FY01 Scope of Work
for
Backfilling a Portion of the West Ruin
of
Aztec Ruins National Monument

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# Table of Contents

List of Figures  
SECTION I – Introduction  
SECTION II – Project Statement  
SECTION III – Project History  
SECTION IV – Description of Project Area  
SECTION V – Backfill Plan  
  Summary  
  Condition Assessment Data  
  Pre-Backfilling Treatments and Special Backfilling Considerations  
  Pre-Backfilling Documentation of Rooms  
  Backfilling Specifications  
  Post- Backfilling Treatments and Special Considerations  
  Mitigation of Impacts to Cultural Resources  
  Safety and Compliance  
SECTION VI – Room-Specific Backfilling Procedures  
SECTION VII - References Cited  
APPENDIX A – Sample GEOWEB Design  
APPENDIX B – Product Literature  
APPENDIX C – List of Reviewers  
APPENDIX D – Moisture Monitoring Specifications
List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1.</td>
<td>Plan of West Ruin</td>
<td>2</td>
</tr>
<tr>
<td>Figure 2.</td>
<td>Rooms Backfilled during FY00</td>
<td>5</td>
</tr>
<tr>
<td>Figure 3.</td>
<td>Rooms to be Backfilled during FY01</td>
<td>6</td>
</tr>
<tr>
<td>Figure 4.</td>
<td>Drainage Plan</td>
<td>14</td>
</tr>
<tr>
<td>Figure 5.</td>
<td>General Backfill Stratigraphy</td>
<td>16</td>
</tr>
<tr>
<td>Figure 6.</td>
<td>Specialized Backfill Stratigraphy</td>
<td>19</td>
</tr>
<tr>
<td>Figure 7.</td>
<td>Plan View of Access Shaft for Room 114</td>
<td>36</td>
</tr>
<tr>
<td>Figure 8.</td>
<td>Elevation View of Access Shaft for Room 114</td>
<td>36</td>
</tr>
</tbody>
</table>
SECTION I – Introduction

The West Ruin at Aztec Ruins National Monument is an architectural complex constructed of stone, mud and wood. In the 20th century West Ruin was partially excavated by archeologists and it remained exposed to the present time. Partial backfilling of selected architectural units that had been previously excavated in the West Ruin was chosen by the National Park Service as a long-term method for preserving many of the above-grade walls, which had been exposed by archeological excavation at Aztec Ruins National Monument (Figure 1). According to the backfilling plan for West Ruin, “the destructive nature of archeology and continual conservation treatment that frequently removes original fabric, compounded by accelerated deterioration due to lack of adequate funding for treatment, will result in little original fabric in the future. It is for these reasons that backfilling archeological sites is becoming increasingly important” (Trott 1998:3). Therefore, the principle objectives of backfilling are to reduce the amount of maintenance required for exposed prehistoric masonry walls and to preserve their integrity.

Figure 1. Plan of West Ruin, Aztec Ruins National Monument.

Backfilling will reduce deterioration of the prehistoric walls caused by exposure to diurnal and seasonal fluctuations in moisture and temperature levels which cause deterioration through wetting–drying stress, salt phase change, and freeze-thaw. Because backfilling is intended to establish hydral and thermal stability within the backfilled environment, it is a viable conservation
option for the preservation of the ruin and will contribute to its survival. Though backfilling will not eliminate all possible agents of deterioration, the selective use of soils and geofabrics will reduce temperature fluctuations and control the movement of moisture and salts through the backfilled environment.

The following scope of work was developed within the context of Aztec Ruins National Monument: Backfilling Plan for West Ruin (Trott 1998), the comprehensive plan for backfilling of major portions of West Ruin. This scope of work details the various steps necessary to conduct backfilling work, including pre-backfilling condition assessments of each room and proposed treatments, drainage plans, backfilling methods, and maintenance. The scope of work describes tasks to be accomplished during FY01 as part of a multiyear backfilling project for sections of West Ruin. While this scope of work was prepared by Glenn D. Simpson, Exhibit Specialist IMSF-CAC, excerpts were taken directly from the original Draft Scope of Work prepared by Angelyn Bass Rivera, Exhibit Specialist IMSF-CAC, in the spring of 1998.
SECTION II – Project Statement

The purpose of this project is to partially backfill selected areas of the North and East Wings of the West Ruin in order to preserve the structural and historical integrity, and the scientific value of the ruin.
SECTION III – Project History

The scope of work presented in this document describes backfilling tasks to be completed during FY01 at the West Ruin. The scope of work for Phase I was developed in May of 1998 (Rivera 1998), and actual backfilling commenced in the late spring of 1999 (Figure 2). During the first campaign of Phase I, 34 architectural units were backfilled using a sandy loam soil and combinations of geofabrics. Afterwards, it was determined that fill levels were too high to accommodate the final clay soil layers specified in the Phase I scope of work. The second campaign of Phase I began in October of 1999 and involved the removal of 10-20 inches of soil from backfilled rooms, the installation of new and redesigned drainage elements, and the application of clay soil and Enkamat® Erosion Control Matting. Final backfilling tasks of Phase I were completed by January 1, 2000. The scope of work for Phase II was prepared in May of 2000 and addressed the backfilling of 24 rooms and two kivas. At this time Phase II tasks are still being implemented.

Figure 2. Rooms specified for Backfilling in FY99 (Red) and FY00 (Blue) Scope of Works.
SECTION IV – Description of Project Area

This scope of work applies to selected areas of the North and East Wings of the West Ruin (Figure 3). Specifically, it includes 34 architectural units: Rooms 64, 65, 66, 67, 69, 82, 83, 84, 90, 91, 92, 93, 94, 95, 96, 99, 100, 101, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 122-2, 123-2, and Kivas H, J, K, L and Kiva Enclosures H (Rooms 68, H-1, H-2, H-3) and J (Rooms J-1 and J-2). Rooms 122-2 and 123-2 are second-floor rooms above original roofs. The Phase II FY00 Scope of Work covered Room 64, however, the fill for adjacent Room 84 was determined to be substantially lower than that of Room 64. Therefore the backfill of Room 64 will need to be modified to accommodate differential pressure mitigation measures.

The walls at West Ruin are built of tabular sandstone blocks laid in mud mortar. The masonry style is double-coursed and cored (rubble core). Wall thickness varies in the north and east wings from 11 to 44 inches. Wall height varies from approximately 16 feet at the center of the north wing to less than 3 feet, as is the case with the south wall of Room 67. The rooms tend to be square, rectangular, or circular (Kivas H, J, K and L).
Figure 3. Rooms to be Backfilled in FY01 Scope of Work.

SECTION V – Backfill Plan

Summary
The backfilling system has been designed to protect the prehistoric stone masonry and architectural features from deterioration caused by exposure to the elements. The principal preservation strategy is for long-term, reversible, partial backfilling of 31 rooms and two of the kivas. Partial backfilling will leave the tops of walls exposed for public presentation and allows the site plan of the West Ruin to remain visible and legible, while protecting and concealing the remainder of the excavated rooms. The backfilling strategy involves creation of a simple horizontal stratigraphy of different soils and geosynthetic fabrics combined in some rooms with a vertical structure to contain the fill to reduce static load pressure on unsupported walls.

In the proposed backfill areas, most of the current fill levels will remain in situ; however, along the east exterior wall some excavation for drainage will be necessary. Vegetation will be cleared from the ground, after which, the ground will be covered with a geotextile horizon marker. Varying types of soil and geosynthetics will then be used as fill materials. Where rooms are to be fully backfilled, they will be filled to a level just below the tops of the walls; surface gradients will be constructed to allow surface water run-off to flow away from the walls toward the center of the rooms. Water will be discharged through a drain box/silt trap and rigid drainage system within each room. A layer of erosion control matting will be placed in all rooms and on slopes along walls to prevent soil movement and allow for re-vegetation.

Drainage will be accomplished by collecting surface water and draining it away from the ruin via subsurface drainpipes and occasionally surface drainage. Water will be discharged toward the north of the ruin into an existing French drain.

The exterior walls of the project area will be buttressed along its length by a soil berm. This will have two effects: first it will reduce the differential pressure exerted on the interior wall by the backfilling pressure within the room; second, it will help to divert water away from the base of the exterior wall and reduce splashing.

The final appearance of the backfilled area should resemble an unexcavated site, but many of the features of the site plan will still be visible. The rooms will be filled to different levels throughout the project area. The profiles of the fill level will be somewhat concave, increasing in toward the walls, with depressed drainage boxes as near as possible to the centers of the rooms. Ultimately,
the project area will be sparsely covered with natural grasses punctuated by exposed wall tops where the fill levels are near to the tops of the walls. Where fill levels are one-half the height of walls or less, backfilling and re-vegetation will not be seen.

