SHPO Position on Burial-in-Place Treatment for Archaeological Sites

SHPO Guidance Point No. 4

Matthew H. Bilsbarrow

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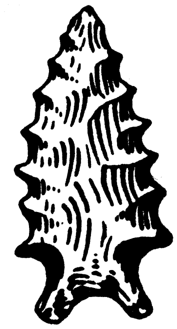

burial *n* **2:** the act or process of burying
bury *vt* **2a:** to conceal by or as if by covering with earth **2b:** to cover from view
Merriam-Webster's Collegiate Dictionary, 1998, pages 153 & 154

Since 2000, state and federal agencies as well as other entities are more frequently considering burial-in-place[1] as a treatment option for archaeological sites that are listed or eligible for inclusion in the State or National Registers of Historic Places solely under Criterion D (Information Potential). Often decision-makers and consultants considering burial-in-place are unfamiliar with the treatment's applicability, requirements, and costs. Scientific studies on the effects of burial-in-place are difficult to find and are not widely known in Arizona. Summaries of nine reports on burial-in-place are presented in **Appendix A** to remedy this shortfall.

What is Burial-in-Place?

Burial-in-place is a rare type of preservation-in-place treatment applicable mainly to archaeological sites. Its shares preservation-in-place's goal of protecting a historic property in its current location while maintaining its integrity. What makes burial-in-place unique is its use of a protective structure, usually earthen, to bury or cap all or portions of a site. Burial-in-place treatment entails designing and constructing a protective structure, as well as monitoring and maintaining both the site's integrity and the structure's effectiveness in perpetuity.

When is Burial-in-Place Appropriate?

Burial-in-place is not a common treatment option; the State Historic Preservation Office (SHPO) knows of its application in only four Arizonan cases over the last four years. This is probably due to the difficulty in designing a structure that preserves a site, the lack of entities willing and able to keep the necessary commitments to protect the site and maintain the structure in perpetuity, the unsuitableness of many archaeological sites for this treatment, and costs over the long term that may approach that associated with other options, such as data recovery. Preservation, Protection, Research Value, and Cost are four factors that should be used to evaluate the appropriateness of a proposed burial-in-place treatment, and each factor is equally

[1] In this document, the term "burial" does not denote human or animal internments, graves, or cemetery plots. Archaeological sites subject to burial-in-place treatment may or may not contain graves.

important. **Figure 1** outlines these factors and provides guidelines for evaluating each one.

How to Design a Burial-in-Place Treatment?

Sometimes archaeological sites are buried and preserved through natural processes and chance, but the intentional application of burial-in-place entails deliberate design, effective engineering, and solid stewardship. Two proposed processes for designing and implementing burial-in-place treatments are summarized in **Appendix A**; the more thorough of the two is prepared by Dr. Mathewson, a geologist at Texas A&M University. He directed the research responsible for the matrix of site decay processes relating site conditions, site components, and effects shown in **Appendix B.** This matrix should guide the design of protective structures. Three examples of burial-in-place treatment are presented in **Appendix A**.

Those pursuing burial-in-place should prepare a treatment plan in consultation with pertinent consulting parties. The plan should present the rationale for treatment (see **Figure 1**), estimate its effectiveness (see **Appendix B**), and specify the measures to be taken by each entity involved. Successful implementation this treatment usually requires expertise of an archaeologist, soil geologist, and engineer, as well as a long-term stewardship commitment by the project's sponsor and its successors.

SHPO Opinion

The State Historic Preservation Officer reminds Agency officials considering burial-in-place treatment for State or National Register-eligible or listed archaeological sites negatively impacted by state plans, or adversely affected by federal undertakings (i.e., Section 106), or proactively managed (e.g., Section 110) that they need to make informed decisions. Judge Jelderks' ruling regarding an agency's decision to arbitrarily implement a burial-in-place treatment at the Kennewick Man discovery site (i.e., Bonnichsen et al. vs. U.S.), which is summarized in **Appendix A**, reinforces this point. SHPO recommends that those pursuing burial-in-place as a treatment option gather and assess information about four factors: Preservation, Protection, Research Value, and Cost using guidelines presented in **Figure 1** together with all consulting parties prior to making a decision. We suggest measuring costs over an archaeological site's lifetime, which given natural decay rates can be quite long. Burial-in-place treatment plans submitted for review should explicitly address the factors and guidelines presented in **Figure 1**. Because of the difficulty in successfully implementing this treatment and its costs over the long term, we expect that burial-in-place will only be appropriate under unique circumstances.

Approved by James Garrison, State Historic Preservation Officer (SHPO)

Figure 1. Factors and Guidelines for Evaluating Burial-in-place Treatments.

