FOREST
MANAGEMENT PLAN

GREAT DISMAL SWAMP NATIONAL WILDLIFE REFUGE
SUFFOLK, VIRGINIA

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I. PROGRAM RELATION TO REFUGE OBJECTIVES

A. Preface

At the turn of the century the Great Dismal Swamp covered 2,000 square miles of the Virginia-North Carolina coastal plain, and even then its size had been reduced by clearing and draining for agriculture. Today only 328 square miles of the swamp remain intact, a loss of 85 percent in as many years. The effects of past disturbances continue to alter the natural balance of the swamp ecosystem.

Despite these transitions, Dismal Swamp is significant as one of the largest remaining wooded wetlands in the eastern United States. In recognition of its values and with growing concern about its future, the public rallied during the early 1970's to preserve the heart of the swamp as a unique ecosystem and nationally important natural area. The Great Dismal Swamp National Wildlife Refuge was established by Congressional mandate in 1974 to protect and manage the swamp's plant and wildlife resources in a manner that would preserve and, where necessary, restore its ecological integrity.

Over 95 percent of the swamp is forested, thus habitat management for wildlife is largely synonymous with forest management. Man has affected the forests, mostly for commercial gain, for over 200 years. No "virgin" forests remain, the entire Dismal Swamp having been cut over at least once. The Great Dismal Swamp Master Plan, completed in 1987, recognized the need for a comprehensive forest management program to maintain or improve conditions for indigenous wildlife and plant species. A second justification mentioned in the planning process was the need for intervention to counteract the degradation of the swamp ecosystem brought on by human interference in the first place. The reader is referred to the refuge Master Plan and accompanying Environmental Impact Statement for background information and insight into the thinking which preceded this management plan.

Dismal Swamp forestry has its own features and problems which may differ from typical programs found on other agency or private lands:

1. biological rather than commercial goals
2. poor accessibility and few roads
3. saturated or organic soils requiring special equipment
4. a majority of stands with species of low market value and poor form

5. heavy undergrowth and organic soils creating fire hazards
6. a scarcity of research information on Atlantic white cedar, a species of market value and declining range
7. a swamp water regime which is closely tied to species composition and tree growth, yet is poorly understood
8. limited water management capabilities
9. difficulty in collecting forest inventory data

Traditional forest management plans are quantitative in nature, containing extensive information both on individual stands (volume per acre, site index, age and growth, density, diameter, height) and the forest as a whole (growth and yield, annual allowable cut). This plan, by necessity as well as design, is conceptual rather than quantitative. We are starting at "ground zero" with the forest management program, with no baseline inventory data to generate quantitative information. Even if data were available, there is a question of relevancy. Since economic return is not a major objective, the need for detailed quantitative information is doubtful.

The emphasis, instead, is on concept and strategy. Biological considerations are always paramount. The management approach is "area control", i.e. operations are applied to a certain number of acres each year, and long-term goals are presented in terms of acres desired for each habitat type and age class.

Some information on volumes and other stand characteristics is required of all forest management programs, regardless of objectives. This is particularly important for conducting timber sales. This data will be collected on an annual basis as needed and presented in the annual prescription package (see Part II.D.).

B. History

Prior to the latter part of the eighteenth century, the Dismal Swamp was usually avoided by the colonists who were intent on farming and timbering the more accessible upland areas. Charged with surveying a dividing line between Virginia and North Carolina, Colonel William Byrd in 1728 led a party through the heart of the swamp and described it as a place of "great nastiness and foul odours". Even in that early time, however, some local farmers used their spare time in "shingle

getting" for the Norfolk market, utilizing cedar or "juniper" from Dismal Swamp.

George Washington visited the Dismal Swamp in the 1760s and was more favorably impressed than Byrd. Believing that the swamp had potential for agriculture and timbering, he and a group of other wealthy Virginians formed the Dismal Swamp Land Company and began commercial operations in the swamp. Farming did not prove successful and was soon dropped but logging of the extensive cedar, cypress, and gum stands was more lucrative. By 1784 the Dismal Swamp Land Company had acquired title to over 40,000 acres of the Dismal Swamp. Washington Ditch, connecting Lake Drummond with the western border of the swamp, was dug by the Land Company in the 1760s to transport logs out of the swamp. This was followed by Jericho Ditch in 1810, and Riddick Ditch at about the same time. The first trees to be cut were cedars for lumber, shingles, barrels, casks, and tubs. The tall, straight-grained cedars provided wood which was light, easily worked, and resistant to decay. One use of cedar staves was for sugar barrels in the West Indies. Cedar was believed to be the only wood suitable for this purpose.

The Dismal Swamp Canal, connecting Deep Creek in Virginia with South Mills in North Carolina, was opened in 1805 to provide barge transportation of farm and forest products. Its initial use was by small, shallow-draft shingle boats. Prior to the Civil War, the cedar shingle business by the Dismal Swamp Land Company alone was in the six to seven million range annually. Other companies along with the Land Company transported 35-47 million shingles annually through the Canal. The Canal also transported timbers and studs for ship and house construction.

By 1836 shortages of cedar for shingles became apparent and companies had to move frequently to exploit new stands. By the 1850's the Dismal Swamp Land Company shifted from cedar to cypress as the primary shingle material. Because cypress trees were larger (up to five or six feet in diameter), cypress shingle production soon surpassed cedar. Numerous shingle mills were in operation on the western side of the swamp from the mid 1800's to the early 1900's. Trees were cut in shingle length bolts and floated to landings where they could be handled by one person. The majority of logging was done by oxen.

John L. Roper leased the Dismal Swamp Land Company lands beginning in 1871. By the late 1800's general lumbering had replaced shingle production and railroads became the main form of log transportation. Rails were laid out 800 feet apart, with steam powered cable skidders pulling logs up to 400 feet distance and placing them on log cars.

The Richmond Cedar Works bought out the Roper holdings in the late nineteenth century. This company operated over 30 miles of narrow-gauge log railroad southeast of Lake Drummond and extending well into North Carolina. Two other firms owned smaller roads. Several companies and individuals cut piling and operated small sawmills along the swamp borders.

Visitors to the swamp in the 1800's and early 1900's described the vegetation as "dark swamp" consisting of cypress, maple, gum, and ash; "light swamp" comprised of cedar, pine, and evergreen shrubs; many acres of fire-killed timber; and many square miles of clearings and "lights" - deep burned areas grown into cane, briers, and various shrub species.

The Camp Manufacturing Company acquired all of the Dismal Swamp Land Company lands in 1909. Camp logged regularly in the swamp from 1925 to the end of World War II. Later to become Union Camp, this company owned 49,100 acres in the northwestern part of the swamp and it was this donation which became the Dismal Swamp National Wildlife Refuge in 1974.

In the 1960's, Walpole Manufacturing Company of Walpole, Maine purchased timber rights to cedar in the North Carolina section south of Corapeake Road. This company later sold its interests to Atlantic Forest Products of Edenton, North Carolina. Walpole operated a cedar fence mill at the west end of Corapeake Road. The company introduced several new logging technologies to Dismal Swamp, including wide-tracked flotation vehicles, feller-bunchers, and even helicopter logging. The last commercial logging in the Dismal Swamp occurred in 1976 in the southern portion of the swamp, near County Line Road.

C. Refuge Objectives

The objectives of forest management at Dismal Swamp must first comply with the broad objectives of the National Wildlife Refuge System. Listed in priority order, these are:

1. To preserve, restore, and enhance in their natural ecosystem all species of animals and plants that are endangered or threatened with becoming endangered on lands of the National Wildlife Refuge System.
2. To perpetuate the migratory bird resources for the benefit of people.
3. To preserve the natural diversity and abundance of mammals and non-migratory birds on refuge lands.
4. To provide an understanding and appreciation of fish and wildlife ecology and man's role in his environment, and provide visitors at Service installations with high quality, safe, wholesome and enjoyable recreational experiences oriented toward wildlife.

Additional guidance specific to Dismal Swamp was contained in the September 1974 Recommendations of the Secretary of the Interior made pursuant to Public Law 92-478 which led to the establishment of the refuge. A timber management program was proposed and its objectives may be summarized as follows:

1. The proposed timber management program for the GDSNWR has the purpose of protecting and preserving the unique and outstanding ecosystem as well as perpetuating the diversity of animal and plant life.
2. Initial timbering activities will concentrate on preserving and perpetuating those shade intolerant species requiring disturbance for their regeneration to include Atlantic white cedar.
3. After adequate study, timbering may be necessary to reduce the over-abundant upland species, such as red maple.
4. The most economical and practical methods will be pursued for biological manipulation, but commercial timbering for the sake of revenue will not be considered as an objective in management.

5. In the future, manipulation of water levels in a long-term program should assist in reducing the vitality of the invading upland species and in stabilizing the more typical swamp species.

Combining and condensing the above two sets of objectives, we end up with the following specific objectives for the Dismal Swamp forest management program:

1. Animal and plant species which are endangered, threatened, or of special concern will be given management priority.
2. Second priority will be given to migratory bird habitat management.
3. All other indigenous wildlife species will be provided for by maintaining and improving the diversity of habitat conditions.
4. Ecosystem diversity will be enhanced by restoring vanishing communities and ensuring a balance of vegetation types and age classes.

The remainder of the forest management plan is largely a discussion of how these objectives will be achieved. Part IV.A. translates objectives into quantified goals.

D. Obtaining Refuge Objectives

For purposes of discussion, the objectives of providing habitat for endangered, threatened, special concern, or migratory bird wildlife will be referred to as the "featured species" objectives; improving habitat diversity for the remaining indigenous wildlife species will be called the "habitat diversity" objective; and promoting vegetation communities which are currently declining in area will be called the "restoration" objective.

Strategies for meeting the featured species objectives will be discussed later in the management plan (see E.).

To understand how the habitat diversity objective can be met, some background information would be helpful. Forest diversity can be categorized as either "interhabitat", the difference between various forest types or stands, or "intrahabitat", differences within a given type or stand.

With regard to interhabitat diversity, Dismal Swamp has a good variety of habitats although some types occupy a disproportionate share of the acreage. For example, maple-gum is only one of at least nine general vegetation types in the swamp, yet it occupies roughly 60 percent of the total refuge area. This is believed to be a far greater imbalance than occurred historically, and is less than ideal for wildlife. Most studies indicate that interhabitat diversity will continue to decline in the swamp since maple invades earlier successional stages or adapts to changing water regimes better than competing species.

Intrahabitat diversity can be related to species composition, understory development, and age class distribution. Concerning species composition, most of the plant communities have a rather limited number of commonly recurring species; only the mesic mixed hardwoods can be considered species rich. Species composition patterns in the swamp tend to be uniform within a given stand or community.

Dense understories are typical of many forest types in the swamp, with cypress-gum having the least understory development. Ditching and draining have decreased the impact of flooding resulting in more understory growth in the hydric communities. On the other hand, lack of regeneration and/or old growth areas within nearly all habitat types has limited the corresponding variations in understory development.

Most forests on the refuge are now in the 40-60 year age classes. A forest managed for maximum wildlife benefits should contain a balance of young regeneration areas, intermediate and mature stands, and old growth areas.

A three-pronged strategy is proposed for meeting the habitat diversity objective: maintenance, conversion, and age class distribution. "Maintenance" as used here is a holding strategy to prevent further losses of desired habitat types. The idea is to maintain these types at their current acreages and on the sites where they now exist. As an example, steps to maintain a cedar stand might include fire protection, insect and disease protection, and carefully planned timber sales and site preparation to regenerate all or part of the stand to cedar seedlings. The maintenance concept recognizes that to perpetuate early successional types, it will be necessary to harvest some mature trees to create young, vigorous stands.

"Conversion" goes a step beyond maintenance in attempting to redress the imbalance in habitat types. Simply stated a portion of an overabundant or less desirable type is removed and regenerated with a more desirable type. For example, a ten acre patch of maple forest may be cleared and planted with oak seedlings. Since a seed source of the desired species is often absent, artificial regeneration using nursery seedlings or direct seeding is usually required.

Age class management recognizes that different wildlife species require different habitat structures, or a single species may require a variety of stand conditions. Pileated woodpeckers prefer old timber, but yellow-breasted chats like forest openings. Turkeys may need old or mature timber for mast, and cleared areas for "bugging". By carefully scheduling management activities, the forest management program will provide a good balance of ages and stand structures.

The restoration objective promotes vegetation types which were historically prevalent but are now declining. Plant communities are seen as legitimate management goals in their own right, rather than simply niches for wildlife. However, the same three-pronged strategy applies here. Maintenance is used to prepetuate a desired community, conversion is used to expand it, and age class management seeks to guarantee the future of the community by providing for regeneration.

Wildlife and Tree Species to be Favored

Complying with the featured species objective, forest management will give special consideration to some wildlife species because of their status as endangered, threatened, species of special concern, or migratory birds.

The red-cockaded woodpecker, a federally listed endangered species, depends on mature or old growth pine stands infected with red heart disease to establish nest cavities. It has been eliminated from most of its historic range in the southern coastal plain because of lumbering. The Dismal Swamp region approaches the northern limit of the species' range, and only a few scattered colonies remain in southeastern Virginia and northeastern North Carolina. The last reported sighting in the Dismal Swamp was in 1961. Management will ensure that some appropriate habitat is available if an attempt is made to reintroduce the species, although reintroduction attempts elsewhere have been unsuccessful thus far. Mature loblolly

or pond pine stands will be selected and prepared using prescribed burning to decrease understory growth. Commercial thinning and timber stand improvement may also be applied to clear the understory and midstory and open the stand. The most likely stands for this treatment are on the north end, south of North Ditch, because of the large acreage in mature loblolly pine, relatively open understory, and shallow organic soils which make prescribed burning more feasible.

Bald eagles, also endangered, have not nested in the Dismal Swamp for at least 25 years. However, since the insecticide DDT was banned eagle populations in Virginia have been steadily expanding and it may be only a matter of time before a pair begins nesting here. The only forest management planned for eagles at this time is to leave an uncut buffer strip aroung the perimeter of Lake Drummond so that the birds can find large nest trees in an undisturbed environment.

The Dismal Swamp southeastern shrew is a recently listed threatened subspecies of the southeastern shrew. Studies have indicated that this subspecies is larger in size than the upland subspecies, but is being "genetically swamped" by the latter as the swamp becomes drier and its preferred habitat declines. Management will provide suitable conditions for the Dismal Swamp southeastern shrew by creating more open areas with grassy or herbaceous vegetation, usually in the course of normal forest regeneration or prescribed burning activities.

The wood duck is a "Resource of Special Emphasis" within the Fish and Wildlife Service, and is particularly significant to this refuge because it is the only migratory waterfowl species which is common throughout the year due to the large amount of suitable nesting, feeding, and resting habitat. Forest management will assist this species by increasing the number of mast producing trees, such as oaks and baldcypress, and encouraging individual trees to produce mast using timber stand improvement techniques. Since red maples 14 inches or larger in diameter are among the most desirable trees for cavity nesting, uncut buffer strips at least 300 feet wide will be left where maple forests border ditches or other aquatic areas. Scattered regeneration openings further in from ditches will allow wood duck hens access into cavity producing stands. There may also be limited potential to seasonally impound selected blocks within the refuge as "green tree reservoirs", but this capability has not yet been determined.

Another migratory gamebird considered a Resource of Special Emphasis within the Service is the American woodcock. Occasionally woodcock are observed on the refuge, usually around Lake Drummond or on mineral soil sites on the swamp perimeter. Scarcity of the birds within the swamp is probably due to lack of the preferred food, earthworms, in the acid organic soils, but lack of openings may also be a factor. Creation of open areas in the course of forest regeneration or prescribed burning may provide habitat for courtship and mating. Dismal Swamp could increase in significance as a stopover area during migration.

The great blue heron is a special concern species in Virginia and North Carolina. To date one large rookery has been located west of Weyerhaeuser Road in the North Carolina portion of the refuge, in a clump of large cypress trees. Management will leave a buffer zone of at least .25 mile radius around all known rookeries and preserve other large cypress trees as potential nest trees.

A number of raptor species have been granted threatened or special concern status in Virginia and/or North Carolina. These include the turkey vulture, black vulture, Cooper's hawk, sharp-shinned hawk, red-tailed hawk, red-shouldered hawk, merlin, and American kestrel. All these species have been reported in the Dismal Swamp. Nest tree areas will be left undisturbed, and forest openings and edges will provide opportunities to hunt small mammals and birds.

The Dismal Swamp is perhaps best noted for its large populations of migratory nongame birds which use the area for migration stops, breeding, or wintering. A number of songbird species, particularly warblers, have been declining in numbers nationwide as a result of habitat disturbance. Forest management, though generally beneficial by providing diverse habitat and early successional types, may adversely affect some species such as ovenbird, worm-eating warbler, and black-throated green warbler: this is due to predation which is greater when the forest is opened. Nest parasitism by brown-headed cowbirds is another problem. These species are characterized by late arrival and early departure to wintering grounds, nesting on the ground or in exposed locations, and low incidence of repeat nesting after predation. The best management for these susceptible species is no management; that is, large blocks of interior forest should be left undisturbed. This will be the case as a matter of course, since access problems will limit most management activities to within ½ mile of a road.

Although not given any special status by state or federal agencies, the black bear deserves consideration because the Dismal Swamp provides the only extensive breeding habitat for the bear in eastern Virginia. For many people, the black bear symbolizes the wild character of the swamp. Like most species, the bear will benefit from a diversity of vegetation types and age classes which will ensure appropriate feeding, breeding, and denning habitat. The evergreen shrub pocosin southeast of Lake Drummond will be managed to ensure continuation of early successional vegetation such as gallberry, important in providing denning sites and winter food. Most mature stands of oak and blackgum will be left undisturbed to ensure a continued supply of critical fall mast and potential den trees. Where it occurs naturally, black cherry will be encouraged as an important summer mast species. Recommendations of the recently completed Dismal Swamp black bear research study (Virginia Cooperative Wildlife Research Unit) will be incorporated in managment planning when they become available.

Several plant species have been given special concern status in Virginia including the dwarf trillium and silky camellia. Sites where they occur will not be disturbed, unless some technique such as killing of canopy trees is desirable to encourage growth and flowering.

Tree species to be favored include baldcypress and a number of oak species, because of their current decline in the swamp as well as their value to wildlife as mast producers; Atlantic white cedar because of its special concern status in Virginia (and nationwide) and its contribution to refuge diversity; blackgum because of its importance to bear as a fall food source; and loblolly and pond pine because of their importance to the red-cockaded woodpecker, their value as habitat for other species, and their contribution to refuge diversity. Other species to be favored as providers of wildlife food include black cherry, American beech, and persimmon.

F. Research Needs

The most immediate need for research information applied to forest management is a determination of those methods and techniques best suited for accomplishing maintenance, conversion, and age class goals. Much of this information will be gained through in-house experience by conducting an interim five-year program of observation and demonstration plots (see Part IV. A.2.). The process of learning by experience will continue indefinitely, of course, but this initial effort should provide a solid base of information from which to proceed.

Beyond this interim program, which will be accomplished by refuge staff, there are a number of areas where university or other outside researchers could contribute to sound habitat management. Monitoring of management areas for use by wildlife would indicate whether practices are having favorable effects or need refinement. For example, census and survey data could suggest optimum sizes and shapes for forest openings or the most desirable conditions for pine understory burning. Usually refuge staff do not have the time to conduct comprehensive surveys of a repetitive nature.

The question of diversity is another topic which could benefit from research. We use the term frequently, but how can a concept as vague as habitat diversity be measured? Can we go to the field or a photograph, take a few measurements, and come up with a comparative index? If so, the above-mentioned wildlife surveys could be compared with diversity indices to see if there is a direct relationship. Once the relationship is defined, computer modeling could be used to determine the best arrangement of habitat types and age classes to meet objectives.

More information on natural succession patterns is needed. For example, do most maple stands represent a "disturbance climax" which will maintain itself indefinitely, or will they eventually be replaced by other species? Which stands will succeed to which species? Is the water regime the determining factor in succession?

Some type of hydrology study would be useful to relate the water regime in the swamp to tree species composition, tree growth, and consequent wildlife use. An investigation of the feasibility of green tree reservoir management on the refuge - where, when, and how - would be helpful.

Equally important is a correlation of soil characteristics to tree species composition. It may be that the best sites for conversion to desired forest types can be selected on the basis

of depth of organic soils or texture of underlying mineral soils. If such a relationship was defined, and the necessary data obtained by a comprehensive soils survey, management activities could be planned on the basis of the potential of a site rather than current vegetation patterns or "seat of the pants" intuition.

G. Glossary

A glossary of terminology used in the forest management plan is provided in Part VII.C. Exhibit 12.

II. PROGRAM POLICIES AND ADMINISTRATIVE CONTROL

A. Fish and Wildlife Service Policy

The policy of the Fish and Wildlife Service on forest management is contained in a single sentence in 6 RM 3.2 of the Refuge Manual: "The policy of the Service is to manage forests in a manner that best meets the overall objectives of a particular refuge".

B. Policy of Harvest

Timber harvesting is viewed by the Service as a cost-effective management tool. To quote 6 RM 3.5H of the Refuge Manual, "Commercial harvest is an important tool available to the Service for accomplishing forest habitat management because it reduces the funds and manpower needed to attain wildlife management objectives".

C. Control Records

Good records are essential to maintaining organization and continuity in the forest management program. All records will be kept in a special forest management file.

The first item to be established in the file will be an index of compartments and management units. The index will consist of ten maps representing the ten forest management compartments on the refuge. Each map will have management units numbered. A unit may also be a stand, or it may be subdivided into smaller stands designated by lower case letters. For example, stand F7b refers to stand b in management unit 7 of compartment F. In addition to the maps, lists of all stands within each compartment may contain descriptive information such as vegetation type, treatments applied, acres, and how to locate the stand in the field.

Annual prescriptions will be filed by the fiscal year in which the work is conducted. The prescription will contain detailed information on compartments and subdivisions, treatments proposed, objectives, and expected results (see D.).

All documents supporting the work carried out will be filed with the prescription. These may include volume tables and other inventory data, bid invitations, special use permits for harvest, and contracts for timber sales, tree planting, site preparation, seedling production, or professional services. Also filed with the prescription will be any follow-up work such as wildlife monitoring to assess the impacts of management actions.

D. Compartment Prescription

The compartment prescription will be prepared along with the annual work plan prior to the fiscal year in which the work is to be accomplished. The prescription is a plan that describes clearly the specific techniques and actions that will be applied to discrete blocks of forest habitat. The development of the prescription must be a team effort between the forester and other professionals on the refuge staff. The compartment will be jointly evaluated to decide what management actions are needed and which techniques will be used. After gathering the necessary field data, techniques should be proposed which ensure that all opportunities for improving diversity are utilized. A management prescription must have the approval of the regional office before implementation of the prescription may begin. When approved, one copy of the prescription will be placed in the forest management files and a second copy bound with the forest management plan.

Generally only one compartment prescription package will be submitted each year. This allows staff to concentrate management work on a specific portion of the refuge at any given time rather than disperse activities over the entire 106,000 acres. With ten compartments of roughly 10,000 acres each, this is still a lot of ground to cover per year. By annually rotating to a different compartment, operations will cover the entire refuge over a ten year period. Crisis situations such as a serious outbreak of southern pine beetle may require that more than one compartment be treated in some years. Intermediate treatments such as thinning or TSI may be conducted at more frequent intervals.

The annual prescription will consist of three sections, each with a map of the compartment and accompanying narrative. The section titled Current Conditions will have all current units and stands mapped and labeled. Labels will indicate forest type,

average dbh, basal area, height class, and age. The narrative will feature a general discussion of each stand in the compartment which may include understory species, observed or expected wildlife use, soils, water regime, probable history, and special problems or features.

The Treatments section depicts on the compartment map the location and type of proposed management activities. Unit and stand labels will refer to the map legend and contain information on the species or type to be regenerated, and whether the treatment is timber sale, site preparation, natural or artificial regeneration, thinning, timber stand improvement, release, or prescribed burning. The accompanying narrative will list the treatment areas in priority order and provide information on each proposed action, reason and objective, size in acres, access and road maintenance considerations, public use considerations, aesthetics, cost and personnel needs, and special provisions.

The final Posttreatment section will have a compartment map with the same type of information as the Current Conditions map, but depicting how the compartment will appear after all treatments are completed. The narrative will discuss how each treatment unit or stand will change following the action, how the change will advance refuge objectives, and the anticipated wildlife use as a result.

Addition information which may be included in the prescription are stand volumes and other data necessary for timber sales, and bar graphs or tables to compare type and age class distribution before and after. Each prescription package must also have written assurance that appropriate supervision will be provided to check compliance with the provisions of any contracts awarded to implement management practices.

E. Natural Areas

In 1972 the Secretary of Interior declared 43,200 acres of the Great Dismal Swamp in Virginia, including Lake Drummond, to be a National Natural Landmark and included it in the National Registry of Natural Landmarks. The objectives of the Natural Landmarks program are: (1) to encourage the preservation of sites illustrating the geological and ecological character of the United States; (2) to enhance the educational and scientific value of sites thus preserved; (3) to strengthen cultural appreciation of natural history; and (4) to foster a greater concern in the conservation of the Nation's natural heritage.

In August 1980 the entire 24,600 acre portion of the refuge in North Carolina was entered on North Carolina's Registry of Natural Heritage Areas. The "Letter of Agreement to Register and Protect the Great Dismal Swamp Refuge Natural Area" signed by the Fish and Wildlife Service promotes the protection of the ecosystem but does not preclude resource management consistent with the maintenance and protection of wildlife and the wetland forest ecosystem. Three categories of natural areas within the refuge are defined under the Natural Heritage Area designation: the mesic island, the remnant marsh, and the entire remaining wetland area in the North Carolina portion of the refuge.

A natural area of approximately 7,500 acres will be set aside between Portsmouth Ditch and the Dismal Swamp Canal, and south of Southeast Ditch. This area was selected because of its good representation of several forest types found on the refuge including pine, cedar, maple-bay, and evergreen shrub; and lack of road access into the block, thus limiting possible human interference. Intervention will be limited to emergency fire suppression.

Other stands will be left unmanaged, with the possibility of eventual nomination as Research Natural Areas or Public Use Natural Areas. These areas will be selected while conducting annual compartment inventories and prescriptions. Suitable natural areas should be mature or old growth stands representative of the community type; have educational or interpretive value; have current or expected use for long-term research studies; serve as control areas with which to compare management effects; or protect critical habitat of featured species. Discussions of possible natural areas will be included in Part IV.C.

F. Special Management Considerations and Techniques

1. Water Management

Installation of water control structures in the ditches will help to stabilize the water table in the swamp. Conserving water during the normally dry summer and fall will recharge groundwater and minimize water table drawdowns, although the distance from ditches that this effect would extend is not known. Moderating of extreme seasonal water table fluctuations should aid management efforts to regenerate and sustain forest communities.

Water and forest management will be closely coordinated to ensure that water manipulations and forest regeneration efforts complement rather than conflict with each other. For example, surface water should be kept out of the stand during the growing season when cypress seedlings are being established. Two to three years after regeneration, flooding could benefit the stand by suppressing less water tolerant species.

It may be possible to use water control structures and culverts to divert water into some blocks and hold it there for extended periods, such as late fall to early spring. These seasonally flooded impoundments, or green-tree reservoirs, could provide feeding and resting areas for waterfowl. Suitable blocks should contain a good number of mast species such as oaks, cypress, and blackgum. If oaks are present, care must be taken to dewater impoundments in the spring before the growing season as these species will not survive more than two to four years of continuous flooding. The compartment descriptions in Part IV.C. include discussions of blocks being considered for impoundment.

2. Fire Management

Fire has been a major influence on Dismal Swamp forest communities dating back to precolonial times. Prior to 1900, fires in the swamp were uncontrolled and probably occurred mostly during periods of drought. Lightning was the main source of ignition, but Indian hunting parties and early loggers may have set some fires. From 1900 to about 1945, railroad and timbering operations increased the frequency of fires which continued to burn

for extended periods. Since the mid 1940's, prevention and suppression techniques have reduced both the number and magnitude of fires within the swamp, but ignition from lightning remains a persistent problem which is particularly evident in drought years.

Most swamp fires result in the removal of the highly combustible organic soils in an amount ranging from a few inches to several feet. Deep fires create depressions or topographic lows which fill with water during normal highwater periods. This creates conditions favorable to revegetation by hydric species. Shallow fires permit germination of Atlantic white cedar seeds in large numbers and remove hardwood competition from mature pine stands.

The impact of reduced number and size of fires within the swamp has not yet been fully assessed. In drier communities, heavy understory growth has increased the amount of above-ground combustible material so that wildfire hazard continues to worsen with time. Fire exlusion is to be a certain extent responsible for the disappearance of the endangered red-cockaded woodpecker within the swamp, since excess understory growth will drive the birds from their colony sites. In wet communities, peat continues to accumulate which raises soil elevation and reduces the saturation level. Cane, Atlantic white cedar, evergreen shrub-pond pine pocosins, and perhaps loblolly pine communities are prepetuated by fire and may gradually disappear if fire continues to be excluded.

Current refuge policy, which reflects that of the Fish and Wildlife Service is to immediately suppress wildfires. Fire suppression is considered an emergency action which takes priority over all other refuge activities. Wildfire is recognized as an important natural factor in maintaining much of the swamp ecosystem, but current political and social constraints do not permit allowing wildfires to burn for extended periods. Uncontrolled fires generate adverse public reaction, and have the potential to cause catastrophic loss of natural resources, threaten neighboring landowners, and cause health and public safety problems from smoke.

Prescribed burning will be increasingly important as a management tool to mitigate undesirable effects on the ecosystem resulting from wildfire suppression. A prescribed burn is a fire intentionally set by refuge staff under carefully controlled conditions to accomplish resource objectives. Weather, environmental conditions, preburn preparations, and burn implementation are covered in annual prescribed burn plans which must be approved by the regional office. Prescribed burning will be used for a variety of purposes related to forest management including fuel reduction to lessen wildfire hazard, reduction of competing tree and brush species in pine stands, improving potential red-cockaded woodpecker and Dismal Swamp southeastern shrew habitat, maintaining early successional vegetation types, and preparing sites for natural seeding or artificial regeneration. Prescribed fire may also have some value in reducing surface elevation to encourage hydric communities.

Like most of the forest management program, prescribed burning is currently in a preliminary experimental stage. Burning is difficult in the swamp; dry season burns in the summer and fall present control problems and may cause irreversible resource damage to vegetation and organic soils. Burns set during the winter or spring often do not carry due to high fuel moistures and saturated soils.

Refer to the refuge Fire Management Plan for additional information on the fire management program.

3. Archeological and cultural resources management

Human occupation of the Dismal Swamp area dates back some 13,000 years, 4,000 years before the formation of the swamp began. Archeologists have unearthed ancient relics both within the swamp and along its edges. These discoveries have bolstered the theory that prehistoric people used the area as a hunting and fishing range abounding in waterfowl and other sources of food. Extensive prehistoric use of the Dismal Swamp area was possible because in the remote past the area had a higher water table that prevented timber growth and allowed the existence of marshlands.

