Live Staking and Joint Planting

Live staking and joint planting involves the insertion of live, vegetative cuttings into the ground in a manner that allows the cutting (stake) to take root and grow. Willow stakes are a live "rebar" while willow poles are generally much longer and used more for structure reinforcement (see Pole Planting). Joint planting or face planting involves tamping live stakes of rootable plant material or rooted cuttings into soil in the interstices of porous revetments, riprap, or other retaining structures. **Refer to Manufacturer Directory - Bioengineering**.

Conditions Where Practice Applies

Live stake cuttings can be used to repair small earth slips and slumps. The stakes can help buttress the soil and arching. Gullies and bare gully banks can benefit from live staking. Live stakes or poles can be inserted or driven through interstices or openings in gabions, riprap, articulated block, or cellular confinement systems. Live stakes can be used to anchor and enhance the effectiveness of willow wattles, straw rolls, coir rolls, turf reinforcement mats, coir mats, continuous berms and other erosion control materials.

Poles, which are longer and of a larger diameter than stakes, are generally used for structure reinforcement on slopes and streambanks, in floodplains where they can reach the water table and vadose zone, or in conjunction with riprap, gabions, rock toe protection or other applications when a longer stake is required. Poles generally have a better chance of survival since the pole cutting is planted much deeper (see Pole Planting).

Joint or face planting is useful for adding a cover of vegetation to an otherwise inert bank surface such as rip rap. The purpose might be for habitat value or for erosion control value, or both. The insertion of long stem cuttings provides structural stabilization of the bank. Rooting adds further resistance to the soil below the inert cover, and if soil is present or added around the inert material, rooting will likely occur there, tying the material to the bank below.

The following chart shows recorded shear stress and velocities withstood by live staking.

Bank Material/Protection	**Shear**		**Velocity**			**Reference**
	lb/ft^2	N/m^2	ft/s	m/s		
Sandy Loam	0.0167		1.75	0.53	Design	Temple, 1980
Silt Loam	0.0218		2	0.61	Design	Temple, 1980
Alluvial silts	0.0218		2	0.61	Design	Temple, 1980
Ordinary firm loam	0.0341		2.5	0.76	Design	Temple, 1980
Very light loose sand, no vegetation or protection			1-1.5	.3-.46	Limit	Fortier & Scobey, 1926
Average sandy soil			2-2.5	.61-.76	Limit	Fortier & Scobey, 1926
Stiff clay, ordinary gravel soil			4-5	1.2-1.5	Limit	Fortier & Scobey, 1926
Live stakes in riprap (immediately after construction)	2.04	100			Limit	Schiechtl & Stern, 1994
Live stakes in riprap (after 3-4 seasons)	6.12	300			Limit	Schiechtl & Stern, 1994
Coarse gravel and stone cover with live cuttings (immediately after construction)	1.02	50			Limit	Schiechtl & Stern, 1994
Coarse gravel and stone cover with live cuttings (after 3-4 seasons)	5.1	250			Limit	Schiechtl & Stern, 1994
Willow posts			3.1	0.94	Limit	Schiechtl & Stern, 1994

Willow cuttings / willow stakes	2.1	103	9.8	3	Limit	Gerstgrasser, 1999

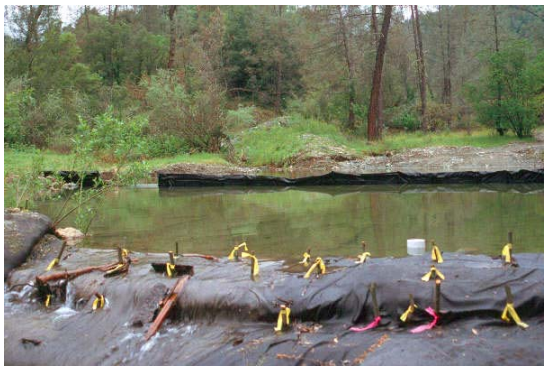
Materials

Live willow cuttings make the best material for live stakes. Willow or cottonwood make excellent poles. Joint planting may require using longer cuttings (poles).

Advantages

Using a system of live stakes or poles can creates a root mat that stabilizes the soil by reinforcing and binding soil particles together. Stake establishment can improve esthetics and provide wildlife habitat. As a temporary measure, live staking performs an important function of stabilizing and modifying the soil, serving as a pioneer species until other plants become established. Stakes can play an important geotechnical function of buttressing and arching.

