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Silviculture Prescription
Goodale Lot Pine Sale

Massachusetts Department of Conservation and Recreation
Bureau of Forestry

Northeast District
Marlboro Sudbury State Forest
Hudson, MA

Prepared by:

Joelle Vautour – Management Forester – Mid State District
Massachusetts Department of Conservation and Recreation
355 West Boylston St, Clinton - MA 01510
joelle.vautour@state.ma.us – 978-368-0126 ext. 128

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Approved by:

Management Forestry
Program Supervisor _____ Date: March 22, 2013
William N. Hill, CF

SITE DATA

Cultural and Historical

The Goodale Lot Pine Sale is located in an isolated parcel of the 104 acre Marlborough-Sudbury State Forest in Hudson, Massachusetts. The state forest is roughly bounded by Main Street to the north, White Pond Road to the east and the abandoned Boston & Maine Railroad to the south. Two separate acquisitions from the Goodale Family make up this parcel of Marlborough-Sudbury State Forest. The original acquisition in 1934 was the largest and included all of the current state forest except for a 200 foot wide section along Main Street. The portion along Main Street was later acquired in 1962. This forest was planted with red and white pine in the 1930's. The Civilian Conservation Corps (CCC) had several forestry camps nearby, such as in Leominster, Upton and Douglas (Berg, 1999). Knowing the forestry work that the CCC was performing and looking at aerial photographs from 1938, it is assumed that the CCC performed these plantings on old abandoned agricultural fields as a type of reforestation project (Harris Penniman, personal communication, January 2013). There are no stone walls or cellar holes located within the project area.

This state forest sits in the middle of a residential suburb in the greater metropolitan Boston area. There are several residential homes which share a boundary line with the state forest and also with the project area. In addition, there are several parcels of protected open space in the area including federal, state and municipal ownerships.

Climate

For this area, the United States Department of Agriculture's Natural Resource Conservation Service (USDA-NRCS) gives a mean annual temperature between 43 and 54 degrees Fahrenheit with a mean annual precipitation between 45 and 54 inches annually. The National Oceanic and Atmospheric Administration (NOAA) more specifically states that the mean annual temperature of this project area is 47.69 degrees Fahrenheit with a mean annual precipitation of 42.93 inches. There have been no significant disturbances of the project area due to weather. The December 2008 ice storm caused minimal crown damage to overstory trees.

As is typical for New England, wind and therefore weather patterns in Massachusetts vary greatly from season to season and even day to day. It is typical in the summer and spring for winds to come from the southeast and southwest. It is common for weather patterns to come down from the north and northeast in fall and winter. These weather patterns can contain both high or low pressure systems and any form of weather historically common to New England. Weather can be a major disturbance in this area of Massachusetts. Hurricanes, wind and ice have had major impacts on this landscape in the past and will continue to do so in the future.

Hydrology and Watershed

There are several significant wetland resources adjacent to the Marlborough-Sudbury State Forest. The Assabet River, Assabet River National Wildlife Refuge, White Pond and Lake Boon are all located within five miles from the property. The Sudbury Reservoir and surrounding land owned and managed by DCR Division of Water Supply and Protection is located three miles south of the property. Within the property and project area there are a few isolated wetland areas including a bog and shrub swamp near Main Street, two potential non-certified vernal pools just south of an interior woods road and a one acre wetland in the southeastern section of the project area (see Harvest Map).

Geology and Soils

The project area is on an outwash plain with droughty soils. It has a relatively flat slope that is +/-3%. There are four soil types which make up the upland portion of the project area. They are the Hinckley loamy sand, the Windsor loamy sand, Carver loamy coarse sand and the Paxton fine sandy loam. Another soil type, Freetown muck is also present, underlying the bog and shrub swamp near Main Street which is adjacent to the project area and will be buffered.

The majority of the project area is underlain by the Windsor loamy sand. This soil ranges in slope from 0-8%. It is derived from loose sandy glaciofluvial deposits and is excessively drained. It underlies the majority of stand 1, the western half of stand 2 and the western portion of stand 4. The next most abundant soil type is the Carver loamy sand. This soil ranges in slope from 0-3% and is excessively drained. As the Windsor loamy sand, it is derived from loose sandy glaciofluvial deposits. This soil underlies the eastern portion of stand 1, the eastern half of stand 2 and all of stand 3. The third most abundant soil type is the Paxton fine sandy loam. This is an extremely stony soil that is present along the western portion of the project area along the bottom of the hillside. This soil type varies in slope from 8-25%, although this portion of the project area does not exceed 10% slope. It is a well drained soil that is derived from friable loamy eolian deposits over dense loamy lodgment till derived from granite and gneiss. This soil type underlies the southwestern portion of stand 1. The last soil type is the Hinckley loamy sand which underlies a very small portion of stand 1 along the eastern border of the property. Its slope ranges from 3-8% and is excessively drained. It is derived from loose sandy and gravelly glaciofluvial deposits derived from granite and gneiss (see Soils Map). All of these soils are highly suitable for forestry operations and the development of upland plant species communities which are suited for these droughty soil types (USDA-NRCS).

Lastly, the Freetown muck underlies the bog and shrub swamp in the northern portion of the property which is outside of the project area. This muck is very poorly drained and is derived from highly decomposed herbaceous organic material. This soil is not suitable for forestry operations (USDA-NRCS).

Current Vegetation

By researching aerial photographs taken in 1938, it appears that the project area was open, containing little to no trees (Harris Penniman, personal communication, January 2013). Based on this, it is thought that within the few years prior to the 1938 Hurricane that the property was being reforested by both the planting of red pine by the CCC and natural regenerative processes. Therefore it is estimated that tree age of the project area is roughly 75 years old. Periodic ground fires have occurred on this property. These have been caused by weather, machinery and in more recent years, “lazy man” campfires and other inappropriate recreational uses of the forest. These fires have not significantly influenced growth of the current forest composition and structure. The last ground fire that went through a small area of the forest in spring 2011 killed a few white pine saplings and scarred the butts of overstory trees.

The overstory of the project area is reaching maturity. The most common species in the overstory are red pine (*Pinus resinosa)*, white pine (*Pinus strobus)*, pitch pine (*Pinus rigida)*, red oak (*Quercus rubra)*, black oak (*Quercus velutina)*, scarlet oak (*Quercus coccinea)* and red maple (*Acer rubrum)*. In most cases, the overstory is fully stocked due to a lack of management since establishment. Stand 1, a plantation of red pine throughout the center of the project area, has stagnated in growth because no management has been implemented since planting. The most structurally diverse area of the project is in stand 4 which underwent a firewood thinning in 1983. In stands 1 and 2, white pine regeneration is thick in patchy spots. This is due to thinning crowns from stand stagnation, declining health and tree mortality. Mixed hardwood and white pine regeneration is present in small amounts also.

In areas of the understory that lack thick pine regeneration, patches of sheep laurel (*Kalmia angustifolia)*, huckleberry (*Gaylussacia baccata)* and low bush blueberry (*Vaccinium angustifolium*) are present. Other species present in lesser stocking are American chestnut (*Castanea dentata)*, bear oak (*Quercus ilicifolia)*, Western bracken fern (*Pteridium aquilinum*) and clubmoss (*Lycopodium spp.)* among others.

The current condition of this property and more specifically, the project area is a function of its past use and disturbance. Historically speaking, this property has undergone significant agricultural use and abandonment followed by reforestation plantings. Without this anthropogenic interference, an ecosystem would be present that is well suited to the dry, nutrient poor conditions that are present at this property. Species that are adapted to these conditions and were present historically include white pine, pitch pine, bear oak and American chestnut. Red pine is often thought of as a non-native species to Southern New England, however this is untrue. Massachusetts is on the southern edge of red pine's native range and could have also been historically present on this property.

Site Productivity

Of the four soil types underlying the project area, the average site index for white pine is 59. As a break down, site index for white pine is 66 for Paxton fine sandy loam, 53 for Carver loamy coarse sand, 57 for Windsor loamy sand and 60 for Hinckley loamy sand (USDA-NRCS). A site class of 59 is considered poor. White pine typically outcompetes hardwoods on excessively drained and well drained soils that are droughty (Lancaster and Leak, 1978). Although we are striving to provide for structural and species diversity, white pine is likely to do the best on these site conditions.

The DCR Management Guidelines of 2012 state that forest stands will be "classed… and considered for silvicultural treatments that generally fit their productivity, structural complexity (or potential thereof) and diversity". An analysis of stands 1-3 of the Goodale Pine Lot site history (land use; agriculture/logging) and conditions (soil types, productivity; vegetation cover) suggests that these even-age lower complexity stands on poorer soils lend themselves to even-age management. The analysis indicates slightly more within stand diversity in Stand 4 due to the firewood harvest in 1983 which resulted in abundant hardwood regeneration (Goodwin and Hill, 2012).

STAND DATA

Stand Descriptions

General

There are four stands located in the project area which will be treated, totaling 28 acres. Each stand is even aged in structure. There is no presence of rare, threatened or endangered species in this project area. A review of this project by the Massachusetts Department of Fish and Wildlife states that "The proposed harvesting will likely have relatively benign short term wildlife impacts (proposed harvesting will likely neither substantially disrupt existing wildlife using the site, nor benefit declining wildlife species associated with larger patches of young forest habitat), but over time, the planned retention of cavity trees and downed woody debris, along with a likely increase in plant species diversity from increasing sunlight, should have positive benefits for a variety of wildlife species." (DFW Review, 2012)

Hiking, horseback riding and minimal hunting are major uses of the project area and this state forest. Illegal ATV use has become problematic, resulting in woods road and trail degradation. Woods roads in the project area will be re-graded and maintained in passable condition by the operator at the end of each work day. The project area will be closed to the public during active logging hours for safety

reasons. Directional felling along the trails in the project area will be made to prevent trees from impeding recreational use. Removal of potentially hazardous trees to aid in public safety will be implemented. This project lies within a heavily suburban surrounding, so aesthetics are a very important concern. Main Street, White Pond Road and all the interior woods roads will be buffered by retaining 50% of the basal area within 50 feet of these roadways. Slash that is greater than one inch diameter will be lopped to less than 2 feet above the ground. The southeastern and southern boundary of the project area will also have a 50-foot no-cut buffer.

Another inappropriate recreational use of the state forest is the creation of campfires which have grown to small wildfires. Given the right conditions, some of these fires could become problematic in the future. Restricting use by installing gates and loading tree tops at ATV access points may minimize the negative impacts on this state forest. In terms of the infrastructure system of the state forest, goals are to restrict ATV access and also to create a perimeter trail around the property.

Stand 1

Stand 1 is a 14 acre red pine plantation that is located in the central portion of the project area. This stand has no history of treatment since its planting about 75 years ago. The dominant overstory species is red pine. White pine and red oak are also present in the overstory in lesser amounts. This stand is currently overstocked, with 200 square feet of basal area per acre and a relative density of 102.05% (Appendix, Table 1). This indicates that almost all of the land area in this stand is being used by the trees in the overstory. As a result, tree growth has stagnated and tree health is beginning to decline leading to mortality. Since the stands establishment, there has been a very high level of competition between all of the trees in the stand for light, water and nutrients. This has caused some differentiation in the stand whereas there are some trees which were able to outcompete others, becoming dominant and co-dominant trees in the overstory. The rest of the overstory stocking is considered intermediate and some have also become suppressed. Most of the suppressed trees have died and the intermediate class is also beginning to die back at this time. Natural mortality has also occurred due to high winds, ice storms and hurricanes.

Due to the dense overstory and heavily shaded forest floor as a result, the understory in this stand is currently sparse throughout. Natural dieback from competition and other disturbances has allowed isolated pockets of advanced white pine regeneration to become established. Only black oak and white pine have been tallied as understory stocking (Appendix, Table 2). Ground species present in this stand include mostly huckleberry and lowbush blueberry. Seedlings include white pine, black oak, red maple and white oak (*Quercus alba)*. Glossy buckthorn (*Rhamnus frangula)* is present in this stand (Appendix, Table 3).

There are 19 snags per acre located in this stand, of which 5 are red pine and the remainders are unidentifiable. There is an estimated downed woody debris volume of 252.17 cubic feet per acre (Appendix, Table 4). The bog and shrub swamp are located on the edge of stand 1 and the two non certified vernal pools are located within the stand (see Harvest Map). To protect these wetland resources, a 50-foot no-cut buffer will surround them. The reason for this is to maintain the overstory surrounding these wetlands in their current condition, to better manage how trees will be felled around them as well as where machinery will operate relative to their proximity.

