

# Survey Guidebook



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## Foreword

The purpose of the Delaware Department of Transportation Survey Guideline, hereafter referred to in this document as the Guideline, is to provide guidance and conformity to in-house survey crews. In addition to providing conformity among consultant survey crews that work for the Delaware Department of Transportation (DeIDOT).

Surveying is a requirement for civil engineering design of roads, bridge and Right-of Way acquisition. In Transportation engineering, surveying provides the foundation of all design. Surveying also provides the basic model for contractors to use in the construction of roads and bridges. It is important for the Delaware Department of Transportation to have consistency among all survey crews that provide data for use in design and construction of Delaware projects.

The Guideline will include basic requirements recommended by the Department and it is not intended to be a comprehensive manual. Topics will include GPS control, Traverse, Vertical control and basic recommendations on field procedures and stakeout. The Guideline also provides *minimum* standards required by the Department.

Some procedures and methods may differ from the Department's survey crews and consultant survey crews. The intent of the Guideline is to ensure all deliverables have the same format and information. The intended goal is to have no deviation in appearance, data, and reliability between all the survey crews providing information to the Department.

The Guideline is not intended to be a safety manual. Although a very important part of everyday surveying activity, safety is not covered within this manual. For information regarding safety please follow all appropriate safety manuals such as the Manual on Uniform Traffic Control Devices (MUTCD). The appropriate safety measures must be followed always.

The Guideline was created as part of a continuing effort to provide guidance and consistency within the Delaware Department of Transportation. Your comments and suggestions for improvement are always welcome.

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## Chapter 1 – Setting GPS (Primary) Control

The Delaware Department of Transportation (DelDOT), under Delaware Code is required to have all Department surveys referenced to the Following:

***Delaware State Plane Coordinates North American Datum (NAD 83/91)***

***North American Vertical Datum 1988 (NAVD 88)***

**Delaware Code: 6 Del. C. 1953, § 5501**

<http://delcode.delaware.gov/title6/c055/index.shtml>

<http://delcode.delaware.gov/sessionlaws/ga140/chp095.shtml>

Before the start of any project that will be used in design, geodetic control will be established along the corridor. The National Geodetic Survey (NGS) monuments are the most accurate control available and should be used when feasible. NGS Monument information will be provided by the Department. If the use of NGS Monuments are not feasible, it is the sole responsibility of DelDOT to set initial geodetic control for a project. It is the responsibility of the Department's Project Manager to submit the survey request form to the Department's survey section for establishing geodetic control.

Link to Survey Request Form:

[https://deldot.gov/Business/drc/forms/survey\\_memo.pdf](https://deldot.gov/Business/drc/forms/survey_memo.pdf)

If outside forces (consultants) are tasked to provide survey for a project, before any topographic survey is performed, the consultant must verify and concur with the Department's control. If there is a disagreement in the findings of control points or the control network, the Department's Project Manager is to contact the Department's Survey Section immediately. No additional survey shall be performed until both the Department and consultant agree on the values of the control.

Each project is unique and GPS control will vary in number of control points and distance set between points. The Department's Chief of Survey will coordinate with the Project Manager to determine the number of control points set on each project as well as the location. Generally, the more initial control that is set, the better the project control network.

Figures (1-B) and (1-C) provide examples of locations of typical Geodetic control for a smaller intersection improvement project and a long corridor project. It is recommended that at least one pair of primary control points are set at least 1000 feet beyond the proposed project limits of construction.

### Method

All Geodetic control points shall be set on a DelDOT cap with the "stamped" identification name and number provided by the Department's Survey Section. As previously mentioned, the number of Geodetic Control Points set shall be project specific and the distance between points shall be determined by the Department. For large projects that are not surveyed by the Department, the Project Manager shall coordinate with the consultant and the Department's Survey Section to determine the number and locations of primary control points.

It is important to plan for future use of the control points and to place the control points at locations that will not be disturbed. Survey control on any project is the foundation of the project. It is important to properly monument, properly identify, properly place, and protect against disturbance or destruction.

### **“Bluebooking” Geodetic Control**

Occasionally the Department will establish a Geodetic Control Network that will be published by the (National Geodetic Survey) NGS. NGS “Bluebook” standards need be followed, documented, and submitted to the NGS for review and publication.

#### **Control Points submitted to the NGS shall have a control point accuracy of Order B**

National Spatial Reference System (NSRS) secondary networks;

High-precision engineering survey - **1:1,000,000**

*Reference figure (1-A) for control point accuracy set by the NGS.*

In 1988, NGS established four orders of control point accuracy, which are outlined in Figure (1-A). The minimum accuracy for each order is expressed in relation to horizontal distance separating two control points of the same order.

#### **Primary control points that are generally used on projects shall have a control point accuracy of Order C:1**

Primary Project Control - **1:100,000**

To achieve the required primary control point accuracy, the existing field conditions must be taken into consideration when choosing the location of the primary control points.

It is important to set the geodetic control points at locations that are not obstructed by overhanging trees or any objects that might obstruct the GPS signal.

- GPS receivers require a minimum of four satellites.
- Satellite signals may be blocked or deflected by several things such as buildings, trees or utility poles. Obstructions such as those mentioned makes GPS difficult to use in urban environments and heavily wooded areas.

**Figure (1-A) \***
**Four orders of control point accuracy**

Order	Survey activities	Maximum base error  (95% confidence limit)	Maximum Line-length dependent error  (95% confidence limit)
<b>AA</b>	Global-regional dynamics; deformation measurements	3 mm	1:100,000,000 (0.01 ppm)
<b>A</b>	NSRS primary networks	5 mm	1:10,000,000 (0.1 ppm)
<b>B</b>	NSRS secondary networks; high-precision engineering surveys	8 mm	1:1,000,000 (1 ppm)
<b>C</b>	NSRS terrestrial; dependent control surveys for mapping, land information, property, and engineering requirements	1st: 1.0 cm 2nd-I: 2.0 cm 2nd-II: 3.0 cm 3rd: 5.0 cm	1st: 1:100,000 2nd-I: 1:50,000 2nd-II: 1:20,000 3rd: 1:10,000

**Control network accuracy standards used for U.S. National Spatial Reference System (Federal Geodetic Control Committee, 1988).**

**\* (The Nature of Geographic Information, Land Surveying and GPS - Chapter 5)**

To achieve the required accuracies or higher, **Statics Positioning** is required. If setting a network for DeIDOT control, two or more receivers shall measure the position from fixed locations over a period of a minimum of **three (3)** hours with multiple observations taken over a period of days. Only **dual frequency carrier phase differential** receivers shall be used when setting geodetic control. RTK (Real Time Kinematic) shall never be used to set geodetic control for DeIDOT design projects.

It is important for the Department's Project Manager to request GPS control be set on a project in a timely manner. This will allow adequate time for the GPS survey crew to set control. As soon as a project is assigned, and project limits are established, the request for GPS control should be submitted to the Department's survey section. If a consultant will be providing topographic surveying on the project, the Project Manager must get concurrence on proposed primary control locations.

The Department's Chief of Survey will provide the Project Manager with a **GPS Control Point Report**. In the report, the metric values for northing and easting, as well as the US Survey Feet values for northing and easting, will be provided. Also provided will be location maps of the control points and tie point diagrams showing a minimum of 3 ties for each point.

**Figure (1-B)**  
**GPS Control Point Example**



**Intersection Improvement Project**



**Long Corridor Project**

## Chapter 2 – Traverse Points between Geodetic Control Points (Secondary Control)

### Traverse

Starting at GPS control points (Primary Control), angles and distances are measured, and trigonometry is used to calculate the locations of new traverse points (Secondary Control).

- A traverse that begins and ends at different locations of unknown value, is called an **open traverse**.
- A traverse that begins and ends at the same point, or at two different but known points, is called a **closed traverse**.

