

SECTION 150-199 ENGINEERING



Section 160 - Quality Control & Quantity Measurement

DESCRIPTION

160.01
Work

This work shall consist of providing quality control in conformance with the Inspection of Construction provisions of this contract to ensure compliance with the drawings, specifications, and provisions of the contract, and measuring the quantities of completed work in conformance with the provisions of the applicable specification. The contractor shall provide all personnel, equipment, tests, and reports necessary to meet the requirements of this specification.

CONSTRUCTION

160.02
Quality Control
& Quantity
Measurement
System

The contractor shall provide and maintain a quality control system that will ensure that all services, supplies, and construction required under this contract conform to the contract requirements. The contractor shall perform, or cause to be performed, the sampling, inspection, and testing required to substantiate that all supplies, services, and construction conform to the contract requirements.

The contractor shall also perform, or cause to be performed, all measurement of quantities of materials incorporated into the work or work processes that are to be measured under the provisions of the contract.

(a) Quality Control Plan. The contractor shall submit in writing the following:

(1) Authorities and responsibilities of inspection and testing personnel.

(2) Experience and qualifications of inspection and testing personnel to be assigned and name and location of any (for hire) testing facility to be used.

(b) Approval of Quality Control Plan. The contractor's proposed quality control plan for all items requiring quality control shall be submitted to the Engineer for review prior to the contractor commencing work. Within 5 days of receipt of plan, the Engineer shall notify the contractor whether the plan adequately covers quality control requirements. Construction work shall not be performed prior to contractor's receipt of written approval of the proposed plan. The contractor shall submit to the Engineer, in writing, any proposed changes in the approved quality control plan. Proposed changes shall not be put into effect until approved in writing by the Engineer.

160.03
Sampling,
Testing,
Inspection, &
Measurement of
Quantities

The contractor shall provide and maintain appropriate measuring and testing devices, equipment, and supplies to accomplish the required measurement, testing, and inspection in a timely manner. Tests, measurements, and certifications shall be made as required by the drawings and specifications. The contractor shall take samples and perform inspections and tests necessary to achieve the quality of construction required by the contract and make required measurements of work under this contract performed onsite or offsite. Sampling and testing frequency for specific items shall be SHOWN ON THE DRAWINGS or in a SPECIAL PROJECT SPECIFICATION.

160.04
Records of
Inspection, Tests,
& Measurement

(a) Inspection and Tests. The contractor shall maintain current records of all inspections and tests performed. The following format or one containing the following information will be acceptable to the Government:

Section 170 - Construction Staking, Transit L-Line

DESCRIPTION

170.01
Work

This work shall consist of the construction staking of a road project by the Transit L-line method in accordance with the drawings and specifications. The work includes furnishing all labor, equipment, instruments, materials, transportation, and other incidentals necessary to complete the construction staking in accordance with these specifications and acceptable engineering practice. The work shall also include setting grade-finishing stakes and staking major structures when required.

Construction staking shall be accomplished under the direction of a registered professional engineer or land surveyor. The professional engineer or land surveyor will be closely associated and familiar with the construction staking; periodic visits to the project site are required.

MATERIALS

170.02
Stakes

All stakes shall have the nominal dimensions SHOWN ON THE DRAWINGS or stated in the SPECIAL PROJECT SPECIFICATIONS. Identification stakes and hubs shall be of sufficient length to provide a solid set in the ground and to provide space for marking above ground when applicable. Other dimensions and materials may be used, such as steel reinforcing bars, wire flagging and markers, and metal pins, if approved in writing by the Engineer. The top 2 inches of all slope, guard, reference, clearing, and structure stakes shall be painted or marked with plastic flagging. Colors used on stakes or for flagging shall be as SHOWN ON THE DRAWINGS or stated in SPECIAL PROJECT SPECIFICATIONS.

170.03
Survey Note
Paper & Books

Paper for survey notes shall be moisture-resistant paper. Notes shall be contained in books with covers that will protect the contents and retain the pages in numerical sequence during field use. Field notebooks or note paper shall be furnished by the contractor.

170.04
Government
Furnished Documents

The contractor will be furnished drawings, P-line survey notes, P-line to L-line offset data, construction staking notes, and the projected locations of catch points. One set of "as staked" drawings and all documents shall be returned to the Engineer.

SURVEY REQUIREMENTS

170.05
Precision

Precision and accuracy requirements are contained in tables 170-1 and 170-2. All work performed under this specification shall meet the precision requirements DESIGNATED in the SCHEDULE OF ITEMS or stated in the SPECIAL PROJECT SPECIFICATIONS.

170.06
Survey Notes

All notes shall become the property of the Forest Service. Slope stakes note format shall conform to that shown in figure 170-2. Other formats may be used if approved by the Engineer.

Manually recorded survey notes shall be printed in characters at least 0.15 inches high and shall be legible at a distance of 2.5 feet. Errors shall be deleted by lining out. Date, crew names and positions, instrumentation, and weather shall be recorded in the notes at the beginning of each day's work. The party chief shall sign or initial each page of the notes immediately after the last entry for each day's work.

Electronically recorded survey notes shall be consecutively numbered and headed to identify the contents. The notes shall be supported and accompanied by a bound Day Book that records the project name and for each day identifies date, crew names and positions, instrumentation, weather, type of survey, stationing of sections between which survey was performed, and survey data or

sketches that cannot be electronically recorded. The party chief shall sign or initial the electronically recorded notes and Day Book immediately after the last entry for each day's work.

170.07
Preliminary
Survey Line

A preliminary survey line has been established on the ground for this project with initial and specific succeeding survey points referenced. The contractor shall reestablish missing P-line points necessary to control subsequent construction staking operations to the precision designated in the SCHEDULE OF ITEMS, SHOWN ON THE DRAWINGS, or stated in the SPECIAL PROJECT SPECIFICATIONS.

170.08
Establishing
Centerline

The contractor shall determine the direction of centerline (L-line) tangents by coordinate ties furnished by the Forest Service. At least two points shall be located on each tangent to establish the direction of each tangent. The location of tangent lines established on the ground shall not be changed.

The deflection angle from one tangent to another shall be measured. When the measured deflection angle differs from the one SHOWN ON THE DRAWINGS, the measured angle and the curve external (E) SHOWN ON THE DRAWINGS shall be used to compute new curve data. The new curve data shall be computed and noted in the field books, and on the "as staked" drawings. The new control points (P.I., or P.C.'s & P.T.'s) shall be established on the ground using hubs and tacks.

Stationing of centerline points shall be established by horizontal distance measurements and staked to the nearest 0.01 foot for control points and 0.1 foot for other points continuously throughout the project. Equations shall be introduced at the P.T. of curves to adjust field stationing to that SHOWN ON THE DRAWINGS when the difference between designed and located centerline stationing exceeds 5 feet. Centerline stakes shall be set at even 100-foot and 50-foot stations when practicable, at significant breaks in the ground, at culvert locations, at station equation points, or other stations indicated in the staking notes. Stakes shall not be more than 50 feet apart. Curves of 20 degrees or more shall be staked every 25 feet. All other curves shall be staked every 50 feet.

Where centerline stations fall in an existing trail, obstruction, or roadway, stakes shall be offset left or right from centerline (perpendicular to tangents and on the radial lines of curves) clear of the trail, obstruction, or roadway, and the offset distance marked on the side facing the centerline. The centerline point shall be a 20-penny or larger nail, flagged, and driven at least 1 inch below the road surface.

The survey line shall be cleared to facilitate travel and surveying. Clearing slash shall be removed from the travel or work area. All brush and trees shall be cut as near to the ground as possible.

170.09
Referencing
Centerline

The contractor shall reference centerline control points, which will be intervisible after clearing is completed to facilitate reestablishment of the centerline. References shall be measured to the precision of the centerline survey. References shall consist of two intersecting lines having an included angle of at least 30 degrees. The forward reference shall be placed a minimum of 25 feet outside the clearing limits as computed from the preliminary slope stake printout notes, and the rear hub or point on each line shall be not less than 30 feet beyond the forward hub or point. Reference points shall be marked with hubs and tacks.

