

**FORM AND FUNCTION
OF FORESTED WETLANDS
RICHMOND NATIONAL BATTLEFIELD PARK**

James E. Johnson
Amy Cimarolli Helm
David O. Mitchem

Technical Report NPS/MARRICH/NRTR - 94/061

Department of Forestry
228 Cheatham Hall
Virginia Tech
Blacksburg, VA 24061-0324

Cooperative Agreement
4000-9-8014

Supplemental Agreement 8

Final Report
June 1994

National Park Service
Mid-Atlantic Regional Office
Division of Resource Management and Visitor Protection
143 South Third Street
Philadelphia, PA 19106-2878

Table of Contents

List of Figures	v
List of Tables	vi
Summary	vii
Introduction	1
Wetland Form	1
Wetland Soils	1
Wetland Vegetation	5
Wetland Hydrology	5
Functions and Values of Wetlands	5
Objectives	8
Methods	9
Description of Study Area	9
Field Inventory	9
Hydrological Sampling	10
Mapping	10
Results and Discussion	11
Malvern Hill	13
Fort Harrison	13
Watt House	13

Table of Contents (continued)

Cold Harbor	15
Beaver Dam Creek	15
Chickahominy Bluff	15
Conclusions	17
Literature Cited	19
Appendix 1 -- Wetland Forest Site Definitions from Kellison et al. (1982)	21
Appendix 2 -- Example Data Form for the Routine On-Site Determination Method	25
Appendix 3 -- Abbreviation, Indicator Status, and Species and Common Name of Plants Species Found in Wetlands of Richmond National Battlefield Park	27
Appendix 4 -- Unit Map with Wetland Boundaries and Groundwater Well Plot Locations for Malvern Hill	31
Appendix 5 -- Unit Map with Wetland Boundaries and Groundwater Well and Plot Locations for Fort Harrison	34
Appendix 6 -- Unit Map with Wetland Boundaries and Groundwater Well and Plot Locations for Watt House	37
Appendix 7 -- Unit Map with Wetland Boundaries and Groundwater Well and Plot Locations for Cold Harbor	40
Appendix 8 -- Unit Map with Wetland Boundaries and Groundwater Well and Plot Locations for Beaver Dam Creek	43
Appendix 9 -- Unit Map with Wetland Boundaries and Groundwater Well and Plot Locations for Chickahominy Bluff	46

List of Figures

Figure	Page
1. Diagram of the Hydrologic Cycle	2
2. Diagram of the Inter-Relations of Wetlands and Groundwater	3
3. Diagram of the Relationship Between Soils and Wetlands	4
4. Diagram of Histosol Formation Overlying Mineral Material	6

List of Tables

Table	Page
1. Estimated Probabilities of Occurrence for Wetland Indicator Plants	7
2. Extent of Jurisdictional Wetlands at the Richmond National Battlefield Park	12
3. Mean Monthly Groundwater Levels (cm) in Wetlands of the Richmond National Battlefield Park	14

Summary

During 1992 an inventory was conducted to determine the extent of jurisdictional wetlands within the Richmond National Battlefield Park, using the 1989 Federal Manual for Identifying and Delineating Jurisdictional Wetlands. Each wetland was mapped, its principal vegetation inventoried, soil features described, and average monthly water table depth measured. The park has a total of six distinct wetlands, located in the following units: Malvern Hill, Fort Harrison, Cold Harbor, Watt House, Beaver Dam Creek, and Chickahominy Bluff. All are palustrine broad-leaved, deciduous wetlands except Beaver Dam Creek, which is mostly composed of dead trees. Collectively, these wetlands total 18.8 ha (46.2 ac), about 6 percent of the park land.

These wetlands contain a large mix of overstory and understory woody plants and ground vegetation. Red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), yellow-poplar (*Liriodendron tulipifera*), and loblolly pine (*Pinus taeda*) are major overstory tree species in the wetlands, while sweet pepperbush (*Clethra alnifolia* L.), button bush (*Cephalanthus occidentalis*), arrowwood (*Viburnum dentatum*), and highbush blueberry (*Vaccinium formosum*), are common shrubs. Muscadine grape (*Vitis rotundifolia*), greenbrier (*Smilax rotundifolia*), Japanese honeysuckle (*Lonicera japonica*), and Virginia creeper (*Parthenocissus quinquefolia*) are common vines. Ground vegetation is healthy and diverse, including such common plants as jewel weed (*Impatiens capensis*), green arum (*Peltandra virginica*), *Polygonum* spp., various ferns, and lizard's tail (*Saururus cernuus*).

Some of the wetlands were extremely wet during 1992, while others were much drier. The wettest months are January through April. Water table depths below the ground surface ranged from 5.1 cm (2.0 in) at Beaver Dam Creek, to 41.4 cm (16.3 in) at Malvern Hill. Four of the six wetlands had average water table depths near 15 cm (6 in) or higher.

Wetlands represent unique and important features on the landscape and should be carefully protected from disturbances that affect the vegetation, soils, and hydrology. Since all of the wetlands in the park extend across park boundary lines, careful observations should be made to be sure surrounding land uses do not negatively impact park wetlands.

Introduction

Wetlands constitute a unique natural resource for any tract of land or region of the country. Naturally occurring wetlands are an important landscape feature. They perform a critical role in ecosystem ecology and have numerable human values as well. Protection of natural wetlands is a wise and prudent land management strategy, as well as a legislated mandate.

Wetland Form

Wetland is a collective term used to describe marshes, bogs, swamps, fens, and other areas that occur in the boundary between dry land and open water. To understand why wetlands develop, it is important to understand the basic hydrologic cycle (Figure 1). When precipitation falls on the land, some is returned to the air through evapotranspiration, but most either runs off the land surface or infiltrates into the ground. Water in the soil that is not taken up by plants eventually travels downward to replenish the groundwater supply, which slowly flows downhill to springs, streams, lakes, etc. If, for some reason, the groundwater is close to the surface, a wetland results (Figure 2). Wetlands also occur in areas where the flowing groundwater approaches the surface, and where water is ponded on an impervious base such as a clay pan or fragipan.

Wetlands are classified in many ways, but the simplest is either coastal or inland. Coastal wetlands, as the name implies, occur along the tidal areas. They are characterized by the mixing of salt and fresh water to form an environment of varying salinity. As fresh water is drawn out of these environments, through well-pumping for example, salt water intrudes farther inland and salinity rises. Coastal marshes with halophytic or "salt-loving" grasses are a good example of coastal wetlands. Inland wetlands are common along floodplains of streams and rivers, in depressions, and other areas where the water table approaches the surface. These include bogs, swamps, and marshes, and are often forested. Black spruce bogs in Minnesota, oak-gum-cypress swamps in Louisiana, and prairie potholes in North Dakota are all examples of inland wetlands.

In the Southeast, a series of wetland forest sites have been identified and classified by Kellison and others (1982). These sites include the various swamps and bottoms commonly found in the Piedmont and Upper Coastal Plain (Appendix 1).

Wetland Soils

Wetlands soils are unique in that they are wet, and as such take on certain characteristics. A variety of soil physical and chemical properties are related to the wetness, both the amount and duration. Color, degree of oxidation (or reduction), mottling, and decomposition are all related to wetness. Wetland soils may be either mineral or organic (Figure 3). Wet mineral soils usually have thicker and darker surface layers due to slower organic matter decomposition. They may also have varying reddish or grayish mottles if the water table rises and falls periodically. If the water table is permanently high, they may be uniformly

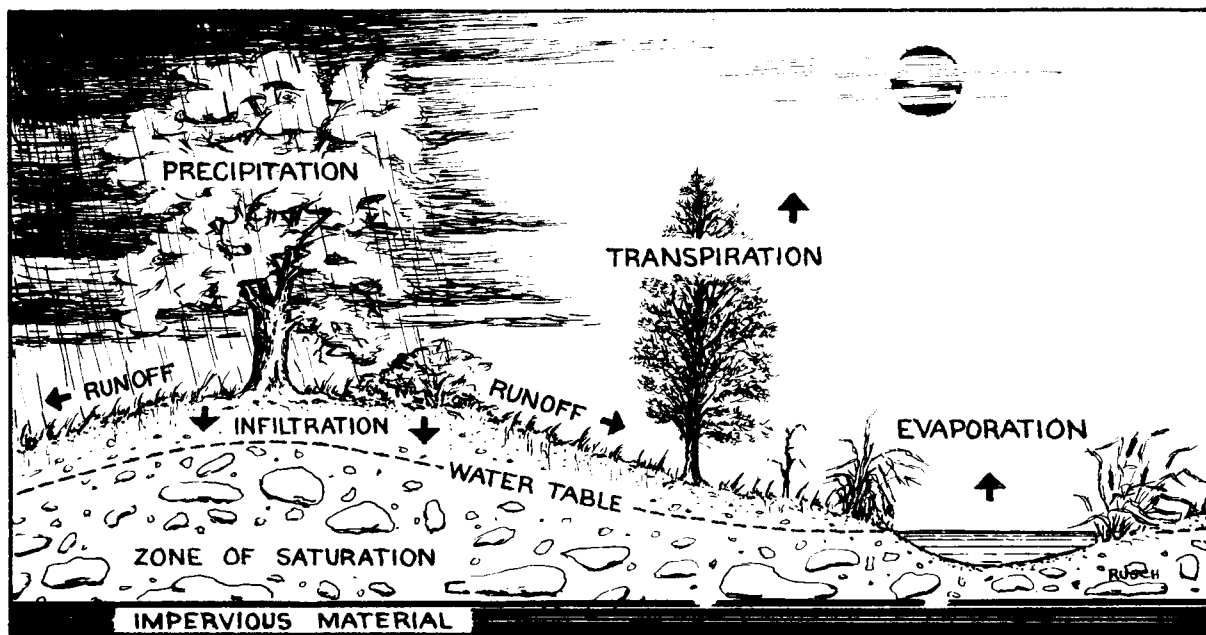


Figure 1
Diagram of the Hydrologic Cycle
(courtesy University of Wisconsin--Extension)