DelDOT requires all surveys use the **closed traverse** method and all traverses are to be adjusted using the **Least Squares** or **Compass Rule** methods of adjustment.

Although traverse point numbers assignments are reserved from **1-999**, traverse points should be numbered between **1 – 499** whenever possible. Point numbers **500-999** are available if needed.

### Side Traverse:

A side traverse is a traverse that is usually perpendicular to the main traverse and extends beyond the limits of the main traverse line of sight. All side traverses shall also be closed and follow the same procedures and rules of the above secondary control.

Side traverse points are identified as any other traverse points and should follow the same rules as traverse points for numbering assignments.

Side traverse point numbers cannot duplicate any existing traverse point number. It is recommended that side traverse points be numbered such that they can be easily identified and not confused with the primary and secondary control traverse points. Side traverse point numbers generally will start with a number much high than what will be used in the primary and secondary traverse control.

### *Side Traverse Numbering Example:*

#### **Traverse points between primary and secondary control:**

Anticipated Traverse Points numbered no greater than 50

**First Side Traverse Line** – Starting point number 100  
– Points used (100 – 110)

**Second Side Traverse Line** – Starting point number 120  
– Points used (120 - 129)

## Method:

### Traverse Points and Measurements:

All traverse points shall be field coded (TP1, TP2, TP3, etc.) on a DelDOT cap or an approved cap with the consultant's name printed on the cap. If applicable recessed PK nails and drill holes are acceptable if a capped rebar cannot be driven. Wooden hubs and tacks are **not** acceptable as traverse points. Most traverse points will be in the ground for years before they are needed during construction. Traverse points shall be made of durable material and recessed slightly below ground to avoid disturbance.

**Maximum** distance between traverse points shall be:

**1200' for large projects**

**600' for smaller projects**

All DelDOT Surveys are to be completed – in:

**US Survey Feet** → 1 foot = 1200/3937 meters → 0.3048006 meters

It is important to make sure all equipment is set to US Survey Foot and **not** the Standard or International Foot.

### Accuracy of Traverse:

The main traverse and side traverse for DelDOT Projects shall have a minimum unadjusted traverse point horizontal accuracy of:

Second Order, Class II: **1:20,000**

*Reference figure (2-A) for control point accuracy.*

If the unadjusted value is less than 1:20,000, the traverse shall be rerun.

### Angles:

Achieving an accuracy of 1:20,000 is not difficult with today's modern equipment. Multiple angles and distance readings should be taken when setting new traverse points. It is recommended that a minimum of 2 sets of direct reverse measurements be taken when setting new traverse points.

### Consultant Survey and In-house Survey:

When consultant designers utilize the Department's survey information or when the Department hires a consultant to survey, for in-house projects it is important that both parties have a comfort level with each other's work. The consultant, if using a DelDOT obtained survey, must verify and concur with the survey before any design work continues. The same applies to a DelDOT design team who may use a consultant survey.

**Survey Verification:**

Verification can be performed by reproducing the main traverse horizontal and vertical values and comparing them to the values obtained in the original survey. If a discrepancy arises, the Department’s Project Manager shall be notified. No design work should start until all issues with the survey are resolved to the satisfaction of the Department’s Project Manager, Chief of Survey, and the consultant.

**Tie Point Diagrams:**

Tie point diagrams are a tool used to locate traverse points. Traverse points, if properly set, will be placed just below ground level and may not be visible. A metal detector and tie points diagrams can be used to locate initial traverse points. A minimum of three ties shall be placed for each traverse point. A tie may be a PK nail set in pavement, a tree, utility pole, or any fixed object that will remain in place for years to come. The diagrams shall be part of the survey field notes provided to the Project Manager for future use by the Department.

**Figure 2-A**

Horizontal Operation	Secondary Control
Maximum Distance Between Secondary Traverse Points	1200’ Large Projects 600’ Small Projects
Minimum Unadjusted Horizontal Accuracy for Secondary Traverse Points and Side Traverse points	1:20,000
Minimum Readings (Angle & Distance)	2 sets of Direct/Reverse
Minimum Number of Tie Points Per Traverse Point	3

## Chapter 3 – Vertical Control

### Vertical Control

All DeIDOT vertical control shall be based on **North American Vertical Datum 1988 (NAVD 88)**.

**Primary Control shall have a traverse point vertical accuracy:**

Second Order Class II maximum misclosure **0.035 (vD)** D = Distance in mile.

**Secondary Control and Side Traverse shall have a traverse point vertical accuracy:**

Second Order Class II maximum misclosure **0.035 (vD)** D = Distance in mile.

### DeIDOT Minimum Leveling Specifications Figure (3-A)

Operation	Differential Leveling	Digital Bar Code Leveling
Maximum Sight Length	250 feet (See Note 1)	250 feet
Distance between fore site and back site should be as equal as possible. Difference in length between fore sight and back sight not to exceed.	20 feet	20 feet
Minimum Accuracy Section	0.035 feet (v D) Control	0.035 feet (v D)
Minimum Accuracy Loop	0.035 feet (v D) Control	0.035 feet (v D)
Method for checking equipment	Two Peg Test and Figure (3-C)	Manufacturers recommendation
Minimum number of readings	N/A	3

#### Notes:

1. Maximum sight distance may decrease due to field conditions.
2. Rerun Peg Test if difference is .003 feet in 100 feet or more. If test continues to be off adjust level or send out for service.

### Vertical Geodetic Control that will be published for National Geodetic Survey (NGS)

The existing Delaware control network is densified or extended periodically, and the values are published by the (NGS). To establish vertical values for control points to be published by the NGS, an Electronic Digital/Bar-Code Leveling System shall be used.

### Differential Leveling using automatic (engineering level)

The most common method of transferring elevation from one point to another point is differential leveling. If the survey control points are not to be published by the NGS, differential leveling will be acceptable for use in setting vertical control.

### Maintaining Equipment

As with all survey equipment it is important to maintain equipment and follow proper procedures when transferring elevations.

- All leveling equipment must be checked regularly and properly maintained to ensure that it remains in good working order. ( See Figure 3-A - “Method of Checking Equipment”)
- Cleaning and adjustment by a survey instrument repair shop, at least once year is recommended.
- All leveling rods should be checked and maintained to ensure consistent readings.

### Leveling Field Notes

It is important to record accurate, neat, and readable field notes. The level notes and traverse point elevations are a crucial part of any survey used in design. Using the notes, true elevations for each traverse point are transferred to the final survey. The traverse point elevations are used to calculate elevations for points on the project, in turn creating a surface model of the project area.

The Survey Party Chief is to compute the level loop field notes. The notes must then be checked by another member of the survey crew. If the level loop is within acceptable allowable closure, the notes are to be turned into DelDOT’s Chief of Survey for a final office check and archiving. If the level loop is outside of acceptable closure, the loop must be rerun. Figure (3-B) is an example of one format of leveling field notes.

### Two Peg Test

Before the start of any level loop, a Two Peg Test method for checking the engineering level should be performed. During the Two Peg Test, the optical reading through the equipment should be horizontal when the instrument is level. If the equipment line of site is out of adjustment (not horizontal) when performing the test, an error in the rod readings will occur. If the level is found to be outside of tolerance, then the level is to be adjusted or sent out for repair. The method of conducting the Two Peg Test is outlined in figure (3-C).

