RUINS STABILIZATION REPORT
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RUINS STABILIZATION: A HANDBOOK

by

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Submitted by

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INTRODUCTION

Stabilization is a technical process that is used to physically preserve archaeological resources that are important to the nation's heritage. It is a process that has been used extensively over the last 90 years to insure that selected resources are appropriately protected and maintained for the use and benefit of current and succeeding generations. Such use includes scientific research as well as interpretation and education to benefit public understanding and appreciation. Stabilization is a practice that has been commonly used throughout the nation on archaeological, historical, and architectural resources. Most stabilization work, however, has been carried out in the southwestern U.S. (primarily Arizona, Colorado, New Mexico, and Utah) on prehistoric archaeological resources that predate A.D. 1600.

According to existing definitions, stabilization is a technical process concerned with physically preserving the remains of standing architecture. Stabilization, as such, is intent on achieving "structural stability" and is accomplished by reinforcing structural fabric and by deterring deterioration and preventing collapse that is the result of, or can be caused by natural and/or human induced impacts.

Despite this pragmatic definition, however, ruins stabilization is also concerned with insuring that all possible efforts are implemented to protect and maintain all features and components of an archaeological site. This includes the architecture (structural and nonstructural) and all associated artifactual material. Thus, stabilization is not only concerned with repairing deteriorating architecture, but it is concerned with curtailing or mitigating those factors that are having an adverse impact upon the integrity and condition of all aspects of an archaeological site.

The actual stabilization of an archaeological site is accomplished by implementing indirect or direct preservation measures. Indirect measures include any nonphysical means of site protection and may include such actions as (1) closing a site to public use, thus restricting or completely eliminating access to a site, (2) developing interpretive or informational programs that increase public awareness of the significance and fragility of a site, or (3) increasing law enforcement measures that curtail malicious activities.

Direct protective measures are physical treatments that are employed to arrest, slow the rate of, or divert the source of natural or human caused deterioration of a site. Such measures include "stabilization," the erection of physical barriers, and data recovery. Specific measures include: (1) repair of the standing structural fabric, (2) backfilling to cover exposed nonarchitectural features, (3) removal or eradication of harmful vegetation and rodents, (4) diversion of surface runoff or ground water movement, or (5) the erection of accessways and barriers that enhance and/or restrict visitor movement. Data recovery measures are employed when no other means of preserving or protecting a site are feasible. Such measures consist of the recovery of archaeological data and material culture, usually through excavation.

The basic premise for implementing the stabilization process lies with various federal laws and regulations that mandate the preservation of the nation's important archaeological resources. The process of protecting, maintaining, and wisely using archaeological resources is called "archaeological resource management." The management of archaeological resources entails the implementation of programs designed to protect them from further damage, stabilize them to prevent further deterioration, and when such measures are not feasible, recover from them any and all relevant information. As such, the practice of ruins stabilization is an integral component in the management of the archaeological resources.

The purpose of this handbook, then, is to provide the archaeological resource manager and the stabilization practitioner with the basic principles and procedures for implementing the stabilization process. It is intended as an overall guide to insure that the basic strategies for employing the stabilization process remain relatively consistent despite the wide diversity of archaeological resources that are in need of stabilization. The basic premise of this handbook is drawn from experience on archaeological resources that are located in abundance throughout the northern Southwest. Despite the geographic limitations, however, the handbook does have application to other types of archaeological resources as well as some historic resources.

The handbook has been organized into three major sections. Section 1 provides a very basic discussion on the historical development of stabilization. Section 2 deals with the basic principles of stabilization and the role stabilization plays in the management of archaeological resources. Section 3 presents the basic procedures that are used to plan and implement the stabilization process. Appendix A contains examples of recording forms. Two Technical Supplements accompany this handbook. The first provides a glossary of stabilization terminology. The second presents a concise discussion on the factors and agents that cause the deterioration of archaeological resources.

Section 1

HISTORICAL DEVELOPMENT OF STABILIZATION

This section provides a brief discussion on the history of stabilization. In no way should this section be construed as an exhaustive compilation of the historical development of the stabilization process, although such a document is sorely needed. The intent is to provide the reader with a general understanding of the development of stabilization so as to better comprehend the principles and procedures that are being implemented today. In order to facilitate this discussion, a series of periods have been defined on the basis of the primary types of work carried out during a given span of years. These breakdowns are somewhat generalized and there is a certain degree of overlap in the purpose and results of each period.

Period I (Inception and Development, 1891 to the mid-1930s)

The history of stabilization in the southwestern United States can be traced back to as early as 1891 to Casa Grande Ruin in southern Arizona, where the first known and documented stabilization work was performed (Lee 1970:20). The full practice of stabilization, however, was not implemented until around the turn of the century and can be attributed to the establishment of Mesa Verde National Park in southwestern Colorado. With the creation of other federal reserves for archaeological resources, the practice of ruins stabilization grew markedly during the time period of the early 1900s to the mid-1930s. Newly created NPS monuments that bore witness to the inception of the practice of ruins stabilization during this time period included Aztec and Chaco Canyon in New Mexico, and Wupatki, Canyon de Chelly, Navajo, Tumacacori, and Tuzigoot in Arizona. New Mexico State Monuments of the time that eventually became NPS areas and that also saw the implementation of the practice of ruins stabilization included Pecos, Abo, Quarai, and Gran Quivira.

From the time of the first completed stabilization work in 1891 up until the mid-1930s, the main purpose of stabilization was to repair walls for purposes of preservation and to make the ruins more attractive and educational to visitors (Torres-Reyes 1970:99). The general philosophy during this period was to preserve ruins as ruins, with repairs completed with the least possible alteration and with no reconstruction and no restoration other than what was absolutely necessary (Torres-Reyes 1970:100; Hewett 1936; Hewett and Fisher 1943). Obviously, not all stabilization practitioners advocated this approach or abided by it, for it was also during this time period that major reconstruction projects were initiated at Mesa Verde, Aztec, Canyon de Chelly, and Wupatki.

Period II (Standardization, 1937 to the early-1970s)

The late 1930s saw a major shift in the practice of stabilization and many of the technical approaches. This was primarily due to the development of the Mobile Stabilization Unit in Chaco Canyon in 1937. While many NPS areas continued to develop their own stabilization programs, and several other archaeologists moved throughout the Southwest

conducting stabilization projects, it was essentially the work of the Chaco Mobile Unit that set the standards for ruins stabilization in the NPS. Many of these practices are still in use today. Much of the philosophy guiding this work was a continuation of that previously advocated. However, there was a significant shift toward achieving a degree of preservation that most nearly approached permanency and, in most cases, towards employing standard or modern building procedures (Vivian 1949:6; Richert and Vivian 1974:3).

It was also during this time period that there was a standardization of the techniques and materials used in the stabilization process. In the late 1930s, the first standardized recording formats for documenting the stabilization process were developed. In the late 1940s, the first stabilization manual was developed. This manual included definitions of ruins stabilization, discussions regarding stabilization materials and their advantages, techniques to be used to deal with the variety of structural problems encountered during the stabilization process, and guidelines regarding the proper way to record the completed stabilization work (Vivian 1949).

From the mid-1930s to the early 1970s, very little change was seen in the philosophy and methods used in the process of ruins stabilization. The ruins stabilization manual developed in the late 1940s was revised and updated in 1962. In 1974, a new version of the ruins stabilization manual was produced in response to a greatly expanded program of preserving cultural properties on a national scale and the need to disseminate guidelines on a broader base (Richert and Vivian 1974:1). As Richert and Vivian indicated (1974:1), the interests served by the two earlier manuals were confined largely to a few NPS specialists whose duties involved preservation and maintenance of prehistoric and historic structures. Many of the goals of the 1974 manual were prompted by the fact that the practice of stabilization had spread in the early 1960s to other federal, state, and private agencies and organizations. Unfortunately, at the time of its publication, the methods and techniques presented were considered to be out-dated and out-moded and, consequently, it never achieved full acceptance nor recognition by the preservation community.

Period III (Methodological Changes, the early-1970s to the present)

In the early 1970s, a subtle shift began to take place in many stabilization approaches and techniques. Much of this change came about as a result of the archaeological profession expressing concern about the direction that the stabilization process had taken. Many archaeologists were of the opinion that stabilization had become nothing more than a technical undertaking that had little regard for the archaeological resource and the inherent values that are of significance to archaeological research. Much of this perception resulted from the fact that most stabilization practitioners were using permanent, incongruous materials and employing techniques that altered, and in some cases were drastically different than, the original. Complicating this issue as the fact there had arisen a wide divergence between the practices of stabilization and archaeology. Very few stabilization projects implemented thorough pre- and post-stabilization data recording procedures sufficient to explain

what original material had existed and what had been replaced or altered. As a result, significant information was being destroyed, and very few data were available to interpret what had originally existed. Consequently, the very process that was initially designed to preserve the original character and features of significant archaeological resources was perceived by most of the archaeological profession as a process that was destroying more than it preserved.

In an effort to respond to this growing concern, the NPS initiated a series of steps designed to insure that more compatible materials were used and that archaeological data were gathered before and during the stabilization process. The Western Archeological Center (now the Western Archeological and Conservation Center) and the Southwest Cultural Resources Center issued memoranda directives in 1974 and 1975 regarding the use of such permanent materials as Portland cement, essentially limiting their use to emergency situations where destruction of the resource was eminent. Thus, there was a slow shift towards the use of stabilization materials that were less destructive to the original fabric. Further evidence of this shift is found in the stabilization material study conducted by the NPS in the mid- to late-1970s which investigated the economic and aesthetic feasibility of using chemically amended stabilizing materials (Fenn and Deck 1978).

At the same time, there was an increasing emphasis on performing comprehensive archaeological data recovery prior to the stabilization process. Notable projects that highlight this change in direction include the prestabilization documentation of the Casa Grande Ruin in 1975 and 1976 (Wilcox and Shenk 1977); the prestabilization documentation of selected sites at Wupatki in 1975 (Gilman and Thornton 1976); and the prestabilization documentation of Sliding Rock Ruin in Canyon de Chelly in 1978 (Nordby 1981).

The concerns promulgated in the 1970s have instigated numerous changes in the way that ruins stabilization is practiced today. There are increasing efforts to fully incorporate the practice of stabilization as a significant component of archaeological resource management. There has also been a significant effort to approach stabilization from both conservation and archaeologically oriented perspectives. The end goal of such a combined approach is: (1) the perpetuation of a visually unaltered resource that will not diminish the visitor's ability to understand and appreciate the architectural achievements of the past, (2) to allow future archaeologists the opportunity to explore new research problems and questions that have yet to be defined, and (3) to make readily available additional information to aid in the explanation of past lifestyles of a given locality or region. In general, such an approach realizes that archaeological resources are finite and nonrenewable and, consequently, that the methods used to preserve them should seek to maximize the quality of data and materials that are ultimately saved. Recently completed projects in Canyonlands National Park, Natural Bridges National Monument, and Glen Canyon National Recreation Area (Metzger et al. 1988a, 1988b) are evidence of this continuing change in the philosophy and approaches to the stabilization process.

