Chaco Culture NHP Intentional Site Reburial Program

The monumental masonry structures and cultural landscape of Chaco Culture NHP are a lasting testimony to the complex civilization that flourished in the 9-12th centuries AD in what is now the southwestern United States. They are also, sadly, a witness to the cumulative impact of decades of exposure on the scientific and interpretive values of archaeological remains. Beginning in the late 1980s, the NPS embarked on an ambitious and far reaching program in intentional site reburial in an effort to stem the tide of deterioration and loss. The lessons learned from this experience serve as both a warning and a guide to similar efforts at other sites.

Chaco Canyon's Chetro Ketl, with subterranean levels exposed through archeological excavation (photo by Robert Blanchette, 2006)

Intentional site reburial is an effective, practical, and economical treatment for the most threatened structures with the greatest visitation and is a sustainable and relatively low-tech solution to some of the more complex structural problems (for example, see Thorne 1989, 1990, 1991; Burch 2004). Although difficult to calculate cost comparisons, the one-time costs for reburying an average room in an ancient Puebloan site like the ones in Chaco Canyon as part of developing the intentional site reburial program are estimated to be up to 5 times the cost of a single routine in-kind fabric treatment. However, the more fragile sections need repair treatment on average every 2 to 5 years. Without considering inflation or other factors such as rising labor and equipment costs, savings are realized within 10 to 20 years, and 'fabric savings' are immediate.

Chetro Ketl reburied to protect masonry walls and wooden beams (photo by Robert Blanchette, 2006)

Nevertheless, intentional site reburial is often problematic for those whose mandate it is to interpret sites to the public. Park staff, therefore, consulted with the public and with special interest groups. This is a routine part of the decision making process for national parks, required by federal environmental laws. During the consultation process the State Historic Preservation Office and the interested public expressed support for long-term preservation, provided access to the resources was not severely limited, and agreed that partial site reburial was an appropriate measure. Consultation with Native American tribes, who are descendants of the people who built and used the structures, revealed a strong preference for benign neglect as the appropriate treatment (that is, to allow the structures to gradually 'return to the earth'). Recognizing, however, that the Park has a legal mandate to protect and preserve the ruins, they accepted the proposed intentional site reburial plan as a relatively passive intervention to their ancestral places and preferable to treatment-oriented interventions.

Background

Chaco Canyon NM was established, in the words of the 1907 presidential proclamation, '...to preserve the extensive prehistoric communal ruins…of extraordinary interest because of their number and their great size...' Research, survey, and excavation have revealed that the prehistoric Chaco cultural system extended far beyond the monument boundaries. In 1980, the US Congress designated Chaco as a National Historical Park, and expanded the boundaries and protection mandate to over 40 major Chaco sites located throughout the Four-Corners region of New Mexico, Colorado, Utah and Arizona. In 1987 Chaco Culture National Historical Park (hereafter referred to as 'the Park,' 'Chaco,' or 'Chaco Canyon') was inscribed as a World Heritage Site.

Chaco is located in northwestern New Mexico, a high cool desert environment (average elevation is 1900m) with high diurnal temperature variations and an average annual precipitation (rain and snow) of about 22cm.

The preservation program at Chaco

There are over 4,000 sites recorded within the park. These sites represent some 10,000 years of almost continuous use or occupation with an intense period of building between 850-1150AD. Of the 4,000 sites, only 40 have been excavated, and none completely, and these are included among the approximately 150 structures that comprise the core of the preservation program. The remaining sites are 'passively' maintained through monitoring, fencing, and other types of access restriction.

The recorded sites encompass tens of thousands of rock art images, masonry habitations, earthen architectural mounds, adobe structures, seasonal camps, stone cut stairways, constructed roadways, and water control features, including architectural monuments known as 'Great Houses.' These huge masonry structures have 1-2 hectare footprints, with enclosed plazas and associated earthen architectural platforms and roads or causeways. The buildings were constructed up to 5 stories high, with substantial timber roofs and subterranean structures, towers, and elevated rooms. As a result of the massive masonry construction, these 1000 year old structures retain walls up to 12 meters high. The remarkable preservation afforded by the arid climate, remote location, and protection of the sites by the original descendants, contributed to the National Park and World Heritage designations. Due to the number and size of these structures, however, preservation has become increasingly problematic to achieve.

For the 150 structures in the preservation program to be maintained in good (i.e. stable) condition preventive fabric treatment on average cyclic schedules of 2-3 years is required. Thus, a minimum of about 15,000 of the total 46,000 sq m of exposed masonry requires some type of preventive treatment each year.