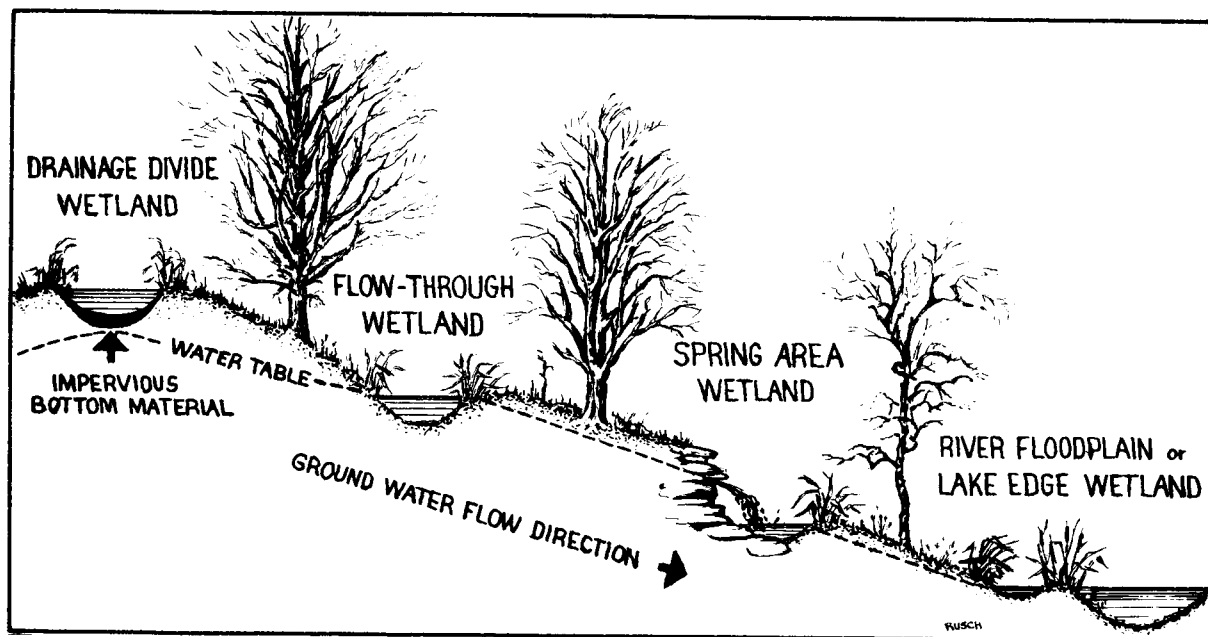


Figure 2
Diagram of the Inter-Relations of Wetlands and Groundwater
(courtesy University of Wisconsin--Extension)

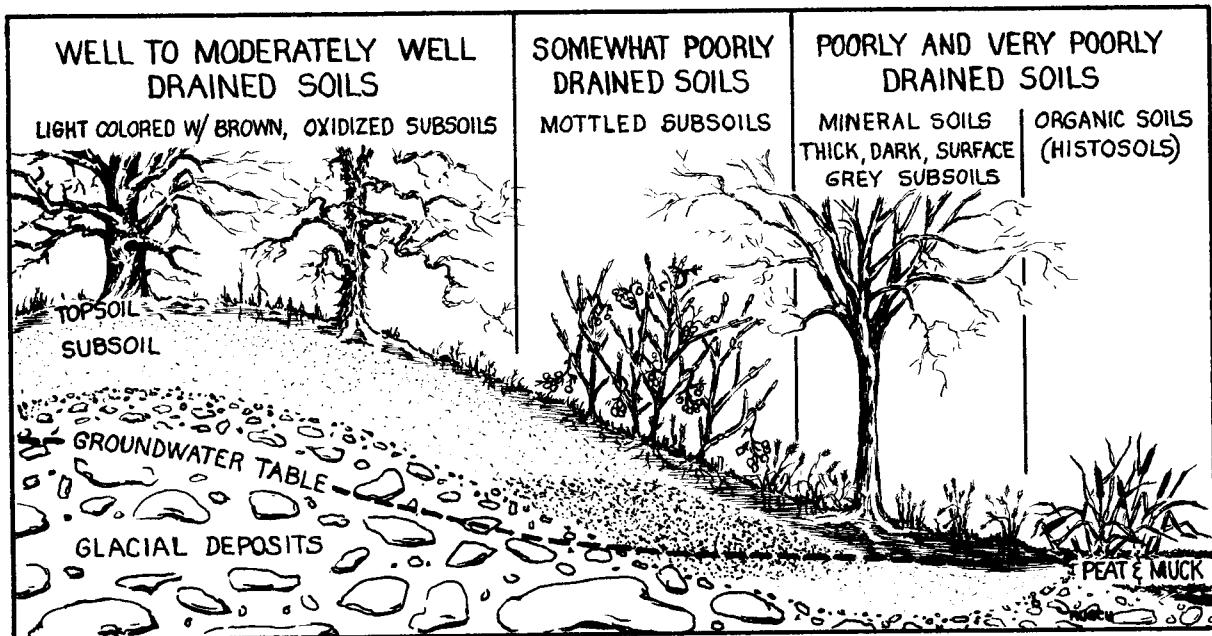


Figure 3
Diagram of the Relationship Between Soils and Wetlands
(courtesy University of Wisconsin--Extension)

gray, a condition known as "gleying." Gleyed soils are gray due to the reduction of iron oxides in wet soils. Organic soils are called Histosols and are formed by decaying vegetation (Figure 4). They are classified based upon the degree of decomposition, with Saprists (mucks) being the most highly decomposed and Fibristis (peats) the least. Often, wetlands will have a combination of soil types, with organic soils occurring over the top of mineral soils.

Wetland Vegetation

The quantity, type, and distribution of plants in wetlands are greatly influenced by the soil and water conditions. Wetland vegetation must be adapted to life in saturated soil conditions. Those species that are so adapted to are termed indicator species. There are five recognized categories of wetland indicator plants:

1. Obligate wetland plants--almost always occur in wetlands under natural conditions.
2. Facultative wetland plants--usually occur in wetlands but occasionally are found in non-wetlands.
3. Facultative plants--equally likely to occur in wetlands or non-wetlands.
4. Facultative upland plants--usually occur in uplands but occasionally are found in wetlands.
5. Obligate upland plants--almost always occur in uplands under natural conditions.

There are certain probability of occurrence levels that have been established for these different vegetation types (Table 1, Federal Interagency Committee for Wetland Delineation 1989).

Wetland Hydrology

Wetland hydrology refers to the level, duration, and flow of water in the soil. Hydrology has been determined to be an important criterion in delineating wetlands, since some wetlands may actually be dry for part of the year. To have wetland hydrology the soil must be inundated or saturated near the surface for a significant period during the growing season. Sampling for wetland hydrology is often difficult due to inherent temporal variability. Long-term monitoring is the best way to establish water levels and duration following rainfall events.

Functions and Values of Wetlands

Wetlands have important ecological functions and social values that should be protected. These include:

- Fish and wildlife habitat
- Water quality improvement
- Flood protection

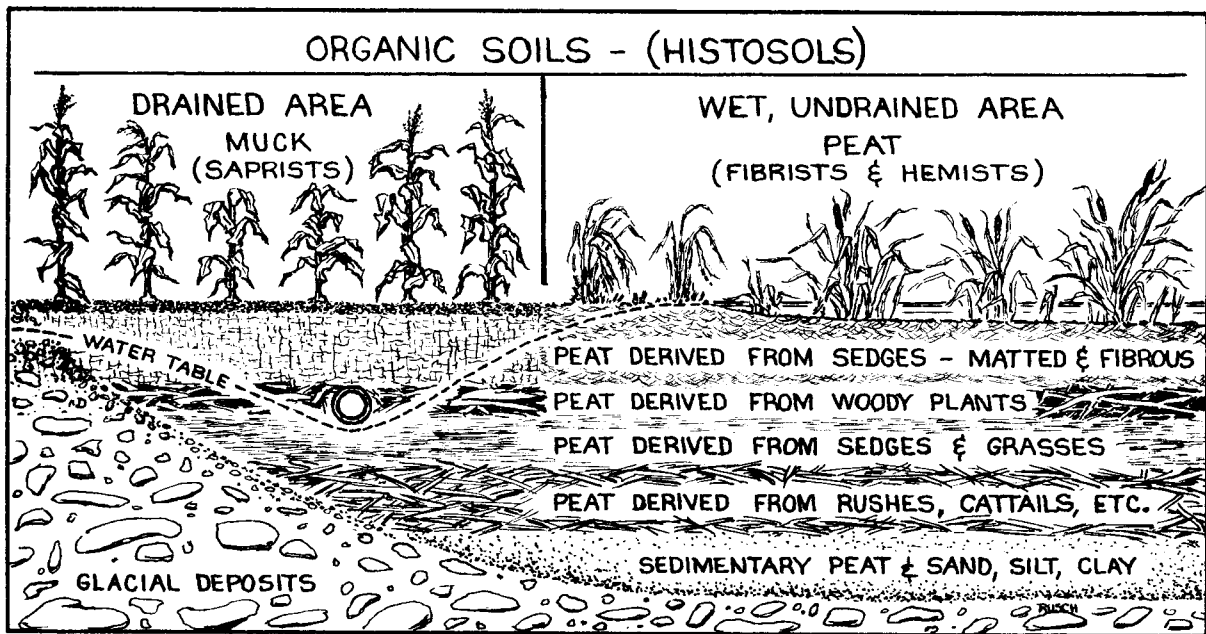


Figure 4
Diagram of Histosol Formation Overlying Mineral Material
(courtesy University of Wisconsin--Extension)

Table 1
Estimated Probabilities of Occurrence for Wetland Indicator Plants

Wetland Indicator	% Probability of Occurrence in	
	Wetlands	Uplands
Obligate wetland	> 99	0-1
Facultative wetland	67-99	1-33
Facultative	34-66	34-66
Facultative upland	1-33	67-99
Obligate upland	0-1	> 99

- Shoreline erosion control
- Natural products
- Recreation and aesthetics (U.S. EPA 1988)

In general, wetland functions refer to ecological or hydrological phenomena that contribute to the self-maintenance of the wetland ecosystem, while wetland values refer to their economic, recreational, or spiritual worth to humans (Walbridge 1993).

Wetlands constitute unique habitats for a variety of fish, amphibians, birds, and other animals. The combination of standing and flowing water and unique plants has developed wetland habitats that are decidedly different from either open water or dry upland habitats. Wetlands are among the most productive ecosystems in the world, producing large quantities of biomass and also a rich diversity of plant and animal life.

Wetlands are very efficient at filtering and removing excess nutrients and pollutants from flowing water. In so doing, wetlands act as natural purifiers of our water supply. They can intercept surface water runoff before it reaches streams, rivers, and lakes. Likewise, wetlands can help purify and abate floodwaters. This makes them especially valuable for protecting downstream property, reducing erosion damage, and preserving agricultural areas.

Since wetlands often occur along streams and rivers, they serve an important role in reducing shoreline erosion. Much sediment that ends up in flowing streams, rivers, and lakes comes from channels and the land adjacent to the channels. Wetland vegetation helps to hold the soil in place by producing an immense root mat and also reduces the force of flowing water through friction.

The natural products produced in wetlands include such items as timber, fish and shellfish, wildlife, blueberries, cranberries, and wild rice. In some areas, the economic impact of these products is enormous. For example, in the Southeast about 96 percent of the commercial fish harvest depends upon the integrity of the estuary-coastal wetland system (U.S. EPA 1988).

The recreational and aesthetic value of wetlands also should not be overlooked. Hunters, hikers, photographers, bird-watchers, artists, and many other groups routinely seek the beauty and solitude of the nation's wetlands. The U.S. EPA (1988) estimates that about 50 million people each year enjoy bird watching in wetlands. It is obvious that wetland protection in both public and private lands has a major ecological, social, and economic impact.

Objectives

This project was established to investigate the wetlands of the Richmond National Battlefield Park. Specific objectives were to identify and map wetland areas through determining the hydric soils, hydrophytic vegetation, and the wetland hydrology characteristics of each area.