Section 2

PRINCIPLES OF STABILIZATION

Introduction

Stabilization has traditionally been concerned with the physical repair of the standing architecture of an archaeological site. In recent years, however, the process has become more diverse and is now specifically oriented towards the preservation of all features, components, and materials of an archaeological site. As a consequence, the stabilization process is rapidly becoming recognized as an important and integral component of the overall archaeological resource management process. This section provides a brief discussion on archaeological resource management and how stabilization fits into the overall process. This section also provides a concise description of the components of stabilization and the basic principles that are involved with each approach.

Ruins Stabilization and Archaeological Resource Management

Within the United States there has always be a vested interest in archaeological resources because they represent the unwritten portion of the nation's history. North American archaeology has been oriented toward gathering information from these resources in order to provide the public, both the professional and layperson, with a meaningful link to and a means for understanding the past. This link has been provided in the form of pamphlets or published manuscripts and books that allow the public to read and learn about a particular site or region from information that was scientifically gathered, or by providing access to a particular site location, or both. Archaeological resource management is oriented towards insuring that archaeological resources and/or the data they contain are appropriately preserved so that current generations have the opportunity to appreciate and learn about the human cultures that previously occupied this nation. Archaeological resource management is also oriented towards insuring that future generations are afforded the opportunity to have access to and be educated by the tangible and intangible remains of the past.

Archaeological resource management more specifically is concerned with implementing programs that will preserve and insure wise or managed use of the nation's important archaeological resources. Preservation is concerned with protecting and maintaining archaeological resources and the data they contain from accidental or purposeful deterioration and destruction. Wise or managed use is concerned with insuring that all realistic efforts are made to protect a resource from destruction, or when this is not feasible, insuring that appropriate forms of data recovery are carried out. Managed use also includes giving consideration to scientifically studying a site that may not be threatened, but which contains significant information not available from other sources that can contribute to a given research problem or a set of problems. Thus, archaeological resource management is concerned with continuing the

tradition of investigating archaeological resources to help better understand the past, but more importantly it is concerned with insuring that there are resources and/or data available for current and future study, interpretation, and appreciation. The basic framework of the archaeological resource management process is presented in Figure 1.

Since as early as 1890, there has been a national effort to preserve archaeological resources. It has been within the last 20 years, however, that there has been a significant increase in not only the interest and concern for archaeological resources, but in the federal government's commitment towards insuring that the nation's important archaeological resources are appropriately cared for. Much of this increased interest has been stimulated by a growing awareness and concern, at both the professional and layperson level, that archaeological resources are fragile, nonrenewable resources that, unfortunately, are rapidly disappearing (cf. McGimsey and Davis 1977; Lipe 1974; Davis 1971). This demise of archaeological resources has been attributed to national development and growth, natural attrition, damage from looters, and impacts from the inadvertent activities of archaeological researchers as well as managing agencies. Recognition of this rapidly accelerating demise has resulted in the development of numerous federal laws and regulations that have established mandates for the preservation and conservation of archaeological resources.

The Federal Government, working in conjunction with state and local governments, is responsible for providing the leadership in preserving the nation's archaeological resources (U.S. Congress 1986:10). The Secretary of the Interior and the Advisory Council on Historic Preservation have been given the primary responsibility of overseeing and providing guidance for all federal preservation efforts (U.S. Congress 1986: 10). Federal agencies, in the spirit of stewardship and trusteeship for future generations and in keeping with their missions, have been given individual responsibility of protecting and preserving archaeological resources that are under their control or jurisdiction (Executive Order 11593). Individual State Historic Preservation Office's are responsible for insuring that state and local preservation projects are carried out not only in compliance with state regulation, but according to nationally mandated standards as well (U.S. Congress 1986:11).

The Secretary of Interior's Guidelines and Standards (U.S. Department of the Interior 1983 and 1985) and the Advisory Council's Handbook for the Treatment of Archaeological Properties (Advisory Council on Historic Preservation 1986) are the primary sources for providing technical advice concerning archaeological resource preservation activities. However, various federal agencies, such as the National Park Service, have developed their own policies and standards that essentially serve to expand and clarify the Secretary of the Interior's guidelines (cf. U.S. Department of the Interior, National Park Service 1985).

The determination of which archaeological resources should be preserved for research or interpretive purposes, which should be immediately studied, and which should be allowed to be destroyed is dependent upon their significance, their existing condition, and the anticipated costs of preservation or data recovery. Archaeological resources that have

FIGURE 1
ARCHAEOLOGICAL RESOURCE MANAGEMENT AND RUINS STABILIZATION FRAMEWORK

CULTURAL RESOURCE MANAGEMENT

Archaeological Resource Management

Insures protection and wise or managed use of the nation's archaeological resources. Insures that all efforts are made to alleviate adverse impacts upon an archaeological resource. Accomplished by protection, stabilization, and, when such measures are not feasible, preservation of information through scientific excavation and study.

Other types of Cultural Resource Management; e.g. Historic Resource Management

Determining Preservation Requirements

Preservation treatments are determined by resource identification and evaluation. Identification serves as a basis for making an objective decision about the importance of a site. Evaluation is necessary so that decisions can be made concerning the appropriate preservation treatment. Evaluations are based on an application of the National Register criteria and the condition of the site.

Preservation Treatment

Protection

Direct and indirect measures designed to prevent disturbance of an archaeological resource.

Indirect

1. Redesign/relocation of developmental projects.
2. Restricting access.
   a. Administrative closure
   b. Physical closure
   c. Authoritative presence
3. Public education.

Direct

1. Site burial.
2. Site camouflaging.
3. Removing or deterring damaging environmental/biological agents.
   a. Site covers
   b. Water diversion
   c. Vegetation control
   d. Animal control

Stabilization

Direct physical measures designed to deter and prevent the deterioration and catastrophic loss of the features and components of an archaeological resources.

Types

1. Primary Stabilization: Initial comprehensive repair of a site that has not been previously stabilized. An intrinsic or extrinsic approach can be taken depending upon the nature and condition of the site and the factors inducing deterioration.

2. Secondary (Maintenance) Stabilization: The means by which the features and components of a previously stabilized site are sustained. The various aspects include:

   a. Monitoring/Routine Housekeeping
   b. Annual Maintenance
   c. Cyclical Maintenance

3. Emergency Stabilization: Limited repairs completed to areas of a site that are immediately threatened with further or irrevocable destruction or catastrophic loss.

Approaches

Approaches are determined by the site's existing condition, current agents of deterioration, and the managing agency's objectives.

1. Intrinsic Stabilization: Stabilization is conducted where needed to preserve or impart stability. Emphasis is placed on maintaining the original features and components as they exist. Stabilization is conducted to preserve the resource for research or interpretive purposes, or both.

2. Extrinsic Stabilization: Stabilization is conducted in a manner that provides protection of the archaeological remains from excessive natural and human caused impacts. Usually performed with the most durable stabilizing materials to provide maximum protection. Primarily performed on resources that only have interpretive value; however, it can be used on sites with research value if the impacts are threatening the remaining original fabric. Can include the restoration and reconstruction of missing or deteriorated architectural features to enhance visitor experience.

Investigation: Data Recovery

Direct physical measure, used when no other means of preserving or protecting a resource are feasible. Consists of the recovery of archaeological data and material culture, usually through active and passive data recovery and documentation.

been identified as a result of standard field surveys are to be evaluated as to their significance in terms of their scientific potential, interpretive potential, or both. From this, a determination is then made as to the most appropriate preservation treatment.

Archaeological significance is determined by an objective application of the National Register of Historic Places criteria. In general, archaeological resources that are considered significant for scientific purposes must retain their integrity and contain either artifactual, architectural, or component diversity that is likely to yield important archaeological data about the past. Archaeological resources that are considered significant for interpretive purposes must contain manifestations that can be appreciated by the public and can be used to broaden the public's understanding of the past as well as archaeology as a whole.

There is a gray area in distinguishing between these two values because an archaeological resource generally cannot be appreciated by the public until information about it is developed through research (McGimsey and Davis 1977:33). Sites that have research value always have the potential for contributing to the public's understanding of the past. This potential may not exist in the form of physical remains that the public can actually see and appreciate, but the sites contain data that can generate information that will enhance the public's understanding about the past.

Sites that are significant solely for interpretive purposes usually have no remaining research value, but they contain manifestations that the public can see and appreciate. Such resources include sites that have been completely excavated and have yielded important information, or sites that have been extensively looted with complete disturbance of the data-bearing cultural fill. Sites that have yielded important information obviously retain more significance than looted sites since there is more information that can be used to enhance the public's understanding of the past. The location of a site also plays an important role in terms of determining its interpretive value. For example, if a managing agency were deciding to expend preservation monies at one of two identical sites, it would be prudent to choose the site near the highway rather than the one only reached by a long hike. The site near the highway would be enjoyed by and would educate far more people.

Archaeological resources that have both research and interpretive potential are by far the most significant site type since they actually contain information that can fully satisfy the requirements of research and interpretation. Thereto, a particular site may not contain manifestations that make it individually significant for either research or interpretive purposes; however, it significance may be realized if it is included as a component of a broader scientific or interpretive framework that incorporates a number of sites.

The condition of an archaeological site weighed against significance plays an important role in determining how it will be dealt with. Generally, a site that is subject to substantial detrimental impacts is less important than a pristine site. Thereto, a site that requires a substantial monetary investment to maintain its existing condition may, in the

long run, be of questionable value. For example, a site may currently possess significant research or interpretive value but it is being severely impacted by natural or human-induced forces. An agency may elect to implement various preservation measures to curtail this damage. The agency may find, however, that in the long run the costs involved in continuously maintaining the site far exceed the value of the remaining information. In this instance, the agency may elect to allow the site to deteriorate and attempt to recover any and all remaining information as the most effective means of preserving the resource.

The preservation and conservation of an archaeological resource is accomplished by protection, stabilization, and when such measures are not feasible, preservation of information through active and passive scientific study. Expanded discussion on each of these aspects is presented below.

Protection

The goal of protection is to insure that all realistic efforts are made to eliminate or minimize those factors and agents that are likely to have an adverse impact on the condition of a site. The protection of an archaeological resource is accomplished by indirect and direct measures. Indirect measures include:

1. Redesign/relocation of developmental projects that could potentially have a negative impact on an archaeological resource. This can include proposed projects that are in or near a site.

2. Restricting access or completely closing a site to visitor use. This is accomplished by:

   a. Administrative closure by publicly announcing that a certain site or an area that contains a certain site is closed to visitation. This can also include withholding information about the nature and location of a particular site.

   b. Physical closure by the erection of barriers, such as a fence, that prevent entrance to a site. This can also include the installation of signs that indicate restricted areas or the construction of accessways that limit visitor mobility.

   c. Authoritative presence that insures that all visitors are informed that an entire site or a portion of a site is closed to visitation. An authoritative presence can also be used to take visitors through a site, thus limiting mobility.

