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Forest Service Specifications for Construction of Roads & Bridges

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PREFACE

The Forest Service, U.S. Department of Agriculture, developed this book for use in the preparation and administration of contracts for the construction of roads and bridges on the National Forest Development Road System under Public Works Contracts, or as a condition of Timber Sale Contracts.

This book contains the Standard Specifications that commonly apply in public works and timber sale contracts. When designated in a Forest Service contract, the specifications in this book are binding on the parties signing the contract and become a part of the contract. Provisions and clauses pertinent to Public Works Contracts are located in the Federal Acquisition Regulation (FAR) and the Department of Agriculture Acquisition Regulations (AGAR). Standard Provisions and Special Provisions for timber sale projects are located in the Timber Sale Contract, Divisions B (BT) and C (CT) respectively. Conditions and requirements peculiar to individual projects, including additions and revisions to Standard Specifications, are located in the Special Project Specifications section of the contract.

The Standard Specifications are generally presented in a format similar to "AASHTO Guide Specifications for Highway Construction" to encourage nationwide uniformity of specifications and contractual matters in highway construction.

This book is available to the public from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

SECTION 100–149 GENERAL SPECIFICATIONS

Section 101 - Abbreviations

101.01
Organizations & Standards

Whenever in these specifications, or in other contract documents, the following terms, or pronouns in place of them, are used, the intent and meaning shall be interpreted as follows. Reference to a specific standard or specification shall mean the latest edition or amendment in effect on date of invitation to bid.

AASHTO--American Association of State Highway and Transportation Officials

ACI--American Concrete Institute

AISC--American Institute of Steel Construction

AISI--American Iron and Steel Institute

AITC--American Institute of Timber Construction

ANSI--American National Standards Institute

APA--American Plywood Association

API--American Petroleum Institute

ASME--American Society of Mechanical Engineers

ASTM--American Society for Testing and Material

ATCC--American Type Culture Collection

AWPA--American Wood Preservers Association

AWPB--American Wood Preservers Bureau

AWS--American Welding Society

AWWA--American Water Works Association

CFR--Code of Federal Regulations

CRSI--Concrete Reinforcing Steel Institute

CS--Commercial Standard issued by U.S. Department of Commerce

DEMA--Diesel Engine Manufacturers Association

FAR--Federal Acquisition Regulation

FED SPEC. or FS--Federal Specifications

FSS--Federal Specifications and Standards

GSA--General Services Administration

MIL--Military Specifications

MSHA--Mine Safety and Health Administration

MUTCD--Manual on Uniform Traffic Control Devices

NBFU--National Board of Fire Underwriters

NBS--National Bureau of Standards

NEMA--National Electrical Manufacturers Association

NESC--National Electrical Safety Code

NFPA--(Fire)--National Fire Protection Association

NFPA--(Forest)--National Forest Products Association

NWMA--National Woodwork Manufacturers Association

OSHA--Occupational Safety and Health Administration

PCA--Portland Cement Association

PCI--Prestressed Concrete Institute

PS--Product Standard issued by the U.S. Department of Commerce

PTI--Post-Tensioning Institute

RIS--Redwood Inspection Service

SAE--Society of Automotive Engineers

SF--Standard Form

SSPC--Steel Structures Painting Council

UL--Underwriter's Laboratories, Inc.

USASI--United States of America Standards Institute

WCLIB--West Coast Lumber Inspection Bureau

WWPA--Western Wood Products Association

101.02
Pay Items
& Pay Units

	ABBREVIATIONS
Aluminum	AL.
Asphalt	ASP.
Barbed Wire	B.W.
Bituminous Coated Corrugated Steel Pipe	B.C.C.S.P. OR B.C.C.S. PIPE
Cement	CEMT.
Cement Treated	CEMT.-T.
Cement Treated Base	CTB
Clearing & Grubbing	CLEAR & GRUB
Compaction	CMPCT.
Concrete	CONC.
Corrugated Metal Pipe	CMP
Corrugated Steel Pipe	C.S.P.
Corrugated Steel Pipe Arch	C.S.P. ARCH
Cubic Yard	C.Y.
Cubic Yard Mile	C.Y.MI.
Diameter	DIA.
Each	EA.
Emulsified	EMLSFD.
Erosion and Pollution Control	E&P CONTROL
Fabricated	FABR.
Foundation	FOUND.
Furnished	FURN.
Gallon	GAL.
Grade	GR.
Height	HT.
High Strength	H. STRENGTH
Horizontal	HOR.
Hour	HR.
Linear Foot	L.F.
Liquid	LIQ.
Loading	LD.
Lump Sum	L.S.
Material	MAT'L
Maximum	MAX.
Method	M.

Mile	MI.
Minimum	MIN.
One Thousand Feet Board Measure	MFBM
One Thousand Gallons	M.GALS.
One Thousand Gallons Mile	M.GALS.MI.
One Thousand Square Feet	M.S.F.
Polyvinylchloride	PVC
Pounds	LBS.
Reflectorized	REFLECT.
Section	SEC.
Square Foot	S.F.
Square Yard	S.Y.
Station	STA.
Station Yard	STA. YD.
Strand	S.
Structural	STRUCT.
Structural Steel	S. STEEL
Stump	STMP
Target Value	TV
Thickness	TH.
Ton Mile	T.M.
Tops and Limbs	T&L
Utilization of Timber	UOT
Vertical	VERT.
White	WH.
Width	W.
With	W/
Without	W/O
Woven wire	W.W.
Yellow	YE.

Section 102 - Definitions

Wherever in these specifications, or in other contract documents, the following terms, or pronouns in place of them, are used, the intent and meaning shall be interpreted as follows:

Adjustment in Contract Price. "Adjustment in contract price" shall mean "equitable adjustment" as used in the Federal Acquisition Regulations, or "Construction Cost Adjustment" as used in the Timber Sale Contract as applicable.

Arch Pipe. A culvert section, usually formed of bolted structural plates, that is an arc of a circle (usually one-half or less); that is, a bottomless culvert.

Base Course. The layer or layers of specified or selected material of designed thickness placed on a subbase or subgrade to support a surface course. (See figure 102-1.)

Bearings. The portion of a beam, girder, or truss that transmits the bridge superstructure load to the substructure.

Berm. Curb or dike constructed to control roadway runoff water. (See figure 102-1.)

Bridge. A structure, including supports, erected over a depression or an obstruction, such as water, road, trail, or railway, and having a floor for carrying traffic or other moving loads.

Bridge Length. The overall length measured along the centerline of road to the back of abutment backwalls, if present; otherwise, end to end of the bridge floor, but in no case less than the total clear opening of the structure.

Bridge Traveled Way Width. The clear width measured at right angles to the longitudinal centerline of the bridge between the bottom of curbs or, if curbs are not used, between the inner faces of parapet or railing.

Change. "Change" means "Change Order" as used in the Federal Acquisition Regulations, or "Design Change" as used in the Timber Sale Contract.

Clearing Limits. The limits of clearing as designated on the ground or on the drawings. (See figure 102-1.)

Conduit. A natural or artificial channel for carrying fluids, as water pipes, canals, and aqueducts.

Construction Slash. All vegetative material not meeting utilization standards, such as tops and limbs, timber, brush, and grubbed stumps associated with construction or reconstruction of a facility.

