

# **CHAPTER 4**

## **DOCUMENTATION**



**SEPTEMBER 2006**



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## 4.1 Overview

### 4.1.1 Introduction

Documentation is an important part of the design or analysis of any hydraulic structure. Appropriate documentation is needed to:

- emphasize the importance of public safety,
- justify expenditures of public funds,
- provide essential information in the future regarding planned changes or rehabilitations to a structure,
- develop information needed for matters of litigation,
- to respond to requests of the public for information, and
- to evaluate changes which may occur in the site conditions.

It is sometimes necessary to refer to plans, specifications and analyses long after the actual construction has been completed. Documentation permits evaluation of structures after flood events to determine if the structures performed as anticipated or to establish the cause of unexpected behavior. In the event of a failure, it is essential that contributing factors be identified in order that recurring damage can be avoided, and design criteria improved to avoid similar problems in the future.

### 4.1.2 Definition

The definition of hydrologic and hydraulic documentation as used in this chapter is the compilation and preservation of design details as well as all pertinent information on which design decisions were based. This may include:

- drainage area maps,
- field survey information,
- source references,
- photographs,
- engineering calculations and analyses,
- correspondence, telephone logs and minutes of meetings,
- field measurements and

- flood history.

Flood history may include narratives from newspapers and individuals such as highway maintenance personnel and local residents who witnessed or had knowledge of an unusual event.

Documentation should not be considered as occurring at specific times during the design or as a final step in the design process. Rather, it should be an ongoing work task that is an integral part of each step in the location and design process. Proper record keeping throughout the project development process greatly facilitates the task of compilation and summarization of essential information. This approach will improve the accuracy of the documentation, provide a sound basis for future steps in the project development process, and provide for consistency in the design even when different designers are involved during different phases of project development.

#### 4.1.3 Purpose

As a practical matter, there is a limit to the amount of information that can be kept since project files are periodically reviewed and purged as necessary to make space for new files. This chapter provides guidance regarding the temporary and permanent documentation of design and construction information related to the hydraulic design of structures. Procedures are established and particular emphasis is placed on recording essential information in the permanent bridge plans.

Documentation serves to define the procedures that were used and to record the basis for selecting the location and design alternatives as well as the details of the design. Documentation may be viewed as the record of reasonable and prudent decisions based on an appropriate degree of data collection and analysis. Thus, documentation can provide the following:

- identification and delineation of existing conditions at the time of design. This could prove to be very important if legal action occurs in the future;
- proof that rationally accepted procedures and analyses were used at the time of the design which were commensurate with the perceived site conditions and flood hazard. This should serve to provide further support to the State's position for any claims of negligence that may be filed in the future;
- a continuous history of any changes which have occurred at the structure. Such information may be of great value in facilitating decisions about future reconstruction;
- the information necessary to evaluate future site problems that might occur during the structure's service life;
- enhancement of the value of submissions made to other offices and agencies, thereby facilitating the task of others in the review and approval process; and
- efficient and orderly plan development as a result of recording the reasons and rationale for specific design decisions.

## 4.1 Overview (Continued)

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Project documentation should include a record of the dates of milestones achieved along with the names of the persons involved in each step of the decision-making process. It is especially important to prepare complete minutes of important meetings since the participants may not remember the details of the meeting at a later time or have varying interpretations of what actually occurred at the meeting.

### 4.1.4 General Procedures General Procedures

The following general procedures are to be used in documenting hydrologic and hydraulic reports and studies for the Office of Bridge Development:

- The engineer should consider the guidance in Chapter 3, Policy and Procedures, in preparing hydrologic and hydraulic studies.
- The engineer should document significant design assumptions and indicate how this information was used in the decision-making process.
- The degree of documentation should be consistent with the risk and importance of the facility.
- Documentation should be concise, sequentially organized and complete as practicable so that designers who may review the documentation in the future will be able to understand the basis for the original design.
- References should be given to studies or reports by others that have been used in the decision-making process.
- Care should be exercised in presenting the degree of precision and the probability of occurrence for the design criteria used in the analysis. If the chosen method of analysis is for a "worst case condition" that may have a low probability of occurrence, this assumption should be specified. Reports should not imply that calculated values are correct to one or two decimal points if the assumptions made or data used do not support this degree of precision.