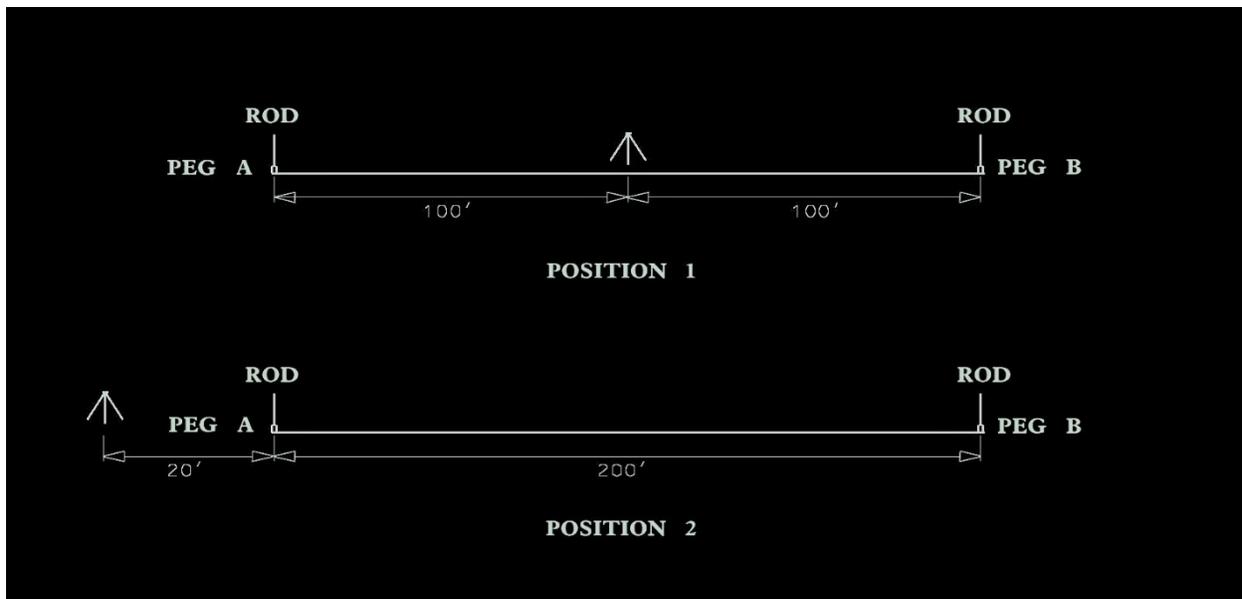
**Leveling Field Notes Example**

**Figure (3-B)**

	+		-			RT 1 and US 9 Int Imp - Cont. T201912501	Cash Boone Jefferson	CLEAR COOL 57"
Sta.	B.S.	H.I.	F.S.	Elev.		Bench Mark 1 is an NGS Benchmark located at the intersection		
BM 1				50.00		North West intersection of Kings HWY and county Road 299		
						The Bench Mark is stamped DS217		
TP 1	5.49	55.49						
			2.48	53.01	TP1			
TP 2	15.28	68.29						
			3.55	64.74	TP2			
TP 3	12.12	76.86						
			1.54	75.32	TP3			
TBM 1	18.44	93.76				TBM (Temporary Benchmark) is a PK Nail set in the east shoulder of RT1		
			3.99	89.77	TMB	500' from south of the intersection of US 9 .		
TP 4	5.28	95.05				TBM has orange ribbon under the PK nail		
			19.14	75.91	TP4	and is spray painted TBM1		
TP 5	2.86	78.77						
			14.94	63.83	TP5			
TP 6	3.11	66.94						
			8.68	58.26	TP6			
BM1	3.51	61.77						
			11.79	49.98				
				50.00	BM1	Distance traversed 2700' = 2700'/5280 = 0.51 miles		
			Error =	-0.02		Allowable closure .035 √ D		
						.035 √ 0.51 = 0.025 ok		
	Computed By : J. Cash							
	Checked By: D. Boone							
	Office Check By: W. Clark							

**2 PEG Test Example**
**Figure (3-C)**

Instrument Position	PEG A (Point A)	PEG B (Point B)		2 PEG TEST
1	5.782	5.412	Instrument Position 1 -Set Instrument equal distance between Point A and Point B approximately 100' from each point read rod at Point A and Point B - record.	
2	5.523	5.151	Instrument Position 2 -Instrument set 20' beyond Point A or Point B read rod at Point A and Point B - record.	
Difference	0.259	0.261		
Check- Difference Point A minus Difference Point B			Check for acceptable reading - less than 0.003.	
	0.259 - 0.261 = - 0.002		0.002 OK	



## Chapter 4 – Topographic Data

### Collecting Topographic Data

A topographic survey is intended to show the existing terrain and the location of fixed objects within the limits of the survey. These recommendations are intended to provide uniformity among crews and are not intended to serve as the only criteria for collecting data. Experience and professionalism of the Survey Party Chief is the key factor in producing a good product. Helping to provide the best possible topographic survey and existing surface is the goal of this chapter.

It is the Department's policy not to use GPS rovers to collect field data. If a consultant or in-house crew chooses to use GPS rovers on a DeIDOT survey, they must receive written permission from the Assistant Director as well as approval from DeIDOT's Chief of Survey. GPS rovers shall never be used to collect data for bridge projects.

It is important for the Survey Party Chief to locate as much detail as possible to create a good Topographic Map of the project area. Below is a general listing of items that need to be collected on every project. The list is not all-inclusive, and it is the duty of the Survey Party Chief to collect all the necessary data.

#### Some Examples of Permanent Fixed Objects

- a. Property corners – iron pipes, concrete monuments, etc.
- b. Street or road pavement, entrances and sidewalks
- c. Retaining walls, bridges, culverts, headwalls, and structures
- d. Spot elevations covering the entire survey limits showing high points, low points, grade changes, and at enough intervals to represent the general character of the terrain
- e. Location of waterways, ponds, lakes, rivers, streams and drainage courses
- f. Location of curbs, top of curb, and gutter
- g. Location of rock outcropping
- h. Electric utilities power poles and pole information (pole numbers), guy wires, anchors, vaults, etc.
- i. Location of all storm and sanitary manholes culverts, drainage inlets and clean outs
- j. Top and bottom elevations of manholes (when requested) and drainage inlets
- k. Show type, size, direction of flow, and invert elevations of all pipes and culverts
- l. The location of any water valves and meters that are visible
- m. The locations of all telephone poles and pole information (pole numbers), manholes, boxes etc.
- n. Street lighting and location of all poles, boxes, etc. that are visible within the survey limits
- o. The location of any existing building, fences, miscellaneous structures and driveways within the project limits
- p. Location of trees, bushes, hedgerows and woods lines.
- q. Location of flagged wetlands

**Field Notes**

Original field notes are sketched and recorded when field measurements are taken. Care must be taken to record notes that are accurate and legible. Notes shall be recorded in a standard hard covered survey field book with survey note paper.

Items that should be recorded in the field notes include:

- a. Title of field book (contract number name of project)
- b. Daily weather, crew, and date
- c. Horizontal Control (GPS -Primary Control)
- d. Horizontal Control (Traverse Point diagrams- Secondary Control)
- e. Level loops
- f. Tie Points and Tie Point Diagrams

**Survey Notebook Daily Cover Sheet Example**

Crew Members Names/Titles	Project Number /Project Name		Instrument Type and Number	Temp. and Weather
		Date		
			Task: Topo	
			Stakout	
			Traverse	
			Prop Corners	
Instrument		HI 5.42		
Location		HT 5.28		
(TP 2)	Cap-Rebar			
BS Location				
(TP1)	MAG			
BS	00 00" 00'	Check		
		H=	V=	
ROD HT	7.00			
PT #	ROD HT	( Any change in Rod Hight )		
Note: Single line through errors - do not erase.				
Example:	<del>PT #20001</del>	PT# 20010		

***Check back-site first shot periodically and record before moving off the Traverse Points.***

## Electronic Data Collector

Electronic data collectors should be downloaded daily. All raw unedited and edited data is to be archived at the end of the survey. All CADD files, FWD, RW5, photos and paper field notes are to be archived at the completion of the project. Consultants are to deliver all ALG, DGN, FWD, RW5, DTM, photos, and paper field notes to the Project Manager at the completion of the survey. The Project Manager is to provide the files to the Chief of Survey for archiving and future reference.