Contracting Officer (CO). The person with the authority to enter into, administer, and/or terminate contracts and make related determinations and findings.

Contractor. The individual, partnership, joint venture, or corporation undertaking the execution of the work under the terms of the contract and acting directly or through their agent, employees, or subcontractors. As used in specifications and drawings for specified roads (Timber Sale Contracts), "contractor" is "purchaser."

Controlled Felling. Directing the placement of trees in felling by wedges, jacks, cable tension, or distribution of holding wood or any combinations of these which will ensure that trees are dropped into previously cleared areas, or clear of any objects that are to remain.

Culvert. A conduit or passageway under a road, trail, or other obstruction. A culvert differs from a bridge in that it is usually constructed entirely below the elevation of the traveled way.

Cushion Material. Native or imported material generally placed over rocky sections of unsurfaced roads to provide a usable and maintainable traveled way.

Defect. A failure to meet a requirement with respect to a single quality characteristic.

Drawings. The documents, including plan and profile sheets, cross sections, diagrams, layouts, schematics, descriptive literature, illustrations, schedules, performance and test data, and similar materials showing details for construction of a facility.

Embankment. A structure of soil, aggregate, or rock material placed on the prepared ground surface and constructed to subgrade.

Engineer. The Contracting Officer's Representative (COR) or Engineering Representative (ER) responsible for onsite administration of the contract.

Equipment. All machinery and equipment, together with the necessary supplies for upkeep and maintenance, as well as tools and apparatus necessary for the proper construction and acceptable completion of the work.

Excess Excavation. Material from the roadway in excess of that needed for construction of designed roadways.

Forest Service. The United States of America, acting through the Forest Service, U.S. Department of Agriculture.

Gauge. The term "gauge" when used in connection with the measurement of plates will mean the U.S. Standard Gauge, except when reference is made to the measurement of metal sheets used in the manufacture of corrugated metal, pipe, metal plate culverts and arches, and metal cribbing, then the term means the "gauge" or "thickness" specified in AASHTO M 36, M 167, M 196, and M 219, as applicable. When the term "gauge" refers to the measurement of wire, it will mean the wire gauge specified in AASHTO M 32.

Government Land. National Forest System lands, and other lands controlled or administered by the Forest Service or by other Federal agencies.

Inspector. The Government-authorized representative designated in writing by the CO, COR, or ER responsible for detailed inspection.

Job-Mix Formula. The percentage of each material in a mixture intended for a particular use.

Laboratory. A testing laboratory of the Government or any other testing laboratory approved by the Contracting Officer.

Materials. Any substance specified for use in the construction of the project and its appurtenances.

Maximum Density. The highest density that can be obtained under stated conditions.

Measurement. Determining and expressing the quantities of work or materials.

Multi-Beam Girder. A precast, prestressed concrete member where the concrete deck is precast as an integral part of the member.

Neat Line. A line defining the proposed or specified limits of an excavation or structure.

Nominal Dimensions or Weights. The numerical values shown on the drawings or in the specifications as measurements of material to be used in the construction.

Nominal Maximum Particle Size. The largest sieve size listed in the applicable specification upon which any material is permitted to be retained.

Overbreak. Material beyond the neat line of an excavation that is removed in the process of excavation, usually by blasting.

Pavement Structure. Subbase, base, or surface course, or combination thereof, placed on a subgrade to support the traffic load and distribute it to the roadbed.

Pioneer Road. Temporary construction access built along the route of the project.

Pipe. A culvert that is circular (round) in cross-section.

Pipe-Arch. A pipe that has been factory-deformed from a circular shape such that the width (or span) is larger than the vertical dimension (or rise).

Profile Grade. The trace of a vertical plane, as shown on the drawings, intersecting the top surface at the centerline of the proposed facility construction.

Purchaser. The individual, partnership, joint venture, or corporation contracting with the Government under the terms of a Timber Sale Contract and acting independently or through his, their, or its agents, employees, or subcontractors.

Random Sampling. Sampling at times or locations determined in advance by the use of a table of random numbers.

Reasonably Close Conformity. Unless working tolerances are specified, all work performed and materials furnished shall be in reasonably close conformity with lines, grades, cross sections, dimensions, and material requirements shown on the drawings, indicated in the specifications, or designated on the ground. "Reasonably close conformity" is compliance with reasonable and customary manufacturing and construction tolerances.

Right-of-Way. A general term denoting (1) the privilege to pass over land in some particular line (including easement, lease, permit, or license to occupy, use, or traverse public or private lands) or (2) land, appurtenances thereto, or interest therein, usually in a strip, acquired for public or private passageway. (See figure 102-1.)

Road Template. The shape and cross-sectional dimensions of the roadway to be constructed as defined by the construction staking notes and the characteristics of the typical sections.

Roadbed. The graded portion of a road between the intersection of subgrade and side slopes excluding that portion of the ditch below subgrade. (See figure 102-1.)

Roadside. A general term denoting the area adjoining the outer edge of the roadway. (See figure 102-1.)

Roadway. The portion of the road within the limits of excavation and embankment, including slope rounding. (See figure 102-1.)

Schedule of Items. A schedule in the contract that contains a listing and description of construction items, quantities, units of measure, methods of measurement, unit price, and amount.

Second Samples. A sample taken when the initial sample indicates that the material is defective.

Shoulder. The portion of the roadway contiguous to the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of pavement structure. (See figure 102-1.)

Sidewalk. The portion of the roadway constructed primarily for pedestrian use.

Special Project Specifications. The specifications that detail the conditions and requirements peculiar to the individual project, including additions and revisions to Standard Specifications.

Specifications. A description of the technical requirements for a material, product, or service that includes criteria for determination whether these requirements are met.

Standard Specifications. Specifications approved for general application and repetitive use.

Subbase. The layers of specified or selected material of designed thickness placed on a subgrade to support a base course.

Subgrade Treatment. Modification of roadbed material by stabilization.

Subgrade. The layers of roadbed that bring it up to the top surface, upon which subbase, base, or surface course is constructed. For roads without base course or surface course, that portion of roadbed prepared as the finished wearing surface. (See figure 102-1.)

Substructure (Bridge). All of that part of the structure below the bearings of simple and continuous spans, skewbacks of arches, and tops of footings of rigid frames, together with the backwalls, wingwalls, and wing protection railings.

Superstructure (Bridge). The entire structure except the substructure.

Surface Course. The top layer of a pavement structure, sometimes called the wearing course, usually designed to resist skidding, traffic abrasion, and the disintegrating effects of climate. (See figure 102-1.)

Tackifier. Binder for vegetative mulch.

Target Value. The percentage of each material in a mixture intended for a particular use from which allowable variations are measured.

Timber Sale Contract. A written contract for the removal of National Forest timber.