Methods

Description of the Study Area

The study sites were located within the boundaries of the National Park Service Richmond National Battlefield Park. The park consists of 10 units, totaling 309 ha (763 ac) located in a semicircle to the north, east, and south of Richmond, Virginia. Richmond is located on the western edge of the Coastal Plain physiographic province, at the fall line where the Coastal Plain meets the Piedmont Plateau. The area has a level to gently rolling topography that is drained by the James, Chickahominy, and Pamunky rivers (Brown 1939). These rivers have built wide floodplains with terraces and steep valley sides, and the smaller tributaries have also cut paths through the landscape (Brown 1939). The bedrock around the Richmond area consists of partially consolidated sedimentary rocks of Cretaceous, Eocene, and Miocene marine sands, gravels, clays, shell marls, and diatomaceous sediment (Dietrich 1970). The soils are primarily sandy loams and silt loams, and agricultural sites range from those on productive bottomland to those on poorly drained and well-drained uplands (Brown 1939). Summer and winter temperatures average 24° C and 3° C (75° F and 37° F), respectively (NOAA 1983). Annual precipitation averages 112 cm (44 in), with most months averaging 8 or 9 cm (3.1 or 3.5 in) except for June and July, which average 13 cm (5.1 in) of rain.

During the Civil War, the battlefield sites were mostly agricultural areas composed of woodlots and fields. Remains of the military earthworks and forts are now covered with forest except where exposed for interpretive use by the park. Some of the battlefields have been maintained as open fields and cropland through the agricultural leasing program, but many are now covered by forest vegetation (RBNBP 1989).

The general composition of the overstory forest vegetation varies among pine, oak, and mixed hardwood cover types. No known endangered or threatened plant species have been identified within the park. Approximately 24 percent of the plant species found are exotics, most notable of which are the widely present Japanese honeysuckle and tree-of-heaven (Hayden and Johnson 1986). The National Park Service has no records of fire or any natural disturbances in the park forests that may have affected the present vegetation or species composition. Wind-throw and insect and disease infestations are common causes of death for mature trees in the study area.

Field Inventory

All field sampling was conducted during the summer of 1992. Each unit of the Richmond National Battlefield Park was investigated for possible wetlands by viewing aerial photographs, followed by ground checking. Potential wetland areas were more closely analyzed by using field checks of soils and vegetation. These checks involved analyzing the sites for standing water; presence of mottling and other hydric indicators in the soil; and abundance of obligate wetland plants, facultative wetland plants, and facultative plants.

All potential wetland areas received intensive investigation following the procedures outlined in Federal Interagency Committee for Wetland Delineation (1989) and Wetland Training Institute (1989). A hand compass and tape grid system was established separately for each wetland, and from 10 to 36 sample points were established in each. At each point the Routine On-Site Determination Method was used, which basically involved an ocular determination of the vegetation present, soil type and characteristics based on a bucket auger sample, and visible signs of wetland hydrology. The wetland boundary was drawn between grid points that differed in wetland delineation. The data form for the Routine On-Site Determination Method (see Appendix 2, for example) was filled out at each point, and the jurisdictional determination made. Soil series identification was made by matching field observations with established series and viewing soil survey maps. All completed data forms are on file at the Richmond National Battlefield Park headquarters.

Hydrological Sampling

At two random locations within each wetland, 60-cm (24-in)-deep PVC groundwater monitoring wells were established. The water depth in the wells was recorded monthly during 1992. The purpose for this sampling was simply to develop coarse estimates of water levels during one year. The random placement of these wells precludes use of the water level data in any rigorous assessment of wetland hydrology, since the water levels depend so much upon placement on the ground. Comparisons of groundwater levels between wetlands based on these data are not particularly valid due to the dependence of water level on well placement. The data, however, do provide a rough estimate of wetness that may be useful in year-to-year comparisons and comparing levels at two locations within the same wetland. All wells were located above any soil restricting layer.

Mapping

Field maps were converted to finished maps in the office, which were then digitized into the ARC INFO Geographic Information System. Scales varied so as to fit all maps on standard paper. Each map included the unit boundary, roads (where available), the wetland boundary, groundwater well sampling points, plot locations, scale, and wetland acreage (Appendices 4-9).

Results and Discussion

Of the 10 units at the Richmond National Battlefield Park, the following 6 contained jurisdictional wetlands:

1. Malvern Hill
2. Fort Harrison
3. Watt House
4. Cold Harbor
5. Beaver Dam Creek
6. Chickahominy Bluff

The extent of these wetlands is outlined in Table 2. The 18.8 ha (46.2 ac) represents about 6 percent of the total park area. All of these wetlands are classified as palustrine broad-leaved deciduous wetlands, with the exception of Beaver Dam Creek, which is a palustrine dead wetland, due to the standing dead trees over 6 m (20 ft) tall (Cowardin et al. 1979).

A variety of hydric soil series occurs within the wetlands of the park, with the dominant series and their classification as follows (USDA SCS 1987):

Wetland	Dominant Soil Series	Soil Subgroup
Fort Harrison	Turbeville	Typic Paleudult
Watt House	Goldsboro	Aquic Paleudult
Cold Harbor	Goldsboro	Aquic Paleudult
Beaver Dam Creek	Wehadkee	Typic Fluvaquent
Chickahominy Bluff	Myatt	Typic Ochraqult
Malvern Hill	Roanoke	Typic Ochraqult

Of these soil series, the Wehadkee and Myatt are classified as hydric soils. If an area has both hydric soils and hydrophytic vegetation, it is classified as a wetland, assuming no significant hydrologic modification. If it does not have hydric soils, it may still be classified as a wetland if it meets other criteria.

Overall, 57 species of overstory, understory, and ground vegetation were identified on the sample points. These plants covered the full range from obligate wetland plants to obligate upland plants. A complete list is contained in Appendix 3. The codes and classifications for these plants were developed by Reed (1988).

Table 2
Extent of Jurisdictional Wetlands at the Richmond National Battlefield Park

Wetland	Land Area in Hectares	Land Area in Acres
Malvern Hill	5.1	12.6
Fort Harrison	1.4	3.5
Watt House	1.5	3.6
Cold Harbor	3.3	8.1
Beaver Dam Creek	2.6	6.3
Chickahominy Bluff	4.9	12.1
Total	18.8	46.2

Ground water level monitoring by month during 1992 provided hydrology data for each wetland (Table 3). Water levels varied by wetland and by season of the year. For most wetlands, January through April tended to be the wettest months. Only at Beaver Dam Creek was the water level very close to or at the surface most of the year. June through September were the driest months. Overall, Beaver Dam Creek, Chickahominy Bluff, and Fort Harrison were the wettest throughout the year. A note should be made here, regarding the placement of the wells. Wells were located randomly, and it is highly likely that if placed in other locations, different water levels would have been recorded. For example, at Malvern Hill, both wells were located close to each other and more toward the upper boundary of the wetland. Based on the hydrology criterion alone, Malvern Hill does not qualify as a wetland, but that is due strictly to the placement of the wells.

Malvern Hill

Malvern Hill has a 5.1-ha (12.6-ac) wetland located along the toe slope of the hill. The wetland grades into an open water beaver pond at the bottom and a mixed pine-deciduous forest up the slope. Loblolly pine, red maple, sweetgum, northern red oak, and white oak dominated the overstory; and Polygonum, Virginia creeper, Japanese honeysuckle, false nettle, and sensitive fern occurred in the ground stratum. The only obligate wetland plants were Polygonum arifolium, Aneilema keisak, button bush, and arrowhead. Based on water level monitoring, the average groundwater depth is 41 cm (16 in). Eighteen sample points for soils and vegetation were established in this wetland (Appendix 4).

Fort Harrison

Fort Harrison contains the smallest wetland in the park, at 1.4 ha (3.5 ac). Based on the 24 sample points located in this wetland, the dominant overstory tree species were red maple, yellow-poplar, sweetgum, southern red oak, and white oak. Understory and ground vegetation included greenbrier, sweetbay, sweet pepperbush, highbush blueberry, sensitive fern, royal fern, and partridge berry. Button bush and royal fern were the only obligate wetland plants found, but several obligate upland species occurred, including lowbush blueberry, mockernut hickory, black oak, and scarlet oak. The average depth to groundwater was 12.7 cm (5.0 in), based on the two sampling wells (Appendix 5).

Twenty-five sample points were located in this wetland. Common overstory tree species included American holly, American beech, chestnut oak, red maple, and sweetgum.

Watt House

Watt House has the second smallest wetland, with only 1.5 ha (3.6 ac) located along Boatswain Creek. This is a typical, sinuous wetland along the floodplain of the creek. Understory and ground vegetation featured sweet pepperbush, southern lady's fern, muscadine grape, lowbush blueberry, strawberry bush, may-apple, and Japanese honeysuckle. No obligate wetland plants were found in this streamside forest. The average

Table 3
Monthly Groundwater Levels (cm)
in Wetlands of the Richmond National Battlefield Park*

Sample Date	Wetland					
	Malvern Hill	Fort Harrison	Watt House	Cold Harbor	Beaver Dam Creek	Chickahominy Bluff
	cm below ground surface					
30JAN92	11.4	2.5	22.9	12.7	1.3	8.9
25FEB92	8.9	1.3	10.2	8.9	1.3	3.8
20MAR92	6.4	3.8	31.8	5.1	3.8	5.1
15APR92	6.4	5.1	38.1	10.2	6.4	7.6
20MAY92	54.7	7.6	36.8	12.7	0.0	2.5
27JUN92	61.0	20.3	45.7	29.2	10.2	25.4
27JUL92	45.7	22.9	42.1	24.1	11.4	29.2
25AUG92	61.0	31.8	43.2	26.7	27.9	24.1
30SEP92	57.2	22.9	41.9	21.6	3.8	30.5
27OCT92	61.0	16.5	39.4	14.0	2.5	11.4
21NOV92	61.0	12.7	30.5	15.2	0.0	6.4
22DEC92	61.0	14.0	40.6	15.2	0.0	8.9
MEAN	41.3	13.5	36.1	16.3	5.8	13.7

* Each value is mean of two well observations.

annual depth to groundwater was 34.5 cm (13.6 in), based on the two sampling wells (Appendix 6).

Cold Harbor

The Cold Harbor wetland also followed a stream, similar to Watt House. This wetland was 3.3 ha (8.1 ac) in size. Thirty-six sample points were located in the Cold Harbor wetland. Overstory tree species included red maple, American holly, white oak, eastern hophornbeam, flowering dogwood, blackgum, and yellow-poplar. Understory and ground vegetation included muscadine grape, sweet pepperbush, greenbrier, sensitive fern, highbush blueberry, and partridge berry. Button bush was the only obligate wetland plant found, and it occurred at 19 percent of the sample points. The average annual water table depth was 15.5 cm (6.1 in), based on the two sample wells (Appendix 7).

Beaver Dam Creek

Beaver Dam Creek has the most visible and obvious of all the park wetlands. Although it is only 2.6 ha (6.3 ac) in size, its easy access and open character due to dead trees makes it a popular spot. Only 10 sample points were established at Beaver Dam Creek. Red maple and sweetgum occurred as trees, and jewel weed, button bush, green arum, Polygonum, and swamp rose were the dominant obligate wetland plants. The average annual groundwater depth was 5.1 cm (2.0 in). The water table was within 15 cm (6 in) for 8 months of the year (Appendix 8).

