

SECTION 01351: EROSION CONTROL, REVEGETATION AND TREE CARE STANDARDS

PART 1 – GENERAL

- 1.0 Erosion control, revegetation, and tree care is required for any project that disturbs soil, vegetation, or trees, and where other types of site stabilization (i.e. landscaping, sod, hardscape) is not included in the project. Compliance with the Standards is mandatory to promote the natural resource and tree protection required by the Integrated Natural Resources Management Plan, Noxious Weed Management Plan, Preble's Meadow Jumping Mouse Conservation Agreement, Construction Storm Water Pollution Prevention Plan (as applicable), and any Municipal Storm Water Permit issued to the U.S. Air Force Academy (USAFA). Any deviation from the Standards must be approved by the Contracting Officer (CO) and/or USAFA Natural Resources (10 CES/CEIEA, (719) 333-3308). As applicable, other Landscaping requirements outlined in the USAFA Design Standards shall also be followed.

Contractors shall consult with USAFA Natural Resources for assistance in understanding these Standards and for guidance to implement an acceptable site reclamation plan. Particular attention shall be given to the requirements for seedbed preparation, supplemental topsoil, planting of native seed mixes, seeding techniques, and erosion control materials and installation.

To prevent the introduction and spread of noxious weeds and other non-native plants, all construction and re-seeding equipment shall be clean of dirt, seed, and plant parts prior to entering the base.

Contractors shall minimize creating new roads and trails adjacent to the project area. Any new trails, roads, parking areas, or staging areas shall be rehabilitated as part of the project.

As part of the Environmental Deliverables List, Contractors shall provide invoices, trip tickets, tags, or other documentation to verify that the specified type, quantity, and quality of seed, topsoil, erosion fabric, and other materials is installed per the Standard.

1.1. SITE PREPARATION

- A. SOIL PREPARATION. All disturbed areas shall be tilled on the contour to a minimum depth of four inches, and then harrowed, raked or rolled to produce a firm seed bed. Imported topsoil (see 1.1.B) shall be required to provide an acceptable planting medium. Large rocks (>3 inch diameter) and debris that may impede seeding shall be cleared from the site. Any required erosion control features (e.g., water bars, berms, basins, turnouts) shall be constructed prior to seeding. No fertilizers shall be applied. Sites that are not adequately prepared prior to seeding (e.g., compacted soil, insufficient topsoil, rocky, eroded surface, etc.) shall be rejected.
- B. TOPSOIL. All areas to be revegetated shall be topsoiled with at least 3 inches of quality soil unless the requirement is waived by the Contracting Officer, with concurrence from USAFA Natural Resources. Where possible, the upper 2-3 inches of the native soil shall also be salvaged for re-distribution over the restoration area. Imported topsoil shall be free of rocks, noxious weeds, large woody debris, or trash. Topsoil shall not be used from areas infested with noxious weeds. Once spread throughout the restoration area, the native and imported topsoil shall be lightly disked on the contour to reduce compaction and to fully mix the soils.

Prior to delivering and spreading the topsoil, a chemical and physical laboratory analysis (including a hydrometer particle size analysis) of randomly collected soil samples (composite of random grab samples) shall be submitted as part of the Environmental Deliverables List for evaluation of the soils compliance with the Standards. Acceptable topsoil shall be tested for and have the characteristics listed in the table below. If the topsoil does not meet these criteria,

approved soil amendments (such as organic compost, humates, or other imported soils) shall be required to meet the Standards.

Soil Texture	Loam, Sandy Loam, Sandy Clay Loam
Particle Size Distribution	Sand <70%, Clay <30%
Soil pH	6.5 to 7.8
Salt Content	<3mmhos/cm
Organic Matter (% by weight)	>2%
Topsoil @ 3" per acre	403 cubic yards per acre

1.2. PLANT MATERIALS FOR REVEGETATION

- A. NATIVE SEED. Depending on the site conditions, and in coordination with USAFA Natural Resources, one of the following native seed mixes shall be used for revegetating disturbed areas. Other seed mixes may need to be developed for unique situations on a case-by-case basis. All seed mixes shall consist of certified seed varieties that are free of noxious weeds and have been tested for purity and germination within one year of the planting date. Locally adapted seed ecotypes collected from a similar elevation (6300-8000' at USAFA; 9000' at Farish Recreation Area) and precipitation zone (15-20 inches) shall be used. Seed certification labels which indicate the species, purity, germination, weed content, origin, and test date shall be submitted as part of the Environmental Deliverable List. If the seed will be broadcast by hand, mechanical spreader or hydro-seeder, the Pure Live Seed (PLS) seeding rate shall be doubled.

