



SECTION 32 93 43

SOIL BIOENGINEERING OR SHORELINE STABILIZATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. CONTRACTOR shall furnish all labor, materials, supplies, equipment, tools and transportation; perform all operations to complete installation of live willow stakes, willow fascines, willow brush layering, willow bundles and cottonwood poles; and guarantee all plantings.
- B. Live stakes and poles are straight branches or saplings that have been cut and pruned from dormant living woody plant material (plants that have lost their leaves for the winter).

1.02 RELATED SECTIONS

- A. The following is a list of SPECIFICATIONS which may be related to this section:
 - 1. Section 01 57 19, Temporary Environmental Controls
 - 2. Section 31 41 13 Topsoil and Wetland Topsoil Stripping and Stockpiling
 - 3. Section 31 23 00 Excavation and Fill
 - 4. Section 31 25 00 Erosion and Sedimentation Controls
 - 5. Section 32 91 13 Topsoil and Wetland Topsoil
 - 6. Section 32 93 00 Landscape Planting
 - 7. Section 32 92 19 Seeding

1.03 GENERAL

- A. No substitutions for specified materials will be accepted in the BID. Alternative BID proposals, which propose material substitutions, may be submitted for consideration by ENGINEER or PLANT ECOLOGIST. Alternative proposals shall be fully supported by necessary documentation showing compatibility/comparability with specified materials.
- B. Additional WORK will be paid for at the CONTRACT unit price. If the CONTRACT unit price is not available, the WORK will be paid for on a time and material basis or for an agreed to lump sum amount.

1.04 STORAGE AND HANDLING

- A. Cuttings shall be kept moist, cool, and shaded at all times until installed. Cuttings shall be stored at between thirty-five degrees (35°) and fifty degrees (50°) Fahrenheit for no longer than one (1) week. Cuttings shall be stored in protected locations where they are shaded and sheltered from sun and wind. The butt end (bottom end) of



cuttings shall be submerged in water during storage. Prior to planting, all cuttings shall have butt ends (not tops) placed in water for a minimum of twenty-four (24) hours, but not longer than fourteen (14) days. The upper end of cuttings shall never be submerged. Plastic trashcans may be used for storing willow or cottonwood cuttings. Cuttings shall be protected from freezing and drying at all times and protected from direct sunlight. Cuttings are never to be stored horizontally in water.

- B. Cuttings shall not be dropped or otherwise mishandled. Minor broken and damaged cuttings shall be pruned prior to planting. Major damage will be cause for rejection.
- C. Cuttings shall be covered with tarp or burlap during any transportation in vehicles.

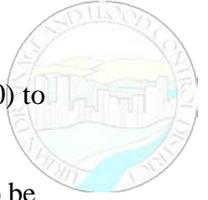
1.05 GUARANTEE AND REPLACEMENT

- A. Guarantee plantings to root and thrive free from defects from any cause until final acceptance of the PROJECT.
- B. Replace plants when they are no longer in a satisfactory condition as determined by ENGINEER prior to final acceptance. This includes plants that die back and lose the form and size originally specified.
 - 1. Make replacements within seven (7) days of notification from ENGINEER.
 - 2. Replace plants in the dormant season only, unless approved otherwise. Remove dead plants within two (2) days of notification.
- C. All replacements shall be of the same kind and size as originally specified and shall be installed as described in the CONTRACT DOCUMENTS. Repairs and replacements shall be made at no expense to OWNER.
- D. Guarantee shall apply to the originally specified and installed plants and other landscape materials, and any replacements made during the construction period.

PART 2 PRODUCTS

2.01 CUTTINGS

- A. Willow materials shall be sandbar willow (*Salix exigua* species) and cottonwood material shall be native plains cottonwood (*Populus deltoide*, syn. = *P. sargentii*), live wood at least two (2) years old. Avoid current year's suckers and current year's growth.
- B. Willow cuttings shall be one-half- (1/2-) inch to one- (1-) inch diameter, of the following lengths:
 - 1. Willow brush layering cuttings shall be five (5) feet to six (6) feet long.
 - 2. Willow stakes shall be two (2) feet long.
 - 3. Willow fascines cuttings shall be at least three (3) feet long.
 - 4. Willow bundle cuttings shall be four (4) feet long.