170.10
Vertical Control
& "L" Profile
Levels

Bench marks established during the P-line survey that are within the clearing limits shall be relocated to points 20 feet or more outside the clearing limits. Elevation of relocated bench marks shall be determined by closed level circuits.

Bench marks shall be constructed to be permanent and to allow a level rod to stand vertically and squarely on the mark. Bench marks may be established by driving a 40-penny or larger nail into a notch cut in the base of a tree, by marking a point on a stable rock, or by other approved means. Spikes in trees shall be less than 12 inches above the ground. Location and descriptions of relocated bench marks shall be recorded in the level notes. At least two bench marks shall be set at each bridge and structural plate culvert site.

A closed level circuit shall be run over the L-line stations between bench marks to determine centerline ground elevations to the nearest 0.1 foot and to verify bench marks.

170.11
Discrepancies

The contractor shall compare the staked centerline horizontal and vertical alignment with the design data. Differences between previously recorded and observed elevations of bench marks shall be referred to the Engineer. Differences exceeding 1 degree in angle found between the horizontal alignment data SHOWN ON THE DRAWINGS and the alignment observed on the ground shall be referred to the Engineer. Differences in centerline profile elevations exceeding 1 foot at any two or more consecutive points shall be reported to the Engineer for evaluation and possible revision. Staking of these areas shall be deferred until these differences are resolved by the Engineer.

170.12
L Topography
Cross Sections

Cross sections shall be taken at right angles to tangents and normal to curves at every staked point on the "L" profile line. The contractor shall determine the elevations of significant breaks in topography, breaks in the designed roadway template, and cross-section reference points. Ground shots for these cross sections shall be recorded in terms of feet plus or minus from ground at centerline, and horizontal distances from centerline. Cross sections shall be measured and recorded to the nearest 0.1 foot in elevation and nearest foot in horizontal distance, and shall extend approximately 20 feet beyond the designed clearing and grubbing limit on cut sections and approximately 20 feet beyond the toe of fill on fill sections.

Cross sections shall be identified at each end of the cross section with lath marked to show centerline station and the horizontal and vertical distance to the centerline.

Cross-section data shall be returned to the Engineer for recomputation of earthwork quantities and slope stake "catchpoint" printouts.

Slope stakes established during the "L" topography cross section phase of the work may be subject to relocation to adjust earthwork quantities.

170.13
Slope Stakes,
Clearing Limits,
& Reference
Stakes

Slope catchpoints, clearing limits, and slope reference stakes shall be established on both sides of the centerline at each "L" station established. The position of these stakes shall be determined by methods that will produce on the ground the designed template shown in the slope stake survey notes to the precisions shown in table 170-2 and specified for this contract. The slope stake "catchpoint distance" shown in the printout may be used as a trial location to initiate slope staking.

The cut or fill and horizontal distance to centerline, to bottom of ditch, or to shoulder as DESIGNATED by the Engineer shall be recorded on the slope stakes and in the slope stake notes as shown on figure 170-2.

Clearing limits shall be set on both sides of the centerline at each established "L" station within the tolerance shown on table 170-2. The clearing limit shall be located on the ground to the dimensions SHOWN ON THE DRAWINGS and marked with lath, flagging, or other methods approved by the Engineer. The total horizontal

distance from the centerline to the clearing limit at each section shall be recorded to the nearest foot in the field book.

The contractor shall establish slope reference stakes at a minimum horizontal distance of 10 feet outside the clearing limits and record on the stakes the horizontal distance to centerline and the vertical distance to the construction grade. The offset from the slope stake catchpoint, and slope stake catchpoint information as shown in figure 170-2, shall also be recorded on the reference stake, and in the slope stake book.

The elevation and location of slope reference stakes shall be verified for accuracy by:

(a) For Precision A. A differential level run over the reference stakes between bench marks.

(b) For Precisions B & C. Differential leveling between slope reference stakes of adjacent sections.

Where the difference in reference stake elevation between that established by slope staking and that observed by differential leveling exceeds the allowed tolerance, the slope stake shall be reset.

170.14
Monuments of
Property
Boundaries or
Surveys of Other
Agencies

If property boundary or survey monuments, or survey markers of other agencies, are found within or adjacent to the construction limits, the contractor shall immediately notify the Engineer.

170.15
Staking Culverts

Slope stakes and slope reference stakes shall be set at all culvert locations. A culvert reference stake and hub shall be set on the centerline of the culvert 10 feet from each end or beyond the clearing limit, whichever is greater. The following shall be recorded on these stakes:

(a) Diameter, actual field measured length, and type of culvert.

(b) The vertical and horizontal distance from hubs to the invert at the ends of the culvert.

When SHOWN ON THE DRAWINGS, headwalls for culverts shall be staked by setting a hub with a guard stake on each side of the culvert on line with the face of the headwall. (This work shall be performed after clearing is completed.)

170.16
Staking Drain Dips

Slope stakes and slope reference stakes shall be established on the projected centerline of the bottom of the dip at all drain dip locations as SHOWN ON THE DRAWINGS.

170.17
Staking Major
Structures

(a) Bridges. Bridge locations shall be designated on the ground by establishing reference points for the bridge centerline and the transverse centerline of one pier or abutment. Reference points shall be hubs and tacks set online beyond the construction limits and marked to identify the point and distance to the point referenced. At least one bench mark shall be set on each side of the stream beyond construction limits but close enough to the bridge site to allow direct leveling between the bench marks and the bridge without an intermediate setup. All of the above information shall be recorded in a separate book that includes a sketch showing the stream, bridge, and location of all construction stakes set. Staking shall be done to the accuracy standards shown in table 170-1.

(b) Cattleguards. Cattleguards shall be staked as SHOWN ON THE DRAWINGS.

(c) Other Structures. When required, other structures shall be staked as described in SPECIAL PROJECT SPECIFICATIONS and/or as SHOWN ON THE DRAWINGS.

170.18
Grade Finishing
Stakes

Finishing stakes shall be set when shown in the SCHEDULE OF ITEMS. Subgrade finishing stakes shall be blue tops. Base course finishing stakes shall be red tops.

Stakes shall be nominal 1-inch by 1-inch hubs and shall be of sufficient length to provide a solid set.

Finishing stakes shall be placed on the staked cross section and road template line. A stake shall be set at each shoulder and at centerline. Additional stakes shall be set when SHOWN ON THE DRAWINGS.

Finishing stakes shall be set when subgrade is within 0.5 feet, or base course is within 0.2 feet of final grade. The stakes shall be set to the nearest 0.02 feet of the measured grade line.

170.19
Marking Stakes

All stakes shall be legibly marked in the format shown in figure 170-1 with a stake pencil that leaves an imprint or with waterproof ink. Marking shall conform to the nomenclature below:

PI	Point of intersection of tangents
PC	Point of curvature
POC	Point on curve
PT	Point of tangency
POT	Point on tangent
RP	Reference point
P	P-line (preliminary location line)
L	L-line (final location line)
BM	Bench mark
TBM	Temporary bench mark
BT	Begin taper (any)
ET	End taper (any)
BFTO	Begin full turnout
EFTO	End full turnout
BFEW	Begin full extra widening
EFEW	End full extra widening
DD	Drain dip
C	Cut
F	Fill
CL	Centerline
D	Ditch
W	Width

170.20
Stake Approval
& Maintenance

Construction work shall not begin within a roadway segment until the stakes, marks, and controls established by the contractor have been approved in writing by the Engineer. The minimum segment for approval shall be 2,000 feet or the length of the project, whichever is less.

Approval of the construction staking will not relieve the contractor of the responsibility for maintaining the survey work and for correcting errors, whether the errors are discovered during the actual survey work or in subsequent phases of the project. Stakes within the roadway need not be maintained after clearing operations have started.

MEASUREMENT

170.21
Method

The method of measurement, described in Section 106, will be DESIGNATED in the SCHEDULE OF ITEMS.

Reestablishing P-line includes all work needed to replace missing portions of the P-line that are necessary for the determination of L-line tangents. When listed in the SCHEDULE OF ITEMS, the quantity shall be the number of stations, measured to the nearest 0.1 station, of P-line reestablished. When the length of P-line

to be replaced does not exceed 10 percent of the measured length of the L-line, reestablishing P-line will be considered incidental to establishing centerline, and no separate payment will be made.

