SAGE
ENVIRONMENTAL

June 22, 2020

Mr. Anthony Delvicario
43 Creston Way
Warwick, RI 02886
Sent via email to: a.delvicario@att.net

RE: Additional Information Requested during the May 21, 2020 Planning Board Meeting
Douglas Pike Solar (A.P. 10, Lots 24 & 218)
North Smithfield, Rhode Island
SAGE Project No. M909

Dear Mr. Delvicario:

During the May 21, 2020 Town of North Smithfield's Planning Board meeting there were some additional details requested pertaining to the Douglas Pike Solar Photovoltaic System Development located at Assessors Plat 10 Lots 24 and 218 (hereinafter the Site). The additional details requested were the following:

- Comparison of the wildlife and wildlife habitat values of the conservation area currently present within the Site versus the proposed conservation area
- Additional details about the archeological resources on the Site
- Preparation of a reforestation plan for affected acres on the Site upon decommissioning of the solar project

Conservation Area Wildlife Comparison

Natural Resource Services, Inc. (NRS) who prepared a habitat analysis for the Site in support of the Master Plan review process evaluated the wildlife and wildlife habitat values of the 10-acre conservation area present within the Site versus the project's proposed 56-acre conservation area. The findings of the evaluation is such that the proposed 56-acre conservation area provides significant improvements to the preservation and protection of wildlife and wildlife habitat from the current 10-acre conservation area. The proposed conservation area conserves more overall land, provides more upland forest, preserves the shoreline of Tarkiln Pond and preserves a linear wildlife corridor along the entire northern portion of the Site. **Attachment 1** provides the full details of the evaluation conducted by NRS.

Archeological Resources

The Public Archaeology Laboratory, Inc. (PAL Inc.) completed an archaeological survey of Site in April 1996. The archaeological survey is documented in a report titled "*A Rare Look into Rhode Island's Upland Interior: An Archaeological Survey Of Gold Farm, North Smithfield, Rhode Island*". The survey was funded by David and Marcia Gold to benefit the Women's Center of Rhode Island. The archaeological survey identified two small Native American sites containing lithic chipping debris and a small stemmed projectile point. The report in its entirety is available by contacting David Gold, a summary prepared by PAL Inc. is

provided in **Attachment 2**. **Attachment 3** provides a map depicting the location of these cultural/historical structures. As denoted on the map, the archeological resources identified by PAL are in the proposed 56-acre conservation area.

Reforestation Plan

The development of the Site encompasses approximately 50 acres of land that will be cleared for the project. Included within this acreage are access roads that occupy approximately 0.5 acres of land, resulting in 49.5 acres of land that would require re-vegetation should the Town want the Site to be reforested upon decommissioning. Land Management Services prepared a reforestation plan that addresses the future process and costs associated with re-vegetation of the Site. It is estimated that the total reforestation cost would be just under $91,000. This cost includes the seedlings, shrubs, tree tubes, stakes, and ties, along with the labor, equipment costs, and overhead required for conducting the planting operation. **Attachment 4** provides the reforestation plan.

Should you have any questions or concerns, please do not hesitate to contact me.

Sincerely,
SAGE Environmental, Inc.

Nicole Mulanaphy, P.E.
Senior Project Manager

Attachments:

Attachment 1: NRS Conservation Area Wildlife Comparison
Attachment 2: PAL, Inc. Archeological Summary
Attachment 3: Map of Historical Structures
Attachment 4: Land Management Service Reforestation Plan

Attachment 1: NRS Conservation Area Wildlife Comparison

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Natural Resource Services, Inc.

Addendum to Narrative in Support
of Master Plan Approval

Douglas Pike Solar
A.P. 10, Lot 218

Prepared for:
Anthony Delvicario
43 Creston Way
Warwick, RI 02886

Prepared by:

Scott P. Rabideau, PWS
Principal

June 17, 2020

P.O. Box 311 Harrisville, RI 02830 401-568-7390 FAX 401-568-7490

Purpose of Addendum

Natural Resource Services, Inc. (NRS) has been asked by Sage Environmental, Inc. (Sage) on behalf of the Douglas Solar principal, Anthony Delvicario, to prepare an addendum to the October 16, 2019 project narrative. The purpose of the addendum is to provide a direct comparison of the wildlife and wildlife habitat values of the 10-acre conservation area present within the property versus the project proponent's proposed 56-acre conservation area.

Figure 1 depicts the approximate limits of the existing and proposed conservation areas. The opinions expressed in this addendum are based upon the original data collected by NRS for the project narrative along with a subsequent site visit in June, 2020.

Description of the Existing Conservation Area

The existing conservation area is located in the southwest section of lot 218. The area is triangular in shape and 10 acres in size. The vast majority of the conservation area is upland forest (approximately 9.75 acres) with a small area of shrub swamp at its northernmost tip (approximately 0.25 acres).

The upland forest features a rolling topography, including areas with relatively steep slopes. The RI Soil Survey depicts the area as underlain with a Hinckley soil series. This is an outwash deposit present throughout most of the property.

NRS has classified the entire upland portion of the conservation easement area as mixed oak/pine forest. NRS established a habitat assessment area data plot (HA 4) adjacent to the conservation easement area. The vegetative composition of the area can be extrapolated from this data (see Figure 2).

There is an isolated shrub wetland at the northern limit of the conservation area. This wetland has bog-like characteristics, as it is contained in a bowl type depression and has an abundance of sphagnum moss covering the surface. The conservation easement encumbers approximately half of this shrub wetland.

Description of Proposed Conservation Area

The conservation area proposed as a "swap" by the project proponent consists of 56 acres stretching from Tarkiln Pond easterly to the property's Mattity Road frontage. The area effectively includes the entire northern and eastern half of the lot. The proposed conservation area includes approximately 31.4 acres of upland and 25 acres of wooded swamp.

The majority of the upland forest is situated at the western limit of the proposed conservation area. A smaller area is situated at the eastern end of the property. There is approximately 17 acres of upland forest contained within the proposed conservation area.

NRS has classified this upland forest as mixed oak/pine forest, the same classification as the existing conservation area. Habitat assessment data plot number 5 provides information on the vegetative composition.

It should be noted that the proposed conservation area preserves approximately 70 percent more upland forest than the existing conservation area. Also, the proposed area will provide over 800 linear feet of direct frontage along Tarkiln Pond.

The remaining land within the proposed conservation area consists of either forested or shrub swamp. These wetlands are currently subject to the protections afforded by the RI Freshwater Wetlands Act (RIGL 2-1-18 et. seq.)

Habitat Assessment Value Comparison

The existing conservation easement encumbers a monotypic mixed oak/pine upland forest. The easement area also covers a section of an isolated shrub wetland. The total area protected is 10 acres.

The proposed conservation easement area would encumber approximately 17 acres of similar mixed oak/pine upland forest, a 70 percent increase in the preservation of this habitat type. The proposed easement area also provides direct shoreline access along Tarkiln Pond. This 800 plus feet of shoreline would be preserved in a natural state if the proposed easement area was adopted.

The proposed easement area would also encompass approximately 25 acres of shrub and forested wetland. Each of these biological wetlands represent high value wildlife habitat. However, it should be acknowledged as part of any comparison that these freshwater wetlands are currently protected resource areas under state law.

Based upon a comparison of the conditions within the existing and proposed conservation easement areas, the proposed area is larger in total (10 acres versus 56 acres), preserves approximately 70 percent more of the on-site upland forest (10 acres versus 17 acres), and preserves over 800 linear feet of naturalized shoreline along Tarkiln Pond. The proposed conservation area also protects 25 acres of freshwater wetland.

NRS concludes that the proposed conservation easement area shall:

1) Preserve more overall land
2) Preserve more upland forest
3) Preserve Tarkiln Pond shoreline
4) Preserve a linear wildlife corridor along the entire northern portion of the property

These are significant improvements to the preservation and protection of wildlife and wildlife habitat values from the conditions present within the existing conservation easement.

Conservation Areas Legend

- Local Conservation Area (+/- 10 ac.)
  Approx. Wetland Area (+/- 0.25 ac.)
  Approx. Upland Area (+/- 9.75 ac.)
- Approx. Proposed Conservation Area (+/- 56.14 ac)
  Approx. Wetland Area (+/- 25 ac.)
  Approx. Upland Area (+/- 31.14 ac.)

Legend

- Approximate Site Location (+/- 121 ac)
- Approx. Proposed "Usable Area" (+/- 36.5 ac)
- Approx. Habitat Assessment Point
- Approx. Wooded Swamp (+/- 31 ac)
- Approx. Agricultural Land (+/- 6.9 ac)
- Approx. Ruderal Grass/Shrubland (+/- 3 ac)
- Approx. Ruderal Forest (+/- 19.6 ac)
- Approx. Mixed Oak/White Pine Forest (+/- 60.5 ac)
- Approx. River/Stream Location

HA5
HA6
HA4
up25
up26-S
Douglas Pike
Mattity Rd
Nichols Rd
Log Rd
Toni Cir
Brookside Dr
Beachway

FOR ILLUSTRATIVE PURPOSES ONLY
NOT A SURVEY PLAN

Performed by Carolyn Decker 8/1/19
using handheld Trimble Geo7X
and aerial photo interpretation

Habitats classified according to:
Enser, et al. 2011 Rhode Island Ecological Communities Classification. Technical Report. Rhode Island Natural History Survey, Kingston, RI.