1. Xeric (dry) areas with a variety of soil and slope conditions shall be planted with the following seed mix:

SPECIES (Variety)	PLS RATE PER ACRE DRILL SEEDING	PLS RATE PER ACRE BROADCAST SEEDING
Perennial Ryegrass (Tetraploid) <i>Lolium perenne</i>	6.0	12.0
Little Bluestem (Camper) <i>Schizachyrium scoparium</i>	3.0	6.0
Blue Grama (Hachita) <i>Bouteloua gracilis</i>	1.5	3.0
Side Oats Grama (Vaughn) <i>Bouteloua curtipendula</i>	3.5	7.0
Green Needlegrass <i>Stipa viridula</i>	0.5	1.0
Sand Dropseed <i>Sporobolus cryptandrus</i>	0.05	0.10
Western Wheatgrass (Arriba) <i>Pascopyrum smithii</i>	3.0	6.0
Slender Wheatgrass (San Luis) <i>Elymus trachycaulus</i>	1.0	2.0

2. Forest and Shrubland areas with a variety of soil and slope conditions shall be planted with the following seed mix:

SPECIES (Variety)	PLS RATE PER ACRE DRILL SEEDING	PLS RATE PER ACRE BROADCAST SEEDING
Perennial Ryegrass (Tetraploid) <i>Lolium perenne</i>	6.0	12.0
Little Bluestem (Camper) <i>Schizachyrium scoparium</i>	3.0	6.0
Blue Grama (Hachita) <i>Bouteloua gracilis</i>	1.5	3.0
Side Oats Grama (Vaughn) <i>Bouteloua curtipendula</i>	3.5	7.0
Green Needlegrass <i>Stipa viridula</i>	0.5	1.0
Sand Dropseed <i>Sporobolus cryptandrus</i>	0.05	0.10
Indian Ricegrass <i>Oryzopsis hymenoides</i>	1.0	2.0
Spike Muhly <i>Muhlenbergia wrightii</i>	0.5	1.0
Prairie Junegrass <i>Koeleria macrantha</i>	0.5	1.0

3. Mesic riparian areas and wetland fringes shall be planted with the following seed mix:

SPECIES (Variety)	PLS RATE PER ACRE DRILL SEEDING	PLS RATE PER ACRE BROADCAST SEEDING
Perennial Ryegrass (Tetraploid) <i>Lolium perenne</i>	6.0	12.0
Switchgrass (Forrestburg) <i>Panicum virgatum</i>	2.5	5.0
Western Wheatgrass (Arriba) <i>Pascopyrum smithii</i>	2.0	4.0
Canada Wildrye (Mandan) <i>Elymus canadensis</i>	4.5	9.0
Slender Wheatgrass (San Luis) <i>Elymus trachycaulus</i>	1.5	3.0
Canadian reed-grass <i>Calamagrostis canadensis</i>	0.25	0.50
Streambank wheatgrass (Sodar) <i>Elymus lanceolatus</i>	1.5	3.0

4. Wetland areas shall be planted with 2.5” containerized live plugs on 18” centers and seeded with the grasses identified below. Plugs shall be planted flush with the ground surface and rooted in moist to saturated soil depending on the species’ moisture preference. The quantity of plugs needed, by species, shall be based on the percentages below.

SPECIES (Variety)	PLS RATE PER ACRE DRILL SEEDING	PLS RATE PER ACRE BROADCAST SEEDING
Canadian reed-grass <i>Calamagrostis canadensis</i>	0.25	0.50
Ticklegrass <i>Agrostis scabra</i>	0.2	0.4
Nebraska sedge <i>Carex canadensis</i>	Plugs – 70%	Plugs – 70%
Creeping spikerush <i>Eleocharis palustris</i>	Plugs – 10%	Plugs – 10%
Torrey’s rush <i>Juncus torreyi</i>	Plugs – 5%	Plugs – 5%
Baltic rush <i>Juncus balticus</i>	Plugs – 10%	Plugs – 10%
Pale bulrush <i>Scirpus pallidus</i>	Plugs – 5%	Plugs – 5%

5. Upland areas at Farish Recreation Area, with a wide variety of slope and soil conditions, shall be planted with the following seed mix:

SPECIES (Variety)	PLS RATE PER ACRE DRILL SEEDING	PLS RATE PER ACRE BROADCAST SEEDING
Perennial Ryegrass (Tetraploid) <i>Lolium perenne</i>	6.0	12.0
Spike Muhly <i>Muhlenbergia wrightii</i>	0.5	1.0
Arizona fescue (Redondo) <i>Festuca arizonica</i>	1.5	3.0
Western wheatgrass (Arriba) <i>Pascopyrum smithii</i>	2.5	5.0
Sideoats grama (Vaughn) <i>Bouteloua curtipendula</i>	2.0	4.0
Thickspike wheatgrass (Critana) <i>Elymus lanceolatus</i>	2.0	4.0
Idaho fescue (Winchester) <i>Festuca idahoensis</i>	1.5	3.0

1.3 SEEDING AND MULCHING

- A. SEEDING DATES. Seeding shall normally occur within 10 working days of the completion of construction. Fall (September-November) or spring (March-May) planting is preferable to help maximize seed establishment. If the project schedule does not coincide with the preferred seeding periods, or there are unsuitable site conditions (i.e. muddy or frozen ground), then soil stabilization and/or stormwater Best Management Practices shall be implemented to stabilize the area until the next appropriate seeding date. Any seeding conducted outside the preferred months shall be approved by the CO and/or Natural Resources.
- B. SEEDING METHODS. Drill seeding or broadcast seeding shall be used for revegetation. As outlined below, the size and slope of the disturbed area shall determine which seeding method(s) is appropriate and acceptable. **Where feasible, rangeland drill seeding combined with a cover of crimped hay mulch or hydro-mulch is the required method of revegetation.**
1. **Slopes less than 3:1** – Seed shall be planted using a rangeland drill with a small seed/legume box and an agitator box for fluffy or bulky seed. Seed rows shall be spaced 7-10 inches apart, and planted 0.5 to 0.75 inches deep. The drill shall have double-disk furrow openers with depth bands and packer wheels. Seeding shall be accomplished using bi-directional drilling and following the slope contour. The drill equipment shall be calibrated daily or whenever there is a change in the seed mix to ensure proper seed distribution and rate.
 2. **Slopes greater than 3:1 or areas less than 0.10 acre** – Seed shall be broadcast by hand, mechanical spreader, or hydro-seeding equipment. Broadcasted areas shall be raked or harrowed to incorporate the seed into the soil at a depth not exceeding 0.75 inches. If hydro-seeding is used, the seed shall not be tank mixed with the hydro-mulch and broadcast. Broadcast seeding shall be avoided when wind speed exceeds 15 miles per hour.
- C. MULCHING. Weed-free native hay, weed-free straw, or virgin wood fiber hydro-mulch shall be used to control erosion and promote seed germination and plant establishment. Native hay, straw, or hydro-mulch shall be applied at 2000 pounds/acre on slopes less than 3:1. On steeper slopes, a mulching rate of 2500 pounds/acre shall be used. Native hay or straw shall be crimped into the soil to a depth of at least 3 inches and must protrude above the ground at least 3 inches. An organic tackifier shall be used to hold the hay or straw in place if crimping alone is insufficient. Hydro-mulch shall be applied using a colored dye and the manufacturer's recommended rate of an organic tackifier.
- D. EROSION CONTROL MATERIALS. Erosion control blankets, straw coir logs, or soil berms shall be used whenever reclaiming slopes greater than 3:1 or along drainage areas where erosion is probable. All erosion control blanket shall be 100% biodegradable, net-free, wood fiber (excelsior) or coconut fiber materials with at least a two-year functional longevity (Western Excelsior Excel S-2 or CC-4 or equivalent). Straw-based erosion fabric or blankets with plastic netting are not acceptable. Manufactured biodegradable stakes (6-inch minimum) or wooden stakes (8-inch minimum) shall be used to anchor all erosion materials; metal staples (8-inch minimum, 8 gauge) may be approved on a case-by-case basis. All erosion control materials shall be installed in accordance with the manufacturer's instructions and recommendations. Particular attention shall be given to overlapping fabric seams, burying the fabric edges, partially burying coir logs, and utilizing a staple pattern and sufficient number of staples or stakes to prevent the erosion fabric from being dislodged or "tenting" with plant growth.
- E. FENCING/BARRIERS. Fencing or other barriers shall be installed around the perimeter of the re-seeded areas to prevent pedestrian and vehicle access.