## 4.2 Types of Records

There are three types of records to be considered in documenting decisions about the hydraulic design of bridges

### 4.2.1 Structure Hydrology and Hydraulics Records

Records under the direct control of Structure Hydrology and Hydraulics. These include:

- Hydrologic Study Reports,
- Hydraulic Study Reports,
- Stream Morphology Reports
- Bridge Scour Evaluation Reports,
- Computer Input/Output Files (including GIS data and computation of water surface profiles)
- The Hydrologic and Hydraulic Data Sheet in the PS&E Plans, and
- Other files, field trip reports and related information as described in Section 4.1.2

### 4.2.2 Other SHA Office Records

Records under the direct control of another office of the State Highway Administration. These include:

- Environmental/Location Studies and Reports,
- Survey Records,
- Avoidance, Minimization and Mitigation Plans and Reports
- TS&L Plans
- Permit Applications,
- Foundation Reports,
- PS&E Plans
- As-built Plans
- Bridge Inspection Reports, and

## 4.2 Types of Records (Continued)

- District Office Records on bridge performance

### 4.2.3 Records of Other Agencies

There are several records prepared by other agencies that are used in plan development as a basis for decisions about the hydraulic design. These include:

- USGS Topographic Maps,
- USGS Water Supply Papers and Hydrologic Study Reports,
- FEMA Floodplain Maps and Studies,
- Computer Program Files for Flood Studies prepared by or for the FEMA, Corps of Engineers or other governmental agency.
- Information and recommendations provided by the Maryland Department of the Environment (MDE).

## 4.3 Responsibilities of SHA Personnel

The Project Team Leader and Senior Project Team Leader assigned to a particular project or area of work should complete and document significant files and records in the manner described in this Chapter.

### 4.3.1 Structure Hydrology and Hydraulics Reports

The Project Team Leader is responsible for reviewing, checking and properly maintaining the records and studies discussed below that fall under his control:

- Hydrologic studies
- Hydraulic studies
- Stream Morphology
- Bridge scour evaluation studies
- Investigation of Flooding Complaints

The content of these reports is described in Chapter 3. At least one hard copy of each study should be retained in the office library for a period of three years after completion of construction. Electronic files of each report should be copied onto CD's and submitted to the designated archive coordinator for permanent storage.

Project design files should be reviewed periodically and purged of unnecessary information. Unnecessary information should be eliminated after the time periods described in the above paragraph have elapsed. Essential information that should remain as a part of the permanent project file should be copied on CD's and stored in a permanent file.

Project computer input and output files used in the hydrologic or hydraulic analyses should be stored on CD's as a part of the permanent project file. Hard copies of this information should be included in the corresponding hydrology or hydraulics report.

The Project Team Leader should review the Hydrologic and Hydraulic Data Sheet to ensure that it is accurate and complete. Complex or unusual features of the design should be outlined in the Special Conditions section of this sheet. Appropriate references should be listed for any special studies or reports that were used as a basis for the design of the structure. The Hydrologic and Hydraulic Data Sheet is the single most important document for hydraulic design since it becomes a part of the permanent plans for each structure.

### 4.3.2 Records of Other SHA Offices

### **4.3 Responsibilities of SHA Personnel (Continued)**

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Structures Hydrology and Hydraulics personnel should review the plans, study reports and other documents listed below to verify that the information in these documents is adequate and accurate. Any comments regarding the need for revisions, additions or deletions should be discussed with the Senior Project Team Leader and submitted to the appropriate offices in order to arrive at a timely resolution of the stated concerns:

#### **A. Environmental/Location Studies and Reports**

The Senior Project Team Leader shall serve on Project Management Teams as appropriate during the early stages of project planning and route location to ensure that:

- the hydraulic aspects affecting the selection of structure and approach road locations in flood plains are fully considered,
- conflicts which may arise between environmental concerns and SHA design or location policies are recognized and promptly resolved at an appropriate level of management,
- planning, environmental and location documents reflect the policies and practices of the Office of Bridge Development, and
- decisions made in the planning process which affect (1) the location or design of structures and (2) the need for environmental mitigation are clearly documented and incorporated in the project plans.
- Requests for aerial photography, mapping or other graphics should be prepared using the form presented in Appendix 4-B.

The Senior Project Team Leader may delegate any or all of these responsibilities to the Project Team Leader.