3. Public education to enhance the visitor's understanding and appreciation of the fragile nature of archaeological resources, the extent and nature of damage that can result from visitation, and the value of preserving such resources. This can be accomplished by passive measures such as pamphlets, signs, slide shows, newspapers, radio, and television, or active measures such as law enforcement.

Direct measures include:

1. Site burial: covering exposed features of a site with protective materials such as sediment or rock. Site burial is effective in protecting a site from human impacts by hiding all indications of its presence. It is also effective in deterring natural impacts by providing a barrier that serves as a buffer from weathering or animal activity. Backfill sediments can be used for drainage control or for providing structural support, and rock or rip-rap can be used to protect a site from arroyo or stream erosion, or from wind deflation. Site burial also has an application to sites that have been excavated by archaeologists or potted by looters where displaced fill materials can be put back into place to cover exposed features. Unless an excavated site is going to be used for interpretive purposes, backfilling should be a necessary prerequisite.

2. Site Camouflaging: Site backfilling is one of the primary means of hiding a site or a portion of a site. Placing dead shrubs or branches over a site entrance or over a particular features is also effective. The planting of uninviting vegetation is also a good means of site camouflaging.

3. Eliminating or deterring damaging environmental/biological agents: This includes deterring damage that could be caused by natural weathering, water, vegetation, and animals.

a. General protection of a site from natural weathering such as rain, snow, wind, and temperature changes can be accomplished by the installation of site covers, roofs, or ramadas. Certain caution should be exercised with the installation of these features because they have the ability to redirect certain agents of deterioration creating new impacts.

b. Water damage is deterred by the placement of diversion systems at or near the source. Diversion systems can take the form of dams, retaining walls, lips (brass, aluminum, or silicone beads), gutters/drains, or contoured surfaces. The philosophy in using such systems is that it is generally better to effect preservation of a site by eliminating the cause of deterioration rather than continually repairing the resulting damage.

c. Vegetation damage is controlled by removal or eradication. Shrubs and trees cause the most damage through root growth and by the abrasive action of blowing branches. Damage can be deterred by manually removing the entire vegetative growth, removing or cutting back what exists above the ground surface, or through the use of biodegradable herbicides. It should be kept in mind that some forms of vegetative growth can be used to protect a site. As discussed above, certain types can be used to obscure a site or inhibit access. Grasses are beneficial because they have little or no ability to cause structural damage, but they can be used to enhance ground surface stability.

d. Rodents, birds, bats, insects, and, in some instances, livestock are among the most destructive natural agents affecting archaeo-

logical resources. Damage occurs as a result of burrowing, secretion, and direct physical contact. Damage can be deterred by live trapping and relocation, poisoning with short-duration biodegradable substances, or through the introduction of predatory species. Methods for dealing with livestock include animal relocation and fencing site perimeters.

Stabilization

Stabilization is concerned with the physical repair and maintenance of the existing standing architecture of a site. The goal of this work is to prevent any further loss or deterioration of the existing remains. This process is accomplished by the reinforcement and replacement of missing and eroded structural components and features.

Approaches

Two basic approaches can be used to complete the structural repair or stabilization of an archaeological site. These approaches consist of what can be termed "intrinsic" and "extrinsic" stabilization. The end goal of each approach is the preservation of the architectural remains. The difference between the two lies in the methods that are used to achieve the goal of preservation.

Intrinsic stabilization is concerned with preserving a site for research and interpretive purposes. Emphasis is placed on insuring preservation (deterring deterioration and imparting stability) and providing a means of adequate visitor appreciation and education. It is accomplished with the least possible impact upon, or disturbance of, the existing architectural and artifactual remains. This approach is usually implemented on sites that have not been previously stabilized.

Extrinsic stabilization is also concerned with preserving a site for research and interpretive purposes. Emphasis, however, is placed on using modern construction materials to substantially enhance a site's resistance to natural and human degradation. The preservation concerns are more with permanency and durability of the stabilizing materials that are used rather than in retaining the original materials and workmanship. This approach is usually implemented on sites that have been previously stabilized by an extrinsic approach, that retain little or no research potential, or that are being severely damaged by human and natural factors.

There are, of course, instances where both approaches will be used to preserve a particular site. This can occur when the nature and intensity of the factors of deterioration require extreme and variable measures be taken to insure preservation, or when the initial approach that has been used has been proven to ineffective. The determination of which approach is most appropriate or whether both approaches should be considered is dependent upon: (1) the nature and location of the site, (2) the factors that are having an effect on the condition of the site, (3) what stabilization work has previously been done at the site, (4) the value of the site in terms of its research and interpretive potential,

(5) the projected management use of the site, whether for research, interpretation, or both, and (6) the site's anticipated short- and long-term stabilization requirements and costs.

Not withstanding, intrinsic stabilization is the most preferred approach from an archaeological perspective since it promotes the preservation and conservation of the original components and features of a site. Extrinsic stabilization is the least preferred approach from an archaeological perspective because it has a significant impact on a site's integrity and aesthetics. However, it does insure adequate protection of the existing architectural remains that would otherwise be destroyed by natural or human impacts.

Intrinsic Stabilization

Intrinsic stabilization is an approach that is designed for sites that possess either a research or interpretive potential, or both. In general, such sites retain both architectural and artifactual material that can be used for current and future scientific study and/or that can contribute to the public's appreciation and understanding of the physical vestiges of the past. The basic objective of this approach is to insure that the material remains of a site are protected from further deterioration and damage and that any work that is conducted is done in a manner that does not compromise the site's architectural aesthetics or archaeological integrity. More specifically, the objective is to insure that the current and future research potential of the site is not impaired through disturbance, destruction, or alteration of the existing architectural and artifactual remains, and that the public is presented with an "authentic" archaeological resource and not a modernized facsimile.

The goal of the approach is achieved by utilizing only those stabilization techniques and materials that are compatible with and that duplicate the original remains as they exist, and by minimizing the disturbance and displacement of any surficial or subsurface cultural deposits in or around designated features or structures. This approach does not consider the restoration or reconstruction of missing structural components. Structural repairs are made only where needed to provide critical structural support. The goal of this approach is furthered through data retrieval before stabilization and documentation of stabilization repairs themselves. Prestabilization documentation insures against loss of archaeological information as a result of the stabilization and provides an opportunity to increase the data base of a site. The documentation of the stabilization tasks, what materials were introduced and where, helps mitigate the impact to a site's integrity because of the introduction of new materials into the architecture, and helps insure that the future research potential of the site will not be diminished as a result of this work.

With the intrinsic approach to stabilization, the burden of continuous preservation is to a great extent placed more on the visitor than the managing agency. In general, it requires that visitors have a sensitivity to the significance and fragility of a site and that they exercise due caution during the course of their visit. In back- and mid-country areas where visitation is moderate to infrequent, this approach is

usually successful in insuring continuous site preservation. However, the managing agency is required to regularly monitor and maintain a site depending upon the intensity of the human or naturally induced impacts. In heavily visited areas, this approach is only successful if it is implemented in conjunction with an active visitor education program. This includes educating visitors on such aspects as the fragile nature of archaeological remains, the extent and nature of damage that can result from public visitation, and the value of preserving archaeological resources. It can also be successfully used on front-country sites if an authoritative figure is present to supervise visitor activities.

In sum, the intrinsic approach is advantageous because it insures that the original integrity and aesthetic quality of the site is preserved, and that the research potential of the site is not significantly affected. There is the additional benefit in that the prestabilization documentation of the site will add to its data base. Further still, any visitors to the site can be assured that they are looking at the "real thing." The disadvantage, however, is that the site remains somewhat susceptible to damage caused either naturally or as a result of visitor use and may require more frequent maintenance.

Extrinsic Stabilization

Extrinsic stabilization is an approach that is primarily designed for sites that have little or no remaining research value or potential, and are meant to be preserved as purely interpretive sites. In general, such sites retain significant architectural remains; however, their features and components have been so altered, replaced, or destroyed that they no longer retain any research value. Most of the damage has occurred as a result of natural or human impacts, past stabilization practices, or past data recovery practices. Sites that fit into this category include most previously stabilized sites that have been subjected to repeated maintenance episodes, and a select number of sites that have been stabilized using an intrinsic approach, but have since been substantially damaged by natural and/or human impacts and thereby require extraordinary stabilization measures. The basic objective of this approach is to extensively stabilize a site, or portion of a site, using the most permanent and durable stabilizing techniques and materials possible. The end result is to reduce the extent of damage that is incurred, and in turn reduce the cost of continual upkeep. Extrinsic stabilization can also be used on sites that retain research value. However, it should be kept in mind that the process does have a significant impact on the structures where it is used and, consequently, on the site as a whole. This approach should be used judiciously and only when all other methods of stabilization or preservation have failed.

For the most part, the goal of the extrinsic approach is accomplished by one or more of the following applications: reinforcing walls with rebar; replacing the original mortar with amended mortar; covering or replacing roofs with plywood supported by modern wood or steel beams; laying down asphalt, concrete, or chemically treated sediments in pathways and open areas; constructing access trails using asphalt paving or gravel; installing steps and handrails; and developing signs or pamphlets

for guidance and interpretation. The selection of materials used in this approach should be carefully evaluated as to their expected effectiveness and their compatibility with the existing architectural remains. No materials should be used that are intrusive to the character of the site. All materials should match, or blend in with, the original construction materials and architectural stylization. Documentation is also a prerequisite with this approach particularly in areas where repairs are being made to deteriorated or damaged original fabric. The documentation of the repairs themselves will provide insight to the effectiveness of the repairs that have been completed as well as trends of deterioration. The documentation also has usefulness for planning future stabilization work; e.g., material and labor estimates and expenditures.

With the extrinsic approach, the site itself bears the burden of preservation. In general, the stabilization has essentially "bomb proofed" the site so it should be able to withstand most natural or visitor-related impacts. This approach, however, does not mean that the site is vandal proof, nor is it maintenance free. A site stabilized using this approach will still require regular maintenance, but the frequency should be greatly reduced. In front-country areas where sites are readily accessible and where visitation is somewhat controlled, this approach is usually successful in insuring site preservation. In certain areas where visitation is intense, this approach coupled with an aggressive visitor education program and/or an authoritative presence is the only way to insure site preservation. This approach should only be considered for sites that retain their research significance if an intrinsic approach cannot adequately deal with the existing impacts.

In sum, the extrinsic stabilization approach can be advantageous because it insures the preservation of the existing architecture from the effects of intense natural and human impacts. It is, however, an approach that should be used with caution and when no other means of preservation are possible, because of the impacts it has on the aesthetics and integrity of the original remains.

Types of Stabilization

There are essentially three types of direct stabilization treatment: primary, secondary, and emergency stabilization.

Primary Stabilization

Primary stabilization is defined as the initial structural repair of a site or structure that has not been previously stabilized. In general, all work is oriented towards placing all architectural features and components in a structurally sound condition. This treatment is to be performed on a comprehensive level, thus placing a site in a status of only requiring periodic secondary stabilization (i.e., monitoring and maintenance).