### Codes and Locations of Data Points

When performing topographic surveys, specific elements such as buildings, gas meters, water valves, manholes, pavement, trees or curb are associated with a feature code. Feature codes allow a survey to be plotted in a minimal amount of time in a MicroStation design file. DeIDOT has developed nearly 100 individual feature codes that represent natural and manmade features. The DeIDOT feature code list continues to evolve and grow. Every feature a surveyor encounters may not have a feature code listing. It is important for the surveyor to clearly describe objects not listed in the feature code list.

Using the correct feature code is an important skill. Some features are included in the existing Digital Terrain Model (DTM) and others are not. In the Contour column of the Feature Code List, a mark (Y) “yes” indicates the elevation of the feature will be added as part of the existing surface. A mark of (N) “no” indicates the elevation of the feature will not be added to the existing surface. Knowing the information that will be added to the surface is important in developing a good terrain model.

Codes are broken into two segments. Control Codes that denote action (such as when to start a linear figure) and the Feature Codes. A list of Control Codes is provided below.

### CONTROL CODES

CONTROL CODE	DESCRIPTION
ST	Defines the beginning of a feature line and only needs to be associated with the first feature code of the line string. Continue with the same feature code until a new line using the same code along with the ST control code is started.
CLOSE	Connects the last feature code in a line string to the first feature codes of the same line string to form a closed shape.
PC	Defines the beginning of a curve or point of curvature for a curvilinear feature.
PT	Defines the end of a curve or point of tangency for a curvilinear feature.
JPT	Connects a feature line from the point the control code is associated with to a point number specified following the JPT control code. This control code requires a space between the control code and the point number to connect to.
JNC	Connects a feature line from the point the control code is associated with to the nearest point with the specified code following the JNC control code. This control code requires a space between the control code and the feature code to join to.
NT	Specifies that a curve is non-tangent to the incoming or outgoing line segment. This code is used in conjunction with the PC and/or PT control codes.
DNC	Specifies the elevation value of a feature cell code will not be included in the surface DTM calculations. This control code will not work for feature lines points.

**DeIDOT FEATURE CODE LIST**

CODE	DESCRIPTION	CONTOUR	NOTE
ABUT	ABUTMENT	Y	
BC	BACK OF CURB	Y	
BLDG	BUILDING	Y	BLDG CORNER NOTE STORY AND TYPE
BM	BENCH MARK	Y	TYPE OF BENCH MARK
BOB	BOTTOM OF BANK	Y	
BOR	BORING	Y	
BU	BUSH	Y	NOTE THE WIDTH
CB	CATCHBASIN	Y	TOPO ALL 4 CORNERS ON THE FRAME
CBL	CONSTRUCTION BASELINE	Y	
CIR	CIRCLE	Y	
CM	CONCRETE MONUMENT	Y	
CONC	CONCRETE	Y	
CR	ROADWAY CROWN	Y	
CURB	CURB (FLOW LINE OF CURB)	Y	
DECK	BRIDGE DECK	N	
DI	DITCH	Y	
DKBC	DECK - TOP BACK OF CURB	N	
DKBLDG	DECK - BUILDING	N	
DKCB	DECK - CATCH BASIN	N	
DKCONC	DECK - CONCRETE	N	
DKCR	DECK ROADWAY CROWN	N	
DKCURB	DECK - FLOWLINE CURB & GUTTER	N	
DKDMH	DECK - DRAINAGE MANHOLE	N	
DKFEN	DECK - FENCE	N	
DKHM	DECK - HOTMIX	N	
DKLINE	DECK - MISC. LINE	N	
DKMH	DECK - UNKNOWN MANHOLE	N	
DKPOST	DECK POST	N	
DKSBGR	DECK - GUARDRAIL	N	
DKSHL	DECK - SHOULDER	N	
DKSMH	DECK - SANITARY MANHOLE	N	
DKSP	DECK SECTION POINT	N	
DKSW	DECK - SIDEWALK	N	
DKTC	DECK - TOP FACE CURB	N	
DKWALL	DECK - WALL	N	
DMH	DRAINAGE MANHOLE	Y	
DR	DRIVE	Y	NOTE THE TYPE
DWL	DELINEATED WET LANES	Y	NOTE ANY NUMBERS
ECB	EXISTING CABINET BASE	N	NOTE ANY NUMBERS
EMH	ELECTRIC MANHOLE	Y	
ET	ELECTRIC TRANSFORMER	N	NOTE ANY NUMBERS
EW	EDGE OF WATER	N	TOPO WITH CROSS SECTION IF POSSIBLE IF TIDAL WATER RECORD DATE AND TIME
FENM	METAL FENCE	Y	NOTE THE HEIGHT
FENP	PLASTIC FENCE	Y	NOTE THE HEIGHT
FENW	WOOD FENCE	Y	NOTE THE HEIGHT
FH	FIRE HYDRANT	N	CENTER OF FH

**DeIDOT FEATURE CODE LIST (Cont.)**

CODE	DESCRIPTION	CONTOUR	NOTE
GI	GAS ISLAND	Y	
GM	GAS METER	Y	
GMH	GAS MANHOLE	Y	
GP	GAS PUMP	Y	
GR	GRASS	Y	
GUT	GUTTER	Y	
GUY	GUY WIRE ANCHOR	Y	
GV	GAS VALVE	Y	
HDG	HEDGEROW	Y	NOTE WIDTH
HDWL	HEADWALL	Y	
HM	HOTMIX PAVEMENT	Y	
IP	IRON PIPE	Y	NOTE SIZE AND TYPE
JB	COMPOSITE JUNCTION BOX	Y	TOPO 4 CORNERS OR NOTE SIZE
JW	METAL JUNCTION WELL	Y	TOPO 4 CORNERS OR NOTE SIZE
LAMP	RESIDENTIAL LIGHT	Y	
LINE	MISCELLANEOUS LINE	Y	DESCRIPTION OF WHAT IS BEING TOPO
LP	LIGHT POLE	Y	NOTE ANY NUMBERS
LS	LANDSCAPING AREA TIES	Y	
MAR	MARSH	Y	
MH	MANHOLE	Y	UNKNOWN
MB	MAILBOX	N	NOTE NUMBERS
MISC	MISCELLANEOUS	Y	
PARA	BRIDGE PARAPET	Y	
PI	PIPE	Y	
PIE	PIE	Y	Elliptical Pipe
PIER	BRIDGE PIER	Y	
PILE	BRIDGE PILE	Y	
PILL	PILLAR	Y	
POR	PORCH	Y	
POST	POST	Y	
PROP	PROPERTY LINE	Y	
RIP	RIPRAP	Y	
RR	TOP SIDE OF RAILROAD	Y	
PLP	PEDESTRIAN LIGHT POLE	N	
SBGR	STEEL BEAM GUARDRAIL	Y	SHOT - FRONT OF FACE OF GUARDRAIL
SCO	SEWER CLEANOUT	Y	
SH	SHOULDER	Y	
SHPL	SHEET PILE	Y	
SIGN	SIGN	Y	NOTE TYPE
SMH	SANITARY MANHOLE	Y	
SP	SECTION POINT	Y	
SQ	SQUARE	Y	
STMP	STUMP	N	NOTE WIDTH
STP	STEPS	N	
STR	STREAM	Y	
SV	SEWER VENT	Y	
SW	SIDEWALK	Y	NOTE TYPE

### DeIDOT FEATURE CODE LIST (Cont.)

CODE	DESCRIPTION	CONTOUR	NOTE
TB	TELEPHONE BOOTH	Y	
TIE	TIE POINT	N	
TMH	TELEPHONE MANHOLE	y	
TOB	TOP OF BANK	Y	
TP	TRAVERSE POINT	N	
TPB	TRAFFIC POLE BASE	Y	
TRC	CONIFEROUS TREES	Y	NOTE SIZE AND SPREAD
TRD	DECIDUOUS TREES	Y	NOTE SIZE AND SPREAD
TTP	TELEPHONE TEST PIT	N	NOTE ANY NUMBERS
UB	UTILITY BOX	N	NOTE ANY NUMBERS
UP	UTILITY POLE	Y	NOTE ANY NUMBERS
UU	UNDERGROUND UTILITY	N	
WALL	WALL	Y	
WL	WOODS LINE	Y	
WM	WATER METER	Y	
WRGR	WIRE ROPE GUARDRAIL	Y	
WV	WATER VALVE	Y	

To avoid “add-on” surveys, the initial data collection of the site shall be as complete as possible. To satisfy the needs of the project, coordination and communication with the Project Manager is needed to identify specific areas of concern. On some projects a site visit with the Survey Party Chief and the Project Manager will be needed.