Stand 2

Stand 2 is a 4 acre white pine plantation that is located in the eastern portion of the project area. There is no evidence in the field or records that this stand has undergone any treatment since its

establishment roughly 75 years ago. The dominant overstory species is white pine. Other species that are present include pitch pine and black oak (Appendix, Table 5). The stocking level for this stand is currently very high with a basal area of 182 square feet per acre and a relative density of 82.53%. This indicates that almost all of the land area in this stand is being used by the trees in the overstory. Similarly to stand 1, the overstory trees in stand 2 have been under serious competition for light, water, nutrients and other resources since establishment. Due to a lack of management, the trees which occupy the stands land area are slowly running out of resources and growth has stagnated. Mortality from competition and natural disturbance has occurred and will continue to in the future. Because tree health and vigor is declining due to competition, mortality will be occurring at more rapid rates. Like stand 1, the intermediate and suppressed size classes are in serious decline, whereas mortality has already begun.

As in stand 1, the understory in stand 2 is very sparse besides a few pockets of advanced white pine and mixed hardwood regeneration. This is due to a dense overstory which is shading out, almost entirely, the ground to direct sunlight. Only American chestnut has been tallied in the understory (Appendix, Table 6). Ground species include lowbush blueberry, clubmoss, Christmas fern (*Polystichum acrostichoides)*, fescue grasses (*Fescue spp.)* and lady's slipper (*Cypripedium spp.)*. Seedlings include mostly white pine and also red maple, white oak and red oak. Glossy buckthorn was not tallied in this stand (Appendix, Table 7).

There are 62 snags per acre in this stand, 47 of which are white pine, and an estimated 1,180.54 cubic feet of downed woody debris (Appendix, Table 8). There are no wetland resource areas in stand 2 (see Harvest Map).

<u>Stand 3</u>

Stand 3 is a 4 acre white pine-oak stand that is located in the northern portion of the project area along Main Street. There is no evidence in the field that this stand underwent treatment since its establishment around 75 years ago. Currently, the stocking level for this stand is high with a basal area of 112 square feet per acre and a relative density of 79.06%. This indicates that the majority of the land area of this stand is being occupied by trees in the overstory. The dominant overstory species is black oak. Other overstory species include white pine, red pine, scarlet oak, white oak, pitch pine and red maple (Appendix, Table 9). Unlike stands 1 and 2, stand 3 was not planted, but established by natural regenerative methods. There is no history of past treatments.

This stand is considered even aged, meaning it is composed of trees generally the same age. Growth has stagnated overall in this stand. Because competition has been so fierce between trees in this stand and most of the stands area is being used by overstory tree stocking, mortality is beginning to occur. Mortality from damaging winds, hurricanes and ice has also occurred.

As with stands 1 and 2, the understory of stand 3 has a low stocking. This is due to almost complete canopy closure of the overstory and the resulting lack of direct sunlight to the forest floor. Only a small amount of white pine saplings were tallied in this stand (Appendix, Table 10). Ground species include mostly huckleberry and lowbush blueberry. Seedlings of white pine and lesser amounts of black oak, red maple, white oak and American serviceberry (*Amelanchier laevis)* are present. Glossy buckthorn was not tallied in this stand (Appendix, Table 11).

There are 28 snags per acre in stand 3 with an estimated 514.26 cubic feet per acre of downed woody debris (Appendix, Table 12). The shrub swamp is located on the western boundary of this stand, which

will receive a 50-foot no-cut buffer as well as Main Street to the north and White Pond Road to the east (see Harvest Map). The reason for this is to maintain the overstory surrounding the shrub swamp in its current condition, to better manage how trees will be felled around this wetland as well as where machinery will operate relative to its proximity. Buffers along the road are to maintain a good aesthetic condition. A 300-foot section of a hiking trail that is located to the south of the shrub swamp is going to be relocated to prevent any future negative impacts on this resource area. Slash and tops will be placed on the trail to deter use. The trail will be relocated to the secondary skid trail that loops around the shrub swamp (see Harvest Map).

Stand 4

Stand 4 is a 6 acre white pine-hardwood stand that is located in the southern portion of the project area. This stand was treated amongst a 13 acre firewood thinning in 1983 that removed about 100 cords of firewood. Due to this treatment, this stand currently has a medium stocking level and there is abundant regeneration present in the understory. The basal area of this stand is 63.3 square feet per acre and a relative density of 43.32%. This indicates that less than half of the growing space is being utilized by the overstory trees (Appendix, Table 13).

The dominant overstory species is black oak. Other overstory species include white pine, red maple, scarlet oak and white oak (Appendix, Table 13). Competition between the overstory trees is much less than what is currently occurring in stands 1, 2 and 3 and therefore natural mortality due to competition is much lower also. Mortality due to natural disturbance has occurred in this stand.

Stand 4 has the highest understory stocking within the project area. This is due in large part to the firewood thinning, which opened up portions of the stand to direct sunlight allowing for species to become established in the understory. Species present in the understory include black oak, white oak, white pine, red maple and black cherry (*Prunus serotina)* (Appendix, Table 14). The most common ground species is lowbush blueberry and huckleberry with lesser amounts of fescue grasses, Western bracken fern, sheep laurel and indianpipe (*Monotropa uniflora*). Saplings present include black oak, red maple, white pine, bear oak, white oak and black cherry. Glossy buckthorn is present in this stand (Appendix, Table 15).

There is only one snag per acre in stand 4 with an estimated 85.83 cubic feet per acre of downed woody debris (Appendix, Table 16). There is a one acre wetland located in the southeastern corner of this stand which will have a 50-foot no cut buffer surrounding it (see Harvest Map). The reason for this is to maintain the overstory surrounding the wetland in its current condition, to better manage how trees will be felled around this wetland as well as where machinery will operate relative to its proximity. There is also a trail that surrounds the wetland that is frequently used by ATV's and has become eroded and degraded. This trail will be abandoned. Slash and tops will be placed on the trail to deter use. Secondary skid trails to the north and south of the wetland will replace this trail.

EVALUATION OF DATA AND PROJECTED RESULTS

Project Objectives

There are several overall objectives of this project:

1.) Demonstrate a silvicultural thinning which will prepare an even aged red and white pine plantation for natural regeneration of white pine, oak and other deciduous hardwood species.
2.) Demonstrate harvesting techniques that exemplify Best Management Practices which aim to protect forest productivity, soil and water resources.
3.) Increase vegetative and structural diversity including increasing the presence of herbaceous and deciduous hardwood species within the almost monoculture like plantation setting that makes up much of the project area.
4.) To provide an opportunity to curb illegal uses of the state forest, most importantly the occurrence of ATV use.
5.) Provide an opportunity to demonstrate forest management in a highly suburban setting.

Silvicultural Prescription and Desired Results

Stand 1

Stand 1 will undergo an even aged shelterwood thinning. This cutting will be a combination of the preparatory cut and the establishment or seeding cut of a shelterwood, which can be performed simultaneously. At this time, the best dominant and co-dominant trees in the overstory will be retained for seed dissemination and shade control for the understory of the stand. These target trees are to have large, healthy crowns and appear wind firm. Advanced regeneration will be protected where present.

The purpose of this is treatment is to open up the overstory to allow enough vacant growing space for the establishment of regeneration. Maintaining the right amount of shade from the overstory is essential in the survival of germinating and existing seedlings, particularly for white pine which is moderately shade tolerant. The operator is to disturb whenever possible the ground conditions to bare mineral soil which will better enable white pine seed to become established. This will not be a perfect process, and ground litter will be left untouched in some areas. This will be beneficial for some hardwood tree species, particularly oak, to seed in. Glossy buckthorn is present in this stand. The forester is to pull by hand as much glossy buckthorn stems as possible prior to the harvest. Post harvest monitoring will take place to delimit the presence and any spread of the species.

To help guide the management decisions in this stand, reference was made to the red pine stocking chart (Gilmore, 2006). Stocking charts are developed based on intensive long term research of a species and can help make decisions based on stand density and growth within a stand. The stocking chart informs the forester if a stand is overstocked (A level), fully stocked (B level) or understocked (C level). Stand 1 stocking is currently above the A level, or overstocked. The objective is to reduce the basal area by, on average, 80 square feet of basal area per acre. This will bring the basal area down to 120 square feet per acre from 200 square feet per acre. Small crowned, poorly formed trees will be targeted for removal while maintaining the healthiest and best formed overstory trees. Trees that exhibit defects will also be targeted for removal.

The short term desired future condition is to establish regeneration throughout the stand that contains mostly white pine but also a deciduous hardwood component as well as higher vertical complexity. To increase vertical complexity, healthy tree and shrub species that occur in all size classes will be retained including reserve (legacy) trees. It is estimated that in 15-20 years, regeneration that has become established may require releasing. It is at that time that a decision be made on the type of entry

required to fully regenerate the stand. Legacy trees which are identified during this harvest should be maintained as such in subsequent entries. The long term desired future condition is to convert this red pine stand into a white pine stand with a hardwood component.

Stand 2

As in stand 1, stand 2 will undergo an even aged shelterwood thinning. This cutting will be a combination of the preparatory cut and seeding cut of a shelterwood. The best dominant and co-dominant trees in the overstory will be retained for seed dissemination and shade control for the understory of the stand. These trees will exhibit good form, vigor, health and wind firmness. Advanced regeneration will be protected where present.

The purpose of this is treatment is to open up the overstory to allow enough vacant growing space for the establishment of regeneration. Maintaining the right amount of shade from the overstory is essential in the survival of germinating and existing seedlings, particularly for white pine which is moderately shade tolerant. The operator is to disturb whenever possible the ground conditions to bare mineral soil which will better enable white pine seed to become established in the stand. This will not be a perfect process, and ground litter will be left untouched in some areas. This will be beneficial for some hardwood tree species, particularly oak, to seed in.

For this stand, reference was made to the white pine stocking chart (Philbrook et al, 1973). Stand 2 stocking is in the upper limits of the B level, being fully stocked. The objective is to reduce the basal area by 50 square feet of basal area per acre, bringing it down from 182 square feet per acre to 132 square feet per acre. Small crowned, poorly formed trees with reduced vigor from the overstory and understory will be targeted for removal. Trees that exhibit defects will also be targeted for removal.

The short term desired future condition is to establish regeneration through the stand that contains a mixture of white pine and hardwood species as well as higher vertical complexity. It is estimated that in conjunction with the other stands, this stand will have developed the regeneration desired in about 15-20 years. At that time, another entry may be needed and an evaluation to determine how to fully regenerate the stand should be made. Legacy trees which will be identified in this harvest should be retained in all future entries. The long term desired future condition is a stand of mixed white pine and hardwood species that are spaced for optimal growth and have overall higher species diversity than the current conditions.

Stand 3

As in stands 1 and 2, Stand 3 will undergo a combination of the preparatory cut and seeding cut of the even aged shelterwood silvicultural system. The best dominant and co-dominant overstory trees will be retained for seed dissemination and to help control the level of sunlight which reaches the forest floor. These trees will exhibit good form, large crowns and wind firmness. Maintaining a moderate amount of shade to the understory will be optimal to establish white pine and mixed hardwood regeneration. The purpose of this treatment is to allow enough growing space for regeneration to become established.

Stand 3 has a current basal area of 112 square feet per acre. The goal is to reduce the basal area by about 30 square feet per acre, to around 80 square feet per acre. Trees targeted for removal include those in the overstory and understory that have small crowns, are poorly formed, have excessive limbiness and are declining in vigor and health.

The short term desired future condition is to establish regeneration that contains a mixture of white pine and hardwood species as well as a higher vertical complexity in the understory with shrubs and herbaceous plant species. It is estimated that in conjunction with the other stands, this stand will have developed the regeneration desired in about 15-20 years. At that time, another entry may be needed and an evaluation to determine how to fully regenerate the stand should be made. Legacy trees which will be identified in this harvest should be retained in all future entries. The long term desirable condition is to have a vigorously growing stand of mixed white pine and hardwoods that have optimal room for good development and increased vertical complexity.

Stand 4

Like stands 1, 2 and 3, stand 4 will also undergo a combination of the preparatory cut and seed cut of the even aged shelterwood silvicultural system. Because this stand was treated in 1983 with a firewood thinning, the basal area is much lower than in the other stands being treated in the project area. The goal is to maintain the best formed and most vigorous dominant and co-dominant overstory trees while thinning the smaller crowned and less vigorous trees in the overstory and understory. This is the most vertically complex stand of the four being treated; therefore this complexity will be protected and enhanced with further thinning. Large trees will be retained as legacy trees in perpetuity. Areas containing advanced regeneration will be protected and released if light is being impeded by the overstory. Glossy buckthorn is present in this stand. The forester is to pull by hand as much glossy buckthorn stems as possible prior to the harvest. Post harvest monitoring will take place to delimit the presence and any spread of the species.

Stand 4 has a current basal area of 63.3 square feet per acre. This will be reduced by 10-20 square feet of basal area per acre, leaving a residual basal area of around 50 square feet per acre. Trees targeted for removal include overstory and understory trees which have small crowns, are poorly formed, show signs of dieback, are less vigorous and exhibit defects such as limbiness, crook, sweep and rot.

