

*Section I*  
**General Information**

*Table of Contents*

<b>A. Introduction</b> .....	<b>I-2</b>
1. Purpose .....	I-2
2. Scope.....	I-2
3. Maintenance .....	I-3
4. Units.....	I-3
<b>B. Public Relations</b> .....	<b>I-3</b>
1. General Public .....	I-3
2. Property Owners .....	I-3
<b>C. Surveying</b> .....	<b>I-4</b>
1. Definition.....	I-4
2. Importance of Surveys .....	I-6
3. Surveying Classifications .....	I-6
a. Control Surveys .....	I-6
b. Photogrammetric Surveys .....	I-6
c. Planimetric and Topographic Surveys .....	I-6
d. Land Surveys.....	I-6
e. Construction Surveys .....	I-6
f. As-Built surveys.....	I-7
<b>D. Surveying within WYDOT</b> .....	<b>I-7</b>
1. Responsibility.....	I-7
2. Preliminary Surveys .....	I-7
3. Construction Surveys.....	I-7

# **I. General Information**

## **A. Introduction**

This version of the Survey Manual has resulted in significant format and content revisions to each section. These revisions are the result of equipment upgrades and procedural changes within the Photogrammetry & Surveys Section (P&S). The construction and land surveying operations are also no longer discussed in this manual. For information on construction surveys or land surveys consult the Construction Manual or the Right-of-Way Program.

### **1. Purpose**

The primary goal of this manual is to establish uniform surveying procedures and to define accuracy standards. By standardizing the tasks and procedures involved in data collection, the overall efficiency of the survey process is greatly increased. The main tasks involved in the creation of project mapping files include:

- Establishing project control monuments
- Collecting preliminary and supplemental surveys
- Editing and adjusting survey data
- Collecting photogrammetric data
- Merging collected data

This manual is intended to be used as a reference in the implementation and administration of surveying projects. In the case of conflict between the requirements of this manual and the requirements of contract documents, the contract documents shall take precedence.

### **2. Scope**

The Survey Manual provides general instructions for the many activities involved in a typical WYDOT project. The activities are defined in the survey meeting and are assigned to programs or sections within WYDOT or private consulting firms. These activities include but are not limited to:

- Creating land ownerships and control (LOCO) maps
- Obtaining permission to survey
- Setting project control monuments
- Placing photo control targets
- Establishing project control coordinates
- Collecting natural and man-made features
- Creating planimetric maps and digital terrain models (DTM's)

More detailed instructions concerning the use and operation of survey equipment are discussed in the Data Collection Manual. For other specific questions involving the preliminary survey process, contact P&S.

### **3. Maintenance**

It is requested that all users of the Survey Manual review the content and submit recommendations for improvement. Suggestions may consist of illustrations and/or notes to be considered for future revisions of the manual. Any suggestions should be submitted to the State Photogrammetry & Surveys Engineer.

### **4. Units**

Whenever possible, dual units are included in this manual. English units are followed by the metric equivalent in parentheses. It is important to note that all WYDOT surveys use the U.S. survey foot and not the international foot. Refer to Appendix G for more information on English and metric system units and their conversions.

## **B. Public Relations**

### **1. General Public**

The Wyoming Department of Transportation (WYDOT) is a public service organization and each employee is a representative of the Department. WYDOT's relationship with the general public, property owners, utility and railroad companies, and other governmental agencies can have a major impact on each project.

Because the survey crew often works within the highway right-of-way, they are one of the most visible groups representing WYDOT. Their conduct on the job and their involvement with the general public are extremely important in maintaining a positive public opinion.

### **2. Property Owners**

When the collection of survey data occurs outside of the right-of-way, permission to survey will be required. The Photogrammetry & Surveys Section will typically initiate contact with property owners to obtain the permission to survey. However, this activity may be delegated to the Resident Engineer's Office or a consultant. During the course of daily survey activities, the survey crew may also have contact with landowners. It is the survey crew's responsibility to assure that the landowner (or the landowner's agent) is notified prior to each entry onto their property (if requested). It is also the survey crew's responsibility to maintain the best working relationship possible with these individuals.

Prior to arriving at the jobsite, every survey crew member should be briefed on the location, scope, and preliminary schedule of the project. All of this information can be obtained from the final survey meeting report, which is made available to all involved personnel. A copy of the survey meeting report, LOCO map, and permit to survey forms should be kept in the project folder and taken to the jobsite. Specific requests or requirements made by the land owner are written in the remarks section of the E-48 form. These requests should be strictly followed to maintain a good working relationship. Refer to Section VI, Preliminary Surveys, in this manual for more information on the survey meeting report and permission to survey forms.

Occasionally, a landowner or a member of the general public will inquire about the nature of a project. Most of the questions can be anticipated and discussed beforehand with the entire crew. The answers should always be as concise as possible without speculation or guesswork. Occasionally, requests will be made for information about which the surveyor

has not been informed or does not have the authority to answer. In these situations, the surveyor should contact the Resident Engineer or the State Photogrammetry & Surveys Engineer to obtain an appropriate answer. The information should then be relayed to the questioner as soon as practical.