I. Burial-in-place will Preserve an archaeological site's contributing elements and important data values (i.e., Register-qualifying characteristics) situated within the treated area.

a. It should maintain as close as possible the existing natural rate of decay of important site elements, features, deposits, or artifacts.

b. It should avoid introducing new impacts to the site and any adjacent historic properties (e.g., compaction, water percolation, leaching).

c. It should reduce existing impacts to the site in number, frequency, or magnitude.

d. It should be reversible.

e. Introduced materials should be clearly distinguishable from existing features, deposits, and artifacts (e.g., non-degradable fabric or culturally sterile, non-local material).

II. The site or portion of thereof subjected to burial-in-place will be Protected in perpetuity.

a. The land manager or owner and its successors should commit to a legally binding agreement in perpetuity (e.g., an easement).

b. The protective structure should be periodically monitored to assess the treatment's effectiveness and verify the archaeological site's integrity.

c. Planned and subsequent land-use activities should be compatible with the protection of the buried site and should not introduce new impacts (e.g., fertilizer-related leaching).

d. The site should be protected from vandalism and inadvertent damage (e.g., construction activities, monitoring, vegetative screening).

e. The site or portion thereof subjected to burial-in-place must be accessible for future research.

III. The Research Value of a site considered for burial-in-place must be assessed prior to treatment.

a. The site should only be listed or eligible for inclusion in the State or National Registers of Historic Places under Criterion D (Information Potential); if other eligibility criteria apply, burial-in-place is probably not an appropriate treatment.

b. The site should have little actual or potential public interpretation or traditional cultural use.

c. The site's information content and condition should be adequately known in order to make informed decisions regarding treatment; archaeological excavations should be conducted only to extent needed to make these decisions (e.g., eligibility testing, determine location & depth of cultural deposits within the site).

d. The site's information value, when considered in terms of current applicable historic contexts, anthropological and archaeological theories, cultural history knowledge, and archaeological techniques, should be justifiably determined either temporarily redundant or not immediately relevant to current research questions and themes.

e. The site's information content should be reasonably expected to address research questions and themes likely deemed important in the future.

IV. Preserving the site or portion thereof through burial-in-place should be more Cost-Effective than conducting data recovery excavations or implementing other options.

a. Burial-in-place treatment costs, both short-term (e.g., design & construction of a protective structure) and long-term (e.g., monitoring & maintenance in perpetuity), should be estimated and compared to cost estimates of other options.

b. A funding source (e.g., endowment; agreeable entity) should be identified to pay for monitoring, annual report preparation, and continual maintenance of the protective structure.

APPENDIX A: Summaries of Nine Burial-in-place Studies

Most burial-in-place studies occur as "gray literature," that is, unpublished contract reports or papers typically only available from the sponsoring agency, project proponent, or author. The reports listed in **Table 1** are summarized in this Appendix for those interested in this treatment option; people seriously considering burial-in-place treatment should read the original documents. U.S. Army Corps of Engineers Waterway Experiment Station-sponsored studies are available through interlibrary loan. The U.S. National Park Service's Technical Briefs are available over the internet.

Table 1. Types of Studies Summarized.

Page No.	Study Type	Reference
5	Experiment	Hester, James J. (editor) 1988 Experiments on the Effects of Site Burial on Archeological Materials. Archeological Sites Protection and Preservation Notebook: Technical Notes. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.
6	Example, Negative	Jelderks, John 2002 Opinion and Order, Bonnichsen et al. vs. U.S., Civil Case No. 96-1481JE, U.S. District Court for the District of Oregon, Portland.
7	Example, Positive	Mathewson, Christopher C. 1994 Intentional Burial as a Means of Archaeological Site Protection. Paper presented at U.S. National Park Service, Western Region, Archaeological Site Stabilization Workshop, Spokane, WA.
8	Process	Mathewson, Christopher C. 1994 Planning, Implementation and Management of an Archaeological Site Burial Project. Paper presented at U.S. National Park Service, Western Region, Archaeological Site Stabilization Workshop, Spokane, WA.
10	Experiment	Mathewson, Christopher C., Tania Gonzalez, and James S. Eblen 1992 Burial as a Method of Archaeological Site Protection. Contract Report EL-92-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.
11	Example, Positive	Moody & Associates 2000 Historic Properties Treatment Plan for Sites Within and Adjacent to the Proposed Harris Site Archaeological District, Starwood Project Area (TM 5073), Santa Fe Valley, San Diego County, California. Mooney & Associates, San Diego.
12	Overview	Nickens, Paul R. (editor) 1991 Perspectives on Archaeological Site Protection and Preservation. Technical Report EL-91-6. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.
13	Overview	Nickens, Paul R. 2000 Technologies for In-Place Protection and Long-Term Conservation of Archaeological Sites. In *Science and Technology in Historic Preservation*, edited by Ray Williamson and Paul R. Nickens, pp. 309-332. Advances in Archaeological & Museum Science Volume 4. Kluwer Academic/Plenum Publishers, New York.
14	Process	Thorne, Robert 1991 *Intentional Site Burial: A Technique to Protect Against Natural or Mechanical Loss.* Technical Brief Number 5. U.S. Department of the Interior, National Park Service Archeology and Ethnography Program, Washington. Revised. http://www.cr.nps.gov/aad/PUBS/TECHBR/tch5pr.htm