#### **B. Survey Records**

The adequacy of survey records should be evaluated by the Project Team Leader as an integral part of the review and use of the structure plans and the cross-sections of the roadway, floodplain and stream channel. The survey record book numbers should be recorded on the Hydrologic and Hydraulic Data Sheet. Any questions or concerns about survey data provided for hydraulic studies shall be promptly discussed and resolved with the appropriate survey personnel in Plats and Surveys. Requests for surveys should be prepared using the form contained in Appendix 4-A.

#### **C. Minimizing Impacts to and Enhancing the Natural Resources of Streams and their Flood Plains.**

The Project Team Leader should review project plans, giving particular attention to the following aspects of the plan:

### **4.3 Responsibilities of SHA Personnel (Continued)**

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- Practicality and cost-effectiveness of the proposed time schedules and work,
- Consistency with environmental requirements of Federal and State agencies pertaining to work within the 100-year flood plain.
- Consistency with the policies and procedures of the Office of Bridge Development, and (for Phase III Planning Projects) the Office of Project Planning
- Effect of the plan on highway and bridge plans and studies.

The Project Team Leader should review permit applications, as discussed below, for appropriate discussion and commitments regarding the accuracy and reasonableness of the proposed actions.

#### **D. Permit Applications**

The Project Team Leader should work with Bridge Division Personnel to ensure that the applications contain all necessary information. Guidance on the role of the Structures H&H Unit in the development of permit applications is presented in Chapter 5.

#### **E. PS&E Plans**

PS&E Plans should be reviewed by the Project Team Leader for consistency with the hydrologic and hydraulic policies and design criteria of the Office of Bridge Development. The information in Chapter 3 may be used as a guide in reviewing the adequacy of PS&E plans. As noted earlier, particular attention is to be given to the review of the Hydrology and Hydraulics Data Sheet since the information summarized on this sheet normally becomes the most reliable and available future source of information about the hydraulic design aspects of the project.

#### **F. As-built Plans**

The Project Team Leader should review as-built plans for projects in flood plains within his or her jurisdiction. Primary emphasis in these reviews should be placed on verifying that:

- minimum pile tip elevations for foundation units (as constructed in the field) are written on the plans.
- scour countermeasures are constructed in substantial conformance with the PS&E plans,
- changes to substructure or superstructure details do not adversely affect the hydraulic performance or stability of the structure, and
- letters containing descriptions of any floodplain map revisions required by the project have been sent to the Federal Emergency Management Agency (FEMA).

#### **4.3.3 Records of Other Agencies**

### **4.3 Responsibilities of SHA Personnel (Continued)**

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The responsibility for the maintenance of one or more of the records listed below should be assigned to the Project Team Leaders:

- U. S. Geological Survey Topographic Maps,
- U. S. Geological Survey Scour Survey Notebooks,
- U. S. Geological Survey Water Supply Papers, Hydrologic Studies and Other Associated Reports,
- FEMA Flood Insurance Rate Maps, Index Maps and other floodplain mapping studies,
- Wetland Index Maps, and
- Metro and County Road System Maps.

For each record, periodic checks should be made to verify that:

- the records are complete and that any missing reports or records are reordered and replaced,
- the records are maintained in a neat and orderly fashion,
- office personnel are instructed in the use of the records, and
- adequate arrangements for security are taken to protect the records from loss or destruction due to careless or negligent use by others.

## 4.4 Responsibilities of Consultants

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The Consultant selected for an SHA project shall be responsible for completing and documenting all assigned work. If the Consultant is of the opinion that a procedure or methodology other than ones approved by OBD should be used for a particular analysis, advanced approval of the method should be obtained prior to commencement of work.

### 4.4.1 Hydrology, Hydraulic and Bridge Scour Reports

The format and content of reports shall be prepared in accordance with the instructions in this Manual and with instructions from the SHA Project Team Leader. The Consultant is encouraged to work in close cooperation with the Project Team Leader so as to minimize problems in communications and resulting non-productive work. Reports shall be self-contained to the extent practicable. Where necessary, reference may be made to outside sources of information used by the Consultant in preparing data or exhibits for the reports. The Project Team Leader may request that the Consultant provide one or more preliminary or technical submissions for review prior to development of a draft report in order to assure that the analysis is proceeding in a manner acceptable to the SHA.

#### 4.4.1.1 Hydrologic Reports

Draft and Final Hydrology Reports shall be prepared in accordance with the instructions in Chapters 3 and 8. Two copies of the draft report and four copies of the final report shall be submitted to the SHA.