**Condition Assessment Data**

The condition of the rooms and kivas in the project area was recorded during the summer of FY00. The condition assessment data were organized and stored using the Integrated Resources Management System (IRMS). IRMS is a platform of integrated software programs that assist in the management of cultural and natural resources by combining archival data, geospatial data, and project work information into one system. It is helpful to define several terms used in assessing resource conditions in the project area and featured in the Aztec Ruins version of IRMS. *Wall* is defined as the interior masonry fabric within rooms unless otherwise noted. *Capping* refers to the horizontal surface at the top of a wall. *Repointing* refers to the process of reapplying mortar in between stones where the mortar has been displaced by erosion.

**Pre-Backfilling Treatments and Special Backfilling Considerations**

Based on the condition assessment data gathered in FY00, seven architectural units within the project area were identified as having conditions potentially requiring treatment prior to backfilling: Rooms 94-96, 110, and 113-114. Additional treatment recommendations for Rooms 95, 112 and 113 will be prepared by Bob Hartzler, Exhibit Specialist FOUN and will be given to AZRU Resources Management prior to the commencement of Phase III backfilling.

**Room 94**

Condition: The wall base in both corners is severely eroded with most stones in advanced stages of deterioration, resulting in undercutting of the wall. There is also an area of severe stone and mortar loss, creating a large void immediately above Vent 93/94-2 on the west end. In the upper NW corner there is a prominent crack some 1.25 m long where the north and west walls have pulled apart. A few small voids (areas of mortar loss) occur throughout the wall.

Treatment: It is recommended that the void above Vent 93/94-2 be stabilized by replacing the deteriorated stone with new stone and amended mortar.

**Room 96**

North Wall Condition: Likely due to the combination of differential fill levels and the presence of cement mortar pointing, stones in the west half of the wall are severely disintegrated. Large voids and eroded stones have left a “honey-comb” of cement mortar. The tile drain outlet at the west
end of the wall has broken, pieces of which are present on the ground. The drain outlet is now recessed ~7 cm behind the wall face.

West Wall Condition: Wall is in good condition except for upper 1/3, below the Rhoplex mortar caps. This area exhibits moderate to severe stone erosion, with intact cement mortar repointing. This erosion may be the result of water entry through deteriorated capping, prior to the capping being repaired in 1987.

South Wall Condition: Interior: There are many severely disintegrating stones throughout the wall. Exterior: Severe disintegration of wall base. There are also loose capping stones.

Treatment: Investigate structural stability of wall areas with voids and severe stone erosion. Replace severely disintegrated stones where necessary to provide structural integrity. Repoint and/or deep-grout where necessary using amended mortar.

Room 110

Doorway 110/122-2 Condition: Doorsill consisting of aboriginal mortar is deteriorated, with several areas of moderate to severe mortar and/or stone disintegration.

Treatment: Stabilize doorsill by resetting sill stones in amended mortar.

Room 113

North Wall Condition: Based on observations after a rain, there do not appear to be any current roof leaks, but the wall remains moist due to differential fill. There are heavy incrustations of salts as high as 1.0 m above present ground surface, as well as numerous voids in the wall as deep as .20 m. Both corners are severely deteriorated. Both vents appear in good condition.

West Wall Condition: Due to moisture damage from differential fill levels, the lower half of this wall is in severe state of deterioration. Nearly all of the lower wall fabric is disintegrating; stones are very soft and friable. Deep deposits of eroded stone and mortar occur all along the wall base, and are especially deep in the corners. The NW corner is in unstable condition, with voids as deep as .30 m all the way up the corner as far as the vent.

Treatment: Stabilize wall bases by replacing deteriorated stone where necessary to re-establish structural integrity. A non-amended mortar should be used to repoint, or to lay new stone. As these wall bases will be backfilled, amended mortar is unnecessary. Non-amended mortar should possess a distinctly modern aggregate and/or other defining characteristic that distinguishes it from the aboriginal mortar, which is plentiful in these walls.
Room 114

North wall Condition: A slight bulge exists in the upper, eastern courses (below the ledge, just west of Vent 113/114-1), but it has been heavily repointed with cement mortar, and appears stable. Wall bases have severe mortar loss, and basal stones are in various stages of decay. The fill on the opposite side of the wall (Room 113) is approximately 20 cm lower than the fill in room 114; capillary action is likely the cause of the moisture and basal disintegration.

East wall Condition: The wall tops and midsection are in good condition. The cement curb is disintegrating, however. The wall base is experiencing moderate to severe stone and mortar disintegration.

South wall Condition: Rain water/snow melt is traveling through the wall and exiting the wall core through the veneer. This moisture affects original plaster on the 1st story wall veneer adjacent at the upper right corner of Doorway 114/115; water is washing over it creating rivulets in the plaster finish, and carrying plaster fabric down the wall. Lastly the wall bases have moderate to severe mortar and stone disintegration.

West wall Condition: Mortar loss is minor to moderate throughout wall veneer. Basal erosion is moderate to severe, and extends up the north end of the wall 1.2 meters. The cement curb is disintegrating.

Treatment: Reset and repair Cap 114/115 to prevent moisture on wall caps from entering wall core. Stabilize wall bases by replacing deteriorated stone where necessary to re-establish structural integrity. Repoint bases using unamended mortar. Unamended mortar should possess a distinctly modern aggregate and/or other defining characteristic that distinguishes it from the aboriginal mortar, which is plentiful in these walls.


As described below in Room Specific Backfilling Procedures, Rooms 65, 66, 67, 69, 82, 83, 84, 90, 91, 92, 93, 94, 95, 96, 99, 100, 101, 110, 111, 112, 113, 114, 115, 118 and Kivas H and J and Kiva Enclosures H (Rooms 68, H-1 and H-2) and J (Rooms J-1 and J-2) are to be backfilled to various levels to accommodate specific problems such as vigas, original and protective roofs, and door and vent lintels. For instance, where an existing viga cannot be covered with at least 18 inches of soil, the room will be backfilled to a level no less than 12 inches below the viga to prevent excessive exposure of the viga to splashing and ascending moisture movement through the wall. The immediate problem with partial backfilling is basal erosion caused by differential
fills. Final grades are often at mid-wall level where prehistoric stone and mortar are still present. These areas tend to have had less history of stabilization. Therefore, during the backfilling of rooms care will be exercised when working at these levels. Sandy loam and clay soils will be placed carefully around the perimeter of the rooms and hand tamped. Following the placement of Layer 3, which consists of 1-2 inches of clay soil that will be placed over the Enkamat, sacrificial coping will then be installed at the bases of all the walls of these rooms to minimize basal stone and mortar erosion at the fill level. The composition and application of the sacrificial coping is described in detail below.

Pre-Backfilling Documentation of Rooms

Prior to backfilling, the NPS documentation team shall formally document the project area. Their report will include photographic and written descriptions of the rooms to be treated, including information on architectural elements, archeological features, and physical conditions, as well as previous room excavation and stabilization histories. This information will serve as a baseline for future research and interpretation of the structures once they are covered. Archeologists will also use the information in the future should the decision be made to re-excavate backfilled rooms.

The documentation must record the appearance and condition of the room before backfilling. If repairs or changes to the walls or other architectural features occur after the formal documentation, they must be recorded using the same procedures as formal documentation and included in the pre-backfilling documentation report. Mortar samples will be taken prior to backfilling and during wall perforations made to accommodate the passage of drainpipes. Mortar samples will be collected to contribute to the development of a mortar typology, which represents the construction and stabilization histories. In the absence of formal documentation of the construction and stabilization of Aztec Ruins, mortar samples and a mortar typology will help to reconstruct construction and stabilization histories. Representative samples will be collected of each type of mortar and documentation will specify the provenience of the sample. The AZRU Archeologist will take and catalog mortar samples consisting of 100-200 grams for future reference and possible analysis. Wooden elements will be documented in detail, including diameters, lengths, tool markings, provenience, and core samples. NPS Archeologist Tom Windes will collect core samples from wooden elements prior to backfilling.

Documentation during and after the backfilling must be undertaken to insure that all aspects of the work are recorded. The stratigraphy of backfilling materials and characteristics of the drainage systems in each room must be described in writing and photographed. The method of soil transport and installation must also be noted. The AZRU Archeologist will ensure proper
recording of the work. This documentation will be used to plan future phases of the backfilling project.

**Backfilling Specifications**

**Wood Preservation**

Prehistoric wood was found as lintels in doors or vents, and occasionally in the walls as remnants of roofing members, or vigas. Lintel wood present in rooms to be backfilled is located, in all cases, in the lower areas of the walls of each room. Vent lintel wood and viga wood present in all rooms is located in mid-section or upper areas of the walls of each room.