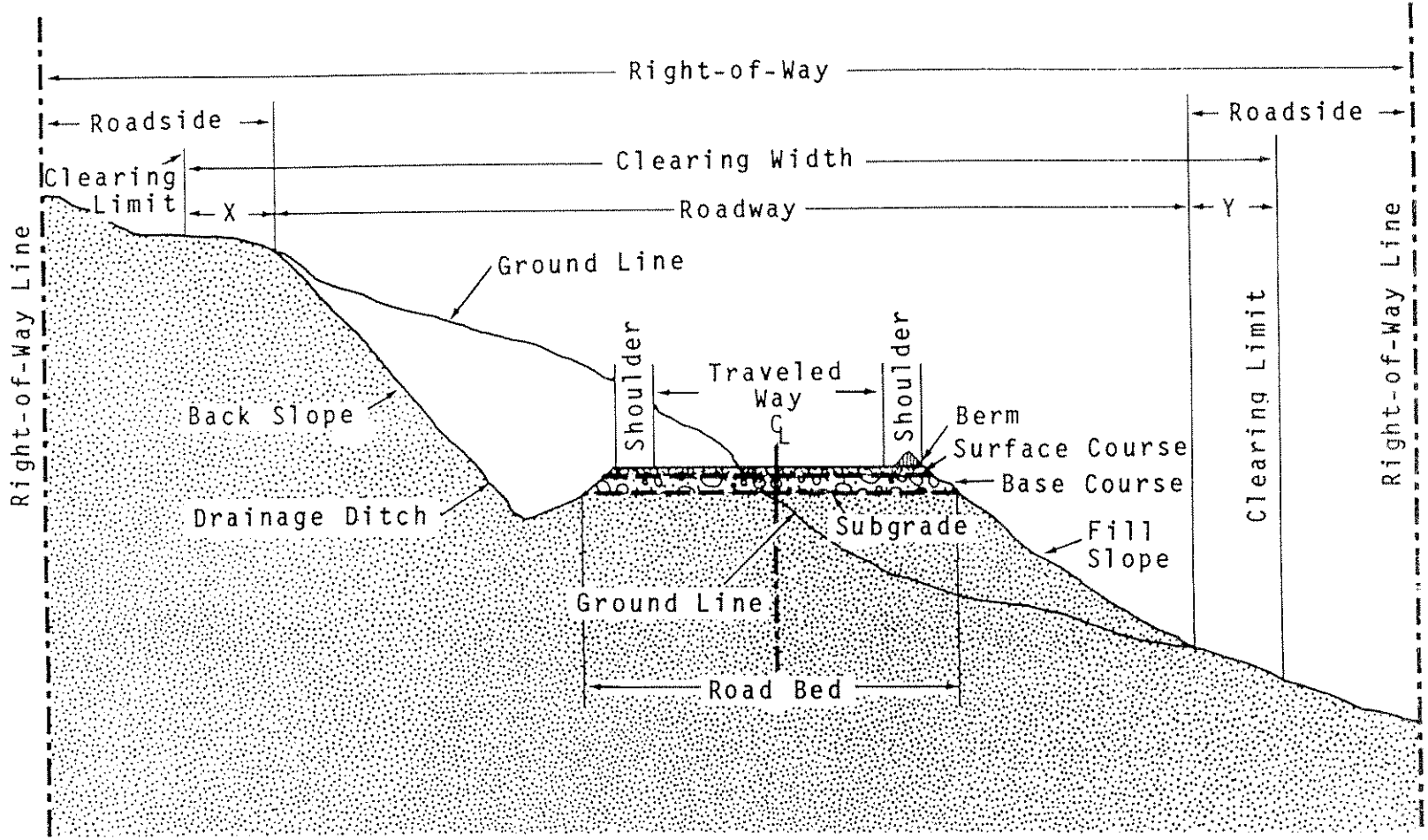
Traveled Way. The portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes. (See figure 102-1.)

Turnout. A short auxiliary lane on a one-lane road provided for the passage of meeting vehicles.

Unit of Measurement. The unit and fractions of units shown in the Schedule of Items.

Unsuitable Material. The material excavated during roadway construction that is not usable in embankment and must be disposed of or that can be used only in certain locations or for limited purposes.

Utilization Standards. The minimum size and percent soundness of trees described in the specifications to determine merchantable timber.



Note: Shapes and dimensions will vary to fit local conditions.
See drawings for typical sections.
X and Y denote clearing outside of roadway.

Figure 102-1.--Illustration of road structure terms.

Section 103 - Intent of Contract

The intent of the contract is to provide for the complete construction of the project described in the contract. Unless otherwise provided, the contractor shall furnish all labor, materials, equipment, tools, transportation, and supplies, and shall perform all work required to complete the project reasonably close conformity with drawings and specifications, and in accordance with provisions of the contract.

Section 104 - Maintenance for Traffic

104.01
Roads To Be
Constructed

Unless otherwise provided in the SPECIAL PROJECT SPECIFICATIONS, existing roads, while undergoing improvement, shall be kept open to all traffic by the contractor and maintained in a condition that will adequately accommodate traffic. No work that interferes or conflicts with traffic or existing access to the roadway surface shall be performed until a plan for the satisfactory handling of traffic has been submitted by the contractor and approved by the Engineer. Specific requirements for temporary closures, detours, part-width construction and access to adjacent or intersecting facilities will be SHOWN ON THE DRAWINGS or described in SPECIAL PROJECT SPECIFICATIONS. Construction signing for traffic control shall conform to the Manual on Uniform Traffic Control Devices (MUTCD).

Prior to the contractor shutting down any operations, the contractor shall take such precautions as may be necessary to prevent damage to the project, such as temporary detours, approaches, crossings or intersections; and shall make provisions for normal drainage and minimization of erosion. All travelways shall be left in a condition suitable for traffic.

The Government may permit use of portions of the project during periods that the contractor has shut down operations. All maintenance attributable to permitted use during periods of work suspension will be provided by the Government unless the maintenance results from fault or negligence of the contractor. Any maintenance not attributable to use, or necessary during suspensions resulting from fault or negligence of the contractor, shall be the contractor's responsibility.

104.02
Use of Roads
by Contractor

The contractor is authorized to use Forest Service roads for all activities necessary for completion of this contract subject to the limitations and authorizations described in SPECIAL PROJECT SPECIFICATIONS, when such use will not cause damage to the roads or National Forest resources and when traffic can be accommodated safely.

Section 105 - Control of Materials

105.01
Handling Materials

All materials shall be transported and handled to preserve their quality and fitness for the work. Aggregates shall be stockpiled, loaded, and transported in a manner that will preserve specified gradation and avoid contamination. Stockpiles of aggregate having different gradations shall not be intermingled.

105.02
Weighing Devices

When the measurement is by weight, the contractor shall provide weigh scales, and shall transport the materials so they can be weighed. All weighing shall be done by the contractor.

(a) Platform Scales. Platform scales shall be of sufficient length and capacity to permit simultaneous weighing of all axle loads of each hauling unit.

The scales shall be accurate to within 1 percent of the correct weight throughout the range of use. Before using the scales and as frequently thereafter as the Engineer determines necessary to ensure accuracy, the contractor shall have the scales checked, adjusted, and certified by a representative of the State agency responsible for weights and measures or by a qualified manufacturer's representative. The contractor shall maintain the scales to the required accuracy.

The contractor shall provide the Government with copies of weight tickets from a certified scale.

The contractor may have the material weighed on other certified scales without additional compensation and shall furnish certified weight tickets for all material delivered to the project. The contractor shall guarantee permission for a Government representative to periodically check the weighing procedure and records.

(b) Belt Conveyor Scales. Belt conveyor weighing will be accepted in lieu of platform scales, provided this method or device meets the requirements specified below and is compatible with the provisions of measurement and payment in the applicable specifications.

