1150 CONTRACTOR CONSTRUCTION SURVEYING

1150-1 General Instructions

The preceding chapters apply to survey by either Contractor or ADOT personnel. It is the intent of this section to present a series of additional guidelines and staking methods for Contractor construction surveying (Specification 925).

Additional information should be sought in the ADOT *Engineering Survey Services Manual for Field Surveys*. The manual will explain how and when different survey methods and instruments should be used. All transits, theodolites, etc., will be referred to as instruments in this manual since they are thoroughly discussed in the *Engineering Survey Services Manual for Field Surveys*. The manual also illustrates field book notation and how electronic data files should be handled.

The methods for note preparation and staking procedures outlined in this manual are presented as acceptable methods of doing the work. The method selected for each phase of the construction survey shall be determined by the surveyor as each project may vary considerably in requirements.

The Department will provide control points for establishing an accurate construction centerline and will establish bench marks adjacent to this line for the proper layout of the work as described herein. Control points will be located in accordance with Standard Specification 925, Construction Surveying and Layout. Some complex projects may require more bench marks control points set by the Department will be identified in the field to the Surveyor and any diagrams available will be provided. The Department will provide the Contractor with field books or data files containing the control point data at the preconstruction conference. If a control point cannot be established at the outset due to right-of-way restrictions, the Department will establish that point at the earliest possible time when right of entry to the area is obtained. At the earliest possible time, the Contractor shall furnish as many large and small sets of construction plans to the Surveyor as needed. The Contractor shall also provide his proposed schedule of work sequence to the Surveyor.

Prior to beginning any survey operations, the Surveyor shall furnish to the Engineer, for his approval, a written outline detailing the method of staking, marking of stakes, grade control for various courses of materials, referencing, structure control, and any other procedures and controls necessary for survey completion. A part of this outline shall also include a schedule which will show the sequencing of the survey and layout work, throughout the course of the contract, listing a percentage of completion for each month. The method of staking and marking of stakes should be reviewed in the field with the Contractor and the Inspector, making certain that all parties understand the staking methods and marking.

It may be advantageous to supply the Contractor with diagrams indicating staking procedures. This could also be helpful in case the individual that originally was in charge of staking, for one reason or another, is not available. Copies of staking layouts should be kept in the project files. This would be especially helpful in difficult or unusual staking situations.

1150-2 Study and Checking of Plans

Before any staking is started, the plans shall be thoroughly reviewed and cross-checked relevant to the juxtaposition of current project items, past projects, and adjacent projects. Also the field control points shall be carefully checked by the Surveyor. All parts of the plans pertaining to control such as curve data, both horizontal and vertical, shall be checked. All major structures shall be checked as to plans elevations from finish grade to bottom of footings. The Surveyor will verify the accuracy of the control points established by the Department and will also check for correlation between these points and the plans.

If errors are discovered during the plans checking or the verification process, or if control points do not agree with the geometrics shown in the plans, the Contractor shall promptly notify the Engineer in writing, and explain the problem in detail. The Engineer will advise the Contractor within 5 working days of any corrective actions which may be deemed necessary.

Directed changes to the work shall be reimbursed under subsection 925-5 of the Standard Specifications and additional contract time may be considered for any delays.

A careful check of plans and control points may prevent costly errors and delay in progress.

The preparation of field books and recording of field measurements are an important part of the survey operation. Keep in mind that these notes will serve as an official document.

All field notes shall be recorded in standard field notebooks which will be furnished by the Department unless an electronic data collector is used. Never use loose-leaf books or pads for permanent records. All field notebooks submitted to ADOT become a permanent record. Electronic files shall be compatible with Department software.

Neatness and clarity are of uppermost importance in the preparation of field notes. When preparing notes, provide sufficient detail that they may be readily interpreted by those who are not familiar with the project. Too much detail is far better than too little. Never crowd survey notes; paper is relatively cheap.

Errors made in the recording of the field notes will not be erased. Draw a line through the erroneous figures and place the corrected figures directly above. When necessary to make revisions in notes, the abandoned notes shall not be destroyed but shall be crossed out and reference made as to the book number and pages where revisions appear. When corrections are made the individual making these should date and initial each change.

Each book should have pages numbered only at the top of the right hand sheet and the contents indexed on the first pages. The date, weather conditions, and party personnel shall be shown at the beginning of each days notes. The person in charge of making the survey or recording the measurements shall affix his or her signature at the end of each days notes and on each page containing the results of a measured item.

