2.6 - TREE PLANTING TOOLS AND TECHNIQUES

Tree planting tools and the planting techniques presented in this section are designed to assure successful plantations. It is assumed that the trees are being planted according to a silvicultural prescription, and that seed source, species, and successional requirements have been met.

2.61 - Planting Spot Selection - Microsites

Planting in favorable microsites protects seedlings from potentially harmful conditions and improves the probability of survival. This is especially true in areas of high animal use, high insolation rates, and extreme winds. To take advantage of microsites, the spacing requirements may need to be adjusted. Silviculturists must evaluate local site conditions to assure the required microsite is tailored to the damaging agent.

1. **Areas of High Animal Use.** Cattle and big game damage is a major cause of plantation failure. Cattle generally trample the seedling and big game tend to feed on the plants. Plant seedlings near logs, stumps, or rocks where they are protected, which will inhibit trampling and animal browsing.

2. **High Insolation.** High insolation results in heat and moisture stress to the seedling and can cause mortality on any sites. Drier habitat types and those on south- and west-facing slopes are most damaging. Direct heat to the tree crown affects the physiology of the tree causing water maintenance deficits. Heat at the soil surface can cause the soil temperatures to be lethal to the seedling stem at the ground line. Early season insolation can also cause the seedlings to break dormancy too soon and become subject to freeze damage. All of these types of damage intensify on exposed slopes over 30 percent.

Stationary shade such as stumps, rocks and larger logs provide the best site protection. On south and west slopes, plant on the north to east side of the stationary shade to protect the seedling from the afternoon sun. Where existing (stationary) shade is not present, other transportable shade types can be used in most cases. Use pieces of wood or branches that are larger than 3 inches in diameter, rocks, staked shingles, shade cards, and other material. Place the shade on the south and west side of the tree, to offer afternoon shade to the seedling (see exhibit 01). Rocks should not touch the tree. Staked shade cards or shingles are costly to install but are an option where there is no natural shade. Although it is beneficial to shade the entire crown of the seedling, the most critical area needing shade is the ground line. This is where insolation rates raise soil temperatures above the lethal point.

Shade is generally not necessary on north slopes, and if used on east slopes, place it on the downhill side to protect seedlings from morning sun. Do not place transportable shade on the uphill side of the tree because it may roll down onto the planted tree.
As a general rule, it is critical to require shade in these conditions:

a. Planting sites on Douglas fir habitat types and drier in Montana, grand fir habitat types and drier in northern Idaho, most habitat types throughout Regions 2, 3, 4.

b. Planting sites on south- and west-facing slopes

c. Planting sites on steep slopes, generally over 30 percent, especially on a dry aspect

d. Shade the tree crown on Engelmann spruce sites above 9,500 feet in the central and southern Rocky Mountains for protection from solarization problems.

e. Other site factors such as soil moisture-holding capacity, plant competition, and elevation compound insolation problems. Without proper site preparation to reduce competing vegetation, shade will not be sufficient to assure survival.
Utilization of Material to Provide Shade

Using existing shade

Do not plant here.

Transporting shade

Do not plant here.
3. **Types of Shade Materials.**

a. **Natural Materials.**

   (1) **Live trees or brush.** Live shade can provide beneficial protection to seedlings. Select planting spots that minimize moisture competition with the live shade plants. Plant so that seedlings are protected from the afternoon sun.

   It is generally beneficial to plant near the root crown of brush because water-absorbing roots of shrubs are not as dense as compared to farther away from the crown, and trees placed here are protected from browsing animals. When planting under a tree overstory, it is generally desirable to plant outside the dripline and within the shade pattern of afternoon sun.

   Planting within brush fields is risky. In a year with good moisture, newly planted trees may survive, however, if the following year is droughty, mortality may result as brush has the competitive advantage for moisture. Rodent damage can be more common in live brush areas resulting in increased damage as well.

   (2) **Standing dead trees or brush.** Shade from standing dead trees and brush provides seedlings protection, but it is difficult for planters to move in dense thickets of dead brush, and falling debris may later smother or damage young seedlings. There is also a hazard to tree planters when planting in areas of standing dead trees.

   (3) **Downed logs, stumps, large pieces of debris.** Down, dead organic material is ideal for microsites. Retain sufficient debris during logging and site preparation to assure adequate shade materials. There is a risk of root pathogens spreading from stumps to regeneration. Where root pathogens like Armellaria spp. are a known problem, do not plant adjacent to stumps. However, on most forested sites there are more benefits (shade and trampling protection) from planting near stumps than there is a risk of mortality from disease.

   (4) **Small debris.** Small debris can protect the tree at ground line where shade is critical and other stationary shade is not present. Insolation often heats surface soils to temperatures lethal to natural regeneration and planted seedlings. Mortality can be attributed to heat lesions at the ground line. To reduce this problem, place small pieces of material, at least 3 inches in diameter, so that they shade the ground and base of seedlings from afternoon sun. Do not place this material on the uphill side of trees.

   (5) **Rocks.** Using rocks as shade may be better than no shade but may cause heat problems if not properly placed. Rocks should not contact the seedling or reflect the sun's rays onto the seedling.
b. **Artificial Material.** Artificial shade should not be necessary on most sites where logging and site preparation have retained sufficient debris. Examples of artificial shade to use if natural shade does not exist include wood shakes, fiberboard stapled to wood, plastic shade tubes, black plastic net material with wire supports, and Styrofoam cups (coffee cups).

The costs of artificial shade vary by type and ease of installation. Staked fiberboard and cedar shakes are usually cheaper to buy, but more costly to install, especially in rocky soils. The styrene cards and black mesh shade cloth systems are generally the best in rocky soils.

Color or size of the mesh opening does not affect effectiveness of material. Both black plastic net and styrene nets have wire prongs that are much easier to install and cause less root damage during installation than stakes or shakes.

Visit sites where artificial shade is used the spring after installation. Straighten or re-install material where animal and snow or other conditions have knocked the material out of place. This is necessary to ensure that animals and weather conditions have not caused the material to cover seedlings.

4. **Areas Prone to High Winds.** Hot, desiccating winds or winter winds that blow snow and ice can cause damage to tree seedlings, especially container-grown stock. In areas known for hot winds, protect seedlings by planting them on the leeward side of large debris.

**2.62 - Planting Spot Site Preparation**

Prepare the planting spot before planting in order to prevent surface debris (dry litter and duff) from falling into the planting hole and to free the spot from competing vegetation. Prior to opening the hole, the planter must follow this procedure:

1. **Clearing.** Remove all surface debris down to moist mineral soil within an area that is a minimum of 6 inches in diameter. Remove duff, litter, rotten or charred wood, loose rock, ashes, snow, surface frost and similar debris. After the tree has been planted, this material may be pushed back over the cleared surface to serve as mulch.

2. **Scalping.** Cut and remove all vegetation to a minimum of 1½ inches below the root crown. Width of the scalp is dependant upon the amount and kind of competing vegetation. Planting in sod-forming grasses generally requires scalping of 18 to 24 inches. Where larger scalps would be needed, herbicide and mechanical spot treatments should be considered.

3. **Mulch.** Add mulch after planting if needed for tree survival. Mulch reduces moisture loss and invasion of competing vegetation. It is most efficient to use surface debris and litter that was cleared from the planting spot. Newspapers, cardboard, plastics, and woven mats have also been used but with limited success although mulch mats specifically designed for this purpose...
have been successful. They should be designed with the light spectrum and water needs of seedlings in mind. A mat 2 to 3 feet square is desirable. Mulching with mats is an expensive operation and is recommended only for special projects or as a last resort to meet specific small project needs.

2.63 - Planting Hole Design

Locate holes for tree planting in good soil that is deep enough to accommodate the fully extended seedling roots. They should not be placed in rotten logs, duff or mixes of organic matter, or soil that easily dries out. The hole must be large enough in all dimensions so that seedling roots may be inserted without becoming deformed or damaged. Only an occasional long lateral root can be laid in the bottom of the hole in a non-vertical position.

Utilize the "Open Hole Method" in all cases. Open a hole with the planting tool to create a hole of adequate size to allow for natural alignment of tree roots and compaction of soil. Place loosened soil back into the hole and progressively firm soil from the bottom of the hole toward the top. The seedling should be positioned in the center of the hole. Side hole planting is only acceptable in limited cases where sandy soils are present.

Do not plant trees in narrow slits opened in the ground (slit planting); the seedling roots will not develop properly in most soils.

The standard minimum-sized planting hole for bareroot stock is:

1. Two inches deeper than the root length of the tree being planted.
2. At least 3½ inches diameter for the full length of the hole. A minimum 4-inch diameter hole is required for auger planting to permit necessary tamping for firmness.

The minimum-size hole for container stock is:

1. One inch deeper than the plug length.
2. At least 3 inches in diameter at top of the hole and 1 inch at bottom.

2.64 - Hand Tools for Planting

There are four broad categories of hand-held planting tools used in the Rocky Mountains. Each of these tools has been used successfully although each has an advantage on specific sites under certain conditions. The optimum tool will vary with the type of ground and kind of stock to be planted, and experience of planting crews. Select the tool to be used recognizing that the primary objective is to open a planting hole sufficient in size, depth, and orientation to allow proper alignment of roots for good tree establishment.
1. **Planting Hoes or Mattocks.** Planting hoes are also referred to as mattocks, R-6 hoe, Rindt tool, hoedag, R-1 tool or Corson tool. The hoedag and Corson tool differ from the others by not having a scalping blade.

Hoes have a planting blade and most also have a scalping blade. They are used to plant the tree and to prepare the planting spot (scraping and clearing). Planting hoes are used to plant all types of planting stock, but are limited by stock size. Bareroot stock with roots longer than 12 inches are too long to properly plant with a hoe, and should be planted with augers or shovels.

Hoe planting is physically demanding and requires skilled planters. The foreman and contract inspectors must enforce proper hole-opening techniques. Plantation failures will result from poorly planted trees, a direct result of improper contract administration.

   a. **Tool Description and Sizes.** Planting hoes are available in a variety of sizes and shapes. Refer to reforestation supply catalogs for further information. Hoes used in bareroot planting are 4 inches wide and the planting blade must be 2 inches longer than the root length of the stock to be planted. Hoes for planting container seedlings are 3 inches wide and must also have a planting blade 2 inches longer than stock.

   Regular hoe handle brackets are designed for a 90-degree relationship between the handle and planting blade. A newer design has the bracket with a 100-degree angle between the handle and blade that allows planter to get vertical holes easier especially on flat ground. Refer to reforestation supply catalogs for more information.

   b. **Hoe Planting Procedure.** One person performs hole preparation and tree planting. The correct procedure for planting is illustrated in exhibit 01. Open the planting hole by swinging the hoe, from one to five or more times, with blade the inserted vertically into soil. Utilize the "open hole method" described in section 2.63. Break the hole out on three sides. Hold the loose soil above the hole with the hoe, and suspend the tree. Fill in hole with original soil, firming soil around tree roots from bottom of hole progressively toward top. Exhibit 01, step 5 illustrates the progressive filling of hole and firming of soil. After planting, roots shall be in their natural position and the stem shall be erect and free to grow.

   Do not fill the hole in such a way as to compact tree roots along side of the planting hole. Exhibit 01, lower diagrams, illustrates an example of the planting hole improperly opened and filled.
2.64 - Exhibit 01

Procedure When Planting With a Hoe

1. Drive the hoe in full length and as near to perpendicular as possible.

2. Raise up on the handle to open the bottom of the hole.

3. Pull back the upper part, making a clean square hole.

4. Place the roots straight down into the middle of the hole, setting it the same depth it was in the nursery.

5. Push a portion of the soil into the hole, packing it firmly around the lower roots.

6. Finish filling the hole and tamp firmly.

7. Pack the upper part. This tree is set correctly.

Improper closure

The soil is pushed into the hole from one side.

Improper closure

The roots are jammed into one narrow plane, resulting in poor water absorption.
c. **Advantages of Hoe Planting.**

(1) Most cost efficient tool for a wide range of conditions and soils.

(2) Can be used with a mix of bareroot and containerized stock efficiently.

(3) Can be used as both the scalping and planting tool.

(4) Can result in more trees being planted because planter can move to a new planting spot within the spacing requirements when unplantable ground is encountered.

d. **Disadvantages of Hoe Planting.**

(1) Not suitable for planting in some rocky and heavy clay soils types if hole cannot be opened properly.

(2) Requires strict contract administration and individual planter control to avoid improper hole opening.

(3) Contract administration costs may be higher than with augers.

(4) Limited to stock with root lengths less than 12 inches. Larger stock requires augers or shovels.

2. **Tree Planting Augers.** Planting augers are powered by chain saw or other types of power heads. Carbide auger bits are recommended and are worth the extra initial cost. They last longer in all soils and are necessary in rocky soils.

   a. **Auger Planting Procedures.** Auger planting consists of three operations: planting hole preparation (clearing, scalping), hole augering, and planting. A different person(s) performs each operation. Auger holes must be planted promptly before the soil dries. Loose soil deposited on surface by the auger dries quickly, and some drying takes place on the face of the hole. Trees must be planted with moist soil thus crews should be balanced so that tree planters work close behind auger operators. Refer to exhibit 02 for diagrams of auger planting.

   (1) Scalper. One to three scalpers precede auger operators. They select the planting spot and prepare the planting hole by clearing and scalping. Hazel Hoe and McLeod Tool are good scalping tools. Hazel Hoes are heavy tools good for grubbing brush and heavy sod. McLeod Tools are good for light vegetation and litter. In areas of heavy site preparation where scalping is not necessary, the auger handler can select suitable planting spots.
(2) Auger Operator.

(a) Select planting spot or proceed to scalped spots with the auger running slowly.

(b) Place point of auger on chosen spot at proper angle. The first attempt should be in center of scalp. Advance motor to full throttle.

(c) Let auger sink into ground of its own accord. Do not force it.

(d) Slow the motor slightly while removing auger from the hole to avoid scattering soil it brings up. Cut motor to about half speed and quickly withdraw auger when hole is 2 inches deeper than root system being planted. Paint or flagging can be used to mark the proper depth (generally 12 to 14 inches) on the auger. Making holes to shallow will cause roots to be planted in U-, L-, or J-shapes. Holes that are too deep increase the possibility of air pockets in bottom of hole.

(e) Drill one or more auxiliary holes in very rocky areas where the fill soil would contain many rock fragments. The auxiliary holes provide good mineral soil to place around the tree.

(f) Return throttle to slower speed and proceed to next spot.

(3) Tree Planters.

(a) Follow behind augers to freshly drilled holes. Soil should still be cool and moist and not drying out. The planter moves along the downhill side of holes.

(b) Reach into the hole with one hand and clear loose dirt, which has slipped from the auger; and hold it to one side of hole.

(c) Remove one seedling from planting bag, and place it in the hole so the root collar is 2 to 3 inches below soil surface.

(d) Raise seedling so the root collar is about level with the top of the hole and tree is centered in the hole.

(e) Fill the hole one-third to one-half full with soil. Firm the soil being careful not to damage lateral roots while holding the tree in the center of the hole. There should be no air pockets at the bottom of the hole and the root collar should be even with the ground surface.

(f) Continue to place damp soil, free of debris, in the hole and firm it until soil is even with the root collar.
(g) Test tree for firmness by testing the ground around the tree. Soil should be firm.

If mulch is needed, place duff and litter around tree.
Procedure When Planting With an Auger

1. Position the auger at an angle between perpendicular-to-slope and true vertical above the planting spot.

2. Let the auger sink into the ground about 2 inches deeper than the root length.

3. Slow the motor while you remove the auger to avoid scattering the soil it brings up.

4. Place the seedling in the hole so that the root collar is even with the surface and the tree is centered.

5. Hold the seedling while filling the hole 1/3 to 1/2 full. Firm the soil to remove any air pockets.

6. Continue filling and tamping until the soil is level with the surface.

7. Pack the upper part. This tree is set correctly.
b. **Auger Operating Precautions.**

(1) Tools and parts should be available to repair machines in the field. Cutting surfaces of auger bits are hard faced. When this material wears off, the rest of the auger wears rapidly. Carbide bits are recommended because they have longer life. Keep spare bits or hard-faced cutting parts available on site, especially when working in granitic and rocky soils. Spark plug and fuel are also necessary on site.