- F. **WATERING.** Supplemental irrigation shall normally not be necessary or required if the seeding is accomplished during the preferred fall and spring planting periods. If a water hook-up is available a sprinkler system may be used to promote rapid plant establishment, but the system must then be operated throughout the first growing season. Generally, watering at 0.75-1.0 inches/week is recommended during the April-October growing season depending on rainfall. Supplemental irrigation of seeded areas using a watering truck is prohibited.

1.4 FINAL INSPECTION AND SEEDING SUCCESS CRITERIA

- A. A final inspection of all revegetated areas shall be coordinated with the CO, Construction Inspector and Natural Resources. If the project is under a Construction Storm Water Permit, the USAFA Water Quality Manager shall also be consulted. Any seeding, topsoil, or erosion control deficiencies noted during the inspection shall be corrected prior to project close-out or final contract payment.
- B. A successful revegetation project shall have at least 3 native grass seedlings/square foot, with no bare areas exceeding one square meter. For drill seeded areas, continuous planting rows shall be visually apparent by the end of the first full growing season. If a partial or total seeding failure is apparent, poorly vegetated areas shall be reseeded in the same manner described above. Appropriate site preparation shall be used to create a suitable seedbed for replanting, but any established native vegetation shall be left undisturbed to the extent possible. Areas that erode before plant establishment can occur shall be repaired and immediately reseeded during the same season.

1.5 CARE OF TREES DURING CONSTRUCTION OR UNDERGROUND UTILITY WORK

- A. There are numerous forms of direct tree injury caused by mechanized equipment: trenching injury, surface grading, soil compaction, bark removal, and branch breakage. Extreme care shall be exercised in protecting root systems and branches of trees. A USAFA Natural Resource forestry representative should be contacted before construction operations commence to ensure understanding and adherence to tree care standards.

Additional information on protecting trees during construction activities can be found at:

- www.warnell.uga.edu/outreach/pubs/pdf/forestry/Development%20Assessment%20Tools%20Pub10-24.pdf
- <http://www.extension.umn.edu/garden/yard-garden/trees-shrubs/protecting-trees-from-construction-damage>
- www.ext.colostate.edu/PUBS/GARDEN/07420.html

- B. Protective Fencing: In construction areas, post highly-visible fencing or barricades around trees and areas to be protected. The optimal size of barricaded areas varies by tree species, size, and construction project. For recently planted trees (one to four years), the area under the branches (dripline) should be adequate (Appendix A). For minimal protection of trees older than four years, barricades should extend beyond the dripline; for each inch of trunk diameter, extend the protection area an additional one foot. For additional protection, a four (4) inch deep layer of seasoned wood chips can be placed around each tree prior to placement of barricades.



- C. Trenching: Trenches shall be placed as far from trees as possible, and filled in as quickly as feasible. No trenching is permitted within the tree dripline. While the dripline is the absolute minimum distance, the goal is to trench no closer than 1.25 feet per diameter inch of tree from the tree stem, known as the protected root zone (PRZ). Damaging structural roots within this zone can have serious adverse impacts on tree stability and health. Directional boring to minimize root damage should be utilized to the extent feasible, with highest priority put on large, healthy trees or groups of trees. Moist conditions shall be maintained during construction to help protect roots, with cut structural roots freshly pruned before filling trenches.



Trenching can cause significant root damage and tree death

- D. Grading: As with trenching, no changes in soil grade are permitted within the dripline of trees. The goal is to limit disturbance to no closer than the PRZ.
1. Soil fill: Excessive amounts of soil around a tree base interfere with normal air and moisture circulation to the roots, resulting in improper gas exchange and toxic gas buildup. Minor fills with topsoil of less than three inches will not harm most trees. Topsoil should not be clay. Early symptoms of decline from excessive fill are small leaf size, premature fall coloration, and branch dieback. Dieback may not be noticed for several years, depending on tree species and initial tree health.
 2. Soil Cut: Lowering soil grade can be equally harmful. Where the grade has been changed near a tree, the most common damage is the complete severing of major roots in that area, leading to decline, death or decreased stability to high winds.