This treatment is specifically concerned with identifying, evaluating, and correcting problem areas and weak points. Those areas of deterioration that actively threaten the stability of a structure are required to be stabilized. The correction of minor problem areas before

they have the opportunity to worsen insures continuous preservation by significantly deterring irreversible structural displacement and damage. This treatment is also concerned with providing recommendations for secondary stabilization to further insure site preservation.

Intrinsic Approach. With this approach, emphasis is placed on preserving the site's overall appearance, integrity, and scientific information. The intent is to impart stability and not to restore a site, or portions of a site, to its actual or presumed appearance at a particular point in time. The intent is to insure site or structural stability and do it with the least possible impact. This approach generally does not include the use of incongruous stabilizing materials such as rebar, cement, or any other nonoriginal materials. There are, however, instances where certain modern materials can and should be used. Use of modern materials should be carefully evaluated and employed as a "last alternative." All modern materials used should be compatible with the original.

The intrinsic approach to primary stabilization is specifically concerned with insuring that: (1) significant features, components, and attributes are retained intact and with no significant alterations, (2) stabilization techniques and materials are used that are compatible with and that adequately duplicate the original construction methods and the existing structural fabric, (3) ground-disturbing activities are minimized to reduce the likelihood of impacting buried cultural remains and material, and (4) adequate data are retrieved from the areas affected by the stabilization process, thus insuring that significant information will not be lost.

Extrinsic Approach. With this approach, emphasis is placed on preserving the site's basic architectural form and outline. Specifically, this involves using the most permanent and durable stabilizing materials feasible to maximize a site's resistance to any damage that is incurred and to provide a safe environment for the visitor. This approach may include the restoration and reconstruction of missing or destroyed architectural features to enhance the visitor's experience. This may also include the installation of modern devices to enhance visitor safety.

Secondary (Maintenance) Stabilization

Secondary stabilization is initiated once a site has been successfully stabilized using either an intrinsic or extrinsic stabilization approach. The goal of this treatment is accomplished by the systematic inspection (monitoring) and the implementation of specific maintenance tasks (routine housekeeping, annual, and cyclical maintenance) that are designed to sustain a site's existing condition, thus insuring continuous preservation. All work is oriented along a preventative approach. That is, emphasis is placed on keeping track of a site in order to identify specific problems and problem areas and the expedient correction of any potentially damaging situations or any damage that has occurred. The detection and correction of minor problem areas before they have the opportunity to worsen, potentially leading to structural displacement and irreversible damage, are important aspects of this type of stabilization.

Monitoring and Routine Housekeeping. These tasks are the initial means by which cultural resources are "kept up" or sustained once primary stabilization has been performed. The objective is to identify and correct minor destructive conditions at a site before they become major threats to the resource. Monitoring is concerned with the regular visual inspection of a site to detect any signs of deterioration that might be occurring. Routine maintenance is concerned with the implementation of simplistic maintenance chores that should, for the most part, keep major forms of deterioration from occurring.

Annual Maintenance. This task consists of the implementation of preventative maintenance on a site that is known to require regularly scheduled (once yearly) repair to insure continuous preservation. The objective is the employment of an annual program of stabilization treatment on specific areas of a site that are projected to be consistently impacted by natural or human-caused damage. Annual maintenance can be programmed for implementation concurrently with the routine housekeeping of a site; however, the extent of these repairs is usually greater than what can be accomplished by a housekeeping staff.

Cyclical Maintenance. This task consists of the implementation of follow-up structural stabilization on a site that has received initial stabilization in the past, but has since deteriorated to a state where repairs can no longer be adequately taken care of through routine housekeeping or annual maintenance. The performance of cyclical maintenance is comparable to the performance of initial stabilization in the sense that all work conducted should be conducted on a comprehensive level and result in achieving a structurally sound condition while maintaining the site's original appearance, integrity, and scientific information.

Emergency Stabilization

Emergency stabilization is defined as the conduct of stabilization treatment on a restricted basis on a structure or site that is in imminent danger of major collapse. In general, such stabilization is performed on a limited basis and only on those areas that are "immediately" threatened with further or irrevocable destruction or catastrophic loss.

Investigation: Data Recovery

No Protection or Stabilization

A no-protection approach is applicable to sites that possess research or interpretive value, or both. With this approach, a site is allowed to deteriorate on its own, or in some instances to be destroyed by natural or human caused impacts. This option is utilized only if it is determined that it would be impossible to preserve the site. Such situations would include for example, an exorbitantly high short- or long-term stabilization cost in comparison to the importance of the site, or an inability to feasibly stabilize the site without significantly impacting or reducing its research or interpretive value. Nevertheless, before the site is allowed to further deteriorate, or be destroyed, it is a mandatory requirement that an archaeological investigation be conducted to insure adequate recovery of any and all pertinent scientific data.

Section 3

STABILIZATION PROCEDURES

Introduction

The implementation of a stabilization program for a specific management area requires an organized compilation of site data so that priorities for stabilization can be established and the implementation of specific stabilization procedures that are designed to insure continuous preservation of selected sites. The basic program structure for an area that is responsible for the stabilization of important archaeological sites includes: (1) a compilation of known sites within an area; (2) the development of decisions on the most appropriate use of the known sites, based on the goals and aims of the area; (3) the conduct of site evaluations and the development of a priority ranking for the known sites that have been deemed worthy of stabilization; (5) the development of a listing and a programming of the sites to receive stabilization treatment; (6) the implementation of subsequent maintenance treatment to insure continuous stabilization. The general sequence for planning and implementing a stabilization program is presented in Figure 2. The following sections discuss the process involved in conducting a stabilization program and the procedures used for implementing a site-specific stabilization project in accordance with Figure 2.

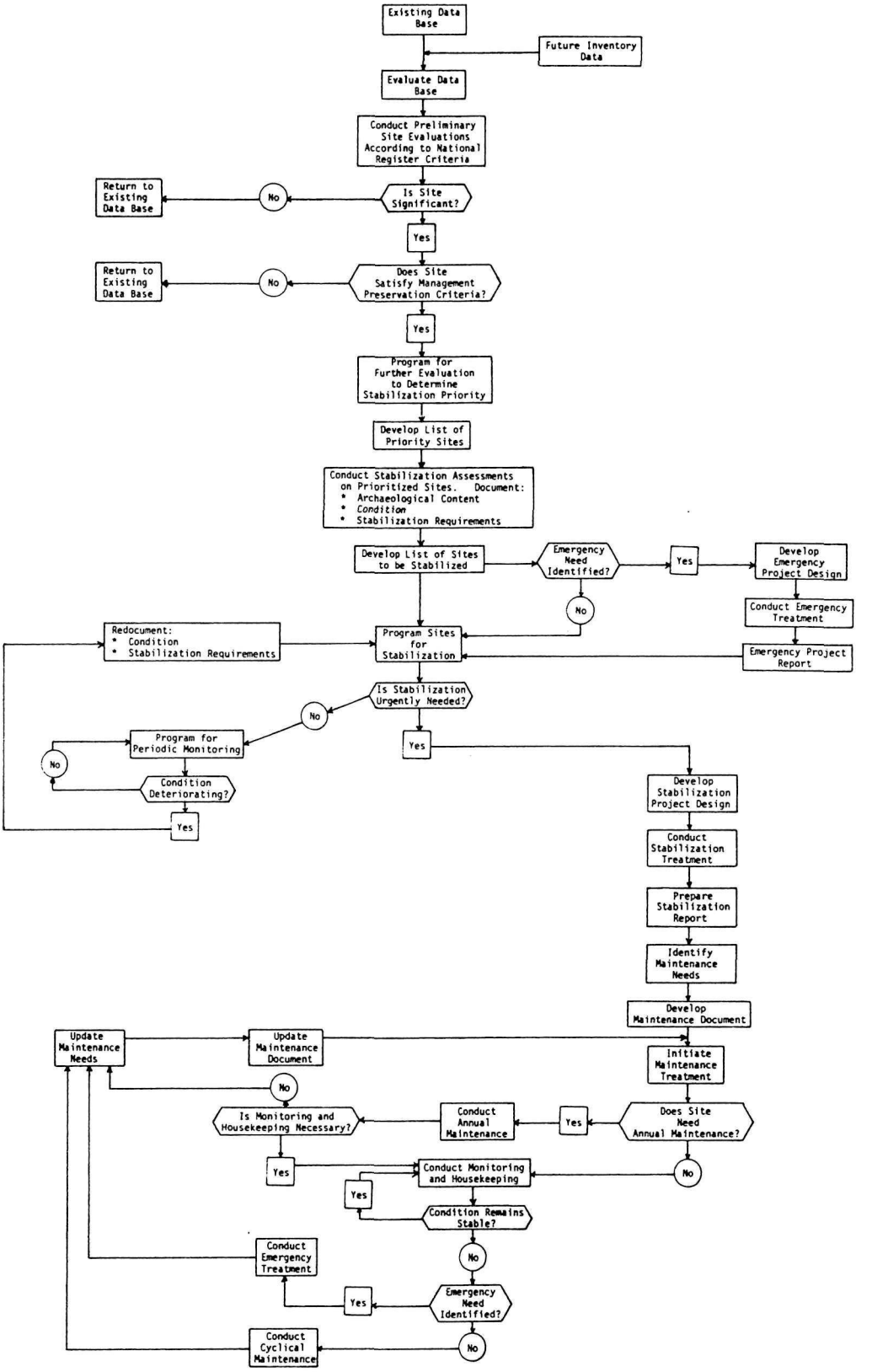
General Planning Procedures

Comprehensive Site Inventory

Information to be used in an area-wide stabilization program should be derived from the existing archaeological resources data base for the area. It is essential to have full knowledge of the extent and nature of the area's archaeological resources, as such information is critical in the development of the first stages of stabilization planning. Such information is used to identify which sites will receive some form of specialized treatment or protection beyond that normally afforded to archaeological resources under the area's jurisdiction. These site data are available from a variety of sources, including archaeological resource survey reports, stabilization reports, and data from area personnel. Since complete knowledge of an area's resources does not usually exist, it will be necessary to conduct additional surveys within the area to identify all potentially significant sites. In addition, since most previous researchers were not interested in recording stabilization data, in many instances it will be necessary to rerecord some of the sites in order to fully assess a particular site's research and interpretive potential, and whether or not it warrants stabilization. All sites that are recorded should be evaluated as to their significance in terms of their scientific or interpretive potential, or both. These evaluations should be based on the National Register of Historic Places criteria.

FIGURE 2

RUINS STABILIZATION PLANNING AND IMPLEMENTATION PROCEDURES



Management Decisions on Appropriate Use

The overall orientation of the stabilization program and, ultimately, the approach taken at an individual site or a group of sites is dependent upon the goals and aims of the area, and particularly the objectives of its archaeological resource management program. These goals essentially address the long-term directions that will be taken by the area for the protection and utilization of the archaeological resources under its jurisdiction. Management determinations for dealing with the area's archaeological resources should be based on each site's interpretive and scientific values and how these values correspond with the area's objectives.