5. Cottonwood poles shall be one (1) to three (3) inches in diameter and ten (10) to eighteen (18) feet long.
- C. Plant materials shall be harvested from on-site sources. Any offsite sources are to be accepted by ENGINEER.

2.02 ACCESSORIES

- A. Beaver Protection Sleeve: Eighteen- (18-) inch diameter; fabricate from forty-eight- (48-) inch wide, two- (2-) inch by four- (4-) inch 12-gauge welded wire fabric, approximately nine and one-half (9-1/2) feet long and fastened to three (3) six-(6-) foot lengths of one-half- (1/2-) inch diameter rebar with two (2) hog ring fasteners.

PART 3 EXECUTION

3.01 GENERAL

- A. CONTRACTOR shall appoint a competent resident superintendent. The superintendent shall be experienced in the specified techniques of woody plant installation and be on-site whenever the WORK is in progress. The superintendent shall not be replaced without notice to ENGINEER. Workers shall be competent in performance of the WORK they are assigned.
- B. Materials planted prior to approval are subject to rejection. All rejected materials shall be removed from the site, replaced and reinspected before planting.
- C. ENGINEER or PLANT ECOLOGIST shall accept the location of all willow plantings before installation.
- D. Planting Time and Completion:
 1. Willows and cottonwoods shall be planted only when weather and soil conditions permit and in accordance with locally accepted practices, and as accepted by ENGINEER. Cuttings shall not be planted when freezing temperatures are forecast twenty-four (24) hours in advance or when the ground is frozen or otherwise unsuitable.
 2. Willows and cottonwoods shall be harvested and planted in the dormant season, February 1 to April 1. However, best success is achieved when harvested and planted in March. Live plant materials shall be properly stored and installed no more than two (2) weeks following collection.

3.02 PREPARATION

- A. Site Inspection:
 1. CONTRACTOR, the Landscape SUBCONTRACTOR, ENGINEER, and PLANT ECOLOGIST shall inspect site prior to being accepted by ENGINEER or PLANT ECOLOGIST as complete and acceptable for the Landscape SUBCONTRACTOR to proceed.
 2. Beginning WORK of this section implies acceptance of existing conditions.



- B. ENGINEER or PLANT ECOLOGIST shall inspect live woody cuttings for acceptability upon arrival at the PROJECT site.

3.03 HARVESTING

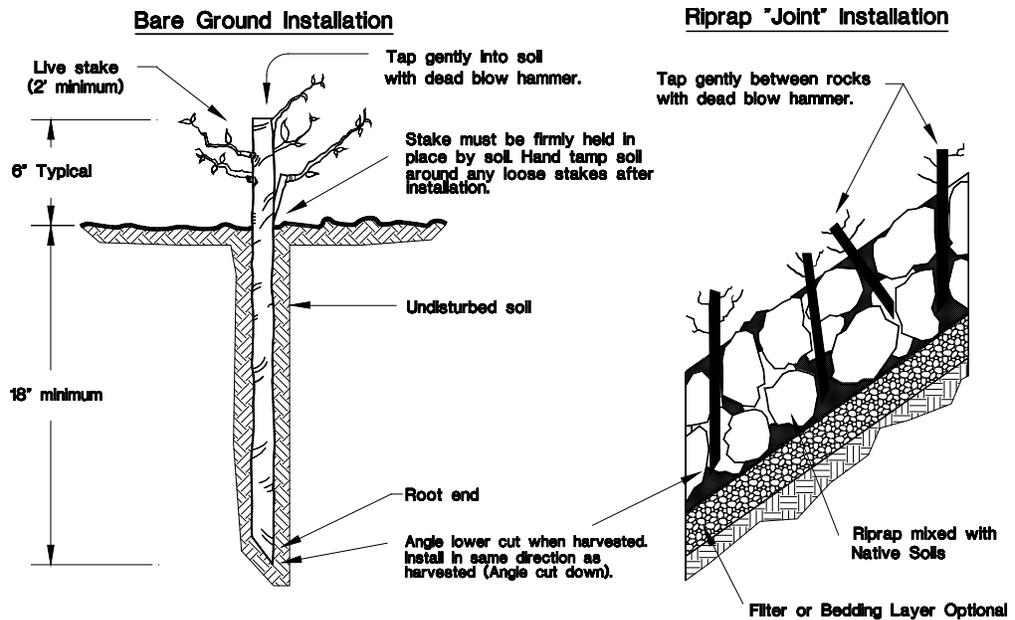
- A. ENGINEER will observe and approve onsite harvesting areas or offsite source of plant materials.
- B. Use extreme care to avoid damage to all remaining plants in harvest areas and the cuttings themselves. Only forty percent (40%) of harvest plants shall be removed for cuttings.
- C. All plant material shall be collected and installed in dormant condition. Cuttings shall be harvested with sharp pruning shears or sharp saws. Cuts are to be made near the soil surface. All material shall be handled with care to avoid bark stripping and trunk wood splitting. Older, stiff or dying stems or stems with dead inner wood shall not be used. For willow stakes and bundles, all side branches and any leaves shall be trimmed from cuttings. Branches shall be left on cuttings for fascines and brush layering. Live cuttings shall be bound together with twine at the collection site for ease of handling and protection during transport. The harvesting site shall be left clean and tidy; excess woody debris material shall be promptly removed from the site. Any soil disturbance outside of construction limits caused by accessing areas for willow or cottonwood harvesting shall be ripped and re-seeded with the specified seed mixture and rate. There will be no additional payment for such disturbance.