Establishing centerline includes all work necessary to establish and reference the centerline, establish vertical controls, determine the centerline profile elevations, and cross-section the original ground from the centerline datum established by this survey. The quantity shall be the number of miles measured to the nearest 0.01 mile of centerline completed and accepted.

Slope staking includes all work necessary to establish slope stakes, clearing limits, and reference stakes from a previously established centerline. The quantity shall be the number of miles, measured to the nearest 0.01 mile, of previously established centerline completed and accepted.

Finish staking includes all work necessary to reestablish the centerline to control placement of finish stakes and set the finish stakes. The quantity shall be the number of miles, measured to the nearest 0.01 mile, of previously established centerline completed and accepted.

Staking major structures includes all work necessary to establish lines and grades for the construction of the structure(s). The quantity shall be the actual number of structures of the type shown in the SCHEDULE OF ITEMS completed and accepted.

PAYMENT

170.22
Basis

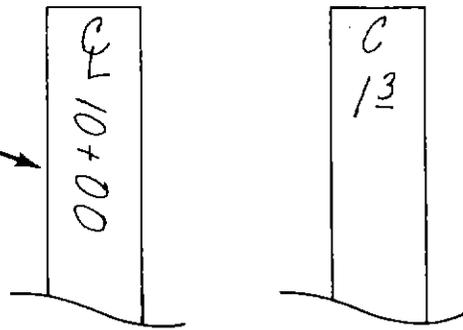
The accepted quantities will be paid for at the contract unit price for each pay item shown in the SCHEDULE OF ITEMS.

Payment will be made under:

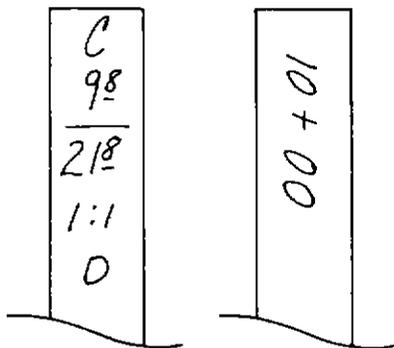
<u>Pay Item</u>	<u>Pay Unit</u>
170(01) Reestablish P-line, Precision _____	STA.
170(02) Establish Centerline, Precision _____	MI.
170(03) Slope Staking, Precision _____	MI.
170(04) Finish Staking, Subgrade, Precision _____	MI.
170(05) Finish Staking, Base Course, Precision _____	MI.
170(06) Staking Major Structure(s), Type _____, Precision _____	EA.

CENTERLINE

Face toward beginning station of project

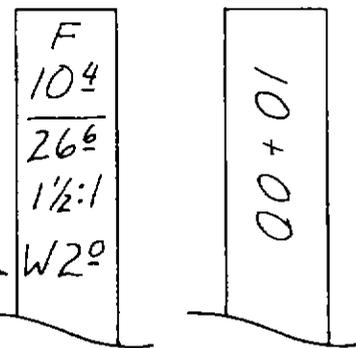


CUT SLOPE STAKE



Face toward centerline

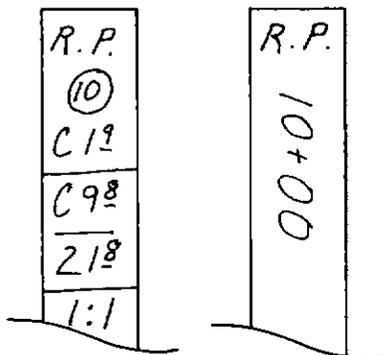
FILL SLOPE STAKE



Face toward centerline

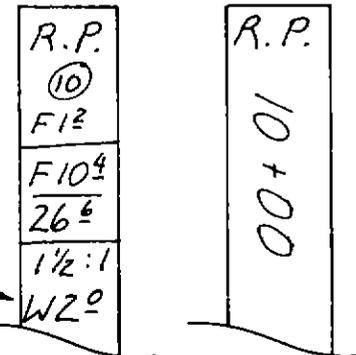
Note any change to basic road template; curve widening, fill widening, superelevation.

REFERENCE STAKE



Face toward centerline

REFERENCE STAKE



Face toward centerline

Note any change to basic road template; curve widening, fill widening, superelevation.

Figure 170-1.--Construction stakes.

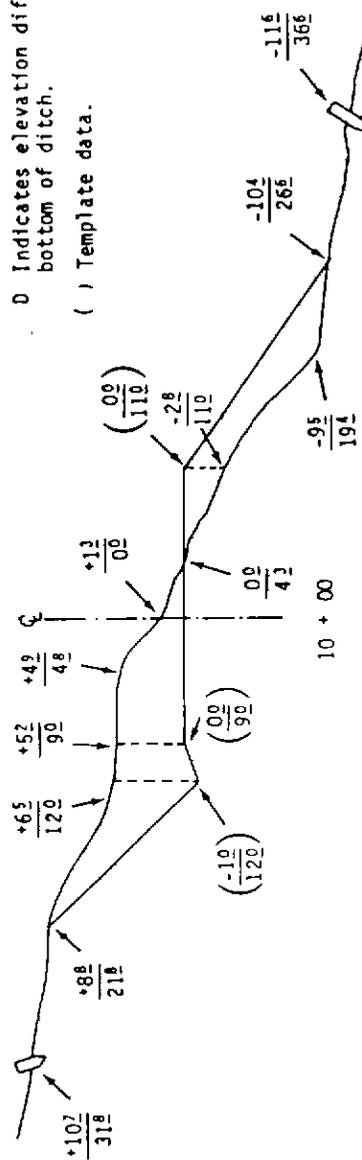
STA.	ELEV. ζ GRADE	ELEV. ζ GRND.	DIST. ζ TO SHOULDER		WIDENING		DITCH PT.		SUPER ELEV.
			LT.	RT.	LT.	RT.	LT.	RT.	
10+00	3213.3	3214.6	9	9	-	2	12	-	-
									18 ^B +6 ^E +5 ^Z +4 ^S +1 ^O 0 ^O -2 ^B -9 ^S -10 ^I
									21 ^S 12 ^O 9 ^O 4 ^S 0 4 ^S 11 ^O 19 ^I 26 ^E
									**
									10 +10 ^I
									C
									10 ^O 31 ^B
									31 ^B
									1/2:1
									1:1
									D
10+50			9	9	-	2	12	-	-

* Data written on slope stake.

** Data written on reference stake.

D Indicates elevation difference to bottom of ditch.

() Template data.



ζ GRADE ELEV. 3213.3 ζ GROUND ELEV. 3214.6

Figure 170-2.--Slope-stake note entries related to actual ground elevations.

Table 170-1.--Accuracy requirements for reestablishing P-line, traverse, and level circuits.

Precision Class	Minimum Position Closure	Angular Accuracy	L-Line Tangent Control Points ^a	Vertical Closure ^b
A (Bridges)	1/10,000	2 sets, direct/reverse 10" rejection limit	N/A	0.035 \sqrt{M} or 0.002/sta. ^c
B	1/5000	2 sets, direct/reverse 20" rejection limit	0.1'	0.05 \sqrt{M} or 0.02 ft/sta. ^c
C	1/1000	1 set, direct/reverse 1' rejection limit	0.2'	0.10 \sqrt{M} or 0.05 ft/sta. ^c

^aAccuracy of offset measurement.

^bM is number of miles in traverse.

^cUse least value.

Table 170-2.--Cross section and slope-stake precision.

Item	Precision		
	A	B	C
Allowable deviation of cross section line projection from a true perpendicular to tangents, a true bisector of angle points, or a true radius of curves.	± 2°	± 3°	± 3°
Cross section topography measurements shall be taken so that variations in ground from a straight line connecting the cross section points will not exceed:	0.5 ft	1.0 ft	2.0 ft
Horizontal and vertical accuracy for cross sections. In feet or percentage of horizontal distance measured from traverse line, whichever is greater.	0.1 ft or 0.4%	0.15 ft or 0.6%	0.2 ft or 1.0%
Horizontal and vertical accuracy for slope stake, slope stake references, and clearing limits. In feet or percentage of horizontal distance measured from centerline or reference stake, whichever is greater.	0.1 ft or 0.4%	0.15 ft or 0.6%	0.2 ft or 1.0%
a. Slope reference stakes and slope stakes.	0.4%	0.6%	1.0%
b. Clearing limits.	1.0 ft	1.0 ft	1.0 ft

Section 171 - Construction Staking, Offset L-Line

DESCRIPTION

171.01
Work

This work shall consist of the construction staking of a road project in accordance with the drawings and specifications. The work includes furnishing all labor, equipment, instruments, materials and transportation, and other incidentals necessary to complete the construction staking in accordance with these specifications and acceptable engineering practice.

