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EARTHWORKS MANAGEMENT MANUAL



Prepared for the
National Park Service
Mid-Atlantic Regional Office
Philadelphia PA

16 December 1986

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By
Andropogon Associates, Ltd.
Ecological Planning & Design
Philadelphia PA

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Project Title: Management Program for the Stabilization and Restoration of Richmond National Battlefield Park, Cold Harbor Unit, and Petersburg National Battelfield Park, Fort Fisher Area; NPS Contract No. MARO-5-53
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A. EXECUTIVE SUMMARY

Today, the National Park Service is faced with the accumulated impacts of increased usage of the parks, the gradual urbanization of park environs, and management and interpretation programs that damage rather than preserve the parks. Current budgetary allocations, given current management practices, are inadequate to maintain park areas accessible to the public, and have resulted in deterioration of the resource. Expanding interpretive projects often demand an increase in maintenance, while urgently needed management and restoration elsewhere are deferred.

During the course of this study, particularly during the interviews and site reviews with park personnel, it was consistently observed that current management practices are damaging the earthworks. At present, the preservation of the resource is clearly at stake. And without the resource, what is there to interpret? -- the better the condition of the resource, the richer the interpretive opportunities. The complex needs of an escalating visitorship cannot be appropriately met until these longstanding conflicts are faced and resolved.

This Earthworks Management Manual is intended for use at the Fredericksburg and Spotsylvania County Battlefields Memorial National Military Park, Richmond National Battlefield Park, Petersburg National Battlefield, and Colonial National Historical Park. The primary focus is to develop management strategies and interpretive guidelines which resolve current conflicts between the requirements for preservation and the impacts of interpretation at the earthwork sites. The basic approach is intended to be adaptable for use at other earthwork sites under somewhat different environmental and cultural conditions, and with further limited study. Many of the recommendations will also be applicable to a variety of natural and managed landscapes.

The most fundamental change recommended in current management practices, and one which more closely adheres to the stated National Park Service policy and legislative mandate, is this: Preservation, and *Not* restoration, should be given the highest priority until an acceptable level

of stabilization is achieved. In order to limit further site degradation and disturbance, all expansion of visitor facilities and programs that increase access to a site should be suspended until severely disturbed sites have been restored and deterioration of the resource halted. Similarly, all management practices which significantly increase maintenance demands should be halted until adequate maintenance has been provided for the entire site.

A second major evaluation reached during the site reviews has also had a significant role in shaping the recommendations found in this manual: Earthwork sites stabilized by healthy, native plant communities are in the best condition, while many current management practices have contributed directly to the degradation of the resource. Past management has been directed toward increasing visitor access, but often is not supported by an increase in interpretive facilities, maintenance, or surveillance and monitoring. Similarly, past management has frequently contributed to the degradation of the natural landscape, which in turn diminishes the historical and cultural setting. At the same time, the potential for well-managed native habitats to provide aesthetically satisfying, environmentally sound, low-cost alternatives to current maintenance practices has been underestimated and underutilized.

The recommendations in this manual, which have been developed jointly with the National Park Service, represent a significant departure from past management practices and also integrate recent interpretive trends into future park planning and management. The new practices recommended focus on managing native landscapes, which are both more ecologically sound and more cost effective than current practices. These new practices will lead to an increased variation in environments, which will provide more opportunities for interpretation.

This manual emphasizes the need to rely increasingly on management that favors native vegetation, versus the maintenance of less suitable, although more familiar, horticultural standards, such as turf. This will also require revisions in interpretive expectations and the design of innovative, new facilities. For instance, at present there are no examples of interpretive programs for a forested site. However, the long-range need is clear to create more durable and effective facilities that can accommodate greater numbers of visitors as well as manage the resource.

The manual contains two major sections. The first is a critique of current management practices, which includes the criteria for evaluating current National Park Service management, derived from policy and enabling legislation. The driving force behind the evaluation of current management, attitudes, and procedures is also examined in this section, as well as an assessment of present vegetative cover types. This section concludes with recommendations for an overall management program aimed at integrating preservation and interpretation objectives.

The second major section is the management manual itself, which begins with procedures for evaluating and monitoring a site with respect to the proposed guidelines. Because effective adoption of the program will require a period of transition, initial management guidelines are distinguished from more routine maintenance issues. The major focus is directed toward dealing with the more serious problems, in addition to implementing initial management guidelines. A sequence of demonstration projects are also outlined in this section. These projects are designed to evaluate a wide variety of management practices, including more innovative and less familiar techniques, and would be accompanied by training sessions for park personnel.

Two specific sites, representing a diverse array of typical conditions and problems, are highlighted in this section to illustrate the recommendations: the Fort Fisher Area of the Petersburg National Battlefield, and the Cold Harbor Unit of the Richmond National Battlefield Park.

Manual Background & Acknowledgements

The Earthworks Management Manual project was organized into three distinct phases: preliminary assessment of existing natural and cultural resources; presentation and review of a conceptual framework for future management strategies; and development of management recommendations. As these recommendations are instituted and the NPS staff is trained in their use, it is likely that the site evaluation and monitoring of the work will lead to modifications of recommended practices and to new ideas that will refine these guidelines.

The preliminary assessment was done in the field during March and April 1986. This included taking infra-red and black and white aerial photographs to prepare topographic maps for two specific areas and identify areas of critical archeological importance; interviews with NPS staff from the regional office and the individual parks; and consultation with a range of other experts to help us develop the framework for our recommendations.

The preliminary interviews with NPS staff were done on-site and intended to determine their primary concerns and goals for this project. Those interviewed and sites reviewed included:

MID-ATLANTIC REGIONAL OFFICE
Interviews:

Brook Blades	Archaeologist
John Bond	Associate Regional Director, Cultural Resource Management
Don Castleberry	Deputy Regional Director
James Coleman	Regional Director
John Costello	Management Analysis
Reed Engle	C.O.T.R. & Historic Architect
Fred Eubanks	Planner
Chet Harris	Regional Chief Interpreter
Ted Hillmer	Chief of Operations
John Karish	Regional Chief Scientist
Henry Magaziner	Regional Historic Architect
Jeff Marion	Regional Scientist
Stuart Maule	Regional Natural Resource Manager

Dave Orr	Regional Archaeologist
William Supernaugh	Chief, Division of Resource Management & Visitor Protection

FREDERICKSBURG AND SPOTSYLVANIA COUNTY BATTLEFIELDS MEMORIAL NATIONAL MILITARY PARK

Interviews:

A. Wilson Greene	Staff Historian
Mike Johnson	Chief Ranger
Bob Krick	Chief Historian

Sites Reviewed:

Fredericksburg Battlefield: Lee Hill Exhibit Center; Lee Drive; Pickett Circle; Meade Pyramid; and Hamilton's Crossing

Chancellorsville Battlefield: Chancellorsville Tavern Site and Hooker Road

Wilderness Battlefield: Wilderness Tavern; Wilderness Exhibit Shelter; Hill-Ewell Drive; Chewning Farm; and Jackson Trail West

Spotsylvania Court House Battlefield: Spotsylvania Exhibit Shelter; Grant Drive; Anderson Drive; Bloody Angle Drive; East Angle; and Burnside Drive

Chatham: House & Garden

PETERSBURG NATIONAL BATTLEFIELD

Interviews:

Glenn Clark	Superintendent
John Davis	Chief of Interpretation
Bill Fluharty	Chief, Resource Management & Visitor Protection
Victor Martin	Chief of Maintenance

Sites Reviewed:

Petersburg Battlefield: Battery Five; Petersburg Visitor Center; Fort Friend; Battery Nine; Living History Exhibit; Harrison Creek; Colquitt's Salient; Fort Stedman; Fort Haskell; Fort Morton; and The Crater

Petersburg Auto Tour: Fort Sedgwick; Fort Davis; Fort Hayes; Flank Road; Fort Wadsworth; Poplar Grove National Cemetery; Fort Urmston; Fort Conahey; Fort Fisher; Defense Road; and Fort Walker

RICHMOND NATIONAL BATTLEFIELD PARK

Interviews:

Keith Morgan	Chief of Interpretation & Visitor Services
Sylvester Putnam	Superintendent
Chuck Rafkind	Chief Ranger
Dan Roddy	Park Ranger
Junius Ross	Chief of Maintenance
Dave Shockley	Park Ranger

Sites Reviewed:

Chimborazo Visitor Center

Chickahominy Bluff: Overlook & Path

Cold Harbor Unit: Cold Harbor Exhibit Shelter and Interpretive Auto Road

Fort Harrison Area: Battlefield Park Road; Fort Gilmer; Fort Gregg; Fort Johnson; Fort Harrison Visitor Center; Fort Hoke; Hoke-Brady Road; and Fort Brady

GETTYSBURG NATIONAL MILITARY PARK

Interviews:

Robert Prosperi	Park Historian
Cathy Georg Harrison	Park Historian

When the earthworks were first constructed, much of the remaining fertile portions of the soil were buried or leached away. And given the droughty and acidic nature of the soils in this part of Virginia, the resulting poor growing conditions, combined with unrestricted access, tended to accelerate disturbance. Since restabilization is a complex issue, the following specialists were consulted:

SOILS

Jim Canterbury	Raleigh NC	Soil Conservation Service
Leo Cotnoir	Newark DE	Soils Consultant
John Dondero	Petersburg VA	Soil Conservation Service
Charles Lander	Richmond VA	Soil Conservation Service
Willis Miller	Richmond VA	Soil Conservation Service
Jim Orbannd	Yorktown VA	Agricultural Extension Service
Keith Salvo	Raleigh NC	Soil Conservation Service

Lester Seglin	Williamsburg VA	Soil Conservation Service
Robbin Sotir	Marietta GA	Soil Bioengineering Corporation

GEOTEXTILES

W.C. Burrows	Midlothian VA	Erosion Control Systems
Steven Leonard	Norristown PA	Explo-Tech Inc.
Randy Thomas	Conshohocken PA	Atlantic Construction Fabrics

ARCHAEOLOGY AND INTERPRETATION

Steven Bressler	Shutesbury MA	Monadnock Media
John Cotter	Philadelphia PA	University Museum
Edward Rutch	Newtown NJ	Historic Conservation and Interpretation

ORDNANCE (Civil War shells and explosives)

Major Henry	Dover NJ	U.S. Army, E.O.D. Section

VEGETATION

John Carrish	State College PA	Pennsylvania State University
Miles Johnson	Richmond VA	Virginia Commonwealth University
Gordon King	Amherst MA	Blueberry Grower
F. M. Moobury	Chadds Ford PA	Brandywine Conservancy
William Niering	New London CT	Connecticut State College
Dennis Ryan	Amherst MA	University of Massachusetts
Alfred Schuyler	Philadelphia PA	Academy of Science
John Williams	Tuftonboro NH	Horticultural Consultant
Don Young	Richmond VA	Virginia Commonwealth University

WILDLIFE

Robert Stovall	Philadelphia PA	Fish and Wildlife Service

The initial interviews, site visits, and reviews with consultants helped identify the areas of concern and the impact of current management practices. A framework of recommended strategies and a vocabulary of techniques was then developed to ameliorate the generic types of disturbance identified in the parks. A two-day workshop, for parks and

regional staff, was held in Richmond, Virginia to present the preliminary assessment and the conceptual approach to management of the earthworks. The following is a list of workshop participants:

MID-ATLANTIC REGIONAL OFFICE:

John Bond	Associate Regional Director, Cultural Resources Management
Reed Engle	Historic Architect
Stuart Maule	Regional Natural Resource Manager
David Orr	Regional Archaeologist
William Supernaugh	Chief, Division of Resource Management & Visitor Protection

COLONIAL NATIONAL HISTORICAL PARK:

James Haskett	Assistant Superintendent
R. H. Maeder	Superintendent
Wally Neprash	Assistant Superintendent
Dale Wilking	Facility Manager

FREDERICKSBURG AND SPOTSYLVANIA COUNTY BATTLEFIELDS MEMORIAL NATIONAL MILITARY PARK:

Skip Brooks	Crew Foreman
Pam Griffin	Resource Management Ranger
Mike Johnson	Chief Ranger
Bob Krick	Chief Historian
Jim Zink	Superintendent

PETERSBURG NATIONAL BATTLEFIELD:

Glenn Clark	Superintendent
John Davis	Chief of interpretation
Bill Fluharty	Chief, Resource Management & Visitor Protection
Victor Martin	Chief of Maintenance

RICHMOND NATIONAL BATTLEFIELD PARK:

Keith Morgan	Chief of Interpretation & Visitor Services
Sylvester Putnam	Superintendent
Chuck Rafkind	Chief Ranger
Junius Ross	Chief of Maintenance
Fred Springer Jr.	Maintenance Mechanic

B. CRITIQUE OF EXISTING MANAGEMENT PRACTICES

The Critique's Rationale

Management, whether intensive or minimal, is motivated by a complex set of underlying assumptions and values. Most conflicts occur when critical values are overlooked, or when management for a single purpose overrides other values. With regard to the earthworks, there are varying interpretive goals and a clear mandate to preserve the natural and cultural resources, all of which must be resolved by the management policy.

A critical function of the interviews and the workshop was to develop a working consensus on the goals of management. Once established, these goals became the basis for evaluating current practices and for generating the recommended management program.

A second major focus of this critique was to examine the relationship between policy and implementation. Even when there is agreement on a goal, for example, the actual effects of implementation may be directly contradictory. Current management practices were reviewed and evaluated for their effectiveness over time, including the long-term consequences and costs of management.

This critique is divided into two major sections. The first establishes the goals of management and the second evaluates current management practices from that perspective.

Legislative Mandate

The preservation and interpretation of cultural and natural resources is basic to all federal historic preservation law. The most recent policy statement governing the management of cultural resources is found in the National Park Service's Cultural Resources Management Guide and

Technical Supplement (NPS 28, Release No. 3, August 1985). These documents are a compilation of the body of historic preservation law, which began with the Organic Act of 1916, and serve as the framework for all existing management.

The Organic Act defined the National Park Service's mission as the preservation of the natural and cultural resources for future generations. This was modified by later public laws, executive orders, and amendments, which added the responsibility to interpret these resources as well. This body of legislation also expanded the definition of "resource" to include historic landscapes, as well as physical features and historic structures.

One of the primary ideas included in all of this legislation is the reliance of all valuable park activity on the preservation and management of the resources. The importance of this precept can be most clearly seen in Chapter V, page 2 of NPS 28. All park managers are directed to "locate, identify, evaluate, preserve, manage, and interpret qualified cultural resources in every park in such a way that they may be handed on to future generations unimpaired . . . consistent with the requirements of law, resources managers and professionals at all levels shall take positive action to perpetuate unimpaired the cultural resources of the National Park System; to prevent adverse effects on these resources by development, visitor use, or resource management activities; and to prohibit vandalism or unauthorized excavation, collection, or appropriation of cultural resources."

The legislative mandate for the earthworks is fundamentally about both the preservation and the interpretation of the resource. The original act of the United States Congress establishing the Petersburg National Battlefield, signed in 1926 by Calvin Coolidge, states the Park's purpose: "to commemorate the campaign and siege and defense of Petersburg VA in 1864 and 1865 and to preserve for historical purposes the breastworks, earthworks, walls, or other defenses or shelters . . ." and to provide roads, historic markers, and monuments for the visitor. The Historic Sites Act of 1935 provides for the preservation of historic American sites, and called for an "educational program and services" for the public. This growing awareness that public understanding is integral to the purposes of preservation is especially evident in the National Historic Preservation Act of 1966, which states "(a) that the spirit and direction of the Nation are founded upon and reflected in its historic past; (b) that the historical and cultural foundations of the Nation should be preserved as a living part

of our community life and development in order to give a sense of orientation to the American people; (c) that, in the face of ever-increasing extensions of urban centers, highways, and residential, commercial, and industrial development, the present governmental and non-governmental historic preservation programs and activities are adequate to ensure future generations a genuine opportunity to appreciate and enjoy the rich heritage of our Nation."

Despite the mandate to integrate preservation and interpretation, the situation in the parks today is one of consistent conflict between these values. Use is too often synonymous with abuse, and the interpretive facilities themselves may directly contribute to the deterioration of the resource. These problems are aggravated by the serious impacts of suburban development surrounding the parks, which alter views and may be environmentally damaging. Funding for maintenance has decreased while the need for maintenance has grown. From this dilemma came the impetus for this critique and the development of a Management Manual.

Consensus on Management Objectives

The following describes the overall objectives identified in this process, with regard to the preservation of cultural resources, including both archaeological and historical resources and their integration, and the preservation of natural resources, including stabilization of the earthworks.

Guidelines for Archaeological Preservation

Archaeological concerns regarding management of the earthworks fall into three categories: identification and evaluation of the resource within its context; survey and inventory of individual structures to identify the location and condition of all existing resources; and the coordination of the level of interpretation of a resource appropriate with its value and condition.

Anthropological data is only found in the original fabric of the earthworks. Filled or covered features, like forts or trenches, probably comprise the major portion of the remaining resources of cultural and historical

significance. However, earthworks which have been exposed or weathered should also be treated with care, because they may contain evidence of the original anthropological fabric as well. In fact, many of the most significant earthworks, like Fort Morton in Petersburg, are now totally buried, and unless careful attention is paid to all of the resources, they could easily be destroyed.

The value of an earthwork is dependent on its above-ground condition and the integrity of the archaeological fabric. The more complete and untouched it is, the more important and valuable is the earthwork. The following categories are useful in evaluating the importance of a structure:

Above-Ground Condition	Archaeological Integrity
1. well preserved	excellent condition
2. major restoration	good condition
3. poorly preserved	good condition
4. poorly preserved	poor condition
5. total reconstruction	non-existent

For the most part, an earthwork will fall into one category; however, because records are not always complete or available, categories 2 and 3 may be difficult to define.

If the earthworks can be clearly identified and categorized, an appropriate interpretive scenario can be developed. No interpretive program should endanger an earthwork. Active interpretation, with large groups or hands-on activities, should only occur on earthworks in categories 4 and 5. These have been disturbed so radically that this intense use will not radically alter their condition. Earthworks in the first three categories cannot withstand intense use or interpretation and require significant protection.

The earthworks are a valuable cultural resource and provide an opportunity to learn about military tactics of an earlier time in our history. However, from an archaeological point of view, the berm portions are the least valuable areas. The real richness lies in the trenches, hut sites, and

interiors of the forts, where cultural artifacts are covered by layers of soil. From this perspective, the critical factor for the preservation of the resource lies in the completeness and intactness of the soil layers, or vertical stratigraphy. As the stratigraphy becomes increasingly mixed, the validity of any archaeological findings, resulting from sanctioned digs, becomes more questionable.

Since the turn of the century, the earthworks have undergone intensive restoration, including Civilian Conservation Corps projects of the 1930s. Much of this work focused on removing eroded material from the back of the slopes and placing this material on top of the earthworks, with the goal of reestablishing the historic form. In some cases, these reconstructed versions are indistinguishable from the original ones.

Since accurate records were not always kept, pinpointing which earthworks are real and which are reconstructions is sometimes difficult. In addition, in the process of moving the eroded material, cultural information in the trenches and building sites may have been shifted. Therefore, earthworks where the stratigraphy has been undisturbed by restoration efforts, tree roots, or relic hunters is of major archaeological value.

Until a survey of the authenticity of earthworks is completed, all earthworks, except documented reconstructions, are assumed to be original and of historic value. The National Park Service is currently conducting a cultural resources inventory of existing documentation for the earthwoks, which is expected to be completed in the spring of 1987. Protection of the archaeological resources will require the completion of this comprehensive site-by-site inventory. The inventory will identify and locate critical resources and evaluate authenticity, level of disturbance, and archaeological value of each designated area. Until this inventory is completed, all trenches, in addition to documented sites, such as huts and bomb proofs, are assumed to be important. As more and more of the sites outside National Parks Service jurisdiction are disturbed, all protected sites will increase in value. Soon, the only ones considered archaeologically significant for future exploration are likely to be within park boundaries.

Upon completion of this inventory, specific interpretive strategies and the appropriate level of management and protection for each site can be determined and prioritized. At present, there is no identified need for

archaeological investigation of any sites, so the most critical objective is to preserve the resource with as little disturbance as possible for further research and investigation. All authenticated sites should be protected from any further deterioration, with protective vegetative cover restored.

Some of the sites may be considered appropriate for inclusion in the interpretive programming. As long as more destructive activites, such digging into the soil, can be controlled, there are no major problems associated with foot traffic over the archaeological resource as long as adequate cover is maintained.

The following guidelines are recommended for the protection of archaeological resources:

1. Adequate protective cover should be maintained on all archaeological sites.

2. Presently undisturbed and unforested sites should be maintained in herbaceous or shrub cover to limit potential disturbance of the stratigraphy from the root systems of mature trees.

3. Vigorous enforcement of the law regarding vandalism and active prosecution of offenders should be pursued.

4. No site should be interpreted unless adequate surveillance can be provided.

5. Access should be restricted to repeatedly vandalized sites, which may also require alterations of the interpretive program.

6. Any disturbance to the vertical stratigraphy should be appropriately marked and recorded for future investigators.

Guidelines for Interpretive Programs

The interpretive program addresses two major aspects of the site: the overall and landscape character of each park as well as visitor facilities, such as paths, parking, and signage. The goal at the larger scale is to establish a setting representative of the historic era of each site. Where

site boundaries and conditions permit, it is desirable to restore the accurate historic scene as much as possible. Elsewhere, maintenance of the native habitats and/or the agricultural character typical of the era and region is appropriate.

At the smaller scale, the interpretive program frames the visitor's experience, providing access and educational opportunities. In the past, access was relatively uncontrolled and has led to deterioration of the resource. More recently, interpretive facilities have been designed to provide a more directed visitor journey. The educational focus of interpretation has also evolved over time, expanding beyond the original emphasis on memorialization and battle strategy analysis to embrace a broader understanding of the heritage and history of each era and its lessons for us today. The "living history" programs are typical of these efforts.

The management of an historic site is inseparable from its interpretive program. It determines the look of the landscape and should reveal the story of the place to the visitor. While the management program cannot address all aspects of interpretation, the landscape character and the nature of access are critical components.

The following guidelines focus on the development of appropriate settings and access which minimize the opportunities for disturbance and degradation often caused by interpretation. It is clear that in order to achieve these goals, some reevaluation of the layout and design of current facilities will be required to achieve an effective management program:

1. An authentic landscape setting should be representative of what might have existed during the historic era of the park.

2. A complete restoration of the historic setting at any one site should be undertaken only when funding is available to ensure adequate site stabilization and long-term management.

3. Agricultural management should maintain the landscape character and artifacts of these historic practices.

4. All habitats, whether natural or agricultural, should be maintained in a healthy condition and protected from adverse environmental impacts.

5. The development of disturbance communities, which are typical of degraded environments, should be minimized and controlled.

6. All visitor access to cultural and historic resources should be clearly defined and directed in order to restrict casual use and potential damage to the resource.

7. Access should not be increased or provided at any site without a comprehensive interpretive approach which addresses the needs of resource preservation and long-term management requirements.

8. No access which entails or invites walking upon the earthworks should be permitted on authenticated sites and should be reevaluated for reconstructed earthworks and degraded sites.

9. The interpretive program should develop a 'storyline' which integrates the specific historic sites, incidents, and environments of each park.

10. The interpretive program should reveal the uniqueness and special qualities of each site.

Not all interpretive needs can be met within park boundaries. Like preservation goals, interpretive goals will also require cooperative negotiations with other agencies and land owners adjacent to the park. It will be important to develop visual standards for areas which impact the viewsheds of the parks, especially those closest to scene restoration areas.

Guidelines for Earthworks Preservation

What is preservation in the context of an earthwork? Most of the earthworks were constructed, at best, to last the duration of the Civil War and required continuous repair to remain useful. The bare soil surface was continuously vulnerable to erosion by wind and water, not to mention bombardment. The earthworks were also subjected to compaction as the piled sediments settled over time, and have been trampled by visitors. After the Civil War, vegetation gradually developed to stabilize the soil,

but additional settling occurred as the heavy timbers and brush, used for structural reinforcing, decomposed.

In many areas, the earthworks have been reconstructed. This began almost immediately after the war. In some cases, the reconstructed earthwork was not sited historically accurately. While archaeological and historical values may have been compromised, many of these reconstructions provide very effective interpretive experiences.

Clearly, preservation can at best refer to reducing the rate at which the form of the earthwork deteriorates, unless reconstructive work is undertaken.

The maintenance of appropriate vegetative cover and the control of disturbance are the two most important aspects of earthworks preservation. The first depends on the vegetative cover type, and the second is related to access and interpretive programs.

The following guidelines are recommended to ensure earthworks preservation:

1. All earthworks should be managed for a recommended vegetative cover type which provides effective stabilization.

2. Management should be keyed to cover type and reflect a real understanding of the specificity of each vegetation type and the long-term consequences of management.

3. All management techniques and practices should be monitored and evaluated before they are applied on a large scale.

4. Any management practice which contributes to soil destablization should be stopped and new strategies devised.

5. No increase in the level of management required should be initiated unless it can be completed properly, adequately followed through, and maintained over time.

6. All sites should require at least an annual monitoring, and most sites will require at least a minimal level of management.

7. Adequate sediment and erosion controls should be incorporated into all management.

8. The principle of 'economy of intervention' should be followed to minimize unnecessary effort and disturbance.

9. Access should be restricted during restoration work and during the establishment period of vegetative cover types.

Interpretive & Management History of the Earthworks

Attitudes toward interpretation and preservation have evolved gradually over time. However, two major interpretive concerns have been consistently important: the form of the earthworks and the setting in which they are viewed.

In the early years, the landscape was managed similarly to the farmlands surrounding the park sites. Once land was acquired, the earthworks were protected from gross disturbance, such as being plowed away by farmers. Areas where commemorative memorials had been created, and where visitorship was high, were kept in turf. Elsewhere, portions of parkland were released to return to forest.

The landscape setting of the earthworks has been another major interpretive concern of the National Park Service. For a number of years, the primary interpretive focus was on battlefield tactics and the individuals or groups who played a significant role at each site.

The need to protect the form of the earthworks from trampling by visitors slowly became evident as paths were worn at favorite crossings. Initially, these heavily used areas were simply reinforced, for example, with steps set into the earthwork. Later, construction became more elaborate, as continued degradation of the earthwork became apparent, and stiles, bridges, decks, and paved paths were added. The visitor perspective remained unchanged: the journey was still up and over the earthwork, where the view was good and the positions of the troops in battle could be clearly seen. Sites which were very popular, such as the Crater, were

literally trampled away and eventually required complete renovation and the installation of a pathway and viewing sites to better control access and use.

Recently, the inherent conflict between visitor access to the earthworks and protection of the form of the earthwork has been increasingly recognized. Older crossing sites are now being decommissioned and new pathways follow a journey which respects the earthworks. Even at recently reconstructed sites with intensive interpretation, such as the Living History site at Petersburg, the visitor, like the soldier during the war, is kept off the earthworks. As sites are renovated, this new policy is gradually being implemented. The bridge at Cold Harbor, which is in need of repair, will probably not be replaced. Issues about alternate parking sites and viewer orientation are being raised, and new solutions sought which should reduce visitor damage to the earthworks. These new policy directions underscore the need for review of the interpretive storylines. Some sites will require a complete redesign of the visitor experience before the earthworks can be adequately protected. At Chickahominy Bluffs, for example, the visitor parks almost adjacent to the bluff and is at the major overlook within seconds. Unfortunately, from this vantage, the major access path is not visible so many people end up on the maze of trails running along the tops of the earthworks which can be seen from the overlook. When interpretive facilities fail to provide adequate access or control, the resource is prone to damage, which in turn compromises future interpretive opportunities.

One of the driving forces behind current management practices is the consistent perception that trees are inherently damaging to earthworks. The summary recommendations of the "Petersburg Conference on the Conservation of Earthworks", held on July 30-31, 1974, concluded that "Trees are the major destructive element" [A, App. I, p. 67]. "Cotter noted that a pure approach to earthwork conservation initially would be to isolate the tender original remains and keep people and trees alike off of them since the first constitute a mechanical erosion agency and the second a chemical and physical disruption due to the acidification of the soil by leaf fall and the disruption of roots and tree trunks" [A, App. I, p. 4].

Ambrose acknowledges that "in some areas, it will be preferable to allow the natural regenerative processes to develop a wooded cover, thus keeping the works hidden from adverse visitor use" [A, p. 75], but generally concurred that trees threatened earthworks and recommended that "a

long-range thinning process should be used to prevent uncontrolled growth resulting in domination of large diameter trees"[A, p. 76].