Any point that may require a description greater than the data collector allows shall be recorded in the field book. The information recorded shall be shot point number, instrument traverse point number, feature code, rod height, description of the point shot, and any notes required.

The Delaware Department of Transportation requires all survey work to follow the Delaware Department of Transportation CADD Standards Manual and appendices located at the following:

[https://deldot.gov/Business/drc/manuals/CADD/cadd\\_standards\\_manual\\_2018.pdf](https://deldot.gov/Business/drc/manuals/CADD/cadd_standards_manual_2018.pdf)

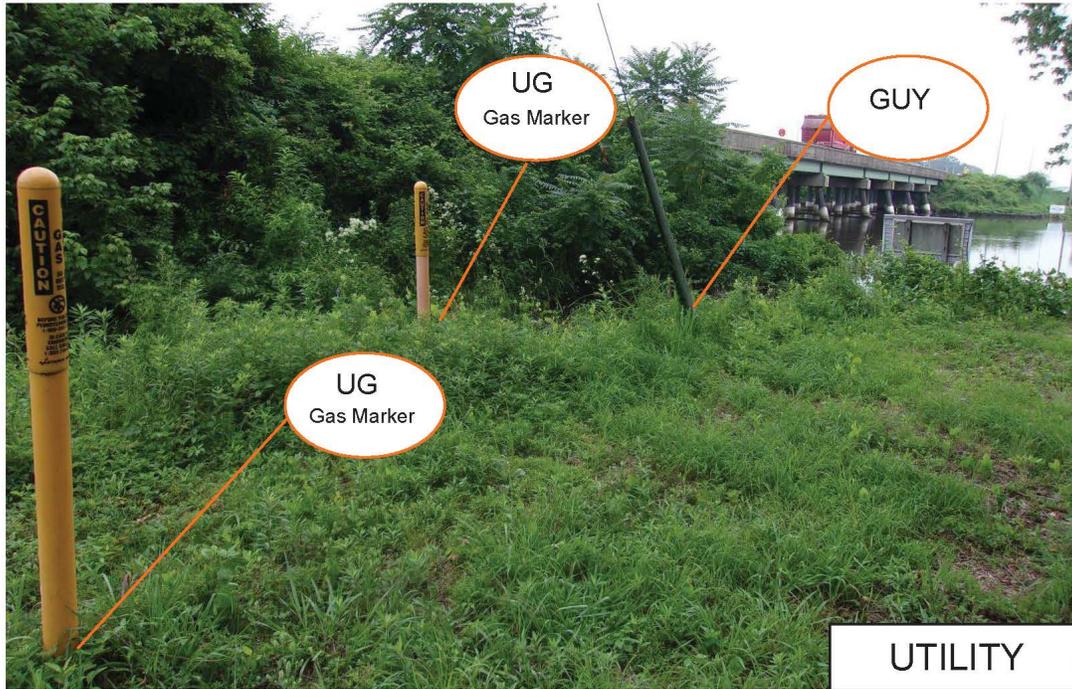
[https://deldot.gov/Business/drc/manuals/cadd\\_manual\\_appendix\\_a.pdf](https://deldot.gov/Business/drc/manuals/cadd_manual_appendix_a.pdf)

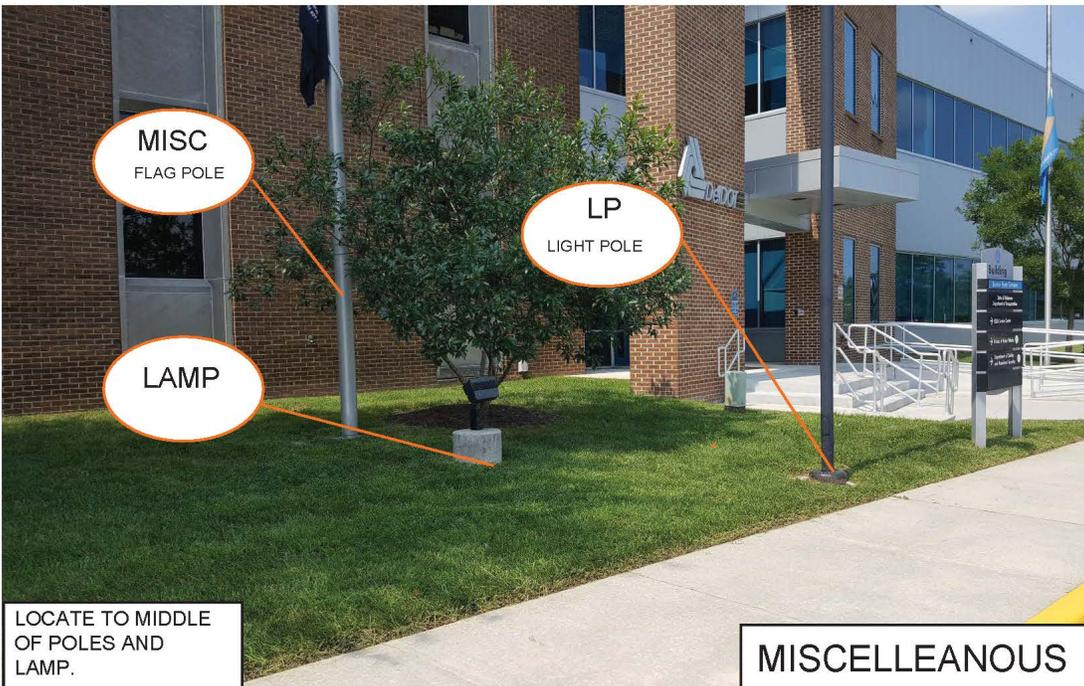
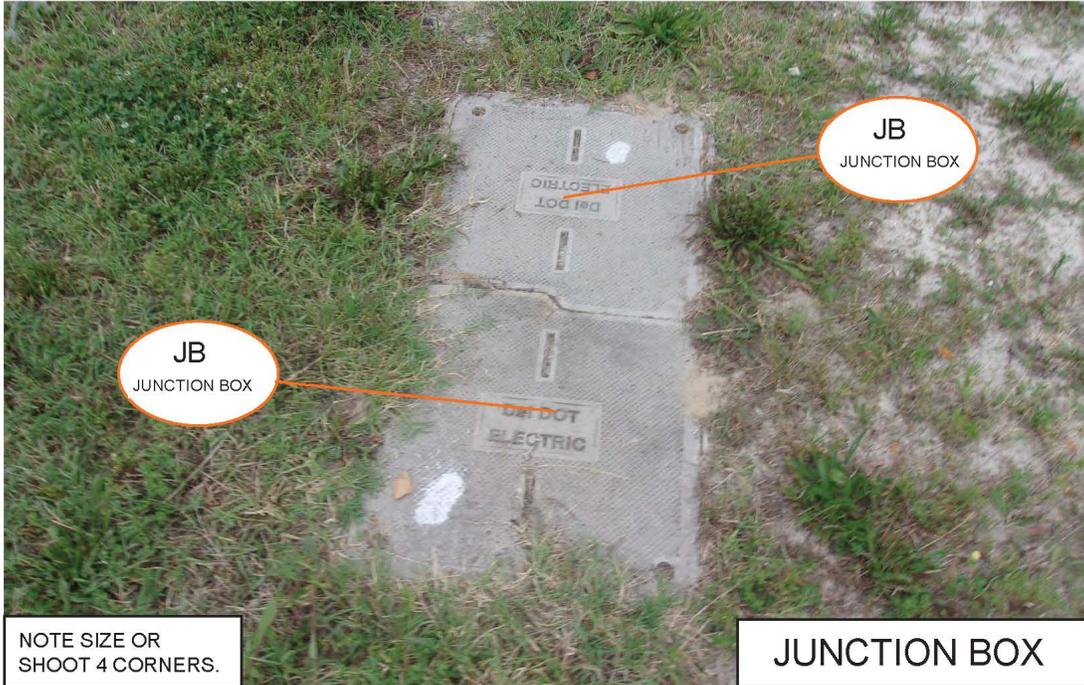
[https://deldot.gov/Business/drc/manuals/cadd\\_manual\\_appendix\\_b.pdf](https://deldot.gov/Business/drc/manuals/cadd_manual_appendix_b.pdf)