MATERIALS

171.02
Stakes

All stakes and hubs shall have the nominal dimensions SHOWN ON THE DRAWINGS or stated in the SPECIAL PROJECT SPECIFICATIONS. Identification stakes and hubs shall be of sufficient length to provide a solid set in the ground and to provide space for marking above ground when applicable. Other dimensions and materials may be used if approved in writing by the Engineer. The top 2 inches of all stakes and lath shall be painted or shall be marked with plastic flagging. Colors used for paint or flagging shall be SHOWN ON THE DRAWINGS or as stated in the SPECIAL PROJECT SPECIFICATIONS.

171.03
Survey Note Paper
& Books

Paper for survey notes shall be moisture resistant paper. Notes shall be contained in books with covers that will protect the contents and retain the pages in numerical sequence during field use. Field notebooks or note paper shall be furnished by the contractor.

171.04
Government
Furnished Documents

The contractor will be furnished drawings, P-line survey notes, P-line to L-line offset data, construction staking notes, and the projected location of catch points. One set of "as staked" drawings and all documents shall be returned to the Engineer.

SURVEY REQUIREMENTS

171.05
Precision

Precision and accuracy requirements are contained in tables 171-1 and 171-2. All work performed under this specification shall meet the requirements of the precision DESIGNATED in the SCHEDULE OF ITEMS or stated in the SPECIAL PROJECT SPECIFICATION.

171.06
Survey Notes

All notes shall become the property of the Forest Service. Slope stake note format shall conform to that shown in figure 171-2. Other formats may be used if approved by the Engineer.

Manually recorded survey notes shall be printed in characters at least 0.15 inches high and shall be legible at a distance of 2.5 feet. Errors shall be deleted by lining out. Date, crew names and positions, instrumentation, and weather shall be recorded in the notes at the beginning of each day's work.

Electronically recorded survey notes shall be consecutively numbered and headed to identify the contents. The notes shall be supported and accompanied by a bound Day Book that records the project name and for each day identifies date, crew names and positions, instrumentation, weather, type of survey, stationing of sections between which survey was performed, and survey data or sketches that cannot be electronically recorded. The party chief shall sign or initial the Day Book immediately after the last entry for each day's work.

The party chief shall sign or initial each page of electronically recorded notes, and the final page of bound notes immediately after the last entry for each day's work.

171.07
Preliminary Survey
Line

A preliminary survey line has been established on the ground for this project with initial and specific succeeding survey points referenced. The contractor shall reestablish missing P-line points necessary to control subsequent construction staking operations to the precision designated in the SCHEDULE OF ITEMS, SHOWN ON THE DRAWINGS, or stated in the SPECIAL PROJECT SPECIFICATIONS.

171.08
Establishing
Centerline

The contractor shall establish the position of the centerline (L-line) by measuring right or left from the preliminary survey line (P-line) the horizontal distance shown in the "offset listing" furnished by the Forest Service. The centerline established shall be adjusted in alignment only to correct misalignment created by measured offsets along skewed sections. The station of the centerline point shall be that listed in the P-line to L-line offset data.

The contractor shall set additional intermediate centerline stakes, at locations SHOWN ON THE DRAWINGS and listed in the construction staking notes, as needed to establish control for beginning and ending of extra widening and turnout tapers, for the beginning and end of full width extra widening and turnouts, for crest and sag of drainage dips, for culvert catch basins, and for turnarounds. The position and the ground elevation of these additional stakes shall be established by measurement from the nearest established centerline stake.

Where centerline stations fall in an existing trail, roadway, or obstruction, stakes shall be offset right or left from centerline (perpendicular to tangents and on the bisector of angle points) and the distance marked on the side of the stake facing centerline. Suitable markers shall be driven on the centerline to denote the actual centerline point.

The survey line shall be cleared to facilitate surveying. Clearing slash shall be removed from the travel or work area. All brush and trees shall be cut as near to the ground as possible.

171.09
Vertical Control
& "L" Profile
Levels

Bench marks established during the P-line survey that are within the clearing limits shall be relocated to points 20 feet or more outside the clearing limits. Elevation of relocated bench marks shall be determined by closed level circuits.

Bench marks shall be constructed to be permanent and to allow a level rod to stand vertically and squarely on the mark. Bench marks may be established by driving a 40-penny or larger nail into a notch cut in the base of a tree, by marking a point on a stable rock, or by other approved means. Spikes in trees shall be less than 12 inches above the ground. Location and descriptions of relocated bench marks shall be recorded in the level notes.

For Precision B, a closed level loop shall be run over the centerline stations between bench marks to determine centerline ground elevations to the nearest 0.1 foot and to verify bench marks.

For Precision C and D, elevation of centerline stations shall be determined by differential leveling from the listed elevation of the P-line station from which they were offset.

171.10
Discrepancies

Differences exceeding 5 degrees of angle found in horizontal alignment of curves having less than 100 feet radius between the data SHOWN ON THE DRAWINGS and that observed on the ground shall be referred to the Engineer. The contractor shall compare the found centerline cut and fill depth with design data. Differences in centerline profile elevations exceeding 1 foot at any two or more consecutive points shall be reported to the Engineer for determination of need of revision. Staking of these areas shall be deferred until correction is determined.

171.11
Slope Stakes,
Clearing Limits,
& Reference
Points

Slope stakes, clearing limits, and slope stake references shall be established at each side centerline station, as SHOWN ON THE DRAWINGS, at each centerline station, on a line at right angles to tangents, and on the radial lines of curves. The method used to establish the slope stake catchpoint shall conform to the METHOD described below, as DESIGNATED in the SCHEDULE OF ITEMS.

(a) Method I - Computed Method. Slope stake catchpoints shall be located by using the template information shown in the slope stake notes to calculate the actual location of the catchpoint. The slope stake "catchpoint distance" shown in the stake notes may be used as a trial location to initiate slope staking.

Where SHOWN ON THE DRAWINGS, topography of the cross section shall be measured at each centerline station. The horizontal and vertical distance to the centerline ground shall be recorded for each break in ground slope between the centerline and the reference point(s).

(b) Method II - Catchpoint Measurement Method. Slope stake catchpoints shall be located by measuring the slope distance shown in the slope stake notes.

Slope stakes shall be temporarily set at the slope stake catchpoint location established under METHOD I or II above for use in determining clearing limits and slope stake references.

Clearing limits shall be located at the distance SHOWN ON THE DRAWINGS from either the slope stake catchpoint or road shoulder, whichever is greater. Clearing limits shall be marked with plastic flagging or tags on trees to be left standing or on lath.

A reference stake or tag shall be established for each slope stake, a minimum distance of 10 feet outside the clearing limits as SHOWN ON THE DRAWINGS.

After clearing limits and references are established, the slope stakes shall be moved to the reference stake and replaced at the catchpoint after clearing is completed.

171.12
Resetting Slope
Stakes

Slope stakes shall be reestablished after clearing and grubbing is completed and before excavation is started. The original catchpoint location shall be rechecked from the reference stake to determine if revisions are needed because of ground disturbance; slope stakes shall be rechecked and reset to the original precision requirements.

171.13
Monuments of
Property Boundaries
or Surveys of
Other Agencies

If property boundary or survey monuments or survey markers of other agencies are found within or adjacent to the construction limits, the contractor shall immediately notify the Engineer.

171.14
Staking Culverts

Slope stakes and slope stake references shall be set at all culvert locations. A culvert reference stake shall be set on the centerline of the culvert 10 feet from each end or beyond the clearing limit, whichever is greater. The following shall be recorded on these stakes:

(a) Diameter, actual field measured length, and type of culvert.

(b) The vertical and horizontal distance from the reference stake to the invert at the ends of the culvert.