It is clear that large dying trees do pose a threat, when sited directly on an earthwork or on a critical archaeological site. As Ambrose notes: "When trees in and around the earthworks are allowed to die in place, their falling limbs can damage the works below. If a tree is blown down by heavy winds, there is the possibility that its uprooting will leave large holes in the fortifications" [A, p. 57].

This perception that all trees have been damaging to the earthworks has led to a current management practice of clearing almost all understory vegetation on forested sites and the removal of most smaller trees (under 13" dbh caliper) leaving only a few solitary mature individuals standing in isolation on the earthworks.

The consequences of this policy have been problemmatic. Thinning and removal of the understory layer can contribute to the immediate destabilization of the earthwork by increasing the potential for stormwater erosion. In addition, the earthwork is more visible and consequently more vulnerable to human disturbance, if surveillance and security are not increased. Lastly, with the elimination of trees from the earthworks, the ground surface will almost certainly be overwhelmed by vines, Japanese honeysuckle in particular, unless turf or other groundcover is established and properly maintained.

The perception that the large tree is a threat has been translated into the implied perception that all native landscapes are a threat to the earthworks, and has led to a search for special cover types suitable for earthworks. Grass was generally perceived as preferable to forest, although rates of runoff and erosion from turf on sloeps are widely acknowledged to exceed those from a natural forest. Similarly, erosion can increase as much as 30% to 40% when a forest is cleared or partially cleared. "The point was made by Cotter that usually trees were deleterious to earthworks inasmuch as they may retard the growth of a grass or other cover which will hold the earth. This is especially noticeable in the case of conifers and oaks which leave a highly acid residue which may prevent growth of grass, especially in sandy soils" [A, App. I, p. 2].

If one examines the earthworks themselves, it is clear that Cotter and others were not accurate about the negative impacts of trees. If the

mandate to preserve the earthworks were taken literally, there is little question that all would be left completely undisturbed under the blanket of forest and vigorously protected from trespass. It is almost axiomatic that, for all practical terms, access is equivalent to erosion, as the most open and accessible sites are the least well preserved. In recognition of this, for example, after Fort Stedman and the Crater required complete renovation, the National Park Service reduced and focused access to limit future impacts.

In his review of conditions at Fort Fisher, in the Clemson Study, Ambrose also observed that keeping earthworks in forest will promote preservation: "Fort Fisher. . . . is in an almost perfect condition with distinct parapet walls and moat. The entire Fort and the area on its north and east sides are covered by young forest growth" [A, p. 59]. The key word here is 'young'. Because of past agricultural use, virtually all the forests of this region are relatively young. Even in a mature forest, only a few of the sapling trees ever become forest giants.

The effectiveness of forest cover in preserving the earthworks was also recognized in the Clemson Study, which recommended: "Tree removal at Fort Fisher should be selective. Natural revegetation should be guided so that a wooded cover will be maintained thus helping to keep the work in obscurity. A long-range thinning and cutting program should be used so that tree growth will not be allowed to continue uncontrolled until only large diameter trees dominate the fort. A mixed-age cover will provide a better screen than will a climax forest" [A, p. 112].

Recognition of the role of forests in preserving earthworks is also noted in a 1980 memorandum from Robert Melnick, Historical Landscape Architect. Concerning management at Fort Foote directed to providing better visual access, Melnick recommended that "vegetation on the earthworks and within the fort should not be cleared. Such clearing will lead to eventual destabilization and erosion of the earthworks. Maintenance of the fort and immediate surroundings should be allowed. Vegetation on the earthworks, especially trees and shrubs, should be carefully pruned in a limited manner." Despite these observations, earthworks are still being cleared in the name of preservation. At Kennesaw Mountain National Battlefield Park, for example, earthworks have not only been cleared recently, but the pine needles and litter layer have been raked away to expose the bare mineral soil to even more rapid erosion. Unsightly piles of brush and rakings have been left on top of the earthworks.

The fact that forest cover better preserves the landform of the earthworks does not necessarily mean that forest cover should blanket all earthworks. The 1974 Petersburg conference recognized that the 'pure' approach was not necessarily the best approach to a complex mandate. Even the highly trampled and severely disturbed earthwork is more valued by the visitor than a lost relic which is unseen in the forest [A, App. I, p.7].

It does mean, however, that a variety of native plant communities, which are inherently suited to the local conditions and which were largely ignored by earlier efforts, might be managed more effectively to provide greater protection that current practices, while fostering interpretive goals as well. It also means that some long-held assumptions must be relinquished before new management strategies can be adequately explored. And, lastly, it means that the large tree on the earthwork must be confronted and dealt with. This situation only becomes more urgent, as thousands of pines throughout the area are stressed by disease and infestation.

In summary, what we are seeing is that forest, which is the single most effective cover for preservation of the earthworks, is being mismanaged to achieve the interpretive goal of greater visibility. Forest quality, including health and diversity, deteriorates rapidly with the onset of management, and declines steadily as long as management is continued. The physical form of the earthwork is also impacted by accelerated erosion and subsequent trampling and visitor abuse, while native cover types are overlooked.

Similar management problems occur in the non-forested portions of the park. In these open landscapes, the earthworks are almost always turf covered, as if turf and interpretation were synonymous. A large majority of these have been severely trampled and renovated or rebuilt over time. Turf is an extremely high-cost groundcover. As maintenance has been reduced in many areas, turf cover has deteriorated to a poorly stabilizing rough grass. In some places, damages from the mowers exceeds that from trampling. In nearly all cases, turf cover has required frequent renovation and a continuous upgrading of facilities to provide greater control of visitor access. No original earthworks in good condition exist in turf, yet a disproportionately large percentage of every year's budget goes to mowing and turf maintenance. This is not a new concern and repeated efforts have been made to reduce the costs of turf maintenance; however, these measures have amounted to corner cutting, such as reducing required

fertilization and liming. The more fundamentals issue of where turf is appropriate and where an alternative cover type might be more appropriate than turf has not been adequately addressed.

There is at present a strong interest at National Park Service to an approach to interpretation in which the larger setting of an historical event is restored and presented to the visitor. 'Scene restoration' is opening up new possiblities for interpretation, including the development of new storylines and access patterns which integrate the visitor's experience with the message being conveyed.

With the recreation of entire scenes, much thought will have to be given to the management of adjacent landscapes to evoke an aura of authenticity. For example, some of the land currently in forest was once part of the scene of a significant battle and was probably worked as farmland, either crop or pasture, in the Civil War era. Like the once pastoral countryside of the region, the landscapes of the parks have changed dramatically. As development replaced the croplands and pastures outside park boundaries, the once open fields within the parks gave way to forest regrowth, ultimately obscuring strategic vistas. The initial emphasis of scene restoration focused on military tactics and sought to reestablish the terrain of the battlefield. This has led to fairly extensive clearance of forest, with many more areas scheduled for eventual clearance.

However, despite the desirability of a return to some form of agricultural use on certain sites, there are still a number of issues to be resolved. The prospect of future use by local farmers contains inherent conflicts with the goals of both interpretation and preservation. For example, the patterns of modern agriculture are increasingly at variance with the patterns of historical agriculture and accurate scene restoration. Use of modern agricultural equipment creates a configuration of fields that is both larger in scale and different in form than historical practices. Dramatic regrading of the land or extensive drainage systems are also often required. Herbicides and insecticides may be frequently used, especially with no-till agriculture. Given all these problems with the use of the land for modern agricultural crops, grazing may be a more desirable solution and is certainly more picturesque. However, the impact of livestock trampling the earthworks is at least as destructive of the resource as human trampling.

Pasturage also has other conflicts with preservation goals. Healthy pasture requires periodic mowing and reseeding, and it is unlikely that fields created from recently cleared forests, with their slowly rotting stumps, would be suitable for adequate pasturage within ten to fifteen year's time. Healthy pasture also requires continuous liming and fertilizing to foster the growth of European pasture grasses typically used, a requirement which is often inadequately followed through on.

Because there has been inadequate site preparation and poor maintenance of other newly seeded areas in the park, sites that might be returned to pasture would lose the original seed. Ultimately, these sites would be taken over by native grasses, but in the interim there would be a considerable amount of bare soil exposed to erosion and large volumes of topsoil would be lost even if gullying is not readily apparent. Earthworks would also be impacted, as this erosion contributes to a long-term loss of soil fertility, which increases the problems of stabilization.

Scene restoration can only be undertaken where the land holdings are large enough to include not only the site but an adequate buffer as well to ensure that no visual intrusions from modern landscapes destroy the illusion of an appropriate historical context. Within the fragmented and more linear parts of the park, similar problems are becoming apparent. What we are, in fact, coming to realize is that many of the most severe threats to the form and setting of the earthworks come from development around the parks, and can only be minimally improved by altering management practices within the parks. These external threats may be direct, such as the ever increasing number of driveways through the earthworks along roads built by the National Park Service for the purpose of interpretation. These same roads are already deteriorating under a traffic load greatly exceeding their capacity and have brought the added disturbance of phone lines and other services as well. For example, as more residences are built along Flank and Defense roads, the same management strategy that exposed the earthworks to the visitor's view also reveals the conflicting and very busy world of the home landscape -- it is not unlike the warrior's memorial statue now captured in the strip development along Crater Road.

The precedent was set to acquiesce to requests for access, so it's likely the demand will grow. And, indirectly, the expansion of airport facilities and the completion of Interstate 295, with a major interchange only three-and-a-half miles from a park entrance, will determine much of the

remaining future of the fields and forests that surround the Richmond National Battlefield Park. The visual context will change dramatically as strip development coalesces along the major roadways, and the number of people looking for recreation sites will increase as undeveloped land disappears. Evidence is growing to suggest that use of the parks for recreational purposes represents a far greater threat to the earthworks than visitor interpretation.

Urbanization of the land around park boundaries inevitably means environmental degradation in a number of ways. Extreme environmental impacts from increased rates of sedimentation are inevitable unless stormwater management is dramatically improved throughout the region. The stresses to the forest and other native plant communities will be profound and grossly diminish the health and diversity of remaining habitats. Disturbance species will be continuously favored in this competition for land.

The more one examines the issue of preservation, the more one realizes that there has been very little experimentation in the management of earthworks, although the need for real research and development has been frequently stated. The 1974 Petersburg conference concluded: "It was evident that a certain amount of experimentation involving different types of vegetative management are needed" [A, App. I, p. 7]. In actuality, there is very little experimentation, and management decisions effecting very large areas are often made on the basis of 'policy' without any clear understanding of long-term consequences. Hundreds of acres may be cleared for 'scene restoration' without adequate funds to properly stabilize the cut-over land. Miles of earthworks may be cleared and opened to access. After clearing, these earthworks need continued management, but there is rarely any clear program for future maintenance. One person interviewed described the approach as "ready-fire-aim." This strategy is a familiar one in government agencies and is as frustrating to those within the system as it is to others looking in from the outside. In this light, it is remarkable how caring and committed the staffs at Fredericksburg, Petersburg, Richmond, and Colonial are, and attests to the power of the earthworks to move the human heart. There is an evident respect and reverence for the earthworks -- the same kind of feelings one hopes to spark in the visitor. There is also pride in the National Park Service and a real desire to do the job well, though these feelings often get suppressed by day-to-day operations. There is a great potential within the individual park staffs and, at present, very little opportunity to tap this resource. It

is critical at this time to find ways to fuel creative efforts and focus the experience and expertise of those working in the parks. Otherwise, there is a tendency to cling to the tried and true and to resist any modification. Only when people have a personal stake in improving the management and developing innovative approaches can the old conventional modes be broken. This is the time to develop the Art of Earthworks Management.

The other critical half of experimentation is continuity. There must be real monitoring and useful assessment of all demonstration projects, and a willingness to adapt and repair as expertise is gained. One of the products of this project will be to develop a sequence of demonstration projects for applied research on some of the more complex problems of management. There is also an evaluation phase which concludes this project, and which will hopefully be the first of a series of reevaluations framed by the Management Program. As experience is gained and information documented, it will be the time to develop the Science of Earthworks Management. While outside consultation will continue to be effective, the really important work should be happening within the parks themselves. This will require close cooperation and improved communication with the regional representatives. The Manual is intended to provide both a structure and a common language to facilitate this effort.

References cited in the text:

A: William S. Ambrose, "An Interpretive Earthworks Preservation Guide for Petersburg National Battlefield". Report prepared for the National Park Service by the Department of Recreation and Park Administration, College of Forest and Recreation Resources, Clemson University (March 1976).

A, App. I: Appendix I: "Petersburg Conference on the Conservation of Earthworks", July 30-31, 1974, Recorder: John L. Cotter.

C. EVALUATION OF EXISTING VEGETATIVE COVER TYPES

Vegetation is the key to earthwork preservation and interpretation. With only minor exceptions, all the earthworks are vegetated and support a diversity of cover types, which vary in effectiveness with regard to the archaeological, interpretive, and preservation values previously described. For the purposes of this review, the existing cover types are divided into three major groups: Forest Cover Types, Field Cover Types, and Special Conditions. The following evaluations are based upon field observations at Petersburg National Battlefield, Richmond National Battlefield, Fredericksburg and Spotsylvania County Battlefields Memorial National Military Park, and Colonial National Historical Park.

FOREST COVER TYPES

The forest cover types include Forest [see Figure 1] and Cleared Woodland [see Figure 2]. Trees provide the primary stabilization, which may be augmented by shrubs, understory trees, vines, and herbaceous plants.

Forest Cover Type

Most of the earthworks in forest [see Figure 1] occur in the oak-pine forest region of the Mid-Atlantic states, bordered to the north by the oak-hickory forest and to the south by the southeastern evergreen forest. The Petersburg, Richmond, Fredericksburg, and Colonial parks are all located in the oak/pine forest region which extends from New Jersey south to Georgia, and west to the Mississippi River Basin. The landscape is gently rolling topography which in Virginia occurs on the coastal plain north of the James River and over much of the Piedmont. The forests are typically mixed oak and pine with more pine occurring in younger landscapes and a gradual replacement by deciduous species. Pines, however, will persist on poorer and drier soils and were prominent in the pre-settlement forest cover. When mature, the forest type is very similar

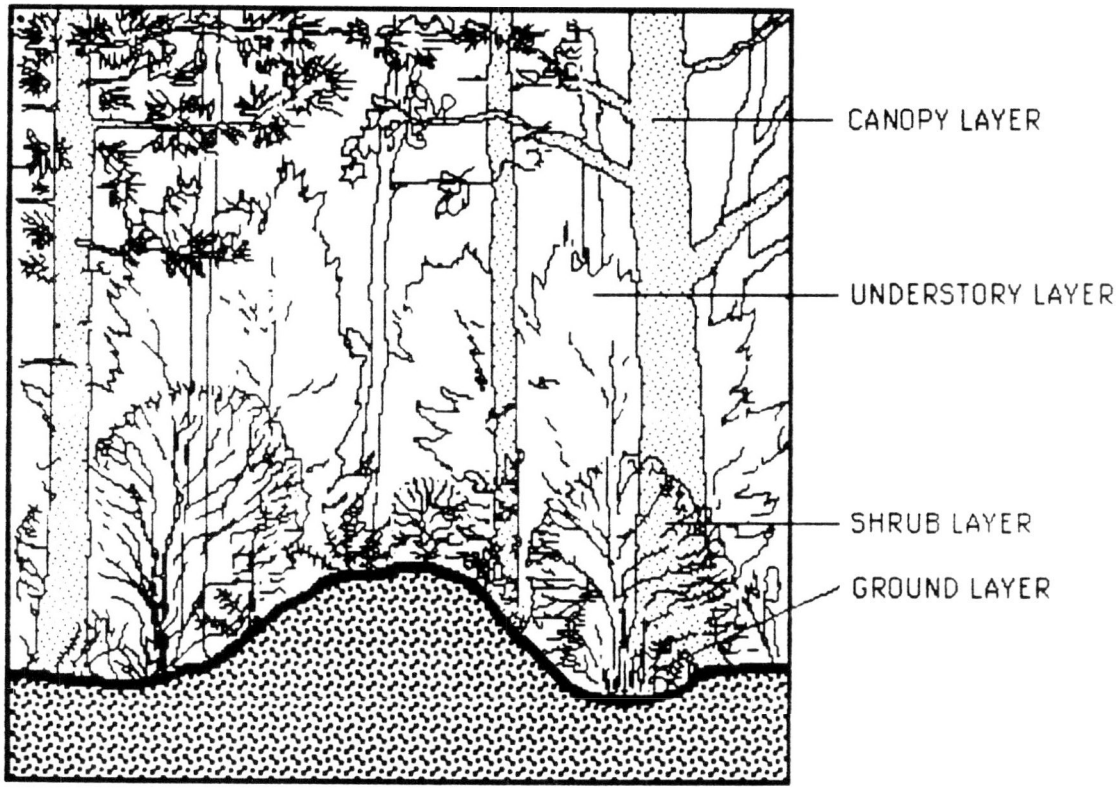


Figure 1:
Existing Forest Cover Types: Forest

Dense native forest. Earthworks well stabilized.

to the oak/hickory forest found further north and west except for the presence of abundant sweetgum and sourwood in the oak/pine forest.

The more northern earthworks sites such as Valley Forge occur in the oak/hickory forest. Further to the south the transition is made to the southeastern evergreen forest, where longleaf pine, which is absent from the oak/pine forest, becomes abundant. Land that is cleared for agriculture and later abandoned is usually initially invaded by pine. The pine forest which then develops is invaded by hardwoods which first appear as a dense understory layer. The forest gradually becomes mixed pine and oak and may in places succeed to mixed oak or oak and hickory.

Lowland vegetation types generally occur in valley bottomlands in the Piedmont sections, while in the coastal plain, broad upland swamps may occur in the shallow interstream topography. Sweetgum, elms, red maple, ash, willow, and water oak are found in the lowlands, as well as river birch, black willow, sycamore, and cottonwood, especially along the stream channels. Common shrubs include blueberries, viburnums, huckleberries, and laurels.

Although there is more forest today than in the Civil War era, when agricultural areas were more extensive, many of the remaining forests today are threatened by disturbance. Despite local disturbance, these forested areas represent a very significant regional resource in the preservation of the heritage of historical native landscapes. At present, however, the opportunity to interpret this aspect of the historic context is largely unrecognized.

It is from an interpretive perspective that the most serious difficulties arise. There are, at present, no satisfactory models for interpreting a forested earthworks. Indeed, it has not even been attempted. As this cover type is already the least accessible, the problem of trampling and other undesirable uses can only be solved by providing a more satisfactory alternate visitor experience and by resolving the conflicts of non-park related uses.

From an archaeological perspective, with earthworks already under forest, potential damage to the stratigraphy by large tree roots has already occurred. If large numbers of trees are then cut in an effort to protect the resource, greater damage may be done by the rotting root systems left in the earthworks. One solution to the problem of large old trees collapsing and tearing apart the earthworks may be to target a few critical sites

where the maturation of existing large trees can be inhibited by selective cutting.

The earthworks under forest cover are the most well stabilized. The naturally acid condition of the soils inhibits some decomposition and actually reduces the rate at which organic matter, such as heavy timbers and old root systems, deteriorates. This is counteracted when the soils are limed to support turf grasses and other non-native vegetation. The forest structure, which is visibly layered above ground, with canopy, understory, shrub, and ground layers, is also layered below ground, with a complex of layered roots which in mass are equal to the trunks and branches above. This does not mean, however, that they are without problems. Erosion and trampling may be locally severe, especially when these areas are adjacent to interpreted sites or other facilities. Damage from animal burrowing and dead or windthrown trees also occurs. Often these problems are used to justify 'management for preservation', and hence clearing. Clearance operations, however, do not control or eliminate any of the undesirable uses. All presently forested sites are too remote to be adequately monitored, regardless of cover type, and casual recreational use on the earthworks is the greatest cause of immediate degradation.

In summary, the forest cover type is by far the most effective in stabilizing earthworks. There are presently no forested earthworks which would be better preserved by changing cover type and many cleared earthworks should be restored to forest.

Cleared Woodland Cover Type

Cleared woodland is a cover type which results from management of previously forested sites. All understory and shrub layers are removed and most canopy trees leaving only a few widely spaced large trees [see Figure 2]. The ground layer is frequently bare, with some leaf litter, vine cover, or occasional herbaceous plants. This management is designed to increase visibility for interpretive and surveillance purposes, and to limit future tree growth, which is currently perceived to pose a threat to earthwork stability, because of root damage and the possibility of windthrow. With the exception of an occasional temporary seeding of annual rye, no effort is made to establish turf or any other ground-layer vegetation. The only plants which appear to be favored by this clearing are vines, especially Japanese honeysuckle, an invasive disturbance species. The rate of the spread of honeysuckle varies with the degree of local infestation and the

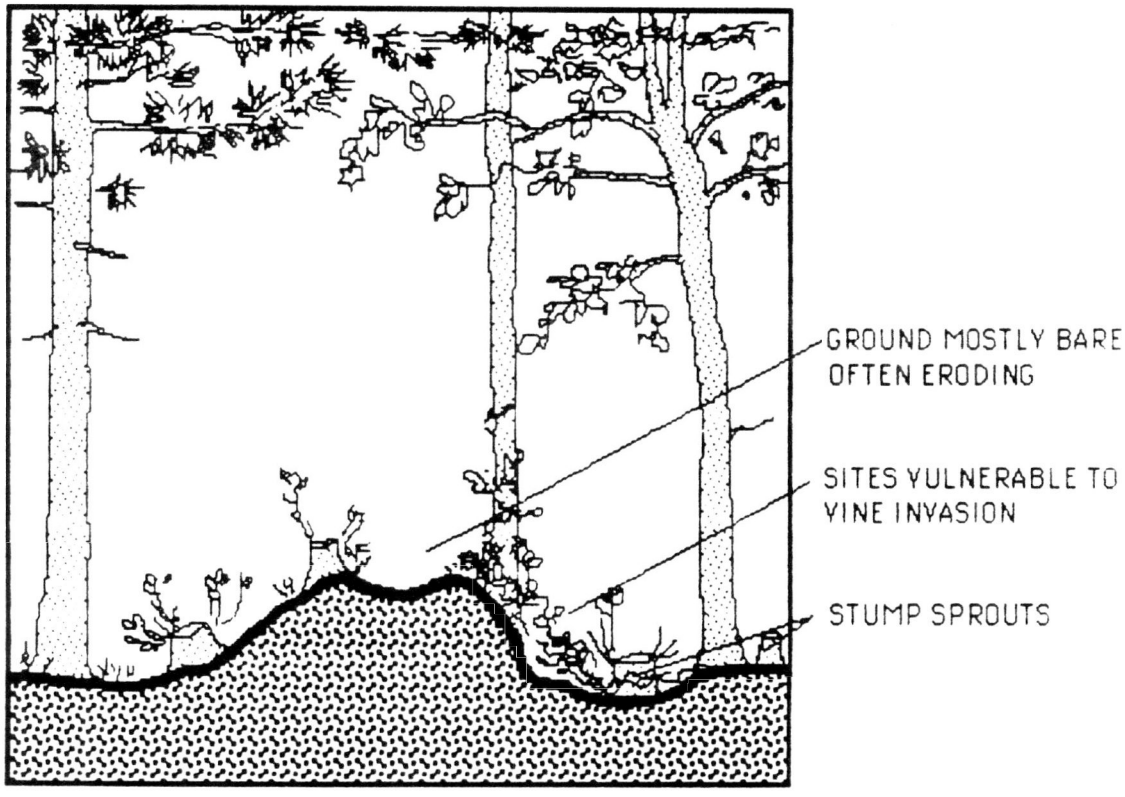


Figure 2:
Existing Forest Cover Types:
Cleared Woodland

All shrub and understory layers removed, with only a few larger canopy trees left standing. Ground mostly bare, with occasional stump sprouts. Erosion often severe.

density of existing canopy cover. Since there has been no provision for eventual canopy replacement, tree cover will continue to diminish over time and vine growth to accelerate, ultimately eliminating the woodland character. In addition, there is the danger that forested areas can be impacted by invasion of disturbance species moving in from areas of cleared woodland.

Clearing to create open woodlands is widespread throughout the parks in forested areas. Unfortunately, it is easy to accomplish with unskilled and changing labor crews, such as students. Although this cover type gives the immediate appearance of a tidy, open woodland, the impact on earthworks stability is always negative. Clearing initiates a major cycle of erosion and encourages continued soil loss over time. The stress of trampling often accompanies increased visibility and access. Along Lee Drive at Fredericksburg, where brush has been removed at irregular intervals over the last fifty years, the dense shrub and sapling layers, which in the surrounding unmanaged forest sharply limit visibility, are noticeably absent, permitting the desired distant views. However, at this site bare soil is exposed over a large proportion of the ground area, with evidence of rain-spash erosion and occasional rills.

The severity of the impacts of this cover type are especially evident the first time an area is cleared. Portions of Fort Conahey at Petersburg show several inches of soil loss within less than one year after clearing. When similar problems were observed on newly cleared sites in the National Capital Region, the clearing process was modified to leave behind at least six inches of stubble, which reduced but did not eliminate erosion. In many areas, the added access in cleared woodlands has aggravated existing problems. In an effort to control relic hunting by increasing visibility, several tiers of earthworks were cleared at Cold Harbor in Richmond. These earthworks are now entirely crisscrossed with trails. Relic hunters have not been controlled by this effort, though they may have retreated deeper into the woods.

Cleared woodlands as a cover type seriously jeopardize the stability of the resource. Despite its widespread acceptance throughout the parks, this cover type should be eliminated. The goal of increasing visitor interpretation by increasing visibility of the earthworks must be reevaluated in light of its destabilizing effects, and alternate solutions to interpretation developed.

FIELD COVER TYPES

There are currently two field cover types: Rough Grass [see Figure 3] and Turf [see Figure 4]. In both cases, grass provides the primary stabilization, although occasional individual trees may occur.

Rough Grass Cover Type

Rough grass usually looks like a poorly maintained lawn. The cover is often discontinuous, and in places may be very sparse, with exposed patches of bare soil [see Figure 3]. The species present are typically a mixture of turf varieties, familiar lawnweeds, desirable and undesirable native grasses, and native wildflowers. Rough grass is typically mowed a little less frequently than turf, but still often enough to inhibit the development of a dense stand of native grasses. However, these infrequent mowings are also inadequate to stimulate good turf cover in the absence of other appropriate maintenance procedures. Much existing rough grass is in park areas where casual recreational use is high and has encouraged problems of littering, overtrampling, and occasional vandalism.

The rough grass cover type generally occurs in areas which were formally turf, but which have deteriorated due to poor maintenance and/or poor soil conditions. Examples include portions of Bloody Angle and East Angle at Fredericksburg and portions of Fort Gilmer and Fort Harrison at Richmond. In some areas, such as Fort Wadsworth at Petersburg, turf grasses were seeded, but failed after the first season because of inadequate site preparation and poor maintenance. Occasionally, rough grass cover has resulted from repeated mowing of native grass lands, such as at Colquitt's Salient at Petersburg and Cold Harbor at Richmond.