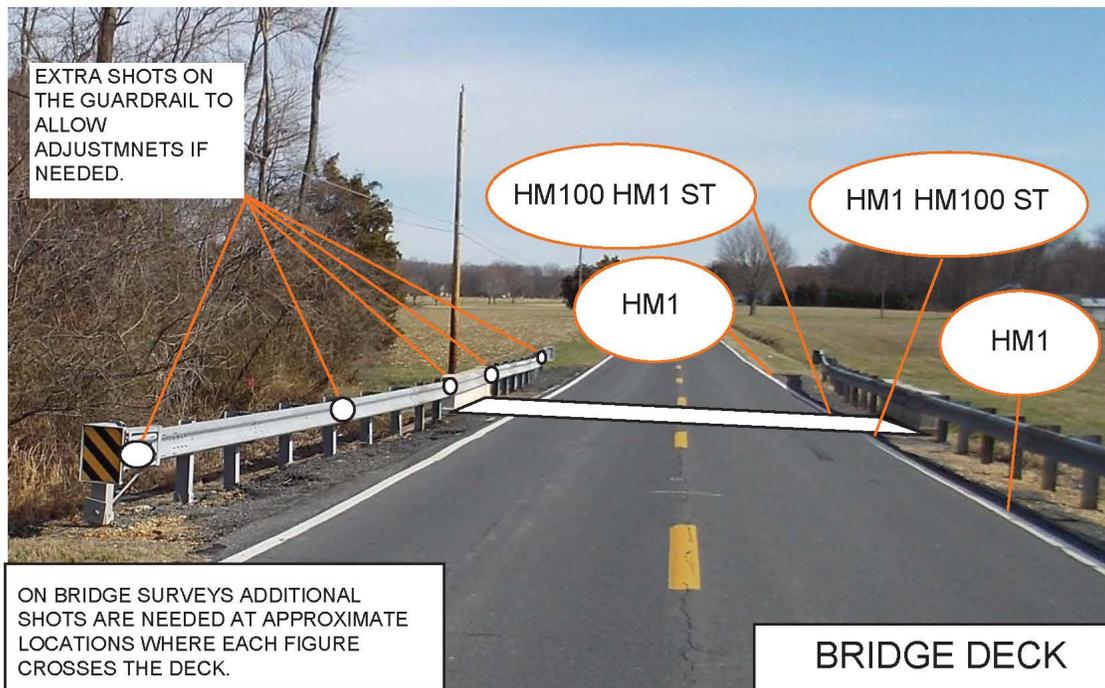
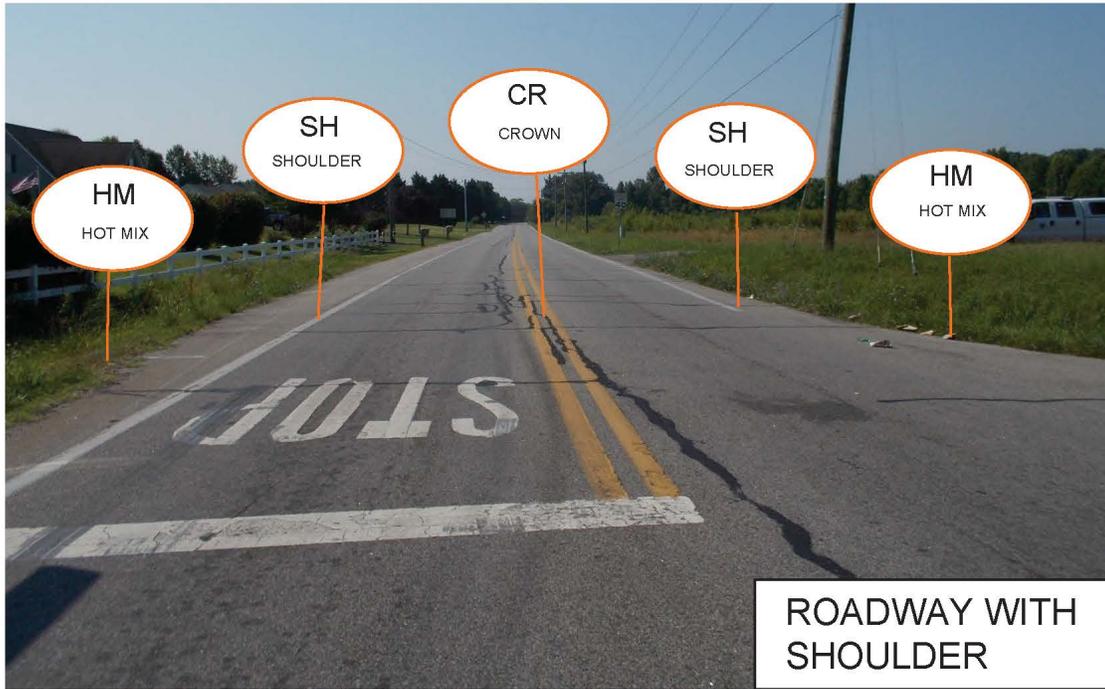
[https://deldot.gov/Business/drc/manuals/cadd\\_manual\\_appendix\\_c\\_combined.pdf](https://deldot.gov/Business/drc/manuals/cadd_manual_appendix_c_combined.pdf)

