in a stable environment. The current record of interior temperature and humidity data indicates extreme fluctuations in environmental conditions, one of the primary causes of deterioration of many historic objects. In particular, erratic fluctuations in relative humidity are responsible for problems that range from cracking of furniture finishes (in the low extreme) to growth of molds and mildew (in the high extreme).

In order to create a more stable environment for museum holdings within the Homestead, a more aggressive mechanical system must be installed. We recommend installing air handlers to serve the interpreted zones on the first and second floor, replacing the structure's outdated radiant heating system, and establishing a controlled source of outside air. The system would not, however, allow for an active cooling component because of the risk of internal condensation that can occur with the operation of such systems in structures like the Homestead.

Despite the introduction of a new mechanical system, historic building operations should be continued. As mentioned earlier, the Homestead was designed to alleviate the effects of humid summers of the mountains. To reduce

the heat gain, the shutters should be used as they were intended and kept closed where heat gain is highest along the southern exposure, which is also the façade with the most windows. Louvered shutters should not be considered merely a protective device for window sash but rather a shading device against the intense heat gain that can occur throughout the summer months.

Furthermore, the constraints of a historic house will limit the effectiveness of a forced-air climate control system. Without undermining the character of the Homestead, only certain temperature and humidity levels will be possible. Sensitive artifacts may require individual treatment or relocation since an efficient environmental system within a historic structure cannot be tailored to the demands of specific artifacts.

Wiring and Fire Prevention

The Homestead was completely rewired in 1957. However, the elapse of more than four decades has rendered portions of that system obsolete and, given the risk of fire from faulty wiring, the entire electrical system inside the house should be replaced. The existence of rigid conduit allows for the replacement of the outdated wiring. As a further measure of protection, a fire- suppression system should be inserted during the selective demolition necessary for installation of new mechanical and electrical systems.

Feature Inventory

The following description of building features reflects data compiled from site visits in 1999 and 2000. All cost estimates for repair reflect values in "2000" dollars.

http://crs.sero.nps.gov/historic/hsar/anjo/pd.htm

FEATURE INVENTORY: EXTERIOR ENVELOPE

Walls - Ceilings - Floors - Windows - Doors - Finishes

All Estimable Items

Materials:	$9,134.00	**Labor:**	$9,160.00	**Total =**	**$18,294.00**

EXTERIOR 4110 Exterior Wall Surface/Cover Brick

Feature Description: Water-struck brick set in an American bond pattern. Previous restorations have included pencilling mortar joints with lead mixture. A discrepancy in brick coloration (caused by hard burning) along the East wall marks an addition made to the Homestead in 1869. Original bricks are oversize (3" x 3 3/4" x 9").

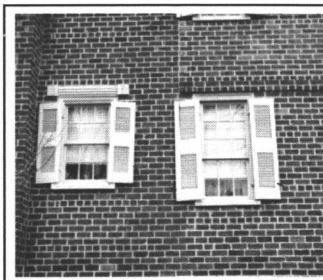
Feature Notes: East and North elevations abutting porch are painted white.

Feature Condition: Good **Total Inventory:** 4790 s.f.

Historic Rating: H **Priority:** Minor

Deficiency: There are minor instances of fascia deterioration. Previous re-pointing jobs have not included pencilling mortar joints.

Recommendation: Repointing should be scheduled every 10 to 15 years, including pencilling mortar joints. Joints should be routinely inspected by park staff following freeze/thaw conditions between winter and spring.



South wall at point of 1869 addition

Materials:	**Labor:**	**Quantity:**	**Total =**	**$0.00**

EXTERIOR 4111 Exterior Wall Structure Brick

Feature Description: Three-brick thick load-bearing wall. Brick is bonded with a mortar mixture using Trinity White cement, hydrated lime with lumps left in, local sand, and twelve cups per bag of cement of a buff mortar color.

Feature Condition: Good 99%
Fair 1% **Total Inventory:** 14370 s.f.

Historic Rating: H/T **Priority:** Minor

Deficiency: Cracking from settled foundation or possibly from 19th century alterations to window openings.

Recommendation: It appears that these cracks were present at the time of the 1957 restoration. All cracking in mortar has been repatched and is in good condition. Since the structural strain seems to no longer be present, monitor for water penetration through the cracked bricks.



South wall

Materials:	**Labor:**	**Quantity:**	**Total =**	**$0.00**

EXTERIOR **4115** **Exterior Column/Post** **Wood**

Feature Description: Posts support porch frame which wraps around the North and East elevations.

Feature Notes: Basement level posts are constructed of ratchet sawn yellow pine timbers. First and second level posts are composite posts made from 4 2" by 4" boards connected side to side and faced with 7/8" fascia, approximately 10' high.

Feature Condition: Good to Fair **Total Inventory:** 8 composite posts

Historic Rating: T **Priority:** Minor

Deficiency: There are some areas of weathered paint.The relatively thin fascia boards covering the 2"x4"s will require periodic replacement.

Recommendation: Include in next scheduled repainting of exterior trim. Cracked or peeling paint should be scraped and surface should be sanded before repainting.



Southeast corner post

Materials: **Labor:** **Quantity:** **Total =** **$0.00**

EXTERIOR **4115** **Exterior Column/Post** **Wood**

Feature Description: Posts support porch frame which wraps around the North and East elevations.

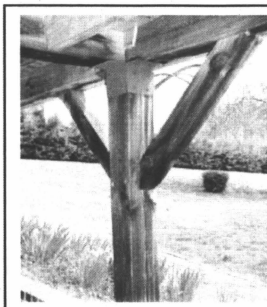
Feature Notes: Basement level are constructed of ratchet sawn yellow pine timbers. Portions of framework were replaced in 1995. Framework was fully replaced between 1988-89.

Feature Condition: Good **Total Inventory:** 4 solid yellow pine posts

Historic Rating: T **Priority:** none

Deficiency: No deficiency noticed during investigation year 2000.

Recommendation: none



Heavy timber post

Materials: **Labor:** **Quantity:** **Total =** **$0.00**

http://crs.sero.nps.gov/historic/hsar/anjo/pd.htm

EXTERIOR | **4116** | **Cornice** | **Brick**

Feature Description: Brick cornice was a component of the west (front) and east elevations of the original houses . The 1869 addition obscured the cornice on the east elevation. The cornice is composed of two molded bricks, a concave profile surmounted by a convex profile. Below these bricks is a dental pattern achieved by alternating recessed and projecting bricks.

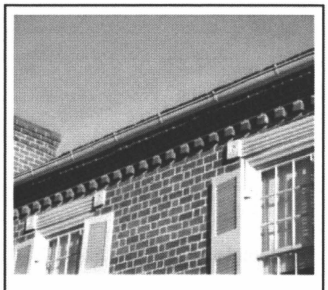
Feature Notes: The cornice on the east elevation is original to the house; the west cornice was reconstructed according to the former.

Feature Condition: Good **Total Inventory:** 88 l.f.

Historic Rating: H/T **Priority:** Minor

Deficiency: No deficiency noticed during investigation year 2000.

Recommendation: Repointing should be scheduled every 10 to 15 years. Joints should be routinely inspected by park staff following freeze/thaw conditions between winter and spring.



West elevation

Materials: **Labor:** **Quantity:** **Total =** **$0.00**

EXTERIOR | **4117** | **Eave/Soffit** | **Wood**

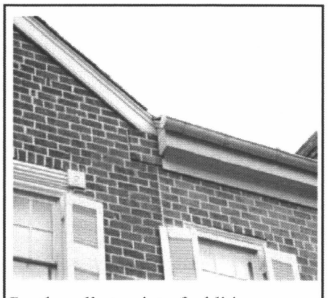
Feature Description: The rooflines of the north, south, and east elevations are framed by wooden eaves with rake boards on the gabled ends of the house proper and a soffit along the eastern addition to the south elevation.

Feature Condition: 80% Fair, 20% Poor **Total Inventory:** 164 l.f.

Historic Rating: T **Priority:** Minor

Deficiency: Although the rake boards appear to be in good condition, the soffit, or cornice boards, are in poor condition, showing signs of water penetration.

Recommendation: Scrape and paint. Remove deteriorated wood where necessary. Include in repainting, see item **4160** for exterior finishes.



South wall at point of addition

Materials: **Labor:** **Quantity:** 33 l.f. **Total =** **$0.00**

EXTERIOR **4120** **Exterior Ceiling Surface/Cover** **Wood/Plaster**

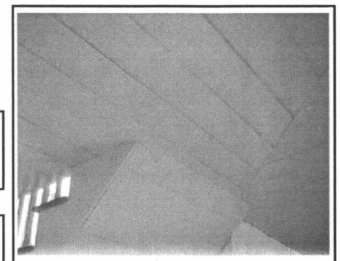
Feature Description: Ceiling planks are made up of 1" by 8" matched sheathing with a 3/16" bead at the joint. Second floor ceiling is plaster, as was the original.

Feature Condition: Good to Fair **Total Inventory:** 1696 s.f.

Historic Rating: T **Priority:** Minor

Deficiency: Cracking paint on second floor ceiling.

Recommendation: Patch during next scheduled painting.
Include in routine inspection of all exterior painted surfaces.



First floor level stair

Materials: **Labor:** **Quantity:** **Total =** **$0.00**

EXTERIOR **4131** **Exterior Floor Structure** **Wood**

Feature Description: The lowest level of the porch is a heavy-timber frame of rough-sawn heart pine. The upper level floors are constructed with nominal dimension lumber and are not exposed.

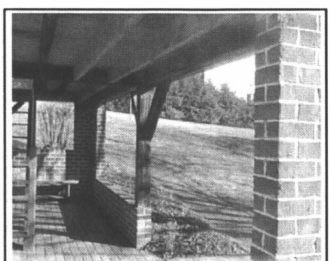
Feature Notes: Because a large portion of the underside of the first floor decking is exposed, care was taken in the first restoration to frame this deck in the same manner as the original. The material used was dense (8 or more rings per inch) yellow pine. All exposed members of this frame and the under side of the flooring above were sized on a band resaw to duplicate original saw marks. A band resaw with a wide set in its teeth will duplicate the saw markings of an old type vertical mill saw.

Feature Condition: Good **Total Inventory:** 2034 s.f.

Historic Rating: T **Priority:** none

Deficiency: No deficiency noticed during investigation year 2000.

Recommendation: none



Basement level of porch

Materials: **Labor:** **Quantity:** **Total =** **$0.00**

EXTERIOR **4132** **Exterior Floor Decking** **Wood**

Feature Description: The porch deck is constructed from 5 1/4" by 1 1/8" heart pine plank, aligned by tongue and groove. Most planks on the west section are continuous (no seams) from wall to edge of porch, though some are butt-jointed.

http://crs.sero.nps.gov/historic/hsr/anjo/pd.htm

EXTERIOR | **4132** | **Exterior Floor Decking continued** | **Wood**

Feature Condition: 50% Fair
50% Good
Total Inventory: 1696 s.f.

Historic Rating: T
Priority: Minor

Deficiency: Joints have separated; boards are curling.

Recommendation: In future replacements, planks should be placed with all rings facing up to resist curling effect. A superior grade, 1/4 sawn lumber must be specified. A certain percentage of flat sawn lumber may have to removed from the batch and hence accounted for in the ordering.


Second floor decking

Materials: $6,784.00 **Labor:** $3,400.00 **Quantity:** 1696 SF **Total =** **$10,184.00**

EXTERIOR | **4133** | **Exterior Railing/Balustrade** | **Wood**

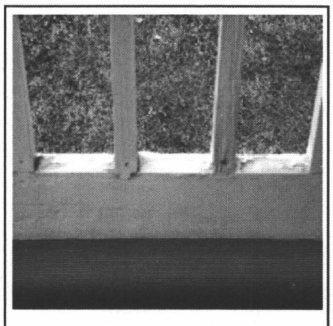
Feature Description: The railing was reconstructed according to a fragment found imbedded in one of the building's alterations done around 1930. The section includes a curved handrail, 1" square spindles, and a 1" by 5" bottom rail. The railing runs in between the eight posts of the first and second floor porch.

Feature Condition: Fair
Total Inventory: 190 l.f.

Historic Rating: T
Priority: Minor

Deficiency: The spindles were fastened with nongalvanized nails, which has resulted in corrosion, evident by rust stains. In addition, there is chipped and pealed paint.

Recommendation: Scrape and repaint railing. Replace any areas where rusted fasteners are present. New construction should specify hot-dipped, double galvanized nails.


Second floor railing

Materials: $300.00 **Labor:** $800.00 **Quantity:** 190 l.f. **Total =** **$1,100.00**

EXTERIOR | **4140** | **Exterior Window Unit** | **Wood**

Feature Description: All windows are double hung sash type with shutters and dogs. Windows of the house proper (constructed prior to 1869) are surmounted by a wooden lintel including a fluted header with two bull's eye corner blocks. Sizes vary to accommodate 6/6, 9/6, and 12/12 sash. Glass size of all sash is 8" by 10."

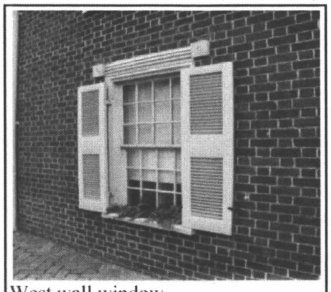
EXTERIOR **4140** **Exterior Window Unit continued** **Wood**

Feature Condition: Good **Total Inventory:** 22 each

Historic Rating: H/T **Priority:** Varies

Deficiency: see items **4141 - 4148**

Recommendation: see items **4141 - 4148**


West wall window

Materials: **Labor:** **Quantity:** **Total =** **$0.00**

EXTERIOR **4141** **Exterior Window Frame** **Wood**

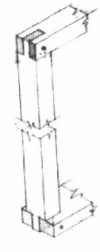
Feature Description: Simple wooden frame with mortise and tenon joinery, covered by brick surface.

Feature Condition: Good **Total Inventory:** 22 each

Historic Rating: H **Priority:** None

Deficiency: Not visible, though sash operation implies frame is intact.

Recommendation: none


construction detail

Materials: **Labor:** **Quantity:** **Total =** **$0.00**

EXTERIOR **4144** **Exterior Hardware** **Metal**

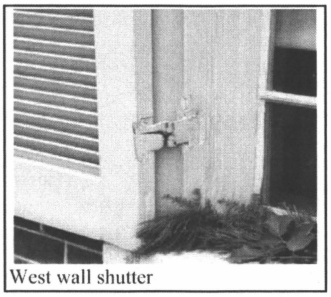
Feature Description: Shutters are attached to window frame by means of hinges. Each shutter has two screw mounted hinges.

Feature Condition: 6 Poor 38 Good 44 Fair **Total Inventory:** 88 each

Historic Rating: T **Priority:** Serious

Deficiency: Four hinges are missing hinge pins, some have cracked, and many are corroding.

Recommendation: Replace or repair cracked and damaged hinges. Repaint with rust inhibitor.


West wall shutter

Materials: $250.00 **Labor:** $360.00 **Quantity:** 20 **Total =** **$610.00**

http://crs.sero.nps.gov/historic/hsar/anjo/pd.htm

EXTERIOR	4145	Exterior Window Sill	Wood

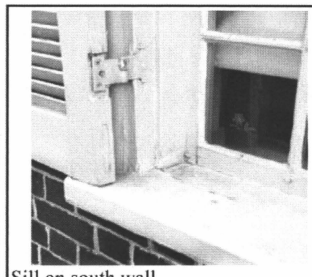
Feature Description: Wooden sill resting on brick wall.

Feature Condition: Good to Fair **Total Inventory:** 22 each

Historic Rating: H/T **Priority:** Minor

Deficiency: Sills have cracked paint and show signs of wood deterioration.

Recommendation: Scrape and repaint all sills.


Sill on south wall

Materials: $300.00 **Labor:** $600.00 **Quantity:** 22 **Total =** **$900.00**

EXTERIOR	4147	Exterior Window Shutters	Wood

Feature Description: Louvered shutter sets on each window.

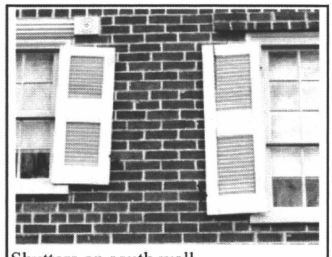
Feature Notes: Last repainted 1995. Last rebuilt in 1990.

Feature Condition: 20 Poor 24 Fair **Total Inventory:** 44 each

Historic Rating: T **Priority:** Serious

Deficiency: Shutters showing signs of wood deterioration.

Recommendation: Replace all shutters to match existing design.


Shutters on south wall

Materials: $800.00 **Labor:** $2,200.00 **Quantity:** 44 **Total =** **$3,000.00**

EXTERIOR	4148	Exterior Window Lintel	Wood

Feature Description: The windows of the original house are capped by a fluted moulding (1.25" thick) and two bull's eye (1.5" thick each) corner blocks. The moulding is recessed behind the brick line, while the corner blocks project beyond it. Both elements are incorporated directly into the masonry and not secured to the window frame.

Feature Condition: Good **Total Inventory:** 9 each

Historic Rating: T **Priority:** Cyclic

Deficiency: No deficiency noticed during investigation year 2000.

Recommendation: Repainting should be scheduled every 6 years.


Detail of west wall lintel

EXTERIOR **4148** **Exterior Window Lintel continued** **Wood**

Materials: **Labor:** **Quantity:** 9 **Total =** **$0.00**

EXTERIOR **4148** **Exterior Window Lintel** **Brick**

Feature Description: English flat arch used on windows for the south elevation addition.

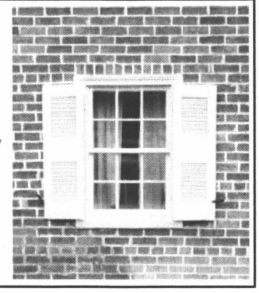
Feature Condition: Good **Total Inventory:** 5 each

Historic Rating: H/T **Priority:** None

Deficiency: No deficiency noticed during investigation year 2000.

Recommendation: none

South wall kitchen window



Materials: **Labor:** **Quantity:** **Total =** **$0.00**

EXTERIOR **4151** **Exterior Door Frame** **Wood**

Feature Description: The entrance frame is an elaborate construction including two sidelight sashes, a transom sash, and four raised panels, all enclosed by two engaged piers, a double lintel, and a projecting cornice with dentil moulding. Aside from the entrance door, the Homestead has nine other exterior doors which are simply framed.

Feature Notes: Door frames are composed of joined and mitered boards, set into the masonry wall structure and faced with decorative moulding.

Feature Condition: Fair **Total Inventory:** 10 each

Historic Rating: T **Priority:** Serious

Deficiency: Woodwork in the entrance frame shows deterioration which may be attributed to water penetration from the lintel (item **4158**).

Recommendation: see item **4158**

West door



Materials: **Labor:** **Quantity:** **Total =** **$0.00**

http://crs.sero.nps.gov/historic/hsar/anjo/pd.htm

EXTERIOR **4152** **Exterior Door** **Wood**

Feature Description: The Homestead has a variety of exterior doors. Some are original, but most are reproductions designed according to the original conditions. The front door is composed of six raised panels. The doors accessing the rear porch include 1 four vertical-panel door, 3 five horizontal-panel doors, 1 six vertical-panel door, and 1 eight-panel with mixed orientation. At the basement level, there are 3 board and batten doors.

Feature Notes: All doors are painted white, except the front door, which has an application of wood grain.

Feature Condition: 1 Fair
9 Good

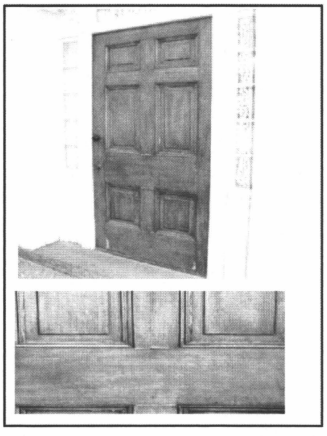
Total Inventory: 10 each

Historic Rating: T

Priority: Serious

Deficiency: The finish on the front door is peeling and cracking due to water penetration. According to park staff, the finish was guaranteed by craftsman Rick Adamson.

Recommendation: Before the door is repaired, remedies should be made to adjacent problems with item **4158**.



Materials: **Labor:** **Quantity:** **Total =** **$0.00**

EXTERIOR **4154** **Exterior Door Hardware** **Porcelain/Metal**

Feature Description: Both doors leading to the foyer (from the east and west) and those doors to Rooms 5, 6, 9, 10, and the upstairs hall, are equipped with a metal stem, porcelain knob and a keyed metal lock. The 3 board and batten doors at the basement level are secured by a latch-type handle.

Feature Notes: The historic locks are no longer in use; all doors are supplemented with non-historic dead-bolts to secure the rooms when tours are not in session.

Feature Condition: Good

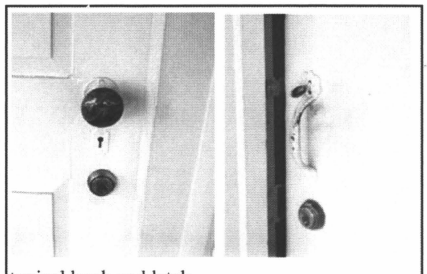
Total Inventory: 10 each

Historic Rating: T

Priority: None

Deficiency: No deficiency noticed during investigation year 2000.

Recommendation: none



typical knob and latch

Materials: **Labor:** **Quantity:** **Total =** **$0.00**

EXTERIOR **4155** **Exterior Door Threshold** **Wood**

Feature Description: The two primary doors of the Homestead are located on the west (front) and east elevations at the street level. Each door is recessed from the wall. Each door frame contains a wooden sill.

Feature Notes: The sill on the east elevation is under cover of the porch, while the sill on the west is directly exposed to the elements.

Feature Condition: 8 Good
2 Fair

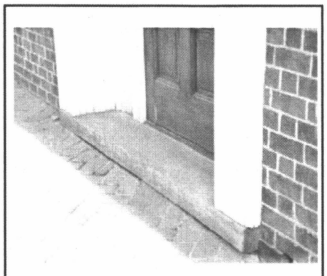
Total Inventory: 10 each

Historic Rating: T

Priority: Minor

Deficiency: The west sill (front door) is suffering from water damage, both from direct contact with the pavement and from a recurring problem with excess run-off from the roof. In addition there appears to be leaking from the lintel above the door. The store room door (south elev.) shows exposure damage from sun/rain.

Recommendation: Replace after correction of west-wall moisture problem. Replace with matching wood species.



Entrance door, west elevation

Materials: $400.00 **Labor:** $1,100.00 **Quantity:** 2 **Total =** **$1,500.00**

EXTERIOR **4158** **Exterior Door Lintel** **Wood**

Feature Description: The 9 doors of the rear elevations all have an English flat arch lintel. The masonry above the front door is obscured by a decorative wooden lintel incorporated with the door frame. The lintel is composed of two beams marked by a small dentil moulding. Above this is a cornice resting on mutules. The cornice is capped by a header board.

Feature Notes: The existing classical frame and lintel is an authentic feature of the building, though it masks the original entrance frame (1851-1869), which is more modest in nature, and resembles the window lintels with a beam and two endblocks.

Feature Condition: 9 Good
1 Poor

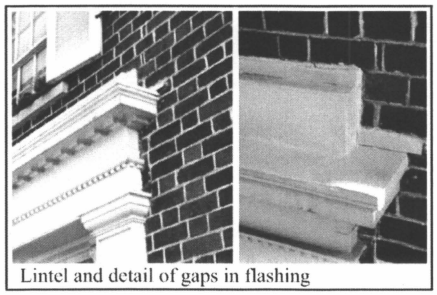
Total Inventory: 10 each

Historic Rating: T

Priority: Serious

Deficiency: Above the cornice, a gap between the brick wall and flashing is allowing water to penetrate behind the woodwork.

Recommendation: Restore flashing immediately. Contact Christian Bookter for specifications. Remove wooden spacer from construction and replace with brick.



Lintel and detail of gaps in flashing

Materials: $200.00 **Labor:** $500.00 **Quantity:** 1 **Total =** **$700.00**

EXTERIOR **4160** **Exterior Finish** **Paint**

Feature Description: Portions of the east and north elevations enclosed by the porch are whitewashed. The effect was duplicated by using a flat oil base cement paint with a silicon stippling agent added to leave brush marks. Modern paints are all self-leveling to eliminate the brush marks which were so characteristic of older work.

http://crs.sero.nps.gov/historic/hsar/anjo/pd.htm

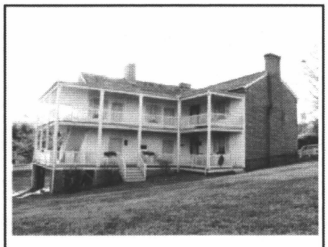
EXTERIOR | **4160** | **Exterior Finish continued** | **Paint**

Feature Condition: Good **Total Inventory:** 1170 s.f.

Historic Rating: T **Priority:** Cyclic

Deficiency: No deficiency noticed during investigation year 2000.

Recommendation: Re-paint windows, shutters, porch railings, posts, and soffit according to schedule of work, as detailed individually.



Homestead from south

Materials: **Labor:** **Quantity:** **Total =** **$0.00**

EXTERIOR | **4170** | **Exterior Stair Surface** | **Wood**

Feature Description: The double flight of stairs accessing the three levels of the porch are constructed with bull nose tread, 10.25" wide, made from yellow heart pine. The single flight of stairs accessing the first floor on the north elevation is constructed with tongue and groove boards, doubled to form treads.

Feature Notes: The single flight stair treads are constructed ad hoc; boards are not seamed tongue to groove. The grooves are filled with dowels. This method is not historically accurate and should be remedied at next reconstruction.

Feature Condition: Fair **Total Inventory:** 25 l.f.

Historic Rating: T **Priority:** Minor

Deficiency: Deteriorated side stair.

Recommendation: Reconstruct side stair with solid planks with beveled edge or accurately assembled tongue-and-groove planks.

Side stair



Materials: $100.00 **Labor:** $200.00 **Quantity:** 3 **Total =** **$300.00**

FEATURE INVENTORY: INTERIOR ENVELOPE

Walls - Ceilings - Floors - Windows - Doors - Finishes

All Estimable Items

Materials:	$15,300.00	**Labor:**	$23,400.00	**Total =**	**$38,700.00**

INTERIOR 4210 Interior Wall Surface Plaster

Feature Description: The original plaster was applied directly to the brick walls and to wood lath, both riven and sawn, on ceilings. Most of the existing plaster was applied during the renovation in 1959 and was fixed to 4.0 lb. 3/8" rib wire lath, except on the ceiling, where standard gypsum lath was used in conjunction with electric heat cable.