Surface grading can sever numerous roots



This tree died within two years of adding 12" of soil

- E. Soil Compaction: Construction traffic can compact soil and severely damage roots, which exist predominantly in the top 18" of soil. Compaction decreases soil permeability, impacts drainage, interferes with gas exchange processes, and leads to less water and nutrient availability. Tree decline and dieback can occur gradually as a result. Construction traffic, vehicle parking and material storage should be kept outside the tree dripline to a distance of one additional foot per inch of trunk diameter, and delineated with construction fencing or similar barrier. If available, a layer of four (4) inches of wood chips can help further mitigate compaction damage.
- F. Bark Removal: Wounding of a tree trunk can significantly damage a tree by introducing a site for decay fungi, and predisposing the tree to other insect and disease agents such as bark beetles. Extreme care should be taken to avoid skinning a tree with equipment, or ripping rather than cleanly pruning branches in need of removal.

- G. Branch Pruning. Removal of live branches shall be kept to a minimum to limit loss of photosynthetic material and to reduce stress to the tree. Branches requiring removal shall be cut back to the trunk or to an acceptable branch, according to proper pruning procedures. The remaining portions of limbs inadvertently broken by the passage of equipment shall also be cut back to the trunk or to an acceptable branch. Flush cuts are not acceptable, as these promote decay of the tree stem. Branches shall be cut by saw; not ripped off by heavy equipment. Pruning procedures are outlined in Appendix B.

1.6 TREE TRANSPLANTING FROM CONSTRUCTION AREA

- A. Whenever possible, existing trees that need to be cleared shall be relocated or sold by USAFA Natural Resources as a forest product prior to site clearing. Transplantable trees are generally less than fifteen feet in height, although this maximum height will be less under extreme drought conditions due to increased transplant shock in larger trees. Coordinate with USAFA Natural Resources at least one month in advance to assess the feasibility of transplanting trees. Under continued drought conditions, tree transplanting may be infeasible.

1.7 CARE OF TREES MOVED INTO CONSTRUCTION AREA

- A. Trees moved into the project area for landscaping purposes shall have irrigation needs addressed for three years, including winter watering. Approximately ten (10) gallons per inch of tree caliper (measured at six inches above ground level) shall be applied to the tree ring area (see "C" below) upon planting. Water shall be applied approximately weekly for the first two months, and then every two to three weeks throughout the remainder of the first growing season, depending on natural moisture and soil conditions. Depending on precipitation, frequency of deep watering during the second and third years may be decreased as the tree continues to establish on the site, but newly transplanted trees will likely still require periodic watering for at least three full growing seasons to maintain tree health and vigor and encourage root establishment. *Light watering applications (i.e. sprinklers) will not provide adequate water saturation, tending rather to promote root proliferation within the top several inches of soil instead of encouraging deeper root establishment which is vital to long-term survival.* The objective of deep watering is to saturate the root ball to a depth of at least twelve (12) inches. Water amounts on heavy clay soils with poor drainage may need to be lessened to avoid drowning the root system. A rule of thumb is to check the edge of the root ball for moisture at a depth of eight inches. If this area is still moist, watering can be postponed.
- B. Winter watering from October through March is critical, especially in dry climates with desiccating winter winds. *Water shall be applied monthly during dry periods, when the ground is not frozen.* Fall plantings shall receive a deep watering upon planting, followed by periodic winter watering as conditions warrant. As the tree becomes established, the need for supplemental watering should decrease. This watering regime shall be implemented for at least the first three growing seasons to assist in establishment, but is advisable beyond this timeframe if the transplanted tree is especially large, or is slow in adapting to its new site. See Appendix C for additional information on watering.
- C. A soil berm or tree ring of at least four (4) inches in height shall be constructed around the tree (roughly under the tree dripline (outer edge of branches), or at least the size of the transplanted root ball). This will allow water to focus onto the root ball. The berm shall be removed in three years, when roots should have spread well beyond the dripline. Retaining the berm beyond this timeframe tends to lead to subsequent watering only within the bermed area, which will encourage root growth primarily in this area and not outward, to the detriment of the tree.
- D. Approximately three to four inches of mulch shall be placed above the root ball to preserve soil moisture, and to protect trees from lawnmower damage in mowed areas. Mulch should not be placed directly against tree stem, as this could cause rotting of wood and afford rodents a place

to hide and potentially damage tree. A distance of at least six inches from the tree stem should be left unmulched.