The short term desirable condition is to establish regeneration that contains a mixture of white pine and hardwood species as well as a higher vertical complexity in the understory with shrubs and herbaceous plant species. This stand may require additional thinning, whether in the understory or overstory, when nearby stands are being re-entered in an estimated 15-20 years. The long term desired future condition is a stand with mixed white pine and hardwood species which are spaced for optimal growth with an understory that is rich in species diversity and vertical complexity.

Logging System Requirements

This harvest will utilize a fully mechanized logging system with a cut-to-length harvester/processor and a forwarder to move wood products to the landing. This type of machinery can effectively and efficiently cut and process large amounts of lower quality wood. It is especially well suited for operating in plantations. Unlike a whole-tree harvesting (WTH) logging system, the cut-to-length machine cuts, de-limbs and bucks the tree at the stump. Use of a forwarder as opposed to a skidder will minimize soil disturbance and damage to residual trees. Also unlike WTH, the use of a cut-to-length harvester will decrease the amount of debris that accumulates on the landing because trees are processed in the woods.

This type of logging system will help to maintain a higher retention of nutrients by leaving branches, needles and leaves dispersed in the harvest area. Because these soils are droughty and excessively well drained, they are highly prone to nutrient loss. A minimum of two cords or 256 cubic feet of downed woody debris will be maintained at a minimum for each stand (Visioning Guidelines, 2012). As outlined

previously, stands 1, 2 and 3 are already meeting this threshold. Stand 4 only has an estimated 85.83 cubic feet per acre of downed woody debris at this time. Due to the soil types that underlay this project area, it is planned that at least 3 cords, or 384 cubic feet per acre of downed woody debris is to be retained. This material will include portions of cull logs and lopped tree tops from processing. The ability to efficiently maintain these levels of downed woody debris will be easier with a cut-to-length logging system than if a WTH is used.

Marking Guidelines

General

1.) The perimeter of the harvest area will be triple marked; trees which are triple marked are to be retained.
2.) The edges of the treatment area will be double marked; trees which are double marked are to be retained. This will include the 50-foot no cut buffers on all wetlands.
3.) The primary skid roads already exist. Secondary skid road location will be flagged.
4.) Marked areas should protect pockets of advanced regeneration when appropriate.

Stand 1

1.) This stand will be thinned from a basal area of 200 square feet per acre to an average basal area of 120 square feet per acre. Effort should be made to maintain an even spacing. Trees to be released and retained should be those that are in the dominant and co-dominant size class that exhibit large and healthy crowns, are wind firm and are seed producers.
2.) Red pine trees are priority for removal followed by white pine and then the associated hardwoods that are present in the stand.
3.) Trees targeted for removal should be poor in vigor and health, have obvious defects such as crook, sweep, excessive limbiness, decay, epicormic branching and multiple leaders or are suppressed.
4.) Trees which exhibit excellent form, regardless of species and size class should be retained to encourage species diversity.
5.) Pitch pine trees which are vigorous and appear to have good form and wind firmness should be retained.

Stand 2

1.) This stand will be thinned from a basal area of 182 square feet per acre to an average basal area of 132 square feet per acre. Effort should be made to maintain an even spacing. Trees to be released and retained should be those that are in the dominant and co-dominant size class that exhibit large and healthy crowns, are wind firm and are seed producers.
2.) White pine trees are priority for removal followed by pitch pine and then the associated hardwoods that are present in the stand.
3.) Trees targeted for removal should be poor in vigor and health, have obvious defects such as crook, sweep, excessive limbiness, decay, epicormic branching and multiple leaders or are suppressed.
4.) Trees which exhibit excellent form, regardless of species and size class should be retained to encourage species diversity.
5.) Pitch pine trees which are vigorous and appear to have good form and wind firmness should be retained.

Stand 3

1.) This stand will be thinned from a basal area of 112 square feet per acre to an average basal area of 80 square feet per acre. Effort should be made to maintain an even spacing. Trees to be released and retained should be those that are in the dominant and co-dominant size class that exhibit large and healthy crowns, are wind firm and are seed producers.
2.) Trees targeted for removal should be poor in vigor and health, have obvious defects such as crook, sweep, excessive limbiness, decay, epicormic branching and multiple leaders or are suppressed.
3.) Red pine trees are priority for removal, followed with black and scarlet oak. Tree quality should dictate the level of priority of tree removal from species to species.
4.) Trees which exhibit excellent form, regardless of species and size class should be retained to encourage species diversity.
5.) Pitch pine trees which are vigorous and appear to have good form and wind firmness should be retained.

Stand 4

1.) This stand will be thinned from a basal area of 63.3 square feet per acre to an average basal area of 50 square feet per acre.
2.) Advanced regeneration should be released when possible, providing that direct light will not be too high.
3.) Trees to be released and retained should be those that are in the dominant and co-dominant size class that exhibit large and healthy crowns, are wind firm and are seed producers.
4.) Trees targeted for removal should be poor in vigor and health, have obvious defects such as crook, sweep, excessive limbiness, decay, epicormic branching and multiple leaders or are suppressed.
5.) Trees which exhibit excellent form, regardless of species and size class should be retained to encourage species diversity.
6.) Black oak and white pine trees are priority for removal. Tree quality should dictate the level of priority of tree removal from species to species.

EXPECTED RESULTS

General

The expected results of the intended treatments for stands 1, 2, 3 and 4 have been simulated using a software program created by the United States Forest Service (USFS), called NED-2. This software program assists in making sustainable forest management decisions by allowing the land manager to create goals, analyze inventory data and simulate hypothetical management treatments. The results that were simulated through NED-2 are hypothetical and being used as a guide and may vary given the more realistic conditions in the field. These simulations were run without any other scheduled treatments in the future.

Stand 1

In two years after treatment (2015), several conditions in the stand will have changed. There will be an obvious increase in the amount of growing space in the stand. The basal area and relative density will be lower. This will allow for more growing space for overstory trees which were retained, additional growing space for any regeneration which will become established in the understory and for advanced regeneration that is already present. Although there will have been a decrease in sawtimber volume and stems per acre, pulpwood volumes will begin to increase because of the greater area of growing

space also. Diameter size of the residual trees will begin to increase throughout the stand (Appendix, Table 17). It is anticipated that abundant seed will occupy the soil in 2 to 5 years after this treatment.

In fifteen years after treatment (2028), it is anticipated that another treatment would be scheduled. The density in the stand will have increased since 2015. In comparison to the stocking condition pre-treatment in 2013, when there was a large amount of smaller stems, the stand this time will have a smaller amount of stems that are generally larger in size. Red pine will still dominate the stand although the presence of white pine will slowly begin to increase as a result of the preferred growing conditions of white pine which were attained by the 2013 treatment. The basal area and relative density will have increased as well as the diameter size of residual trees. Volumes for both sawtimber and pulpwood will have increased as a result of the additional growing space allotted from the 2013 treatment. Pulpwood volumes at this time will reflect a portion of the advanced regeneration present as saplings in 2013, which have since grown into pole sized trees (Appendix, Table 18).

In fifty years (2063) after the treatment in 2013, there will be some substantial differences in stand structure compared to the pre-treatment conditions in 2013 and even the post treatment conditions in 2015. Stand density will be as high as pre-treatment conditions in 2013, except the trees present in the stand will be very large in diameter on average. Without any further treatment, red pine will still dominate the stand but there will be a large component of white pine that has become established in the overstory. The volumes of these trees will also be high. Stems per acre will have declined due to mortality from competition, age and natural disturbance. Regeneration that developed as a result of the treatment in 2013 will have reached the overstory (Appendix, Table 19).

A graphic visualization of what this stand will look like pre-treatment (2013) and fifteen years after treatment (2028) are located in the appendix in figures 1 and 2. These graphics were derived using the Stand Visualization System (SVS) which can be used in conjunction with NED-2 to generate images based on current and simulated stand conditions.

<u>Stand 2</u>

In two years after treatment (2015), stand 2 will have an increased area of growing space due to treatment. There will be a lower stocking density than previously measured, with a lower basal area and relative density. This will allow for more growing space for overstory trees which were retained, additional growing space for any regeneration which will become established in the understory and for advanced regeneration that is already present. Residual trees will have grown larger in diameter. There will be a general decrease in sawtimber volumes from the harvest, but pulpwood and sawtimber volumes will steadily begin to rise from the increased growing space (Appendix, Table 20). It is anticipated that abundant seed will occupy the soil in 2 to 5 years post treatment.

In fifteen years after treatment (2028), several stand conditions will have changed since treatment in 2013. It is anticipated that another treatment would be scheduled at this time. Because the residual trees were released and given additional growing space, they have grown larger in diameter and increased in volume. This also applies to the advanced regeneration which was present prior to treatment as well as regeneration which has become established in the understory. The basal area and relative density have increased to nearly the same level as pre-treatment values in 2013. There is however, a major difference in stand structure relative to those compared values. Prior to treatment, there were many smaller diameter stems occupying the growing space in the stand. In 2028, there will be fewer, larger trees now present in the stand. Pulpwood values have increased since 2013 and 2015 and reflect their development to saplings from 2013 and 2015 (Appendix, Table 21).

In fifty years (2063) post treatment, the residual trees which were retained in 2013 will have continued to grow larger in diameter and in volume. The basal area will be higher than in the pre-treatment stand conditions in 2013 and the relative density will have increased to almost the same value in 2013. There will have been some mortality in the stand due to competition, age and natural disturbance over the past 50 years, so the amount of stems per acre will have decreased over time. Overall stand volumes are high. Regeneration that developed as a result of the treatment in 2013 will have reached the overstory (Appendix, Table 22).

A graphic visualization of what this stand will look like pre-treatment (2013) and fifteen years after treatment (2028) are located in the appendix in figures 3 and 4.

Stand 3

In 2015, two years after treatment, stand 3 will be similar to the condition of stands 1 and 2. Growing space will have increased due to a reduced basal area and relative density so the residual trees will be growing larger in diameter. The overall volume of the stand is beginning to increase also. Additional growing space will be provided for advanced regeneration as well as any regeneration which will soon become established (Appendix, Table 23). It is anticipated that abundant seed will occupy the soil in 2 to 5 years post treatment.

In fifteen years after treatment (2028), stand conditions are still continuing to change. It is anticipated that another treatment would be scheduled at this time. The residual trees have grown larger in diameter and increased in volume as a result of more growing space. This also applies to the advanced regeneration which was present prior to treatment as well as regeneration which has become established in the understory. The basal area and relative density have increased to nearly the same level as pre-treatment values in 2013. There is however, a major difference in stand structure relative to those compared values. Prior to treatment, there were many smaller diameter stems occupying the growing space in the stand. In 2028, there will be fewer, larger trees now present in the stand. Pulpwood values have increased since 2013 and 2015 and reflect their development to pole sized trees from saplings in 2013 and 2015. The amount of stems per acre is less in 2028 than 2015; this mortality is due to competition, age and natural disturbance. Mortality due to competition will be higher in the sapling and pole size classes. Mortality due to age will play more of a role in the larger size classes (Appendix, Table 24).

In fifty years (2063) post treatment, the residual trees which were retained in 2013 will have continued to grow larger in diameter and in volume. Regeneration that became established as a result of this treatment will have reached the overstory. The basal area will be higher than in the pre-treatment stand conditions in 2013 and the relative density will have increased to almost the same value as in 2013. There will have been some mortality in the stand due to competition, age and natural disturbance over the past 50 years, so the amount of stems per acre will have decreased over time. Overall stand volumes are high (Appendix, Table 25).

A graphic visualization of what this stand will look like pre-treatment (2013) and fifteen years after treatment (2028) are located in the appendix in figures 5 and 6.

Stand 4

In 2015, two years after treatment, stand 4 will undergo changes that vary overall from stands 1, 2 and 3. The understory will have grown considerably, seeing a doubling of stems, which indicate that some

trees will have reached the overstory and some seedling and saplings have grown into the pole size class. The trees retained in the overstory will continue to grow larger in diameter while the trees in the understory are growing in height. Volumes for both sawtimber and pulpwood are on the rise (Appendix, Table 26).

In 2028, fifteen years after the treatment, stand growth is continuing. Sawtimber and pulpwood volumes, average stand diameter, basal area and relative density values are rising. Trees which were established as a result of the firewood thinning in 1983 and the treatment in 2013 are beginning to take on a dominant role in the stands structure (Appendix, Table 27).

In fifty years after the treatment (2063), the stand will be densely stocked with white pine, a mixture of oak and other hardwoods. Trees in the overstory will be large and volumes will have increased for both sawtimber and pulpwood. The ability for the stand to attain this structure will have been widely dependent on the treatments in 1983 and 2013. The number of stems will have decreased slowly over time from mortality due to competition, age and natural disturbance (Appendix, Table 28).