Hester, James J. (editor)
1988 Experiments on the Effects of Site Burial on Archeological Materials. Archeological Sites Protection and Preservation Notebook: Technical Notes. U.S. Army Engineer Waterways Experiment Station, Environmental Laboratory, Vicksburg, Mississippi.

The editor summarizes a difficult-to-obtain study on burial-in-place prepared for the California Department of Transportation (Caltrans) in 1983, which is based on work performed in the late 1970s. He notes that it is the most comprehensive study on burial-in-place.

In the Caltrans study, researchers conduct laboratory tests on archaeological deposits and artifacts, and experiment on simulated archaeological sites in the field. Their goal is to examine gross changes in artifact condition caused by pressure exerted by the addition of protective fill. Other factors, such as chemical and microenvironmental conditions, are controlled to the extent possible.

In the lab, they conduct compression and chemical tests on sediments obtained from midden deposits at two archaeological sites, nearby non-site locations, and the proposed fill material, specifically degenerative granite, as well as on a range of collected artifact types. Their site-specific results indicate that the placement of fill at rates between two and four feet a day would result in a negligible degree of artifact breakage and no discernable consolidation of midden sediments. Their chemical analysis indicates that the protective fill and midden deposits are compatible, and it is unlikely that the fill will induce a chemical change in the site's deposits.

In the field, they set up their experiment by constructing two simulated archaeological sites composed of artifact replicas and modern charcoal sticks, and then burying them under a 40- to 75-foot-tall earthen highway embankment. Almost two years later, the researchers excavate one of the sites and compare the recovered "artifacts" to their original condition and position. They note that most "artifact" types were undamaged, only faunal bones broke consistently, and minor alterations to some "artifacts" occurred. For example, charcoal sticks bowed but did not break, some shell items discolored slightly, a sand-dollar shell fractured badly, and a piece of obsidian flaked. According to their observations, "artifacts" exhibited little evidence of horizontal or relative vertical displacement. They could not evaluate the significance of the limited chemical changes in the sediments surrounding the "artifacts."

They conclude that burial-in-place will result in minimal physical damage to artifacts present within archaeological sites, even when deeply buried. They recommend burial-in-place as a treatment provided that four conditions are met:

1) sufficient information about a site's content, location, and significance is gathered to make informed decisions,
2) protective fill type is selected to minimize chemical contamination
3) fill placement is conducted in such a manner as to minimize damage to surface or near-surface artifacts and cultural deposits, and
4) a means (e.g., tunnels) for future access to buried, particularly deeply buried archaeological deposits is included in the treatment plan.

Jelderks, John
2002 Opinion and Order, Bonnichsen et al. vs. U.S., Civil Case No. 96-1481JE, U.S. District Court for the District of Oregon, Portland.

In this court ruling, a U.S. Magistrate judge concludes that the U.S. Army Corps of Engineers "violated the National Historic Preservation Act requirements" in their decision-making about the burial-in-place treatment of the Kennewick Man discovery site (pg 68). The judge found that Corps failed to adequately consult with all consulting parties about the proposed treatment, failed to mitigate the likely loss of archaeological data associated with the implementing the treatment, and did not fully and carefully consider the treatment's negative impacts to the archaeological site.

For those that may be unfamiliar with this controversial 1996 discovery in eastern Washington, Kennewick Man is the oldest, most complete human skeleton found in North America. According to scientists, the discovery site, as well as the recovered artifacts and human bones contain rare and important information about the peopling of North America. Four local Indian tribes claim cultural affiliation with the individual represented by the skeleton. They prefer that human bones and associated artifacts be reburied without further scientific study and that the remaining bones and artifacts likely present at discovery site be protected from further disturbance.

The order recaps actions that occurred in 1998. The Corps covered the Kennewick Man discovery site, claiming that burial-in-place was necessary to preserve the site's archaeological value, despite knowing that a Congressional directive forbidding such action was being finalized. The protective fill, which the Corps described as "armoring" and "permanent protection" (pg 11), consisted of ca. two million pounds of rubble and dirt. In addition, the Corps planted thousands of riparian trees on top of the fill. After the protective structure was built, the Corps denied all legitimate requests by archaeologists to study the site.