Feature Notes: Sidewalls were finished with a screened gypsum plaster with a special fine vermiculite aggregate, giving a hard and smooth finish.

Feature Condition: Good 80%
Poor 20%

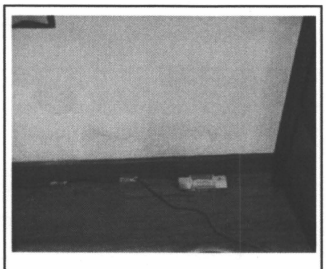
Total Inventory: 4262 s.f.

Historic Rating: T

Priority: Serious

Deficiency: Instances of rising damp in Rooms 2 and 4 were active, but today the rooms may be dry. Signs of efflorescence. Cracking plaster near fireplace in room # 10.

Recommendation: Delay patch and refinish of deteriorated plaster until site drainage is remedied. Continue to monitor conditions after repair.



Kitchen wall (Room 2)

Materials:	$2,300.00	**Labor:**	$5,700.00	**Quantity:**	850 SF	**Total =**	**$8,000.00**

INTERIOR 4213 Interior Wall Trim Wood

Feature Description: All finished interior rooms have a baseboard moulding 5 3/16" tall with a 1 1/16"half-round bevel at the top. Room 3 has a chair rail composed of a 1 1/4" by 3 5/8" slat capped with a 2" by 13/16" ledge. Rooms 5 and 6 have a chair rail composed of a 1 1/8" by 3 7/8" slat with a 7/16" half-round bevel at the base capped by 2 3/4" by 1 1/8" ledge with a half-round profile.

Feature Condition: Good

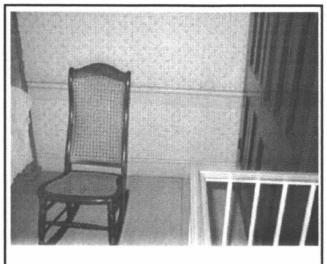
Total Inventory: 553 l.f.

Historic Rating: T

Priority: None

Deficiency: No deficiency noticed during investigation year 2000.

Recommendation: none



Room 9

Materials:		**Labor:**		**Quantity:**		**Total =**	**$0.00**

http://crs.sero.nps.gov/historic/hsar/anjo/pd.htm

INTERIOR **4218** **Interior Fireplace**

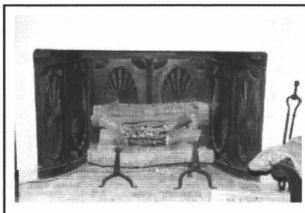
Feature Description: Cast iron firebox with 4 jambs. Not original to the Homestead, replaced in 1959. Located in Rooms 4 and 3, the fireboxes are encased with stucco. All chimneys are capped.

Feature Condition: Good **Total Inventory:** 2 each

Historic Rating: T **Priority:** None

Deficiency: No deficiency noticed during investigation year 2000.

Recommendation: none



Andrew Johnson bedroom

Materials: **Labor:** **Quantity:** **Total =** **$0.00**

INTERIOR **4218** **Interior Fireplace**

Feature Description: Brick firebox, brick hearth located in Rooms 2 (kitchen), 5, 6 (dining room), 7, and 8. All fireplaces are capped in stucco and framed with a wood mantel. All chimneys are capped.

Feature Condition: Good **Total Inventory:** 5 each

Historic Rating: T **Priority:** None

Deficiency: No deficiency noticed during investigation year 2000.

Recommendation: none



Kitchen hearth

Materials: **Labor:** **Quantity:** **Total =** **$0.00**

INTERIOR **4220** **Interior Ceiling Surface** **Plaster/Wood**

Feature Description: Interior ceiling surfaces are covered in plaster, except for Rooms 7, 8, and the upstairs hall, which are covered in wood boards.

Feature Notes: All the ceilings were replastered during the 1959 restoration. Because the ceilings are equipped with electric heat cable, plaster was applied to standard gypsum lath. The wood ceilings are an original feature of the Homestead.

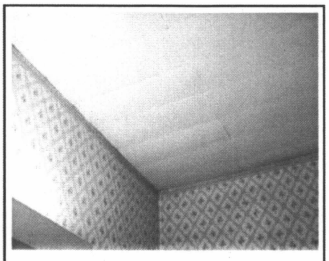
INTERIOR **4220** **Interior Ceiling Surface - continued** **Plaster/Wood**

Feature Condition: Good to Fair **Total Inventory:** 3008 s.f.

Historic Rating: T **Priority:** Minor

Deficiency: Wood boards are cupping, especially in Room 7 along west wall. Instances of cracked plaster in Room 9. Signs of efflorescence in Rooms 4 and 3

Recommendation: Time replacement of cupped boards with installation of sprinkler system. Maintain wood species, finish, and construction details.



Room 7

Materials: $200.00 **Labor:** $400.00 **Quantity:** 25 SF **Total =** **$600.00**

INTERIOR **4230** **Interior Floor Surface** **Wood**

Feature Description: All the wood floors on the first and second level are original, though they were refinished in 1959. At that time, a new floor, hand-tooled and constructed from random width pine, was added to the kitchen.

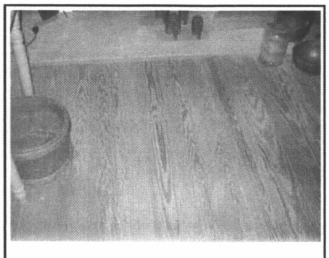
Feature Notes: The floors are concealed by a protective covering in all the rooms of the first and second level. The kitchen floor is uncovered and rests on a concrete slab with a vapor barrier.

Feature Condition: Good **Total Inventory:** 3008 s.f.

Historic Rating: T **Priority:** None

Deficiency: No deficiency noticed during investigation year 2000.

Recommendation: none



Kitchen floor

Materials: **Labor:** **Quantity:** **Total =** **$0.00**

INTERIOR **4231** **Interior Floor Structure** **Wood**

Feature Description: The 3 inch wide by 7.5 inch deep framing at 24 inches on center spans 18.7 feet and runs in the east-west direction throughout the second floor. On the first floor the framing, visible from the crawl space, is similar except that the spans are somewhat less due to the greater thickness of the lower level walls and the additional joists attached to the original framing as part of the 1957 renovations.

Feature Notes: The first floor structure has been strengthened by doubling joists or adding "sister" beams to account for problematic spans or deteriorated lumber. Non-original beams have been branded with their date of installation.

http://crs.sero.nps.gov/historic/hsar/anjo/pd.htm

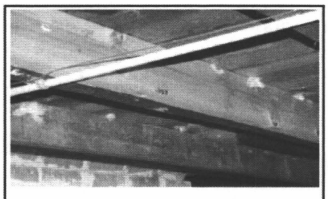
INTERIOR | **4231** | **Interior Floor Structure - continued** | **Wood**

Feature Condition: Fair **Total Inventory:** 2752 s.f.

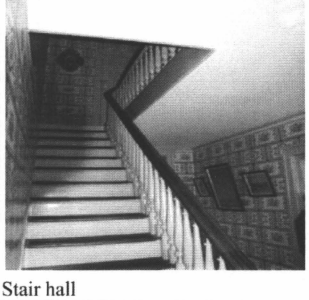
Historic Rating: H **Priority:** Critical

Deficiency: From William Russell's report (8/99) first floor appeared stiffer than second. Flexibility in stair hall framing may be due to unengaged joists.

Recommendation: An architectural destructive investigation is necessary to determine what remedial action is necessary to strengthen the floor and/or stiffen it. The effectiveness of the added joists should be determined by removing the trim around the stair to expose the added joists and their attachment, if any, to the flooring and adjacent structural members. If the added joists are not engaged, then attaching them would provide adequate strength and marginal stiffness. It may be that the ends of the joists have rotted in the masonry pockets. In such case, a half-lap splice should be added once a vapor barrier is put in place. Greater stiffness could be achieved by increasing the size of the joists as well as attaching them to the flooring. Construction must include provisions for dust protection, equipment usage curtailment, protection of existing work, and temporary shoring and bracing.



Branded "sister" beam beneath Johnson bedroom



Stair hall

Materials: $8,400.00 **Labor:** $12,600.00 **Quantity:** 300 SF **Total =** **$21,000.00**

INTERIOR | **4241** | **Interior Window Frame** | **Wood**

Feature Description: Interior window conditions are characterized by a wide sill (9" on the first floor, 5 1/2" on the second floor) encased by wood panels.

Feature Condition: Fair **Total Inventory:** 22 each

Historic Rating: H **Priority:** Minor

Deficiency: Appears to be some water penetration along the sills which is affecting frame and moulding.

Recommendation: Monitor. Repair where necessary.



First floor window

Materials: $300.00 **Labor:** $600.00 **Quantity:** **Total =** **$900.00**

INTERIOR **4242** **Interior (Exterior) Window Sash** **Wood**

Feature Description: All glass panes are 8" by 10" in configurations of 6/6, 9/6, and 12/12. Sash frames are 1 3/8" wide with a 3" base and a 2" crown. Overlapping rails are 1 1/4".

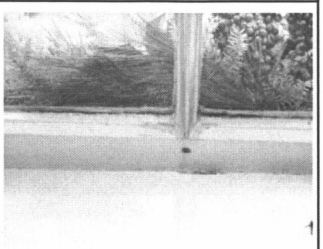
Feature Notes: The number of authentic glass panes varies among windows. Any replacements should be made with hand-processed, cold-rolled glass.

Feature Condition: Fair to Poor **Total Inventory:** 44 each

Historic Rating: H **Priority:** Minor

Deficiency: Cracked, loose glazing is causing paint to peel. There are also instances of fastener corrosion due to the use of non-galvanized nails.

Recommendation: Deconstruct sash and reapply glazing using a **linseed-based** putty only. Repaint.



First floor window

Materials: $800.00 **Labor:** $1,200.00 **Quantity:** 22 **Total =** **$2,000.00**

INTERIOR **4253** **Interior Door Trim** **Wood**

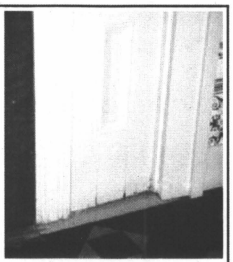
Feature Description: The sidelights and transom of the entrance door (west elevation) are framed in wood moulding. Incorporated with the door frame are raised wood panels, located beneath the sidelights.

Feature Notes: The woodwork is an original feature of the Homestead.

Feature Condition: Fair **Total Inventory:** 26 l.f.

Historic Rating: T **Priority:** Serious

Deficiency: Water has penetrated the woodwork, possibly entering through the wall or rising from the exterior threshold.



Interior west door frame

Recommendation: Sand, fill gaps, and repaint, once lintel has been repaired.

Materials: $300.00 **Labor:** $500.00 **Quantity:** 3 SF **Total =** **$800.00**

INTERIOR **4260** **Interior Finish** **Paint/Wallpaper**

Feature Description: All the rooms of the house are finished with wall paper, except for the kitchen. Consult the *Second Supplement to the Survey Report*, Henry A. Judd, 1959, for samples. All rooms, including the kitchen, have painted wall trim.

http://crs.sero.nps.gov/historic/hsar/anjo/pd.htm

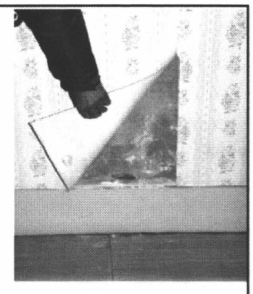
INTERIOR | **4260** | **Interior Finish - continued** | **Paint/Wallpaper**

Feature Notes: Evidence of the paint colors used for trim was revealed by stripping the original woodwork. The only room where evidence of the original wallpaper was discovered is room #8. Unfortunately, this room has since been re-wallpapered.

Feature Condition: Good to Poor **Total Inventory:** 3870 s.f.

Historic Rating: T **Priority:** Minor

Room 8



Deficiency: Separation of wallpaper due to rising damp in Rooms 4 and 8, in both cases along west wall.

Recommendation: Carefully remove wallpaper and set aside for later re-application. Remove damaged plaster, repatch, and refinish wall surface. Delay all repairs until source of water infiltration is determined. Repair cost included in item **4210**

Materials: **Labor:** **Quantity:** **Total =** see item **4210**

INTERIOR | **4282** | **Ceiling Insulation**

Feature Description: At the 1957 restoration, five inches of vermiculite insulation was poured over all second floor ceilings.

Feature Condition: Good **Total Inventory:** 1500 S.F.

Historic Rating: N **Priority:** Serious

Deficiency: low RH value

Recommendation: Replace with fiberglass batt insulation.

Materials: $3,000.00 **Labor:** $2,400.00 **Quantity:** 1500 SF **Total =** **$5,400.00**

FEATURE INVENTORY: ROOF

Surface - Structure - Chimney - Flashing - Downspout

All Estimable Items

Materials:	$23,350.00	**Labor:**	$38,900.00	**Total =**	**$62,250.00**

ROOF 4310 Roof Surface Wood/Metal

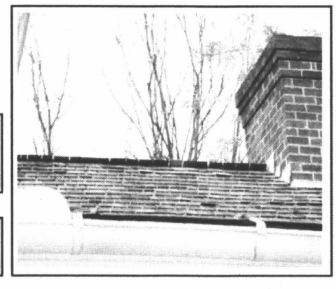
Feature Description: The first restored roof on the house was constructed from 5/8 inch by 4 inch by 20 inch drawn oak shingles, 6 inch to weather, set on 1 inch by 10 inch roof sheathing. The present roof is covered with variable width cedar shingles. The porch roof is covered with a standing seam roof. The distance between seams was kept to match the width of tin purchased by Johnson, according to his records.

Feature Condition: Good **Total Inventory:** 1290 s.f.

Historic Rating: T **Priority:** Cyclic

Deficiency: No deficiency noticed during investigation year 2000.

Recommendation: none



Materials:	**Labor:**	**Quantity:**	**Total =**	**$0.00**

ROOF 4311 Roof Structure Wood

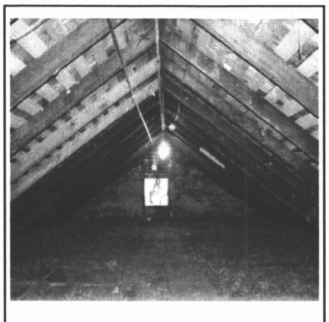
Feature Description: The wing running north/south along Main St. is the original building of the Homestead. From observation, rafters appear to be original, or at least pre-date the 1959 restoration.

Feature Condition: Good **Total Inventory:** 968 s.f.

Historic Rating: H **Priority:** Serious

Deficiency: A structural analysis of the original rafters shows that the rafters, assuming a good grade of southern pine, are strong enough (in shear stress, axial stress, and bending stress) to comply with current building codes. Since the ridge member provides little support for the roof loads, the rafters must support a horizontal thrust of approximately 500 pounds per rafter at the eave. The "toenails" between the rafters and the sill must carry this thrust. Since each "toenail" can only carry about 70 pounds, the existing "toenails" are not sufficient to carry the full dead load and roof live load.

Recommendation: Reinforce connection.



North/south wing

http://crs.sero.nps.gov/historic/hsar/anjo/pd.htm

ROOF | **4311** | **Roof Structure continued** | **Wood**

Feature Description: The east-west portion of the roof was added to the Homestead after 1869. It covers the rooms of the east-west wing, including the access door to the attic.

Feature Condition: Poor **Total Inventory:** 680 s.f.

Historic Rating: H **Priority:** Critical

Deficiency: The reused rafters do not directly attach to the ridge member but rather stop approximately 13.5" short of the ridge. 1x lumber is scabbed onto the sides of the rafters to connect to the ridge. A structural analysis of these rafters shows that the rafters, even assuming a reasonably good grade of southern pine, are not strong enough to comply with current building codes.

Recommendation: These rafters should be reinforced or given additional support. Since the rafters are undersized, inadequately connected at the eave, and not directly attached to the ridge, it is recommended that roof beams be added to relieve the rafters and their connections of most of the roof load. These additional beams would also allow the existing rafters to remain intact and relatively undisturbed. Four beams would be required with spans of approximately 15 feet and widths of 3.5" and depths of about 12". Since access to the attic space is limited without removing some of the roofing, it may be preferable to construct the beams with a combination of dimension lumber and plywood, which can be passed through the ceiling hatch and assembled in the attic space.



East/west wing

Materials: $23,250.00 **Labor:** $38,400.00 **Quantity:** **Total =** **$61,650.00**

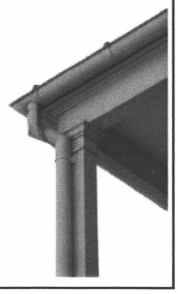
ROOF | **4351** | **Gutter/Downspout** | **Metal**

Feature Description: Half-round gutter 4 7/8 inch diameter mounted with gutter spikes. Drainage is conveyed into round downspouts 2 5/8 inch diameter. All constructed from tin, as was typical in Johnson's time period.

Feature Condition: Good to Poor **Total Inventory:** 242 l.f.

Historic Rating: T **Priority:** Serious

Deficiency: Rust on interior of north elevation gutter as evidenced by stains running from downspout. The overhang of the shingles at the west elevation gutter or the southward slope of the gutter may be causing water runoff down the face of the Homestead.



downspout at northeast corner

Recommendation: Sand north gutters down to the bare metal, removing rust and paint. Prime and repaint. Verify correct gutter slope on west elevation. Correct gutter overtopping above southwest wall of ell. Maintain rigorous and frequent cleaning schedule for gutters and trench drain.

Materials: $100.00 **Labor:** $500.00 **Quantity:** 120 LF **Total =** **$600.00**

FEATURE INVENTORY: FOUNDATION

FOUNDATION **4413** **Foundation Vent** **Brick**

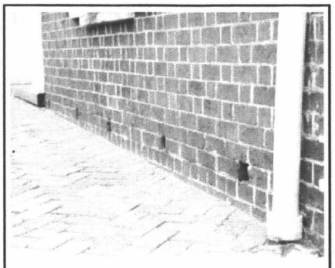
Feature Description: Gaps in brick wall located on the east and west elevations allow air flow from unexcavated areas in the basement.

Feature Condition: Good **Total Inventory:** 10

Historic Rating: H **Priority:** Minor

Deficiency: No deficiency noticed during investigation year 2000.

Recommendation: Ensure screens are in place to deter rodent entry.



Vents along Main St. elevation

Materials: **Labor:** **Quantity:** **Total =** **$0.00**

FEATURE INVENTORY: FIRE/LIFE/HEALTH SAFETY

FIRE SAFETY **4730** **Fire Suppression System** **Dry**

Feature Description: None presently exist.

Feature Condition: **Total Inventory:**

Historic Rating: **Priority:** Critical

Recommendation: Ideally water service will come from off-site municipal water supply, assuming water pressure/volume is adequate for dry-pipe or pre-action system and no fire pump is required. Design for a pre-action sprinkler system throughout the building, possibly with on/off capability, such as "Fire-Cycle" system, or dry pipe system throughout building, zoned to correspond to use zones. Fire protection system water service, entry, and station should be located in ell cellar utility room in storeroom. Siamese fire department connection should be located adjacent to service parking area.

Mat. & Install. : $17,000.00 **Cont., Etc. :** $9,350.00 **Quantity:** **Total =** **$26,350.00**

http://crs.sero.nps.gov/historic/hsar/anjo/pd.htm

FEATURE INVENTORY: ELECTRICAL SYSTEMS

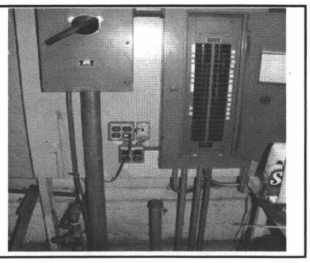
ELECTRICAL 5420 Primary Electrical Distribution System

Feature Description: When the house was restored in 1957, all existing electrical installations were removed and a new system was installed. An underground service was brought in from an existing pole on the northern property boundary to the new utility area under the porch. The trench contains three conduits: one for the present electrical system, one for the telephone line, and a third 1 1/2 ID, installed from below the panel to the outside of the footing and capped off on either end. This is for any future change of a utility and will eliminate any future need to break up the utility room floor.

Feature Notes: The underground line runs approximately 110 feet from the house. Main Distribution Panel: 225 amp, 4 wire 120-208 v. 3 ø solid neutral.

Feature Condition: Good **Total Inventory:** one distribution panel

Historic Rating: N **Priority:** Critical



Deficiency: It has been determined that the present system should be updated.

Recommendation: Replace main panel. Remove existing radiant heating subpanels and control panels and circuits, including portable heater receptacles. Add to subpanel for mechanical outbuilding if necessary. Add manual transfer switch and tie-in for portable generator connection for essential systems during power outage. Remove existing electrical wire from fixed conduit and replace.

Mat. & Install. : $16,000.00 **Cont., Etc. :** $8,800.00 **Quantity:** **Total =** **$24,800.00**

FEATURE INVENTORY: BUILDING UTILITIES

All Estimable Items

Materials:	$150,000.00	**Labor:**	$82,500.00	**Total =**	**$232,500.00**

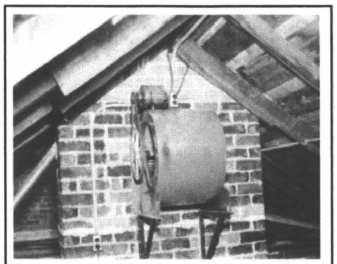
BLDG/UTIL **5873** **Ventilation system** **Metal**

Feature Description: The exhaust fan mounted to the chimney located between Rooms 5 and 6 pulls air from Rooms 3 and 8 and exhausts it out through the center flue. This provides ventilation to these rooms and other parts of the house, depending on which doors and windows are open.

Feature Condition: Good **Total Inventory:** 3

Historic Rating: N **Priority:** Critical

Deficiency: Inability to accurately control temperature and humidity of building interior endangers historic materials and artifacts.



Exhaust fan mounted to chimney

Recommendation: Install new system of ventilation. One air handler for low temperature first floor collections zone, located in ell cellar storeroom, with ducted air supply and return in cellar and crawl spaces below first floor. One air handler for low temperature second floor collections zone, located in ell attic, with ducted air supply and return in block and ell attics above second floor. Controlled source of outside air for each air handler zone. Intake(s) should be remote from street and from finished grade/landscaped areas. There should also be an exhaust fan for the restroom. System to be computer controlled with remote monitoring connectability.

Mat. & Instal. :	$150,000.00	**Cont., Etc. :**	$82,500.00	**Quantity:**	**Total =**	**$232,500.00**

BLDG/UTIL **5850** **Heating system** **Heat coil**

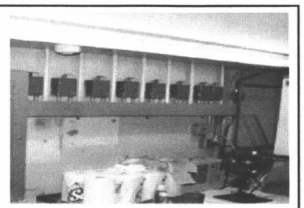
Feature Description: Ceiling heat system manufactured by Raywall Co. A radiant heat ceiling cable imbedded in ceiling plaster, spaced 1.5 inch on centers. Outlets (220v) were also placed in rooms 1,2,7, and 8 for individual space heaters.

Feature Notes: Inspection of imbedded cable as of August 1999 revealed that original system is in good condition.

Feature Condition: Good **Total Inventory:** 3008 s.f.

Historic Rating: N **Priority:** Critical

Deficiency: Electrical wiring may have exceeded its lifespan.



sub-panels for heat cables

Recommendation: Replace with natural gas-fired boiler with small volume hot water storage tank. Boiler may be located in in ell cellar storeroom. Hot water coils in two air handlers; one for first floor collections zone, one for second floor Collections zone. Perimeter hot water baseboard heat in Staff/Housekeeping zone.
Cost included in item **5873**.

http://crs.sero.nps.gov/historic/hsr/anjo/pd.htm

Materials: **Labor:** **Quantity:** **Total =** see item **5873**

BLDG/UTIL **5821** **Pump**

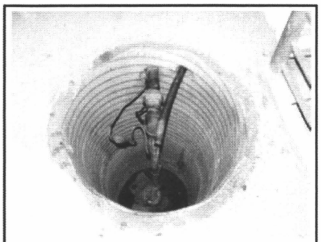
Feature Description: In Room 1 of the basement, a sump pump is mounted in the dirt floor to control any rise in the water table. The pump is a Webtrol model 30d513F and is connected to the sewer line.

Feature Condition: Good **Total Inventory:** 1

Historic Rating: N **Priority:** Minor

Deficiency: No deficiency noticed during investigation year 2000.

