

# CHAPTER 8

# HYDRAULIC SURVEYS

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## **Sec. 8.01 Introduction**

One of the most significant input parameters for any design activity is the hydraulic & structure survey data. The importance of complete information cannot be over emphasized. The amount and detail of survey data to be collected should be commensurate with the complexity of the hydraulics of the site, classification of the highway facility and detailed in the survey scoping prior to commencement of the survey. **The survey features and specifications outlined in each of the following sections shall be included unless specifically excluded during the scoping.**

All consultant/district surveys for hydraulics and structures must be coordinated with the Consultant/District sections outlined in [Chapter 7, Sec. 7.02](#) of this manual prior to the survey taking place to identify the proper scope of survey needed. Each of the sections listed in Sec. 7.02 are responsible for providing the applicable information for each section of the [LD-23](#) form to the Project Manager at the scoping meeting.

Consultant/District Survey staff are required to develop the survey hydraulics/structures/SUE scope based on this coordination effort. Open line of communications are required to be established to each section for specific questions while onsite prior to commencement of survey.

**This collaboration shall create an efficient and cost effective scope that provides adequate deliverables for all design disciplines. This will ensure that only needed topographical data is obtained based on professional judgement of each discipline.**

**Open line of communications with these teams are required and should be established for specific questions while onsite prior to commencement of survey.** A point of contact for each discipline shall be designated and provided to the Survey Team.

The specifications outlined in this chapter may be modified on a case by case basis to fit each site during the coordination meeting. Any modifications shall be documented in the survey scoping document.

## Sec. 8.02 General

Survey will use a combination of the survey files designated as s(UPC#), su(UPC#), spo(UPC#), scr(UPC#), sbd(UPC#) and s(UPC#)b(Bridge#), as necessary, to provide design with the required information. (See the VDOT [CADD Manual](#) & [OpenRoads Standards](#) for file designation and file contents) **In all cases, the horizontal and vertical datums must match the datum and working units used for the original survey dgn (s(UPC#)).** All survey work will be developed and stored within the ProjectWise environment, **no exceptions.**

All drainage features in this chapter shall be located in 3D (N, E, Z) with the following feature attributes, **if applicable:** < > - indicates tolerances in feet

- a. Material
- b. Shape
- c. Lined
- d. Size <0.10'>
- e. Direction of flow (positive or negative)
- f. End section type
- g. Condition.
- h. Inverts/elevations <0.01'>

It is the responsibility of the Survey Manager to ensure that the data is complete and accurate when the final survey data is posted to ProjectWise. The Project manager shall be notified by email that the files are available for use. Phased deliveries may be used to accommodate large projects with tight schedules. This must be discussed at the initial scoping meeting and agreed upon by the Project Manager.

Existing fee right of way, limited access lines, easements (public/private), property line data and prescriptive easements will be shown by referencing the project sbd(UPC#) file. Right of entry will need to be secured prior to the commencement of survey efforts per [Chapter 4](#) of this manual and the Code of Virginia ([Section §33.2-1011](#)). It is the responsibility of the professional in responsible charge to ensure that all right of entry procedures are followed when and where applicable.

### **Sec. 8.03 Hydraulic & Major Structures**

For the purpose of this chapter, all facilities employed to convey or retain water will be classified as:

#### **Sec. 8.03.1 Small Hydraulic Structures** <s(UPC#)>

(Culverts less than 3 feet in diameter and ditches with top span less than 10 feet)

Stream DTM and profile taken a sufficient distance up and downstream of the anticipated construction area (not less than 100 feet beyond the construction area) to define the alignment and grade of the stream or swale (a stream traverse is not necessary on sites covered by aerial mapping).