Rough grass is also found on many sites which have been cleared for scene restoration. In most cases, the intent was to establish pasture grasses for future agricultural use. However, inadequate site preparation and poor maintenance of newly seeded areas is typical. During the period from the demise of the original seed until takeover by native grasses, there is a considerable amount of bare soil exposed to erosion, and large volumes of topsoil are lost even if gullying is not readily apparent. This not only leads to excessive soil loss, but diminishes long-term soil fertility. Unless there is justification for an appropriate level of investment to maintain

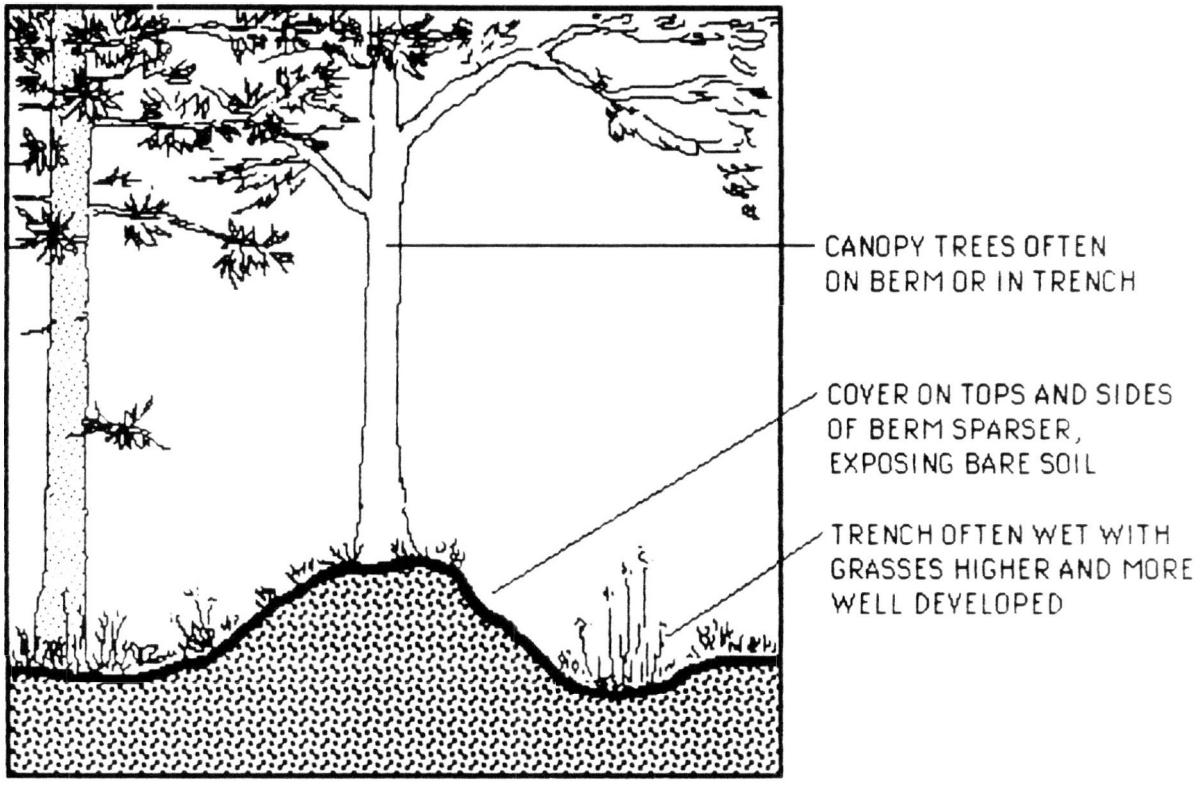


Figure 3:
Existing Field Cover Types:
Rough Grass

Patchily established mixture of lawn grasses, native grasses, and wildflowers.

dense pasture cover, all these sites should be converted to native tall grass meadows, which are less costly to maintain and provide more effective stabilization.

From an archaeological perspective, rough grass poses no direct threat to the resource, but its limited stabilizing effect could lead to excessive erosion in some areas.

In summary, rough grass cannot be maintained in good condition, because it is suspended between two vegetation types -- turf, which requires mowing and alteration of native soils, and native grasses, which are intolerant of frequent mowing and favor existing soil conditions. In virtually all cases, rough grass should be converted to another cover type. Although much of the extent of rough grass is presently perceived of as turf, it should not be renovated to support turf in the future. Failure to establish turf often indicates the site is unsuitable for turf for a variety of reasons. Sites, such as Fort Wadsworth which was inadequately prepared for turf, would require too high an initial investment to maintain in healthy turf. This site, also too remote for adequate surveillance, is better stabilized by forest.

Turf Cover Type

The term 'turf' refers to what is commonly known as mown lawn [see Figure 4]. Today lawns are comprised primarily of hybrid varieties of non-native grasses which retain a green color during the spring and fall growing seasons and brown out during the summer and winter dormant seasons. These grasses are tolerant of frequent mowing which stimulates the development of new shoots. This maintained juvenile growth pattern is uniform and carpetlike in appearance.

From an interpretive perspective, turf cover is very satisfactory, since the form and scale of the earthwork is completely visible to the viewer. Turf in combination with shade trees also contribute to a park-like character, and grass is often considered a high priority by most park officials and visitors.

The root system of turf is similar to the shoot system. When intact, the dense, fine, and relatively shallow root network provides good stabilization of the surface, but does not anchor a slope with the graduated system of larger woody roots, typical of trees and shrubs. Turf,

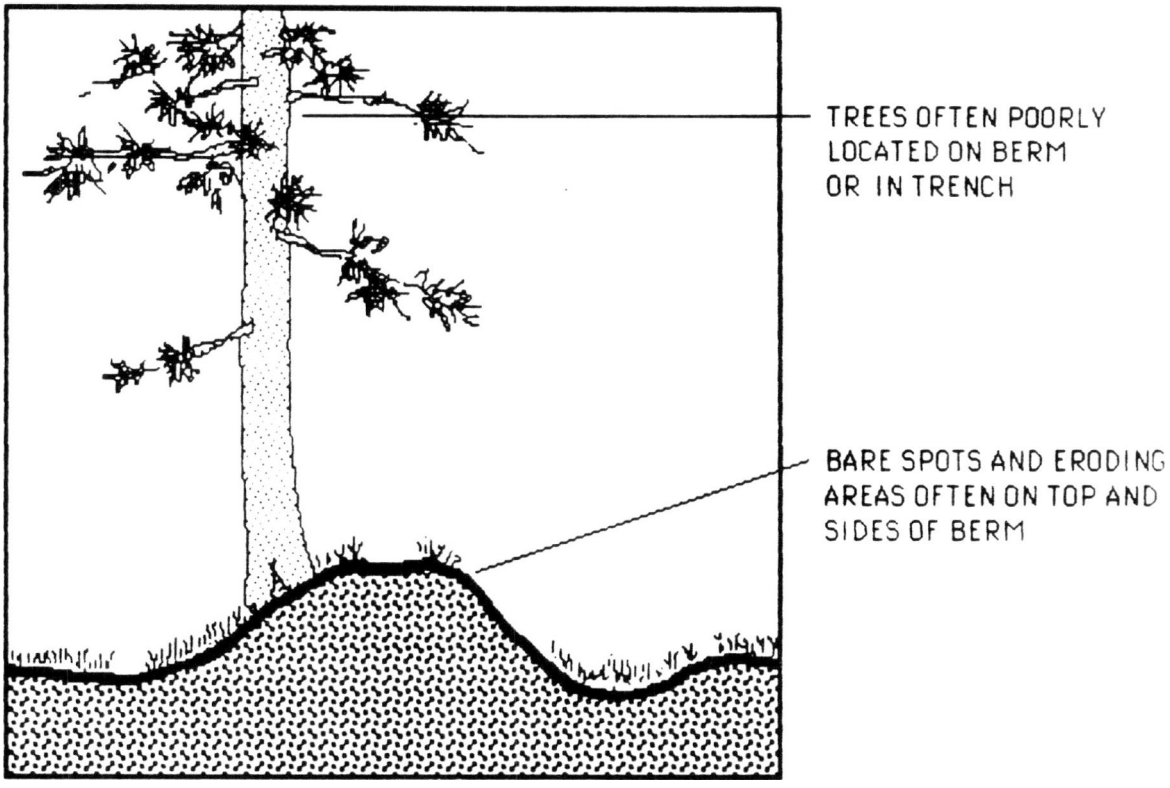


Figure 4:
Existing Field Cover Types: Turf

Lawn grasses often poorly established, under occasional tree canopy.

when well maintained, protects the earthworks from erosion. The shallow rooted grasses do not disrupt the stratigraphy of soil and artifacts below grade.

Turf does not occur naturally and is usually established by seed. During the growing season, turf requires almost continuous mowing. Turf grasses require a higher pH than the soils native to most of the eastern United States and must be limed regularly. Turf also requires supplementary fertilization, in part to support the continuous new growth. These maintenance requirements are exaggerated on earthworks where the less fertile and more acid subsoils occur at the surface. The construction of the earthworks did not entail reserving the topsoil for use to provide a good turf growth medium.

As a cover type, turf is labor intensive and costly to maintain. Currently, a significant proportion of park management budget goes to turf maintenance, draining funding which might be directed to more critical projects.

Turf is found throughout the parks and is the cover type most characteristic of interpreted areas and areas with a high visitorship. It is most frequently found on intensively interpreted earthworks, generally near major visitor centers which are centrally located within each battlefield park. At Fredericksburg, examples of turf cover include the fields and earthworks at the Lee Hill Exhibit Center and portions of East Angle and Bloody Angle. At Petersburg, the Visitor's Center area, including Battery Five, the Crater, Fort Stedman, are turf covered. In contrast, it Richmond, there is almost no turf cover intact on earthworks, though some lawns are maintained adjacent to some facilities, such as the Chickahominy Bluffs Overlook. At Colonial, virtually all the interpreted earthworks are turf covered. The condition of the turf on these sites varies considerably with the intensity of use and level of maintenance.

The most effective turf cover is generally found on renovated or reconstructed earthworks which have had a surface application of topsoil and appropriate liming and fertilization, at least during the establishment period. While the grass at some of these sites is still in relatively good condition, elsewhere it has deteriorated over time, because routine maintenance, such as fertilization and liming, has not been adequate to maintain turf in good condition.

At Colonial, where the earthworks were reconstructed, in the 1930s and 1950s, and again in 1976, the grass is still in excellent condition. Native soil conditions at Colonial are less acid and less sandy than those found at Fredericksburg, Richmond, and Petersburg and therefore are considerably more favorable for the establishment and support of a turf cover, and eroded places are consistently repaired as needed. Erosion problems still occur, however, where foot traffic is concentrated and uncontrolled, and on some steeper slopes where establishment of turf is poor.

The most serious problems with turf cover type are related to stabilization issues. Many of the earthworks are more steeply sloped than is generally recommended for grass stabilization, and would be better reinforced by the more complex root network provided by forest cover.

The steep slopes are difficult to mow. Where the surface is uneven, the grass cover may be skinned off by the mower, exposing bare ground. Eroded patches are ubiquitous and require continuous repair, which in places exceeds the present maintenance capacity of the park units.

Most critically, turf provides virtually unrestricted visitor access. Wherever there is trampling, compaction occurs, and where it is excessive, the cover fails and the surface erodes. Where foot traffic is largely uncontrolled, alterations of the earthwork form due to compaction are inevitable. While the open character of a grass landscape allows good visibility, this is only effective where nearly continuous surveillance is possible.

There is, at present, insufficient evidence to determine the level of stabilization that can be achieved using turf cover versus forest cover. Most of the sites which now support turf have been so significantly altered by trampling and subsequent erosion that evaluation of the effectiveness of the cover type is difficult. At Colonial, where good cover has been maintained for a period of time, the geometry of the earthworks appears to be largely intact. The reconstructions at Colonial have held up well despie high visitorship. Since walking on the earthworks is integral to the current interpretive program, conditions are likely to deteriorate over time. While it is clear that earthwork walking is a very enjoyable visitor experience and provides an excellent battlefield view, it clearly conflicts with preservation goals and with policy at other battlefield parks.

Trampling is not an issue where turf covered earthworks are predominantly reconstructed. However, walking over earthworks on original sites, even when there is an effective path system, encourages trampling. Therefore, turf should be limited exclusively to sites which are renovated or rebuilt, or of no historic significance. No original earthworks should be converted to turf. In summation, turf provides appropriate stabilization only when maintained in good condition. Given the high cost of existing turf maintenance, turf should be restricted to those areas where visitor access can be adequately controlled. where visitor access cannot completely controlled, no original earthworks should be stabilized by turf, nor should turf be used at remote sites which cannot be monitored. Renovation of existing turf in poor quality should be given high priority, and those areas which cannot be properly maintained should be converted to a cover type which better restricts access and provides a higher degree of preservation.

SPECIAL CONDITIONS

Vine Cover Type

While honeysuckle, an alien species, is the predominant vine in this cover type, many native vines, such as poison ivy, catbrier, and raspberries, are also vigorous, though less abundant. Kudzu, found frequently outside the park, was not observed within park boundaries, although it may occur occasionally. Native vines are not invasive enough or found extensively enough to cause significant problems. Japanese honeysuckle mounds occur largely in monospecific patches of greater or lesser extent, depending on the age of the patch and the amount of disturbance at the site. Because of the dense growth characteristic of honeysuckle, tree and shrub germination are inhibited and existing woody vegetation, other than the vines themselves, are smothered and eventually killed.

The vine cover type [see Figure 5], which is predominantly honeysuckle, is at present relatively limited in extent, the most extensive areas are found in Richmond along Battlefield Park Road. Smaller localized patches of this cover type occur throughout the parks, especially in areas where forest has been cleared of brush and cleared woodland created, or in those areas where the ground is bare. Patches of vine cover can also occur even in

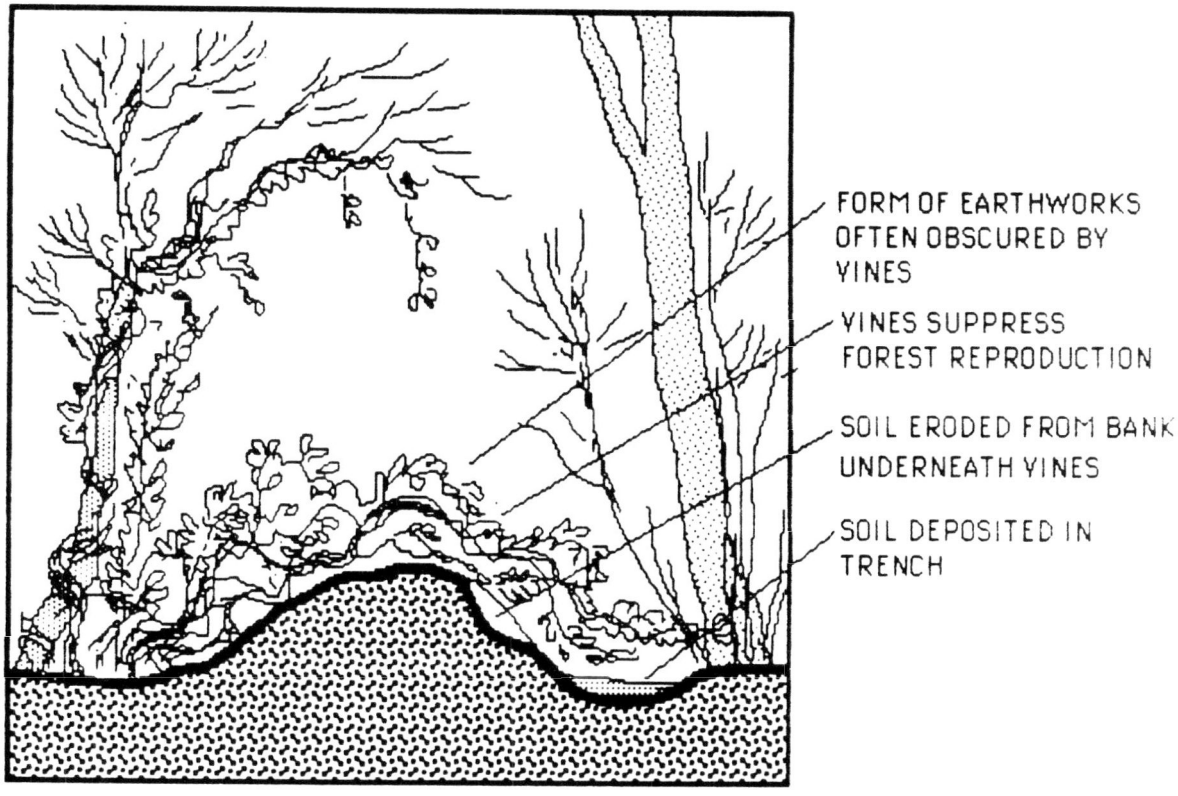


Figure 5:
Existing Special Conditions: Vine Cover

Nearly monospecific mounds of vines, predominantly Japanese honeysuckle. Typically found in patches, and occasionally forms nearly solid undergrowth.

forested conditions as the result of invasion from adjacent cleared areas. For example, at Fort Harrison, honeysuckle was well established in the forest even before the site was cleared nearly fifty years ago.

As more land is cleared for agriculture and urbanization, many of the remaining fragments of forest are threatened by disturbance from invasive alien species. Many, of these species, such as honeysuckle and kudzu, were introduced to control erosion resulting from excess grazing, tilling, or grading and have become serious pests. This cover type, ubiquitous throughout the region was probably well established in the area even before the Civil War and was planted to stabilize railroad embankments throughout the region. Honeysuckle also spread rapidly as a consequence of forest clearance by the National Park Service and the continued disturbance of forested areas throughout the region.

Honeysuckle, like kudzu, was once widely perceived as an excellent ground stabilizer. Growth is rapid, cover seems complete, and applicable to almost any site. But the long-term results did not warrant the early optimism. The vine's shallow, opportunistic root systems do not provide anything close to the level of stabilization of native forest systems. Slumping and soil slippage continue to occur, and surface soils are still exposed to erosion beneath the heaping cover. In Virginia, where honeysuckle is virtually evergreen, it holds the soil far better than kudzu when young. As it matures, however, it heaps higher and higher over old stems and the number of rooting sites diminishes, with a probable decrease in its capacity to check erosion. Not only do these species fail to stabilize as hoped, they have proved to be highly invasive and largely free from the natural controls of their own native habitats. An equally serious problem related to this cover type is its potential impacts on native habitats within and near the park lands. As forests throughout the region are increasingly disturbed and fragmented, they are ever more vulnerable to honeysuckle.

From an interpretive perspective, the overall layout of a fort is adequately called out by the vine cover type, where the floor of the fort is mown grass and contrasts well with the darker leafy vines. The specific form of each earthwork, however, is somewhat obscured as the vines mature and form heaping masses. Along linear earthworks, the visual distinctions between trench and berm are gradually obliterated as the vine mound enlarges. The vine cover type also does not satisfy the goal of recreating an authentic historic setting, either cultural or natural, although vines present no significant threat to buried archaeological artifacts.

In summary, management for preservation of earthworks should not foster the widespread distribution of a disturbance species which threatens the health and diversity of native plant communities both in and adjacent to the parks. We recommend elimination of this cover type, especially since there are other cover types which can provide more effective site stabilization.

Horticultural Groundcovers

Despite the fact that most previous management reviews have recommended a variety of low growing woody and herbaceous groundcovers, there is very little of these cover types established in the parks. Some periwinkle was planted at Fort Harrison, and is being overtaken by honeysuckle. Some sand lovegrass was also planted at Fort Harrison in the repair of eroded areas, but it has taken only in patches. There was no evidence that any other similar groundcovers have been attempted. Other groundcovers recommended in past reviews fall into three groups: (1) invasive alien species, such as memorial rose, which is contrary to current policy and should be viewed as a disturbance species; (2) native vines, such as trumpet honeysuckle and Virginia creeper, which do not provide adequate cover for stabilization; and (3) conventional stabilization species, such as crownvetch, sand lovegrass, and 'wildlife grains', all of which do poorly under the light tree cover found on most of the earthworks and are also not native, conflicting with existing policy. All of these species are extremely vulnerable to honeysuckle invasion.

From an interpretive perspective, groundcovers might serve to clearly call out the form of the earthworks, but the idea of maintained beds of horticultural plantings on earthworks conflicts with the goals of evoking a genuine historical setting.

There appears to be no reason to further pursue the establishment of groundcovers for earthworks preservation. This cover type is costly to install and maintain, is poorly suited to solving large-scale, long-term management problems, and represents a hazard to the native plant communities. Several of the flowering groundcovers, such as thrift or creeping phlox, provide no cover whatsoever during the winter months. A gardenesque approach cannot be implemented on the scale of the earthworks, and it is questionable if, from an interpretive perspective, such groundcover beds are appropriate. Despite the suggestion that species selected be suitable to existing environmental conditions, most, are not

well suited to the acid, sandy, clay loams of this region and require substantial fertilizing, liming, weeding, and mowing.

Bare Soil

A bare soil condition is maintained at the demonstration earthworks built as a Living History exhibit at Petersburg. The site requires regular maintenance similar to that which was required during actual military use, and this is incorporated into the interpretive program. As these are not original earthworks, the soil loss and subsequent rebuilding does not impact any cultural or archaeological resources. The exhibit is a very effective interpretive tool and helps provide a sense of immediacy that is not possible with vegetatively stabilized sites. The current management and maintenance appears appropriate and adequate. It is, however, important to ensure that no sedimentation occurs in nearby small tributary streams.

Gravel Stabilization

A replica earthwork built by Civilian Conservation Corps crews at Lee's Lookout, Fredericksburg, was stabilized at the surface with a graded gravel, designed to accommodate foot traffic. But because this cover type occurs where the earthworks have been recreated and are not authentic, like the Living History sites, no critical cultural or archaeological resources are impacted. As the earthwork is bare, it allows the visitor to see and experience it as it was during the Civil War. Gravel also appears to work well in stabilizing the earthworks. At the replica earthwork at Lee's Lookout, there is some erosion on the side slopes but, considering that the site has been virtually unmaintained for fifty years, it has held up remarkably well. However, since this cover type encourages pedestrian use, it conflicts with policy guidelines to avoid all traffic on the earthworks, and if used on original earthworks would lead to excessive trampling.

Other Proposed Non-Plant Cover Types

Some interest has been expressed in non-plant stabilizing materials, such as plastic fibers and netting as well as soil cement and epoxy treatments. While limited use of some of these products may be useful for reclamation of severely disturbed areas, none is applicable for broad application in

earthworks stabilization. The cost would be prohibitive and in many cases such treatment would actually inhibit the establishment of stable vegetative cover and long-term preservation.

D. RECOMMENDED VEGETATIVE COVER TYPES

In order to provide vegetative cover that will be lower in cost, easier to maintain and that will also protect the resource, four cover types are recommended. Forest and Light Forest cover types are suited to closed forest landscapes, where canopy cover is virtually continuous and woody plants provide primary stabilization. Tall Grass and Turf cover types are suited to open field landscapes where herbaceous plants provide primary stabilization. For both forest and field landscapes, there is a high-maintenance and low-maintenance alternative, each with appropriate interpretive strategies to permit visitorship to the earthworks without degradation.

Forest and Tall Grass, which provide the greatest level of stabilization and require the least maintenance, should become the most prevalent cover types over time. Light Forest should be restricted to areas where visibility is important and is related to appropriate interpretive facilities. Turf, which is already too extensive, should be substantially reduced. The existing Rough Grass, Cleared Woodland, and Vine cover types should be completely phased out, and current management of these cover types immediately revised.

FOREST COVER TYPES

Forest Cover Type

The forest cover type [see Figure 6] is comprised of naturally established native forest communities. The forest landscape is enclosed and intimate. Visitor attention is focused on specific site details, rather than on the larger panorama. As development increases everywhere, the experience of real forest becomes more special and immediately conveys the sense of stepping back in time. The fact that these earthworks were not forested at the time of the battle is not likely to confuse the visitor either. Rather, the visitor will experience the excitement of discovering the artifact

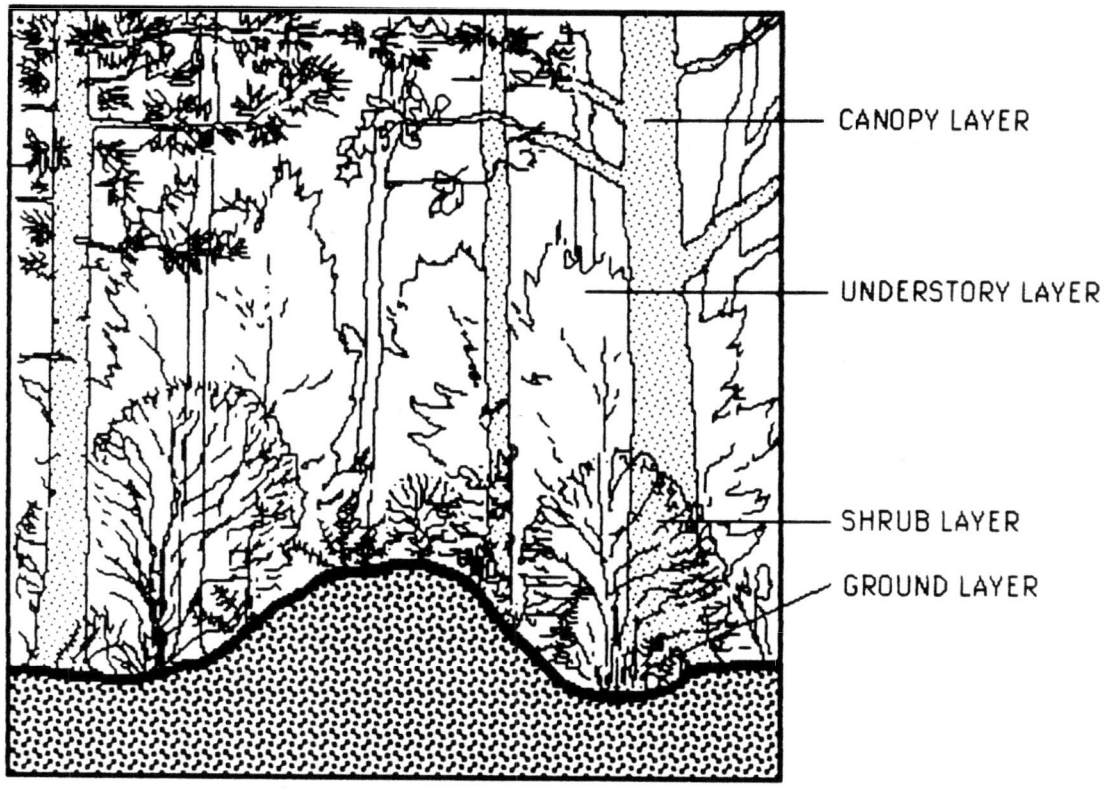


Figure 6:
Recommended Forest Cover Types: Forest

Dense native forest managed to maintain multi-aged, multi-layered structure. Monitor for hazards, such as windthrows, animal burrows, and relic hunter's holes.

preserved beneath the forest blanket. In addition, many of the forested sites occur where land parcels are quite small and only forest cover provides an adequate buffer from the intrusions of surrounding land uses.

Because of the limited tolerance to trampling of the forest cover type, all interpretive facilities require a high degree of control of access. No undirected interpretation should be permitted. For example, a parking area and signage without a related path system only invites misuse of the resource by the visitor. It is also important that the path system clearly convey the message of the fragility of the earthworks and forests. Therefore, a boardwalk, slightly elevated and preferably with railings, is recommended rather than a simple paved trail. A boardwalk allows the visitor to see the earthworks from different elevations and can compensate for the limited visibility within the forest. Views can be directed to site details, which might otherwise be overlooked from a paved path. Signage should occur along the entire journey at selected viewpoints, rather than occurring only at the point of entry. Boardwalks are more costly than paved trails and will require careful planning and a well thought-out design. In places, a combination of boardwalk and path trail may also be reflective. Sustaining the remarkable level of preservation of many forested sites is worth the investment and allows these areas to be interpreted. Vandalism, when it does occur, is most likely to be directed toward the facilities, which are replaceable, rather than toward the resource.

Virtually all currently forested or recently cleared sites are suitable for the forest cover type, although it is largely restricted at present to uninterpreted sites. When established and protected from disturbance, these sites are virtually self maintaining. Under forest, the ground is protected from erosion and monitoring will control damage from windthrows, rotting stumps, burrowing animals, and relic hunters. Because forest cover restricts access more effectively than any other cover type, all remote uninterpreted sites should be left forested or allowed to return to forest.

The ultimate managment objective of the forest cover type is to have a stable, healthy, and self-sustaining native landscape community requiring almost no maintenance. Where the budget allocation is directed primarily toward upgrading the interpretive program, education about historic native habitats should also be incorporated into the program, and might address such issues as timber harvesting, medicinals, livestock browsing, hunting

and trapping, and other historic uses of forest resources, as well as the natural and ecological history of native habitats.

Light Forest Cover Type

Light Forest cover [see Figure 7] is simply naturally established native forest communities which have been selectively thinned or prescribed burned to provide greater visibility, while retaining the natural stratification of canopy, understory, shrub, and ground layers. As a management type, it is recommended to replace the present cleared woodland cover type, which removed all trees less than 13" dbl caliper and all shrubs, thus eliminating long-term forest vegetation.

The character of a light forest should be similar to the surrounding native forest. Visitor attention should be focused on the earthwork, without a specific awareness of the thinner cover.

Selective thinning and prescribed burning are intended to maintain the natural layered structure of the forest, removing only a portion of the shrub and understory plants, or reducing their height, rather than removing these layers completely. In this manner, greater species diversity can be maintained as well as reproductive continuity of the forest community.

FIELD COVER TYPES

Tall Grass Cover Type

Tall grass cover is composed primarily of native grasses with occasional naturalized alien grasses and wildflowers [see Figure 8]. Tall grass cover that is not mowed or burned yearly or bi-annually will return to forest. The root systems of tall native grasses are relatively dense and deep and this cover type provides excellent stabilization. which is persistent and requires low maintenance. Pasture is a more intensely managed alternate to native grasses, which today is comprised primarily of Kentucky tall fescue (K 31), chewings fescue, and clover.