Site Evaluation and Priority Listing

To develop priorities for stabilization, all sites that are determined eligible or potentially eligible for inclusion on the National Register of Historic Places should be systematically evaluated. The purpose of such an evaluation is to objectively assess all sites through a quantitative process that takes into account a particular site's stabilization requirements and the site's scientific and interpretive values. Such an evaluation is designed to recognize and quantify these qualities to assure that all National Register sites in an area are ranked and prioritized according to their relative significance and stabilization needs. In general, this listing should reflect those sites which have been identified as being significant and the relative degree of their stabilization needs. It should be noted that this process can either be implemented when a site is initially recorded, or when the area is initially developing priorities for stabilization. An excellent example of a stabilization ranking system that was developed for Canyonlands National Park can be found in Reed (1987).

Stabilization Assessment

A stabilization assessment should be conducted on all sites in accordance with the listing developed by the site evaluation and priority ranking process. The purpose of the assessment is to determine in detail the appropriate level of effort required to adequately preserve the site. The determinations for the appropriate level of treatment are dependent upon the status or condition of the site according to a variety of factors that include (1) the site setting (exposed or protected), (2) the factors affecting site deterioration (natural or human-induced), and (3) the rate and intensity of the erosional factors. Recognition of these factors should allow for a decision to be made as to what customary or specialized techniques or materials will have to be used. In general, a determination of the appropriate level of stabilization requires a recognition of the problems inducing deterioration and a determination as to which stabilization techniques and materials will be the most effective in curtailing or eradicating the problem. Further discussions on the analysis of the agents of deterioration and the proposed stabilization techniques and materials are presented in subsequent sections.

The assessment requires an on-site inspection and a detailed evaluation of the condition of the site on a structure-by-structure basis. The assessment should discuss what factors are causing damage and make recommendations as to the most appropriate repairs and what materials and techniques can most effectively be used. The assessment should include a discussion on the logistical arrangement in terms of availability of natural repair materials (e.g., sediment for mortar or backfilling, water for mortar mixing and curing, stone for masonry repairs, and wood for roof and wall repairs) and the difficulties involved in getting personnel and equipment into a site. The assessment should also discuss the labor and material investments that will be required to complete the stabilization.

The assessment should also include a concise archaeological description of the site. This should consist of a scale map, general and detail photographs, and concise descriptions of the artifacts and architectural features. The purpose is to provide detailed baseline data of the site to verify its scientific or interpretive value, thus justifying the expenditure of funding for stabilization. It also provides preliminary documentation of the site that can be used to partially satisfy the prestabilization archaeological requirements. Further discussions on the prestabilization archaeological requirements are presented in a subsequent section.

The assessment should result in a written document that provides the basic information on the site and it should serve as a guide to the overall approach and scope to the prescribed stabilization. This document should discuss (1) all management actions undertaken that have established the most appropriate use of the site, (2) the condition of the site, (3) the stabilization needs and requirements of the site, and (4) a description of the site including a discussion of the nature and extent of the archaeological materials and data. The report should be adequately illustrated as appropriate with maps and photographs. The National Park Service's format for Historic Structures Reports (U.S. Department of the Interior 1985, Technical Supplement: Chapter 5, pp. 12-13) is recommended for presenting this type of information.

Listing of Priority Sites and Programming for Stabilization

Once sufficient information has been gathered on a number of sites, the area should be able to develop a priority list of sites to be stabilized. The listing should consist of three categories: sites that require emergency treatment, sites that are in urgent need of stabilization, and sites that are in need of stabilization but at which the work can be put off indefinitely. Sites within each category should be logically grouped on a priority basis according to their significance (scientific or interpretive value), types of stabilization work required, and costs. This listing will thus represent the order of sites to be stabilized. The sites should be stabilized beginning with the emergency category and working downward. Sites that are in critical need should be immediately stabilized and then programmed for further stabilization depending upon their other stabilization needs. Sites in urgent need should be stabilized according to their listing. Sites that are not immediately stabilized should be continuously monitored to insure that

their condition does not worsen. If a substantial amount of time is allowed to elapse between when a site was assessed and when stabilization can be feasibly implemented, it would be prudent to reassess the site to update its condition, stabilization needs, and costs. This situation is most critical for sites that have been placed in the low priority category. It should be kept in mind that these listings are dynamic and will require constant updating as stabilization is completed, maintenance needs are identified, and as new sites are located within the area.

Project Implementation Procedures

Project Design

The information that was gathered when the site was assessed should be used to develop the project scope-of-work. In general, a scope-of-work is a prerequisite to beginning a stabilization project since it contains the necessary information concerning what work will be done, how, and with what materials. The scope-of-work can either be drawn directly from the assessment report or from additional information gathered during a prework site visit. The scope-of-work should be sufficient in detail so that the stabilizing personnel will have the necessary information to complete the project from beginning to end. The scope-of-work, at a minimum, should consist of:

1. A description of the stabilization techniques that will be used.

2. A description of the materials that will be used to complete repairs.

3. A description, on a structure-by-structure basis, of the areas where work is to be done, including quantitative measurements as appropriate.

4. A description of the logistical requirements, including the transportation of personnel and equipment as well as any specialized tools or techniques that will be used.

5. A listing of the number of personnel that will be required to complete the work and the necessary experience of these individuals.

6. The requirements for documenting the work that will be completed (e.g., stabilization or maintenance data forms, before and after photographs, project completion report).

7. A description of any archaeological documentation or data recovery needs (e.g., prestabilization architectural data, planview map, photographs, excavation or surface collection).

8. The expected cost for completing the project.

9. A proposed scheduling time frame.

Figure 3

OUTLINE OF STABILIZATION ACTIVITIES

STAGE I. PRESTABILIZATION ACTIVITIES

Step 1. Site Review

a. Assess scope of stabilization work required
b. Investigate and develop logistical needs and requirements

Step 2. Investigation and Development of the Required Stabilization Materials

a. Stabilization Mortar Design (mortar and sediment tests)

1) Collect and test aboriginal mortar samples
2) Locate suitable sediment source
3) Collect and field test sediment samples
4) Develop tentative mortar mix

b. Stone-Masonry tests

1) Examine and/or test for suitability
2) Locate suitable stone (usually from masonry rubble no longer in a structural context)
3) Locate alternative stone source for contingency

Step 3. Site Documentation

a. Prestabilization photographs

1) Photographs taken of general site, site setting and individual structures
2) Photographs from all perspectives of areas affected by stabilization process (before stabilization)

b. Data recording (prestabilization data forms)

1) Structural condition data sheets
2) Archaeological/Architectural data sheets
3) Site Mapping
   a) Planview map
   b) Cross sections

Figure 3 (Cont'd)

STAGE II. STABILIZATION ACTIVITIES

Step 1. Bring in, organize, and set up required stabilization equipment (Logistics)

Step 2. Preparation of stabilization materials

a. Procure and process materials for mortar
   1) Mining
   2) Mixing and kneading

b) Procure stone for masonry
   1) On-site
   2) Alternate source

c. Procure water

Step 3. Job/Structure preparation

a. Assemble equipment

b. Assemble stabilization materials

c. Cleaning
   1) Walls
   2) Joints
   3) Masonry

d) Perform and document necessary collections or excavations

Step 4. Perform required stabilization activities

a. Repointing b. Remudding c. Newlaying d. Relaying e. Resetting

f. Wedging g. Curing h. Texturing i. Selective in-progress photographs

STAGE III. POST-STABILIZATION ACTIVITIES

Step 1. Job/Structure clean up

a. Removal of stabilization equipment

b) Removal of extraneous stabilization materials

Step 2. Post-stabilization documentation

a. Post-stabilization photographs

   1) Photographs, from all perspectives, of areas affected by stabilization process

b. Stabilization activities documentation

   1) Ruins stabilization record forms

   2) Labor and material expenditure sheets

Step 3. Site clean up

a. Removal of stabilization equipment and debris

b. Return site to natural condition

Project Planning

Once the project scope-of-work has been developed, the site proposed for stabilization should be scheduled for stabilization treatment. In general, this consists of determining when the work can feasibly be done and then organizing the equipment, materials, and personnel that will be used to complete the work. Depending upon where the project is being conducted, this should include establishing housing and subsistence for the crew, storage for the equipment, acquiring vehicles to transport both personnel and equipment, and purchasing any customary or specialized materials and equipment. Stabilization equipment that is routinely used includes 3-gallon white plastic buckets, wheelbarrows, 55-gallon water drums, 5-gallon water spray cans, shovels, canvas tarps, burlap sacks, trowels, grouters, whisk brooms, masonry hammers, chisels, ladders, ropes, pulleys, and winching systems. All equipment requirements, however, are dependent upon the types of repairs required and the accessibility of the site.

Project Implementation

The actual stabilization of a site is accomplished by implementing prestabilization, stabilization, and poststabilization procedures. Figure 3 presents a generic step-by-step outline of these procedures. Each is briefly discussed below.

Prestabilization

Prestabilization activities include: (1) an assessment of the scope-of-work, (2) an investigation and development of the logistical needs and requirements necessary to safely implement the project, (3) an investigation into the availability of the required stabilization materials, and (4) the performance of site and structure documentation prior to initiating the stabilization repairs.

Assessment of Required Work. Each area targeted for stabilization should be closely reviewed to assure full comprehension of the required work. It is essential to clearly understand what has caused or is causing the damage and deterioration since these factors generally dictate what techniques and materials will be used. The analysis of appropriate techniques and materials should have been made as a result of the stabilization assessment of the site. However, these factors should be carefully reviewed and modified as necessary prior to undertaking the stabilization. Depending upon the nature of the deterioration, specific preservation specialists should be called in to provide consultation on the damage that is occurring and how best to deal with the situation. For example, a structural engineer can be called upon to determine if there is slope movement that may be undermining a wall, or to determine if there is lateral movement that may result in the collapse of an unbuttressed wall. Soils specialists can be called in to determine appropriate methods and materials that could be used in backfilling, or in the development of the stabilization mortar design. An archaeologist can be called upon to deal with specific problems relating to the documentation or recovery of archaeological data and materials.

A variety of causes or agents can be responsible for the deterioration at the site. Most of these can be ascribed to natural or human-induced causes, or to inherent construction flaws as a result of the materials and techniques employed by the original builders. In many cases, removal of the agent(s) of deterioration is sufficient to bring the site to a state of relative stability. In other cases, repair of the structural fabric is necessary to prevent further damage.

During this review it is critical to evaluate the materials that have been selected to complete the stabilization. It is essential to know the availability and nature of the local materials that will be used and how well these materials will interact with any specialized materials that are proposed for use. For example, are the sediments to be used in the mortar repair in ample supply? Do they contain soluble salts? Will they adequately match the color and texture of the original mortar? Can they be satisfactorily used with acrylics or cements? If necessary, specialized tests should be conducted on any and all materials that are proposed for use to insure that they will be effective and not detrimental to the original remains.

