Chapter 12

FIELD WORK: Requests, Procedures & Reviews

Introduction

Fieldwork obtained through conventional topographic ground survey is the typical method used to generate accurate base data for plan development. However, there are instances where base plan data may be compiled from other data sources including existing plans, aerial or topographic maps, and land survey descriptions (i.e., deeds). Without accurate and timely data to develop project designs on, it is almost impossible to effectively and efficiently design projects.

It is essential that the designer(s) review the project in the field to fully comprehend the correlation between surveyed plan and section information, and actual field conditions, as well as verify that the field survey performed is accurate. This helps avoid missing or misinterpreting the context of the surrounding area, and assists in identifying field issues that should be considered within the elements of the proposed design.

Other techniques for acquiring information about the project site involve aerial survey, aerial photography, photogrammetric mapping, GPS mapping, subsurface (utility and geotechnical) investigations, drainage and bridge inspections, design team and environmental field inspections. These techniques are briefly described in this chapter, with the emphasis being on field surveys obtained by conventional field methods.

The 2010 *Survey Manual* (refer to the Highway Design Document Library, (http://www.nh.gov/dot/org/projectdevelopment/highwaydesign/documents.htm) and revisions hereto adopted by the NHDOT outlines procedures to be used by the Survey Section of the Bureau of Highway Design. The designer should have a general knowledge of the contents to better understand the practical work of field surveying.

Field Survey & Base Plan Preparation

Responsibility

The Highway Design Bureau's Design Services Section is comprised of the Survey Section and the Utilities, Hydraulics, and Rail Section. Therefore, the Chief of Design Services is directly responsible for work completed in both sections. With respect to survey, the state is divided into two east/ west sections, I-93 being the approximate dividing line. Each section is assigned to one of two Survey Area Supervisors who in turn manage a number of field survey crews. Requests for survey work are typically directed to the respective Survey Area Supervisor, and copied to the Chief of Design Services. (See Appendix 12-2 for Survey Request Slip)

Survey work is expensive, time consuming, and places field personnel in close proximity to traffic, a particular concern on high speed, high volume facilities. It is the responsibility of the highway (or bridge) designer to limit the requested survey

information to that which is necessary to properly complete the design. However, it is also important to obtain enough information to avoid remobilizing survey crews and other ancillary resources, such as traffic control, which can be an expensive portion of the survey process should lane closures, shadow vehicles, uniformed officers with vehicles, etc., be needed to safely gather the data.

Base Data

Base data may include the following:

- Photogrammetric or Aerial mapping tied to the State Plane Coordinate System. Aerial mapping typically provides 2 dimensional information, an X (northing) & Y (easting); while Photogrammetry can be either 2 or 3 dimensional with an X (northing), Y (easting), & Z (elevation).
- Old record (As-Built) project plans
- Bridge inspection and drainage reports
- Driveway permits for major traffic generators; District approves permits for business and site developments and maintains a record of the granted permit
- U.S. Geological Survey Quadrangle sheets
- Traverse lines tied to the State Plane Coordinate System
- Written and verbal information
- Major property line information on plats or subdivision plans
- Municipal and/or Public utility plans showing manhole locations, valve and shut-off locations, hydrant locations, transmission and distribution lines, and other visible and/or subsurface features.
- Subsurface utilities obtained from plans provided by the utilities

Developing Base Plans without Survey: In some instances, when the project scope is limited to basic pavement rehabilitation with minimal drainage and guardrail improvements, base plans are produced without the benefit of field survey. See Appendix 12-1 Existing Data Locations for suggested locations of existing data for project background information and base plan development.

Horizontal Control

The New Hampshire State Plane Coordinate System of 1983 is used on all NHDOT projects. The advantages of using the State Plane Coordinate System are:

- All control surveys are on a single datum, and thus the relationship of one survey to others is established.
- All subsequent surveys can originate and close at stations of known position and reliability. Therefore, the reliability of the new survey can be easily determined and adjusted, if necessary.

- With GPS technology, points can be readily reestablished if geodetic monuments are unavailable.
- Route surveys can be started at various points along the route with assurance that the survey sections will "fit."

The datum must be noted appropriately on all plans.