(2) Follow the manufacturer's lubrication instructions. Do not use petroleum products to oil the chain due to the potential for petroleum products to contaminate the planting hole and kill the tree. Vegetable oil is the recommended alternative lubricant.

(3) The auger tends to hang up on medium-sized rocks and roots. The auger operator should be alert to this danger and when the machine first contacts the obstacle, it should be withdrawn before a binding contact is made.

(4) Auger operators must have chaps or baseball type shin guards to protect their legs from injury.

c. **Advantages of Auger Planting.**

(1) Augers are more consistent in opening clean holes in a wide range of soils. There is optimum root arrangement in the hole with roots extending 10 to 12 inches vertically into soil. Problems associated with improper hole opening and roots pushed into one plane (slit planting) or compacted into shallow holes is easier to avoid with augers than with other tools.

(2) All tasks do not require physically strong people as do hand tool operations. This allows for an assignment of labor skills to the most appropriate job.

(3) Fewer contract administration problems related to hole opening.

(4) Easier planting of large trees with roots up to 12 inches long.

(5) More suitable for certain types of rocky and heavy clay soils.

d. **Disadvantages of Auger Planting.**

(1) Scalpers work ahead of the auger, so planting spots are selected in advance. Unplantable spots are less detectable and may result in fewer trees planted per acre than with other tools.
(2) Safety hazard on very steep ground (50 to 60 percent plus) or where footing is difficult.

(3) Not recommended in extremely rocky soils or soils with lots of thick tree roots, because auger bits can bind up.

(4) Contract costs can be high when compared to other methods.

(5) Mechanical breakdowns occur and there is need for fuel (gas and oil), and the high cost of equipment.

(6) Higher safety hazard.

(7) Requires more people to complete planting operations.

3. Shovels and Spades. Shovels modified for tree planting are available from reforestation equipment suppliers. They are not commonly used in the Rocky Mountains, but they are used in other parts of the United States. Shovels are used for large planting stock, such as transplant or large 3-0 bareroot stock when operating in easily worked soils with little rock.

Rules for shovel planting are similar to that for planting hoes. However, in some cases the soil is completely removed and replaced after inserting the tree. The technique may vary a little depending on the type of shovel employed. Shovels may be preferred especially when planting long-rooted stock. Roots must be properly aligned as described in the open hole method (see section 2.63).

4. Planting Bars. KBC planting bars are suitable for planting small trees with roots less than 10 inches long, on very rocky soils. The blade may need to be extended for planting large stock. This can be done by welding additional steel to the original blade. Wedge-shaped bars (OST) are not useful in rocky soils.

   a. Bar Planting Procedure. Two operations are required, the scalper and the tree planter.

      (1) Scalper. Preceed planters and prepare planting hole using Hazel hoes, McLeod tools, or other scalping tool.

      (2) Tree planter

         (a) Drive the bar full length into the ground at the proper angle near the center of the selected spot. Use foot on the step as needed. Repeated efforts may be required to adequately insert the bar into the ground.
(b) Withdraw the bar 1 inch. Open the bottom of the hole by pulling the bar 4 to 6 inches toward the body while using the point where the bar enters the ground as a fulcrum.

(c) Force the bar into the ground so the tip acts as a fulcrum and push the bar 6 to 8 inches away from the body. This should open the top of a rectangular hole approximately 14 inches deep. Remove the bar from the hole without disturbing the soil faces.

(d) Carefully remove one seedling from the planting bag. Insert the tree into the hole until the root collar is 2 inches below the soil surface. Do not slide the roots into place on the blade of the planting tool. It will result in root deformities.

(e) Raise the tree so the root collar is level with soil surface. Make sure the roots are fully extended and near natural position, not curled or twisted.

(f) Thrust the bar into the soil 3 inches in front of the tree while holding the seedling at the proper depth near the center back of the. Push the bar forward, forcing dirt into the top of the hole, securing the seedling in place. Avoid crushing the roots between rocks or by the bar when closing the planting hole.

(g) Drive the bar full length into the soil as before at the same point used above. Do not permit the bar to angle into the planting hole.

(h) Withdraw the bar 1 inch and pull it 4 to 6 inches toward the body. This action closes the bottom of the hole.

(i) Force the bar into the ground so the tip acts as a fulcrum and push the bar 6 to 8 inches away from the body. This action should close the top of the hole, leaving an open crimp hole. Avoid crushing the roots between rocks or by the bar when closing the planting hole.

(j) Remove the bar and repeat steps g, h, and i (above) once or twice so the seedling is surrounded by firm soil.

(k) Place heel across last crimp hole and step firmly to plug it. Check tree for firmness and stem position and proceed to next spot.

b. **Advantages of Bar Planting.**

(1) Allows planting of very rocky soils, however, they have no advantage over augers or hoes on most other soils.

c. **Disadvantages of Bar Planting.**
(1) Seedling will not be planted in center of hole, thus it is limited in use in most soil types.

(2) Pushing the bar back and forth creates X- or K-shaped holes that cannot be planted or closed properly.

(3) A V-shaped hole is the preferred shaped hole, however, extra effort is required to achieve good root positioning so roots are not pushed into a single plane.

2.65 - Planting Machines

Machine planting can be a useful technique where there are large expanses of relatively flat ground with easily worked soils and little debris.

Planting machines are pulled behind small tractors. A Coulter wheel, or steel blade, is mounted on the front of the planting machine. It cuts a narrow trench through the ground when the machine, in planting position, is pulled by the tractor. A planting shoe opens the trench to a width of 4 inches, providing a place for the tree to be inserted into the ground. A pair of packing wheels at the rear of the machine compacts the soil on each side of the tree as the tree passes between the wheels. The planting machine must be calibrated to open a trench 14 inches deep in order to plant the trees to the proper depth.

1. Machine Planting Procedure. The planting machine operation is a team effort between the tractor operator and the planter. A trailing inspector may also be required. The tractor operator must be constantly aware of what is occurring on the planting machine and must drive in a manner which will not cause injury to the planter or distract him from proper planting of the trees.

   a. Tractor Operator.

      (1) With the motor running, the planting machine mounted, and the planter in the seat ready to plant, start the tractor in motion along the row to be planted.

      (2) Position the hydraulic controls to gently let the planting machine shoe move into the ground while moving forward. Putting the planting machine shoe in the ground while standing still fills the planting shoe with dirt, making it inoperative.

      (3) Drive along the planting row. Avoid, or push away with the dozer blade, any poles and debris that could injure the planter or damage the equipment.

      (4) At the end of the row, lift the planting machine from the ground and turn into the next row.

      (5) Avoid backing while planting.
b. **Planter.**

(1) When the tractor is in motion, select a single tree from the planting box. Hold the seedling with root collar between the thumb and forefinger of one hand.

(2) On the Rocky Mountain planter, insert the seedling in the forward part of the planting shoe. With the tree held vertically at the proper depth, move the tree to the rear of the planting shoe. Assure proper spacing is achieved.

On the Whitfield planter, place the seedling in the holders. The machine is calibrated for proper depth and spacing.

(3) Gently hold the tree erect, releasing it just before it passes between the packing wheels.

2. **Advantages of Machine planting.**

   a. Ability to plant large areas and numerous trees in a short time period.

   b. Requires a small crew.

3. **Disadvantages of Machine planting.**

   a. Does not work well on sloping terrain, rocky or clay soils, or areas of heavy debris. Trees generally will not be planted properly.

   b. Requires constant inspection to assure proper planting. It is common for the machine to lose its calibration resulting in poorly planted or improperly spaced trees.

   c. Commonly results in sweeping roots causing growth problems that are not recognized until the tree are older.

   d. Requires skilled operators.

   e. Cannot select best microsites or plant by stationary shade. Moveable shade can be applied in a separate operation.

4. **Maintenance and Safety.** All machine planters require daily maintenance. Check and tighten loose bolts and grease movable parts. Keep spare parts on hand for repairs. Provide frequent maintenance to maintain productivity during good planting conditions. Review safety hazards daily with planting crews working on or around planting machinery. Use the following safety reminders:

   a. Ensure that the tractor operator is qualified and understands the operation of both the tractor and the planter.
b. Be sure the planter understands the operation of the planting machine.

c. Keep other workers a safe distance away from operating machinery.

d. Wear a hardhat at all times.

e. Planter must wear a seatbelt at all times.

f. Tractor operator and planter should wear ear protection.

g. Do not operate planting machines on slopes in excess of 35 to 40 percent.

h. A mirror should be mounted on the tractor or in the cab so the operator can observe the machine and planter while in motion. Provide a buzzer system so the planter can contact the tractor operator.

2.66 - Planting the Bareroot Tree

The planting hole must be properly opened for correct tree placement. The seedling must be inserted at the proper depth with proper root and stem alignment. After the tree is properly aligned, moist mineral soil must be firmed around the roots. See exhibit 01 for examples of properly and improperly planted trees.

1. Planting Depth. Plant the seedling at approximately the same ground line as it was in the nursery. The root collar or cotyledon scar is an indicator of the original ground line. No portion of the roots should be exposed, nor any needles or branches covered with soil.

Correct depth placement is especially critical on high insolation sites. The stem tissue at the base of the tree at the ground line is insulated (thickest bark) better than stem tissue above or root tissue below for protection from temperature extremes. High soil temperatures at ground line can be lethal to tender stem or root tissue.

2. Root Arrangement and Alterations. The seedling should be planted so the root system is in its natural configuration and free to grow. The roots should radiate downward in a conical arrangement. Proper arrangement is critical for maximum water uptake. Properly train inspectors to recognize improper root arrangement. Do not twist the roots; compact the root system along one plane, or plant with the roots in a U, J or L shape. An occasional lateral root may be J-, U-, or L-shaped, however, taproots must be in a natural position and never bent.

Do not allow planters to cut, strip, or otherwise alter roots prior to planting. Inspectors and foremen must have a firm visual impression of the root systems in order to inspect for violations. Root systems vary by species and tree lot, therefore, inspectors should visit the wrapping shed or tree bagging sites regularly. Observe the length and number of lateral roots as well as the length of the tap root. This is important as planters may strip or shorten only the lateral roots of the
tree. Tree root systems should normally have a bell shape with many of the laterals hanging down to a length equal with or sometimes longer than the tap root. The root system should not look like a “skinny carrot” with no laterals, nor should the laterals all be appreciably shorter than the tap root.

Root stripping is done when planters have trouble fitting roots properly into hole. To help avoid root stripping, the appropriate kind of stock should be ordered for the site. For example, do not order 12 inch long bareroot stock for a site with shallow soils. It may be more appropriate to use 6 inch container stock. When applicable, make sure the nursery has properly pruned the bareroot stock prior to shipment.

3. **Stem Orientation.** Orient the tree stem at an angle between 90 degrees with the horizontal plane to 90 degrees with the slope face. This will be achieved if the hole is opened properly.

4. **Firmness.** Firmly tamp the soil around the planted tree roots filling and firming the hole progressively from the bottom toward the top. Do not tamp with sticks or by "heeling in" alongside the seedlings after planting. Do not leave any large air pockets in the hole and do not leave debris in the hole after closure. Roots not in close contact with mineral soil will dry, resulting in tree mortality.
2.66 - Exhibit 01

Planting the Bareroot Tree

**Satisfactory and Unsatisfactory Plantings**

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</table>

- **Satisfactory Planting**: Proper orientation, roots in place, hole at correct depth.
- **Unsatisfactory Planting**: Too deep, needles buried, improper orientation, roots not placed correctly, hole too narrow or shallow, roots exposed, air pocket, planted in rotten wood, roots not in mineral soil, "U" or "J" shaped tap root, compacted roots, hole too narrow.
2.67 – Planting the Container Plug

The container plugs are extracted from the container racks and packed (20 to 25 seedlings per package) in wrapped bundles or plastic baggies. Distribute plugs to planters in baggies, which are placed directly into the planting bag.

Container 6- to 9-inch plugs are generally easier to plant than longer rooted bareroot seedlings. Containers are especially recommended for rocky sites where hoels cannot be opened properly for bareroot stock. Containers can be planted with almost any planting tool available. Hoes, bars, and augers have all been used successfully, however, dibbles are not recommended.

1. **Planting Depth.** Plant the plug deep enough so that about 1 inch of soil can be placed on top of plug, level with surrounding soil surface in order to seal the plug in the ground. This is necessary in areas prone to frost heaving. In all cases, the entire plug and root media must be below the ground surface.

2. **Plug (root) Arrangement.** While container trees are somewhat easier to plant than bareroot trees, the same care should be given to ensure containers are properly planted. Do not break, bend, flatten or distort the plug in any manner to avoid damage to the root system. After the planting hole has been properly opened, plant the container tree as described for bareroot seedlings in section 2.66.

3. **Protection.** Containerized seedlings are similar morphologically to natural and 1-0 seedlings in that they have very little heat protection (bark) on the stem. The high soil temperatures at ground level can easily kill the tree if not properly shaded.

4. **Dibbles - Caution.** Dibbles should be used with caution. They are metal tools shaped in the form of a container that is pushed into the soil leaving a hole the shape of the container plug to be planted. Dibbles are suitable in light, fine textured soils, but in clay soils they have the effect of glazing or compacting the sides of the hole. This causes problems in root penetration or creates an air layer between plug and soil. When the air layer fills with water and freezes, frost heaving will occur.

2.68 - Artificial Seeding Projects

Direct seeding is not an operational reforestation tool in the Rocky Mountains, however, it may be an option on small projects or administrative studies. Success in the past was poor due to unavailability of bird and rodent repellants and poisons, and high cost of seed. In the past, large wildfire areas were seeded with seed mixes of trees and other vegetation, however, tree success was rare.
2.7 - Reforestation Surveys and Monitoring

Reforestation surveys are required to monitor reforestation activities in artificial and natural regeneration treatments. They are used to determine stocking density, distribution, species composition, and health of regeneration as required by the NFMA. They are also used to monitor the effects of management treatments on lands with reforestation objectives. Utilize the regional activity data base for tracking reforestation activities including surveys.

Maintain all reforestation records in the regional computerized activity data bases and in stand folders. Utilize Region 1 Timber Management Control Handbook (FSH 2409.21e R-1), Region 3 and 4 RMRIS User Guide and Dictionary, and Region 2 RMACT User Guide for data entry procedures discussed in this section. Reforestation reporting requirements discussed in this handbook are detailed in the above references.

2.71 - Quality Control and Reports

Monitoring reforestation treatments is very important. The effectiveness of treatments must be known and the results must be available for use by the Forest Service and other organizations. Refer to section 2.75 for examples of reports.

The following persons have responsibility for appropriate monitoring and reporting:

1. Regional Forester/Forest Supervisors.
   a. Review database reports and stand records to ensure accurate and timely reporting
   b. Provide program quality control checks through site visits and technical support.

2. District Rangers.
   a. Ensure all regeneration harvest stands since 1976 are appropriately coded in the regional activity data base.
   b. Ensure all other nonstocked land in the timber base treated since 1976 is appropriately coded.
   c. Ensure stands that are satisfactorily stocked1976 are recorded properly in the database.