171.15
Staking Drain Dips

Slope stakes and slope stake references shall be established on the projected centerline of the bottom of the dip at all drain dip locations as SHOWN ON THE DRAWINGS.

171.16
Staking Cattleguards

Cattleguards shall be staked as SHOWN ON THE DRAWINGS.

171.17
Marking Stakes

All stakes shall be legibly marked in the format shown in figure 171-1 with a stake pencil that leaves an imprint or with waterproof ink. Marking shall conform to the nomenclature below:

- RP Reference point
- P P-line (preliminary location line)
- L L-line (final location line)
- BM Bench mark
- TBM Temporary bench mark
- BT Begin taper (any)
- ET End taper (any)
- BEFTO Begin full turnout
- EFTO End full turnout
- BFEW Begin full extra widening
- EFEW End full extra widening
- DD Drain dip
- C Cut
- F Fill
- CL Centerline
- D Ditch
- W Width

171.18
Stake Approval & Maintenance

Construction work shall not begin within a roadway segment until the stakes, marks, and controls established by the contractor have been approved in writing by the Engineer. The minimum segment for approval shall be 2,000 feet or the length of the project, whichever is less.

Approval of construction staking will not relieve the contractor of the responsibility for maintaining the survey work until construction has been completed nor for correcting errors, whether the errors are discovered during the performance of survey or in subsequent phases of the project. Centerline stakes need not be maintained after clearing operations have started.

MEASUREMENT

171.19
Method

The methods of measurement, described in Section 106, will be DESIGNATED in the SCHEDULE OF ITEMS.

Reestablishing P-line includes all work needed to replace missing portions of the P-line that are necessary for the determination of L-line tangents. When listed in the SCHEDULE OF ITEMS the quantity shall be the number of stations, measured to the nearest 0.1 station, of P-line reestablished. When the length of P-line to be replaced does not exceed 10 percent of the length of the P-line, reestablishing P-line will be considered incidental to construction staking and no separate payment will be made.

Construction staking includes all work necessary to establish the project centerline and to establish slope stakes, clearing limits, and reference stakes in accordance with the METHOD DESIGNATED in the SCHEDULE OF ITEMS. The quantity shall be the number of miles, measured to the nearest 0.01 mile, of construction staking completed and accepted.

PAYMENT

171.20
Basis

The accepted quantities will be paid for at the contract unit price for each pay item shown in the SCHEDULE OF ITEMS.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
171(01) Reestablish "P-Line", Precision _____	STA.
171(02) Construction Staking, Precision _____, Method _____	MI.

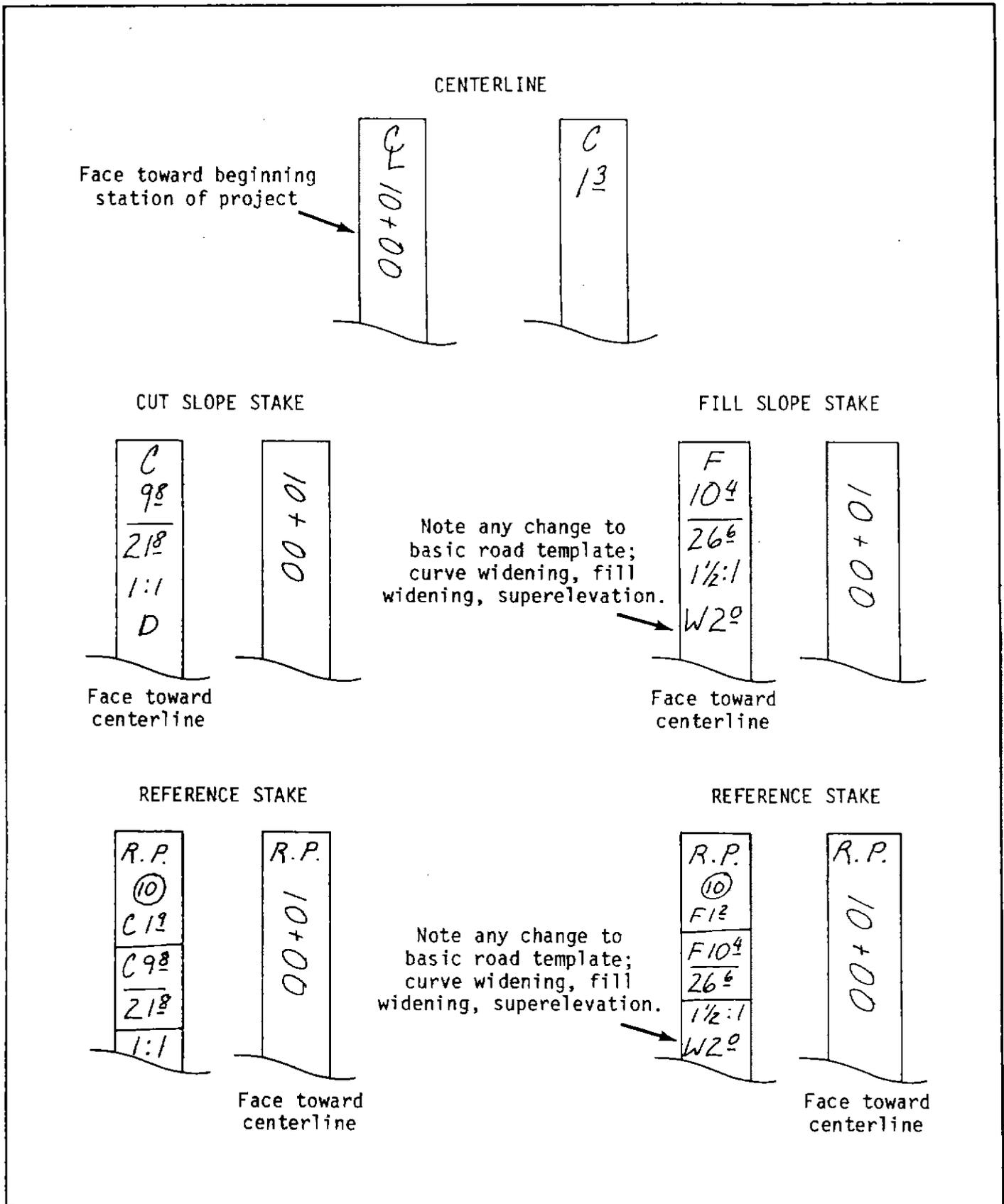
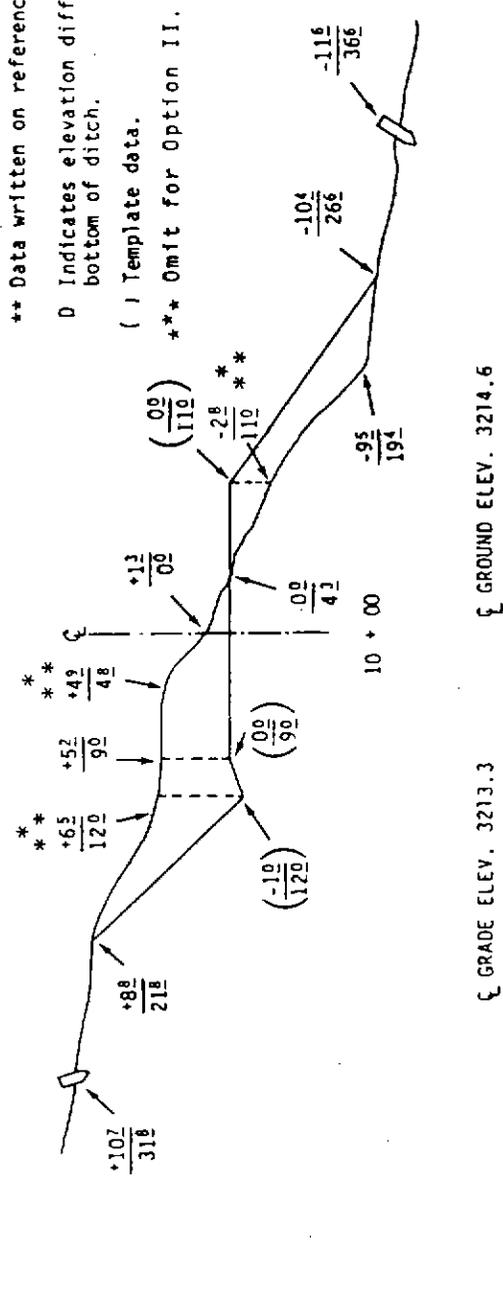


Figure 171-1.--Construction stakes.