At present, examples of tall grass cover are found on virtually all abandoned crop and pasture fields in the region. These areas typically revert to native grasses before gradually returning to forest or being

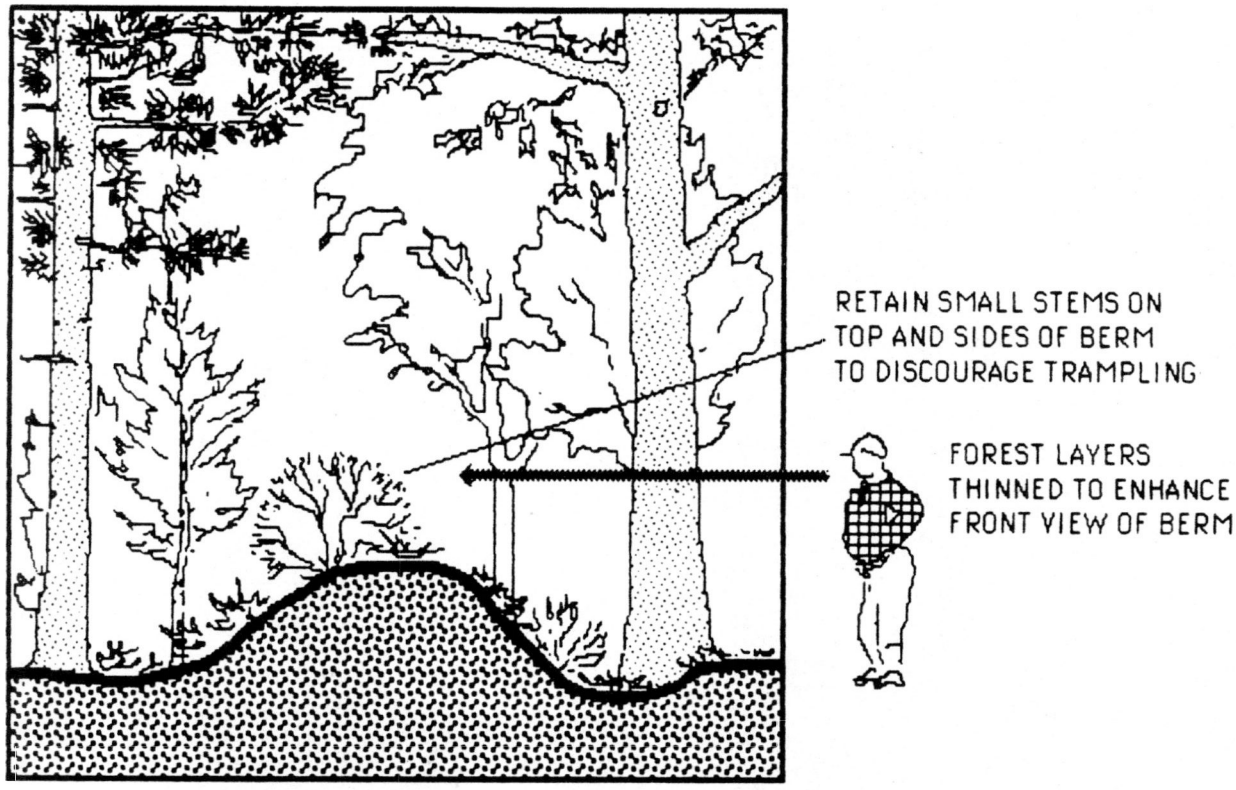


Figure 7:
Recommended Forest Cover Types:
Light Forest

Native forest selectively thinned in the shrub and understory layers to allow adequate visibility while retaining overall layered structure. Only a small amount of thinning should be done each year.

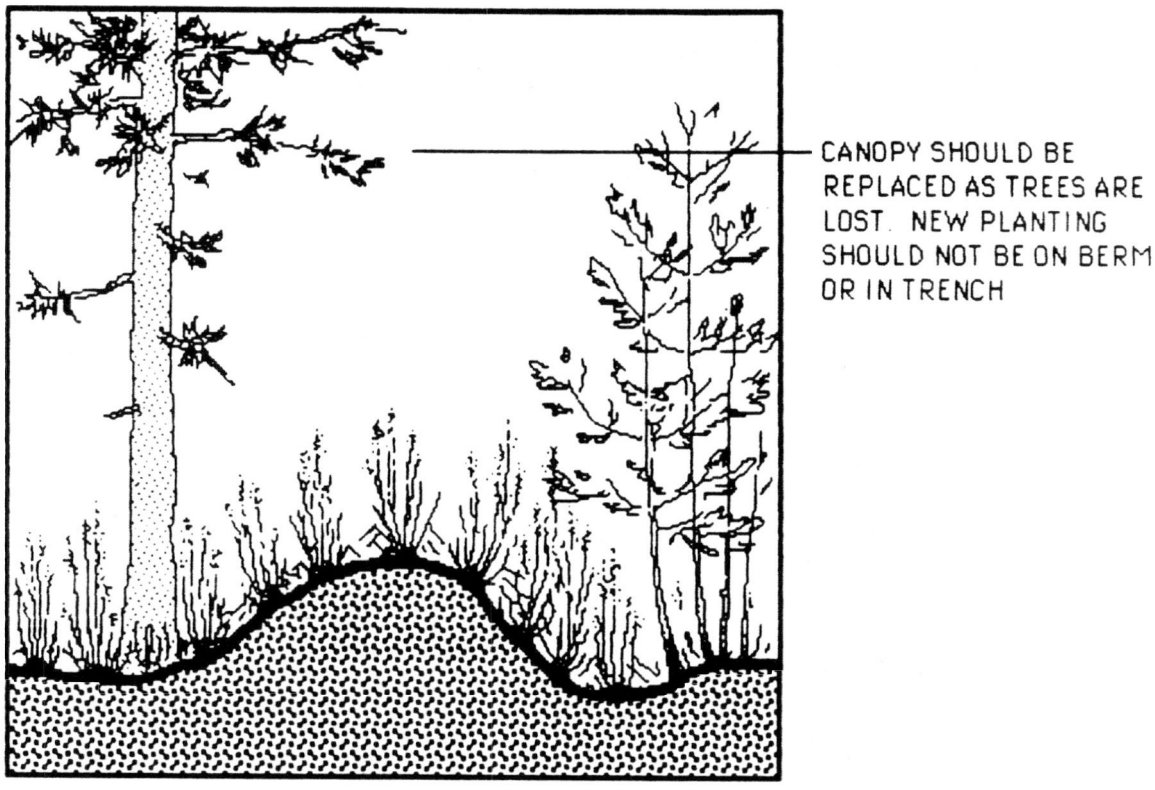


Figure 8:
Recommended Field Cover Types:
Tall Grass

Dense stands of native grasses, primarily little bluestem, under a light tree canopy.

taken over by vine mounds. The most predominant grass is little bluestem which is also called locally broomsage or broomsedge, and is botanically familiar as Andropogon scoparius, recently reclassified Schyzachrium scoparium. Most of the recently cleared woodlands in the park are developing native grass cover naturally. It usually takes at least three to five years for dense cover to establish, as most of the grasses in the parks are long lived and relatively slow to develop.Portions of tall grass meadows occur at East and Bloody Angles, in Spotsylvania, and between Fort Stedman and Colquitt Salient, and in virtually every park, although most are being managed as rough grass.

Tall grass cover is especially suitable for sites where a dense stable cover can be established fairly quickly, with some alterations to current management practices. Some examples include portions of East and Bloody Angles and Colquitt Salient. Almost any open site with 40% or less tree cover can be stabilized with native grasses. The acid, infertile subsoil which occurs at the surface of most earthworks is a poor growing medium for turf but will support dense growth of native grasses with only minimal maintenance required.

There are extensive areas in the park units which now support poorly established native, pasture, and rough grasses. Many sites currently maintained as rough grass provide less effective stabilization than they might. If they were managed to favor tall grasses instead, a considerable cost saving over time could result.

From an interpretive perspective, tall grass discourages trampling and access more effectively than turf and still provides excellent visibility of the earthwork. The path system for interpreted earthworks in tall grass cover can be either hard surfaced or turf. It is recommended that turf trails set in larger tall grass areas should be eight to twelve feet wide to limit concentrated foot traffic and to minimize visitor exposure to ticks and other pests. The general guidelines for paths would be similar to those for other cover types, keeping to level ground adjacent to the earthwork and minimizing crossings. No trail should be located on the top of an earthwork and all crossings should occur slightly above grade.

The most significant opportunities for tall grass cover occurs at sites designated for scene restoration, where large expanses of herbaceous cover must be maintained economically. Like turf, tall grass can be used to create broad sweeping vistas and reveal the natural contours of the land,

as well as the dramatic forms of the earthworks where it is desirable to give the impression of an historically accurate setting, tall grass is preferable to because, of its natural character which creates a pastoral rather than a park-like setting. A rich interplay of native field and forest habitats could provide a landscape very similar to that which must have existed during the Civil War and this evocation of an historical setting is increasingly important to a coherent visitor experience as the surrounding rural environment, which once was the context for all the parks, disappears. The relatively uniform character of a tall grass meadow can create the image of 19th-century agricultural use.

Agricultural pasture grass should be considered a suitable alternative to native grasses only where grazing livestock is deemed integral to scene restoration and where the area can be adequately maintained, including mowing, fertilizing, and periodic reseeding. It is recommended only for open fields with no cultural resources. It is not suitable for earthworks, or where actual cropping or pasturage would result in environmental damage through erosion, or threaten critical cultural resources through the grading, tile drainage and access roads associated with modern agriculture.

In summary, existing turf and rough grass areas which cannot be adequately maintained could be effectively converted to native tall grasses. The major obstacle in establishing this cover type is the limited experience in creating and managing meadows. The manual guidelines are only a beginning and should be continuously revised and updated as expertise is gained.

Turf Cover Type

The Turf cover type [see Figure 9] consists of mown lawn grasses with occasional groves and specimen trees. It is described fully in the existing cover type section. Turf is an effective stabilizer only when properly maintained. The use of turf as a cover type must be accompanied by a real commitment to regular care and immediate patching of washed out or thin areas.

Because turf is an effective stabilizer of earthworks only when well maintained and is far and away the most costly cover type, it should be restricted to those areas where it meets special interpretive needs, and to

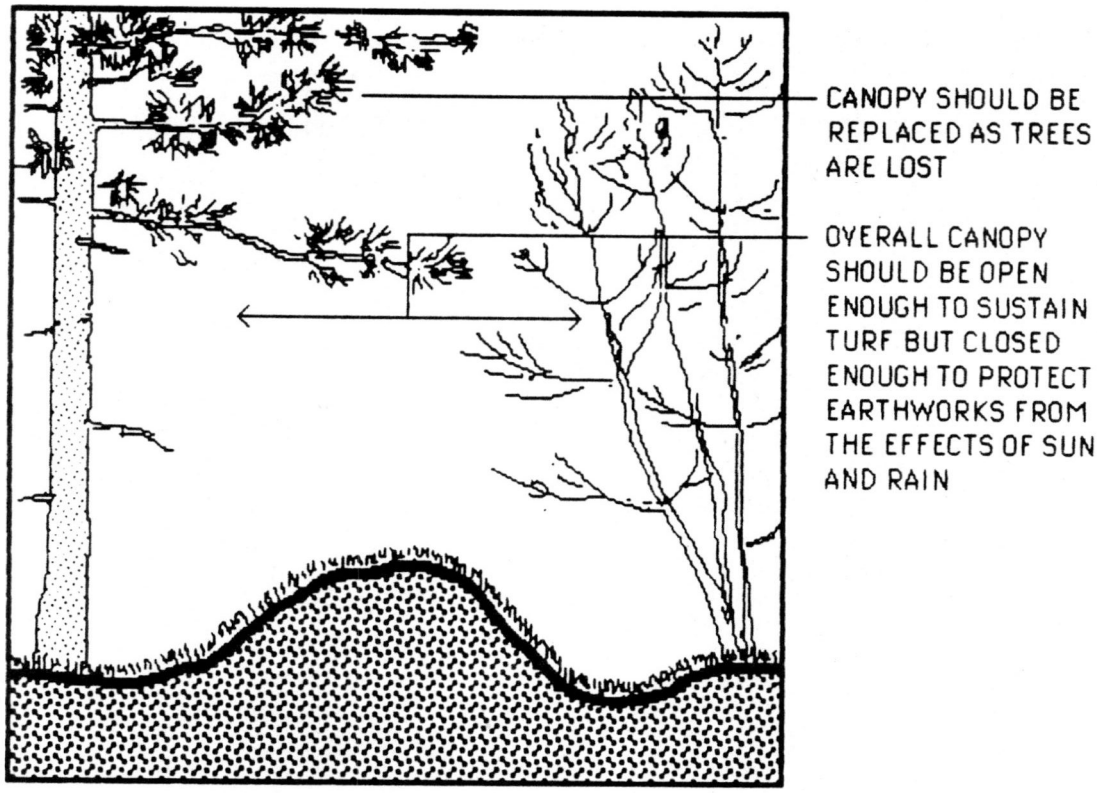


Figure 9:
Recommended Field Cover Types:
Turf

Mown lawn grasses, with occasional groves and specimen trees. Turf should be managed to be dense and with a continuous cover to prevent erosion.

those areas where visitor use warrants such a high investment. Sites where recreational use is planned are also appropriate for turf, although use of turf can encourage casual use where it is not desirable.

Turf alone does not create a landscape setting. The overall character of a predominantly grassy landscape is actually determined by the topography of the site and by the landscape elements such as hedgerows, groves and woodlands, which define the spaces and the views. Whether a literal scene restoration is undertaken or not, it is important to address the aesthetic considerations which establish the park character. Many of the open spaces in the park are relatively small when compared with the historic landscape, due to forest regrowth and the limitations imposed by the park boundaries.

In order to enlarge the sense of perceptual spaces broad changes in the scale and texture of the landscape should be used to create a landscape setting which includes foreground, middle ground and background.

For example, a specimen shade tree near a visitor center might frame a view across a lawn to a tall grass meadow embraced by groves of trees in the middle ground, with the forest beyond in the distant view. In this way, the lawn occurs in a larger landscape context evocative of the era, but restricted to those areas intensely used by visitors and to selected memorial settings.

All cultural sites with turf cover should have a hard surfaced path system. Even turf will not tolerate excessive trampling and grass paths cannot be appropriately delineated. Asphalt paving is currently most frequently used; however, gravel paths and other historic paving materials, such as brick dust and crushed shells should also be considered for use, as well as porous asphalt. Appropriate stormwater management of path drainage is crucial to prevent erosion at the edges and bases of paths. Existing eroded edges should be patched during the Interim Stabilization Program, such as at Battery 5.

A path should never run along the top of, or cross over or run through an earthwork. Where a crossing is mandatory, a wooden stile which does not touch the earth surface should be used. The unvegetated portion beneath the decking can be stabilized with gravel. Specific viewing sites and associated interpretive signage should be incorporated along the path journey. When existing path systems require restoration, a complete

review of their suitability relative to these guidelines should be undertaken. Redesign of the system should be completed before any renovation work is undertaken.

The most significant deviation from these recommendations occurs at Colonial, where uniform turf cover is maintained in the central interpreted area adjacent to the Visitor's Center. At Colonial, current maintenance is generally adequate to maintain cover despite heavy use, but there are some localized problem areas which should be evaluated in light of these recommendations. In places, the turf simply needs renovation, but where eroded pathways are developing, a more stable path surface or more effective control of pedestrian movement may be required. Similar situations occur elsewhere, for example, at Gettysburg where reconstructed lunettes are turf covered and well-trampled. A long-range plan should also be undertaken to determine if a suitable path system can be reasonably developed to eliminate the conflicts between Colonial and the other earthworks parks units where no walking on earthworks is permitted.

In summary, at present, the extent of turf in the parks is greater than can be adequately cared for or protected from inappropriate use, and maintenance costs monopolize budgets despite the needs or other areas with serious environmental problems. Many areas currently in rough grass would be better maintained as tall grass rather than turf. Thre were no sites observed in the field which warrant conversion to turf. Where an authentic restoration of the historic scene is desirable, turf should only be used where turf occurred historically. It is not a suitable substitute for pasture, meadow, or cropland. Most importantly, a careful reevaluation of the need for turf for interpretive purposes must be undertaken, and a program for the selective reduction of the extent of turf initiated. The Management Manual is directed toward maintaining a limited area of well-care-for turf only where visitorship and facilities are concentrated.

E. RECOMMENDED INTERIM STABILIZATION PROGRAM

Introduction

The National Park Service is committed to both preserving and interpreting the historic Civil War battlefields in their care. Clearly, however, there can be no interpretation if there is no site, and current conflicts in policy are resulting in a rate of deterioration of this irreplaceable resource that amounts to a crisis of major proportions. The recommendations contained in this section, therefore, emphasize the fact that preservation must come first, if there is to be a resource worth interpreting, and that there has to be an immediate change of priorities if this preservation effort is to succeed. Once a successful preservation program is in place, the interpretive programs can be evaluated and fully integrated with the management of the sites.

The recommendations address both the specific methods of preservation and the strategies by which the current management crisis can be handled in the interim, as the new program are phased in. The recommendations are as follows:

1. Moratorium

The evaluation of current management practices identified severe conflicts between preservation and interpretation. Many current practices directly damage the earthworks, as well as being detrimental to other cultural and natural resources within the parks. Access and security needs, for example, are almost always met at the expense of preservation, and the long-term quality and survival of the resource is compromised. It is recommended, therefore, that there be an immediate moratorium on the development or implementation of any new program, practice, or facility. This should remain in effect until the most critical problems of preservation have been identified and critical situations stabilized.

2. Interim Stabilization Program

Following the implementation of the moratorium, immediate steps should be taken to identify the most pressing problems and institute an interim stabilization program to deal with them on an emergency basis while a full long-term program is being developed. The goal of this program is to achieve adequate stabilization of all the sites and should include the following components:

2a. Reconnaissance Survey

A reconnaissance survey of all the sites should be undertaken to determine the level of stability of the resource, with an inventory of all severely damaged or threatened areas. Because of the importance of achieving a proper balance of values in all the issues involved, the survey team should be comprised of the director, senior staff responsible for both cultural and natural resources, and the chief of maintenance in each park.

The extent and severity of all damaged or threatened areas should be identified and mapped by the inventory team. This should include, but not necessarily be limited to, the following: inadequately stable cover types, such as cleared woodland; poorly established cover types, such as failing turf; disturbance vegetation; dead or dying trees which threaten earthworks or other resources; damage from stormwater, including erosion, sedimentation, and earthworks collecting roadside drainage; damage from relic hunting, trampling, windthrows, animal burrows, or trails; and damage resulting from inappropriate facilities.

2b. Determination of Cause

In each case, where damage has been identified, the cause of the damage should also be determined. In particular, it is important to identify whether the cause is external, such as increased stormwater runoff generated by adjacent development, or related to Park Service practices, such as a poorly designed path.

2c. Establishing Priorities

Not all problems will have the same level of urgency, so it is essential that a clear list of priorities be established. This should be closely tied to an action plan that ensures that the most critical areas get immediate attention and that damaging or destabilizing practices are discontinued.

2d. Action Plan

An Action Plan for stabilizing every site should be implemented. At this stage, the focus should be on early and effective action, guided by the priorities established above, to halt the most serious deterioration. In the long term, it is recommended that the principal method of stabilizing the sites should be the establishiment of appropriate vegetative cover. To do this for all the sites will require a careful program that will take time to achieve and this is addressed more fully under the heading 'Permanent Program' at the end of this section and in the Management Manual. The Action Plan is designed to enable stabilization to begin immediately. Many of its recommendations are very simple, such as the cessation of mowing. Specifically, the main areas of concentration should be:

i.) All management practices that destabilize the vegetative cover, such as brush clearance on earthworks, or more than twice a year mowing of any grassland area (except turf) should be stopped.

ii.) All conditions where bare soil exists should be repaired and revegetated (except living history and demonstration reconstructions).

iii.) Facilities that tend to destabilize the resource should be removed or repaired. This may entail a temporary reduction in the level of interpretation and/or access until stabilization is achieved.

iv.) Management practices which increase maintenance demands, such as forest clearance for scene restoration and turf establishment, should be halted until all existing sites are adequately stabilized.

The Interim Stabilization Program is intended to address the most serious degradation of the resource at the earliest possible time. It can, therefore, only deal with the most obvious problems in ways which do not require lengthy research, major changes in long-term policy, or reeducation of staff. However, there is no hard and fast line between the recommendations for immediate action and those for the long term, and it is expected that the Interim Stabilization Plan will, in fact, be the first steps to the implementation of a permanent program.

3. Establishing a Permanent Management Program

A permanent program for the management of all the National Park Service sites should be established, which ensures the survival of the resource for the conceivable future, is fully integrated with all interpretive programs, and is compatible with the needs of daily operation, security, and maintenance of each site. Since current practices have been the cause of many of the problems in stabilization, there will be a need for a period of transition, during which workshops and demonstation projects should take place in order that the new policies can take root and become firmly established in the institutional fabric. It is suggested that the following steps be taken to implement the permanent program:

3a. Establish Standards for New Cover Types

One of the principal management recommendations is the establishment of appropriate vegetative cover at all the sites. Forest is the natural condition for this area and as such gives the maximum protection from both man-made and natural erosion. It is also the least costly to maintain once properly established. In all cases, therefore, compatible with the function of the area, the object is to move the cover type closer to the natural forested condition. On most sites, this will mean that there has to be a transfer of cover type from what is currently there to the recommended type. This can be briefly summarized as follows:

i.) Where the current cover is healthy forest this should be kept.

ii.) Where the current cover is cleared woodland, this should be allowed to revert to forest.

iii.) Where the current cover is rough grass, this is should be converted to tall grass meadow.

iv.) Where the current cover is turf, this it should be evaluated for condition and need, and where possible, be converted to tall grass meadow, or otherwise remain in turf.

Specific methods for the establishment and management of the recommended cover types are described in the Earthworks Management Manual.

3b. Establish Design Standards Compatible with Preservation Goals

Not all of the problems in the parks are caused by inappropriate vegetative cover. There are many examples of design flaws that cause unnecessary damage, such as paths that lead people into sensitive areas, poorly placed signage, poorly located parking and entrance areas, poorly placed drainage, etc. These are all matters of design and can be changed provided there are clear guidleines that relate to preservation and management. Such guidelines should be developed and should address, but not necessarily be limited to, the following issues:

i.) All facilities for access and interpretation and maintenance should be designed for the least possible intrusion on the resource. In particular, penetration or other disturbance of the ground that would disturb the archaeological strata should not occur unless there is absolutely no alternative.

ii.) Construction techniques for any new facilities should be compatible with preservation goals; structures, for example, should avoid extensive foundations, services that need extensive trenching, or methods that require heavy machinery and equipment, should also be avoided near the resource.

iii.) Address stormwater management and erosion and sedimentation control design standards for application within the parks.

iv.) Existing facilities that do not meet these requirements should be redesigned.

3c. Establish Preferred Standards for Community Context

Some problems originate outside the parks. Originally, most of the battlefields were in rural areas,but as time has passed, development has begun to encroach on park perimeters, causing a number of problems. A review of the immediate context of each park should be undertaken that addresses, in particular, the following issues:

i.) Stormwater management standards, erosion and sedimentation control standards, and enforcement strategies should be developed for all park watersheds. Ideally, this should be done in coordination with local regulatory agencies.

ii.) Policies to address the casual recreational use of the parks by people from adjacent communities should be developed. These may range from denying or restricting access to severely impacted sites, to promoting alternative recreational developments in cooperation with appropriate county and municipal agencies.

iii.) Develop a protection plan for each site, in cooperation with local agencies, civic and other private groups that will act as an early warning system against possible threats and help develop an informed support constituency for the parks.

3d. Workshops and Demonstration Projects

To explain and establish the new management policies, there should be a program of workshops and demonstration projects. These will be given, in cooperation with the Park Service, by Andropogon Associates Ltd., Soil

Bioengineering Corporation, Inc., and other consultants. The focus will be on the three major issues addressed in the Earthworks Management Manual:

i.) Learning to evaluate the sites to determine appropriate management solutions.

ii.) Learning methods of reestablishing ground stability and establishing recommended new cover types.

iii.) Learning methods of managing the new cover types over time.

It is important to reaffirm, at all stages, the necessity for the integration of all aspects of the operation of the Parks; therefore, as with the reconnaissance survey, the workshops should be attended by directors and staff responsible for both natural and cultural resources, as well as maintenance and other personnel. The workshops are primarily designed to introduce a policy and kick-off the permanent program; however, as the program becomes established, it is also recommended that workshops become a regular part of the National Park Service routine, both to train new personnel as they come into the Service, and to ensure that the program is updated as experience grows and that the basic principles are adhered to over time.

The demonstration projects will be useful on several counts. Initially, test and control plots should be established to monitor the effectiveness of different management practices. These will be useful in both the current and future training of personnel. They will also be useful for obtaining preliminary data on the actual costs, in real time, manpower and expenses of different techniques, which could ultimately be convertible into realistic budget allocations and scheduling for future preservation and management.

4. Integrating Interpretation with Management and Preservation

The emphasis of the recommendations has been on stabilizing and preserving the resource, and on the continuing managment of that resource into the future. Although it is not in the scope of this report to specifically address the subject of interpreting the sites, it is

nonetheless critical that all standards and activities relating to stabilization, preservation, and continuing management, be developed in the context of interpretation.

As preservation and management needs of each site are identified and developed, it will become imperative to develop a parallel program for interpretation that dovetails with the preservation effort. Clearly, many on-going interpretive programs will continue, though perhaps with an altered context in the light of new preservation and management imperatives. However, there is considerable scope for the development of new interpretive ideas that do not conflict with preservation objectives. Many current sites are visually similar, and the frequently used 'Park Drive' concept is increasingly compromised by surrounding development. Furthermore, forested sites are virtually uninterpreted, despite the fact that they contain some of the most dramatic earthworks. New interpretive programs should therefore be developed that highlight the special character of each park. On forested sites, programs could be designed to preserve the resource by controlling the access appropriately while providing the visitor with a rich and dramatic story. In contrast, broad fields spanning the battle scene offer equally dramatic interpretive opportunities.

5. Conclusion

Preservation is the cornerstone of the National Park Service policy. This is intelligent and right. However, a false dichotomy has somehow permeated the institution that there is an inherent conflict between preservation and interpretation. It is the contention of this report that this is not the case. In fact, solutions to many of the perceived conflicts are very simple: just stop doing something that is both detrimental and not needed. Almost without exception, the recommendations made herein are cheaper, more cost effective in the long run, and easier to implement than many current practices. They do require that the parks be seen from, a new perspective. For not only are the solutions there for those that wish to see, but with imagination and dedication, a much richer and fuller future is possible for these legacies of our most traumatic period in America's history.

F. MANAGEMENT MANUAL INTRODUCTION

Management generally consists of a set of typical practices which are repeated over and over again. In the case of the earthworks parks, these practices include lawn and meadow mowing, brush and understory clearance, installation of paths and features, etc. Despite the diverse characters of the parks examined, current management practices are remarkably simplistic, often leading to consistently negative impacts. The goal of this Management Manual is to replace this widespread set of current practices with an alternate set of practices that are more effective in preserving the cultural and natural resources, both in the short run and over time.

The Manual is comprised of two major sections. The first addresses vegetation management of the recommended cover types, from on-going maintenance to restoration practices. The second section addresses the repair and restoration of sites where disturbance of the ground stability has occurred.

The maintenance of healthy native plant communities lies at the foundation of this Manual. However, native vegetation is the one aspect of the park sites that park personnel are generally the least familiar with. The contribution of native landscapes to the site character is frequently misunderstood and undervalued. It is recommended that each park seek additional training in recognizing native plant communities and the patterns of natural succession as well as disturbance.

Monitoring and Evaluation

The continuous monitoring and evaluation of a site over time is a critical component of an effective management program, and is limited by the accuracy and the continuity of observations of site conditions over time. Because a landscape is a complex living system impacted by an incredible

variety of factors, many of which are beyond the control of the National Park Service, the best management that which is highly responsive and adaptable to changing circumstances.

The object of site monitoring and evaluation is to identify and record an accurate description of what is happening at each site over time -- to see change, so that management can be effectively adjusted accordingly. The goal is to look at both the whole site and to see it as a complex system, as well as the specific symptoms of change or disturbance which may require action or closer scrutiny. Particular problems, such as a windthrow on an earthwork, are often straightforward to deal with. However, larger decisions, such as the need to significantly alter an interpretive scenario, require a clear perspective on the whole site.

Because no one factor necessarily overrides any other, it is important that the evaluation be undertaken by representatives representing both natural and cultural resources as well as park administration, security, and maintenance. Field review and evaluation of all earthworks sites should be made on an annual basis and form a significant portion of the data base for developing the next year's management program and clarifying long-term goals.

The site monitoring and evalutation team should be equipped with pencils, a clipboard, adequate evaluation forms, and blank site maps (8-1/2 X 11"), a duplicate of last year's evaluation forms and maps, as well as a 100' measuring tape. A camera is also advisable for recording site information. Surveyor's flagging tape may also be useful.