3.04 PLANTING WILLOW STAKES

- A. Planting locations shall be staked by CONTRACTOR for approval by ENGINEER or PLANT ECOLOGIST prior to planting.
- B. Live stakes shall be single sticks. They shall be twenty-four (24) inches long, taken from the lower stems of healthy, actively growing plants, approximately one-half (1/2) to one (1) inch in diameter. Cut the apical buds plus several inches off the cutting before planting it. (The apical bud at the tip of the branch releases a plant growth hormone which discourages lateral bud development.) All side branches shall be trimmed. Bark on lower portion of the stems shall be sprayed lightly with white paint to identify lower ends for planting. Do not dip ends of cuttings into paint; butt ends shall not be painted.
- C. Cuttings shall be planted in a staggered pattern or random pattern in the locations shown on the DRAWINGS at the designated density. Prepare a pilot hole to the groundwater depth by hammering a rebar, dibble bar, or stinger, or other approved method, into the soil. Place cutting gently upright into the hole, ensuring that the base end is at or below the ground water level. Cuttings shall protrude from the ground four (4) to six (6) inches. At least two-thirds (2/3) of each cutting shall be inserted into the soil.
- D. Holes shall be backfilled with an approved soil, as necessary, so that no voids remain around the cutting. If willow stakes are to be inserted through an erosion fabric, backfill of planting holes is still required. Watering shall be done between backfill lifts to ensure all voids are filled. Do not bury top of cutting. Tamp surface around the cutting to secure it in place. Cuttings which move freely within holes will be rejected.



- E. Access corridors for heavy equipment used to facilitate digging of pilot holes for willow stakes (such as within riprap), and all disturbed or compacted soil shall be ripped and scarified prior to final seeding.
- F. Figure A below shows a typical installation of a live willow staking.



Single Willow Stake Detail
For use in granular soils with available ground water

Figure A

3.05 WILLOW BRUSH LAYERING

- A. Dig a two- (2-) foot deep by one- (1-) foot wide trench at the locations shown on the DRAWINGS. The depth may need to be adjusted to ensure that the bottom of the trench is within the wet soil (ground water level).
- B. Place a six- (6-) inch thick densely packed layer of willow cuttings five (5) feet to six (6) feet long into the trench, top end up, leaning toward the creek, as shown in the details. The ends of all willow cuttings shall be in the groundwater.
- C. Backfill the trench so that no voids remain around the stems of the cuttings. Watering should be done between backfill lifts to ensure all voids are filled. Do not bury tops of cuttings. Tamp surface around the cutting to secure it in place.