By the time European colonists arrived, the area had acquired its swamplike character and most Indians lived in peripheral settlements. The Nansemond Indians settled along the Suffolk escarpment. Artifacts of this tribe and others in the Powhatan Confederation as well as at least one independent group have been found throughout lowland Virginia and North Carolina. Their axes and other utensils indicate that they were a forest-oriented people.

A cultural resources reconnaissance consisting of archival and background research and a site-specific impact assessment at Great Dismal Swamp was undertaken during September and November of 1978. With the exception of noting that prehistoric sites are more likely to occur on well drained land within the confines of the swamp and along the boundaries of the refuge, no adequate predictive model can be developed on the basis of existing information. Potential refuge sites are likely to belong to the Middle Archaic and Late Archaic periods.

A map of proposed treatment areas will be sent to the Regional Historic Preservation Officer each year at the time the annual prescription package is developed. If he feels that some areas warrant further investigation, he will contact the Virginia or North Carolina State Historic Preservation Officer who may elect to do an on-site field check before commencement of management activities. Planned management will then be modified to comply with recommendations.

All archeological and historic sites must be adequately protected. If any archeological or historic sites are discovered during forest management operations, the operations must be halted, the site protected and the refuge supervisor notified immediately.

4. Aesthetics

Aesthetics will be considered and made part of forest management decisions. Some silvicultural practices, especially clearcutting, temporarily disrupt the aesthetic qualities of the site, particularly to persons unfamiliar with habitat management. Whenever possible, strips of uncut forest at least 300 feet wide will be left along roads and ditches to minimize unfavorable visual impressions.

Forest regeneration areas will be no larger than forty acres in area, if within ½ mile of roads. Occasional treatment areas in the interior of a block may exceed forty acres, but in no case will they exceed 100 acres. As a rule of thumb, the closer a clearing to a road, the smaller the area.

Clearings within ½ mile of roads will be irregular in shape, and usually longer than wide, to maximize the amount of edge favorable to most wildlife. Interior management areas, on the other hand, will be designed with minimum edge to avoid displacement of interior birds by more competitive edge species.

Rounded corners will be preferred to sharp corners in forest clearings and irregular edges preferred to straight. Clearings will be flagged in this fashion by refuge staff prior to cutting. Logging contractors will be encouraged to use curved rather than straight skid roads. Contractors may also be required to fell all unwanted trees and cut low stumps. Logging slash may be lopped by the contractor to lie close to the ground, or drum chopped after cutting.

Regeneration areas will be at least 500 feet apart to prevent clustering of management areas and also provide wide corridors for wildlife movement. An exception would be small experimental plots of five acres or less, where it may be convenient for observation and demonstration purposes to have adjacent treatment areas.

In areas where trees are artificially seeded or planted, every effort will be made to produce as natural appearing a stand as possible. Planting will be done in a random fashion rather than in straight lines, to avoid the appearance of row crops. Intervention in the stand following establishment will be kept to a minimum, to allow a natural understory to develop.

G. Insect and Disease Control

The entire refuge will be inspected aerially at least once each summer to detect possible forest insect or disease outbreaks. If problem spots are discovered, follow-up flights may be needed to monitor the growth and extent of the outbreak. Spots will be mapped and ground checked to gain additional information on the pest species involved and the severity of the outbreak.

Problematic pest outbreaks will be reported promptly to the regional office and appropriate state, federal, and local agencies. Decisions should then be made on whether control will be used; and if so, what methods will be employed. Section 7 RM 14 of the Refuge Manual will be consulted for policy and guidance on pest control.

Insecticide use is not forseen. If insect outbreaks are serious enough to warrant action, control measures other than chemical treatment will be preferred. If a situation develops where insecticide use is the only option for reasons of cost or effectiveness, approval must be obtained from the Assistant Regional Director-Wildlife Resources as well as the Regional Resource Contaminant Specialist.

Most forest pest species occurring in the swamp are indigenous and part of the natural ecosystem. For example, outbreaks of the forest tent catepillar recur periodically at intervals of ten years or less. During outbreak periods the caterpillars may defoliate thousands of acres of water tupelo and blackgum trees, but after a few weeks the insects decline and eventually disappear. Decline is probably due to elimination of the food supply, parasitism, and bird predation. The deciduous hosts are seldom killed even by many successive annual defoliations; therefore, branch killing and loss of woody growth is the main type of damage. The caterpillars may even be of some benefit by providing food for large numbers of insectivorous birds such as yellow-billed cockoos. Indigenous insects and diseases of this nature are not serious problems and are best left alone to run their course.

The gypsy moth is a relative newcomer to this area. Introduced into the Boston area from Europe in 1869, it is now distributed through most of Pennsylvania, north to Quebec, and is expanding its range southward. It is now well established in northern Virginia, where it is of increasing concern, and lower level populations are being

detected in southern Virginia and North Carolina including the Dismal Swamp. Cooperative surveillance efforts with the U.S. Forest Service have trapped small numbers of male moths on the refuge since 1982. The population level is very low and shows no evidence of increasing. Surveillance will continue but no control efforts are planned at this time. If the population increases to a level where oak defoliation and mortality are apparent, control options may be explored in cooperation with the Forest Service, but any proposal involving chemicals or biological control agents must be approved by the regional office. Preventive silvicultural treatments will be preferred to direct chemical control. Because extensive stands of oaks are scarce within the refuge, gypsy moth outbreaks are expected to be limited and confined to small acreages. However, it is this very limited extent of oaks and their high value as mast producers that makes any mortality cause for concern.

The insect species having the greatest potential for serious stand mortality is the southern pine beetle. Occasional spots of beetle-killed pine timber up to three acres in area have been periodically noted on the refuge, but none have expanded beyond this size and no control efforts have been attempted to date. Complacency is not justified, however, because several thousand acres of refuge pine stands are highly susceptible to beetle attack. These stands possess a number of high risk characteristics including a large amount of mature timber; slow growth and low vigor; high density; and low, wet sites. Most high risk stands are located in the northern part of the refuge in compartments A, B, and C; these are in the vicinity of North, East, Williamson, and Hudnell Ditches.

Small beetle-killed spots under five acres in area which are not actively expanding are beneficial to many wildlife species. The killed trees provide an opening and edge similar to a small clearcut, and become snag trees supporting cavity nesters and foraging birds. Trees infested with beetles and larvae attract downy, hairy, and pileated woodpeckers; woodpecker populations may be 8 to 58 times more abundant within infestations than in noninfested areas.

Larger, expanding infestations are of greater concern because entire stands may eventually be killed, and the outbreak may develop to a point where adjacent private lands are threatened. Habitat managed for the red-cockaded woodpecker could also be in jeopardy.

Periodic aerial surveillance is recommended during years when the southern pine beetle population is on the upswing part of its cycle. Spots should be carefully located and described on a refuge map, then examined on the ground. Procedures recommended by the U.S. Forest Service will be used to evaluate and prioritize spots for control. Where control is needed, preferred methods will be salvage removal by timber sale or felling, piling, and burning by refuge staff. If recently attacked trees are present, a horseshoe-shaped buffer strip of green uninfested trees 40 to 100 feet wide around the active head will also be removed to discourage further spread.

Preventive silvicultural techniques to minimize stand susceptibility to southern pine beetle will be encouraged. These include thinning to maintain stand densities under 100 sq. ft./acre of basal area, regenerating overmature stands, minimizing logging damage to trees, and encouraging mixed pine and hardwood stands.

H. Timber Marking and Thinning Procedures

The International ¼" Log Rule is the standard log rule for Atlantic white cedar and will be used for all cedar sales. The Doyle Log Rule is standard for all other species in this area, but since the International ¼" Rule is much more accurate, most timber bid invitations will present volumes in both Doyle and International Rules. Unless field data provides reason to change the standards, Form Class 78 will be used for pine and cedar; Form Class 68 will be used for ash, cypress, and tupelo; and Form Class 75 will be used for all other species.

Even inch diameters will be used in all phases of work. Tree species will be tallied individually or by groups according to value.

The procedure for marking and tallying trees will vary depending on size of the sale area, type of regeneration system used, and value of the product. Each tree in the sale will be tallied and marked for cutting on small sales involving high value trees such as pine or cedar, or when only a portion of the stand is to be removed as in thinning, shelterwood, or seed tree cutting. On larger sales of maple or cedar where clearcutting is used, it will be sufficient and less costly to delineate the perimeter of the sale area with flagging and conduct a cruise to determine volume, without marking the trees to be sold. In these cases, marking and tallying each tree would not be cost-effective because of

the low value of the product (maple) or would require too much time because of very high tree density (cedar). The percent cruise will be determined by the size, value, and species of the sale and addressed in the management prescription.

The following guidelines will be used when marking timber for sale:

1. For sales where trees to be cut are marked, one spot of paint will be applied to the base of each tree and a second spot applied at about 4.5 feet above ground level.

2. Trees which are unmerchantable but need to be removed to release desirable reproduction will be marked with an X and a base spot but not tallied. The buyer is required to cut such stems.

3. Trees containing suitable or potential cavities for nesting and denning purposes will be reserved.

4. Minimum 300 foot aesthetic zones will be left along roads and aquatic areas as discussed previously.

5. Care will be taken to mark all trees in a given area on the same side to facilitate tree marking and harvesting operations.

6. Trees to be reserved as seed trees, shelterwood, snags, or mast producers, in addition to not being marked, will be identified with fluorescent flagging or a painted S to ensure that they are easily identified by logging crews.

7. Where timber stand improvement (TSI) is to be done by an inexperienced crew such as Youth Conservation Corps or Student Conservation Association, all stems to be chemically injected will be marked with paint.

Thinning will occasionally be practiced in pine stands to improve growth, discourage southern pine beetle infestations, provide red-cockaded woodpecker habitat, and encourage herbaceous understory for wildlife. Leave trees should be the best in the stand in terms of form, crown development, and canopy position. The best trees will be in the dominant or codominant position. In even-aged pine stands, the most vigorous trees will also have the largest diameters. Snags, cavity trees, and mast producers will be left for wildlife benefits.

I. Policy and Administration of Sales

The sale or disposition of forest products shall be governed by formal or informal bid solicitations. Formal bid solicitations will be used to establish the market value for most sales of forest products where a reasonable demand and competition exist.

Relatively small timber sales of under 750 thousand board feet (MBF) of sawtimber and 500 cords of pulpwood will be preferred for the following reasons:

1. In most cases logging can be completed during a 12 month period. No sales will be made which will require more than two years to complete because after two years tree marking paint will be deteriorated, and in addition there may be significant volume growth with longer periods.

2. Small sale areas will result in a diversity of wildlife habitat conditions.

3. Unsuccessful bidders will have additional opportunities to purchase timber.

4. Disturbance to other resources will be kept to a minimum by working in small areas.

Once the timber has been prepared for sale, bid invitations will be sent to all prospective buyers. Bid invitations will include the following as a minimum:

1. Species to be harvested

2. Estimated volume in cords or board feet

3. Acreage of sale area

4. Bid opening date and time

5. Compartment and sale area maps

6. Special timber harvesting permit conditions

7. Certificate of Independent Price Determination (101-45.4926 Fed. Prop. Mgt. Reg.)

8. Equal Employment Opportunity Clause

9. Formal bid sheet

10. Time frame in which to harvest

11. Date for sale showing

An example of a sawtimber formal bid invitation along with a prospective buyers list is found in Part VII.

The bid invitations will specify dates. Usually there will be two weeks between the mailing date and the sale area inspection date. A period of 10 to 15 days will be given between the inspection date and the bid opening date. During this period, prospective buyers are urged to cruise or inspect the sale area for timber quality and volume evaluations. The bids are opened at a specified time in the refuge office. Immediately prior to the actual bid opening, the sale is again discussed so there will be no confusion to the bidders. Bids received after the closing date and time specified in the invitation will not be considered. In the event of a tie, new bids will be solicited. The bid will be awarded to the highest bidder; however, the government reserves the right to reject any or all bids. On refuge lands formerly owned by the Union Camp Corporation, that company must be given the opportunity to bid on all sales and match the highest bid. The bid form will specify the amount of the performance guarantee to be submitted depending on the size, timber quality and other conditions of the sale. The deposit will be retained to cover any damage or claim the government might have against the permittee. Any excess deposit will be returned to the permittee.

Advance payments will be required for all sales, be they lump sum (preferred) or partial payments; however, in the event the size of a sale necessitates the partial payment method, the timber within a designated unit must be paid for prior to its removal. All payments, including the

performance guarantee deposit, will be made payable to the U.S. Fish and Wildlife Service in the form of a certified check or bank draft.

Three copies of Special Use Permit Form 3-1383 will be prepared by the Service and signed by the permittee. The permittee retains the original copy, the refuge keeps the pink copy and the yellow copy goes to the Regional Office, along with all bids and a copy of DSC Form 4 showing performance guarantee. All checks and drafts will be forwarded to the Denver Service Center.

Before a permittee begins operating on a sale he must pay the lump sum or partial payment and meet with the refuge Forester for a pre-entry conference. This is to ensure that all involved are aware of permittee and refuge responsibilities.

Inspections will be made by refuge personnel to ensure harvest operations are conducted in a satisfactory manner. Timber harvesting operations can be stopped at any time when field inspections reveal justifiable reasons. Field inspection reports are to be filled out and retained in the sale file.

The Refuge Manager will certify that all requirements of the sale have been completed and request that the performance guarantee be returned to the permittee.

Information specifying compartment, sale number, date of sale, purchaser, type of sale, timber volumes, acres involved, and revenue received will be recorded and filed for future reference.

Aside from all the standard terminology that appears on the bid that specifies and legalizes the general conditions of all sales, an attachment is included which sets forth certain conditions which will be part of an individual sale. These special conditions vary according to location, type of sale, and other circumstances. The most commonly specified conditions are listed below:

1. All marked trees will be cut. No unmarked trees will be cut. Penalties will be assessed for unmarked trees (usually double or triple the stumpage rates). Penalties may also be assessed for not cutting marked trees.

2. Trees will be cut to a specified stump height.

3. Littering is prohibited. Performance bond monies may be used to pay for litter clean-up if permittee allows littering to occur.

4. Permittee may be required to maintain Service roads used.

5. The Refuge Manager reserves the right to temporarily shut down logging operations to avoid conflicts with public use programs, conflicts with wildlife, during periods of extreme fire danger, or during wet weather to prevent road damage.

6. Main logging decks will be placed in specific locations as agreed by refuge officials and the permittee. Decks will be removed after logging.

7. Main logging road locations will be mutually agreed upon by refuge officials and the permittee.

8. No tops will be left in any drainages, ditches, or roads.

9. A pre-entry conference with permittee and his logging contractor will be held before entry is made on the sale area. This will be necessary before any work is done on the sale.

10. The length of logs to be skidded may be limited to prevent damage to standing trees.

11. Permittee will obtain any necessary right-of-way across private lands.

12. When necessary to cross a ditch, the permittee will build a temporary bridge. After logging, the bridge will be removed and the ditch left in the same condition as previously found.

13. Permittee may be required to pay for damages or suppression costs resulting from wildfires caused by logging operations.

J. Sale Appraisal

Demand, accessibility, species, quality and quantity, and logging conditions will determine the stumpage value for all sales.

K. Funds

Forest management funds are expected to be programmed through normal refuge O&M budgets and ARMM projects. Expense for sales funds are used only for actual timber harvest costs such as salaries, equipment, and supplies.

III. PROGRAM DESCRIPTION, PROBLEMS, AND SOLUTIONS

A. Scope of Forest Program

The U.S. Fish and Wildlife Service is responsible for the administration of the National Wildlife Refuge System. The primary purpose for setting aside this network of lands and waters is for the protection and perpetuation of America's wildlife resource.

The mission of the Great Dismal Swamp forest management program is not only to create optimum habitat conditions for wildlife but also to preserve and perpetuate the ecosystem through maintenance and restoration techniques, and to provide opportunities to the public for quality wildlife-oriented interpretation, environmental education, and recreation.

B. Description

1. Acreage

As of December 31, 1986 the refuge acreage totalled 105,367 acres with 24,556 acres in North Carolina in the counties of Gates, Pasquotank, and Camden; Virginia acres totalled 80,811 with 34,256 in the City of Suffolk and 46,555 in the City of Chesapeake. Total refuge area increases yearly as additional tracts within the proposed acquisition boundary are purchased; final area is expected to approach 120,000 acres (see map VII.C. Exhibit 1.).

2. Topography

Dismal Swamp lies in the Embayed Section of the Atlantic Coastal Plain, which consists of three

wide, gently sloping terraces separated by longitudinal, eastward-facing escarpments. The Dismal Swamp Terrace lies between the Suffolk Scarp and the Deep Creek Swale. Churchland Flat bounds Dismal Swamp on the north.

The refuge can be divided into three physiographic zones: Lake Drummond, forested wetlands, and a transition zone. Located in the swamp's center is 3,100 acre Lake Drummond. This shallow and nearly circular lake is one of only two natural lakes in Virginia. Forested wetlands, the predominant feature of the refuge, are sharply defined on three sides by the Dismal Swamp Canal and two highways. Along its western edge, the transition from swamp to uplands is more gradual, creating a zone of mixed characteristics.

To the west of the Suffolk Scarp, elevations rise and relief is variable. To the east and in Dismal Swamp, the elevation drops at the rate of one foot per mile to the Deep Creek Swale (just east of the Dismal Swamp Canal). In the Virginia portion of the swamp, elevations range from 15 to 25 feet above sea level; in Pasquotank County, North Carolina, elevations range from 10 to 20 feet; Camden County varies from 17 feet or lower. The topography exhibits a gentle west to east slope imposed on an even gentler north to south slope. The normal surface elevation of Lake Drummond is 18.65 feet.

3. Drainage

Ground and surface water were critical elements in the formation of Dismal Swamp and continue to play an important role. The basic hydrologic requirements for the formation of large peat swamps are a humid climate with reasonably uniform rainfall throughout the year and restricted surface and subsurface drainage. Maintenance of a stable water table - the key factor controlling the swamp's wetland environment - depends on a balance between water entering and water leaving the ecosystem.

Direct precipitation is a major source of water, contributing about 28.5 billion gallons to the swamp annually. Precipitation is highest during the summer months in normal rainfall years.

Surface water inflow occurs in the form of stream and sheetflow from the west along the Suffolk Scarp (see map VII.C.Exhibit 2.). About 82 square miles of upland area drain into the swamp, primarily via Cypress and Taylor

Swamps, supplying approximately 22 billion gallons of surface water each year. Eighty-nine percent of this inflow occurs from November through April. Evapotranspiration in areas upstream from the swamp severely limits inflow during the summer despite higher rainfall rates.

Ground water flows into the swamp from the west through the shallow Norfolk aquifer. Although the volume of ground water contributed to the swamp has not been calculated, a general estimate based on studies of swamps in North Carolina places ground water at about 50% of the annual water budget.

Evapotranspiration accounts for the biggest portion of water removed from the swamp ecosystem. It exceeds rainfall during the growing season and causes a lowering of water levels in the swamp throughout the summer. Estimated annual evaporation loss from the swamp is about 39 inches. The rate of transpiration is not known.

Surface water runoff through the swamp is also a major means of outflow. Historically, the principal drainage were the Northwest, Pasquotank, and Elizabeth Rivers, and Shingle Creek. Over the last two centuries natural outflow patterns have been almost completely obliterated; most surface water now drains from the swamp through channelized outlets.

Ground water discharge is a secondary output event. Wherever the upper layer confining the shallow aquifer is absent, fresh water wells up into the overlying peat and is naturally discharged from the peat by evapotranspiration. Ground water is also discharged by seeping directly into Lake Drummond. Where the aquifer is breached, ground water is discharged from the swamp as surface flow through outlet channels.

Many people perceive swamps as having standing water year-round. However, this is not the case in Dismal Swamp, and in fact most swamp vegetation could not survive permanent inundation. The Dismal Swamp has an annual hydrologic cycle which results in changing water levels throughout the year. Historically, the swamp's natural hydrologic cycle followed the seasons. The following description of this cycle is adapted from Otte (1985):

> In autumn the swamp was at its driest, with little or no standing water (except for Lake Drummond and

some of the larger stream channels) and a low water table. There was little downstream movement of water; most water moved upward and out of the soil by evapotranspiration.

In the winter -- as rains increased, temperatures declined, and evapotranspiration rates slowed -- stream flow swelled and the water table rose until it reached the surface. At this point streams overflowed into the swamp and surface sheetflow toward the east and south predominated.

By spring the swamp was flooded to its maximum extent with little lateral movement of water. As temperatures rose and plants began to grow in the late spring, evapotranspiration removed large quantities of water from the swamp and the water table began to drop below the ground surface. This allowed soils to aerate and vegetation to obtain oxygen needed for growth. While there were fluctuations in the annual cycle of surface water within the swamp, subsurface water losses were moderated by the large water holding capacity of the peat soils.

Modifications to the swamp's surface and ground water systems over the past 200 years have significantly altered this natural hydrologic cycle and continue to play a major role in the swamp's water budget. This has resulted in extensive changes in the wetland characteristics of the swamp.

The construction of 158 miles of canals and ditches with their attendant spoil bank roads have combined to form the single most significant disruption to the swamp's water regime. In principle, the elevated spoil bank roads serve as dams to overland water flow. Conversely, surface water on the ditch side of the road drains rapidly, the ditches breaching the ground water system and channeling surface flow out of the swamp; this results in the loss of an important buffer to spring and summer evapotranspiration drawdown. Many of the swamp's ditches form a network which channels most of the current surface flow into Lake Drummond, which in turn drains into the Feeder Ditch through a gated spillway and then into the Dismal Swamp Canal. Other ditches, including Corapeake, Big Entry, and several smaller ditches, drain directly

into the Dismal Swamp Canal. Several ditches in the southern portion of the swamp drain into Cross Canal and ultimately into the Pasquotank River basin. Jericho Ditch drains northwest to Shingle Creek and also south to Lake Drummond (due to flat terrain, the flow in several ditches is reversible, depending on rainfall, obstructions, and other factors).

The Dismal Swamp Canal has had a powerful effect on the hydrology of the swamp. The canal intercepts a majority of the surface water flowing out of the swamp and has breached the ground water aquifer. Water flow through the canal is managed by locks at either end of the canal and by the spillway on the Feeder Ditch at Lake Drummond. By intercepting natural surface runoff patterns and removing surface water much more quickly and efficiently than the natural drainage system, the canal and ditches have altered over 75% of the surface flow patterns of the swamp. Where the ditches and canal breach confining soil layers, ground water is discharged as channeled surface flow rather than through vertical movement into the peat layer. This condition is observed particularly during the growing season after winter surface water levels recede. Under low flow conditions when there is almost no surface flow through the swamp, it has been estimated that up to 90% of the water entering the Dismal Swamp Canal is due to ground water discharge. It is theorized, however, that when the aquifer is very low it may be recharged from the ditches at these discharge points.

The effects of the roads on ground water are not clearly understood, but it is assumed that associated soil disturbance, compaction, and addition of outside materials to swamp soils have significantly altered historical patterns of ground water movement through the swamp. Questions remain as to the permanence and irreversibility of these subsurface dams.

The net effect of all these modifications to the swamp's surface and ground water systems is that while a few sections of the swamp have become wetter due to the damming effects of the spoil bank roads, the majority of the peat soils in the swamp are drier for a longer period of the annual cycle than would occur naturally.

Prior to federal acquisition of the Dismal Swamp, the private owners recognized the need for water control to reduce water losses and manage water levels for timbering

purposes. One hundred and fifteen water control devices and culverts were installed over the years by previous owners. Many of these structures have deteriorated with time. During its tenure, the Service has rehabilitated 23 out of 28 critical water control structures. These devices significantly moderate water losses in the swamp, although currently only about 15% of the swamp's area is fully controlled.

4. Soils

The soils of Dismal Swamp play a critical role in supporting its wetland communities. Organic soils predominate with mineral soils confined to the northern end of the refuge; the toe of the Suffolk Scarp; and to the historic outflows of tributaries to the Elizabeth, Northwest, and Pasquotank Rivers (see map VII.C. Exhibit 3.). Mineral soils in the swamp are defined as those having an organic layer of less than 16 inches. The mineral soils are divided into several classes with varying characteristics, and the occurance of the mesic mixed hardwood and loblolly pine types corresponds to the presence of the mineral soils which are the preferred sites.

The organic soils are divided into two taxonomic classes. Typic Medisaprists are organic soils more than 51 inches thick, underlaid by mineral subsoils. Terric Medisaprists are organic soils more than 16 inches and less than 51 inches thick, underlaid by loamy or sandy mineral subsoils.

In general, the organic soils of the swamp are black, fine-grained, highly decomposed mucky peats. Undercomposed logs and stumps are buried in the decomposed organic material at depths ranging from a few inches to five feet. The organic soils are characterized by poor or very poor drainage, and high acidity. Permeability varies with the composition of the subsoil.

Organic soils are susceptible to a number of forces. They are highly subject to fire: when burned, the average combustible component of the soil is 93%, leaving a 7% ash content. Historically, uncontrolled fires directly removed organic soils from the swamp. In more recent times fire suppression has countered this trend, allowing organic soils to accumulate.

Uncontrolled drainage has also contributed to organic soil loss on the ditch side of the road-ditch corridors

lacing the swamp. In their natural, undehydrated state the swamp's organic soils are 85-95% water. In areas that have undergone excessive drying due to drainage, these soils aggregate into a granular form that will not re-wet even under inundated conditions. The dehydrated soils oxidize at a rapid rate and their granular nature reduces saturation in the vegetation root zone, possibly facilitating the incursion of drier-site vegetation.

Where water is impounded in the swamp by elevated roads and functioning water control structures, saturated organic soils accumulate. The interplay between organic soil loss and accumulation caused by the opposing forces of burning, fire suppression, drainage, and impounding, as well as inherent soil instability, have resulted in very complex soil dynamics in the swamp. As peat accumulates, the distance between surface soils and the water table increases, renewing the oxidation/subsidence process in the unsaturated layer with subsequent soil loss, until the cycle begins again. The key to maintaining saturated soils for wetland vegetation is, therefore, to keep an optimum distance (estimated to be 12 inches) between surface elevations and the water table.

5. Problems

Development of a forest management program at Dismal Swamp is faced with a number of inherent, resource-related problems which will limit its implementation. Several of these problems have been mentioned earlier in the management plan, but will be restated in this section.

Access to management units is poor: there is only one mile of refuge road for every 750 acres of forest, and many of these roads are passable only when dry. Most need some form of rehabilitation such as grading, spot filling of holes, or bridge replacement. The access problem is thus twofold: since it is impractical for heavy equipment to travel more than ½ mile from roads, much of the refuge habitat will be left unmanaged; and many roads will have to be upgraded to facilitate entry and exit of logging trucks.

The organic soils present major difficulties in stand entry to heavy equipment. Even foot travel becomes difficult when the soils are saturated or inundated in

winter and spring. During summer and fall they are usually dry, but caution must still be exercised as the soils are loosely textured and easily compacted. Historically, narrow-gauge railroad tracks laced the swamp, but higher labor costs preclude this option today. The only alternative is to use low ground pressure equipment, such as wide-tracked bulldozers and feller-bunchers. Cable yarding techniques can also help by decreasing the need to travel directly on the soil surface.

Problems associated with the water regime have been thoroughly discussed previously but will be reemphasized. The hydrology of the swamp and its relation to stand composition, growth, and regeneration are poorly understood. Although new or rehabilitated water control structures will improve our ability to stabilize water levels and conserve water in the summer and fall, the capability to more actively manage water levels either to recreate historic flow patterns or seasonally impound selected blocks will always be very limited.

Wildfire suppression will always be a problem, and may worsen with time as fuels continue to accumulate. Reintroduction of logging and increased management activities will increase fire risks and hazards such as cigarettes, cooking fires, sparks from equipment, and accumulations of logging slash.

Prescribed burning is an essential element of the management program, but is difficult to apply: winter burns often do not carry because of high fuel and soil moistures, whereas summer and fall burns may result in unacceptable losses to soil and vegetation and present control problems.

Many forest stands contain species of low market value and individual trees are often of poor form for commercial purposes. This will limit the extent to which commercial sales can be used as cost-effective management tools.

From the standpoint of optimum habitat diversity, there is an imbalance in both stand types and age classes which can never be completely remedied. Mesic mixed hardwoods, for example, are the most valuable type for wildlife but occupy only about one percent of refuge area. There is an obvious lack of both regeneration and old growth age classes, which happen to be the most heavily used by most wildlife.

Good prescriptions require thorough forest inventory data. Typically, this would consist of sampling along evenly spaced transects throughout the compartment, collecting data on stand volumes, ages, and species composition, among other things. Inventories of this intensity will probably not be possible without additional personnel, funding, or contracting of services. Problems in conducting inventories at Dismal Swamp include the large size of the compartment, poor road access, and dense understories which make foot travel slow, tedious, or even impossible in some areas.

6. Timber Type Classification

Dismal Swamp forests can be classified into five general types which are indicative of moisture and soil conditions, as well as historical influences of fire and cutting practices. These general types can be further subdivided into 13 forest cover types based on the classification system of the Society of American Foresters. This section will describe each of the types in terms of species composition, ecological relationships, objectives, and management strategy. Vegetation types which are not considered forest but which may be managed using forestry techniques are discussed in Section IV.B.

a. Maple-gum
SAF type 108 (red maple)
SAF type 104 (sweetbay-swamp tupelo-redbay)

The maple-gum habitat type encompasses those areas of the refuge where red maple, often in combination with blackgum or swamp tupelo, comprises a majority of the stocking. Species commonly associated with maple include sweetbay and redbay on organic soil sites, and sweetgum and yellow poplar on shallower organic or mineral soils.

Maple-gum is the only habitat type in the Dismal Swamp which is increasing in area. Red maple is able to thrive within a wide range of soil types, soil moisture regimes, and light conditions, so that it is replacing most other vegetation types in the course of succession. The expansion of maple-gum as a cover type is generally attributable to disturbance in stands where red maple was formerly only an associate. In stands that were partially cut, red maple was often left as an undesirable residual. These residual trees have responded to release by growing rapidly and increasing their proportion of the stocking.

More severe disturbances, such as fire and clearcutting, have converted many forest stands to red maple. This species produces a heavy seed crop nearly every spring, with trees as young as four years old producing seed, and the seed germinates almost immediately. Thus, if a site has been burned or cut in winter or spring, red maple will have nearly a full growing season's head start over species that produce fall-maturing seed. Equally important, red maple stumps and damaged seedlings develop vigorous sprouts.

Most red maple stands are immature with the majority of their stocking in saplings and poletimber trees. On higher elevation mineral sites, as these stands mature, the moderately shade tolerant and relatively short-lived maple may gradually give way to more tolerant species. There is also some evidence that maple-gum stands on drier organic soils where the water table has been greatly reduced may be slowly succeeding to sweetgum, willow oak, and yellow poplar. In the majority of the swamp, though, red maple can probably maintain itself indefinitely as an edaphic climax.