Since much of the wood will be buried deep in the fill, it is expected to remain relatively stable. Studies on wood deterioration in buried environments conducted by the Getty Conservation Institute have shown that wood wrapped in polyethylene and geotextile was better preserved than wood with no protective covering (Selwitz 1997:91). In this case, however, it is impossible to fully wrap the wood because it is built into the masonry. Deterioration processes associated with only partially covered wood are not known. Wood deterioration will be mitigated in several ways: first, by using a soil with a neutral (or close to neutral) pH to reduce biodegradation known to occur in highly concentrated acidic or alkaline environments (Blanchette 1994:62-63), and second, by insuring that the wood present in the mid-section and upper walls be buried to an optimal depth of 18 inches below the surface, measured from the grade line down to the top of the wood. Fill levels will be established below the bottoms of vigas at an optimal distance of 12 inches wherever possible. In some cases, fill levels will be between vent lintels and vigas and there will not be sufficient distance between the two to have vigas the optimal 12 inches above the fill level. Another measure to mitigate subsurface wood deterioration will consist of placing a small piece of vertical drain material against the wall immediately above the wood lintels to be covered. The drain will be positioned such that it will slope toward the interior of the room, thus directing any moisture away from the wood elements.

AZRU personnel will periodically inspect sensitive wood elements above the backfilled grade to determine their condition and possible exposure to backsplash and decay. Following recommendations provided by Dr. Robert Blanchette, modern wood specimens will be buried in some of the backfilled rooms for subsequent retrieval to assess the effects of ground moisture in different backfill environments. The AZRU Archeologist will select locations where modern wood specimens of different species will be buried and later retrieved in order to obtain information for assessing the condition of prehistoric wood elements. Moisture-monitoring systems may also be
installed in selected rooms to monitor moisture in vigas and door and vent lintels to determine if mitigation measures have proven successful and to generate further subsurface wood preservation data.

**Comprehensive Drainage Plan and Specifications**

Drainage of the rooms to be backfilled during FY01 will be accomplished by the use of drain boxes/silt-traps connected to drainpipes passing from room to room through existing doorways and walls, and discharging on the east side of West Ruin (Figure 4). It will be necessary for these drainpipes to pass through exterior walls in Rooms 90, 93 and 99. The drainage from Rooms 90-95, 99-101, 110, 111, 114, and 115 will connect to the French Drain just below the surface of the present site grade on the north side of West Ruin. The drainage for Rooms 65, 66 and 82-84 will be connected to existing drains for Rooms 63, 64, and 78-81 which were installed during Phase II in accordance with the FY00 Phase II Scope of Work (Simpson 2000: 12-14). Drainage for Room 118 will ultimately tie into the drainage for Rooms 240 and 255, which will be addressed in the future Phase IV Scope of Work. Drainage for Room 118 will temporarily discharge on the just north of the interpretive path and away from the south wall of the room.

**Pipe Specifications**

All pipe, couplings, Y’s, and elbows used for drainage will be Poly-Vinyl Chloride (PVC), Schedule 40. Pipes will be cemented using a two-step process, first applying a PVC primer on all surfaces to be cemented and, second, applying PVC cement on all surfaces to be cemented. The PVC pipe used within all of the rooms and on the exterior of the ruin will be 4 inches in diameter. This diameter was calculated based on the diameter required to drain the average sum square footage of six rooms receiving rainfall totaling 1 inch per hour. All elbows used to affect vertical or horizontal changes in pipe direction will be made in the smallest increment possible starting at 22.5 degrees. No 90-degree elbows will be used; 90-degree turns will be accomplished using pairs of 45-degree elbow or 90-degree sweeps if available. Intersections of interior drainpipes will be accomplished using Sanitary Y’s only. The slope of the interior drainpipes will be a minimum of ¼ inch per foot. Each drain outlet will be covered with a ½ inch stainless steel or bronze screen placed so that it may be easily removed for drainpipe maintenance. The areas of the intersections of the new drainpipes installed during Phase III and the exterior French Drain will be excavated to allow full access the French Drain pipes so that sanitary T’s and reducers may be easily installed.

**Drain Boxes/Silt-Traps**

The same types of drain boxes/silt-traps will be used as in the previous phase. Drain boxes/silt-
traps and drainpipes will be placed in advance of backfilling. The method for placement of the drainpipes will follow that used in standard applications for placement of internal components within a concrete unit. The drain boxes will be located as close as possible in the center of each room and will be installed so that the top surface of the box is level. The entire drainage run will be assembled and placed into its permanent location with the use of wire or string to suspend the drainage run at various points sufficient to keep the system stable during backfilling. The wire or string will attach to the pipes and drain boxes by wrapping several times around them and then will be attached to 2 inch by 4 inch pieces of dimensional lumber spanning across the tops of the walls of each room perpendicular to the drainpipe run. The wire or string will be removed once a level of fill is achieved sufficient to support the placement of the drainpipe run.

![Figure 4. Phase III Drainage Plan.](image-url)
Clean Outs
Schedule 40 Sanitary Y’s with access plugs for drain clearing will be placed at strategic locations throughout the drainage system, as shown in Figure 4.

Wall Perforations
Wall perforations are a necessary component of the comprehensive drainage plan because subsurface placement of drainpipes might disturb unexcavated archeological features. Three perforations will be made through the North Exterior Wall of the West Ruin during FY01 backfilling. This number represents the minimum amount required to facilitate drainage of the ruin while utilizing alternate passages such as doorways and other natural breeches. Perforations will be made using hand tools. They should be circular in shape and no greater than 8 inches in diameter to accommodate one pipe. The perforations will minimize the amount of prehistoric fabric to be displaced. Perforations will be made in advance of backfilling and during the placement of drainpipes. The perforations will be made under the supervision of the designated AZRU Archeologist, who will monitor the removal of materials, document artifacts and other materials recovered, take samples of the original mortar within the wall being perforated, and make a photographic record of each perforation. In general, stones displaced by wall perforations will be retained for use elsewhere in stabilizing the ruin; however, some stones will be replaced around the drainpipes as they pass through the walls to form a tight closure around the drainpipes. This will prevent burrowing rodents from entering the ruin after backfilling is completed. Mud mortar will be used in replacing the stones around the drainpipes.

General Backfill Stratigraphy
All rooms except Rooms 64, 68, 110, 114, H-1 and J-2 will have the following general backfilling stratigraphy composed of multiple layers of soil and geosynthetic materials (Figure 5).

1. Geotextile Horizon Marker
2. Layer 1: Sandy loam soil
3. Geotextile separation layer
4. Layer 2: 4-6 inch. clay soil
5. Enkamat surface stabilization layer

Each stratigraphic layer will extend from wall to wall, filling each room. The specific height of the fill will be determined during the backfilling process, but general guidelines are provided for each room based on drainage needs, aesthetics of the backfill landscape, and depth needed to protect fragile features such as wood. The quantity (in cubic yards) of soil required for fill will be estimated
using measurements acquired during the documentation phase. Actual quantities of fill will be determined on an as-needed basis during the course of backfilling.

**Geotextile Horizon Marker**

Prior to backfilling the room with soil, a horizon marker is needed to distinguish between the existing and new fill layers, and to prevent mixing of the fill caused by settling or insect or rodent activity. A layer of geotextile will be cut to fit the dimensions of the room and will be used as a horizon marker. Geofabrics are synthetic, highly permeable materials that allow for the passage of moisture, while filtering out soil particles. Geofabrics are lightweight, relatively inexpensive, and easy to handle. Since the material is synthetic, it is highly resistant to hydrolytic and oxidative degradation in a buried environment (Selwitz 1997:13). In addition to serving as a marker, a solid layer of fabric allows the fill layers to be separated should the backfilled soil be re-excavated. Typar 3401 was used during the first phase of backfilling and will also be used during this phase of backfilling.

**Layer 1: Sandy Loam Soil**

Layer 1 will be a thick layer of sandy loam soil placed directly on top of the horizon marker. The
texture and medium range porosity of the sandy loam will provide a stable backfill environment by minimizing air movement and fluctuations in moisture and temperature. When compacted, this type of soil will provide an intimate continuum next to the walls to protect them. The depth of Layer 1 will depend on the height of the walls and the amount of wall to be left exposed. As the fill level rises higher up the wall, the grade should begin to slope to the area where the surface water drainage system is or will be installed.

The soil should contain as little soluble salt and organic matter as possible and a neutral or slightly less than neutral pH to minimize damage to wood (Blanchette 1995). The soil will also have aggregates no larger than ½ inch in size and no greater than two percent in volume.