Recommendation: Sealing sump bottom with bentonite may reduce interior source moisture. Ensure that pump operates on demand by seasonal inspection.



culvert pipe housing pump

Materials: **Labor:** **Quantity:** **Total =** **$0.00**

FEATURE INVENTORY: ESTIMABLE COST TOTALS

Materials: $230,784.00 **Labor:** $172,110.00 **Total =** $402,894.00

http://crs.sero.nps.gov/historic/hsar/anjo/drawings.pdf

Graphic Documentation

Conjectural Representations of Homestead, ca. 1850 and ca. 1869 **52**

Floor Plans as restored (basement, first floor, and second floor), 1956 **53**

East Elevation as restored, 1956 **56**

West Elevation & Details as restored, 1956 **57**

South Elevation as restored, 1956 **58**

North Elevation as restored, 1956 **59**

East-West Section as restored, 1956 **60**

Electrical Installation (basement, first floor, second floor, and attic), 1956 **61**

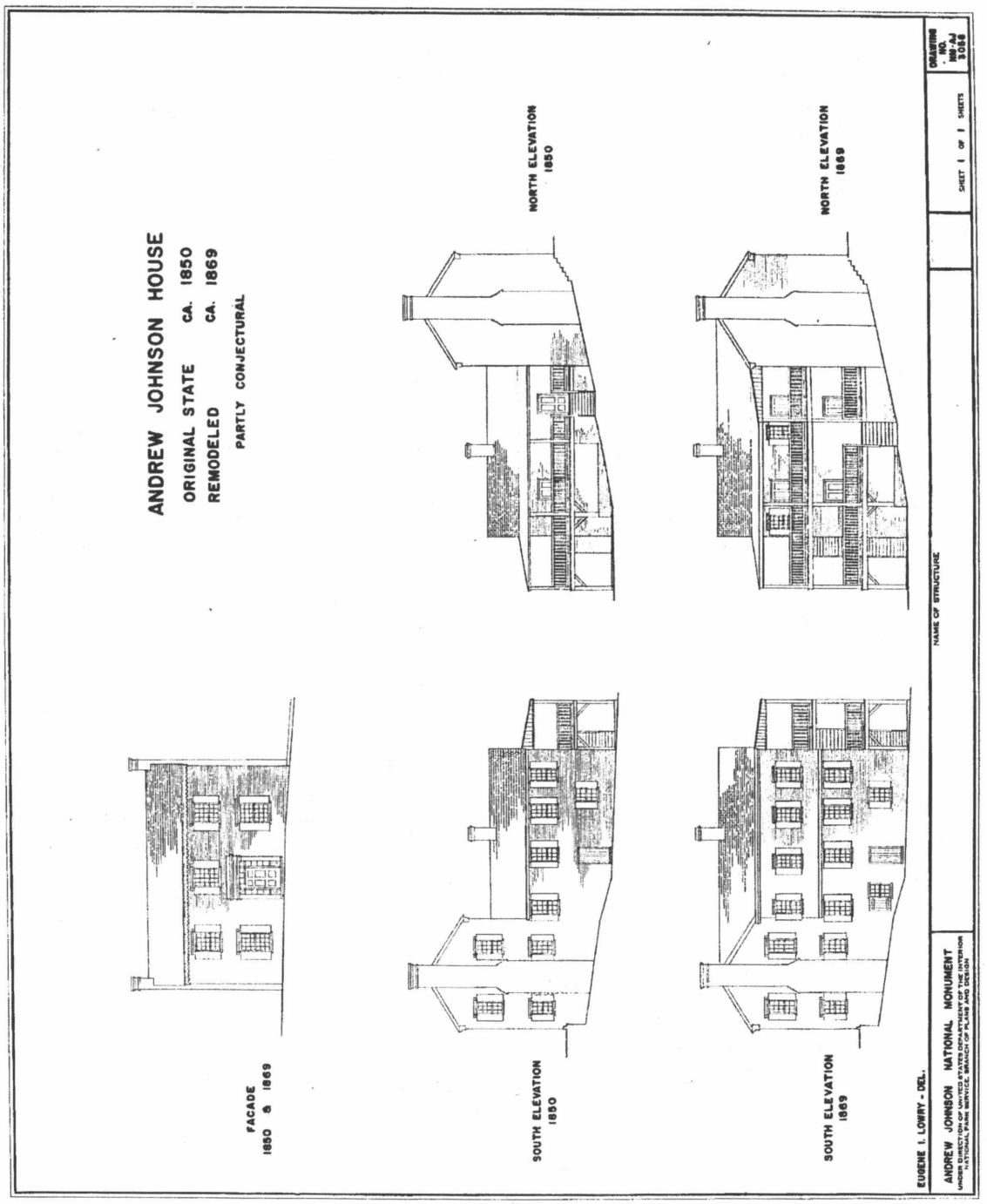
Porch Details as restored, 1956 **65**

Cornice Details as restored, 1956 **66**

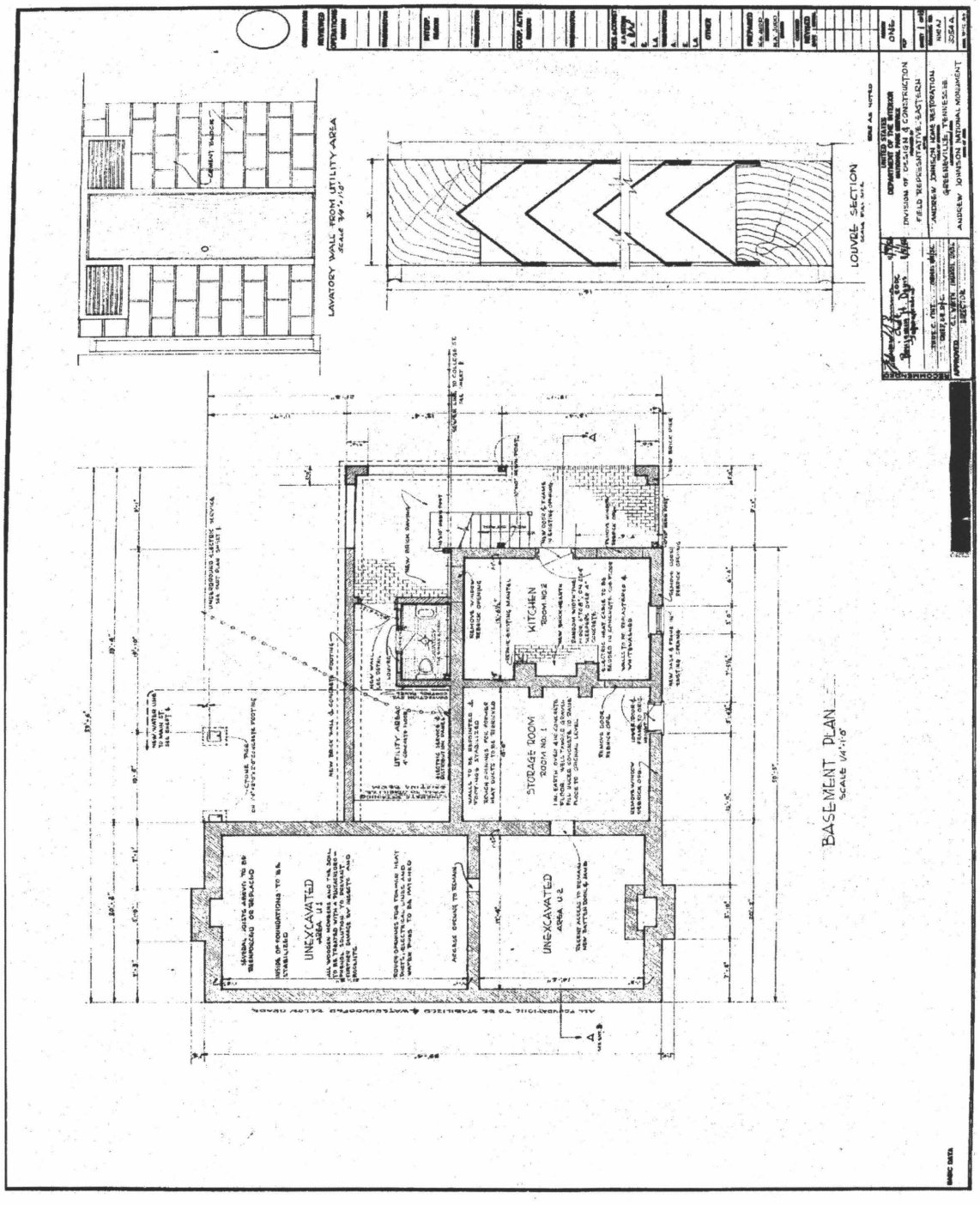
Window & Shutter Details as restored, 1956 **67**

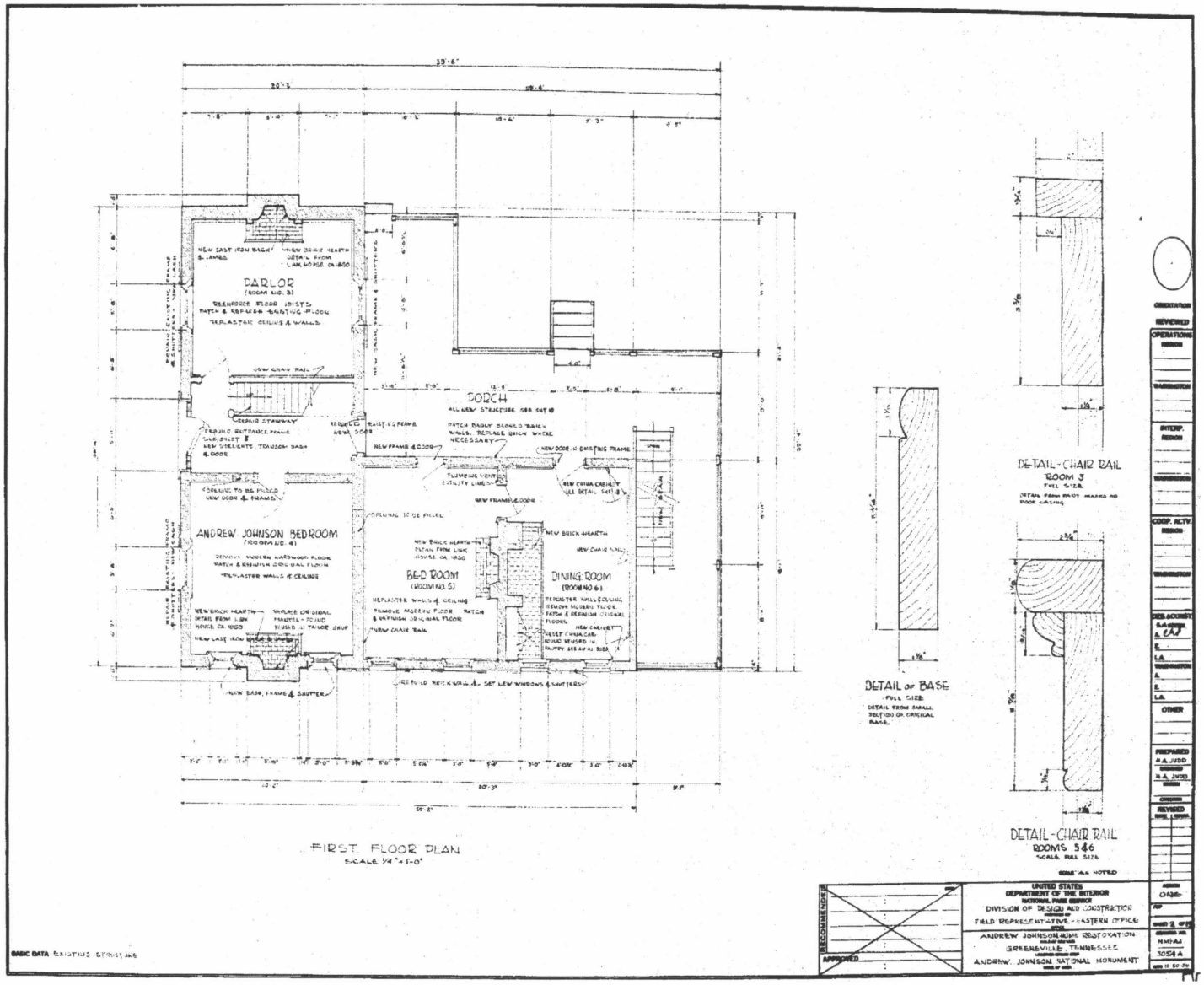
Window & Door Frame Details as restored, 1956 **68**

All drawings from Southeast Regional Office, Cultural Resources Microfiche Collection, Park ID 365. Original drawings are on file in storage (Federal Records Center, Denver).

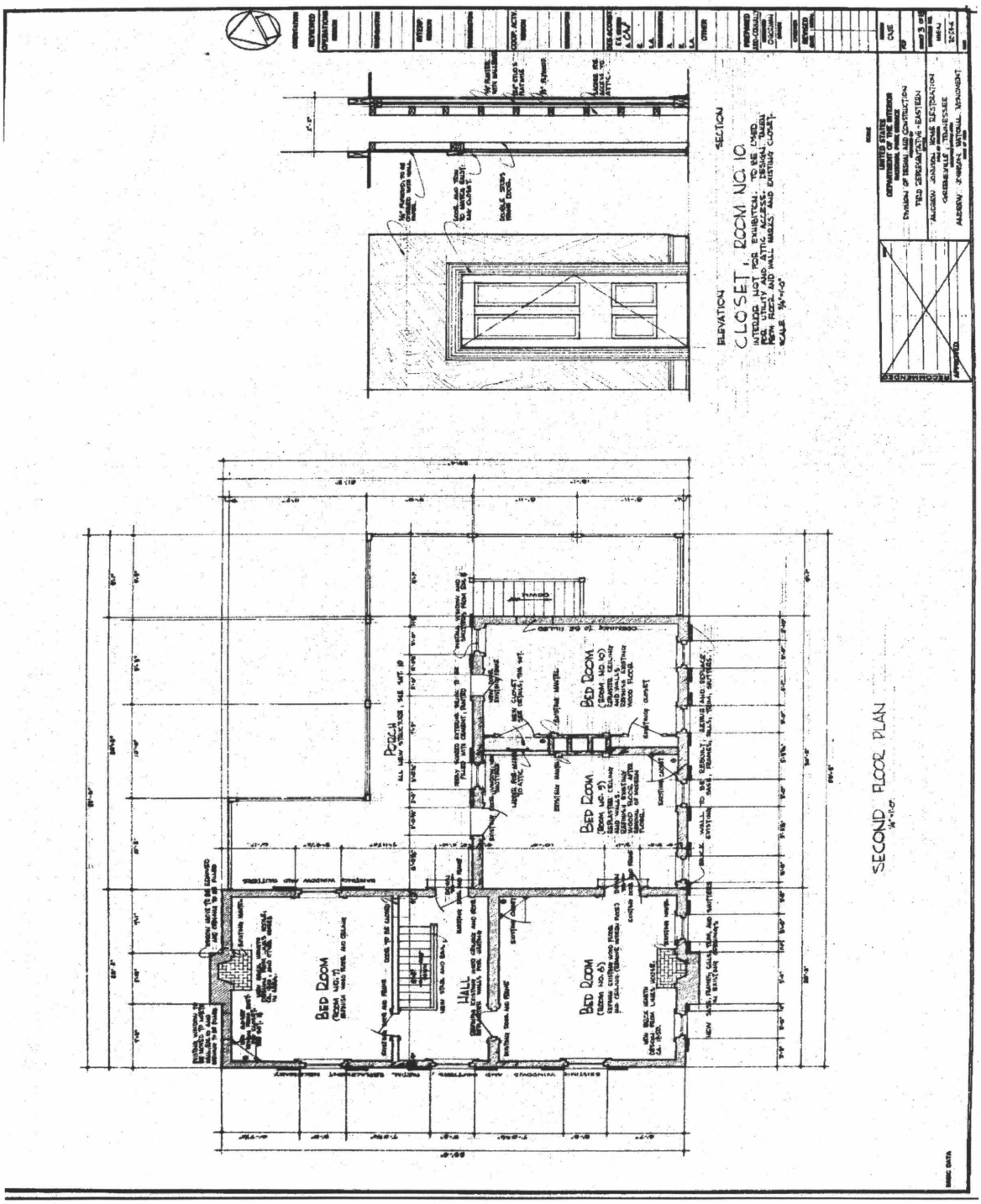

ANDREW JOHNSON HOUSE
ORIGINAL STATE CA. 1850
REMODELED CA. 1869
PARTLY CONJECTURAL
NORTH ELEVATION 1850
NORTH ELEVATION 1869
FACADE 1850 & 1869
SOUTH ELEVATION 1850
SOUTH ELEVATION 1869
EUGENE I. LOWRY - DEL.
NAME OF STRUCTURE
ANDREW JOHNSON NATIONAL MONUMENT
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE, BRANCH OF PLANS AND DESIGN
SHEET 1 OF 1 SHEETS
DRAWING NO. NHP-AJ 3008

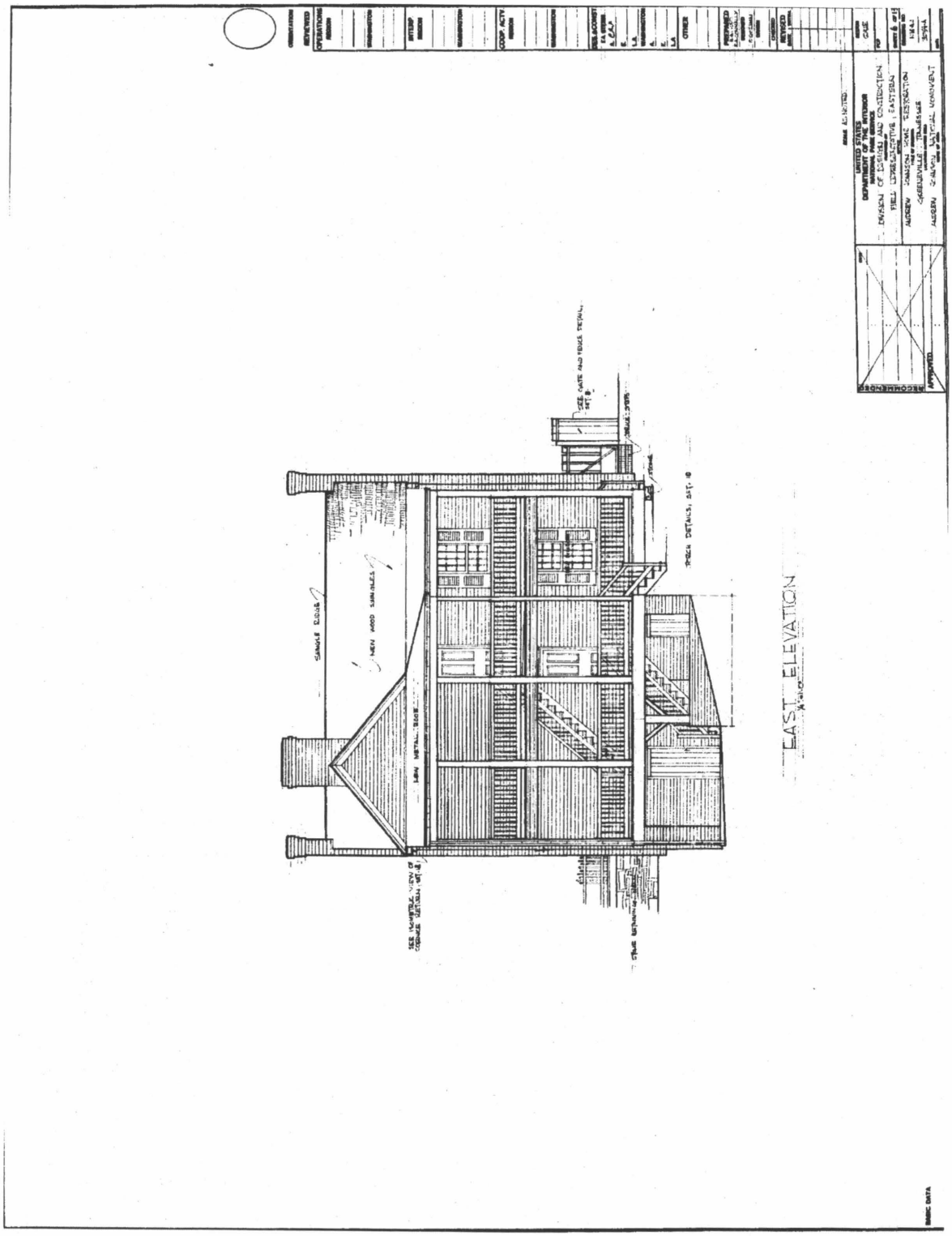
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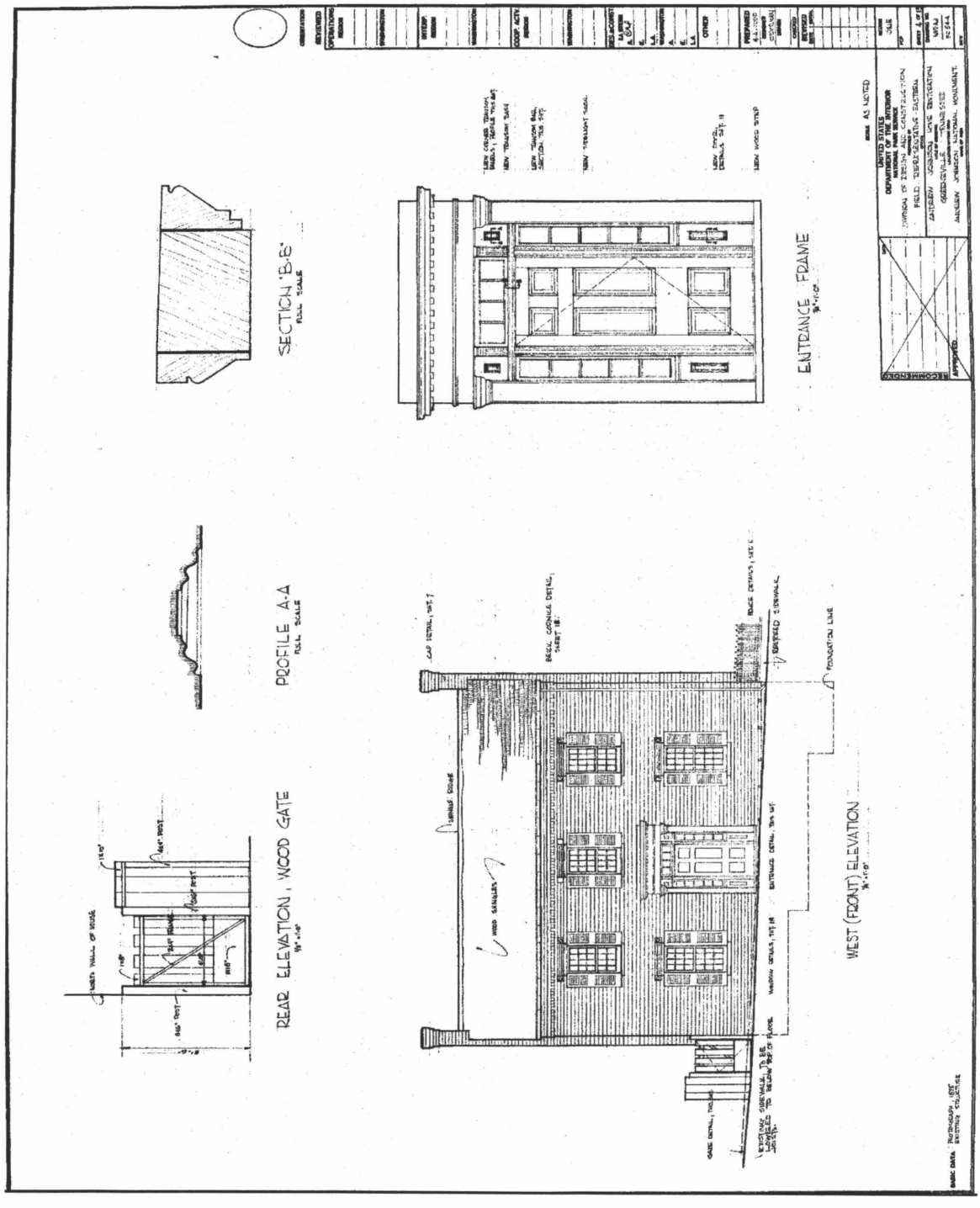

PARLOR
(ROOM NO. 3)
REINFORCE FLOOR JOISTS
PATCH & REPAIR EXISTING FLOOR
REPLASTER CEILING & WALLS
NEW CHAIR RAIL
REPAIR STAIRWAY
REBUILD ENTRANCE FRAME
SAS SILLS &
NEW SHELVES TRANSOM SASH
& DOOR
PORCH
ALL NEW STRUCTURE SEE SHT #8
PATCH BADLY BROKEN BRICK
WALLS. REPLACE BRICK WHERE
NECESSARY
REMOVED
NEW DOOR
EXIST. DS FRAME
NEW FRAME & DOOR
NEW DOOR IN EXISTING FRAME
PLUMBING VENT
UTILITY LINES
NEW CHINA CABINET
SEE DETAIL SHT #8
NEW FRAME & DOOR
OPENING TO BE FILLED
NEW BRICK HEARTH
NEW CHAIR RAIL
ANDREW JOHNSON BEDROOM
(ROOM NO. 4)
REMOVE MODERN HARDWOOD FLOOR
PATCH & REFINISH ORIGINAL FLOOR
REPLASTER WALLS & CEILING
NEW BRICK HEARTH
DETAIL FROM LUM
HOUSE GA 1850
REPLACE ORIGINAL
MANTEL - FOUND
PIECES IN ATTIC SHOP
NEW CAST IRON GRATE & JAMBS
BED ROOM
(ROOM NO. 5)
REPLASTER WALLS & CEILING
REMOVE MODERN FLOOR PATCH
& REFINISH ORIGINAL FLOOR
NEW CHAIR RAIL
DINING ROOM
(ROOM NO 6)
REPLASTER WALLS & CEILING
REMOVE MODERN FLOOR
PATCH & REFINISH ORIGINAL
FLOORS
NEW CHAIR RAIL
REMOVE CHINA CAB.
REMOVE MODERN W.
PAINTW SEE SHT #8
REBUILD BRICK WALL & SET NEW WINDOWS & SHUTTERS
NEW SASH, FRAME & SHUTTER
FIRST FLOOR PLAN
SCALE 1/4" = 1'-0"
DETAIL OF BASE
FULL SIZE
DETAIL FROM SMALL
SECTION OF ORIGINAL
BASE.
DETAIL - CHAIR RAIL
ROOM 3
FULL SIZE
DETAIL FROM PAINT MARKS ON
DOOR CASING
DETAIL - CHAIR RAIL
ROOMS 5 & 6
SCALE FULL SIZE
SOME AS NOTED
BASIC DATA EXISTING STRUCTURE
RECOMMENDED
APPROVED
UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
DIVISION OF DESIGN AND CONSTRUCTION
FIELD REPRESENTATIVE - EASTERN OFFICE
ANDREW JOHNSON HOME RESTORATION
GREENEVILLE, TENNESSEE
ANDREW JOHNSON NATIONAL MONUMENT
ORIENTATION
REVIEWED
OPERATIONS
INTERP. DIVISION
MAINTENANCE
COOP. ACTIV.
DES. ACCEPT.
SAFETY
E.
L.A.
WASHINGTON
A.
E.
L.A.
OTHER
PREPARED
H.A. JUDD
REVISED
DRAWING NO.
NHP-AJ
3054 A
SHEET 2 OF 8