The judge notes that the administrative record strongly suggests the Corps' primary reason for burying the site was to prevent additional human bone and artifacts from being recovered, and not to preserve the site's archaeological value or to remedy erosion problems (pg 10). The Corps' denial of requests to study the treated site belays their stated goal of preserving the site's archaeological values. The judge observes that the burial-in-place treatment hinders efforts to verify Kennewick Man's antiquity, and effectively precludes further studies to determine whether or not additional artifacts relating to Kennewick Man are present at the site (pg 12).

The administrative record also does not support the Corps' claim that they adequately considered the effects of the proposed treatment and how damage to the site's information content could be minimized. The record shows that the Corps ignored their own scientist's advice that "it would seem advisable to be cautious about the long term deleterious effect of engineering site protection measures" (pg 68). The judge concludes that "it appears that protecting the archaeological value of the site in a manner consistent with the National Historic Preservation Act was not a major concern [to the Corps]" (pg 67).

Mathewson, Christopher C.
1994 Intentional Burial as a Means of Archaeological Site Protection. Paper presented at U.S. National Park Service, Western Region, Archaeological Site Stabilization Workshop, September 14, 1994, Spokane, Washington.

The author reviews previous studies and designs a treatment plan for two archaeological sites that the Texas Department of Transportation plans to bury-in-place under a roadway. The sites contain animal bone, shell, charcoal, lithics, ceramics, and features and occur in an environmental setting that includes cyclic wet-dry and freeze-thaw cycles. The modern ground surface within the sites exhibits evidence of agricultural disturbance, such as tilling. As this example shows, burial-in-place treatments involve the construction of well-designed, resource-specific structures.

First, he compares the important site components to chemical, physical, and microenvironmental processes (using the matrix shown in **Appendix B**). Although he does not explicitly discuss how he prioritized the sites' components, importance usually relates to the sites' significance in terms of a historic context and the National Register of Historic Places criteria. Previous studies show that certain burial-in-place-created processes can enhance preservation, accelerate decay, or not effect certain artifact types and site components. In the case of the two sites in Texas, he recommends that all surface water be directed away from the sites, standing water be prevented from occurring, freeze-thaw cycles be reduced in severity, and animal intrusions be prevented.

Second, he calculates the amount of downward stress generated by the construction of the protective structure and use of proposed roadway in order to determine a suitable fill composition. In order to establish a baseline for comparison, he measures stress generated by farm machinery driving across sediments similar to those present at the sites. He also establishes the compaction of the archaeological deposits and the amount of fill necessary to reach the desired roadway grade. Based on this analysis, he determines that placing a geogrid (an open lattice composed of a composite material designed to interlock with and reinforce subgrade soils) commonly used in highway construction and six inches of stress-absorbing fill will match or reduce the existing amount of stress on the sites.

Third, he plans the protective structure's construction to reduce the downward transfer of stress during its construction and use. In order to prepare the sites for construction, he instructs work crews to remove vegetation by hand leaving stumps and roots alone, spread a limestone sand using light machinery (at low speed to reduce vibrations) to level the ground surface, and lay down a geogrid by hand to provide lateral stability and mark the top of the original ground surface. The fill, which comprises most of the structure, is composed of two parts. For the lower part, he specifies that crews place a six-inch-thick layer of limestone sand over the geogrid. Heavy machinery may be used, but the equipment cannot directly touch the geogrid or it will break. For the upper part of the fill, crews may place locally available fill materials using heavy machinery to increase the size of structure to reach the desired grade. The roadway can then be built on top of the protective structure over the archaeological sites.

Mathewson, Christopher C.
1994 Planning, Implementation and Management of an Archaeological Site Burial Project. Paper presented at U.S. National Park Service, Western Region, Archaeological Site Stabilization Workshop, September 14, 1994, Spokane, Washington.

Planning, implementation, and management are three steps that the author outlines for people interested in preserving archaeological sites using a burial-in-place treatment. Such treatments often entail designing and constructing protective structures, such as berms or engineered-covers, that are either temporary or permanent. Temporary structures are usually boards, landing mats, or other types of rigid platforms used to protect areas during construction of an adjacent project. Permanent structures are typically composed of earthen or gravel fill and are designed to enable long-term modern uses to occur without impacting the underlying archaeological site. Of these steps, the author stresses that planning is the most important one.

Planning

The first step he describes entails analyzing site decay processes, characterizing the site, and establishing treatment objectives. Site decay processes that impact archaeological sites include various forms of erosion, intrusion, land use, and weathering (e.g., physical, biological & chemical). Known effects of these processes on site components are shown in **Appendix B**. The author recommends that a qualified geomorphologist determine the types and rates of active decay processes at a particular site. He argues that the proposed burial-in-place treatment must counteract existing natural decay processes (pg 2).