Wetland edges, streams, usable area, and conservation areas referenced from "Site Plan with Conserv. Areas, Sheet 5 of 5" by DiPrete Engineering dated 12/9/19

Figure 1:
Limits of Exising and Proposed Conservation Easement Area
Douglas Pike; A.P. 10, Lot 218
North Smithfield, RI

Prepared by
Scott P. Rabideau, PWS
June 17, 2020

0 200 400 800 Feet

N W E S

April 2019 aerial
RI DEM Mapping

Natural Resource Services, Inc.
PO Box 311
180 Tinkham Lane
Harrisville, RI 02830
p: (401) 568-7390
f: (401) 568-7490

Figure 2: NRS Habitat Data

NRS File No. 19-220	**Douglas Pike, A.P. 10, Lot 218**	**Site Visit: 8/1/19**	**Weather: sunny ~85F**
HABITAT ASSESSMENT FIELD DATA	**North Smithfield, RI**		

Habitat Assessment Point (sample)	Species Common Name	Species Scientific Name	Tree	Shrub/ Sapling	Emergent/ Fern	Vine	Herb	Relative Abundance within Sample Layer	Relative Abundance within Sample Total
			Species % Cover	Species % Cover	Species % Cover	Species % Cover	Species % Cover	(Species as % of Physiognomic Layer)	(Species as % of all Layers)
HA4	White Pine	*Pinus strobus*	50					56%	32%
Mixed Oak/Pine Forest	Red Oak	*Quercus rubra*	25					28%	16%
	Red Maple	*Acer rubrum*	10					11%	6%
	Sugar Maple	*Acer saccharum*	5					6%	3%
	White Pine	*Pinus strobus*		35				78%	23%
	Low Bush Blueberry	*Vaccinium angustifolium*		10				22%	6%
	Eastern Spicy Wintergreen	*Gaultheria procumbens*					5	25%	3%
	Partridge Berry	*Mitchella repens*					5	25%	3%
	Pipsissewa	*Chimaphila maculata*					5	25%	3%
	Canada Mayflower	*Maianthemum canadense*					5	25%	3%
Layer Total % Cover			90	45			20		155
Notes: rolling topography, young pine understory, mature oak/pine/maple canopy, abundant woody debris, moderate # of small cavities in trees, some snags, black oak and mockernut hickory also nearby tufted titmice, american crow, blue jay, black capped chickadee									
HA5	Black Oak	*Quercus velutina*	30					43%	21%
Mixed Oak/Pine Forest	White Pine	*Pinus strobus*	20					29%	14%
	Red Oak	*Quercus rubra*	10					14%	7%
	Red Maple	*Acer rubrum*	10					14%	7%
	Black Huckleberry	*Gaylussacia baccata*		30				67%	21%
	Low Bush Blueberry	*Vaccinium angustifolium*		15				33%	10%
	Poverty Grass	*Danthonia spicata*					15	50%	10%
	Path Rush	*Juncus tenuis*					15	50%	10%
Layer Total % Cover			70	45			30		145
Notes: high ground above steep drop to pond, abundant woody debris, pines young and dense, majority of trees less tall than interior fo property, some small cavities, a few large cavitites, several snags nearby in forest are stands of oaks with few pines but most areas are intermixed, american robins									
HA6	Red Maple	*Acer rubrum*	35					100%	14%
Shrub Swamp	High Bush Blueberry	*Vaccinium corymbosum*		50				56%	20%
(Shrub Swamp)	Blue Huckleberry	*Gaylussacia frondosa*		25				28%	10%
	Winterberry	*Ilex verticillata*		10				11%	4%
	Sweet Pepperbush	*Clethra alnifolia*		5				6%	2%
	Tussock Sedge	*Carex stricta*			60			80%	24%
	Broad-leaved Cattail	*Typha latifolia*			10			13%	4%
	Marsh Fern	*Thelypteris palustris*			5			7%	2%
	Sphagnum Moss	*Sphagnum sp.*					30	60%	12%
	Skunk Cabbage	*Symplocarpus foetidus*					20	40%	8%
Layer Total % Cover			35	90	75		50		250
Notes: near wetland edge at bottom of steep slope, most trees dead, wetland becomes more shrubby to the north, wetland saturated/standing water, extremely dense shrub interior, mucky soil, abundant woody debris and rotting logs, more Clethra deeper in wetland, hairy woodpecker, red tailed hawk									

Attachment 2: PAL, Inc. Archeological Summary

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Public Archaeology Laboratory

June 16, 2020

Nicole Mulanaphy, P.E.
Senior Project Manager
Sage Environmental, Inc.
172 Armistice Boulevard
Pawtucket, RI 02860

Re: Gold Farm Property Archaeological Resources

Dear Ms. Mulanaphy;

In 1996, The Public Archaeology Laboratory, Inc. conducted archaeological investigations on the Gold Farm in North Smithfield, RI. The investigations led to the identification of two small Native American sites containing lithic chipping debris, the result of manufacturing and maintaining stone tools, and a Small Stemmed projectile point. These types of archaeological sites are found in numerous settings throughout southern New England and northern Rhode Island is no exception.

The Gold Farm 1 Site is a very low-density lithic scatter (11 small fragments). It is approximately 30-x-60 feet in size and, at the time of identification, had good physical integrity. The Gold Farm 2 Site contained more material and a projectile point, a type that was manufactured over thousands of years, and is the only indicator of the site's age. The Gold Farm 2 Site appeared to be approximately 30-x-45 feet in size but that may only be a remnant piece of the original site area. The site was disturbed by a historic logging road. These two sites range in age from 3,000 to 5,000 years ago; it is not possible to be more specific without material suitable for radiocarbon dating.

PAL staff also recorded the Augustus E. Field Piggery dating to the last quarter of the nineteenth century and the Sayles Burying Ground, utilized in the late eighteenth and early nineteenth centuries.

The two Native American archaeological sites are not recommended as significant or eligible to the State or National Register of Historic Places. The Piggery is an interesting part of husbandry history in North Smithfield but further archaeological investigation is unlikely to yield information that cannot be obtained from historical records. The Sayles Burying Ground should be preserved and maintained.

26 Main Street Pawtucket, RI 02860 | 401.728.8780 Main | 401.728.8784 Fax
palinc.com

Public Archaeology Laboratory

If you have any questions or need further information, please do not hesitate to call me at your convenience.

Regards,

Deborah C. Cox, RPA
President

26 Main Street Pawtucket, RI 02860 | 401.728.8780 Main | 401.728.8784 Fax
palinc.com

Attachment 3: Map of Historical Structures

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Native American
archaeological site locations
added by RIHPHC 1-13-2020

RI-2141

RI-2142

Joseph Inman Lot Cemetery

Cemetery North Smithfield #41

Elijah Smith Cemetery

Augustus Fields Swinery/
Field's Railroad Station

Sterry Young Lot Cemetery

NICHOLS RD

LOG RD

MATTITY RD

MATTITY RD

BROOKSIDE DR

OVERLEA RD

7

Site Location

Legend

- Approximate Property Boundary
- 500' Buffer from Solar Panels
- Solar Panel Locations
- Historical Cemeteries
- Historic Sites

N

0 87.5 175 350 Feet

Data Provided by RIGIS
Orthoimagery provided by nearmap

Cultural/Historic Resources (2019)

Douglas Pike Solar
AP 10, Lot 218
North Smithfield, Rhode Island

Date: 09/20/2019

Job#:

Created By: ALM

Figure

SAGE ENVIRONMENTAL

Attachment 4: Land Management Service Reforestation Plan

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LAND MANAGEMENT SERVICES
303 Courthouse Lane, Pascoag, RI 02859
401-568-3410
mstremb@cox.net

June 8, 2020

Reforestation Plan
Proposed Douglas Pike (Gold) Solar Project

Subject Property:
AP 10, Lot 218
Bel Air Realty, LLC
North Smithfield, RI

Purpose:

The proposed development of a solar array on the subject property will involve establishment of access roads, sediment basins, electrical equipment, and the rows of ground-mounted solar panels that will require the clearing of approximately 50 acres of a 122.5-acre property in No. Smithfield, RI. The subject site is currently forested with a mix of old-field White pine and a mix of pines and hardwoods on well-drained to excessively well-drained soils. The eastern portion of the subject site has been subject of a previous gravel mining operation.

This Reforestation Plan addresses the future process and costs associated with the reforestation of the affected acres upon decommissioning of the solar project. The projected timeframe for this plan is 30 years from its installation, and the plan would be implemented upon completion of the removal of the solar arrays from the property. Therefore, the reforestation practices are projected for the year 2050, with present costs calculated. Present costs can be amortized for the year 2050. There are options to renew contracts for energy production, depending on the technology and demand for this type of renewable energy at that time. Projected costs would need to be adjusted for any advanced timeframes at that time.

Scope of Project:

As designed by DiPrete Engineering, the solar array sites on the subject property encompass a total of 50 acres of land that will be cleared for the project. Included within that acreage are access roads that should be retained for future use as woods roads. These access roads occupy approximately 0.5 acres of land, resulting in 49.5 acres of land that will be re-vegetated upon decommissioning of the solar project in 2050. This reforestation plan incorporates the planting of tree and shrub species on all of the disturbed areas, save the access roads mentioned above.