Soil will be placed in the rooms/kivas in 10-inch lifts and then manually tamped with a hand-held steel plate tamper or a weighted drum roller. Tamping compacts the soil, minimizes pore space, reduces hydraulic conductivity, and breaks up large soil clods. A power-driven tamper is not appropriate for use because of the small size of the rooms and the danger of vibrations causing damage to standing walls. Water can be sprinkled on the surface of each lift to facilitate tamping, but the soil must be dry before the successive layer is added.

Rooms should be filled consecutively in 10-inch lifts to introduce lateral pressure incrementally on walls during filling. If there is a drainpipe in the room within this layer, it must be installed before backfilling. The drainage system must be installed with a clear understanding of the drainage design and the slope needed for adequate water flow, as described in the previous discussion of Drain Boxes/Silt-Traps in the Comprehensive Drainage Plan and Specifications, which provides a description of the placement of drain boxes and drainpipes prior to backfilling.

**Geotextile Separation Layer**

A sheet of geotextile will be placed atop Layer 1 soil to prevent the upper layer of fine-grained fill from mixing with the sandy loam below. Again, Typar 3401 will be used in the same manner as was applied during the previous phase of backfilling. The geotextile should be cut to fit the size and slope of the room and made to accommodate a drop inlet drainage pipe where necessary.

**Layer 2: 4-6 inch. Clay Soil**

Layer 2 will consist of 4-6 inches of clayey soil and will serve as low permeability material to absorb surface moisture, which will infiltrate through Layer 3. A compact clay soil is intended as a second line of defense to impede the movement of water percolating down from the surface. The thickness has been determined on the basis of information provided by an historical architect.
regarding clay usage in similar or more demanding situations such as are present at Chesapeake & Ohio Canal National Historical Park (Paul Neidinger 2000, pers. comm.) Water slowly absorbed by the fill will be contained within the layer, and will gradually evaporate. Surface moisture monitoring conducted for a period of over two years at Chetro Ketl demonstrated that the penetration of moisture from snow and rain was less than three feet deep in a sandy clay loam material ( Getty Conservation Institute 1995). It is expected that moisture penetration in a clayey soil will be even less.

Layer 2 will be placed in one lift. It should be compacted in the same manner as Layer 1. In general, the grade will be high near the walls, sloping to the center of the room or to a drainage inlet, except in rooms where slopes terminate in a drainage inlet at either end of a room. In heavy rains, most water will run off the clayey surface into drainage inlets where subterranean drainpipes will transport water to the exterior. The surface slope should allow the free flow of water without causing surface erosion of the soil. Generally, the grade should not be steeper than a 2:1 (30%). The clay soil will have an aggregate size no larger than ½ inch, and a quantity no greater than one percent of the overall volume. As shown in Figure 5, when the fill level rises higher up the walls, the grade should begin to slope to the area where the surface water drain is installed. Depending on the room, this will either be in the center of the room or closer to a particular wall.

**Enkamat Surface Stabilization Layer**

To prevent surface erosion and to provide suitable ground for the germination of seeds and vegetation growth, a layer of Enkamat soil erosion control fabric will be applied over the clay soil of Layer 2 in the same manner as the previous phase of backfilling. Enkamat is a three-dimensional nylon matting with 95% open space to contain soil and organic matter such as seeds. It anchors vegetation and soil and protects against surface erosion created by high-volume water flow, which can occur on a daily basis in the late summer. The Enkamat should be cut to fit the size and slope of the fill in each room and to accommodate the drop inlet drainage pipe.

**Layer 3: 1-2 inch. Clay Soil**

A 1-2 inch layer of clay soil will be placed over the Enkamat and worked into the matting, enough to cover the surface. This layer will then be lightly wetted to insure coverage of the Enkamat.
Specialized Backfill Stratigraphy for Rooms 64, 68, 110, 114, H-1 and J-2

In addition to stratigraphic layers outlined above, Rooms 64, 68, 110, 114, H-1 and J-2 will have specialized backfill stratigraphy to minimize differential pressure exerted by uneven fill levels on a particular wall. Problems of wall stress from static loads and moisture movement associated with differential fills are well known; backfilling of these rooms has been designed to mitigate some of these problems (Figure 6). To reduce pressure and stress on walls from static load, a vertical retaining wall constructed of GEOWEB will be used in the same manner as during the previous phase of backfilling. GEOWEB will confine static load forces and distribute the load more evenly.

Use of GEOWEB in the backfilling of prehistoric architecture is considered experimental. To mitigate moisture movement through the masonry wall, coarse well-draining sand will be used as the interface between it and the GEOWEB. The sand will be composed of sub-angular particles no greater in size than \( \frac{1}{2} '' \), that is, any matter that does not pass through a #40 sieve. This will minimize wicking, or the capillary movement of water into the wall from the fill.
Differential fill levels are recognized to have an adverse effect on the walls of rooms with lower fill levels (Trott 1999, personal communication). Unimpeded moisture will pass from the room with a higher fill level through the wall and into the room with the lower fill level, causing chemical changes to the stone and mortar over time. To mitigate the problem of moisture movement caused by differential fill levels, coarse sand will be placed between GEOWEB structures and the masonry walls on which differential fill levels exist.

Following is a description of the vertical and horizontal soil stratigraphy recommended for backfilling rooms with higher fill levels adjacent to rooms with lower levels:

1. **Geotextile horizon marker**
2. **Layer 1: Sandy loam soil**
3. **GEOWEB** - consecutive layers of GEOWEB filled with ¾ inch road base and the remainder of the room with sandy loam.
4. **Geotextile separation layer**
5. **Layer 2: 4-6 inch clay soil**
6. **Enkamat surface stabilization layer**
7. **Layer 3: 1-2 inch clay soil**

Each stratigraphic layer will extend from wall to wall, filling each room. The specific height of the fill will be determined during the backfilling process, but general guidelines are provided for each room based on drainage needs, aesthetics of the backfill landscape, and depth needed to protect fragile features such as wood. The quantity (in cubic yards) of soil required for fill will be estimated using measurements acquired during the documentation phase. Quantities of GEOWEB and fill will be estimated prior to GEOWEB wall construction and backfilling.

*Geotextile Horizon Marker*
A Geotextile Horizon Marker will be installed in the same manner as described for the other rooms.

*Layer 1: Sandy loam soil*
A layer of sandy loam will be placed in the same manner as described for the other rooms, but it will extend only across the area behind the GEOWEB retaining wall and to a level equal to the height of the GEOWEB wall.

*GEOWEB*
To reduce lateral pressure from the static load on walls with differential fill, GEOWEB will be used. GEOWEB is a soil confinement system composed of three-dimensional cells that form a flexible structural bridge to distribute concentrated loads over a wide area. In this application,
multi-layered GEOWEB retaining walls filled with soil will function as a structural support element to reduce stress on the unsupported prehistoric walls. The GEOWEB grid structure will be placed on the sides of the rooms and kiva where differential pressure mitigation is needed. The specific locations are indicated below in the backfilling plans for each room. The cells will be filled with a ¾ road base soil. The road base soil will have a wide particle size distribution and angular shape in order to help resist lateral movement with high frictional. Geogrid reinforcement or a suitable substitute shall be placed between the GEOWEB courses as specified by the soils engineer. The geotextile Amoco 4551 with a minimum of 160 pounds strength and a minimum of 0.15 permittivity has been determined to be a suitable substitute for geogrid reinforcement. When using this geotextile, it should be stretched in place until taut and then buried under tension (Trott 1999).

Appendix A includes a specification for installation of the GEOWEB as designed by the manufacturer. This specification is only a sample and was based on a single room dimension using a sandy loam fill. All design specifications for GEOWEB walls will be generated by a qualified engineer at the request of AZRU Resources Management, using accurate parameters such as room dimensions obtained from the pre-backfilling documentation. The design specifications must also take into consideration subterranean drainage pipes that may be installed in the rooms.

The GEOWEB confinement system mitigates some of the problems of static load in differential fills, but it does not alleviate moisture problems, such as capillary migration of moisture, primarily groundwater, through the fill. To reduce the amount of moisture passing into the wall from the fill, a 4-6 inch layer of coarse sand adjacent to the wall will be used. A 4-6 inch wide area between the wall and the GEOWEB will be filled with a layer of coarse sand composed of subangular shaped particles ranging in size up to ½-inch (any matter that does not pass a #40 sieve). By nature of its geometry and particle size distribution, this coarse sand has large pore spaces between particles for air; consequently, it minimizes capillary rise of ground moisture and dries quickly. By reducing capillary action, the volume of water and soluble material such as salts transported through the fill into the wall are correspondingly less. The sand layer will extend as high as the layer of clayey fill. A layer of geofabric can be used between the GEOWEB and the sand as a separator, if needed. No drainpipes will pass through the GEOWEB wall.