A graphic visualization of what this stand will look like pre-treatment (2013) and fifteen years after treatment (2028) are located in the appendix in figures 7 and 8.

APPENDIX

CURRENT CONDITIONS

Table 1. Stand 1 - Red Pine Overstory Data Table (Stems ≥ 5" dbh)

	All species	Red Pine (Pinus resinosa)	Eastern White Pine (Pinus strobus)	Northern Red Oak (Quercus rubra)
Basal Area (square feet)	200.0	165.7	32.9	1.4
Percentage of stand basal area (%)	100.0	82.9	16.4	0.7
Stems Per Unit Area (stems per acre)	405.4	336.4	65.8	3.2
Quadratic Mean DBH (inches)	9.5	9.5	9.6	9.0
Relative Density (percent)	102.05	86.99	13.73	1.33
Sawtimber gross total (board feet/acre)	12,209	10,103	2,106	0
Pulpwood gross total (cords)	394	330	59	5
Pulpwood net total (cords)	315	264	47	4
Gross total (cords)	755	625	124	5
Net total (cords)	604	500	99	4

Table 2. Stand 1 - Red Pine Understory Data Table (Stems >4.5' tall and <1" dbh)

	All Species	Black Oak (Quercus velutina)	Eastern White Pine (Pinus strobus)
Basal Area (square feet)	2.6	1.9	0.6
Percentage of stand basal area (%)	100.0	75.8	24.2
Stems Per Unit Area (stems per acre)	42.9	14.3	28.6

Table 3. Stand 1 - Red Pine Ground Species Data Table (Stems <4.5' tall)

Species	Density (mean number of stems per acre)	Relative Density	Frequency	Relative Frequency	Percent Cover	Relative Percent Cover	Importance Value
Huckleberry (Gaylussacia)	242.86	24.64	71.43	17.24	26.50	79.61	40.50
Eastern White Pine (Pinus strobus)	435.71	44.20	100.00	24.14	0.00	0.00	22.78
Black Oak (Quercus velutina)	200.00	20.29	100.00	24.14	0.00	0.00	14.81
Lowbush Blueberry (Vaccinium angustifolium)	50.00	5.07	85.71	20.69	6.07	18.24	14.67
Red Maple (Acer rubrum)	28.57	2.90	14.29	3.45	0.00	0.00	2.12
Fescue (Festuca)	7.14	0.72	14.29	3.45	0.71	2.15	2.11
White Oak (Quercus alba)	14.29	1.45	14.29	3.45	0.00	0.00	1.63
Glossy Buckthorn (Frangula alnus)	7.14	0.72	14.29	3.45	0.00	0.00	1.39

Table 4. Stand 1 - Red Pine Snag Data Table

DBH Range	Total	Unidentified Species	Red Pine (Pinus resinosa)
< 6.00	14.29	14.29	0.00
>=6.00 and <=12.00	5.35	0.00	5.35
>12.00 and <=18.00	0.00	0.00	0.00
>18.00 and <=24.00	0.00	0.00	0.00
>24.00 and <=30.00	0.00	0.00	0.00
>30.00	0.00	0.00	0.00

Table 5. Stand 2 - White Pine Overstory Data Table (Stems ≥ 5" dbh)

	All species	Eastern White Pine (Pinus strobus)	Pitch Pine (Pinus rigida)	Black Oak (Quercus velutina)
Basal Area (square feet)	182.0	138.0	40.0	4.0
Percentage of stand basal area (%)	100.0	75.8	22.0	2.2
Stems Per Unit Area (stems per acre)	287.3	227.5	52.7	7.1
Quadratic Mean DBH (inches)	10.8	10.5	11.8	10.2
Relative Density (percent)	82.53	54.83	24.23	3.47
Sawtimber gross total (board feet/acre)	13,157	9,832	3,325	0
Pulpwood gross total (cords)	25	19	5	1
Pulpwood net total (cords)	20	15	4	1
Gross total (cords)	54	40	12	1
Net total (cords)	43	32	10	1

Table 6. Stand 2 - White Pine Understory Data Table (Stems >4.5' tall and <1" dbh)

	All Species	American Chestnut (Castanea dentata)	White Oak (Quercus alba)	Pitch Pine (Pinus rigida)
Basal Area (square feet)	1.7	1.7	0.0	0.0
Percentage of stand basal area (%)	100.0	100.0	0.0	0.0
Stems Per Unit Area (stems per acre)	60.0	20.0	20.0	20.0

Table 7. Stand 2 - White Pine Ground Species Data Table (Stems <4.5' tall)

Species	Density (mean number of stems per acre)	Relative Density	Frequency	Relative Frequency	Percent Cover	Relative Percent Cover	Importance Value
Eastern White Pine (Pinus strobus)	5050.00	91.16	100.00	20.00	0.00	0.00	37.05
Lowbush Blueberry (Vaccinium angustifolium)	20.00	0.36	40.00	8.00	3.90	48.15	18.84
Clubmoss (Lycopodiella)	10.00	0.18	20.00	4.00	2.50	30.86	11.68
Black Oak (Quercus velutina)	260.00	4.69	100.00	20.00	0.00	0.00	8.23
Fescue (Festuca)	20.00	0.36	40.00	8.00	1.00	12.35	6.90
Lady's Slipper (Cypripedium)	20.00	0.36	40.00	8.00	0.60	7.41	5.26
White Oak (Quercus alba)	90.00	1.62	60.00	12.00	0.00	0.00	4.54
Northern Red Oak (Quercus rubra)	30.00	0.54	40.00	8.00	0.00	0.00	2.85
Christmas Fern (Polystichum acrostichoides)	10.00	0.18	20.00	4.00	0.10	1.23	1.81
American Chestnut (Castanea dentata)	20.00	0.36	20.00	4.00	0.00	0.00	1.45
Red Maple (Acer rubrum)	10.00	0.18	20.00	4.00	0.00	0.00	1.39

Table 8. Stand 2 - White Pine Snag Data Table

DBH Range	Total	Eastern White Pine (Pinus strobus)	Pitch Pine (Pinus rigida)
< 6.00	14.67	14.67	0.00
>=6.00 and <=12.00	46.88	36.29	10.59
>12.00 and <=18.00	0.00	0.00	0.00
>18.00 and <=24.00	0.00	0.00	0.00
>24.00 and <=30.00	0.00	0.00	0.00
>30.00	0.00	0.00	0.00

Table 9. Stand 3 - White Pine-Oak Overstory Data Table (Stems ≥ 5" dbh)

	All species	Black Oak (Quercus velutina)	Eastern White Pine (Pinus strobus)	Red Pine (Pinus resinosa)	Scarlet Oak (Quercus coccinea)	White Oak (Quercus alba)	Pitch Pine (Pinus rigida)	Red Maple (Acer rubrum)
Basal Area (square feet)	112.0	62.0	24.0	12.0	8.0	2.0	2.0	2.0
Percentage of stand basal area (%)	100.0	55.4	21.4	10.7	7.1	1.8	1.8	1.8
Stems Per Unit Area (stems per acre)	176.6	87.8	39.7	23.1	9.1	4.5	2.2	10.2
Quadratic Mean DBH (inches)	10.8	11.4	10.5	9.8	12.7	9.0	13.0	6.0
Relative Density (percent)	79.06	52.14	9.46	6.14	6.59	1.80	1.18	1.75
Sawtimber gross total (board feet/acre)	6,592	3,378	1,647	793	612	0	162	0
Pulpwood gross total (cords)	18	11	3	2	1	1	0	0
Pulpwood net total (cords)	14	9	3	1	1	0	0	0
Gross total (cords)	32	18	7	3	3	1	1	0
Net total (cords)	26	14	6	3	2	0	1	0

Table 10. Stand 3 - White Pine-Oak Understory Data Table (Stems >4.5' tall and <1" dbh)

	All Species	Eastern White Pine (Pinus strobus)
Basal Area (square feet)	0.5	0.5
Percentage of stand basal area (%)	100.0	100.0
Stems Per Unit Area (stems per acre)	80.0	80.0

Table 11. Stand 3 - White Pine-Oak Ground Species Data Table (Stems <4.5' tall)

Species	Density (mean number of stems per acre)	Relative Density	Frequency	Relative Frequency	Percent Cover	Relative Percent Cover	Importance Value
Huckleberry (Gaylussacia)	50.00	11.63	60.00	23.08	33.50	82.72	39.14
Eastern White Pine (Pinus strobus)	290.00	67.44	60.00	23.08	0.00	0.00	30.17
Lowbush Blueberry (Vaccinium angustifolium)	20.00	4.65	20.00	7.69	7.00	17.28	9.88
Black Oak (Quercus velutina)	30.00	6.98	40.00	15.38	0.00	0.00	7.45
Red Maple (Acer rubrum)	20.00	4.65	40.00	15.38	0.00	0.00	6.68
White Oak (Quercus alba)	10.00	2.33	20.00	7.69	0.00	0.00	3.34
Allegheny Serviceberry (Amelanchier laevis)	10.00	2.33	20.00	7.69	0.00	0.00	3.34

Table 12. Stand 3 - White Pine-Oak Snag Data Table

DBH Range	Total	Black Oak (Quercus velutina)	Pitch Pine (Pinus rigida)
< 6.00	14.67	14.67	0.00
>=6.00 and <=12.00	12.01	12.01	0.00
>12.00 and <=18.00	2.17	0.00	2.17
>18.00 and <=24.00	0.00	0.00	0.00
>24.00 and <=30.00	0.00	0.00	0.00
>30.00	0.00	0.00	0.00

Table 13. Stand 4 - White Pine-Hardwoods Overstory Data Table (Stems ≥ 5" dbh)

	All species	Black Oak (Quercus velutina)	Eastern White Pine (Pinus strobus)	Red Maple (Acer rubrum)	Scarlet Oak (Quercus coccinea)	White Oak (Quercus alba)
Basal Area (square feet)	63.3	31.7	21.7	5.0	3.3	1.7
Percentage of stand basal area (%)	100.0	50.0	34.2	7.9	5.3	2.6
Stems Per Unit Area (stems per acre)	106.1	44.6	34.8	17.2	3.3	6.2
Quadratic Mean DBH (inches)	10.5	11.4	10.7	7.3	13.6	7.0
Relative Density (percent)	43.32	26.54	8.51	3.95	2.71	1.62
Sawtimber gross total (board feet/acre)	3,808	2,065	1,478	0	265	0
Pulpwood gross total (cords)	50	25	15	6	3	2
Pulpwood net total (cords)	40	20	12	4	2	1
Gross total (cords)	90	45	32	6	5	2
Net total (cords)	72	36	26	4	4	1

Table 14. Stand 4 - White Pine-Hardwoods Understory Data Table (Stems >4.5' tall and <1" dbh)

	All Species	Black Oak (Quercus velutina)	White Oak (Quercus alba)	Eastern White Pine (Pinus strobus)	Red Maple (Acer rubrum)	Black Cherry (Prunus serotina)
Basal Area (square feet)	7.0	3.3	1.9	1.3	0.4	0.1
Percentage of stand basal area (%)	100.0	47.2	27.5	18.1	5.8	1.3
Stems Per Unit Area (stems per acre)	200.0	66.7	33.3	50.0	33.3	16.7

Table 15. Stand 4 - White Pine-Hardwoods Ground Species Data Table (Stems <4.5' tall)

Species	Density (mean number of stems per acre)	Relative Density	Frequency	Relative Frequency	Percent Cover	Relative Percent Cover	Importance Value
Lowbush Blueberry (Vaccinium angustifolium)	75.00	5.96	100.00	13.64	28.33	56.38	25.33
Black Oak (Quercus velutina)	533.33	42.38	100.00	13.64	0.00	0.00	18.67
Huckleberry (Gaylussacia)	25.00	1.99	50.00	6.82	13.33	26.53	11.78
Red Maple (Acer rubrum)	150.00	11.92	100.00	13.64	0.00	0.00	8.52
Eastern White Pine (Pinus strobus)	133.33	10.60	100.00	13.64	0.00	0.00	8.08
Fescue (Festuca)	33.33	2.65	50.00	6.82	5.25	10.45	6.64
Western Brackenfern (Pteridium auilinum)	50.00	3.97	66.67	9.09	2.42	4.81	5.96
Bear Oak (Quercus ilicifolia)	100.00	7.95	33.33	4.55	0.00	0.00	4.16
White Oak (Quercus alba)	50.00	3.97	33.33	4.55	0.00	0.00	2.84
Black Cherry (Prunus serotina)	50.00	3.97	33.33	4.55	0.00	0.00	2.84
Glossy Buckthorn (Frangula alnus)	41.67	3.31	33.33	4.55	0.00	0.00	2.62
Sheep laurel (Kalmia angustifolia)	8.33	0.66	16.67	2.27	0.83	1.66	1.53
Indianpipe (Monotropa uniflora)	8.33	0.66	16.67	2.27	0.08	0.17	1.03