- E. Transplanted pines are a prime target for the Ips (engraver) beetle, which are attracted to environmentally stressed trees. Landscape planted spruce are highly susceptible to the white pine weevil which can cause significant damage to the tree crown. Transplanted pines and spruce shall be sprayed to prevent bark beetle infestation with a persistent formulation with the active ingredient Carbaryl, as specified on the USAF-approved pesticide list. Spring-planted pine and spruce shall be sprayed within one week of transplanting. Autumn-planted pine and spruce shall be sprayed within one week of planting, and again at the beginning of the following growing season. All pine and spruce shall be sprayed by late March for the following two years (three years total). USAFA Natural Resources will be available to consult on spraying activities. All pesticide use shall be coordinated through the HAZMART and Pest Management Coordinator.
- F. In general, trees over six (6) feet in height shall be staked, unless they are not located in a wind-prone location (i.e. sheltered from predominant west/north winds by a building), or do not have a large crown. Stakes shall be removed in one year, unless in unusually windy location, in which case they should be removed after the second growing season. Retaining stakes for too long compromises windfirmness and encourages a tall spindly rather than a sturdy tree trunk.
- G. Trees should not be fertilized upon transplanting, as this encourages stem growth at the expense of root growth. Root growth is more critical at this time, so fertilization (nitrogen in particular) is best held off for several years. A root stimulant (generally high in phosphorus) may be used during or immediately after transplanting.
- H. Holes resulting from trees shall be filled with weed-free soil and graded evenly to ground level within one week of tree removal. Holes shall be marked with at least three (3) brightly-colored pin flags during the interim.
- I. Coordinate with USAFA Natural Resources for advice on transplant tree care.

1.8 MERCHANTABLE WOOD

- A. In accordance with Department of Defense Instruction (DODI) 4715.3, DODI 7310.1, and AFI 32-7064 Section 8.3, forest products shall not be given away, abandoned, destroyed, or used to offset contract costs. Removal of forest products without a permit from USAFA or Farish Recreation Area constitutes theft of government property and shall be punished under the applicable laws or regulations.
- B. Trees to be removed shall be cut and limbed (all limbs removed). Merchantable firewood (sound tree trunks greater or equal to four (4) inches in diameter) shall be delivered to the USAFA Natural Resources woodlot at Building 9030. Branch wood is not considered merchantable firewood, with the exception of straight portions greater or equal to four (4) inches in diameter.
- C. Contractor may opt to purchase wood at the existing published rate. All wood delivery or purchase shall be coordinated in advance with USAFA Natural Resources. Disposition of wood products from Farish Recreation Area shall be determined by USAFA Natural Resources.

1.9 UNMERCHANTABLE WOOD AND STUMP REMOVAL

- A. Disposal of woody slash (limbs, tops), rotten wood, stumps and rootwads (stumps with attached roots) is the sole responsibility of the Contractor. All unmerchantable wood will be removed from the installation, with the following two possible exceptions. If approved in advance by a Natural Resource forestry representative, woody slash may be chipped and spread across up to 50% of the project area to a depth not to exceed three inches, with chips spread at least 30 feet from a

road, trail or building. No chips shall be spread in improved or mowed areas. On small projects, it may be possible to dispose of minor amounts of woody slash by lopping and scattering onsite, but only if prior approval has been given by Natural Resources. In such cases, the limbs shall be moved at least 50 feet from buildings, roads, or major trails, and lopped and scattered so as not to exceed eight inches above ground level. Limbs on all insect-infested trees shall be chipped to destroy emerging broods within branches.

- B. Where trees are removed but stumps and roots are not extricated, stumps shall be cut as close to ground level as practical, not to exceed two (2) inches (measured on the uphill side of the tree on a slope) above ground level within 25 feet of buildings, roads or major trails, and four (4) inches above ground level elsewhere.

1.10 BEETLE-INFESTED TREES

- A. *A USAFA Natural Resource forestry representative shall be contacted in the event that any trees to be cut may be infested with beetles.* These will generally be faded green, red or straw-colored, and may have visible pitch tubes or red sawdust-like frass at the base of the tree. If a tree is determined to be actively infested with beetles, known as a "brood" tree, wood shall not be delivered to the NR woodlot unless coordinated in advance with a USAFA Natural Resources forestry representative. All limbs of infested tree will be chipped to destroy branch bark beetles. If removed from site and not processed in a mill, infested wood should not be placed within five miles of any pines, to prevent beetle spread to other areas.