The belt conveyor scale shall meet the design, marking, installation, and tolerance requirements of the National Bureau of Standards Handbook No. 44, and shall be certified by a copy of a National Bureau of Standards Prototype Examination Report of Test.

The weighing mechanism shall contain a weight totalizer and a self-printing device that legibly imprints the load-out weight on appropriate serially numbered and time-dated tickets. The time dating may be done either by an automatic printing device or manually. Each ticket shall be delivered to the Government representative at job site or point of use. The totalizer calibration adjustment and ticket imprinter shall be furnished with a security lock and key.

Under observation of the Engineer or of a designated Government representative, the contractor shall run a daily zero-load test in accordance with National Bureau of Standards Handbook No. 44.

105.03
Sampling
& Testing

For contractor-furnished sources (see Section 105.06), the contractor shall submit test results and a Certificate of Compliance that states that the aggregate meets the contract requirements. For designated sources (see Section 105.06), the contractor shall submit test results for aggregate gradation and a Certificate of Compliance that states gradation meets contract requirements. Crushing, screening, and mixing plants shall be equipped with sampling devices. The contractor shall take additional samples as required to validate the certification.

Sampling and testing of the material before incorporation into the work shall be in accordance with AASHTO requirements and shall occur as follows:

(a) For onsite produced materials at crushing or screening plants: after additions of any necessary blending material.

(b) For commercially produced aggregates: at the producer's plant or stockpile.

(c) For gradation of combined aggregate in bituminous plant mixtures: either before or after introduction of bituminous material.

These test results shall not preclude later sampling and testing for final acceptance after final processing of the material.

105.04 Certification & Sampling of Bituminous Materials

(a) Certification with Shipments. When each load of bituminous material is delivered, the contractor shall furnish the Engineer with one copy of the Bill of Lading and a fully executed Certificate of Compliance conforming to the format below (see figure 105-1). A separate Certificate of Compliance will not be required if the standard Bill of Lading contains the essential information required by the certificate.

(b) Sampling. Sampling of bituminous material may be required to validate certifications furnished by the contractor. When sampling is directed by the Government, the actual samples shall be obtained by the contractor in the presence of the Engineer. All delivery and plant equipment shall be constructed to permit sampling in conformance with AASHTO T 40 test procedure.

Consignee _____ Designation _____
Contract Number _____ Date _____
Identification (truck no., car no., etc. _____
Type and Grade _____ With Additive (percent and brand) _____
Loading Temp. _____ Net Weight _____
Net Gallons _____ Specific Gravity _____

This shipment of bituminous material identified above and covered by this Bill of Lading complies with Forest Service STANDARD SPECIFICATIONS as modified by SPECIAL PROJECT SPECIFICATIONS applicable to this project.

Producer _____
Signed _____
Producer's Representative

Figure 105-1.--Sample Bill of Lading and Certificate of Compliance.

105.05 Rights in & Use of Materials Found or Produced on the Work

(a) The contractor, with the written approval of the Contracting Officer, may use on the project suitable stone, gravel, sand, or other material found in the excavation. Payment will be made both for the excavation of such materials at the corresponding contract unit price and for the pay items for which the excavated material is used. The contractor shall replace, without additional compensation, sufficient suitable materials to complete the portion of the work that was originally contemplated to be constructed with such material.

(b) Materials produced or processed from Government lands in excess of the quantities required for performance of this contract are the property of the Government. The Government is not obligated to reimburse the contractor for the cost of their production.

105.06
Material Sources

(a) Designated Sources. Sources of local materials designated in the SPECIAL PROJECT SPECIFICATIONS or SHOWN ON THE DRAWINGS are guaranteed by the Government for the quality and quantity of material in the source. The contractor shall determine the equipment and work required to produce the specified product. The contractor shall submit test results and a Certificate of Compliance that states that the gradation of the aggregate meets the contract requirements.

The contractor shall utilize all suitable material in the source. The designation of a source will include the right of the contractor to use areas SHOWN ON DRAWINGS for the purposes designated (that is, plant sites, stockpiles, haul roads). Unless otherwise indicated or approved, no additional operating area will be allowed, and the contractor will be required to operate in the confines of the area(s) designated.

The weight/volume relationship used for determination of designed quantities of material in designated sources subject to weight measurement are SHOWN ON THE DRAWINGS.

Should the designated source, due to causes beyond the control of the contractor, contain insufficient suitable material, the Government will provide another source with an adjustment in contract price.

(b) Contractor-Furnished Sources. When the material sources are not designated as provided above, or the contractor elects not to use designated sources, the contractor shall be responsible for furnishing material that produces an end product equivalent in performance to that originally designated. An adjustment in contract price will be made where the weight/volume relationship differences between designated source material and contractor-furnished source material results in a financial disadvantage to the Government. The contractor shall be responsible for completing any pit development specified for a designated source, even though the contractor does not choose to obtain material from the source if such a statement is SHOWN ON THE DRAWINGS.

Quality testing in conformance with applicable requirements and acceptable to the Engineer to establish the equivalency of the end product shall be the responsibility of the contractor. Test results shall be furnished to the Engineer.

Section 106 - Measurement & Payment

106.01 Measurement & Payment

Measurement and payment for contract work will be made only for and under those pay items included in the SCHEDULE OF ITEMS. All other work and materials will be considered as included in the payment for items shown.

When more than one class, size, or thickness is specified in the SCHEDULE OF ITEMS for any pay item, suffixes will be added to the item number to differentiate between the items.

106.02 Determination of Quantities

The following measurements and calculations are used to determine contract quantities.

For individual construction items, longitudinal and lateral measurements for area computations will be made horizontally or corrected to horizontal measurement unless otherwise specified. Measurements for seeding, mulching, geotextiles, netting, erosion control blankets, and sodding will be along slope lines.

The average end area method will be used to compute volumes of excavation or embankment. However, if in the judgment of the Engineer, the average end area method is impractical, measurement will be made by volume in hauling vehicles or by other three dimensional methods.

Structures will be measured according to neat lines SHOWN ON THE DRAWINGS or as altered by the Engineer in writing to fit field conditions.

For items that are measured by the linear foot, such as pipe culverts, fencing, guardrail, and underdrains, measurements will be made parallel to the base or foundation upon which the structures are placed. Pipe and pipe arch culverts shall be measured along center of invert and arches shall be measured at spring line.

For aggregates weighed for payment, the tonnage will not be adjusted for moisture content, unless otherwise provided in SPECIAL PROJECT SPECIFICATIONS.

For bituminous material, volumes will be measured at 60 °F or will be corrected to the volume at 60 °F by using ASTM D 1250 for asphalts. Emulsified asphalt will be measured at 60 °F or measured by converting the gallonage at another temperature to gallonage at 60 °F by means of the following formula:

$$\text{Gallons at } 60\ ^\circ F = \frac{\text{Gallons at } A\ ^\circ F}{1 + 0.00025\ (A\ ^\circ F - 60\ ^\circ F)}$$

in which A °F is the Fahrenheit temperature of the material at the time the gallonage is measured.

For vehicular shipments, net certified scale weights or weights based on certified volumes will be used as a basis of measurement. Measurements will be adjusted when bituminous material has been lost from the vehicle or from the distributor, has been wasted, or has otherwise not been incorporated into the work. Determining true weights of hauling vehicles shall be made by weighing the empty vehicles at least once a day at the times the Engineer directs. Each vehicle shall bear a plainly legible identification mark.