Table 16. Stand 4 - White Pine-Hardwoods Snag Data Table

DBH Range	Total	Black Oak (Quercus velutina)
< 6.00	0.00	0.00
>=6.00 and <=12.00	0.00	0.00
>12.00 and <=18.00	1.19	1.19
>18.00 and <=24.00	0.00	0.00
>24.00 and <=30.00	0.00	0.00
>30.00	0.00	0.00

Table 17. Stand 1 - Red Pine 2015 Projected Overstory Data Table (Stems ≥ 5" dbh)

	All species	Red Pine (Pinus resinosa)	Eastern White Pine (Pinus strobus)	Black Oak (Quercus velutina)	Northern Red Oak (Quercus rubra)
Basal Area (square feet)	124.8	98.3	26.1	0.2	0.1
Percentage of stand basal area (%)	100.0	78.8	20.9	0.2	0.1
Stems Per Unit Area (stems per acre)	243.5	144.6	66.2	26.7	6
Quadratic Mean DBH (inches)	9.7	11.2	8.5	1.3	1.7
Relative Density (percent)	61.04	49.17	11.2	0.58	0.10
Sawtimber gross total (board feet/acre)	9,676	7,823	1,853	0	0
Pulpwood gross total (cords)	1,255	996	257	0	1
Pulpwood net total (cords)	1,004	797	206	0	1
Gross total (cords)	2,933	2,333	599	0	1
Net total (cords)	2,346	1,866	479	0	1

Table 18. Stand 1 – Red Pine 2028 Projected Overstory Data Table (Stems ≥ 5" dbh)

	All species	Red Pine (Pinus resinosa)	Eastern White Pine (Pinus strobus)	Black Oak (Quercus velutina)	Northern Red Oak (Quercus rubra)
Basal Area (square feet)	149.0	116.3	32.5	0.2	0.1
Percentage of stand basal area (%)	100.0	78.0	21.8	0.1	0.1
Stems Per Unit Area (stems per acre)	218.2	140.6	62.9	12.1	2.5
Quadratic Mean DBH (inches)	11.2	12.3	9.7	1.7	2.5
Relative Density (percent)	69.73	56.19	13.08	0.36	0.09
Sawtimber gross total (board feet/acre)	12,900	10,246	2,655	0	0
Pulpwood gross total (cords)	1,472	1,162	309	0	1
Pulpwood net total (cords)	1,178	929	247	0	1
Gross total (cords)	3,681	2,900	780	0	1
Net total (cords)	2,945	2,320	624	0	1

Table 19. Stand 1 – Red Pine 2063 Projected Overstory Data Table (Stems ≥ 5" dbh)

	All species	Red Pine (Pinus resinosa)	Eastern White Pine (Pinus strobus)	Black Oak (Quercus velutina)	Northern Red Oak (Quercus rubra)
Basal Area (square feet)	194.6	145.5	49.1	0.1	0
Percentage of stand basal area (%)	100.0	74.7	25.2	0	0
Stems Per Unit Area (stems per acre)	182.9	127.3	53.8	1.4	0.3
Quadratic Mean DBH (inches)	14	14.5	12.9	2.6	4.7
Relative Density (percent)	84.16	66.41	17.63	0.08	0.04
Sawtimber gross total (board feet/acre)	18,919	14,143	4,776	0	0
Pulpwood gross total (cords)	1,845	1,401	443	0	1
Pulpwood net total (cords)	1,476	1,121	354	0	1
Gross total (cords)	5,151	3,870	1,281	0	1
Net total (cords)	4,121	3,096	1,025	0	1

Table 20. Stand 2 – White Pine 2015 Projected Overstory Data Table (Stems ≥ 5" dbh)

	All species	Eastern White Pine (Pinus strobus)	Pitch Pine (Pinus rigida)	Black Oak (Quercus velutina)	American chestnut (Castanea dentata)
Basal Area (square feet)	137.1	104	29.4	2	1.7
Percentage of stand basal area (%)	100.0	75.8	21.5	1.5	1.2
Stems Per Unit Area (stems per acre)	173.4	116	28.2	10.7	18.5
Quadratic Mean DBH (inches)	12.0	12.8	13.8	5.8	4.1
Relative Density (percent)	58.58	38.36	16.62	1.79	1.82
Sawtimber gross total (board feet/acre)	12,260	9,320	2,940	0	0
Pulpwood gross total (cords)	1,357	1,028	283	46	0
Pulpwood net total (cords)	1,086	823	227	37	0
Gross total (cords)	3,456	2,645	765	46	0
Net total (cords)	2,765	2,116	612	37	0

Table 21. Stand 2 – White Pine 2028 Projected Overstory Data Table (Stems ≥ 5" dbh)

	All species	Eastern White Pine (Pinus strobus)	Pitch Pine (Pinus rigida)	Black Oak (Quercus velutina)	American chestnut (Castanea dentata)	White Oak (Quercus alba)
Basal Area (square feet)	156.6	121.8	31.5	1.9	1.3	0.1
Percentage of stand basal area (%)	100.0	77.8	20.1	1.2	0.8	0.0
Stems Per Unit Area (stems per acre)	163	112.4	26.7	5.8	13.1	5.0
Quadratic Mean DBH (inches)	13.3	14.1	14.7	7.7	4.3	1.6
Relative Density (percent)	63.74	43.39	17.19	1.62	1.39	0.16
Sawtimber gross total (board feet/acre)	14,760	11,547	3,212	0	0	0
Pulpwood gross total (cords)	1,533	1,187	302	44	0	0
Pulpwood net total (cords)	1,226	950	242	35	0	0
Gross total (cords)	4,094	3,212	839	44	0	0
Net total (cords)	3,276	2,569	671	35	0	0

Table 22. Stand 2 – White Pine 2063 Projected Overstory Data Table (Stems ≥ 5" dbh)

	All species	Eastern White Pine (Pinus strobus)	Pitch Pine (Pinus rigida)	Black Oak (Quercus velutina)	American chestnut (Castanea dentata)	White Oak (Quercus alba)
Basal Area (square feet)	191.5	156.3	33.2	1.3	0.6	0.0
Percentage of stand basal area (%)	100.0	81.6	17.3	0.7	0.3	0.0
Stems Per Unit Area (stems per acre)	131.4	101	22.8	1.8	5.2	0.0
Quadratic Mean DBH (inches)	16.3	16.8	16.3	11.6	4.7	2.4
Relative Density (percent)	71.27	52.55	16.97	1.1	0.62	0.03
Sawtimber gross total (board feet/acre)	21,189	17,304	3,885	0	0	0
Pulpwood gross total (cords)	1,793	1,452	309	32	0	0
Pulpwood net total (cords)	1,436	1,162	247	25	0	0
Gross total (cords)	5,265	4,323	909	32	0	0
Net total (cords)	4,212	3,459	728	25	0	0

Table 23. Stand 3 – White Pine-Oak 2015 Projected Overstory Data Table (Stems ≥ 5" dbh)

	All species	Black Oak (Quercus velutina)	Eastern White Pine (Pinus strobus)	Red Pine (Pinus resinosa)	Scarlet Oak (Quercus coccinea)	Pitch Pine (Pinus rigida)	Red Maple (Acer rubrum)	White Oak (Quercus alba)
Basal Area (square feet)	83.9	43.6	19.8	10.2	7.9	1.9	0.2	0.1
Percentage of stand basal area (%)	100.0	52.1	23.6	12.2	9.5	2.3	0.2	0.2
Stems Per Unit Area (stems per acre)	230	122.9	56.1	12.8	8.6	2	19.1	8.4
Quadratic Mean DBH (inches)	8.2	8.1	8	12.1	13	13.3	1.4	1.8
Relative Density (percent)	57.87	36.62	8.26	4.97	6.49	1.11	0.18	0.24
Sawtimber gross total (board feet/acre)	6,905	3,379	1,886	867	617	155	0	0
Pulpwood gross total (cords)	908	495	182	103	106	19	1	2
Pulpwood net total (cords)	726	396	145	82	85	15	1	2
Gross total (cords)	2,060	1,051	500	254	203	49	1	2
Net total (cords)	1,648	841	400	203	162	39	1	2

Table 24. Stand 3 – White Pine-Oak 2028 Projected Overstory Data Table (Stems ≥ 5" dbh)

	All species	Black Oak (Quercus velutina)	Eastern White Pine (Pinus strobus)	Red Pine (Pinus resinosa)	Scarlet Oak (Quercus coccinea)	Pitch Pine (Pinus rigida)	Red Maple (Acer rubrum)	White Oak (Quercus alba)
Basal Area (square feet)	99.7	48.8	27.3	12.5	8.5	2.2	0.2	0.2
Percentage of stand basal area (%)	100.0	49.0	27.4	12.5	8.6	2.2	0.2	0.2
Stems Per Unit Area (stems per acre)	205.2	81.5	87.9	12.5	7.7	1.9	9.6	4.0
Quadratic Mean DBH (inches)	9.4	10.5	7.5	13.5	14.2	14.5	2.2	2.8
Relative Density (percent)	66.02	39.88	11.69	5.85	6.86	1.21	0.30	0.23
Sawtimber gross total (board feet/acre)	8,770	3,981	2,617	1,232	696	244	0	0
Pulpwood gross total (cords)	1,039	548	231	123	112	21	2	2
Pulpwood net total (cords)	831	439	185	99	89	17	1	2
Gross total (cords)	2,497	1,210	677	323	225	57	2	2
Net total (cords)	1,997	968	541	259	180	46	1	2

Table 25. Stand 3 – White Pine-Oak 2063 Projected Overstory Data Table (Stems ≥ 5" dbh)

	All species	Black Oak (Quercus velutina)	Eastern White Pine (Pinus strobus)	Red Pine (Pinus resinosa)	Scarlet Oak (Quercus coccinea)	Pitch Pine (Pinus rigida)	Red Maple (Acer rubrum)	White Oak (Quercus alba)
Basal Area (square feet)	131.4	53.9	49.1	17.0	8.5	2.6	0.2	0.1
Percentage of stand basal area (%)	100.0	41.0	37.4	13.0	6.4	2.0	0.1	0.1
Stems Per Unit Area (stems per acre)	138.6	42.7	73.9	11.5	5.6	1.7	2.2	0.9
Quadratic Mean DBH (inches)	13.2	15.2	11.0	16.4	16.6	16.8	3.9	5.4
Relative Density (percent)	76.19	42.13	18.25	7.53	6.62	1.32	0.19	0.15
Sawtimber gross total (board feet/acre)	12,991	4,921	5,166	1,880	721	298	0	5
Pulpwood gross total (cords)	1,322	579	451	158	107	24	2	1
Pulpwood net total (cords)	1,057	463	361	127	85	19	1	1
Gross total (cords)	3,413	1,397	1,243	466	233	70	2	2
Net total (cords)	2,730	1,117	995	373	186	56	1	2

Table 26. Stand 4 – White Pine-Hardwoods 2015 Projected Overstory Data Table (Stems ≥ 5" dbh)

	All species	Black Oak (Quercus velutina)	Eastern White Pine (Pinus strobus)	Scarlet Oak (Quercus coccinea)	White Oak (Quercus alba)	Red Maple (Acer rubrum)	Black Cherry (Prunus serotina)
Basal Area (square feet)	61.4	32.7	21.4	3.4	2.4	1.2	0.2
Percentage of stand basal area (%)	100.0	53.3	34.9	5.5	4.0	2	0.3
Stems Per Unit Area (stems per acre)	306.4	113.7	71.5	3.1	41.5	61.6	15.1
Quadratic Mean DBH (inches)	6.1	7.3	7.4	14.1	3.3	1.9	1.6
Relative Density (percent)	46.41	28.94	9.56	2.7	3.04	1.33	0.83
Sawtimber gross total (board feet/acre)	4,019	2,093	1,653	273	0	0	0
Pulpwood gross total (cords)	625	359	210	44	3	10	0
Pulpwood net total (cords)	500	287	168	35	3	8	0
Gross total (cords)	1,292	695	496	88	3	10	0
Net total (cords)	1,034	556	397	70	3	8	0

Table 27. Stand 4 – White Pine-Hardwoods 2028 Projected Overstory Data Table (Stems ≥ 5" dbh)