Geotextile Separation Layer
A geotextile separation layer will be installed in the same manner as described for the other rooms, but extending across the top of the GEOWEB retaining wall.
Layer 2: 4-6 inch. Clay Soil
A 4-6 inch layer of clay soil will be placed in the same manner as described for the other rooms but extending across the top of the GEOWEB retaining wall. This layer will establish the form of the final grade.

Enkamat Soil Stabilization Layer
An Enkamat soil stabilization layer will be placed over the clay soil in the same manner as described for the other rooms.

Layer 3: 1-2 inch. Clay Soil
A 1-2 inch layer of clay soil will be placed over the Enkamat in the same manner as described for the other rooms.

Soil Placement
It is recommended the AZRU Resources Management arrange for the services of a crane and operator for the placement of soils into the various rooms. The crane should be located on the north side of West Ruin and be capable of reaching from its location the farthest room covered to be backfilled within this scope of work. A crane similar to the Link-Belt RTC-8050 may be sufficient (See Appendix B), but AZRU Resources Management will make the selection of the crane. The crane should have a bucket attachment, which allows for a grab of approximately ½ yard. A professionally licensed operator will operate the crane under the supervision of the AZRU Archeologist or AZRU Chief of Maintenance. The utilization of a crane will allow for rapid placement of large amounts of soil with less impact on the resource than the conveyor method, which has proven to be slow, difficult to move, detrimental to the walls and wall caps, and somewhat unsafe. The cost of crane use will likely be less than the slow movement of soils by hand and conveyor; however, the cost should be compared based on the Phase II work performance record.

Sacrificial Clay Coping
At the base of the walls, migration of water through the wall from capillary rise of groundwater will continue to cause basal erosion. To minimize damage from wet/dry cycling and salt phase change, a clay coping will be applied to the base of the walls in all rooms. The concept and use of sacrificial protective coatings is well established and is an acceptable treatment to minimize basal erosion (Torraca 1988:111). This coping will not change the amount of moisture that passes through the wall from the ground, but it does change the evaporative front from the exposed surface of the wall to the coping. The evaporative front is the area where moisture and
soluble salts are drawn to and deposited, and where accelerated deterioration occurs. By making the coping the evaporative front, damage from wetting/drying and salt crystallization will occur in the sacrificial and replaceable material, rather than in the prehistoric wall. The coping will also shed water away from the wall and may serve as an insulating layer to minimize damage from freeze/thaw. Materials and methods of applying the coping should be tested in the field prior to use. The coping shall have the properties of a good, non-amended earthen plaster, with a high enough clay content to remain adhered to the wall, and a high enough sand content to prevent cracking. The material shall be sympathetic in appearance and performance with the surrounding masonry. It shall be applied as high as the capillary fringe, or the basal erosion zone. The coping must be maintained and can be removed and replaced as needed.

Temporary Shoring
Rooms 214 and 246 are on the western edge of the extent of proposed backfilling for FY01. Unchecked, the backfilling of these rooms would create a condition where rooms that have been backfilled to high levels would be adjacent to rooms with no backfill at all for up to a year. This situation would result in differential pressures being exerted against common walls with the potential for wall failure. Therefore, temporary shoring will be erected in Rooms 214 and 246 to compensate for the fill in Rooms 114 and 115. The temporary shoring will consist of 2x6 No. 1 or 2 Douglas Fir members, one end placed against the upper part of the east walls of Rooms 214 and 246 and 84 and the other end placed against the foot of the opposing walls. Between the end of the shoring members and the walls on the upper end will be pieces of ¾ inch ACX Douglas Fir plywood cut to a dimension of 2 feet by 3 feet and fastened on center with 3 inch galvanized deck screws with coarse threading. The shoring assemblies will be placed 30 inches apart measured from center shoring member to center shoring member. The shoring will begin 30 inches from the corners of the walls being supported, measured from the corners of the walls to the centers of the shoring members.

Moisture Monitoring
In order to assess the effectiveness of moisture mitigation measures taken during backfilling, a moisture monitoring system may be installed, as outlined in Appendix D. AZRU Resources Management and the IMSF-CAC Exhibit Specialist will determine the exact placement of the sensors during the course of backfilling. In addition, several pieces of wood, matching as close as possible in species and size to wooden architectural elements present in the area to be backfilled, will be buried within the FY01 backfill area for later excavation and moisture level assessment.
Post-Backfilling Treatments and Special Considerations

Re-vegetation
Shallow-rooted vegetation such as native grasses will be allowed to grow on the surface of the backfilled areas. Vegetation will contribute to surface absorption and evaporation of water, and the binding action of roots at the upper levels will help to minimize surface soil erosion. The choice of plants for re-vegetation will be AZRU Resources Management and will take into account the depth of rooting (which should be shallow) to minimize subsurface disturbance and growth of roots into the prehistoric fabric. The use of Enkamat soil erosion control fabric will help to anchor seeds and organic matter on the surface and facilitate re-vegetation. Soil collected from areas nearby West Ruin shall be scattered by the shovel-full very lightly on the surface (5-6 shovels-full per room) to make native microbes available for the growth of native grasses.

Maintenance
Upon completion of this project, approximately one-half of the currently exposed masonry in the project area will be covered by fill. The remaining exposed architecture will still require cyclic maintenance. The improved drainage throughout the project area will slow but not eliminate deterioration. The sacrificial coping applied to the walls where fill levels are adjacent to prehistoric mortar and chinking will need to be inspected to insure it is functioning as intended, and that it has sufficient integrity to displace moisture away from the walls. If inspection reveals an adverse affect to the base of a wall at the new fill level such as accelerated basal erosion, the sacrificial coping shall be removed to slow this process. Drainpipes and drain boxes/silt-traps will require annual maintenance to assure that they remain open and functioning. The surfaces of the filled rooms will require periodic maintenance to assure that contouring and slope angle facilitate rapid drainage. Evaporative basins may fill at rates greater than evaporative and should be checked following major precipitation events and pumped using portable 110-volt electric sump pumps, if necessary. Other cyclic preservation treatments such as capping repair, mortar joint repointing, and occasional stone replacement will be necessary.

Re-excavation
In order to assess the effectiveness of the backfilling methods followed during FY01 as a viable means of preserving West Ruin it may be necessary to re-excavate one backfilled room and inspect mortar, stone, and wood conditions. Re-excavation shall be completed approximately 5 years from the completion date of FY01 backfilling. The selection of the room to be re-excavated will be made by AZRU Resources Management.
Mitigation of Impacts to Cultural Resources

Backfilling as a method of preservation will reduce loss of prehistoric fabric and integrity by stabilizing and protecting the architecture from damage as a result of natural or cultural processes. Yet, it must be kept in mind that the resource is much more fragile and vulnerable to deterioration than when originally buried, so it is difficult to predict changes in the condition of the resource in the future. Though the benefits of backfilling greatly outweigh the alternative of leaving them exposed, there are potential impacts to the resource as a result of the proposed action. Fuller discussion of these impacts and mitigation measures may be found in Aztec Ruins National Monument Backfilling Plan for West Ruin (Trott 1998). Following is a list of potential impacts and measures to be taken to minimize damage:

Loss of direct research data in the rooms that are backfilled
Loss of direct research data in backfilled areas will be mitigated through formal, detailed recording of the resource prior to backfilling. The documentation can be used for both research and interpretative needs. Also, since backfilling is reversible, it can be removed if necessary.

Disturbance, loss or accelerated deterioration of prehistoric wood
Loss or accelerated deterioration of prehistoric wood will be mitigated through maintaining optimal soil levels at least 18 inch above, or 12 inches below, prehistoric wood, wherever possible. Moisture monitoring systems may be installed in selected areas to determine effectiveness of mitigation. Core samples of prehistoric woods will be taken from all wooden elements prior to backfilling for long-term curation and analysis. Loose wooden elements identified in pre-backfilling condition assessments will be mortared back into place to retain provenience.

The tops of walls will be subject to heavy foot traffic and possible damage during the backfilling process.
The use of a crane will eliminate much of the wear and tear of the walls and wall caps caused by the movement and vibration of the conveyors. During backfilling, the tops of walls will serve as the only access to deep rooms and to rooms without doors; therefore they will receive heavy foot traffic. In addition the use of a crane will reduce the need for employee fall protection use. To minimize damage, the wall caps and upper courses of the walls should be reassessed and stabilized if needed before backfilling. Buffers such as wood or rubber matting will be placed between equipment and the tops of walls where it is necessary to rest equipment on walls and to reduce possible damage from equipment vibrations.
Deterioration of the upper courses of walls left exposed will continue to occur, possibly at an accelerated rate.