#### **Sec. 8.03.2 Large Hydraulic Structures** <s(UPC#)>

(Culverts with diameter 3 feet to 20 feet and channel top width of 10 feet or greater)

1. The stream DTMs and topo should be extended 500 feet  $\pm$  upstream and downstream of the anticipated right of way line. The DTM should be taken at intervals not to exceed 50 feet (**50 ft**) and should extend each way from the existing channel to points that are above known or anticipated high water levels.
2. High water elevations, date, source of information, point of measurement, if provided by Environmental/Hydraulics.
3. When structures are in place at the proposed site or within one thousand feet (**1000 ft**) up or downstream, the following information is required:
  - a. Description of structure
  - b. Dates and high water elevations for major floods that have occurred since construction, if provided by Environmental/Hydraulics
  - c. Performance during past floods if provided by Environmental/Hydraulics
  - d. Evidence of scour or erosion
  - e. Location of overflow areas
  - f. Appurtenance structures (i.e., energy dissipaters, rip rap, etc.)

Where the location parallels an existing road, as in the case of a survey for a dual lane road, in these cases, it is necessary to secure complete drainage data on both sides of the existing lane unless instructed otherwise.

In the case of a location paralleling a railroad, secure all information required above for a location paralleling an existing road. Right of entry must be secured to survey on railroad property. **Entry to railroad property must be coordinated through** the VDOT Right of Way and Utilities Division, Rail Section. **The Rail Section** is located in the Central Office at 1401 East Broad Street, Richmond, VA, 23219 (804)-786-2932.

**Sec. 8.03.3 Major Structures (Bridges) <s(UPC#)> and <s(UPC#)b(bridge#)> (if requested)**

(Structures with clear span or diameter greater than 20 feet)

**Existing Structures (to remain)**

Field measurements shall be made of all accessible outlines of the substructure. Also, all outside dimensions of superstructure, complete layout dimensions and elevations of all bridge seats, top of basic floor, both immediately above the bridge seats and on top of the roadway surfacing, shall be field measured.

**Existing Structures (to be replaced)**

Field measurements shall be made of all accessible outlines of the substructure to determine the hydraulic opening. Existing centerline elevations of the bridge deck shall be obtained with the approach roadway.

**Bridge Widening**

In the case of widening at streams, no upstream or downstream cross-sections are to be secured unless specifically requested at a given site.

Where an existing bridge is to be widened and as-built plans are on file, measurements shall be secured and shown on a copy of as-built bridge plans as follows:

1. Skew angles at beginning and end of bridge and at all piers.
2. Bridge seat elevations at exterior beams on both sides of the bridge.
3. Dimension from bridge centerline to outside edge of deck.
4. Elevations of basic slab at gutter line at beginning and end of bridge and at centerline of piers.

On certain widening projects, the clearance is often critical, especially if the structure to be widened crosses a surfaced facility. In view of this, DTMs are to be secured along the centerline of the roadway beneath the bridge at ten feet (10 ft) intervals. DTMs are to be secured under the bridge at a distance of ten feet (10 ft) from the centerline of the exterior beam to a distance ten feet (10 ft) outside the proposed edge of the widened pavement. These DTMs shall extend to the top of the shoulder or the bottom of the ditch only, except at the regular station or fifty feet (50 ft) intervals, which are to be collected as usual. Elevations are to be secured for the bottom of beams at the supports for the exterior beams and any adjacent beams of greater depth.

## Bridge Situation

The Bridge Situation Survey shall provide sufficient information for the engineers and the designers to layout a structure and make the necessary hydraulic and impact studies. **The s(UPC#)b(bridge#) file should only be created upon request.** The planimetric (sUPC#), surveyed utilities (suUPC#), and dtm(tin) files created provide designers with this information and the ability to create profiles on their own normally.

The bridge situation file should show the following elements, if applicable, from left to right:

1. Title Block - Route Project, Date, Legend, etc.
  - Utility Owners (only if a su(upc#) file is not included)
2. The stream traverse (i.e. streambed, normal water, etc.), grade separation or railroad profiles will be plotted to the right of the profiles of the situation portion, only if requested during scoping.
3. Flood plain cross-sections, when requested, will be plotted to the right of the stream centerline and grade separation profiles.