Currently approximately 64,000 acres, or 60 percent of the refuge, is classified as maple-gum. In the interests of promoting biological diversity and preserving the integrity of the Dismal Swamp ecosystem, the current imbalance in favor of maple should be partially corrected by reducing the acres in this habitat type.

This is not to say that maple-gum is without value. Like all other vegetation communities, it is recognized as a valid component of the swamp. When interspersed with other types, it contributes to vegetational and ultimately wildlife diversity. The rare Swainson's warbler is usually found in wetter maple-gum stands with a thick cane or vine understory. Other than this bird, no other species are known to prefer maple-gum habitat exclusively. However, most species use maple-gum stands rather frequently as feeding, resting, or breeding habitat.

The ability to reduce the acreage of maple-gum in favor of other habitat types will depend on removing the trees completely, including the root systems, by mechanical clearing. Deep peat burning is another option which may be attempted on small areas.

Other than type conversion, management of maple-gum will be confined to improving age class diversity. Clearcutting will be the principal method used to provide the open or brushy areas preferred by many wildlife species. Thousands of acres will be left undisturbed to permit the development of old growth stands and benefit those wildlife species preferring large, continuous tracts of interior forest. Buffer strips at least 300 feet wide will be left along ditches and aquatic areas so that older maples can provide cavity nests for wood ducks.

In stands where blackgum is a common associate with maple, selective cutting may be used to remove the maple but leave the gums. Relieved from competition, the blackgums would then be free to develop large crowns and produce fall mast for bear and other wildlife. Natural regeneration may be possible under these seed trees.

Because red maple is a relatively short-lived tree, this forest type will be managed on an 80 year rotation. However, it is anticipated that many stands will be removed before rotation age to provide regeneration areas and to convert to preferred types. The eventual goal is to have about 12 percent of the type in regeneration (0-10 years) and about 19 percent (66-80 years) in old growth. It should also be noted that due to the vast expanses of this timber type there will be large acreages of unmanaged old growth timber governed by the natural biological age of the species.

b. Pine
SAF type 81 (loblolly pine)
SAF type 82 (loblolly pine-hardwood)
SAF type 98 (pond pine)

Both loblolly and pond pines are known to be important native elements in the ecosystem. Recurring wildfires were probably influential in maintaining this type. There are no known maps or records to indicate the amount of pine existing in the swamp prior to logging during the colonial era.

Currently there are approximately 15,500 acres of pine on the refuge. Generally loblolly pine prefers poorly or moderately drained mineral soils such as those found along the western and northern ends of the refuge.

Common associates are sweetgum, red maple, blackgum, willow oak, and yellow poplar. Pond pine is commonly found in soils of high organic matter content in the swamp interior, particularly the area southeast of Lake Drummond and in the vicinity of Hudnell Ditch. Its associates include maple, blackgum or swamp tupelo, sweetgum, sweetbay, and redbay. Both species of pine occur in some areas of the refuge and there may be some hybridization between the two.

Some pine areas have been lost through natural succession and the suppression of wildfires. Small areas have been artificially added by previous landowners as hardwood stands were converted to pine by direct seeding or planting.

Certain species of wildlife are known to prefer pine and would be seriously affected if this forest type was allowed to disappear through succession. Among these are the green-backed heron, brown creeper, pine warbler, brown-headed nuthatch, and red-headed woodpecker. Maintaining pine would promote overall refuge diversity. Reintroduction of the red-cockaded woodpecker to the Dismal Swamp would depend on maintaining suitable old growth pine stands.

Management will focus on maintaining and regenerating existing pine stands, and improving age class diversity. Emphasis will be on even-aged management using clearcut, seed tree, or shelterwood cutting. Natural regeneration will be preferred to artificial planting or seeding.

Coastal plain loblolly pine usually produces good seed crops every year. Seeds mature and begin to fall in early October and may continue through the winter, but about 90 percent of the seed has fallen by January 1. Pond pine seeds can fall any time during the year under warm, dry conditions. Unless the serotinous cones are heated by fire, natural regeneration is extremely slow and very uncertain.

Clearcutting for loblolly regeneration is possible in the swamp, but timing of the logging operation is so critical that its use will be limited. Tree removal must be accomplished after the majority of the seed has fallen but before the wet conditions of winter set in. This limits logging to November and possibly December depending on when the winter rains start.

The seed method is better suited to refuge needs. With this method, four to twelve trees per acre are left after logging to provide seeds for regeneration. Since seeds are provided by residual rather than cut trees, timing of logging is not as

critical and work can be done during the summer and early fall dry season. The seed trees provide insurance in case of seed failures as they will still be available the following year. Having some trees on the site is less displeasing aesthetically than clearcutting, and the trees provide roosting and foraging for many bird species. It may be necessary to free potential seed trees from competing trees three to five years prior to the main harvest, to allow crown expansion and increase seed production.

Shelterwood cutting is much the same as the seed tree method, except that more trees are left after the initial cut to provide both seed and shade for the seedlings. Twenty to thirty trees per acre are recommended. It is the most pleasing aesthetically, and provides the most trees for bird species. After seedlings are established the shelterwood may be harvested.

Seed tree or shelterwood methods are also recommended for pond pine stands. Prescribed burning is helpful in regenerating both species, but it is particularly important for pond pine. Burning should be done in the winter following harvest to encourage the cones to open. For loblolly pine, burning on organic soils must be accomplished in the winter to prevent peat combustion, but as early in the season as possible to prepare the site for seed fall. If conditions are wet enough, October 1 to January 1 would be the ideal burning season. On mineral soils it may be possible to have a hot summer or early fall burn.

Prescribed burning will be extensively employed in pine stands to reduce hazardous fuel accumulations, stimulate seed germination and growth of herbaceous plants for wildlife, prepare sites for natural regeneration, and maintain habitat for the red-cockaded woodpecker.

The pine stand selected for potential red-cockaded woodpecker habitat will consist of a 200 acre foraging area surrounding a colony site of at least ten acres. Within the foraging area, natural regeneration where it occurs will be by the shelterwood method so that mature trees will still be available. No more than 30 percent of the foraging area will be in the 0-20 year age class at any given time. At least 50 percent of the foraging area will be in the 40-80 year age class. Regenerating areas will be 30 acres or less, and care will be taken not to isolate colonies from foraging areas. Burning or herbicide injection will be conducted at three to five year intervals to

control dense understory. A regeneration area should be established adjacent to the colony site so that when the old stand reaches age 125 and trees become abandoned, the newer stand will be ready for occupation. Snags and cavity trees will be left for other cavity nesting species to reduce competition for red-cockaded cavities.

A normal rotation age of 80 years will be used for loblolly pine and pond pine. Some stands may be cut before or after rotation age to achieve a better balance of age classes.

Some loblolly pine stands on mineral soils, may be converted to oak species to increase the acreage of mast producing species for wildlife. The number of acres involved in this conversion is expected to be small, however.

c. Cypress-gum
   SAF type 101 (baldcypress)
   SAF type 102 (baldcypress-tupelo)
   SAF type 103 (water tupelo-swamp tupelo)

Cypress-gum is a hydric, or water associated, community usually found in areas where surface water occurs well into the growing season. These stands are located in the western part of the swamp near the toe of the Suffolk escarpment, where water is furnished by heavy groundwater discharge or surface inflows such as Cypress Swamp and Taylor Swamp. The only other major cypress-gum area is a tongue extending from Cypress Swamp eastward between Washington and Middle Ditches, across Jericho Ditch, to beyond East Ditch. This area is believed to follow the ancestral flow pattern of surface water in the Dismal Swamp prior to ditching and road construction.

Baldcypress can be either a major or minor component of the community, but pure cypress stands are small and few on the refuge. Water tupelo, swamp tupelo (also known as swamp blackgum), and baldcypress may occur together or separately. Generally cypress is not as exacting in its site requirements as the gums, being able to grow on either mineral or shallow organic soils and under a variety of moisture conditions. Water tupelo prefers soils with higher silt or clay content, higher pH, and deeper and longer periods of flooding than swamp tupelo. For this reason it is mostly restricted to areas along the toe of the Suffolk Scarp, where swamp tupelo is able to extend into the swamp interior on organic soil sites. Other associates of cypress-gum include red maple; swamp cottonwood; American elm; green, pumpkin and Carolina ash; redbay; sweetbay; laurel oak; sweetgum; and persimmon.

Cypress-gum was formerly a major component of the Dismal Swamp ecosystem which is now declining because of human intervention. Early logging records show that cypress, in great demand for shingles and siding, was found throughout the swamp, particularly around the circumference of Lake Drummond. Extensive logging removed most of the cypress (and the seed source for regeneration), so that today the proportion of cypress in relation to water tupelo or swamp tupelo is very small in most stands. Furthermore, road and ditch construction altered the water regime in many locations to such an extent that conditions were no longer satisfactory for regeneration of hydric species. Lowering of the water table, or changes in the duration, frequency, or timing of inundation, encouraged a transition to other species such as red maple and sweetgum. Today cypress-gum occupies about 12,500 acres.

Cypress-tupelo swamps are important nesting, feeding and resting places for such waterfowl species as wood ducks and mallards. Green-backed and great blue herons commonly use large cypress trees as rookeries. Black bears use cypress-gum swamps for escape cover, denning sites, and fall food (swamp tupelo fruits). Raccoon, otter, and mink may also be found in the swamps.

Currently there is little evidence of either cypress or gum regeneration beneath mature stand overstories. Instead, there is an abundance of maple in the understory and midstory, except in areas where flooding is deep and of long duration. Management strategy will be to prevent additional losses of this type to maple using regeneration cuts or timber stand improvement. In addition, maple-gum stands on suitable sites and adjacent to cypress-gum areas may be cleared and regenerated to cypress and tupelo.

Planned regeneration of cypress and tupelo has not been widely practiced in the South so there is a lack of knowledge and experience in this area. The importance of the water regime in regeneration and growth further complicates the problem.

Natural regeneration is best accomplished where water levels can be managed to allow drawdown during germination and early seedling development, then inundation to kill the less water tolerant species. It is not anticipated that water level management will attain this degree of finesse in most areas of the refuge. Without water level management, regeneration will require mechanical or chemical removal of competing species.

Generally cypress will be emphasized over tupelo in regeneration attempts, since it is being replaced by tupelo in many stands. Clearcutting cypress-gum stands for regeneration purposes appears ill-advised. In shallow swamps, water and swamp tupelo reproduce more successfully than cypress because of greater seed production and somewhat faster early growth. Following heavy cutting the type usually reverts to water or swamp tupelo. Regeneration of tupelo by stump sprouts is also of major importance in cutover stands; sprouting of baldcypress occurs but to a lesser degree than gums.

Mature cypress and swamp tupelo trees have great value as mast producers and potential den, cavity, and nest trees; and individual trees are very long-lived. Because of this, management will emphasize retention rather than removal of cypress and swamp tupelo. Activities will be directed at converting maple stands to cypress and gum, or increasing the proportion of cypress and swamp tupelo in stands where only scattered trees now occur.

Maple stands will be converted by clearing and planting with nursery stock. Seedlings will be raised under contract with state or private nurseries, using Dismal Swamp seed to preserve genetic lines. An alternate method involving less site disruption and preparation cost, but more planting cost, will be to plant seedlings under an existing overstory; following this, all or part of the overstory will be killed by herbicide injection to release the seedlings.

In stands where cypress or tupelo trees occur as scattered individuals and comprise a minor part of the stocking, areas around such trees may be cleared to encourage seed tree regeneration. Clearing can be accomplished by a number of techniques including bulldozing, herbicide injection, or chain saw felling.

d. Atlantic white cedar
SAF type 97 (Atlantic white-cedar)

Atlantic white cedar is found on peat deposits in the swamp interior, generally overlying sandy soils. The species occupies approximately 7,400 acres in the refuge, either in pure even-aged stands or in mixture with swamp hardwoods such as red maple, swamp tupelo, sweetbay, and redbay. Pond pine is also an associate.

Atlantic white cedar is a subclimax but relatively long-

lived type, developing in even-aged stands that originate after disturbance - fire, flooding, windthrow, or clear-cutting. Appropriate conditions for regeneration of solid stands of cedar are created by certain types of fires, such as crown fires that kill dense cedar stands having few understory hardwoods or shrubs, allowing seeds in the duff layer to germinate, or fires that eliminate competing hardwoods and shrubs. Historically natural fires caused by lightning periodically burned large areas of the swamp and encouraged the regeneration of cedar.

Cedar has been vigorously pursued since the Dismal Swamp Land Company began operations in the eighteenth century. Loggers usually cut the cedar but left the hardwoods to take over the site, or left so much slash on the ground that the cedar seedlings were unable to develop in the shaded conditions. Other important factors resulting in the gradual succession of cedar stands to hardwood were the suppression of wildfires beginning in the early twentieth century, and the construction of ditches and roads causing changes in the water regime.

The Dismal Swamp contains the only significant stands of white cedar in Virginia, making it a species of special concern in the state. There are more areas of white cedar in North Carolina, but timber and agriculture interests are rapidly converting these stands. It is possible that in the future the Dismal Swamp, where the Atlantic white cedar reportedly attains its best growth and development, will be one of the last holdouts of the species on the mid-Atlantic coast.

Atlantic white cedar has always been in great commercial demand, the wood being straight-grained, easy to work, and highly resistant to decay.

No wildlife species are known to require white cedar over other forest types. However, bird studies conducted in refuge cedar stands reported as many as 23 species of breeding birds using the stands regularly, with densities of 1300 birds per square kilometer or higher. These cedar stands had the highest bird densities of all eastern coniferous communities for the 1980 breeding bird census.

A tentative rotation age of 100 years will be adopted for cedar. Some stands will be cut earlier or later than this age to provide a balanced age class distribution. Eventually approximately 20 percent of refuge cedar stands would be

old growth (80-100 years) and about 10 percent would be regeneration (0-10 years). By comparison, old growth and regeneration areas together account for only about three percent of the total area in cedar today.

Clearcutting will be the principal regeneration tool used, relying on seed in the duff layer or blown in from adjacent stands. Little (1950) reported successful regeneration in clearcut strips up to 400 feet wide and running at right angles to prevailing winds. Prescribed fire will be used the winter or spring following cutting to consume slash and prepare the seedbed, or the area can be prepared mechanically by bulldozing. When burning, the water table must be close to the surface to prevent ground fires which could destroy the seed.

If needed, environmentally safe herbicides may be applied aerially to kill competing hardwoods in regeneration areas. In older stands, individual tree injection may be used.

Many cedar stands have reverted to maple-gum but still contain scattered cedars. It may be possible to increase cedar stocking by clearing around these trees and encouraging natural seeding.

Up to 2,400 acres are planned for conversion of maple-gum to cedar. The existing forest cover will be removed, followed by mechanical site preparation and/or prescribed burning to reduce slash. Seedlings furnished by state or private contractors will then be planted. Only Dismal Swamp seed will be used for seedling production. Cedar produces seed prolifically nearly every year, with peak production usually occurring in November.

Atlantic white cedar seedlings are preferred deer browse; seedlings may have to be protected using synthetic tubes or chemical repellants.

Establishment of wilding production areas for planting stock would eliminate the expenses of seed collection and nursery propagation. One production area in Dare County, North Carolina contained 40 seed trees per acre after a partial cut on a ten acre area. Logging slash and brush were cut and piled following logging to prepare the site for germination. The following year there were about 500,000 seedlings per acre. Seedling production areas can produce plantable stock in two years and each year thereafter.

e. Mesic mixed hardwoods
SAF type 91 (swamp chestnut oak - cherrybark oak)
SAF type 98 (willow oak - water oak - laurel oak)
SAF type 57 (yellow poplar)
SAF type 87 (sweetgum - yellow poplar)

The term "mesic hardwoods" refers to an association of mixed deciduous tree species occuring in the higher elevation, mineral soil sites of the refuge. These forests are situated in the extreme northern end of the refuge, near North Ditch and Jericho Ditch; on the Suffolk escarpment along the western boundary; and on a series of sand ridges, or "islands", near Weyerhaeuser Road. Some of the tree species found in this type include sweetgum; yellow poplar; beech; willow, water, laurel, white, swamp chestnut, cherrybark or southern red oaks; blackgum; ash; elm; and red maple. Nondeciduous species which are occasionally found in this type include American holly, southern magnolia, sweetbay, and loblolly pine.

Only 1,500 acres of refuge property contain mesic hardwoods, or about 1.4 percent of the total area. There is no evidence to indicate that the mesic hardwood type was significantly more extensive than it is today. Most of the refuge is either too wet, peaty, or infertile to satisfy the site preferences of these species. Some of the less site specific species within this type, such as sweetgum and yellow poplar, can be found throughout the refuge but are usually in association with the maple-gum type.

The mesic hardwoods are the most valuable forest type in the refuge for wildlife, due to the diversity of tree species and the occurrence of hard mast-producing trees such as beech and the various oaks. Black bear, gray squirrels, white-tailed deer, and wood ducks make heavy use of the mast crops.

Since mesic hardwoods are so important to wildlife and occupy a very small portion of the refuge, a majority of this type will be left undisturbed except for occasional timber stand improvement to release oak crowns for mast production. The oak-beech component of this type may represent a climax, and if so should perpetuate itself indefinitely barring further disturbance. Instead, emphasis will be placed on increasing the area of oaks by conversion of other types.

A small amount of experimental natural regeneration may be attempted in mesic hardwood areas. Oak species have proved difficult to regenerate. Selective cutting and uneven-aged management are sometimes recommended but tend to favor shade tolerant species such as maple, dogwood, and holly; and repeated small cuttings require many stand entries by equipment which can be detrimental to the site and stand. Shelterwood cutting, leaving a thin overstory as a seed source, is sometimes successful but not reliable. Clearcutting may favor oak species but again the species composition cannot always be predicted. Experience in other areas of the South recommends patch clearcuts of three acres or less, preceded by timber stand improvement to release oak seedlings which may be present in the understory.

Conversion to mesic hardwoods depends on the availability of suitable mineral soil sites. These areas are scarce and some good loblolly pine stands may have to be sacrificed. Conversion of some maple-gum stands will be possible, but will be difficult due to the prolific seeding of maples and their ability to resprout from the stump. Scattered willow and laurel oaks are found in areas of the refuge containing shallow orgainc soils; these trees will serve as indicators for possible conversion sites.

Planting will require either direct seeding or nursery seedlings. Once planted, it is uncertain to what degree oak plantations will need to be maintained. Forest industries, interested in maximum growth, fertilize and cultivate their hardwood plantations but hopefully this will not be necessary. Some timber stand improvement work may be necessary to control competing species.

7. Volumes

No stand volume data is available at this time. A limited amount of volume information will be presented each year with the prescription package, as needed to conduct timber sales.

8. Growth and Maximum Cut

These terms imply a forest management strategy based on volume regulation rather than area control. Since the Dismal Swamp program quantifies objectives in acres rather than board feet, the concepts have little relevance.

C. Program Effect on Local Economy

The forest management program will have a favorable effect on the local economy by providing jobs associated with timber harvesting or other contracted work such as site preparation, tree planting, or nursery production.

D. Other Values

The Dismal Swamp provides unique public use opportunities since it is a type of ecosystem that is intriguing to many people and is also in public ownership. The refuge receives in the neighborhood of 10,000 visits annually, with hiking and deer hunting accounting for about half; the remainder consist of boating on Lake Drummond, limited vehicle access, wildlife tours, environmental education, fishing, and photography. The refuge's location adjacent to the Hampton Roads metropolitan area makes it accessible to over a million people. Visits are expected to increase significantly in the future as the area population expands westward toward Suffolk, the amount of undeveloped land outside the refuge continues to decrease, and the Service provides new facilities to accommodate the public.

Forest management will enhance the experiences of most visitors. Activities that result in clearings, edge habitat, and generally improved habitat quality will, in turn, increase wildlife viewing opportunities in the swamp. Management sites will be incorporated into the educational and interpretive programs, thus interpreting management per se in addition to the swamp environment.

There will be some conflicts between forest management and public use which will need to be addressed. Rotational management will require area closures in various parts of the swamp, although the impact will be temporary and sporadic.

Forest clearing is visually displeasing to most people until the area has revegetated. Negative visual impressions will be moderated by leaving buffer strips along most roads and aquatic areas. The clearings themselves will be made to appear as natural as possible, being small in size and irregular in shape. Preservation of unmanaged forest areas will enhance the wilderness-style experience for those who seek it.

IV. PROGRAM UNITS

A. General

The Dismal Swamp forest management program will consist of two phases. An initial experimentation period running until 1990 will utilize a series of small observation plots to determine which methods and techniques hold the greatest potential for meeting forest management objectives. Using these results as guidelines, the long-term operational program will get underway in 1991.

1. Long-term Program

The regeneration schedule below provides information on rotation ages, current acreages, and long-term area objectives for maintenance and conversion.

Type	Long-term Area Objectives				
	Rotation Cycle	Current Acreage	Acreage Objectives Maint.	Conv.	Total Acreage
Cypress-gum	N.A.	12,500	12,500	+5,800	18,300
Atlantic white cedar	100	7,400	7,200	+2,400	9,600
Mesic Hardwood	N.A.	1,500	1,500	+2,000	3,500
Pine	80	15,500	12,700	- 700	12,700
Maple-gum	80	64,000	N.A.	-9,600	54,400
Evergreen Shrub		800	800		800
Marsh		5	5	+ 145	150
Bog		400	400		400

Early successional forest types - cedar, pine, and maple-gum - will be managed on a rotational system using even-aged regeneration methods. This approach will ensure a balanced distribution of age classes and provide the open conditions needed to reproduce the species. The rotation ages - 80 for maple and pine and 100 for cedar - are intended to reflect the approximate stages in stand development when natural mortality becomes significant and other species begin to capture the overstory. At these ages, stands will be removed and new reproduction established. Some areas will be left undisturbed as special habitats or possible natural areas.

Current acreage figures were based on vegetation type mapping using aerial photography with some field verification, followed by area determination with dot grid, planimeter, or computerization. Actual acreage will be refined as

inventory data becomes available. It is expected that actual acreages in most types except maple-gum will be even less than presented here. Some areas now typed as cedar or cypress may contain these species as minor rather than major components of the stocking; if so, the type designation will be changed.

Cypress-gum and mesic hardwoods will not be managed on a rotational system. These are long-lived, late successional types which should be able to maintain themselves for several hundred years. A prime consideration in not regenerating these types by harvest is the high value of mature trees as mast producers as well as den, cavity, or nest trees. Management emphasis will be placed on converting maple-gum stands to these types, rather than regenerating existing stands.

Maintenance will maintain current acreages of most types. Some decline in pine reflects the placement of 2,100 acres of this type in the Portsmouth Ditch natural area, where management will not occur, and conversion of 700 acres to oaks. About 200 acres of cedar are also included in the natural area. Since maple-gum occupies a disproportionate share of refuge area and is in no danger of declining, there are no maintenance objectives for this type.

As discussed previously in Part I.C., the term "maintenance" as used here simply means that provision is made for a certain stand or forest type to perpetuate itself at its current size and location. The strategy for accomplishing this will vary depending on the nature and requirements of the species. Early successional types will eventually be lost to other species without natural disturbance or human intervention. The usual method of maintenance will be to remove the current stand by timber sale or shearing and piling, and providing for natural regeneration. In late successional types, simply leaving the stand alone may be enough to perpetuate it. At some indefinite point in the future, however, these old growth stands of cypress or oak must be closely examined to determine if they are regenerating or giving way to other species. More active intervention will be required if the latter case applies.

"Conversion" implies clearing less desirable stands, usually maple-gum, and replacing them with more desirable species, either by direct seeding or planting of nursery seedlings. Conversion areas will be carefully selected to match species to appropriate site conditions. Priority will be given to sites adjacent to the desired species,

and where the species historically occurred but has since declined or disappeared. Often the desired species will still be present as a minor component of the stand. Identifying suitable conversion areas will require thorough inventory work; the acreage figures given in the conversion objectives column are tenuous and will undoubtedly be changed as information becomes available.

The Annual Area Objectives schedule proposes the number of acres of maintenance and conversion to be undertaken each year by vegetation type. Maintenance figures are derived by dividing the long-term maintenance objectives of each type by the rotation age. Theoretically, at the end of the rotation period all ages would be represented equally. Cypress-gum and mesic hardwood do not have annual maintenance objectives because no active maintenance is planned at this time. Up to 150 acres of maple-gum are proposed for regeneration each year, not for maintenance objectives (there are none) but rather to provide age class diversity. The three nonforested types - evergreen shrub, bog, and marsh - are discussed in Section IV.B. Conversion figures are derived in a similar fashion to maintenance; long-term objectives are divided by rotation age. Cypress-gum and mesic hardwood objectives are divided by 125, even though these types are not given a rotation age. Note that annual maintenance and conversion objectives dovetail neatly with age class diversity objectives: although their purposes are somewhat different, their method of implementation is identical. Both long-term and annual area objectives are intended as general guidelines. The figures will need to be refined in the future as suitable conversion sites are better identified, current acreages are more accurately determined, and the number of acres actually accessible for management becomes more apparent.

Type	Annual Area Objectives Acres Regenerated Per Year		Annual Prescribed Burning
	Maintenance	Conversion	
Cypress-gum	N.A.	50	
Atl. white cedar	75	25	70
Mesic Hardwood	N.A.	15	
Pine	160		2000
Maple-gum	150		
Evergreen Shrub	50		50
Marsh	5	50	30
Bog			100

Besides cutting and regenerating timber, other management techniques to be employed include thinning, prescribed burning, and timber stand improvement (TSI).. Thinning was mentioned briefly in Part II.H. Thinning will be practiced primarily in pine stands, but may be attempted on an experimental basis in other types. The major limitation to the application of thinning is the low interest among local timber buyers in bidding on this type of work: per acre production is less than with clearcutting and a great deal of care must be exercised to protect the remaining trees.

The reader is referred to Part II.F.2. for a discussion of prescribed burning as it relates to forest management.

Timber stand improvement is the noncommercial removal of less desirable trees in a stand which are interfering with the growth, development, or regeneration of desirable trees. Girdling, chain saw felling, or dozer with KG blade may be used, but the most common and efficient method is injection of a herbicide directly into the stem using specialized, hand-held equipment. Possible applications of TSI at this refuge are:

a. releasing oaks or other mast producing species so that crowns can develop fully and increase production of mast.

b. releasing seed trees or shelterwood trees 3-5 years prior to harvest to encourage seed production.

c. reducing undesirable species in selected stands of cedar, pine, or cypress.

d. reducing the understory and midstory in potential red-cockaded woodpecker habitat.

e. removing trees from designated nonforested areas such as the bog and marsh.

f. reducing the overstory and midstory to favor seedling reproduction.

g. removing undesirable stems to release or encourage oak reproduction.

h. as an alternative to mechanical clearing around scattered, desirable trees to encourage natural seeding.

i. as an alternative to clearcutting in creating small wildlife openings where commercial interest is lacking, equipment accessibility is poor, or aesthetic concerns preclude clearing.

TSI work is very labor-intensive, requiring trained crews. If it is to be undertaken on a significant scale, either seasonal youth workers such as Youth Conservation Corps or Student Conservation Association will have to be used or the work will be contracted out. Close supervision by refuge staff will be required at all times.

Part VII.C. Exhibit 7 is a forest management schematic illustrating how the long-term program could be carried out on a given compartment over a 30 year period.

2. Interim Program

The long-term forest management strategy is to strive for biologically "ideal" conditions, such as a near perfect balance of age classes or an optimum diversity of vegetation types, while acknowledging that practical limitations will forever keep these goals beyond reach. Since a management program of this magnitude (and with biologic rather than economic objectives) has never been attempted in the Dismal Swamp, there is very little previous experience to guide us. Answers are needed to such questions as:

a. which silvicultural techniques will be successful and also cost-effective?

b. what constraints will funding levels put on the program?

c. what interest will commercial timber buyers have in the various stands proposed for cutting?

d. what will be the impacts of management practices on site factors, air and water quality, wildlife populations, and associated plant communities?

e. to what extent can negative short-term impacts be accepted in exchange for long-term benefits?

In attempting to provide answers to these concerns, an initial five-year trial period, from 1986 to 1990, will precede implementation of the long-term operational program. A series of small observation plots will test silvicultural methods. Located near roads, these plots will also serve as demonstration areas for forestry practices. Small timber sales will provide information on the degree and nature of commercial interest. Annual prescriptions for observation plots will be developed according to the following conditions:

a. All habitat types will have at least one plot. Plot sizes will range from .25 to 5 acres. Where a variety of techniques are to be tried, several continguous plots may be managed.

b. In cases where trial timber sales are planned, plots may need to be larger than five acres to generate interest among prospective buyers. Plots may also need to be larger where prescribed burning is used, so that the fire can build to sufficient intensity to achieve objectives.

c. Plots will be situated within ½ mile of the road allow convenient access for management and observation. In public use areas, demonstration plots will be interpreted for refuge visitors.

d. Each plot will be compared to an unmanaged control plot of equal size. To the extent possible, water will be conserved in all trial areas - both managed and unmanaged plots.

Refuge staff will monitor the effects of these trial practices on wildlife, plants, and the environment. Based on the results, recommendations will be made in 1990 to proceed with the long-term program as outlined here or modify it accordingly.

Experimentation and monitoring will continue indefinitely and not simply end in 1990. The initial five-year effort, however, should provide a solid core of experience so that more extensive management can be initiated with some level of confidence.

It should be stressed that the observation plots are only intended to provide a minimum level of experience to guide later management, and in no way does the program aspire to represent valid research. Limited staff resources, and the the need to gain maximum information over the short five year period, preclude plot replications and other statistical procedures necessary for scientific research. This should not be a problem if managers understand that trial results are not definitive, and are for in-house use only and not publication.

Experimental prescribed burning is currently under way, and burning is expected to become an increasingly important tool for habitat management as well as hazard reduction. Since prescribed burning is covered separately under the approved refuge fire management plan, it will not be considered a part of this five-year forest management trial. An exception would be where fire is used as a site preparation tool, usually in combination with drum chopping or shearing. When trial results and management recommendations are reported in 1990, there will be a section covering prescribed burning results and proposals.

Part VII.C.Exhibit 8 is a list of observation and demonstration plots currently in place as well as those proposed through 1990. Proposals for future plots are tentative at this time and must be refined as conditions change, new information comes to light, or unforseen circumstances develop. Final proposals will be presented as an annual prescription package prior to the beginning of each fiscal year. Part VII.C. Exhibit 9 is a sample plot prescription.