Vertical Control

For all projects involving survey, elevations of all Geodetic Monuments and the subsequent traverse points are relative to National Geodetic Vertical Datum of 1929 (NGVD29) or to the North American Vertical Datum of 1988 (NAVD88). The datum used must be noted on all plans. The designer will confer with the Survey Area Supervisor to confirm whether the 1929 or 1988 vertical datum was utilized on their particular project. This information is necessary to complete the survey note contained under the 'General Notes' on the 'Index of Sheets and General Notes' sheet in the contract plans. (Note: Survey will put a note in the Survey Data Recorder (SDR) file stating what datum was used.)

Types of Survey

Preliminary (Pre-Construction) Surveys

Preliminary surveys are defined as any survey work performed prior to advertising the project for construction. This includes establishment of a primary traverse and complete 3 dimensional (x,y,z) topographic ground survey coverage of the project area. Particular attention must be given to all details on the surface, underground (i.e. utilities, drainage), or overhead, which may in any way affect the location or construction of the proposed improvements.

The purpose of the preliminary survey is to facilitate the preparation of preliminary plans. When the project scope is fully established, the preliminary survey can be a complete contract plans survey.

Prior to entry onto any private property, Right-to-Enter letters are sent to all property owners within the project area. Property owners are given ten (10) working days to respond to these letters once they have been sent from NHDOT Headquarters.

When information from old as-built plans is outdated, or insufficient, to provide the necessary project plan coverage with sufficient accuracy, new survey may be requested. Some projects of limited scope such as, guardrail replacement or pavement rehabilitation, may utilize existing as-built plans or basic field data that result in simplified plan "sketches" without full survey. Essential data pertinent to the intent of the project is verified and/or located in the field by the Design personnel. Photographs, videos, van data (available through Materials & Research), and various intranet maps, may be of value as they provide additional reference material, and may eliminate additional field reconnaissance, while also providing a visual record of the existing preconstruction condition. In the end, the final base plan should provide a sufficient amount of information to permit the various stakeholders (ROW,

Environment, Utilities, etc.) to utilize it to complete their work, and avoid rework or unnecessary delays.

With the advent of computer aided design and drafting (CAD/D) and Total Station/Data Recorder surveying technology, the need to return to the project area is less likely than in the past. The preliminary survey covers a wide area and includes river grids, drainage outfalls and channels, wetland delineation and information around structures that may be necessary for quantity calculations. In some instances, the survey crew is not required to return to the project area until the proposed construction line layout is requested for geotechnical investigation or expanded survey is required.

There are times when new site developments occur within the project limits after the initial survey. New developments that alter curb lines, change drainage, and modify slope conditions, etc., should be added to the existing conditions drawing so contract designs and quantities are as accurate as possible. If a site plan can be obtained, the new information should be added to the (EDD) existing digitized detail drawing. If a site survey is obtained, the information is added to the (EXD) existing detail drawing. NHDOT naming convention standards for CAD/D drawings are located on the intranet at http://dotweb/cadd/msv8/existdetail.htm

With rare exception, profiles, cross-sections and river grids are typically produced electronically, based on surveyed information. If any alignment changes are necessary, adjustments are made using CAD/D, and new profiles, cross-sections and grids are produced. Preliminary Design's Plan Prep section is responsible for developing and field checking a 3-dimensional ground model based upon the Survey Data Recorder (SDR) information gathered. If there are any inconsistencies, Plan Prep will contact the Survey Area Supervisor to resolve the issue(s).

Construction Line Layout

Once a project advertises, the Survey Area Supervisor will contact the Design Team to obtain a COGO (Coordinate Geometry) report of the proposed construction alignment, so a field crew can lay out the alignment in the field prior to construction. (See Appendix 12-3 Sample COGO Report) In addition, a COGO report of proposed relocated utility pole locations is provided so the field crew can simultaneously lay out the utility locations with the alignment.

Post Construction Surveys

Post construction surveys are those surveys completed after construction is complete. Though they are no longer common practice, surveys following completion of construction are sometimes requested in conjunction with a final audit to determine final quantities of certain pay items and show the as-built location of the improvements made as part of the project. As a minimum, the Contract Administrator will request that survey be completed to accurately locate bounds constructed as part of the project for accurate record of the right-of-way.

Computations: Traverse & Benchlines

The Survey Section is responsible for computing the closure of horizontal traverses and adjusting bench runs before turning them over to the design teams. Computations and adjustments are made by computer. The original computations are retained in CAD/D for use throughout the duration of the project.

Field Books: Plotting Detail & Descriptions

The Plan Prep Section of Preliminary Design generates a 3-D ground model, plots detail and topography, using SDR information and field book descriptions generated by the Survey crews.