### **Sec. 8.04 Hydraulic Topographic Features <s(UPC#)>**

The survey should provide sufficient information for the location engineer and the designer to select the location of the structure and make the necessary hydraulic and impact studies for all significant physical and cultural features that would be adversely affected by the construction.

#### Buildings/Backwater

Backwater may extend a considerable distance upstream in streams with relatively flat slopes. Structures, features, and buildings that may be affected by backwater should be located and elevations collected on the finished floors of buildings.

1. The location and elevation of pertinent points of all buildings and other valuable structures situated on the upstream side of a proposed or existing highway that would be flooded in the event high waters were to inundate the proposed or existing highway.
2. A description of all buildings, structures, land and activities in the area that would be flooded in the event the proposed or existing drainage structure caused the low point in the highway grade to become inundated. Note the location where the finished floor elevation was obtained (first level, basement, etc.). If the lowest floor of the structure isn't accessible (basement, cellar, split-level) at the time of the survey, the field notes should clearly indicate the floor obtained is a higher floor with an explanation.

3. Make note of any buildings or other property previously flooded or closely located to previously known flood stages.

#### Channels & Ditches

1. Show width and centerline depth to the nearest 0.25 ft.
2. If a stream is three (3) or more feet wide, four or more break lines should be used for a more accurate depiction of the stream in lieu of a centerline only break line.
3. Topography suitable to provide a profile should be secured at least 100' beyond the inlet and outlets of all structures.

Pipe Cover                      Pipe Cover shall be shown to the nearest 0.25 ft.

Storm Sewer                      All structures within the survey limits and the next structure outside of survey limits shall be included for storm sewer networks.

#### **Sec. 8.05 Water Features <s(UPC#)> and/or <sUPC#b(bridge#)>**

##### Flood Plain

Cross-sections, which can provide a representative description of the flood plain, shall be taken throughout the area covered by the stream traverse. **These sections shall be obtained at the locations marked during the field visit by the Hydraulics staff prior to survey fieldwork. Under no circumstance will the entire flood plain be surveyed without prior approval by the GeoSpatial Program Manager and State Hydraulics Engineer.**

- A cross-section shall be taken at right angles to the flood flow of the stream at the proposed bridge site and shall extend far enough to cover all the area under high water.
- Where practical, the stream cross-section shall extend to cover an area at least two feet (**2 ft**) above high water.
- As a general guideline, sections should be taken  $\pm$  one hundred feet (**100 ft**) upstream and downstream of all structures (proposed and existing),  $\pm$  one hundred feet (**100 ft**) and  $\pm$  one thousand feet (**1000 ft**) downstream of the proposed roadway centerline, and  $\pm$  five hundred feet (**500 ft**) and  $\pm$  one thousand feet (**1000 ft**) upstream of the proposed roadway centerline.
- The stream location and cross-section shall be plotted in the s(UPC#)b(bridge#).dgn. A solid line representing the location of this cross-section shall be drawn.
- An ascii file containing: Station, Northing, Easting, Elevations, Description will be delivered to the Hydraulics staff with a sketch of the cross sections.

All flood plain cross-sections shall be referenced by station and angle to the stream traverse and shall be plotted in the s(UPC#)b(bridge#).dgn file.

### High, Normal, and Low

1. High, Normal and low waters to be determined by Environmental and/or Hydraulics staff.
2. In the case of a parallel stream, the elevation of normal and high water is required at frequent intervals.

### Ponds

At all ponds or lakes that will affect or may be affected by the proposed construction, the following is to be secured:

1. Outline (perimeter) of lake
2. Elevation of normal and high water
3. Detailed description at normal spillway works including dimensions and elevations
4. Detailed description of emergency spillway works including dimensions and elevations
5. Description of adjustable gates or other control devices
6. Profile along top of the dam and a typical cross-section of the dam
7. Determine the use of the pond, (stock water, fish, recreation, etc.)
8. Note the existing conditions of the pond as to turbidity and silt

### Special Conditions

Unusual circumstances such as standing water, sinkholes, caves, outcrops, or any other condition which might need special attention from materials investigation should be noted by the Survey Manager or Survey Party Manager (Land Surveyor) in the Survey Report.