A site's character includes both its significance and its condition. He recommends that an archaeologist determine a site's significance in terms of applicable historic contexts and National Register of Historic Places criteria and then prioritize site components for preservation. A geochemist should determine a site's physical, biological, and chemical condition and identify past decay processes. For example, if an archaeological site occurs in an alkaline soil, all culturally related plant materials decayed long ago, but any shell artifacts present will be well-preserved.

The author recommends establishing explicit objectives for a burial-in-place treatment based on site decay analysis and characterization. These objectives may include preventing further site erosion, limiting site intrusions, maintaining existing chemical characteristics, inducing beneficial characteristics, reducing or eliminating cyclic environmental processes (i.e., wet-dry & freeze-thaw), creating favorable moisture conditions, or minimizing stress. He notes that preserving all site components may not be feasible, so priority should be given to those components containing important information.

continued.

Mathewson, Christopher C., 1994, Planning… continued.

Implementation

Implementation, as he outlines it, entails documenting the archaeological site being preserved, designing and constructing a site-specific protective structure that best meets the established objectives, and blending the structure into the surrounding environment. He recommends mapping the archaeological site boundary, its features and components, any excavated areas, and the elevation of modern ground surface in order to aid future research and management; establishing permanent off-site reference points may be necessary. The site's pre-burial soil chemistry, moisture content, and stratigraphy should be documented as a baseline for assessing the burial-in-place treatment's effectiveness.

The protective structure should blend into the surrounding landscape to reduce the underlying site's visibility. The topography of the structure should avoid creating and increasing water-related impacts to the underlying site. Any vegetation planted on the structure must be compatible with the structure's design and the burial-in-place treatment's objectives. Use of non-native plants is discouraged, because they may highlight a site's location.

He notes that turf grass should be used cautiously even though it provides beneficial cover over an earthen protective structure. Turf requires continuous management and maintenance that may include applying fertilizer and other chemicals as well as flood irrigation. These activities can significantly affect a buried archaeological site and should only occur on protective structures that contain mechanisms, such as impervious layers and drainage mechanisms, to prevent moisture-related impacts.

Management

The last step he describes entails maintaining and monitoring a protective structure and associated archaeological site to ensure that the burial-in-place treatment meets its objectives. He recommends that protective structures be monitored at least once a year, and more frequently if they are subjected to heavy use. Monitoring should include assessing and noting changes in erosion, vegetative cover, moisture content, and evidence of human or animal intrusion. If grass turf is present, its maintenance plan should be reviewed and the fertilizing and water schedules adjusted as necessary. If impacts to the underlying archaeological site are detected directly or indirectly, they must be remedied. Since burial-in-place is a relatively new treatment, its effectiveness should be assessed through excavation.

Mathewson, Christopher C., Tania Gonzalez, and James S. Eblen
1992 Burial as a Method of Archaeological Site Protection. Contract Report EL-92-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

The authors study the effects of burial-in-place on archaeological deposits through controlled observations of inadvertently buried sites and replicative experiments. Previous studies on burial-in-place are also summarized.

First, they compare core samples extracted from archaeological deposits and non-site locations buried by historic-period structures, such as levees, as well as control samples from nearby never-buried contexts. As a result, they identify eight physical or morphological changes and four chemical differences in the buried archaeological deposits. Variation in horizon thickness, hue, color value, chroma, texture, structure, carbonate nodules, and amount of mottling (pg 67), as well as pH, potassium content, organic carbon content, and total carbon content (pg 73) between buried and never-buried soils are statistically significant and vary depending on soil type, protective fill type, and environmental conditions.

Second, they set up a stress experiment by burying “artifacts” (i.e., clay flower pots, glass rods & charcoal drawing sticks) in different soils at various depths, covering the fill with plywood, and then running heavy equipment over them. As a result, they identify four variables related to artifact breakage: depth, artifact orientation and overlap, fill compression, and protective cover type. Their six conclusions (pg 96) are straight forward: the amount of artifact breakage decreases with increasing depth of the fill; artifacts in vertical positions are less likely to break than those in horizontal positions; artifacts that overlap are more susceptible to damage than solitary artifacts; artifact damage is greater in compressible fill; covers that minimize the amount of strain on subsurface artifacts are better than those that don’t; and ductile artifact types, such as charcoal, tend to bend without breaking.

Third, they note that other studies show that burial-in-place can reduce the erosion and weathering at archaeological sites. The treatment can also create new conditions or amplify existing ones that increase a site’s natural decay rate (see **Appendix B**). Wet-dry and freeze-thaw cycles are some of the most damaging environmental factors observed.