Plot treatments draw from a wide range of forestry techniques which are common practice in the southeastern coastal plain. Explanations of these techniques are provided in the glossary. They include:

a. clearing - by timber sale, or shearing with bulldozer and KG blade.

b. site preparation - after clearing, felled trees and brush may be removed or decreased by piling or drum chopping. Piled or chopped material may be further reduced by burning.

c. natural regeneration - treating the overstory trees with a clearcut, seed tree, or shelterwood cut to encourage establishment of seedlings. Some form of site prep such as burning may be required to prepare the seed bed.

d. artificial regeneration - direct seeding, or planting of nursery seedlings. Seedlings may be planted in a cleared site or beneath an existing canopy. Seedlings will be produced from locally collected seed. Survival and growth studies will provide data for matching species to suitable sites.

e. intermediate treatments - undertaken during the growth of the stand. Release from competition may involve commercial thinning or chemical application.

B. Miscellaneous Items of Management Importance

1. Firewood

Special Use Permits for firewood cutting may be issued to individuals requesting them at any time of year at the discretion of the Refuge Manager. Usually material available as firewood is limited to trees which have already been pushed over and piled within 50 feet of roads as a means of keeping road rights-of-way clear. Forest management operations will be conducted 300 feet or more from roadbeds and hence any excess wood would be inaccessible to most people. Commercial firewood dealers may express an interest in cleaning up after logging operations or even buying standing timber for firewood. Dealers will be treated like all other prospective timber buyers and will have to bid on sale areas as they become available.

2. Snags and Cavity Trees

A snag is a standing dead or partially dead tree. These trees are of exceptional value to many bird species, either because of nesting cavities or because of insect infestations in the bark or interior of the snag which provide food. In addition, the exposed, spreading crowns of large snags provide roosting and observation sites for some raptors.

A cavity tree is simply any tree containing a used or potential nesting cavity. Ideally, a cavity tree should contain some heart rot with sound sapwood on the outside. It may be either dead or alive. Twenty-three native bird species breeding in the Dismal Swamp use cavities for nesting. These include six species of woodpeckers, turkey and black vultures, kestrels, screech owls, wood ducks, chimney swifts, great-crested flycatchers, purple martins, Carolina chickadees, tufted titmouse, white-breasted and brown-headed nuthatches, house and Carolina wrens, eastern bluebirds, and prothonotary warblers. Mammals such as

raccoons and bears also use these trees as denning sites. Trees with damaged tops often develop into good den trees.

Several guidelines previously mentioned will favor retention and development of snags and cavity trees. Long rotation periods - 80 years or more - will allow cavity development and natural tree mortality in managed areas. Large blocks of inaccessible interior forest will be left unmanaged. Stands of mature baldcypress, swamp blackgum, and oak - species most susceptible to cavity development - will not be cut at all. Buffer zones will be left along ditches and aquatic areas where cavities are often most abundant.

Additional guidelines will be directed expressly at encouraging snags and cavity trees:

a. As many snags as possible will be retained in all management areas. Some snags along roads and public use areas will have to be removed for safety reasons. Some snags will need to be cut along fire control lines, but only to the extent necessary to ensure containment of the fire.

b. A patch of at least ¼ acre of permanent forest will be retained within each five acres of clearcut to provide reserve snags and cavity trees (Evans and Conner 1979).

c. When using seed tree regeneration, seed trees will be retained as potential snags. When using the shelterwood method, as many shelterwood trees as possible will be retained without suppressing regeneration.

Robbins (1979) mentioned one disadvantage of promoting snags in an interior forest situation. The problem is that snags are used by brown-headed cowbirds for watching the activities of other birds in whose nests they will lay their own eggs. Small insectivorous birds such as warblers are particularly susceptible to cowbird parasitism. Robbins recommends clustering snags in a few areas rather than encouraging them throughout the forest.

3. Nonforested Vegetation Types

Although nonforested communities do not fall strictly within the scope of forest management, forestry techniques will be necessary at least initially to remove encroaching woody vegetation.

a. Bog

The 400 acre area along North Ditch contains various grasses and sedges, Virginia chain fern, sphagnum moss, cotton grass, switch cane, red maple, and loblolly pine. The area is characterized by 6"-18" of organic litter and peat overlying a clay soil, with a perched water table above the clay much of the year. Discovery of charcoal layers in the soil, and the situation of the bog between two railroad tracks, suggest that this area may have been burned repeatedly by sparks from passing locomotives.

The bog area will be burned in winter, late spring, or summer to control invading woody species. Observation plots will be established to test various burning frequencies and seasons. Follow-up TSI may be necessary to help reduce overstory trees.

b. Marsh

The remnant marsh is apparently the oldest marsh in the swamp. This marsh area was known locally as Washington's rice farm. It was supposedly used for cultivation of food for Washington's men working in the northern part of the swamp during the 1760's. An area of approximately 300 acres was diked and ditched for water control. It is resonable to assume that this was a natural marsh prior to this use since the preparation of forested land for rice growing was an unreasonable task at that time. There was no evidence of a burn in the test boring in the marsh and no tree stumps are present in the grassed area. Today less than five acres are recognizable as open marsh and this remaining portion is being invaded by maples. Without management, it is anticipated that the entire marsh will become a maple forest in the near future. Human alterations in the local water regime are probably responsible for the loss.

A 1981 survey of the remnant marsh determined that the dominant and codominant species were Virginia chain fern, reed grass, manna grass, three-way sedge, nutsedge, golden club, arrow-arum, lizard's tail, and red maple.

Management will attempt to restore the marsh to the initial 100-150 acres on refuge property. Prescribed burning alone will not be feasible because of the scarcity of fine fuels beneath the invading maple. A variety of treatments will be tested on observation plots, including shearing followed by drum chopping or piling, chain saw felling with herbicide application to stumps, and TSI by tree injection. Following removal of the maples and establishment of fine fuels, periodic prescribed burning will be used to maintain marsh vegetation. Various burning frequencies and seasons will be tested. Some form of water management may be desirable to enhance the marsh community.

c. Evergreen Shrub Pocosin

The terms "evergreen shrub", "shrub bog", and "pocosin" all refer to a specific successional stage of many coastal palustrine wetlands dominated by broadleaved evergreen shrub vegetation less than 20 feet tall. Pocosins occur in areas of poorly developed internal drainage usually having organic or peat soils.

The pocosin communities of the Dismal Swamp are located south of the Feeder Ditch and north of Corapeake Ditch. Species commonly found in this type include bitter gallberry, fetterbush, downy Leucothoe, titi, myrtle, sweetbay, and redbay. Often there is a scattering of pond pine. Approximately 800 acres of the refuge have been identified in this type, although the boundaries are indistinct as it tends to grade into the pond pine type. The main characteristic distinguishing the evergreen shrub pocosin from the pond pine forest is that in the latter, tree crowns cover at least 25 percent of the area. Undoubtedly mapping boundaries and acreage figures will be modified as forest inventory information is gathered.

Confusion exists as to why the evergreen shrub type exists in certain areas. There are basically two theories of pocosin succession which are in sharp contrast to each other. The first assumes that the frequency and intensity of fire controls successional development. According to this theory, short pocosin is a pioneer stage leading to bay forest as a climax. The second theory assumes that nutrient levels are the controlling factor. According to this hypothesis, the

successional sequence is marsh-swamp forest-bay forest-tall pocosin-short pocosin. Other factors which probably influence pocosin vegetation are thickness of the peat and length of the hydroperiod.

Overriding all these natural influences is the effect of human activities. Natural burns always occurred in the swamp, but their frequency increased as Indians and later loggers set fires (intentionally or not). More recently, fire suppression policies have all but eliminated fire from the swamp. Loggers altered natural succession patterns by removing forest cover. Road and ditch construction have altered water regimes and encouraged a transition to maple and pine.

The marsh rabbit is believed to frequent evergreen shrub areas. Studies indicate that black bears make heavy use of this type for escape cover, ground denning sites, and as a source of winter food.

Management will be directed at maintaining the 800 acre pocosin community, and expanding it if possible. Since there is strong evidence that it is a fire dependent community, prescribed burning will be the principal technique of habitat maintenance. Burning without prior site preparation is the method of least cost and site disruption, but is difficult because of the inaccessibility of the area to land traffic and problems in controlling fires due to highly flammable vegetation and heavy fuel accumulations. Winter burning by helicopter ignition has been used successfully in North Carolina pocosins and will be attempted here. Burning by ground crews is feasible on smaller blocks if the area is first prepared by drum chopping or shearing and the fuels allowed to cure before ignition. Winter burning is recommended to permit fire control and prevent severe ground fire. Regardless of the ignition method used, burning should be restricted in area in any given year to avoid excessive disruption of denning or feeding black bears.

Creation of additional habitat may be possible by clearing relatively unproductive maple stands adjacent to pocosins. Close monitoring of this practice will determine if desired vegetation replaces the maple.

C. Timber Management Compartments

The following descriptions are a general overview of each of the ten forest management compartments. Part VII.C. Exhibits 5 and 6 feature a map of the refuge divided into compartments, and a closeup of each compartment depicting vegetation types. These maps should be referred to when reading this section. Vegetation type and age class designations are based on the best information available at this time, and will be modified as annual prescription inventory data is collected.

1. Compartment A

This northernmost compartment is bounded by refuge boundaries on the north and west, Jericho Lane and Hudnell Ditch on the south, and East Ditch on the east side. One leg of the compartment extends east to the Hitch property boundary and south to the Norfolk Southern railroad tracks.

The area north of the Norfolk Southern railroad tracks is characterized by mineral or shallow organic soils. Much of the area is in mature loblolly pine, and a portion of the stand east of Short Ditch is planned for red-cockaded woodpecker management. Prescribed burning will be conducted in most of these pine stands. Red maple stands are monotypic and are prime candidates for conversion to oaks. An unusual feature of this area is a sphagnum bog covering approximately 800 acres on both sides of North Ditch. Most of the bog is succeeding to maple and pine forest. Experimental prescribed burning at various times of the year and with differing frequencies is being conducted to determine the best management regime to maintain open bog vegetation.

South of the tracks deep organic soils become prevalent, particularly around New and Hudnell Ditches where an extensive pond pine stand occurs. Prescribed burning using aerial ignition may be attempted here to reduce heavy fuel accumulations and rejuvenate understory plants for wildlife. Natural regeneration of pines using seed tree or shelterwood methods is also planned. The large block bounded by Williamson, New, Hudnell, and East contains a diversity of tree species including pond pine, loblolly pine, maple, swamp blackgum, sweetgum, poplar, cypress, swamp chestnut oak, and cherrybark red oak. The occurrence of these species probably

depends on slight differences in topography and soil type. Green tree reservoir management has been suggested for the northeast portion of this block but its feasibility is unknown at this time. The west side of the compartment around Jericho Lane and Jericho Ditch contains some of the finest stands of mesic hardwoods on the refuge. The rare dwarf trillium is found near Jericho Ditch.

2. Compartment B

Compartment B is bounded by Big Entry Ditch and other refuge boundaries on the north, the Dismal Swamp Canal on the east, East Ditch on the west, and Juniper Ditch and Southeast Ditch on the south.

As in Compartment A, maple-gum and pine are the dominant forest types. Most of the pine is loblolly, and some prescribed burning and rotation cutting will be practiced. Until roads are improved and old bridges replaced, management will be mostly confined to areas near and east of Portsmouth Ditch. Cedar stands along Juniper Ditch will be managed as this area becomes more accessible.

3. Compartment C

This compartment is bounded on the north by Jericho Lane and Hudnell; on the east by Hudnell and East; on the south by Badger, Middle, and Camp; and on the west by refuge boundary.

The eastern part of the compartment, between Jericho and Hudnell, is largely maple-gum or maple-bay forest with scattered cedar. Cedar was more extensive early in the twentieth century, but has been eliminated by timber cutting. Four small "islands" of old growth cedar near Camp Ditch are remnants of this former stand. The westernmost island is suggested as a possible natural area. The maple-bay scrub forest adjacent to these islands is recommended for conversion to cedar. A large stand of pond pine near Hudnell is a continuation of the same stand discussed in Compartment A.

Between Lynn and Jericho is a large stand of mixed cedar, maple, blackgum, and bay. Succession from cedar to maple and other swamp hardwoods is clearly evident. Because of the large size of the stand and the relatively good access from both Lynn and Jericho, this area has the greatest potential for cedar management north of Lake Drummond.

Management should focus on increasing the proportion of cedar in the stand.

4. Compartment D

Compartment D is bounded on the north by Badger, Middle, and Camp; on the east by East; on the south by Lake Drummond and Railroad Ditch; and on the west by refuge boundary.

The area south of Camp Ditch contains several isolated stands of cedar surrounded by maple-bay forest similar to Compartment C. These adjacent maple-bay stands would be ideally suited for conversion to cedar, using natural seeding from existing stands whenever possible. A large stand of cedar crosses East Ditch south of the Camp junction.

Running through the middle of Compartment D is an extensive area of baldcypress, tupelo gum, swamp black-gum, and other hydric species reflecting the historic inflow channel from Cypress Swamp. Construction of the Washington, Lynn, and Jericho road and ditch system interrupted this flow pattern, with the result that surface inflow north of Washington is very limited. With the recent ability to conserve and divert Washington Ditch inflow up Lynn and across Middle, it may be possible to send water into this block once again. This could have the effect of retarding succession to drier-site species and enhancing growth and regeneration of cypress-gum. Whether a green tree reservoir could be established here would depend on ability to raise and lower water levels and prevent water from flowing across Jericho Ditch. Maple-gum stands within this block could be cleared for cypress-gum regeneration, or existing cypress stands could be improved by timber stand improvement. Oak regeneration plots could be established where topography is slightly higher, such as along Lynn Ditch. Management access will be mostly confined to Lynn and Middle; the south end of Jericho is impassable to traffic, and Washington has priority as a public use access road and aesthetic corridor. Limited access by temporary bridge may be possible from Railroad.

5. Compartment E

Boundaries consist of Juniper and Southeast Ditches on the north, the Dismal Swamp Canal on the east, Feeder Ditch and private property on the south, and East Ditch to the west.

The majority of this compartment to the east of Portsmouth Ditch will be left unmanaged as a natural area. Vegetation consists of pine and maple-gum, with two small cedar stands.

The area west of Portsmouth Ditch is open to management, but access is limited. Temporary bridges across East Ditch would permit logging of the large cedar stand for maintenance and age class diversity. The road paralleling Portsmouth Ditch ends just south of Southeast Ditch. Cedar management along Juniper Ditch would depend on replacement of existing bridges.

6. Compartment F

Compartment F is bounded by Railroad Ditch on the north, Lake Drummond and Riddick Ditch on the east, South Ditch on the south, and private property on the west.

Large stands of swamp blackgum and cypress lie to the west of West Ditch and also south of Interior Ditch. Between West Ditch and Lake Drummond is a large block of intermediate-aged maple and gum. Portions of the stand near West and Railroad may be suitable for conversion to cypress or cutting alone to improve age class diversity.

Very large stands of cedar occur in the southern portion of the compartment between Interior and South. Strip or patch clearcuts are recommended to establish cedar regeneration and provide open areas for wildlife. Access via South Ditch will be necessary to manage this area.

7. Compartment G

This area is bounded on the north by the Feeder Ditch and South Ditch, on the east by the Dismal Swamp Canal, on the south by Corapeake Ditch and the Virginia-North Carolina state line, and on the west by Riddick Ditch and private property north of Corapeake.

The western leg of this compartment contains some cypress-gum, maple-gum, and a large stand of cedar. Management

access would be from the north by way of South Ditch, or from the south by temporary bridge over Corapeake Ditch.

The entire eastern block contains some of the best black bear habitat on the refuge. A large stand of mature swamp blackgum southeast of Lake Drummond is heavily used for fall feeding. A 1967 wildfire south of Paw-paw Ditch produced a variety of fruit-producing plants such as black cherry which are used for summer food. Evergreen shrub pocosins near Western Boundary, Myrtle, Persimmon, and Old Cedar Railroad provide excellent winter denning and feeding habitat.

Evergreen shrub areas will be maintained by prescribed burning if observation plots show this method to be beneficial. Burning may be preceded by site preparation. Adjacent pine and maple stands may be suitable for conversion to pocosin vegetation by mechanical clearing.

Prescribed burning by aerial ignition will be attempted in the grid blocks to reduce hazardous fuel loads and renew or create conditions suitable for evergreen shrub vegetation.

8. Compartment H

The northern boundary for this compartment is Corapeake Road. Forest Line Ditch and the old Richmond Cedar Works railroad bed form the eastern boundary. The old railroad turns west to form the southern boundary, along with the west end of Cross Ditch. The western boundary consists of private property on the north and Weyerhaeuser Ditch on the south end.

Immediately west of Sherrill Ditch is a large stand of tupelo gum with scattered cypress. The remnant marsh area is also located here. East of Sherrill the area is a mosaic of intermediate-aged and mature cedar stands surrounded by areas of maple-gum. A very large portion of the cedar in this block was harvested in the mid 1970's and the area has now reverted to a mixture of maple and cedar regeneration. A 1975 wildfire severely burned about 100 acres of cutover cedar near Forest Line Road.

The south end of this compartment is similar, with cedar harvested in the late 1970's prior to federal acquisition and now replaced by maple-cedar regeneration. A mature stand of cedar lies between Cross Canal and County Line

Road. The remainder of the south end is maple, gum, and bay except for three small islands of mesic hardwoods.

Because of the large amount of timber cutting carried out in this area within the last ten to fifteen years, Compartment H will be one of the last compartments to receive management attention. An exception is the marsh area which will be managed in the immediate future to eliminate encroaching trees. Mesic hardwood islands will be left as potential natural areas. Possibilities for future management include maintenance regeneration in cedar stands using strip clearcuts, and conversion of some maple-gum stands to cedar.

9. Compartment I

Boundaries consist of Cross Canal and the old Richmond Cedar Works railroad bed on the north; Weyerhaeuser Ditch, private property, and the south end of County Line Ditch on the east; Route 158 on the south; and private property to the west.

The eastern half of the compartment is almost entirely maple-gum. Some opportunity may exist to convert small portions of these stands to cypress or oak, depending on the elevation of the site and soil conditions. Mesic islands containing beech, oak, and loblolly pine will be undisturbed, but maple areas adjacent to these islands may be candidates for oak planting or seeding.

The western part of the compartment contains a very large block of tupelo gum and cypress which is wet much of the year from ground water discharge. A great blue heron rookery is found in this area in a clump of large cypress trees. No management is anticipated in the cypress-gum area due to wetness, inaccessibility, and refuge policy to leave mature cypress-gum stands as prime wildlife habitat.

The south end of Compartment I borders a man-made channel along Route 158 which supports marsh vegetation. This marsh will be maintained by prescribed burning, and a portion of the adjoining maple forest will be cleared and piled in an attempt to enlarge the marsh.

10. Compartment J

The northern and eastern boundary of Compartment J is Bull Boulevard, private land forms the southern boundary, and the old Richmond Cedar Works railroad bed is the western edge.

Nearly the entire compartment is maple-gum. Management options are limited to cutting maple for age class diversity, or converting small blocks of maple to cedar. The headwaters of the Pasquotank River at the south end of County Line Road contain a variety of tree species and are used by bear for fall mast. This area should be protected.

V. PHYSICAL PLANT AND EQUIPMENT USE REQUIREMENTS

A. Roads

A shortage of roads in relation to refuge area, and poor roadbed conditions in many cases, will always be limiting factors in implementing the forest management program. Any prescription for a timber sale will have to consider access problems for logging equipment and steps to be taken to maintain the roadbed. Most roads used by heavy logging equipment will need to be graded and spot filled periodically during and immediately after logging, whether done by the refuge or by the logging contractor.

One new road is planned for future construction. This is a 1500 foot extension of Juniper Road connecting it to East. This road will shorten the time and distance necessary to reach the northeastern part of the refuge. Other than this, no additional roads are planned because of high cost and the disruption of surface and ground water flow which could result.

A 1987 project to reopen the road on South Ditch to Riddick Ditch will provide limited management access to this area.

B. Miscellaneous Equipment

Currently one 1986 Chevrolet four-wheel drive pickup is assigned to the refuge Forester. One or two additional vehicles may be assigned to the forestry program if a second Forester and Forestry Technician positions are filled.

As the forest management program becomes operational, a large amount of data and records will be generated which would best be stored and processed in a computer system. Computer software, and compatible hardware to use it, could be employed to write prescriptions and timber sale invitations; maintain records of compartments and work done; store files of prospective contractors and timber buyers; store inventory data and compute volumes and other desired outputs; and, using a geographic information system, store compartment and stand maps and revise them as stands are modified.

C. Engineering Services

Seventeen thousand dollars have been allocated in 1987 for design work to replace ten bridges and culverts in Compartment B. Replacement will be necessary for fire suppression and management access to much of this area.

Engineering services may also be needed for construction of the Juniper Road extension mentioned above.

VI. FUNDS AND PERSONNEL REQUIREMENTS

Funds necessary to conduct a fully operational forest management program are difficult to estimate at this time. Many questions and variables will have to be addressed. These include:

1. Annual funds limitations imposed by the overall refuge budget as determined by Congressional and Service allocations.

2. The number and grade level of staff assigned to forest management.

3. Vehicles and equipment assigned, and their replacement schedules.

4. Availability and amount of expenses for sales funds.

5. Scope and intensity of forest management indicated by results of interim management, equipment access limitations, and interest level of prospective contractors and timber buyers.

6. The amount of work to be done by contracting and force account.

7. The amount of road maintenance attributable to forest management operations.

As answers to these questions become apparent, the Forester will annually recommend to the Refuge Manager a funding level which will best meet prescription objectives based on experience, available staff time, and overall budget constraints.

For the immediate future, during the period of interim forest management, funding is restricted to a portion of the refuge budget distributed either as fixed expenses or specially funded projects. Fixed expenses for forest management are primarily the time of the refuge Forester/Fire Management Officer (1/3 of salary) and the Heavy Equipment Operator (estimated 1/4 of salary). Other expenses may be included under a habitat management project and might include costs for contracting services (site preparation, nursery, tree planting) and fuel and maintenance of equipment when involved in habitat management. The following list depicts the estimated annual amount needed for forest management through the year 1990:

Salaries	
GS-11 Forester/Fire Management Officer (1/3 salary)	$10,000
WG-10 Heavy Equipment Operator (1/4 salary)	6,000
Contracting and Equipment Maintenance	10,000
Total	$26,000

Personnel needed to conduct the operational long-term managment program are presented in the refuge Master Plan. They include:

GS-11 Forester/Fire Management Officer (1/3 salary)	$10,000
GS-7/9 Forester	23,000
GS-5 Forestry Technician	16,000
Total	$49,000

VII. PROGRAM DATA

A. Timber Cruise Data

As previously mentioned, no systematic cruises of the forest compartments have been conducted to date. Inventory information will be forthcoming as individual compartments are examined prior to preparing annual prescriptions.

Stand types and age class categories depicted on compartmental maps (VII.C.Exhibit 6.) are based on information gleaned from aerial photographs with some field verification. Stand boundaries, type classifications and ages will be refined as more accurate field data is collected.

B. Markets

Local demand for Atlantic white cedar is quite good, although only a few companies are currently using this product due to limited availability. As Dismal Swamp cedar is made available to buyers, additional companies may process and market cedar products.

Pine demand in the area is also strong, but organic soils and poor accessibility of many stands will probably limit the number of interested buyers.

The demand for maple, blackgum, and other hardwood species has never been particularly strong even on upland sites and will be very limited in the swamp. The Union Camp Corporation in Franklin has for many years been the major purchaser of hardwood pulpwood for paper manufacturing, but it remains to be seen if they will be interested in bidding on Dismal Swamp stumpage. Very low prices will have to be accepted here if hardwood species are to be sold; however, any purchase is preferable to the cost of paying contractors or using refuge resources to clear timber.

Lists of prospective timber buyers, as well as contractors for site preparation, nursery production, and planting are located in VII.C.Exhibit 14. These lists will be stored on computer file and updated as companies enter or leave the market. A phone survey will be conducted prior to undertaking the first timber sale to assess the level and type of interest of each company.

C. Exhibits

Exhibit 1. Refuge Map

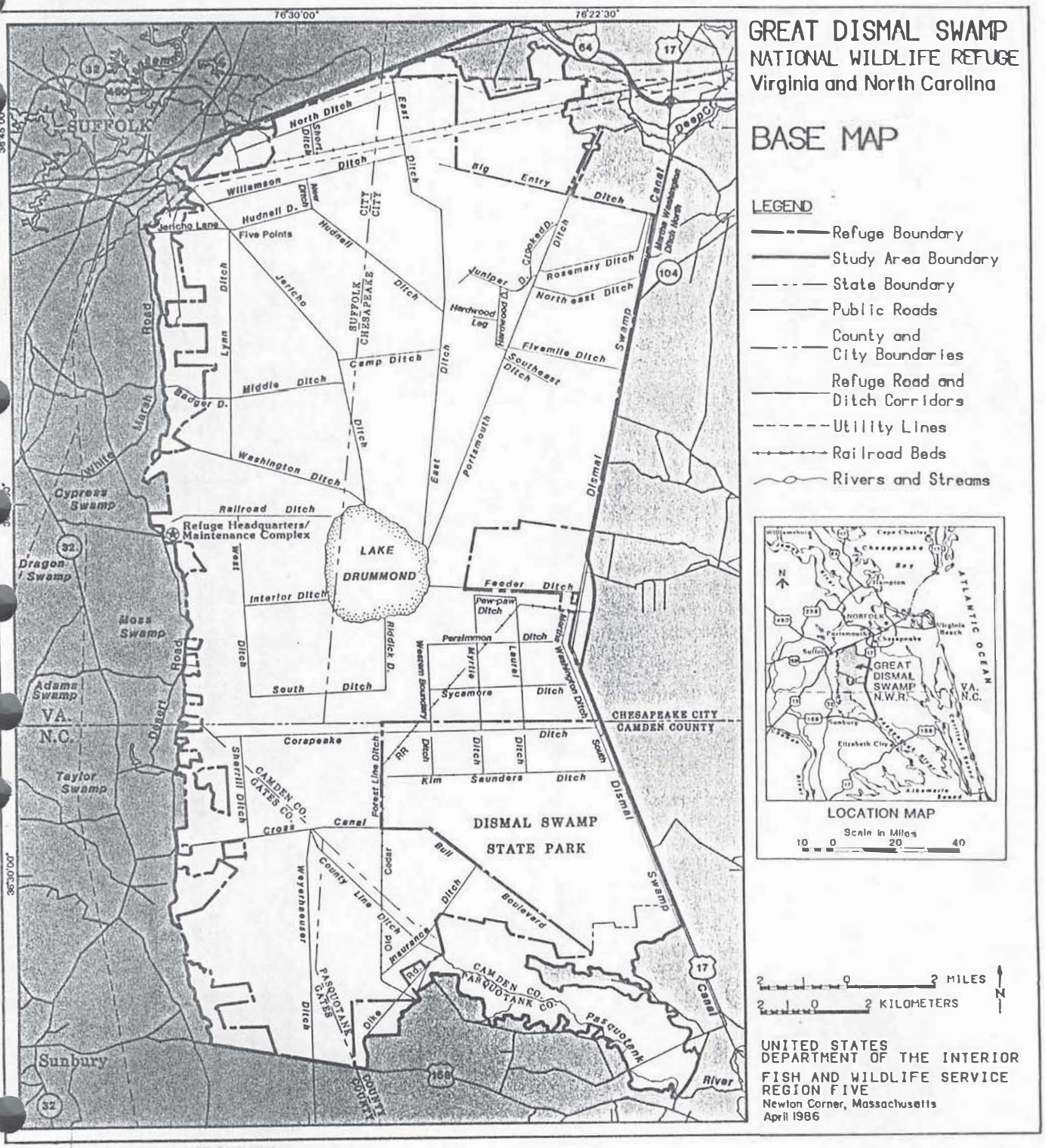


Exhibit 2. Drainage

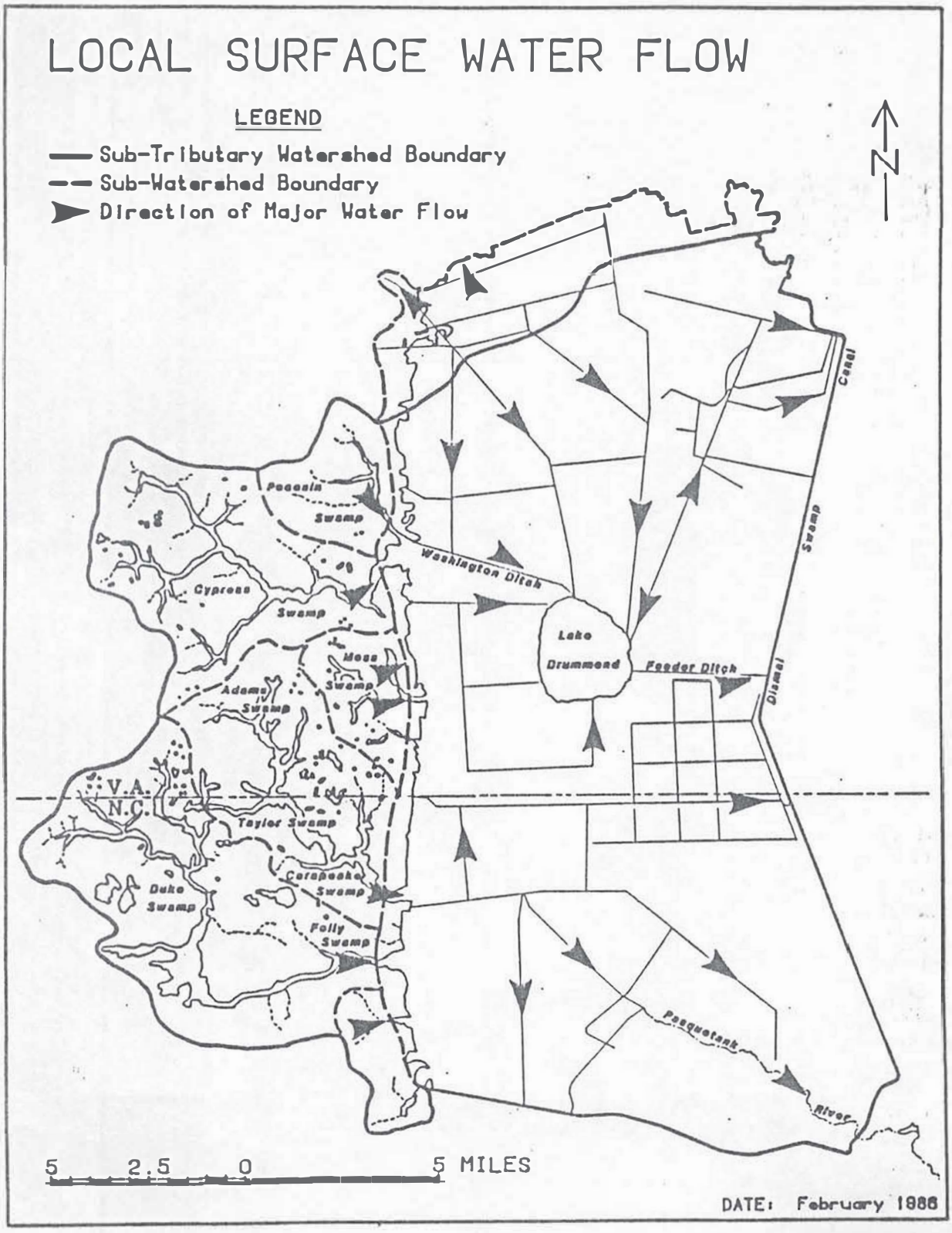
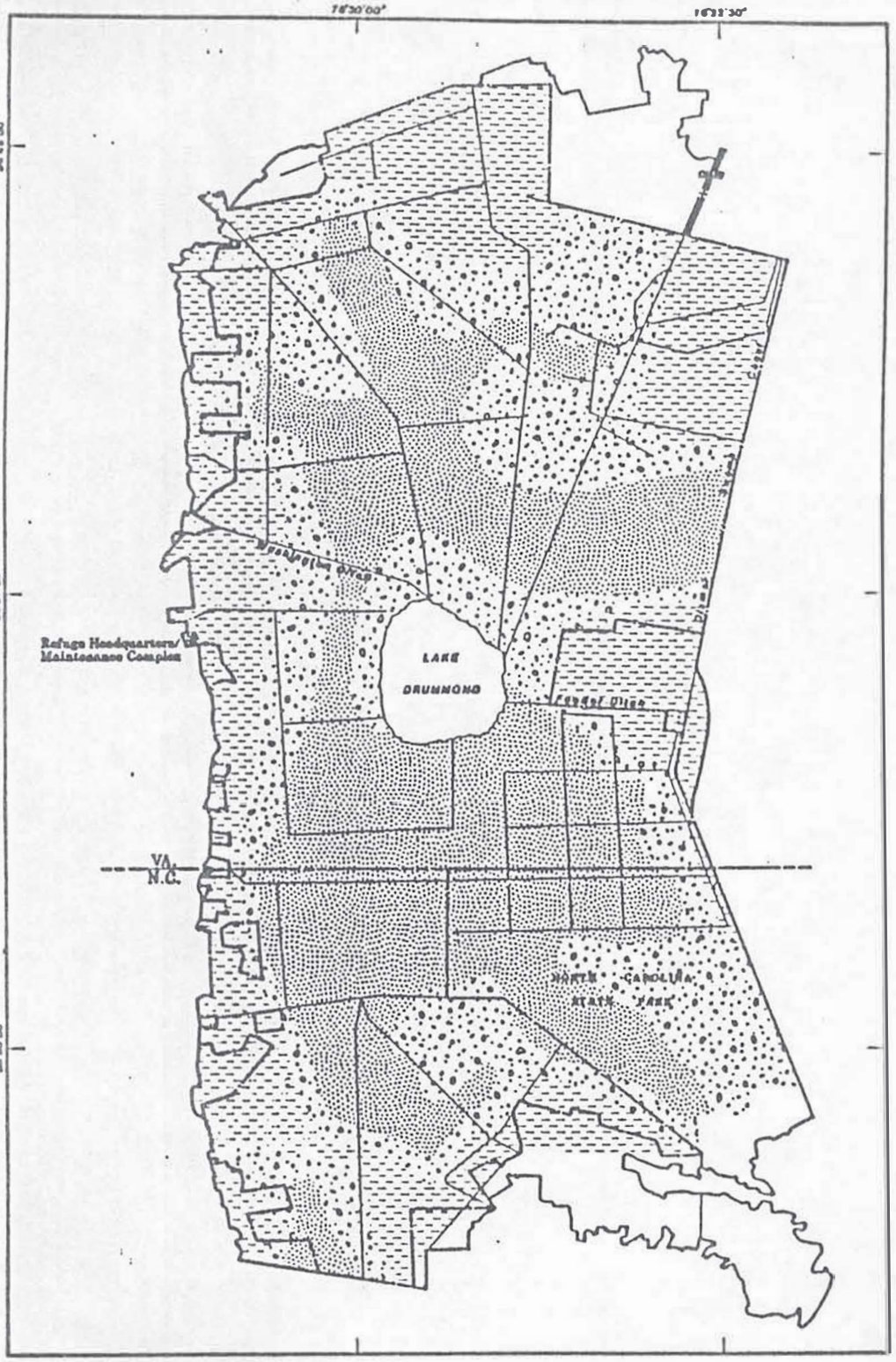