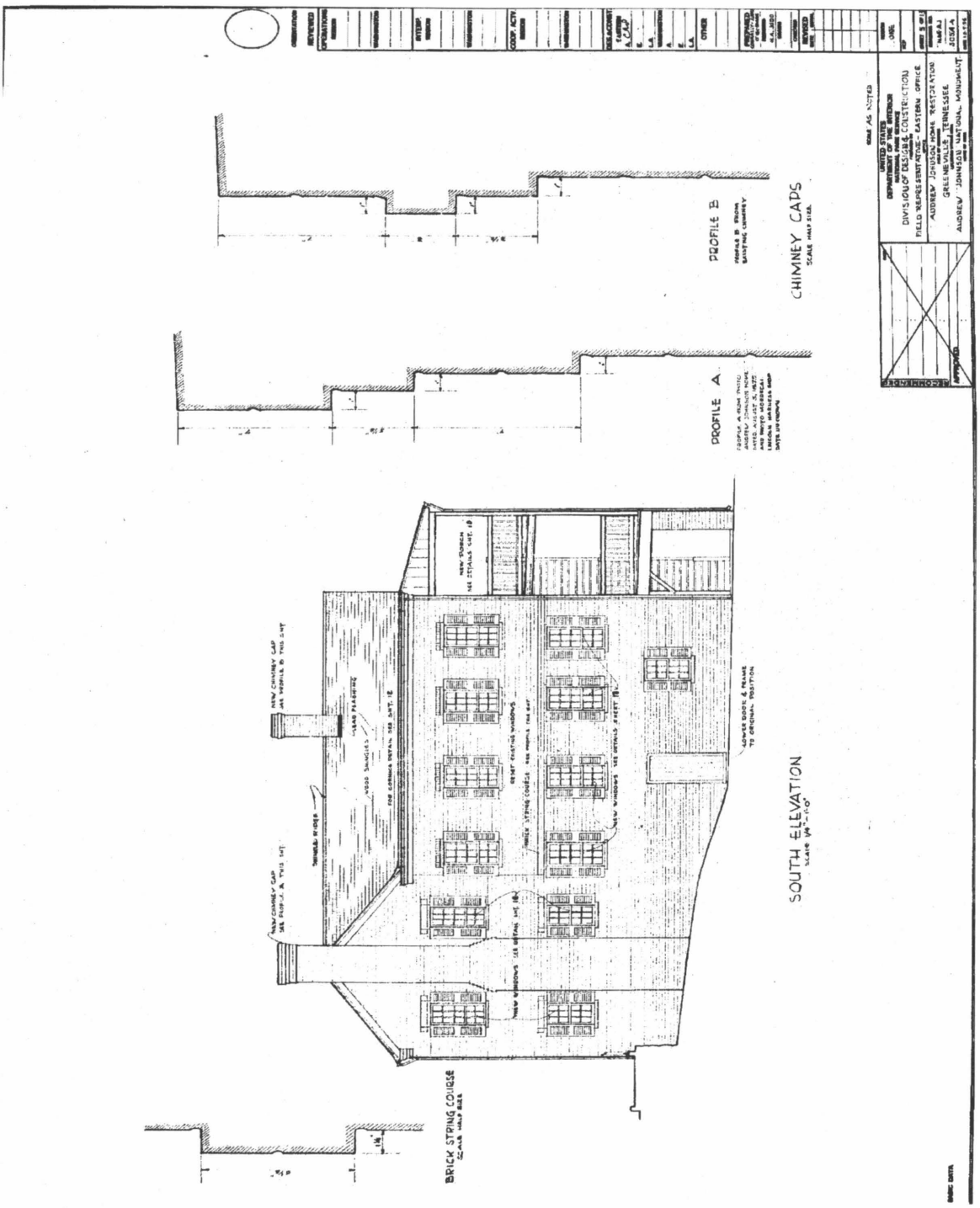
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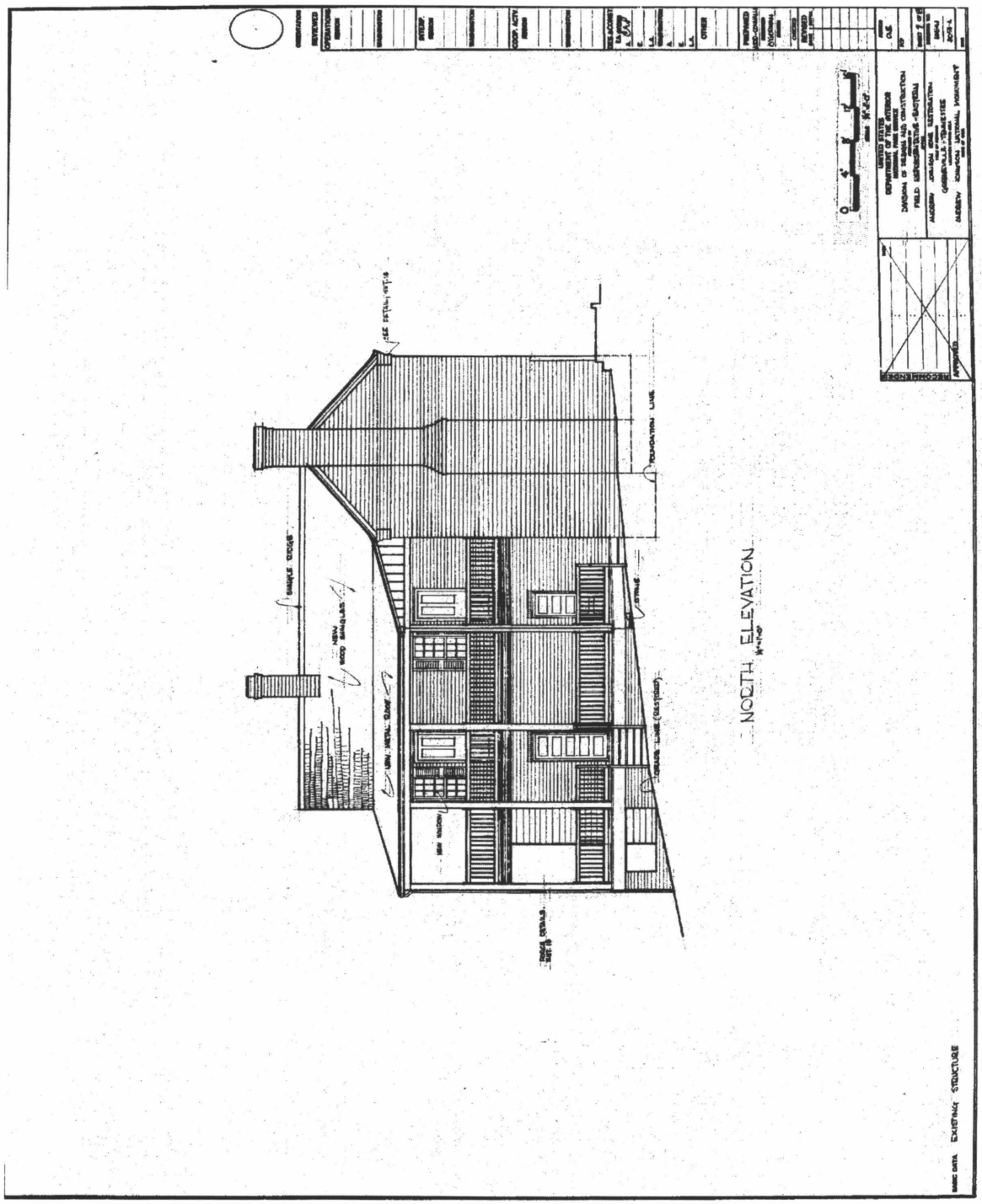

EAST ELEVATION

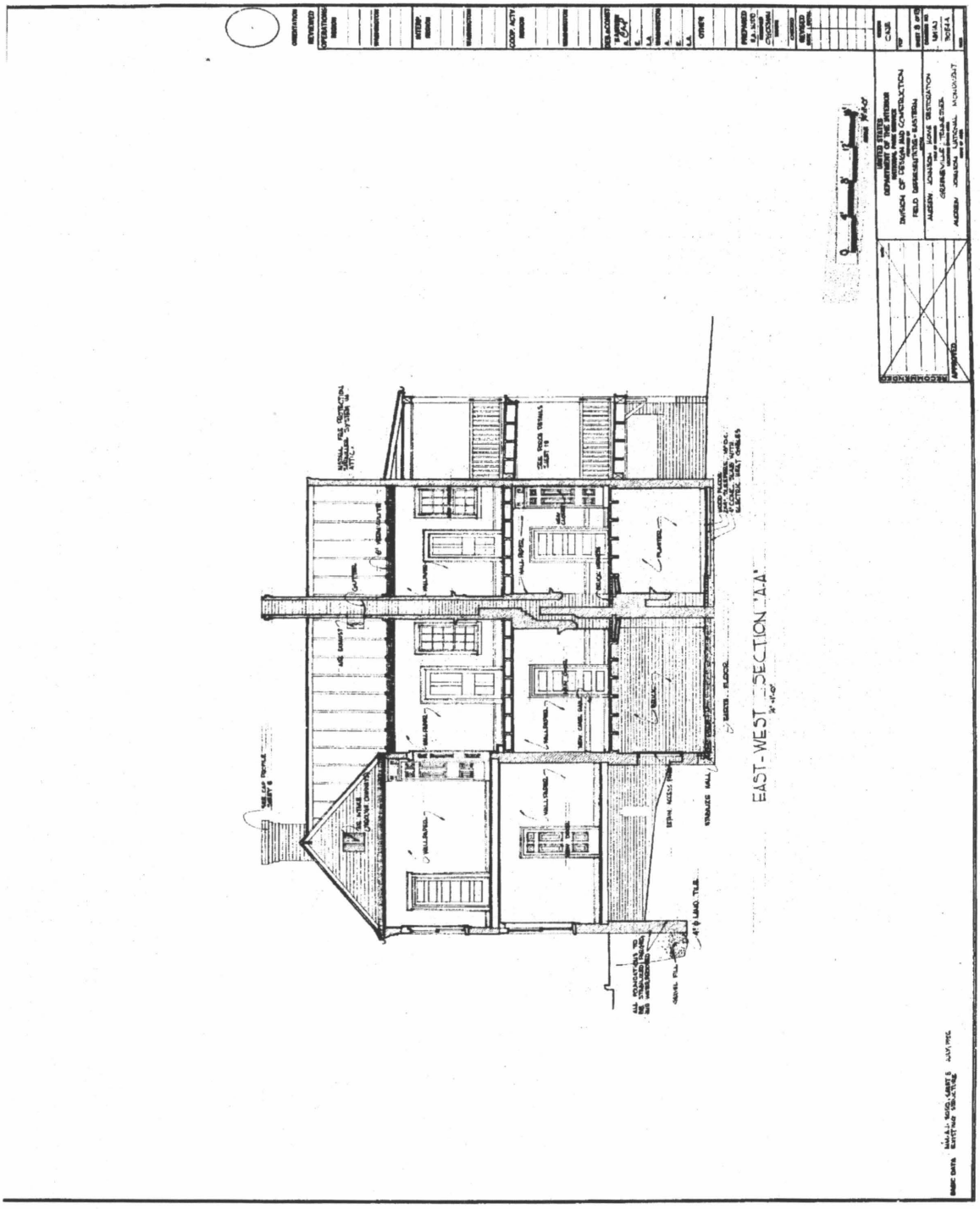
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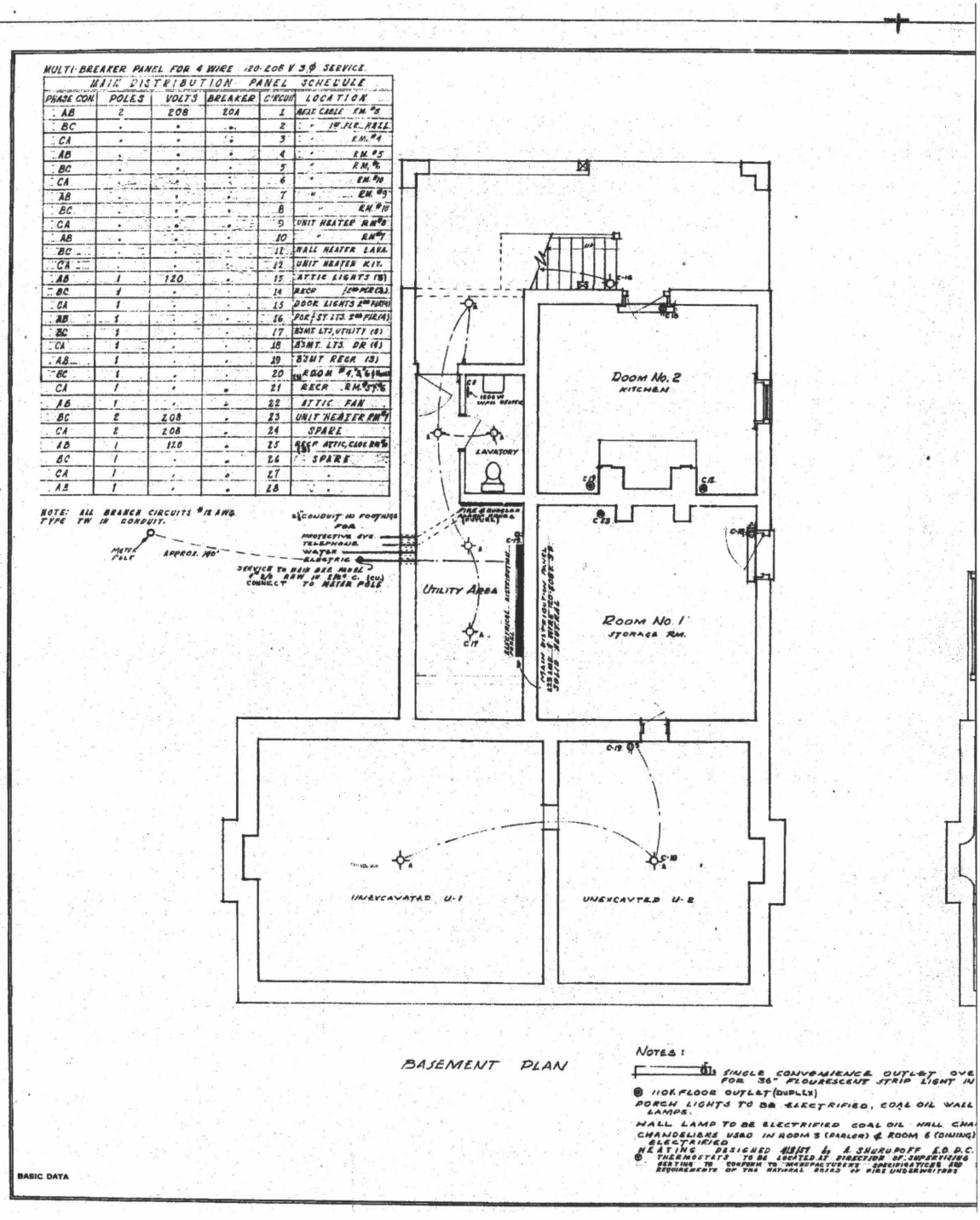

PROFILE B
CHIMNEY CAPS
PROFILE A
SOUTH ELEVATION
BRICK STRING COURSE

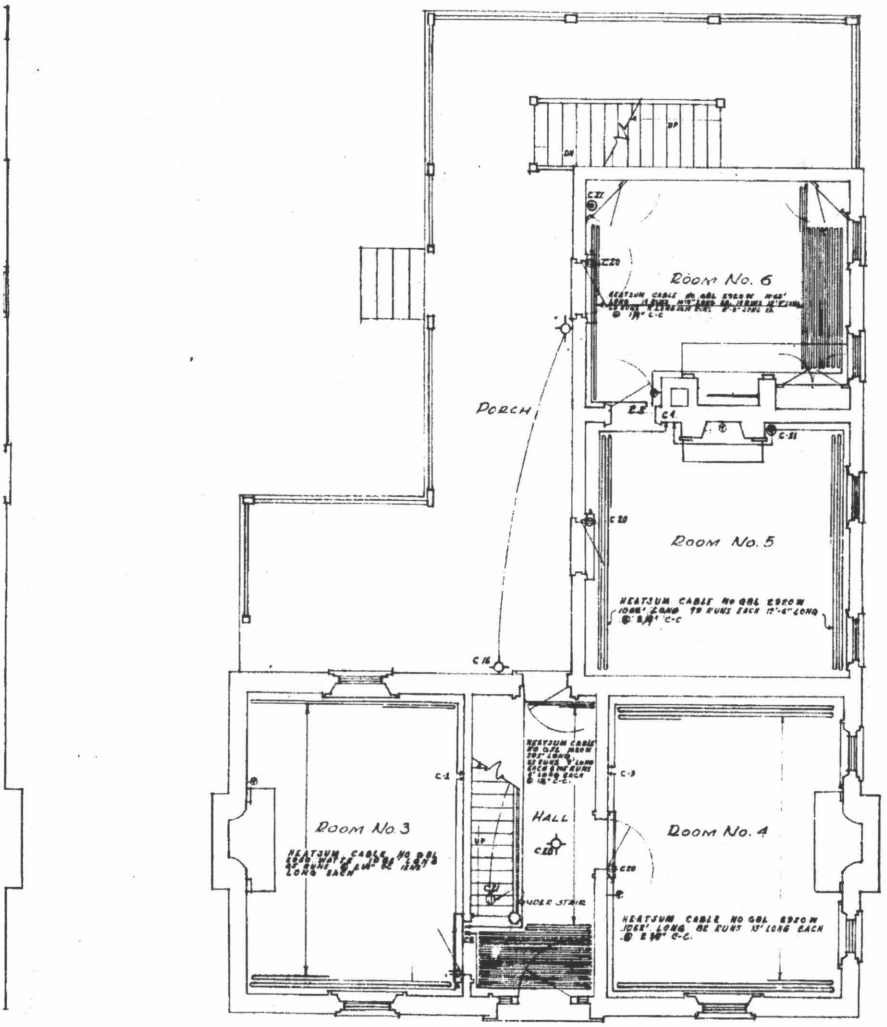
http://crs.sero.nps.gov/historic/hsar/anjo/drawings.pdf




EAST - WEST SECTION 'A-A'

http://crs.sero.nps.gov/historic/hsar/anjo/drawings.pdf





CONVENIENCE OUTLET OVER DOOR
5" FLOURESCENT STRIP LIGHT IN TROUGH
(DUPLEX)
ELECTRIFIED. COAL OIL WALL BRACKET
LECTRIFIED COAL OIL HALL CHANDELIER.
N ROOM 5 (PARLER) & ROOM 6 (DINING) NOT TO BE
4/13/37 by A. SHUKUPOFF E.O.D.C.
LOCATED AT DIRECTION OF SUPERVISING ARCHT.
TO MANUFACTURERS SPECIFICATIONS AND THE
NATIONAL BOARD OF FIRE UNDERWRITERS

FIRST FLOOR PLAN

WORKING DRAWING

THESE DRAWINGS HAVE BEEN PREPARED IN COMPLIANCE WITH PRELIMINARY DRAWING NO. NM-AJ 3658A APPROVED BY SUPT. BEN M. DAVIS 11/15/36 AND DIRECTOR MATHER BY MEMO 11/18/36

Chas. S. Peterson
ACTING CHIEF E.O.D.C.
Jan 5, 37

RECOMMENDED

APPROVED

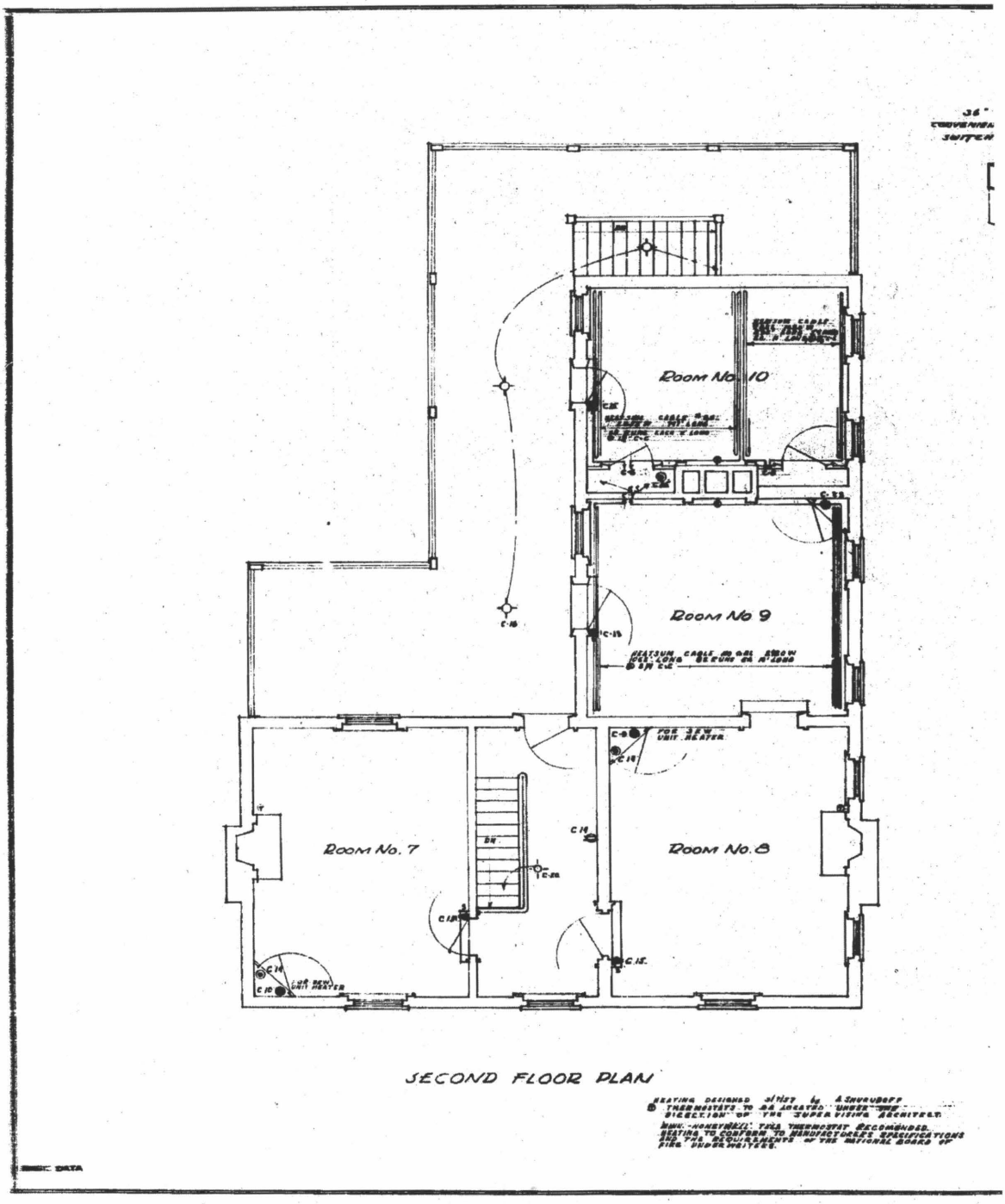
DATE

0 4' 8' 12' 16'
SCALE 1/4 IN. = 1 FT.

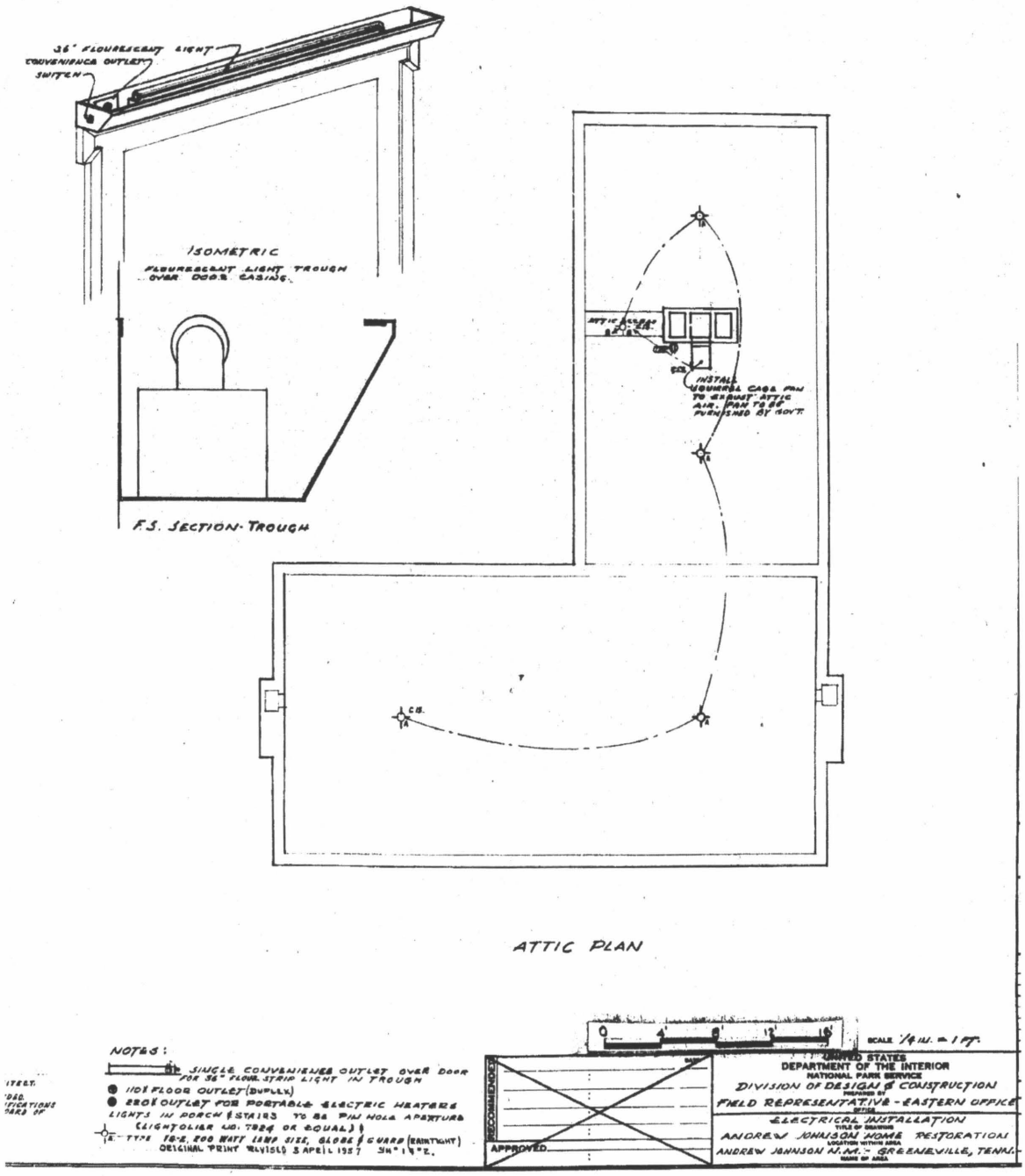
UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
DIVISION OF DESIGN & CONSTRUCTION
PREPARED BY
FIELD REPRESENTATIVE - EASTERN OFFICE
OFFICE

ELECTRICAL INSTALLATION
TITLE OF DRAWING
ANDREW JOHNSON HOME RESTORATION
LOCATION WITHIN AREA
ANDREW JOHNSON N.M. - GREENEVILLE, TENN.
NAME OF AREA