#### 4.4.1.2 Hydraulic Reports

Hydraulic Reports are to be prepared in accordance with the guidance in Chapters 3, 9, 10 and 13 as appropriate. The following information will normally be expected to be included in reports submitted to the SHA for review/approval:

#### PRELIMINARY TECHNICAL SUBMISSIONS (2 copies)

Preliminary submissions should be made using the information in Chapter 3 as a guide regarding the content and format of the report.

#### FINAL DRAFT REPORT (2 Copies)

- Information from the preliminary technical submission, as revised to account for review comments and other modifications.
- Report text and exhibits.
- Cost estimates for each of the alternative structures.
- Commentary and recommendations regarding alternatives for stream diversions and

## 4.4 Responsibilities of Consultants

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sequence of construction.

### FINAL REPORT (4 Copies)

- Completed text, exhibits, summary tables, computer output data and other technical information as discussed above that has been revised in accordance with the review comments of the State.
- Computer CD's containing input and output data from computer programs and word processor files for the final report.

#### 4.4.1.3 FEMA Reports

Any highway project located in a flood plain under the jurisdiction of the Federal Emergency Management Agency (FEMA) must be designed and constructed in a manner that is consistent with the flood plain management regulations of FEMA. These procedures are presented in Chapter 5.

#### 4.4.1.4 Bridge Scour Reports

Bridge Scour Reports should be prepared in accordance with the instructions in Chapter 11. Two copies of the draft report and two copies of the final report will normally be requested by the Project Team Leader.

#### 4.4.2. Hydrologic and Hydraulic Data Sheet

The Hydrologic and Hydraulic Data Sheet is to be filled out for each structure designed for the Office of Bridge Development. The SHA Project Team Leader will advise the Consultant as to when the Data Sheet should be prepared.

#### 4.4.3 Project Records

The SHA Project Team Leader will advise the Consultant, prior to completion of the work, regarding any project records (design documents, drawings, field survey data, etc.) that the State wishes to obtain from the Consultant for the state project files.

## **5.0 Surveys**

### 5.1 Overview of Actions by H&H for Coordinating Flood Plain Surveying Work with Plats and Survey

Plats and Surveys and Structures H&H normally use the same surveyors for their respective work, and these surveyors are considered to be reliable. However, it is important that H&H engineers follow the steps below to obtain the best results from their open-end consultants

1. Work with Plats & Surveys on all survey requests.
2. Notify Plats & Surveys of the scope of the job, and ask for an area surveyor to help (1) process the request, (2) aid our consultant in obtaining the data and (3) review the cost proposal.
3. Specify the deliverables: 2 CD's – One for our processing, and one for Plats & Surveys to be forwarded to George Hadel, to be checked and put on the server.
4. Always have the surveyor give us a hard copy, which has a seal by Plats & Surveys.
5. Have the surveyor deliver, as part of the project, a map outlining the area in which the work was conducted.
6. Work with Plats and Surveys on notification of affected property owners

### 5.2 Flood Plain Survey Requests

#### 5.2.1 General Guidelines

1. Elevations for today's surveys should be referenced to NAVD 1988 instead of NGVD 1929 unless there is a specific reason to use the old datum such as a tie-in to an old survey. Approval should be obtained from the Office of Bridge development prior to any decision not to use the NAVD 1988 datum.
2. The engineer should develop a clear concept of the anticipated 100-year flow pattern so as to establish the number, location and configuration of the required cross-sections.
3. The width of cross-sections should be, at a minimum, to cover the anticipated 100-year floodplain and to incorporate in a reasonable manner the 500-year flood. In some cases where the areal extent of the 500-year flood is great, it may be necessary to limit field surveys to the 100-year flood plain and later modify the hydraulic model with vertical barriers at the 100-year flood boundary in order to model the 500-year flood. If 50-scale or 100-scale topographic maps are available, it may not be necessary to survey the entire flood plain. In this case, the extent of cross-sections to be surveyed may be approximately 50 to 100 feet on either side of the stream channel banks (or as directed by H&H). The remaining portion of the cross-section can then be derived from the existing topographic mapping.
4. Number the cross-sections from downstream to upstream.