3.06 LIVE WILLOW FASCINES

- A. A continuous fascine shall be built in a prepared trench, as opposed to individual willow bundles laid end-to-end. CONTRACTOR shall contact ENGINEER or PLANT ECOLOGIST prior to beginning the WORK to arrange for oversight and guidance during the construction of fascines. Trimmings of young suckers and some smaller branches may be included in the fascines, but half of the stems in the fascines shall be at least one-half (1/2) inch in diameter. Complete live willow fascines shall be ten (10) inches in diameter, with the growing tips and butt ends oriented in alternating directions. Cuttings shall be staggered in the fascines so that the growing



tips are evenly distributed throughout the length of the bundle. Soil shall be worked into the fascines to fill the voids (stems shall be in close contact) and fascines shall be compressed and tightly tied with biodegradable rope or twine of sufficient strength and durability. Fascines shall be tied at two- (2-) foot intervals.

- B. The trench shall be dug into the base of the slope approximately one- (1-) foot deep or as specified in DRAWINGS. The coir mat shall be laid in the empty trench with the bulk of the fabric along the lower (water) side of the trench. The fabric shall be staked securely into the trench on two- (2-) foot intervals with two- (2-) foot wooden stakes. Lay twine crossways in the trench at approximately two- (2-) foot intervals, overlapping the sides of the trench sufficient length to wrap around the fascine and tie. Lay the cuttings within the trench as noted above. Backfill the trench with sand or soil; filling voids between the cuttings. Tie the twine securely around the fascine. The coir mat blanket for the adjacent slope shall be wrapped around the fascine as shown in the DRAWINGS. The trench on each side of the fascine shall be backfilled with compacted topsoil. The top of the fascine shall be slightly visible when the installation is complete.
- C. Fascines shall be staked firmly in place with one row of two- (2-) foot long diagonally cut two- (2-) inch by four- (4-) inch wooden stakes every twenty-four (24) inches, alternating sides of the fascine. Tapered ends of adjacent fascines shall be overlapped so that the overall fascine diameter is uniform and continuous. Two (2) stakes shall be used at each fascine overlap such that a stake is driven between the last two ties of each fascine.
- D. Figure B below shows a typical installation of live willow fascines.

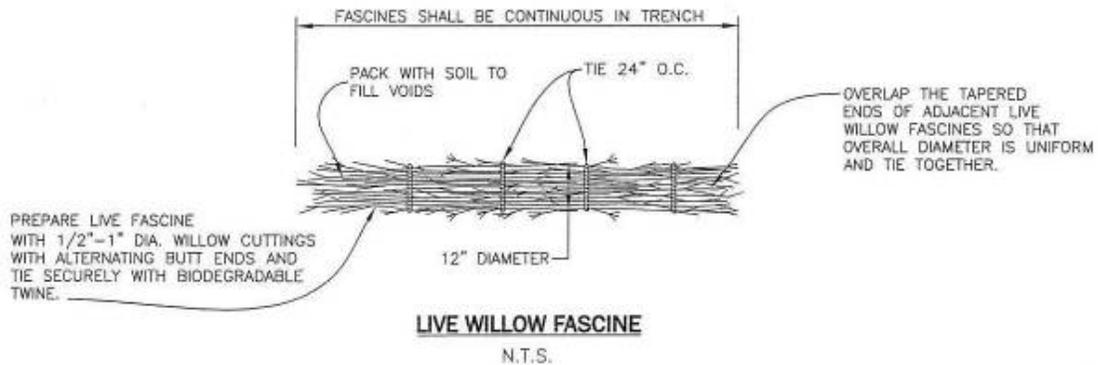
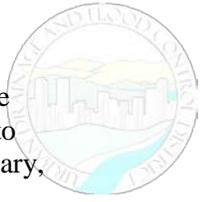


Figure B

3.07 WILLOW BUNDLING

- A. Bundles shall consist of five (5) to seven (7) cuttings bound into two- (2-) to three- (3-) inch diameter bundles. Bundles shall be planted with tops of cuttings all oriented up, at elevations to be determined by ENGINEER or PLANT ECOLOGIST with four- (4-) foot spacing or as indicated in DETAIL. Bundles shall be inserted directly into the soil or between rock riprap until they penetrate the groundwater and still protrude four (4) to eight (8) inches from the soil surface. In no case shall the cuttings protrude more than eight (8) inches above the soil surface. In the case of joint planting in riprap, the protruding measurement shall be taken from the soil level between the rocks and not from the top of rock. If tamping is necessary, care shall be taken to prevent splitting of the cuttings. Backfill around the installed bundle with the



original soil to eliminate air voids, then tamp the ground lightly around the bundle with a hammer to hold it securely in place. After the bundles are fully inserted into the soil, the top one (1) to two (2) inches of each cutting shall be pruned if necessary, to a clean, non-damaged cut.