Exhibit 3. Soils



GREAT DISMAL SWAMP
NATIONAL WILDLIFE REFUGE
Virginia and North Carolina

SOIL CLASSES

LEGEND

- Refuge Boundary
- Study Area Boundary
- State Boundary
- Refuge Road and Ditch Corridors
- Deep Organic Soils
- Shallow Organic Soils
- Mineral Soils

SOURCE: Data compiled by Lee Otte, PhD 1984 Unpublished

2 1 0 2 MILES

2 1 0 2 KILOMETERS

N

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
REGION FIVE
Newton Corner, Massachusetts
November 1985

Exhibit 4. Vegetation

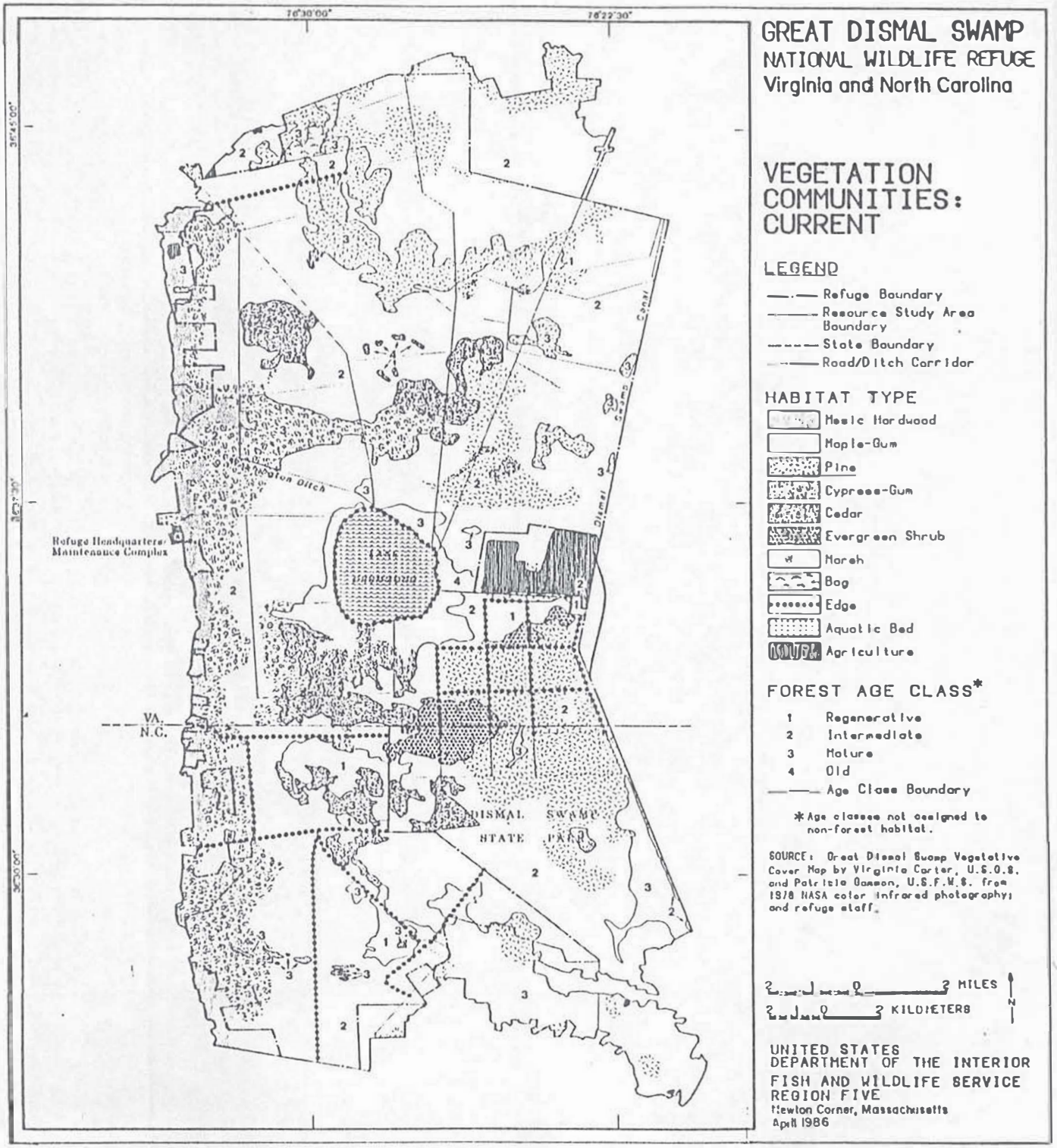
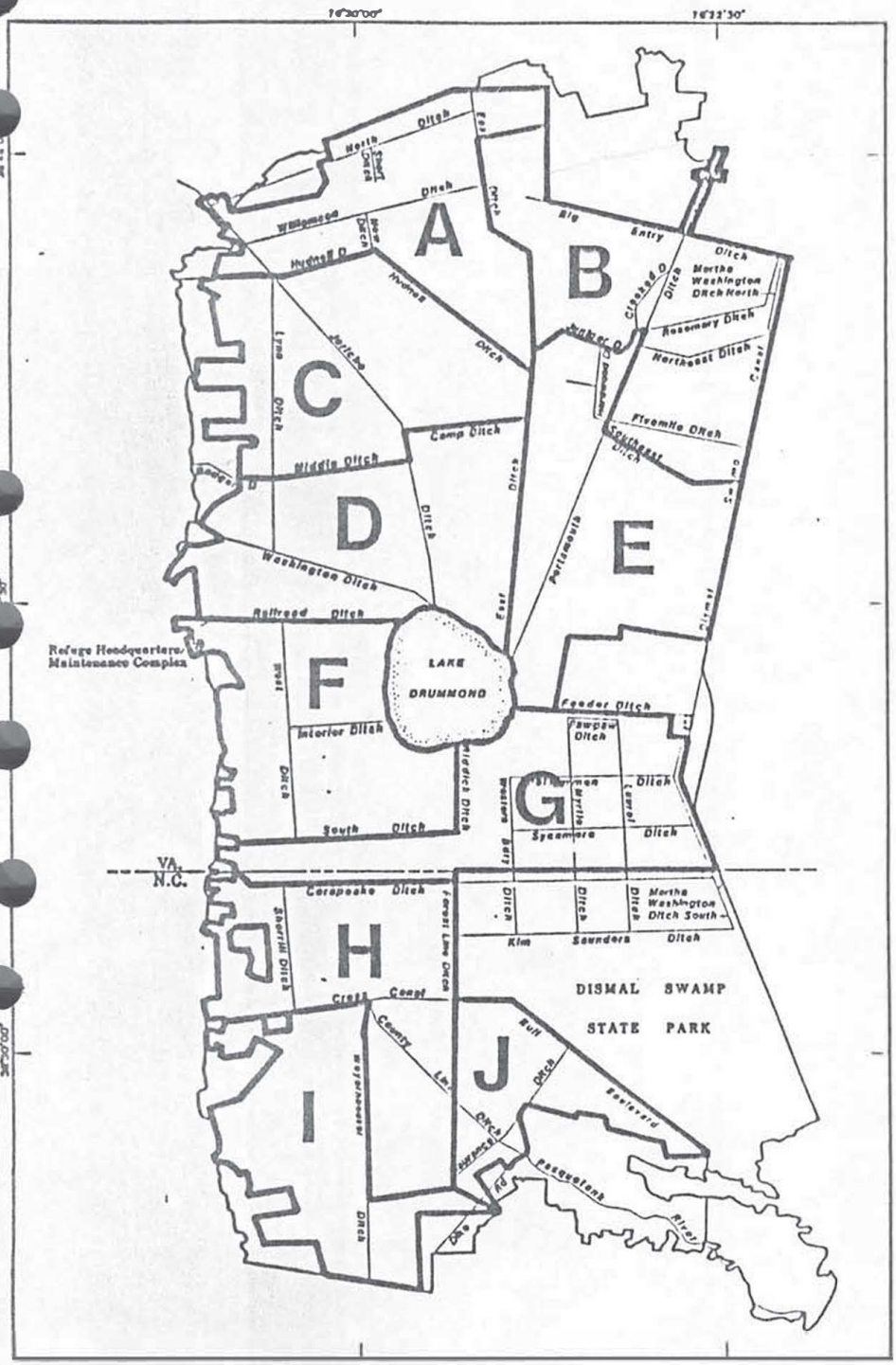


Exhibit 5. Compartment Map



GREAT DISMAL SWAMP
NATIONAL WILDLIFE REFUGE
Virginia and North Carolina

FOREST MANAGEMENT COMPARTMENTS

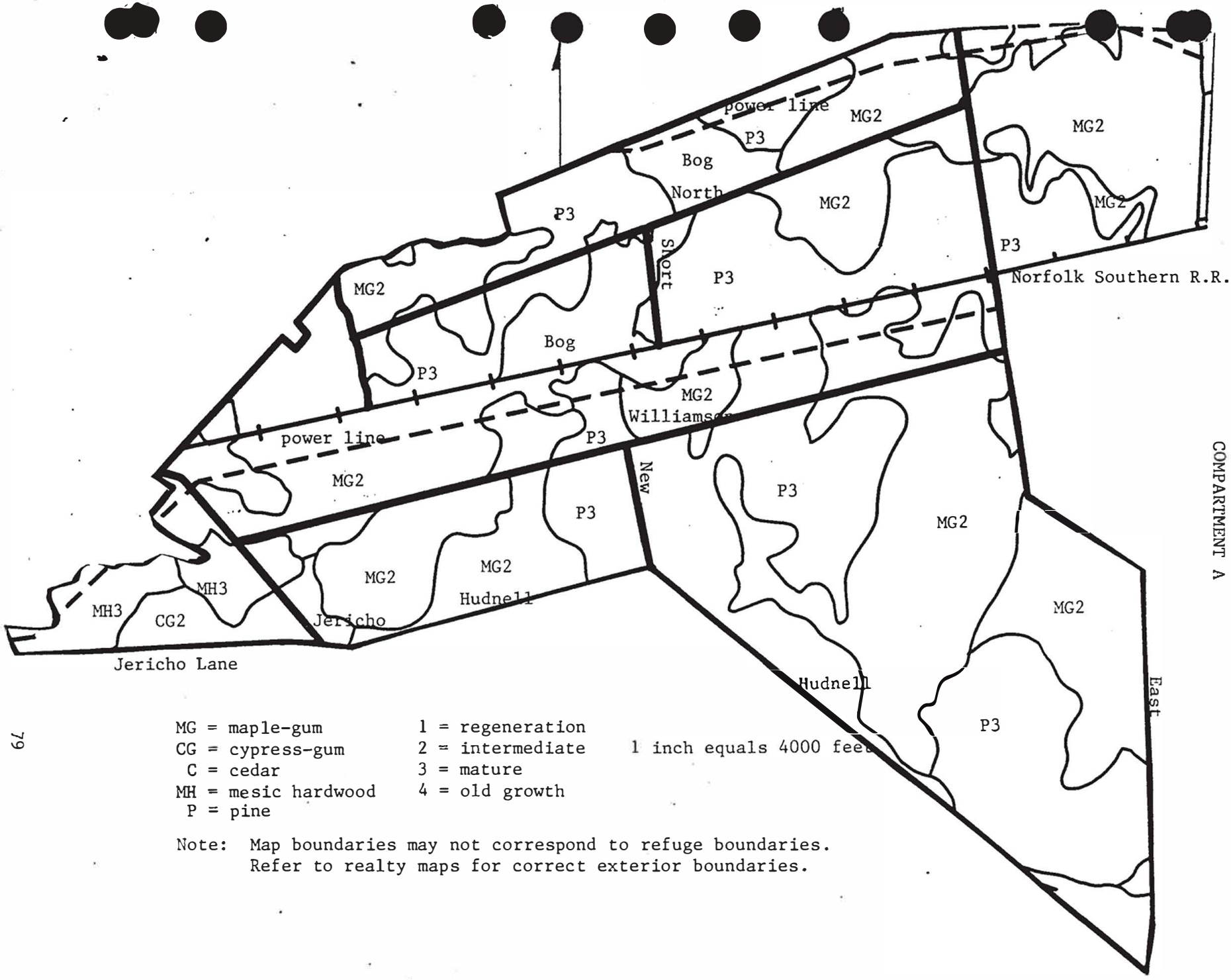
LEGEND

- Refuge Boundary
- Study Area Boundary
- State Boundary
- Refuge Roads and Ditch Corridors
- B — Compartment Label
- Compartment Boundary

2 1 0 2 MILES
2 1 0 2 KILOMETERS

N

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
REGION FIVE
Newton Corner, Massachusetts
February 1986



COMPARTMENT A

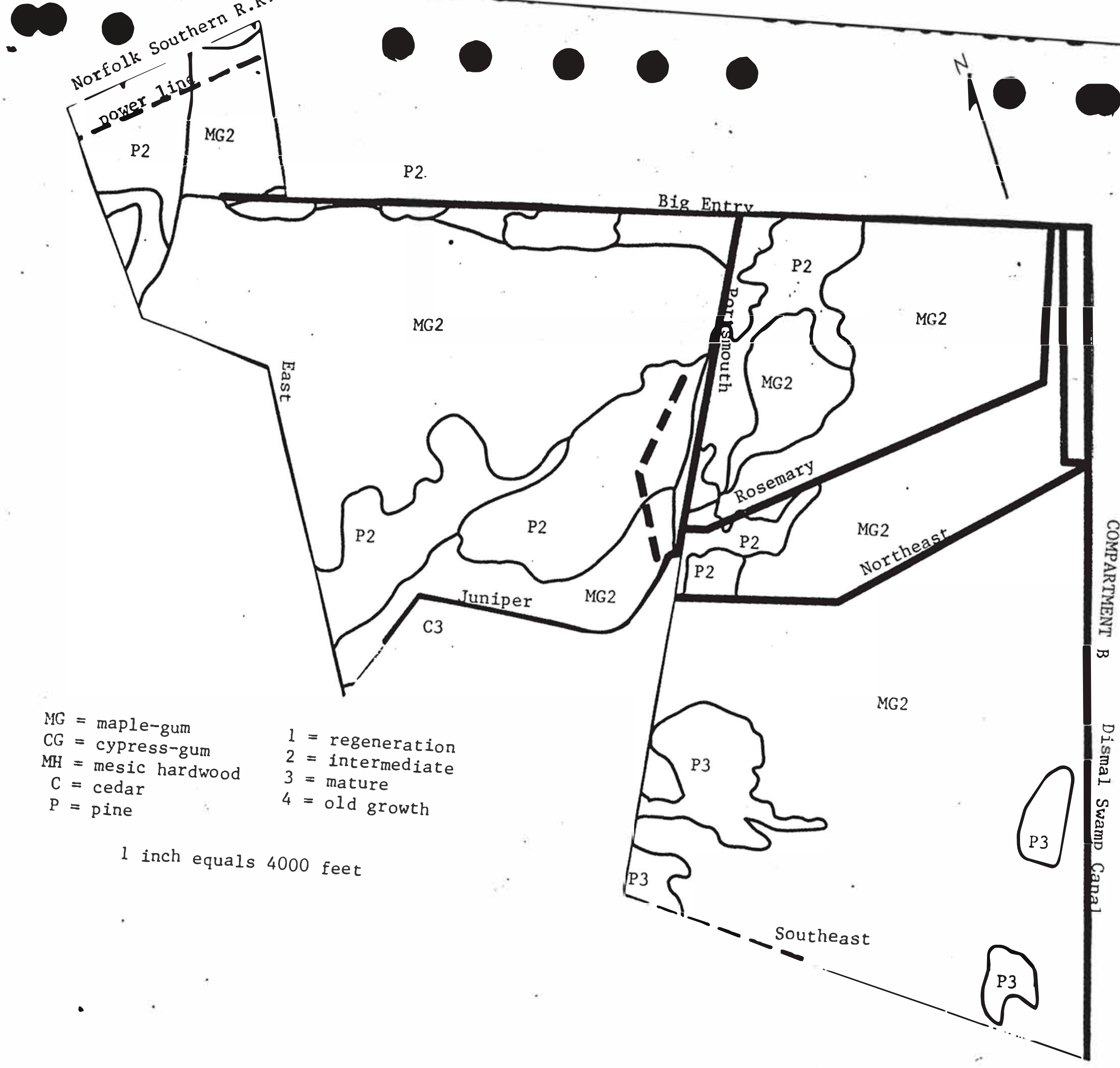
MG = maple-gum
CG = cypress-gum
C = cedar
MH = mesic hardwood
P = pine

1 = regeneration
2 = intermediate
3 = mature
4 = old growth

1 inch equals 4000 feet

Note: Map boundaries may not correspond to refuge boundaries. Refer to realty maps for correct exterior boundaries.

Exhibit 6. Forest Management Compartments



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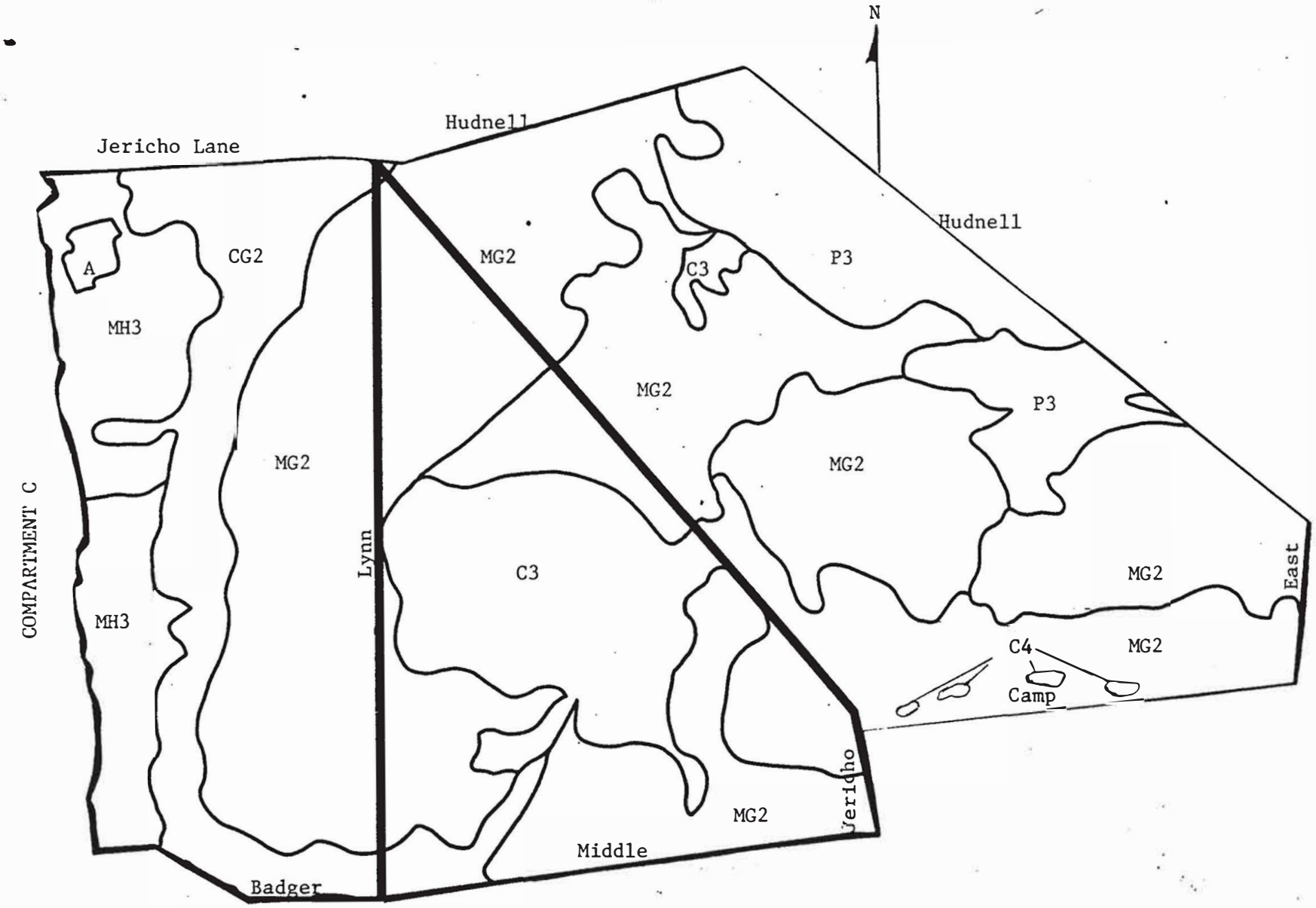


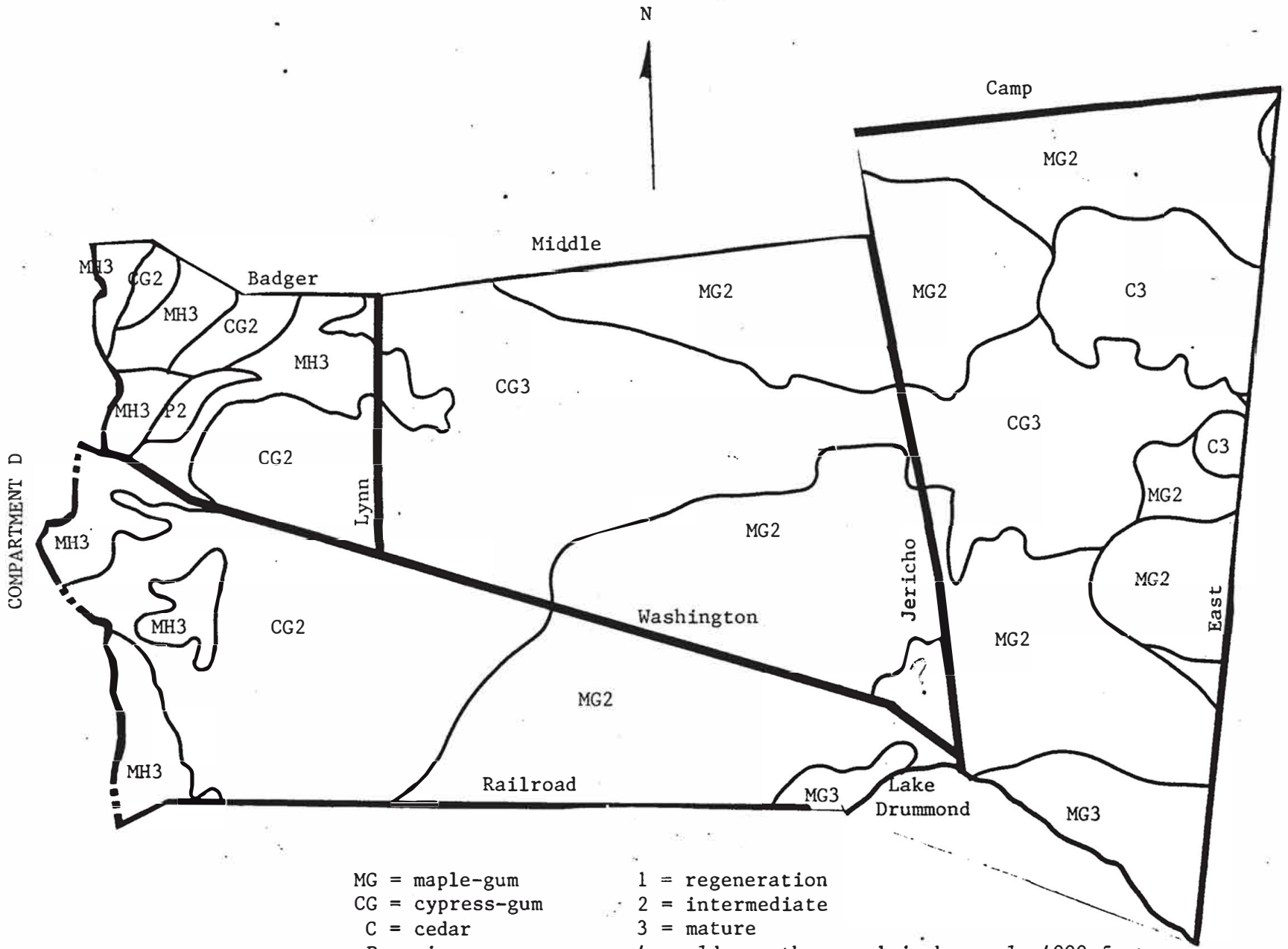
MG = maple-gum
CG = cypress-gum
C = cedar
P = pine
MH = mesic hardwood
A = field

1 = regeneration
2 = intermediate
3 = mature
4 = old growth

1 inch equals 4000 feet

Exhibit 6. (contd.)

Exhibit 6. (contd.)



MG = maple-gum
CG = cypress-gum
C = cedar
P = pine
MH = mesic hardwood

1 = regeneration
2 = intermediate
3 = mature
4 = old growth

1 inch equals 4000 feet

Exhibit 6. (contd.)