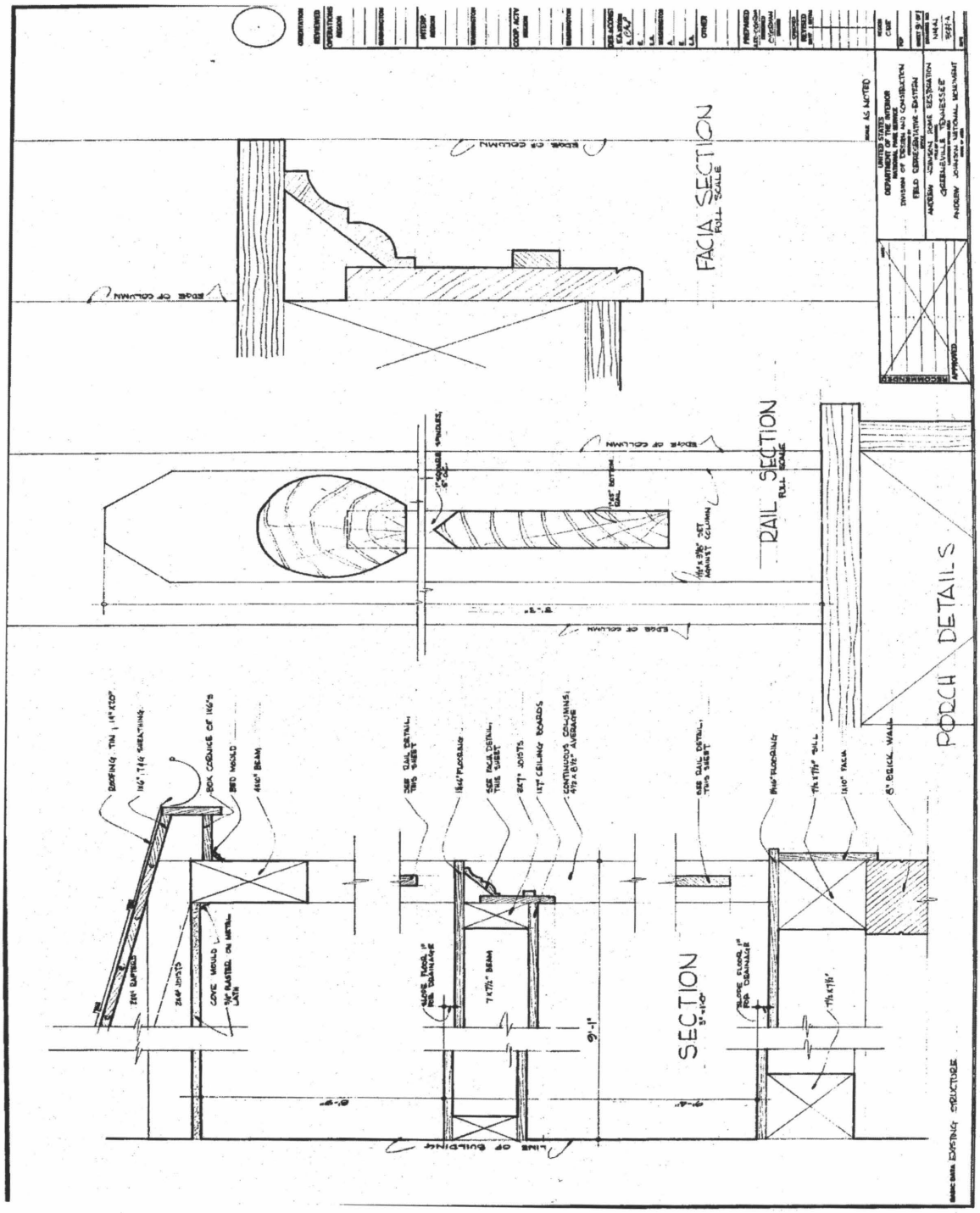
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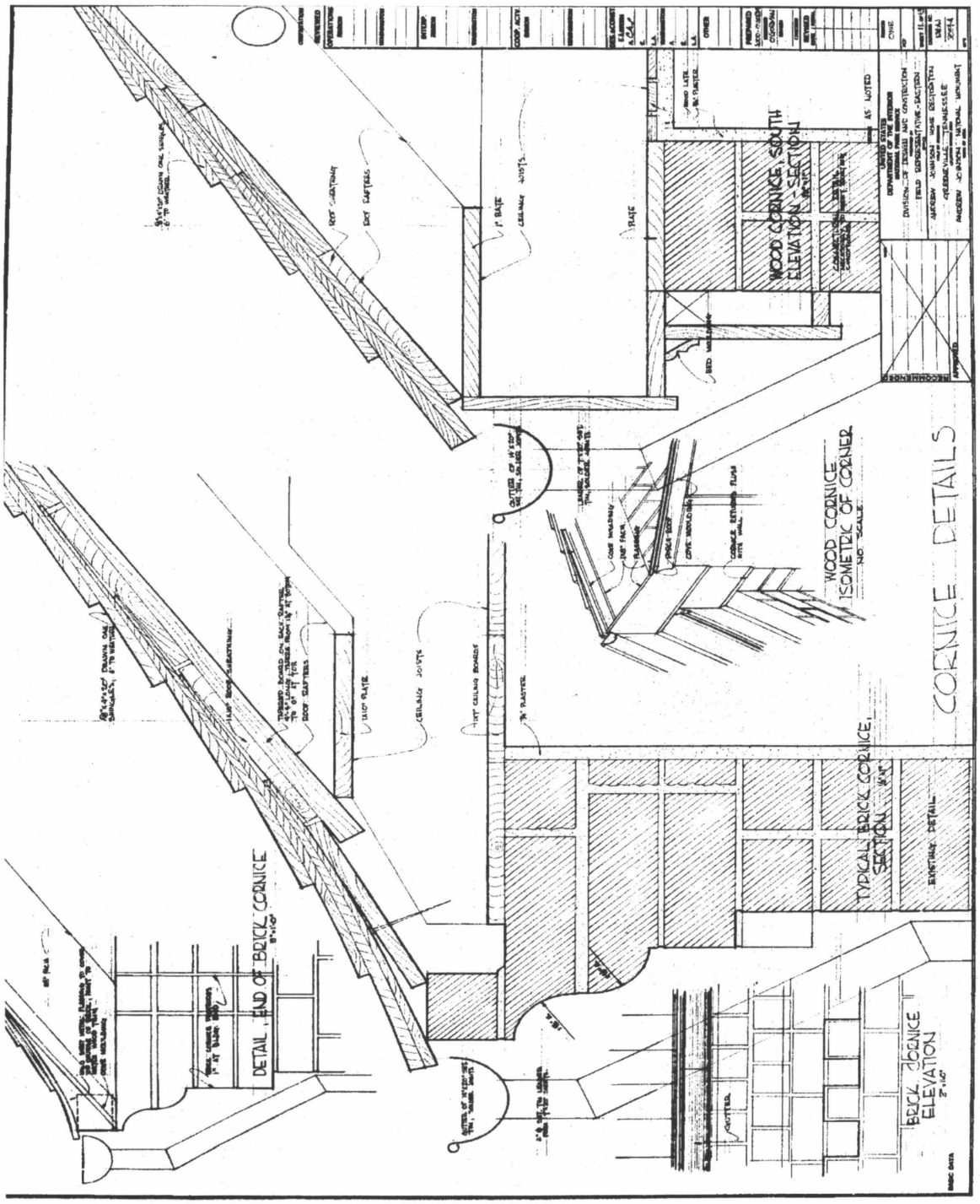


SECOND FLOOR PLAN

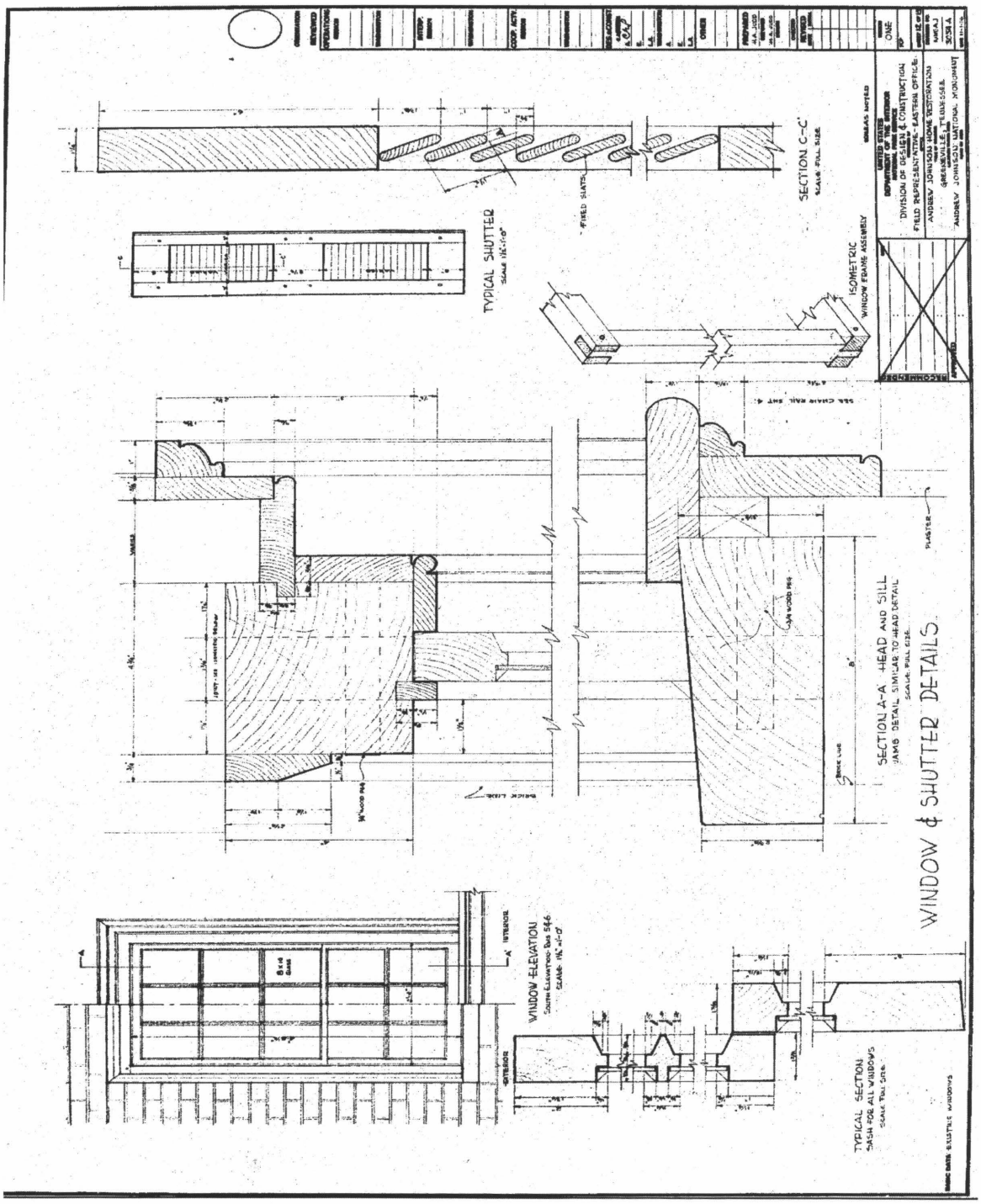

36" FLOURESCENT LIGHT
CONVENIENCE OUTLET
SWITCH
ISOMETRIC
FLOURESCENT LIGHT TROUGH OVER DOOR CASING
F.S. SECTION-TROUGH
ATTIC ACCESS
INSTALL LOUVERED CASE FOR TO EXHAUST ATTIC AIR. FAN TO BE FURNISHED BY GOV'T.
C.S.
ATTIC PLAN
NOTES:
SINGLE CONVENIENCE OUTLET OVER DOOR FOR 36" FLOUR. STRIP LIGHT IN TROUGH
110 V FLOOR OUTLET (DUPLEX)
220 V OUTLET FOR PORTABLE ELECTRIC HEATERS
LIGHTS IN PORCH & STAIRS TO BE PIN HOLE APERTURE (LIGHTOLIER NO. 7824 OR EQUAL)
TYPE 18-E, 200 WATT LAMP SIZE, GLOBE & GUARD (RAINTIGHT)
ORIGINAL PRINT REVISED 3 APRIL 1957 SH = 1/4"=1'.
SCALE 1/4 in. = 1 ft.
APPROVED
UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
DIVISION OF DESIGN & CONSTRUCTION
FIELD REPRESENTATIVE - EASTERN OFFICE
ELECTRICAL INSTALLATION
ANDREW JOHNSON HOME RESTORATION
ANDREW JOHNSON N.M. - GREENEVILLE, TENN.

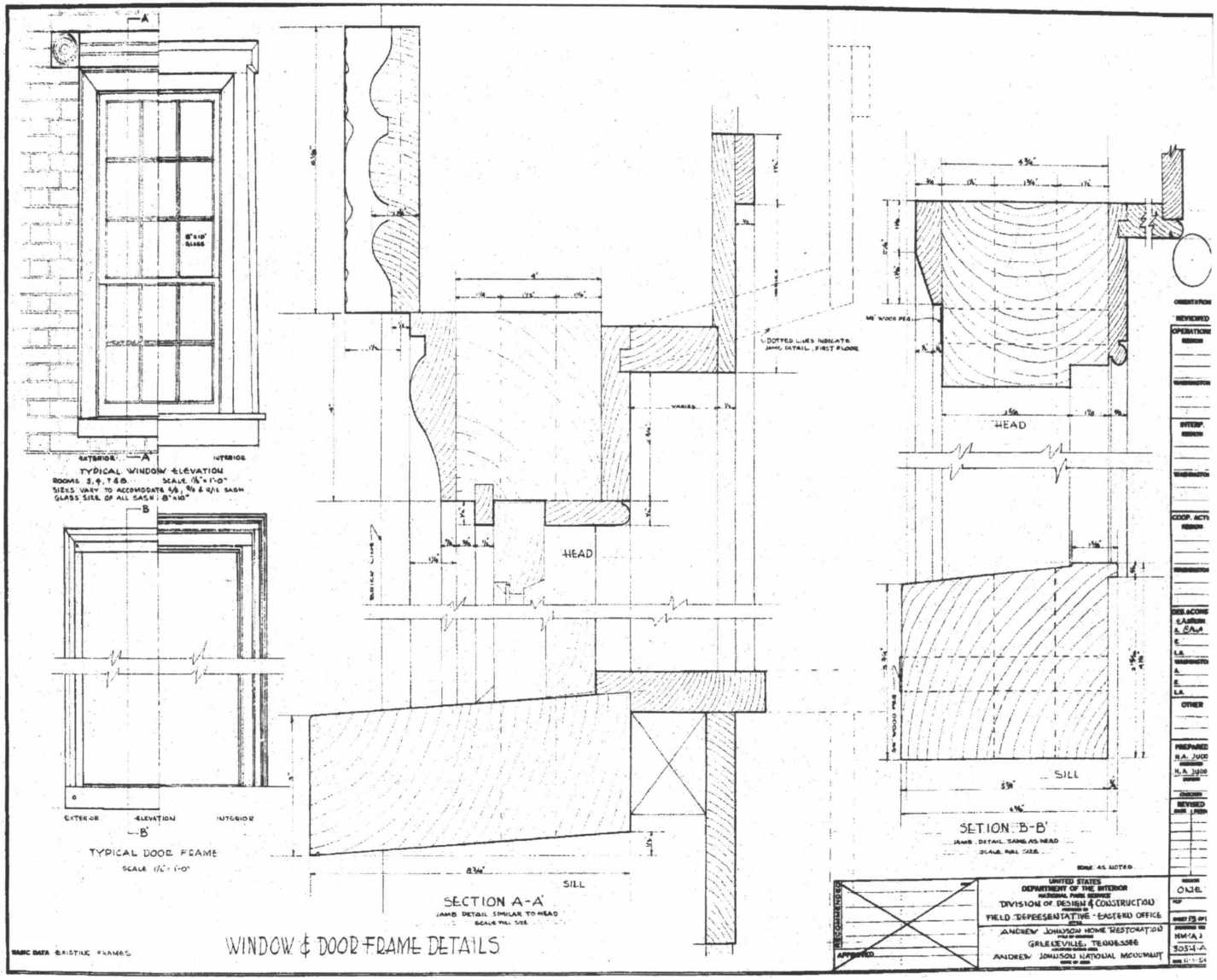
http://crs.sero.nps.gov/historic/hsar/anjo/drawings.pdf




CORNICE DETAILS
WOOD CORNICE, SOUTH ELEVATION - SECTION
WOOD CORNICE ISOMETRIC OF CORNER
TYPICAL BRICK CORNICE SECTION
BRICK CORNICE ELEVATION
DETAIL END OF BRICK CORNICE
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
ANDREW JOHNSON NHS
GREENEVILLE, TENNESSEE

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TYPICAL WINDOW ELEVATION
ROOMS 3, 4, 7 & 8. SCALE 1/8" = 1'-0"
SIZES VARY TO ACCOMODATE 1/4, 3/4 & 1/1 SASH
GLASS SIZE OF ALL SASH : 8"x10"
EXTERIOR
INTERIOR
TYPICAL DOOR FRAME
SCALE 1/2" = 1'-0"
SECTION A-A'
JAMB DETAIL SIMILAR TO HEAD
SCALE FULL SIZE
HEAD
SILL
DOTTED LINES INDICATE JAMB DETAIL, FIRST FLOOR
SECTION B-B'
JAMB DETAIL SAME AS HEAD
SCALE FULL SIZE
WINDOW & DOOR FRAME DETAILS
UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
DIVISION OF DESIGN & CONSTRUCTION
FIELD REPRESENTATIVE - EASTERN OFFICE
ANDREW JOHNSON HOME RESTORATION
GREENEVILLE, TENNESSEE
ANDREW JOHNSON NATIONAL MONUMENT
NHA-J
3034-A

http://crs.sero.nps.gov/historic/hsar/anjo/rt.htm

Requirements for Treatment & Use

As the Homestead is an integral component in the presentation of the Andrew Johnson story, and in consideration of the virtually complete status of this presidential household, the historic structure should continue its present use as a house museum, without the incorporation of offices, visitor services, concessions, or any other tangential programmatic use.

The National Park Service Cultural Resources Management Guideline (DO- 28) requires planning for the protection of cultural resources "whether or not they relate to the specific authorizing legislation or interpretive programs of the parks in which they lie." Therefore, the Homestead must be understood in its own cultural context and managed in light of its own values so that it may be preserved unimpaired for the enjoyment of present and future generations.[1]

1. "Cultural Resource Management Guidelines," (1997), p. 1.

Section 106 of the National Historic Preservation Act (NHPA) also mandates that federal agencies, including the National Park Service, take into account the effects of their actions on properties listed or eligible for listing in the National Register and give the Advisory Council on Historic Preservation a reasonable opportunity to comment.

NHPA regulations (36 CFR 800.10) mandate special requirements for protecting National Historic Landmarks. Section 110(f) of the Act requires that the Agency Official, to the maximum extent possible, undertake such planning and actions as may be necessary to minimize harm to any National Historic Landmark that may be directly and adversely affected by an undertaking. Examples of adverse effects include, but are not limited to:

- Physical destruction of or damage to all or part of the property;
- Alteration of a property, including restoration, rehabilitation, repair, maintenance, stabilization, hazardous material remediation and provision of handicapped access, that are not consistent with the Secretary's Standards for the Treatment of Historic Properties (36 CFR part 68) and applicable guidelines;
- Removal of the property from its historic location;
- Change of the character of the property's use or of physical features within the property's setting that contribute to its historic significance;
- Introduction of visual, atmospheric or audible elements that diminish the integrity of the property's significant historic features;
- Neglect of a property which causes its deterioration; and
- Transfer, lease, or sale of property out of Federal ownership or control without adequate and legally enforceable restrictions or conditions to ensure long- term preservation of the property's historic significance.

Furthermore, in agreement with the guidelines stated in the New Orleans Charter for the Joint Preservation of Historic Structures and Artifacts (1991), any action to rehabilitate conditions within the Homestead or to benefit the collections within may not place the house or its historic fabric in jeopardy. Measures which promote the preservation of either the historic structure or the artifacts, at the expense of the other, should not be considered.These guidelines are especially important in light of the recent effort to control environmental conditions within the Homestead. Present and future cooperation between curatorial managers and historic structure managers will be necessary for this unique resource.

http://crs.sero.nps.gov/historic/hsar/anjo/at.htm

Alternatives for Treatment & Use

In the broadest sense, three alternative approaches to the treatment of the Andrew Johnson Homestead can be identified: preservation, rehabilitation, and restoration. Each of these approaches is fundamentally different, and each has a different impact on the existing historic building.

The first alternative, preservation, would seek simply to repair existing material and maintain the existing character of the building, making those repairs and alterations that are necessary (1) to secure the building and its contents against further deterioration, (2) to eliminate threats to life safety, and (3) to make improvements to the building's fire detection system. A preservation approach would maximize the amount of existing historic material that can be retained and would require the least investment of Park resources.

The second alternative, rehabilitation, would subsume the concerns of the first but would also seek to make improvements and/

or alterations that would increase the building's utility to Park visitors and others who use the building. These would include improvements in accessibility for the disabled and replacement of building systems and/or equipment that may be antiquated but which are not hazardous to the building, its contents, or its occupants. Since this approach would focus on the building's function and not its design, the building's existing character and features would be mostly preserved.

The third alternative, restoration, would seek to return the building to its historic appearance in the the year 1875. This was the alternative chosen by Henry Judd and his associates as they proceeded to alter the Homestead from its condition in 1942 (which revealed various generations of family ownership, taste, and modernization) to its appearance in 1875.

http://crs.sero.nps.gov/historic/hsar/anjo/ut.htm

Ultimate Treatment & Use

The ultimate treatment of the Homestead, while focusing on the structure's overall preservation, includes the rehabilitation of modern improvements made during the 1957 restoration. Recommended treatment should

- preserve and maintain the existing, historically- significant features and materials of the building;
- rehabilitate the building's electrical, heating, and ventilation systems to benefit presevation of museum objects;
- rehabilitate undersized structural systems, original to the building's period of significance, to accommodate visitor and environmental live loads;
- add a fire suppression system.

In any case, the main concerns should always be focused on

- repairing and maintaining those existing features that contribute to the building's historic character, and

- slowing the rate at which those existing historic materials and historic furnishings are lost.

The project will require the supervision of an architecture and engineering firm with *demonstrated* experience in the rehabilitation of historic structures.

Preservation of the Building Envelope and Fabric

The Homestead site has periodically had problems with subsurface moisture. To control moisture at its source, a number of routine maintenance and prevention exercises should be performed. The highest priority is maintenance of adequate means of collection and drainage of roof runoff; positive gutter slope and function should be verified and maintained. A rigorous regimen of gutter and trench drain cleaning should be enforced.

In addition to maintaining the gutters in good working order, to accomodate runoff, the trench drain should be enlarged to increase in depth with distance. As the rate of vehicular traffic increases along Main Street, so does the volume of road splash and sidewalk runoff during heavy precipitation. If gutters and drains are functioning properly and there is a marked increase in the frequency or severity of moisture infiltration along the building's northwest elevation, the open- jointed brick sidewalk should be rebuilt to include an under drain or water barrier to prevent infiltration into the building.

Immediate caulking of the cornice and trim at the front (west) door has been recommended to park staff. Caulked joints around all window and door openings should be routinely inspected, and repairs should be made promptly to eliminate moisture penetration and air infiltration into the building.

The house's porch decks account for 40 percent of the structure's usable space but are almost fully exposed to the elements. As a result, numerous repairs have been necessary over the years. The climate and the nature of the deck's historic design are such that constant vigilance will always be necessary to prolong the useful life of the materials.

Convective heat loss/gain by air infiltration/ exfiltration is a pervasive problem in the house; weatherstripping at windows and doors should be repaired or upgraded. Furthermore, exterior doors should remain closed as much as possible, especially if the exterior temperature is extremely low. To reduce radiant heat loss/gain, the vermiculite insulation in the attic should be replaced with fiberglass batt insulation.

To control and reduce natural light at windows and doors,use of light- reducing window shades or material incorporated into the window treatments should continue. The shutters on the southwest ell and main block should be closed from April to October. In addition, the use of new artificial lights that have heat- generating lamps or ballasts should be minimal.

Structural Rehabilitation

Examination of the roof structure above the rear ell (about 1869) revealed the need for additional support. Since the present timbers are historic and were probably reused from the earliest construction of the home, they should

http://crs.sero.nps.gov/historic/hsar/anjo/ut.htm

be braced or otherwise stabilized and not removed or altered in any irreversible way. (See Appendix B, report by Bill Russell.) The existing scabbed rafters should be preserved. Four roof beams (span: 15 feet, width: 3.5 inches, depth: 12 inches) should be installed to relieve rafters of the roof load. The existing rafters should be braced by means of vertical supports.

Structural weakness was also detected in the second- floor framing of the entry hall, but the cause of that weakness has not been specifically identified. There should be a correction for flexibility in the second floor structure (approximately 15 percent greater stiffness). The trim around the stairs will have to be carefully removed, exposing the existing joists and their attachment to the flooring. These attachments to flooring and adjacent structural members must be inspected. If they are not the cause of the floor's flexibility, the size of the existing joists much be increased by "sistering" or some other suitable remedy. Future repairs must be coordinated with selective removal of finishes in the stair hall to determine the extent of any damage or deterioration.

Electrical Rehabilitation

The Homestead was completely rewired in 1957. However, the elapse of more than four decades has rendered portions of that system obsolete, and, given the risk of fire from faulty wiring, the entire electrical system inside the house should be replaced. The existence of rigid conduit allows for replacement of the out- dated wiring. As a further measure of protection, a fire- suppression system should be inserted during the selective demolition necessary for installation of new mechanical and electrical systems.

The existing underground service to the Homestead should be retained. The main panel in the utility room in the ell cellar should be replaced due to its age and the overhaul of the existing systems. The existing radiant heating subpanels, and control panels, and circuits, including portable heater receptacles, should be removed.

Electrical modifications should include a remote controlled pre- set lighting for the Collections zone, including the service/housekeeping lighting level. Conventional lighting is appropriate for the Staff/Housekeeping zones and in the Mechanical zones. Service/convenience receptacles should be made available throughout all zones.

All power and control wiring should be routed through conduit.

Limited site lighting should be provided for access and security.

To support essential systems during a power outage, a manual transfer switch and tie in for a portable generator connection is recommended

Fire Prevention

Assuming water pressure/volume is adequate for dry- pipe or pre action system and no fire pump is required, a fire suppression system with water service from an off- site municipal water supply should be installed.

Application of the NFPA #13 *Standard for the*

Installation of Sprinkler Systems must be sensitive to the historic character of the Homestead to avoid the destruction of historic fabric.

A pre action sprinkler system, possibly with on- off capability, such as "Fire- Cycle" system, or dry pipe system, zoned to correspond to use zones, should be introduced throughout the building.

The fire protection system water service, entry, and station should be located in the ell cellar utility room in storeroom.