Once the backfill soil is in place, exposed masonry will be subject to accelerated weathering from direct contact with rain and snow, and through capillary rise of water from the surrounding fill. To reduce moisture infiltration of water into the backfill and to maximize the performance of the drainage system, the surface should be graded away from the walls. As a preventive measure, it is recommended that snow be manually removed from the walls after a heavy snowstorm, especially along the south (or north-facing) sides where snow builds up and melts slowly. The exposed portions of the walls will require diligent maintenance to minimize damage. When damage does occur, such as cracks and eroded mortar, it must be repaired before it leads to larger problems.

The addition of a sacrificial coping added to the raised base of the interior walls will alter the appearance of the prehistoric walls.

To minimize damage from wet/dry cycling and salt phase change, a protective coping will be applied to the base of the wall. This sacrificial layer, which should appear similar to a floor band or wainscot of plaster, serves as a sacrificial layer, changing the evaporative front from the prehistoric masonry wall to the artificial coping. Basal erosion should largely occur in the coping, rather than in the prehistoric wall. To minimize its visual impact, the coping will be of a color similar to the surrounding mortar.

There will be impacts to the ground surface from the backfilling activity.

Vehicle traffic and transportation of dirt, people, and equipment will compact the soils in these areas and will also visibly intrude on visitor experience. The backfilling crew will use vehicles only when necessary in the plaza and they will remove them and any other equipment when not needed. Care will be taken to avoid running over vegetation present in the area. Crews will thoroughly clean areas where fill dirt was stockpiled and sifted, restoring the area to its original appearance. The movement of the crane on the north side of West Ruin has the potential to seriously affect subsurface archeological features. Subsurface features should be identified prior to the commencement of work and, if located should be avoided by the crane and soil delivery trucks. If avoidance of subsurface archeological features is impossible due to the demands of crane use than suitable archeological mitigation measures will be employed, or the soil delivery method will be changed.

Potential for subsurface disturbance of archeological features during drainage installation.

Care will be taken during excavation for drainage installation to disturb as little ground as
possible, and this work will be monitored and thoroughly documented by the AZRU Archeologist. In the event human remains are encountered, work in the area of the remains will cease immediately and procedures complying with the Native American Grave Protection and Repatriation Act (NAGPRA) and the Plan of Action will be followed.

**Safety and Compliance**

**Safety**

All work shall be carried out in compliance will all applicable OSHA standards and regulations. The Project Manager will be responsible for the overall safety of the project. Prior to beginning the project, the Masonry Work Leader will develop with the backfilling crew a Job Hazard Identification and Analysis, and will discuss and revise its content during the course of backfilling. He will conduct regular weekly and/or bi-monthly tailgate safety meetings with the crew. In addition to broader safety policies determined by the AZRU Resources Management, all employees working in the designated work area will be required to wear during crane operations hard hats at all times.

**Compliance**

Compliance with Section 106 and Section 110 of the National Historic Preservation Act will be the responsibility Aztec Ruins National Monument and will be achieved consistent with procedures and protocols described in *NPS-28, Cultural Resource Management Guideline, Release No. 5, 1995.*
SECTION VI – Room-Specific Backfilling Procedures

Below are specific instructions for backfilling individual rooms. The instructions cover the placement of the different types of soil and geofabrics, the establishment of fill levels and slopes, the placement of drains and boxes/silt-traps, and the size of drainpipes required. This section is to be used during implementation by the backfilling crew and at the direction of the backfilling supervisor. It is recognized that unforeseen problems may arise during the backfilling process. Questions regarding changes to the scope of work should be directed to the Project Manager/Archeologist and/or the Exhibit Specialist responsible for the preparation of this scope of work. Some procedures will require monitoring by the AZRU Archeologist.

Kiva H
Kiva H will have a final grade level approximately 60 inches above the tops of the pilasters. The final grade should be dish-like, with the grade sloping gently from the walls to the center of the kiva. Backfilling will follow the general backfill stratigraphy. Drainage for Kiva H will be through the use of three, stainless steel parabolic evaporative basins 48 inches in diameter and 6-12 inches in depth, placed in a tight triangular pattern in the center of the kiva. Sacrificial coping will be applied at the bases of the walls as determined by the new fill levels.

Kiva H Enclosures

H-1  Kiva H enclosure H-1 will have a final grade level just below the tops of the lowest places of the surrounding walls. The backfilling of the room will follow the specialized backfill stratigraphy for the combination of soil/geofabric stratigraphy with a GEOWEB structure. The GEOWEB will be placed against the south wall of the room. The purpose of the GEOWEB wall in H-1 is to mitigate differential pressure exerted by the fill on the adjacent, open Room 69. Due to the small size of the room no drainage will be installed.

H-2  Kiva H enclosure H-2 will have a final grade level just below the tops of the lowest places of the surrounding walls. Backfilling will follow the general backfill stratigraphy. Due to the small size of the room no drainage will be installed.

H-3  Kiva H enclosure H-3 is already backfilled.

Room 68  Kiva H enclosure 68 (previously referred to as Room 68) will have a final grade level just below the tops of the lowest places of the surrounding walls. The backfilling of the room will follow the specialized backfill stratigraphy for the combination of soil/geofabric stratigraphy with a GEOWEB structure. The GEOWEB will be placed against the south wall of the room. The purpose of the GEOWEB wall in Room 68 is to mitigate differential pressure
exerted by the fill on the adjacent, open Room 67. Due to the small size of the room no drainage will be installed.

**Kiva J**

Kiva J will have a final grade level approximately 24 inches above the tops of the pilasters. The final grade should be dish-like, with the grade sloping gently from the walls to the center of the kiva. Backfilling will follow the general backfill stratigraphy. Drainage for Kiva J will be through the use of three, stainless steel parabolic evaporative basins 48 inches in diameter and 6-12 inches in depth, placed in a tight triangular pattern in the center of the kiva. Sacrificial coping will be applied at the bases of the walls as determined by the new fill levels.

**Kiva J Enclosures**

**J-1** Kiva J enclosure J-1 will have a final grade level just below the tops of the lowest places of the surrounding walls. Backfilling will follow the general backfill stratigraphy. Due to the small size of the room no drainage will be installed.

**J-2** Kiva J enclosure J-1 will have a final grade level just below the tops of the lowest places of the surrounding walls. The backfilling of the room will follow the specialized backfill stratigraphy for the combination of soil/geofabric stratigraphy with a GEOWEB structure. The GEOWEB will be placed against the south wall of the room. The purpose of the GEOWEB wall in J-2 is to mitigate differential pressure exerted by the fill on the adjacent, open Room 96. Due to the small size of the room no drainage will be installed.

**Kiva K**

Kiva K will not be backfilled.

**Kiva L**

Kiva L will not be backfilled and will remain open as a stop on the visitor interpretive trail.

**Room 64**

Room 64 was scheduled to be backfilled under the Phase II FY00 Scope of Work. If backfilled already, Room 64 will need to be re-excavated. Room 64 will still have a final grade level 4-5 stone courses below the threshold of Upper Door 64/80, but backfilling of the room will follow the specialized backfill stratigraphy for the combination of soil/geofabric stratigraphy with a GEOWEB structure. If the room is still unfilled, the GEOWEB will be placed against the west wall of the room. The purpose of the GEOWEB wall in Room 64 is to mitigate differential pressure exerted by the fill on the adjacent, partially backfilled Room 84. Drainage for Room 64 will be
accomplished through the use of a drain box/silt-trap placed in the center of the room with vertical drainpipe connecting to the drainpipes coming into the room through Door 64/80 and through the perforation in the wall between Room 64 and Room 84. The drain will then be connected to the drainage in Room 63 via the wall perforation in the east wall of Room 64. The drainpipe coming into Room 64 from Room 84 will run two feet beyond the perforation into Room 84 where it will be capped and left for connection with drainpipes placed in Rooms 65 and 66 during FY01 backfilling. Sacrificial coping will be applied at the bases of the walls as determined by the new fill levels.

**Room 65**
Room 65 will have a final grade level half the distance between the top of Door 65/84 and the bottom of the viga protruding from the north wall. The backfilling of the room will follow the general backfill stratigraphy for the soil/geofabric stratigraphy. Drainage for Room 65 will be accomplished through the use of a drain box/silt-trap placed in the center of the room, connecting with the drainpipe coming in from Room 66 via Door 65/66. The drainpipe will then pass through Door 65/84 and connect with the drainage for Room 84. Sacrificial coping will be applied at the bases of the walls as determined by the new fill levels.