Field books contain descriptions for various ground features identified in the field and are used as a guide for Plan Prep to produce an accurate computer ground model and plans. Any questions regarding information shown, or not shown, should be resolved by referring to the field book. Field books are hard copy notebooks of survey information gathered by a survey crew. Recent practice is to have this information scanned and stored electronically. (See Appendix 12-4 Scanned Field Book Location & Sample) (Note: Not all crews have access to this yet, but hopefully will in the near future.)

Survey crews are required to log the date, weather, survey members and their duties at the start of each work day. Field books allow the crew to make notes regarding specific details (pole numbers, fence & structure types, etc.) of the survey that are not readily stored in the SDR file.

Field books also specify the reference traverse used for the topographic locations. All traverse points are normally shown on the plan. The Survey Section will make every effort to number the traverse points so as not to duplicate point numbers.

Standard graphic symbols and drafting practices are used to provide consistency in the preparation of plans. Standard abbreviations and symbols used in field survey books are illustrated in the *Survey Manual* (2).

Other Field Information

Right-of-Way Monumentation

All existing right-of-way monumentation (bounds, pins, etc.) is to be located by survey as part of the initial survey request. Coordinate this initial request with the Bureau of Right-of-Way so ROW can prepare a plan showing anticipated locations of monumentation based on record and site plans.

Land Boundaries

Land boundary markers may have legal, as well as historical, significance. Both considerations should be recognized. Surveyors are instructed to record the markings on monuments, and designers must be aware that plans should show the location accurately.

The Commissioner is responsible for making policy decisions concerning re-establishment of monuments, or dealing with historical markers.

Legal

Boundary markers established by public surveyors must not be moved without authority of the NHDOT. Surveyors of the NHDOT locate boundary markers and reference them for later re-establishment if necessary. Government benchmarks (there are multiple agencies with benchmarks, including USGS), triangulation monuments, or officially set landlines of public surveys, must be referenced or replaced. This work should be coordinated through the Survey Office with the responsible authority. Work to replace or re-establish these features may require services of a licensed land surveyor through a statewide surveying consultant or contract item.

Historical, Cultural, Conservation, and Hazardous

Old, well-established landmarks may have historical significance and must be identified as a potential environmental (cultural resource) consideration. A marker or landmark may be a granite survey bound, stone, heavy iron stake, or historic tree. The designer will confirm that the project's Environmental Manager (refer to Chapter 1 - Related Bureaus and Organizations, Bureau of Environment section, Chapter 2 Project Development Process, and Appendix 12-6 for Bureau of Environment Organization Chart) is coordinating early on with any historical or conservation groups for the project area. The project surveyors should be alerted if there are any known or suspected historical landmarks, cultural, conservation, or hazardous sites, within the project area.

Environmental Delineation – Wetland & Invasive Plants

Every project will involve coordination and review by the Bureau of Environment. Design personnel should take note of any wet areas, invasive plants, and active stream crossings identified during field reviews. The designer will coordinate early on with the project's Environmental Manager for wetland and invasive plant delineation, and stream assessments, as environmental permitting and stream crossing rules influence drainage design and project schedule with respect to permitting.

Bridge, Large Culvert, and Major Retaining Wall Sites

The Bureau of Bridge Design is typically responsible for requesting more in-depth survey and boring information for bridges including any major drainage hydrographic surveys. Waterway openings at bridges as well as major drainage structures are always given special consideration by the survey crews. The Bureau of Materials and Research should always be consulted for foundation suitability and boring locations when contemplating installation of large box culverts and retaining walls.

High-Water Marks & Eroded Areas

Survey crews and field reviews should note the presence of debris piles or wash within the project limits. When warranted and possible, designers should consider contacting maintenance personnel or nearby property owners, to obtain information on flood

frequency and elevation. Many times, the reported frequency will coincide with major storms of record, which is useful information for the drainage designer. Significant erosion or washouts should be noted and reported.

Field location of Borings

Locations of subsurface explorations (test borings and test pits), both proposed and actual, are recorded in the field notes. Although the designer will typically refer to the recommendations in the Geotechnical Report (prepared by the Bureau of Materials and Research – see Chapter 1 Related Bureaus and Chapter 2 Project Development Process), the designer may need to refer to the field notes occasionally to check ground elevations to compare with the subsurface exploration logs. Subsurface exploration records are prepared and filed by the Bureau of Materials and Research.