Environmental Factors Impacting Reforestation Efforts:

There are a number of factors that will influence the nature and success of reforestation efforts on this property. The existing soil types, the extent of grading to establish the solar project, soil

compaction during the construction and future maintenance of the arrays, disturbance and compaction during the removal of the arrays, vegetation that becomes established during the 30 year period, including non-native invasive plants, the slope and aspect of the planting sites, and any effects that climate change will have on species selection, along with the deer population, will all have roles to play in determining what species to plant and the success of the reforestation efforts in 2050 or beyond.

Further discussion of these factors is provided following the details of the reforestation plan.

Soil Types & Slope Conditions:

Soil conditions: According to the USDA Soil Survey, the existing soil conditions underlying the proposed solar array sites on the property are primarily the excessively well-drained Hinckley gravelly sandy loams, 8 to 25 percent slopes, with rolling and hilly terrain, which are typically found on terraces and glacial features such as outwash plains, kames, and eskers.

The gravelly, sandy loams of the Hinckley soils are best suited to growing White pine, where it regenerates readily. They have a Site Index value that ranges from 49 for Red oak and 60 for White pine. Site Index value is an indication of how well trees will grow in that soil type, and those values are poor in the upland areas, with slightly better conditions in the lower slope sites due to the available soil moisture in the bottom of the coves, in relation to other Rhode Island soils.

The USDA Soil Survey includes information on depth to bedrock, soil texture, seasonal water table influences, and suitability for certain tree species. A copy of the USDA Soil Survey report for the subject property is attached to this assessment.

The USDA Soil Survey includes information on depth to bedrock, soil texture, seasonal water table influences, and suitability for certain tree species. These constraints are factored into the selection of tree species for this reforestation plan.

Slope and Aspect: Species selected for reforestation must factor in the slope position and aspect of the specific locations for planting, as well as the soil types. South and west-facing upper slopes in conjunction with excessively well-drained gravelly soils will require planting with drought-tolerant species, while lower slope sites and north or east-facing slopes can be planted with a wider variety of species that can take advantage of these more favorable sites.

The solar array sites are situated on rolling terrain, with a mix of slopes and aspect conditions. The east-central area of the project is the only area that is situated on more level terrain in the bottom of the gravel pit. The soil and slope conditions that are present will require planting with more drought-tolerant species such as Pitch pine and White oak, with White pine and Northern red oak planted on the lower slope sites.

REFORESTATION PLAN

There are options for the establishment of forest vegetation on the site. They include:

- Bare-root planting of seedlings 3-5' tall;
- Bare-root shrubs;
- Direct seeding method of acorns and hickory nuts;
- Indirect seeding method of light seeds from pine species;
- Encouraging natural regeneration.

Of those, the more reliable method of establishing desired tree and shrub species at a reasonable cost is to plant the bare-root tree seedlings and shrubs, and provide protection from deer browse.

The following reforestation process is subject to review and revision prior to its implementation due to any of the factors that may influence the appropriateness of these recommendations in the year 2050 or beyond. Species selection is dependent on climatic conditions and the physical impacts to the soil conditions from installation and decommissioning activities.

Implementation:

Upon decommissioning, the Owner, Town, and/or their agents at the time shall hire a professional forester with experience in implementing large-scale tree planting projects to conduct a review of the site conditions and prepare suitable contracts for the planting project, according to industry standards that are in place at that time. The forester shall adjust the species recommendations according to climatic and soil conditions that are present, and shall oversee the implementation of the planting contract, conduct inspections, and order adjustments and re-planting if survival rates are not adequate to properly re-forest the site.

Additionally, state labor laws and rules in effect at the time of the implementation of the planting project must be taken into consideration with regard to the hiring of non-union contractors and the need to include union participation and fair wage considerations.

Site Preparation:

The following site preparation guidelines are provided with the assumption that the pre-existing topsoil will remain on site during the initial installation of the solar arrays.

- Removal of solar arrays will provide rows of disturbed soils that will now facilitate planting of bare-root seedlings and also provide a mineral soil seedbed for natural seeding of the site.
- Removal of the rows of solar panel mounting poles will provide rows of post holes approximately 10' apart, separated by a 20' wide grassy strip. (please refer to the PV Array Distance Schematic attached).
- Upon removal of solar arrays, some site preparation may be necessary, to the extent needed to allow hand planting crews safe access to plant trees.
- Control of any non-native invasive plants that may have become established may be necessary to prevent the site from being dominated by shrubs such as multi-flora rose, Autumn-olive, and non-native trees such as Ailanthus (Tree-of-Heaven). Vines such as honeysuckle and bittersweet may also be present. These shrubs and trees will likely be

present on the outer perimeter of the array sites, along the fence lines, and on the edges of the adjacent wooded areas.
- Protection of existing vegetation between the rows of solar arrays will provide erosion control while the tree cover is being established.

Planting Methods & Practices:

- Tree planting shall be conducted by contracted hand planting crews and/or tractor-drawn field planting equipment, as deemed appropriate for the site conditions at the time by the supervising forester. Please refer to the sample contract and other information on the use of planting contractors in the Appendix;
- Plant 200 bare-root pine and hardwood seedlings and 100 bare-root shrubs in a staggered fashion, utilizing the disturbed soil within the rows of post holes, to create a full stocking condition of mixed pine and hardwood species interspersed with native shrubs to provide habitat and water quality benefits;
- Protect planted hardwood seedlings with tree tubes (fact sheet attached) that will allow seedlings to become established without being browsed by deer. Some girdling of seedlings by rodents will occur. Removal of these tree tubes may be required upon successful establishment of the trees to allow their future development;
- The supervising forester and planting crew foreman shall provide supervision and inspection to assure quality control of the planting;
- The supervising forester shall provide annual inspections for a period of five (5) years following the initial planting to determine seedling survival, natural seed establishment, and adequacy of the reforestation effort;
- Excessive mortality must be remedied through additional plantings and additional protection measures, as per contract guidelines.

Tree & Shrub Species Selection:

Based upon the factors that influence the reforestation of the subject site, the following tree and shrub species are recommended for the various soil and slope conditions:

- Well-drained Upland sites with southern and western aspect
    - White oak (*Quercus alba*); Pitch pine (*Pinus rigida*); Pignut hickory (*Carya glabra*); Lowbush blueberry
- Moderately well-drained Lower slope/Level sites with variable aspect
    - White pine (*Pinus strobus*); Black oak (*Quercus velutina*); Highbush blueberry; Witch hazel (*Hamamalis virginiana*); Maple-leaved viburnum (*Viburnum acerifolia*); Highbush cranberry (*Viburnum trilobum*)

The 2018 Aerial Imagery of the subject site has been marked up to indicate what areas of the proposed solar array sites are appropriate for the two (2) planting scenarios provided above. See Attachment A.

Habitat Enhancement for Wildlife Species:

The RI Wildlife Action Plan identifies a number of amphibians, mammals, and bird species that are of Greatest Conservation Need. At the time of decommissioning and re-forestation, there will be an opportunity to enhance the habitat values of this landscape for a number of these species, with the New England cottontail, a variety of listed birds, pollinating insects, and other scrub/shrub habitat species benefitting from the re-establishment phase of the forest.

The shrub species listed above, as well as some of the tree species, are flowering plants that are known to provide good pollinator food sources, as well as nesting, brooding, and feeding sites for birds and small mammals. The scrub/shrub conditions of the establishment phase provides escape cover that is critical to their survival.

Reforestation Cost Estimates

The present costs of this reforestation plan covers the seedlings, shrubs, tree tubes, stakes, and ties, along with the labor, equipment costs, and overhead required for conducting the planting operation. These costs are subject to change depending on specific site conditions and final species selection and plant availability at the time of decommissioning.

- Contract with supervising forester to review and adjust plan, provide supervision and inspection services for the 5-year term of a planting project = $7,500

Total Area for Planting = 49.5 acres, Number of plants (Tree and Shrub) per acre = 300

- Total # of Plants Required = 14,850 @ $1.25 per plant = $18,562.50
- Qu. 4,950 4" x 48"Tree Tubes, Stakes, & Ties (oak seedlings) @ $3.00 each = $14,850
- Labor, Equipment, & Overhead Costs* = $575 per acre = $28,462.50

(12 hours per acre time estimated for planting & tree tubes, plus supervision & equipment costs)

Post-Planting Activities:

- Excessive Mortality Replacement (30%) = $14,107.50
- Removal of Tree Tubes @1.50 each = $7,425

Total Reforestation Cost Estimate = $90,907.50

Contingency = 20% of Cost Estimate = $18,181.50

Total Reforestation Project Bond Amount = **$109,089**

* From USDA Natural Resource Conservation Service Conservation Practice Scenario Costs, developed for EQIP program implementation: www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/?cid=nrcseprd1328426

Additional Factors Affecting the Implementation of this Reforestation Plan:

- On-site vegetation: Vegetation maintenance of the array sites, according to an Operation & Maintenance Plan, typically includes mowing and weed-whacking 2 or 3 times a year to maintain a grassy condition. Any planned establishment of pollinator plant species at the initiation of the project may require some additional vegetation management activities within the first few years. It is anticipated that, over the life of the solar array project, the site will be maintained in a grassy to low shrub condition.

  Pioneer seeding of tree seedlings and shrubs will likely occur during the 30-year time period, despite the regular mowing schedule. Root systems will develop with repeated cutting of the plant's stem, and these naturally-seeded trees and shrubs, including non-native invasive species, will then be in a position to respond to the removal of the solar arrays and cessation of mowing activities. This will be particularly true at the edges of the solar array sites, contributing to the screening provided in the Landscape Plan.