2.72 – Project Status Classification

Stands are considered to be in reforestation status from the time they are identified as having a reforestation need until they have been certified as satisfactorily stocked and not requiring further reforestation treatment. The expected treatment and survey schedules are listed in exhibit
01. Classify stands in reforestation status as either progressing, certified, or as failing. Reassess failures promptly and schedule re-treatment if needed. Identify target stocking levels in the silviculture prescription utilizing guides and objectives from Forest Plans. For more details on the prescription process, refer to section 2.3 - Reforestation Prescription.
## 2.72- Exhibit 01

Expected Reforestation Treatment and Survey Schedules

<table>
<thead>
<tr>
<th>Scheme</th>
<th>Harvest that Initiates Regeneration Status</th>
<th>Site Preparation Schedule</th>
<th>Timing of Planting or Seeding</th>
<th>Survey Period Begins</th>
<th>Expected Length of Time to Certification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Suitable Timber Land</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Clearcut with natural regeneration</td>
<td>Final</td>
<td>At time of, or within 1 year of harvest</td>
<td>N/A</td>
<td>The first or second fall after a cycle that includes a site preparation, fall seed crop</td>
<td>The fall survey 5th year after harvest</td>
</tr>
<tr>
<td>2. Clearcut with planting or direct seeding</td>
<td>Final</td>
<td>At time of, or within 1 year after seed or regeneration cut</td>
<td>Immediately after or within 1 yr. of site prep</td>
<td>End of first growing season after planting or artificial seeding</td>
<td>The fall survey 5th year after harvest</td>
</tr>
<tr>
<td>3. Seed tree, shelterwood and selection system with natural regeneration</td>
<td>Seed or regeneration cut *</td>
<td>At time of, or within 1 year after seed or regeneration cut</td>
<td>N/A</td>
<td>The first or second fall after a cycle that includes a site preparation and fall seed crop</td>
<td>5-7 years after survey period begins</td>
</tr>
<tr>
<td>4. Seed tree, shelterwood and selection system with artificial regeneration</td>
<td>Regeneration cut *</td>
<td>At time of, or within 1 year of regeneration</td>
<td>Immediately after or within 1 year of site prep</td>
<td>End of first growing season after planting or artificial seeding</td>
<td>3-5 years after survey period begins</td>
</tr>
<tr>
<td>5. Fire</td>
<td>Fire</td>
<td></td>
<td>Prior to the second growing season after the fire</td>
<td>First or second growing season after fire for natural regeneration, or first growing season after planting, or artificial seeding</td>
<td>5-7 years after survey period begins</td>
</tr>
<tr>
<td><strong>Unsuitable Timber Land</strong></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>6. Clearcut</td>
<td>Final</td>
<td>By Prescription</td>
<td></td>
<td>Area must be classified as unsuitable if acceptable regeneration is not assured within 5 years.</td>
<td></td>
</tr>
<tr>
<td>7. Shelterwoods</td>
<td>Final</td>
<td>By Prescription</td>
<td></td>
<td>Note: Area must be classified as unsuitable if acceptable regeneration is not assured within 5 years.</td>
<td></td>
</tr>
</tbody>
</table>

* NFMA 5 year requirement on suitable timber land for regeneration of seed tree and shelterwood harvests begins with the overstory removal cut, although regeneration status tracking begins with the seed cut or regeneration cut.
1. **Stands Progressing Toward Certification.** Stands in this category have either been planted or have received treatments that resulted in natural regeneration. Regeneration is establishing but conditions have not yet been met to certify the stand as satisfactorily stocked.

   a. **Region 1.** Stands in Progressing Status.

      (1) **Planted Stands.** Generally, stands should not be in a progressing status for more than two seasons although stands may be in this status longer when there are factors that are limiting regeneration success. Certify stands as satisfactorily stocked and needing no further treatment as soon as possible to avoid repeated survey costs. The stand should be failed if more than 20 percent of the acreage needs full planting or more than 30 percent needs interplanting.

      (2) **Naturally Regenerated Stands (except lodgepole pine).** Classify stands planned for natural regeneration as progressing satisfactorily following the first exam after initiating the regeneration treatment. Stands should not be classified as progressing for more than four successive years. Stands not examined two growing seasons after this cycle are automatically counted as failing stands in the Region's Reforestation Indices Report. The stand should be failed if more than 20 percent of the acreage needs full planting or more than 30 percent needs interplanting.

      (3) **Naturally Regenerated Lodgepole Pine Stands.** Lodgepole pine germinating from serotinous cones may take up to three to four growing seasons to be noticeable. When the second and third year exams reveal no germinates but site preparation and cone dispersion on the site is known to be adequate, progressing status can be waived until the third or fourth year until regeneration is apparent. Progressing status cannot be waived following the fourth growing season. Classify the stand as failed and schedule for planting if no seedlings are present after the fourth-year growing season. Follow specific regional or local guidelines to make determinations for these stands.

   b. **Regions 2, 3, and 4.** Coding Stands in Progressing Status. Monitor and record stand conditions in the stand folder until determination for certification or failure is made. Use the appropriate regeneration activity code (planting or site preparation) to indicate that it is in regeneration status. The stand is considered to be progressing satisfactorily if certification or failure status is not entered in the activity screen.

2. **Certified Stocked Stands.** For the stand to be certified as satisfactorily stocked, it must meet the following criteria:

   a. **Establishment.** Established regeneration, both planted and natural regeneration, must have survived at least three growing seasons and be healthy with good buds and leaders.
b. **Quantity.** The number of established seedlings on the stand meets stocking levels including tree numbers and distribution described in the silvicultural prescription.

c. **Future Treatments.** The silviculturist has determined that the stand requires no further regeneration treatment or regeneration exams. Seedlings are free to grow and there are no conditions that would affect stocking levels.

The stand can be certified as satisfactorily stocked and regeneration period complete when these criteria are met. Record this status in the stand folder and record reforestation status in the regional activity data base as certified.

Stands are most frequently certified following the third year exam or later after planting or site preparation. Continue with follow-up monitoring as needed after the stand is certified. Schedule the next anticipated treatment or survey in the database.

In some instances, the certified silviculturist may certify stands not meeting the originally prescribed stocking quantities provided the prescription is amended. Reasons for modifying the prescription may include reducing the desired tree numbers to reflect natural disturbance patterns, resource needs other than timber management, or that costs of additional treatments is not justified. They may also state in their analysis that early stocking is sufficient, and the rate of anticipated natural fill-in during the next decade will add additional stocking to reach the desired stocking level. Clearly state the reasons for modification in the prescription.

3. **Failing Stands.** Failing stands are stands that do not meet reforestation requirements for certification without additional reforestation treatment such as site preparation, planting, or interplanting. Re-evaluate failed stands and schedule the necessary treatment promptly. If it is decided to do no additional treatment, document the decision in the stand folder. Stands not meeting the criteria for progressing or certification should be entered in the database as failing.

**2.73 - Stocking Surveys**

Conduct reforestation stocking surveys to determine the quality and quantity of regeneration. Surveys are either done to assess unknown conditions in areas in order to determine treatment needs, or to assess the success of the treatments. Sometimes additional surveys are taken in order to facilitate the logistics of treatments. Silviculturists should develop field sampling designs to assure the methodology and the survey format is consistent with methods described in this section. Survey methods include walk-through, systematic plots, or staked trees.

1. **Types of Reforestation Surveys.**

   a. **Pre-treatment Surveys.** Pretreatment surveys are generally necessary after fires, blowdown, harvest, or insect and disease mortality and other similar events.
Information obtained from these surveys is used to diagnose and prescribe stand treatment needs on lands suspected to be in need of reforestation.

The best time to survey stands with questionable stocking may be after a few frosts when summer vegetation has died back and turned brown. This allows for better distinction of green seedlings against tan deciduous vegetation. In western larch stands, it is best to complete surveys while yellow needles are still on the seedlings.

Pre-treatment surveys are optional, but if performed, should be entered into the regional activity data base with companion codes if a reforestation need is identified.

b. Pre-Planting Surveys. The primary purpose for pre-plant surveys is to prepare a planting contract or to prepare force account planting projects. Conduct these surveys to estimate the amount of planting stock needed, percent of plantable ground available for planting; scalping needs, shade or microsite availability, and other contract specifications.

Pre-plant surveys are not required, however, they provide essential information for the planting project. They may be entered into Timber Stand Management Record System (TSMRS) in R-1 although it is not required. They are not coded into the activity bases in R-2, 3, or 4.

A walk-through survey is generally sufficient. Intensity of the survey must be adequate to detect changing conditions both above and below the soil surface.

c. Post-treatment Stocking Surveys. Utilize post-treatment stocking surveys to monitor regeneration and determine status (certified, progressing, or failing) after seeding, planting, or natural regeneration to determine estimated density and distribution of seedlings.

Surveys start at the end of the first full growing season following planting, seeding, site preparation for natural regeneration, or coppice harvest, refer to 2.72 exhibit 01 for the estimated survey schedule. Assess regeneration after the first and third growing seasons at a minimum. In Region 1, Reforestation Indices reports will reflect the failure to meet the survey schedule requirements.

(1) Planted Units. Schedule the survey based on time of year trees when planting occurred. Survey units planted in spring and early summer at the end of the growing season of the first year of planting. Survey units planted in late summer and fall at the end of the growing season the following year. Third-year surveys are 2 years later.

(2) Natural Regeneration and Seeding. Survey stands by the end of the second growing season after a site preparation treatment followed by seed dispersal cycle.
Site preparation is considered accomplished by a harvest or by a separate site preparation treatment.

(3) **Coppice Method.** Survey after one full growing season following the regeneration initiating activity, which may be a harvest, prescribed burn, or other action.

Conduct a combination of walk-through exams and quick plot exams. Poorly stocked stands may be failed with one or two walk-through surveys. Well-stocked stands can be certified with only two walk-through surveys. Other stands may require as many as three or four walk-through surveys and two quick plot surveys before stocking is sufficient for certification. Schedule surveys based on past experience on similar sites. An assessment of regeneration success by habitat type can be useful in predicting the success of regeneration and surveys needs.

If the above information is unavailable, plan surveys as described below. Conduct additional surveys if the unit is not certified as satisfactorily stocked or prescribe activities to correct failing units

(a) **Planted Unit.** Two walk-through surveys; or one walk-through and one quick plot survey.

(b) **Clear-cut and Natural Regeneration.** Two walk-through surveys and a quick plot survey.

(c) **Shelterwood and Natural Regeneration.** Three walk-through surveys and one quick plot survey.

(d) **Coppice Regeneration (Aspen).** At least one walk-through survey. Conduct multiple walk-through exams where animal activity may be impacting regeneration establishment. Use quick plot surveys where stocking may be in question.

d. **Maintenance Surveys.** Schedule maintenance surveys to monitor certified stands where there is a risk that regeneration may be damaged during harvest (for example, shelterwood tree removal), or by animals or other agents.

e. **Staked Tree Survival Surveys.** Utilize staked tree survival surveys to evaluate seedling survival. Refer to section 2.74.

2. **Reforestation Stocking Survey Methods.** Variations of walk-through and quick plots are used for pre-treatment, pre-plant, post-treatment, and maintenance surveys. A walk-through survey is typically adequate for pre-treatment and pre-plant exams. Post-treatment exams may consist of a walk-through survey in early years and a quick plot exam prior to certification. A quick plot exam is not required and may not be necessary in well-stocked units. The
A silviculturist will determine the type of exam based on expected stocking levels and goals of the exam. Staked tree surveys will be conducted consistent with the procedure described in section 2.74.

a. **Walk-through Surveys.** Walk-through surveys do not require taking plots. These are conducted by walking through the treatment area, recording ocular observations. The examiner should have reforestation experience to ensure that accurate observations are made. Survey the entire area of concern. Occasional plots may be taken to record specific data but results do not have statistical basis. Document results of the survey.

During the exam, observe regeneration under varying conditions such as topography, aspect, and differences in site preparation method. Expect differences in regeneration establishment in machine piled areas versus prescribed burn areas and in drainage bottoms or depressions where frost may be a problem.

b. **Plot Surveys.** Plot surveys are systematic plot surveys taken on a grid with at least enough plots to produce a 1 percent minimum sample.

(1) **Plot Size.** Select plot size best suited for the stand being examined. Plot size should be large enough to pick up three trees per plot. Do not change plot size within a unit.

(a) In most plantations and natural stands, 1/100th-acre plots will result in the desired number of sample trees.

(b) In well-stocked stands with more than 400 well-distributed trees per acre, on steep slopes or thick vegetation, smaller plots 1/300th-acre in size is generally suitable. However, the 1/300th-acre plot is not suitable for plantations with widely spaced trees. It may yield data that is difficult to analyze for understocked or nonstocked stands since there will be no trees tallied even in areas with adequate stocking. One-hundredth-acre plots may be used in stands where coppice treatments result in thousands of sprouts.

(c) Large plots, 1/50th-acre in size, may be needed in units of widely spaced seedlings to achieve sufficient trees on the plot.

(2) **Adjustment of Plot Radii on Steep Slopes.** Use exhibit 01 to determine the circular plot radii for 1/100th-acre or 1/50th-acre plots. The 1/300th- and 1/1000th-acre plots are small enough that it is acceptable to adjust tape height manually.

To utilize the table, first find the slope of the plot area. Determine plot radius from the table. Do not change the radius of plot or height of tape when going from the extreme slope to the contour within a plot as this variation has been calculated into
the table. (Example: On a 50 percent slope, use a radius of 12.5 feet all around the 1/100th-acre plot with no adjustments.)

(3) Examination within the Plot. Record trees in a systematic manner to avoid missing trees. One method is to start on the uphill side (or north, if level) and move in a clock-wise direction.

2.73 - Exhibit 01

Table of Elliptical Radii for Various Slopes and 1/100th- & 1/50th-Acre Plots

<table>
<thead>
<tr>
<th>Percent Slope</th>
<th>Plot Size 1/100</th>
<th>Plot Size 1/50</th>
<th>Percent Slope</th>
<th>Plot Size 1/100</th>
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<tbody>
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</table>

4. Survey Forms. The following survey forms (ex. 2, 3, and 4) are available for optional use by Regions 1, 2, 3 and 4. Alternate forms such as locally adapted forms or Common Stand Exam (CSE) forms may also be used. Regardless of form, the following minimum information should be collected. Recognize the purpose of each survey when deciding which form to use and information to collect.
a. **Stand Diagram.** Stand diagrams are useful in most exams to identify the relative location of site characteristics that affect reforestation based on the survey findings. Sketch the unit map indicating features such as rock outcrops, landings, skid trails, road access, untreated slash and other features for reference and to indicate the ability to re-stock portions of the unit. Sketch the travel route for walk-through exams indicating stocking levels. Indicate plot locations and plot lines when plots are taken. Draw figures around groups of unstocked (or non-stockable) areas or plots to depict the shape and size of the nonstocked area on the ground. See exhibit 02 for an example of a plot survey done for stocking surveys.

2.73 - Exhibit 02
b. **Analysis or Summary.** Write an interpretation of the findings on the back of the map or on a separate sheet. Indicate the type of survey (walk-through or quick plot), purpose of survey, and analysis of the findings.

Examples of useful information to include in the write-up:

1. “Area meets stocking certification requirements.”

2. “Area appears stocked and progressing adequately, schedule a survey next year for certification.”

3. “Schedule a prescription for replant on west slope.”

4. “Total area has failed and needs new prescription.”

5. “Stand has several holes larger than 2 acres that need replanting. Non-stocked areas are due to frost; plant lodgepole pine.”

6. “Stand has several areas larger than 2 acres where stocking is marginal, areas are in rock outcrop and do not justify a replant to rectify marginal stocking.”

If the survey is a plot survey, tables may be constructed on each field form to summarize stocked acres and non-stocked acres. Unsatisfactorily stocked areas are generally areas larger than 2 acres.

This information is needed to determine status of the stand and if further treatments are needed.

c. **Pre-Planting Survey Form.** Utilize the R-1, 2, 3, 4 FS 2470-17 Pre-Planting Survey Form or a locally developed form to collect information on unit plantability. See exhibit 03 for examples of several units with a walk-through survey and sample plots taken throughout units. Adapt the form to meet local needs. Check for rocks and other underground conditions that affect plantability by using a hoe in a similar manner to that used when inspecting for planting spots in contract administration.