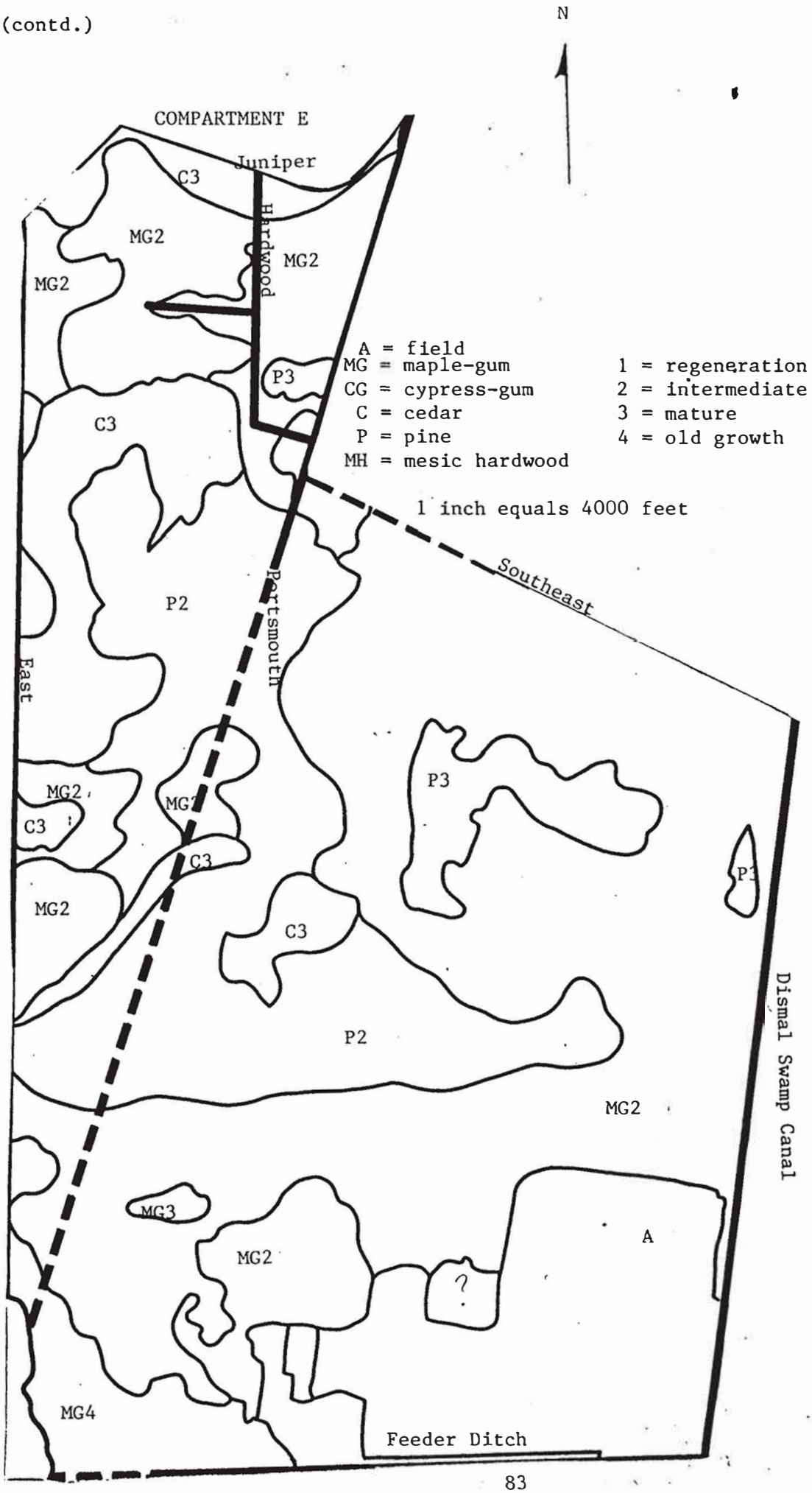
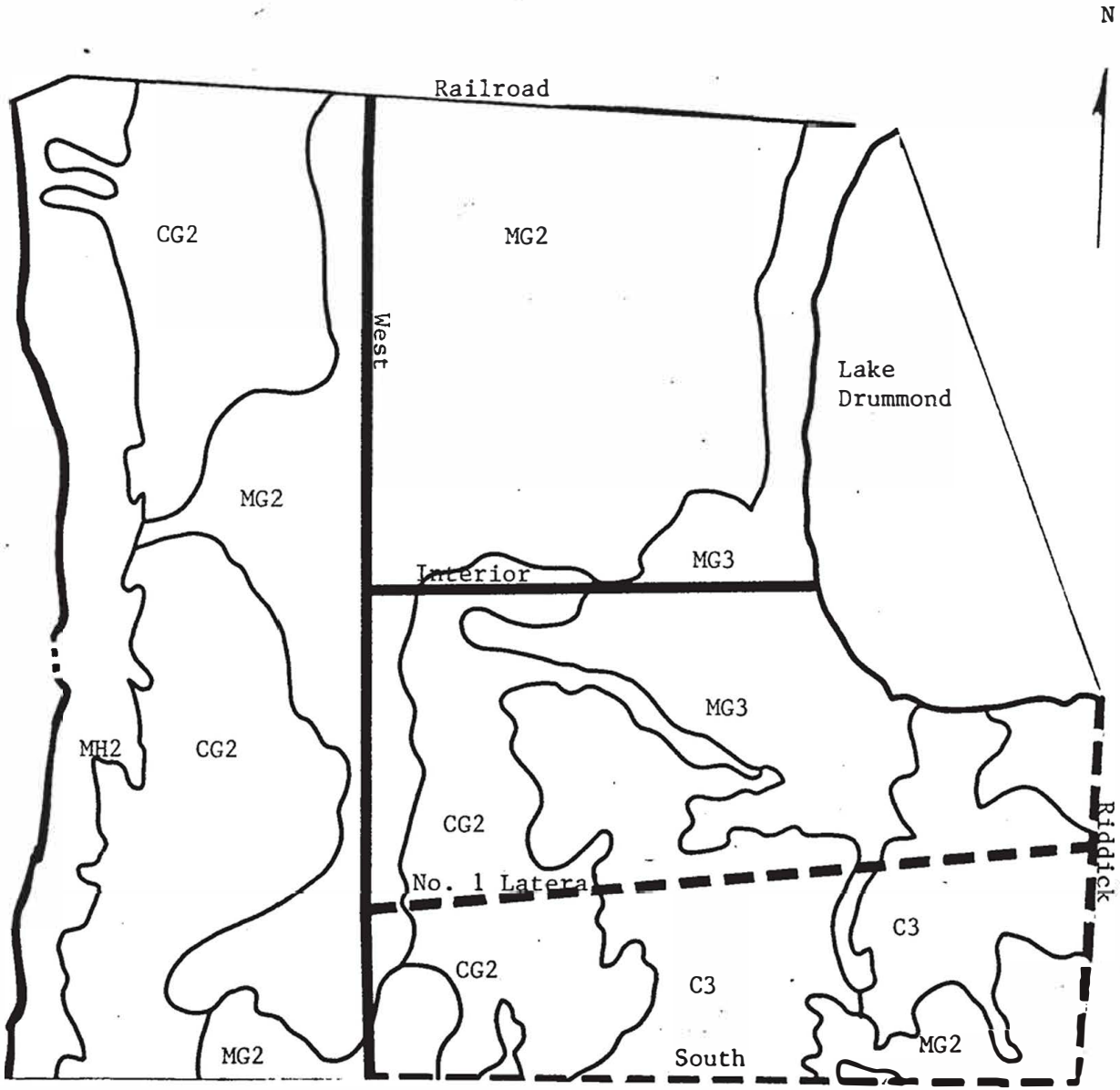


Exhibit 6. (contd.)

COMPARTMENT F



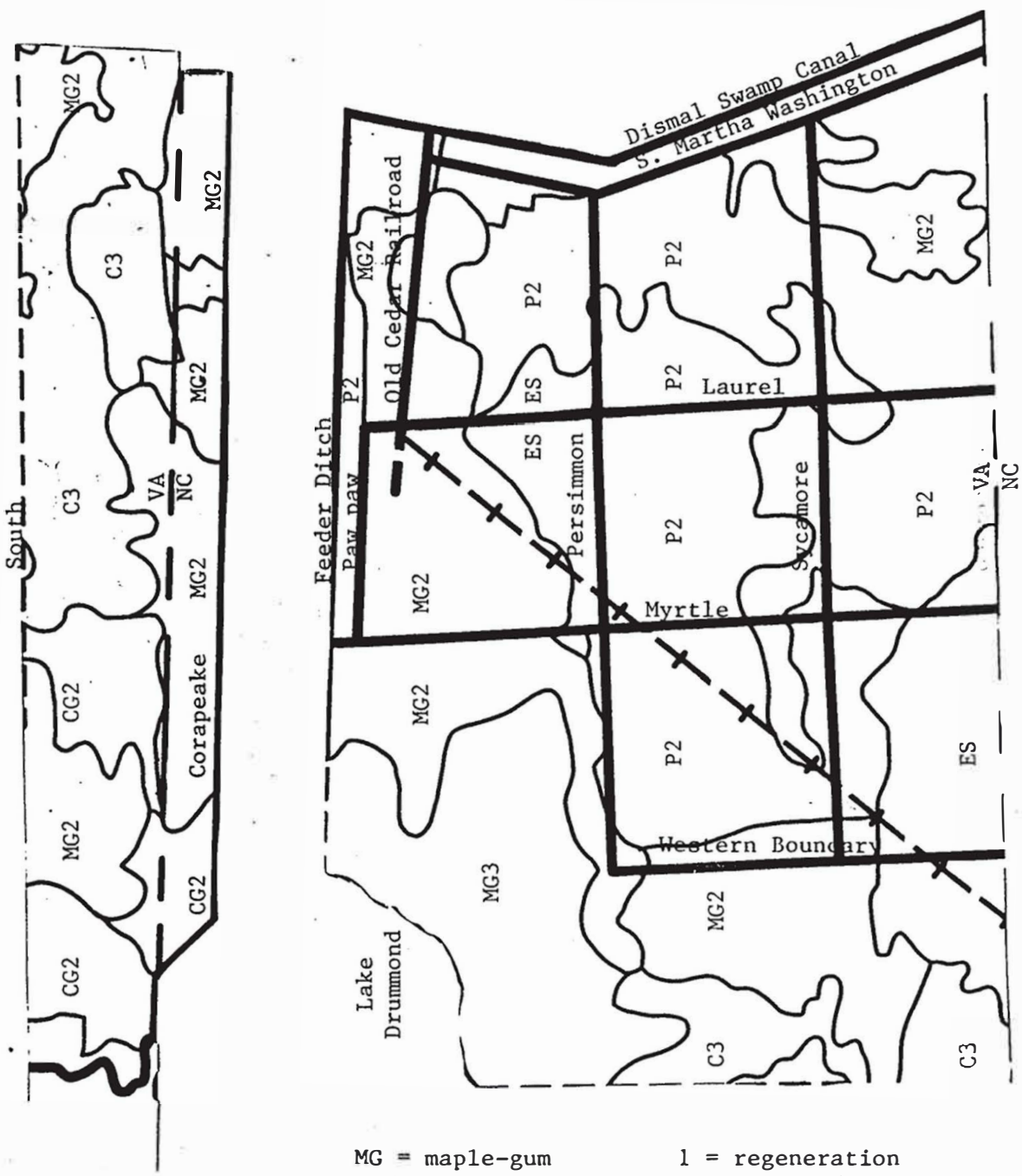
MG = maple-gum
CG = cypress-gum
C = cedar
P = pine
MH = mesic hardwood

1 = regeneration
2 = intermediate
3 = mature
4 = old growth

1 inch equals 4000 feet

Exhibit 6. (contd.)

COMPARTMENT G



MG = maple-gum
CG = cypress-gum
MH = mesic hardwood
C = cedar
P = pine
ES = evergreen shrub

1 = regeneration
2 = intermediate
3 = mature
4 = old growth

1 inch equals 4000 feet

Exhibit 6. (contd.)

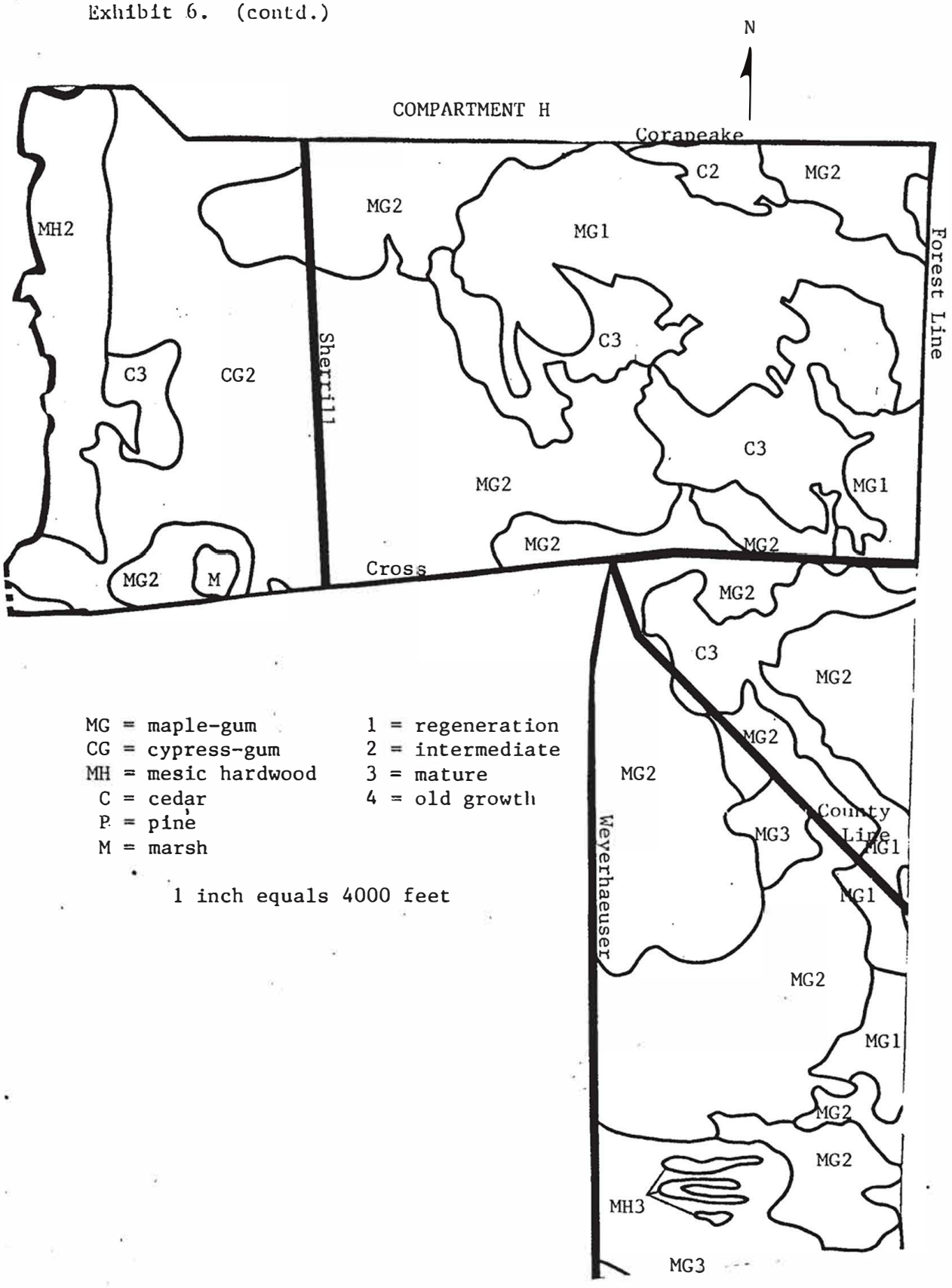


Exhibit 6. (contd.)

COMPARTMENT I

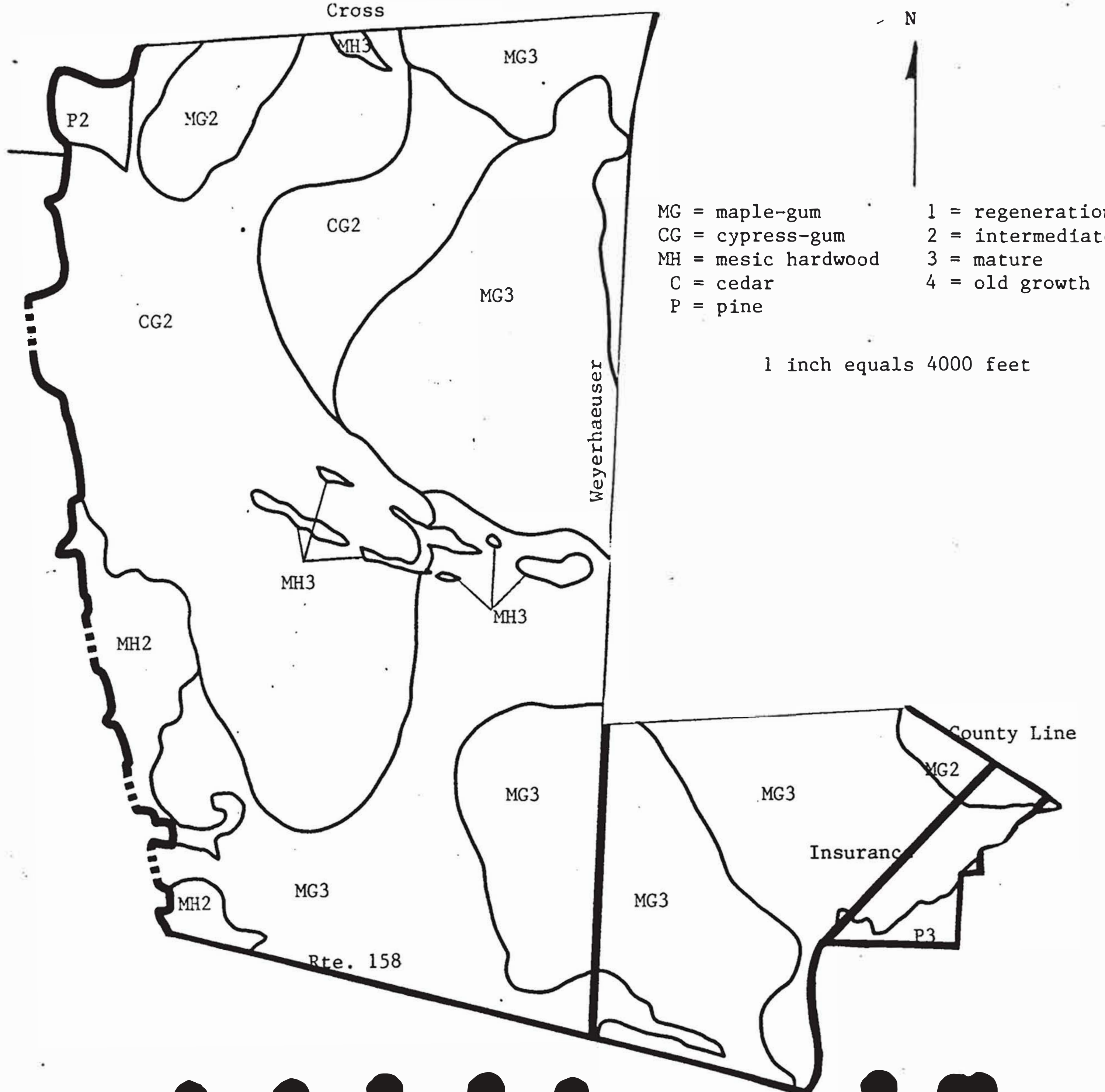
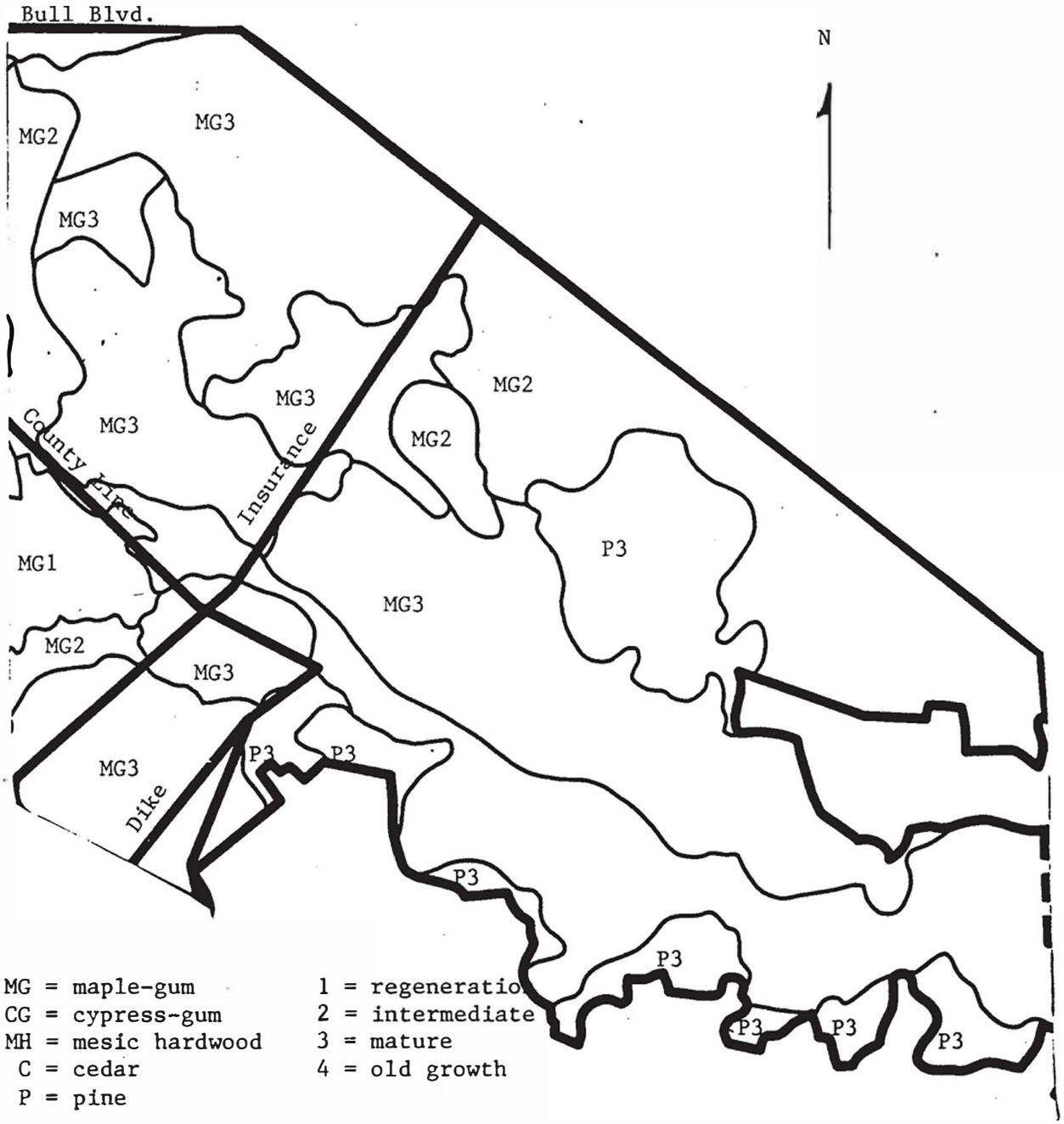


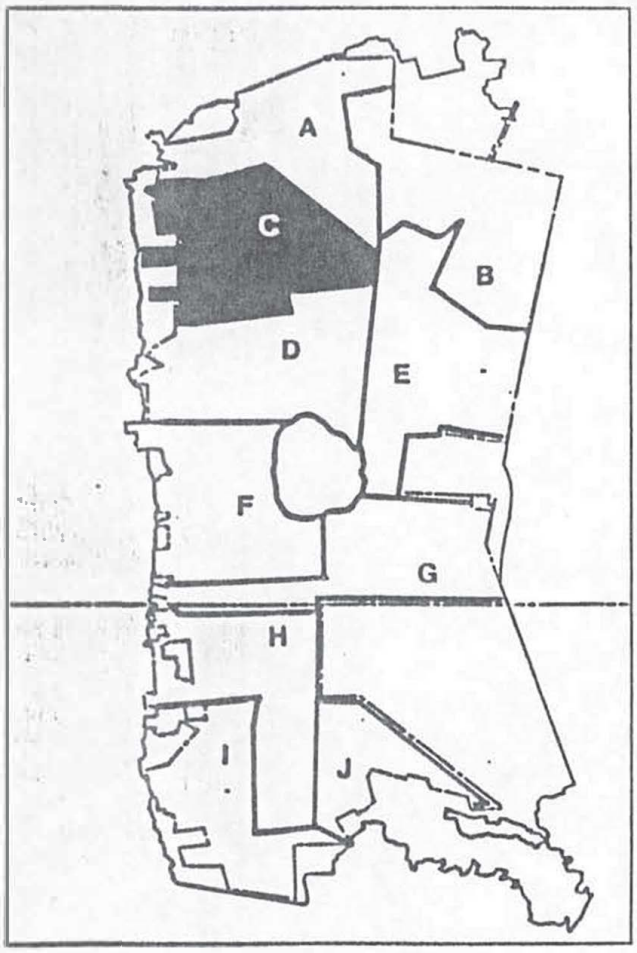
Exhibit 6. (contd.)

COMPARTMENT J



1 inch equals 4000 feet

Exhibit 7. Forest Management Schematic



FOREST MANAGEMENT SCHEMATIC

LEGEND

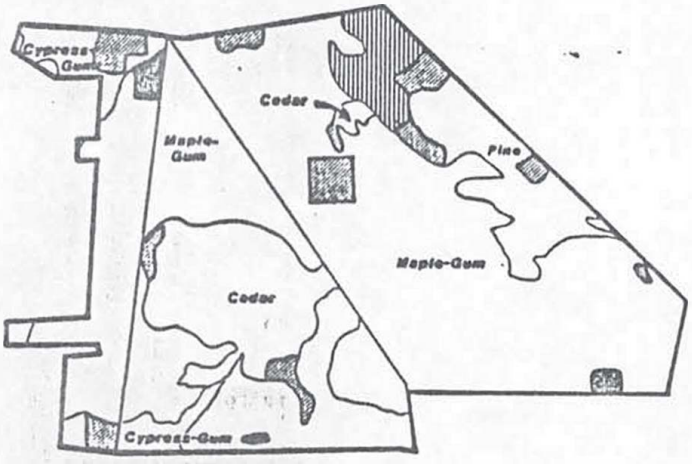
- Forest Compartment Boundary
- Study Area Boundary
- Previous Forest Management Activities

REGENERATION AREAS:

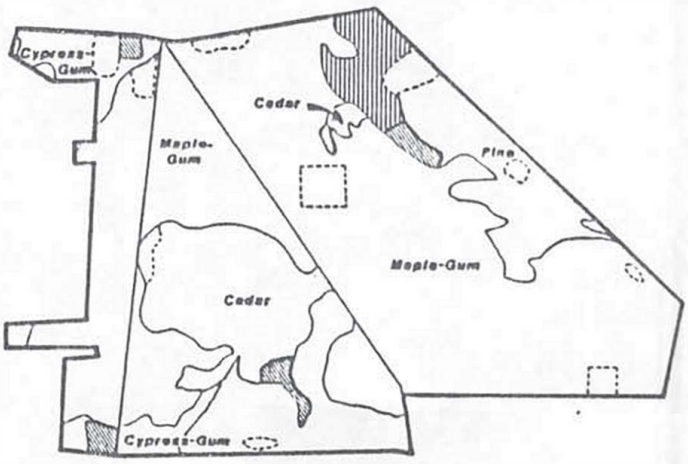
- Interim Management
- Prescribed Burning
- Conversion
- Maintenance

FOREST MANAGEMENT ACTIVITIES

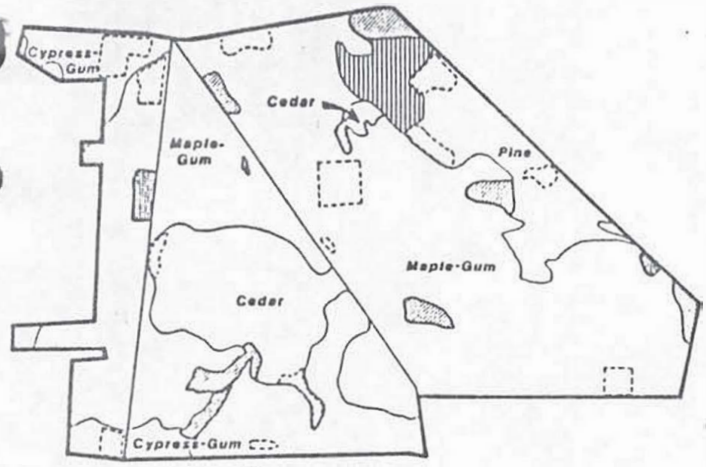
The following sketches depict a possible scheme for forest management in Forest Management Compartment C. Forestry activities over selected target years are shown at a scale of 1"=94,000'.



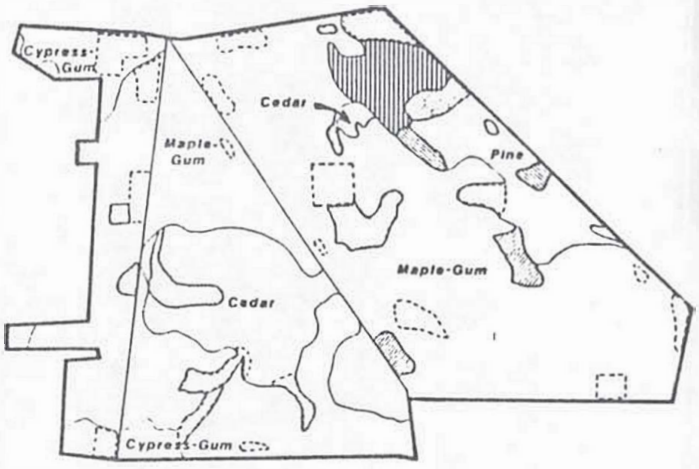
1. Forest regeneration activities in year 1990. Maintenance involves up to 475 acres, conversion involves up to 85 acres, and prescribed burning (limited to pine habitat) involves up to 2,000 acres. Regeneration activities occur at 10-year intervals.



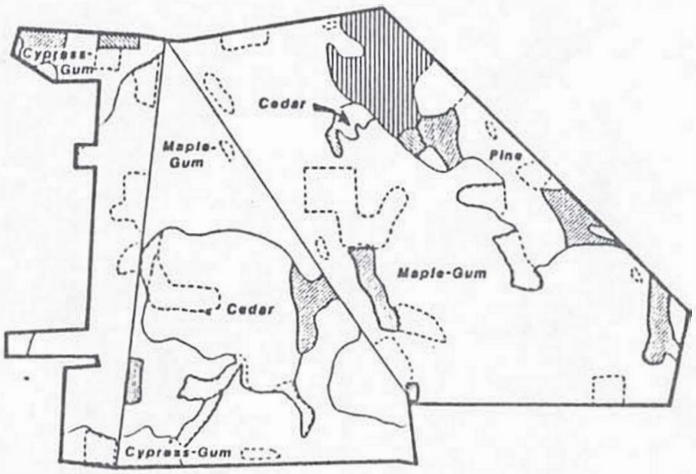
2. Year 1995, illustrating activities which occur at less than 10-year intervals. Pine understory burning recurs every 5 years. Release of seedlings from competition takes place 3 to 5 years following regeneration, if needed.



3. Year 2000. Additional cut and regeneration areas for forest maintenance and conversion are shown encompassing similar acreage as management in 1990.



4. Year 2010, showing additional cut and regeneration areas, with thinning now ocurring in some of the 20-year old pine stands.



5. Year 2020. Timber stand improvement occurs on an interim basis in some of the 30-year old stands.

Forest management activities would continue at 10-year intervals in Compartment C through the rotation cycle for all forest types at similar acreages.

Exhibit 8. Observation and Demonstration Plots

Fiscal Year	Treatment	Location	Size (acres)
1986	cypress underplanting	East	0.5
	wetland conversion	Railroad & West	10.0
	cedar seed tree regen.	Lynn	1.0
	cypress seed tree regen.	East	1.0
	pocosin regeneration	Western Bound.	15.0
	(1)cedar clearcut regen.	Corapeake	3.0
	(2)remnant marsh shearing	Cross	10.0
	maple shear, oak seeding	Lynn	3.0
	cedar underplanting	boardwalk	0.1
1987	cedar clearcut regen.	Camp	5.0
	(3)maple shear and pile	Camp	5.0
	(2)remnant marsh drum chop	Cross	10.0
	remnant marsh shear & pile	Cross	5.0
	(1)cedar shear and pile	Corapeake	3.0
	(4)maple shear and pile	Middle	5.0
	maple shear and pile	Rte. 158	10.0
	oak planting	Headquarters	1.0
	remnant marsh TSI	Cross	4.0
1988	oak planting	Headquarters	3.0
	(3)cedar planting	Camp	5.0
	(4)cypress planting	Middle	5.0
	maple-cedar timber sale	Lynn	15.0
	pine TSI (r.c. woodpecker)	North	10.0
	maple shear and pile	Sycamore	5.0
	(5)maple shear and pile	Rosemary	5.0
	cypress TSI	East	1.0
	(6)oak nat. regen.- precut	Big Ditch	5.0
1989	maple timber sale	West	10.0
	cedar timber sale	Corapeake	20.0
	pine timber sale	Hudnell, North	10.0
	(7)maple shear and pile	East and North	5.0
	oak planting	Headquarters	3.0
	(5)oak planting	Rosemary	5.0

Exhibit 8. (Contd.)