  Natural seeding from adjacent vegetation is routine and typical of abandoned fields and habitat clearings promoted by wildlife biologists for creating early-successional habitat. Natural seeding will eventually return this disturbed area to a forested condition, even if no efforts are made to reforest the site. The natural succession process takes time, and there is no control over which species become dominant. The subject site includes forested wetlands to the north of the arrays that is stocked with a mix of deciduous trees. There are patches of White pine present to the south and west of the property, which will provide a significant source of pine seed that will be scattered over the site by the prevailing winds.

- Climate Change: Projections for more frequent drought events, warmer temperatures, and more severe precipitation events require that any reforestation efforts in 2050 or beyond take into consideration the impacts on tree species selection and planting success. Will planting of southern pine species in 2050 be required?

  The Northern Institute of Applied Climate Science has provided projections for the Southern and Coastal New England sub-area, where species such as White pine and Quaking aspen (poplar) are predicted to decline, while other species such as White oak, Black oak, and Pitch pine are likely to increase their presence in the landscape. (See enclosed Fact Sheet). Southern species, such as Virginia pine and Sweetgum, may be good choices for planting in 2050 and beyond.

  New insect and disease problems will also occur between now and 2050 which will impact the final selection of tree species for this reforestation effort. Oaks are susceptible to Gypsy moth defoliations, which may occur with increased frequency as spring droughts become more common, and the Southern pine beetle has been found in Rhode Island. This beetle will feed on and kill Pitch pine.

- Animal damage: Browse impacts from deer, mice, and other species will have an impact on the survival and species composition of the re-forested site. Of particular concern will

be the deer population at that time, and what efforts are provided to control its presence during the establishment of the new forest. Although the 6' fence around the site will limit the travel of deer through the site, taller fencing is needed to keep the stronger adult jumpers from getting in and feeding on established plant material. In the event de-commissioning includes removal of all fencing as well as the solar arrays, then other means of protecting planted trees will be required.

Use of tree shelters will be needed to improve success rates, with subsequent maintenance needed to remove the shelters once trees have attained a suitable height to avoid browse damage.

Prepared By: Marc J. Tremblay, CF

MA Forester Lic #239, CT Certified Forester #F-517, RI Lic. Arborist #104

Certification: I hereby attest that the above Reforestation Plan prepared for the proposed Main Street Solar Project has been prepared according to the appropriate standards and information available, and the information provided is as accurate as current forestry practices allow.

Marc J. Tremblay, CF

Attachments:

- Schematic of Species to Plant by Soil and Slope
- USDA Soil Survey Forestland Productivity Tables (5 pp)
- Plan Detail Showing Distance Between Rows of Panels
- Climate Change Projections for Individual Tree Species, Southern and Coastal New England – Northern Institute of Applied Climate Science (2 pp)
- Protex Pro/Gro Solid Tube Tree Protectors info sheet from Forestry Suppliers, Inc.
- Tree Planting Guidelines, from the USDA Natural Resources Conservation Service, Texas Forestry Technical Note, TX-FS-12-4 (9 pp)
- Planting Contractor Info and Sample Contract

2018 AERIAL IMAGERY
SPECIES TO PLANT BY SOIL AND SLOPE
DOUGLAS PIKE SOLAR PROJECT
NORTH SMITHFIELD, RI

N

1"=420'

- WELL-DRAINED UPLAND SITES - WH. Oak / Pitch Pine / Pignut Hickory

- LOWER SLOPE - LEVEL SITES - WH. Pine / Black Oak

- APPROX. PROPERTY BOUNDARY

- APPROX. PROJECT BOUNDARY

"A4. A"

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

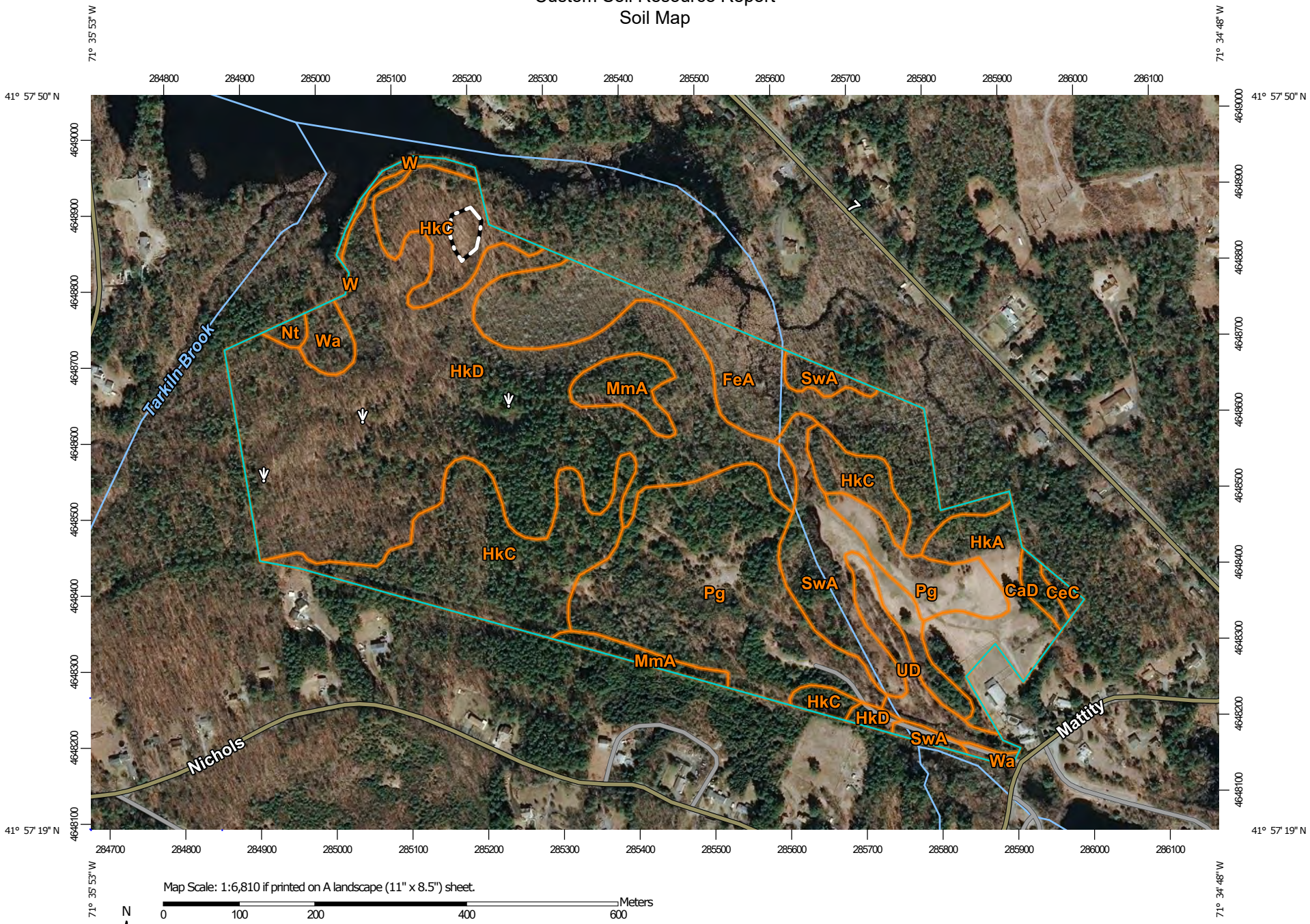
A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties

Bel Air Realty - Douglas Pike Solar, North Smithfield, RI

October 17, 2019

Custom Soil Resource Report
Soil Map



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties
Survey Area Data: Version 19, Sep 12, 2019

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Apr 3, 2019—Apr 29, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CaD	Canton-Charlton-Rock outcrop complex, 15 to 35 percent slopes, very stony	0.7	0.6%
CeC	Canton and Charlton fine sandy loams, 3 to 15 percent slopes, very rocky	0.3	0.3%
FeA	Freetown muck, 0 to 1 percent slopes	12.9	11.0%
HkA	Hinckley loamy sand, 0 to 3 percent slopes	5.6	4.8%
HkC	Hinckley loamy sand, 8 to 15 percent slopes	19.0	16.1%
HkD	Hinckley loamy sand, 15 to 25 percent slopes	41.8	35.6%
MmA	Merrimac fine sandy loam, 0 to 3 percent slopes	3.1	2.6%
Nt	Ninigret fine sandy loam, 0 to 3 percent slopes	0.4	0.3%
Pg	Pits, gravel	20.4	17.4%
SwA	Swansea muck, 0 to 1 percent slopes	8.4	7.1%
UD	Udorthents-Urban land complex	2.7	2.3%
W	Water	0.6	0.5%
Wa	Walpole sandy loam, 0 to 3 percent slopes	1.5	1.3%
Totals for Area of Interest		**117.4**	**100.0%**

Soil Information for All Uses

Soil Reports

The Soil Reports section includes various formatted tabular and narrative reports (tables) containing data for each selected soil map unit and each component of each unit. No aggregation of data has occurred as is done in reports in the Soil Properties and Qualities and Suitabilities and Limitations sections.

The reports contain soil interpretive information as well as basic soil properties and qualities. A description of each report (table) is included.