Logistical Requirements. The logistical requirements at the site should be investigated to identify the difficulties involved in transporting personnel, equipment, and materials to a particular work location. The investigation should result in (1) the development of mechanical aids and safety devices that will insure the safest and most effective means of completing the stabilization, and (2) developing the most effective means of creating the least impact upon the site's surrounding terrain.

Stabilization Material Procurement.

Stabilization mortar: Development and procurement of the stabilization mortar should involve cursory analysis of the original mortars followed by investigations into sediment sources that possess properties comparable to the original. The mortars used in the stabilization process should match, to the extent possible, the original mortars that are in existence. Every attempt should be made to accomplish this goal. Depending upon the location of the site, sediment sources within the immediate vicinity should be utilized, since there is a greater chance that they will match the original, and in all likelihood they are near the sources that were used by the original builders. There will, however, be instances where mixing from a variety of sources away from the site will be required to come up with an acceptable mortar match. This situation may be necessary if there are no sediment sources in the immediate vicinity of the site that are an acceptable match, or where use of the sediment source would cause unacceptable impacts. Matching the original mortars is critical for both aesthetic purposes and to insure adequate structural compatibility between the old and new mortars.

According to soil studies conducted by Fenn and Chambers (1978) within 13 National Park Service areas, the optimum soil mortar should be a sandy loam texture and contain roughly 60% to 70% sand, 20% to 25% clay, and 0% to 10% silt. According to Fenn and Chambers (1978:6) any mortars that are used should be low in silt content, since silt is of

intermediate particle size and provides neither good binding, as does clay, nor good strength, as does sand. This rule of thumb, however, is not always possible to follow. For example, in areas such as Canyonlands, Natural Bridges, and Glen Canyon, most original mortars as well as sediment sources contain high silt contents because of their geologic setting. Although the original mortars and sediments can be categorized as sandy loams, the composition differs drastically from the ideal. While it is desirable to insure that the most durable mortars are used in the stabilization process, the actual materials used should be dictated by the composition of the original mortar. Of course, certain allowances can be made for matching original mortars that are extremely friable and that would undoubtedly fail.

To determine the most appropriate stabilization mortar, cursory tests should be performed on the original mortar types present throughout the site. Samples of the mortar types that are present should be collected and color-coded against a Munsell color chart and then tested to determine sand, silt, and clay content and inclusions. Tests for texture should consist of cursory settlement test using a soil texture analysis unit and by touch and "spit-and-roll" tests. Subsequent to the analysis of the original mortars, local sediment sources should be investigated to find sediments that will match the original and that will be sufficient in quantity to perform the required stabilization. In addition to performing the same tests used on the original mortars, "test patties" should be made from the proposed sediments to allow a visual inspection of their color and durability in comparison to the original. To verify the color and textural compatibility of the original mortar with the proposed stabilization mortar, samples of both should be collected and submitted for laboratory analysis. In addition to establishing a working knowledge of the texture and particle size assemblage of these samples, the analysis should provide insight as to the presence of any undesirable elements, such as soluble salt, that could be detrimental to durability of the mortars.

Once preliminary stabilization mortar sources have been identified and confirmed, test patties should be made with a proposed mortar amendment to insure that the two materials will adequately interact with each other. There are a variety of mortar amendments that are currently being used and that show great promise. They include: Rhoplex E-330 and MC-76, Daraweld-C, Acryl 60, Union Carbide R-20, and Soil Seal. Based on studies initiated by Dennis Fenn in Chaco Canyon (Fenn and Deck 1978), Rhoplex E-330 has been the most commonly used mortar amendment. It has been used extensively in the National Park Service Southwest and Rocky Mountain Regions since 1978. For the most part, Rhoplex has performed satisfactorily where it has been used. Results after 10 years of testing in Chaco Canyon have shown that Rhoplex is still an effective mortar amendment (Dennis Fenn, personal communication 1987). In addition, short-term studies conducted by the New Mexico State Monuments has also confirmed the effectiveness of Rhoplex (Taylor 1986).

In general, Rhoplex is considered to be an effective mortar amendment because: (1) it does not change the color and texture of the stabilizing mortar so it blends in well with the original mortar, (2) its capillary potential exceeds that of most stone, which prevents forcing

inordinate amounts of moisture through adjacent stones, (3) its compressive strength is lower than that of most stone and, under stress loading, it will erode before the stone, and (4) it can be removed without damage to the original fabric. Rhoplex is produced by the Rohm and Haas Co., an industrial chemical supplier with offices throughout the U.S. Rhoplex is an acrylic resin emulsion that is liquid and looks like milk. Depending upon the site location and the particular structural problems in evidence, it should be used in dilution ranging from one part Rhoplex to 4 to 2-1/2 parts water by volume.

As noted above, other mortar amendments have been used and are currently being tested. Until long-term studies can determine the effectiveness of these materials, they should be used judiciously and with input from specialists who are knowledgable about their use and application.

Portland cements, including masonry cements, were the primary mortars used to make stabilization repairs up until the mid-1970s. Their use was substantially decreased and in many cases completely eliminated because of both visual and structural incompatibilities. There had always been a problem in getting Portland cements to look like an original mud mortar and often, if the cement was not mixed with a soil aggregate, it would fade to various shades of pink and purple. Portland cements were also found to be responsible for the destruction of adjacent original structural fabric. Because of its durability, it was found to be shedding off moisture onto the original fabric, thus inducing and accelerating its erosion. The only circumstances under which Portland cement should be used in stabilization are if there are no other materials that will effectively provide structural stability, or if it is the only material that is currently remaining in a site or structure, and if visitor safety is of concern.

Under no circumstances should original mortar chunks be considered for use as stabilization mortar. This caveat is based in part on the fact that it is very difficult to get reconstituted mortars to match the intact original fabric because of the type and amount of inclusions used originally. Because of the variability within each random mortar chunk, the ability to control the overall color and appearance of the reconstituted stabilization mortar, on a structure-by-structure basis, is significantly handicapped. The reconstituted mortar usually looks drastically different than the original. In addition, it has recently been found that original mortar has archaeological value. In general, original mortar can be used to determine seasonality of construction through pollen analysis. There may also be potential for it to be used for chronometric dating through thermoluminescence analysis.

Stone masonry: Sources for stone masonry should be investigated to insure that adequate and compatible supplies are available for the required repairs. Potential sources can include reusable stone from within the structure that is being worked on, as long as an archaeological context no longer exists. Alternate off-site sources can be used if on-site sources have been exhausted. All stone that is chosen for use is required to have the potential for being modified to make it aesthetically compatible with the area that is being repaired. It is also required

to meet certain durability standards. In many instances, the original masons used both consolidated and deteriorated stone in their construction. Unfortunately, poor quality masonry is a primary stimulus for the displacement of the structural fabric. While little can be done in terms of the original placement, all stabilization repairs should be completed with more durable types, and an attempt should be made to replace the poorer quality stone when possible. Tests to determine stone quality should consist of a visual examination and quantitative rubbing and fingernail tests. Obvious signs of poor quality stone include friability of the stone with a crumbly and exfoliated exterior.

Water: A pedestrian survey should be conducted to locate a suitable water source that is in sufficient supply to satisfy the stabilization needs. In-field tests for purity should be conducted to insure that the water is potable and not contaminated with carbonates which, for example, can cause efflorescence and staining of the exterior facets of the masonry and mortar. This situation can ultimately lead to chemical and mechanical breakdown of the structural fabric and eventually structural collapse. A general rule of thumb is that if the water is free of organic debris and does not have an unpleasant smell it is probably acceptable. If the water does appear to be contaminated, consideration should be given to importing water from domestic sources.

Vegetal material: Sources of vegetal material should be investigated to insure that there is an ample supply and that the exact species are located. Potential sources can include reusable materials from within a structure that is being worked on as long as an archaeological context no longer exists. Off-site sources can also be used, providing the species are identical to the original materials.

Prestabilization Documentation. Prestabilization documentation is a critical component to the stabilization process. Because of the destructive nature of stabilization, the collection and preservation of archaeological data prior to the commencement of the stabilization is a mandatory requirement. Unless the site has been previously excavated or a stabilization assessment has been performed, the site should be accurately mapped and photographed and the architecture and other visible features completely documented. The prestabilization documentation of the site should be used to enhance the existing archaeological data for the site, particularly in the areas where specific stabilization repairs will be made.

Prior to the conduct of the stabilization work, structural condition forms should be completed on individual structures and walls to determine the extent of structural deterioration and to identify the causes. Information compiled on these forms includes the types of impacts, areas of deterioration, and rates of deterioration. This information is useful for identifying trends of deterioration.

Since the stabilization process tends to adversely affect archaeological remains, whether intact or deteriorated, forms of data recovery are essential to preserve information with the potential for contributing to the local or regional archaeological resource base. Specific forms should be used to record the architectural attributes of the structural

remains. Information compiled on these forms should include descriptions of wall construction attributes and the recordation of features such as entryways, niches, and roofing.

All structures that are targeted for repair should be photographically documented with particular emphasis on the areas to be affected by the stabilization process. Photographs should also be taken of specific architectural details such as entryways and other relevant features. In addition, archaeological remains such as rock art, work areas, plazas, and exposed cultural deposits should be photographed. Overall photographs and general photographs of the environmental setting of the site should also be taken.

Site mapping should depict structure locations and orientation and the general site layout as it exists at the time of recordation. The site should be mapped using the transit/stadia controlling point method. Information compiled on the maps, in addition to the above, should include all observable artifactual material.

All areas or structures that are subject to subsurface disturbance during the stabilization process should be excavated prior to stabilization using standard professional archaeological methods. Surface artifacts and other features, such as rock art or intact cultural deposits, should be completely documented in the event of loss or disturbance during stabilization.

Stabilization

Stabilization activities include: (1) the organization and set up of the required stabilization equipment; (2) the preparation of the stabilization materials; (3) the preparation of the work area for stabilization; and (4) the performance of the specific stabilization activities.

Equipment Organization and Set Up. All equipment required to complete the required stabilization repairs should be assembled at the site and readied for distribution and set up at the appropriate work location. Access routes should be marked to reduce random trampling of the environment.

Preparation of Stabilization Materials. The preparation of the stabilization mortar includes: (1) mining the sediment from the source location, (2) transporting the processed sediment to the mortar processing area, depending upon the mine location, and (3) mixing the sediment to make the stabilization mortar.

The sediment to be used as the stabilizing mortar should be mined with shovels and shifted and screened through 1/4-inch wire mesh screen to remove unwanted items such as rocks and twigs or other organic debris. If the sediment is being processed in bulk, it should be stored on tarps and covered to protect it from getting wet. If the sediment is wet, it should be allowed to dry out before it is mixed. This is extremely important if mortar amendments are going to be used, since wet sediment will have an adverse effect on the amendment to water ratios.

The sediment source location can serve as a mortar processing area. However, if the source is located too far from the site, a processing area should be set up near the structures that are being stabilized.