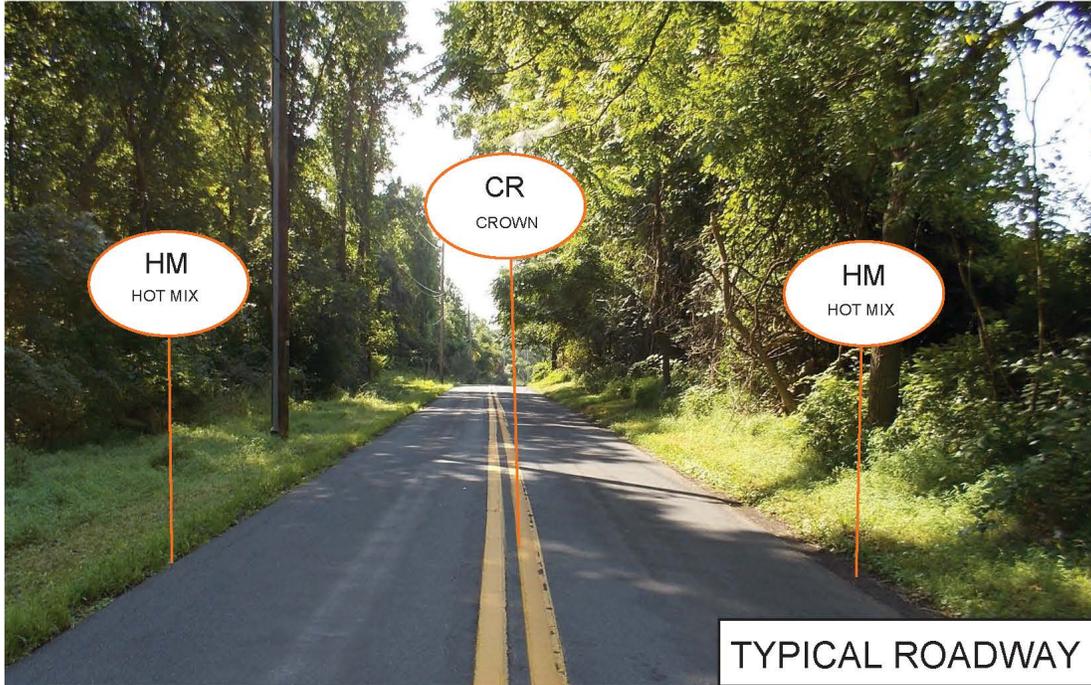
#### Shot Location Guidance

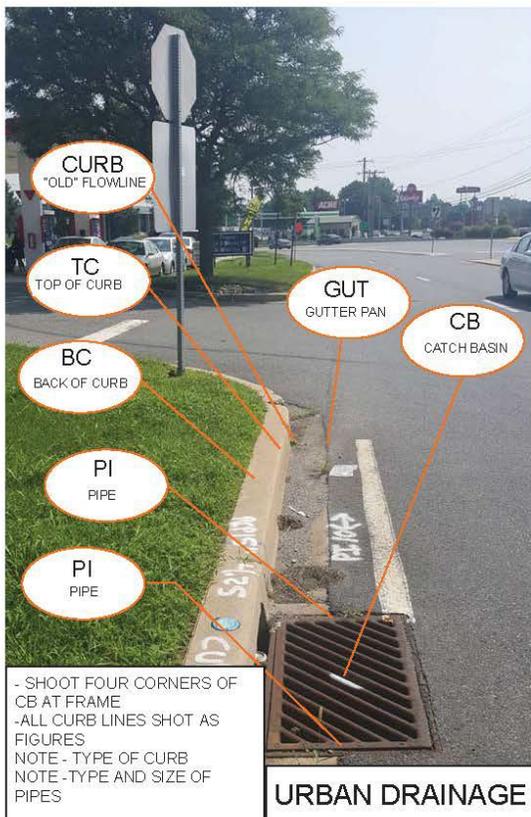
As previously mentioned in this Guideline, the purpose is to provide guidance and conformity to in-house and consultant survey crews. Photos of topographic shot locations are provided. Photos are for guidance. Ultimately the experience and judgement of the survey crew will determine the survey shot location. Everyone on the survey crew should consider the existing terrain and identify any breaklines within the topographic area. As technology advances, it is important to follow the appropriate protocol when collecting data. This will ensure that the best possible product is delivered to the designer and contractors.













## Chapter 5 – Survey Stakeout

### Survey Stakeout

Survey stakes are a method of communication used by surveyors to convey information to contractors, utility companies, Right-of-Way agents, property owners, state agencies, and other surveyors. It is important for the Delaware Department of Transportation to achieve uniformity to avoid confusion and misinterpretation of information provided on their stakes.

The Project Manager will submit all request for survey stakeout. No survey stakeout shall be done without the Project Manager's knowledge. While in design and before construction, in most cases the stakes will be placed on private property. It is important to inform the Project Manager when surveyors are on private property installing survey stakes. This avoids confusion if a property owner calls and inquiries about the surveyors and survey stakes. Also, when the stakeout is completed the Project Manager should be notified. This will enable the Project Manager to coordinate with the utility companies and the Department's Right-of-Way section.

### Right - of - Way Stakeout

Right-of-Way stakeout can serve many purposes. Stakeout can be used in the appraisal process, Right-of-Way negotiations, utility relocation, or for property owner information. Right-of-Way should be staked at the following location or as directed by the Project Manager:

1. Existing and proposed Right-of Way
2. Proposed Easements
3. Changes in Right-of-Way or Easements widths
4. Stakes should be placed at a minimum of 50' intervals in urban areas
5. Stakes should be placed at a minimum of 200' intervals in rural areas (farm fields)

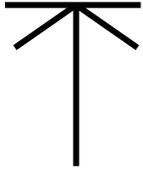
### Common Abbreviations Found on DelDOT Stakes

<b>FEE – Proposed Right-of-Way</b>	<b>CZ – Clear Zone</b>	<b>BL – Baseline</b>
<b>PE – Permanent Easement</b>	<b>LOC – Limits of Construction</b>	<b>TP – Traverse Point</b>
<b>UE – Utility Easement</b>	<b>WL – Wetland</b>	<b>0+00 – Baseline Stationing</b>
<b>R/W – Existing Right-of-Way</b>	<b>TCE – Temporary Construction Easement</b>	

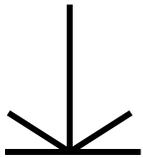
When staking out FEE, if the property has been purchased, stakes should be labeled R/W. They will still be identified as FEE on the R/W plans. It is important to coordinate with the project manager to determine the appropriate markings on stakes for existing and proposed Right-of-Way.

## Survey Stake Legend

### STA 1+00 Baseline Stationing



Fill at point - measure from the top line up



Cut at point - measure from the bottom line down



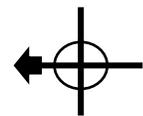
Fill at offset - measure from top line up



Cut at offset - measure from bottom line down



Offset direction right from baseline point



Offset direction left from baseline point

**PROJECT MANAGER & R/W AGENTS**

<b>FRONT</b>	<b>R/W STAKEOUT ON POINT</b>	<b>BACK</b>
<b>DESCRIPTION</b>		<b>POINT NUMBER FROM R/W PLANS</b>



**UTILITY COMPANIES**

<b>FRONT</b>	<b>R/W STAKEOUT TO POINT</b>	<b>BACK</b>
<b>DESCRIPTION</b>		<b>STATION AND OFFSET TO POINT</b>



## Utility Stakeout

Proposed utility stakeout is an important part of DeIDOT's survey role in the Department. To avoid confusion, it is important to use standards for marking utility stakes. The American Public Works Association has created a uniform standard utility code for marking utilities. Ribbon on stakes should be used to identify proposed utilities whenever possible.

### \*Uniform Color Code for Utilities:

	Red: Electric Power Lines, Cables, Conduit & Lighting Cables
	Yellow: Gas Oil, Steam, Petroleum or Gaseous Materials
	Orange: Communication, Cable TV, Alarm or Signal Lines, Cables or Conduit
	Blue: Potable Water
	Green: Sewers and Drain Lines
	Purple: Reclaimed Water, Irrigation and Slurry Lines
	Pink: Temporary Survey Markings
	White: Proposed Excavation

\*APWA (American Public Works Association) Uniform Color Code for Marking Underground Utility Lines

The Department's survey crews will stakeout existing R/W, proposed R/W, FEE, and CZ.

It is important when placing proposed utility stake:

1. The utility company verifies the proposed locations and coordinates of the relocation.
2. Stakes are placed and labeled correctly.
3. Stakes should be marked if in a cut or in a fill and how much cut or fill measured.
4. Survey crew documents location and markings of utility stakes with photos.
5. Before utilities are relocated, a field meeting with the Designer, Project Manager, Utility Coordinator, utility company and DeIDOT Surveyor should occur to ensure all utilities are being properly relocated.