A siamese fire department connection should be located adjacent to the service parking area.

Mechanical Rehabilitation

A new heating system should be installed. A natural- gas- fired boiler with a small volume hot water storage tank (sized for 55 F interior temperature at exterior design low temperature) is recommended. The boiler should be located in the ell cellar storeroom, with appropriate measures for fire prevention. Utility service for natural gas will have to be added to the Homestead. The system should havehot water coils in two air handlers, in addition to perimeter hot water baseboard heat in the Staff/ Housekeeping zone.

Ventilation must be improved within the Homestead. The building needs a compact and unobtrusive system, with one air handler for the low temperature first floor Collections zone, located in ell cellar storeroom, with ducted air supply and return in cellar and crawl spaces below the first floor; and one air handler for the low temperature second floor Collections zone, located in the ell attic, with ducted air supply and return in the main block and ell attics above the second floor.

There should be a controlled source of outside air for each air handler zone. Intake(s) should be remote from street (to avoid vehicular emissions) and from finished grade/landscaped areas (to avoid excess moisture and microorganisms).

An exhaust fan should be added to the rest room.

Recommended climate controls should allow for integral monitoring and control via a direct digital control system, and a small local desktop computer, and, for remote monitoring via a dedicated data transmission line to the ANJO NHS office.

The system logic should allow for air handler fans to re- circulate and filter air continuously. Smoke detection should be incorporated to stop the fans. Outside air should be admitted when exterior humidity ratio is closer to desired interior humidity ratio than the existing actual humidity ratio (i.e., if interior relative humidity exceeds desired range, and exterior conditions are drier, then outside air is introduced). Hot water to air handler coils should be modulated to maintain low level (45 F to 70 F) space temperature. The temperature set point for heating should be based on a desired interior relative humidity level.

Despite the introduction of a new mechanical system, historic building operations should be continued. As mentioned earlier, the Homestead was designed to alleviate the effects of humid summers in the mountains. To reduce the heat gain, the shutters should be used as

http://crs.sero.nps.gov/historic/hsar/anjo/ut.htm

they were intended and kept closed where heat gain is highest along the southern exposure, which is also the façade with the most windows. Louvered shutters should not be considered merely a protective device for window sash but rather a shading device against the intense heat gain that can occur throughout the summer months.

Furthermore, the constraints of a historic house will limit the effectiveness of a forced-air climate control system. Without undermining the character of the Homestead, only certain temperature and humidity levels will be possible. Sensitive artifacts may require individual treatment or relocation since an efficient environmental system within a historic structure cannot be tailored to the demands of specific artifacts.

http://crs.sero.nps.gov/historic/hsar/anjo/sherwood.htm

PLANNING, FACILITY MANAGEMENT AND DESIGN
SOUTHEAST SUPPORT OFFICE
TRIP REPORT

Name of Traveler:	Steve Sherwood
Destination:	Andrew Johnson NHS
Date(s) of Trip:	12 August 1999
Purpose of Trip:	Homestead HSR & Climate Control Issues
Traveled with:	**Dan Scheidt, SERO** **Alan Bohnert, SERO** **Bill Russell, Architect Consultant**
Met With:	**Mark Corey, ANJO** **Jim Small, ANJO**
Items Discussed:	HVAC & Electrical Issues surrounding Homestead residence

Information others should know: Met w/park staff to inspect the Homestead of Andrew Johnson so that the HSR can be updated and investigate the ventilation and climate control requirements for the building. Prior to the visit, a detailed history of temperature and humidity for various rooms and a description of the ceiling heat was provided for my review. From that data it was determined that the house has significant swings in temperature and humidity that are very detrimental to the artifacts contained in the house as well as certain parts of the house itself. Heating of the structure is provided by a heating cable that is imbedded in the plaster ceiling of each room. Although normally not a common method for heating buildings, this is apparently used in the Greeneville area, especially in the timeframe in which it was installed. Additional discussions with the park indicate that the elements above the foyer were replaced in the 1980s, representing a newer generation of heating elements. While on site, the park removed a portion of the ceiling in one of the rooms so that an inspection could be made of the material. We also reviewed the methods of ventilation to the building and possible HVAC scenarios. There is no present air conditioning or de-humidification. These findings are covered below:
1 . Ventilation is provided to the building by various exhaust fans that draws air into specific rooms via louvers installed in strategic places. Although the buildup of mold or mildew may have been reduced by this configuration, this method of ventilation may

aggravate the humidity problem in some of the rooms, particularly on a very hot and humid day.

2. An inspection of the heating cables indicated that the wire (at least in the very small space we exposed it) is in very good condition, considering the amount of time that had transpired since it was installed. If the remaining heating cable is in as good as shape as the sample piece, then we probably do not have a safety hazard, at least from the embedded wire. I cannot say whether the wiring feeding the heating cable is in this same category as we did not inspect it. Notwithstanding the good condition of the sample section, however, I would recommend the disconnection of the wiring and a new heating system be installed in the house.

3. Alternatives of HVAC systems were discussed that would provide the best protection for the structure and its artifacts that would also be safe and non-intrusive to the building. A forced-air ducted system was recommended for optimum climate control. This was recommended because of the good air flow and air mix, and relatively tight parameters (temp/humidity) one can gain using this type of system. Also, since there is a basement below the main floor and an attic above the second story, a minimum of historic fabric destruction and visual intrusion can be obtained.

4. Once a forced-air system was recommended for the building, alternative fuel sources were discussed. Below are several fuel alternatives with discussions of pros and cons for each one.

A Natural Gas - Since gas is available in town, this would be my choice of fuel for a non-historic structure. A gas forced-air furnace is probably the most cost-effective, has the highest efficiency, and burns the cleanest of any hydrocarbon. It can provide the most comfortable "creature" temperature throughout the building. The down sides of this fuel are combustion inside of the building, openings through the roof or out the side for combustion gases and combustion air intake, and gas piping must be introduced into the spaces where the furnaces are to be located (attic and basement).

B Propane (LPG) -Only used for remote locations where natural gas is not available. In addition to having the same negatives as natural gas, it also is heavier and has a lower combustion temperature, is more expensive, and requires a storage tank. Efficiencies are on par with natural gas, but the cost per therm is substantially higher.

C Fuel Oil - All of the same negatives as for natural gas and propane and the storage tank would also require spill containment. Oil furnaces do not get as high efficiencies as gas and produces dirtier combustion products. Oil is usually more expensive than natural gas but typically cheaper than propane.

D Heat Pumps (air-to-air) - This is the HVAC system of choice for this structure. If sized properly with an outdoor thermostat, this unit would probably be the most cost-efficient of all alternatives, considering life-cycle costs. Humidity control

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would be achieved easier with this system as well. No fuel storage or lines nor openings for flue or combustion air are required. However, the electrical system might have to be upgraded.

E Heat Pumps (ground source) - Although these would have the lowest operating costs, there are up-front and maintenance costs as well as environmental issues with which to contend. Numerous wells or sizeable trenches would have to be drilled on the site. This would also include a water system in the house, a source of potential damage to artifacts. E. Chiller/boiler System - Probably not recommended because of the water system throughout the house and high purchase price.

F Humidity Control - This would be necessary no matter what type of system is selected. It would most likely involve reheat using electric strip heaters (or hot-gas bypass which is "free" heat) and a humidifier for the dry winter months.

5. Other considerations and points of interest - Although heat and smoke detectors are installed in the house, a fire sprinkler system is strongly recommended to best protect this valuable resource and it's artifacts. Since the structure is located in-town, the likelihood of good pressure/flow characteristics in the domestic water system is a positive.

6. Although the electrical system was not inspected in detail, there is a possibility that an electrical upgrade is a good idea. There have been numerous changes to the National Electrical Code since the house was electrified, and an increase in load is likely if air conditioning is added to the house. When an HVAC and/or sprinkler system is installed, the replacement of electrical service and all branch circuits is recommended.

http://crs.sero.nps.gov/historic/hsar/anjo/russel.htm

WILLIAM RUSSELL ARCHITECT

772 YORKSHIRE RD NE ATLANTA, GA 30306PHONE: (404) 876-3655

19 June 2000

TO:Dan Scheidt
National Park Service
100 Alabama Street, SW
Atlanta, GA 30303

FROM:William Russell

RE: Inspection Report on Andrew Johnson Homestead

The Andrew Johnson Homestead at 209 South Main Street in Greeneville, TN was inspected on 12 August 1999 and again on 18 May 2000, The purpose of the inspections included an evaluation of the structural condition of the wood framing in the second floor stair hall on the first visit and the roof framing on the second visit. The site visits and inspections were assisted by Dan Scheidt, Steven Sherwood, Alan Bohnert from the Atlanta office and Mark Corey with other Park Service personnel at the Andrew Johnson Homestead. The inspection was limited to the portions of the structures which were visible from the exterior (including roof) and interior spaces (including attic) without modifying any finishes or excavating at the foundations. A previous HSAR was conducted in 1956 was the basis for extensive renovations in 1957. Lucy Archer, a student intern, expressed concern about the structural condition of the hall framing in a condition report she prepared in 1996.

The floor systems were inspected in the older western portion of the homestead which fronts on the street. The 3.0 inch wide by 7.5 inch deep framing at 24 inches on center spans 18.7 feet and runs in the east-west direction throughout the second floor. On the first floor the framing, visible from the crawl space, is similar except that the spans are somewhat less due to the greater thickness of the lower level walls and the additional joists attached to the original framing as part of the 1957 renovations. Since the second floor joists could not be inspected directly, it could not be determined whether any reinforcement was added in the 1957 renovations.

TYPICAL FLOOR FRAMING:
A structural analysis of the original joists shows that the joists, assuming a good grade of southern pine, are strong enough (in shear stress and bending stress) but are more flexible than would be permitted by current building codes. This is probably what prompted the reinforcement of the first floor joists in the 1957 renovations. A 'heel drop' test in the main rooms showed noticeable flexibility in the second floor system and confirms the results of the calculations. The first floor appeared somewhat stiffer due to the added reinforcement.

STAIR HALL FRAMING AT SECOND FLOOR:
The second floor stair hall was the most flexible of all even though the joists, of similar size and span to the other floor joist, are somewhat closer together, approximately 18 inches on center as evidenced by the cut nail heads visible in the flooring. This flexibility is what prompted the comments in the 1996 report and the current inspection. The hall was tested with 'heel drops' and found to be much more flexible than the other floors, including the lower level stair hall which has similar framing. Several small holes were drilled in the joints between the 0.9 inch thick tongue and groove flooring, which spans between the joists, to determine the joist size and location adjacent to the stair. It appears that the stairway has been enlarged from its original size with the width increased 4 or 5 inches and the length increased one tread (approximately 9.5 inches). It is not known when this revision was made but could have been in the 19th century. The floor joist adjacent to the stair was cut off to permit the wider stairway and replaced with what appears to be a 9.0 wide (three 3.0 inch members) by 7.0 deep joist beside the current stair width. The new joists are not nailed to

the flooring and appear to have a gap of about 0.5Cinches between the top of the joist and the underside of the flooring. This indicates that the new joists are not directly engaged in carrying the floor loads which would account for the noticeable flexibility. A structural analysis of the revised floor system shows that the joists, if all are engaged, are strong enough (in shear stress and bending stress) but somewhat too flexible (current codes would require approximately 15% greater stiffness). If the added joists are not engaged, as appears to be the case, the original joists do not distribute the loads evenly and could be overstressed as well as too flexible (approximately 40% greater stiffness to satisfy current codes). It should be noted that the stiffness, or deflection, requirements in the current codes are 'advisory' and not mandatory.

RECOMMENDATIONS ON HALL FRAMING:
Remedial action is recommended to strengthen the floor, if necessary, as well as stiffen it. The effectiveness of the added joists should be determined by removing the trim around the stair which would expose the added joists and their attachment, if any, to the flooring and adjacent structural members. If the added joists are not engaged, then attaching them would provide adequate strength and marginal stiffness. Greater stiffness could be achieved by increasing the size of the joists as well as attaching them to the flooring. No modifications or repairs to the stair had been made by the time of the second inspection on 19 May 2000.

TYPICAL ROOF FRAMING:
The roof framing is readily visible in the attic and appears to have been constructed in two stages with the with the newer, east wing roof being added to the original West wing roof. The original (West wing) roof is supported on rafters (8 in 12 slope) approximately 2.5" wide and 4.0" deep and spaced at 24" on center. The rafters are connected to 1x ridge member at the top and a 2x sillCmember (on top if the ceiling joists) at each eave. A structural analysis of the original rafters shows that the rafters, assuming a good grade of southern pine, are strong enough (in shear stress, axial stress, and bending stress) to comply with current building codes. Since the ridge member provides little support for the roof loads, the rafters must support a horizontal thrust of approximately 500 pounds per rafter at the eave. The 'toenails' between the rafters and the sill must carry this thrust. Since each 'toenail' can only carry about 70 pounds, the existing 'toenails' are not sufficient to carry the full dead load and roof live load. This connection should be reinforced.
The newer roof framing at the East wing has a similar configuration but with smaller rafters (2.5" wide and 3.0" deep at 24" on center) that appear to have been reused from an earlier roof with a shallower slope or perhaps a smaller span. As a result the rafters do not directly attach to the ridge member but rather stop approximately 13.5" short of the ridge. 1x lumber is scabbed onto the sides of the rafters to connect to the ridge. A structural analysis of these rafters shows that the rafters, even assuming a reasonably good grade of southern pine, are not strong enough to comply with current building codes. These rafters should be reinforced or given additional support. Since the rafters are undersized, inadequately connected at the eave, and not directly attached to the ridge, it is recommended that roof beams be added to relieve the rafters and their connections of most of the roof load. These additional beams would also allow the existing rafters to remain intact and relatively undisturbed. Four beams would be required with spans of approximately 15 feet and widths of 3.5" and depths of about 12". CSince access to the attic space is limited without removing some of the roofing it may be preferable to construct the beams with a combination of dimension lumber and plywood which can be passed through the ceiling hatch and assembled in the attic space.

MOISTURE PROBLEMS AT THE WEST WALL:
The interior of the west wall shows water damage on either side of the entrance (i.e. in the Parlor and the Bedroom) near the base. Reroofing, sidewalk drains, and crawl space ventilation have been implemented to correct this problem with some, but not sufficient success. Since no moisture was visible in the crawl space, it is not likely that the moisture is rising from the foundation level. It is more reasonable to look for water sources penetrating the wall around or over the entrance doorway at the street. Likely sources of water penetration would be the flashing around the wood entrance trim and the gutter and eave at the second floor ceiling level. The south wall has been reported to have settled several inches over the years which could cause the doorway flashing to separate and allow water penetration into the wall. The wood shake or shingle roofing almost completely overhangs the round gutter, which if overflowing could allow the water to enter the wall. The damaged areas of the interior wall appear to be on gypsum board added to the

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original masonry wall and finishes. If the gypsum board is furred out, the water could travel easily from the roof or second floor through the furring space and cause damage at the first floor level. It is recommended that the eave and entrance flashing be investigated for leaking and repaired as indicated. During the 19 May 2000 inspection, the interior walls and crawl space appeared dry but evidence of the previous delamination of the interior finishes remained. A dry paper towel was placed in the crawl space where evidence of previous water existed to determine if leaks through the front wall (near the entry) is still occurring. The windows, door, and eaves are the most likely sites for the water infiltration.

Please let me know if there are further questions or more specific information regarding these observations and recommendations.

Sincerely,

William Russell AIA
Architect

File: 9917insprpt2

http://crs.sero.nps.gov/historic/hsr/anjo/bohnert.htm

Trip Report: Andrew Johnson National Historic Site (ANJO), August 12, 1999

Traveler: Allen Bohnert

The site visit occurred August 12, 1999. SERO participants were Dan Scheidt, Steve Sherwood, And Bill Russell (Consultant). We met with ANJO Superintendent Mark Corey and several staff members including Jim Small and Elaine Clark. The primary purpose of my participation on the trip was to review the physical and environmental conditions in the furnished spaces in the Homestead from a curatorial perspective. In this regard, the park provided environmental monitoring data for several rooms on all three floors of the Homestead. Data below illustrate the range of variation recorded in the Homestead.

ANJO Homestead - sample environmental data

	Parlor - 1st floor		D's Bed Rm - 2nd floor		Kitchen - Basement	
	Rh	Temp	Rh	Temp	Rh	Temp
Aug 5-12, 1998	50-65%	75-82	48-67%	75-84	58-76	72-78
Sep 16-23	63-72	75-82	42-66%	77-86	54-74	76-80
Jan 6-13, 1999	11-35%	63-72	23-50%	50-60	31-72	40-53
Feb 17-24	14-41%	79-83	25-45%	53-66	33-66	46-68

	A Jr's Bed Rm- 1st floor		Dining Rm - 1st floor	
Aug 5-12, 1998	50-64%	75-81	52-66%	75-81
Sep 16-23	44-59%	79-83	47-62%	79-83
Jan 6-13, 1999	11-31%	60-70	15-47%	56-61
Feb 3-6	19-34%	66-68	18-45%	58-69 (2/17-24/99)

Guest Bed Room (2nd floor) data provided subsequent to August trip

Aug 5-12, 1998	48-67%	75-81
Sep 16-23	42-66%	77-87
Jan 6-13, 1999	23-45%	51-60
Feb 17-24	18-45%	58-69
Jul 21-30	57-76%	68-88

The park presently uses floor fans in several rooms and attic or exhaust-type fans in an effort to improve air-flow throughout the Homestead. The fans are used daily, either for 24 hour periods or for intermittent time periods (i.e., during operating hours). Windows in some of the rooms are also opened slightly during operating hours at various times in the year. While the use of fans may help alleviate mold growth in some spaces, it more likely than not supports wide fluctuations in both relative humidity and temperature. Opening windows similarly supports such fluctuations, as well as contributing to dust and insect problems. Sticky traps are placed strategically throughout the house. Those in the basement were literally full of crickets and 'earwigs', providing an excellent vector for infestations of museum pests. Insect traps on the first and second floors contained varying numbers of ants, gnats, and silverfish. One trap on the first floor contained what appeared to be an adult clothes moth.

The park's 1992 Collection Management Plan called for the development and institution of a more rigorous method of documenting environmental conditions within the Homestead and installation of "an HVAC system in the Tailor Shop and one in the Homestead, if environmental readings warrant." A more rigorous approach to monitoring the environmental in the homestead was subsequently implemented by the park. Datalogers were strategically placed throughout the Homestead. Recent and current environmental data illustrate the need to improve our ability to control the environment in the Homestead. These data, combined with the historic significance and monetary value (based upon 1991 professional appraisal) of the Homestead furnishings, support giving further consideration to designing and installing a suitable heating, ventilation and air conditioning system. The system would, of course, need to be compatible with the historic nature of the Homestead and site interpretation, given the constraints of the physical layout. Additionally, such a system would support insect and dust reduction housekeeping efforts.

Allen Bohnert

http://crs.sero.nps.gov/historic/hsar/anjo/henry.pdf

RECOMMENDATIONS FOR INTERIOR ENVIRONMENTAL IMPROVEMENTS

for

THE ANDREW JOHNSON HOMESTEAD

Andrew Johnson National Historic Site
Greeneville, Tennessee

Prepared for
The National Park Service
United States Department of the Interior
Southeast Regional Office
Atlanta, Georgia

Funded by
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Prepared by
Watson & Henry Associates
Bridgeton, New Jersey
Project 00-018

Final Report
02 March 2001

Michael C. Henry, PE, AIA
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PROJECT DIRECTORY

Project

RECOMMENDATIONS FOR
INTERIOR ENVIRONMENTAL IMPROVEMENTS
The Andrew Johnson Homestead
Andrew Johnson National Historic Site
Greeneville, Tennessee

Client

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The statements and opinions contained herein are for the use and information of the National Park Service. The opinions reflect the judgment of a Professional Engineer and Registered Architect performing with the care and skill ordinarily used by other Professional Engineers and Registered Architects when dealing with existing structures at the same time and in the same or similar localities. Conclusions drawn in this report are based on those conditions and surfaces accessible to the unaided visual observation of the Architect/Engineer. No warranties or guarantees can be inferred from, or implied by, the statements or opinions contained in this report.

INTRODUCTION

BACKGROUND

The Andrew Johnson National Historic Site (AJNHS) in Greeneville, Tennessee, is owned and operated by the National Park Service (NPS) and consists of:

- •The Visitor Center and Tailor Shop;
- •The Early Andrew Johnson Home;
- •The Andrew Johnson Homestead;
- •The Andrew Johnson National Cemetery.

The National Historic Site interprets the life of Andrew Johnson (1808 to 1875), Vice-President of the United States under Abraham Lincoln (1864 to 1865), the 17th President of the United States (1865 to 1868, succeeding the assassinated Lincoln), United States Senator (Tennessee, 1860 to 1862 and 1875), and military Governor of Tennessee (1862). A tailor by trade, and a strict Constitutionalist and anti-secessionist, Johnson found himself at odds with his Southern constituency and later, with a Northern-dominated post-Civil War Congress; throughout, he remained consistent in his faith in, and allegiance to, the Constitution and the people. Johnson's accomplishments include presiding over the restoration of the Union and purchase of the Alaska territory from Russia. Controversial, Johnson was impeached by the House of Representatives in 1868; he was acquitted by the Senate by a margin of one vote.

Andrew Johnson and his wife, Eliza McCardle Johnson, moved to the Homestead in 1851; during the Civil War, it was confiscated and used as a hospital. The Johnson's returned to the Homestead in 1869; at that time it was part of Johnson's substantial real estate and business holdings in Greeneville.

The National Park Service maintains and interprets the Andrew Johnson Homestead as a historic house museum; the collections include original Johnson family possessions and furnishings and are considered very valuable due to their provenance. The Homestead was restored by the National Park Service in 1957; the periods of restoration and interpretation returned the house to its appearance during the Johnson occupancy.

The present systems for interior environmental management of the Homestead largely date from the 1957 restoration; replacement of these systems should be preceded by identification of the objectives for preventive conservation of the building and collections, and by development of strategies for achieving those objectives.

PURPOSE AND SCOPE

In September 2000, the Southeast Regional Office (SERO) of the National Park Service contracted with Watson & Henry Associates (W&HA) to visit the site, review available documentation, interview staff and prepare a report outlining recommendations for future interior environmental improvements for the Andrew Johnson Homestead.

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This report is the resultant deliverable. This report:

- •Documents the report methodology and the existing building and systems;
- •Recommends objectives for preservation of the building, conservation of the collections, and operation of the new systems;
- •Recommends potential environmental management strategies for achieving the objectives, with emphasis on interior environmental *management* versus climate *control*, along with preliminary descriptions of the systems for implementing the strategies;
- •Identifies recommendations for immediate environmental improvements.

The report also addresses incidental structural, fire protection and electrical issues, but only to the extent that these issues relate to the interior environmental improvements; a comprehensive survey of building, structural, and systems conditions was not commissioned for this report.

ACKNOWLEDGMENTS

Forty-three years after its first restoration, the Andrew Johnson Homestead is in very good condition; this bears witness to the stewardship and superintendence of the AJNHS personnel.

Watson & Henry Associates thanks Mark Corey and Elaine Clark of the AJNHS for their care of the building and collections and for their assistance during the site visit, particularly in producing documentation and records. Watson & Henry Associates also thanks Jon Buono and Alan Bohnert of the SERO for their assistance in the project and for collaboration in developing realistic conservation objectives for building and collections.

End of Introduction

OBSERVATIONS

METHODOLOGY

The descriptions and observations presented in this report result from:

- •Review of available information on the building, the collections, the interior environment and the exterior climate;
- •Visit to the site on 15-16 November 2000 to observe the building, systems, collections and site context firsthand;
- •Discussions with AJHS staff and SERO staff to identify past problems and attempted solutions;
- •Review of the information gathered above to assess the performance of the building and systems with respect to building and collections conservation.

CLIMATE AND SITE CONTEXT

Greeneville is situated in the northeast corner of Tennessee in the foothills of the western slope of the Appalachian Mountains. The National Climate Data Center publishes climate data for two locations in the vicinity of Greeneville, Tennessee:

- •Knoxville, 68 miles to the southwest and
- •Bristol, 45 miles to the northeast.

Review of the available climate data records (Appendix B) suggests that Knoxville is slightly warmer and more humid than Bristol. Both locations indicate a prevalent wind pattern from the southwest quadrant, with lighter breezes dominating from the northeast quadrant; the prevalent wind directions appear to be defined by the topography of the Appalachian Mountains. Rainfall data is available for the Knoxville location only.

Based on the data for the above two locations, the Greeneville climate can be characterized by the following conditions:

- Summer median extreme high temperature: 95 ×F (dry bulb) at 75 ×F (wet bulb), 40 % RH;
  Summer 1.0% occurrence, high temperature: 90 ×F (dry bulb) at 75 ×F (wet bulb), 51 % RH;
  Summer median high wet bulb temperature: 80 ×F (wet bulb) at 90 ×F (dry bulb), 66 % RH;
  Summer 1.0% occurrence, high wet bulb temperature: 76 ×F (wet bulb) at 86 ×F (dry bulb), 64 % RH;
- Winter median extreme low temperature: 1 ×F (dry bulb) at 0 ×F (wet bulb), 65 % RH
  Winter 99.0% occurrence: 14 ×F (dry bulb) at 12 ×F (wet bulb), 61 % RH;
- Median daily dry bulb temperature range: 20 ×F
- Mean precipitation:
  >4.5 inches per month: March, July, December;
  >4.0 and <4.5 inches per month: January, February, May, June;
  >3.5 and <4.0 inches per month: April, November;
  >3.0 and <3.5 inches per month: August, September, October.
- Freeze-thaw cycles, annual average: 50 to 59

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The climate may be qualitatively characterized as hot summers with occasional periods of moderately high relative humidity and cold winters with periods of very low relative humidity. On a daily basis, high relative humidity is likely in the morning and evening, especially in spring, summer and fall.

The Andrew Johnson Homestead is located in the historic urban core of Greeneville. The house faces slightly west of northwest (nominally referred to as northwest for reference in this report) and is situated on Main Street, US Highway 321; the front façade of the building is set hard to the sidewalk. The street slopes down to the southwest; the site generally slopes down from the north corner to the south corner, with the steeper inclination parallel to the street. The rear of the site is bounded by College Street; a small creek flows across the rear of the site, paralleling College Street .

The site is reportedly underlain by limestone rock formations permeated by natural springs; one such spring surfaces in the rear of the site and drains to the creek. The spring appears to be 5 to 10 feet below the cellar floor of the house.