1990	maple timber sale	Weyerhaeuser	10.0
	cedar timber sale	Cross	10.0
	(7)oak planting	East and North	5.0
	(6)oak timber sale	Big Ditch	3.0

( ) Plots preceded by identical numbers represent sequential work on same area, e.g. maple shearing and piling in 1988 is followed by oak planting in 1989.

Exhibit 9. Sample Observation Plot Plan and Evaluation Form

OBSERVATION PLOT

Plan and Elvaluation

I. Plan

1. Compartment C
2. Unit 1
3. Type Description

Overstory	Understory
Red maple 90ft^2/ac BA	Highbush blueberry, Lyonia,
Atlanticwhite cedar 45ft^2/ac BA	Leucothoe, Sweet pepperbush, Redbay
Swamp blackgum 15ft^2/ac BA	

4. Objectives

Attempt to increase the stocking of cedar by natural regeneration using existing trees as seed sources.

5. Plot Location

1.5 miles north of Lynn-Middle intersection. One acre plot on east side of Lynn.

6. Treatment

1986: Shear all hardwood trees and brush with dozer and KG blade. Push trees and brush to plot perimeter, leaving surface soil exposed. Leave a minimum of five cedars as seed trees.

7. Resources Needed

D6 dozer with KG blade, Staff Days: Clearing - 2, Admin. - 1

8. Evaluation Procedures
1987: Cedar seedling count
1988-90: Monitor succession and stand development, deer damage.

II. Posttreatment Evaluation

1. Results

1986: Fifteen cedars in place as seed trees. Area cleared in July.
1987: Seedling count in August indicated approximately 1500 cedar seedlings in place and well distributed throughout plot. Two seed trees blown down by wind. About 600 maple seedlings are also present. Little other vegetation is present at this time.
1988: Approximately 1200 cedar seedlings are still alive and have attained a height of 1.5 feet. Some deer browse damage to

Exhibit 9. (Contd.)

seedlings has occurred around plot perimeter. Maple seedlings are about 0.5 feet tall. Blackberry and greenbrier have begun to appear. Eleven of the original seed trees are still alive and doing well.

1989: 1000 seedlings alive and well. Deer browsing and natural mortality have eliminated about 1/3 of the original regeneration. Cedars are about 2.0 feet in height. Estimated 400 maple seedlings are alive but at 0.6 feet are not threatening cedar reproduction. Blackberry, greenbrier, and grasses are present but not overtopping cedars.

1990: Most of the 100 seedlings are still alive and well, about 3.0 feet tall. Maples still present but declining from cedar competition. No apparent increase in blackberry, greenbrier, or other species. Some blueberry bushes now occur.

2. Cost

1986:	Dozer operation	$200.00
	Administration	$100.00
1987:	Evaluation	$ 50.00
1988:	Evaluation	$ 50.00
1989:	Evaluation	$ 50.00
1990:	Evaluation and Recommendations	$100.00
		$550.00

3. Recommendations

Seed tree regeneration can be applied successfully to stands where some mature cedars are available as seed trees. Mechanical clearing of the site is essential, leaving the ground exposed. Cost per acre is expected to be less on larger areas. Piling debris in scattered round piles, rather than pushing it to the perimeter in windrows, should lower costs considerably and allow better access for mammals. Deer damage is a concern but was not excessive on this plot. The remaining stocking of 1000 trees per acre is quite satisfactory.

An adjacent uncleared control plot contained 60 $ft.^2$/acre BA of mature cedar (18 trees) with no evidence of seedling regeneration.

Most of the seed trees survived and will add an element of diversity to the plot, creating a two-aged stand of mature cedar and dense regeneration.

The edge around the plot perimeter was used by a variety of bird species including prairie, hooded, and yellowthroat warblers; Carolina wrens; Carolina chickadees; and cardinals. Seed trees were used as foraging trees for downy, hairy, and pileated woodpeckers. Indigo buntings and a pair of yellow-breasted chats were observed using the plot interior, possibly for nesting.

Exhibit 9 (Contd.)

4. Ongoing Monitoring

The plot will continue to be monitored to observe stand development. Development of understory species is of particular interest.

Exhibit 10. Sample Prescription

FOREST MANAGEMENT
PRESCRIPTION

FY 1991

COMPARTMENT C

GREAT DISMAL SWAMP NATIONAL WILDLIFE REFUGE
Suffolk, Virginia

Submitted: _____ Date: _____
Refuge Manager

Reviewed: _____ Date: _____
Refuge Supervisor

Approved: _____ Date: _____

COMPARTMENT C

Current Conditions

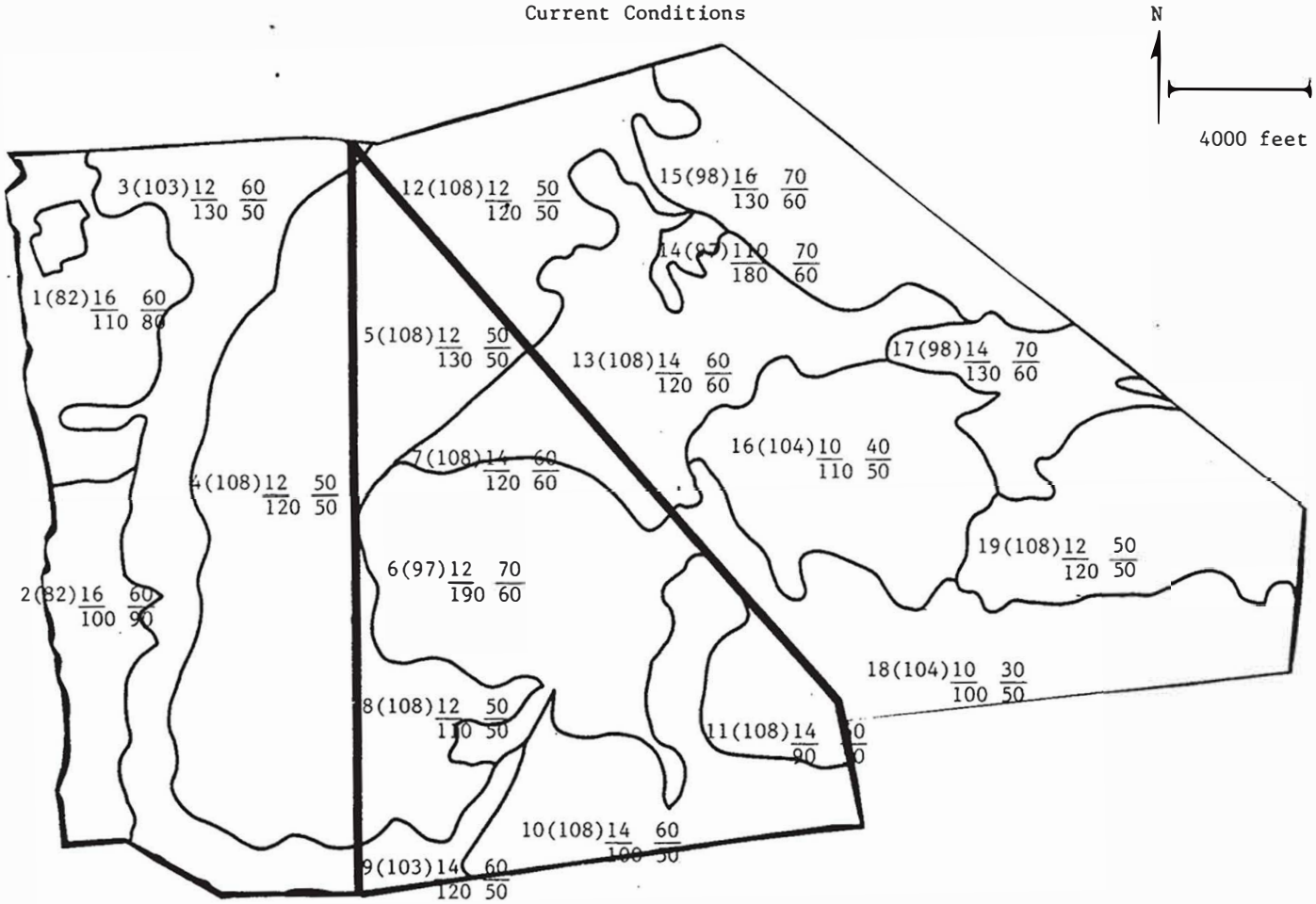


Exhibit 10. (contd.)

Stand Labels

1(2) 3/4 5/6

1 = stand number
2 = SAF cover type
3 = average tree dbh
4 = basal area per acre
5 = average tree height
6 = stand age

SAF Cover Types

82 = Loblolly pine-hardwood
97 = Atlantic white cedar
98 = Pond pine
103 = Water tupelo-swamp tupelo
104 = Sweetbay-swamp tupelo-redbay
108 = Red maple

Exhibit 10. (Contd)

I. Current Conditions

Stand 1 - Loblolly pine comprises 20 percent of the local area with the remainder in a variety of hardwoods including sweetgum, yellow poplar, willow oak, red maple, and American elm. Soils are clay with about four inches of organic litter. Understory species include American holly, greenbrier, sweet pepperbush, and Japanese honeysuckle. The stand shows evidence of heavy deer browsing and some gray squirrel activity. Bird species observed were pileated woodpecker, red-bellied woodpecker, Carolina wren, Carolina chickadee, prothonotary warbler, and red-shouldered hawk. The stand provides excellent wildlife habitat and no management is recommended at this time.

Stand 2 - Very similar to stand 1, but slightly older. Willow and laurel oaks are more prevalent in this stand. Some wild turkey sign was observed. Many cavity trees occur in this stand, with evidence of use by pileated woodpeckers and prothonotary warblers. Recommend selective TSI around smaller oaks to improve mast production.

Stand 3 - Fairly dense stand comprised of about 70 percent swamp tupelo, 20 percent water tupelo, and 10 percent baldcypress. Water from ground discharge is retained on the surface until late spring. Soils are mostly clay. Understory is limited because of inundation but there is some greenbrier, crossvine, sweet pepperbush, and poison ivy. Bear scats indicate that this area is used for fall feeding on swamp typelo fruits. Cypress cavity trees are used by pileated woodpeckers and wood ducks. No management recommended at this time.

Stand 4 - Red maple is the predominant species with about 20 percent swamp typelo. Soils consist of shallow peat deposits. The understory is a fairly dense tangle of greenbriers, sweet pepperbush, American holly, and blueberry. Cavity trees near Lynn Ditch suggest use by wood ducks.

Stand 5 - Similar to 4, but slightly greater basal area in red maple.

Exhibit 10. (Contd.)

Stand 6 - A mixed stand of about 50 percent cedar and the remainder in swamp tupelo and red maple. Understory and midstory species include redbay, American holly, greenbier, blueberry, and leucothoes. Deep organic soils predominate. Stumps indicate that this area was heavily logged for cedar in the early 1900's. Management recommended to increase cedar stocking.

Stand 7 - A red maple stand with few other overstory species. Soils are deep organic. Stumps suggent that cedar occurred here previously. Understory species similar to stand 4. Maples are rather large with many cavity trees present.

Stand 8 - Similar to 4, but less basal area stocking. Very thick greenbrier in understory.

Stand 9 - A continuation of 3, but trees are larger. The stand receives heavy use by bear and wood ducks. No management recommended.

Stand 10- A red maple stand with about 20 percent swamp tupelo. Sweetbay and redbay occur in the midstory, and the understory is a dense thicket of greenbrier, leucothoe, blueberry, and sweet pepperbush.

Stand 11- Similar to 10, but less basal area. Many birds observed in this stand including prothonotary warblers, worm-eating warblers, northern waterthrush, Carolina wren, Acadian flycatcher, ovenbird, and red-bellied woodpecker.

Stand 12- Similar to 5, but less basal area.

Stand 13- Similar to 7. Scattered cedars are present here. Cavity trees are common, particularly along Jericho Ditch.

Stand 14- A dense stand of small diameter Atlantic white cedar. Understory species include leucothoe, fetterbush, blueberry, and sweet pepperbush. No management recommended.

Stand 15- A dense stand of mature pond pine, with about 10 percent swamp typelo and red maple. Redbay and sweetbay are found in the midstory. Understory species include greenbrier, gallberry, and switchcane. Charcoal indicates a fire history in this stand. Bear trails were found in some portions of the area. Deep peat soils predominate.

~~Exhibit~~ 10. (Contd.)

Stand 16- A stand with a history of fire. Sweetbay, swamp tupelo, red maple, and redbay predominate in the overstory and midstory. Understory is a thick tangle of gallberry, leucothoe, lyonia, greenbrier, sweet pepperbush, and muscadine grape.

Stand 17- Similar to 15, but trees slightly smaller.

Stand 18- Similar to 16, but canopy not as high. Scattered cedars and pond pine occur here. Recommend converting a portion of the stand to cedar.

Stand 19- Small red maple, with 20 percent swamp tupelo. Redbay and sweetbay are common in the midstory. Lyonia, leucothoe, sweet pepperbush, and greenbrier are common understory species. Extensive bear sign in this stand. No management recommended.

COMPARTMENT C

Treatments

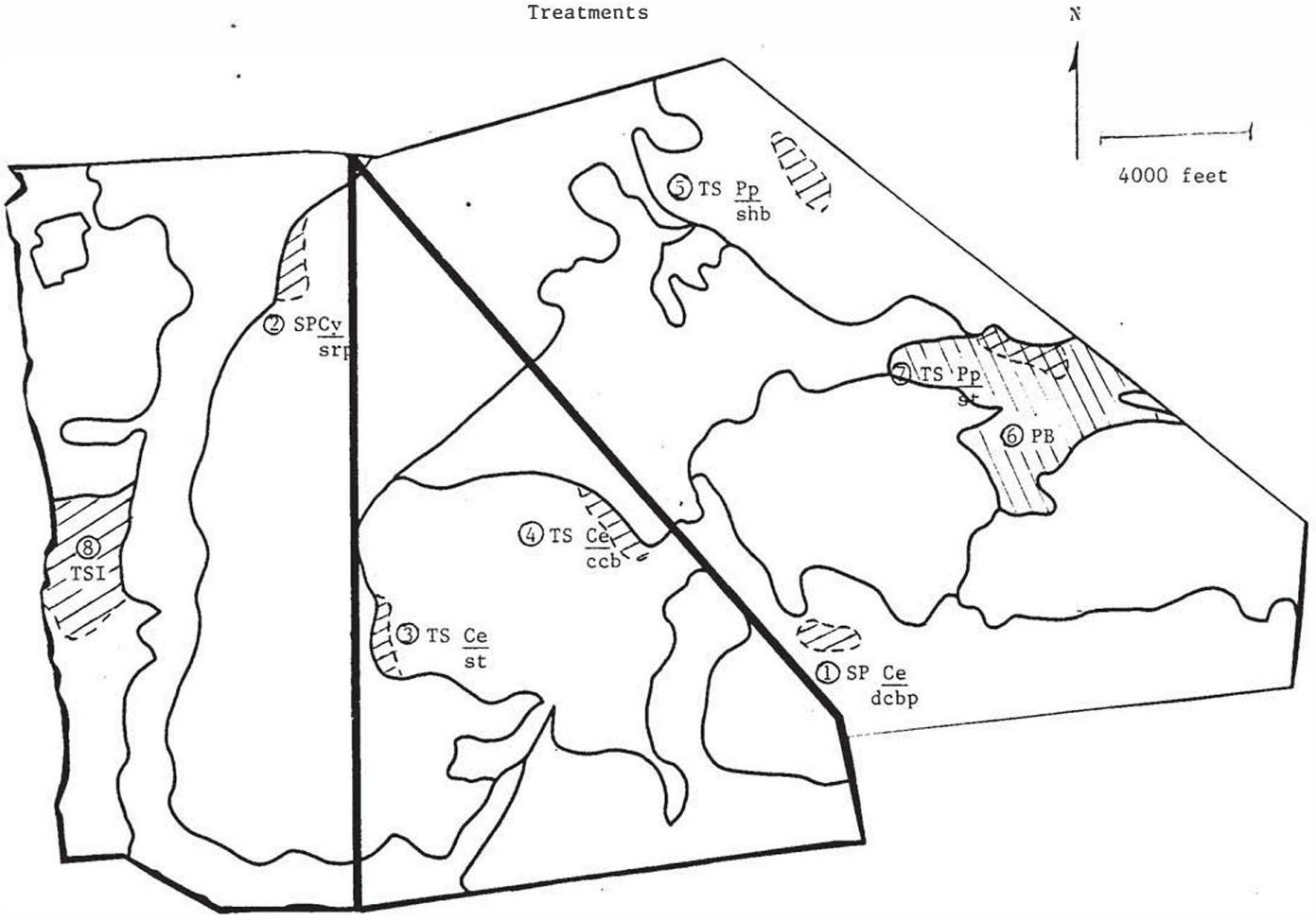


Exhibit 10. (contd.)

Stand Labels	Methods	Species	Techniques
① 2 3/4	TSI = timber stand improvement	Ce = cedar	st = seed tree
1 = treatment priority	TS = timber sale	Cy = cypress	sh = shelterwood
2 = treatment method	SP = site preparation	Pp = pond pine	cc = clearcut
3 = species regenerated	PB = prescribed burning		sr = shear
4 = treatment technique			dc = drum chop
			p = plant
			b = burn

Exhibit 10. (Condt.)

II. Treatments

1 - Clear 29 acres of maple-bay forest by drum chopping in summer of 1991, followed by burning and planting cedar seedlings in winter of 1992. Recommend planting at density of 1000 trees per acre. Treatment will restore Atlantic white cedar to its original site, and provide edge and open habitat. Snags, cavity trees, and at least six ¼ acre islands of reserve trees should be left in place. Access is from Jericho. Site prep will be done in-house at estimated cost of $600. Planting and seedlings will be contracted at cost of $1500 for trees and $4500 for planting.

2 - Clear 32 acres of maple-gum by shearing and piling in summer of 1991, followed by planting cypress seedlings in winter or spring of 1992. Round piles may be burned. Access will be from Lynn Ditch via portable bridge. Recommend planting density of 500 trees per acre. Objectives and snag provisions are similar to 1. Site prep to be done in-house at cost of $600. Seedlings will cost $1000 from the nursery, and planting is estimated at $4000.

3 - Seed tree cut on 23 acres of mixed cedar and red maple, leaving 8 trees per acre for natural cedar regeneration. Timber sale will involve 345 mbf (thousand board feet INT ¼") of cedar and 402 mbf of maple as determined by a 100% tally. Access will be from Lynn Ditch. Clearing and piling slash may be necessary after logging to prepare seedbed. Snag provisions will be followed. Sale will regenerate cedar and increase edge and open habitat. Administration of timber sale is expected to involve 16 staff days (Forester and Forestry Technician) at cost of $2700.

4 - Clearcut on 26 acres of mixed cedar and maple. Sale will involve 327 mbf of cedar and 394 mbf of maple as determined by a 5% cruise. Access is from Jericho Ditch via temporary bridge. Prescribed burning in the winter of 1992 following logging will aid cedar regeneration. Snag and cavity tree provisions will be followed. Sale will regenerate cedar and increase edge and open habitat. Administration of sale is expected to involve 16 staff days at a cost of $2700.

5 - Shelterwood cut on 34 acres of pond pine. Sale will involve 580 mbf of pine as determined by a 100% tally. Thirty trees per acre will be left in place. These trees will be removed

Exhibit 10. (Contd.)

in a later year if necessary to release regeneration. Burning in early winter following logging will aid natural regeneration. Access is from Hudnell. Sale will provide for maintenance of the pine type, and increase edge habitat and age class diversity. Sale administration is expected to involve 16 staff days at a cost of $2700.

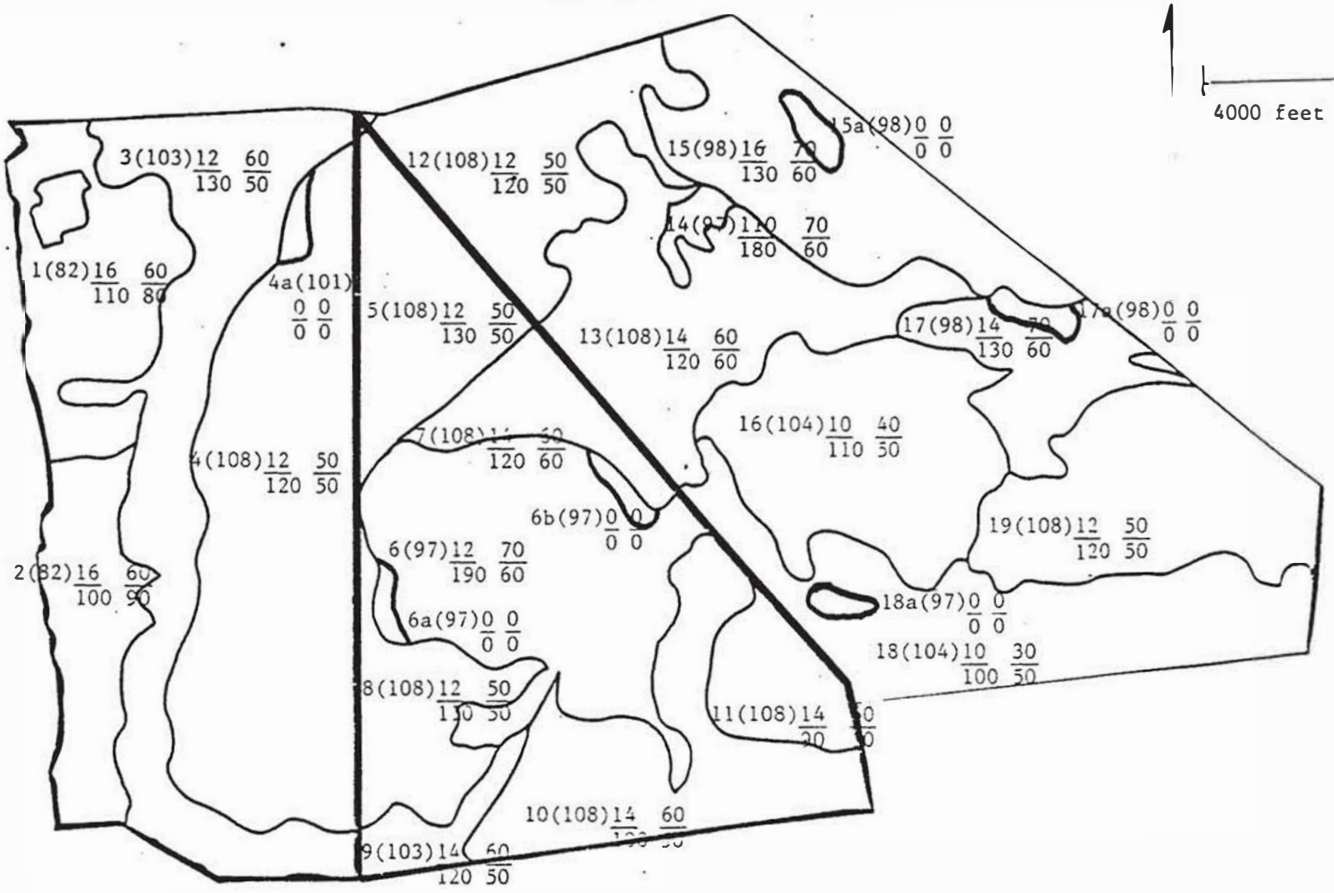
6 - Prescribed burning of 365 acres of pond pine understory by aerial ignition. Objectives are to reduce hazardous fuels, rejuvenate understory plants for wildlife, and prepare seedbed for natural pine regeneration. Burning will be done in winter, with control lines plowed around stand perimeter prior to ignition. Annual prescribed burning plan contains detailed information.

7 - Seed tree cut on 32 acres of pond pine. Sale will involve 618 mbf of pine as determined by a 100% tally. Six trees per acre will be left in place as seed sources, in addition to snags and cavity trees. Burning in late fall or early winter following logging will aid natural regeneration. Access is from Hudnell. Objectives and costs are similar to 5.

8 - Timber stand improvement on 75 acres of mesic hardwoods using tree injection and Garlon 3A herbicide. Objective is to release suppressed crowns of oaks and beeches from competition to increase mast production. Crew will consist of three SCA volunteers, one Forestry Technician, and one Forester. Estimated time is seven days at a cost of $1300.

COMPARTMENT C

Posttreatment



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103 = Water tupelo-swamp tupelo
104 = Sweetbay-swamp tupelo-redbay
108 = Red maple
101 = Baldcypress

Exhibit 10. (contd.)

Exhibit 10. (Contd.)

III. Posttreatment

Stand 2 - Timber stand improvement in the northern portion of this stand will result in deadening of some trees adjacent to oaks and beeches for improved mast production. Only trees whose crowns are suppressed and which have potential for responding to release will be selected for treatment. Trees to be injected will be limited to those directly interfering with crown development of the selected mast trees. Increased production of wildlife food should benefit gray squirrel, deer, black bear, wild turkeys, and possibly wood ducks depending on the proximity of pools or other aquatic areas.

Stand 4a- Clearing of the maple-gum forest and replacement with baldcypress seedlings should advance the objectives of increasing the acreage of the cypress-gum type as well as the regeneration age class. Species requiring edge or open habitat conditions should benefit. As the cypress approach maturity, seed production should benefit wood ducks. Some cypress trees may eventually be used as rookery sites or cavity trees.

Stand 6a- Removal of all forest cover except for cedar seed trees will create edge and open habitat conditions suitable for many wildlife species. Wildlife should continue to use retained snags, cavity trees, and seed trees. Establishment of natural cedar regeneration will advance refuge objectives of increasing cedar acreage and regeneration age classes.

Stand 6b- Benefits will be similar to stand 6a, except that seed trees will not be retained. Natural cedar regeneration should result from germination of seeds already in place following prescribed burning.

Stand 15a- Shelterwood cut of pond pine should create edge and semi-open conditions advantageous to a variety of wildlife species. Habitat diversity within stand 15 should be improved. Wildlife should continue to use retained shelterwood trees and snags. Prescribed burning following logging should promote growth of herbaceous plants in addition to natural pine regeneration. Shelterwood regeneration should further refuge objectives of maintaining acres in the pine type and increasing acres in the regeneration age class.

~~Exhibit~~ 10. (Contd.)

Stand 17 - Prescribed burning of the pine understory should reduce hazardous fuel accumulations, encourage herbaceous understory plants, and prepare the ground surface for natural pine regeneration. The expected nonuniform nature of the burn, and occasional torching of individual trees, should increase the diversity of habitat conditions within the stand.

Stand 17a - Similar benefits as stand 15a, except that fewer pine trees will be retained since this is a seed tree cut.

Stand 18a - Clearing of the maple-bay forest and replacement with cedar seedlings should advance the objectives of increasing acreage of the cedar type and the regeneration age class. Species requiring edge or open habitat conditions should benefit. Wildlife should continue to use retained snags and cavity trees. Habitat diversity within stand 18 should be improved.

Exhibit 11. Sample Timber Bid Invitation

GREAT DISMAL SWAMP NATIONAL WILDLIFE REFUGE
P.O. BOX 349
SUFFOLK, VIRGINIA 23434
May 18, 1991

TIMBER BID INVITATION

Formal (sealed) bids will be received in the office of Refuge Manager of the Great Dismal Swamp National Wildlife Refuge, P.O. Box 349, Suffolk, Virginia 23434, until 1:00 p.m., June 16, 1991, for the sale of Atlantic white cedar and red maple sawtimber, located in stand 6a, Compartment C of the refuge. All bids must be securely sealed in a suitable envelope and plainly marked "TIMBER BID- C6a" in the lower left corner of the envelope.

Formal bids are requested on the assumption that there are approximately 755,000 boardfeet (INT ¼") of sawtimber on the 23 acre sale area. The breakdown of the total volume by species and diameter class is attached to this invitation. Volumes are not guaranteed and interested parties are urged to inspect the sale area prior to bidding.

The timber will be shown on June 1, 1991. All interested parties should meet at the refuge office at 3216 Desert Road, Suffolk, Virginia at 10:00 a.m.

After the bid opening a permit-agreement will be prepared and submitted to the successful bidder for his acceptance and signature.

The permittee (successful bidder) will submit (1) payment in full or the first payment (50% of total bid) for timber to be removed from the sale area, and (2) a performance guarantee deposit of $1,000 within ten days after receipt of the Special Use Permit. If the two payment option is exercised, the second payment (50% of total bid) will be due 60 days after receipt of permit. The payment(s) must be made in the form of bank draft(s) or certified check(s) made payable to the U. S. Fish and Wildlife Service. The performance deposit will be retained by the Government as a guarantee deposit to cover any damages or claims the Government may have against the permittee as a result of his operations under the terms and conditions of the permit agreement. The balance, if any, will be returned to the permittee upon satisfactory completion of the operation.

Bids and timber harvest operations will be in accordance with the Special Conditions attached.

Exhibit 11. (Contd.)

Operations must be completed on or before August 31, 1992.

The right to reject any and all bids is reserved by the government.

If judged the successful bidder, the undersigned agrees to accept the permit agreement and make the required payments as stated above after receipt of the permit.

Before commencing operations the permittee will meet with the refuge Forester for a pre-entry conference to ensure that all involved are aware of permittee and refuge responsibilities.

STAND 6a COMPARTMENT C 23.0 ACRES

DOYLE BOARD FOOT VOLUME BY SPECIES AND DIAMETER CLASS

1 of 2

SPECIES LISTING	NO. TREES	TWO INCH DIAMETER CLASSES 10	12	14	16	18	20	22	Total Volume
Atlantic white cedar	3213	26565	50064	62412	15972	6080	2088	344	163525
Maple	5496	31010	47430	51948	47478	18526	7040	627	204059
Blackgum	63	0	0	1944	139	3544	640	627	4959
Totals	8772	57575	97494	116304	64844	24960	9768	1598	372543
Number trees by DBH Class		3480	2579	1741	717	192	56	7	

2 of 2

INTERNATIONAL ¼" BOARD FOOT VOLUME BY SPECIES AND DIAMETER CLASS

SPECIES LISTING	NO. TREES	TWO INCH DIAMETER CLASSES 10	12	14	16	18	20	22	Total Volume
Atlantic white cedar	3213	83472	110581	113629	25362	8730	2855	371	345000
Maple	5496	95243	102479	92348	75224	26480	9486	740	402000
Blackgum	63	0	0	3472	2213	513	862	922	8000
Totals	8772	178715	213060	209449	102799	35741	13203	2033	755000
Number trees by DBH Class		3480	2579	1741	717	192	56	7	

Exhibit 11. (contd.)