	All species	Black Oak (Quercus velutina)	Eastern White Pine (Pinus strobus)	Scarlet Oak (Quercus coccinea)	White Oak (Quercus alba)	Red Maple (Acer rubrum)	Black Cherry (Prunus serotina)
Basal Area (square feet)	83.1	40.3	33.1	4.0	3.3	1.7	0.7
Percentage of stand basal area (%)	100.0	48.5	39.9	4.8	3.9	2	0.9
Stems Per Unit Area (stems per acre)	230.8	86.4	68.6	2.9	26.0	36.1	10.9
Quadratic Mean DBH (inches)	8.1	9.2	9.4	15.9	4.8	2.9	3.5
Relative Density (percent)	57.21	34.24	13.38	3.13	3.55	1.90	1.01
Sawtimber gross total (board feet/acre)	5,898	2,823	2,740	336	0	0	0
Pulpwood gross total (cords)	842	444	292	51	43	13	0
Pulpwood net total (cords)	674	355	234	40	34	10	0
Gross total (cords)	1,838	905	770	108	43	13	0
Net total (cords)	1,470	724	616	86	34	10	0

Table 28. Stand 4 – White Pine-Hardwoods 2063 Projected Overstory Data Table (Stems ≥ 5" dbh)

	All species	Black Oak (Quercus velutina)	Eastern White Pine (Pinus strobus)	Scarlet Oak (Quercus coccinea)	White Oak (Quercus alba)	Red Maple (Acer rubrum)	Black Cherry (Prunus serotina)
Basal Area (square feet)	125.4	64.0	49.2	5.0	3.6	1.8	1.7
Percentage of stand basal area (%)	100.0	51.1	39.2	4.0	2.9	1.5	1.3
Stems Per Unit Area (stems per acre)	146.7	62.2	51.9	2.4	10.9	7.2	12.1
Quadratic Mean DBH (inches)	12.5	13.7	13.2	19.7	7.8	6.8	5.0
Relative Density (percent)	71.86	22.59	39.34	3.80	3.37	1.25	1.51
Sawtimber gross total (board feet/acre)	11,038	6,403	4,084	524	14	0	14
Pulpwood gross total (cords)	1,401	684	545	61	67	32	13
Pulpwood net total (cords)	1,121	547	436	49	53	25	11
Gross total (cords)	3,181	1,709	1,214	142	69	32	16
Net total (cords)	2,545	1,367	971	113	55	25	13

Figure 1. Stand 1 Conditions Pre-Treatment 2013 (SVS)

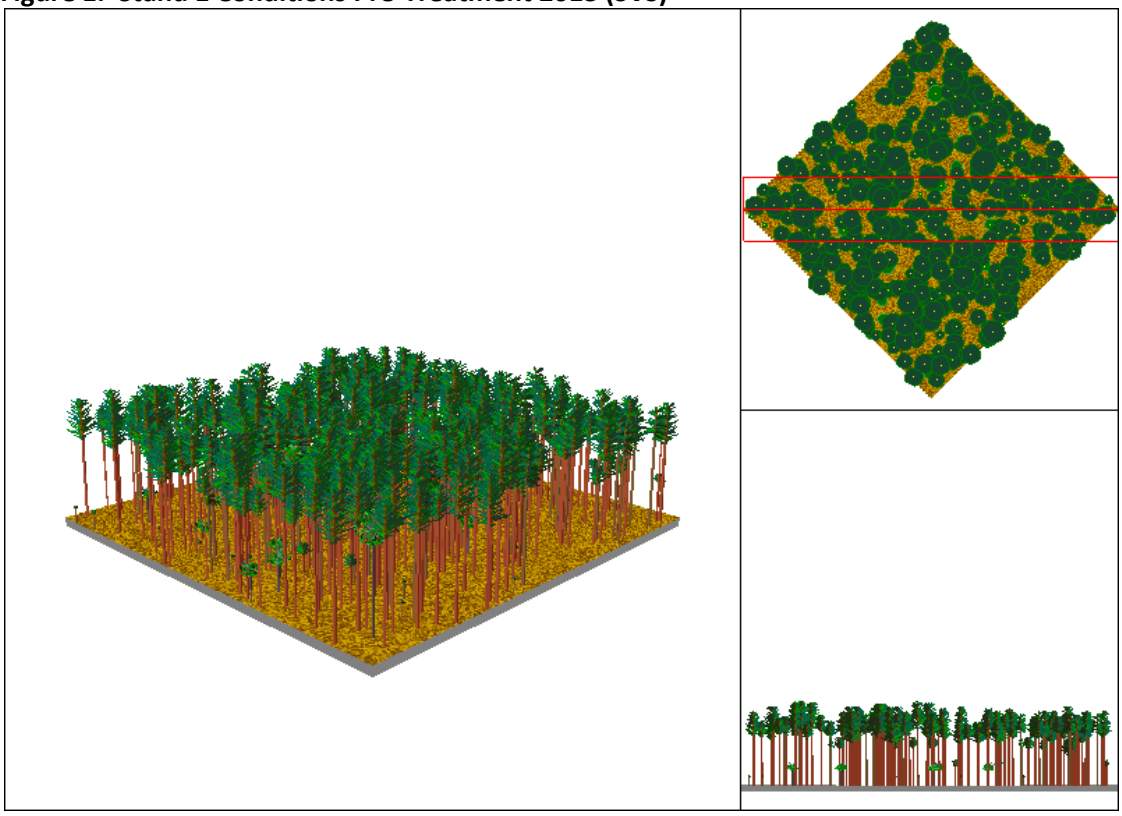


Figure 2. Stand 1 Conditions Post-Treatment 2028 (SVS)

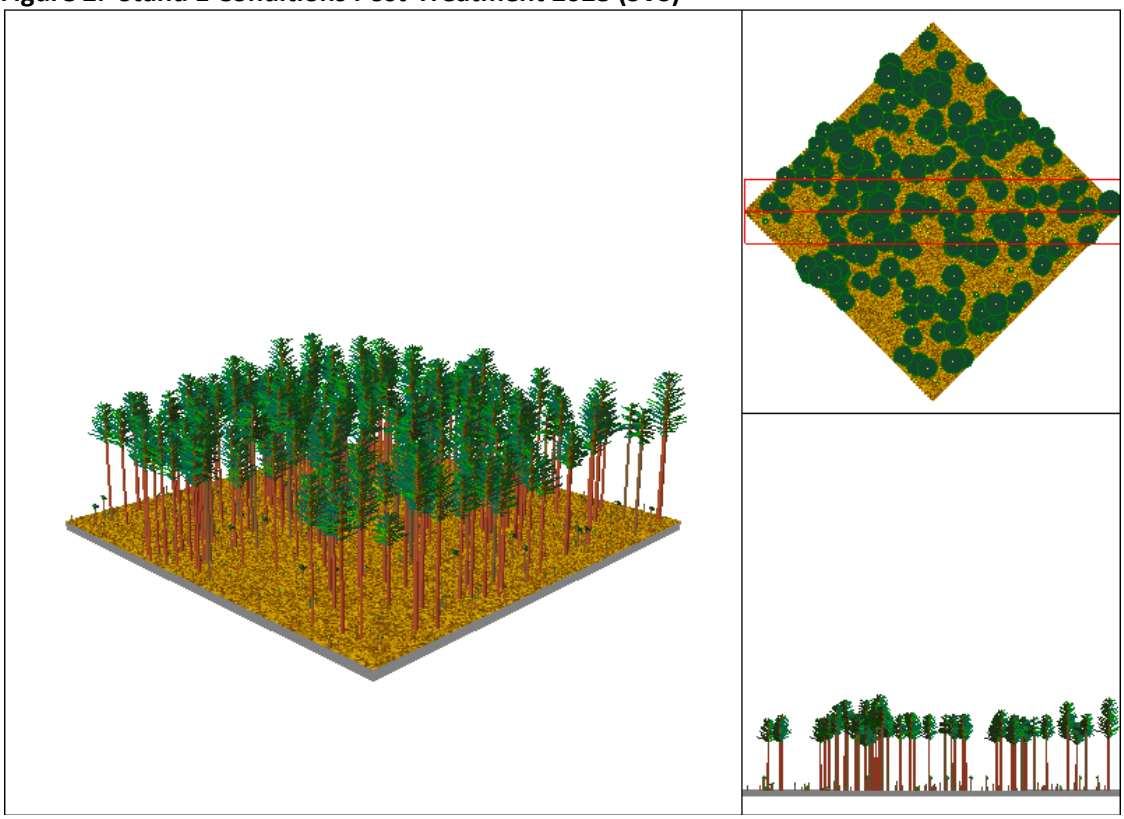


Figure 3. Stand 2 Conditions Pre-Treatment 2013 (SVS)

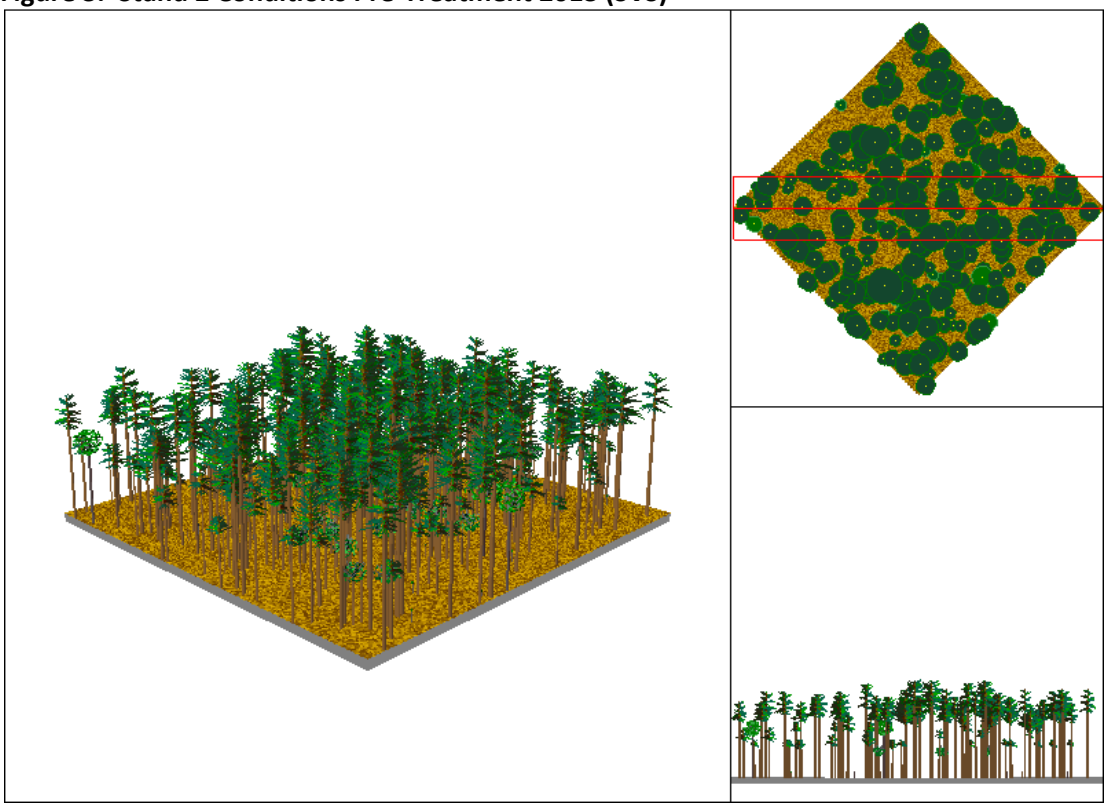


Figure 4. Stand 2 Conditions Post-Treatment 2028 (SVS)

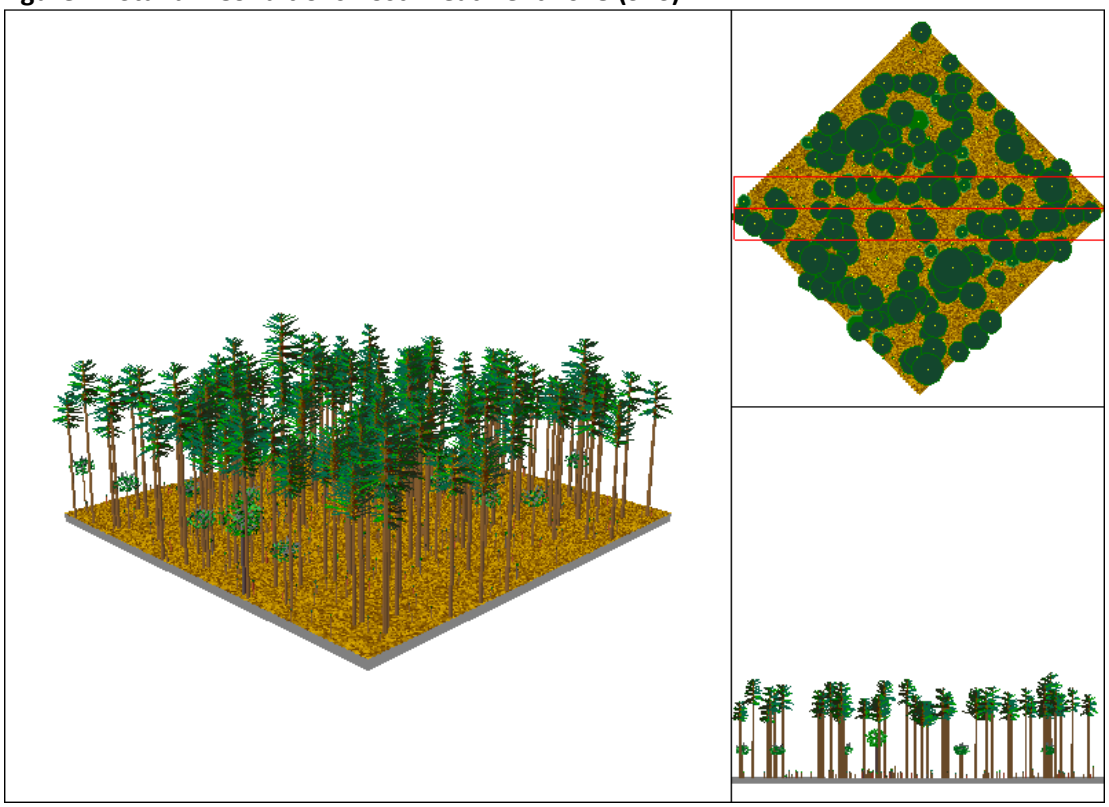


Figure 5. Stand 3 Conditions Pre-Treatment 2013 (SVS)