When bituminous materials are shipped, net certified weights, or volume corrected for loss of foaming, can be used for computing quantities.

For standard manufactured items--such as fence, wire, plates, rolled shapes, pipe conduits--identified by gauge, weight, section

dimensions, and so forth, such identifications shall be considered the nominal weights or dimensions. Unless controlled by tolerances in cited specifications, manufacturer's tolerances will be accepted.

106.03
Units of Measurement

Payment will be by units defined and determined according to U.S. Standard measure and by the following:

(a) Cubic Yard. A measurement computed by one of the following methods:

(1) Excavation, Embankment, or Borrow. The measurement computed by the average end area method from measurements made longitudinally along a centerline or reference line.

(2) Material in Place or Stockpile. The measurement computed using the dimensions of the in-place material.

(3) Material in the Delivery Vehicle. The measurement computed using measurements of material in the hauling vehicles at the point of delivery. Vehicles shall be loaded to at least their water level capacity. Leveling of the loads may be required when vehicles arrive at the delivery point.

(b) Cubic Yard Mile. A combination of linear and volumetric measurement meaning the movement of a cubic yard of material 1 mile.

(c) Each. One complete unit, which may consist of one or more parts.

(d) MFBM. One thousand feet board measure based on nominal widths, thicknesses, and extreme usable length of each piece of lumber or timber actually incorporated in the job.

(e) Station. One hundred linear feet measured horizontally.

(f) Station Yard. A combination of linear and volmetric measurement meaning the movement of a cubic yard of material one station.

(g) Thousand Gallons Mile. A combination of linear and volumetric measurement meaning the movement of 1,000 gallons of material 1 mile.

(h) Ton. Short ton consisting of 2,000 pounds.

(i) Ton Mile. A combination of linear and weight measurement meaning the movement of 1 ton of material 1 mile.

106.04
Methods of Measurement

One of the following methods of measurement for determining final payment is DESIGNATED on the SCHEDULE OF ITEMS for each pay item:

(a) Designed Quantities (DQ). These quantities denote the final number or units to be paid for under the terms of the contract. They are based upon the original design data available prior to advertising the project. Original design data include the preliminary survey information, design assumptions, calculations, drawings, and the presentation in the contract. Changes in the number of units SHOWN in the SCHEDULE OF ITEMS may be authorized under any of the following conditions:

(1) As a result of changes in the work authorized by the Contracting Officer.

(2) As a result of the Contracting Officer determining that errors exist in the original design that cause a pay item quantity to change by 15 percent or more.

(3) As a result of the contractor submitting to the Contracting Officer a written request showing evidence of errors in the original design that cause a pay item quantity to change by 15 percent or more. The evidence must be verifiable and consist of calculations, drawings, or other data that show how the designed quantity is believed to be in error.

(b) Staked Quantities (SQ). These quantities are determined from staked measurements prior to construction.

(c) Actual Quantities (AQ). These quantities are determined from measurements of completed work.

(d) Vehicle Quantities (VQ). These quantities are measured or weighed in hauling vehicles.

(e) Lump Sum Quantities (LSQ). These quantities denote one complete unit of work as required by or described in the contract, including necessary materials, equipment, and labor to complete the job. They will not be measured.

106.05 Price Adjustment for Out-of-Specification Bituminous Materials

Bituminous materials are defined as all types and grades of asphalt cement, liquid asphalt, emulsified asphalt, and dust oil.

If bituminous material fails one or more test requirements, and the Contracting Officer determines it is in the public interest to accept the material at a reduced price, the price reduction shall be based on the test results giving the largest percent price adjustment. The contractor may remove and replace the defective material or accept the adjustment.

The price reduction shall apply to all pay items affected.

Price adjustment will be based on samples taken in duplicate in accordance with AASHTO T 40 under the supervision of the Engineer. Samples shall be sent to an authorized laboratory. The laboratory shall test one of each duplicate sample and retain the other. When any test result is not within the specification limits, the laboratory shall immediately notify the supplier and the Engineer. The Engineer will then authorize check testing of the retained sample.

If the retained sample tests satisfactorily, the material will be accepted. If the retained sample also fails, the following schedule of price adjustments shall apply. The average of test values for the two samples will determine the basis for price adjustment, except when test results on the samples differ by more than the applicable AASHTO or ASTM Repeatability Unit; then, the test result numerically nearest the specification requirement will be used. (A repeatability unit is defined as D2S or D2S% limit for single operator precision described in ASTM recommended practice C 670.)

The schedule of price adjustments shall not apply to the following tests:

Test	AASHTO Test Method
Spot Test	T 102
Particle Charge	T 59
Ductility	T 51

Bituminous materials failing to meet specifications for these tests shall be removed and replaced.

See Table 106-1 for the schedule of price adjustments for bituminous materials that do not meet specifications.

Table 106-1.--Schedule of price adjustments for out-of-specification bituminous materials.

Application	Deviation from Specification Limit Measured in Reproducibility Units[a]			
	Less than 1	1, but less than 2	2, but less than 3	3 or greater
Price reduction applicable to bituminous base course and pavement mixture or to seal coat and bituminous surface treatment aggregate.	0%	5%	25%	Remove & Replace
Price reduction applicable to bituminous material paid for as a separate item.	0%	10%	25%	Remove & Replace

[a]A reproducibility unit is defined as D2S or D2S$_\Delta$ limit for multi-laboratory precision described in ASTM recommended practice C 670.

The Sieve Test (AASHTO T59) results may be exempt from the schedule of price adjustments provided the contractor's quality assurance program includes checking the uniformity of bituminous spread rates in increments no greater than 1 foot over the width of the spray bar and variation between increments is no greater than 5 percent.

106.06 Earthwork Tolerances

Adjustments of horizontal or vertical alignment, within the tolerances specified in this contract, or shifts of balance points up to 100 feet shall be made by the contractor as necessary to produce the designed roadway section and to balance earthwork. Such adjustments shall not be considered as "Changes."

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:

Road No._____ Contract No._____

Pay Item No.	Test	Date	Station	Standard	Results	Test By (Initials)

The contract shall certify in writing that all inspections and tests were performed in accordance with specifications.

(b) As-built Drawings. The contractor shall maintain a set of the contract drawings depicting as-built conditions. These drawings shall be maintained in a current condition and shall be available for review. All variations from contract drawings shall be indicated in red on the drawings. Upon completion of the contract work, as-built drawings shall be submitted to the Engineer.

160.05 Certifications & Measurements

(a) Offsite Produced Materials. The contractor shall furnish certificates executed by the manufacturer, supplier, or vendor, stipulating that all offsite produced materials incorporated into the work meet the applicable requirements SHOWN ON THE DRAWINGS or stated in the specifications. Incidental purchases needed to remedy minor shortages of material shall be certified by the contractor.

(b) Quantity Measurements. The contractor shall make all measurements for computation of quantities for all work items except those specified for payment by Designed Quantity (DQ). The contractor shall compute the quantities for periodic progress payments; the Engineer will compute the quantities for the final payment based on measurements taken by the contractor. All contractor measurements are subject to verification. The contractor shall submit all field notes, calculation sheets, and other data used to determine quantities. The contractor shall certify in writing as to the accuracy of the measurements and computations submitted.