Utilities

Utilities of all types, aerial, surface and sub-surface features for underground, including: water and gas shutoff valves, electrical pull boxes, manholes (sewer, electric, telephone), poles, etc., are field located when possible, and then supplemented using 'as-built' plans provided by the utility companies. Be aware that 'as-builts' are not always accurate and are required to be verified by the individual utilities early in the utility coordination process. Depending on project needs, more exact methods of locating utility locations may be required. See the Subsurface Investigation – Geotechnical and Utility section below for additional information.

Septic Systems & Wells

Existing septic systems and wells that could be potentially impacted by a project should be located by survey when possible. Often, there is no physical evidence of the septic system, and wells can be missed by survey when not obvious. Occasionally locations can be obtained from site plans filed with the Town, or permit applications filed with the Department of Environmental Services.

Design Team Field Reviews

See Appendix 12-7 Field & Emergency Review Guidelines for suggested field review procedures, equipment, and data.

Aerial Survey

Aerial surveys performed by others for use by the NHDOT consist of enlarged photographs or photogrammetric mapping to be used for preliminary and/or final design purposes allowing for preparation of a 2-dimensional base plan.

There are a number of combinations of aerial photographs and maps, which can be used by the designer. In all cases, there are limitations to the accuracy that should be recognized. In particular, enlarged, uncontrolled photographs are less distorted in the center. However, all original distortion is magnified. The enlargement sometimes gives the designer 'scale confidence' that is not justified.

Another significant limitation of aerial survey is the density of vegetative cover. This is of particular concern in areas with coniferous vegetation. The areas where deciduous vegetation is prevalent can often be worked around by performing flights during late fall/ early winter, prior to snowfall, when the leaves have fallen and do not obscure the ground.

There are however, significant advantages to using aerial enlargements, especially from a preliminary design standpoint. For example, the area of interest can be determined with reasonable accuracy from photographs and this information (embellished) can be used as a location map for presentations or as a mark-up to request more accurate ground survey.

Accuracy Limitations

When dealing with photogrammetrically prepared, planimetric or topographic maps, the designer should be aware of the accuracy to be expected. The Department has established two sets of specifications for photogrammetric mapping. The criteria for the *Planning* level specification are the national mapping standards and are listed below in Table A. The *Engineering* specification requires the information to be processed using more accurate control. This requires extensive ground control set by the Department's Geodetic Section. The specific criteria are listed below in Table B:

TABLE A *(Planning Level accuracy)*

Contours	90 percent of solid-line contours will be 1/2 of a contour interval from true elevation. 10 percent may not be in error more than one contour interval.
Spot Elevations	90 percent within 1/4 of a contour interval, 10 percent within 1/2 of a contour interval.
Coordinate Grids	All grid coordinates will be within 0.01 inches (0.25 mm) of true value.
Planimetry	90 percent of all well-defined objects (on photographs) will be positioned to 0.025 inches (0.625 mm) of their true position. No feature will be misplaced by more than 0.05 inches (1.25 mm) from true coordinate's position.

TABLE B *(Engineering Level accuracy)*

Transportation Surfaces	2.5 in or less (62 mm) This category includes features such as paved or unpaved roads, shoulders, parking lots and driveways, as well as curbs, bridges, retaining walls and sidewalks.
Engineering Surfaces/ Drainage	5 in or less (125 mm) This category includes features such as roadway embankments, drainage ditches, water-body edges, lawns and areas within 60 ft (20 m) of the edge of pavement.

Other Surfaces	10 in or less (250 mm)	Non-engineered surfaces and areas over 60 ft (20 m) from the edge of pavement.

LIDAR

LIDAR, Light Detection and Ranging, is a newer methodology that uses low level laser pulses in conjunction with GPS (Global Positioning System) to develop 3-dimensional topographic maps. Though not widely used by the Department yet, it holds potential to be of ample assistance to the designer. Currently, LIDAR mapping for limited areas of the state is available through NH GRANIT at the following UNH web address: http://lidar.unh.edu/map/

Subsurface Investigation: Geotechnical & Utilities

Underground geotechnical and utility information, at best, is the educated interpretation of existing conditions by trained geologists and/or engineers based upon state-of-the-art technology and information available. The designer should accept findings with the understanding that the information is the best practically obtainable, given the obvious limitations.