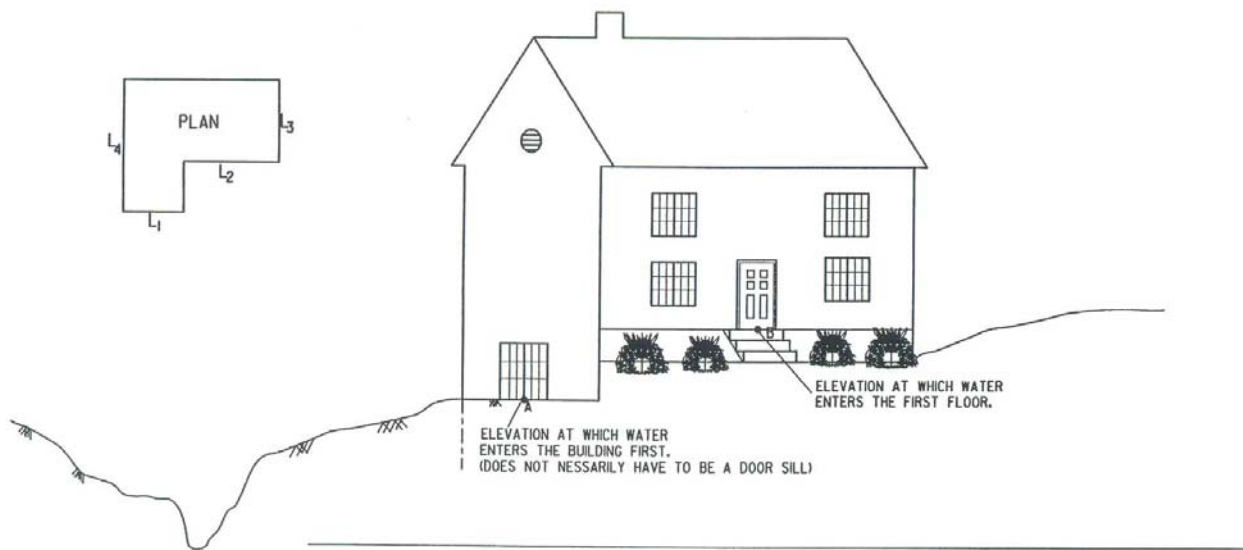
## 5.0 Surveys

5. In coordination with Plats and Surveys, develop a cross-section location map at an appropriate scale. (usually 1" = 50', 1" = 100', or 1" = 200'). This map should clearly depict the following information, where applicable.
  - Scale, contour interval, project number, project location and description, and north arrow.
  - Maryland State grid coordinates.
  - Existing waterways and roadways.
6. Identify cross-sections needed for hydraulic modeling, considering the factors listed below.
  - a. Presence of tributaries (cross-sections needed in the immediate vicinity of the confluences).
  - b. Sharp bends in the waterway (cross-sections should not overlap )
  - c. Significant changes in bed slope, stream channel size, and/or surface roughness characteristics (additional cross-sections are usually needed at such locations).
  - d. Presence of hydraulic structure downstream of the proposed project for possible backwater effects at the starting cross-section.
  - e. Spacing between cross-sections. Normal spacing is about 50 to 200 feet for smaller streams. The spacing between cross-sections should be measured along the stream. For larger streams, a greater spacing can be used, but not greater than 500 feet. Cross-sections at relatively closer spacing will be required to model the existing and proposed culvert/bridge and other structures. However, the number of required cross-sections at the hydraulic structures should be evaluated on a case-by-case basis, considering the factors, such as height of the embankment, channel erosion, limits of outlet protection and extent of wing walls/abutments' etc. Some cross-sections required for structure hydraulic modeling may not require field survey.
  - f. A typical minimum stream reach in which the cross-sections are to be surveyed is 1500 to 3000 feet downstream and 1500 to 2000 feet upstream. However, this reach should extend to cover a suitable location to start the computations downstream, and far enough upstream to cover the possible hydraulic impacts. Normally the channel slope will be a factor to consider in establishing these limits with longer study reaches required for flatter channel slopes.
  - g. If one or several existing hydraulic structures are to be included in the hydraulic analysis, both structure details and additional cross-sections are required near/within such structures.