Joint planting is useful where rock riprap, log cribwalls, rock deflectors, cellular confinement systems, gabions, or other structural practices are required. Eventually, a living root mat grows in the soil upon which the rock or structure has been placed, greatly reducing pull out. The root mat helps to bind the soil and to prevent sediment loss between and below the rocks and the rooted vegetation helps anchor the structure to the slope.



Disadvantages

Live staking and joint planting must be implemented during the dormancy period of chosen plant species, late fall to early spring. If native willows or cottonwood are not

found in the vicinity, live staking may not be a good option. Planting willows, in some cases, can adversely interact with other natural forces, such as water hydraulics. Willows can sometimes deflect currents adversely. Stream banks and steep slopes are highly susceptible to erosion and damage from significant storm events. Live stakes alone provide very little initial site protection during the establishment period. With joint planting, it is sometimes difficult to plant between in-place structural elements and filter fabric. Stakes should be in contact with native ground below structures for best results.

Implementation

Stakes shall be harvested and planted when the willows, or other chosen species, are dormant. When harvesting cuttings, select healthy, live wood that is reasonably straight. Use live wood at least 2 years old. Avoid suckers of current years growth as they lack sufficient stored energy reserves to sprout consistently. The best wood is 2-5 years old with smooth bark that is not deeply furrowed. Trimming the terminal buds on the willow will redirect the plants energy to root growth. Leave the terminal buds on the cottonwood.

Several species of willow will grow from cuttings in less favorable soil conditions such as road fills and gullies in bare denuded land. Even in very unfavorable sites willow cuttings will often grow vigorously for a few years before they die out. Willows have several different growth forms, from shrubs to large trees. Small to medium sized shrub-type and rhizomatous or creeping-type willows are used for planting channel banks. Upland willow species are found in relatively dry areas and should be used on similar sites. Tree-type willows are selected for the upper bank and flood plain area.

Make clean cuts without splitting ends. Trim branches from cutting as closely as possible. The butt end of the cutting shall be pointed or angled and the top end shall be cut square to help identify the top and bottom when planting . The top, square cut, can be painted and sealed by dipping the top 25 -51 mm (1-2 inches) into a 50-50 mix of light colored latex paint and water. Sealing the top of stake will reduce the possibility of desiccation, assure the stakes are planted with the top up, and makes the stakes more visible for subsequent planting evaluations.

Cuttings should generally be 19 mm (¾ inch) in diameter or larger depending on the species. Cuttings of small diameter (up to 40 mm (1 ½ inches)) shall be 0.5 m (18 inches) long minimum. Poles should be 35-90 mm (1.5-3.5 inches) diameter and 2-3 m long. The actual length of cuttings depends on the application but the cutting should be long enough to reach into moist soils in mid-summer or the capillary fringe.