The following format or one containing the following information will be acceptable to the Government:

Road No._____ Contract No._____

Pay Item No.	Date	Station	Quantity or Measurement	Measured By (Initials)

MEASUREMENT

160.06 Method

There will be no separate measurement for this section.

PAYMENT

160.07 Basis

The accepted quantities will be paid for at the contract unit price for each pay item shown in the SCHEDULE OF ITEMS. Otherwise, quality control and quantity measurement shall be incidental to other specified work.

Payment will be prorated on the percentage of work accomplished on the related pay item that meets specifications.

Section 161 - Quality Control & Quantity Measurement

DESCRIPTION

161.01
Work

This work shall consist of providing certification that the quality and quantity of construction conforms to the drawings, specifications, and requirements of the contract.

CONSTRUCTION REQUIREMENTS

161.02
Certifications & Measurements

(a) Offsite Produced Materials. The contractor shall furnish certificates executed by the manufacturer, supplier, or vendor, stipulating that all offsite produced materials incorporated into the work meet the applicable requirements SHOWN ON THE DRAWINGS or stated in the specifications. Each certificate shall apply to a single commodity or invoice. Incidental purchases needed to remedy minor shortages of material shall be certified by the contractor.

(b) Quantity Measurements. The contractor shall make all measurements for computation of quantities for all work items except those specified for payment by Designed Quantity (DQ). The contractor shall compute the quantities for periodic progress payments; the Engineer will compute the quantities for the final payment based on measurements taken by the contractor. All contractor measurements are subject to verification. The contractor shall submit all field notes, calculation sheets, and other data used to determine quantities. The contractor shall certify in writing as to the accuracy of the measurements and computations submitted.

The following format or one containing the following information will be acceptable to the Government:

Road No._____ Contract No._____

Pay Item No.	Date	Station	Quantity or Measurement	Measured By (Initials)

161.03
Records

As-built Drawings. The contractor shall maintain a set of the contract drawings depicting as-built conditions resulting from Government-authorized changes. The drawings shall be maintained in a current condition. Changes from the original contract drawings shall be indicated in red on the drawings. At the completion of the contract work, as-built drawings shall be submitted to the Engineer.

MEASUREMENT

161.04
Method

There will be no separate measurement for this item.

PAYMENT

161.05
Basis

Payment will be considered incidental to other pay items in this contract.

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 neareast 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
℄	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:

Pay Item		Pay Unit
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.

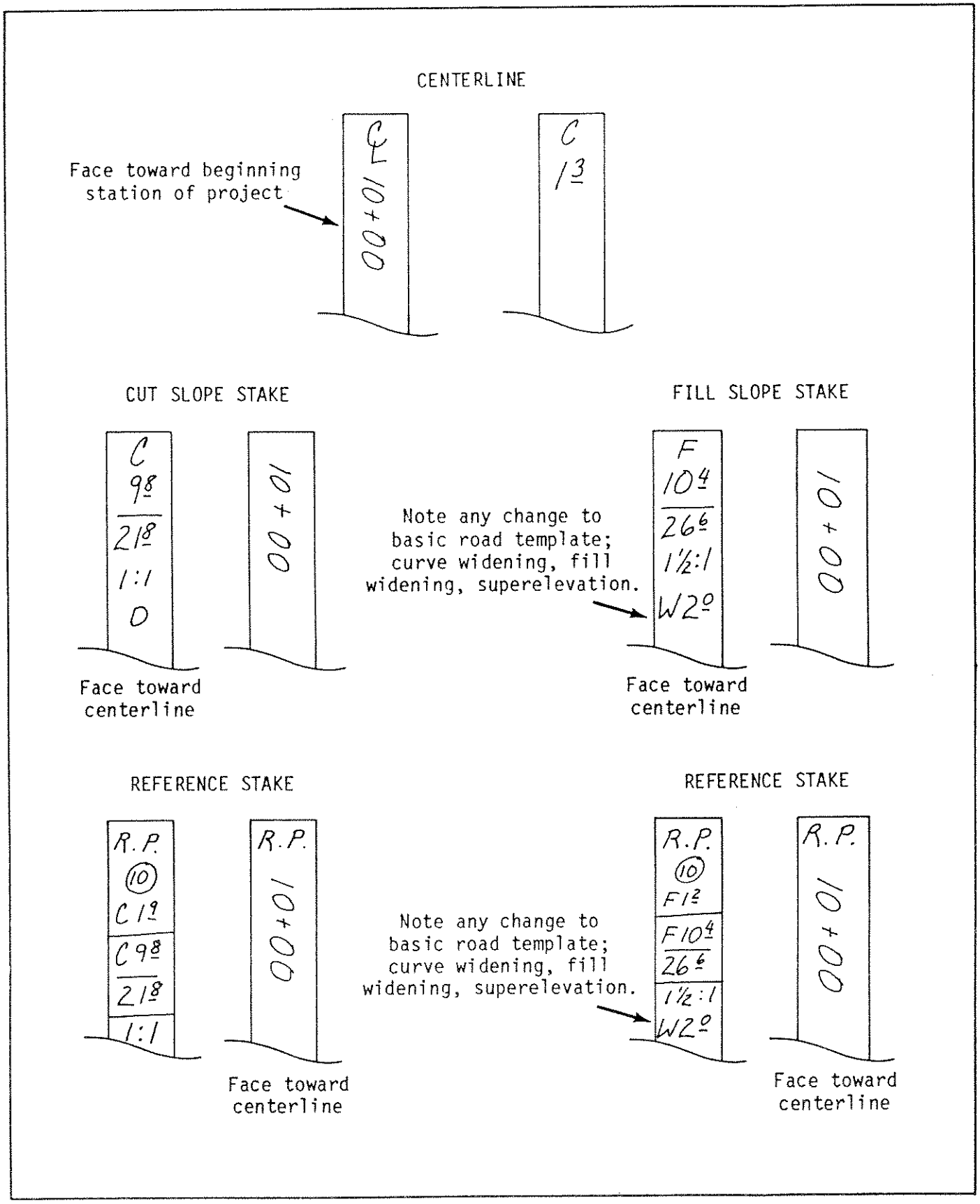


Figure 170-1.--Construction stakes.

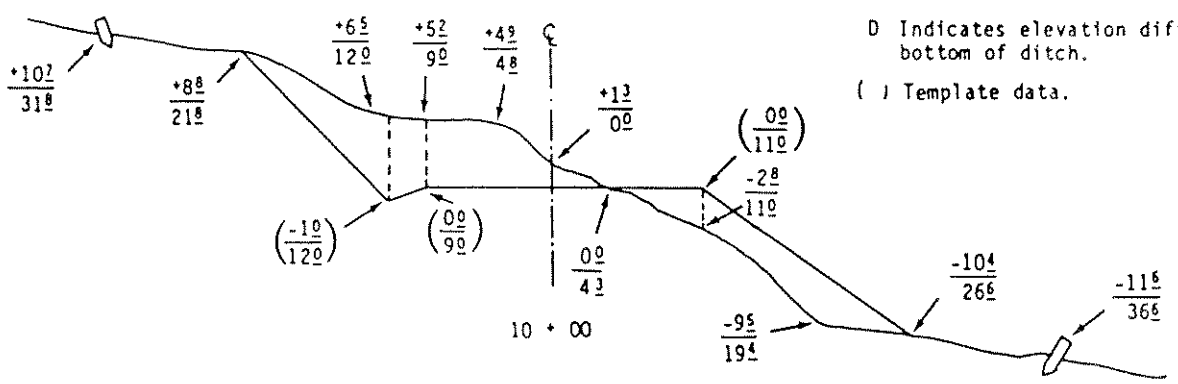
STA.	ELEV. ℄ GRADE	ELEV. ℄ GRND.	DIST. ℄ TO SHOULDER		WIDENING		DITCH PT.		SUPER ELEV.								
			LT.	RT.	LT.	RT.	LT.	RT.									
10+00	3213.3	3214.6	9	9	—	2	12	—	—	$+8^{8}$	$+6^{5}$	$+5^{2}$	$+4^{9}$	$+1^{3}$	0^{0}	-2^{8}	-9^{5}	-10^{4}
										21^{8}	12^{0}	9^{0}	4^{8}	0	4^{3}	11^{0}	19^{4}	26^{6}
										**			*			*		**
										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}			$1\frac{1}{2}:1$		36^{6}
										$C9^{8}$			1:1			W2		$F10^{4}$
										21^{8}			D					26^{6}
										1:1								$1\frac{1}{2}:1$
										D								W2
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.