All stabilizing sediment should be mixed with water and kneaded, combining the solid and liquid into one fluid mass ready for application. The stabilization mortar itself should be of bread dough consistency; i.e., workable but not very wet. This consistency makes the application process easier, plus it reduces the likelihood that shrinkage cracks will occur because the mortar was excessively wet.

The amended mortar should be mixed according to established application procedures. In instances where Rhoplex is used, it should be premixed in the stabilization water before batching with the stabilization sediment. This mixture should not be allowed to sit for longer than two hours, otherwise it will have to be thrown away. Careful control over the amended mortar is necessary to insure that any dry or hardened mortar is applied to the walls or joints, as it becomes ineffective as a mortar at this point. For this reason small batches of mortar should be used.

All stone material should be assembled at the work location prior to beginning the repairs. This speeds up the repair process and cuts down on the time that is spent trying to find the right materials. As necessary to insure that newly repaired areas will match the original, the masonry should be appropriately shaped or dressed. Where possible, stone should be used from within or near the structure being worked on. As noted above, stone should not be "robbed" from other structures, particularly if such stones are in situ. If necessary, stone can be quarried from an off-site source. Chinking stones usually can be found in ample supply throughout the site or from the debris resulting from any stone shaping.

The vegetal material, like the masonry, should be assembled at the work location prior to beginning the repairs. Generally, dead material is preferable to fresh or green material since it has already been cured or dried out. Rotting or molded material should never be used. No materials that are to be used should exhibit evidence of having been cut or trimmed using modern implements.

All water should be stored in an accessible location and transported to the work area in buckets or 5-gallon containers. Ample water should be available at the work location to perform the necessary repairs and for use in curing.

Preparation of the Work Area. Before repairs are made, all structural surfaces should be cleaned of dirt and debris, and all loose or out of place stone, mortar or vegetal fragments should be removed until a firm clean surface is established. If a footing is required, loose dirt and soft cultural fill should be removed until a firm, relatively compact surface is encountered. Whenever possible, repairs should be made without reorientation or moving individual structural components. In these instances, the original materials should be reset into position. This should only be done, however, if structural stability is not compromised.

archaeological material encountered during this process should lected or carefully excavated, bagged, and labeled according to cal and horizontal provenience, and removed from the site for lab- cataloging and analysis.

tine Stabilization Techniques. There are essentially six stabi- techniques that are routinely used to stabilize deteriorating es that are built with stone, mortar, and vegetal material. They of repointing, newlaying, relaying, resetting, wedging, and re- All repairs that are completed using these techniques should be a manner that blends in with or replicates the adjacent original For example, a fragmented wall end should appear as an irregular of stone. Entryways with missing sections of masonry along the ould not be reconstructed, but should continue to appear in their orm. Eroded joints should be filled only to a point that satis- e requirement of structural stability, or to match the finished nce of the adjacent intact fabric. The following presents a on on the procedures used to implement the various stabilization es.

pinting procedures: Repointing involves the repair of deterio- tar where cracking, separation, or loss of mortar has resulted ed support for the overlying walls. Repointing procedures f the following: (1) joints are dampened with water so that the ng masonry and/or mortar do not draw excessive moisture from the ng mortar, causing it to dry out or crack; (2) mortar is tightly to the joint, being careful to fill all voids; and (3) damp, ls are added when joints are greater than 4 cm wide to reduce e of necessary mortar. True and leveler spalls are also added ssary to match the existing aboriginal fabric.

aying, relaying, and resetting on wet-laid walls: These stabi- tasks are used to correct problem areas caused by masonry loss, , and displacement. The general procedure for newlaying, relay- resetting stone on wet-laid walls consists of the following: ble, textured surface is prepared for the stone; (2) the area is with water and a bed of mortar is applied; and (3) the stone is and set on the mortar bed. The best results are achieved by the stone lightly on the mortar bed with approximately 2 cm of rior facet extending outward from the wall, then gently sliding into the wall, placing it flush with the surrounding facets. leveler spalls are used to reduce the volume of mortar and level . False spalls are added when necessary to match the existing abric.

ewly added mortar should be textured by tooling with a grouter d after an initial set up period to create a rough, natural . Care should be taken to avoid smoothing or over-texturing . After the mortar has reached a completely dry stage, it final textured by brushing with a whisk broom to take away the ilized look and create and old, weathered appearance. Mortar hould never be textured by dimpling the surface with the end of oom.

All newlaid, relaid, and reset areas should be covered with wet burlap and tarps, when necessary, to slow the curing rate of the mortar. The wall should be covered for a period of 24-36 hours and kept from exposure to extreme heat.

Newlaying and resetting on dry-laid and dry-laid/mudded walls: These tasks involve dry-laid stonework repairs to areas weakened by masonry loss and/or displacement of stone. The procedures for completing these tasks are as follows: (1) a clean surface is exposed to provide a solid contact area for the stone; (2) the stone is placed within the void, flush with the adjacent wall surface; and (3) the stone is tapped into place or wedged with leveler spalls to secure it. The maximum amount of stability is achieved by minimizing joint size and by overlapping stones.

Wedging stone within dry-laid and dry-laid/mudded walls: The general procedure for this task involves checking the existing wall stones for any looseness. If movement is noted, the stone is tightened or wedged into place by (1) gently tapping the stone back into the wall so it achieves a more complete contact with the surrounding stones, and (2) adding leveler spalls or chunks as wedges to help lock the wall stones in place.

Remudding non-masonry walls or surfaces: This procedure involves the repair of deteriorated mortar along non-masonry surfaces such as roof closing material or jacal walls. Deteriorated mortar and any other loose debris should be removed and a clean, solid surface exposed to which the stabilization mortar can adhere. The surface should be dampened and the stabilization mortar applied, making sure it adheres to the surrounding surfaces. The stabilization mortar should then be smoothed over the adjacent original mortar to help blend in and insure bonding.

Specialized Stabilization Techniques. There are a variety of specialized stabilization techniques that are not routinely used, but that can be used under specialized circumstances. They include backfilling, wood preservation, stone preservation, water control, and structural reinforcement. The following presents a brief discussion on each of these techniques.

Backfilling/adding rubble: Backfilling involves the addition of sterile sediments and/or stone to provide support and protection to structural fabric and archaeological remains. Backfilling along wall bases should be used to equalize differential fill levels within a structure, to provide supporting fill, and to protect wall bases and foundations. The addition of backfill sediments and stones also enables the development of drainage contouring without disturbing the existing fill, or in the absence of enough soil depth, to successfully channel water runoff. Backfill sediments should also be added over exposed archaeological deposits to protect them from the impacts of exposure and foot traffic. Stones can be used in this process to reduce the amount of sediment needed and to brace the fill and provide additional support. When stones are used, they should be added in a manner so as to simulate rubble or naturally occurring stones. Backfilling can also be used to completely "bury" a site or structure protecting it in toto from the

effects of natural or human-induced impacts. Backfilling sediments should be of a sandy loam texture to allow adequate moisture percolation through the soil stratum. Sediments with a high clay or silt content should not be used, as both particles tend to hold moisture or serve as moisture barriers. Sediments with a high sand content can be used but effort will have to be made to keep the sediment from being blown away or moved around by foot traffic.

Wood preservation: A nonstaining wood preservative should be applied to wood members exposed to weathering impacts. The purpose of the preservative is to prevent deterioration of the wood due to moisture contact and burrowing insects. The preservation of the wood members is critical in wall footings and in primary supports of roof superstructures, especially when found in exposed locations.

The most preferred wood preservative consists of a combination of linseed oil, paraffin wax, and mineral spirits. There are, however, a number of commercially available preservatives that can be used.

Wood gluing is another method of wood preservation. Generally it consists of regluing broken or cracked wood members, or consolidating deteriorated or rotting members. It is an approach preferred over beam replacement, since the original wood member is retained. Both carpenter wood glues and epoxies can be used. Conservation Services, in Kinnelon, New Jersey, currently produces the widest variety of epoxies that have been proven successful for gluing and repairing deteriorated beams in prehistoric sites in the southwestern U.S.

Stone preservation: Stone preservation usually involves impregnating deteriorating stone with methyl methacrylates or ethyl silicates to essentially replace the natural cementing stones in stone such as sandstone. These chemicals usually serve as a water repellent or simply as a stone consolidant. This type of treatment has not received much attention or use in stabilization. Consequently, very little is known about how the chemicals react to masonry in prehistoric archaeological sites that are in harsh environments and that are being severely impacted by a variety of agents. ProSoCo Inc., in Kansas City, Kansas currently produces a variety of stone consolidants that might have good potential for stabilization. Since deteriorating stone is a major contributor to deteriorating structural fabric, this practice should be more thoroughly investigated.

Water control: It is important that the stabilization process fully consider ways for deterring or eliminating the movement of water through a site or structure; it is a major cause of structural deterioration. A new technique in the Southwest, which is also currently being used by preservation specialists with the Australian National Parks and Wildlife Service, is the application of silicone rubber caulking above sites being impacted by water runoff (Hughes and Watchman 1983). This practice is based on the idea of interrupting and redirecting the natural flow of water into an alcove or rockshelter. By applying a silicone bead to the lip or rim of the alcove opening, an artificial dripline can be created at the front of the alcove, diverting water that would normally run down the alcove back or drip from the alcove roof to the alcove opening. As a

result, water runoff impacts to any cultural remains within the alcove would be eliminated. This system is currently being used in Hovenweep National Monument, Natural Bridges National Monument, Canyonlands National Monument, and Mesa Verde National Park.

Drainage modification itself is not a new idea in the Southwest; retaining walls, drainage channels cut into the bedrock, and copper "lips" set into cliff faces above sites have been used extensively. These techniques are effective but tend to be somewhat obtrusive and permanently alter the site environment.

Drainage systems are another method for dealing with water runoff. Fifty-five gallon drums have been set in the floors of structures as a catchment basin, and actual "plumbing" pipe has been used as a method for drainage water away from wall bases. A drainage pipe system is currently in use at Aztec National Monument.

Ramadas and site covers are another method for dealing with water runoff as well as all other weathering elements. These type of features are being effectively used at Casa Grande National Monument, a number of sites in Mesa Verde, and at Anasazi State Park in southeastern Utah.

Vegetation and animal control: Methods for dealing with damage caused by vegetation and animals, such as rodents, birds, bats, and insects, involves removal and eradication. In terms of vegetation, this involves cutting down or cutting back vegetation that has a potential for causing above ground or subsurface damage to the architectural remains. Grasses and small shrubs should be encouraged to grow since they provide stability to surface deposits. Large shrubs and trees, however, should be cut off at the ground surface. The roots should only be extracted if the process does not disturb the surrounding fill or cause damage to subsurface architectural features.

Methods for dealing with animals is somewhat problematic. Insects can be effectively dealt with, at least in terms of wood members, by the application of a wood preservative. Methods for dealing with insect damage to mortar and with rodent, bat, and bird damage to the various other aspects of the site are yet to be developed. Biodegradable pesticides probably would be effective, but the effects may be short-lived and the ecological implications will have to be dealt with. Removal is another possible solution, but it usually results in the creation of a void that is readily filled by neighboring animals. This practice may be beneficial on a short-term basis, however. One other possible solution includes the introduction of predator species. For example, a bull snake could be brought into the site to deal with the rodent problem without upsetting the ecological balance of the site too dramatically.

