

# Chapter 1

## Introduction

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# Chapter 1 Introduction

## **1.1 Purposes of Manual**

The principal purposes of this Manual are:

- To establish and maintain survey standards.
- To improve the overall efficiency of the NJDOT's survey function.
- To provide a single reference source for surveying policies, procedures, and information.
- To secure an optimum degree of statewide uniformity in surveying.
- To serve as a reference for new employee orientation.
- To provide source material for developing training.
- To help employees in other offices gain a better understanding of surveying and its proper relationship to other NJDOT activities.

This Manual, in general, covers surveying policies, procedures, and appropriate reference material. It is not a textbook or a contract document, nor is it a substitute for surveying knowledge, experience, or judgment. Although portions include textbook material, this Manual does not attempt to completely cover any facet of surveying. General policies and procedures, such as those related to safety, that apply to all NJDOT employees are not reviewed in this manual. They are omitted from the survey manual for two reasons. The first is to avoid inconsistencies and disparity between this manual and other established NJDOT policies and procedures. The second reason for not including them here is to avoid unnecessary revisions of this manual whenever policies and procedures change.

## **1.2 Importance of Surveys**

- Surveying is basic to all civil engineering works. In transportation engineering, 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 that contractors and State engineers use in building and inspecting transportation projects.
- Surveying provides a thread of continuity throughout an engineering project. Surveying is the single engineering function that links all the elements of a project: from conception; through design, land acquisition, and construction; to final monumentation.
- To a great degree, the acceptability and cost effectiveness of planning, land acquisition, design, and construction are dependent upon properly performed surveys.

### **1.3 Definition of Surveying**

The traditional definition of surveying is:

*The art of making measurements of the relative positions of natural and man-made features on the earth's surface, and the presentation of this information either graphically or numerically.*

In 1990, the International Federation of Surveyors (FIG) adopted a more contemporary definition of surveying. This definition is more specific about the particular activities involving a surveyor.

According to FIG, a surveyor may be involved in one or more of the following activities that may occur either on, above or below the surface of the land or the sea and may be carried out in association with other professionals:

The determination of the size and shape of the earth, and the measurement of all data needed to define the size, position, shape, and contour of any part of the earth surface.

1. The positioning of objects in space, and the positioning and monitoring of physical features, structures, and engineering work on, above or below the surface of the earth.
2. The determination of the position of boundaries of public and private land, including national and international boundaries, and the registration of those lands with the appropriate authorities.
3. The design, establishment and administration of land and geographic information systems, and the collection, storage, analysis and management of data within those systems.
4. The study of the natural and social environment, the measurement of land and marine resources, and the use of the data in the planning of development in urban, rural, and regional areas.
5. The planning, development, and redevelopment of property, whether urban or rural land.
6. The assessment of value and management of property, whether urban or rural land.
7. The planning, measurement, and management of construction works, including estimate of cost.
8. The production of plans, maps, files, charts, and reports.

This list includes some activities that are not universal to all countries or organizations, because it was prepared by surveyors from different countries. Nevertheless, it is informative to know the extent of the scope of surveying.

In recent years there was a trend to use the term Geomatics instead of surveying. The rationale for Geomatics is that surveying has changed and expanded beyond what people traditionally considered as surveying. Since the adoption of the term Geomatics is not universal, the term will not be used in this edition of the survey manual.

In summary, surveying is performed to determine the relative location or positioning of points on or near the earth's surface. More specifically, surveying is the science of making measurements, relative to known or assumed datum and standards, and applying the principles of mathematics to such measurements to determine existing or future horizontal and vertical position, form, area, magnitude, boundaries, and extent of land parcels and topographical features.

### **1.3.1 Types of Surveying**

There are numerous types of surveying. The classification is based mostly on describing a specific surveying activity such as construction surveys, etc. Sometimes the classification is determined by the methodology used to perform it (i.e., geodetic surveys). The following are some of the types of surveying:

- Geodetic Surveys - Surveys that take into account the true shape of the earth. Used mainly to establish control networks on a mathematical datum that closely approximates the shape of the earth. The introduction of the Global Positioning System (GPS) and Geographic Information System (GIS) made this type of surveying essential in most projects.
- Plane Surveys – Surveys that assume that the earth is flat. This assumption simplifies the procedures and computations of surveying projects. For small, isolated and local projects this assumption may introduce only small and negligible errors.
- Control Surveys – Made to establish the horizontal or vertical positions of arbitrary points to be used as a reference in prior and future surveys.
- Property Surveys - Surveys that include retracement and establishment of property boundaries including highway Right-of-Way. These are also known as land or boundary surveys.
- Topographic Surveys – Made to determine the configuration of the ground.
- Engineering Surveys - Surveys performed for the design and cost estimating of fixed works.
- Route Surveys - Surveys performed for locating, designing, and constructing transportation facilities.
- Construction Surveys - Surveys that establish stakes in the ground, and other like reference points, at known horizontal and vertical positions to define location and size of fixed work contract items, enable inspection of contract items, and serve as a basis of payment for work.
- Hydrographic Surveys – Surveys that determine the configuration of the bottom of a water body.
- Aerial Survey or Photogrammetry - A method of measurement which is applicable to various surveying activities. Normally, it utilizes aerial photographs and specialized office equipment to perform control, engineering, topographic, and other surveys.

### **1.3.2 Related Activities**

Surveying also includes the related activities of:

- Cartography - The design and production of maps compiled from existing data, and the development and maintenance of map information systems.
- Geographic (Land) Information Systems(GIS/LIS) - An organized collection of computer hardware, software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced information

## **1.4 Organization**

### **1.4.1 Survey Sections**

In NJDOT, Survey Sections may be organized either on an area or on a functional basis. In the "area" organization a Survey Operations Manager is responsible for all surveys, of whatever type, in a given area. This area may be a region, specific counties, district, or the entire state. Under the "functional" system, individual field crews are assigned to specific types of surveys; for example, control surveys, planning and design surveys, land surveys, or construction surveys.

### **1.4.2 Survey Functions**

Basically, a Survey Section will perform and provide all surveying services and data required. Surveying functions may include, but not be limited to the following:

- Establish the New Jersey State Plane Coordinate System along transportation corridors by providing a network of horizontal control surveys.
- Establish project control surveys.
- Obtain supplemental data for design and special purposes.
- Perform land surveys for appraisal, deed descriptions, acquisition, relocation, and monumentation.
- Perform Right-of-Way and construction staking, including bridge staking.
- Perpetuate existing survey monuments.
- Establish monumentation.
- Prepare Centerline Survey Plats.
- Maintain files of horizontal and vertical data.
- Furnish horizontal and vertical data to other public agencies and private surveyors.
- Cultivate and maintain proper relations with private citizens, public agencies, private surveyors, and other Departmental branches.
- Monitor survey costs and evaluate efficiency.
- Provide training for Survey personnel.

### **1.4.3 Survey Crew**

The survey crew shall consist of sufficient employees to safely and efficiently complete the proposed work. It shall include a crew chief and survey assistants. Crew size may be increased as required by operational considerations such as: safety, survey type, terrain, survey priority, and weather. In addition, crew size may be reduced if safety of personnel or the public is not jeopardized by the reduction.

#### **1.4.3.1 Survey Crew Daily Report**

A. Reporting - Daily, each crew chief should record his or her crew's operations.

Entries shall be made daily, regardless of whether the report is submitted on a daily or weekly basis. Errors are much more probable when entries are delayed for one or more days and made from memory.

B. Submittal - Submit this report either daily or weekly as directed by the Survey Operations Manager.

C. Information to Report - Include the following minimum information:

- The date(s) the report covers.
- The identification of the project(s) on which the crew worked.
- The names of the survey crew members and the number of hours they worked on each project. If a regular crew member does not work, show the number of hours on leave and the type of leave, such as vacation or sick leave.
- In the narrative portion of the report briefly discuss weather conditions; the location; type of work performed; important conversations with the contractor, engineer, property owners, or others; and any other matters of importance, including damages.

D. Other Information - This report may also be used to record any other information the crew chief desires to make a part of the written record.

E. Precautions - Carefully prepare each Survey Crew Report. Survey Crew Reports should be as neat and accurate as survey notes.