Overall, they conclude that burial-in-place can be a viable option for protecting archaeological sites provided that alterations to important physical, chemical, and biological properties are prevented. They offer several recommendations (pg 104):

+ The protective fill should not increase the vertical load on the archaeological site. If the site occurs in a compressible soil type, a rigid cover should be used to dissipate the added stress. Otherwise, artifacts may be damaged or displaced or both.

+ The protective fill should create chemical and microenvironmental conditions that closely match that of the archaeological deposit. A limited difference in pH may be acceptable since the relatively high organic fraction of most archaeological deposits can act as a buffer.

+ The protective fill should not increase the frequency or magnitude of existing cyclic changes in the moisture content within archaeological deposits. In general, increases in moisture content damage archaeological deposits and should be avoided, unless completely wet anaerobic conditions (i.e., total inundation) can be achieved.

Moody & Associates
2000 Historic Properties Treatment Plan for Sites Within and Adjacent to the Proposed C.W. Harris Site Archaeological District, Starwood Project Area (TM 5073), Santa Fe Valley, San Diego County, California, Mooney & Associates, San Diego.

The consultants present a six-point preservation-in-place plan designed to meet the developer's needs and comply with applicable federal, state and local requirements. The plan calls for capping portions of three archaeological sites located within a proposed golf course and preserve unburied, two other sites as open space within a residential development.

First, they recognize the need to gather a limited amount of information about the sites prior to implementing the burial-in-place treatment, and propose test excavations at two sites, which were previously unexcavated. They present a logically sound research design and show how the recovered information can be used to fine-tune later treatment measures. In addition, previous work performed at the sites will be synthesized. As a result, the knowledge gained can be incorporated into the plan's public outreach component, which is discussed later.

Second, they assess the likelihood of the 10-to-15 feet thick protective structure inducing changes to the archaeological site. They summarize previous studies on the effectiveness of burial-in-place and apply the results to the current plan. On this basis, they recommend that the sites be covered with a permeable fabric to avoid trapping moisture and a six-inch-thick layer of culturally sterile sand to absorb and distribute overlying fill's weight. The sand should be slightly saline to match the chemical composition of the archaeological deposits. The rest of the cap will be composed of fill used building the golf-course.

Third, the plan includes procedures for avoiding the site during construction. They propose having a qualified archaeologist mark site boundaries and the limits of a buffer zone. Temporary fencing will be erected along the buffer zone boundary to prevent any inadvertent impacts during earthwork. Within the site boundary, vegetation will be removed by hand, trees will be truncated at ground level, and motorized equipment will not be used within the fenced-off area.

Fourth, they recognize the need for a visible, corrosive-resistant, protective marker over the sites. They propose placing orange plastic webbing between the permeable fabric and the sand layer. This marker will allow for easy identification of areas where the cap has worn through and allow future excavators to establish the pre-burial ground surface.

Fifth, the plan includes enforceable provisions that ensure long-term preservation. Future non-research-related excavation below the cap is expressly prohibited. The treated sites will be annually inspected in perpetuity by an archaeologist and a Native American monitor hired by homeowners' association. The resulting reports will be filed with the county. In addition, the homeowners' association will designate and train a lookout to monitor the areas and report any natural or man-made intrusions.

Sixth, the plan calls for a public outreach effort. The developer agrees build and place an interpretative display about the sites in a public place and create a hands-on exhibit for use in local schools. The remaining recovered artifacts will be curated at an accredited institution.

Nickens, Paul R. (editor)
1991 Perspectives on Archaeological Site Protection and Preservation. Technical Report EL-91-6. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi.

This volume contains 12 conference papers discussing the merits of non-destructive preservation treatments for archaeological sites in contrast to the most common treatment—data recovery excavation. The authors, a majority of which are federal agency archaeologists, consider four preservation-in-place methods: avoidance, adaptive reuse, stabilization, and burial-in-place. As one participant points out, "site preservation is neither simple nor straight forward" (pg 32).

Physically avoiding a site can be accomplished by redesigning a project around it. However, this provides only short-term protection from a project's direct effects, and may ignore a project's indirect or cumulative impacts. Avoided sites are subjected to the vagaries of chance in an environment where sites are being destroyed at a rate of one percent a year. This method only works when a land-managing agency can actively protect a site that is avoided by a particular project.

Adaptively using an archaeological site entails selecting a land use that is compatible with the preservation of its Register-qualifying characteristics. For example, a site situated in an orchard is unlikely to be impacted further by the continuation of orchard-related activities. A site with a modern use may produce income and usually has an attentive steward (e.g., orchard manager). This strategy is certainly preferable to isolating an archaeological site from society by erecting a protective fence around it.