From the 1920s through the early 1980s preservation methods impacted fabrics of the ruins in a variety of ways. Deeply excavated rooms next to unexcavated ones resulted in drainage problems, severe horizontal loading on the walls, and accelerated loss of mortar and stone on the exposed surface. Moisture infiltration into walls, in combination with freeze-thaw cycles and salt crystallization, accelerated stone and mortar erosion, particularly at wall bases and tops of walls. To counteract these trends, harder and more durable mortars replaced the mud mortars in an attempt to extend the period between repair cycles. But under many conditions, particularly in wall bases, these cement-based hard mortars, incompatible with the soft sandstone and original mud mortars, led to severe consequences in the long-run. Large sections of the structural sandstone elements began to fail, and entire sections of walls eroded and collapsed. The repetitive fabric treatments were significantly affecting the authenticity and integrity of structures.

Re-thinking the preservation options

Concerns over the impacts of preservation to the architectural, archeological and cultural integrity of the structures prompted a review and analysis in the 1980s of the preservation program. The review identified a set of alternatives that could provide practical and effective protection to the exposed fabric. These were:

- Continue the maintenance regime based on replacement of eroded elements, with recognition that these would need constant and, in some cases, progressively more frequent replacement.
- Construct protective roofs and other types of shelters.
- Research and test new additives for mortars and reversible preservation techniques that are non-invasive and low impact. This alternative requires facilities and expertise not available at the Park.
- Remove some of the resources from the active preservation program and include them in the category of benign neglect. This decision can only apply to sites with no visitor access, because visited sites require maintenance and stabilization for safety of the visitors and protection of the resource from visitors.
- Rebury the most fragile or inaccessible portions of excavated structures and improve drainage, thus providing reversible long-term protection. This option is most likely to preserve the architectural, cultural, and archeological integrity.

Park management determined that all of these alternatives were viable treatments, but intentional site reburial responded most comprehensively to the overall assessment of significance, condition and management context. This would be the focus of the preservation program as a whole. Partial site reburial would be undertaken at selected visited sites, including the Great Houses, and 14 excavated sites with no visitor access would be reburied to their level prior to excavation. Partial intentional site reburial was not considered appropriate for every Great House. Pueblo Bonito, the type site and cultural icon of Chaco Canyon, was judged to be far too significant in the public mind to consider even partial intentional site reburial (although minor backfilling is being undertaken to reduce differential fill levels between adjacent rooms).

The decision to focus on intentional site reburial as a conservation strategy engendered the need for a research and testing component, which took the form of a long-term collaborative project between the NPS and the Getty Conservation Institute (GCI), beginning in 1990. The goals of the research and testing program were to document the efficacy of intentional site reburial, define the optimal intentional site reburial environment for the variety of architectural elements, test materials and methods for mitigating the impact of differential fills and basal erosion, to apply the results of research and testing in an implementation project, and finally to disseminate the findings more widely.

Documenting the efficacy of intentional site reburial

Given the scale of intentional site reburial contemplated at Chaco, there was a clear need to demonstrate and document the efficacy of intentional site reburial as a preservation strategy. To this end, five rooms were selected at Pueblo Bonito that had been filled either immediately (intentionally through backfilling) or within a few years (through backfill and natural processes of wind-blown sand) after their excavation in the late 19th or early 20th centuries (Dowdy and Taylor 1993). Selection was also based on the existence of good photographic documentation for purposes of evaluation. These rooms were partially re-excavated in 1992 to determine the condition of original fabric after nearly a century in a reburied environment. The results demonstrated unambiguously the beneficial effects of intentional site reburial on preservation of stone, mortars, and plasters, but they also brought forth problems (in particular, the deterioration of wood) that would need to be addressed if intentional site reburial was to afford maximum preservation of original fabric.

It was found that the upper 30cm or so of fill, subject to wet/dry and freeze/thaw cycles, provided only partial protection. Below this level, preservation was somewhat variable, relating to the length of exposure before intentional backfilling or natural processes of deposition, but in general the mortars, plaster, stone, and floor features were in good to excellent condition. In contrast, the walls exposed above the fills had lost almost all of their original mortar and plaster, and revealed stone erosion, loss of construction detail such as chinking patterns, and replacement fabric. Walls were a composite of masonry, wood, and a type of wattle and daub construction. Nearly one hundred years after their excavation and backfilling, the earthen render and mortar were in excellent condition, but the wood in the construction had suffered decay. Wood buried near the surface (the top of the wall was encountered just below the fill surface) suffered from rot and termite infestation, while more deeply buried wood was decayed but in better condition. Moisture in the fills (determined from carbide meter and converted to weight %) was highly variable, but tended to increase with depth, from dry conditions at the ground surface through 5 wt. % at the midpoint to 7.4 wt. % in the deepest part of trenches. Moisture and shallow burial conditions played a key role in deterioration.

Intentional site reburial testing

On-going site testing is a crucial component of the intentional site reburial program. Testing includes as a basic goal the definition of the range of suitable fill environments and materials for buried architectural wood. Testing a range of intentional site reburial and drainage alternatives was necessary to address the variety of unique conditions in the buildings, such as existing protective roofs over intact original roofs, the importance of interpreting the juxtaposition of subterranean rooms and elevated towers, and the requisite to maintain, as far as possible, the form and outline of the structures.