Chickahominy Bluff

The wetland at Chickahominy Bluff consists of the upper portion of the floodplain of the Chickahominy River, along the northern boundary of the unit. At 4.9 ha (12.1 ac), this is the second largest wetland at Richmond National Battlefield Park. Twenty-six sample points were established in this wetland. Dominant overstory tree species included red maple, sweetgum, yellow-poplar, willow oak, and loblolly pine. Understory and ground vegetation included Japanese honeysuckle, jewel weed, lizard's tail, sensitive fern, muscadine grape, button bush, arrowwood, and Virginia creeper. Obligate wetland plants included lizard's tail, button bush, arrowhead, and royal fern. The average annual water table depth was 12.2 cm (4.8 in), based on the two sample wells (Appendix 9).

Conclusions

Wetlands perform a variety of important functions that not only maintain ecosystem stability, but produce human economic and social values as well (Mitsch and Gosselink 1993). As wetland areas dwindle, it is critical to maintain and protect remaining wetlands, particularly on public lands where access is relatively open. The Richmond National Battlefield Park has nearly 19 hectares (46 ac) of wetlands scattered across six units. These wetlands contain a rich diversity of plant and animal life and add appreciably to the mix of ecosystems that are protected in the park. Park personnel should try to maintain the quality of these ecosystems and watch for detrimental land use practices on adjacent ownerships. All of these wetlands cross the park boundary, and thus are susceptible to external impacts.

Literature Cited

Brown, W.R. 1939. Coastal plain geology of the Richmond area, Virginia. M.A. Thesis. University of Virginia. Charlottesville, VA. 110pp.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRue. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Dept. of the Interior Fish and Wildlife Service Rep. OBS-79/31. Washington, DC. 103pp.

Dietrich, R.V. 1970. Geology and Virginia. The University Press of Virginia. Charlottesville, VA. 213pp.

Federal Interagency Committee for Wetland Delineation. 1989. Federal manual for identifying and delineating jurisdictional wetlands. U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, and U.S.D.A Soil Conservation Service Cooperative Technical Publication. Washington, DC. 76pp.

Hayden, W.J. and M.F. Johnson. 1986. Flora of Richmond National Battlefield Park (Chickahominy Bluff, Cold Harbor, Fort Darling, Fort Harrison, Gathright House, and Watt House Units). MAR-16. 40pp.

Kellison, R.C., D.J. Frederick, and W.E. Gardner. 1982. A guide for regenerating and managing natural stands of southern hardwoods. North Carolina State Univ. Agricultural Research Service Bulletin 463. Raleigh, NC. 23pp.

Mitsch, W.J. and J. G. Gosselink. 1993. Wetlands. Van Nostrand Reinhold, New York, NY. 2nd Ed. 722pp.

National Oceanic and Atmospheric Administration. 1983. Climate normals for the U.S. 1951-1980 (First Edition). Compiled by National Climatic Center, Environmental Data and Information Service, National Oceanic and Atmospheric Administration. 712pp.

Reed, P.B. 1988. National list of plant species that occur in wetlands: national summary. U.S. Dept. of the Interior Fish and Wildlife Service Biological Rep. 88(24). Washington, DC. 244pp.

Richmond National Battlefield Park. 1989. Statement of management and outline of planning requirements. Richmond National Battlefield Park. 104pp.

U.S. Department of Agriculture, Soil Conservation Service. 1987. Hydric soils of the United States. U.S.D.A. Soil Conservation Service, National Technical Committee for Hydric Soils. Washington, DC.

U.S. Environmental Protection Agency. 1988. America's wetlands -- our vital link between land and water. U.S. Environmental Protection Agency. Office of Wetlands Protection Pub. OPA-87-016. Washington, DC. 10pp.

Walbridge, M.R. 1993. Functions and values of forested wetlands in the southern United States. Journal of Forestry 91:15-19.

Wetland Training Institute. 1989. Field guide for delineating wetlands: unified federal method. WTI 89-1. Poolesville, MD. 131pp.

Appendix 1
Wetland Forest Site Definitions From Kellison et. al. (1982)

Muck Swamp

Very poorly drained area, usually with standing water. Broad expanses between tidewater and upstream runs and along blackwater rivers and branch bottom stands; also found in miniature in sloughs and old oxbows of redwater rivers and branch bottoms. Characterized by heavy accumulation of organic matter (amorphous, lacking structure). Soils range from silt loam through clay. Water tupelo and baldcypress are common in deeply flooded areas and swamp black gum predominates toward the fringes.

Peat Swamp (Headwater Swamp)

Occupy broad interstream areas from which blackwater rivers and branch bottoms originate. These swamps are poorly drained, with heavy accumulations of raw organic matter. Soils resemble those of muck swamps but in general are heavier and of better site quality. Examples are: Dismal Swamp of Virginia-North Carolina, Green Swamp of North Carolina-South Carolina, Little Wambaw of South Carolina, and Okefenokee Swamp of Georgia-Florida. Swamp black gum and red maple predominate in mixture of many hardwood species; coniferous species found are loblolly and pond pines, and Atlantic white cedar to the north. This category includes the true pocosins of the Carolinas such as White Oak Pocosin in Hofmann Forest.

Wet Flat

Topographically similar to peat swamps and pocosins, they all lie in broad interstream areas where drainage systems are poorly developed. However, wet flats are better drained than their associates because of higher elevation. The nonalluvial soils may possess some accumulation of organic matter but fertility is superior to peat swamps and pocosins because of superior parent material. Abandoned rice fields of the southern lower Coastal Plain often fall in this category. Examples are: Jordan and J&W pocosins in North Carolina. Species generally encountered: (1) on wetter portion--sweetgum; red maple; water, laurel and willow oaks; ashes; loblolly pine; elms and other species; (2) on "islands," with better drainage--cherrybark, Shumard and swamp chestnut oaks; yellow-poplar; hickories; and occasionally beech. (Locally, in the Northern Coastal Plain, wet flats are known as "pocosins," whereas in the South Coastal Plain they are called "hammocks.")

Red River Bottom

Floodplain of major drainage system originating in the Piedmont or mountains. Immediately adjacent to the drainage systems, sloughs and oxbows are commonly found; if of sufficient size, they are classified as muck swamps. Some organic matter may accumulate on the clay soils. Water tupelo predominates over cypress, red maple, swamp black gum, swamp cottonwood, laurel oak, and others. Beyond the sloughs and oxbows are found first bottoms (low ridges) which flood periodically to considerable depths. However, drainage is fairly rapid because of high elevation. Soils are loam or silt loam. Species included sweetgum; green ash; water hickory; sycamore; red maple; river birch; elms; and willow, water, laurel, and overcup oaks. At still higher elevations, second bottoms and terraces (high ridges and fronts) are found. Here flooding is infrequent or rare, and more mesophytic species of cherrybark, swamp chestnut and white oaks; hickories; beech; and occasionally yellow-poplar make their appearance. Examples of red river bottoms are: Roanoke--Virginia, North Carolina; Santee--South Carolina; Oconee--Georgia; and Alabama River--Alabama.

Black River Bottom

Floodplain of major water system originating in Coastal Plain. Classification of minor site types and species similar to red river bottom, with exception of muck swamps being more prevalent and first and second bottoms and terraces being on a more modest scale. Examples of rivers where blackwater bottoms are found are: Blackwater--Virginia; Waccamaw--North Carolina, South Carolina; Black--South Carolina; and St. Mary's--Georgia and Florida.

Branch Bottom

Relatively flat, alluvial land along minor drainage system which is subject to minor overflow. On wetter portions with heavier soils, the predominant species are willow, water and laurel oaks; swamp black gum; sweetgum; red maple; and ash. The lighter soils of second bottoms and terraces support cherrybark, Shumard, swamp chestnut, and white oaks; sweetgum; hickory; yellow-poplar; and loblolly pine. Sloughs and oxbows of limited extent along the main channel support tupelo and swamp black gum. Examples: Big Swamp--North Carolina.

Bottomland

In lower Piedmont, conditions identical to red river bottom are encountered. However, upstream, sloughs, oxbows, and first bottoms decrease in frequency and area until only well-drained bottomland (second bottom and terrace) is encountered. This type also includes the area adjacent to the tertiary streams of the red rivers. Species found here are sycamore, yellow-poplar, sweetgum, green ash, cottonwood, water and willow oak, loblolly pine, and others.

Coves, Gulfs, and Lower Slopes Adjacent to Streams

This site type is characterized by uneroded, fertile mineral soils that are moist but well drained. It is common to upper Piedmont and mountain provinces. In the Cumberland Plateau range, valleys or hollows extending from the crest of the range to major drainage systems are known as gulfs. They are characterized by plateaus that are separated by steep terrain. Here the mixed mesophytic forest consisting of yellow-poplar, sweetgum, white ash, northern red oak, black oak, black cherry, and black walnut is at its best.

Upland Slopes and Ridges

Here the mineral soils are more shallow and less moist than the coves and lower slopes. White oak and hickory predominate but yellow-poplar, black and scarlet oaks, and blackgum are also common. Shortleaf and Virginia pines are common coniferous associates.

Appendix 2
Example Data Form for the Routine On-Site Determination Method

DATA FORM
ROUTINE ONSITE DETERMINATION METHOD¹

Field Investigator(s): David Mitchem Date: 7/1/92
Project/Site: Malvern Hill State: Va. County: Henrico
Applicant/Owner: N.P.S. Plant Community #/Name: 1-1
Note: If a more detailed site description is necessary, use the back of data form or a field notebook.

Do normal environmental conditions exist at the plant community?
Yes X No (If no, explain on back)
Has the vegetation, soils, and/or hydrology been significantly disturbed?
Yes No X (If yes, explain on back)

VEGETATION

Dominant Plant Species			Dominant Plant Species		
Indicator Status	Stratum		Indicator Status	Stratum	
1. <u>LST</u>	<u>FAC</u>	<u>T</u>	11. <u> </u>	<u> </u>	<u> </u>
2. <u>Polygonum Spp.</u>	<u>OBL</u>	<u>H</u>	12. <u> </u>	<u> </u>	<u> </u>
3. <u>AKE</u>	<u>OBL</u>	<u>H</u>	13. <u> </u>	<u> </u>	<u> </u>
4. <u> </u>	<u> </u>	<u> </u>	14. <u> </u>	<u> </u>	<u> </u>
5. <u> </u>	<u> </u>	<u> </u>	15. <u> </u>	<u> </u>	<u> </u>
6. <u> </u>	<u> </u>	<u> </u>	16. <u> </u>	<u> </u>	<u> </u>
7. <u> </u>	<u> </u>	<u> </u>	17. <u> </u>	<u> </u>	<u> </u>
8. <u> </u>	<u> </u>	<u> </u>	18. <u> </u>	<u> </u>	<u> </u>
9. <u> </u>	<u> </u>	<u> </u>	19. <u> </u>	<u> </u>	<u> </u>
10. <u> </u>	<u> </u>	<u> </u>	20. <u> </u>	<u> </u>	<u> </u>

Percent of dominant species that are OBL, FACW, and/or FAC >50%
Is the hydrophytic vegetation criterion met? Yes X No
Rationale:

SOILS

Series/phase: Roanoke Subgroup:² Typic Ochraquults
Is the soil on the hydric soils list? Yes X No Undetermined
Is the soil a Histosol? Yes No X Histic epipedon present? Yes No
Is the soil: Mottled? Yes X No Gleyed? Yes X No
Matrix Color: 2.5Y 7-0 Mottle Colors: 7.5YR 4-6
Other hydric soil indicators:
Is the hydric soil criterion met? Yes X No
Rationale:

HYDROLOGY

Is the ground surface inundated? Yes No X Surface water depth:
Is the soil saturated? Yes X No
Depth to free-standing water in pit/soil probe hole: 10"
List other field evidence of surface inundation or soil saturation.
Is the wetland hydrology criterion met? Yes X No
Rationale:

JURISDICTIONAL DETERMINATION AND RATIONALE

Is the plant community a wetland? Yes X No
Rationale for jurisdictional decision: Vegetation, soils and hydrology criteria are met.