Vegetative Productivity

This folder contains a collection of tabular reports that present vegetative productivity data. The reports (tables) include all selected map units and components for each map unit. Vegetative productivity includes estimates of potential vegetative production for a variety of land uses, including cropland, forestland, hayland, pastureland, horticulture and rangeland. In the underlying database, some states maintain crop yield data by individual map unit component. Other states maintain the data at the map unit level. Attributes are included for both, although only one or the other is likely to contain data for any given geographic area. For other land uses, productivity data is shown only at the map unit component level. Examples include potential crop yields under irrigated and nonirrigated conditions, forest productivity, forest site index, and total rangeland production under of normal, favorable and unfavorable conditions.

Forestland Productivity

This table can help forestland owners or managers plan the use of soils for wood crops. It shows the potential productivity of the soils for wood crops.

Potential productivity of merchantable or *common trees* on a soil is expressed as a site index and as a volume number. The *site index* is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that forestland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability. More detailed information regarding site index is available in the "National Forestry Manual," which is available in local offices of the Natural Resources Conservation Service or on the Internet.

The *volume of wood fiber*, a number, is the yield likely to be produced by the most important tree species. This number, expressed as cubic feet per acre per year and calculated at the age of culmination of the mean annual increment (CMAI), indicates the amount of fiber produced in a fully stocked, even-aged, unmanaged stand.

Trees to manage are those that are preferred for planting, seeding, or natural regeneration and those that remain in the stand after thinning or partial harvest.

Reference:
United States Department of Agriculture, Natural Resources Conservation Service, National Forestry Manual.

Report—Forestland Productivity

Forestland Productivity–State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties				
Map unit symbol and soil name	**Potential productivity**			**Trees to manage**
	Common trees	**Site Index**	**Volume of wood fiber**	
			Cu ft/ac/yr	
CaD—Canton-Charlton-Rock outcrop complex, 15 to 35 percent slopes, very stony				
Canton, very stony	Eastern white pine	58	100.00	Eastern white pine, White spruce
	Northern red oak	52	29.00	
Charlton, very stony	Eastern white pine	65	114.00	Eastern hemlock, Eastern white pine, European larch, Northern red oak, Norway spruce, Red pine, Scarlet oak, Sugar maple, Tuliptree, White ash, White oak, White spruce
	Northern red oak	65	43.00	
	Red maple	55	29.00	
	Red pine	70	129.00	
	Red spruce	50	114.00	
	Shagbark hickory	—	0.00	
	Sugar maple	55	29.00	
Rock outcrop	—	—	—	—

Forestland Productivity–State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties				
Map unit symbol and soil name	**Potential productivity**			**Trees to manage**
	Common trees	**Site Index**	**Volume of wood fiber**	
			Cu ft/ac/yr	
CeC—Canton and Charlton fine sandy loams, 3 to 15 percent slopes, very rocky				
Canton, very stony	Eastern hemlock	—	—	Beech, Bitternut hickory, Black oak, Eastern hemlock, Eastern white pine, Gray birch, Mockernut hickory, Northern red oak, Pignut hickory, Red maple, Shagbark hickory, Sugar maple, White ash, White oak, Yellow birch
	Eastern white pine	58	100.00	
	Northern red oak	52	29.00	
	Red maple	55	29.00	
	Shagbark hickory	—	0.00	
	Sugar maple	55	29.00	
	White oak	—	—	
Charlton, very stony	Eastern white pine	65	114.00	Eastern white pine, European larch, Northern red oak, Norway spruce, Red pine, Scarlet oak, Sugar maple, Tuliptree, White ash, White oak
	Northern red oak	65	43.00	
	Red maple	55	29.00	
	Red pine	70	129.00	
	Red spruce	50	114.00	
	Shagbark hickory	—	0.00	
	Sugar maple	55	29.00	
FeA—Freetown muck, 0 to 1 percent slopes				
Freetown	American elm	55	0.00	—
	Atlantic white cedar	60	0.00	
	Balsam fir	45	86.00	
	Eastern hemlock	55	0.00	
	Green ash	35	29.00	
	Red maple	50	29.00	
	Red spruce	50	114.00	
HkA—Hinckley loamy sand, 0 to 3 percent slopes				
Hinckley	Eastern white pine	61	100.00	Black oak, Eastern white pine, Pitch pine
	Northern red oak	49	29.00	
	Paper birch	60	54.00	
	Pitch pine	60	—	
	Red pine	54	92.00	
	Red spruce	39	86.00	
	Sugar maple	59	30.00	
	White spruce	52	114.00	

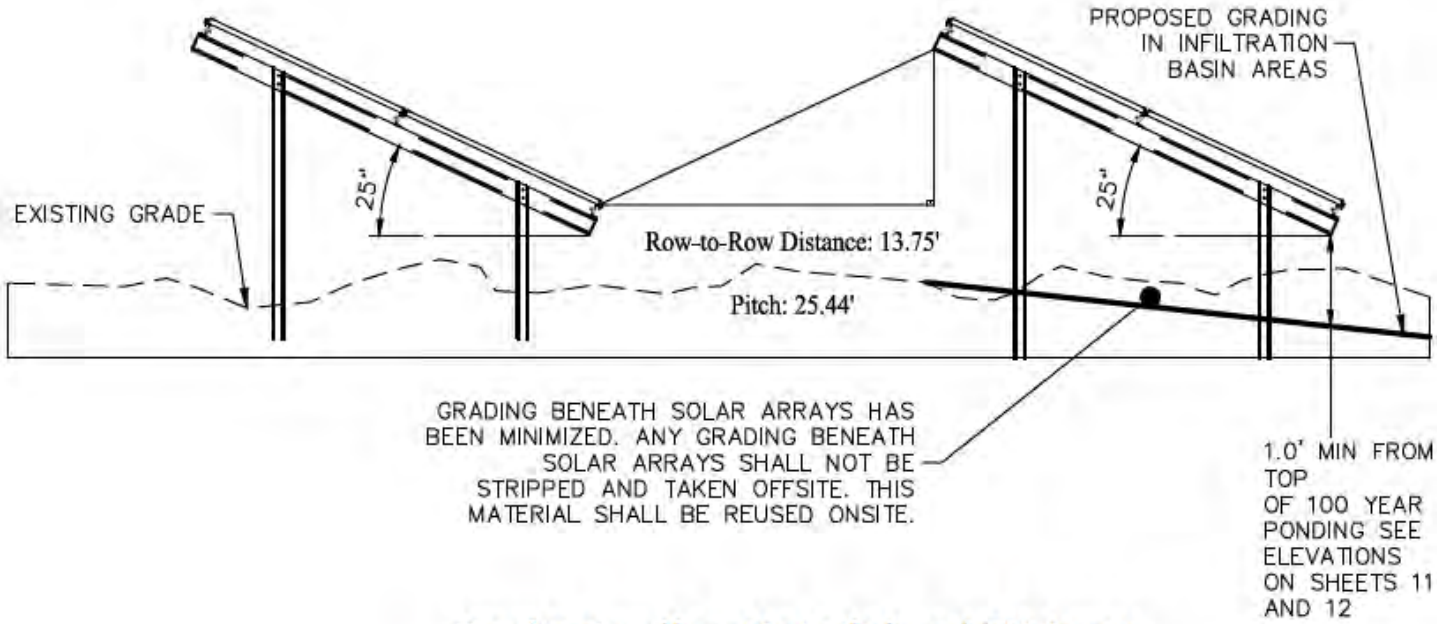
Forestland Productivity–State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties				
Map unit symbol and soil name	**Potential productivity**			**Trees to manage**
	Common trees	**Site Index**	**Volume of wood fiber**	
			Cu ft/ac/yr	
HkC—Hinckley loamy sand, 8 to 15 percent slopes				
Hinckley	Eastern white pine	61	100.00	Black oak, Eastern white pine, Pitch pine
	Northern red oak	49	29.00	
	Paper birch	60	54.00	
	Pitch pine	60	—	
	Red pine	54	92.00	
	Red spruce	39	86.00	
	Sugar maple	59	30.00	
	White spruce	52	114.00	
HkD—Hinckley loamy sand, 15 to 25 percent slopes				
Hinckley	Eastern white pine	61	100.00	Black oak, Eastern white pine, Pitch pine
	Northern red oak	49	29.00	
	Paper birch	60	54.00	
	Pitch pine	60	—	
	Red pine	54	92.00	
	Red spruce	39	86.00	
	Sugar maple	59	30.00	
	White spruce	52	114.00	
MmA—Merrimac fine sandy loam, 0 to 3 percent slopes				
Merrimac	—	—	—	—
Nt—Ninigret fine sandy loam, 0 to 3 percent slopes				
Ninigret	Eastern white pine	75	143.00	Bigtooth aspen, Black cherry, Black oak, Eastern white pine, Gray birch, Hemlock, Northern red oak, Paper birch, Pitch pine, Red maple, Sugar maple, Sweet birch, White ash, White oak
	Northern red oak	65	43.00	
	Red maple	60	43.00	
	Sugar maple	55	29.00	
	White oak	—	—	
Pg—Pits, gravel				
Pits	—	—	—	—