Structural reinforcement: Structural reinforcing materials include metal reinforcing bars, wire clips and hooks, and wire mesh. These materials have been used for integral structural support or as bracing for all types of wall construction and in roofs. Generally, they are used to provide lateral support to multistoried walls that are unbuttressed and within or alongside roof beams that have been broken or are weakened from excessive weight. The use of these materials is not highly

encouraged since they have a tendency to rust, causing material deterioration. They can and should be used if no other means of providing structural stability is possible. If these materials are used, they should be incorporated in the structural fabric and effectively hidden from view. In addition, stainless steel should be used, or the metal should be coated with a rust-proofing agent.

Plywood and other milled lumber can also be used to enhance structural stability. For example, 2 x 4s and 2 x 6s can be used as temporary braces to support collapsed or leaning walls. Plywood can be used to protect an original roof that is being severely impacted by natural or human-induced degradation. Like the metal reinforcing materials, wood materials can and should be used, but only if no other means of providing structural stability are possible.

Other Related Stabilization Techniques. Other techniques that can be used to indirectly insure the preservation of a site include: (1) closing a site to visitor use; (2) camouflaging a site to prevent detection visitors; (3) increasing the presence of an authoritative figure; (4) using an authoritative figure to monitor visitor movement within a site; (5) implementing visitor education programs to increase the visitor's awareness of the significance and fragility of the site; (6) installing signs to enhance the visitor's awareness of the site; and (7) installing barriers to inhibit visitor movement within a site. Although these activities are not a specific responsibility of the stabilization work, they are an integral component of the overall process of insuring the continued stabilization and preservation of a site.

Post-Stabilization

Post-stabilization activities include: (1) the clean up of the areas where repairs have taken place; (2) the documentation of the completed stabilization work; and (3) the return of the site to a natural, undisturbed condition.

Structure Clean Up. Following the completion of the stabilization activities for a particular area, all loose or broken stone mortar, vegetal material, tools, and other extraneous materials should be removed. The area should then be returned to a prestabilization appearance as much as possible.

Stabilization Documentation. Both written and photographic documentation should be completed on all areas where repairs were conducted. Stabilization data sheets should be completed to document the stabilization activities performed and to record the man-hours spent and the quantity of materials used. Photographs should also be taken to serve as a visual record of the completed stabilization activities.

Site Clean Up. All equipment, tools, and all items associated with the stabilization should be removed, and all work scars and wear areas should be eradicated. All residual waste generated should be removed and properly disposed. Finally, all evidence of the stabilization activities should be obliterated and the site returned to a prestabilization appearance as much as is possible.

Project Documentation

A detailed report of the stabilization should be completed immediately following the project. The report is very important, as it documents any alterations of the original fabric at the site and serves as the mitigating measure for any stabilization impacts to the site. It is also important that the report be a complete and detailed document. A few photographs and a simple set of forms that very generally describes the work done is not an adequate stabilization report. The report should be prepared in a format reflecting contemporary organization and illustrative standards of professional archaeological journals, and should be suitable for publication.

The stabilization report should contain the following information as a minimum requirement for documentation of the work. Additional sections may be required depending upon the scope of the stabilization project.

1. An introduction describing the project, personnel involved, time frame, and any special problems encountered.

2. A description of the project background, including any previous stabilization or other related activities at the site.

3. A brief description or reference to the site's environmental and cultural setting.

4. A description of any archaeological documentation or data recovery such as excavations or artifact collections.

5. A description of the methods and approaches used for the stabilization.

6. A description of the materials used for the stabilization.

7. A structure-by-structure description of the stabilization that was completed.

8. A summary of the project for management use.

9. A bibliography of the references that were consulted.

10. A series of appendices that include:

    a. Forms documenting the condition of the site.

    b. Forms documenting the standing architecture.

    c. Forms documenting the work performed on a structure-by-structure basis, including at a minimum one before and after photograph of each area stabilized.

d. A planview map or other appropriate maps of the site showing the location of the structures that were stabilized and other relevant features such as the location of sediment sources, etc.

Determination of the Maintenance Requirements

Following the performance of the primary stabilization, a maintenance document should be prepared for the site. This document should be prepared by the same person responsible for the primary stabilization. The National Park Service's format for Historic Structures Preservation Guides (U.S. Department of the Interior 1985; Technical Supplement, Chapter 5, pp. 8-11) is recommended for presenting this type of information. Preparation of the maintenance document and implementation of the recommendations is a very important but often overlooked step in the stabilization process. Regular monitoring and inspection followed by the maintenance of any problems observed is necessary to keep the site in a stable condition and will save considerable expenditures for stabilization in the future.

The recommendations and requirements in the maintenance document should define and guide the maintenance activities and determine the appropriate schedule for the specific activities. The specific activities that should be discussed include (1) site monitoring and routine housekeeping, (2) cyclical maintenance, and (3) annual maintenance. Site monitoring and routine housekeeping is concerned with the regular inspection of the site to identify potential stabilization needs and the performance of low-level activities designed to provide minimum upkeep. Cyclical maintenance is concerned with the performance of repairs to areas that have been identified through the monitoring process as requiring full stabilization treatment. Annual maintenance is concerned with the performance of full stabilization treatment to areas that are known to require repair on a regular basis and within a given time period. The maintenance document essentially serves to (1) identify the specific areas that should be monitored to insure that no new damage is occurring; (2) determine how often the monitoring should occur; (3) discuss what housekeeping activities can be performed to keep the site in a relatively stable condition, and (4) discuss what type of annual maintenance should be performed and where the repairs should be completed. The maintenance document should also discuss what personnel should be used to monitor the site and perform the annual maintenance, as well as the costs that will be involved.

The maintenance document should also result in the development of a monitoring site packet that can be taken into the field by the maintenance personnel. The site monitoring packet consists of a summary of all stabilization activities that have been conducted at the site. This includes a brief summary of the primary stabilization work that was conducted to place the site in a structurally sound condition, summaries of previous monitoring and maintenance activities that have taken place, and the most current recommendations for insuring the continued stabilization of the site.

Implementation of the Maintenance Requirements

There are essentially three aspects to insuring the continued preservation of stabilized sites: (1) monitoring and routine housekeeping; (2) annual maintenance; and (3) cyclical maintenance. Ideally, the monitoring and annual maintenance program should be conducted biannually. Inspection and repair programs should be conducted following the periods of greatest impacts: in the spring after the season of winter precipitation and in the fall after the season of greatest visitation. The cyclical maintenance program should be implemented whenever the condition of a structure deteriorates to a state where structural stability is threatened.

Monitoring and Routine Housekeeping

The monitoring program should be tailored toward the documentation of the condition of the standing architecture with an emphasis on the causes and areas of deterioration and the inspection of the areas where stabilization has taken place. Specifically, the monitoring of a site should inspect the foundations, mortar joints, wall, stone, and wood members. The inspection should look for: (1) signs of general erosion and deterioration, (2) loose or displaced fabric, (3) structural strain or failure, (4) damage from insect and rodent activity, (5) obtrusive vegetation, and (6) damage resulting from visitation. Specific areas include:

1. Masonry: inspecting all mortared joints, top courses, midsections, and basal foundations for eroding or missing mortar. The stone masonry should be inspected for signs of deterioration or displacement that might cause or contribute to structural stability.

2. Wood members: inspecting all wood members in roofs, doorways, and walls for signs of damage, strain, or failure.

3. Midden and intact cultural deposits: inspecting remains to identify loose or damaged sections and areas of impact.

4. Surrounding fill and interior floor areas: inspecting for evidence of water channeling, rodent burrowing, pothunting, or displacement of sediments which might have an undermining effect on the architecture.

5. Rock art: inspecting for graffiti.

Monitoring personnel do not necessarily need to be stabilization personnel, although some familiarity with stabilization terminology would be helpful. The equipment stabilization terminology would be helpful. The equipment necessary to conduct the monitoring of a site includes: pen or pencil, clipboard, camera with wide angle lens, and a monitoring packet for the site, and blank monitoring forms. Specific data that should be recorded by the monitoring personnel include changes in the site condition, types and areas of deterioration, and recommendations for future monitoring or maintenance. In addition to filling out forms in

the field, photographs of the site should also be taken to help document any deterioration that has occurred. The planview map should also be used to plot locations of deterioration.

In addition to inspecting the site, limited maintenance activities can be performed by the monitoring personnel. These include such activities as adding backfill sediment to exposed archaeological deposits or wall bases, wedging stone on a dry-laid wall, placing splash stones to deflect a water pouroff, removing vegetation, or removing graffiti. Certain caution should be exercised in the performance of such activities to insure that they do not result in any modifications to the existing site features. If there is any doubt concerning what is or is not an appropriate housekeeping activity, it is best that it not be performed.

All housekeeping activities should be documented as to the activity performed, where it was performed, how long it took, and the quantity of materials that were used. All housekeeping activities should also be documented with photographs.

The monitoring and housekeeping activities themselves should be documented in a short narrative report. This should include a description of what was done and any recommendations there might be for any future monitoring activities, or any requirements for annual or cyclical maintenance repairs. This short report should serve as an addendum to the maintenance document for the site. The monitoring site packet should also be updated to reflect this particular monitoring episode.

Cyclical and Annual Maintenance

The regular monitoring and housekeeping of a stabilized site through time should result in the development of recommendations for cyclical maintenance or to upgrade or modify the annual maintenance requirements. In general, the repairs recommended should be those that could not be performed by the monitoring personnel because the work would result in the alteration of the existing site architecture. The monitoring recommendations should essentially request that the site be programmed for maintenance treatment, or that a trained stabilization specialist evaluate the site to determine the exact stabilization needs.

Cyclical and annual maintenance activities, like the primary stabilization, may alter the original fabric of the site. As a result, all work conducted should consistently follow the guidelines that were followed when the site was initially stabilized. All work completed should "once again" place the site in a structurally sound condition. The work should be adequately documented through before and after photographs, maintenance forms, and a maintenance report. Following the completion of this work, the site should again be scheduled for monitoring and maintenance treatment.

Personnel Qualifications

All personnel that are used in the stabilization process should have specialized knowledge and expertise in stabilization and historic preservation and should have experience and academic credentials in archaeology or architectural history.

All supervisory personnel, at the project director or field supervisor level, should have a college graduate degree, or an undergraduate degree and an equivalent amount of archaeological or historic architectural experience, plus a minimum of two years of full-time professional experience in stabilization. Supervisory personnel should be able to demonstrate their ability to plan and conduct a stabilization project through to completion and to prepare a written report.

Crew supervisory personnel should have an undergraduate degree in archaeology or architectural history and have a minimum of one year of full-time experience in stabilization.

Crew members should have an undergraduate degree in archaeology or architectural history or an equivalent amount of experience in archaeology or architectural history.

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