STA.	ELEV. ζ GRADE	ELEV. ζ GRND.	DIST. ζ TO SHOULDER		WIDENING		DITCH PT.		SUPER ELEV.	***		***						
			LT.	RT.	LT.	RT.	LT.	RT.		***	***	***	***					
10+00	3213.3	3214.6	9	9	-	2	12	-	-	+8 ⁸	+6 ⁵	+5 ²	+4 ⁹	0 ⁰	-2 ⁸	-9 ⁵	-10 ¹	
										21 ⁸	12 ⁰	9 ⁰	4 ³	0	4 ³	11 ⁰	19 ¹	26 ⁶
										**	**	**	*	*	*	*	**	**
										10	+10 ⁷			C	F10 ⁴	-11 ⁶	10	
										C10 ⁷	31 ⁸			9 ⁸	26 ⁶	36 ⁶	F11 ⁶	
										31 ⁸				21 ⁸	1/2:1		36 ⁶	
										C9 ⁸				1:1	WZ		F10 ⁴	
										21 ⁸				D			26 ⁶	
										1:1							1/2:1	
										D							WZ	
10+50			9	9	-	2	12	-	-									

* Data written on slope stake.
 ** Data written on reference stake.
 D Indicates elevation difference to bottom of ditch.
 () Template data.
 *** Omit for Option II.



ζ GRADE ELEV. 3213.3 ζ GROUND ELEV. 3214.6

Figure 171-2.--Slope-stake note entries related to actual ground elevations.

Table 171-1.--Accuracy requirements for reestablishing P-line, traverse, and level circuits.

Precision Class	Minimum Position Closure	Angular Accuracy	L-Line Tangent Control Points ^a	Vertical Closure ^b
C	1/1000	1 set, direct/reverse 1' rejection limit	0.2'	$0.10\sqrt{M}$ or 0.05 ft/sta. ^d
D	1/300	Foresight & Backsight 1/4° rejection limit ^c	0.4'	$0.20\sqrt{M}$ or 0.10/sta. ^d
E	1/100	Foresight & Backsight 1/2° rejection limit ^c	0.8'	0.10/sta.

^aAccuracy of offset measurement.

^bM is number of miles in traverse.

^cMagnetic attraction will require a deflection angle traverse.

^dUse least value.

Table 171-2.--Cross section and slope-stake precision.

Item	Precision		
	C	D	E
Allowable deviation of cross section line projection from a true perpendicular to tangents, a true bisector of angle points, or a true radius of curves.	± 3°	± 5°	± 5°
Cross section topography measurements shall be taken so that variations in ground from a straight line connecting the cross section points will not exceed:	1.0 ft	1.5 ft	2.5 ft
Staking by Computed Method			
Horizontal and vertical accuracy for cross sections. In feet, or percentage of horizontal distance measured from traverse line, whichever is greater.	0.15 ft or 0.6%	0.2 ft or 0.8%	0.3 ft or 1.0%
Horizontal and vertical accuracy for slope stake, slope stake references, and clearing limits. In feet, or percentage of horizontal distance measured from centerline or reference stake, whichever is greater.			
a. Slope reference stakes and slope stakes.	0.15 ft or 0.6%	0.2 ft or 0.8%	0.25 ft or 1.5%
b. Clearing limits.	1.0 ft	1.5 ft	2.0 ft
Staking by Catchpoint Measurement Method			
Accuracy for setting slope catchpoints, reference points, and clearing limits. In feet or percentage of slope distance, measured from centerline, whichever is greater.			
a. Slope catchpoint stakes and reference points.	0.15 ft or 0.5%	0.2 ft or 0.7%	0.3 ft or 2.0%
b. Clearing limits.	1.0 ft	1.5 ft	2.0 ft

Section 172 - Construction Staking, Offset L-Line

DESCRIPTION

172.01
Work

This work shall consist of the construction staking of a road project in accordance with the drawings and specifications. The work includes furnishing all labor, equipment, instruments, materials and transportation, and other incidentals necessary to complete the construction staking in accordance with these specifications and acceptable engineering practice.

MATERIALS

172.02
Stakes

All stakes shall have the nominal dimensions SHOWN ON THE DRAWINGS or stated in the SPECIAL PROJECT SPECIFICATIONS. Identification stakes and hubs shall be of sufficient length to provide a solid set in the ground and to provide space for marking above ground when applicable. Other dimensions and materials may be used if approved in writing by the Engineer. The top 2 inches of all stakes and lath shall be painted or shall be marked with plastic flagging. Colors used for paint and flagging shall be as SHOWN ON THE DRAWINGS or as stated in the SPECIAL PROJECT SPECIFICATIONS.

172.03
Survey Note
Paper & Books

Paper for survey notes shall be moisture-resistant paper. Notes shall be contained in books with covers that will protect the contents and retain the pages in numerical sequence during field use. Field notebooks or note paper shall be furnished by the contractor.

172.04
Government-Furnished
Documents

The contractor will be furnished drawings, P-line survey notes, and construction staking notes. All documents shall be returned to the Engineer.

SURVEY REQUIREMENTS

172.05
Precision

Precision and accuracy requirements are contained in tables 172-1 and 172-2. All work performed under this specification shall meet the requirements of the survey precision DESIGNATED in the SCHEDULE OF ITEMS or stated in the SPECIAL PROJECT SPECIFICATIONS.

172.06
Survey Notes

All notes shall become the property of the Forest Service. Slope stake note format shall conform to that shown in figure 172-2. Other formats may be used if approved by the Engineer.

Manually recorded survey notes shall be printed in characters at least 0.15 inches high and shall be legible at a distance of 2.5 feet. Errors shall be deleted by lining out. Date, crew names and positions, instrumentation, and weather shall be recorded in the notes at the beginning of each day's work.

Electronically recorded survey notes shall be consecutively numbered and headed to identify the contents. The notes shall be supported and accompanied by a bound Day Book that records the project name and for each day identifies date, crew names and positions, instrumentation, weather, type of survey, stationing of sections between which survey was performed, and survey data or that cannot be electronically recorded. The party chief shall sign or initial the Day Book immediately after the last entry for each day's work.

The party chief shall sign or initial each page of electronically recorded notes, and the final page of bound notes immediately after the last entry for each day's work.

172.07
Preliminary
Survey Line

A preliminary survey line has been established on the ground for this project with initial and specific succeeding survey points referenced. The contractor shall reestablish missing P-line points necessary to control subsequent construction staking

operations to the precision designated in the SCHEDULE OF ITEMS, SHOWN ON THE DRAWINGS or stated in the SPECIAL PROJECT SPECIFICATIONS.

172.08
Establishing
Centerline

The contractor shall establish the position of the centerline (L-line) by measuring right or left from the preliminary survey line (P-line) the horizontal distance shown in the staking notes furnished by the Forest Service. The centerline established shall be adjusted in alignment only to correct misalignment created by measuring offsets along skewed sections. The station of the centerline point shall be that listed in the staking notes.

The contractor shall set additional intermediate centerline stakes at locations SHOWN ON THE DRAWINGS or listed in the construction staking notes as needed to establish control for beginning and end of extra widening and turnout tapers, for the beginning and end of full width extra widening and turnouts, for bottom of sag of drain dips, for culvert catch basins, and for turnarounds. The position and ground elevation of these additional stakes shall be established by measurement from the nearest established centerline stake.

Where centerline stations fall in an existing trail, roadway, or obstruction, stakes shall be offset left or right from centerline (perpendicular to tangents and on the radial lines or curves) clear of the intersecting roadway, trail, or obstruction, and the offset distance marked on the side facing the centerline. Suitable markers shall be driven on the centerline to denote the actual centerline point.

The survey line shall be cleared to facilitate surveying. Clearing slash shall be removed from the work area. Brush and trees shall be cut as near to the ground as possible.

172.09
Vertical Control

Elevation of centerline stations shall be determined by differential leveling from the listed elevation of the P-line station from which they were offset.