### C. Surveying

#### 1. Definition

In general, surveying is the technique of accurately determining the relative location of points on or near the surface of the Earth. More specifically, surveying is the science of making measurements, relative to a known datum or datums. The measurements are used to establish horizontal and vertical positions of survey monuments, legal boundaries, topographical features, etc. Surveyors often use elements of geometry, engineering, trigonometry, mathematics, physics, and law to accomplish their tasks.

There are two general types of surveys, geodetic and plane. Geodetic surveys are performed on an ellipsoid to make precise measurements over large areas. The ellipsoid is a theoretical curved surface approximating the size and shape of the Earth. GPS equipment and methods are generally used when performing this type of survey by measuring radio signals emitted from orbiting satellites to determine relative positions. Typically, vertical positions are measured relative to mean sea level by differential leveling methods.



*Figure I-1. GPS receiver and antenna.*

Plane surveys are performed on an assumed plane to compute horizontal positions. For small areas, the surface of the Earth can be approximated by a flat plane. However, plane surveys performed on larger areas require a correction factor to account for the Earth's curvature. Conventional (or optical) surveying equipment is generally used to measure distances and angles to determine relative positions. As with geodetic surveys, vertical positions are determined relative to mean sea level.



*Figure I-2. Digital level.*



*Figure I-3. Optical total station.*

### **2. Importance of Surveys**

Surveying provides the basic framework for the mapping, designing, and constructing activities inherent to transportation facilities. With each surveying project, the surveyor must be aware of the associated accuracy requirements. They must also understand how to achieve those requirements through methodology and instrumentation. To a great degree, the quality and cost effectiveness of the completed project depends upon properly performed surveys.

### **3. Surveying Classifications**

The nature of each survey will determine the accuracy requirements, which in turn will dictate the selection of surveying instruments and procedures. Refer to Section VIII, Survey Standards, for accuracy requirements concerning the collection of specific mapping features. WYDOT surveys may include but are not limited to the following types of surveys:

#### **a. Control Surveys**

Control surveys are performed to establish horizontal and vertical coordinates for a network of monuments. The project control provides the basis for all surveys from preliminary collection to construction staking. Because of this, accuracy is extremely critical when performing these surveys.

#### **b. Photogrammetric Surveys**

Photogrammetric surveys use aerial photographs to locate features on the surface of the Earth. The position of each feature is assigned horizontal and vertical coordinates and included in the project mapping.

#### **c. Planimetric and Topographic Surveys**

These surveys provide measurements that define the position and elevation of natural and man-made features within the project corridor. The collected data is plotted at a specific scale in the development of computer generated planimetric maps and three dimensional (3-D) terrain models. The design of roadway elements is based on the mapping files created by P&S.

#### **d. Land Surveys**

Land surveys, also known as cadastral surveys, are used to locate original land boundary corners, verify their positions, and re-establish if necessary. The first stage in a land survey is to research relevant documentation. These records include land titles (or deeds), easements, survey monuments, and any public or private records. Land surveys are required to be performed by or under the supervision of a Professional Land Surveyor registered in the State of Wyoming. The Right-of-Way Program should be consulted for additional requirements of the land survey.

#### **e. Construction Surveys**

A construction survey is used to locate and then stake the positions of various roadway elements. These items include alignments, bridges, drainage structures, signs and other objects for subsequent installation or construction. Construction surveys also provide the means to measure or compute various pay items. For more information on construction surveys consult the WYDOT Construction Manual.

**f. As-Built surveys**

As-built or as-constructed surveys are performed after the construction project has been completed. The survey is used to verify that the project was built to the plan specifications or to locate modifications made during construction.

**D. Surveying within WYDOT****1. Responsibility**

Per Operating Policies 18-8 and 18-16, The State Photogrammetry & Surveys Engineer is responsible for the timely and accurate collection of all preliminary surveys. Also defined in this policy, the District Construction Engineers and the Construction Program will determine and develop their own construction surveying methods and procedures.

The Photogrammetry & Surveys Section is responsible for defining procedures used for collecting preliminary survey data. P&S is also responsible for developing a set of survey codes that define natural and man-made features. All preliminary survey data is analyzed, edited, and adjusted before it is included in the planimetric mapping files and terrain models.

**2. Preliminary Surveys**

During the reconnaissance meeting, the type of preliminary survey (aerial or field collected) and mapping limits are determined. The specifics of each surveying activity are then covered in detail during the survey meeting. Once the surveying tasks have been assigned and a completion schedule for each task has been determined, the preliminary survey phase can begin. As mentioned earlier, survey data collected during the preliminary phase is used to create mapping files that initiate the roadway design process. Refer to Section VI, Preliminary Surveys, for a more detailed description of the preliminary survey process.

**3. Construction Surveys**

After the final design has been completed and the project contract has been awarded, construction surveys establish lines, grades, and elevations. All construction surveys are based on the project control previously established by P&S. The construction staking surveys delineate work areas and provide a guide for the contractor during construction activities. Construction staking also enables WYDOT personnel to compute quantities of pay items and determine compliance with the design and contract specifications.