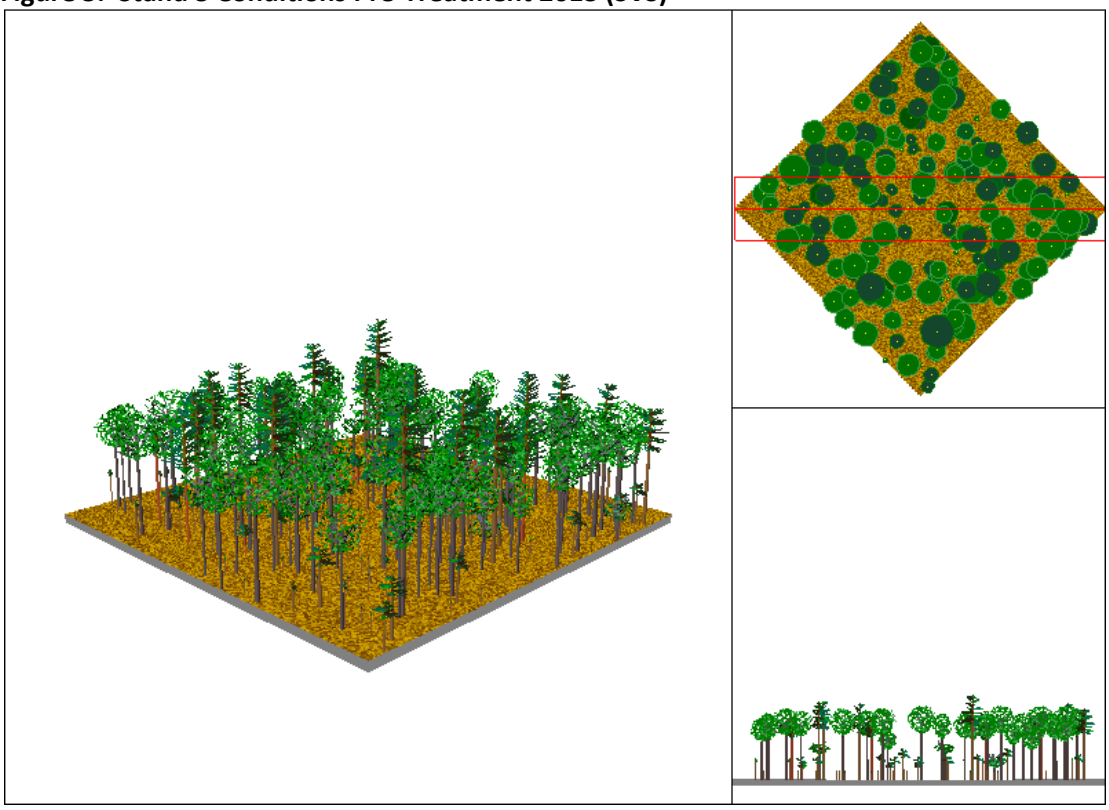


Figure 6. Stand 3 Conditions Post-Treatment 2028 (SVS)

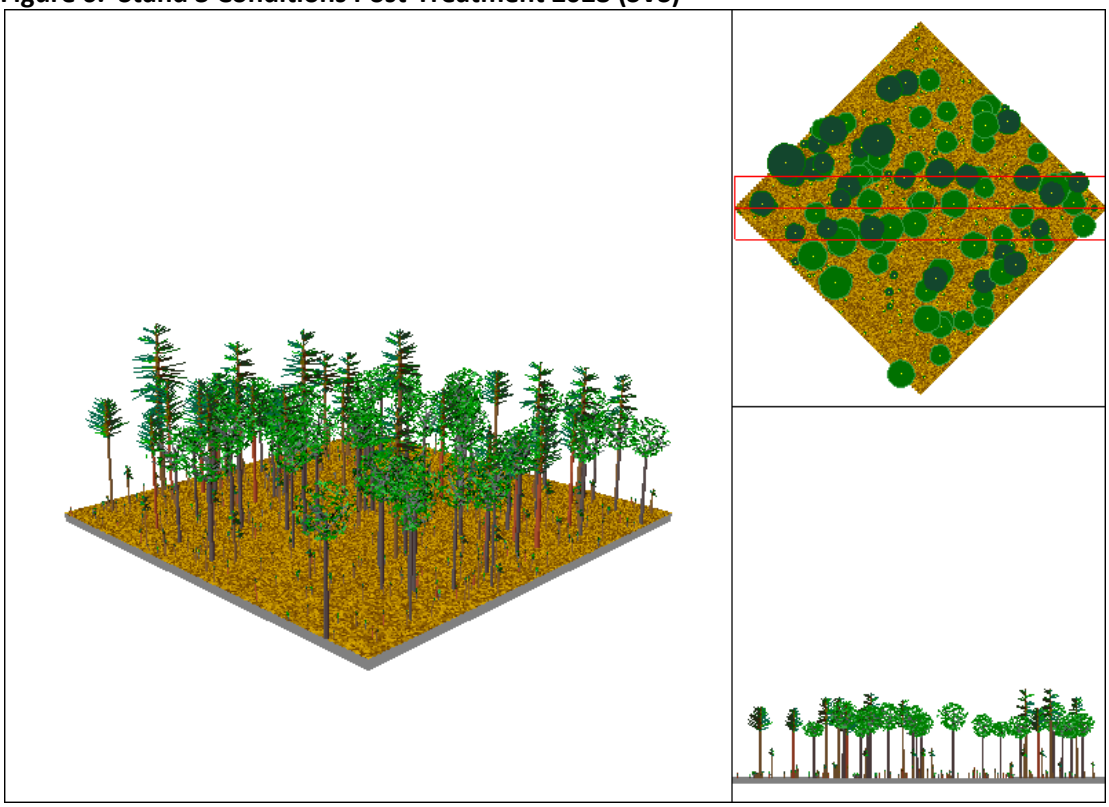


Figure 7. Stand 4 Conditions Pre-Treatment 2013 (SVS)