There are columns on the Pre-Plant Survey form to identify the clearing and scalping needs of each planting spot at each stop or sample plot in the unit. Document the type of shade available on the plot and indicate the shade needs in the remarks column. Identify the portion of the sample plot that is unplantable and the reason. Provide remarks necessary to prepare the contract and further treatment such as animal damage control and access problems.

As a minimum, collect the following information:
(1) Number of available plantable spots based on desired stocking level.

(2) Need for scalping and clearing requirements.

(3) Availability of shade (stationary or transportable), and microsites.

(4) Presence of non-plantable spots and reason for non-plantability.

(5) Indicators of rodent or other animal presence, which would affect establishment.

(6) Access to unit and roads within unit.

Estimate percent of plantable ground:

\[
\text{% plantable ground} = \frac{\text{Total number of plantable spots on the plots}}{\text{Desired number of spots} \times \text{number of plots}}
\]

or

\[
\text{% plantable ground} = \frac{\text{Number of plantable spots on the plots}}{\text{Number of plantable spots} + \text{number of unplantable spots}}
\]
### 2.73 - Exhibit 03

**PRE-PLANTING SURVEY FORM**

**FIELD RECORED**
(Ref. FSH 2409.17)

<table>
<thead>
<tr>
<th>STAND NUMBER OR UNIT NAME</th>
<th>SURVEYED BY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cougar Creek</td>
<td>Greenup</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DESIRED NUMBER PLANTING SPOTS</th>
<th>DESIRED SPACING</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 per 1/50th-acre plot</td>
<td>20 x 20 BR stock</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>E</th>
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<th>NONPLANTABLE</th>
<th>REMARKS</th>
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</thead>
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<td></td>
<td>No Treatment</td>
<td>Clearing Required</td>
<td>Scalping Required</td>
<td>TRANS- PORTED</td>
</tr>
<tr>
<td>1</td>
<td>9+</td>
<td>9+</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>9+</td>
<td>9+</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>9+</td>
<td>9+</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>9+</td>
<td>9+</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>9+</td>
<td>9+</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>9+</td>
<td>9+</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

**Example 1:** Unit has fresh site prep, good ground

1. 9+ (Summary: Stationary shade or transportable shade will be adequate)
2. 9+ (6" clearing will be adequate. Scalping not necessary. Hoe plant.)
3. 9+ (BR, 12" roots okay. Pocket gopher.)
4. 9+ (Baiting may be needed.)

**Example 2:** Unit has fresh site prep, rocky ground

1. 0 (Summary: Extremely rocky. Not plantable with BR stock. About 60% plantable with containers only. Stationary shade preferred, then transportable. 6" clearing adequate. 12" scalp needed on portions of unit. Hoe plant.)
2. 8 (Need 18" scalp, 6" clearing okay.)
3. 9 (Stationary shade preferred, then transportable, lastly in the open.)
4. 3 (Vexar tubes need for animal protection. Suitable for BR stock.)
5. 0 (Auger due to clay soils.)

**Example 3:** Older unit, interplant prescribed to boot stocking

1. 3 (Summary: DF, WL acceptable tree spp.)
2. 4 (Need 18" scalp, 6" clearing okay.)
3. 5 (Stationary shade preferred, then transportable, lastly in the open.)
4. 1 (consider shade cards. Suitable for BR stock.)

**Example 4:** Old unit, heavy sod on SW exposure and 40% slope

1. 9 (Summary: Heavy sod, clearing 6" and scalping 24" needed. 10% unplantable due to rock. Shade is needed.)
2. 9 (consider shade cards. Suitable for BR stock. Auger due to clay soils.)
3. 9 (consider shade cards. Suitable for BR stock. Auger due to clay soils.)
4. 9 (consider shade cards. Suitable for BR stock. Auger due to clay soils.)
d. **Walk-through Survey.** Utilize a locally adapted form to document results of the walk-through survey. Utilize plot survey forms such as the quick plot survey form (ex. 04) described below to document information on sample plots; or modify the pre-plant survey form (ex. 03) to meet the intent of the survey. Include stand diagrams and an analysis of the condition; both are essential for documenting the findings and conclusions of the walk-through survey.

e. **Reforestation Quick Plot Survey Form.** Use R1, 2, 3, 4 FS-2470-18a or a locally developed form for taking plot surveys. The standard form allows for rapid hand calculation and plot summary computations. See exhibit 04 for an example of the Quick Plot Survey Form used in a stocking survey. The stand diagram and analysis should also be included with the plot survey results.

Fill in the unit name, date of survey, and names of surveyors at the top of the form. Adjust column headings under planted stock and natural regeneration to meet local needs.

(1) **Plot Number.** Record plots consecutively through final plot number.

(2) **Planted Stock.** The standard form has columns for species and tree conditions; make adjustments to columns as needed.

(3) **Planted Species.** There are three columns for species planted. These columns may be used for individual species or groups of species.

(4) **Tree Condition.** There are three columns under each species to identify condition such as size or tree health. Determine the condition to be surveyed, and tally the number of trees fitting the category. Suggested size categories are <1 foot in height, 1-2 feet in height, >2.5 feet. The columns may instead be used to identify tree health utilizing column headings such as (H) healthy, (S) stressed, and (D) dead trees. Stressed trees are those stressed to the point where survival is questionable. Indicators of stress include dead tips and buds; red, yellow, or brown foliage, heavily browsed tops, or poorly formed buds. If a large portion of the trees is listed in the stressed columns, schedule a survey for the following year. Trees listed as dead should have no live green tissue.

(5) **Natural Regeneration.** There are three columns for natural regeneration. Determine the categories to be surveyed. Suggested categories are by species or by size classes (for example, 0-6 inches, 7 inches to 2½ feet, 2½ feet tall or taller). List only trees of acceptable quality. Do not count stagnated residual trees or badly damaged trees, suppressed trees, or diseased trees unless experience has shown these trees will eventually release. Good terminal leader growth is a good measure of tree vigor. Generally, only trees 2 years old or older are counted. Specify criteria used in
this tally in notes or in the remarks column. Survey crews should be well trained in
tree quality expected for the area in which they are to work.

(6) **Total Live Trees in Plot.** Enter the total number of acceptable tallied live trees
found on the plot. Generally include all acceptable natural regeneration and healthy
planted trees meeting the size criteria. It may also be desirable to reflect the total
trees on the plot when it will affect future treatments. Very heavy stocking, even if it
is with undesirable species or with trees of poor condition, may indicate a need for
site preparation before planting or an early TSI activity to release crop trees.

Prior to conducting the survey, determine the maximum number of seedlings that will
be considered in calculations for unit stocking. The maximum seedlings on a 1/100th-
acre plot for desired 600 trees per acre is generally set between 9 and 15. Adjust the
maximum for lower desired stocking levels. Even if more trees are tallied in the plot,
only count up to the established maximum for calculations. If this is not done, heavy
stocking on a few plots will distort the trees per acre for the entire unit.

(7) **Plot Stocking Class.** Criteria for plot stocking classification must be clearly
established prior to initiating survey. Assign a category for each plot based on
stocking levels: Satisfactorily stocked (S), Understocked (U) and Non-stocked (N).
Determine desired trees per plot based on plot size and minimum stocking levels for
the stand described in the silvicultural prescription.

For example, if 400 trees per acre were the established minimum, then on a 100th acre
plot, the stocking classes would be:

(a) **S** - Plots with four or more trees per plot are satisfactorily stocked or plots with
one to three trees per plot are satisfactorily stocked if the rest of the plot is
nonstockable due to a lack of planting spots or microsites from natural causes such as
rock, slash, water, and so forth.

(b) **U** - Plots with less than four trees per plot are unsatisfactorily stocked if planting
spot(s)s are available for additional trees.

(c) **N** - Plots are deemed nonplantable if void of trees and there are plantable spots on
the plot.

(8) **Totals.** Total the numbers of trees by species at the bottom of the column if
desired.

(9) **Remarks.** Use this column to designate changes in topography or habitat type,
presence of new germinants, seedling damage, and other information useful in
evaluating site stocking.
5. **Database Entry.** Document stocking accomplishments in TSMRS consistent with FSH 2409.21e in Region 1, RMACT User Guide in Region 2, and RMRIS User Guide in Region 3 and 4.
2.73 - Exhibit 04

USDA Forest Service

REFORESTATION QUICK PLOT SURVEY FORM
FIELD RECORD
(Ref. FSH 2409.17)

<table>
<thead>
<tr>
<th>UNIT NAME</th>
<th>DATE</th>
<th>SURVEYED BY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lucky Dog</td>
<td>9/30/99</td>
<td>Greenup</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PLOT NUMBER</th>
<th>SPECIES</th>
<th>SPECIES</th>
<th>SPECIES</th>
<th>SPECIES</th>
<th>TOTAL LIVE TREES IN PLOT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DF &lt;1’</td>
<td>1-2’</td>
<td>&lt;2-5’</td>
<td>&lt;1’</td>
<td>&lt;2-5’</td>
</tr>
<tr>
<td></td>
<td>LP</td>
<td></td>
<td></td>
<td></td>
<td>AF LP DF</td>
</tr>
<tr>
<td></td>
<td>S</td>
<td>U</td>
<td>N</td>
<td>Max 15 trees per plot</td>
<td></td>
</tr>
</tbody>
</table>

| 1          | 2       | 2       | 1       | 6       | 16* x                   |
| 2          | 2       | 1       | 2       | 7* x    |
| 3          | 1       | 3       | 4       | x       |
| 4          | 1       | 1       | 2       | 5* x    |
| 5          | 3       | 3       | 4       | 10* x   |
| 6          | 1       | 2       | 2       | 1       |
| 7          | 4       | 1       | 8       | 10* x   |
| 8          | 0       | x       |
| 9          | 0       |         |         |         |
| 10         | 3       | 2       | 1       | 2       |
| 11         | 4       | 1       | 2       | 7* x    |
| 12         | 3       | 3       | 6       | x       |
| 13         | 3       | 3       | 3       | 9* x    |
| 14         | 1       | 1       | 7       |
| 15         | 1       | 2       | 3       |
| 16         | 2       | 3       | 2       |
| 17         | 2       | 2       | 2       |
| 18         | 2       | 1       | 3       |
| 19         | 2       | 3       | 3       | x       |
| 20         | 4       | 4       | 1       |
| 21         | 1       | 1       | x       |
| 22         | 1       | 1       | x       |
| 23         | 0       | x       |
| 24         | 4       | 4       | 2       |
| 25         | 4       | 3       | 2       |
| 26         | 16      |

TOTAL: 5 45 2 43 9 26 16 1

AF is residual.

Brush not a problem in unit.

Mostly rock.

Deep slash on ½ plot.

*max 6 trees counted in TPA calculation
2.74 Staked Tree Survival Surveys

Staked tree surveys are used to provide consistent data for the annual national plantation survival report of first and third year planted tree survival. Staked tree surveys are not suitable for long-term performance evaluations such as the long-term evaluation of genetic stock. Use permanent plot techniques for evaluations longer than 3 years.

Design staked tree surveys to sample the species and stock types over varying conditions that were planted. Staked tree surveys should be established in rows immediately after planting. Conduct surveys after the first and third growing season.

1. Sample size. Select approximately 10 plantations on each National Forest at the time of planting for survival surveys. Design the survey so that at least 100 planted seedling in each major species group will be staked. A minimum of 10 percent of the plantations on each district will generally provide an adequate sample but this should be adjusted to reflect variability in planting conditions and species. If fewer than 10 units are planted on a National Forest, design the sample to provide the minimum 100 trees per major species planted. Plantations should be selected without bias but should represent the major species, stock type, and planting sites being planted. Do not misrepresent the sample by selecting all very harsh sites or all very good sites.

   a. Guidelines for locating and installing the staked tree row.

(1) Locate row(s) to sample varying conditions of the unit including such conditions as aspect (north vs. south slope, for example) and planting variability. Do not bias the outcome of the sample by the location of the row.

(2) Install one to four rows of at least 25 trees. If conditions are uniform throughout the unit, one long row of 50 properly located stakes is preferable to two 25-tree rows. If conditions are variable, use several short rows if this will give a better sample of different conditions.

(3) Install stake row(s) the day unit is planted.

(4) Use wood or plastic stakes, approximately 1 by 2 inches or 2 by 2 inches and 12 to 18 inches long. Paint upper 3 to 4 inches of stake bright orange, if desired, to be easily located.

(5) Set stakes 6 to 18 inches away from tree to be marked. Always set stakes on the downhill side of tree. On flat ground, consistently stake trees on the same side. Drive them firmly into the ground leaving 6 to 12 inches above ground.

(6) Identify species to be staked before initiating the row. Units planted with a single species will have staked rows of one species. It is acceptable to have either single
species or multiple species in the row in units planted with more than one species. Assure there are 100 staked trees per major species planted on each National Forest.

(7) From beginning of the row, stake each tree (of selected species) encountered as the line progresses. Avoid abrupt turns in line. Any major variance in line direction should be recorded.

(8) Number stakes with a permanent ink marker or use stamped/scribed aluminum tags. Attach tags with ring shank nails, screw nails, or multiple staples. Numbers must be readable for at least 3 years.

(9) At the beginning of each staked row, firmly set a fence post or an iron pipe at least 4 feet above ground as a reference point. This post should be painted or flagged.

(10) Sketch a map locating the reference point and the rows for easy location later in the season.

b. Staked Tree Data. Record tree data on a staked tree form similar to the one shown in exhibit 01. Record initial tree data, such as tree species, at the time trees are staked. Include date and stand number in the heading of the chart.

Return to the rows after the first and third growing season to record the condition of each staked tree. In cattle allotment areas, it may be necessary to read the rows at the end of the growing season and again the following spring to distinguish between cattle and wildlife damage.

Circle stake numbers with dead trees and note the reason in the mortality column. Also note the cause of damage affecting live trees especially in the first year survey to aid in evaluating future mortality. Calculate survival by each species and stock type (see sec. 2.75).

c. Causes of mortality.

(1) Environmental.

(a) Heat and drought (insolation).

(b) Cold (frost or winter cold).

(c) Soil sloughing.

(d) Water (too much).

(2) Human Related.
(a) Poor planting.

(b) Poor quality nursery stock.

(3) Animal.

(a) Cattle.

(b) Big game (deer or elk).

(c) Pocket gophers.

(d) Rabbits.

(e) Mice or voles.

(4) Competing Vegetation.

d. Staked tree survival surveys are required at the end of the first and third growing season. See section 2.73, Stocking Surveys for survey schedules based on the season trees are planted.

Track staked tree survival by scheduling the planned or accomplished activity in the regional activity data base.
2.74 - Exhibit 01

Example - Survival Form after the third year survey

<table>
<thead>
<tr>
<th>Stake No.</th>
<th>Species</th>
<th>Stock Type</th>
<th>1st yr Survival</th>
<th>3rd yr Survival</th>
<th>Mortality/Damage Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DF</td>
<td>BR</td>
<td>live - stressed</td>
<td>dead</td>
<td>cattle damage</td>
</tr>
<tr>
<td>2</td>
<td>WP</td>
<td>C</td>
<td>live</td>
<td>live</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>DF</td>
<td>BR</td>
<td>dead</td>
<td>dead</td>
<td>drought or heat</td>
</tr>
<tr>
<td>4</td>
<td>WP</td>
<td>C</td>
<td>live</td>
<td>live</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>DF</td>
<td>BR</td>
<td>dead</td>
<td>dead</td>
<td>gopher damage</td>
</tr>
<tr>
<td>6</td>
<td>DF</td>
<td>BR</td>
<td>live</td>
<td>live</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>DF</td>
<td>BR</td>
<td>live</td>
<td>live</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>DF</td>
<td>BR</td>
<td>dead</td>
<td>dead</td>
<td>poor planting</td>
</tr>
<tr>
<td>through</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>DF</td>
<td>BR</td>
<td>live</td>
<td>stake not found</td>
<td></td>
</tr>
</tbody>
</table>

2.75 - Monitoring Reports

Reports described in this section are reports that are used by Districts, Forests, and Regions to monitor reforestation programs. Refer to FSM 2490 for Washington Office required reports, which are compiled from Regional reports from regional activity bases or other reporting methods.