## **1.5 Public Relations**

### **1.5.1 General**

- A. Importance - Public relations is one of the more important duties of the surveyor. This is especially true for surveyors who enter onto private property. The wide variety of situations encountered by the surveyor requires a constant awareness of the rights and needs of others. The ability to adjust to these needs is also required.
- B. Basic rules - Common sense and common courtesy are the best rules in any form of public relations. Be prepared, and try to create a good impression when meeting the public. First impressions, whether good or bad, are often lasting. Maintain a pleasant, professional attitude at all times and be informed about your job. The impression you create thereby will be a credit to you, your profession, and the Department of Transportation.
- A crew chief contacts many individuals: property owners, other surveyors, park rangers, etc. Often it is necessary to leave a telephone number and an address with these people. Crew chiefs may use, when available, business cards or office contact number to help in fostering good relationships with others. At other times, the business card can simply be a means of introduction or of creating goodwill. All employees should carry their State issued identification cards at all times.
  - The value of developing good public relations cannot be over-emphasized. Time and money are saved, and the work is more pleasant for all concerned. Public contact enables a surveyor to improve his or her ability to meet and deal with people. This increases personal stature and the stature of the surveying profession. In addition, it improves the Department's image.

### **1.5.2 Internal Relations**

- A. Survey Crew - Proper relationships within a survey crew are necessary if individuals are to function as a team.
- Crew chiefs can help maintain good crew relationships by keeping crew members well informed about individual and crew roles and the duties for each job.
  - Crew chiefs and supervisors should be kept informed of important developments. *They should not be put in the embarrassing positions of learning important information from outside sources.*
- B. Region - Good relations among region personnel can be maintained through good communications and a clear understanding of responsibility. When in doubt about the requirements of a survey request, telephone the requester for clarification.
- C. Department - Relations and contacts with other Regions and with Central Office should be courteous and business-like.

### **1.5.3 Reporting Unusual Occurrences**

A vital part of public and internal relations is the prompt reporting of unusual and unexpected occurrences.

A. Types of Occurrences - These are incidents which:

1. Affect public safety.
2. Involve damage to NJDOT facilities.
3. Could lead to litigation.
4. Involve NJDOT and would be considered newsworthy.
5. Involve other governmental agencies on matters of mutual interest that would affect NJDOT.
6. Might have a derogatory effect on the NJDOT.

B. Examples:

1. Traffic accidents.
2. Flood damage, landslides, and earthquakes.
3. Damage to or failure of facilities.
4. Public protests or demonstrations affecting use of facilities.

C. Reporting - All incidents must be reported immediately. A written report of observations may be required. Notify the Regional Survey office and/or immediate supervisor if occurrence is during normal working hours. In addition to the above, minor damage, or damage which does not affect public safety must be reported to the appropriate Regional Maintenance supervisor, or the project engineer if on a construction project. Thefts of State equipment or supplies must be reported to the New Jersey State Police. Additional reporting requirements can be found in Departmental Policy and Procedure directives.

### **1.5.4 Relations With the Public**

- Attitude - Each employee is a representative of the New Jersey Department of Transportation. Each is responsible for developing and maintaining public goodwill. The Department is a public service organization; our behavior reflects on the Department.
- Conduct - The outdoor nature of surveying keeps surveyors in the "public eye" much of the time. Work should be accomplished efficiently and with a minimum



of idle time. Good-natured relations among crew members helps morale. However, around the public, you must be prudent in oral and sign communications.

- **Direct Contact** - All direct contact with the public should be pleasant, courteous, and businesslike. This includes answering questions, listening to criticism (justified or not), and listening to suggestions.
- **Answering Questions** - In the field, refer questions concerning the work to the crew chief who should answer each appropriate question for which he or she knows the facts. If any doubt exists, the person asking the question should be referred to the crew chief's immediate supervisor. Probabilities, conjectures, or statements which might be misunderstood or misinterpreted should be left unsaid.

### **1.5.5 Relations With Property Owners**

Dealing with property owners is a most vital phase of public relations. Property owners are the ones who could be directly affected by the survey and, possibly, by subsequent construction. They will naturally take a close interest in any intrusion on their property, no matter for what purpose.

Good relations developed by conscientious surveyors carry over in the owner's attitude toward other NJDOT employees.

### **1.5.6 Entry on Private Property**

#### **1.5.6.1 Right of Entry**

NJSA 27.7-21g and NJSA 45:8-44.1 gives the State, acting through its employees, the right to enter private property to make surveys. See Appendix A for further reference.

#### **1.5.6.2 Pre-Entry Contacts**

NJSA 27.7-21g and NJSA 45:8-44.1 gives the State, acting through its employees, the right to enter private property to make surveys. See Appendix A for further reference.