172.10
Discrepancies

Differences of 5 degrees of angle or larger found in horizontal alignment of curves having less than 100 feet radius, between the data SHOWN ON THE DRAWINGS and that observed on the ground, shall be referred to the Engineer. The contractor shall compare the found centerline cut and fill depth with design data. Differences found in centerline profile elevations exceeding 1.5 feet at any two or more consecutive points shall be reported to the Engineer for possible revision. Staking of these areas shall be deferred until correction is determined.

172.11
Slope Stakes,
Clearing Limits,
& References

Clearing limits shall be established on both sides of the centerline. Slope stakes and slope stake references shall be established at each centerline station, as SHOWN ON THE DRAWINGS, on lines approximately right angle to tangents, and on the radial lines of curves. The method used to establish the slope stake catchpoint shall conform to the METHOD described below, as DESIGNATED in the SCHEDULE OF ITEMS.

(a) Method I - Computed Method. Slope stake catchpoints shall be located by using the template information shown in the slope stake notes to calculate the actual location of the catchpoint. The "catchpoint distance" shown in the stake notes may be used as a trial location to initiate slope staking.

(b) Method II - Catchpoint Measurement Method. Slope stake catchpoints and clearing limits shall be located by measuring the "catchpoint" distance shown in the slope stake notes.

(c) Method III - Reestablishing Slope Stakes, Clearing Limits, and References. Slope stakes and marks previously established for this project have either been destroyed or have become

unreadable. The contractor shall reestablish the missing stakes and marks from the original slope-stake notes as described in the SPECIAL PROJECT SPECIFICATIONS.

Clearing limits shall be marked with colored plastic ribbon or tags on trees to be left standing or marked on lath.

A reference stake or tag for each slope stake shall be placed 10 feet outside the clearing limit. Slope stakes shall be removed to the reference stake prior to clearing and replaced after clearing is completed.

172.12
Monuments of
Property Boundaries
or Surveys of
Other Agencies

If property boundary or survey monuments or survey markers of other agencies are found within or adjacent to the construction limits, the contractor shall immediately notify the Engineer.

172.13
Staking Culverts

Slope stakes and slope reference stakes shall be set at all culvert locations. A culvert reference stake shall be set on the centerline of the culvert 10 feet from each end or beyond the clearing limit, whichever is greater. The following shall be recorded on these stakes:

- (a) Diameter, actual field measured length, and type of culvert.
- (b) The vertical and horizontal distance from the reference stake to the invert at the ends of the culvert.

172.14
Staking Drain Dips

Slope stakes and slope reference stakes shall be established on the projected centerline of the bottom of the dip at all drain dip locations SHOWN ON THE DRAWINGS.

172.15
Staking Cattleguards

Cattleguards shall be staked as SHOWN ON THE DRAWINGS.

172.16
Marking Stakes

All stakes shall be legibly marked in the format shown in figure 172-1 with a stake pencil that leaves an imprint or with waterproof ink. Marking shall conform to the nomenclature below:

P	P-line (preliminary location line)
L	L-line (final location line - centerline)
BM	Bench mark
TBM	Temporary bench mark
BT	Begin taper (any)
ET	End taper (any)
BFTO	Begin full turnout
EFTO	End full turnout
BFEW	Begin full extra widening
EFEW	End full extra widening
DD	Drain dip
C	Cut
F	Fill
℄	Centerline
D	Ditch
W	Width

172.17
Stake Approval
& Maintenance

Construction work shall not begin within a roadway segment until the stakes, marks, and controls established by the contractor have been approved in writing by the Engineer. The minimum segment for approval shall be 2,000 feet or the length of the project whichever is less.

Approval of the construction staking work will not relieve the contractor of the responsibility for maintaining the survey work until construction has been completed and for correcting errors, whether the errors are discovered during performance of the survey or in subsequent phases of the project. Centerline stakes need not be maintained after clearing operations have started.

MEASUREMENT

172.18 Method The methods of measurement, described in Section 106, will be DESIGNATED in the SCHEDULE OF ITEMS.

Reestablishing P-line includes all work needed to replace missing portions of the P-line that are necessary for the establishment of the L-line. When listed in the SCHEDULE OF ITEMS the quantity shall be the number of stations, measured to the nearest 0.1 station, of P-line reestablished. When the length of P-line to be replaced does not exceed 10 percent of the length of the P-line, reestablishing P-line will be considered incidental to construction staking and no separate payment will be made.

Construction staking includes all work necessary to establish the project centerline and to establish slope stakes, clearing limits, and slope stake references. The quantity shall be the number of miles, measured to the nearest 0.01 mile, of construction staking completed and accepted.

PAYMENT

172.19 Basis The accepted quantities will be paid for at the contract unit price for each pay item shown in the SCHEDULE OF ITEMS.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
172(01) Reestablish "P-Line", Precision _____ . . .	STA.
172(02) Construction Staking, Precision _____ Method _____	MI.

Table 172-1.--Accuracy requirements for reestablishing P-line, traverse, and level circuits.

Precision Class	Minimum Position	Angular Accuracy	L-Line Tangent Control Points ^a	Vertical Closure ^b
D	1/300	Foresight & Backsight 1/4° rejection limit ^c	0.4'	0.20√M or 0.10/sta. ^d
E	1/100	Foresight & Backsight 1/2° rejection limit ^c	0.8'	0.10/sta.

^aAccuracy of offset measurement.
^bM is number of miles in traverse.
^cMagnetic attraction will require a deflection angle traverse.
^dUse least value.

Table 172-2.--Cross section and slope-stake precision.

Item	Precision	
	D	E
Allowable deviation of cross section line projection from a true perpendicular to tangents, a true bisector of angle points, or a true radius of curves.	± 5°	± 5°
Cross section topography measurements shall be taken so that variations in ground from a straight line connecting the cross section points will not exceed:	1.5 ft	2.5 ft
Horizontal and vertical accuracy for cross sections. In feet, or percentage of horizontal distance measured from traverse line, whichever is greater.	0.2 ft or 0.8%	0.3 ft or 1.0%
Staking by Computed Method		
Horizontal and vertical accuracy for slope stake, slope stake references, and clearing limits. In feet, or percentage of horizontal distance measured from centerline or reference stake, whichever is greater.		
a. Slope reference stakes and slope stakes.	0.2 ft or 0.8%	0.25 ft or 1.5%
b. Clearing limits.	1.5 ft	2.0 ft
Staking by Catchpoint Measurement Method		
Accuracy for setting slope catchpoints, reference points, and clearing limits. In feet or percentage of slope distance, measured from centerline, whichever is greater.		
a. Slope catch point stakes and reference points.	0.2 ft or 0.7%	0.3 ft or 2.0%
b. Clearing limits.	1.5 ft	2.0 ft