1. Seedling Survival Report. Staked tree seedling survival is reported to the WO on an annual basis. The seedling survival report is the summary of staked row surveys and is due in the Regional Office by December 15 every year. Each Forest shall report first and third year seedling survival based on staked trees representing at least 100 trees for each major species. An example spreadsheet is shown in exhibit 01. Regional silviculturists/reforestation specialist will provide the appropriate format to be used Region for reporting staked row surveys for each region.
Assure the years are reported appropriately. For example, the 2000 report included first-year staked trees results for trees planted in the fall of 1999 and spring/summer of 2000 and the third-year survival results for trees planted in the fall of 1997 and spring/summer of 1998.

Species and stock types are recorded separately for each unit. There is a column for planted acres and sample acres. These are equal when only one species and stock type is planted. When more than one species or stock type is planted, sample acres is the proportional area represented by the species/stock type. Calculate sample acres by dividing number of outplanted species (or stock type) by total trees planted in the unit and multiply the result by the planted acres.

\[
(TPA \text{ “species A”} / \text{total TPA planted}) \times \text{Planted acres} = \text{Sample acres}
\]

Survival is based on the weighted average of sample acres by species/stock type.

2. **Region 1 - Program Monitoring Reports.** Refer to exhibit 02 for a list of monitoring reports used in Region 1. The Reforestation Program Indices Report is used to evaluate District and Forest reforestation programs. The RO runs the report after April 1 annually. Districts or Forests may run other monitoring reports on an as-needed basis.

3. **Field Verification.** Field verification of stands is an important monitoring step in evaluating the reforestation program. Review the stand folder, database, and field conditions to assure they are consistent and reflective of the actual condition.

Regional and Forest silviculturists should review a sample of stands as part of their ongoing service and review trips to the Districts. Check stand folders, survey results, and database entries with actual field conditions.
### 2.75 - Exhibit 01

**Staked Tree Survival Report**

<table>
<thead>
<tr>
<th>District</th>
<th>STAND NO.</th>
<th>AC plant</th>
<th>Sample AC</th>
<th>ASP</th>
<th>HAB Type</th>
<th>YR PLT</th>
<th>SEA</th>
<th>SPP</th>
<th>TYPE</th>
<th>TOOL</th>
<th>T/A PLT</th>
<th>TR Stk</th>
<th>1 YR STK found</th>
<th>1 YR LIVE</th>
<th>1 YR % SURV</th>
<th>3 YR STK found</th>
<th>3 YR LIVE</th>
<th>3 YR % SURV</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>001</td>
<td>30</td>
<td>20</td>
<td>W</td>
<td>262</td>
<td>96</td>
<td>f</td>
<td>PP</td>
<td>c</td>
<td>m</td>
<td>200</td>
<td>16</td>
<td>16</td>
<td>15</td>
<td>93.8%</td>
<td>16</td>
<td>13</td>
<td>81.2%</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>001</td>
<td>30</td>
<td>10</td>
<td>sw</td>
<td>262</td>
<td>96</td>
<td>f</td>
<td>DF</td>
<td>c</td>
<td>m</td>
<td>100</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>100.0%</td>
<td>14</td>
<td>13</td>
<td>92.8%</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>013</td>
<td>3</td>
<td>4</td>
<td>e</td>
<td>510</td>
<td>99</td>
<td>z</td>
<td>ES</td>
<td>c</td>
<td>m</td>
<td>250</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>100.0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>015</td>
<td>10</td>
<td>10</td>
<td>s</td>
<td>510</td>
<td>99</td>
<td>z</td>
<td>WL</td>
<td>c</td>
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<td>24</td>
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<td></td>
<td></td>
<td></td>
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<tr>
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<td>020</td>
<td>13</td>
<td>13</td>
<td>w</td>
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<td>ES</td>
<td>c</td>
<td>m</td>
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<td>96.0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>037</td>
<td>150</td>
<td>150</td>
<td>s</td>
<td>262</td>
<td>99</td>
<td>s</td>
<td>PP</td>
<td>br</td>
<td>m</td>
<td>400</td>
<td>50</td>
<td>50</td>
<td>45</td>
<td>90.0%</td>
<td></td>
<td></td>
<td></td>
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<td>038</td>
<td>22</td>
<td>11</td>
<td>s</td>
<td>262</td>
<td>99</td>
<td>s</td>
<td>PP</td>
<td>br</td>
<td>m</td>
<td>200</td>
<td>22</td>
<td>22</td>
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<td>90.9%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>038</td>
<td>22</td>
<td>6</td>
<td>s</td>
<td>262</td>
<td>99</td>
<td>s</td>
<td>DF</td>
<td>br</td>
<td>m</td>
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<td></td>
<td></td>
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<td>038</td>
<td>22</td>
<td>5</td>
<td>s</td>
<td>262</td>
<td>99</td>
<td>s</td>
<td>PP</td>
<td>c</td>
<td>m</td>
<td>150</td>
<td>25</td>
<td>25</td>
<td>23</td>
<td>92.0%</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>6</td>
<td>041</td>
<td>14</td>
<td>14</td>
<td>f</td>
<td>510</td>
<td>96</td>
<td>f</td>
<td>LP</td>
<td>c</td>
<td>m</td>
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<td>25</td>
<td>25</td>
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<td>88.0%</td>
<td>23</td>
<td>22</td>
<td>95.6%</td>
<td></td>
</tr>
<tr>
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<td>98</td>
<td>f</td>
<td>LP</td>
<td>c</td>
<td>m</td>
<td>300</td>
<td>25</td>
<td>25</td>
<td>24</td>
<td>96.0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Stand 001 and 038 is listed multiple times to reflect the mix of species and stock types within planted unit. Sample acres are proportioned based on actual trees planted by species(stock type).
### 2.75 - Exhibit 02

#### R-1 Monitoring Reports

<table>
<thead>
<tr>
<th>Monitoring Tool</th>
<th>Data Source</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reforestation indices (revised in 1991)</td>
<td>TSMRS. Keys on prescription, harvest, reforestation treatment activities, reforestation exam and reforestation status.</td>
<td>Monitors entire reforestation program from harvest (type) to certification. Used to evaluate District and Forest reforestation program performance. Evaluates both database and treatments success. Designed to help Districts find errors and omissions in data. Index 1, 3, 13, 14, 15, 16, 37 and 38, are most useful for monitoring.</td>
</tr>
<tr>
<td>2. Reforestation Timeframe Monitoring (developed in 1990)</td>
<td>TSMRS. Harvest, reforestation and exam activities and reforestation status. Aspect, habitat type and elevation are important variables.</td>
<td>Measures time frame from harvest to satisfactory stocking. Very useful to Silviculturists for use in Forest Plan monitoring and timber sale analyses. It displays past competence in meeting satisfactory stocking. It can also be used to detect where regeneration problems have occurred in the past, as to type of harvest habitat, elevation and aspect.</td>
</tr>
<tr>
<td>3. Reforestation – TSI Needs Report.</td>
<td>TSMRS. Schedule of Reforestation activities; also includes TSI and all silvicultural exam activities.</td>
<td>Displays planned needs and accomplishments. Can be used by program managers to monitor needs and accomplishments, and scheduled treatments missed or not accomplished. Can be used in matching budgets to out year needs. Options for summary or by individual stands.</td>
</tr>
<tr>
<td>5. Master List Report Stand History</td>
<td>TSMRS – All activities.</td>
<td>The master list contains all activities in each stand. Generally, when problem stands are identified in other reports, the mast list report (historical entry of activities) can be reviewed.</td>
</tr>
</tbody>
</table>
2.8 - TREE PLANTING CONTRACT ADMINISTRATION

Tree planting contracts are administered under the Contracting organizational structure. The Contracting Officer (CO) is the responsible official. Most preparation and inspection work is delegated to a Contracting Officer Representative (COR). The COR may supervise one or more inspectors. The details of this organization and how it functions are covered in FSH 6309.11, Contract Administration Handbook.

1. Types of Contracts. There are a variety of contract types. Work with the Forest contracting officer to select the appropriate contract to meet your needs. Contract specifications shall assure that proper tree care and planting techniques are used. Submit requests for procurement to the contracting office under the established Forest procedures and in accordance with Forest Service Acquisition Regulations (FAR). Utilize the standard regional contracts except when approved by the regional silviculturist/reforestation specialist. Clearly identify forest- and project-specific clauses from standard clauses for ease of implementation by the contractor and contract administrators.

   a. Payment. The preferred payment method is for contractors to receive full pay when planting quality is 90 percent or greater. Payment is reduced when planting is 80 to 89.5 percent. The contractor is not paid for work quality below 80 percent. Payment can be based on the acres planted or actual numbers of trees planted, as described below. Other payment methods may be used with concurrence by the CO and regional silviculturist/reforestation specialist.

   b. Method of Measurement.

      (1) PerAcre. Per Acre measurement method provides payment to the contractor based on the acres planted, modified by inspection results.

      (2) Per Tree. The per tree or per thousand tree method pays the contractor based on the quantity of trees planted. This method tends to encourage the contractor to find spots and put trees in the ground. There is no pay for covering the acreage if no trees are planted. When payment is based on trees counted in inspection plots, then additional plots must be done to assure reliable results. An optional method for payment is to make payment based on trees issued to the contractor. The CO must agree to the payment method. When per tree contracts are used, inspection shall be rigid with inspectors on site at all times while planting is in progress.

2. Contract Administration Requirements. CORs on planting contracts shall meet the requirements of Departmental Regulation 5001-1 (DR 5001-1) and FAR, and be designated by the CO. To assure adequate experience in planting contracts, CORs shall have 2 years of planting inspection experience and have attended at least one regional or forest workshop on contract tree planting administration in the last 2 years.
Inspectors shall meet the FAR requirements, be designated by the COR, and have previous planting experience or intensive training from experienced personnel prior to work on a tree planting contract.

Since planting contract time is limited, CORs and inspectors must understand the contract specifications and maintain strict contract administration to minimize contract disputes.

### 2.81 - Contract Preparation

Match the contract specifications to the ground conditions of the planting site.

1. **Site Examination and Data Collection**. Prior to the preparation of the contract (or task order for indefinite quantity contracts), make the following determinations in a pre-plant or a reforestation survey.
   
   a. Determine actual acres to be planted within a 5 percent tolerance for per acre payment contracts.

   b. Estimate number of plantable spots available on the site to determine planting stock needs. The number of available planting spots may be considerably less than prescribed levels due to rock, existing trees, other vegetation and conditions that limit a tree from being planted.

   c. Estimate amount (scalp size) and difficulty of hand site preparation needed.

   d. Identify shade and protection needs based on seedling needs and available shade material.

This information must represent current conditions on the site and should be obtained in fall or summer before the contract or task order is prepared.

The survey, generally a walk-through, should be intense enough to estimate plantable area within the unit. Do not depend only on above-ground observations. Open a few holes to determine ease of planting and tools required. Failure to do an adequate survey may result in paying the contractor for areas that are stocked or not plantable with the tool prescribed or in appropriate scalp or shade requirements. The pre-plant survey also provides and estimate of trees to be planted although actual quantity will vary. It is best to determine plantable spots when conditions are similar to that when planting will occur. For example, if planting is to occur in the spring, surveying in fall when the ground is dry, may yield more un-plantable ground than will actually occur in the spring.

2. **Contract Specifications**. The technical specifications of the standard regional planting contracts are available from the respective regional offices and forest contracting offices. All aspects of the contract shall be consistent with tree planting guidance provided in this handbook.
The proposals accepted in negotiated contracts shall be evaluated relative to the items in this section. All aspects of the accepted proposal shall also be consistent with tree planting guidance.

a. Identify the quantity of trees and units to be planted. Specify by unit whether payment will be by the acre or per tree or thousand trees. Clearly state that actual number of trees planted may vary and does not substitute for a prospective contractor’s site inspection and their own estimates.

b. Government Furnished Property. Specify the type of stock and preparation method for planting stock. Identify minimum and maximum root lengths, top heights and other stock quality standards the contractor can expect. List other supplies being provided by the government such as wrapping materials and reflective tarps. Identify when and where the property shall be issued and returned (when applicable) and cost that will be assessed to the contractor if the property is not returned.

c. Identify planting stock size in broad ranges. If the range is too narrow or does not fit the stock, a costly contract adjustment may occur. It is recommended that the nursery stock standards be used, but districts should substitute more specific information if it is more accurate.

Identify the procedure for issuing tree stock to the contractor and the time frame for planting after delivery. Identify how stock will be cared for until planting. Identify how stock shall be cared if more stock is requested and delivered than is planted. Specify how the contractor will be charged for wasted trees when trees ordered are not planted in a timely manner and cannot be used. Although the responsibility for ordering the correct number of trees each day lies with the contractor, it is not advantageous to the Government to have a lot of excess trees. Negotiate with the contractor so stock orders reflect the quantity that can be planted within the stated time frame.

d. Planting Equipment. Specify required type and size of tool that is to be used and enforce contractor compliance. Tool size requirements cannot be adjusted after contract award without negotiations that may result in payment adjustments. Tool type (for example, auger vs. hoe) generally cannot be changed after contract award.

Specify bareroot and plug hoe lengths, allowing tolerance for wear. Minimum hoe size is 15 to 17 inches for bareroot and 12 to 13 inches for container planting. Tool blade should be 1 inch longer than the roots being planted.

Augers should produce a 4-inch hole for bareroot and 3-inch hole for containers and be capable of drilling holes 2 inches deeper than roots of stock being planted.

Bars must have a minimum 14-inch blade length and 4-inch width capable of accommodating the root system of stock being planted.
Planting bags are normally required to be 15 inches deep and light in color. Reflective silver canvas bags may be specified to reduce bag temperatures.

e. Care of Trees. This section covers all aspects of tree care. Standard provisions in the regional contracts should generally be used without modification.

f. Planting Spot Selection. Selection of the planting spot is dependant on spacing and amount of tree protection needed for survival. When protection from mid-day sun is needed, specify that shade must be on the south to west side of tree. If protection from wind or animals is needed (instead of shade), location of material may vary. In these cases, specify that material be on the side of the tree of the prevailing wind; or that the location may vary as long as it is close to the seedlings for animal protection. The largest material available is generally preferred however specify the minimum piece sizes (generally 3-, 4-, or 6-inch diameter) in this clause. A 50 percent spacing allowance is generally allowed to provide flexibility in finding a suitable planting spot.

Some considerations for shade or protection are:

1. Stationary material only. Plant the seedling next to stationery shade such as stumps, logs or other debris. When there is no stationary shade within the spacing allowance, do not plant a tree. This is a necessary requirement on harsh sites where survival is dependant on seedling protection. This clause limits the actual trees per acre planted. A 75 percent spacing variance may be desirable to allow more trees to be planted.

2. Stationary material first, then transportable shade. Plant the seedling next to stationary shade. When stationary shade does not exist in the spacing allowance, transport shade to the seedlings. Generally material within one-half the spacing allowance is considered suitable if it meets the size specifications. When neither stationary nor transportable shade exists, do not plant a tree.

3. Stationary material first, transportable shade second, plant in open last. Plant the seedling next to stationary shade. If stationary shade does not exist in the spacing allowance, transport shade to the planted seedlings. Generally material within one-half the spacing allowance is considered suitable if it meets the size specifications. When neither is available, plant the seedling in the open without protection.