¹ This data form can be used for the Hydric Soil Assessment Procedure and the Plant Community Assessment Procedure.
² Classification according to "Soil Taxonomy."

Appendix 3
Abbreviation, Indicator Status, and Species and Common Name
of Plants Found in Wetlands of Richmond National Battlefield Park

Abbreviation ¹	Indicator Status ¹	Species
AAS	FAC ²	Southern Lady's Fern <u>Athyrium asplenoides</u>
AKE	OBL ³	<u>Aneilema keisak</u>
APL	FACU ⁴	Ebony Spleenwort <u>Asplenium platyneuron</u>
ARU	FACW ⁵	Red Maple <u>Acer rubrum</u>
BCY	FACW	False Nettle <u>Boehmeria cylindrica</u>
CAL	FAC	Sweet Pepperbush <u>Clethra alnifolia</u>
CCA	FAC	Eastern Hophornbeam <u>Carpinus caroliniana</u>
CFL	FACU	Flowering Dogwood <u>Cornus florida</u>
COC	OBL	Button Bush <u>Cephalanthus occidentalis</u>
CRA	FAC	Trumpet Creeper <u>Campsis radicans</u>
CTO	UPL ⁶	Mockernut Hickory <u>Carya tomentosa</u>
DVI	FAC	Persimmon <u>Diosporos virginiana</u>
EAM	FAC	Strawberry Bush <u>Euonymus americanus</u>
EHF	FACU	Fireweed <u>Erechtites hieracifolia</u>

Abbreviation	Indicator Status	Species
FGR	FAC	American Beech <u>Fagus grandifolia</u>
FPE	FACW	Green Ash <u>Fraxinus pennsylvanica</u>
GFR	FACU	Huckleberry <u>Gaylussacia frondosa</u>
ICA	FACW	Jewel Weed <u>Impatiens capensis</u>
IOP	FACU	American Holly <u>Ilex opaca</u>
LJA	FAC	Japanese Honeysuckle <u>Lonicera japonica</u>
LOB	FACU	Groundpine <u>Lycopodium obscurum</u>
LST	FAC	Sweetgum <u>Liquidambar styraciflua</u>
LTU	FACU	Yellow-Poplar <u>Liriodendron tulipifera</u>
MRE	FACU	Partridge Berry <u>Mitchella repens</u>
MVI	FAC	<u>Microstegium vimineum</u>
MVIR	FACW	Sweet Bay <u>Magnolia virginiana</u>
NSY	FACW	Blackgum <u>Nyssa sylvatica</u>
ORE	OBL	Royal Fern <u>Osmunda regalis</u>
OSE	FACW	Sensitive Fern <u>Onoclea sensibilis</u>

Abbreviation	Indicator Status	Species
PAC	FACU	Christmas Fern <u>Polystichum acrostichoides</u>
PAR	OBL	<u>Polygonum arifolium</u>
POC	FACW	Sycamore <u>Platanus occidentalis</u>
PPE	FACU	May-Apple <u>Polophyllum peltatum</u>
PQU	FACU	Virginia Creeper <u>Parthenocissus quinquefolia</u>
PTA	FAC	Loblolly Pine <u>Pinus taeda</u>
PVI	OBL	Green Arum <u>Peltandra</u>
QCO	UPL	Scarlet Oak <u>Quercus coccinea</u>
QFA	FACW	Southern Red Oak <u>Quercus falcata</u>
QPH	FAC	Willow Oak <u>Quercus phellos</u>
QPR	UPL	Chestnut Oak <u>Quercus prinus</u>
QRU	FACU	Northern Red Oak <u>Quercus rubra</u>
QVE	UPL	Black Oak <u>Quercus velutina</u>
RPA	OBL	Swamp Rose <u>Rosa palustris</u>
RRA	UPL	Poison Ivy <u>Toxicodendron radicans</u>

Abbreviation	Indicator Status	Species
SCA	FACW	Elderberry <u>Sambucus canadensis</u>
SCE	OBL	Lizard's Tail <u>Saururus cernuus</u>
SLA	OBL	Arrowhead <u>Sagittaria latifolia</u>
SNI	FACW	Black Willow <u>Salix nigra</u>
SRO	FAC	Greenbrier <u>Smilax rotundifolia</u>
UAM	FACW	American Elm <u>Ulmus americana</u>
URU	FAC	Slippery Elm <u>Ulmus rubra</u>
VCO	FACW	Highbush Blueberry <u>Vaccinium corymbosum</u>
VDE	FAC	Viburnum (Arrowwood) <u>Viburnum dentatum</u>
FO	FACW	Highbush Blueberry <u>Vaccinium formosum</u>
VPA	UPL	Lowbush Blueberry <u>Vaccinium pallidum</u>
VRO	FAC	Muscadine Grape <u>Vitis rotundifolia</u>

¹From Reed (1988).

²FAC = Facultative plants.

³OBL = Obligate wetland plants.

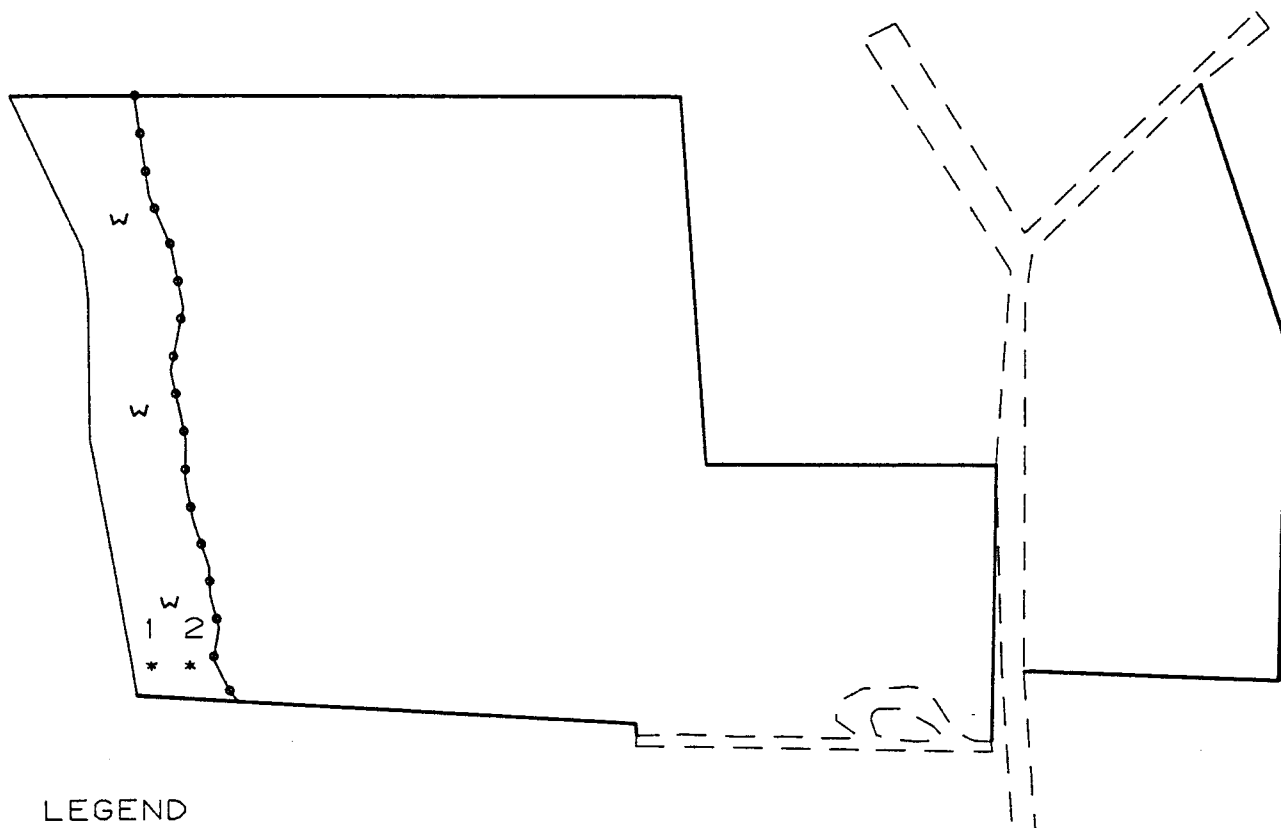
⁴FACU = Facultative upland plants.

⁵FACW = Facultative wetland plants.

⁶UPL = Obligate upland plants.