#### **1.5.6.3 Notification**

NJSA 27.7-21g and NJSA 45:8-44.1 gives the State, acting through its employees, the right to enter private property to make surveys. See Appendix A for further reference.

Before a State employee enters a property not in the State's possession as of the time of entry, a written notice, in accord with the standard approved form, shall be sent to the owner of record by certified and regular mail or personally at least three days prior to entry (three days must be added to this time frame when notice is by mail) the notice shall only be signed and sent by a State employee even though entry is for a contractor or consultant. The notice shall state the purpose of the entry, the approximate date and time during which the entry will last and what specific activities will take place. The

approximate anticipated length of the entry shall be included. The owner of record must receive this notice before any entry is actually carried out, even where the property is vacant or not farmed or where no physical disturbance of the property would occur.

#### **1.5.6.4 Objection to Entry**

When a property owner or tenant objects to entry, DO NOT ENTER! If a property owner claims actual or anticipated damage or interference after a survey has begun, immediately leave the property. The Regional Survey Supervisor should be alerted and actions according to DEPARTMENT Policy and Procedure shall be taken to gain right of entry. The actual negotiation will be handled by the Regional Survey Supervisor.

#### **1.5.6.5 Conduct and Property Care**

Conduct operations in a manner that will not create ill feelings in property owners or tenants. This will be accomplished by:

- Survey Methods - Choose the survey method which will have the least effect on the land.
- Stake Location - Place stakes and other markers where there is little likelihood of them being a hazard.
- Property Rehabilitation - As nearly as possible, leave the property in the condition that existed prior to the survey. Repair any damage, fill any holes, and restore the property to its original condition, when possible. If you must temporarily leave a hazard created by your work, protect people and animals by the use of protective devices, such as cones, barricades, and portable fencing.
- Removal of Hazards - Remove all temporary and hazardous survey stakes and other potentially hazardous items from the work area after their usefulness has ended. The crew chief is responsible for determining which items to remove and when to do so. However, each crew member should call the crew chief's attention to possible hazards. Examples of items to be removed are stakes across fields which are to be mowed, stakes in pedestrian areas, back sights and foresights, and photogrammetry ground control materials.
- Concern for Children - Consider hazards to children when setting or leaving survey stakes.
- Litter Removal - DO NOT LITTER. Paper, stake fragments, and other trash shall be placed in litter cans in State vehicles. Litter shall not be left on private or on public property.

#### **1.5.7 Private and Public Agencies**

##### **1.5.7.1 Utility Companies**

Survey data, new development, and other survey information are freely exchanged between utility companies and public agencies. This practice exists at the federal, state, county and local level and includes both public and private utility companies. To

maintain this goodwill and a cooperative attitude, promptly reply to requests from such agencies and companies.

### **1.5.7.2 Private Surveyors**

Land surveyors, photogrammetrists and engineers in private practice have valuable information in their files which we frequently need. Their attitudes and the extent of their cooperation results, largely, from previous contacts. Survey Sections should cultivate good relationships with private firms. Extend full cooperation to them whenever possible (this includes access to our control data and right of way engineering information).

### **1.5.7.3 Railroads**

Property which a railroad owns primarily as a landowner (land which does not carry rails) should be regarded as any other private property.

Land which carries rails is called "operating Right-of-Way". Before entry is made on such property, a notice of entry must be sent. All personnel entering railroad property must have a valid ID indicating railroad safety training within the current year. Right of entry permit must be obtained from Railroad Company.

Stay alert at all times, and remember that you are there to survey safely. Railroad operations are not to be disrupted.

### **1.5.7.4 Public Lands**

Public lands should be treated as special types of private property where attention to additional regulations is required. Some of the types of public lands where you might survey are state parks, national parks, local parks, national forest, wilderness areas, state and national monuments, and historical sites.

#### **1.5.7.4.1 Pre-Entry Activity**

Before surveying in agency areas:

- A. Contact the person having responsibility for the public facility. (This contact should be made by the crew chief or the crew chief's immediate supervisor.)
- B. Explain the need for the survey, its anticipated duration, and any probable effects on the facility.
- C. Learn the requirements for working in these areas: permits, fire regulations, brush cutting procedures, and restriction on vehicular operations. In addition, the Park Supervisor (Ranger) might be able to give valuable information, such as the locations of control points and access roads.