4. Stationary or transportable shade (planters discretion). Plant the seedling next to stationary shade or transport material to the at the planter’s discretion. When stationary or transportable shade is not available, do not plant a tree.

5. Stationary or transportable shade first (planters discretion), plant in the open last. Plant the seedling next to stationary shade or transport material to the seedling at the
planter’s discretion. When stationary or transportable shade is not available, plant the seedling in the open.

(6) **No shade requirements.** Plant seedlings based on spacing with no protection requirements.

g. **Planting Spot Preparation.** Utilize one of the following options for planting spot preparation dependant on the site being planted.

(1) **Clearing.** Clearing debris from the soil surface in an area 6-inch by 6-inch square or 6-inches in diameter so that a hole can be opened without surface debris and litter falling into the hole. Identify the maximum depth of material that is required to be cleared. When debris is deeper than that depth, the spot is considered unplantable. Clearing is generally required in all units.

(2) **Clearing and Scalping.** Clearing and scalping should only be required in areas with existing competing vegetation that hampers survival. The clause specifies that the spot must be cleared as described in (1) and all vegetation must be removed or scalped from an area of specified size (generally 12 to 24 inches in diameter) prior to planting a tree. Also specify the maximum depth of the scalp. If a deeper scalp is required to clear away the vegetation, then the spot is considered unplantable. Scalping depth should be 1 to 2 inches below the root collar of all plants to be removed. When this clause is used in the contract, it is a planting violation if the contractor fails to create the planting spot as specified.

(3) **Mulching following clearing.** Mulching after clearing requires pushing surface debris back around the tree once the tree has been planted. The material is placed back around the seedling and helps prevent moisture loss from evaporation, cools the ground line of the seedling and provides a possible nutrient source for the tree as the material decays over time. If this option is used, it may be difficult to inspect for proper clearing.

(4) **Considerations in site preparation method.** If no planting spot preparation clause is used, the contract allows trees to be planted through existing duff, debris, and vegetation. If clearing is specified and a no scalp clause is used, then the contractor is required to clear a 6-inch area and ignore existing vegetation outside the cleared area. Existing vegetation does not make the spot unplantable in this case. If there are adequate planting spots free of vegetative competition, the scalping clause is not necessary. Clearing alone will remove light vegetation within the clearing limit.

Clearing and scalping should be required on units with competing vegetation. Scalping vegetation such as pinegrass, beargrass, or sedge, requires extra effort and will be reflective in the bid price. Use a scalp large enough to promote establishment...
of seedlings in the first year. If vegetation is present, but is not considered to be competitive, an option is to require the scalp to be the same size as the clearing.

h. **Planting Techniques.** Utilize the contract clauses in the standard contract. Proper planting techniques will assure good inspection results. Refer to the inspection requirements in section 2.82.

### 2.82 - Contract Inspection

Planting contracts require intensive inspection. Follow contract inspection procedures specified in the contract and described in this section. If the contractor is responsible for inspection, the government shall conduct quality assurance inspections as described in the contract. In negotiated contracts, field inspection performed by the contractor shall be consistent with the approved quality control plan. The quality control plan shall be consistent with the following procedures.

There are two phases of contract inspection: (1) Inspection while work is in progress observing tree care, wasting of trees, and planting technique while planting is in progress, and (2) plot inspection where the inspector checks quality of planting using systematically placed plots.

1. **Inspection while Work is in Progress.** The COR and inspector(s) shall inspect the contractor's work during all aspects of tree planting from the time trees are issued to the contractor until they are returned or planted. Inspectors shall be with the contractor at all times when the contractor has trees in possession for per tree and per thousand (tree) contracts. It is recommended that an inspector be with the contractor on per acre contracts particularly at the onset of the contract. It is preferable the inspector be on site and observing tree planting and tree care throughout the planting operation. Much of the damage to tree seedlings that can occur during planting cannot be detected in the inspection plots that will follow.

a. **Inspect the following items throughout the planting period:**

   (1) **Rate of Progress.** Contractor's rate of progress.

   (2) **Weather conditions.** Weather conditions suitable for planting

   (3) **Organization of work.** Crew should be working in an organized manner.

   (4) **Tree care and field handling.** Tree preparation when it is the contractor’s responsibility.

   (5) **Planting Technique.** Scalps or other clearing standards, spacing, and planting techniques.

   (6) **Intentional wasting of trees.** Monitor suspect behavior that may indicate planters are disposing of trees.
(7) Appropriate equipment.

b. Rate of Progress. Monitor the contractor's progress to assure the time periods stated in the contract are met. Tree survival and growth are dependent upon proper soil and weather conditions at the time of planting, and these conditions exist for a limited time; contract extensions may not be allowed.

c. Weather Shutdown Guidelines. When the COR determines that temperature, humidity, soil moisture, winds, or a combination of these and other physical conditions are unsuitable for tree planting, move the work force to another area or suspend operations. Whenever suspension due to weather is contemplated, considerations must be given to the risk of delaying planting. Will conditions worsen or improve? Is tree survival at risk? When will the contractor return to complete the work?

(1) Factors to consider prior to suspending operations due to weather:

(a) Degree of stress to trees created by current weather conditions.

(b) Predicted future weather, including expected rainfall, winds or temperature changes.

(c) Length of planting season remaining.

(d) Number of trees left to plant.

(e) Condition of planting stock, particularly relative to dormancy.

(f) Availability of alternate sites on cooler aspects or to adjust work shifts (early or split shifts)

(2) Appropriate conditions for temporary shutdowns:

(a) Snow on the ground. Snow makes it difficult to select planting spots; too much snow will obscure planting spots and snow may fill the planting hole. Snow covering steep slopes may also be a hazard to planters.

(b) Frost on the ground. When there is more than ½ inch of frost in the ground, planting holes cannot be opened or closed properly.

(c) Freezing weather. Frozen tree roots or root plugs become brittle and roots are easily damaged and broken. Tops and needles are also subject to damage.

(d) Dry Soil. The soil is too dry to properly firm the tree. Dry soils that have the consistency of flour or hard clay cannot be planted without additional moisture.
However, trees should be planted if the soil is workable and chance of future moisture is reasonable.

(e) **Wet Soil.** The soil is too wet to properly firm the trees. Sometimes soils must be allowed to drain before planting can continue.

(f) **Winds.** Sustained winds of 20 miles per hour or more with low humidities and high temperatures of 75 degrees Fahrenheit or more are damaging to seedlings. Winds coupled with low humidities and warm temperatures cause high moisture stress to seedlings. Consider planting at alternate time of day if possible. Many times, Rocky Mountain springtime weather fluctuates rapidly. Temperatures variations of 40 to 50 degree with changing winds and humidity may occur within hours. In these conditions protect seedlings from drying winds with wet kimtex type towels or burlap for short periods of time.

(g) **High temperatures.** Temperatures exceeding 85 degrees Fahrenheit for more than 4 hours cause moisture stress to the seedlings. Under these conditions, it may be desirable to only plant in the morning and evening rather than shut down operations.

(h) **Wind or weather conditions in a burn area.** Wind or other weather conditions can make planting hazardous such as in a burn area. Planting should not continue when there are winds predicted or occurring that increases risk of snags falling within the unit during the planting operation.

(i) **Weather Guides.** When using weather guides for determining planting windows, use only those developed for the local area. Guides from other areas are not appropriate.

d. **Organization of Work.** Contractors shall maintain quality control over their crews and perform planting in an organized systematic manner. Do not permit planting crews to be scattered.

e. **Tree Care and Field Handling.** Tree care and handling shall be inspected while the work in progress. Utilize the contract clauses for wasted tree charge when the contractor mishandles seedlings. Issue a notice of noncompliance for serious or recurrent violations. The following items should be inspected regularly. It is preferable to correct deficiencies early, to avoid tree mortality caused by poor handling.

(a) Appropriate planting equipment, tools, and planting bags.

(b) **Proper location and facilities for tree wrapping.** Do not allow seedlings to be exposed to heat; do not allow the roots to be exposed to drying conditions.

(c) **Proper storage of tree boxes.** Do not expose boxes to sun.
(d) **Proper technique in tree wrapping.** Inspect for root pruning. To adequately inspect for root shortening during wrapping and field handling, know the root lengths of shipped trees before issuing them to a contractor.

(e) **Proper storage of wrapped trees.** Keep bundles cool and moist.

(f) **Too many trees in planting bag.** Seedlings will be damaged if planters put too many trees or container plugs in the tree bags. Do not allow more trees to be carried than what can be outplanted before drying occurs.

(g) **Careless treatment to trees in planting bag.** Do not allow planters to lay on bags, pile equipment on them, or expose them to oil or gas.

(h) **Dry kimtex or burlap wrap.** The wrapping material must be moist to touch.

(i) **Tree roots exposed to air during planting.** Do not allow planters to carry trees in their hands between holes or while preparing a hole. Trees should be removed from the planting bag after the hole has been opened.

(j) **Dropped trees that are left on ground.** Except for incidental trees, count dropped trees as wasted trees.

(k) **Wasting trees.** Monitor planters for careless handling that exposes trees to heating and drying, or leaving bags of trees in the sun. Hiding, stashing, or destroying trees is also a form of wasting. Intentional wasting of trees shall not be tolerated.

(l) **Root stripping or pruning by planters.** Do not allow stripping or tearing of the lateral root or shortening the root system. It is a tremendous shock to the tree and results in high mortality rates. Watch the planters and if stripping is suspected, dig trees to observe the roots. Notify the contractor if stripping is found. If the contractor fails to correct root-stripping violations, issue a suspension of work order and notify the CO.

(m) **Planting spot selection.** Assure tree shade and protection is adequate and meets contract specifications.

(n) **Planting spot preparation.** Assure clearing and scalping is adequate and meets contract specifications.

(o) **Spacing requirements.** Seedlings should be planted to meet spacing specifications.

(p) **Species mix.** Assure proper species and stock types are being planted as per contract specifications.
(q) **Hole opening and tree insertion.** The hole should be open from all sides and tree roots shall be suspended in a natural position. The tap root shall not be twisted, balled up or in the form of a J or L. Tree shall be upright and between vertical and 90 degrees with the slope plane.

(r) **Tamping soil in auger holes.** Root damage can occur if tamping is done with tool handles or sticks.

(s) **Moist soil in the planting hole.** Dry soil will occur if the auger operator is too far ahead of tree planters in auger planting operations.

(t) **Failure to close auxiliary holes in auger operations.** Root drying will occur when open holes are left in proximity of auger holes.

2. **Inspecting for Planting Quality.** The primary factor in determining the contractor's payment is the plot inspection. Use the following process and standard inspection form (R-1, 2, 3, 4 FS-2470-9). Variations to this may be done with approval of the CO and regional silviculturist or reforestation specialist to meet specific planting requirements. Specify the inspection process in the contract. Refer to exhibit 01 for a sample of the standard inspection form. The inspector shall sign the inspection form and initial any changes, as this is the main basis for contract payment. All inspectors should fully understand the inspection forms and procedures for completing the inspection.

   a. **Equipment Needed.**

      (1) Clipboard and pencils.

      (2) Inspection sheets

      (3) Full contract (with exhibits).

      (4) Fifty-foot logger's tape.

      (5) Plot pole or shovel with swivel on handle to attach the tape.

      (6) Flagging.

      (7) Screwdriver, ice-pick, or garden trowels that aid in below ground inspection.

      (8) Tile spade, hognose spade, planting hoe for hoe planting.

      (9) Slope correction table.

      (10) Clinometer or Abney.

   b. **Plot Design.**
(1) **Plot Size.** Use either 1/50\(^{th}\)- or 1/100\(^{th}\)-acre plots for planting up to 10- by 10-foot spacing. At wider spacings, use the 1/50\(^{th}\)-acre plot to ensure there are adequate trees per plot for statistical reliability.

Plot radius will vary depending on slope. After determining slope percent, use the plot table in section 2.73; exhibit 01, for determining radii for plot on 1/100\(^{th}\)- and 1/50\(^{th}\)-acre plots. Use these radii for the full plot. Do not compensate by changing radius or raising and lowering the tape when going around the plot. Such adjustments are included in the table.

(2) **Plot Placement.** Establish plot in a systematic manner, distributed uniformly over entire acreage. A grid system is recommended.

(3) **Quantity of Plots.** The minimum sampling intensity is specified in the contract. When payment reductions are anticipated, a 2 percent sample is required.

c. **Inspection Within The Plot.** Mark the plot so that it can be relocated by the COR or Contractor. Inspect each plot in accordance with contract. Utilize the following inspection for most contracts. Follow this procedure in the described order for accurate inspection results.

(1) **Locate and mark plot center on the ground.** A pin flag with plot number or similar locator is recommended for the center point.

(2) **Inspect and record the aboveground condition of each tree planted.** Working in a clockwise direction from true north, locate, examine, and record the condition of planted trees in spaces under column 2 of the inspection form. Use codes listed below. A poorly planted tree may have more than one violation, however, only one code may be listed. Identify the most severe.

\[\checkmark\] - Satisfactory tree above ground.

S - **Spacing Violation.** A tree that has been planted closer than one-half of the spacing allowance to another acceptable tree is a violation unless otherwise stated in the contract. For example, if the spacing is 10 feet by 10 feet and a tree is closer than 5 feet to another planted tree, one tree is in violation for spacing. If one of the trees is improperly planted due to another reason, charge the spacing violation to the improperly planted tree and check the remaining good tree as properly planted.

P - **Planting Spot Violation.** Tree planted in debris, loose soil, duff, ashes, or similar material.

X - **Shade Protection Violation.** Shade and seedling protection is not consistent with the contract clause specified for the unit.
D - Planting Depth Violation. Trees are planted too deep or shallow. The contract requires that after filling, packing, and leveling, the soil shall come up to a point even with, or up to 1 inch above, original ground line of tree. Note that the original ground line is always above the root collar and should be considered in the area between the cotyledon scar and the root collar. No portion of the roots shall be exposed nor any branches covered with packed soil.

If soil is loose around branches and needles above the ground line, soil will settle and no harm is done. However, if soil is packed tightly or branches and needles are in the hole (below the normal ground line), a violation should be cited. Inspectors must ensure that they recognize where the root collar is. It can be seen by scraping bark back to the cambium in the root collar area. Stem tissue immediately under bark of the stem will have some green color. Below the root, scraping reveals only white tissue. Trees with roots exposed are in violation. The root system on ponderosa pine and occasionally Douglas fir and grand fir generally does not branch for 2-4 inches below the root collar. This unbranched portion of the root system is often erroneously interpreted as stem and left above ground. The root does not have thickened bark and can be easily damaged by insolation and high soil surface temperatures. Make sure the entire root system is below ground.

Container plugs should be covered with soil (1/2 inch or more) in order to prevent frost heave problems.

A - Stem Position Violation (erect tree). The stem should be oriented between vertical and 90 degrees with the slope plane. Improper angle may result from improper hole opening with hoes. If the tree looks erect above ground but slanted below ground, then a belowground violation instead should be cited.

F - Firmness Violation. Trees should be tamped as firmly as soil conditions allow. In most Rocky Mountain soils, trees should not pull easily from soil. The inspector may grab the stem and gently tug. If tree comes up to expose roots (below the root collar) then the tree was not firmed up and is in violation. This test must be used with caution in very light or sandy soils.

C - Scalp or Clearing Violation. Scalp or cleared area is too small or too shallow.

W - Wrong (incorrect) Species. Species planted in area of unit where it is not supposed to be

T - Cull Trees. Cull tree is planted. Use when the contract specifies that the contractor shall not plant cull trees and identifies what constitutes a cull tree.