Forestland Productivity–State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties				
Map unit symbol and soil name	**Potential productivity**			**Trees to manage**
	Common trees	**Site Index**	**Volume of wood fiber**	
			Cu ft/ac/yr	
SwA—Swansea muck, 0 to 1 percent slopes				
Swansea	American elm	55	0.00	Balsam fir, Eastern hemlock, White spruce
	Atlantic white cedar	60	0.00	
	Balsam fir	45	86.00	
	Eastern hemlock	55	0.00	
	Green ash	35	29.00	
	Red maple	50	29.00	
	Red spruce	50	114.00	
UD—Udorthents-Urban land complex				
Udorthents	—	—	—	—
Urban land	—	—	—	—
W—Water				
Water	—	—	—	—
Wa—Walpole sandy loam, 0 to 3 percent slopes				
Walpole	Eastern hemlock	54	114.00	—
	Eastern white pine	68	114.00	
	Red maple	75	43.00	
	White ash	61	43.00	

DETAIL OF DETAIL SHEET 1, PG 18 OF 18

SHOWING DISTANCE BETWEEN ROWS OF PANELS

MAIN STREET SOLAR, HOPKINTON



Onsite Grading Material and PV Array

Distance Scheme - Tilt, Angle, and Shading Detail

NOT TO SCALE

CLIMATE CHANGE PROJECTIONS FOR INDIVIDUAL TREE SPECIES

SOUTHERN AND COASTAL NEW ENGLAND

The region's forests will be affected by a changing climate during this century. A team of forest managers and researchers created an assessment that describes the vulnerability of forests in New England and northern New York (Janowiak et al. in press). This report includes information on the current landscape, observed climate trends, and a range of projected future climates. It also describes many potential climate change impacts to forests and summarizes key vulnerabilities for major forest types. This handout is summarized from the full assessment.

Remember that models are just tools, and they're not perfect. Model projections don't account for some factors that could be modified by climate change, like droughts, wildfire activity , and invasive species. If a species is rare or confined to a small area, Tree Atlas results may be less reliable. These factors, and others, could cause a particular species to perform better or worse than a model projects. Human choices will also continue to influence forest distribution, especially for tree species that are projected to increase. Planting programs may assist the movement of future-adapted species, but this will depend on management decisions.

TREE SPECIES INFORMATION:

This assessment uses two climate scenarios to "bracket" a range of possible futures. These future climate projections were used with two forest impact models (Tree Atlas and LANDIS) to provide information about how individual tree species may respond to a changing climate. More information on the climate and forest impact models can be found in the assessment. Results for "low" and "high" climate scenarios can be compared on page 2 of this handout.

Despite these limits, models provide useful information about future expectations. It's perhaps best to think of these projections as indicators of possibility and potential change. The model results presented here were combined with information from published reports and local management expertise to draw conclusions about potential risk and change in the region's forests.

SPECIES	ADDITIONAL CONSIDERATIONS
LIKELY TO DECREASE	
Balsam fir	Requires cold climate and susceptible to drought, fire, and insects
Eastern white pine	Good disperser, but susceptible to drought and insects
Paper birch	Early-sucessional colonizer, but susceptible to insects and drought
Quaking aspen	Early-sucessional colonizer, but susceptible to heat and drought
Red spruce	Needs a particular type of habitat, limited seedling establishment
Striped maple	Shade tolerant and easily established, but susceptible to drought
MAY DECREASE	
American beech	Affected by beech bark disease, extremely shade tolerant
Bigtooth aspen	Early-sucessional colonizer, but susceptible to drought
Eastern hemlock	Hemlock woolly adelgid causes mortality
Gray birch	Disperses easily, but susceptible to drought, fire, and insects
Red pine	Fire-adapted, but susceptiple to some insects
Yellow birch	Good disperser, but susceptible to fire, insects, and disease
NO CHANGE	
Black cherry	Susceptible to insects and fire, but tolerates some drought
White ash	Emerald ash borer causes mortality

SPECIES	ADDITIONAL CONSIDERATIONS
MAY INCREASE	
American elm	Affected by Dutch elm disease, grows across a variety of sites
Black oak	Drought-tolerant, but susceptible to insects and disease
Eastern hophornbeam	Grows across a variety of sites and tolerates shade
Eastern redcedar	Drought-tolerant, but susceptible to insects and fire
Pitch pine	Susceptible to some insect pests
Shagbark hickory	Susceptible to some insect pests
White oak	Fire-adapted and grows on a variety of sites
MIXED MODEL RESULTS	
Chestnut oak	Grows on a variety of sites, but susceptible to insects and disease
Northern red oak	Susceptible to some insect pests
Pignut hickory	Grows on a variety of sites, but susceptible to drought and insects
Red maple	Competitive colonizer tolerant of disturbance and diverse sites
Scarlet oak	Drought- and fire-adapted, but susceptible to insects and disease
Sugar maple	Grows across a variety of sites and tolerates shade
Sweet birch	Susceptible to drought, fire topkill, and insects

SOURCE: Janowiak et al. in review. New England and New York forest ecosystem vulnerability assessment and synthesis: a report from the New England Climate Change Response Framework. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. ***www.forestadaptation.org/new-england/vulnerability-assessment***

NIACS
Northern Institute of Applied Climate Science

www.forestadaptation.org

FUTURE PROJECTIONS

Data for the end of the century are summarized for two forest impact models under two climate change scenarios. The Climate Change Tree Atlas (www.fs.fed.us/nrs/atlas) models future suitable habitat, while LANDIS models changes in forest growth over time (future tree density presented in this table; additional data are available in the assessment).

▲ **INCREASE**
Projected increase of >20% by 2100

● **NO CHANGE**
Little change (<20%) projected by 2100

▼ **DECREASE**
Projected decrease of >20% by 2100

★ **NEW HABITAT**
Tree Atlas projects new habitat for species not currently present

ADAPTABILITY

Factors not included in the models, such as the ability to respond favorably to disturbance, may make a species more or less able to adapt to future stressors.

\+ high
Species may perform better than modeled

. medium

– low
Species may perform worse than modeled

SPECIES	LOW CLIMATE CHANGE (PCM B1) TREE ATLAS	LOW CLIMATE CHANGE (PCM B1) LANDIS	HIGH CLIMATE CHANGE (GFDL A1FI) TREE ATLAS	HIGH CLIMATE CHANGE (GFDL A1FI) LANDIS	ADAPT
American basswood	●		▲		.
American beech	●	●	▼	▼	.
American chestnut	●		●		.
American elm	▲		▲		.
American holly	●		▲		.
American hornbeam	●		▲		.
American mountain-ash	●		●		–
Bald cypress	★		★		.
Balsam fir	▼	▼	▼	▼	–
Balsam poplar	▼		▼		.
Bigtooth aspen	●		▼		.
Black ash	▼		▼		–
Black cherry	●	●	●	●	–
Black hickory			★		.
Black oak	▲	●	▲	●	.
Black spruce	▼	▼	▼	▼	.
Black walnut	★		★		.
Blackgum	▲		▲		+
Blackjack oak			★		+
Boxelder	●		●		+
Bur oak	●		▲		+
Cherrybark oak			★		.
Chestnut oak	▲	▲	▲	▼	+
Chinkapin oak			★		.
Common persimmon	★		★		+
Eastern hemlock	●	●	▼	▼	–
Eastern hophornbeam	●		▲		+
Eastern redbud	★		★		.
Eastern redcedar	▲		▲		.
Eastern white pine	▼	▼	▼	▼	.
Flowering dogwood	▲		▲		.
Gray birch	●		▼		.
Green ash	●		▲		.
Hackberry	●		▲		+
Loblolly pine	★		★		.
Mockernut hickory	▲		▲		+
Mountain maple	●		▼		+
Northern red oak	●	●	▼	●	+
Northern white-cedar	▼	▼	▼	▼	.
Overcup oak			★		–

SPECIES	LOW CLIMATE CHANGE (PCM B1) TREE ATLAS	LOW CLIMATE CHANGE (PCM B1) LANDIS	HIGH CLIMATE CHANGE (GFDL A1FI) TREE ATLAS	HIGH CLIMATE CHANGE (GFDL A1FI) LANDIS	ADAPT
Paper birch	▼		▼		.
Pignut hickory	▲	●	▲	▼	.
Pin cherry	●		●		.
Pin oak	▲		▲		–
Pitch pine	▲	●	●	●	.
Pond pine	★		★		–
Post oak	▲		▲		+
Quaking aspen	▼	▼	▼	▼	.
Red maple	●	●	▼	●	+
Red pine	●		▼		.
Red spruce	▼	▼	▼	▼	–
Sassafras	▲		▲		.
Scarlet oak	▲	●	▲	▼	.
Serviceberry	●		▼		.
Shagbark hickory	▲	●	▲	●	.
Shingle oak			★		.
Shortleaf pine	★		★		.
Silver maple	▲		▲		+
Slippery elm	●		▲		.
Sourwood	▲		▲		+
Southern red oak	★		★		+
Striped maple	▼		▼		.
Sugar maple	●	●	●	▼	+
Sugarberry			★		.
Swamp chestnut oak	●		▲		.
Swamp tupelo	★				–
Sweet birch	▲		▼		–
Sweetbay	★				.
Sweetgum	★		★		.
Sycamore	▲		▲		.
Tamarack (native)	▼		▼		–
Virginia pine	★	●	★	●	.
Water oak			★		.
White ash	●	●	●	●	–
White oak	▲	●	▲	●	+
White spruce	▼		▼		.
Willow oak			★		.
Winged elm	●		▲		.
Yellow birch	●	●	▼	▼	.
Yellow-poplar	▲	▲	▲	●	+

Protex® Pro/Gro Solid Tube Tree Protectors

Acts as a miniature greenhouse.