- D. Orient each surveyor involved. Tell each about all survey requirements.
- E. Obtain required permits.

Forest and park rangers and supervisors are cooperative and helpful when all rules are obeyed. Consulting them in advance will ensure that regulations will not inadvertently be broken.

#### **1.5.7.4.2 Work Activity**

- A. Survey within all the requirements determined above.
- B. Obtain additional permits when work arises which is not covered by an active permit.
- C. Consult with the ranger or supervisor when additional "non-permit" work arises.
- D. Inform the responsible ranger or official of your daily location.
- E. Notify the responsible official when you leave and when you reenter, when there is a substantial time break in the survey.

#### **1.5.7.4.3 Wilderness Areas**

Surveys in wilderness areas are subject to very stringent regulations. **DO NOT WORK** in these areas prior to receiving approval from U.S. Forest Service. Usually, a permit will be required. Obtain approval for a survey in a wilderness area with the forest supervisor in charge of that area.

#### **1.5.7.4.4 State Parks**

The New Jersey Department of Parks and Recreation requires permits for surveys in State parks. For reconnaissance surveys, the Regional Survey Supervisor or crew chief might be able to arrange for surveying without a permit by having a thorough discussion with the park supervisor.

#### **1.5.7.5 Law Enforcement Agencies**

When a survey requires night work, notify local law enforcement agencies. This enables them to be aware of the source and reason for the appearance of "unusual" lights and activity.

#### **1.5.8 Cemeteries**

General Guidelines - Do not let survey activities interfere with the operation or maintenance of cemeteries. Contact cemetery owners to see if they have any special entry requirements. Pet cemeteries should be handled in the same manner.

Undocumented Sites - Be on the lookout for old cemeteries, large or small, when working in rural areas. In addition to obvious headstones, look for enclosed areas, unusual mounds of grass, and other indications. If evidence indicates a cemetery, the crew chief should promptly report the evidence to the Survey Section so proper approval can be obtained. When a cemetery or individual gravesite is not discovered until the construction phase, many problems can develop.

### **1.5.9 Archaeological Sites**

Site Recognition - Most potential sites can be recognized only by a trained archaeologist. However, the more obvious evidence can be recognized by a layperson. Watch for such things as mounds of earth, fossil beds, charcoal pits, circular pits, and unusual stones. The archaeology departments of local colleges can furnish information on recognizing potential sites. This Bureau of Environmental Services can furnish information on recognizing potential sites.

Reporting a Site - When a site is located, the archaeologist needs considerable time for exploration. Therefore, promptly notify the archaeological representative.

Site Integrity - Leave the site in its "found" condition. Leave artifacts, undisturbed, at the site.

## **1.6 Safety**

### **1.6.1 "Code of Safe Surveying Practices"**

NJDOT employees survey in many different challenging environments. Rugged terrain, high-speed traffic, tools used, and construction equipment are some of the elements that typify survey hazards.

Most people have one thing in common with many who have experienced an accident: they believe it could not happen to them. A meaningful safety program requires that each Survey employee acknowledge that, "It can happen to me". Each must also ask, "What is my responsibility?", and "What can I do to keep it from happening?"

NJDOT employees should consult and follow the safety codes and procedures as outlined in the most recent "Safety Manual" of the New Jersey Department of Transportation. Each field employee shall have ready access to this manual.

- All field personnel shall have a practical working knowledge of this Manual.

- Each employee is charged by law to do everything reasonably necessary to protect life, safety, and health of everyone and comply with all occupational safety and health regulations which are applicable to his or her job.
- Promptly report injuries and accidents and unsafe conditions, tools, and equipment.
- Report to work each day in a physical condition that will enable functioning with agility and alertness.

Supervisors, crew chiefs and/or Field Supervisors are responsible for:

- Monitoring safety conditions and performance.

### **1.6.2 First Aid**

The crew should be equipped with a First-Aid manual, and an approved first-aid kit.

## **1.7 Communications**

Good communications are essential to efficient and safe survey operations. Survey employees shall strive to communicate as effectively as possible.

Besides the usual verbal and written communications, survey may directly or indirectly use the following communication systems:

- Telephones.
- FCC accepted mobile, hand-held and base station radios, and fax machines.

NJDOT employees should follow the established regulations and proper conduct with regard to using and operating these devices.