All construction records shall be plainly marked for identification with the contents, route, project number, stations, name of Surveyor, and year.

All project records shall be delivered to ADOT upon completion of the work where they will become permanent project records.

Survey data may also be collected using an electronic data collector. When survey data is collected electronically it should be turned into the Resident Engineer on the original diskette along with a copy that is sent to CADD/Mapping illustrating the day of completion. Ensure that electronic files are compatible with Department software. Refer to ADOT *Engineering Survey Services Manual for Field Surveys* for additional information.

1150-3 Staking Structures

Refer to subsection 1108 of this Manual for culvert and bridge structure staking requirements.

1150-4 Slope Stakes

Slope stakes may be placed prior to the Contractor clearing the ground in cases of open, grassy prairie, or cultivated land, where a minimum of clearing is required; otherwise, a clearing line should be established and the roadway prism should be cleared prior to setting of slope stakes, or as specified in the special provisions. (See Exhibits 1109-4-1, 1109-4-4, and 1109-4-5.)

The slope stakes outline the cut or fill limits and the slopes to be built for the Contractor. Usual practice is to stake at all full and 50 foot (15 meter) stations and at all breaks in topography within the roadway section.

Measurements shall be from the centerline of the survey and shall be noted in the field book. In setting slope stakes the rod is read to the nearest 0.1 feet (3 centimeters) and horizontal distances measured with a metallic tape (if required) at right angles to the survey centerline also recorded to the nearest 0.01 feet (3 millimeters). In heavy work on steep hillsides, special care shall be taken in reading the rod and in setting slope stakes at right angles to the centerline and also in properly measuring the horizontal distances from the survey centerline to the point where rod readings are taken and where slope stakes are set.

The use of hand levels and the Rhodes Arc should generally be limited to determining elevations of inaccessible locations because elevations taken by this method are not as accurate as elevations read with an engineer's level. In rough terrain, parallel profile levels outside of the slope stake lines may be used to check hand level work. It is recommended that electronic instruments are used for this application to increase accuracy.

A slope stake shall be set where the cut slope intersects the existing ground surface (this is known as the "catch point"). The slope stake will be marked on the back side with the appropriate stationing. The inside of the slope stake will bear the letter "C" (indicating that a cut is to be made), the amount of cut to be made at that particular point, the horizontal distance from the centerline to the slope stake, the ratio of slope, and the shoulder distance or hinge point distance.

During the excavation operation, the life of a slope stake is of short duration due to equipment operation. Therefore, a reference to each slope stake in a cut section should be set as follows:

- A guinea shall be driven flush with the ground, outside the slope rounding area, and preferably at an even horizontal distance from the slope stake; a 10 foot (3 meter) offset is usually adequate; if not, additional increments of 10 feet (3 meters) is suggested.
- A guard stake shall be driven behind the guinea. (A guinea is a small stake driven flush with the ground surface.) The back side of the guard stake shall show the station of the section. The front side shall show the cut at the slope stake and the horizontal distance from the slope stake to the reference.

Slope rounding shall be staked to conform to the roadway standards when slope rounding is required.

In most cases, it is not necessary to offset the fill slope stake except where the fill will catch on a traveled roadway. In this event a guinea should be driven flush with the ground at the point where the toe of the fill intersects with the natural ground (catch point). The slope stake shall be placed back of the guinea and out of the traveled way at right angles to the centerline. The marking shall show the stationing of the section on the back of the stake; the front face shall show the letter "F" to indicate fill, with the amount of the fill from the guinea to the grade, shoulder point, the horizontal distance from centerline to the guinea and the ratio of the fill slope to be constructed.

A slope stake marked 0.0 should be driven at the shoulder grade point on entering a cut from a fill or vice-versa.

The standard size slope stake is 1in. X 2 in. X 14 in. (2.54 cm X 5.08 cm X 35.6 cm).

1150-5 Drainage Stakes

Drainage staking shall conform to Subsection 1110 of this Manual, except preparation of a drainage excavation book is optional.

1150-6 Miscellaneous Construction Stakes

Refer to Subsection 1112 of this Manual for miscellaneous construction staking requirements.

1150-7 Grade Stakes (Blue Tops)

Refer to Subsection 1113 of this Manual for grade stake requirements.