Stabilization focuses on preventing further erosion or deterioration to an archaeological site. Common examples include capping standing masonry walls, placing mats in trampled areas, or adding riprap to a stream bank or gully. However, the magnitude of this treatment should be watched carefully, because of what one federal land manager calls the "ruin stabilization paradox" (pg 108). That is, modifications made to preserve some site attributes, such as form and outline, may ultimately result in the complete destruction of others like materials, craftsmanship, or information potential. For example stabilization could result in wall that looks nothing like what it did during the site's period of significance or even 20 years ago.

Burial-in-place entails placing an earthen structure over a site to protect it from overlying modern activities. Corps-sponsored studies have made significant progress in determining the appropriateness and effectiveness of this method. However, this method is only suitable for a certain types of archaeological sites, such as those lacking standing architectural remains, and is probably the most invasive of the four preservation-in-place methods.

While the technical basis exists for non-destructive preservation methods to be implemented, a lack of awareness among professionals hinders their use. More examples, well-tested procedures, and professional recognition are needed to convince others to use these conservation-minded methods. In the long run, non-destructive site preservation will be "selected when it is the best alternative not just the cheapest." (pg 149).

Nickens, Paul R.
2000 Technologies for In-Place Protection and Long-Term Conservation of Archaeological Sites. In *Science and Technology in Historic Preservation*, edited by Ray Williamson and Paul R. Nickens, pp. 309-332. Advances in Archaeological and Museum Science Volume 4. Kluwer Academic/Plenum Publishers, New York.

This volume is highly accessible and can likely be found in most university libraries. The author presents an excellent overview of non-destructive techniques for conserving non-architectural archaeological sites and provides numerous examples and illustrations. A discussion of the history and principles of conservation archaeology provide background for the author's interest in promoting alternatives to data recovery excavations. Four techniques or strategies for protecting non-structural archaeological sites are covered: intentional burial, engineered stabilization, vegetation management, and rock stabilization.

Archaeological sites are or were buried at one time, as the author points out. Reburying sites entails the "placement of an engineered protective covering designed to enhance the long-term preservation of those resources" (pg 313). The potential for introducing new or different adverse impacts should be considered and resolved through the design of the covering. In addition, future scientific access to the site and views of cultural groups associated with the site should be addressed. Physical, biological, and chemical factors that affect archaeological sites are relatively well-understood due the work performed by Texas A&M University (see summaries of Mathewson 1994; Mathewson et al. 1992).

Protective measures designed to retard or prevent erosion to landforms, such as shorelines, can also protect archaeological sites situated therein. Often called stabilization, these approaches include placing riprap protection and non-degradable grids or fabrics. As the author's examples show, stabilization sometimes results with sites being mostly or completely covered, in which case the treatment should be considered burial-in-place.

A less physically intrusive approach to engineered covers and stabilization methods entails using plants. Engineers call them "living vegetative materials," and when planted they protect sand dunes, shorelines, and denuded slopes. The use of natural species is preferable, since they often don't require additional maintenance once established and are less likely to create imbalances in the surrounding environment.

While techniques for conserving stones in architectural settings are relatively well established, those for treating natural outcrops containing rock art are not. Recent tests in Kansas suggest that ethyl silicate can be effective in cementing and waterproofing deteriorating petroglyphs without causing discoloration and impermeability.

The author also discusses different guidelines and strategies that are available to assist managers in making decisions about preserving sites. The methods and examples used in the text are well-referenced giving direction to researchers interested in particular techniques.

Thorne, Robert
1991 ***Intentional Site Burial: A Technique to Protect Against Natural or Mechanical Loss.*** **Technical Brief Number 5. U.S. Department of the Interior Departmental Consulting Archeologist and National Park Service Archeology and Ethnography Program, Washington. Revised.**

Many archaeological sites are buried and preserved through happenstance and natural processes, but intentional burial and preservation of sites by humans entails deliberate design and effective engineering. The author talks about how to design a burial-in-place treatment using four steps: evaluating site components, measuring impacts, assessing benefits, and selecting methods. The best burial-in-place treatments use a multidisciplinary team composed of an archaeologist, geologist, and engineer. The author provides an annotated bibliography of relevant studies and examples.

In his first step, a site's important components are evaluated and prioritized by the team's archaeologist for preservation. The author stresses that an archaeological site's significance in terms of applicable historic contexts and National Register of Historic Places criteria should have been established prior to this step. The site's current condition, including it's biological, physical, and chemical properties, should be documented in order to establish a baseline for future study.

The second step of his process involves assessing impacts and setting goals. He argues that ultimately the treatment must "insure maximum protection is afforded the resource while minimizing any negative effects caused by the overburden" (pg 4). The team's geologist should select fill for the protective structure that will best protect important site components. The team's engineer should design the structure and its construction to minimize stress and moisture-related impacts from occurring to the archaeological site. Impacts from any vegetation planted on top of the structure should also be considered. The author states that burial-in-place treatment's primary goal is the "mitigation of the effects of decay processes and the external forces that impact the resource," and its secondary goal is "not accelerating ongoing decay [processes] or establishing new destructive processes"(pg 4).