The house is L in plan. The short axis is a compact 2 ½-story center hall main block which parallels Main Street; the long axis is a 3 ½-story ell (without halls) extending from the rear of the main block. The L opens to the northeast; open-sided two-story porches are set on the north half of the rear of the main block and the northeast side and southeast end of the ell. The ell rooms and main block center stair hall communicate directly with the two-story porches; the porches allow circulation between the main block and the ell rooms. The main block has a crawl space and the ell has a full cellar which opens to grade on the southeast and southwest exposures; placement of the ell cellar takes advantage of the sloping site. Circulation between the ell cellar and the remainder of the house is via the porches.

The southwest side of the house, brick masonry three stories high, is exposed to the largest amount of solar radiation, and hence heat and light, during the months of October through March; the average monthly amount is 700 to 860 BTU/square feet/day. The northwest front, generally unshaded, is exposed to peak solar radiation during the months of April to August; the average monthly amount is 690 to 740 BTU/square feet/day. The two-story porches shade the remaining exposures.

DESCRIPTION OF BUILDING, SYSTEMS & INTERPRETATION

The Andrew Johnson Homestead was restored in 1957 under the direction and supervision of the National Park Service; the restoration removed late nineteenth century and early twentieth century alterations and returned the house to its appearance during the Andrew Johnson occupancy.

Briefly, the construction of the Andrew Johnson Homestead consists of the following major elements:

- Stone and brick foundation walls, some with 1957 concrete underpinnings;
- Brick masonry exterior walls;
- Brick masonry interior partitions;
- Bare earth floor in the main block crawl space and part of the ell cellar;
- Wood floor over concrete slab and painted concrete slab floors in portions of the ell cellar;
- Wood-framed floors for the first and second stories;
- Wood-framed roof with wood shingles on open-spaced wood nailers;

- Wood-framed porches with wood floor decks and sheet metal roofing, and with plaster ceiling on the second story and painted board ceiling on the first story ceiling;
- Plaster interior finishes on exterior walls and interior partitions of the first and second floors;
- Unfinished ceilings in the main block crawl space and the ell cellar;
- Plaster ceilings on selected first and second floor spaces, with painted wood boards on the remainder.

Over 40 years after its completion, the restoration remains a textbook example of complete and thorough project documentation; three volumes of documentation include:

- *Survey Report (Architectural Data), Restoration of the Andrew Johnson Homestead, Greeneville, Tennessee*, 20 August 1956, Ernest Allen Connally, Ph.D., Architect, National Park Service. This is a description of the preliminary investigations and the philosophy and direction for restoration;
- *First Supplement to the Survey Report*. This volume was not available at the site, but is reported to contain the detailed plans and specifications for executing the restoration;
- *Second and Final Supplement to the Survey Report*, April, 1959, Henry A. Judd, Architect, National Park Service. This is a detailed post-restoration accounting of the undertaking, including discoveries made during the exposure of the historic fabric during construction.

From the project documentation, it is apparent that an effort was made to sensitively integrate mechanical and electrical systems into a building that was not electrified or mechanically conditioned during its period of interpretation/restoration. The design scheme included:

- Radiant electric heating embedded in the plastered ceilings of selected spaces of the main block and ell;
- A limited system of forced ventilation in the main block.

The *Survey Report* (p. 62) indicates that radiant electric ceiling heat was chosen to minimize visual intrusion and provide essential heating, noting that "in weather when heating is required, the visitors will be wearing coats thus making it necessary only to remove the chill from the building and prevent freezing. One room may be heated to a comfortable level for the convenience of an attendant." The *Second Supplement* notes that radiant ceiling heat was installed in the first floor rooms and hall of the main block and in the first and second floor rooms of the ell. The *Second Supplement* also notes that portable electric heaters were intended for the cellar storeroom and kitchen and for the second floor rooms of the main block. Thermostats for the radiant ceiling heat were located in fireplaces, apparently to avoid intrusion; reportedly, this placement was later abandoned because the fireplace location resulted in false thermostat readings and the spaces were consequently overheated.

According to copies of working drawings, summer ventilation was provided by an exhaust fan in the attic that discharged into the upper portion of the kitchen chimney in the ell; screened openings in the end wall chimneys drew air from the main block rooms through the fireplaces and flues and into the attic. The effectiveness of this ventilation scheme is not known; the roof and attic may have been sufficiently "leaky" that the exhaust fan drew little air up through the chimneys from the rooms below. This may be why two exhaust fans have been installed in the openings of the chimneys; these pull air from the rooms and exhaust into the attic, essentially acting as booster fans. The original attic exhaust fan continues to discharge to the ell chimney. There is no provision for make-up air to the main block spaces; instead, the ventilation system relies on infiltration through the windows and doors. A single switch controls all three fans in the attic: the exhaust fan and the two newer booster fans.

The crawl space under the main block originally featured passive ventilation by way of screened brick vents in the south half of the front façade and the north half of the rear façade. The 1957 restoration retained these

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vents. Subsequent to the restoration, an exhaust fan was installed in the north crawl space; make-up air is provided through the crawl space brick vents and from a series of openings in the interior partitions and exterior doors of the ell cellar. Screened louvers have been installed in the exterior doors of the ell cellar storeroom, the kitchen and the utility room; communicating vents have been installed between: the store room and crawl space; the utility room and crawl space; and the kitchen and the storeroom. The crawl space fan is operated by a switch in the crawl space, adjacent to the access door.

From the project documentation, it is also apparent that the 1957 restoration included measures for source moisture control, including:

- Footing drains and exterior foundation waterproofing at the front façade;
- Roof gutters, downspouts, and subgrade collection and discharge piping.

A sleeved sump pit is in the earth floor of the ell cellar storeroom; the pit is 7 feet – 7 inches deep and 24 inches in diameter. The pit postdates the 1957 restoration; a sump pump was installed in 1974.

The 1957 restoration included thermal improvements for the building, including:

- Installation of 6 inches of vermiculite insulation above the second floor ceiling of the main block and ell;
- Window and door restoration;
- Masonry restoration.

The Andrew Johnson Homestead is used exclusively for interpretation; tours are conducted at scheduled times. All collections are exhibited within interpreted rooms; there are no dedicated collections storage spaces in the building. Visitors view the main block rooms from the main block stair hall; they view each of the ell rooms from the room doors which open to the exterior. A small utility room in the ell cellar serves as a cramped space for docents between tours; this use occurs primarily during the Christmas tour season.

OBSERVATIONS OF THE BUILDING SYSTEMS & INTERPRETATION

The Andrew Johnson Homestead appears to have enjoyed a high level of stewardship since its 1957 restoration and is in a very good state, overall.

Observations of the building, its systems and its interpretation, as they relate the interior environment and its effects on collections conservation and preservation of historic building fabric are as follows.

- **Heating System**

The present electric radiant ceiling heating system was justified under the original restoration philosophy. The original objective of providing a low level of heat, and maintaining a minimal interior temperature during the heating season, remains sound.

However, the present heating system is poorly suited for continued use in the long term:

- The risk of fire from aged and brittle heating cable insulation is indeterminate, but increases each year;
- The cost of operation is very high relative to the interior temperature and general lighting load ($2,400 for 18 November 1999 through 18 November 2000);
- The present system does not allow modulation to interior temperatures in the 50 to 55 ×F range;
- The present system does not allow humidistatic control;
- The present system does not serve several rooms in the house, resulting in uneven distribution of heat.

- **Ventilating System**

The present ventilation system of exhausting crawl space and cellar air and exhausting interior air through the attic is a reasonable solution given the constraints of the 1957 restoration.

However, the present ventilating system and its operation pose a number of problems with respect to conservation of collections and preservation of the historic building fabric:

- Make-up (outside) air is uncontrolled and largely relies on infiltration. This introduces unfiltered air directly into collections spaces with resultant soiling, especially diesel soot and large abrasive particulates;
- The present system must be manually operated;
- The present system is often operated continuously. This results in the forced infiltration of exterior moisture vapor (via the make-up air) during periods of low exterior temperature and high relative humidity (summer nights and mornings), increasing interior relative humidity levels;
- The system puts the interior at slightly negative pressure relative to the exterior increasing the potential for moisture vapor transport into the house;
- The present system does not address rooms of the house, resulting in stagnant air in those spaces (except when doors and windows are opened or portable fans are operated).

- **Source Moisture Control**

The 1957 restoration addressed many areas of source moisture control, especially with respect to roof drainage and the front sidewalk. Source moisture control continues to be addressed by the AJNHS staff.

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Source moisture control is generally effective; however:

- Splash lines on the southwest wall of the ell strongly suggest that the gutter is overflowing near the middle of the run and at the roof valley discharge between the main block and ell;
- The detachment of wallpaper from the first floor front walls in the main block indicates excess moisture in the masonry and plaster substrate of the lower front façade wall. This suggests moisture intake by the front exterior wall from splashing, or from capillary uptake of water which infiltrates the open joints of the brick sidewalk;
- The open joints of the brick front sidewalk appear to admit large amounts of surface water into the soil adjacent to the front wall of the house;
- The brick front sidewalk has little or no cross-slope to the trench drain; surface water appears to flow parallel to the house (and into the open joints) rather than into the drain;
- The trench drain does not increase in depth with distance; this suggests that the capacity of the drain is constant along its run and may be undersized relative to road splash volume and sidewalk runoff volume;
- Vehicular traffic may splash the front façade during heavy rains and, in particular, during snow and ice melt when road salts are present ;
- The condition of the subgrade roof drainage system is indeterminate; it may be compromised by tree and shrub root growth.
- The sump pit is a potentially significant source of interior moisture vapor, especially when standing water is present;
- The bare soil of the crawl space and ell cellar storeroom may be sources of interior moisture vapor when ground moisture is high.

- **Envelope Performance**

The 1957 restoration and continued AJNHS maintenance have addressed many areas of envelope performance.

The following observations and considerations have been identified:

- The arrangement of the individual ell spaces and main block hall, with doors that open to the exterior porches, will always compromise and complicate the maintenance of stable and consistent interior environmental conditions, especially during tours. This is an inherent limitation of the historic vernacular architecture of this house and its regional kin; the room arrangement is an architectural response to the climate to improve occupant comfort, but did not anticipate collections considerations;
- The masonry construction of the building provides thermal and moisture capacity; these can buffer the rate of change of interior temperature and relative humidity;
- Windows and doors, although weather-stripped, often experience significant air infiltration;
- Closure of the shutters on the southwest wall of the ell and main block has been highly beneficial in maintaining interior temperature stability;
- The vermiculite insulation in the attic may retain atmospheric moisture, increasing the moisture load in the building. The thermal performance of vermiculite is not comparable to fiberglass batt insulation;
- The house has no vapor barriers. This precludes the maintenance of large differentials between interior and exterior relative humidity levels.

- **Related Issues**

The following related issues were observed:

- The roof and attic floor framing, especially in the ell, probably will not support the additional loads of heating and ventilating equipment or fire protection systems;
- There is no automatic fire protection sprinkler system to protect the house.

- **Monitoring Program**

The Andrew Johnson Homestead has had a comprehensive interior environmental monitoring program since 1999.

Briefly, the present program includes monitoring of temperature and relative humidity with ACR dataloggers in the following spaces:

- Ell cellar kitchen;
- Ell first floor bedroom (Andrew Johnson, Jr. bedroom);
- Main block first floor southwest room (Andrew Johnson bedroom);
- Main block first floor northeast room (Parlor);
- Main block second floor northeast room;
- Main block second floor southwest room.

The present monitoring program also includes digital thermohygrometers in several of the rooms; these are observed and noted by docents or staff members during tours or visits to the building. As part of the present monitoring program, the following information is noted and recorded manually:

- Commercially available weather forecasts, with high and low temperatures;
- Event log at the house, with notations concerning operational status of exhaust fans; door and window openings and closures; and other operational or unusual conditions. Typical interior environmental conditions recorded by the monitoring program are contained in Appendix C. Based on the monitoring program, it is clear that the Andrew Johnson Homestead experiences:
- Occasional periods of unacceptably low relative humidity (less than 35% RH) during the heating season;
- Moderately high relative humidity levels (greater than 70 % RH, approaching sufficiency for mold growth if sustained over long periods) during the non-heating seasons;
- Rapid and extreme variations of relative humidity and temperature over 24 to 48 hour intervals, throughout the year.

End of Observations

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RECOMMENDATIONS

METHODOLOGY

The operation and interpretation of historic house museums is often characterized by the needs for:

- Retention and preservation of the historic building fabric;
- Long-term preventive conservation of the collections through management of the interior environment;
- Access to collections and interior spaces for interpretation;
- Considerations for comfort of the occupying staff and visitors;
- Other considerations such as capital and operational costs, location and climate, available contractors, and reliable utility infrastructure.

The process of architectural and engineering design for environmental improvements for a historic house museum should identify and address these needs. In many instances, these needs may compete or conflict with each other; the design process should seek to reconcile and resolve these conflicting needs in the early planning stages, using the informed collaborative decision-making of the project constituencies, including an advocate for the collections.

The recommendations in this report are the first step in the design process.

PROJECT OBJECTIVES

A clear statement of project objectives can inform decision-making throughout the design, construction and occupancy phases of a building.

The suggested objectives for future interior environmental improvements at the Andrew Johnson Homestead, expressed in the broad sense, are presented in the tables following this narrative and include:

- Operational Objectives;
- Collections Objectives;
- Building Objectives.

These objectives are based on Watson & Henry Associates' experience with historic house museums and systems and have been refined through discussions with Jon Buono and Alan Bohnert of the NPS SERO and Mark Corey and Elaine Clark of the AJNHS.

OPERATIONAL OBJECTIVES	COMMENTARY
1. Improve and simplify monitoring of interior and exterior environment and of mechanical systems operation.	• Staff should be able to monitor system performance and operation.
2. Limit systems capital cost and operating cost.	• Systems should not divert limited resources from other critical needs.
3. Keep systems simple, reliable and easily maintained.	• Systems selection should reflect the technical capabilities of the institution & local contractors.
4. Address unique characteristics of the Homestead location.	• Interior climate management strategies and systems/equipment selection should take into account local conditions, including site microclimates, vehicle pollution, local utility infrastructure and reliability.
5. Continue the present visitor experience.	• Visitor tour routing necessitates access to individual ell rooms from the exterior porches; opening of exterior doors of individual ell spaces exposes the ell spaces to rapid and significant changes in temperature and relative humidity, entry of insects and pests, and to infiltration of particulates.
6. Satisfy Secretary of Interior's *Standards for the Treatment of Historic Properties, 1995, New Orleans Charter for the Joint Preservation of Historic Structures and Artifacts*, the AIC Code of Ethics, governing building and fire codes and National Park Service policies pertaining to historic buildings and to collections.	• These represent the prevailing standard of care for the building and collections.

COLLECTIONS OBJECTIVES	COMMENTARY
1. Improve interior air quality with respect to particulates and microorganisms.	• High particulate levels increase need for housekeeping and risk of damage to collection. Large air-borne particulates lead to soiling, abrasive damage and may contain damaging soluble salts. Microorganisms can infest and consume organic materials.
2. Reduce visible and ultraviolet light on collections from natural and artificial sources.	• Light causes cumulative irreversible damage to collections and should be minimized.
3. Reduce micro-organism opportunities.	• Control conditions, *i.e.*, high relative humidity and particulate deposition, that are conducive to microorganisms.
4. Prevent collections desiccation.	• Collections have become acclimated to the present range of relative humidity extremes. Drying and desiccation problems appear to be more prevalent than moisture problems.
5. Reduce risk of fire.	• See Building Objectives.
6. Reduce potential for air-borne insect entry, a potential problem at a rural or small-town site.	• Air-borne insects may infest and consume collections. Air-borne insects should be intercepted and controlled at the points of entry to the building. The integrated pest management strategy should continue.
7. Protect collections from exposure to damage from construction operations.	• Construction activities introduce significant risks to collections in partially occupied buildings. These risks include fire, smoke, abrasive dust, vermin, theft and water leaks.

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BUILDING OBJECTIVES	COMMENTARY
1. Reduce fire risk to the building.	• Loss from fire is absolute. Fire risk may occur from installation, operation or maintenance activities.
2. Reduce moisture entry from exterior and systems.	• Intercept exterior moisture before building entry. Reduce potential for system leaks.
3. Limit the visual and physical intrusion of new systems on the historic spaces and fabric.	• New systems and components should be concealed from view: installation should minimize irreversible changes to the historic building fabric. See also Operational Objectives, item 8.
4. Recognize performance limits of building envelope.	• The historic building envelope cannot support wide differentials in inside/outside RH.
5. Minimize systems failure risks.	• System failure may cause harmful climate changes or may result in leaks.

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STRATEGIES FOR ACHIEVING THE OBJECTIVES

Recommended strategies have been developed for achieving the forgoing objectives; these strategies are intended to provide guidance for further design investigation and solutions.

The recommended strategies are organized according to the following categories:

- Space Planning;
- Envelope Performance, including Natural Light;
- Source Moisture Control;
- Interior Environmental Management;
- Fire Risk;
- Construction Implementation.

The recommended strategies are for use of the National Park Service and future design consultant(s) in making design decisions for the interior environmental improvements. Many, if not all, of the recommended strategies have some interrelationship; a design decision concerning one strategy will often have an effect (desired or undesired) on another strategy. Therefore, the recommended strategies should be viewed in the whole, and decisions should be made after considering the potential effects or consequences relative to other objectives and strategies.

As with any project, design decisions will involve fundamental issues such as capital and operating costs as well as pragmatic considerations such as constructability, construction logic and project duration. Implementation of these recommendations will require ongoing consideration, and in some cases, the final determination may be that a recommended strategy cannot be fully implemented.

Therefore, Watson & Henry Associates strongly recommend that the National Park Service curatorial and conservation staff continue to participate in the development of the design of the interior environmental improvements. The continuing participation of conservation professionals during the design phases will help assure that the new interior environmental control improvements contribute to the long-term preventive conservation and protection of the collections in a cost-effective manner.

STRATEGY	DESCRIPTION & COMMENTARY	SUGGESTED ACTIONS
Space Planning	Provide adequate space for new systems. *Interior climate management systems, especially those for collections, require more space than conventional systems. Adequate space facilitates future systems maintenance, increasing the reliability and performance of the systems.* Separate the building uses into distinct zones of use. *Separate use zones imply separate mechanical systems zones. Separate use and systems zones simplify systems and minimize collections risks.*	• Provide generous space for climate systems equipment & distribution: Revert ell cellar storeroom to pre-1957 use as mechanical room; Use attic for ventilation equipment; Convert utility room to staff/docent space; Reconstruct missing site outbuilding for gas-fired heating equipment. • Separate use zones physically. Consider vertical as well as horizontal separation. Suggested zones are: Interpreted (Collections) spaces; Staff and housekeeping spaces; Mechanical spaces.
Envelope Performance, including Natural Light	Selectively improve existing envelope performance according to interior climate needs. *Thermal performance of the envelope includes conductive and convective heat transport across the boundaries of the building envelope. Improved thermal performance reduces mechanical systems capacity, especially in zones containing collections.* *Include passive and active measures to reduce intensity and duration of visible and ultraviolet light and to reduce solar-driven temperature fluctuations.*	• Reduce/control convective heat loss/gain by air infiltration/exfiltration: Repair/upgrade weatherstripping at windows and doors; Minimize duration of open exterior doors, especially if exterior temperature is extremely low; Control introduction of outside (make-up) air into ventilation system. • Reduce conductive heat loss/gain: Replace vermiculite insulation with fiberglass batt insulation in attic; Close window shutters at night to reduce conductive/radiant heat loss at windows. • Control/reduce natural light at windows & doors: Use light-reducing window shades or material incorporated into window treatments; Close shutters on southwest ell & main block wall from April to October. • Minimize use of artificial lights that have heat-generating lamps or ballasts.

STRATEGY	DESCRIPTION & COMMENTARY	SUGGESTED ACTIONS
Source Moisture Control	Reduce moisture entry from surface and subsurface water and from air infiltration. *Source moisture control reduces the potential for direct and indirect damage to building fabric and to collections.* *Effective source moisture control reduces the need/complexity & cost of mechanical systems & leads to more stable interior relative humidity levels.*	• Roof water collection and drainage system: Verify correct gutter slope and function; Correct gutter overtopping above southwest wall of ell; Install overflow deflectors where roof valleys discharge to gutter; Inspect (w. fiberoptics) drain lines for damage/blockage & correct; Maintain rigorous & frequent gutter cleaning schedule. • Confirm all yard areas adjacent to building drain away from the building: Check yard area immediately southwest of cellar kitchen for ponding; Check landscaped area along porches for positive drainage; Slope surfaces within 15 feet of building to drain away from building; Do not use gravel or highly previous soil materials to fill low spots. • Reduce water infiltration at front sidewalk: Rebuild open-jointed brickwork with underdrain/water barrier; or, rebuild brickwork with mortared joints; Monitor vehicular splashing on front façade, especially in winter. • Reduce convective transport of moisture vapor: Repair/upgrade weatherstripping at windows and doors; Control outside air volume during very high/low exterior RH; or, precondition and dehumidify outside air during high exterior RH. • Reduce interior source moisture: Install high performance vapor barrier in store room & crawl space; Trim shrubs & trees to promote ventilation & exterior drying of building; Consider sealing sump bottom with bentonite. • Protect building and collections from wet systems: Provide leak protection/pans for equipment & piping (except sprinklers); Locate landscape irrigation system away from building.

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STRATEGY	DESCRIPTION & COMMENTARY	SUGGESTED ACTIONS
Interior Environmental Management	Address interior environmental needs of each use zone with a specific system zone. *Final specification and implementation of the T & RH conditions for collections areas will depend on several related design decisions, such as zoning, exterior envelope, capital and operating costs, et cetera.* *Humidification of the Andrew Johnson Homestead should be avoided. Humidification is impractical and may be destructive to the building fabric due to:* • *Single glazed windows;* • *Masonry wall construction with pocketed joists;* • *Large ratio of envelope surface area to interior volume;* • *Significant air exchange that occurs during tours, especially in the ell;* • *Absence of vapor retarders in the wall or ceiling assemblies.* *Interior RH should be managed to minimize fluctuations or changes occurring over a 24 hour period. Temperature may be permitted to fluctuate more in order to stabilize RH.*	Interpreted (Collections) Zone systems: • Heating Mode: Maintain RH using low temperature, humidistatic-control heating; Occasionally elevate temperature with heating (not more than 70 °F) in fall and spring to depress excessive relative humidity; Re-circulate air continuously to suppress microorganism activity; Filter recirculated and outside air to reduce particulates; Regulate/control outside air with the ventilation system; Maintain exfiltration to prevent uncontrolled infiltration. • Ventilating Mode: Introduce large volumes of outside air when exterior humidity ratio is within acceptable limits; Dehumidification when interior RH approaches 70 %; Re-circulate air continuously to suppress microorganism activity; Filter recirculated and outside air to reduce particulates; Regulate/control make-up (outside) air with the ventilation system; Maintain exfiltration to reduce uncontrolled infiltration. • System Control and Monitoring: Use direct digital controls (DDC); Incorporate T & RH monitoring into DDC controls from heating/ventilating system so that collections staff may track interior conditions without separate monitoring equipment (see Appendix A). • Develop and review interior environmental parameters for collections with a collections conservator.

STRATEGY	DESCRIPTION & COMMENTARY	SUGGESTED ACTIONS
Fire Risk	Introduce passive and active measures for fire resistance, detection and protection. *Measures include:* • *Reduce ignition risk;* • *Contain fire & smoke;* • *Reduce detection & response time;* • *Suppress fire quickly.*	Ignition Risk Mitigation: • Replace radiant electric heating system • Rewire electrical system, using existing conduit; • Consider installation of lightning protection system; • Locate boiler and mechanical equipment outside Homestead building, possibly in reconstructed outbuilding. Fire and Smoke Containment • Separate collections zone from mechanical areas with fire-rated construction, including attic and below-grade spaces; • Shut down HVAC systems upon smoke detection. Detection/Response • Install automatic fire protection sprinkler system (dry or pre-action).
Construction Implementation	Include measures and precautions to minimize risks to collections & building during construction. *Risks include:* • *Fire;* • *Solvents and chemicals;* • *Leaks;* • *Physical damage;* • *Theft.* Coordinate & implement structural upgrades & reinforcement of the ell roof/attic framing with the attic mechanical & fire protection system improvements.	Measures & precautions should include, at a minimum: • Relocation & off-site storage of collections during construction; • Special in-situ protection & monitoring for objects or furnishings that cannot be easily relocated during construction; • Require contractor conformance with NFPA 241; • Prohibit welding, brazing, other hot work & smoking within the house; • Prohibit construction materials & tools storage within the house; • Require dust control measures; • Require that wet piping systems be pressure tested with air prior to filling with water or hydrostatic testing. Incorporate space requirements & dead loads of mechanical and sprinkler equipment into design of ell roof/attic frame reinforcement.

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PRELIMINARY SYSTEMS DESCRIPTION

The execution of the recommended strategies will require new mechanical and electrical systems. Design of the systems is beyond the scope of the present report; however, a preliminary description of the mechanical and electrical systems is included. Based on the foregoing strategies, Watson & Henry Associates offers the following preliminary systems descriptions for the Andrew Johnson Homestead.

These preliminary systems descriptions will require further development and refinement by a engineer and an architect experienced in interior environmental management of historic house museums; the descriptions are not intended to be used for a scope of work for a contractor. If these preliminary descriptions are used to develop conceptual construction costs, generous contingencies must be included, as well as costs for cutting and patching, collections protection, construction access and other activities related to the undertaking.

These preliminary systems descriptions are for use of the National Park Service and future design consultant(s) in making design decisions for the future interior environmental improvements; the descriptions are based on the recommended strategies also presented in this report. Therefore, decisions concerning the strategies may materially change the systems description; changes to the systems descriptions will affect the fulfillment of the strategies.

PROPOSED SYSTEMS	PRELIMINARY SYSTEMS DESCRIPTION
Mechanical	Heating • Natural gas-fired boiler with small volume hot water storage tank (sized for 55 °F interior temperature at exterior design low temperature); • Boiler located in small reconstructed outbuilding or in ell cellar storeroom; • Utility service for natural gas; • Hot water coils in two air handlers; • Perimeter hot water baseboard heat in Staff/Housekeeping zone; Ventilating • One air handler for low temperature first floor Interpreted (Collections) Zone, located in ell cellar storeroom, with ducted air supply & return in cellar and crawl spaces below first floor; • One air handler for low temperature second floor Interpreted (Collections) Zone, located in ell attic, with ducted air supply & return in main block and ell attics above second floor; • Controlled source of outside air for each air handler zone. Intake(s) should be remote from the street (to avoid vehicular emissions), and from finished grade/landscaped areas (to avoid excess moisture and microorganisms); • Exhaust fan for restroom. Controls • Integral monitoring and control via direct digital control system, small local desktop computer and remote monitoring via dedicated data transmission line to either visitor center or the AJNHS office. Operational Logic • Air handler fans recirculate and filter air continuously. Smoke detection stops fans; • Outside air is admitted when exterior humidity ratio is closer to desired interior humidity ratio than the existing actual humidity ratio (i.e. if interior relative humidity exceeds desired range, and exterior conditions are drier, then outside air is introduced); • Hot water to air handler coils is modulated to maintain low level (45 °F to 70 °F) space temperature; • Temperature setpoint for heating is based on desired interior relative humidity level.