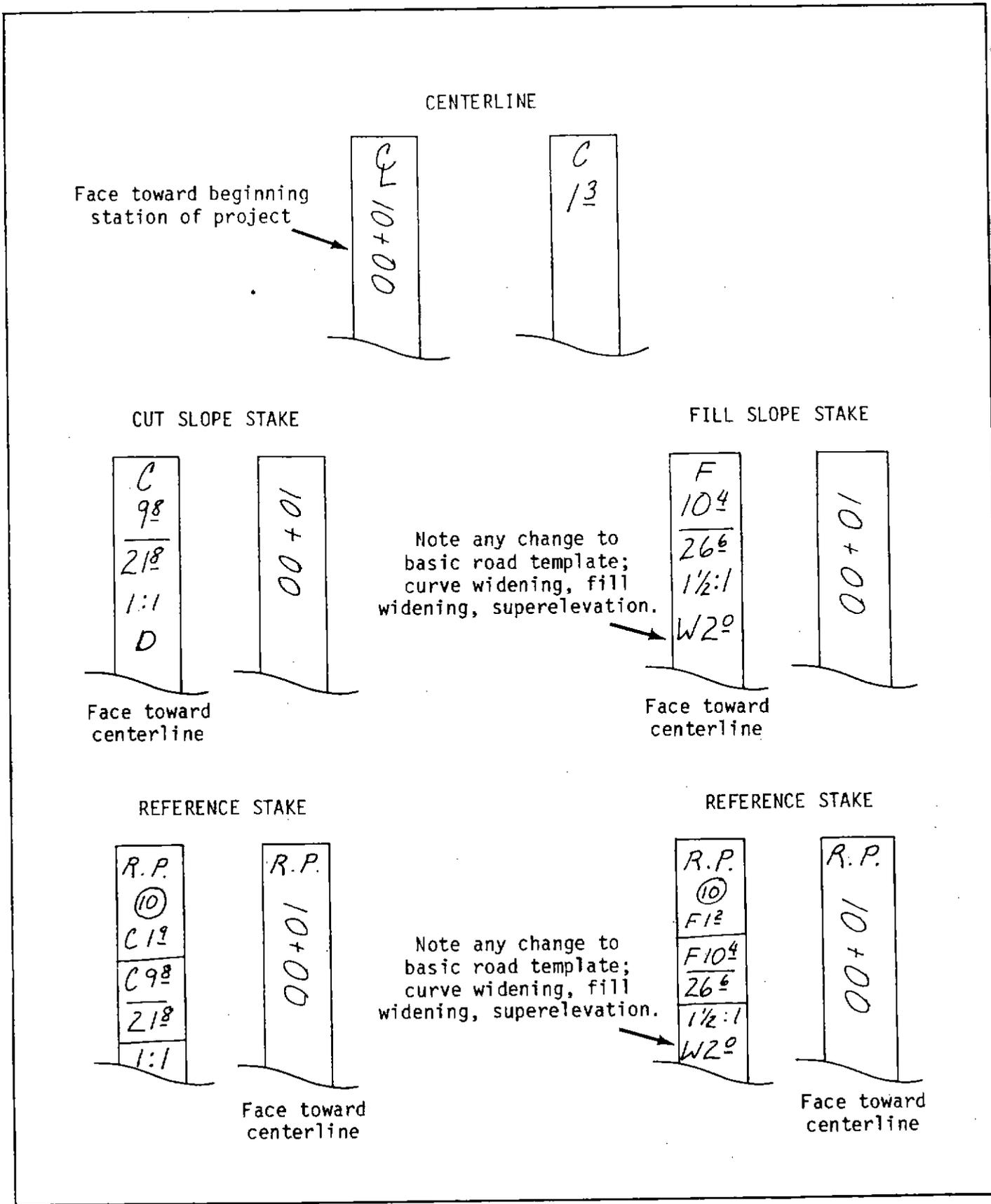


Figure 172-1.--Construction stakes.

Section 173 - Construction Staking, Location Line

DESCRIPTION

- 173.01
Work
- This work shall consist of the construction staking of a road project that will be constructed predominantly by sidecast construction methods. Construction staking will include establishing clearing limits and staking of drainage structures. Slope stakes for cuts and fills shall be established when SHOWN ON THE DRAWINGS. The survey required by this specification may be used in conjunction with other specifications in specific areas SHOWN ON THE DRAWINGS to produce staking adequate for construction needs.
- The work includes furnishing all labor, equipment, instruments, materials, transportation, and other incidentals necessary to complete the construction staking in accordance with these specifications and acceptable engineering practice.

MATERIALS

- 173.02
Stakes
- All stakes shall have the nominal dimensions SHOWN ON THE DRAWINGS or stated in the SPECIAL PROJECT SPECIFICATIONS. Identification stakes shall be of sufficient length to provide a solid set in the ground and to provide space for marking above ground when applicable. Other dimensions and materials may be used if approved in writing by the Engineer. The top 2 inches of all stakes and lath shall be painted or shall be marked with plastic flagging. Colors used for paint or flagging shall be as SHOWN ON THE DRAWINGS or as stated in the SPECIAL PROJECT SPECIFICATIONS.
- 173.03
Survey Note Paper
& Books
- Paper for survey notes shall be moisture-resistant paper. Notes shall be contained in books with covers that will protect the contents and retain the pages in numerical sequence during field use.
- 173.04
Government-
Furnished Documents
- The contractor will be furnished drawings, P-line survey notes, and where applicable, construction staking notes. All documents shall be returned to the Engineer.

SURVEY REQUIREMENTS

- 173.05
Precision
- Accuracy of measurements shall be that attainable with a woven or fiber glass/plastic tape in good condition and a hand level or abney.
- 173.06
Survey Notes
- Survey notes shall be neatly recorded in a standard format approved by the Engineer. Lettering shall be at least 0.15 inches high and legible at a distance of 2.5 feet from the eye. Errors shall be deleted by lining out. All field notes shall be certified as to originality and shall become the property of the Forest Service.
- 173.07
Location Survey Line
- A location line for this project has been established on the ground.
- 173.08
Clearing Limits
- The contractor shall establish clearing limits on each side of the location line by measuring the slope distances shown in the stake notes. The clearing limits shall be marked with flagging or tags on trees to be left standing or on lath. Markings shall be intervisible but in no case farther than 100 feet apart.
- After the clearing limits have been established, the location line stake shall be moved outside the clearing limits for station identification purposes and shall be marked with horizontal distance to location line.
- 173.09
Slope Stakes &
References
- When SHOWN ON THE DRAWINGS, slope stakes shall be located on DESIGNATED portions of the road. The slope stake catchpoints shall be located and used to establish clearing limits and slope stake

references. The method used to establish the slope stake catchpoint shall conform to the METHOD described below, as DESIGNATED in the SCHEDULE OF ITEMS.

(a) Method I--Computed Method. Slope stake catchpoints shall be established by using the template information shown in the slope stake notes to calculate the actual location of the catchpoint. The slope stake "catchpoint distance" shown in the stake notes may be used as a trial location to initiate slope staking.

(b) Method II--Catchpoint Measurement Method. The location of slope stake catchpoints shall be determined by measuring the catchpoint distances shown in the stake notes.

Slope stakes shall be placed as SHOWN ON THE DRAWINGS and shall indicate the station, the amount of cut or fill in feet and tenths, the horizontal distance to centerline in feet and tenths, and the cutslope or fillslope ratios.

Slope reference stakes shall be placed a minimum of 10 feet outside the clearing line and marked with the offset distance to the slope stake.

Prior to clearing and grubbing operations, the slope stake shall be moved outside the clearing limit to the slope reference stake. After clearing and grubbing and before excavation, the slope stakes shall be reset in their original position.

173.10
Monuments of
Property Boundaries
or Surveys of
Other Agencies

If property boundary or survey monuments or survey markers of other agencies are found within or adjacent to the construction limits, the contractor shall immediately notify the Engineer.

173.11
Staking Culverts

Culvert reference stakes shall be set at all culvert locations. A culvert reference stake shall be set on the centerline of the culvert 10 feet from each end or beyond the clearing limit, whichever is greater. The following shall be recorded on these stakes:

(a) Diameter, design length, and type of culvert.

(b) The horizontal distance from the reference stake to the invert at the ends of the culvert.

173.12
Staking Drain Dips

Reference stakes shall be established outside the clearing limits on the projected centerline of the bottom of the drain dip at all drain dip locations as SHOWN ON THE DRAWINGS.

173.13
Staking Cattleguards

Cattleguards shall be staked as SHOWN ON THE DRAWINGS.

173.14
Marking Stakes

All stakes shall be marked with a stake pencil that leaves an imprint, or with waterproof ink, in a format approved by the Engineer.

173.15
Approval &
Maintenance

Construction work shall not begin within a roadway segment until the stakes and marks established by the contractor are approved in writing by the Engineer. The minimum segment for approval shall be 2,000 feet or the length of the project, whichever is less.

Approval of construction marking or staking will not relieve the contractor of the responsibility for maintaining the survey work until construction has been completed and accepted, and for correcting errors, whether the errors are discovered during the performance of the survey or subsequent phases of the project. Location line stakes need not be maintained after clearing operations have started.

MEASUREMENT

173.16
Method

The method of measurement, described in Section 106, will be DESIGNATED in the SCHEDULE OF ITEMS.

PAYMENT

173.17
Basis

The accepted quantities will be paid for at the contract unit price for each pay item shown in the SCHEDULE OF ITEMS.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
173(01) Establish Clearing Limits	MI.
173(02) Establish Slope Stakes, Method _____	MI.

Section 174 - Construction Staking, Bridges, & Major Structures (Reserved)