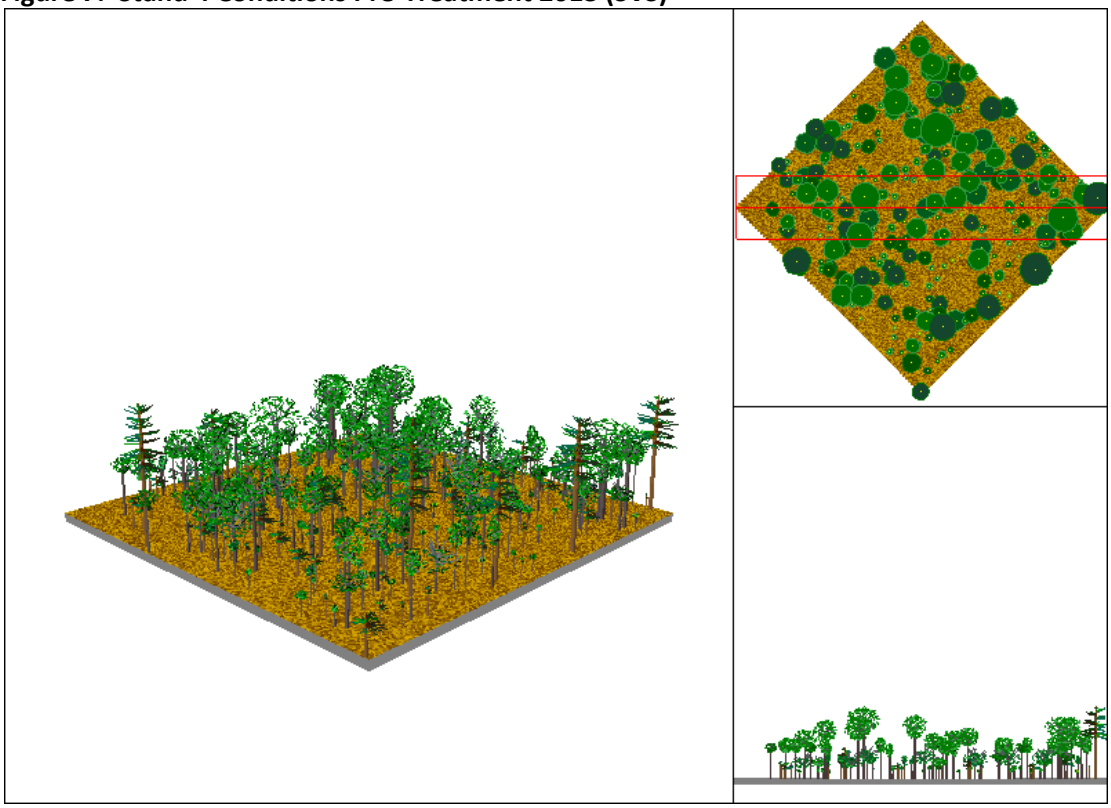
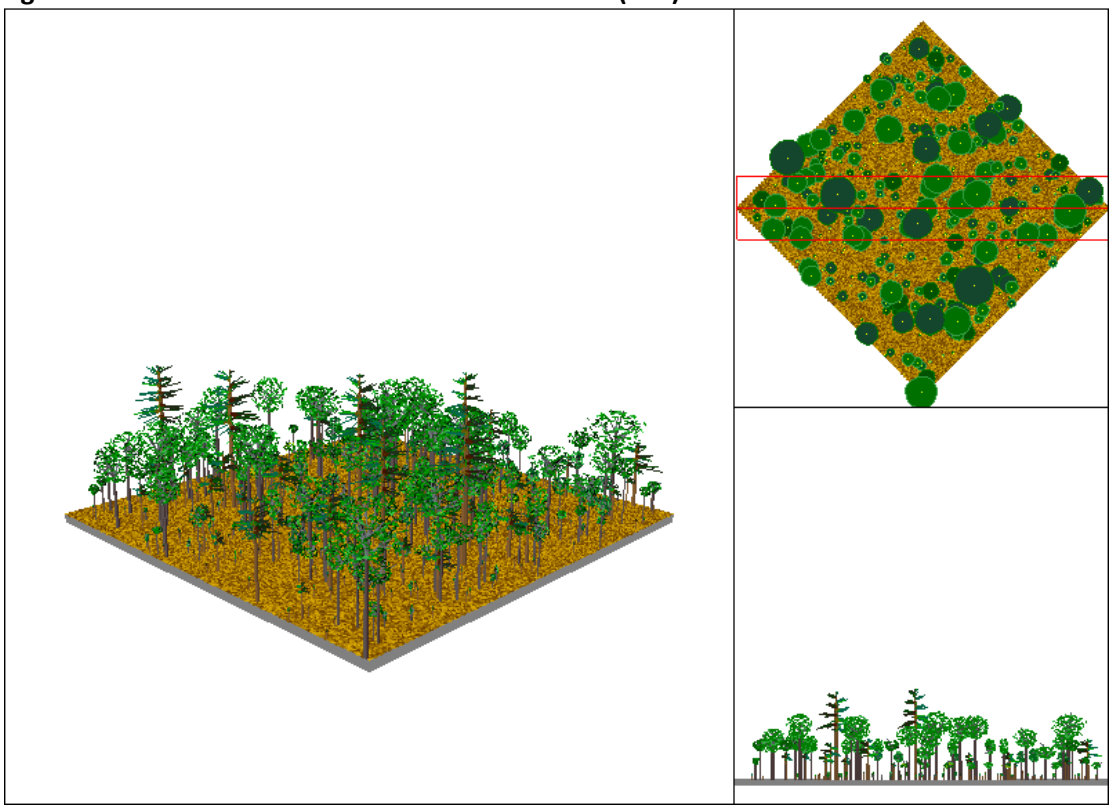
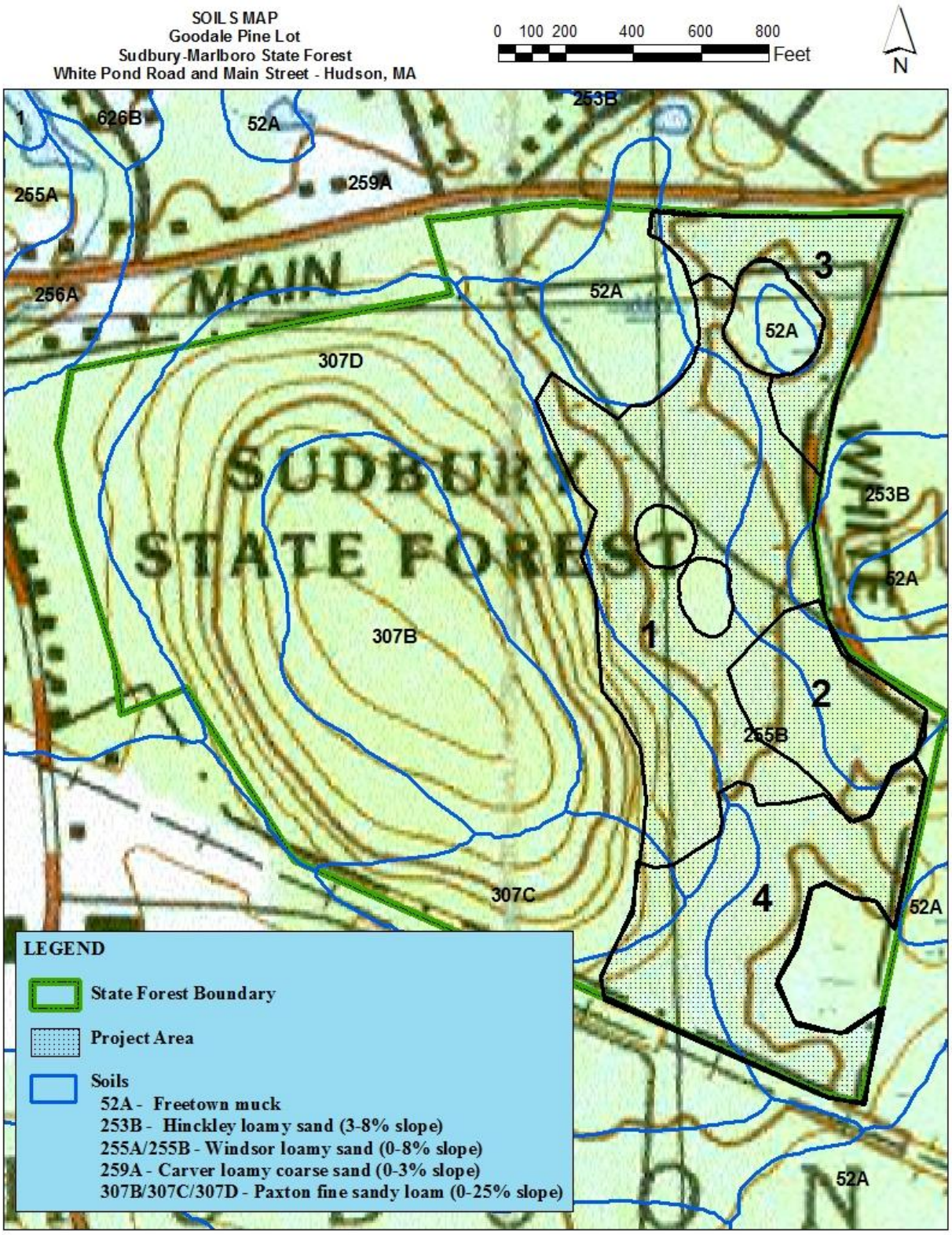
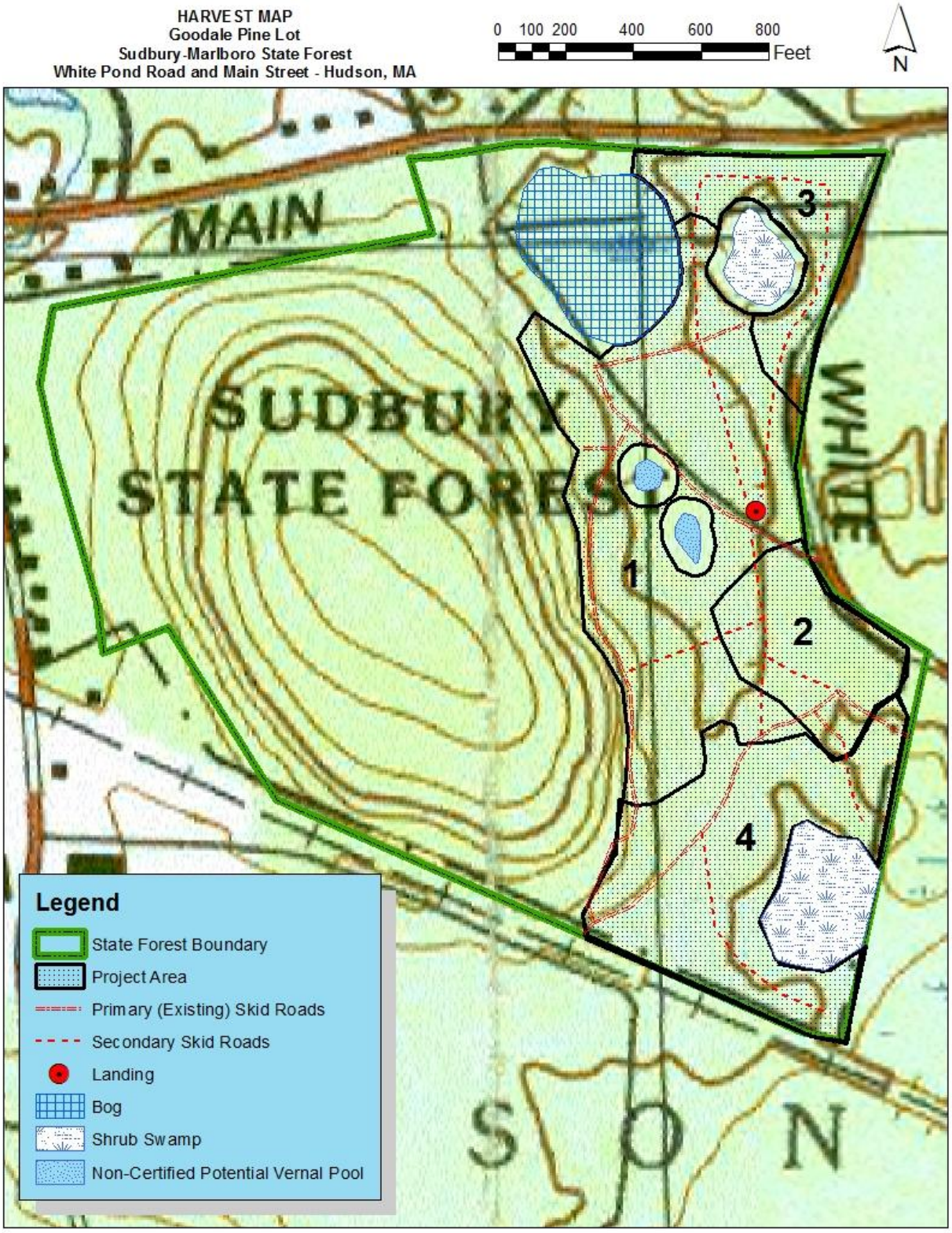


Figure 8. Stand 4 Conditions Post-Treatment 2028 (SVS)



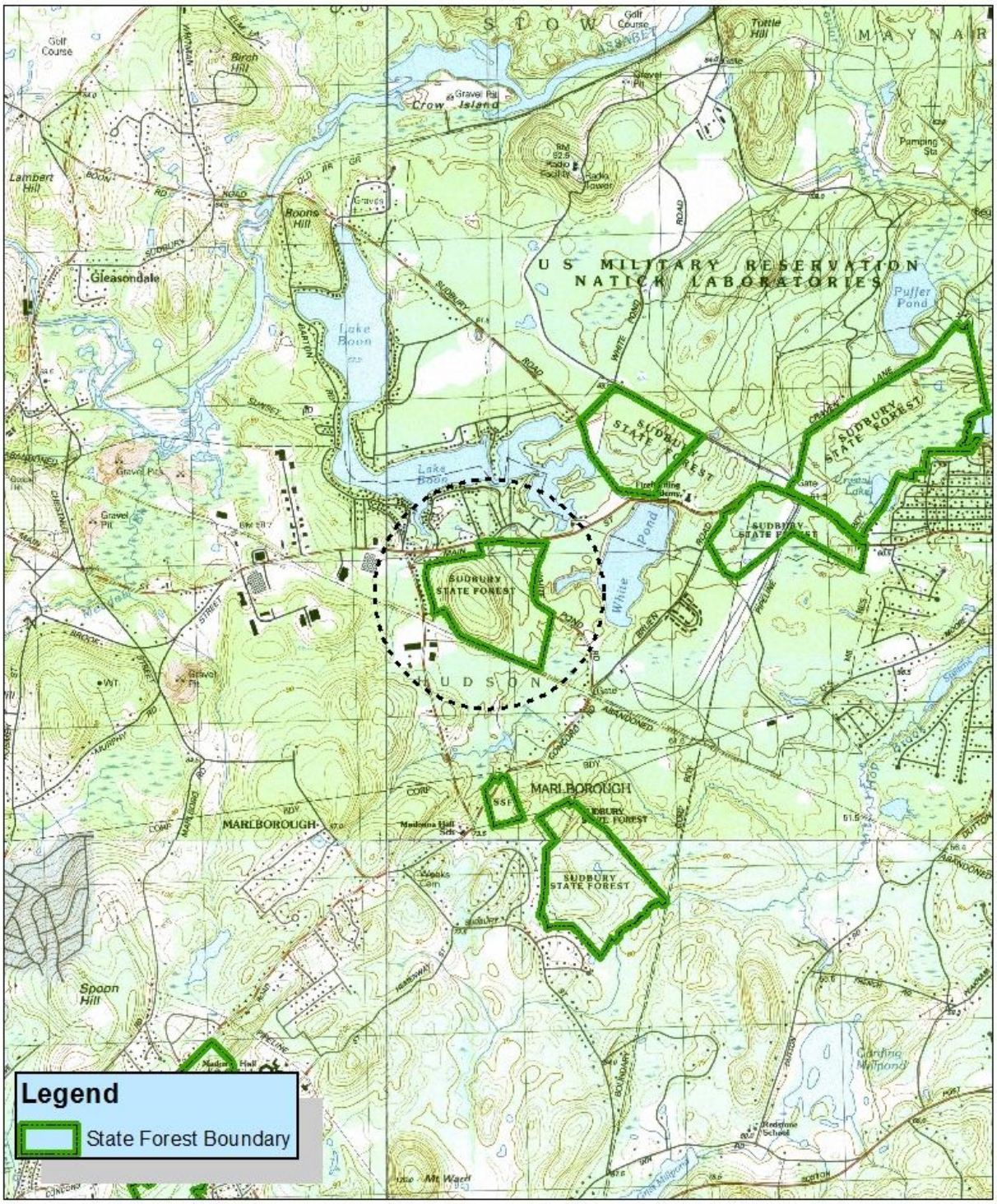

SOIL S MAP
Goodale Pine Lot
Sudbury-Marlboro State Forest
White Pond Road and Main Street - Hudson, MA
0 100 200 400 600 800
Feet
N
1
626B
52A
253B
255A
259A
256A
MAIN
52A
3
52A
307D
SUDBURY
STATE FOREST
253B
52A
307B
1
2
255B
307C
4
52A
52A
LEGEND
State Forest Boundary
Project Area
Soils
52A - Freetown muck
253B - Hinckley loamy sand (3-8% slope)
255A/255B - Windsor loamy sand (0-8% slope)
259A - Carver loamy coarse sand (0-3% slope)
307B/307C/307D - Paxton fine sandy loam (0-25% slope)


HARVEST MAP
Goodale Pine Lot
Sudbury-Marlboro State Forest
White Pond Road and Main Street - Hudson, MA
0 100 200 400 600 800
Feet
N
MAIN
SUDBURY
STATE FOREST
WHITE
1
2
3
4
Legend
State Forest Boundary
Project Area
Primary (Existing) Skid Roads
Secondary Skid Roads
Landing
Bog
Shrub Swamp
Non-Certified Potential Vernal Pool

LOCUS MAP
Goodale Pine Lot
Sudbury-Marlboro State Forest
White Pond Road and Main Street - Hudson, MA

0 750 1,500 3,000 4,500 6,000 Feet

N



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