℄ GRADE ELEV. 3213.3 ℄ 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]

[a]Accuracy of offset measurement.
[b]M is number of miles in traverse.
[c]Use 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.			
a. Slope reference stakes and slope stakes.	0.1 ft or 0.4%	0.15 ft or 0.6%	0.2 ft or 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)
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

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:

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

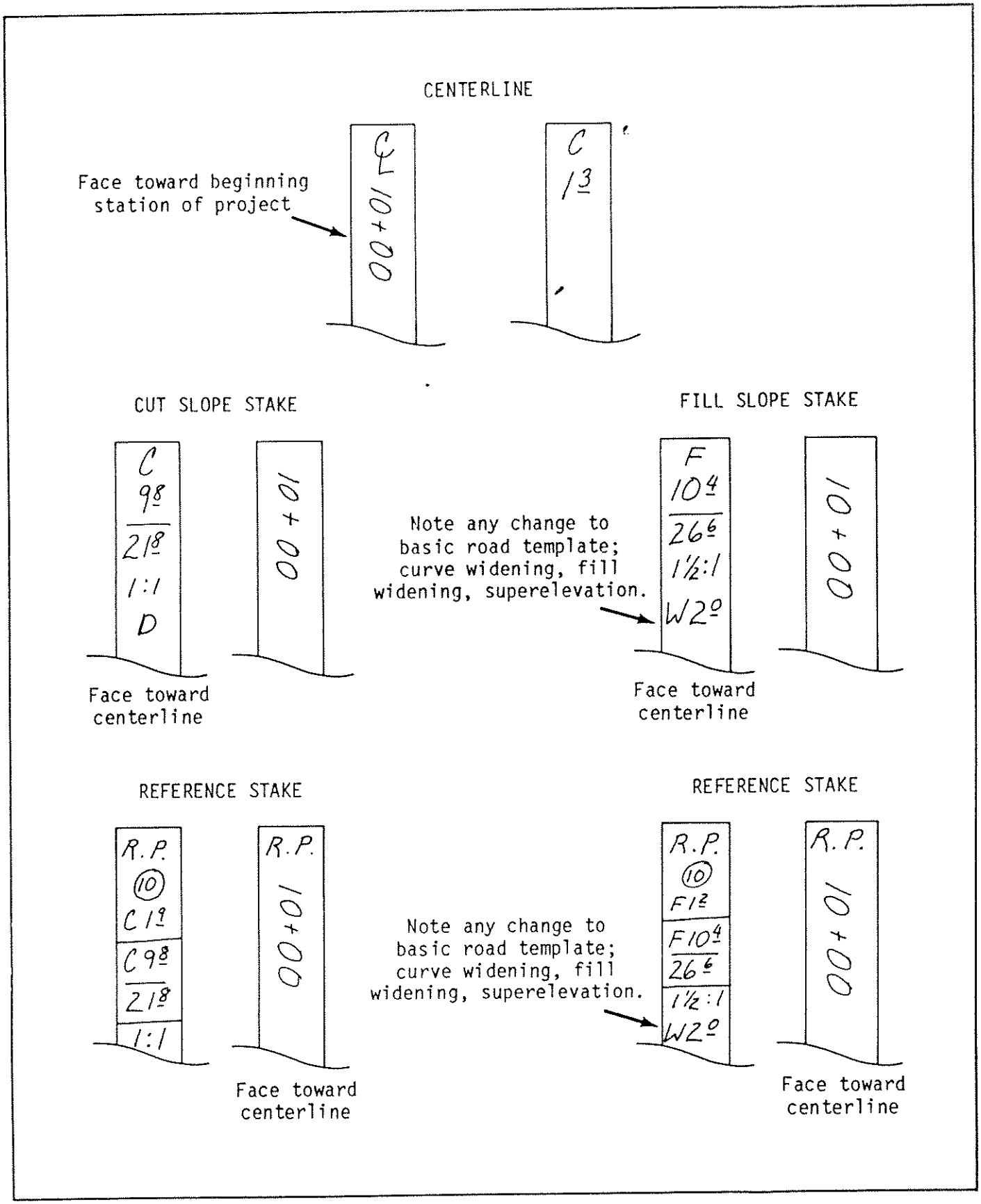
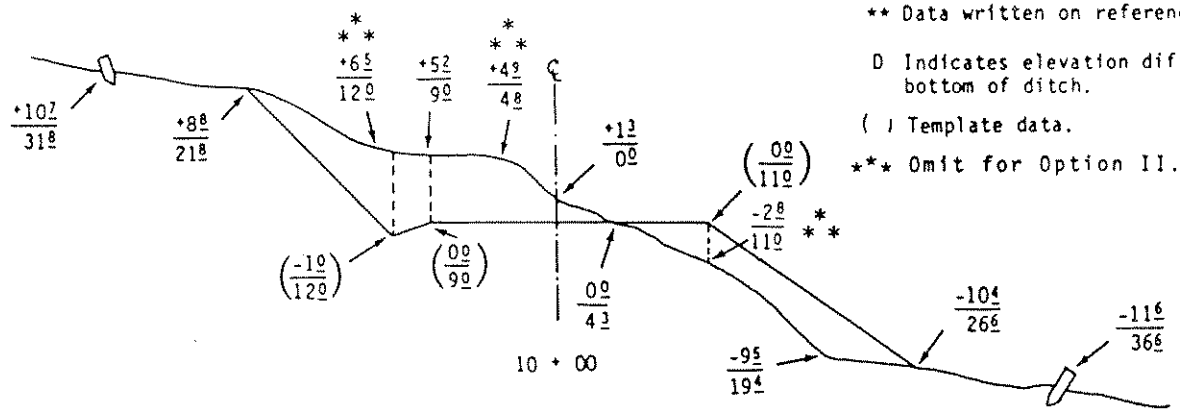


Figure 171-1.--Construction stakes.