★★★★★ 12 customer reviews

Availability: In Stock

Stock Number: 17141

Size: 48"H

Quantity	Price
1+	$2.95
200+	$2.75
400+	$2.55

Quantity: 1 Add To Cart

Add To My Equipment List

Share on:

Description | Specifications | Reviews (12) | Q&A (3)

48" Protex Pro/Gro Solid Tube Tree Protectors

Each 4" diameter tube speeds photosynthesis by trapping moisture, thereby raising relative humidity and ambient temperature inside the tube. Also protects the tree from animals, wind desiccation, small rodents, and insects. Use optional cable ties to install optional bamboo stakes or wood guard stakes with each tube for support. Stakes and cable ties sold separately. Constructed of type 2 recyclable polyethylene.

Natural Resources Conservation Service
Texas Forestry Technical Note, TX-FS-12-4

Tree planting is a widely used method to regenerate cutover sites and return cropland or pastures back to forested land. Planting trees allows one to adjust tree species and density on their acres while influencing wildlife habitat as well. Tree planting can also be used to create windbreaks and shelter belts providing a buffer from wind, snow, dust and noise.

Seedling Planting Guidelines

CAUTION – READ

1. Safety – the planting operation should be performed safely as the environment will have several hazards that can make walking difficult such as briars, down woody material, etc.
2. Seedling care – Seedlings should not be exposed to extreme temperatures, wind or contaminants (fuel or herbicides).
3. Seedling roots must not be exposed to excessive drying conditions – do not hold a handful of seedlings while you are planting or leave the bag or box of seedlings open.
4. Planting quality – Seedlings should be planted to the proper depth and firmly packed to ensure the highest likelihood of survival. One can tell if the seedlings are packed tight by grasping a few needles and pull upward – If the seedling moves it is not firmly packed, if the needles pull off then it is firmly packed.

Seedling handling: Handling involves seedling storage, transit and field handling.

Seedling Storage:

1. Avoid damaging seedling bags or boxes to minimize damage to seedlings, tape up any hole to prevent moisture loss and drying of the seedlings.
2. Keep seedlings and their containers out of direct sunlight.
3. Allow space for air circulation between seedling boxes/bags.
4. Don't allow seedlings to freeze. (Don't plant seedlings frozen for more than 2 days)
5. Plant seedlings within two weeks of lifting if possible.
6. Seedlings four weeks or older should be carefully checked for mildew, mold or decay.

Transit:

1. Prevent injury when lifting seedling bags or boxes by keeping your back straight and lifting with your legs.
2. Keep seedlings shaded and covered. A tarp will work if the vehicle is not covered (ie. van or truck with camper shell.
3. Drive at speeds allowed by law and road conditions.

4. Keep seedlings away from contamination commonly fuels or herbicides.
5. Keep the area with seedlings free from sharp objects.
6. Don't allow seedlings to freeze.
7. Don't stack seedlings more than 2 boxes/bags deep without spacers to provide support.

Handling seedlings before and during planting:

1. Keep seedlings moist – Dry roots kill seedlings.
2. Keep seedlings shaded and covered - High temperatures kill seedlings.
3. Don't prune the roots unless the laterals are long (5" or longer) – prune the laterals with a sharp machete to 3 to 4 inches in length. A good root system is essential to seedling growth and survival.
4. Don't beat seedlings against objects to remove clay slurry
5. Close boxes or bags and place out of direct sunlight
6. Remove only minimum number or seedlings that can be planted quickly to avoid exposing roots to wind and sun very long.
7. Discard cull seedlings – seedlings with a stem diameter smaller in diameter than a kitchen match, dry seedlings, or seedlings without a good root system.
8. Don't dump out the whole box or bag of seedlings to sort them before planting.

Hand Planting:

Hand planting allows areas to be planted not suitable for machinery due to debris, terrain, wet conditions and availability of suitable machines.

1. If area has duff, litter, etc., rake to bare mineral soil to ensure proper seedling depth and tightness.
2. Remove no more than 3 or 4 seedlings (drop any culls) from the planting bag.
3. Make the planting hole wide and deep enough to insert the root system so the seedling is straight and the roots are straight down in the planting hole. (It is highly undesirable to have the roots curled up in the planting hole).
4. Lift the seedling up in the hole until the root collar is slightly below the soil level for loblolly, slash and shortleaf pines and for longleaf pine plant the root collar at the soil level keeping the terminal bud above ground.
5. Pack the seedling firmly using your planting tool eliminating the air pockets. See diagram at the back of this document.
6. Plant when there is good soil moisture.
7. Don't plant when the ground is frozen.

Tools for hand planting include a dibble bar, hoe dad, or sharp shooter shovel. A planter bag worn around the waist makes the planting faster and more efficient keeping the seedlings moist and readily available. Seedlings properly planted by hand should have a high percentage of surviving trees.

Hand planting with bare-root seedlings usually occurs between late December and early April. The seedlings have to "harden off" or set buds at the end of the growing season and in southern nurseries this usually does not occur until late November or early December. This hardening off is a little easier to

visualize with hardwood seedlings as the leaves fall off and one can easily see the buds. In planting loblolly, slash or shortleaf pines and the hardwood species, the seedlings should be planted at the root collar which is the location the seedling grew in the nursery (where the above ground and below ground portion of the seedling meet). Longleaf seedlings should be planted at a depth where the root collar is slightly above the soil line ensuring that the terminal bud stays above the ground.

The earlier one can plant their seedlings (Jan – Feb) the more time the seedling will have to establish their root systems. The better the roots get established, the better the seedlings can survive dry conditions that will occur during the summer months.

Containerized seedlings have a wider window for planting beginning in late October and going through April. Containerized seedlings are grown in tubes that help the seedling develop a dense root system that is fairly easy to plant. Containerized loblolly, slash and shortleaf pines can be planted with the entire root plug placed in the planting hole. The terminal bud is well away from the ground line. Containerized longleaf pines however are planted in the grass stage meaning that you have a root plug, a very short stem and a terminal bud surrounded by the needles. Plant containerized longleaf pine with a small portion of the plug above the planting hole to ensure the terminal bud is above the ground.

The photo shows an example of hand planting hardwood seedlings. Some positive things to notice is only one seedling out of the container, a wide planting bar, seedlings with their roots protected and moist in the bucket.

Some common hand planting errors include:

- Planting the seedling too shallow: The root collar and roots are exposed above the soil drying out the roots.
- Planting the seedling too deep: The hardwood seedlings root collar is 2” or more below the soil surface and loblolly/shortleaf/slash pines terminal bud is within 2” of the ground line while longleaf pines has the terminal bud below the soil line.

- J or U Roots: Roots form a J or U shape from the seedling being pushed into the planting hole resulting in the primary root to point to the side or back upward. This problem contributes to poor root development and seedling problems. (Avoid by making the planting hole a little wider before planting the seedling.
- Seedling too loose: A firm pull on the seedling should not move the plant. The seedling should be packed firmly in the soil.
- Seedling not erect: The tap root should not be planted at more than 30^{o} from perpendicular.

Machine Planting:

Machine planting can be accomplished on areas that have received good site preparation, have little debris remaining on the site; areas that have been windrowed or bedded; old fields or farmland being converted back to forests.

There are many safety concerns to consider during machine planting operations as a person is being pulled behind a tractor or dozer. Some items to consider for safety are how the planter communicates with the tractor operator, first aid kit, personal safety gear, fire extinguisher, etc.

1. Only open enough seedlings to fill the planting box. Keep the seedlings upright with the roots down out of the wind. A little water can be added to the planter box to keep the roots moist.
2. Do not cut or prune the roots.
3. Do not leave unplanted seedlings exposed to sun and wind.
4. Plant seedlings along the contour.
5. Do not plant the seedlings to deep or to shallow, when holding the seedlings and placing them in the planting rip do not release them until the packing wheels start to close the rip. Otherwise the seedlings will drop to deep covering the terminal bud. On the other side, do not pull the seedlings upward as the seedling will be planted to shallow exposing some roots.
6. Periodically check the planted seedlings for firmness or packing, planting depth and number of seedlings per acre.
7. Look for skips in planting as the planter may have difficulty in getting seedlings out of the holding tray.
8. The planting operation needs to occur at speeds where the proper number of seedlings are planted which takes coordination between the operator and planter.

Machine planting is an effective method of planting seedlings if the operator and planter work as a team. The operator has to be constantly aware of the safety hazards and protect the individual riding in the planter.

- With machine planting, make sure the seedling depth is satisfactory and that the seedlings are not leaning due to being dragged by the planter. The seedlings should be upright and firmly packed in the soil.

How many seedlings per acre:

Everyone has their reasons for a particular planting density and spacing. One might want to mow between the planted rows so the rows need to be wider than the available equipment. There are many options available (see Table 1). You can calculate the number of seedlings needed per acre by multiplying the spacing between seedlings, for example (10 X 10 = 100); dividing 43,560 sq ft per acre by the sq ft spacing provides the number of seedlings needed per acre. Our example: 43,560/100 = 436 seedlings per acre. Thus, you can substitute any spacing and determine the number of seedlings needed per acre.