Appendix 4
Unit Map with Wetland Boundaries and Groundwater Well
and Plot Locations for Malvern Hill

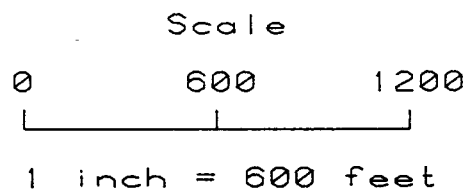
RICHMOND NATIONAL BATTLEFIELD PARK Malvern Hill



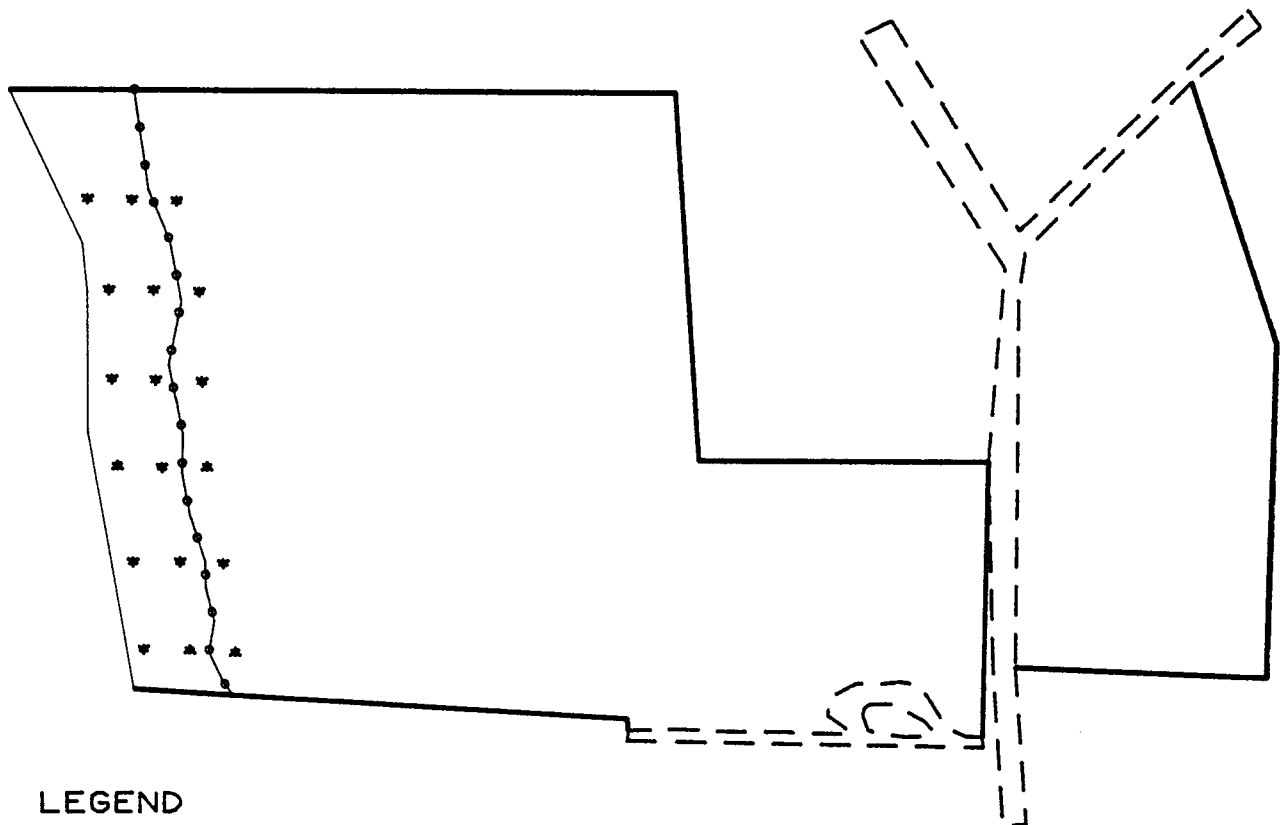
LEGEND

-  Property Boundary
-  Roads
-  Wetland Boundary
-  Stream Channel
- * Approximate Ground-water well locations

12.6 Wetland Acreage



RICHMOND NATIONAL BATTLEFIELD PARK Malvern Hill



LEGEND

-  Property Boundary
-  Roads
-  Wetland Boundary
-  Stream Channel
- * Approximate plot-locations

12.6 Wetland Acreage



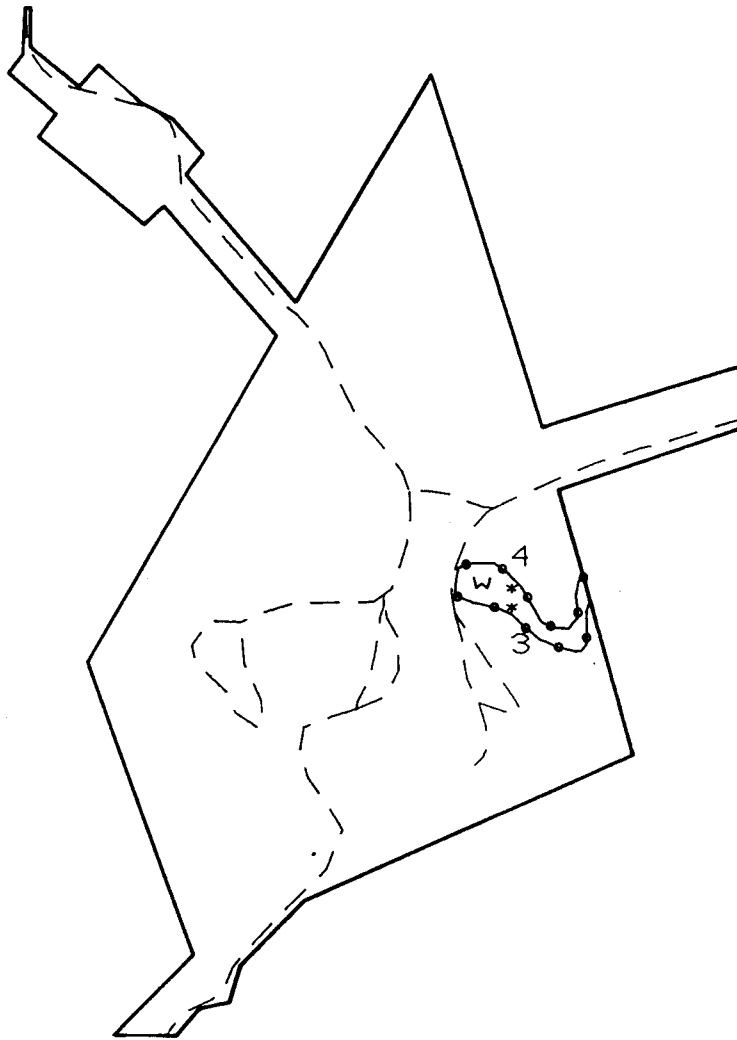
Scale

0 600 1200

1 inch = 600 feet

Appendix 5
Unit Map with Wetland Boundaries and Groundwater Well
and Plot Locations for Fort Harrison

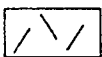
RICHMOND NATIONAL BATTLEFIELD PARK Fort Harrison



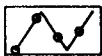
LEGEND



Property Boundary



Roads



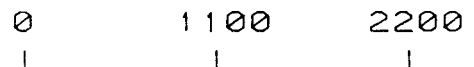
Wetland Boundary

* Approximate Ground-water well locations

3.5 Wetland Acreage

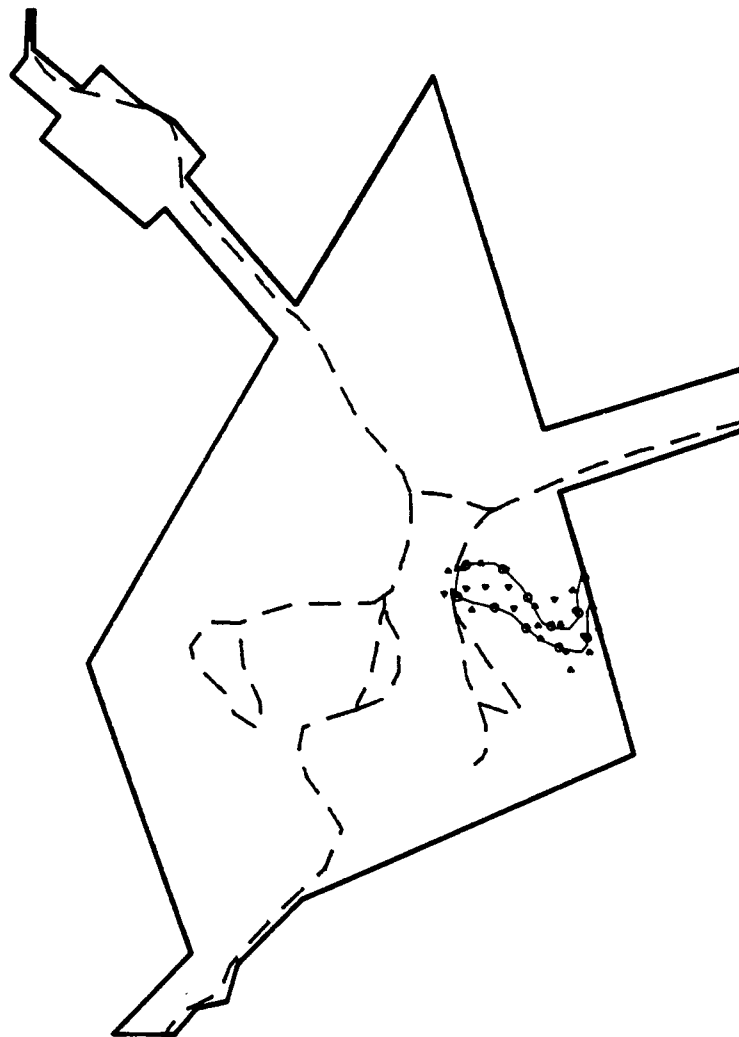


Scale



1 inch = 1100 feet

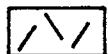
RICHMOND NATIONAL BATTLEFIELD PARK Fort Harrison



LEGEND



Property Boundary



Roads



Wetland Boundary

• Approximate plot-
locations

3.5 Wetland Acreage



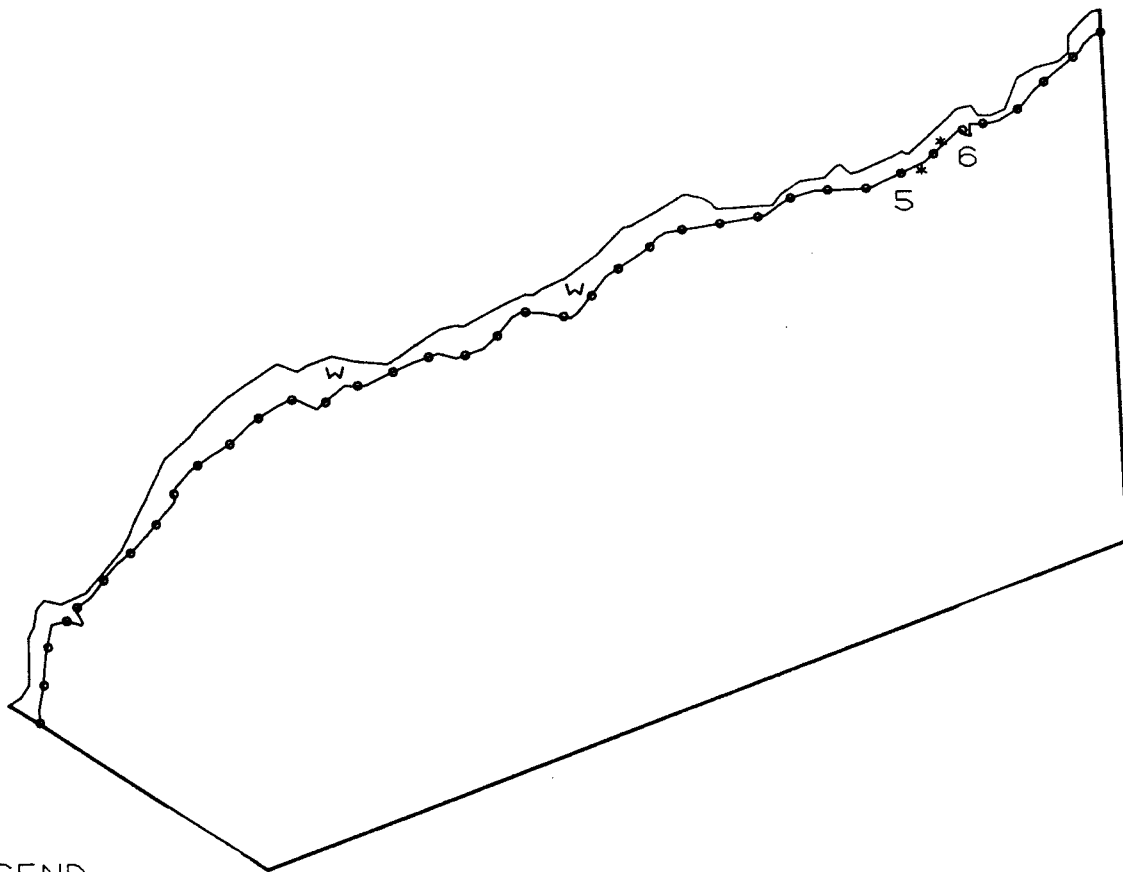
Scale

0 1100 2200

1 inch = 1100 feet

Appendix 6
Unit Map with Wetland Boundaries and Groundwater Well
and Plot Locations for Watt House