### Stream Traverse

A traverse of the stream for a distance one thousand feet (**1000 ft**) minimum on each side of the location centerline shall be secured and shown so that its course can be determined. A continuous channel bed profile is required though the area may be cross-sectioned.

### Tidal Waters

In tidal areas, mean low water and mean high water shall be obtained. The month and year of extreme high tide and the name of the individual furnishing information must also be shown.

On all surveys for navigable streams, the channel and bridge fender systems that are in place must be accurately located and shown. The channel alignment is usually referenced to buoys or permanent markers on the shoreline. This information can be secured from the United States Coast Guard and must be tied into the survey traverse and recorded in the notes.

On all surveys made for bridges in tidal areas, the Consultant/District Survey should determine whether there are oyster beds in the vicinity of the proposed bridge, and, if so, accurately locate.



**Sec. 8.06 Bridge Data Sheets (Form LD-23, See Figure 8-A)**

The bridge data sheet should be prepared on all proposed special design bridges and should be completed giving all of the pertinent information required on the sheet. This information will be provided to the Project Manager by: Bridge, Environmental, and Hydraulics prior to the commencement of the survey.

Emphasis should be placed on the importance of each and every item on the data sheet. This is often the only information available to design a costly structure and the time and effort expended to accurately determine all values is well spent.

Certain data required on bridge data sheets for stream and road crossings is superfluous for railroad grade separation structures and certain data for railroad crossings is needed that is not required on stream and road crossings. Only that portion applicable to the site plan being taken should be completed.

On all bridge site surveys for bridges over navigable waters, a statement must be included on the bridge situation as to whether the proposed bridge and approaches to the bridge will require the use of any land from a public park, recreation area, wildlife and waterfowl refuge or historical site.

Figure 8-A, [Form LD-23](#)

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(3-29-19)

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VIRGINIA DEPARTMENT OF TRANSPORTATION  
LOCATION AND DESIGN  
BRIDGE HYDRAULICS DATA SHEET

<b>Date:</b> Click to enter a date.			
To:		Click to choose an item.	
From (District or C.O. Survey Section):			
<b>Project Information</b>			
UPC	VA_UPC	State Project Number	VA_PRJ_NUM
District	VA_DIST	Jurisdiction	VA_POOL_JRSDCTN
Residency	VA_RES	City/County	VA_CO_CTY_NAME
Route	VA_ROUTE	Street Name	VA_POOL_ST_NAME
Road System	VA_POOL_RD_SYSTEM	Federal Number	VA_POOL_FED_NUM

<b>General Instructions</b>			
Fill out all blanks carefully, giving information on all points. High water data is especially important and should be thoroughly investigated. Comments on any item covered in Survey Instruction Manual which are not covered below should be noted on an attached sheet.			
<b>Location Information</b>			
Location (Nearest Town, etc.)		Date of Survey	Click to enter a date.
Federal Route Base No.			
Situation data for design of bridge on Route		Over	
Plane Coordinates or Latitude and Longitude from Transportation Department County Map			
<b>Bridge and Structure Information</b>			
Date of original construction	Click to enter a date.	Was present bridge in place at time of extreme high water?	Yes <input type="checkbox"/> No <input type="checkbox"/>
Upstream side of existing structure* Elevation/Location			

**Figure 8-A, Form LD-23 (con't)**

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(3-29-19)

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Downstream side of existing structure* Elevation/Location			
At other locations on the flood plain (describe)			
<b>Water Body Information</b>			
Date of Maximum High Water (MM/YYYY)			
Elevation of maximum high water and location			
Source of Information			
Elevation of normal water (MM/YYYY)			
Source of information			
Amount and character of drift present			
Location, description, and ID of any water- gaging station in the immediate vicinity			
Elevation		on gage corresponds to elevation	on survey datum
<b>Remarks</b>			
Remarks			

\*Existing structure is any structure at or in the vicinity of the proposed site having comparable drainage area.