The original site evaluation forms and maps should become part of a site notebook which is kept, independent of office files. Its purpose is to monitor and document each site's condition as well as the nature and effectiveness of management to date and over time.

G. MANAGEMENT GUIDELINES FOR RECOMMENDED FOREST COVER TYPES: FOREST AND LIGHT FOREST

FOREST COVER TYPE

Criteria for Forest Review & Evaluation

Each forested site should be examined as part of a larger regional forest system as well as a discrete unit of forest. The conditions which are necessary for long-term growth and health must be respected when management is undertaken.

Forest is the highest value cover type and every effort should be made to retain it intact and in a healthy condition wherever it currently exists. Under no circumstances should forest be converted to a less stable cover type and most Cleared Woodlands should gradually be returned to forest. Limited areas of Light Forest should be substituted for Cleared Woodlands, but only where there is an overriding interpretive demand.

Configuration

One of the most critical aspects of a forest is its configuration. The once virtually continuous forest cover which greeted the European settlers has been reduced to fragments and strips in an increasingly developed context. Species composition has been effected, invasive alien species and pests have been widely disseminated, and the natural processes and cycles, such as fire or rainfall and recharge, have been substantially altered. The most endangered habitat of all is the forest interior and the species limited to that environment. While a popular axiom holds that edge conditions are favored by wildlife (often 'game species') and urges the creation of more

edge, a more realistic view is that edge abounds, while the amount of interior is diminishing steadily.

This issue is an important one for management. In the past, decisions to clear forested land for scene restoration have often been made on interpretive bases alone, without consideration of the impact on long-term management of natural resources.

Measurements of the distance into the forest over which edge effects occur are variable, and may range over 300 feet. Therefore, a block of forest 1,000 feet square or almost 23 acres in size can support little more than 3-1/2 acres of interior habitat. A minimum of ten acres of forest is required, roughly circular in shape, to reliably support any interior habitat at all. Clearly then, every effort should be made to minimize disturbance to any forested blocks over ten acres in size. This includes road building and facilities development as well as the clearance of vegetation. Where disturbance does occur, it should be confined to the edges, which are already more subject to disturbance and more accessible to management. Since most disturbance in a forest stems from the edges, large unbroken forest tracks require the least management of all landscape types and permit management budgets to be spent primarily on serving visitor and interpretive needs.

The long-term management of smaller and narrower forested areas, which might not necessarily support interior habitat, is also facilitated by limiting the amount of edge condition created and sustaining a less fragmented pattern. Long-term management costs will be reduced and long-term maintenance of native communities will be fostered.

Continuity

Continuity is as important to natural systems as configuration. Islands of habitat isolated from surrounding natural areas experience a decline in native species diversity and are less adaptable to stress over time. Management and proposed alterations in current forest patterns should always foster, rather than reduce, the continuity of natural habitats. Critical forest linkages should be protected and missing links should be reestablished through management. This is equally important at all scales of the landscape.

Natural Processes

A major goal of management is to undertake the least intervention necessary to achieve the desired condition. In all cases, where natural processes regulate and sustain the habitat, the need for outside management diminishes while increasing the health of the whole landscape system.

Environmental conditions have been substantially altered by man's activities over time and severely compromise the long-term prospects for the sustenance of complex natural systems. Some impacts are virtually global, such as the greenhouse effect, and can only be minimally offset by actions within the park. The maintenance of expansive forest cover is somewhat helpful, for example. Others, such as acid rain are expressed more regionally and can be substantially impacted by activities and regulations at the federal and state levels. Still others are operative almost entirely at the local level and the gradual accumulation of negative impacts can be substantially turned around by actions taken within the parks and surrounding communities. It is these issues that are primarily addressed in the Management Manual.

Hydrology

Throughout the developed landscape, a major shift in natural hydrology is occurring. Water which previously was recharged into the ground to support the water table and the base flow in streams is being collected on impervious surfaces and in pipes and discharged as stormwater runoff. Streams become flashier; that is, peak and flood flows increase dramatically, increasing both erosion and sedimentation, while streams dry up during droughtier periods because of lowered groundwater elevations. Newly implemented regulations focus primarly on the retention of stormwater to reduce flooding conditions downstream in severe storms, but rarely result is more effective recharge, and often ignore the negative impacts of the high-frequency rain storm which may be a real gullywasher after development has occurred. These impacts occur at every scale, from road drainage which is inappropriately discharged into an earthworks trench along a park road to the wholesale development of a creek's watershed beyond park boundaries such as Poor Creek in Petersburg. The impacts are varied and often severe. Earthworks and other park features,

including roads and bridges are structurally undermined, native plant communities are subjected to severe stress, and the long-term protection of surface and groundwater resources jeopardized. The problem must be looked at at all levels. The next to last section of this manual -- Restabilization and Repair of Ground -- deals with specific design details and restoration techniques to repair damaged sites and to limit further disturbance which can be undertaken within the parks. The last section describes regulatory issues in operation beyond the park's boundaries which could be pursued by the National Park Service to foster better regional stormwater management.

Fire

The control of fire has been a focus of forest management for so long that many people forget that fire was once integral to the natural processes of the forest. Some areas, such as sandy, barren sites with mixed oak and pine often burned more frequently and visibly, but no forest does not have a fire history. Recent management efforts have concentrated on a rediscovery of the importance of fire to the management of natural areas, as well as to the beneficial effects and relatively low cost of fire as a management tool. Management approaches range from virtually wild fire cycles which are being reinstituted on large tracts where a major conflagration would not pose undue hazard to settled areas to annual winter burns over smaller areas to favor certain game species and reduce the likelihood and severity of wildfire. Ultimately, the goal of all fire management should be to restore as near a natural fire cycle as possible. In most areas of the earthworks parks, light controlled burns limited to restricted sites are probably the most feasible.

Since most of the earthworks were once battlefields, there is the possibility that unexploded shells could be buried in the earthworks. Both the U.S. Army Ordinance Section and the National Park Service have expressed concern that burning might ignite some of these shells. Because each site history is unique and subsequent use different, this issue will have to be addressed on an individual site basis by a team of fire management people, explosive experts, local park historians, and regional staff.

The National Park Service recognizes the importance of fire as a management tool. Consequently, guidelines for the control of wildfires and

the management of prescribed and research burns have been developed and are described in Wildland Fire Management: NPS 18. Major topics included in this Manual are the identification of roles and responsibilities of governmental agencies, procedures for fire analysis, documentation, and staff training and distribution, as well as guidelines for wildfire control and management objectives for prescribed burning.

Highest priority should be given to reestablishing fire in larger forested tracts, especially those which support interior. A pulsed cycle, with varying intervals of burn, rather than regular intervals, is preferable. For example, annual burning for the first few years in a forest to reduce fuel accumulation and renew herbaceous cover may also stimulate germination of oaks and other woody species. At this point, fire could be withheld to allow the new saplings to develop a to sufficient size so that they would not be killed by a light ground fire.

Second priority for fire management should be given to those areas where fire management could serve interpretive needs, while maintaining stable cover and reducing long-term management costs. For example, flanks of earthworks along park roads currently managed by clearing, which often causes erosion, could be managed by fire to form more stable herbaceous and low shrub growth as well as increasing visibility.

There are several caveats to fire management. Adequate control of a prescribed burn is dependent on a system of fire breaks, which may include natural features, such as streams and wetlands, or built features, such as roadways and lawn areas. Where new fire breaks are required, careful review is mandatory to ensure that the firebreak does not serve as a route for disturbance, disrupt natural drainage, or otherwise adversely impact the forest.

Natural Checks and Balances

The components of natural habitats found in a region have coevolved over millennia and produced a natural system of checks and balances. While this does not insure that dramatic change will never occur, the overall vulnerability of a complex community to natural stresses is reduced. The introduction and often widespread dissemination of an alien species by man into an environment where there are no natural controls or defenses can be devastating. When kudzu was in vogue, for example, and falsely

perceived of as a cure-all for erosion, over 34 million seedlings were distributed from a government nursery in Georgia. While it is true that over time natural systems will change in the presence of a new entity or disturbance, it is also true that this change can decimate extensive areas of native habitat and limit the capacity for recovery in a system already severely hampered by a wide range of environmental stresses. Indeed, some native pests are exerting a greater influence now than in the past due to accumulated stresses on the landscape. The diversity and quality of protected natural areas are deteriorating everywhere in the developed corridor along the East Coast.

Even when the need to control diseases, such as Dutch elm disease, or invasive vegetation, such as honeysuckle is accepted, how to achieve effective results is often unclear or hotly debated. Despite the lack of widespread agreement on approach, several guidelines are appropriately followed.

Evidence is mounting that restoration practices which foster more natural fire and hydrologic cycles make natural the habitats more resistent to invasion by exotic plants and animals as well as to debilitating diseases and pests, both introduced and naturally occurring. Therefore, management which sustains natural processes and patterns in order to foster a healthy diverse community is the most resistent to a wide range of environmental stresses. The restoration of native shrub and understory layers and the reestablishment of a natural fire regimen appears to be more effective in controlling pine bark beetle, for example, than vigorous eradication and clearance efforts. Unfortunately, past management often has fostered the spread of exotic disturbance species and has tipped the scales heavily against native communities, warranting a concerted effort to mitigate the consequences. Japanese honeysuckle, an invasive species that was already widely distributed at the time of the Civil War, presents the greatest threat to forest resources in the earthworks parks, although other alien species may be a problem locally.

Current National Park Service policy favors the integrated pest management approach which seeks to achieve effective control rather than total eradication and to minimize the use of chemicles by employing a combination of methods, including mechanical and environmental controls, such as prescribed burning.

Objectives and guidelines for general management problems as well as specific targets are described in the National Park Service's Integrated Pest Management Information Manual. Split into two sections, the first part is a National Park Service policy statement on chemical control and the second is a series of updated information package on specific pest disease, or problem vegetation species. One of the most appropriate is Exotic Weeds II which focuses on Japanese honeysuckle; this section describes the plant's biology and ecology as well as techniques for chemical, mechanical, and environmental control. Essentially, the package recommends close monitoring and immediate suppression. If large areas are infested, immediate stabilization with native woody or herbaceous vegetation is recommended to prevent erosion. Where honeysuckle infestations are minimal, only minimal efforts should be necessary to prevent its spread, if adequately monitored. Control at the edges of larger forested tracks is particularly important in sustaining more extensive undisturbed habitats, while many narrow forested strips may present almost insurmountable control problems. In all cases, however, early efforts at control before infestation becomes widespread, are most effective.

Occasional concern is expressed over the natural aging process of a forest's development. As a landscape matures, for example, concern may be voiced that the older canopy is now vulnerable to disease or that the canopy should be 'therapeutically' thinned. There is no evidence that these concerns are real or that treatment is necessary or productive. More often than not it is destructive, so the temptation to "thin" in such situations should be resisted.

If larger scale decisions are appropriately made along these guidelines, routine maintenance of forested areas should be remarkably minimal. Once a healthy community is established, monitoring change over time is perhaps the most critical activity and insures that potential problems will be detected and acted on early. If further disturbance is curtailed, minimal effort should be required to limit the expansion of invasive species.

Occasionally, the removal of a dead or dying tree may be required if an earthwork or other resource is jeopardized by the likelihood of windthrow or drop of major limbs. Often, the root system may still be alive and may resprout, providing canopy replacement and limiting decomposition of the old root structure. In order to maximize the likelihood of sprouting, hardwoods should be cut before they are entirely dead and the trunk cut six

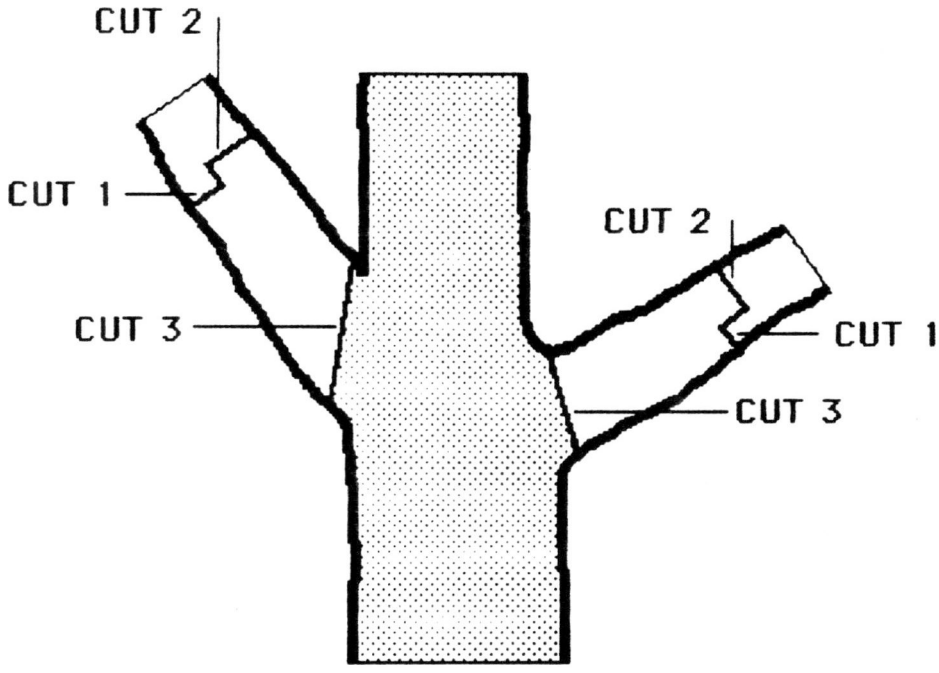
inches above the ground; the cut should be made at a slight angle to shed rainwater and minimize rotting. Evergreen species, which will not resprout, should be cut flush with the ground. Stump removal is not necessary. Standing dead trees which do not pose a liability hazard to the visitor or threaten a resource should be left standing and nature allowed to take its course. Such trees often provide critical den space and are an important food source for such species as woodpeckers. Felled trees, which cannot be conveniently removed, should be stacked with logs and brush in piles out of public view. A hazardous limb which threatens the earthworks or visitors should be cut appropriately [see Figure 10].

Natural Structure

A forest is naturally layered, and in this region typically includes a diversity of species in the ground, shrub, understory, and canopy layers. While some very young or very old landscapes might be notably less layered than others, the general tendency to layer or stratify can be seen even in the herbaceous oldfield where 'understory' and 'canopy' grasses can be distinguished. Management which eliminates one or more layers completely is especially disruptive, and the impact accelerates with an increase in the aerial extent of clearance. Not only is the existing structure destabilized, but a whole raft of "empty niches" are created which often are then colonized by rapidly spreading disturbance species.

Where layers of the forest are missing, especially on earthworks, some replanting is desirable. Vegetative cover on earthworks provides an essential reduction of the impact of raindrops, a major component of erosion. Where large stretches of an earthwork have inadequate cover, or where bare soil is exposed, canopy cover should be replaced. Both bareroot or balled-and-burlapped planting methods require excavation of a planting pit [see Figures 11 & 12]. Therefore, canopy replacement species should be not planted directly on earthworks trenches or over historic artifacts, but can be planted adjacent to them in order to achieve long-term canopy cover. Where bare soil is exposed on an earthwork, shrub mats (collected locally or propagated commercially) can be planted [see Figure 13].

The need to respect the forest's layered structure is most evident in the interpretation of forested sites, which previously were cleared to achieve greater visibility. While this practice should be eliminated, the need to view the earthworks and other features remains.



CORRECT CUTS TO PREVENT TEARING (1&2) AND TO ALLOW HEALING OF WOUNDS (3)

Figure 10:
Typical Pruning Detail for Large Branches

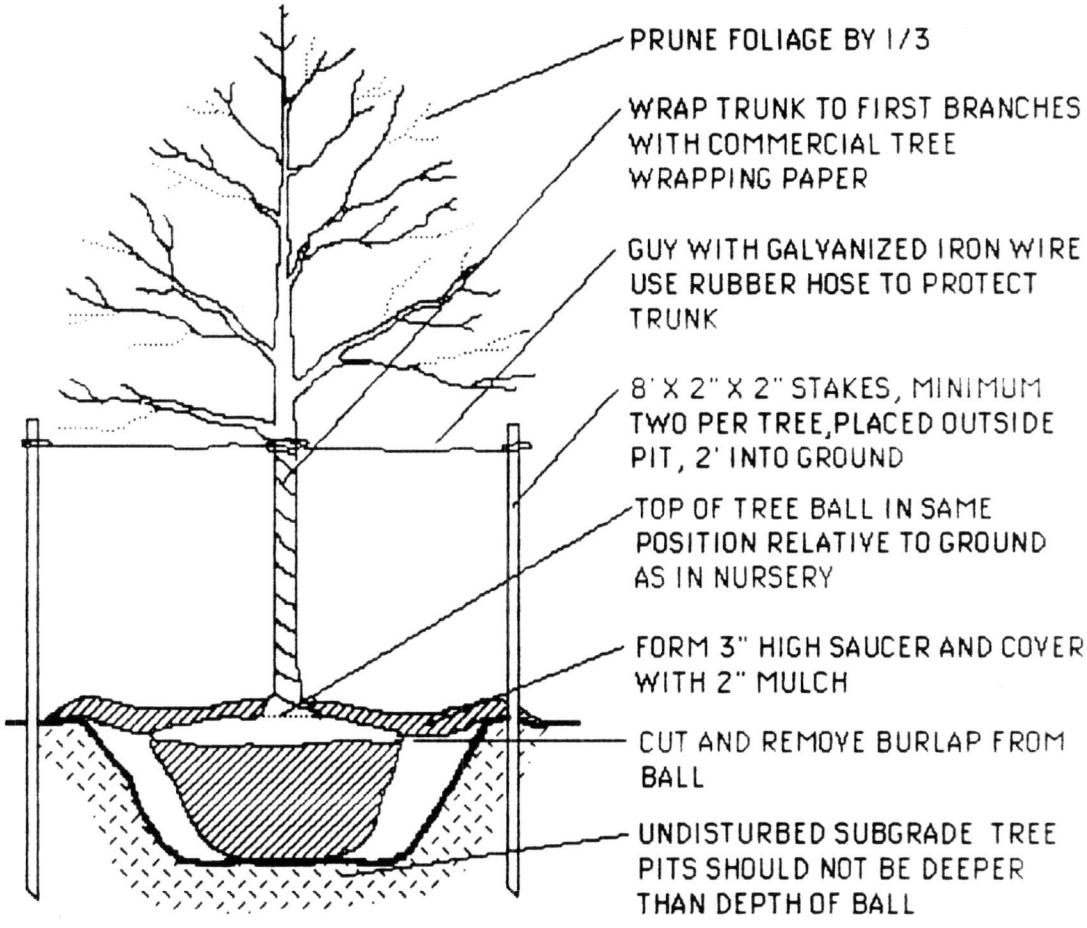


Figure 11:
Typical Balled-and-Burlapped (B&B)
Tree Planting Detail

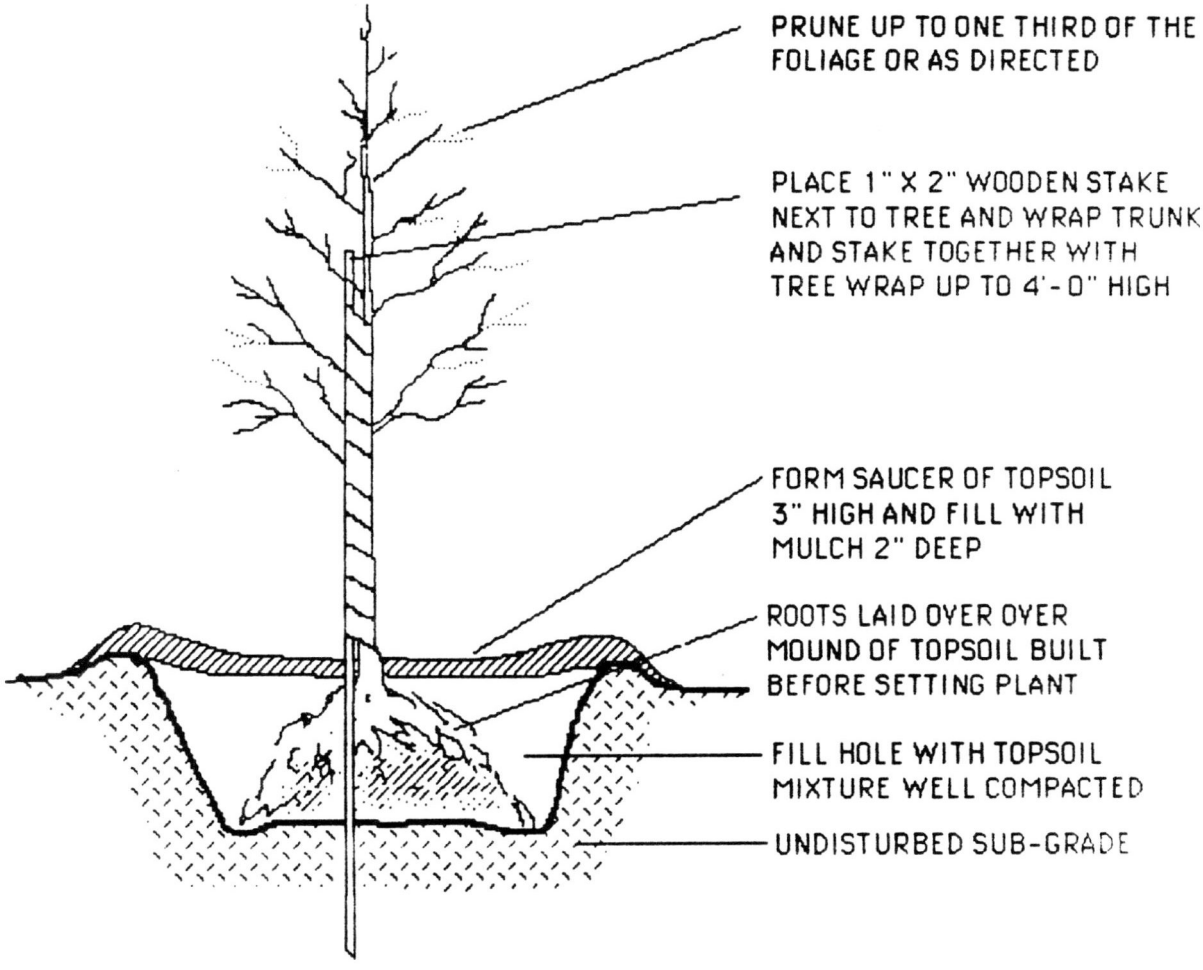


Figure 12:
Typical Bareroot Tree Planting Detail

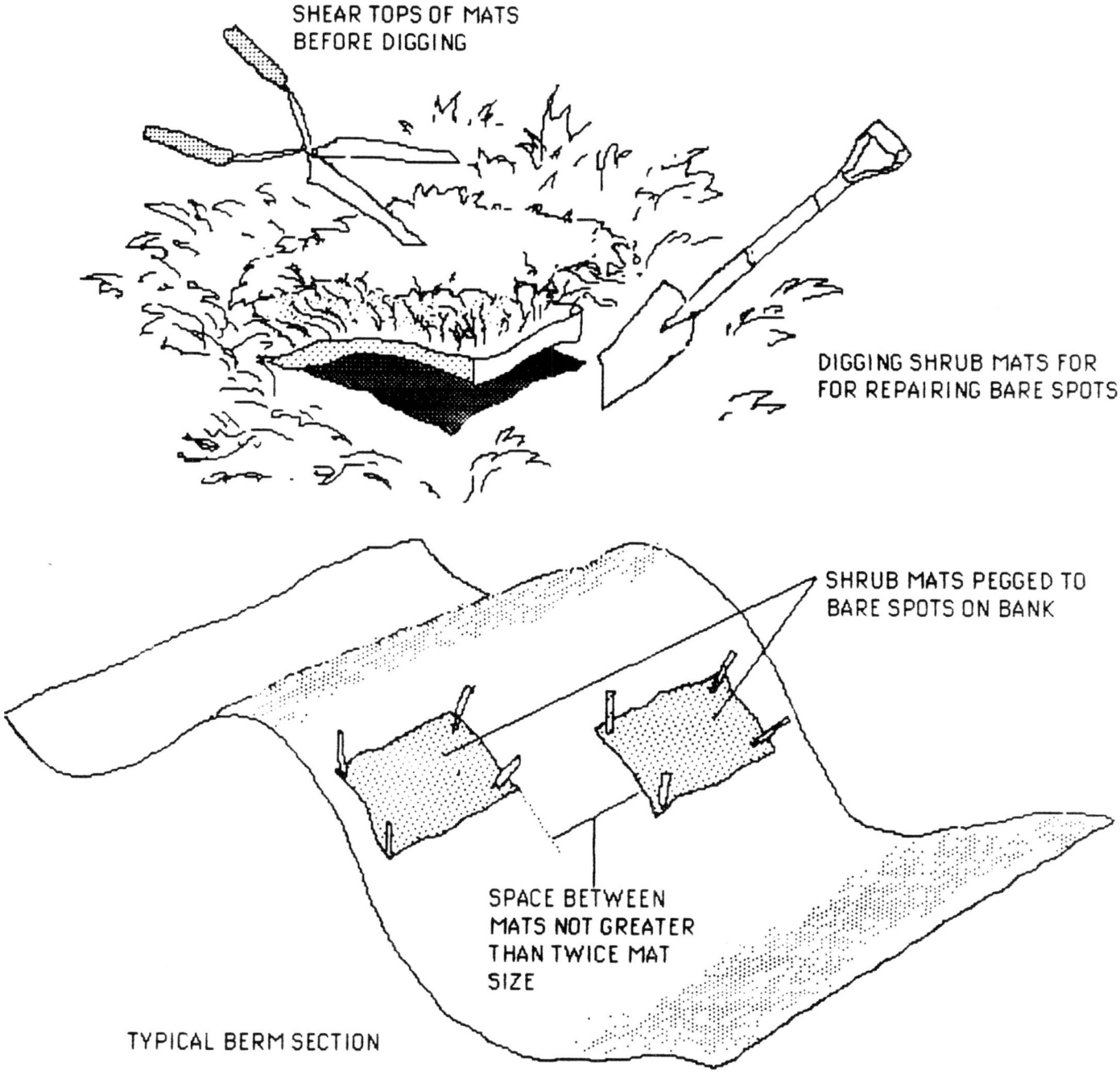


Figure 13:
Shrub Mat Establishment Detail

LIGHT FOREST COVER TYPE

Where selective views are desired, the Light Forest cover type is recommended. This cover type can be managed by prescribed burning or selective clearing. The primary goal of management of the Light Forest Cover Type is to maintain stability while increasing visibility. As Forest Cover should be as continuous and unfragmented as possible, Light Forest as a cover type should be patchy, isolated, and limited in extent.

Prescribed Burning

Prescribed burning can be undertaken in limited areas to create selective views. Relatively frequent burns initially -- such as once a year for two years, decreasing to once every ten to fifteen years -- will stimulate lower, denser shrub growth and denser more diverse herbaceous cover, while somewhat limiting the development of new canopy. Because this promotes site stabilization and reestablishes a natural process, it is recommended as the preferred method for establishing Light Forest. It is especially appropriate for displaying running lengths of earthworks or tiers of earthworks where relatively large areas should be visible to the public; this practice also does not have the destabilizing effects of brush clearance.

All prescribed burnings should follow the guidelines in Wildland Fire Manual: NPS 18 for staffing, fire analysis, control methods, and documentation.

Where fire management cannot be undertaken to achieve Light Forest, selective clearing is recommended. The object is to eliminate as little as possible from each of the shrub, sapling, and understory layers, while increasing visibility [see Figure 14]. Except for coniferous species (which should be cut fluish with the ground), trees should be cut leaving 4-6" of trunk or stack remaining; this will help reduce potential erosion and provides a discouragement to walkers. The appearance of the forest after selective clearing results in an overall thinning of the middle layers of the forest, in contrast to prescribed burning which tends to reduce the height of the middle zone of the forest.