Examples of utility stakeout and markings on stakes are provided in the Guideline. The example shown illustrates the gas line relocation. All utilities can be staked using the same symbols and markings. The only changes will be the name of the utility and possibly the colored ribbon.

**STAKEOUT FOR UTILITY COMPANIES**

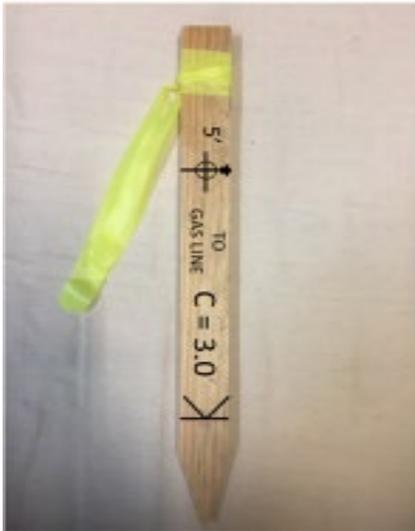
**FRONT**

**UTILITY STAKEOUT TO POINT**

**BACK**

**OFFSET STAKE WITH ARROW  
TO POINT WITH CUT MARK**

**STATION AND OFFSET  
TO POINT**



**STAKEOUT FOR UTILITY COMPANIES**

**FRONT**

**UTILITY STAKEOUT ON POINT**

**BACK**

**CUT WITH DOWN ARROW  
AT POINT**

**STATION AND OFFSET  
AT POINT**



## STAKEOUT FOR UTILITY COMPANIES

FRONT	UTILITY STAKEOUT ON POINT	BACK
<b>FILL WITH UP ARROW</b>		<b>STATION AND OFFSET</b>
<b>AT POINT</b>		<b>AT POINT</b>



### Equipment:

The Department's survey crews and consultants shall use adequate equipment and instruments in good working order. Routine maintenance of surveying equipment is an important part of the Department's surveying efforts. Lack of good maintenance habits can jeopardize the outcome of a survey. It is important to follow the manufacturers recommended scheduled maintenance on equipment. Most surveys performed by the Department and its consultants will use a total station. The minimum requirements for a total station used to collect data shall have a minimum measuring accuracy of [3mm+2ppmxD] and an angle accuracy of up to 2.0 arc seconds or 0.6 milligons. The minimum standards required to complete a survey are outlined in these Guidelines. As in any endeavor it is best to strive for above the minimum.

All equipment shall have a routine maintenance schedule and the equipment periodically checked for accuracy. Delaware currently has a calibration baseline located outside of Ellendale, Delaware adjacent to Redden State Forest.

*The base line is located about 4.3 km (2.74 mi) south southeast of Ellendale, 9.2 km (5.7 mi) north northwest of Georgetown, and 16.1 km (10.0 mi) south of Milford along the west side of U.S. highway 113 in a cleared area paralleling the highway.*

(National Geodetic Survey)

Information on the Ellendale Calibration Base Line can be found at the following location:

<https://www.ngs.noaa.gov/CBLINES/BASELINES/de>

## Resources

### Chapter 1:

***Penn State College of Earth and Mineral Sciences – The Nature of Geographic Information, Land Surveying and GPS – Chapter 5 (Survey Control)***

[https://www.e-education.psu.edu/natureofgeoinfo/c5\\_p6.html](https://www.e-education.psu.edu/natureofgeoinfo/c5_p6.html)

***State of New Jersey Survey Manual (Chapter 2)***

<https://www.state.nj.us/transportation/eng/documents/survey/Chapter2.shtm>

### Chapter 2:

***Penn State College of Earth and Mineral Sciences – The Nature of Geographic Information, Land Surveying and GPS – Chapter 5 (Traverse)***

<https://www.e-education.psu.edu/natureofgeoinfo/c5.html>

***Delaware Department of Transportation Engineering Instructions Title: Surveying Standards, Requirements and Deliverables.***

[https://deldot.gov/Business/drc/pd\\_files/plan\\_development/ei-pm-16-001\\_surveying\\_requirements.pdf?081916](https://deldot.gov/Business/drc/pd_files/plan_development/ei-pm-16-001_surveying_requirements.pdf?081916)

***DeIDOT Road Design Manual 1985 - Appendix E***

***Federal Geodetic Control Committee Standards (FGCC) Standards and Specifications***

***Policy of the National Geodetic Survey Concerning Units of Measure for the State Plane Coordinate System of 1983.***

***NOAA Manual NOS NGS 5 – State Plane Coordinate System of 1983***

### Chapter 3:

***DeIDOT Road Design Manual 1985 - Appendix E***

***Delaware Department of Transportation Engineering Instructions Title: Surveying Standards, Requirements and Deliverables.***

[https://deldot.gov/Business/drc/pd\\_files/plan\\_development/ei-pm-16-001\\_surveying\\_requirements.pdf?081916](https://deldot.gov/Business/drc/pd_files/plan_development/ei-pm-16-001_surveying_requirements.pdf?081916)

***Federal Geodetic Control Committee Standards (FGCC) Standards and Specifications***

[https://www.ngs.noaa.gov/FGCS/tech\\_pub/1984-stds-specs-geodetic-control-networks.htm#2.1](https://www.ngs.noaa.gov/FGCS/tech_pub/1984-stds-specs-geodetic-control-networks.htm#2.1)

## Chapter 3 (Cont.):

### ***FGCC Standards and Specifications for Geodetic Control Networks***

#### ***National Geodetic Survey:***

<https://www.ngs.noaa.gov/heightmod/GuidelinesPublications.shtml>

#### ***Standard Specifications for Geodetic Control Networks***

[https://www.ngs.noaa.gov/FGCS/tech\\_pub/1984-stds-specs-geodetic-control-networks.htm](https://www.ngs.noaa.gov/FGCS/tech_pub/1984-stds-specs-geodetic-control-networks.htm)

#### ***NSPS Model Standards for Topographic Surveys (Section E) 3/12/02***

[https://cdn.ymaws.com/www.nsp.us.com/resource/resmgr/Model\\_Standards/sectione.pdf](https://cdn.ymaws.com/www.nsp.us.com/resource/resmgr/Model_Standards/sectione.pdf)

## Chapter 4:

### ***National Society of Professional Land Surveyors Model Standards for topographic Surveys - Section E***

<https://www.nsp.us.com/page/ModelStandards>

#### ***Wyoming Department of Transportation Data collection Chapter 4***

[http://www.dot.state.wy.us/files/live/sites/wydot/files/shared/Highway\\_Development/Surveys/Data%20Collection%20Manual/Chapter%204%20-%20Feature%20Codes.pdf](http://www.dot.state.wy.us/files/live/sites/wydot/files/shared/Highway_Development/Surveys/Data%20Collection%20Manual/Chapter%204%20-%20Feature%20Codes.pdf)

#### ***South Dakota Department of Transportation (Surveyors chapter 6 Preliminary Survey)***

<http://www.sddot.com/business/design/docs/survey/smchap6.pdf>

## Chapter 5:

### ***Miss Utility Marking Guideline Manual***

<http://www.missutility.net/pdfs/MarkingGuidelinesManual.pdf>

### ***CDOT Colorado Department of Transportation Survey Manual - CDOT July 2017***

<https://www.codot.gov/business/manuals/survey>

### ***GDOT Automated Surveying Manual***

[www.dot.ga.gov/PartnerSmart/DesignManuals/SurveyManual/SurveyManual.pdf](http://www.dot.ga.gov/PartnerSmart/DesignManuals/SurveyManual/SurveyManual.pdf)

### ***NSPS Model Standards for Topographic Surveys (Section E) 3/12/02***

[https://cdn.ymaws.com/www.nsp.us.com/resource/resmgr/Model\\_Standards/sectione.pdf](https://cdn.ymaws.com/www.nsp.us.com/resource/resmgr/Model_Standards/sectione.pdf)