Table 1: Various spacings and initial planting densities for tree seedlings

Spacing (feet)	Square Feet per	Number of Tree/Shrub Seedlings per Acre
5 x 5	25	1,742
6 x 6	36	1,210
6 x 8	48	907
8 x 8	64	680
8 x 10	80	544
10 x 10	100	436
10 x 14	140	311
12 x 12	144	302
12 x 16	192	227
14 x 14	196	222
10 x 20	200	218

Ideally, the planting operation should be checked out by personnel with the Texas Forest Service. However, in some instances the TFS may not be available so an approved Technical Service Provider may be used. Thirdly, NRCS personnel may be used to evaluate the planting operation. If this is the case, here are some tips on checking out a planting job.

How to quickly check behind a planting operation:

What needs to be checked? Proper planting of seedlings – depth and firmness; number of seedlings properly planted per acre.

How many seedlings per acre?

A quick way to determine the number of seedlings planted on an acre is to obtain a cane pole or an extending fishing pole at least 12 feet in length. Mark on either a point at 11'8" long. This distance is equivalent to a 1/100th acre plot radius. Holding the pole over a fixed point and then move the pole around making a circle and count each seedling that is contained in the 1/100th acre plot. Each seedling represents 100 seedlings per acre. For plantings with fewer than 600 trees per acre a 1/50th acre plot may be used (16.7' plot radius). Sample multiple plots and average the seedlings per acre.

For example: The goal is to hand plant 545 trees per acre (8 X 10) spacing. The planting check found:

Plot 1 = 5 seedlings; Plot 2 = 6 seedlings; Plot 3 = 5 seedlings; Plot 4 = 5 seedlings, you would have 525 seedlings planted per acre. That's the average number of seedlings tallied in the sampled plots. The field measurements are compared against the targeted seedlings per acre and should be within 10% for a satisfactory planting job. The 525 is within the 10% guide for number of seedlings per acre. The question is now how many of the seedlings were satisfactorily planted. From this example, 21 seedlings were located on our 1/100th acre plots so no more than 2 seedlings can be unsatisfactory, if 3 or more are unsatisfactory then the planting will fail.

The following provides a guide in determining number of plots needed per acre by tract acreage:

1 to 60 acres – 1 plot per acre
61 – 90 acres – 1 plot per 2 acres for hand plantings to 5 acres for machine plantings
91+ acres – 1 plot per 3 acres

Tract maps can be created with plots laid out on the proper spacing to fulfill the requirements provided above using newer versions of ArcGIS or other GIS mapping software.
Once at the tract, the inspector should orient their self and use their map to navigate to plot 1.

- Mark the center of the plot with a pin flag
- Using a plot radius tape or device, count and check all seedlings in the specified plot radius.
- Seedlings should be checked for proper planting depth, proper closure of the hole, and proper packing of the seedling in soil. To check that seedlings are properly packed, grab a seedling by 3 to 5 needles and gently pull on the seedling, if the seedling moves up or down then the seedling is not properly packed.
- Results should be documented on the seedling inspection form
- When between plots (i.e. traveling from one plot to the next) carefully dig up two seedlings and check for underground planting problems but properly replant seedlings to maximize survival. **(This is not required for container plantings)**
- Results should be documented on the seedling inspection form
- Continue to next four plots and repeat.
- After plot 5 the inspector will need to calculate the excavation factor. The excavation factor is the percentage of good seedlings being dug up and can be calculated by dividing the number of good trees that have been dug up by the total number of seedlings that have been dug up. (See example below)

Calculating Excavation Factor:
After 5 plots
10 total trees dug up
1 J-root for a total of 9 good out of the 10
Good trees divided by total = percentage or in this case 9 ÷ 10 = 0.90 or 90%

The excavation factor should be calculated after every 5th plot. If at any time during the inspection the percentage falls below 90% the inspector should begin digging up four trees rather than two. While digging up four seedlings, if the percentage rises back above 90% then the inspector may resume digging up only two seedlings.

Once the entire tract has been inspected the inspector should then determine the total trees per acre. The total trees per acre should be within 10% above or below the original planting prescription. Above ground problems should be documented for each plot and deducted from the plot total while below ground problems will be deducted from the total inspection number and both will be used to determine whether the tract passes or fails.

Above ground

1. Examine a planted seedling as it should be planted close to the root collar where it grew in the nursery. For longleaf pine, be sure the terminal bud is not buried and is above the soil line. For other pine species, the root collar can be planted below the soil line but do not cover the terminal bud, in fact it should be 2" or higher above the soil line.
2. For pine species, pull upward on a few needles. If the seedling is planted firmly, the needles should pull off in your hand. If the seedling starts lifting out of the ground, the seedling is not firmly planted. No seedling should be capable of moving up or down easily in a planting hole.
3. Seedlings not firmly planted will dry out in the planting hole and not survive.
4. The main root should be completely below the soil line.
5. For pine seedlings, the green side goes up.
6. For Hardwood seedlings, the root collar should not be more than 2" below the soil line.
7. Hardwood seedlings should be firmly packed in the soil and if pulled on they should not easily move in the planting hole.
8. Be observant in the field, you may find discarded seedlings, piles of roots that have been cut off of the seedlings, unplanted seedling boxes or bags exposed to full sunlight. These are practices that you do not want occurring on your planting site.
9. Spacing – improper spacing will cause either too many or too few seedling per acre.
10. Planting hole not closed up, additional holes created to close the planting hole should be stomped shut.
11. Excessive lean in seedlings.

Below ground

12. A few seedlings will need to be dug up to examine for J, L or U roots by using a shovel. Carefully remove the soil and notice the shape of the roots. No more than 10% of all seedlings planted should have J, L or U roots (the primary tap root).
13. Tap root not 5 inches long, the tap root should be a minimum of 5 inches or be culled.
14. Cull seedlings less than $1/8^{th}$ inches in diameter.

A planting check-out form is available labeled "*planting check sheet*" that you can use to document the planting operation. Ninety percent of the planted seedlings should be satisfactory.

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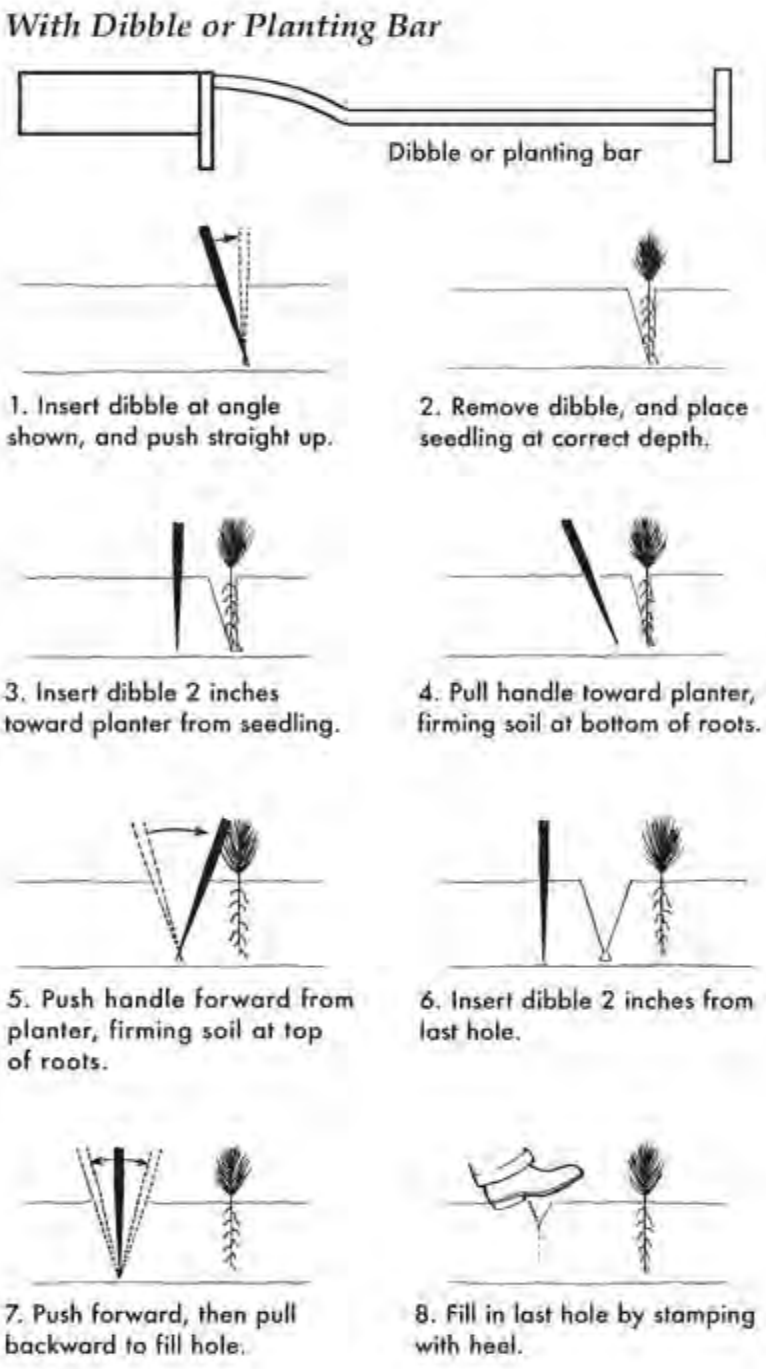
The following illustration shows the proper hand planting technique:



Machine planting a cut-over site.

Machine planting pine seedlings. (note: the green side is up, nearly straight with the roots below the ground line, minimal soil disturbance)

Planting hardwood seedlings.

Hardwood seedling roots, note where the root was undercut in the nursery, new root growth