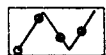
RICHMOND NATIONAL BATTLEFIELD PARK Watt House



LEGEND



Property Boundary



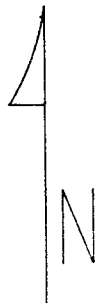
Wetland Boundary



Stream

* Approximate Ground-water well locations

3.6 Wetland Acreage

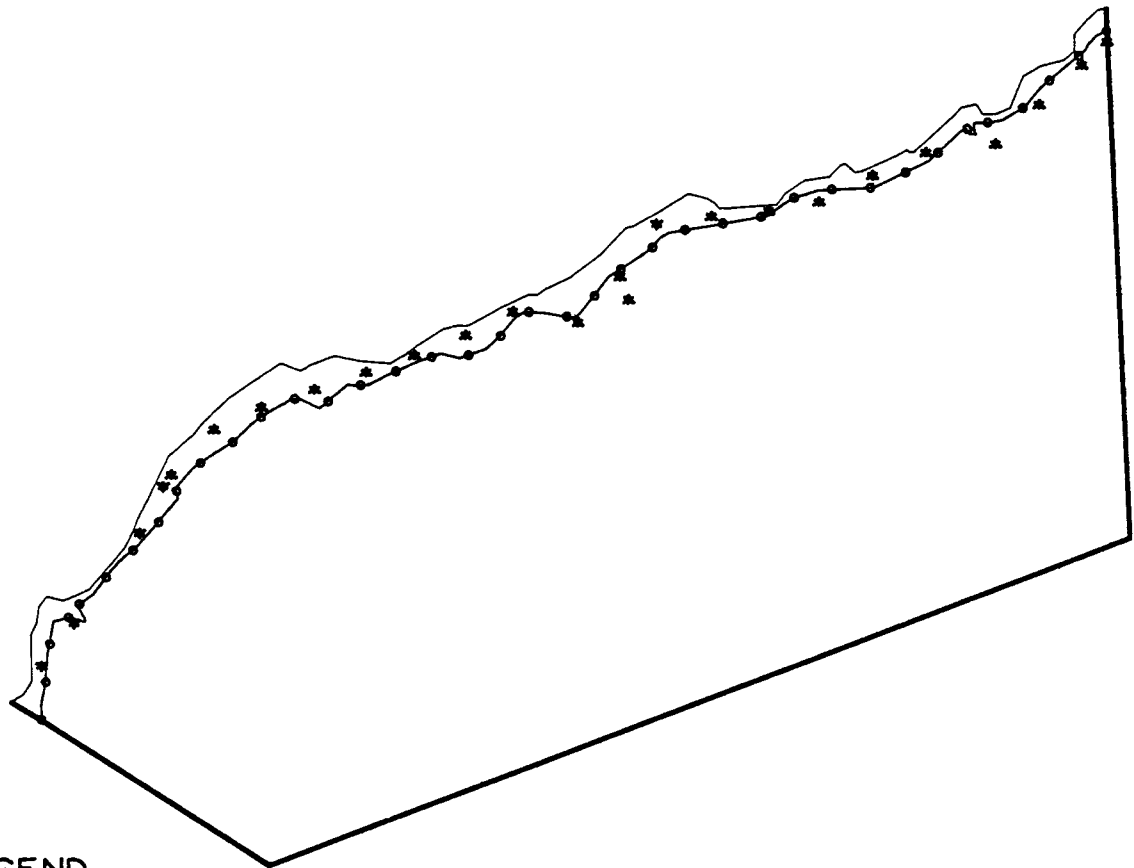


Scale

0 450 900

1 inch = 450 feet

RICHMOND NATIONAL BATTLEFIELD PARK Watt House



LEGEND

-  Property Boundary
-  Wetland Boundary
-  Stream
- * Approximate plot-locations

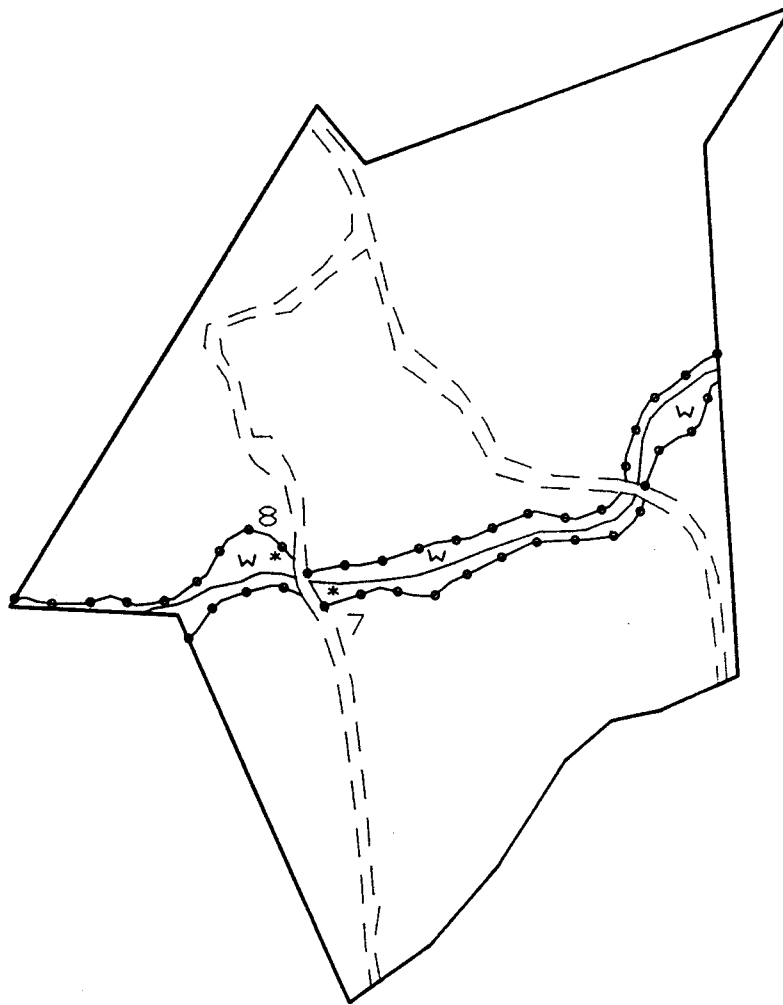
3.6 Wetland Acreage



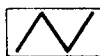
Scale
0 450 900
1 inch = 450 feet

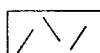
Appendix 7
Unit Map with Wetland Boundaries and Groundwater Well
and Plot Locations for Cold Harbor

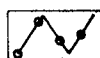
RICHMOND NATIONAL BATTLEFIELD PARK Cold Harbor

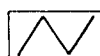


LEGEND

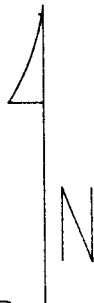
 Property Boundary

 Roads

 Wetland Boundary

 Stream Channel

* Approximate Ground-water well locations

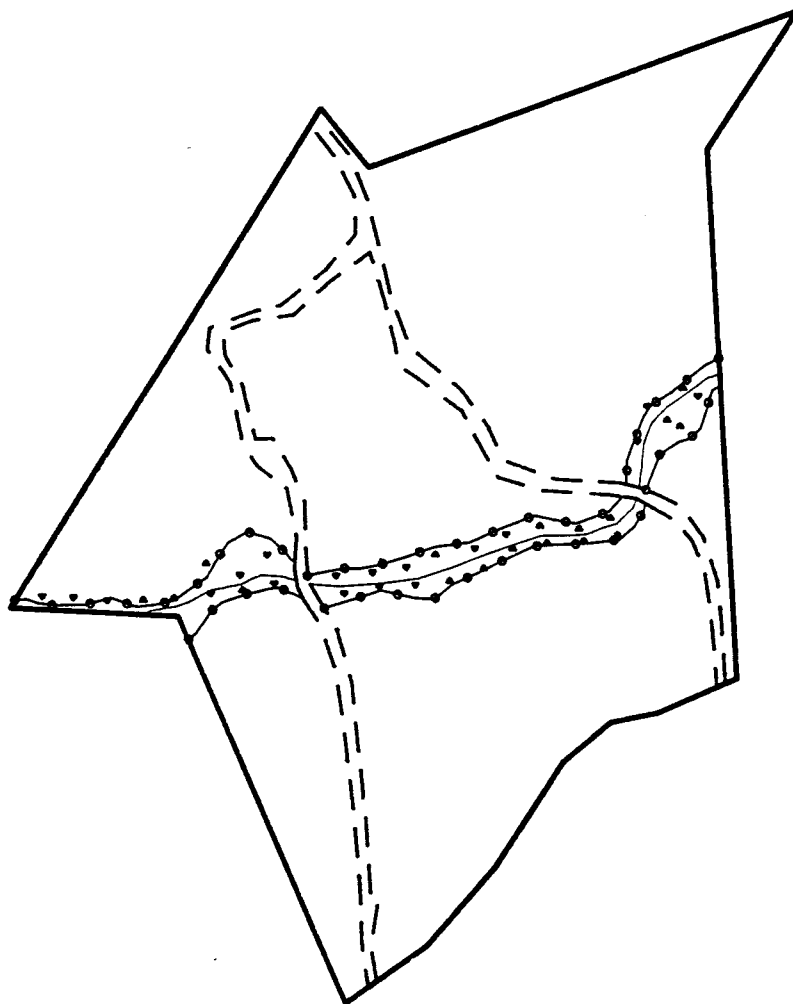


Scale

0 750 1500

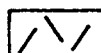
1 inch = 750 feet

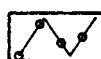
RICHMOND NATIONAL BATTLEFIELD PARK Cold Harbor