Timber Sale Location

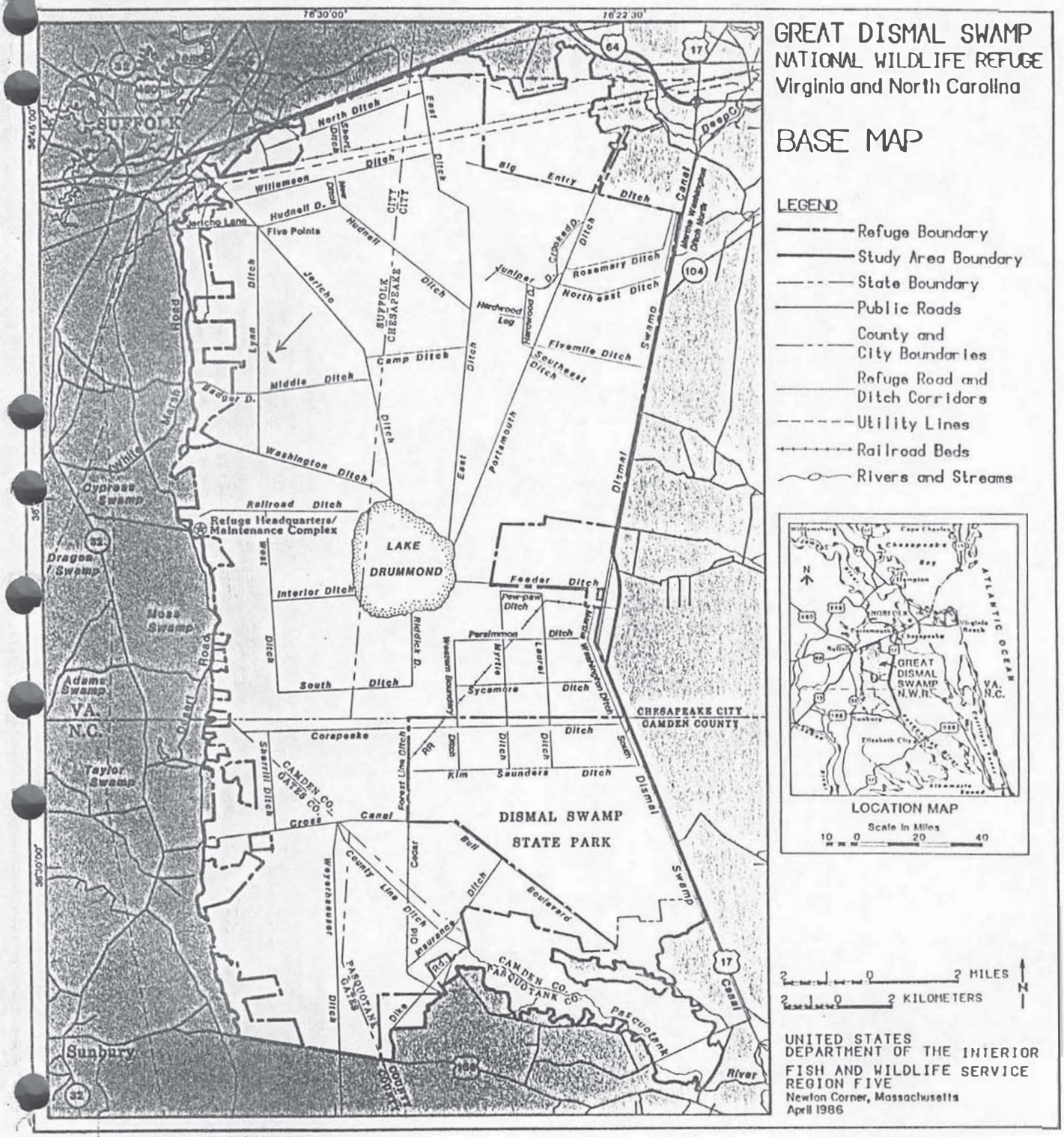

Exhibit 11. (contd.)

Sale Location

Stand C6a

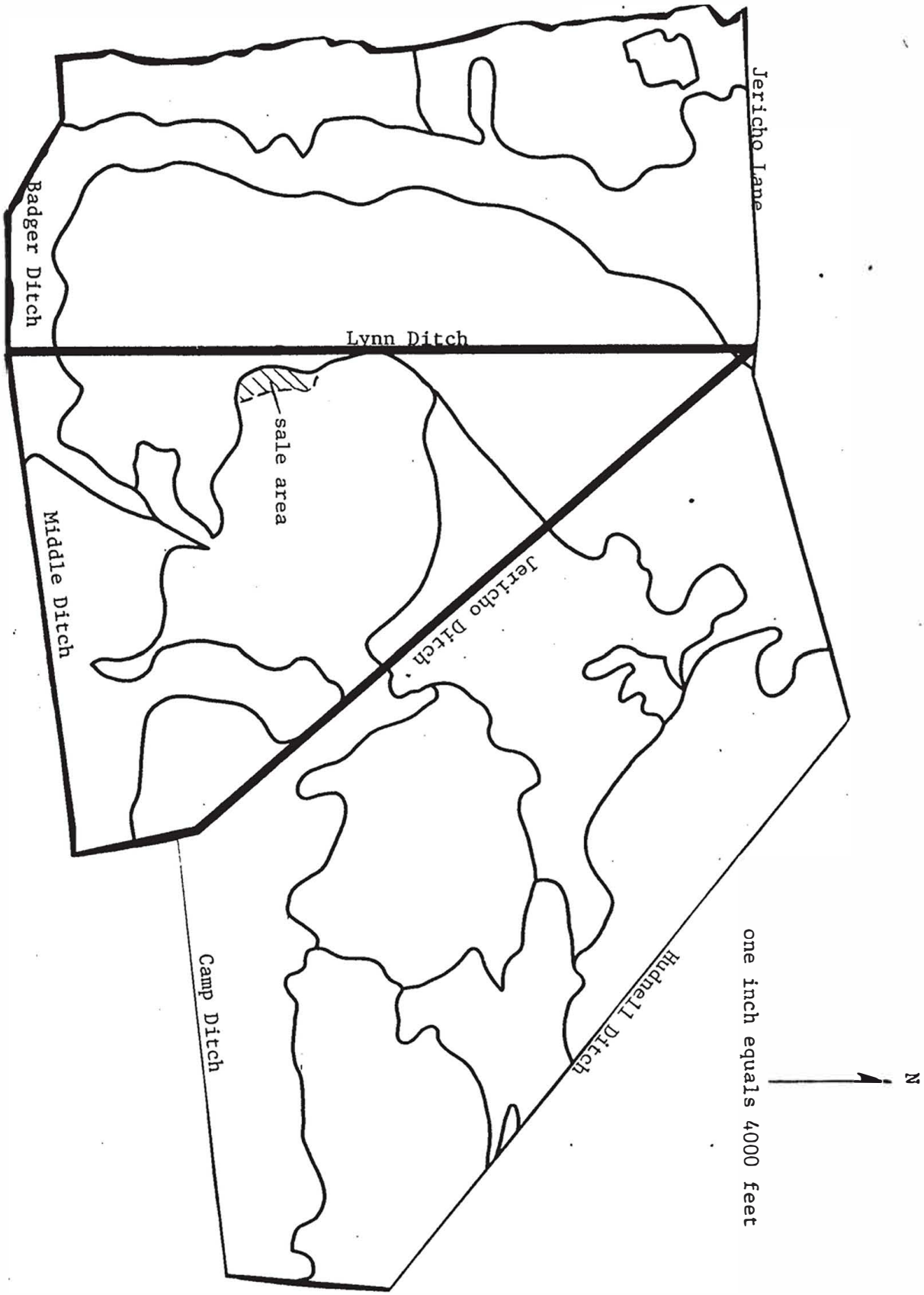

Exhibit 11. (Contd.)

SPECIAL CONDITIONS

1. All trees in the sale are marked with blue paint at 4.5 feet and on the butt and must be cut. A penalty of double the stumpage rate will be charged for cutting unmarked trees.

2. Unmerchantable cull trees marked with a blue "X" are not part of the sale but must be cut. A penalty of $1.00 will be charged for each marked cull tree not cut.

3. Approximately eight cedars per acre will be left as seed trees. These trees are clearly marked with a yellow "S" and fluorescent flagging. The penalty for cutting seed trees will be triple the stumpage rate.

4. The successful bidder will submit a current statement demonstrating his financial ability and the ownership or control of necessary equipment to carry out the operation on the basis herein specified.

5. Trees shall be cut leaving a stump not more than six inches high.

6. Roads and ditches will be kept clear of tops and logging debris.

7. Litter will not be left on the refuge by the permittee or his employees.

8. Location of logging decks and logging trails will be mutually agreed to by refuge officials and the permittee. Decks must be removed after logging.

9. The permittee will be responsible for maintaining refuge roads impacted by logging operations.

10. Seed trees and unmarked trees must not be damaged by logging operations.

11. Permittee may be required to pay for damages and suppression costs resulting from wildfires caused by logging operations.

12. The Refuge Manager reserves the right to temporarily shut down logging operations to avoid conflicts with the annual deer hunt, during periods of extreme fire danger, or during wet weather to prevent road damage. The permittee should expect to cease operations during the wet winter and early spring seasons. If in the opinion of both parties inclement weather prevents completion of the operation in the allotted time, additional time will be granted to the permittee to complete operations; however, in no case will the time be extended beyond August 31, 1993.

Exhibit 11. (Contd.)

FORMAL SAWTIMBER BID
(Stand 6a Compartment C)

Great Dismal Swamp National Wildlife Refuge
P.O. Box 349
Suffolk, VA 23434

Species	Estimated Value (INT ¼")	Price Bid per MBF	Total Amount per bid
Cedar	345,000	$_____	$_____
Maple-gum	450,000	$_____	$_____

Date:_____

Firm:_____

Address:_____

_____

Telephone ( )_____

Signature:_____

Title:_____

United States Department of the Interior

FISH AND WILDLIFE SERVICE

CERTIFICATE OF INDEPENDENT PRICE DETERMINATION
(101-45.4926 Fed. Prop. Mgt. Reg.)

(a) By submission of this bid or proposal, each bidder or offeror certifies, and in the case of a joint bid or proposal each party thereto certifies as to its own organization, that in connection with this sale:

(1) The prices in this bid or proposal have been arrived at independently, without consultation, communication, or agreement, for the purpose of restricting competition, as to any matter relating to such prices, with any other bidder or offeror or with any competitor;

(2) Unless otherwise required by law, the prices which have been quoted in this bid or proposal have not been knowingly disclosed by the bidder or offeror and will not knowingly be disclosed by the bidder or offeror prior to opening, in the case of a bid, or prior to award, in the case of a proposal, directly or indirectly to any other bidder or offeror or to any competitor; and

(3) No attempt has been made or will be made by the bidder or offeror to induce any other person or firm to submit or not submit a bid or proposal for the purpose of restricting competition.

(b) Each person signing this bid or proposal certifies that:

(1) He is the person in the bidder's or offeror's organization responsible within that organization for the decision as to the prices being bid or offered herein and that he has not participated, and will not participate, in any action contrary to (a) (1) through (a) (3), above; or

(2) (i) He is not the person in the bidder's or offeror's organization responsible within that organization for the decision as to the prices being bid or offered herein but that he has been authorized in writing to act as agent for the persons responsible for such decision in certifying that such persons have not participated, and will not participate, in any action contrary to (a) (1) through (a) (3), above, and as their agent does hereby so certify; and

(ii) He has not participated, and will not participate, in any action contrary to (a) (1) through (a) (3), above.

(c) This certification is not applicable to a foreign bidder or offeror submitting a bid or proposal for a contract which requires performance or delivery outside the United States, its possessions, and Puerto Rico.

(d) A bid or proposal will not be considered for award where (a) (1), (a) (3), or (b), above, has been deleted or modified. Where (a) (2), above, has been deleted or modified, the bid or proposal will not be considered for award unless the bidder or offeror furnishes with the bid or proposal a signed statement which sets forth in detail the circumstances of the disclosure and the head of the agency, or his designee, determines that such disclosure was not made for the purpose of restricting competition.

Exhibit 11. (contd.)

U.S. DEPARTMENT OF THE INTERIOR
Fish and Wildlife Service
Bureau of Sport Fisheries and Wildlife

EQUAL EMPLOYMENT OPPORTUNITY CLAUSE

(Executive Order No. 11246, as amended October 13, 1967)

Equal Employment Opportunity. During the performance of this contract, the contractor agrees as follows:

1. The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex or national origin. The contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the contracting officer setting forth the provisions of this Equal Employment Opportunity Clause.

2. The contractor will, in all solicitations or advertisements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex or national origin.

3. The contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the agency contracting officer, advising the labor union or workers' representative of the contractor's commitments under Section 202, of Executive Order No. 11246, as amended, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

4. The contractor will comply with all provisions of Executive Order No. 11246, as amended, and the rules, regulations, and relevant orders of the Secretary of Labor.

5. The contractor will furnish all information and reports required by Executive Order No. 11246, as amended, and by the rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the contracting agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

6. In the event of the contractor's noncompliance with the Equal Employment Opportunity Clause of this contract or with any of the said rules, regulations, or orders, this contract may be cancelled, terminated, or suspended in whole or in part and the contractor may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order No. 11246, as amended, and such other sanctions may be imposed and remedies invoked as provided in the said Executive Order or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

7. The contractor will include the provisions of paragraphs (1) through (7) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order No. 11246, as amended, so that such provisions will be binding upon each subcontractor or vendor. The contractor will take such action with respect to any subcontract or purchase order as the contracting agency may direct as a means of enforcing such provisions, including the sanctions for noncompliance; Provided, however, that in the event the contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the contracting agency, the contractor may request the United States to enter into such litigation to protect the interests of the United States.

Form 3-170
(Revised April 1969)

Exhibit 12. Glossary

Age Class--one of the intervals, commonly 5 or 10 years, into which the age range of forests is divided for classification purposes.

Basal Area (BA)--the area of the cross-section of a tree stem at breast height and inclusive of bark.

Canopy--the cover of branches and folige formed collectively by the crowns of adjacent trees and other woody growth.

Cavity Tree--any tree, living or dead, containing a hole with current or potential use for wildlife nesting or denning.

Clearcut--the removal in a single cut of all trees in a stand, except for designated snag or cavity trees.

Climax--the culminating stage in plant succession for a given environment, the vegetation being conceived as having reached a highly stable and self-perpetuating condition.

Community--any assembly of organisms inhabiting a common environment and interacting with one another.

Compartment--a geographical portion of a forest with clearly defined boundaries within which annual prescriptions and management activities are conducted.

Control--that part of an experimental series providing a standard of comparison for determining the effects of the treatment.

Conversion--the replacement of an existing forest type with a different type to meet resource objectives.

DBH (diameter breast height)--diameter of a tree approximately 4.5 feet above the ground.

Direct Seeding--a technique of artificial regeneration in which desired tree species are established by planting seeds.

Diversity--the distribution and abundance of different plant and animal communities and species within a given area.

Drum Chopping--a site preparation techniques in which a heavy rolling cylinder with blades is pulled by bulldozer over standing or down vegetation to pulverize it and hasten the curing process.

Exhibit 12. (Contd.)

Edge--the more or less well-defined boundary between two or more vegetative elements.

Even-aged--a forest or stand composed of trees having no, or relatively small, differences in age.

Habitat--the abode, natural or otherwise, of a plant or animal, considered particularly in relation to all the environmental influences affecting it.

Intermediate--a generalized age class category in which trees have progressed beyond the seedling stage but have not yet reach full maturity.

KG Blade--a site preparation tool consisting of a sharpened blade attached to the front of a bulldozer used to cut tree stems.

Maintenance--the perpetuation of an existing forest type at its current location, either by leaving it undisturbed or managing it to provide for regeneration.

Mast--fruits, berries, and nuts produced by vegetation and consumed by wildlife for food.

Mature--a generalized age class category at which trees have attained full development, particularly height, and are in full seed production.

Midstory--a component of the vertical structure of a forest stand consisting of trees taller than the prevailing ground vegetation but beneath the dominant canopy trees.

Mosaic--an arrangement of plant communities or community conditions in a "patchwork" pattern, in contrast to zonation.

Old Growth--a generalized age class category at which trees are biologically mature and natural decay and mortality take an increasing toll.

Overstory--a component of the vertical structure of a forest stand consisting of trees in the dominant canopy position.

Pocosin--an Algonquin word meaning "swamp on a hill". An evergreen shrub-bog growing on waterlogged, acid, nutrient-poor, sandy or peaty soils located on broad, flat topographic plateaus, usually removed from large streams and subject to periodic flooding.

Exhibit 12. (Contd.)

Prescribed Burning--a fire burning at a particular place under specified conditions to achieve resource management objectives. All prescribed fires are authorized by a written plan which has been approved by a line officer.

Prescription--a plan written for a compartment before any work is started stating what is to be done and why the treatment is necessary.

Regeneration--the renewal of a forest stand, or a portion of a stand, whether by natural or artificial means. Regeneration may also refer to the seedlings themselves.

Root Raking--a site preparation technique in which a heavy toothed rake attached to the front of a bulldozer is used to remove stumps and roots.

Rotation--the planned number of years between the regeneration of a stand and its final cutting at a specified stage of maturity.

Seed Tree Cut--removal in one cut of the trees from an area except for a small number of seed bearers left singly or in small groups.

Shearing--the removal of trees from a stand by cutting with a sharpened blade such as a KG blade.

Shelterwood Cut--a regeneration method under an even-aged silvicultural system under which a portion of the mature stand is retained as a source of seed or protection during the period of regeneration. The mature stand is usually removed in two or more cuttings commonly called seed cutting and removal cutting. The seed cutting may or may not be preceded by a preparatory cutting.

Silviculture--the theory and practice of controlling the establishment, composition, constitution, and growth of forests.

Site--an area considered in terms of its environment, particularly as this determines the type and quality of the vegetation the area can carry.

Site Index--a particular measure of site class, based on the height of the dominant trees at an arbitrarily chosen age.

Site Preparation--preparation of the ground surface before planting or natural regeneration occurs.

Exhibit 12. (Contd.)

Slash--woody debris left after logging or other clearing operations.

Snag--a standing dead tree used by birds for nesting, roosting, perching, courting, and/or foraging for food and by some mammals for escape cover, denning, and reproduction.

Stand--a forest community possessing sufficient uniformity regarding vegetation type, age class, vigor, size class, and stocking class to be distinguishable from adjacent communities.

Stocking--the degree of occupancy per acre or hectare by trees, measured by basal area and/or the number of trees in a stand, compared to that required to fully utilize the growth potential of the site.

Stumpage--the commercial value of timber as it stands uncut.

Succession--the gradual supplanting of one community of plants by another.

Thinning--a partial cutting in a forest stand to improve wildlife habitat conditions, or to improve the growth and form of the remaining trees.

Timber Stand Improvement (TSI)--activities conducted in forest stands in which a portion of the vegetation is removed to provide for natural regeneration, improve growth and form of remaining trees, or improve wildlife habitat conditions. As distinguished from thinning, TSI is the noncommercial removal of vegetation whereas thinning is a commercial removal involving a timber sale.

Tolerance--refers to the relative capacity of a forest plant to survive and thrive in the understory or midstory.

Type--a forest classification system such as that developed by the Society of American Foresters in which forests are classed according to the dominant tree species.

Understory--a component of the vertical structure of a forest stand consisting of vegetation at or close to the ground surface.

Uneven-Aged--a forest or stand composed of intermingling trees that differ markedly in age.

Wilding--a tree seedling produced by natural regeneration which is lifted and transplanted elsewhere.

Exhibit 13. Common and Scientific Names

Arrow-arum	*Peltandra* spp.
Ash, Carolina	*Fraxinus caroliniana*
Ash, green	*Fraxinus pennsylvanica*
Ash, pumpkin	*Fraxinus profunda*
Baldcypress	*Taxodium distichum*
Beech, American	*Fagus grandifolia*
Blackberry	*Rubus argutus*
Blackgum	*Nyssa sylvatica* var. *biflora*
Blueberry, highbush	*Vaccinium corymbosum*
Cherry, black	*Prunus serotina*
Cottongrass	*Eriophorum virginicum*
Cottonwood, swamp	*Populus heterophylla*
Cyrilla, swamp	*Cyrilla racemiflora*
Dogwood, flowering	*Cornus florida*
Elm, American	*Ulmus americana*
Elm, winged	*Ulmus alata*
Gallberry, bitter	*Ilex glabra*
Gallberry, sweet	*Ilex coriacea*
Golden club	*Orontium* spp.
Greenbrier	*Smilax* spp.
Holly, American	*Ilex opaca*
Leucothoe	*Leucothoe* spp.
Lizard's tail	*Saururus* spp.
Lyonia, fetterbush	*Lyonia lucida*
Magnolia, southern	*Magnolia grandiflora*
Manna grass	*Glyceria* spp.
Maple, red	*Acer rubrum*
Moss, sphagnum	*Sphagnum* spp.
Muscadine	*Vitis rotundifolia*
Oak, cherrybark	*Quercus falcata* var. *pagodifolia*
laurel	*Quercus laurifolia*
swamp chestnut	*Quercus michauxii*
water	*Quercus nigra*
white	*Quercus alba*
willow	*Quercus phellos*
Pawpaw	*Asimina triloba*
Pepperbush, sweet	*Clethra alnifolia*
Persimmon, common	*Diospyros virginiana*
Pine, loblolly	*Pinus taeda*
Pine, pond	*Pinus serotina*
Redbay	*Persea borbonia*
Reed grass	*Calamagrostis* spp.
Sourwood	*Oxydendron arboreum*
Sweetbay	*Magnolia virginiana*
Sweetgum	*Liquidambar styraciflua*

Exhibit 13. (Contd.)

Switchcane	Arundinaria gigantea
Three-way sedge	Dulichium spp.
Titi	Cyrilla racemiflora
Trillium	Trillium spp.
Tupelo, swamp	Nyssa sylvatica var. biflora
Tupelo, water	Nyssa aquatica
Virginia chainfern	Woodwardia virginica
Wax myrtle	Myrica cerifera
White cedar, Atlantic	Chamaecyparis thyoides
Yellow poplar	Liriodendron tulipifera

Exhibit 14. Prospective Timber Buyers and Contractors

Sawtimber Buyers

Ashton Lewis Lumber Co., Gatesville, N.C. 27938 PH: (919) 357-2191
Atlantic Forest Products, Inc., Manns Harbor, N.C. PH: (919) 473-3663
Beechum, A., 4669 Truman Lane, Va. Beach, Va. 23455 PH: 464-6993 or 427-5235
Byrd, W.O., 3200 Archers Mill Rd., Suffolk, VA 23434 PH: 539-0813
Canal Wood Corp., P.O. Box 697, Lewiston, N.C. 27849 PH: (919) 348-2076
Richard Griffin, Jr.,
Chesapeake Lumber Co., Box 1626, Elizabeth City, NC. 27909 PH: (919) 335-1760
Coastal Lumber Co., Weldon, N.C. 27890 PH: (1) 800 334-1925
Continental Can Co., Woodlands Div., P.O. Box 1041, Hopewell, Va. 23860 PH:748-220
Dan Baptist Lumber Co., Boykins, Va. 23827 PH: 654-9330
Eason, Rochelle, Whaleyville Station, Suffolk, Va. 23438
Felton, J.E., 412 Military Ave., Suffolk, Va. 23434 PH: 986-4613
Gates Custom Milling, Inc. RFD 37, Gatesville, N.C. PH: (919) 357-0116
Georgia-Pacific Corp., Drawer D., Emporia, Va. 23847 PH: 634-5123
Georgia-Pacific Corp. Box 406, Ahoskie, N.C. 27910 PH: (919) 332-3141
Gray Lumber Co., Waverly, Va. 23890 PH: 834-2291
Griffin, Hudson, Windsor, Va. 23487
Hobbs, Luther A., 2401 Battlefield Blvd., Chesapeake, VA 23322 PH: 421-3151
Hoffler Lumber Co., Sunbury, N.C. 27979 PH: (919) 465-2861
Johnson, A.H. & Co., Rt. 2, Suffolk, VA 23434 PH: 539-4523
Kirk Lumber Co., Rt. 4, Box 442, Suffolk, Va. 23434 PH: 255-4521
Marks, Charles, Baum Road, Chesapeake, Va. 23322
Meiggs, W.E., Camden, N.C. 27924 PH: (919) 771-2253
Perry, F. Lumber Co., Nurney Siding, Suffolk, Va. 23434 PH: 539-8278
Ragsdale, G.B., Inc. P.O. Box 906, McKenney, Va. 23872
Ramsey Lumber Co., Box 1623, Suffolk 23434 PH: 539-3491
Sawyer, Nat Lumber Co., Driver Station, Suffolk, Va. 23435 PH: 539-0127
Sawyer, W., Camden, N.C. 13316
Sheffield Lumber Co., Inc., Box 1909, Suffolk, Va. 23434 PH: 934-3281
Suffolk Forest Products, Inc., P.O. Box 385, Suffolk, VA 23434 PH: 986-2171
Tarkington, Hassell, 104 Benefit Rd., Chesapeake, Va. 23322 PH: 421-2512
Tidewater Timber Co., 401 Shore Dr., Emporia, Va. 23847
Topping, R.L. Roanoke Rapids, N.C. 27870
Union Camp Corporation, Franklin, Va. 23851 PH: 569-4321
Union Camp Corporation, Box 245, South Mills, N.C. 27996 PH: (919) 771-5512
White, J. Franklin, Rt.2, Waverly, Va. 23890 PH: 834-2801
Whitehurst, J.W., Moyock, N.C. 27958 PH: (919) 435-6398
Winslow, Calvin, Rt. 2, Edenton, N.C. 27932 PH: 482-4932

Exhibit 14. (Contd.)

Pulpwood Buyers

Beechman, A., 4669 Truman Lane, VA Beach VA 23455 PH: 464-6993 or 427-5235
Continental Can Co., P.O. Box 1041, Hopewell, VA 23860 PH: 748-2208
New River Wood Co., (Lewis May) Morgans Corner, N.C. 27909 or Weyerhaeuser Forester
Tidewater Timber Co., 401 Shore Drive, Emporia, VA 23847
Union Camp Corp., Box 245, South Mills, N.C. 27976 PH: (919) 771-5512
Union Camp Corp., Franklin, VA 23851 PH: 569-4623
White, J. Franklin, Waverly, VA 23890 PH: 834-2801
Weyerhaeuser Corp., Plymouth, N.C. 27962 PH: 793-8073

Pole and Piling Buyers

Advanced Wood Products Co., Rt. 1, Box 228, Suffolk, VA 23434 PH: 539-9019
Atlantic Wood Industries, Inc., P.O. Box 340, Portsmouth, VA 23705 PH: 397-2317
Jones, J.W. Lumber Co., Rt. 3, Elizabeth City, N.C. 27909 PH: (919) 771-2497
Koppers Co., Inc., Eure, N.C. 27935

Post Buyers

Saunders Supply Co., Chuckatuck Station, Suffolk, VA 23432 PH: 255-4531

Veneer Buyers

Chowan Veneer Co., Edenton, N.C. 27932
Long, W.W., Rt. 6, Box 382-A, Richmond, VA
Norfolk Veneer Mills, Elm Ave. & Veneer Rd., Portsmouth, VA 23702 PH: 393-2551
Spivey, D.L., 1209 Carolina Rd., Suffolk, VA 23434 PH:539-2740
Vargo, Willie, Box 281, Hopewill, VA 23860

Firewood Producers

Ash, Jessie, 402 Oak Street, Suffolk, VA 23434, PH: 539-4903
Beechum, A., 4669 Truman Lane, VA Beach, VA, 23455 PH: 464-6993 or 427-5235
Byrd, W.O., 3200-B Archer's Mill Rd., Suffolk, VA
Cross, Donald, 5715 Holy Neck Rd., Suffolk, VA 23437 PH: 657-6596
Gardner, Johnny, Suffolk, VA PH: 934-2206
Hastead, W.R., Backbay, VA Beach, VA 23457
Hobbs, Luther A., 2401 Battlefield Blvd., Chesapeake, VA 23322 PH:421-3151
Hoggard, D., Backbay, VA Beach, VA 23457
Marks, Charles, Baum Rd., Chesapeake, VA 23322
Perry, Frank A., 1687 Whaleyville Blvd., Suffolk, VA 23438 PH: 539-7914
Saunders, Leon, Suffolk, VA 23434 PH: 934-2837
Taylor, Stephanie, Chesapeake, VA PH: 497-7603

Exhibit 14 (Contd.)

Nurseries

Goldsboro Forestry Center
North Carolina Forest Service
Rt. 8, Box 380
Goldsboro, N.C. 27530
(919) 735-9116
(Loblolly pine, cedar, and baldcypress available on special request)

Griffiths Forestry Center
North Carolina Forest Service
2411 Garner Road
Clayton, N.C. 27520
(919) 553-6178
Attn: Jim Smith
(Custom contract for cedar and cypress production)

Union Camp
Capron Hardwood Nursery
Capron, VA
(804) 658-4184
(Sweetgum, green ash, willow-water oak)

Site Preparation Contractors

Dan Koliadko
Yale, VA 23897
246-5771

Johnny Edwards
Smithfield, VA

T. N. Snow
South Boston, VA

Mike Reason
Spring Grove, VA
866-8470

Francis "Pee Wee" Temple
Elizabeth City, NC
(919) 771-5440

Bobby Vinson
Winton, NC

Ted Upton
Rt. 2, Stoney Creek, VA
246-4931

W. Cordell Wilso
Emporia, VA

Dan Irdy
Blackstone, VA

Garland Scott
Hertford, VA

Harrell Mizelle
Windsor, NC

Exhibit 14. (Contd.)

Tree Painting Contractors

James Berry
Alberta, VA
949-6115

Denny Townsend
Rt. 1, Box 21B
Rawlings, VA
478-4668

Sterling Buford
Rt. 1, Box 26
Rawlings, VA
949-7784

Samuel L. Newsome
Ahoskie, NC

Authur Nowell
Rt. 2, Edenton, NC
482-3908

Claude Sexton
Rt. 1, Box 43
Camden, NC 27921
(919) 336-4522

Bobby Vinson
Winton, NC

Mike Neal
Colerain, NC

Exhibit 15. Age Class Categories

TYPE	REGENERATION	INTERMEDIATE	MATURE	OLD GROWTH
maple-gum	1-10	11-50	51-65	66-80
cypress-gum	1-10	11-50	51-100	101+
pine	1-10	11-40	41-65	66-80
Atlantic white cedar	1-10	11-50	51-80	81-100
mesic hardwood	1-10	11-60	61-100	101+

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