1.11 CONE COLLECTION

- A. Project areas will be examined for developing cone crops, which may be useful for future reforestation needs. A USAFA Natural Resources representative will assess this opportunity and, if feasible, coordinate with project manager to collect cones from high quality trees scheduled for removal. Cones generally ripen in late September. If feasible and agreeable to Contractor, USAFA Natural Resources would fell trees for collection upon ripening, if this does not hinder construction progress. Trees would be left onsite. Seed from cones would be utilized to grow tree seedlings for future reforestation needs on the Academy.

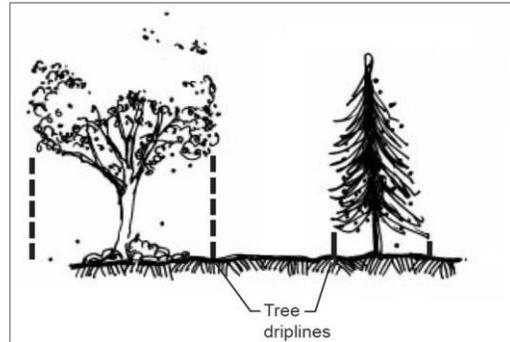
2.1 LIVE WILLOW STAKING

- A. Prior to planting, Natural Resources shall identify all necessary willow staking areas and approve any on-site locations for the harvesting of plant materials. All willow stakes shall be disease- and insect-free (e.g., oyster scale). Off-site plant materials shall only be used with prior approval from Natural Resources.
- B. Willow stakes shall be harvested and planted in late-winter to early-spring before plant dormancy is broken (identified by swelling buds). Planting shall only be conducted when the weather and soil conditions allow. Stakes shall not be planted when the ground is frozen or otherwise unsuitable.
- C. Live stakes shall be coyote willow (*Salix exigua*) cuttings that are one-half inch (1/2") to one-inch (1") in diameter and at least 4.0-feet (4.0') in length. Stakes shall be harvested with sharp pruning shears with the base cut at a forty-five degree (45°) angle and a branched top left intact. All side branches that would be buried below the ground shall be pruned without damaging the branch collar. The butt end of each stake shall be placed in water immediately after cutting to keep them hydrated. All stakes shall be planted within 7 days of harvest.

- D. Stakes shall be kept moist, cool and shaded and protected from the wind until installed. During transport or storage, the stakes shall be covered to protect them from heat, light and wind damage.
- E. Willow stakes shall normally be planted on 2-foot centers in a staggered pattern, but the pattern and spacing may need to be adjusted depending on the availability of groundwater. A planting hole shall be excavated to the groundwater using a hammer drill and a one-inch drill bit, or other approved method. Damage to any erosion blanket shall be avoided to the maximum extent possible. Stakes shall be gently placed in the hole, ensuring that the butt end is seated below the groundwater level. Each hole shall be backfilled, hand-tamped, and/or watered to eliminate air pockets around the stake.

SECTION 01351 APPENDIX A – “DRIPLINE” SKETCH AND DEFINITION

Dripline: The dripline is the area directly located under the outer circumference of the tree branches. Because this area contains the highest amount of roots, protecting roots from cutting or compaction is critical. No trenching is permitted within this zone.



SECTION 01351 APPENDIX B – PRUNING TECHNIQUES

Pruning Cuts

Pruning cuts should be made so that only branch tissue is removed and stem tissue is not damaged. At the point where the branch attaches to the stem, branch and stem tissues remain separate, but are contiguous. If only branch tissues are cut when pruning, the stem tissues of the tree will probably not become decayed, and the wound will seal more effectively.

1. Pruning living branches (Fig. 6)

To find the proper place to cut a branch, look for the **branch collar** that grows from the stem tissue at the underside of the base of the branch (Fig. 6A). On the upper surface, there is usually a **branch bark ridge** that runs (more or less) parallel to the branch angle, along the stem of the tree. A proper pruning cut does not damage either the branch bark ridge or the branch collar.