LEGEND

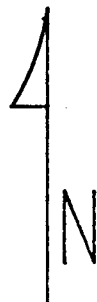
 Property Boundary

 Roads

 Wetland Boundary

 Stream Channel

• Approximate plot-
locations



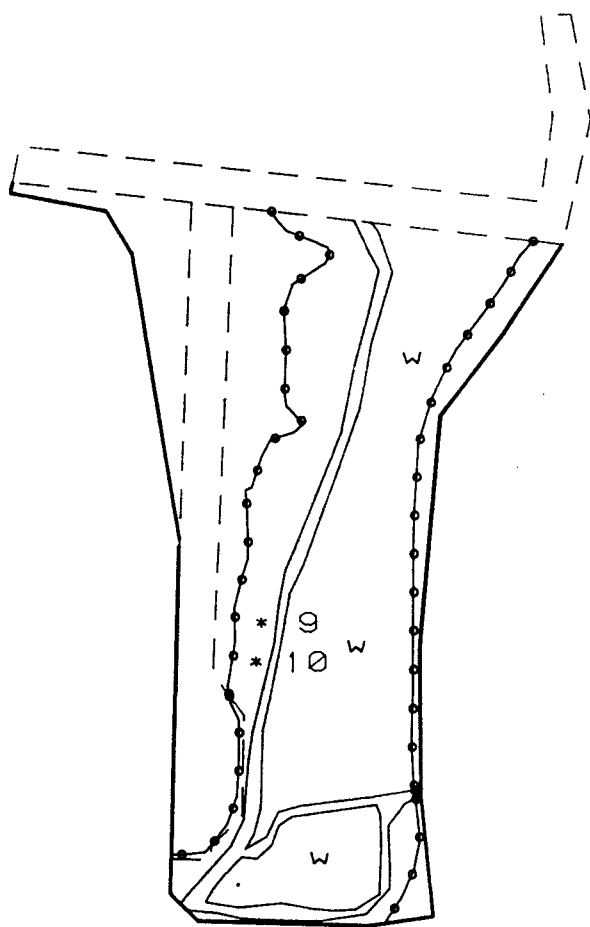
Scale

0 750 1500

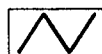
1 inch = 750 feet

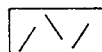
Appendix 8
Unit Map with Wetland Boundaries and Groundwater Well
and Plot Locations for Beaver Dam Creek

RICHMOND NATIONAL BATTLEFIELD PARK Beaver Dam Creek

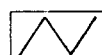


LEGEND

 Property Boundary

 Roads

 Wetland Boundary

 Stream Channel

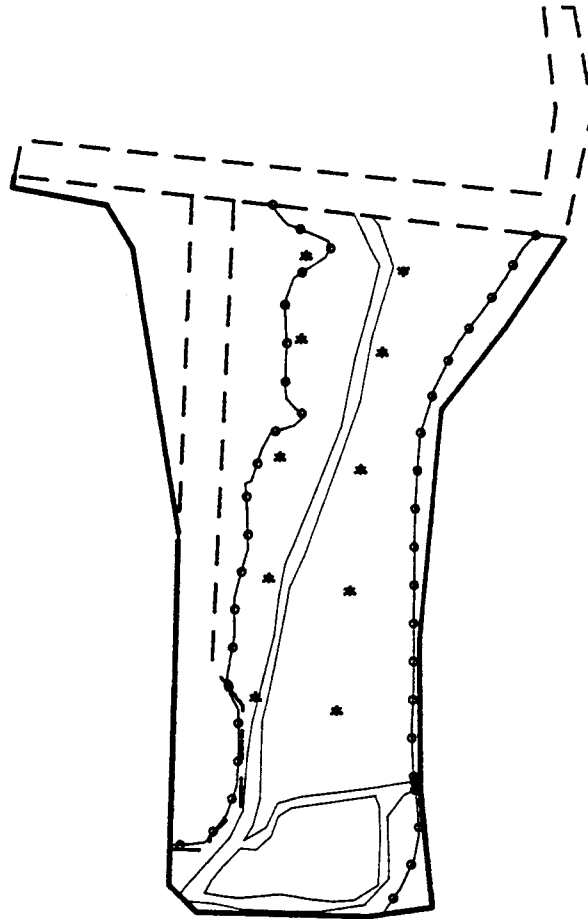
* Approximate Ground-water well locations

6.3 Wetland Acreage

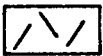
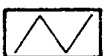


Scale
 0 300 600
 1 inch = 300 feet

RICHMOND NATIONAL BATTLEFIELD PARK Beaver Dam Creek



LEGEND

-  Property Boundary
-  Roads
-  Wetland Boundary
-  Stream Channel
- * Approximate plot-locations

6.3 Wetland Acreage



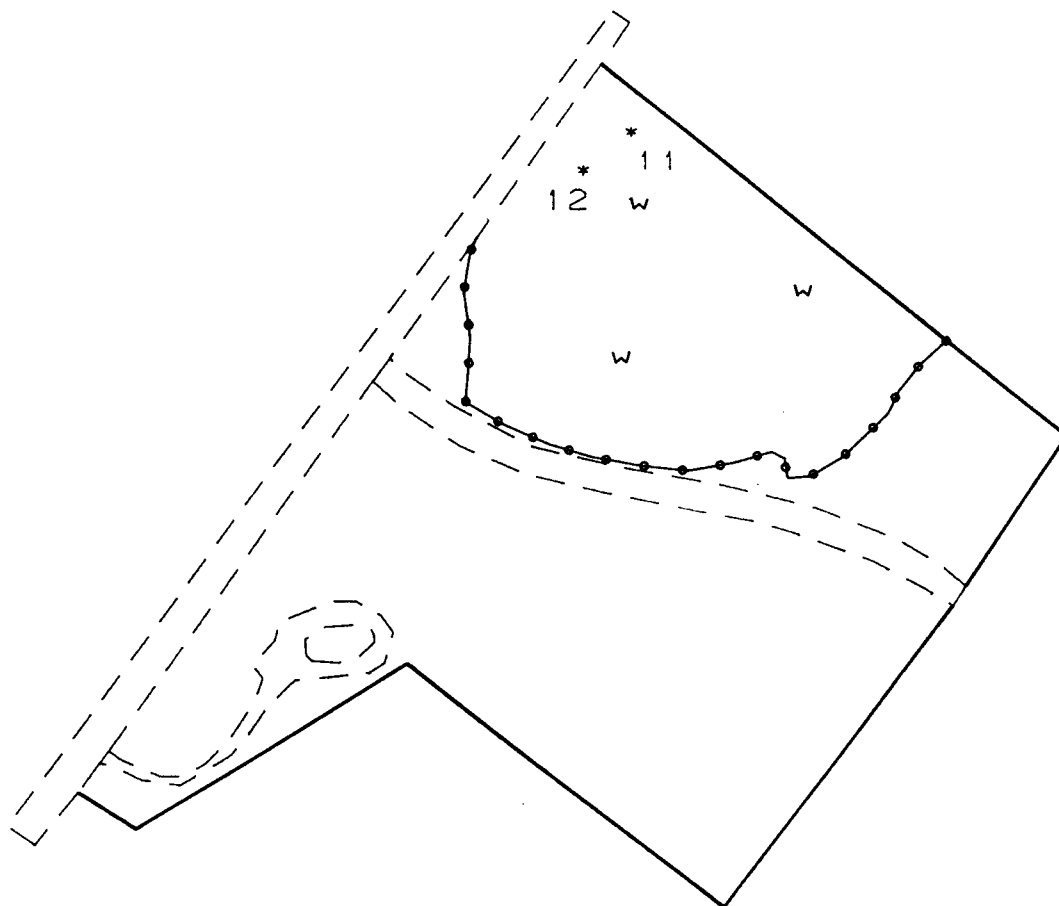
Scale

0 300 600

1 inch = 300 feet

Appendix 9
Unit Map with Wetland Boundaries and Groundwater Well
and Plot Locations for Chickahominy Bluff

RICHMOND NATIONAL BATTLEFIELD PARK Chickahominy Bluffs

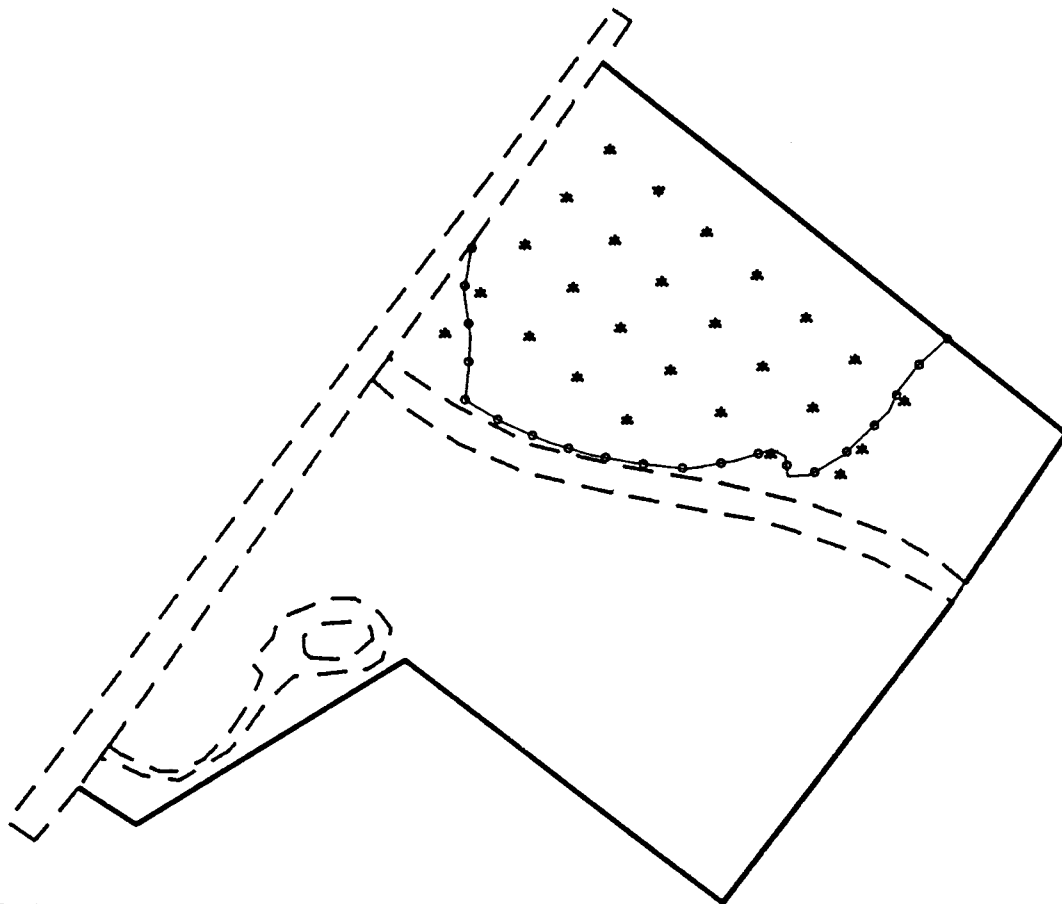


LEGEND

-  Property Boundary
-  Roads
-  Wetland Boundary
- * Approximate Ground-water well locations

12.1 Wetland Acreage

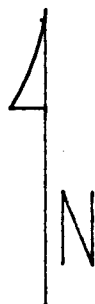
RICHMOND NATIONAL BATTLEFIELD PARK Chickahominy Bluffs



LEGEND

-  Property Boundary
-  Roads
-  Wetland Boundary
- * Approximate plot-locations

12.1 Wetland Acreage



Scale
0 400 800
1 inch = 400 feet