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PROPOSED SYSTEMS	PRELIMINARY SYSTEMS DESCRIPTION
Electrical	• Retain existing underground service to house; • Replace main panel in utility room in ell cellar; • Remove existing radiant heating subpanels and control panels and circuits, including portable heater receptacles; • Add to subpanel for mechanical outbuilding; • Remote controlled pre-set lighting for Interpreted (Collections) zone, including service/housekeeping lighting level; • Conventional lighting in Staff/Housekeeping zones and in Mechanical zones; • Service/convenience receptacles throughout all zones; • Power for mechanical systems; • All power and control wiring in conduit; • Limited site lighting for access and security. Option • Consider manual transfer switch and tie in for portable generator connection for essential systems during power outage.
Fire Protection	• Water service from off-site municipal water supply, assume water pressure/volume is adequate for dry-pipe or pre-action system and no fire pump is required; • Pre-action sprinkler system throughout building, possibly with on-off capability, such as "Fire-Cycle" system, or Dry pipe system throughout building, zoned to correspond to use zones; • Fire protection system water service, entry and station in ell cellar utility room or in storeroom; • Siamese fire department connection located adjacent to service parking area.

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MONITORING PROGRAM & PRESENT OPERATIONS

Until the recommended strategies can be implemented through a new interior environmental management system, there are several steps that can be immediately taken to improve the interior environment at the Andrew Johnson Homestead. The following recommendations address the monitoring program and the present operations.

- **MONITORING PROGRAM**

The present interior environmental monitoring program at the Andrew Johnson Homestead is comprehensive; it is diligently and consistently executed.

The purpose of the monitoring program in the immediate future should be to inform the design process for the replacement system. To this end, the monitoring program should produce data and information which clearly and readily:

- Demonstrate the response of the building interior to exterior conditions;
- Demonstrate the overall environmental comportment, or behavior, of the building, from top to bottom and from end to end.

Therefore, the following minor changes are recommended for the present program in order to improve its efficiency and to enhance the usefulness of the collected data.

The temperature and relative humidity dataloggers should be comparison checked and then redeployed as follows:

- Exterior, perhaps the ceiling of a first floor porch or a similar location, protected from direct sunlight and from water/rain;
- Ell cellar storeroom;
- Ell first floor dining room;
- Ell second floor bedroom (above dining room);
- Main block first floor northeast room (Parlor);
- Main block second floor northeast room (above parlor bedroom);
- Attic, near floor at juncture of ell and main block.

Site-specific exterior temperature and relative humidity readings are essential to understanding the response of the interior of the house to the exterior conditions. Exterior readings should be taken with one of the dataloggers and a remote sensor (a small sock is available from ACR to protect the sensor from insects and dust). A duplicate exterior reading should be taken at a nearby location with a separate datalogger and remote sensor; this will provide back-up data in the event that one sensor fails.

Interior and exterior dataloggers should be set to read at 20 minute intervals; download the dataloggers monthly. This should reduce some of the labor in the program.

Printout temperature and relative humidity data using identical chart formats:

- Use one-month and three-month intervals. Long intervals are better for revealing overall trends;
- Standardize all chart ranges on the horizontal and vertical axes (i.e., 0 to 100 % RH and 0 to 100 ×F temperature). Standardizing the chart format and ranges will facilitate comparison of graphical data between datalogger locations;

- Print charts in landscape format. This stretches out the time line and makes it easier to read day-to-day changes.

Continue with the event and weather logs, but simplify the content and format:
- Set up a form that allows observation for an entire month on a single sheet, perhaps in table format;
- Note weather conditions such as cloud cover, wind speed and direction, precipitation and significant weather changes (such as when a cold or warm front moves in). Five day forecasts are not necessary;
- Note attic and crawl space fan operational status;
- Note shutter position;
- Note equipment problems;
- Note tour times;
- Note any special conditions.

A monthly table/checklist format will allow easy comparison of changes from day to day; a monthly time frame will correspond to the temperature and relative humidity charts from the dataloggers.

The present program is an excellent example of care, consistency, diligence and careful organization; this level of commitment and attention should continue. For a general discussion of the design and execution of monitoring programs, please refer to Appendix A.

- **PRESENT OPERATIONS**

The following recommendations are made for the operation of the building and systems until the replacement system is designed, constructed and commissioned. The efficacy of these recommendations can be verified with the revised monitoring program as outlined above.

Ventilation and Attic/Crawl Space Fans:
- In summer, avoid operating the fans when the exterior air has a higher humidity ratio than the interior air; typically, operate the exhaust fans at the hottest, driest periods and avoid operating the exhaust fans during the night and early morning. Operation of the fans during night and morning can aggravate interior moisture levels by introducing cooler air with a higher relative humidity than the interior;
- In winter, avoid operating the exhaust fans unless unusually high interior relative humidity is encountered;
- In spring and fall, operate the exhaust fans as outlined for summer when necessary to manage high interior relative humidity;
- Continue to operate the portable fans whenever the building is attended. Check fans to confirm that they are properly positioned before operating (a toppled fan can overheat). Check fan and extension cords monthly for embrittlement, nicks and damage; replace immediately if found.
- Consider wiring the attic and crawl space fans to new switches mounted in the utility room. This will facilitate exhaust fan operation by the staff. Also consider time clock control for summer operation of the exhaust fans, initially setting the time clock to operate the exhaust fans from 12 noon to 5 to 7 in the evening, when the exterior air tends to be hot and dry. Manually override the clock control on rainy days.
- Consider closing the crawl space brick vents; this should increase air flow through the adjoining cellar spaces when the crawl space fan operates. If there is a concern that this will cause high relative humidity levels in the crawl space when the fans are running, monitor the space to check the results.

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Temperature control:

- Set all thermostats so that interior room temperature is maintained at not more than 50 to 55 ×F during the winter; increase space temperature to 65 ×F from late March to May. Some thermostats may have to be set higher or lower, depending on their location; actual room temperature is the criterion, not the thermostat;
- Abandon use of all portable electric heaters due to age and potential fire hazard;
- Keep the shutters closed on the southwest side of the ell and the main block between October and March, and between May and August. This will reduce interior temperature spiking in all months and high interior temperatures in the summer. For purposes of reducing light damage to collections, it may be advisable to keep these shutters closed year-round;
- Limit opening duration of ell room doors to the shortest practical time when exterior conditions vary greatly from interior conditions;
- Consider closing the shutters on the front (northwest) of the main block in the afternoons between May and August.

Source Moisture Control:

- Clean all gutters at least quarterly, except autumn, which should be monthly;
- Flush downspouts to confirm they are clear;
- Inspect underground drainage pipes with video and fiberoptics. Clear of roots and obstructions and repair broken pipes, if found;
- Correct the gutter overflow on the southwest wall of the ell;
- Install overflow diverters on the top edge of all gutters at roof valleys;
- Correct the apparent shallow grade near the south corner of the ell, outside the kitchen;
- Investigate sealing the sump pit with bentonite and then filling and abandoning. Implement if practical;
- Monitor the front exterior wall when roads are salted to see of vehicles splash road slush on the exterior. Investigate temporary measures to protect the exterior;
- Consider filling open joints in the sidewalk in front of the house with mortar, until the sidewalk can be reconstructed with an underdrain.

The high degree of care and stewardship that has been given to the Andrew Johnson Homestead by the AJNHS staff should continue.

End of Recommendations

APPENDIX A

SUGGESTED PROTOCOL FOR DIAGNOSTIC MONITORING IN MUSEUMS

Michael C. Henry, PE, AIA

http://crs.sero.nps.gov/historic/hsar/anjo/henry.pdf

SUGGESTED PROTOCOL FOR DIAGNOSTIC MONITORING IN MUSEUMS

Michael C. Henry, PE, AIA

INTRODUCTION

Note: This document was originally prepared for the Getty Conservation Institute as part of the Museums in Hot & Humid Climates project, specifically the assessment of the Museu de Arte Sacra, Salvador, Bahia, Brazil. General distribution is permitted courtesy of the Getty Conservation Institute.

Conservation assessments typically do not rely on, or include, the concurrent installation of sophisticated environmental monitoring and data collection systems. Monitoring activity was not intended as an assessment activity in the development of The Guidelines for assessments.

However monitoring may be a recommendation of the conservation assessment. The priority for installation and deployment of the system is usually after the implementation of immediate actions such as source moisture control measures.

Monitoring has become a common trend with museums and historic structures; monitoring has become something that Institutions and Consultants want, or think is needed, but do not necessarily understand. The technology of monitoring - computers, graphics, sensors and electronic devices - often has greater technological appeal than common sense diagnosis and careful building observation, investigation and analysis. With digital indicators and computer printouts of data to multiple decimal places, monitoring with modern hardware can convey a sense of exactitude that is fictional.

Unnecessary monitoring does not put a building or collection structure in direct risk. However, it can divert valuable financial resources from basic maintenance and restoration activities, and the staff time necessary for implementation of a long-term diagnostic program may effectively delay necessary repairs. The cost of monitoring may often approach or exceed the cost of strategies to mitigate or eliminate of the readily apparent causes of a problem, strategies such as source moisture control, natural light control, improved ventilation or basic building repairs.

Therefore, monitoring, and in particular, multiple-sensor or multiple data-logger monitoring, should be applied with intelligence and restraint.

This document provides a brief overview of:
- Capabilities and limitations of monitoring;
- Basics of measurement theory and practice;
- Monitoring as a diagnostic tool, especially for moisture-related problems;
- Some of the technical issues associated with monitoring programs;
- A suggested methodology for developing a diagnostic monitoring program.

CAPABILITIES AND LIMITATIONS OF MONITORING

Monitoring is a tool for enhanced observation of a problem or condition. Monitoring:
- Sharpens our focus by quantifying variables that elude qualitative description;

- Serves as a magnifying glass for changes or differences too small to observe;
- Expands our window of observation by continuous, round-the-clock recording;
- Multiplies our points of observation by simultaneously recording variables at different locations;
- Offers the capacity to present a consistent and organized record of data in a variety of formats;
- Provides us with detailed quantitative information that facilitates our analysis of a particular problem.

Monitoring is not a panacea to problems of building and collections conservation, nor does it yield answers to all questions. Monitoring:

- Does not eliminate the need for observation and diagnosis by experienced professionals;
- Does not magically yield comprehension, understanding or solution of a problem;
- Requires understanding of measurement theory, statistics, psychrometrics, the mechanics of air, moisture and thermal energy transport, and the moisture content characteristics of materials to make sense of the data collected;
- Is not necessarily improved by more frequent measurements or increased measurement locations;
- Can yield meaningless data in the absence of a rigorous program for initial, final and interim calibration;
- Is limited by the performance characteristics, such as accuracy, of the monitoring equipment. Differences or changes in recorded data that are within the error band or range of accuracy of the system are effectively inconsequential.

Monitoring and computerized data collection are potentially expensive and labor intensive, especially with respect to data reduction and analysis. Indiscriminate, non-specific monitoring can quickly generate stacks of incomprehensible computer outputs, cause "data indigestion" for the Consultant, and lead to unfulfilled expectations for the Institution.

Monitoring is a tool, a means to quantify specific responses to a known set of conditions, thus informing diagnostic logic and the analytical process. However, monitoring is not an end in itself.

MEASUREMENT THEORY AND PRACTICE

A material property may be observed and characterized by an observer on a broad qualitative scale; such characterizations may include terms as "hot," "cold," "saturated," or "dry". In many situations these terms are adequate for descriptive communication or intuitive diagnostic analysis.

However, comparison of property at different observation points in time or in location, requires some consistent and reliable standard to which to refer over time or from place to place. To this end, simple devices, such as a hand-held thermometer, a relative humidity color strip, or a blue wool comparator, may be sufficient for the task of comparative diagnostic analysis.

More complex problems may elude intuitive or comparative diagnostic analysis. In such cases, quantitative analysis may be necessary and the quantitative analysis must utilize property data that have been consistently measured within a known range of accuracy.

In many instances, properties, such as relative humidity, are not be measured directly, but are the result of measurement of other variables, such as wet-bulb and dry-bulb temperatures, which allow calculation of the

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variable in question. These indirect measurements require a greater degree of sophistication than, for example, measuring a crack in masonry.

It is essential that we understand the limitations of measurement before we collect and attempt to interpret data. This is especially important with digital outputs, where readings with several decimal places may convey a false sense of exactitude.

First, consider fundamental terminology and principles of measurement.

- Monitoring
  Collecting and recording measured data in a systematic, consistent and repetitive manner.
- Measurement
  Quantifying the value of a variable using an instrument or device.
- Instrument system
  A device or series of devices for determining the value or magnitude of a quantity or variable, either directly or indirectly.
  An instrument system generally consists of a sensor, a transmitting means, and an indicating or recording element. Each of these introduces error into a measurement.
- Sensor
  Responds directly to a measured variable, producing a related signal, usually a small, variable electrical current or voltage.
- Transmitter
  Converts the signal to a usable form, either digital or analog, and may include the wires or circuitry between the sensor and the indicating/recording element.
- Indicating or recording element
  Either displays or records the measured quantity in analog (dial or graph) or digital format.
- Range
  The range of values of a measured variable over which the instrument is useful. The useful range of an instrument may be limited by its accuracy or precision, or by environmental or physical factors (such as pressures or temperatures which may render the device inoperable or inaccurate).
- Accuracy
  The degree of agreement between the instrument reading and the true value of the variable being measured. This is important if it is necessary to compare subtle differences in readings from devices at different locations.
- Precision
  The degree of agreement between successive readings for a fixed variable. This is important if it is necessary to draw conclusions from differences in values from the same instrument over time.
- Sensitivity
  The ratio of the instrument output signal to a change in the measured variable. Sensitivity in important in assembling an instrument system, since the sensor, transmitting device and indicating/recording device should be well matched with respect to sensitivity.
- Resolution
  The smallest change increment in a measured variable which will result in a response from the instrument. This is important if it is necessary to measure small discrete changes.
- Drift
  The change in a reading for a given quantity over time; drift may be simple shift of all readings over the

entire range, or it may be skewed or non-linear. Drift is important in long-term monitoring programs and in establishing calibration frequencies.

- Calibration
  Establishing the accuracy of a device through comparison to a known standard and documenting the deviation or adjusting the device to within a range of acceptable accuracy. Calibration is done prior to, and after, use of a device; under long-term programs it is checked at specified frequencies during use.

DEFINING THE MONITORING OBJECTIVE

There are three broad objectives for monitoring of buildings and collections:

- Curatorial or documentary monitoring;
- Diagnostic monitoring;
- Validation or performance monitoring.

Curatorial or documentary monitoring:

- Documents the conditions to which a building, collections or materials are exposed, such as temperature and relative humidity;
- Is generally a long term activity (the lifetime of the object, collection or institution);
- Utilizes individual recording devices such as hygrothermographs or data loggers;
- Is typified by the monitoring programs at most museums.

Diagnostic monitoring:

- Acquires data to quantify the response of a building, collection, material or environment to known changes in the interior or exterior environment. It may document an apparent correlation between an effect and a postulated cause;
- Is a tool to supplement condition assessments and diagnosis of building problems;
- Allows longer term recording of data than is possible with spot observations;
- May be short in period, such as one day, or may extend over four seasons;
- May include tracking interior and exterior environmental conditions and phenomena as well as conditions within specific materials. Requires identification of extraordinary events which may affect the recorded data;
- May utilize a variety of devices which measure not only interior temperature and relative humidity, but also light, building materials moisture content, rainfall, wind speed and direction, surface temperature, groundwater level, soil moisture content or structural movement.

Validation or performance monitoring:

- Acquires data to confirm the predicted or desired performance of a building, or a building system;
- Generally intermediate term (system life-span, or more likely the control system life-span);
- May include tracking interior and exterior environmental conditions and phenomena as well as equipment status and system variables;
- Can be integrated with the HVAC control system;
- May include tracking of materials conditions to confirm design assumptions on building envelope performance.

The objectives of a monitoring program, and how the monitoring data are to be used, affect:

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- Equipment selection;
- Device installation;
- Monitoring frequency and time frame;
- Data format and output.

The objective of the monitoring program must be clearly defined by the Consultant and Institution before the system is designed.

DIAGNOSTIC MONITORING - FORMING THE PROBLEM STATEMENT

If diagnostic monitoring is a tool, then a clear statement of the problem to be solved should precede the design of a monitoring program.

The problem statement is formed after:
- Assessment and analysis of the condition of the building and the collections;
- A preliminary identification of potential causes of the problem (such as moisture sources) and the development of a hypothesis as the mechanics of the potential causes and the observed effect or condition (such as moisture, air and energy transport between the building and the environment);
- Spot readings to determine potential ranges and differences of the variables to be monitored.

Diagnostic monitoring is often employed in resolving moisture-related problems. The discussion that follows address addresses such monitoring, but is also applicable to other monitoring, such as structural movement.

For moisture related problems, the problem statement should:
- Define the moisture, air and thermal energy transport between the environment and building;
- Identify the moisture driving functions;
- Identify the dependent variables;
- Select properties and variables to be monitored.

Definition of the moisture, air and thermal energy transport between the environment and building should address:
- Interior and exterior atmospheric environments;
- Subgrade environments;
- Building structure and materials;
- Mechanical and plumbing systems;
- Visitation, use and day-to-day operations;
- Relative interaction of moisture transport, air transport and thermal energy transport;
- Unique building assemblies or configurations which influence moisture, air and energy transport between spaces or within the wall and floor constructions.

Identification of the independent variables of moisture transport should address:
- Sources of moisture, such as the atmosphere, subgrade soils and structures, mechanical and plumbing systems or occupancy and operations;
- Whether any of the moisture sources can be isolated or corrected immediately;

- Where moisture is retained and how is it released/absorbed in establishing equilibrium;
- Where the greatest moisture imbalances are;
- How, where and to what extent does temperature and ventilation affect moisture transport.

Identification of the dependent variables should:

- Be based on a hypothesis for the cause and effect relationships of moisture transport, air transport and thermal energy transport.

The selection of variables to be monitored should focus on variables which are representative of the hypothetical cause and effect relationship of the moisture problem. The monitored variables should:

- Be readily isolated from extraneous or spurious influences;
- Aid in the confirmation or disproving of the hypothesis;
- Be useful in measuring the effectiveness of remedial measures;
- Be simple!

ESTABLISHING THE MONITORING PARAMETERS

After the problem statement is defined, the variables to be measured can be identified and the parameters for the monitoring program can be established. The parameters of the monitoring program will be based on:

- Data on material properties;
- Estimated ranges of variables to be monitored;
- Necessary level of accuracy and performance;
- Time and frequency of monitoring;
- Estimated volume of data;
- Budget for acquisition and operation.

Material properties data should be obtained for the materials which may affect the monitored variables, such as building materials, interior and exterior coatings, collections materials and furnishings, and soils. Data may include:

- Moisture capacity and permeability characteristics from published data;
- Probes, sampling and laboratory testing for site specific or unique materials and assemblies such as soils or archaic materials.

The ranges of the variables to be monitored are established by:

- Spot readings and perhaps short term spot monitoring to determine the values of the variables that will be monitored;
- Review of available exterior and interior environmental monitoring data;
- Determination of whether saturation conditions are likely to be encountered, since saturation/condensation may foul some sensors.

Determination of the necessary accuracy and performance specifications is a critical step and should consider:

- How the value of monitored variables will differ throughout a building. The differences which are significant to understanding the moisture, air and energy transport must be identified.

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- The threshold difference in a monitored variable which will be considered significant, whether relative to a single location, or relative to other locations, or over time.
- The desirable performance specifications for the instrument system, based on the threshold differences of significance, with respect to accuracy, precision, resolution, sensitivity.

Establishing the time and frequency of monitoring should recognize that:
- The transport of moisture, air and thermal energy between a building and its environment is in constant flux, rarely static;
- Some variables, such as interior and exterior relative humidity are greatly influenced by diffusion and small scale convection - this can be seen in the fluctuations in real time relative humidity readings from hand-held devices;
- Other variables, such as the moisture content of building materials, are slower to respond to change.

A modern monitoring system can generate a large volume of data. Transmission, storage, retrieval and analysis of large volumes of data can be a significant cost of the monitoring program; this can be a "reality check" for the practicality and cost of the monitoring program. Therefore, the estimated volume of data should be considered before the program is undertaken. Some considerations of data volume include:
- The number of variables monitored, and the frequency of monitoring and recording the values of these variables; this will establish the volume of data;
- Extraneous and unnecessary data may obscure the information needed to understand the cause and effect relationship of the data;
- The hardware requirements for data acquisition with respect to data transfer and storage speeds, power supply and back-up, data storage capacity, and back-up data storage;
- Data storage and format and system hardware costs. Stored data and its retrieval will have a direct impact on the speed and level of effort of analysis and data reduction.

The acquisition and operation budget should realistically address all aspects of the monitoring program, including:
- Design;
- Hardware and software;
- Installation, calibration, and maintenance;
- Data collection and storage;
- Data reduction, analysis and presentation.

EQUIPMENT SELECTION

Equipment selection is based on a number of factors:
- Performance specifications;
- Mechanical and environmental considerations;
- Calibration requirements;
- Matching equipment to needs;
- Cost of acquisition and operation.

Specifying the performance of the monitoring equipment includes the following considerations:

- A preliminary equipment selection which meets the desirable performance specifications for the instrument system with respect to accuracy, precision, resolution, sensitivity;
- Compatibility of the devices with the data collection hardware and software;
- Whether the hardwired sensors or self-contained data loggers are used; how downloading of data will be handled;
- Data acquisition hardware and software performance.

Mechanical and environmental considerations include the following:
- The potential exposure of the devices and equipment to the public, shock, pressure or mechanical damage;
- How each is to be mounted or secured;
- Whether each will perform accurately in the full range of temperature and humidity service conditions;
- Whether the sensor elements or equipment will be exposed to condensation or saturation conditions;
- If reliable power is available.

Measurement devices require calibration if data is to be reliable; calibration considerations include:
- Method, level of difficulty and time necessary to perform calibration;
- Whether calibration will be done in place or in a lab;
- The recommended frequency of calibration.

Monitoring equipment should be matched to needs and budgets:
- Selection of the devices may require compromise - the perfect device for each application may not be inexpensive or readily available.

DEPLOYMENT AND MAINTENANCE OF THE MONITORING SYSTEM

Deployment of the monitoring system requires:
- Determination of sensor placement;
- Initial calibration;
- Commissioning and troubleshooting;
- Maintenance calibration.

Sensor placement includes the following considerations:
- Sensors should be isolated from spurious or extraneous influences on readings;
- Visibility of devices to the visiting public;
- Need for mechanical protection of devices and wiring;
- Whether wiring requires shielding from radio frequency interference;
- Whether protection required from lightning, power surges or voltage drops;
- Ease of relocation of sensors if initial placement does not accurately reflect the conditions to be monitored.

Initial calibration must be performed, or else the data is of no use:
- Establish responsibility, equipment and competence for initial calibration;
- Determine if electronic devices require "burn in" before calibration.

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Commissioning and troubleshooting:
- Establish responsibility for training in the operation of software or devices;
- Assign responsibility for answering questions and troubleshooting problems after start-up;
- Establish a plan for maintenance;
- Determine what spare parts are needed to avoid interruptions in data.

Maintenance calibration:
- Establish responsibility for interim calibration, as well as calibration check at completion of monitoring or retirement of devices;
- Determine how collected data will be handled for devices which drift out of calibration.

IMPLEMENTATION OF A MONITORING PROGRAM

Using the collected data for understanding and analysis of the building comportment is essential to diagnostic monitoring. It should include:
- Collection and compilation of the data;
- Organization and interpretation of the data;
- Presentation of data and results.

Data collection and compilation should address:
- Whether the collected data are immediately useful, or whether it must be converted for further calculations;
- Software will be used for data analysis and whether the collected data can be downloaded directly into this software;
- The most effective format to present data for diagnostic analysis:
  Simple time-dependent graphs;
  Min-Max-Average for weekly or monthly summaries;
  Bar or line histograms or statistical distribution curves; or
  Representational floor plans or building axonometrics.

Data organization and interpretation should answer:
- Whether the initial hypothesis has been confirmed by the data collected, and if not, why;
- What the data show that may not have been anticipated;
- How does the data improves or changes understanding of the behavior or response of the problem.

Data presentation and results should:
- Present data to the Institution in a comprehensible and efficient format.

SUMMARY

A well-designed diagnostic monitoring program can be a useful tool in analyzing and correcting a problem or condition, particularly those related to moisture, affecting museum collections and buildings.

Because diagnostic monitoring programs can divert financial and staff resources, and can result in large volumes of spurious or meaningless data, it is essential that monitoring programs be thoughtfully designed, and that the program be preceded by:

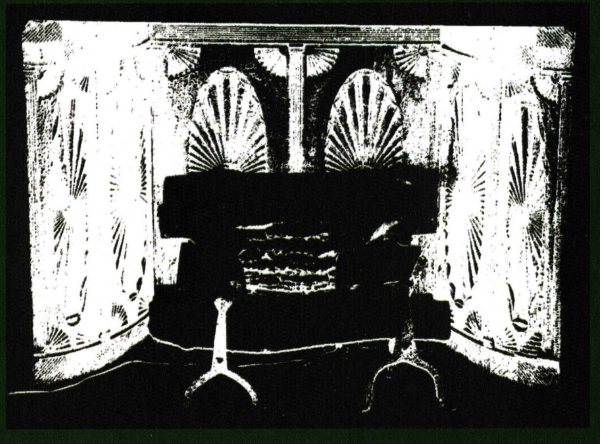
- Disciplined and thorough assessment of the building and collections and their conditions;
- Formation of a problem statement defining the hypothetical cause and effect relationship of the observed condition;
- Identification of the variables to be monitored to solve the problem statement or prove/disprove the hypothesis;
- Selection of devices and equipment appropriate to the problem, the conditions of the building and the financial and staff resources available for the undertaking, using the simplest, rather than most complex, available technology;
- Implementation of the program and analysis of the results.

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