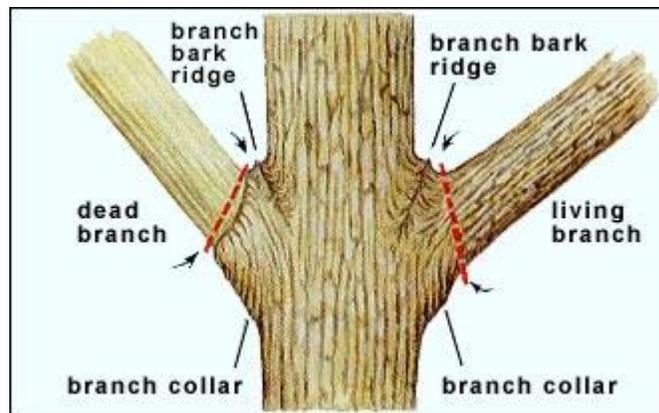
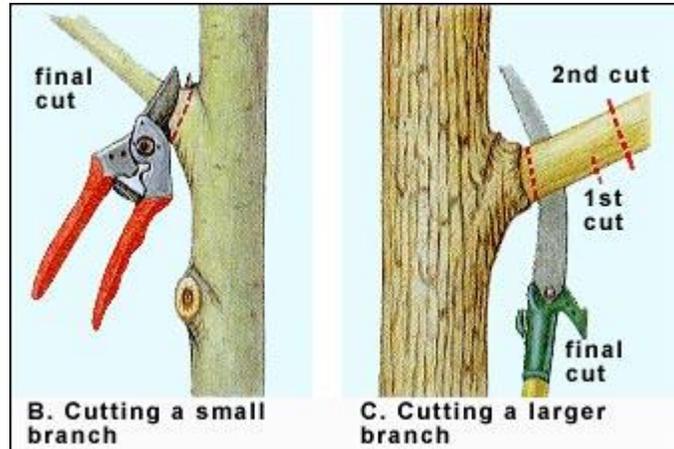


Figure 6A. Targeting the cut

A proper cut begins just outside the branch bark ridge and angles down away from the stem of the tree, avoiding injury to the branch collar (Fig. 6B). Make the cut as close as possible to the stem in the **branch axil**, but outside the branch bark ridge, so that stem tissue is not injured and the wound can seal in the shortest time possible. If the cut is too far from the stem, leaving a branch stub, the branch tissue usually dies and woundwood forms from the stem tissue. Wound closure is delayed because the woundwood must seal over the stub that was left.



The quality of pruning cuts can be evaluated by examining pruning wounds after one growing season. A concentric ring of woundwood will form from proper pruning cuts (Fig. 6B). **Flush cuts** made inside the branch bark ridge or branch collar, result in pronounced development of woundwood on the sides of the pruning wounds with very little woundwood forming on the top or bottom (Fig. 7D). As described above, stub cuts result in the death of the remaining branch and woundwood forms around the base from stem tissues.

When pruning small branches with hand pruners, make sure the tools are sharp enough to cut the branches cleanly without tearing. Branches large enough to require saws should be supported with one hand while the cuts are made. If the branch is too large to support, make a three-step pruning cut to prevent bark ripping (Fig. 6C).

1. The first cut is a shallow notch made on the underside of the branch, outside the branch collar. This cut will prevent a falling branch from tearing the stem tissue as it pulls away from the tree.
2. The second cut should be outside the first cut, all the way through the branch, leaving a short stub.
3. The stub is then cut just outside the branch bark ridge/branch collar, completing the operation.

2. Pruning dead branches (Fig. 6)

Prune dead branches in much the same way as live branches. Making the correct cut is usually easy because the branch collar and the branch bark ridge can be distinguished from the dead branch because they continue to grow (Fig. 6A). Make the pruning cut just outside of the ring of woundwood tissue that has formed, being careful not to cause unnecessary injury (Fig. 6C). Large dead branches should be supported with one hand or cut with the three-step method, just as live branches. Cutting large living branches with the three step method is more critical because of the greater likelihood of bark ripping.

SECTION 01351 APPENDIX C – TREE CARE FOLLOWING PLANTING

After planting the tree, build a 4-inch tall berm around the edge of the hole. Fill the berm with mulch (i.e. shredded bark, compost). The mulch and berm make it easier to water the tree and reduce weed competition. Below are diagrams of a typical tree planting.

Right after planting, water the tree in by filling the bermed basin with water. This will settle the existing soil around the root ball. Fill the bermed basin with water once a week during the growing season, unless natural precipitation is abundant. The goal is to wean the tree slowly off of supplemental irrigation, and get the root system large enough for the tree to thrive on natural rainfall. Continue with winter watering once a month during extended dry periods from late October through March, unless ground is frozen.

REMEMBER: These are just guidelines. Use your index finger to check the soil moisture under the mulch. More plants are killed by over-watering than by under-watering.



(Portions of this appendix are from Douglas F. Welsh, Landscape Horticulturist Texas A&M University, College Station, Texas).