**Room 66**
Room 66 will have a final grade level 18 inches above the top of Door 66/67. The backfilling of the room will follow the general backfill stratigraphy for the soil/geofabric stratigraphy. Door 66/67 will be filled in with stones tightly dry-laid or mortared in place so that the exposed side visible from in Room 67 from the interpretive trail is recessed approximately three inches back from the surface of the north wall of Room 67. Drainage for Room 66 will be accomplished through the use of a drain box/silt-trap placed in the center of the room, connecting with the drainpipe exiting the room via Door 65/66, and then connecting with the drainage for Room 65. Sacrificial coping will be applied at the bases of the walls as determined by the new fill levels.

**Room 67**
Room 67 will have a final grade equal to the top of the south wall and will have a measured slope from the north to south walls of approximately 4:1. The backfilling of the room will follow the general backfill stratigraphy for the soil/geofabric stratigraphy. Drainage will be accomplished using the surface drainage method where surface water accumulation is allowed to wash down the backfilled slope over the south wall and out into the plaza. Sacrificial coping will be applied at the bases of the north, east and west walls as determined by the new fill levels.
Room 69

Room 69 will have a final grade equal to the top of the south wall and will have a measured slope from the north to south walls of approximately 4:1. The backfilling of the room will follow the general backfill stratigraphy for the soil/geofabric stratigraphy. Drainage will be accomplished using the surface drainage method where surface water accumulation is allowed to wash down the backfilled slope over the south wall and out into the plaza. Sacrificial coping will be applied at the bases of the north, east and west walls as determined by the new fill levels.

Room 82

Room 82 will have a final grade level 18 inches above the top of Door 82/83 and 12 inches below the vents also on the south wall. On the north wall the fill level will be at the bottoms of the vents. The backfilling of the room will follow the general backfill stratigraphy for the soil/geofabric stratigraphy. Drainage for Room 82 will be accomplished through the use of a drain box/silt-trap placed in the center of the room, connecting with the drainpipe exiting the room via Door 82/83, and then connecting with the drainage for Room 83. Sacrificial coping will be applied at the bases of the walls as determined by the new fill levels.

Room 83

Room 83 will have a final grade level generally equal to the ledge line of the room, however on the north side of the room the fill level will be slightly above the ledge line, and on the south end the fill level will be slightly below the ledge line. The backfilling of the room will follow the general backfill stratigraphy for the soil/geofabric stratigraphy. Drainage for Room 83 will be accomplished through the use of a drain box/silt-trap placed in the center of the room, connecting with the drainpipe coming in from Room 82 via Door 82/83. The drainpipe will then pass through Door 83/84 and connect with the drainage for Room 84. Sacrificial coping will be applied at the bases of the walls as determined by the new fill levels.

Room 84

Room 84 will have a final grade level 18 inches above the top of Doors 83/84 and 65/84 and 12 inches below all vents and the diagonal door at the southwest corner of the room. The backfilling of the room will follow the general backfill stratigraphy for the soil/geofabric stratigraphy. Drainage for Room 84 will be accomplished through the use of a drain box/silt-trap placed in the center of the room with drainpipe connecting to the drainpipes coming into the room through Door 65/84 and 83/84. The drainpipe will connect to the drainpipe protruding from the east wall, which was installed during the implementation of Phase II Scope of Work. Sacrificial coping will be applied at the bases of the walls as determined by the new fill levels.
Room 90
Room 90 will have a final grade level 18 inches above the top of Door 90/91 and 12 inches below the vents also on the south wall. On the north wall the fill level will be at the bottoms of the vents. The backfilling of the room will follow the general backfill stratigraphy for the soil/geofabric stratigraphy. Drainage for Room 90 will be accomplished through the use of a drain box/silt-trap placed in the center of the room, connecting with the drainpipe entering the room via Door 90/91 and then connecting with the drainpipe exiting the room via a perforation in the north wall, finally then connecting with the French Drain on the north side of West Ruin. Sacrificial coping will be applied at the bases of the walls as determined by the new fill levels.

Room 91
Room 91 will have a final grade level 18 inches above the tops of lintels of Doors 90/91 and 91/92, and 12 inches below the north and south vigas and vent lintels. The backfilling of the room will follow the general backfill stratigraphy for the soil/geofabric stratigraphy. Drainage for Room 91 will be accomplished through the use of a drain box/silt-trap placed in the center of the room, connecting with the drainpipe exiting the room via Door 90/91, and then connecting with the drainage for Room 92. Sacrificial coping will be applied at the bases of the walls as determined by the new fill levels.

Room 92
Room 92 will have a final grade level 18 inches above the tops of Door 91/92, and 12 inches below the bottom of the north vent lintel. The fill level will also be at least six inches below the threshold of Upper Door 91/92. The backfilling of the room will follow the general backfill stratigraphy for the soil/geofabric stratigraphy. Drainage for Room 92 will be accomplished through the use of a drain box/silt-trap placed in the center of the room, connecting with the drainpipe exiting the room via Door 91/92, and then connecting with the drainage for Room 91. Sacrificial coping will be applied at the bases of the walls as determined by the new fill levels.

Room 93
Room 93 will have a final grade level 18 inches above the lintel of Door 93/94 and just below or equal to the top of the north wall. Backfill layers 2 and 3 will be mounded at the doorway of Door 93/94 to insure the discharge of moisture away from the lintel. On the north wall the fill level will be at the bottoms of the vents. The backfilling of the room will follow the general backfill stratigraphy for the soil/geofabric stratigraphy. Drainage for Room 93 will be accomplished through the use of a drain box/silt-trap placed in the center of the room, connecting with the
drainpipe entering the room via Door 93/94 and then connecting with the drainpipe exiting the room via a perforation in the north wall, finally then connecting with the French Drain on the north side of West Ruin. The connection to the French drain will require subsurface disturbance. Previous archeological excavations in this area revealed minimal cultural material; therefore little impact on subsurface cultural material is anticipated (Jim Trott 2001: pers. comm.). Sacrificial coping will be applied at the bases of the walls as determined by the new fill levels.

Room 94
Room 94 will have a final grade level 18 inches above the lintel of Doors 93/94 and 94/95 and just below or equal to the top of the north wall. Backfill layers 2 and 3 will be mounded at the doorway of Door 93/94 and 94/95 to insure the discharge of moisture away from the lintel. On the north wall the fill level will be at the bottoms of the vents. The backfilling of the room will follow the general backfill stratigraphy for the soil/geofabric stratigraphy. Drainage for Room 94 will be accomplished through the use of a drain box/silt-trap placed in the center of the room, connecting with the drainpipe exiting the room via Door 93/94, and then connecting with the drainage for Room 95. Sacrificial coping will be applied at the bases of the walls as determined by the new fill levels.

Room 95
Room 95 will have a final grade level 18 inches above the lintel of Door 94/95 and just below or equal to the top of the north wall. The backfilling of the room will follow the general backfill stratigraphy for the soil/geofabric stratigraphy. Drainage for Room 95 will be accomplished through the use of a drain box/silt-trap placed in the center of the room, connecting with the drainpipe exiting the room via Door 94/95, and then connecting with the drainage for Room 94. Sacrificial coping will be applied at the bases of the walls as determined by the new fill levels.

Room 96
Room 96 will have a final grade level equal to the level just below the south wall. The backfilling of the room will follow the general backfill stratigraphy for the soil/geofabric stratigraphy. Drainage for Room 114 will be through the use of two, stainless steel parabolic evaporative basins 48 inches in diameter and 6-12 inches in depth, placed in side-by-side in the center of the Room. Sacrificial coping will be applied at the bases of the walls as determined by the new fill levels.

Room 99
Room 99 will have a final grade level 18 inches above the lintel of Door 99/100 and just below or
equal to the top of the north wall. Backfill layers 2 and 3 will be mounded at the doorway of Door 99/100 to insure the discharge of moisture away from the lintel. On the north wall the fill level will be at the bottoms of the vents. The backfilling of the room will follow the general backfill stratigraphy for the soil/geofabric stratigraphy. Drainage for Room 99 will be accomplished through the use of a drain box/silt-trap placed in the center of the room, connecting with the drainpipe entering the room via Door 99/100 and then connecting with the drainpipe exiting the room via a perforation in the north wall, finally then connecting with the French Drain on the north side of West Ruin. Sacrificial coping will be applied at the bases of the walls as determined by the new fill levels.