## 5.0 Surveys

h. In coordination with Plats and Surveys, identify and indicate all buildings within anticipated 100-year floodplain to obtain the following information for each building (Figure 1):

- Name and address of owner.
- Street address of building
- Elevation at which the floodwaters enter the building first.
- Elevation at which the floodwaters enter the first floor.
- Plan View with Dimensions; coordinates of any two corners

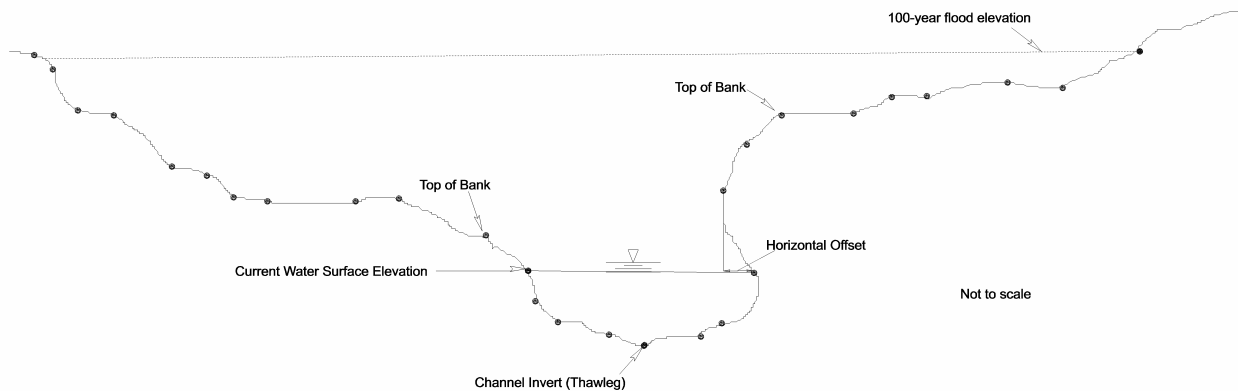


**Figure 1**

7. Review the survey information requested for the hydraulic analysis to assure that it is adequate.

## 5.0 Surveys

### 5.2.2 Guidelines For Taking Channel And Flood Plain Cross- Sections



**Figure 2**  
**Cross-Section Data**

1. The location and orientation of the cross-sections should be maintained.
2. Elevations and offsets should be obtained for all points of significant grade break along the cross-section.
3. Obtain the offsets and elevations of points along the cross-section where the ground cover changes significantly (for example, from trees to grass)
4. Locate by offset and station, conditions such as scour, holes, islands, wetland boundary flagging, utility structures, etc
5. Obtain the offsets and elevations of the edges of water for every cross-section
6. If cross-section data is obtained on different days, note the dates.
7. The bottom of stream channel should be surveyed, using a minimum of 5 points. Larger stream channels (say. > 10 ft. wide) usually require more points to be consistent with the intent of Item 5 above.
8. The horizontal coordinates of all points on the cross-section should increase from left to right (looking in the direction of flow).

## 5.0 Surveys

9. Cross sections should extend to the approximate 100-year floodplain limits.
10. Main stream channel should be identified clearly when multiple channels exist.
11. A point shall be collected at the minimum stream channel invert (thawleg).
12. For concave banks (Figure 2) provide a horizontal offset along the water surface from the vertical.

### 5.2.3 Guidelines for Information On Existing Highway Structures

Develop a detailed sketch (with dimensions and reference elevations) showing the following information for each highway structure:

#### a. Location (station and offset)

#### b. Bridge Data

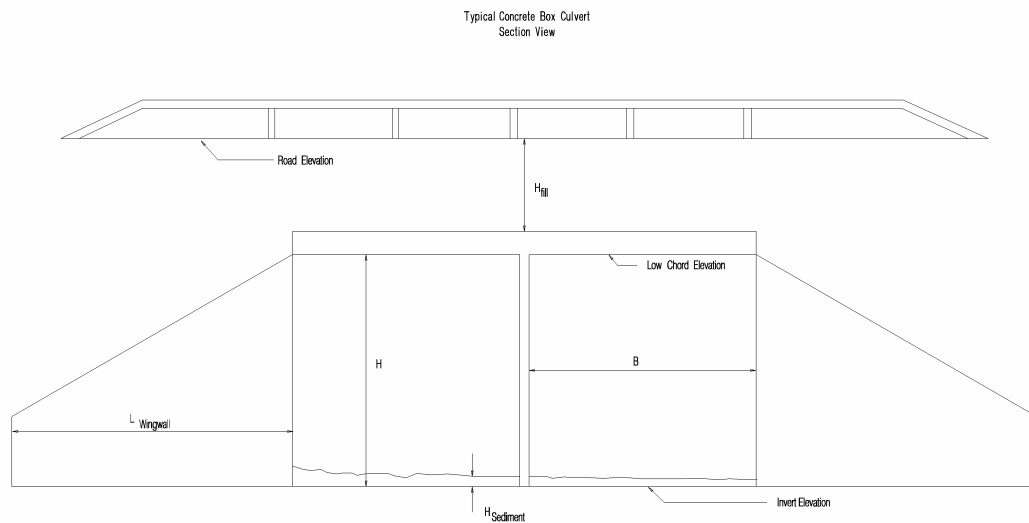
- If a referenced monument is not used to establish a datum for an existing bridge, a point on the bridge should be selected as the datum. This point should be clearly marked and identified in the field and in the survey notes to clearly identify it as the datum for all elevations
- Material, type, skew angle, widths perpendicular to abutment and piers; effective hydraulic width perpendicular to stream flow
- Referenced elevation of low chords, upstream and downstream.
- Cross-section and profile of bridge deck and approaches
- Type of top surface (concrete, steel/wooden girders, etc.)
- Dimensions and elevations of wingwalls
- Material, type, size and width of the piers, including their alignment with respect to the road and referenced elevations of pile caps and pier caps
- Type of pier nose (semi-circular, triangular, flat, etc.)
- Depth and extent of scour holes at piers and abutments
- Height, extent and type of parapets (grooved, solid, etc.)with appropriate referenced elevations.
- Presence of debris

#### c. Culvert Data

- Culvert description: type, size, material, invert elevations at both ends (not the top of sediment, but the bottom of structure).

## 5.0 Surveys

- Type of entrance (headwall, projecting end, mitered end, headwall with wing walls, including beveled, depression, etc.) and show the details, including elevation of top of headwalls and the station-offset data of wing walls' ends.
- skew angle
- Average sediment depth at both ends (if any) and note if it is loose or compact
- Type of bottom surface (natural, or concrete in case of boxes, etc.)
- Presence of debris



**Figure 3**  
**Culvert Data**

### 5.2.4 Cross-Section Data at Structures.

Additional cross-sections are desired at Bridge and Culverts:

- a. Cross-section approximately one foot below the exit face
- b. Cross-section approximately one foot above the exit face (i.e. within the structure – \* see note below)
- c. Cross-section approximately one foot below the entrance (i.e. within the structure – \* see note below)
- d. Cross-section approximately one foot above the entrance

## 5.0 Surveys

- e. Cross-section at downstream toe of roadway embankment slope
  - f. Cross-section at upstream toe of roadway embankment slope
  - g. Cross-sections at the junctions where there are changes in the waterway opening (both gradual and abrupt) within the structure
  - h. Roadway profile over the structure (the length of the roadway should include that portion over which the weir flow might occur during the 100-year flood).
- 

\*The cross-sections taken inside of the entrance and exit faces of the structure should enable the Hydraulic Engineer to determine the exact shape of the waterway opening. For example, in the case of an arch structure, the inside cross-sections should plot the entire arch (including bottom surface).

In case of multiple span bridges, the length of each span should be measured. Where applicable, include the shapes and dimensions of piers and pier footings where exposed.

**APPENDIX 4-A SURVEY REQUEST FORM**  
Maryland Department of Transportation  
State Highway Administration



Date: \_\_\_\_\_

**SURVEY REQUEST FORM**

TO: George A. Hadel, Chief  
Plats & Surveys Division

FROM: Glenn Vaughan, Chief  
Bridge Design Division

Attention: George Hadel

Survey information needed by: Michael Blahut

FMIS Contract No. \_\_\_\_\_

Project Description: \_\_\_\_\_

Survey of: Circle one

- |                        |  |
|------------------------|--|
| 1. Full cross-sections | 2. Stream channel & 100' on either side only |
|------------------------|--|

Enclosed are the following:  
(check as appropriate)

Survey information needed:  
(check as appropriate)

- 1.  Vicinity
- 2.  Location map
- 3.  Cross-section location map
- 4.  Map showing structures
- 5.  Map showing the buildings
- 6.  All the above
- 7.  Other (describe below)

- 1.  Cross-sections  
(note circled item above)
- 2.  Structural details only
- 3.  Flood-prone building details only
- 4.  All the above
- 5.  Other (describe below)

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

H&H Engineer: \_\_\_\_\_  
FIII.E.C:\SURVEY.REQ

Telephone: \_\_\_\_\_