- B. Figure C below shows a typical installation of willow bundling. Bundles, which are loose or not fully surrounded by lightly packed soil, will be rejected.

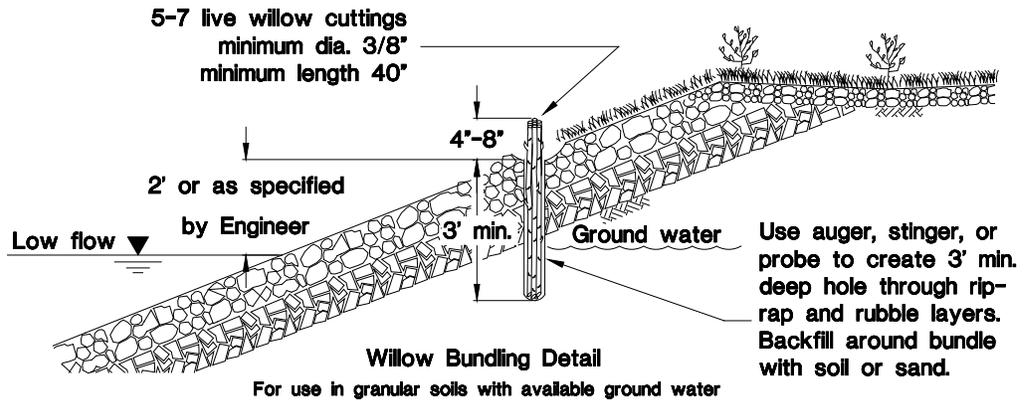


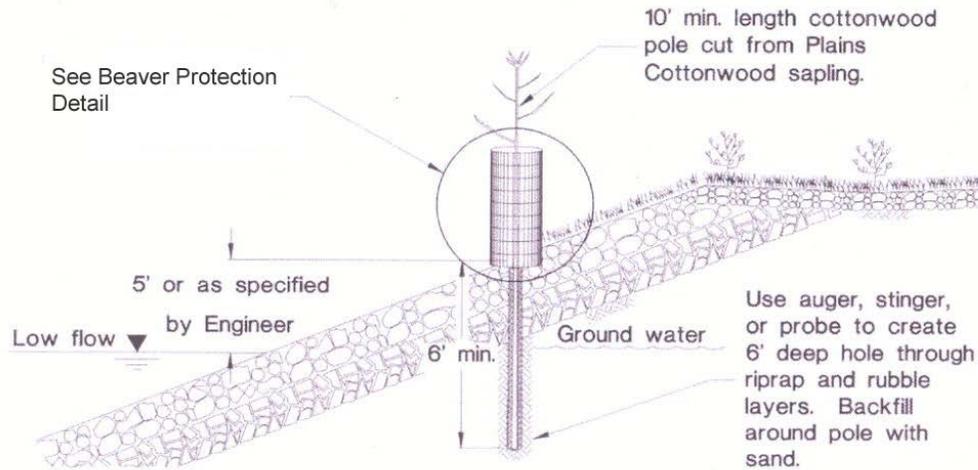
Figure C

3.08 COTTONWOOD POLING

- A. Poles shall be planted at locations shown on the DRAWINGS or as determined by ENGINEER or PLANT ECOLOGIST. Cottonwood poling is possible only in naturally "sub irrigated" areas with a shallow water table, generally two (2) to four (4) feet below the ground surface. Cottonwood poles also shall not be planted into areas with less than two (2) feet of moist aerated soil *above* the saturated soil (groundwater level). Four (4) to six (6) feet of the poles shall be inserted into the soil, with the lower foot or two of pole extending below the surface of the water table. Poles shall extend from four (4) to twelve (12) feet above the soil surface after planting, with one-third (1/3) to one-half (1/2) of the pole buried below the surface. Reduce the number of branches on the pole by trimming most of the smaller branches, starting below the upper tip on the top of pole. Do not cut the upper-most tip. There shall be at least six (6) to eight (8) upper branches, plus the tip, remaining on the trimmed pole. Prepare a pilot hole by using an auger, stinger, or probe to bore to a minimum depth of six (6) feet or as directed by ENGINEER or PLANT ECOLOGIST. The pilot hole shall be of sufficient diameter to facilitate easy insertion of cottonwood pole. Backfill around the installed vertical pole with loose sand to eliminate air voids, then tamp the ground lightly around the pole with a hammer to hold it securely in place. A slight saucer shall be formed around each pole to capture and hold precipitation. The upslope side of the saucer shall be open to receive run off and the lower portion of the saucer shall intersect the pole.