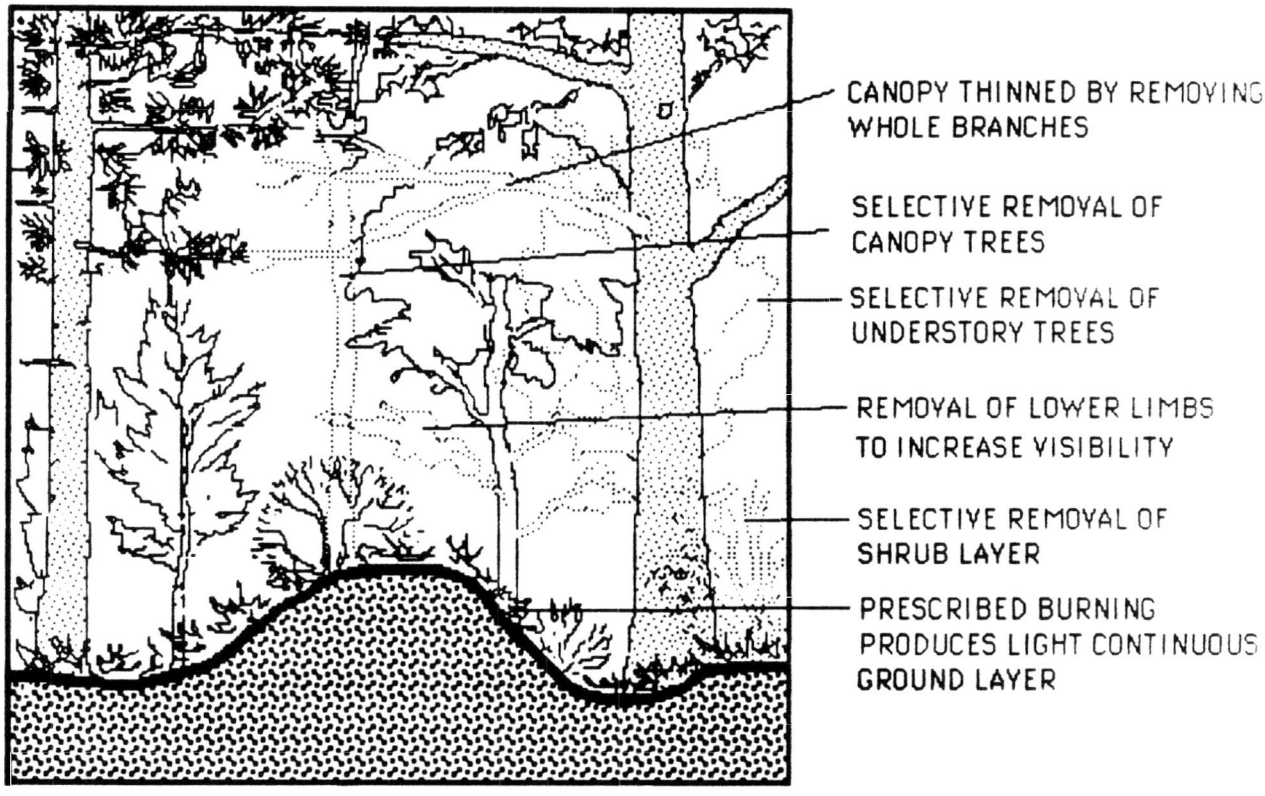


Figure 14:
Light Forest Management --
Prescribed Burning and Selective Clearing

Liming

Areas where herbaceous cover is sparse, or where shrub growth and woody reproduction are limited, may benefit from a very occasional (no more than once every ten years) light application of lime. The native soils, for the most part, are naturally acid and the earthworks, which usually have a high proportion of subsoil at the surface, may be excessively acid. Where some selective clearing is desirable for visibility, additional liming may foster the development of denser herbaceous cover, which may encourage a display of native wildflowers. The most suitable sites for wildflowers are on the damper slopes around the trenches. On the drier berm portions, liming may permit more dense grass growth. No liming should be undertaken without a soil test.

Soil testing is done at the Soil Testing Lab, Smyth Hall, VPI & SU, Blacksburg VA, 24061. It is important to remember that recommendations from the lab, Soil Conservation Service, or the Extension Service are aimed at agricultural or horticultural crops and not for the maintenance of native landscapes. Consequently, ask how to raise the pH to a specific level -- 5.5. for Light Forest -- rather than for a specific type designated on the form. Send one pint of soil in a carton clearly marked with the name of the location. Since only the first word will be registered by the lab, make sure it is descriptive -- for example, use 'Stedman', rather than 'Richmond-Stedman'.

Liming is liklely to be required only once in any forested situation, and the goal is to raise the pH to around 5.5 for a short period of time. Use agricultural limestone with 100% passing a 35-mesh sieve and 80% passing a 100-mesh sieve. If the soil tests reveal that the magnesium level (Mg) is higher than the calcium level (Ca), use calcite limestone instead of agricultural limestone, ground to the same sieve fineness. The limestone should be hand broadcast and left on the surface. Try to scratch it into the top one inch in areas adjacent to streams, on steep slopes, and in swales. Spread the limestone three to four days before rain is anticipated if possible.

At present, there has not been enough testing in the field to assess the effectiveness and suitability of occasional liming for the forest cover type. The procedures recommended here should be viewed as experimental. Further monitoring and field evaluation is required, and this is an example

of where the monitoring and evaluation procedure recommended will lead directly to making a real contribution to the amount of information available on natural areas management versus horticulture maintenance.

A major exception to this recommendation is where there is good development of acid-requiring shrubs, such as azaleas, laurels, hollies, blueberries, and huckleberries. Additional lime adjacent to these shrubs could reduce their vigor and should be avoided.

All three of these management techniques -- prescribed burning, selective clearance, and liming -- may have unpredictable impacts relating to the spread of invasive species, especially honeysuckle. Prescribed burning sometimes may temporarily encourage sprouting or may help exhaust rootstocks in a management program. In all cases, a plan for monitoring and limiting the spread of disturbance species should be included in the management program.

Additional Planting

It is strongly recommended that, with the exception of specific historic site restorations, all additional site plantings should consist of locally native species, including landscaping at a visitor center or parking facility.

Transitions

Virtually all areas of Cleared Woodlands should be managed to return to a layered forest cover. However, simply "letting them go" is not adequate. On some sites, resprouting may be minimal and additional cover may be required. In these situations, canopy and understory replacement species should be planted adjacent to, but not on, the earthworks; shrub mats could be established on the earthworks, especially where bare soil is exposed [see Figures 11, 12, and 13].

It is also important to remember that these sites are especially vulnerable to invasion by exotics, especially vines, such as honeysuckle. High priority should be given to providing effective control during the regrowing period to ensure that disturbance species do not out-compete the regenerating native community. The more severely disturbed sites will

require a higher level of monitoring and management than less radically altered sites, and recovery will take longer. Lightly cleared sites with low disturbance and good sprouting could be relatively well-layered within as little as two years, while severely disturbed sites with serious access problems, such as Fort Gilmer, may require some level of intervention for decades.

Fort Fisher

For sites which are well preserved under forest cover, the development of new interpretive models which provide focused visitor access and selective views is required. Fort Fisher in Petersburg has been redesigned as an illustrative example of the recommended approach.

Fort Fisher is one of the best preserved earthworks of the National Park Service. Because it was never the site of a battle, acting only as a storage depot, and has been heavily wooded since the end of the nineteenth century, the details of the structures, from cannon carriage ruts to firing steps, are still very clear.

Recently, however, the front half of the fort was cleared, except for canopy trees, and a parking lot was built. In addition, it was identified as a destination on park literature and shown on guide maps. In one corner, the outer trench was filled in where a ramp was built to provide access into the interior of the fort. No trails were built, so people tend to walk around on the top of the earth walls. Increased traffic has also led to the paving of roads on two sides, diverting runoff into the outer trenches. This increased use and clearing has sharply increased the rate of erosion, blurred the clarity of detail, and threatens the stability of the outer walls [see Figure 15]. To preserve the valuable resource, the forest should be reestablished, access controlled, and runoff redirected from the road [see Figure 16].

Through burning, limited pruning, soil modification, and planting, a multi-layered forest can be encouraged to grow over time. In addition, the filled-in portion of the outer trench and existing entrance and parking area should be removed. Finally, the stormwater runoff from local roads should be redirected; however, this is a very complex management issue and should be addressed in a consistent manner throughout the parks. Currently, there is no established park strategy or design standards.

During the interim stabilization period, therefore, critical stormwater problems should be addressed on a site-by-site basis.

Once stabilization is achieved, and interpretive guidelines revised, a new visitior path loop and services might be appropriately installed [see Figure 17]. Elevated walkways and an entrance bridge could be constructed inside the fort to provide access and reveal specific historical, structural, or contextural information. In the areas immediately surrounding these destination points, the forest could be selectively thinned to enhance the view.

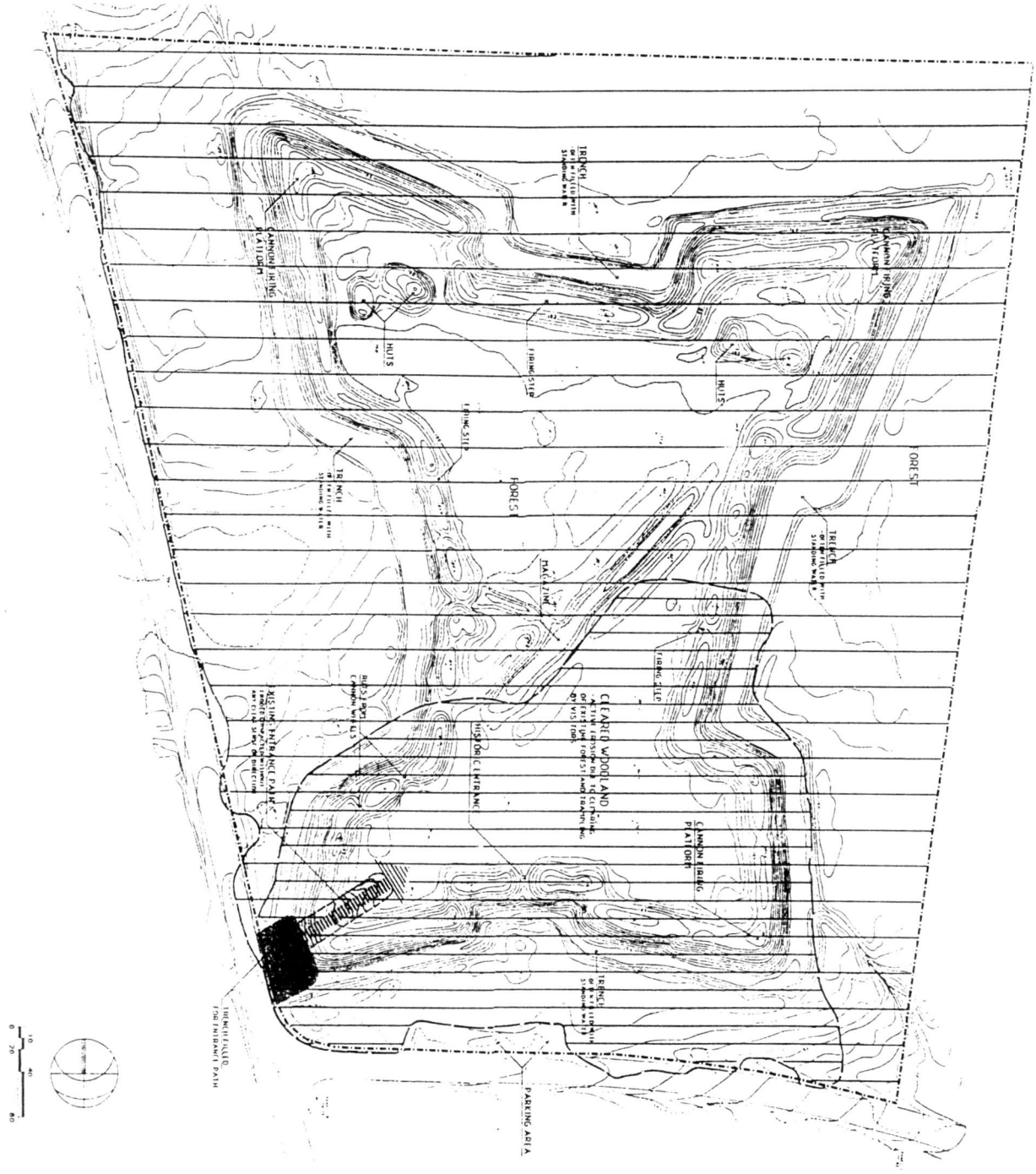


Figure 15: Fort Fisher, Existing Conditions

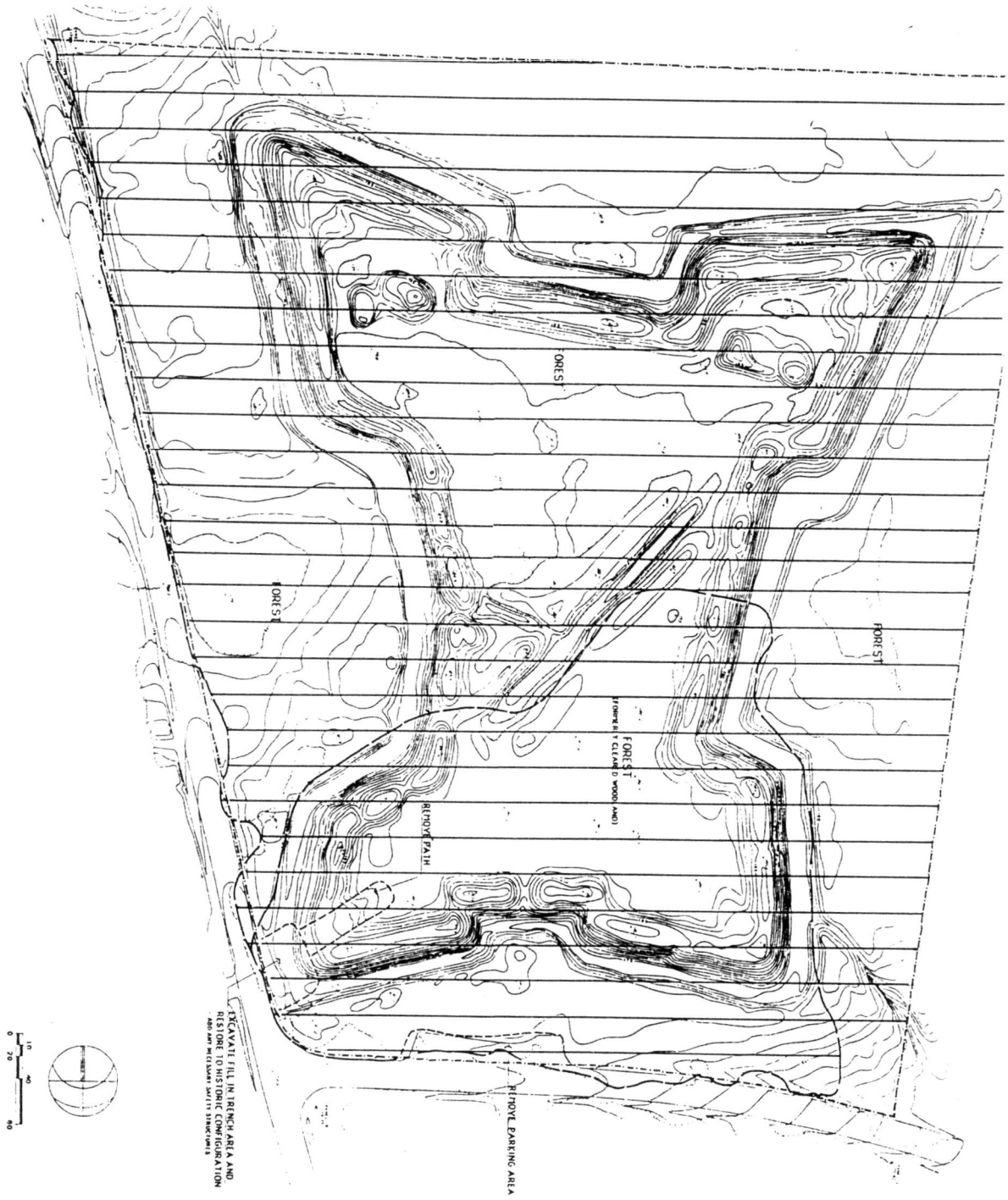


Figure 16: Fort Fisher, Interim Stabilization Program

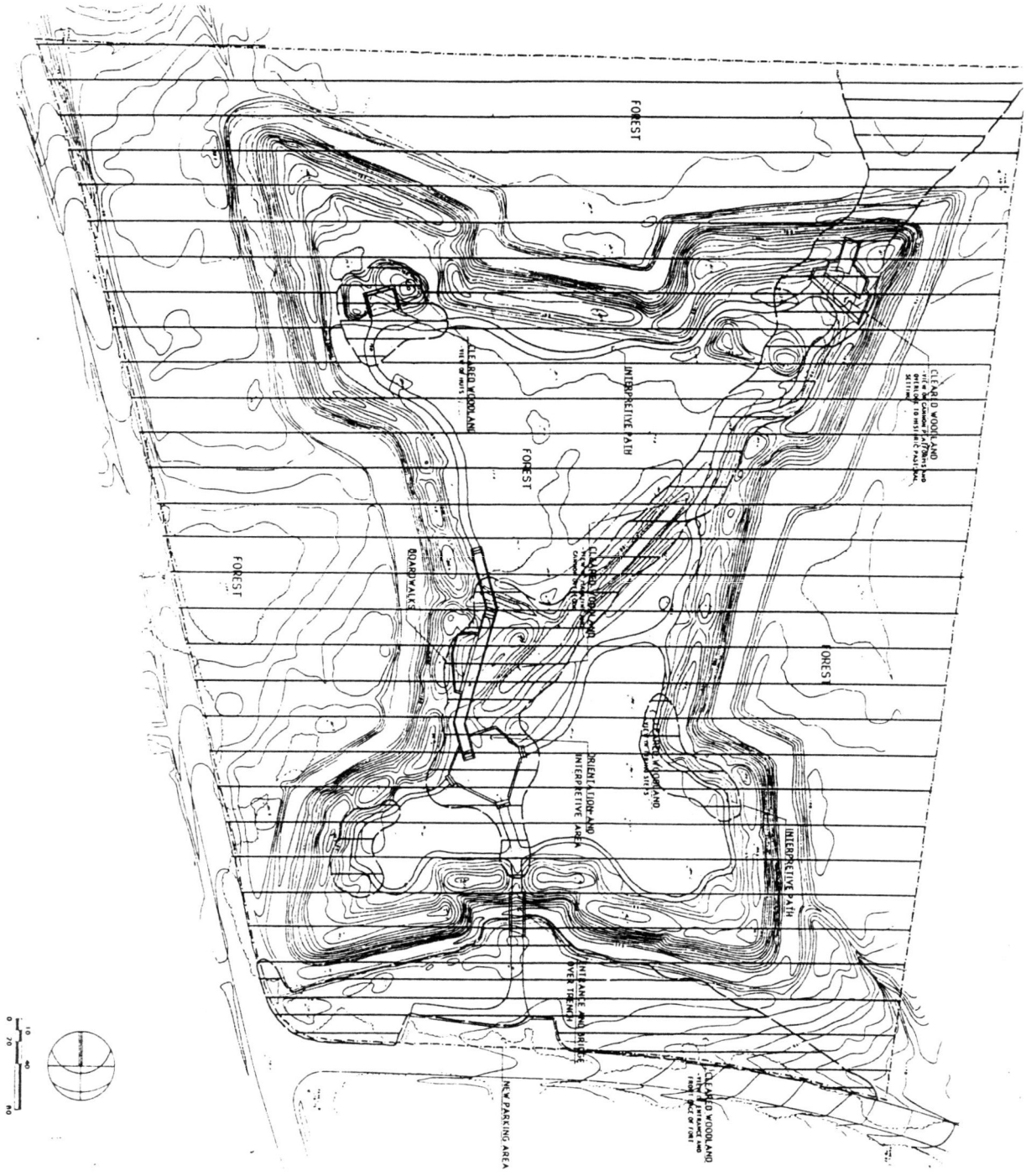


Figure 17: Fort Fisher, Long-Range Program

H. MANAGEMENT GUIDELINES FOR RECOMMENDED FIELD COVER TYPES: TALL GRASS AND TURF

All of the areas presently maintained as grasslands, including turf, would now support forest if they had not been managed for interpretive purposes, with the exception of marshes, beaches, and rocky balds. Under natural conditions, open landscapes are short-lived phenomena in this region. The primary object of grassland management is to arrest this natural succession in selected areas and prevent the sites' gradual return to forest.

Configuration

The configuration of virtually all the parks' open landscapes was initially determined by visitor and interpretive goals. Lawn areas are commonly accepted and expected in parks, and are generally far more extensive than required to meet functional needs, and consume a disproprotionate amount of park maintenance budgets. Throughout the battlefield and earthworks parks, there has also been a consistent interest in retaining the historic pattern of forest and field wherever feasible.

At this time, as budgets dwindle and other park problems command more attention, it is clear that the amount of lawn and other close-cropped grasses should be reduced. This does not, however, necessarily mean a return to forest. In many areas, the configuration can be retained by replacing lawns and maintained pastures with tall grasses and successional meadows. This will effect substantial cost savings and increase the diversity and health of native communities, while providing a greater aesthetic range to the park's landscape character. Virtually all areas which are presently rough grass, and much that is new lawn, should be converted to tall native grasses, as well as much of the agricultural grasses, which require continuous maintenance, are generally both poorly installed and cared for within the park. This change of cover type will provide an immediate and significant reduction in expenditures.

Initial management efforts involved in the conversion from rough grass to tall grass should diminish within a period of two to three years, leaving a cover type that requires little maintenance beyond an annual mowing or prescribed burning. Transition from turf to tall grass requires a slightly longer period and will require increased management. However, because soils in this area are slightly infertile and naturally acid -- conditions which favor native grasses -- a dense healthy stand should be established within three to five years; thereafter, little maintenance, beyond mowing or burning, is required.

At Fort Necessity, for example, in Braddick PA, has an extensive lawn area that has been left unmowed for the last two years due to financial constraints. A diverse and colorful wildflower meadow has developed, which is far closer in character to the historic site character of 'tall grasses' than a neatly trimmed lawn. Effective management is, however, still required in Fort Necessity's meadow. Numerous tree saplings are developing and should be controlled if an open meadow is to be sustained over time. Similarly, at Colonial National Historic Park, just this past year lawn areas were left unmown over the earthworks.

The most difficult problem is likely to be the need for reeducation of both the National Park Service staff and the visiting public to the aesthetic, historic, and ecological qualities of the tall native grasslands.

Continuity

Just as it is important for forest to be as continuous and unbroken as possible, the open landscapes should be as small and isolated as possible to minimize fragmentation of forest systems. This also serves interpretive needs. During the Revolutionary and Civil wars, views were almost always enclosed by forests and seen beyond the fields or past the edge of town. As suburban development coalesces, the forest buffer will be more important; however, relatively broad expanses are required for effective screening. These younger landscapes represent important natural values. Many support a remarkable diversity of plant species and provide habitat for many plants and animals which are confined to these transitional stages.

It is appropriate that the full range of successional habitats be managed for to provide a different kind of continuity as well. Present management

in the parks and on most private properties is very restrictive, and more intensive than is appropriate. Beyond turf, pasture, tall grasses, and wildflowers, a variety savannah landscapes, dotted with thickets and young groves, could be sustained. This will also greatly improve wildlife habitat throughout the parks.

Natural Processes

As stated for forest cover types, a major goal of management is to identify the minimal level of intervention necessary to achieve the desired goal. Management can be reduced as natural processes are reestablished and more relied upon to do the work.

There are several kinds of tall native grasslands, requiring different levels of management described later in this section:

1. Woody Meadow, which supports abundant young woody species in a matrix of grasses and wildflowers.

2. Tall native grasslands, in which little bluestem is the most ubiquitous species.

3. Pasture, which includes hybrid species, both native and exotic, and requires maintenance.

4. Turf, which is comprised of hybrid species, again both native and exotic, and which requires the most intensive maintenance.

Hydrology

Many significant alterations to natural hydrology are undertaken to provide adequate drainage or moisture to support pasture grasses and turf in areas where they are environmentally inappropriate. For example, no further destruction to native wetlands or lowlands should be permitted. Where lawn or pastures are failing to thrive because it is too wet or dry, native communities should be reestablished largely by reducing maintenance. Where serious erosion has occurred, woody meadows will provide better cover than entirely herbaceous landscapes, and provides better stabilization cover than pasture or cropland.

Fire

Grasslands throughout the region were managed by burning by both indians and settlers in the past, and often were also the result of wildfire. For all field cover types, except turf, prescribed burning is the most effective management method and eliminates the need for most other management.

Currently, prescribed burning is almost always undertaken in the winter, which is perceived to reduce negative impacts on wildlife and to be easier to control. Grasslands, however, under natural conditions, burn most frequently in the summer, exactly when the hazard of fire is greatest; a prescribed burn could reduce accumulated fuels. Little bluestem, for example, does not send up its seed stalk until quite late in the season, probably protecting it from summer fires.

Further exploration is recommended toward developing prescribed burning practices which more closely resemble the natural fire cycle. The firebreak system should be designed into the site layout and may include paths and other features.

Natural Checks and Balances

The control of invasive disturbance vegetation is important to grasslands as well as to forests. Field management efforts in the past have fostered the widespread dispersal of exotic vegetation. Most of the exotics invaded the forest from surrounding fields, and like honeysuckle and kudzu were first planted on cleared forest areas too steep to stabilize with herbaceous species. Both mowing and burning, which effectively check the development of forest canopy, are not necessarily adequate to control exotics and may, without careful monitoring, encourage invasives.

Herbicide management is usually required and should be selectively applied to the vulnerable new shoots which appear after mowing or burning thereby reducing the amount of herbicide needed for effective control, according to the National Park Service's Integrated Pest Management Information Manual.

Natural Structure

As noted earlier, the primary object of field management is to limit woody species, i.e., preventing the development of a natural forest structure. For woody meadows and native grassland, mowing and burning are sufficient to sustain the habitat. For pasture and turf, repeated liming and some fertilizing is also required to alter the native environmental conditions. These varying needs are reflected in the routine management requirements.

Woody Meadows

Many of the earliest woody species to appear in a successional landscape are species which send up numerous shoots and frequently form dense thickets, such as sassafras, sumac, and locust, amidst the little bluestem and forbes. Small fruiting and flowering trees, such as cherry and shadblow, are also abundant and many forest canopy species are present, at least as seedlings. These woody species form islands which without management would coalesce and close over time.

The amount and configuration of these woody islands can be determined and maintained by mowing around them. A simple annual mowing is generally sufficient to suppress most tree species and should be undertaken after several hard frosts have occurred in the fall to ensure that seed development has been completed. The woody islands are the most likely sites for vine development and should be carefully monitored. Excessively droughty or acid soils, with very slow establishment of woody species, could be mown infrequently, possibly as little as every ten years if vines are not vigorous.

These woody meadows also can be maintained by burning. An annual burn generally will keep the amount of woody cover static over time. A significant exception to this are the stoloniferous species, such as sassafras, locust, and sumac, which are fire-increasers. They are stimulated to produce numerous shoots when burned and can rapidly overtake a meadow, which recently occurred at the Big Meadow in Shenandoah National Park after a controlled burn.

Tall Grass Cover Type

The tall grass meadows are predominantly little bluestem, a ubiquitous native grass which thrives on a wide variety of soil conditions, although it is not tolerant of heavy shade. This long-lived, perennial, native grass requires no liming or fertilization and may vary in height from about eighteen inches on droughty sites to three feet on deep fertile soils. The growth pattern is clumpy on the drier soils. Typical meadows might also support any of the species found in rough grass, as well as a variety of taller native and introduced wildflowers and grasses.

Under natural conditions, little bluestem meadows probably resulted more frequently from wildfire and prescribed burning, the later being the most desirable form of management. Once every one or two years is generally adequate. When burning is not feasible, mowing should be done as infrequently as is adequate for the control of woody species. In some areas, the hazard of naturally occurring fire is sufficient to require twice annual mowing to reduce accumulated fuels. The extra mowing should occur at the end of June or early July, after spring blooming species have set seed and before fall blooming species have sent up flowering stalks. When mowing, the blade should be set at least six inches high to avoid damaging the clump form of bluestem.

Whether management is by mowing or controlled burning, or a combination of both, the actual frequency of cutting or burning should be determined by observation, rather than by a rule of thumb. For example, if woody invasion in a field is minimal and the grass provides good cover, no additional management may be required that year. A midsummer cut might be advisable in one dry year, but not the next, and a fall cut not necessary on the heels of a summer one. Ultimately, developing real familiarity with the field landscapes is as important as getting to know the forests.

On a few extremely acid sites, grass cover may be sufficiently sparse to be of concern. In such cases, a single season of liming may be advisable to achieve better establishment. As with forests, lime native grasslands only once and request recommendations for a pH of 5.5, rather than for a specific crop. Do not use the Soil Conservation Service's commercial "native pasture" category, because this is geared for fescue and bluegrass, not little bluestem and switchgrass. Recommended amounts of lime for fescure, for instance, would be far too high for native tallgrass

landscapes. Request information on the amount of lime necesary to raise the pH to 5.5. On many of these sites, there are higher levels of magnesium (Mg) than calcium (Ca), in which case calcite limestone should be used instead of agricultural limestone, ground to the same sieve fineness.