The third step entails determining the benefits of implementing a burial-in-place treatment. Will it protect the site from impacts associated modern development and vandalism? Will it protect the site from further erosion and decay? He recommends that the broadest possible post-treatment uses of the protective structure be considered.

The last step involves selecting procedures that meet the treatment's goals. He recommends establishing permanent reference points to allow future researchers to locate the site and orient themselves in terms of the site's components. He also suggests marking the modern ground surface and preventing inadvertent mixing of archaeological deposits and any added fill. In this case, he recommends using a non-degradable fabric or visually distinctive, culturally sterile material (e.g., sand, clay). He emphasizes that the protective structure's construction techniques should not impact the site.

continued

Thorne, Robert, 1991 continued.

One procedure that the author states must be used in any burial-in-place treatment is post-construction monitoring, and he describes three types of monitoring. The first entails documenting the protective structure's condition. The second involves assessing and documenting the protective structure condition and making efforts to rectify any deficiencies. The third involves determining the condition of the archaeological site and evaluating its preservation in comparison to its pre-treatment condition. This last type of monitoring requires a means of physically accessing the archaeological site under the protective structure. Regardless of the types selected, monitoring should be conducted on a regular basis.

Finally, the author asks people considering burial-in-place to realistically estimate the treatment's short-term and long-term costs. Short-terms costs include the multidisciplinary team's salaries during both design and construction, soil sample collection and analysis, mapping and setting benchmarks, construction materials, crews and equipment, and landscaping. Long-term costs include regular monitoring and maintenance of the protective structure. He recommends establishing a funding source to pay for the treatment's long-term costs.

APPENDIX B: Site Decay Model

Figure 2. Matrix Showing Conditions that Enhance Preservation or Accelerate Decay of Archaeological Site Components.

SITE COMPONENTS

SITE CONDITIONS	Animal Bones	Shell	Plants, Ecofacts	Charcoal	Crystalline Lithics	Granular Lithics	Ceramics	Features	Soil Attributes	Metals	Context	Rock Art	Isotopic Content
Cyclic Wet-Dry	A	A	A	A	A	A	A	A	A	A	N	A	A
Continuously Dry	E	E	E	E	N	E	N	N	N	E	N	E	E
Continuously Wet,Anaerobic	E	E	E	A	A	A	A	A	A	A	N	A	A
Continuously Wet, Aerobic	A	A	A	A	N	A	A	A	A	A	N	A	A
Cyclic Freeze-Thaw	A	A	A	A	A	A	A	A	A	N	A	A	A
Freeze	A	A	A	A	N	A	A	N	E	N	A	A	E
Thaw	N	N	N	N	N	A	N	N	A	N	A	N	A
Compression	A	A	A	A	N	N	A	A	A	N	A	N	N
Movement	N	N	N	A	N	N	N	A	A	N	A	N	N
Erosion	A	A	A	A	A	A	A	A	A	A	A	A	A
Deposition/Sedimentation	E	E	E	E	E	E	E	E	E	E	E	E	E
Microorganisms	A	N	A	A	N	N	N	N	N	A	A	A	A
Macroorganisms	A	A	A	A	N	A	N	A	A	N	A	N	N
Vegetation	N	N	N	N	N	N	N	A	A	N	A	A	N
Human Intrusion	A	A	A	A	A	A	A	A	A	A	A	A	A
Acidic Environment	A	A	E	N	N	A	N	N	A	A	N	A	N
Basic Environment	E	E	A	N	N	E	N	N	A	A	N	A	N
Oxidizing Environment	A	A	A	A	N	N	N	A	A	A	N	N	A

Notes:
E - Condition Enhances Preservation or Reduces Decay of Site Component
A - Condition Accelerates Decay of Site Component
N - Condition is Neutral or Has No Effect on Site Component

Based on Figure 1 in Mathewson, Christopher C., 1994 Planning, Implementation and Management of an Archaeological Site Burial Project. Paper presented at U.S. National Park Service, Western Region, Archaeological Site Stabilization Workshop, September 14, 1994, Spokane, Washington, which cites the original source as: Mathewson, Christopher C., 1989 Logic-based Qualitative Site Decay Model for the Preservation of Archaeological Sites. In An Interdisciplinary Workshop on the Physical-Chemical-Biological Processes Affecting Archaeological Site to Develop an Archaeological Site Decay Model, edited by Christopher C. Mathewson, pp. 227-238. Technical Report EL-89-1. U.S. Army Corps of Engineers, Waterway Experiment Station, Vicksburg, Mississippi.