(3) Determine average number of planting spots from Table 1 and record results in column 3 of the inspection form.
TABLE 1

Average Number of Planting Spots

<table>
<thead>
<tr>
<th>Average Spacing</th>
<th>1/50 Acre</th>
<th>1/100 Acre</th>
<th>1/20 Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 x 7</td>
<td>18</td>
<td>9</td>
<td>N/A</td>
</tr>
<tr>
<td>8 x 8</td>
<td>14</td>
<td>7</td>
<td>N/A</td>
</tr>
<tr>
<td>9 x 9</td>
<td>11</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>10 x 10</td>
<td>9</td>
<td>4</td>
<td>22</td>
</tr>
<tr>
<td>11 x 11</td>
<td>7</td>
<td>N/A</td>
<td>18</td>
</tr>
<tr>
<td>12 x 12</td>
<td>6</td>
<td>N/A</td>
<td>15</td>
</tr>
<tr>
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<td>5</td>
<td>N/A</td>
<td>13</td>
</tr>
<tr>
<td>14 x 14</td>
<td>4</td>
<td>N/A</td>
<td>11</td>
</tr>
</tbody>
</table>

(4) Determine number unplantable spots by identifying spots void of planted trees that are unplantable due to ground conditions or acceptable existing natural regeneration. Recognizing average number of planting spots on the plot, scan plot for areas void of natural and planted trees. Look for voids the planters missed. Then check to see if it is a non-plantable spot. Record in column 4.

(a) When a tree has been planted, the contractor, by default, has determined it to be a plantable spot. In terms of the inspection, the spot with a planted tree is a plantable spot no matter what the inspector finds after the fact.

(b) An unplantable spot as defined by the contract is an area within the specified spacing limits in which it is not possible to plant a tree according to specifications, and no tree has been planted. For hoe planting, a plot is considered unplantable if the inspector cannot find a suitable spot in three attempts within spacing requirements and if the hole cannot be opened at the spot with five swings or less. Auger planting requires three attempts to find the spot that will be scalped or cleared, and then three attempts to open the hole in the spot with the auger, first attempt being made in the middle of the scalp.

One unplantable spot is allowed for each single unplantable area equal in size to the average specified spacing. For example, if a single unsatisfactory area of 64 square feet exists on an 8- by 8-feet spacing, one unplantable spot will be recognized. If half of a 1/50\textsuperscript{th}- plot is unplantable, then 435.6 square feet (half of 871.2) is unplantable. For 9- by 9-feet spacing, five spots would be credited as unplantable.

(5) Determine number of planting spots by subtracting column 4 from average number of planting spots (column 3). Record in column 5 of inspection form.
(6) Determine maximum number of allowable trees from Table 2, and record in column 6 of inspection form.

**TABLE 2**

Maximum allowable trees based on
Number of plantable spots determined in Table 1

<table>
<thead>
<tr>
<th>Plantable Spots</th>
<th>Maximum Trees</th>
<th>Plantable Spots</th>
<th>Maximum Trees</th>
<th>Plantable Spots</th>
<th>Maximum Trees</th>
</tr>
</thead>
<tbody>
<tr>
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<td>2</td>
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<td>13</td>
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<td>7</td>
<td>8</td>
<td>17</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>10</td>
<td>18</td>
<td>22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>11</td>
<td>19</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>12</td>
<td>20</td>
<td>24</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(7) Record the number of trees planted on the plot (also listed in column 2) in column 7 of inspection form.

(8) Determine wasted trees by subtracting maximum number of allowable trees in column 6 from those planted (column 7). If more than 0, record in column 8.

(9) Record number of planted trees meeting aboveground specifications from column 2 only up to maximum listed in column 6 of the inspection form.

Below Ground Inspection.

(10) Determine minimum number of trees to be inspected below ground utilizing Table 3 based on number of trees that are satisfactory above ground. Record in column 10 of the inspection form. To avoid bias, dig trees nearest plot center first and progress outward. Do not dig any trees that were unsatisfactory in the aboveground inspection. Correctly replant sampled trees immediately. Use moist mineral soil to pack roots.
TABLE 3

Minimum number of trees to be dug

Based on number of trees satisfactory above ground.

<table>
<thead>
<tr>
<th>Number of above ground satisfactorily planted trees on plot</th>
<th>Minimum number of trees to dig</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2-6</td>
<td>2</td>
</tr>
<tr>
<td>7-9</td>
<td>3</td>
</tr>
<tr>
<td>10-12</td>
<td>4</td>
</tr>
<tr>
<td>13 plus</td>
<td>5</td>
</tr>
</tbody>
</table>

* Note this is the minimum; there is no maximum. The inspector may dig all satisfactory trees on plot.

(11) Inspect and record the below-ground condition of each planted tree in spaces under column 2 of inspection form using appropriate codes listed below. Record the number of trees meeting belowground specification in column 11.

√ - Satisfactory Tree Below Ground.

R - Root Configuration Violation. Root systems must not be twisted, jammed in one plane, or curved in the shape of the letters U, J, or L. Individual lateral roots may be slightly bent like the letters J or U but the primary vertical root system cannot be distorted. Container plug must not be jammed from the top (accordion effect) or the side (flattened).

To inspect for this violation, dig a rectangular shaped hole on one side of the tree. Start the hole far enough away from the tree stem (at least 10 inches) so that roots are not disturbed in the process of inserting the spade. This is best done with a tool like a tile spade. Once the primary hole is dug, probe toward the root system with a pointed instrument such as a screwdriver, ice pick, or similar tool to explore the seedling roots for orientation.

M - Foreign Material Violation. Holes must not contain large rocks, sticks, litter, cones, or other foreign debris. Inspect the same as that for root configuration. In hoe planting, if rocks, roots, and pieces of wood are present in soil prior to opening the hole, they are not considered foreign material to the hole.

F - Firmness Violation. Firmness, as determined from below ground, is done while probing the root system as described under root configuration. Soil should be nearly as firm as the undisturbed surrounding soil. There should be no air pockets where the
soil is not firm. Firmness may be a problem in the bottom of auger holes if planters have not firmed soil progressively upward.

L - Altered Root Length Violation. If the dug tree has an obviously shortened root system, consider it as an improperly planted tree below ground. The contract shall state a minimum root length; trees with substandard roots should not be planted and considered a violation if they are planted.

Fresh root cuts can often be distinguished from roots cut at the nursery or during tree preparation. Living inner tissue of roots cut in advance of planting should be brown at the cut. The brown color may extend up the root under the bark for a short distance. Freshly cut roots will be white under the bark unless roots are dead when cut. Root shortening violations can also be detected during inspection while work is in progress.

O - Planting Hole Orientation Violation. This violation is seldom observed in absence of aboveground stem angle or root configuration violations. Occasionally, trees with small root systems can be propped up following slit planting. Roots may not be distorted and angle looks okay from above ground, but hole is not properly opened. Examples would be a V-shaped hole or a hole not vertical with slope plane.

(12) After all plots have been taken and recorded for the pay item, calculate the planting quality by the following formula:

\[
\text{Planting Quality Percent} = \frac{\text{No. of satisfactory planted trees above ground (column 9)}}{\text{Actual No. of plantable spots on which trees should have been planted (column 5)}} \times \frac{\text{No. of trees satisfactory below ground (column 11)}}{\text{No. of dug trees (column 10)}} \times 100
\]
### Instructions are provided on the back of the standard form.
3. Relative Importance of Individual Inspection Items. Some inspection items are more critical to tree survival than others. Violations of some of these items will result in immediate mortality, while others affect survival and growth over time. The following provides an insight of the relative importance of inspection items for tree survival.

a. Critical violations with high risk of mortality.

(1) Cutting, stripping, or shortening root systems (this includes lateral roots) just prior to planting. This is especially lethal to pines.

(2) Planting species in the wrong location. The contract shall specify how units of mixed species are to be planted. If species are not planted as specified, this is a violation. For example, the contract should specify that cedar or spruce should not be planted on dry exposed portions of the slope.

(3) Improper handling of trees that result in drying of roots, or overheating of trees in general.

(4) Improper root orientation due to improper hole opening or root placement that results in U-, J-, or L-shaped roots.

(5) Failure to utilize microsites on harsh sites or where high animal damage is anticipated.

b. Important - violations that result in growth reduction and may cause mortality on severe sites.

(1) Poor tamping or foreign material in hole.

(2) Improper depth of tree.

(4) Poor scalp size and depth.

(5) Lack of clearing size and depth.

(6) Lack of shade.

2.83 - Payment

Payment procedures are authorized by the CO. Inspectors should work through the examples in the contract package and understand the payment procedure of the contract. There are different payment options in various contracts. Payment procedures shall be fully understood by the COR and all inspectors prior to implementing the contract.
2.9 - Nursery Coordination

This section addresses the coordination with the five Forest Service nurseries historically used by Region 1, 2, 3 or 4.

<table>
<thead>
<tr>
<th>Nursery</th>
<th>Location</th>
<th>Administering Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. E. Bessey</td>
<td>Halsey, NE</td>
<td>R-2, Nebraska NF</td>
</tr>
<tr>
<td>Coeur d'Alene</td>
<td>Coeur d'Alene, ID</td>
<td>R-1, Idaho Panhandle NFs</td>
</tr>
<tr>
<td>J. Herbert Stone</td>
<td>Medford, OR</td>
<td>R-6, Rogue River NF</td>
</tr>
<tr>
<td>Lucky Peak</td>
<td>Boise, ID</td>
<td>R-4, Boise NF</td>
</tr>
<tr>
<td>Placerville</td>
<td>Placerville, CA</td>
<td>R-5, El Dorado NF</td>
</tr>
</tbody>
</table>

Responsibilities for administration and management of nurseries are outlined in FSM 2473. Forests may purchase tree stock from Forest Service nurseries or private nurseries to meet their needs. When nursery stock is grown by a private grower, utilize stock standards as described in this section. Nursery managers at Bessey, Coeur d’Alene and Lucky Peak shall assist personnel in R-1, 2, 3, 4 in developing contract clauses to assure quality tree seedlings are provided by contract growers. Coordinate conifer seedling contracts through the respective regional office.

Responsibility for efficient management of nurseries lies with the Forest Supervisor and more directly with the nursery managers. Program oversight, coordination and direction is provided by the Regional Office.

Bessery, Coeur d’Alene, and Lucky Peak Nurseries shall meet annually with its Forest Service customers. Meetings should include the nursery manager and other personnel, customers, and the regional silviculturist/reforestation specialist. During these meetings, customers should view stock in nursery beds and greenhouses, make adjustments in lift and pack requests, and discuss adjustments in lot quantities. They also should report on the quality of the past season's planting stock and discuss coordination with the nursery manager. The nursery staff should provide information on current nursery operations and business in general. Other topics of reforestation interest may also be discussed as part of the workshop format.

2.91 - Critical Nursery/Reforestation Program Coordination Dates

Each nursery shall provide a list of critical dates to customers or maintain them on a web page. Personnel responsible for nursery program coordination should retain a copy of this list. Forests are responsible for meeting the required deadlines. Schedule appropriate lead time to ensure timeframes can be met.
2.92 - Ordering Planting Stock (Sowing Requests)

All tree orders in Regions 1, 2 and 4 shall be sent to the respective Region's nursery regardless of where trees will be grown. Region 3 tree orders shall be sent to the Director of Forestry and Forest Health in the R-3 Regional Office. Nurseries shall provide procedures for ordering planting stock. Forms and due dates for orders shall be available directly from nursery or from their web page.

1. **Sowing Request.** Provide the following information in the sowing request.
   a. **Planned planting program** - where is planting planned and acres.
   b. **Type of stock** - bareroot or container, age of seedling, size of container, special requirements (root, height or caliper).
   c. **Year and season of delivery** - spring, summer or fall planting.
   d. **Quantity of stock** - nearest thousand seedlings.
   e. **Seed lot** - from Seed Inventory, must be matched for site.

2. **Ordering Schedule.** Depending on type of stock being used, orders may be made as far as 3 years in advance of actual planting.

   **Example of Sowing Schedule**

<table>
<thead>
<tr>
<th>Plant Date</th>
<th>Stock Type</th>
<th>Submit Sowing Request</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring 2005</td>
<td>3-0 Bareroot</td>
<td>December 2001</td>
</tr>
<tr>
<td>Spring 2005</td>
<td>2-0 Bareroot</td>
<td>December 2002</td>
</tr>
<tr>
<td>Spring 2005</td>
<td>1-0 Bareroot</td>
<td>December 2003</td>
</tr>
<tr>
<td>Spring 2005</td>
<td>Container</td>
<td>December 2003</td>
</tr>
<tr>
<td>Summer 2005</td>
<td>Container</td>
<td>November 2004</td>
</tr>
<tr>
<td>Fall 2005</td>
<td>Container</td>
<td>November 2004</td>
</tr>
<tr>
<td>Spring 2005</td>
<td>Plug +1</td>
<td>December 2002</td>
</tr>
</tbody>
</table>

Check each nursery for due dates. Dates vary for each nursery and by species, stock type, and season of delivery.

3. **Types of Stock.** Order stock type consistent with prescriptions for acres that are being planted. Refer to Reforestation Prescription (sec. 2.3), Types of Planting Stock and Season of Planting for guidance.
Each nursery will generally grow seedlings according to standard specifications and cull according to grading specifications unless otherwise requested by the forest. Coordinate all special stock specifications in advance with the nursery manager to assure the request is feasible. Identify special growing or grading specifications on the sowing order. Late requests may limit ability for the nursery to meet special requests in some cases. Specifically note on the sowing request if larger caliper is needed for harsh sites or special root lengths for specific sites. If the nursery does not have standards specifications, coordinate with the nursery to develop specifications for your order.

Fall lift is recommended for all conifer species.

4. **Quantity of Stock.** Order as large a quantity as possible of each seed lot. Small lot orders increase the probability of over-run or under-run problems and increase the cost of growing stock. Some nurseries charge extra for small lots. Districts should consolidate orders to avoid small lot orders.

   a. Consider the following to estimate quantity of stock needed.

      (1) Desired number of trees per acre from the prescription. This number includes assessment of available planting spots and anticipated mortality.

      (2) Extra trees allowed to be planted in the contract. To allow for differences in spacing variances and types of planting tools used or other factors; the stock order may be increased by 10 or 20 percent. Use past experience to determine if extra trees should be ordered.

   b. Consider past planting performance to ensure there will not be excessive trees and shortages will not occur.

5. **Seed Lot.** Specify seed lots for seedlings. Refer to the Seed Handbook FSH 2409.26f for seed transfer guidelines. Use only seed appropriate for the specific site. Nurseries and districts should monitor seed lot performance. Refer to 2409.26f for seed quality guidelines.

2.93 - **Ordering Trees (Lift and Pack Requests)**

Contact nursery or utilize the nursery web page for packing instructions. Schedule shipping date with the nursery as early as possible. The nurseries may coordinate shipments with adjoining districts or forests.

1. **Summer and Fall stock - Special Considerations.** In years with an abnormally dry, early summer or fall, districts may want to delay extraction of seedlings until there is reasonable assurance of suitable conditions for planting. If weather limits the planting window, this stock can be held over and planted as spring stock, but close coordination with the nursery is required.
Fall stock that is extracted and placed in coolers at the nursery or at the district in mid-August can be held over to spring if fall planting conditions are unsuitable. This, however, requires sensitive storage and handling practices. Coordinate with the nursery prior to holding stock over. If stock will be frozen at the district or nursery, have the nursery test for cold hardiness prior to freezing.

### 2.94 - Seed Inventories

Each nursery will regularly update the seed inventory. Seed for R-1 is stored at Coeur d’ Alene Nursery, for R-2 at Bessery Nursery, for R-3 and 4 (except Humboldt-Toiyabe NF) at Lucky Peak and Humboldt-Toiyabe National Forest at Placeville Nursery. Inventories are available from the nursery or from the web page. Guidance for maintaining 10-year seed needs, cone collection requirements, and logistics are documented in the Regional Seed Handbook (FSH 2409.26f).