**Room 100**
Room 100 will have a final grade level 18 inches above the lintels of Doors 99/100 and 100/101. The backfilling of the room will follow the general backfill stratigraphy for the soil/geofabric stratigraphy. Drainage for Room 100 will be accomplished through the use of a drain box/silt-trap placed in the center of the room, connecting with the drainpipe exiting the room via Door 100/101, and then connecting with the drainage for Room 99. Sacrificial coping will be applied at the bases of the walls as determined by the new fill levels.

**Room 101**
Room 101 will have a final grade level 18 inches above the lintels door and vent lintels in the north, south and west walls. The backfilling of the room will follow the general backfill stratigraphy for the soil/geofabric stratigraphy. Drainage for Room 101 will be accomplished through the use of a drain box/silt-trap placed in the center of the room, connecting with the drainpipe entering the room via Door 101/111 and the drainpipe exiting the room via Door 100/101. Sacrificial coping will be applied at the bases of the walls as determined by the new fill levels.

**Room 110**
Room 110 will have a final grade level 12 inches above the tops of the vigas protruding from the north and south walls. The backfilling of the room will follow the specialized backfill stratigraphy for the combination of soil/geofabric stratigraphy with a GEOWEB structure. The GEOWEB will be placed against the east and north walls of the room starting approximately at the ledge line. The purpose of the GEOWEB wall in Room 110 is to mitigate differential pressure exerted by the fill on the adjacent, partially filled Rooms 112 and 100. Drainage for Room 110 will be accomplished through the use of a drain box/silt-trap placed in the center of the room, connecting with the drainpipe exiting the room via Door 110/111, and then connecting with the drainage for
Room 111. Sacrificial coping will be applied at the bases of the walls as determined by the new fill level.

Room 111
Room 111 will have a final grade level 18 inches above the lintels of Doors 101/111 and 110/111. The backfilling of the room will follow the general backfill stratigraphy for the soil/geofabric stratigraphy. Drainage for Room 111 will be accomplished through the use of a drain box/silt-trap placed in the center of the room, connecting with the drainpipe exiting the room via Door 101/111, and then connecting with the drainage for Room 110. Sacrificial coping will be applied at the bases of the walls as determined by the new fill levels.

Room 112
Room 112 will have a final grade level 24 inches above the threshold of Door 110. The backfilling of the room will follow the general backfill stratigraphy for the soil/geofabric stratigraphy. As Room 112 is a covered no drainage measures are needed, however; the fill should be mounded in a ridge along the threshold of Door 110/112 to prevent moisture from entering the room from Room 110. Sacrificial coping will be applied at the bases of the walls as determined by the new fill levels.

Room 113
Room 113 will have a final grade level equal to half of the height of the Door 113/114. The backfilling of the room will follow the general backfill stratigraphy for the soil/geofabric stratigraphy. As Room 113 is a covered no drainage measures are needed, however; the fill should be mounded in a ridge along the threshold of Door 110/112 to prevent moisture from entering the room from Room 110. Sacrificial coping will be applied at the bases of the walls as determined by the new fill levels.

Room 114
Room 114 will have a final grade level 18 inches above the top of the lintel of Door 113/114. The backfilling of the room will follow the specialized backfill stratigraphy for the combination of soil/geofabric stratigraphy with a GEOWEB structure. The GEOWEB will be placed against the north wall and access shaft and the south wall. The purpose of the GEOWEB wall in Room 114 is to mitigate differential pressure exerted by the fill on the adjacent, partially filled Rooms 113 and 115. An access shaft will be constructed using 4x4, 2x6 and 2x12 Douglas fir pressure treated material to allow continued access Room 113 (Figure 7). The shaft will be free
Figure 7. Plan View of Access Shaft for Room 114.

Figure 8. Elevation View of Access Shaft for Room 114.
standing and will be placed against the north wall covering Door 113/114 and will be held against the wall by the coarse sand placed between the GEOWEB and the wall. A hinged covered constructed of exterior grade 15/16 inch (1 inch) plywood will be installed at the to of the access shaft to prevent water from passing through the top of the shaft and entering Room 113. In addition geofabric will be placed against the sides of the access shaft also to prevent water from passing through the top of the shaft and entering Room 113. Drainage for Room 114 will be through the use of two, stainless steel parabolic evaporative basins 48 inches in diameter and 6-12 inches in depth, placed in side-by-side toward the south end of the Room. Sacrificial coping will be applied at the bases of the walls as determined by the new fill levels.

Room 115
Room 114 will have a final grade level 18 inches above the lintel of Door 114/115. The backfilling of the room will follow the general backfill stratigraphy for the soil/geofabric stratigraphy. Drainage for Room 114 will be through the use of two, stainless steel parabolic evaporative basins 48 inches in diameter and 6-12 inches in depth, placed in side-by-side in the center of the Room. Sacrificial coping will be applied at the bases of the walls as determined by the new fill levels.

Room 116
Room 116 will not be backfilled.

Room 117
Room 117 will not be backfilled.

Room 118
Room 118 will not be backfilled.

Room 119
Room 119 will not be backfilled.

Room 120
Room 120 will not be backfilled.

Room 122-2
Room 122-2 will not be backfilled.
Room 123-2
Room 123-2 will not be backfilled.

Exterior Walls
The exterior wall of the north wing along Rooms 82, 90, 93, 99,112, and 113 will be buttressed with a berm of sandy loam soil stabilized with a layer of Enkamat followed by a layer of clay soil approximately 6 inches thick at the walls and tapering to approximately 4 to 5 inches as the slope approaches the existing exterior grade level. The soil will support the wall from pressure exerted by differential loads should they exist, and will minimize damage from lateral moisture movement through the walls. The buttress will contact the wall as high as possible, sloping away from the wall with a slope generally no steeper than 2:1 to minimize erosion. The soil must be placed at the same time as the fill on the opposing side to minimize stress from differential loading. The soil should be placed in 10-inch lifts and compacted (if possible to 90% of standard proctor). A layer of Enkamat soil erosion control matting will be placed on the surface and covered with a 1-2-inch layer of clay soil to prevent surface erosion and to promote growth of grassy vegetation. The dirt road running parallel to the exterior walls will not be covered by the berm.
SECTION VII – References Cited


Simpson, Glenn D. 2000 FY00 Scope of Work for Backfilling a Portion of West Ruin, Aztec National Monument, National Park Service, Intermountain Support Office, Conservation Projects Program, Santa Fe, New Mexico.


APPENDIX A – Sample GEOWEB Design
APPENDIX B – Product Literature
For sample crane information please visit this website.

http://www.owsleyandsons.com/lbhrtc.htm
APPENDIX C – List of Reviewers

Alysia Abbot  
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APPENDIX D – Moisture Monitoring Specifications

Items needed for wood moisture monitoring

**Moisture Meter (R-2000)** $305
This meter is able to measure wood moisture from 6-60%. It can be plugged into a station selector to read the moisture content from 6 separate locations.

**Manual station selector (SS-6)** $140
This device can have 6 different cables (from different locations) connected into it. The station selector is needed because the moisture meter cannot be connected directly to the cables coming from the pins. Although one could attach a special end to the cables to make this work, it is not sold by this company. Cables connect to the device using bare ends.

**Contact pins** $4.50-$5.50 ea.
2 pins are set into the wood at each location and are the “sensors” for the wood moisture. 2/cable. These pins are about ⅛ in diameter

**Load Cables** (which connect to contact pins) $35/cable
Only load cables can be connected to contact pins. Load cables come with 2 different ends, bare; which can be connected directly to the selector switch and have a maximum distance of 15, 20, or 25 ft, or a female end; which opposite of the pins can only be connected to a main cable (for added distance) and have a maximum distance of 15 ft.

The order numbers for the 15, 20, and 25 ft cables without connectors are not listed on the price sheet. So if you need to use them here they are:
- 15ft cable---315CAB-0020/015
- 20ft cable---315CAB-0020/020
- 25ft cable---315CAB-0020/025

**Main Cables** see price list under Main cables
These would only be necessary if the distance between the monitoring pins (in the wood) and the station selector is over 25 ft. If this distance is greater than 25 ft, you will need to buy a 15 ft load cable (with a female end) to connect to a main cable (which come in 50, 100, 150, and 200 ft, prices are listed).

Cables only need to be 2-conductor, which has two ends (3 conductor has three ends, the third connects to a pin in the wood for shell moisture, this can be used to measure the surface moisture of the wood). Load cables with the bare ends only come in 3 conductor, the third end to the cable if not used can be cut and sealed.

**Drill kit and template** $35
This is useful for drilling the pins into the wood. Also, the pins have to be sealed from outside moisture in the soil. Silicone or some type of adhesive/sealant should work, but the product must be nonconductive and able to keep a strong seal around the pins in the soil environment. If there is contact with the soil a soil moisture reading will be obtained and not wood moisture.