Utility Reconnaissance

Underground utility locations evidenced by visible surface features (e.g. manholes, water shutoffs) should be accepted as relatively accurate but critical locations, that may be impacted due to installation of drainage, roadway selects, or signal conduit, may need to be uncovered (potholed) by the utility company and positively located by the survey crew. Subsurface Utility Engineering (S.U.E.) may be utilized by the Department, as determined by the Highway Design Bureau's Design Services section (see UTILITIES, Chapter 9), to more accurately locate existing underground utility facilities. This process involves several different methods for obtaining existing underground utility information. The four quality levels of utility depiction as described in the American Society of Civil Engineers *CI/ASCE 38-02, Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data* (1) are listed below:

Quality Level D - Typically referred to as "records research," this level provides information that has been obtained from existing records or oral recollections.

Quality Level C - This level adds field survey of visible, aboveground utility facilities such as valves, fire hydrants, manholes, etc., reconciled to existing utility records (identified by field survey).

Quality Level B (Designating) - This level involves using surface geophysical prospecting techniques to determine the existence and horizontal position of underground utilities.

Quality Level A (Locating) - This level uses minimally intrusive excavation equipment at critical points to determine the precise horizontal and vertical location as well as other utility attributes of the underground utilities.

The use of quality levels allows engineers and project owners to certify on the plans that a certain level of accuracy has been provided. All four quality levels may be used on large projects, depending on the level of accuracy necessary at utility conflict points.

Geotechnical Reconnaissance

As explained briefly in Chapter 2 Project Development, personnel from the Bureau of Materials and Research, or geotechnical consultants engaged by the Department, perform geotechnical reconnaissance surveys. This type of visual inspection is sometimes supplemented by select subsurface exploration.

There are occasions when muck, bedrock locations, erodible soil, seepages, slides or settlement (evidenced by pavement subsidence, tilted guardrail or trees), or pavement rutting and cracking through embankment cut areas (a possible indication of inadequate subsurface drainage), are identified by the designer through a field review and should be discussed with the Group Supervisor or Project Manager. If underlying conditions could influence the design, thereby impacting adjoining properties, environmental resources, traffic control, or other significant design constraints, a preliminary geotechnical reconnaissance by the Bureau of Materials and Research should be requested. (For a description of support services, see Appendix 12-5 for Bureau of Materials & Research Organization Chart and Chapter 1- Related Bureaus and Organizations, Bureau of Materials & Research section.)

Likewise, if a proposed design involves bridges, large culverts, signal masts, large sign foundations, soundwalls, large ITS components, or retaining walls, the designer should consult with Materials and Research to determine if borings should be requested.

If subsurface geotechnical exploration is required, it is normally requested during the Preliminary Design phase of project development. If it wasn't performed during Preliminary Design, Final Design should request it upon project turnover to the team. Typically, the latest available plans including utility information, profiles, and cross-sections are forwarded with this request. The designer should consult with the Geotechnical Chief to confirm what information they require in regard to existing conditions, pavement recommendation, and project scope. The designer should be aware of any visual physical cues noted in the field such as the presence of wetlands, cracks in slopes or pavement, leaning guardrail, etc., and should always question and bring suspicious geotechnical conditions to the attention of the Geotechnical Engineer.

Note: Requests for subsurface exploration must be coordinated with Design Services, Dig Safe and municipal utilities to prevent damage to underground utilities. Standard practice is to prepare a plan accompanied by a letter from the Chief of Design Services to the Bureau of Materials and Research listing the utilities known to have facilities within the area. Additionally, the designer should have coordinated with the project Environmental Manager to determine what locations, if any, exist for encountering natural or cultural resources and hazardous materials.

Subsurface Exploration Methods

Subsurface exploration for highway construction is accomplished with soil augers, rock cores, auger drill rigs and backhoes. The type of exploration to be performed is determined by the Bureau of Materials and Research after evaluating the geological strata and project characteristics.

Rock coring or auger drilling is used for bridge, large culvert or retaining wall foundation exploration but, again, the Bureau of Materials and Research determines the method of exploration.

References:

1. American Society of Civil Engineers (ASCE), CI/ASCE 38-02, *Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data,* ASCE, 1801 Alexander Bell Drive, Reston, Virginia, 2003.
2. New Hampshire Department of Public Works and Highways, *Survey Manual,* NHDOT, 7 Hazen Drive, Concord, New Hampshire, January 2010.