### 2.95 - Planting Stock Standards

Planting stock standards are used as a basis for nursery and reforestation personnel to strive for a common understanding of what quality nursery stock is. Stock not meeting standards has a lower survival probability than acceptable stock. Small, spindly trees or those with disease or stress symptoms have poor survival. Over-sized trees can be difficult or impossible to plant properly and may be damaged during handling.

Determine stock specifications applicable for the site and species to be planted. Districts and nurseries should work to determine these specifications based on experience and applicable research when standard specifications do not yield acceptable survival.

Refer to section 2.51, Receipt of Tree Seedlings for additional descriptions of quality stock.

1. **Bareroot Standards.** Following is a list of quality standards for bareroot seedlings.

   a. **Bareroot Stock Dormancy.** Trees must be in optimum physiological condition, and be dormant with properly hardened winter buds prior to lifting and storing. The safe lifting period (lifting window) for dormant stock shall be determined at each nursery based on the best technique for cold hardiness testing.

      Stock with late season lammas growth and stock from understorries with small or soft buds may not become dormant. If dormancy problems are suspected, the nursery will conduct dormancy tests to assure they are dormant.

      Nurseries use fertilizer, irrigation, and lifting practices to produce desired dormancy of tree stock. These practices are detailed in the written cultural regimes guides and nursery handbooks for each nursery.
b. **Top Pruning.** Tree height should generally be managed through cultural practices. However, top pruning may be needed to control height in species such as western larch or jack pine. Top pruning must be done when shoots are tender. If done improperly, it can disrupt dormancy development and cause problems in stock hardening, which in turn affects cold hardiness.

c. **Root Length.** Root length is determined by cultural practices at the nursery and by pruning. Pruning practices vary by nursery. Coeur d'Alene Nursery prunes roots during packing to standard specifications unless otherwise requested. Lucky Peak Nursery does not root prune unless specified by the forest. The cotyledon scar is used as the reference point for measuring roots.

d. **Healthy Appearance.** Trees shall be free from defect, damage, and symptoms of disease that lower seedling survival potential. Seedling lots with extensive root disease in nursery beds should be destroyed. Experience has shown that healthy trees cannot be visually separated from trees with root disease in these diseased lots. Terminal buds will be mature, well formed, and of good size. Trees with small, weak buds, or short needles (bottlebrush) should normally be culled. Foliage should be a normal color. Trees that are green during the growing season may exhibit yellow and purple tints in fall. This is a part of the normal hardening off process.

Acceptable stock shall not have late season lammas shoots with soft buds or immature green stem tissue or active root growth. The nursery will cull pines with soft buds or buds with more than two fingers width (placed horizontally) of green tissue below the bud as this indicates lammas growth. Trees with hard buds and brown tissue below the bud generally store well when packed and are not cold damaged after planting. Trees with forked tops occurring in the lower 25 percent of the main stem should be culled. However, considerable judgement is required when culling for tree form. Trees with any visible mechanical or insect wounds shall be culled.

Nurseries shall pack seedlings to assure adequate moisture and nutrient regimes. Roots may appear dry if the soil around the roots had dried. This is not a concern unless the roots have actually dried.

Contact the nursery if you have concerns with the appearance of stock that is received.

e. **Lifting Damage.** There are two significant kinds of damage that can occur during lifting. Root chips occur when lateral roots are torn from the main root when pulled upward. This leaves a wound (white chip) on the main root. These trees have poor survival and should be culled. Chips frequently occur when lifting in wet, heavy soils or when lifting lots where trees roots have become intertwined in mats. Engelmann spruce, lodgepole pine, and white pine are prone to root chips. Another form of
damage is excessive mud on foliage. Roots caked with mud and dirt on tree foliage will cause storage and survival problems.

f. **Size Standards.** Examples of bareroot stock specifications are displayed in exhibit 01. Standards vary among nurseries and are available from the nursery or the web page. Standards will be assumed for growing, and grading during packing unless otherwise agreed to by the nursery and ordering forest. Coordinate with the nursery to adjust these specifications at time of the sowing request or prior to the time trees are packed. The nursery shall attempt to meet the goal size in most cases. At least 94 percent of each seed lot will meet minimum size specifications. With this tolerance, districts should not be expected to grade. Notify the nursery and regional silviculturist/reforestation specialist if any seed lots do not meet minimum specifications within the acceptable tolerance.

### 2.95 - Exhibit 01

*Example of Bareroot Standard Size Specifications*

<table>
<thead>
<tr>
<th>Age</th>
<th>Site</th>
<th>Species</th>
<th>Min. Shoot Ht (in.)</th>
<th>Max. Shoot Ht (in.)</th>
<th>Min. Root length (in.)</th>
<th>Max. Root length (in.)</th>
<th>Min. Caliper (mm)</th>
<th>Caliper Goal (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-0</td>
<td>PP</td>
<td>4.0</td>
<td>12.0</td>
<td>8.0</td>
<td>12.0</td>
<td>2.5</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>WL</td>
<td>4.0</td>
<td>16.0</td>
<td>8.0</td>
<td>12.0</td>
<td>2.5</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>2-0</td>
<td>Moderate</td>
<td>DF &lt;5000 ft</td>
<td>4.0</td>
<td>16.0</td>
<td>8.0</td>
<td>12.0</td>
<td>3.0</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>PP</td>
<td>4.0</td>
<td>16.0</td>
<td>8.0</td>
<td>12.0</td>
<td>4.0</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>WP</td>
<td>3.0</td>
<td>16.0</td>
<td>8.0</td>
<td>12.0</td>
<td>3.0</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>3-0</td>
<td>DF</td>
<td>4.0</td>
<td>16.0</td>
<td>10.0</td>
<td>12.0</td>
<td>4.0</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ES</td>
<td>4.0</td>
<td>16.0</td>
<td>10.0</td>
<td>12.0</td>
<td>4.0</td>
<td>5.0</td>
<td></td>
</tr>
</tbody>
</table>

Note that caliper is expressed in millimeters and height in inches.

Refer to standard size specifications for each nursery prior to ordering stock as standard specifications differ.

2. **Container Standards.** Following is a list of quality and size standards for container grown stock. Also refer to section 2.51 for additional descriptions.

a. **Stem Condition.** Container seedlings must have sturdy stems and must stand erect. Spindly or floppy stock is not acceptable.
b. **Foliage.** All container stock foliage should be green and have a healthy appearance except that pines stored for spring planting may have a purple tint. Larch is deciduous and green color requirements do not apply to fall- and spring-planted stock.

c. **Root plug.** Root plugs should be firm and filled with roots. Soft plugs indicate insufficient roots or diseased roots. Trees must not be pot bound which tends to occur if trees are held over too long from the scheduled season for delivery. The roots of pot-bound trees will often spiral around the wall of the container or form a thick mat of roots at the bottom of the plug. Properly filled root plugs, when shaken to remove soil media, should reveal larger roots pointing downward and smaller roots filling the plug interior.

d. **Healthy Appearance.** Container stock shall be free from defect and damaging disease symptoms.

Terminal buds on spring- and fall-planted stock must be mature, well formed, and of good size. Buds of spring stock shall be dormant. Weak, soft, immature buds, or green lammas shoots are not acceptable.

Summer stock must have a definite visible terminal bud. Stems must be lignified enough to tolerate handling by planters without damage to stem tissue. White root tips should be numerous in the root plug.

e. **Size Standards.** Each nursery has growing specification that they use for planning cultural practices. Refer to exhibit 02 for an example of container size specification. Contact each nursery for specifics of their stock. Standard size specifications may be altered to meet local conditions. Work with the nursery to develop local specifications. Stock grown at lower densities is generally more expensive than those grown at higher densities.
2.95 – Exhibit 02

Example of Container Standard Size Specifications

<table>
<thead>
<tr>
<th>Container Type</th>
<th>Species</th>
<th>Min. shoot Ht (in.)</th>
<th>Ht. Goal (in.)</th>
<th>Max. Shoot Ht (in.)</th>
<th>Min. Caliper (mm)</th>
<th>Caliper Goal (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>160 Long 9.0&quot; long plug 7.4 cu. in. volume (also called styro9 or 323)</td>
<td>DF</td>
<td>4.0</td>
<td>8-10.0</td>
<td>12.0</td>
<td>2.5</td>
<td>3.5+</td>
</tr>
<tr>
<td></td>
<td>PP</td>
<td>4.0</td>
<td>8-10.0</td>
<td>12.0</td>
<td>2.5</td>
<td>3.5+</td>
</tr>
<tr>
<td></td>
<td>WL</td>
<td>4.0</td>
<td>8-10.0</td>
<td>12.0</td>
<td>2.5</td>
<td>3.5+</td>
</tr>
<tr>
<td>160 standard 6.0&quot; long plug 5.5 cu. in. volume (also called vent6, 160/90, or 315B)</td>
<td>DF</td>
<td>4.0</td>
<td>8-10.0</td>
<td>12.0</td>
<td>2.5</td>
<td>3.5+</td>
</tr>
<tr>
<td></td>
<td>PP</td>
<td>4.0</td>
<td>6-8.0</td>
<td>10.0</td>
<td>2.5</td>
<td>3.0+</td>
</tr>
<tr>
<td></td>
<td>WP</td>
<td>3.0</td>
<td>6-8.0</td>
<td>10.0</td>
<td>2.5</td>
<td>3.0+</td>
</tr>
<tr>
<td>91 6.0&quot; long plug 6.5 cu. in. volume (Also called 8L, 91/130, or 415C)</td>
<td>DF</td>
<td>4.0</td>
<td>6-8.0</td>
<td>10.0</td>
<td>2.5</td>
<td>3.5+</td>
</tr>
<tr>
<td></td>
<td>PP</td>
<td>4.0</td>
<td>6-8.0</td>
<td>10.0</td>
<td>2.5</td>
<td>3.5+</td>
</tr>
<tr>
<td></td>
<td>WL</td>
<td>4.0</td>
<td>6-8.0</td>
<td>10.0</td>
<td>2.5</td>
<td>3.5+</td>
</tr>
</tbody>
</table>

2.96 - Predictors of Stock Quality

The following chart displays stock quality factors in descending order of importance in predicting seedling survival. Refer to applicable research to determine the values for each factor to increase survival probability. Utilize these factors when determining size specifications necessary for a specific seed lot. Do not compromise chances of survival by lowering standards below necessary specifications.
2.96 – Exhibit 01

Stock Quality Predictors

<table>
<thead>
<tr>
<th>Seedling factor</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Diameter (caliper)</td>
<td>Best and easiest predictor of subsequent survival and growth. Generally larger caliper increases survival however, after a certain size, survival begins to decline as diameter increases, possibly reflecting lack of balance in larger trees.</td>
</tr>
<tr>
<td>2. Shoot/Root Ratio</td>
<td>Can be a useful index, if corrected for seedling size, for predicting survival. Shoot/root ratio is not a growth predictor. May have value to determine when seedlings height is too large and the tree is out of balance.</td>
</tr>
<tr>
<td>3. Bud Height</td>
<td>Can be used to refine growth predictions when heights or caliper are equal between two lots.</td>
</tr>
</tbody>
</table>
| 4. Dickson Quality Index         | QI = Total seedling dry weight (g)  

\[
\text{QI} = \text{Height (cm)} + \frac{\text{Shoot weight (g)}}{\text{Diameter (mm)}} - \frac{\text{Root weight (g)}}{
\]

The quality index predictor shows promise and is relatively easy to measure. Needs further evaluation.

*Additional considerations (not prioritized)*:

- **Color**: Very broad subjective measure of vigor and physiological condition.
- **Multiple Shoots**: Seed-collection procedures should eliminate most genetic causes. Multiple tops results from nursery cultural practices, insect, or animal damage usually exhibit rapid field recovery within the first year.
- **Bottle Brush Growth**: Decreased needle length and distance between needles usually indicate seedlings grown under water stress conditions, or root disease. Of the two, the former is more likely. Short distances are plantable, but total loss of previous year's needles should cull the seedling.
- **Root Size**: Current measurement systems are not sufficient to compare root systems. Subjective judgment is used to determine root surface area capability for water and nutrient absorption. Large, fibrous root systems are best.
- **Root Damage/Deformity**: Both conditions require good judgment. Generally damage and deformity are poor survival risks.
2.97 - Standard Grading Standards

Nurseries shall meet stock size specifications for at least 94 percent of each seed lot. These standards will be used for grading seedlings at the nursery unless changed by the ordering forest. Refer to exhibit 01 for examples of grading criteria used by the nursery.

Stock not meeting the above standards shall not be shipped to districts without prior approval of the forest stock coordinator and/or the ordering district. The forest stock coordinator or the district assumes responsibility for stock performance when accepting sub-standard stock. Sub-standard stock should be accepted only in rare instances and only when the chances of meeting planting objectives are good. For example, some seed lots may not meet minimum height, but may be accepted by the district when caliper is adequate.

Report to the nursery and regional reforestation specialist/silviculturist if substandard stock is received without prior approval.
2.97 – Exhibit 01

Example of Nursery Grading Specifications

**General Characteristics Used to Sort Out Cull Tree Seedlings**

**FOLIAGE COLOR**
- Green – Okay
- Yellow – Cull unless larch
- Brown – Cull unless larch

**ROOT COLOR**
- Dark brown and damp – Okay
- Light brown or dry – Cull

**MINIMUM SHOOT LENGTH**
- Often 3, 4, or 6 inches.
- Measured from the cotyledon scar to the top of the bud.

**MAXIMUM SHOOT LENGTH**
- Usually 16 inches; also 20 or 30 inches.

**MINIMUM ROOT LENGTH**
- Generally 8 or 10 inches.
- The root length is measured from the cotyledon scar to the ends of the roots. The maximum root length is measured after pruning.

**MINIMUM STEM CALIPER (Diameter)**
- Generally 3 or 4mm.
- The stem caliper is measured just above the cotyledon scar.

**SHOOT FORM**

Shoots with forks in the lower 1/4 AND with no dominant shoot are culls.
2.98 - Surplus Tree Seedlings

1. Surplus Seedlings at the Nursery.
   a. Nursery Overrun. Surplus seedlings ranging from slight to moderate overages of stock in excess of the original request caused by nursery sowing factors should be expected. This overrun is not a chargeable surplus to ordering units.

   Forests may, at their option, accept the overrun on a specific lot at the time of lift and pack request. Forests can accept this overrun and trade it for chargeable surplus that arises from not taking trees in their original orders. When substituting, they are not charged for the amount declined from the original request unless already ordered and packed.

   b. Chargeable Surplus. Chargeable surplus arises from stock ordered by districts and then rejected. Forests are responsible for growing costs of this stock up to the time of rejection, plus a destruction charge.

      When the nursery is notified that stock is rejected prior to lift and pack, lift and pack charges will not be assessed. If rejection is after the lift and pack, the forest will also be assessed lift and pack costs. Destruction costs are assessed in all cases.

2. Management of Surpluses. Follow the process outlined below to sell chargeable surplus stock.

   The nursery has the lead role in selling surplus stock but forests and districts also have a major interest in selling surplus stock.

   a. Role of Forests and Districts. Districts and forests have an incentive to sell surplus stock as they will be charged for chargeable surplus if not sold.

      Districts and forests can help primarily through local contacts. They should ensure that the local forest management agency offices in the immediate area are aware of surpluses. District and forests can contact local people responsible for reforestation and inform them of the surpluses, then have them contact the nursery.

   b. Role of Nursery. The nursery shall notify the other forests when there are surplus seedlings prior to offering them to other government agencies or to the public. Contact the nursery for specific dates.
c. **Surpluses at the District.** When there is a large amount of surplus seedlings at the district, trees can be sold or disposed of as perishable goods consistent with Forest Administrative Services Directives (GSA). The district and forest has the responsibility to try to recover the costs of this surplus by sale to other agencies or the public. Districts should contact adjoining forests to check on their needs prior to advertising to other agencies and the public.