- B. Figure D below shows typical native cottonwood poling detail in rip rap. (Note: Installation of cottonwood poles may also occur into soil.)

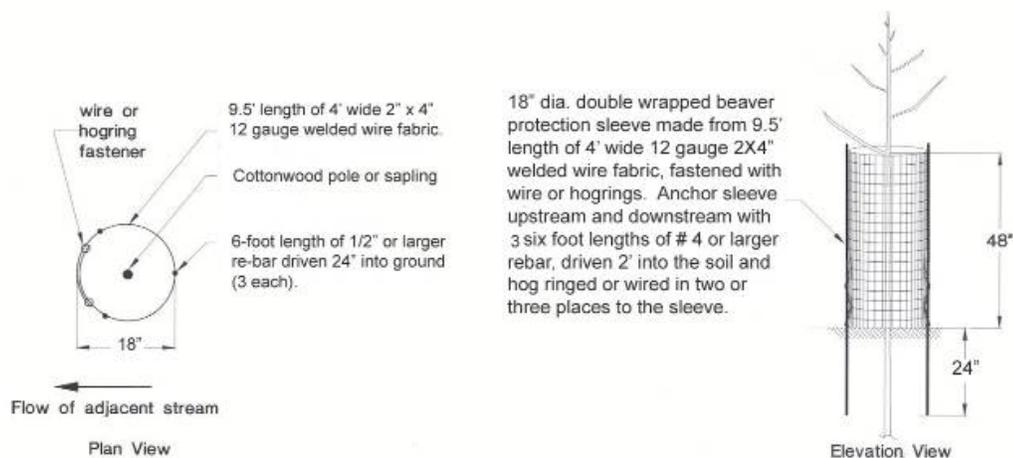


Cottonwood Poling Detail

For use in granular soils with available ground water

Figure D

- C. Unless otherwise accepted by ENGINEER or PLANT ECOLOGIST, each cottonwood pole or newly planted cottonwood tree shall be protected against beaver damage by the installation of an eighteen- (18-) inch diameter, double wrapped beaver protection sleeve made from a nine and one-half- (9-1/2-) foot length of forty-eight- (48-) inch wide, two- (2-) by four- (4-) inch 12-gauge welded wire fabric which has been fastened with at least two (2) hog rings to each of three (3), six- (6-) foot lengths of one-half- (1/2-) inch diameter rebar, inserted at least two (2) feet into the soil on either side of the tree.
- D. Figure E below shows a typical installation of a beaver protection cage.



Beaver Protection Detail

Figure E



3.09 FIELD QUALITY CONTROL

A. Acceptance:

1. The final walk-through shall be performed at the completion of all planting operations under this CONTRACT.
2. At the time of the final walk-through, the Landscape SUBCONTRACTOR shall have planting areas free of debris, and leftover woody plant materials and trimmings. Plant basins shall be installed properly and in good repair. Debris and litter shall be cleaned up, and walkways, curbs, and roads shall be cleared of soil and debris. The inspection shall not occur until these conditions are met.
3. ENGINEER or PLANT ECOLOGIST will identify any deficiencies in the form of a punch list.
4. ENGINEER or PLANT ECOLOGIST will give WRITTEN NOTICE of final acceptance when WORK has been performed in compliance with the CONTRACT DOCUMENTS.
5. Deficiencies shall be corrected within the first ten (10) days of the final walk-through. Correct WORK in accordance with the CONTRACT DOCUMENTS at no cost to OWNER.
6. Final acceptance will not be given until all deficiencies are corrected. The Landscape SUBCONTRACTOR shall maintain the site until final acceptance.

END OF SECTION



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