Pasture Grasses

Pasture grasses today are generally comprised of 'cool season' grasses which have their major growth periods during the cooler, moister spring and fall seasons. Most are hybrid species, both native and exotic, which are not sustained without a regular routine of liming, especially on the sandier soils of this region.

While there is little or no grazing taking place in the parks, there is considerable area managed as pasture, and usually of very poor quality. The least successful have been established on recently cleared forest. These sites are unlikely to ever provide quality pasturage without extensive management and are far more suited to native tall grasses. Similarly, the more acid sites, certainly any areas with a native pH less than 5.2, are not suited to pasturage. Unless there is a compelling interpretive need or an immediate possibility for grazing without impacting other resources, there is at present no reason to manage for pasture.

Fire is also a suitable management technique for pasture. Light winter burn increases the available nutrients and raises the pH just before the spring growing season and may be used in combination with midsummer mowing. Twice annual cutting (or a winter burn and summer cut) is generally required to maintain pasture grass cover. Less frequent management will encourage the development of little bluestem and/or forbs, especially on more acid or droughty sites.

All pasture areas should be soil tested approximately once every three years and reliming may be necessary that often. At present, it is advisable to contact the local agricultural extension service or Soil Conservation Service. It is important, however, to appraise them of overall National Park Service goals and the desire to support pasture only where it is most suited and appropriate.

All pastures should be both limed and fertilized. Request recommendations for "tallgrass pasture" or "native pasture (0-25% legume)". Note that no grass will be harvested and include as much soil information as possible.

Agricultural crops have occasionally been proposed as an alternate to pasture grasses. At this time, we strongly recommend against making this choice. The conflicts between agricultural needs and the preservation of natural and cultural resources are too severe and, as yet, unresolved. Efforts to control erosion in crop fields have almost inevitably led to disturbance of wetland habitats and destruction of cultural resources.

Turf Cover Type

Turf is the most difficult and expensive cover type to maintain because it requires a high pH and fertilization level, is susceptible to drought, and often sustains the heaviest foot and vehicular traffic load. Consequently, the areas chosen for turf should be only those that can be well maintained.

Turf Maintenance

There are three main tasks which must be done on a regular basis. Adding soil amendments, mowing, and repairing damaged areas. These must be done consistently for turf to remain healthy. If let go for a couple of years, an expensive and lengthy renovation process must occur. So it is both cheaper and takes less time in the long run to invest the required amount of management up front.

Turf Soil Amendments

All turf areas should have a soil test every one or two years. Use the white commercial forms and indicate that the crop is "industrial lawn". Use a 1-1-1 or a 2-3-2 fertilizer, with slow release nitrogen, in three applications, each application being one-third of the recommended rate: one from August 15 to September 1, the second from October 1 to October 15, and the third from 1 to 15 December. Use the recommended rates identified by the soil tests. As noted before, use agricultural limestone. If, however, there are higher levels of magnesium (Mg) than calcium (Ca) in the soil, use calcite limestone. If the recommended rate exceeds 25 pounds per 1,000 square feet (1,000 pounds per acre), apply half in November and the remainder in the spring.

Turf Mowing

The frequency of mowing will vary depending on the weather, time of year, and maintenance practices. Basically, grass can be kept shorter in the spring and fall when it is growing fastest, and should be kept longer in the summer to protect the ground and turf from drying out. The following schedule provides general guidelines for mowing:

Time of Year	Frequency of Mowing	Height of Grass
Late March to early April	Once	2 to 3 inches
April to June	Weekly	2 to 3 inches
July to August	Every 12 to 17 days	3 inches or higher
September to November	Every 10 to 14 days	2 to 3 inches

Another general guideline is to cut higher rather than lower. Remember that loss of vegetation almost always leads to erosion and a low blade can skim the earthworks or cut into a slope. If the area is very uneven, with lots of holes, raise the blades 1/2" to 1" to be safe. Never cut more than one-third of the grass blade's total height.

Repair of Damaged Turf Areas

Repair damaged or worn areas before they begin to erode. This can be done either by seeding or sodding. Seeding is appropriate on level areas. Sodding is appropriate for slopes, drainage swales, and embankments.

Between the roots and shoots, old leaf blades and cuttings gradually accumulate and compact to form a layer called "thatch". Sometimes thatch build-up becomes excessive, inhibiting soil aeration and permeability. When this occurs the lawn can be "thatched", which removes built-up thatch throughout turf areas.

Turf Overseeding

In areas where the grass is thin and there is little sign of erosion, overseed the area with the following mix: 70% hard fescue, 25% chewings fescue, 5% alsike clover. This mix is measured by weight, not by volume. Consult with the Agricultural Extension Service agent on the proper application rate. Spread the mix over the existing turf with any soil amendments recommended by the soil test. If it does not rain, soak the area to a depth of 4" and let germinate. Continue watering for several weeks following germination, if there is no significant rainfall, to promote good growth. Do not mow until the new grass is at least three inches tall. Make sure the blade is sharp, so it cuts and does not rip the new shoots. Overseeding should be done between March 1st and May 1st or October 1st to the 15th.

Turf Seeding

In areas that need complete renovation, clear all debris and large clumps of dead grass. Scarify the soil to loosen the top three inches, and rough rake so no gully or rill is deeper than one-half inch. Spread seed and tamp or hand roll to ensure that the seed has good contact with the soil. Follow the recommended seeding times, watering schedule, and mowing regimen for overseeding and consult with the Agricultural Extension Service agent to determine the proper application rate.

Cover the newly seeded area with a uniform 1-1/2 inch thickness of hay mulch (1-1/2 tons per acre). Spray with a tackifier according to the recommendations of the manufacturer or the Agricultural Extension Service agent, either by hand or machine sprayer. Do not mow until the new grass is at least three inches tall.

Turf Sodding

For steeper slopes and in swales, use sod instead of seed. For slopes steeper than 3:1, use 2' x 2' x 13" sod secured with hardwood pegs to unitially hold the sod in place. Prepare the soil as for seeding, water lightly, and place the sod with less than 1/4-inch gaps between sections. Fill any gaps with soil and hand roll. Remember to place the strips with the long sides parallel to the slope and keep the sod moist. Dry pallets will have a poor germination rate and will tend to curl up around the edges.

Transitions

The field cover types are likely to involve significantly revised management procedures for the National Park Service during the next few years. Existing expanses of erratically maintained turf should be diminished as well as much of the pasture and rough grass, and replaced by native grasslands.

Establishing Tall Native Grasses

Existing pasture, rough grass, or turf can be managed gradually to develop into tall native grasses. Both rough grass and turf should be immediately released from regular mowing for at least one year before managing for native tall grasses.

The most favorable management for native tall grasses is controlled burning. Good access is generally already available at these sites and a perimeter fire break is relatively easy to establish. An important benefit of fire management is that fire raises the pH and makes essential soil nutrients more available. The standing crop and grasses will be immediately invigorated and the resource better stabilized. Fire management also eliminates the need to disturb the soil layers and possibly artifacts in order to reseed.

Where fire management is not feasible, a reduced mowing regimen and a simple lack of maintenance will eventually lead to development of native species. However, additional management is recommended to foster more rapid stabilization. Park personnel has consistently underestimated the amount of erosion occurring on a site, despite visible evidence. 'Flat' land was assumed not to erode and severe erosion after clearing was not observed. In this light, it is especially important not to underestimate the care a landscape requires wherever healthy native landscapes are not yet established. Unfortunately, there are, at present, no surefire methods for locally establishing little bluestem, the most predominant native grass, with the exception of fire management.

Little bluestem and other perennial native grasses develop slowly, whether seeded or vegetatively established. Further experimentation is required on park sites to determine the most effective establishment

methods. The following guidelines are recommended:

Seeding Native Grasses

Overseed in late April or May with little bluestem at a rate of 15.20 lbs. PLS (pure live seed) per acre. No liming or fertilizing is necessary. On wetter sites, sow switch grass in late April or May at the rate of 5 to10 lbs. per acre PLS. Again, no lime or fertilizer is required. The soil surface should only be lightly scarified before overseeding. It is important to retain the major portion of the existing cover for erosion control.

During the first season, new seedlings will develop slowly and are likely to be overtopped by other vegetation by midsummer. At this time, one mowing is advisable. The blade should be set high enough to avoid severing the new growing tips of the bluestem, while removing top growth of other species and reducing competition with the new seedlings.

In the second season, a light liming, sufficient to raise the pH to 5.5, may be helpful on more acid soils if cover is still sparse. At this point, routine field management of an approximately annual burn or mow is generally adequate. It may take anywhere from two to ten years for a healthy native grassland to be established.

Native Grasses by Plugs

There is also an experimental alternate to overseeding which should be field tested. Vegetative plugs of little bluestem (collected locally, disturbing no more than 10% of any site area), measuring approximately 6" x 6" should be planted on about 75 foot centers, leaving the rest of the landscape undisturbed. This method is likely to be especially effective where a site is fire managed.

Seeding Native Grasses on Bare Soil

Seeding and mulching are required to establish native grasses on bare soil. The soil should be sufficiently compacted to provide a clean firm seedbed. A pre-emergent herbicide may be advisable before seeding, if the soil is weedy. The seeding rates are increased to 25-30 lbs. PLS per acre for little bluestem and 10-15 lbs. PLS per acre for switchgrass. Adding white clover to the grass mix at a rate of 25 lbs. per acre may also be advisable.

Because seedling growth is so slow, a good mulch cover is critical to reduce erosion. A straw mulch, three inches deep, and punch-tacked or tackified is recommended.

A recommended alternate source of mulch may also serve as an alternate to seeding as well -- little bluestem or switchgrass straw. An existing tall native grassland can be cut and baled when seeds are ripe. This can be applied as mulch to bare soil after seeding, with tackifier. Some experimental plots should be established to see if this also serves as an adequate seeding option.

Establishing a Woody Meadow

Healthy tall native grasslands with minimal invasion of disturbance species are suitable for developing woody meadows. Both mowing and burning should be stopped for two years at least. The new woody growth should then be evaluated to determine which areas should be released and which areas should be mown or burned as needed, no more than once a year, to retain the desired balance of woody and herbaceous vegetation.

Establishing Pasture

There were no sites identified which were recommended for conversion to pasture. If at a later date some pasture is required, both the Soil Conservation Service and the Agricultural Extension Service should be contacted, with soil tests as described earlier.

Establishing New Turf Areas

There were no sites identified which were recommended for conversion to turf. If at a later date new turf areas are required, soil tests should be taken and the Agricultural Extensive Service contacted for current recommendations. In the meantime, the directions for the repair of damaged turf areas are sufficient for establishing small turf areas.

Cold Harbor

Cold Harbor is the single largest piece of land in the Richmond National Battlefield Park. Historically forested, a central area has been cleared to expose two sets of earthworks. A ring road and private property access roads have also been built in the past twenty years. Since then, most of the exposed earthworks have been denuded and the tops and sides have begun to erode. In addition, relic hunters have damaged adjacent banks of earthworks, leaving large holes and destroying the soil stratigraphy.

Although there has been an increase in the level of use, neither the interpretive material nor the circulation system has provided adequate direction or perspective on the whole site. The visitor's journey is disjointed, preventing a clear picture of the site and its historic context. Parking lots, bridges, and paths all encourage visitors to walk along the tops of the earthworks on a tracery of dirt trails.

The goal of the proposed long-range program is to provide clear, controlled access to the earthworks and to develop a unified interpretive journey that reveals both the historic event in its landscape context and the structural artifacts of the battle at Cold Harbor.

Initially, the parking lots should be removed and could be replaced by a single lot built on the north side of the clearing. An orientation area adjacent to the parking lots could be the beginning and the end of a circular interpretive loop that would explore the site along the edges of the earthworks. Vegetation would prevent easy physical access to these structures while permitting uninterrupted visual access.

As funds become available, the ring road should be be removed and shortened. The private access road should be moved north below the crest of the hill. This would leave the entire interpretive area clear of cars and roads and provide a sense of unity to this memorial. An orientation point could be built on the south side of the clearing, adjacent to the new parking lot, to provide an overview of the entire site.



Figure 18: Cold Harbor, Existing Conditions

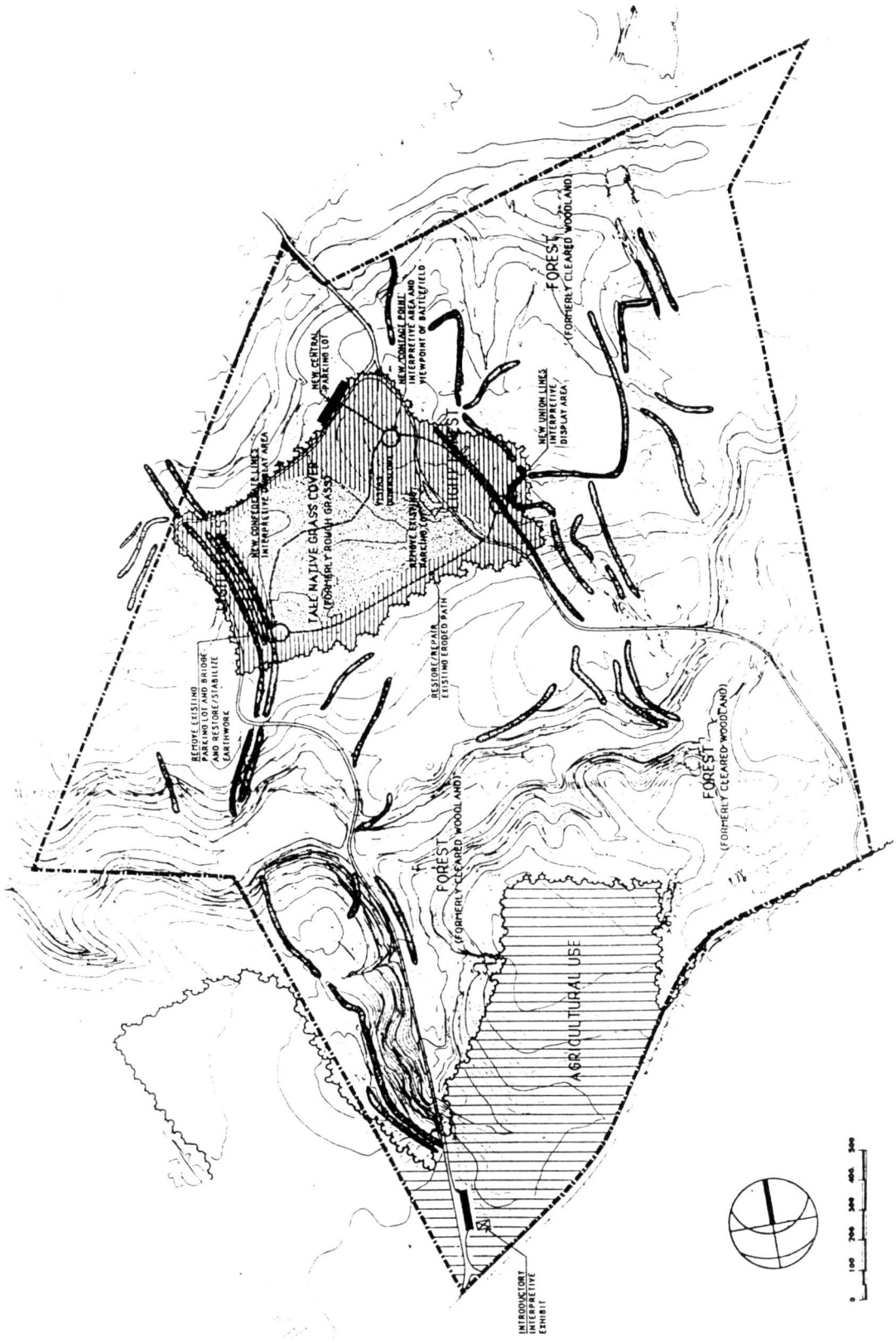


Figure 19: Cold Harbor, Interim Stabilization Program



Figure 20: Cold Harbor, Long-Range Program

I. MANAGEMENT GUIDELINES FOR THE RESTABILIZATION AND REVEGETATION OF DAMAGED GROUND SURFACES

The Ground as a Guide

The ground is literally a guide to management priorities. The most visible management problems are apparent on the ground, such as excessive trampling or erosion. They indicate active damages to the resource. These problems should be given the highest priority for assessment and repair.

Nearly every example of ground disturbance requires some level of repair and may often indicate a deeper and still unresolved problem in the management of the resource -- from uncontrolled passive recreation and relic hunting to poorly designed or inadequate visitor facilities. The more severe the damage, the higher the priority is for both repair and resolution of the problem.

The ground also provides important insights into management successes. Highly used sites that do not show evidence of disturbance are clearly functioning well, and may serve as models for developing appropriate management practices and solutions elsewhere.

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IV. RESTABILIZATION AND REVEGETATION OF DAMAGED GROUND SURFACES

A. INTRODUCTION

The restabilization and revegetation of the surface erosion conditions which at the present directly affects the earthworks that re and have been man induced, shall be described herein. As discussed earlier, all sites shall be carefully evaluated, monitored and maintained, (SEE SITE EVALUATION) restabilized and revegetated (SEE THIS SECTION) monitored and managed (SEE SECTION VEGETATION MANAGEMENT BY COVER TYPE) for discussions on existing vegetation health, which then translates into priority disturbance.

STABILIZATION SYSTEMS

The NPS should, as we discussed in the SITE EVALUATION SECTION, make regular inspections of the earthworks to detect signs of potential erosion or failure. Observed, NPS should immediately initiate stabilization measures. Taking steps as soon as possible to correct the problem can minimize damage and can prevent the need for major expensive rehabilitation work later. It is extremely important for the NPS to be alert for signs of erosion, and be ready to implement stabilization techniques.

This section explains a variety of systems or techniques which NPS can use to stabilize eroding and damaged conditions on and around the earthworks. These living systems are recommended as measures which are intended to reduce to the surface erosion and improve the structural integrity of the earthworks. Many techniques exist, but the suggested ones seem to offer the best potential for the special requirements of the earthworks.

The methods recommended here are applicable on small to large observed damaged earthwork failures. The scale of work required is within the ability of the existing NPS staff, ability of the existing NPS staff, but it may be appropriate to develop a small crew of three (3) or four (4) people to carry out these repairs and main tenance procedures.

LIVING RESTABILIZATION METHODS

In most instances, these eroded sites can be restored to a stable, healthy condition through the estab lishment of vegetation. Under natural conditions of equilibrium, within the earthworks project site, the undisturbed and stable sites are covered with wood vegetative growth. This network of plants absorbs the waters energy during rainfalls, provides habitat for wildlife, conserves soil moisture, and stabilizes the soil within the earthworks with root networks. Vegeta tive restoration also results in the most natural appearance.

Restabilized by woody cuttings will retain soil and structural integrity, but are extremely vulnerable to damage by visitor traffic immediately after installation. Within weeks of the onset of the growing season roots estab-lish from properly installed cuttings. Within the first year of growth, a good shushy cover can be expected. The density and overall plant growth is dependent on the selected species. Once established, selective trimming of vegetation every three (3) years will provide a stabilized structure, and a good supply of cuttings for other locations repairs.

LIVING SYSTEM DESCRIPTION

A cutting is a branch removed from a living plant, capable of regeneration. When placed in soil under proper condi tions of sun and moisture, these living branch cuttings taken from native shrubs are expected to root and grow. Cuttings used from native plants are very practical and economical, especially if they are available on-site or nearby.

Depending on design requirements of the particular installation, and upon the species used, cuttings can range from 1/2" to 1-1/2" in diameter, and from 1' to 10' in length. In all cases, the cuttings must be long enough to reach undisturbed soil, and must have buds for rooting and leaf development. The branches should be cut on an angle at the base. This will facilitate tamping the butt or basal end of the cutting into the ground.

Cuttings must be installed during the dormant season. The dormant season normally extends from November to March, with some variation, depending on the particular year and the plant species selected. Cuttings must be kept moist in a shaded area and placed in the soil within twenty-four (24) hours of being cut. They usually do best when planted in a sunny location with moist soil.

Live stake cuttings shall be tamped into the soil at a 45 degree angle. The angle at which the cuttings are installed must be ten (10) to twenty (20) degrees to facilitate root growth. For the best results, 3/4" to 4/5" of the length of the cutting should be installed in the ground. To revegetate and restabilize the earthworks with cuttings, read the GENERIC SOLUTIONS section for instructions.

The species most commonly used for erosion control has been the willow shrub. Willows are often found along streams, are available, root readily and grow quickly. There are several types of willow shrub found along streams, cuttings from the most available native variety can be utilized. Cuttings from other plant species that have proven to be effective are privet, red stem dogwood and russian olive. Other shrub species may also be effective if rooting can be successfully accomplished.

B. GENERIC PROBLEMS

The following typical examples of erosional conditions observed in the field, which directly affects the earthworks are as follows:

1. Along the sides of these structures;
   (sloughed damaged or otherwise denuded open eroded sites often caused by human use.) See Photos 3 & 4.

2. At the base of the earthworks;
   (Same as in 1.) See Photos 1 & 2.

3. On the tops/over the tops (longitudinal and at right angles); (Same as outlined in 1.) See Photos 5, 6, 9, & 10.

4. Holes and slumps in the earthworks; (Similar to 1, but these are deeper and may have caused by wine throw or human abuse.

5. Complete cut-throughs; (A condition which has been caused by change in land use and interest.)

6. Connection paths between the earthworks; (Similar to 1, 2, & 3, but all caused by human use.) See Photos 7 & 8.

7. Disturbance around Civil War relics that are located within the earthworks system; (Same as 6.) See Photo 11.

8. Drainage ditches along the base; (These have been caused by reestabilished drainage patterns, some due to the earthworks themselves, other due to road systems, etc.) See Photos 15 & 16.

9. Facilities built into these earthen structures; (Same as 6 & 7.) See Photo 13 & 14.

10. Trails to and from the various facilities; and (Same as 6, 7, & 9.) See Photo 12.

11. Finally, trials which are part of the above descriptions, but appear to have developers due to lack of formal direction. (Same as 6, 7, 8, 9, & 10.)

C. GENERIC SOLUTIONS

The following types of restabilization and revegetation systems shall be employed.

1. Live stakes, long straw and jute mesh (in grassed sites, the live stakes should be deleted).

2. Live fascines with jute mesh.

3. Live fascines with live stakes.

4. Branchpacking in existing slumps or holes in the earthworks.

5. Brushlayers to repair cut-throughs in the earthworks.

GENERIC SOLUTIONS SELECTION

To choose the correct repair, review the site situation to determine which recommended technique will work the best. Each system is described in terms of its area of effectiveness, construction guidelines, and timing. Use all of the information in deciding on the best solution for the specific problem.

The methods used should maintain the qualities of a natural setting, or the developed areas. Choose a method that fits the character of the particular location. For example, the revegetation techniques should in time blend totally with the natural environment, provided there is sufficient sunlight for vegetation to become estalished. Often, live cuttings used in combination with non-living materials or structural devices, such as "dead stout stakes" or timbers, are the best alternative, since each enhances the other. This type of combination works particularly well where digging is not permitted, yet a stables site and a natural appearance are important.

Vegetative techniques are still the most cost effective and natural in appearance, where space and stability will allow for their application.

In all cases, you should choose a method that is unobtrusive in its setting. This can be done by using materials that are similar to those already found near the specific site. By matching the colors, textures, and scale of the existing materials, you will create a harmonious appearance between the earthworks, its adjacent surroundings, and the new stabilization installation.

SITE PREPARATION

Before a restabilization and revegetation system is undertaken, the cause of the problem should be indentified and corrected. The effort to incorporate vegetative cuttings into an earthwork as a restabilization material will be futile, for instance, where visitors may go. Fence the remainder of the earthworks prior to attempting any vegetative rehabilitation. Cuttings can be incorporated during the dormant season and become established on the earthworks. No regrading shall ever be done prior to the installation of these living systems on these historical structures.

The Generic Solutions shall be used as follows:

1. Live stakes, long straw and jute mesh.

   This system shall be employed on trails and open areas that are two (2) inches or less in depth. The following site situations may apply on the earthworks:

   a. Along the sides of the earth mounds;

   b. On the tops and over the tops (longitudinally and at right angles to the earthworks);

   c. Connection paths between the earthworks;

   d. Disturbances around the Civil War relics that are located within the earthwork systems;

   e. Along the sides of facilities which have been built into the earthworks;

   f. Trail systems to and from various facilities; and

   g. General sporatic trail and damage land sites within the earthworks systems.

   This system, without the live stakes, shall also be used when the season does not permit the use of living installation.

2. Live fascine with jute mesh.

This reconstruction system shall be employed on trail, erosion sites and open areas that are more than two (2) inches in depth, but not greater than ten (10) inches in depth.

The following site situtations may apply on the earthworks:

a. Along the sides of the earth mounds;

b. On the tops and over the tops (longitudinally and at right angles to the earthworks);

c. Trail systems to and from various facilities; and

d. General sporatic trail and damage land sites within the earthworks system.

3. Live fascines with live stakes.

This system shall be placed at the bottom of the earthworks:

a. In drainage ditch sites along the base of damaging or potentially damaging locations.

4. Branchpacking

This reconstruction system shall be placed in holes which have formed in the earthworks.

a. On the lowest points along the sides and on the ends of the earth mounds.

5. Brushlayers

This reconstruction system shall be used to rebuild earthworks which have been cut-through.

In shady areas it may be necessary to cut out some upper tree limbs, in order to allow some sunlight to penetrate the ground surface. In areas where this is not desirable or is impractical, the eroded section should be repaired using one of the above mentioned appropriate systems. Even if they do not grow and produce internal structural stability they will be able to reduce surface erosion and thus allow for the invasion of an appropriate plant species.

When repairing turf areas, use only shrubs that shall not root. These sites may also be repaired in the summer months, that is outside of the dormant season.

All fill areas shall be prepared with friable, well draining soils which are not toxic or in any way inhibiting to plant growth.

DESCRIPTIONS AND CONSTRUCTION GUIDELINES OF GENERIC SOLUTIONS

LIVE STAKES

DESCRIPTION

Live stakes are living woody plant cuttings capable of rooting. The cuttings are large enough and long enough to be tamped in as stakes. The live stakes are intended to root and grow into mature shrubs that stabilize the earthworks.

EFFECTIVENESS

A very effective stabilization method once vegetation is established.

An effective technique when construction time is limited.

An effective system for pegging.

Effective in quickly camouflaging an unwanted path system.

CONSTRUCTION GUIDELINES

Timing -

Dormant season (generally November to March).

Sizes -

The cuttings are usually 1/2" to 1-1/2" in diameter and 2' long.

Materials -

The cuttings must be alive, with side branches cleanly removed, and with bark intact.

The larger or thicker butt ends should be cleanly cut at a 45 degree angle, for eary insertion into the soil,

and the top should be cut square or blunt.

Cuttings must be fresh and must be kept moist. After they have been prepared into appropriate lengths, they should be installed the same day.

Installation -

Tamp the cuttings into the ground at right angles to the slope.

4/5 of the length of the cutting should be tamped into the ground, and soil should be firmly packed around the cutting.

Do not split the cuttings during tamping.

An iron bar can be used to make the hole; tamping the cutting into the bank is best accomplished with a dead-blow hammer (hammer with hollow head filled with shot or sand).

The density of the installation depends on site conditions, ranging from 2-6 cuttings per sq./yd. A spacing of 2' or greater is recommended.

The stakes should be placed in off center rows.

LIVE FASCINES (bundles)

DESCRIPTION

Live fascines are sausage like bundles of live cuttings wired or tied together and secured onto the earthworks with live and dead stout stakes.

They are placed on slopes parallel to the contour.

EFFECTIVENESS

This method offers some immediate protection from erosion when properly anchored into the lowest section of ditch sites.

A very effective stabilization technique once rooting is established.

Live fascines are capable of holding fill soil on the face of the earthworks.

CONSTRUCTION GUIDELINES

Timing -

Construction must occur in the dormant season.

Sizes -

Fascines can be 15' to 20' long.

The bundles are 6" in diameter when prepared.

The branches which are contained in the bundle should be at least 4' long and have a maximum trunk diameter of 1 inch.

Wire for bundling should be about the size of electrical fencing wire, or string for tying the bundles shall be bailing twine.

Materials -

Cuttings must be from a species that roots easily, and has long, straight branches. Young willows or red twig dogwoods are ideal for this method.

The cuttings are placed in bundles with the butt ends in the same direction, and wired together every 12".

Live stakes should be 2' long. Livestakes should be placed below the fascine. "Dead stout" stakes shall be placed directly through the fascine.