STA.	ELEV. ℄ GRADE	ELEV. ℄ GRND.	DIST. ℄ TO SHOULDER		WIDENING		DITCH PT.		SUPER ELEV.								
			LT.	RT.	LT.	RT.	LT.	RT.									
10+00	3213.3	3214.6	9	9	—	2	12	—	—	$+8^{8}$	$+6^{5}$ **	$+5^{2}$	$+4^{9}$ **	$+1^{3}$	0^{0} **	-2^{8} **	-9^{5}	-10^{4}
										21^{8}	12^{0}	9^{0}	4^{8}	D	4^{3}	11^{0}	19^{4}	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}			$1\frac{1}{2}:1$		36^{6}
										$C9^{8}$			1:1			W2		$F10^{4}$
										21^{8}			D					26^{6}
										1:1								$1\frac{1}{2}:1$
										D								W2
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.

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.

[a]Accuracy of offset measurement.
[b]M is number of miles in traverse.
[c]Magnetic attraction will require a deflection angle traverse.
[d]Use 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:

Pay Item		Pay Unit
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'	$0.20\sqrt{M}$ or 0.10/sta.[d]
E	1/100	Foresight & Backsight 1/2° rejection limit[c]	0.8'	0.10/sta.

[a] Accuracy of offset measurement.
[b] M is number of miles in traverse.
[c] Magnetic attraction will require a deflection angle traverse.
[d] Use 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

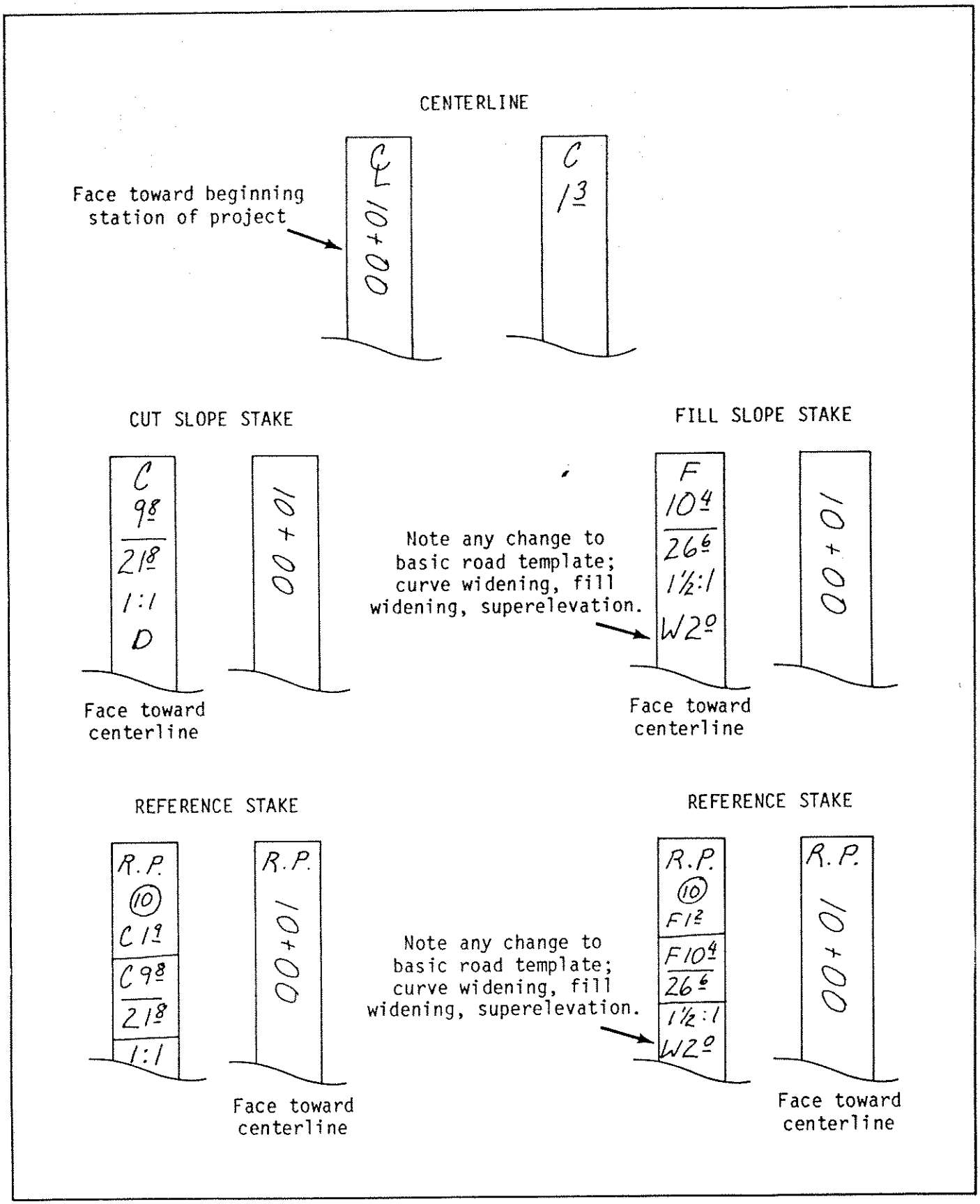


Figure 172-1.--Construction stakes.

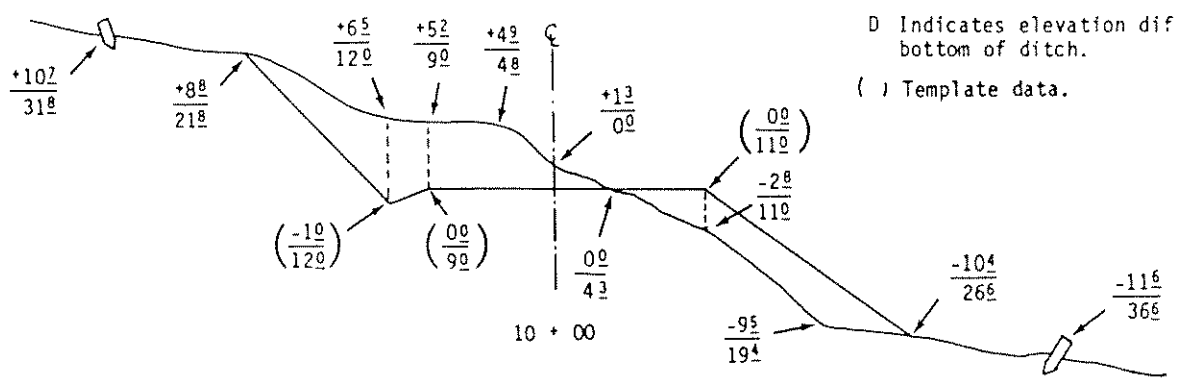
STA.	ELEV. ℄ GRADE	ELEV. ℄ GRND.	DIST. ℄ TO SHOULDER		WIDENING		DITCH PT.		SUPER ELEV.					
			LT.	RT.	LT.	RT.	LT.	RT.						
10+00	3213.3	3214.6	9	9	—	2	12	—	—	$+10^{7}$	$+8^{8}$	$+1^{3}$	-10^{4}	-11^{6}
										31^{8}	21^{8}	0	26^{6}	36^{6}
										**	*		*	**
										(10)	C9 8		F10 4	(10)
										C10 7	22		27	F11 6
										32	1:1		1½:1	37
										C9 8	D		W2	F10 4
										22				27
										1:1				1½:1
										D				W2
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.



℄ GRADE ELEV. 3213.3 ℄ GROUND ELEV. 3214.6

Figure 172-2.--Slope-stake note entries related to actual ground elevations.

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:

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

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