SURVEYING

This chapter contains the following sections:

OVERVIEW

Note: *Refer to "Conventions Used in This Manual" on page 1-3 "Conventions Used in This Manual" on page 1-3 for terminology used in this chapter and/or the order of precedence of contract documentation.*

Surveying is essential to all civil engineering projects. In transportation engineering, surveying is the single engineering function that links all the elements of a project from conception through design. Surveying provides the foundation and continuity for route location, design, land acquisition, and all other preliminary engineering. A survey sets up a basic framework of control, or positioning, that contractors and engineers use in constructing and inspecting construction contracts.

Within NDOT, both the Location Division and the Construction Crews perform surveys.

- The Location Division establishes permanent survey monuments and property lines. Per Nevada Revised Statutes (NRS), 625.040, a Nevada State Professional Land Surveyor is responsible for Location Division surveys. The Location Division is responsible to discern or set property lines and set/reset survey monuments disturbed during construction. Refer to the Location Division's *Special Instructions for Location Consultants* for more information
- The Construction Crews establish and maintain horizontal and vertical survey controls needed to construct a transportation contract. For information about construction surveying and staking, refer to the *Construction Survey Manual*. The Resident Engineer is responsible for surveys performed and the documentation of survey on a construction contract. The Resident Engineer's crew plans and coordinates all surveying efforts with the Contractor. Detailed information for construction surveying and staking is located in the *Construction Survey Manual*.

LOCATION DIVISION SURVEY

The Location Division frequently performs location surveys several years before construction begins. To eliminate extensive surveys during construction, location surveys establish permanent horizontal and vertical construction control points where they are least likely to be disturbed or destroyed. These construction control points, or reference points, are semi-permanent and are stamped with a unique name or number. Control points provide the basis for the development of design plan alignments and the surveying during construction.

The Location Control sheets list information for each control point established. The Location Control sheets are contained in the construction contract plans. If control points are found in the field, but not listed in the location control sheets, the control point should not be used, unless approved by the Location Division. When control sheets are not available, the Resident Engineer requests the Location Division to establish control.

Location control sheets list the coordinates using the Nevada State Plane Coordinate System, which means these coordinates are Northings (identifiers in the north-south direction) and Eastings (identifiers in the east-west direction). Nevada is divided into three geographic zones:

- East Zone: Clark, Elko, Eureka, Lincoln, and White Pine counties
- Central Zone: Lander and Nye counties
- West Zone: Carson City, Churchill, Douglas, Esmerelda, Humboldt, Lyon, Mineral, Pershing, Storey and Washoe counties

PRESERVING MONUMENTS AND MARKERS

Before or during construction activities, the possible loss or destruction of control points or other survey monuments may be unavoidable. In most cases, the survey control sheets of the plans provide direction on the proper treatment of the monuments. When control points or survey monuments need to be perpetuated, the Location Division or a professional land surveyor (PLS) will perform the perpetuation after construction activities have ended. State law prohibits the willful damage or destruction of survey monuments set by a PLS.

CONSTRUCTION SURVEY

Section 200, "Construction Stakeout", of the Standard Specifications, defines the Department and Contractor responsibilities for construction survey requirements. In all cases, the Contractor surveys bridge structures; additional survey requirements are identified in the Special Provisions.

Surveys for construction contracts generally consist of the following operations:

- Staking in preparation of earthwork and structure construction
- Making initial measurements to provide the basis of payment for items of work
- Establishing construction limits and construction easements
- Pilot lining (or "Marking for pavement striping")
- Establishing centerline
- Staking drainage structures
- Establishing control points
- Obtaining cross sections
- Setting slope stakes
- Setting grade stakes
- Setting clearing stakes
- Preserving monuments and markers
- Staking fence line

The common sequence of survey activities on a construction contract is:

1. Establish horizontal and vertical control points
2. Survey the roadway alignment
3. Take cross sections for quantity verification
4. Establish slope stakes

The Contractor's operations dictate surveying activities during construction. Several survey activities can be started and completed before the Notice to Proceed. When the Contractor begins operations, coordination between the survey crew and the Contractor allows work to progress uninterrupted and without delaying construction.

The Resident Engineer should allocate sufficient time to prepare survey documentation before stakeout. Survey documents are also available to the Contractor. In accordance with the Standard Specifications and Special Provisions, either the survey crew chief or Contractor then completes the following tasks:

- Compute and print alignment and slope stake data based on the original design information as defined in the plans
- Prepare grade documentation (grade book) in accordance with the *Construction Survey Manual*.

Preliminary surveying should take place prior to the Contractor beginning work and should start with stakeout of the beginning activities for the Contractor.

Several survey tasks can be completed using information contained in preliminary plans. To reduce possible delays, surveyors should complete as much work as possible before the Contractor begins work. Once the Contractor begins work on the project, surveying should be completed in a timely manner.

The Resident Engineer or survey crew chief examine the data and spot check it for accuracy. If the calculated data is incorrect or otherwise unusable, coordinate resolution with the Project Coordinator.

After construction is complete, the survey crew chief reviews all survey reports and documents for accuracy and completeness. Transfer the final survey documents and reports to the Construction Division. Include notations or corrections made during field stakeout. The survey is performed and documented to provide information for others to reproduce the survey; documentation becomes part of the permanent records.

The Resident Engineer and/or Contractor may request material quantities be surveyed to resolve discrepancies on final quantities in accordance with the applicable section(s) of the Standard Specifications.

CONTRACTOR SURVEY

The Resident Engineer assigns NDOT personnel to oversee and cross-check the work of the Contractor's surveyors. The Resident Engineer checks and verifies the Contractor's survey. It is the responsibility of the Contractor to provide the Resident Engineer with complete survey documentation compatible with Department software.

SURVEY EQUIPMENT, STANDARDS

The procurement and inventory of survey equipment is managed by the Chief Construction Engineer. The Construction Crew is responsible to keep an accurate inventory of survey equipment and provide it to the Construction Division annually. To effectively manage the Department's survey equipment, the Resident Engineers and Assistant District Engineers coordinate with the Construction Division to prioritize a replacement schedule for budgetary consideration.

The Chief Construction Engineer oversees a Survey Committee, comprised of Construction Division, Location Division, and Construction Crew personnel.

- *Construction Survey Manual*
- Applicable sections of the Standard Specifications (105.06 and 200)
- Standardization of equipment and technologies
- Recommendations for replacement schedules
- Standardization, development and implementation of a training program for Construction Crew personnel.