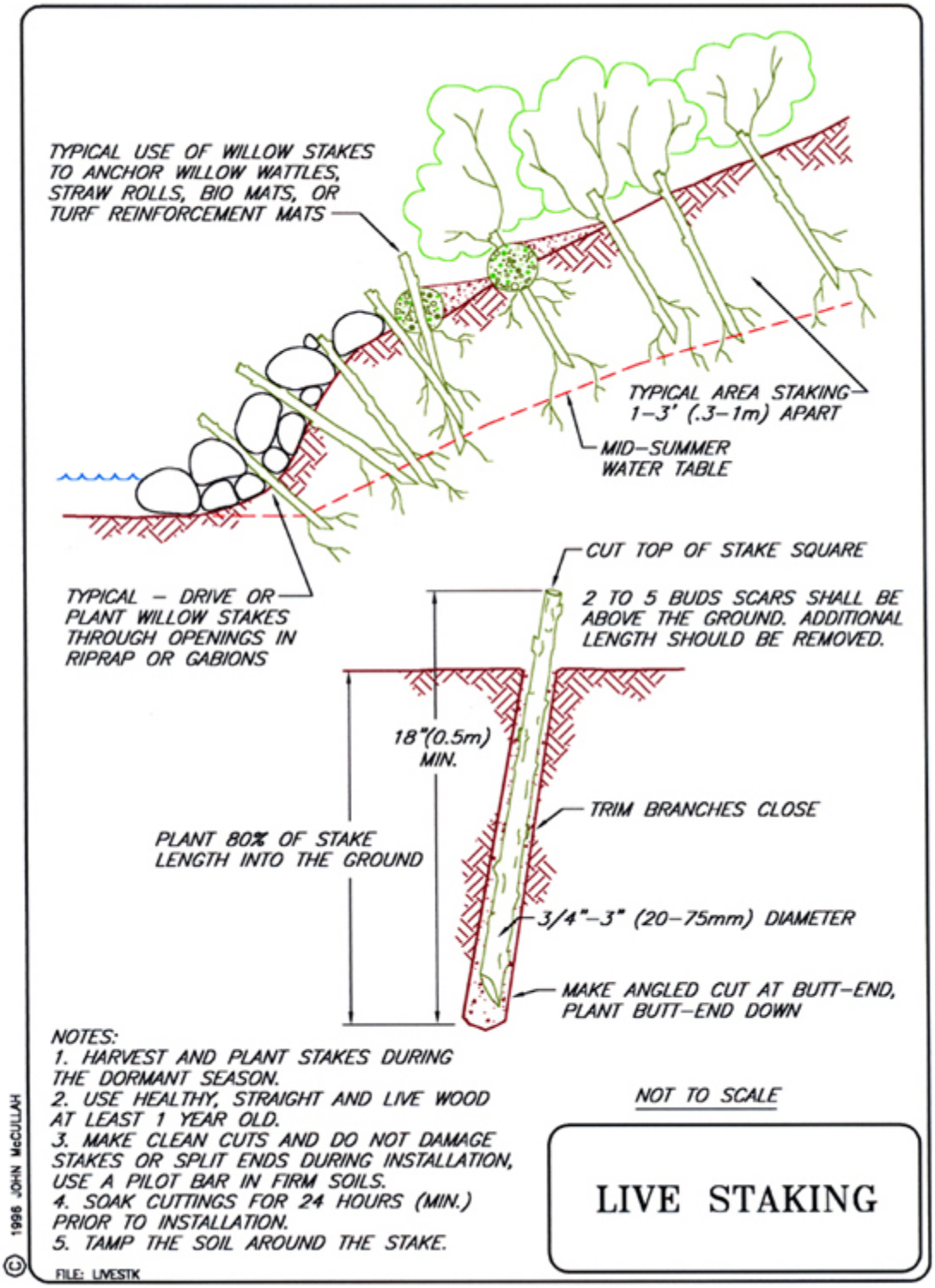
Stakes must not be allowed to dry out. All cuttings should be soaked in water for 5-7 days (a minimum of 24 hours). Soaking significantly increases the survival rate of the cuttings, however they must be planted the same day they are removed from water. Use a iron stake or bar to make a pilot hole in firm soil. Plant the stakes butt-ends into the ground, with the leaf bud scars or emerging buds always pointing up. Be careful not to damage the buds, strip the bark or split the stake during installation. The stakes should

not be planted in rows or at regular intervals, but at random in the most suitable places at a rate of 2-5 cuttings/m^2.

Set the stake as deep as possible into the soil, preferably with 80 percent of its length into the soil and in contact with mid-summer moist soils. The stake should protrude only to a maximum of one-quarter its length above the ground level to prevent it from drying. Stakes should be cut so that cutting extends above competing herbaceous vegetation. At least 2 buds and/or bud scars shall be above the ground after planting. It is essential to have good contact between the stake and soil for roots to sprout. Tamp the soil around the cutting.

The pole plantings shown in the photos above were not planted deeply enough. In the photo on right, notice that only about 20% of the cutting was in the ground. Ideally, about 80% of cuttings should be in the soil.

With joint planting, live stakes are typically installed after the inert cover material is in place. Often a pry bar will have to be used to establish a hole for the stake. Drive or plant willow stakes through openings in riprap, gabions, or other structures.



Typical drawing of Live Staking and Joint Planting

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Costs

The installed cost of Live Stakes typically ranges from $1 - $2 per stake, depending on local labor rates, proximity of harvesting area to site, and other site variables.

References

Fortier & Scobey 1926. Permissible Canal Velocities, *ASCE Transactions*, Vol 89, Paper No. 1588, pp 940-984

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