The major problem associated specifically with partial site reburial is a consequence of differential fills (i.e. different levels of fill in adjacent rooms) and migration of moisture through the fill. A primary objective in the NPS-GCI testing program was to evaluate the performance and effectiveness of geosynthetic products, specifically geodrains (i.e. composites consisting of a water-conducting core wrapped in permeable geotextiles), as a means of eliminating or significantly reducing moisture in the fill under circumstances of differential fills. Tests were implemented in 1991 to address two common situations at Chaco: where original (never excavated) fill existed, which could not be trenched; and where differential fills could not be equalized for interpretive reasons, but could be trenched. The former utilized a horizontal area geodrain covered with gravel; the latter utilized a vertical geodrain in contact with the wall of the room. Geodrains were constructed on site using Enkamat 7020 as the drainage core, wrapped with geotextile (Enkafilter E43). (For further details and graphics on the application of geodrains at Chaco Culture NHP, see Demas, Lin, Agnew, and Taylor, 1993).

The horizontal geodrain was effective in removing rain water and preventing snow melt from penetrating the fill and remains in place. The vertical geodrain, however, failed to function as a drain (even when tested by the addition of water to the adjacent soil) due, it is believed, to insufficient hydrostatic (pore water) pressure from the wet soil in contact with the hydrophobic (water-repellent) polypropylene fibers of the geotextile wrapped drain. These drainage materials are subject to a threshold hydrostatic pressure, which must be exceeded to force water through the geotextile into the core of the drain. This threshold 'entry pressure' is small enough not to be significant for conventional geotechnical drainage applications but large enough to prevent the drain from functioning as intended in the vertical application. Although the threshold entry pressure may be only slightly greater than zero, the pressure in pore water migrating due to soil suction or gravity does not exceed zero (personal communication, E. Kavazanjian; see also Kavazanjian, 2004). In circumstances such as the vertical geodrain application at Chaco, an easily wetted (hydrophilic) geotextile (of which we were unaware at the time) would be required for the vertical geodrain to function as intended.

The vertical drain was removed since it was not functioning as intended under the circumstances of insufficient hydrostatic pressure. Consideration was given, however, to leaving it in place to continue to act as a capillary break, that is, a void space to prevent capillary continuity between soil and wall, thereby limiting moisture in the walls deriving from lateral migration. Partial intentional site reburial raises the evaporative zone to a new (higher) level in the masonry structures, leading over time to erosional loss through crystallization of soluble salts. Though expensive in materials and labor, and required on both sides of a wall (assuming soil on both sides), the geodrain should perform a capillary break function when dealing with this consequence of partial intentional site reburial. Based on present knowledge of the depth of infiltration of moisture in Chaco soils, a capillary break of depth 0.75m should mitigate basal erosion.

Careful consideration was given to implementing these and other tests on-site, understanding that some might not be successful. Other testing at Chaco included reversible and temporary methods of capping walls to protect them from infiltration of snow melt, and measures for mitigating capillary rise in walls leading to basal erosion. Although many of the basic principles have been developed in other testing simulations, or in laboratory experiments, the practical, real-time testing proved invaluable.

Status of the Intentional Site Reburial Program at Chaco Culture NHP

Through the Vanishing Treasures Initiative of the NPS, sixteen major excavated structures in the park have been partially reburied over the past 12 years. Some 6,000 sq m of masonry has been reburied, representing about one-eighth of all exposed masonry. The replacement of eroded mortar and stone is now more manageable and the required treatments less invasive. The intentional site reburial plan proposes in the next 5 years to partially rebury an additional 8 to10 excavated structures resulting in about one quarter of the total exposed fabric in the Park being reburied.

Although visitors have noticed a change in appearance of the structures, most understand the need for long-term preservation. The rationale and location of site reburials are incorporated into interpretive talks, but the full interpretive and educational potential of the intentional site reburial program at Chaco has yet to be fully realized. There are plans to add exhibits in the visitor's center and update guidebooks with respect to intentional site reburial interventions, but the goal on site has always been to strictly limit modern intrusions into the cultural landscape and therefore signage and interpretive panels on site are not being considered.

Intentional site reburial design has been fairly simple in concept and premised on two basic principles. The first is to equalize fill levels within the structures wherever possible; this alleviates problems associated with lateral pressure and moisture infiltration. The second is to design drainage systems that effectively remove surface moisture and keep the site reburial fill as dry as possible. Geotextiles are used as horizon markers to indicate where the intentional site reburial fill begins, and bulk fills are locally available soils.

This system has worked well for the majority of structures where fills could be equalized and the primary fabric to be reburied is stone and mortar. In cases where equalization of fills could not be achieved, testing of geodrain systems was undertaken.

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