Installation -

Beginning at the base of the slope, place the live fascine.

Drive the "dead stout stakes" directly through the fascine bundles.

Next, two (2) feet up the face of the slope, repeat the above procedure, to the top of the slope.

"Dead stout stakes" should be spaced approximately 18" apart. Extra stakes should be used as joints. Leave the tips of the stakes flush with the bundle.

Place moist soil along the sides of the bundles.

Walk on top of the bundles and on the soil in between.

Next, place jute mesh over the top of the fascines and soil. Secure top and bottom with live stakes.

Tamp live stakes under the live fascines in between the "dead stout stakes", to secure the jute mesh to the face of the earthworks.

Fascines should be prepared immediately before installation.

BRANCHPACKING

DESCRIPTION

Branchpacking is alternating layers of live branches and soil incorporated into a holeor slump in the earthwork The branches root to form a permanent reinforced installation.

EFFECTIVENESS

The installation produces an immediate filter barrier, reducing gully erosion.

One of the most effective methods for revegetating holes in earthen embankments.

CONSTRUCTION GUIDELINES

Timing -

During the dormant season.

Sizes -

Branches may be 1/2" to 2" in diameter, and long enough to original bank soil with 8" to 12" left exposed on the outside.

Stakes should be 6' to 12' long.

Materials -

Live cuttings are required.

Soil is used in alternate layers between the layers of brush.

Installation -

Starting at the lowest point, tamp dead stakes vertically into the soil 1' to 2' apart.

First, a layer of branches 4" to 6" thick is placed in the bottom of the hole between the vertical stakes, at right angles to the earthwork, and covered with a 6" to 8" layer of soil.

The following layers of branches are installed with the basal ends angled down, so that they are lower than the tip of the branches.

Each layer of branches must be followed by a layer of soil and compacted thoroughly, tamping by foot, in order to insure soil contact with the branch cuttings.

Succeeding layers of branches and fill are alternated until the hole is completely filled.

At the bottom, rocks should be placed for good drainage, where necessary.

BRUSHLAYERS

DESCRIPTION

Brushlayers are alternating layers of live branches and soil incorporated into a fill section of earthwork to reconstruct

EFFECTIVENESS

The installation produces a rejoined and therefore continuous earthwork.

It retards gullying.

It serves to reinforce the fill earth.

CONSTRUCTION GUIDELINES

Timing -

During the dormant season.

Sizes -

Branches shall be 1/2" to 2" in diameter, and long enough to reach the center ofthe reconstruction and 1' beyond the final outside edgeof the earthworks.

Materials -

Live cuttings are required.

Soil is used in alternate layers between the brushlayers.

Installation -

Starting at the lowest point, the live cut brush is placed on the existing ground, at right angles to the earthwork.

The brushlayers should be 2" to 3" thick.

The basal ends of the brush should be lower than the tips.

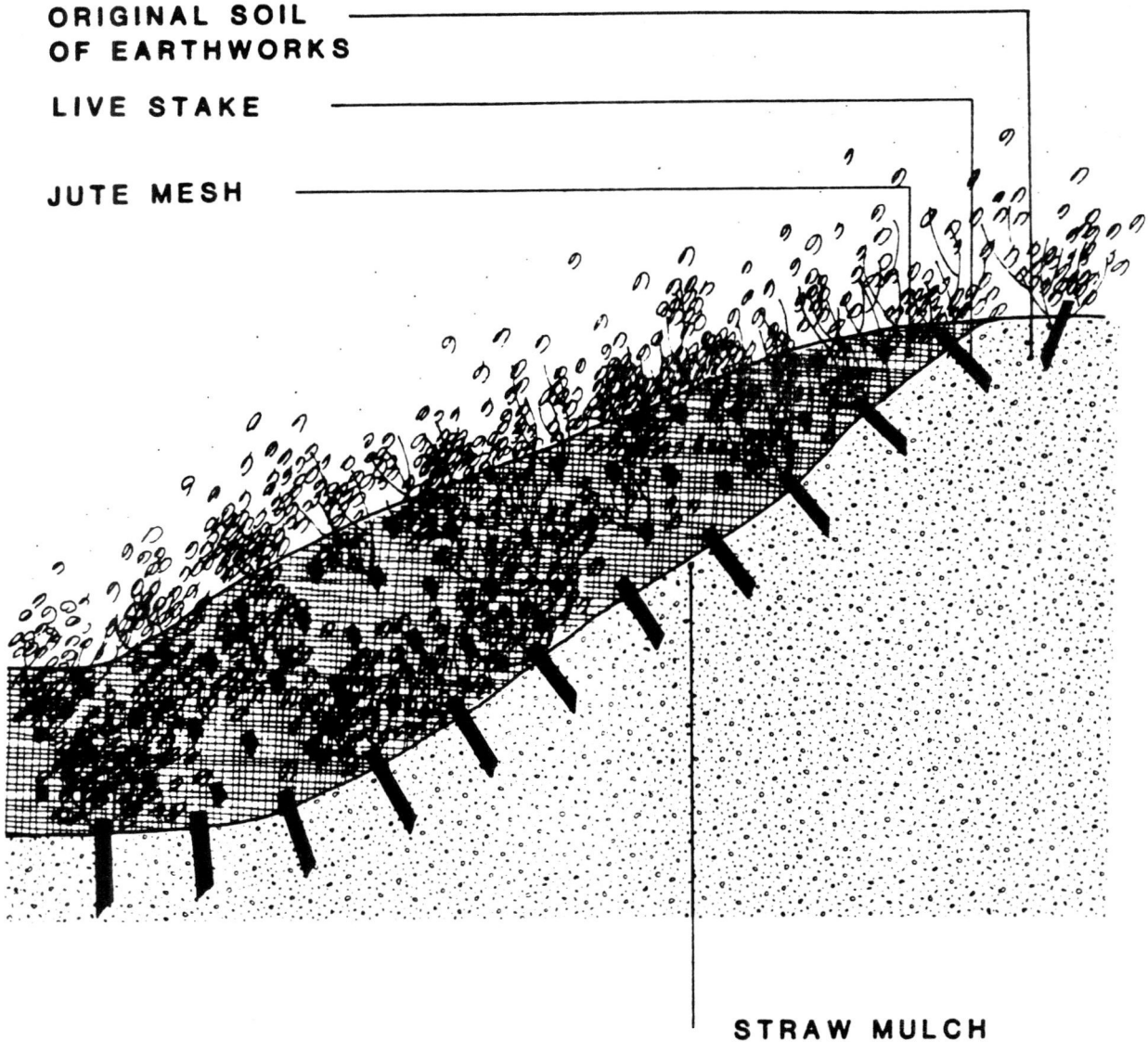
The brush is then covered with 1' to 1-1/2' of fill soil.

The soil should be foot compacted every 4" to 6" to ensure soil contact.

The above described process continues until the earthwork is rebuilt to the original height.

D. SUMMARY

Each employed system shall reflect the existing vegetation landscape feature types (SEE RECOMMENDED GROUND COVER TYPES). Following repair, the sites must be protected against further damage from visitors foot and motorized traffic. The restabilization and revegetation systems are fragile in their initial growing stages, but if old patterns of use are restabilized at the earthwork sites, redamage will again rapidly reoccur. These installed living systems shall require monitoring and maintenance.



LIVE STAKE / JUTE MESH / STRAW MULCH

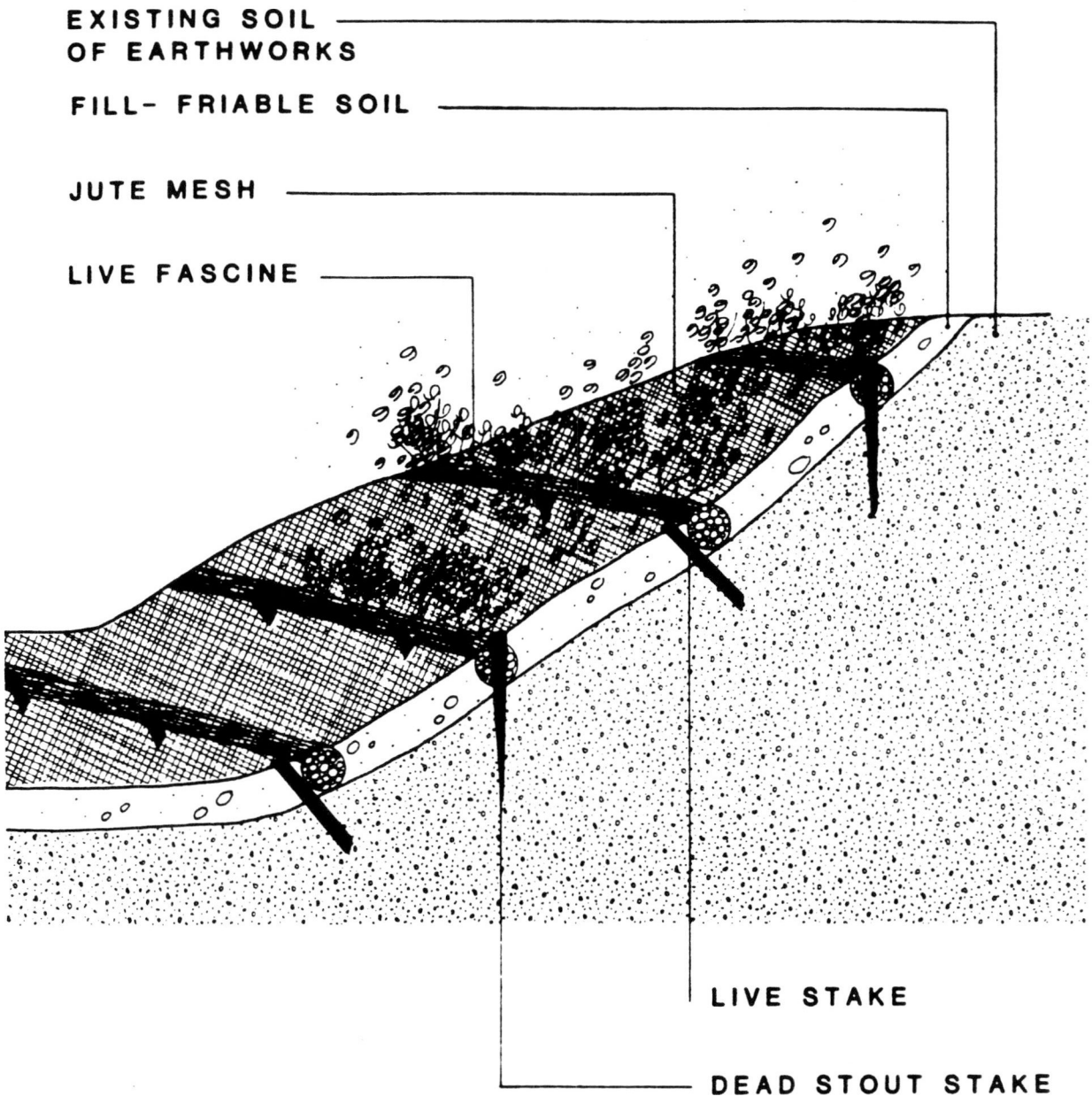
(Use in the repair of shallow open eroded areas)

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GENERIC SOLUTION 1
Figure 21



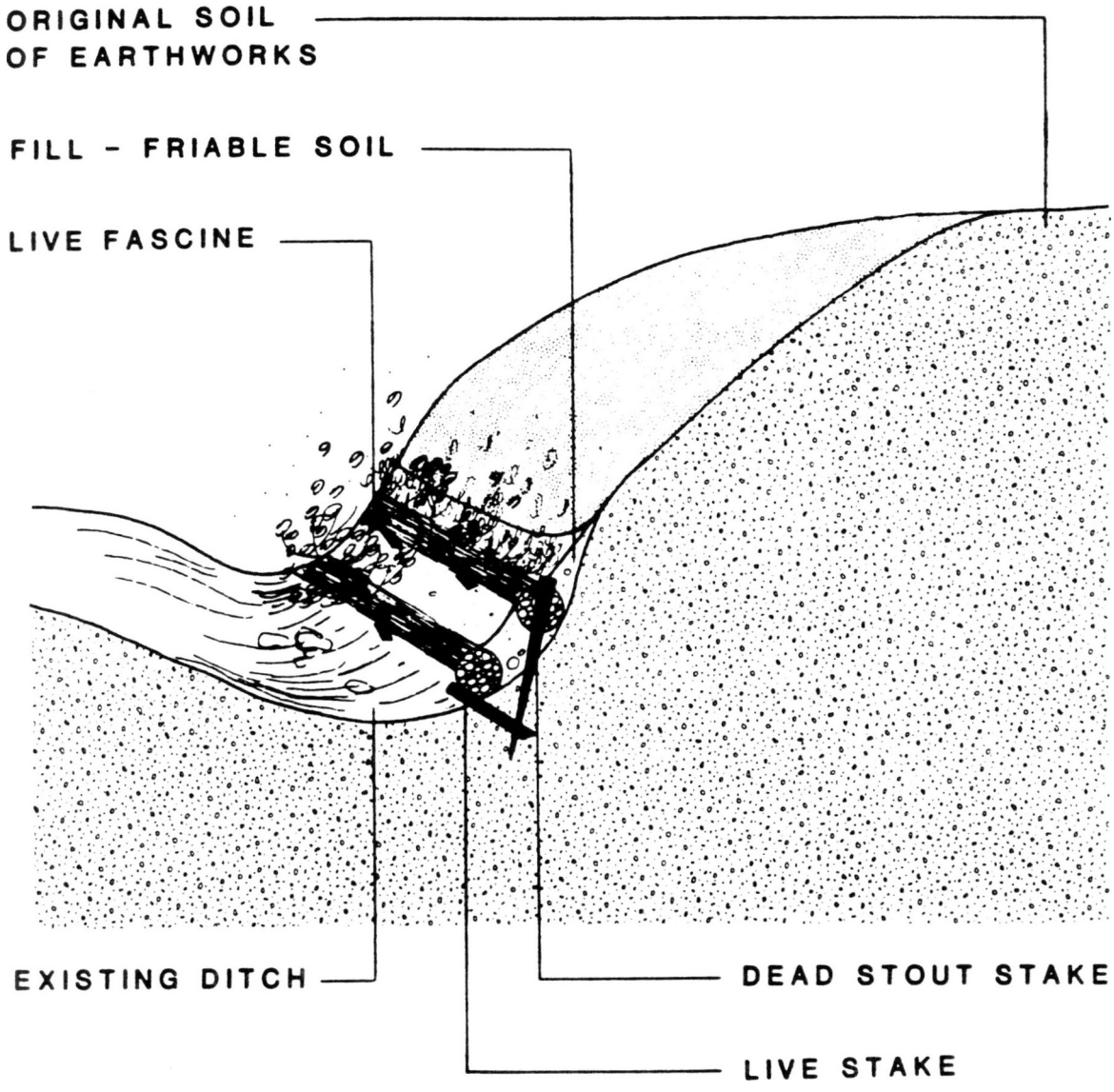
LIVE FASCINE / JUTE MESH

(Use in the repair of deeper eroded areas)

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GENERIC SOLUTION 2
Figure 22



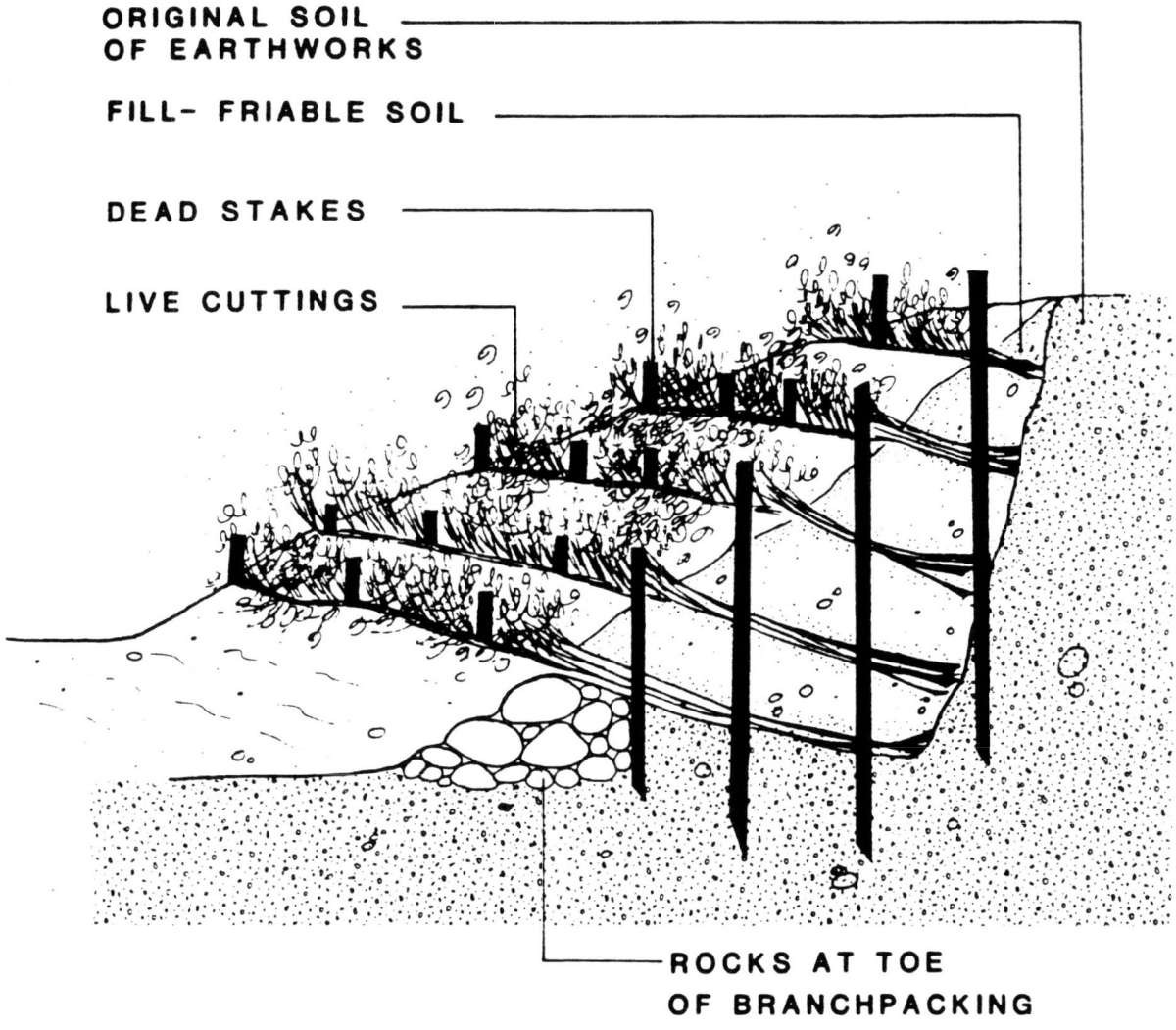
LIVE FASCINE / LIVE STAKE

(Use in stabilizing the base of ditches)

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GENERIC SOLUTION 3
Figure 23



BRANCHPACKING

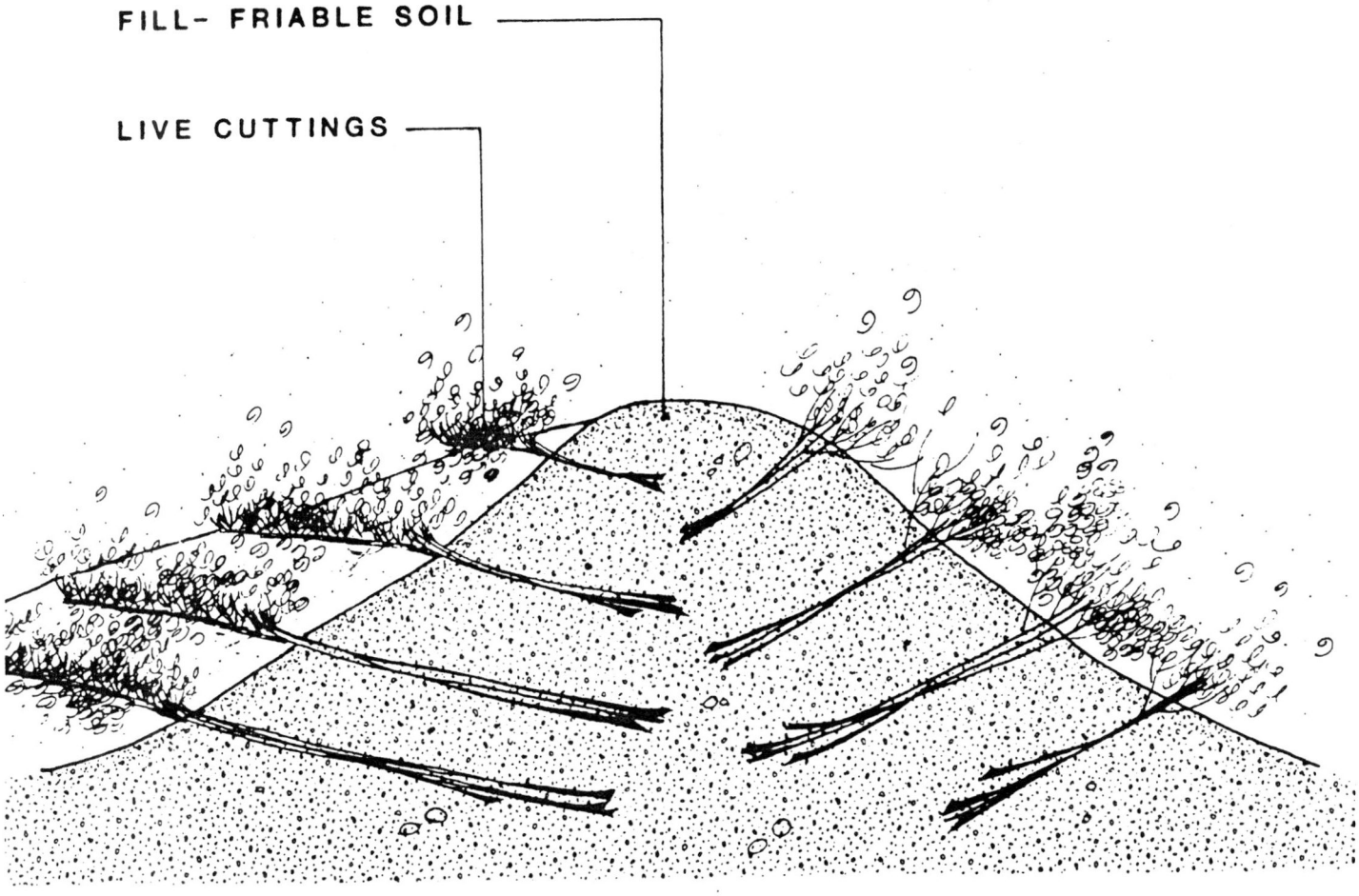
(Use in the repair of holes)

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GENERIC SOLUTION 4
Figure 24



BRUSHLAYER IN FILL

(Use in the repair of cut throughs)

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GENERIC SOLUTION 5
Figure 25



Photo 1.

This illustrates damage in the upper and mid sections along the sides of the earthworks.



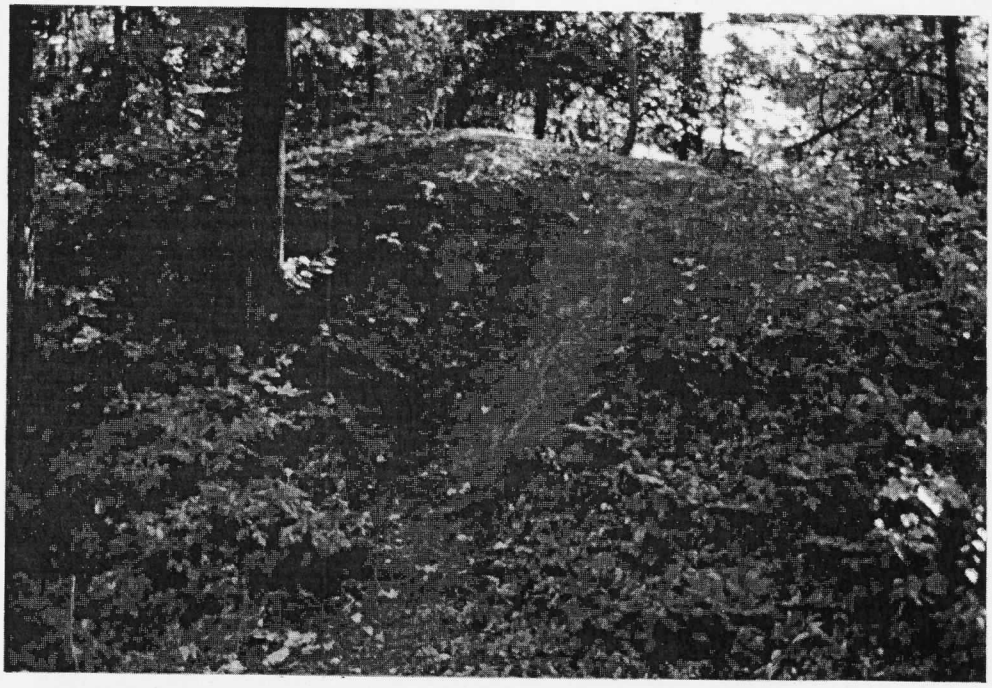
Photo 2.

This is a close-up of the same damaged site in Photo 1.



Photo 3.

Typical example of severe side and top denudation damage. This case is due to motorized vehicles which have been driven up the side of the earthworks.



Phote 4.

This is a close-up of the same damage sited in Photo 3.



Photo 5.

Typical example of a foot trail over the earthworks.

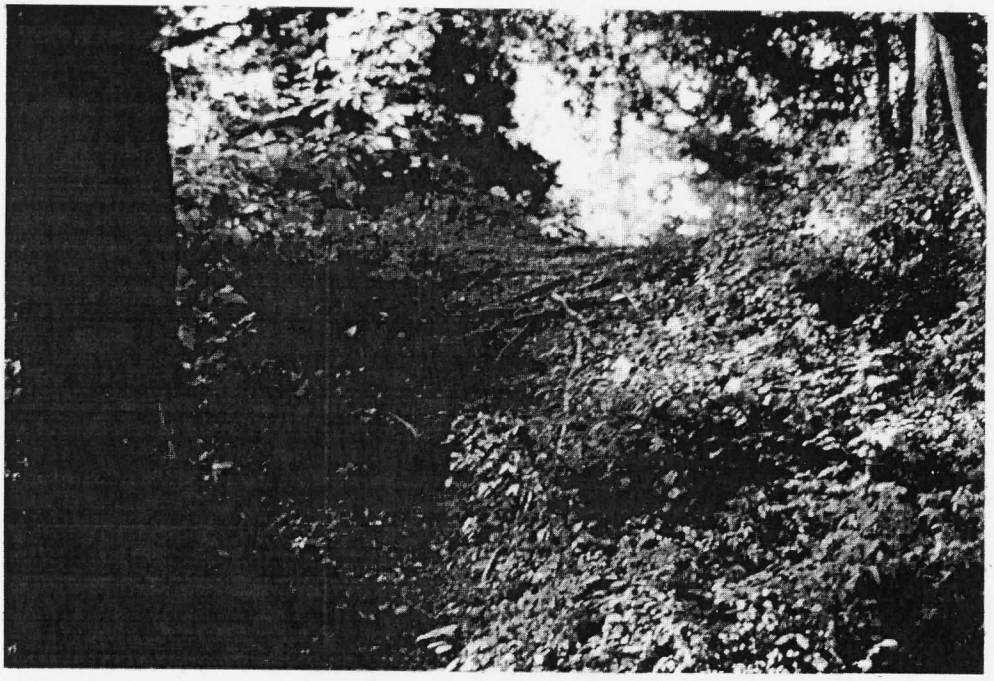


Photo 6.

Close-up of the same site as in Photo 5. This view clearly illustrates the damage being done to the roots of the existing vegetation, which is being destabilized.



Photo 7.

Typical interconnecting foot trail systems. These are found on the top and inbetween the earthworks. (Example 1)



Photo 8.

Another illustration of the interconnecting trail systems. (Example 2)



Photo 9.

Interconnecting trail systems which run primarly on top of the earthworks.



Photo 10.

Interconnecting trail system close-up of Photo 9.



Photo 11.

Severe disturbance around Civil War relics, which are located within the earthworks.



Photo 12.

Typical example of trails which lead from parking lot facilities to the earthworks or to relics within these structures.



Photo 13.

Facilities which have been built into the earthwork systems. (Example 1)



Photo 14.

Facilities which have been built into the earthwork structures. (Example 2)



Photo 15.
Drainage ditches at the base of the earthworks. (Full view)



Photo 16.
Drainage ditch close-up view from Photo 15.