1.1 OVERVIEW OF THE DESIGN AND CONSTRUCTION PROCESS

The scope of engineering work from the design through the actual construction may be divided into six stages. A general knowledge of these stages in the design and construction of a structure is essential for the detailer to prepare a high-quality set of plans. The stages are as follows:

I. Preliminary Design

In this stage of the plan development, a structure type will be selected. Two or more alternate structure types will generally be considered at each site. Economy is usually the best substantiation for the final type selection. However, many other items shall be considered, such as: appearance, maintenance costs, construction details, traffic convenience during construction, time for construction, similarity to adjacent structures, availability of materials, features crossed, span lengths, vertical clearance. The type or types of Accelerated Bridge Construction (ABC) are determined during preliminary design.

The decisions made at this stage are very important, and time should be taken as necessary to assure a good start with valid criteria because the rest of the structure plans will be built around this information. Typically, a General Layout sheet and Typical Sections are developed for this design phase.

II. Final Design

This stage includes a detailed stress analysis and preparation of drawings and sketches necessary to illustrate to the detailer the general arrangement of the structure, member sizes, and any other information necessary to clearly interpret the designer's ideas.

III. Detailing

This consists of preparing drawings from the designer's notes. The drawings must be clear enough for suppliers to prepare the necessary fabrication drawings and support any quantity calculations. As part of the detailing process, quantities shall be calculated and results used for preparing the summary of quantities table.

IV. Checking

The design check and check set of quantity calculations shall be made using the detail drawings.

V. Fabrication

This includes cutting and bending of reinforcing steel, the building of the structural steel components, and the casting of precast-prestressed components.

VI. Construction

This consists of the actual building of the structure from the drawings. This phase of the work can be expedited by conscientious work during plan preparation.

1.2 GENERAL STEPS OF DETAILING PROCEDURES

When the detailer has received the design data for the preparation of the detailed drawings, the work may be divided into the following steps:

Step 1 Design Study: The detailer shall carefully study the design notes and material provided by the designer. It is important that the detailer understand the Engineer's design, as well as the probable step-by-step construction of the structure. The detailer is expected to carry out all instructions given in the design notes; nevertheless, any points that the detailer considers worthy of discussion must be brought to the attention of the designer.

Step 2 Bridge Geometry: The person preparing the Bridge Geometry input shall study the layout of the structure and roadway approaches, and while coding in the geometry input shall refer to the Bridge Geometry User's Manual provided by the Staff Bridge Branch.

Step 3 Planning the Drawings: In coordination with the designer, the detailer shall plan the drawings, determining what details and information are to be placed upon each sheet, the scales to be used and the number of sheets required.

Step 4 Preparation of the Drawings: This consists of the actual drafting procedure. The detailer and/or designer will prepare some sketches and computations as necessary to place accurate information on the drawings.

Step 5 Checking: Upon completion of the drawing set, copies are given to the designer, the design checker and the detail checker, along with all pertinent data necessary to perform a comprehensive check. All dimensions, stations, elevations, and details shall be checked for accuracy and consistency. A consistent method of markups shall be used. In a commonly used system, the checkers indicate possible corrections or additions that may be needed on the drawings in red. Correct information is highlighted in yellow by the designer or submitter of the comments. Marked up drawings should be initialed and dated. When the checking has been completed, the check prints shall be returned to the designer who will back check the mark-ups. The designer will confirm the items marked as incorrect are indeed incorrect and the corrections or additions are accurate prior to sending the set back to the detailer for revisions. The checker and designer shall also resolve any differences prior to sending the corrected set back to the detailer.

Step 6 Making Corrections: After verifying the redlined corrections indicated on the check prints, the detailer shall then make the changes. As the changes are being made, they shall be marked in blue highlighter prior to returning to the checker. Alternately, the check prints may be marked "changes made" with initials and date. This allows the designer to verify changes by highlighting the detailers blue with orange. The corrected drawings will then be reviewed against the check prints to verify the marked corrections have been incorporated correctly. If additional changes are still necessary, it’s usually cleanest/easiest to mark up a new set of prints rather than continuing to use the old marked up sets.

1.3 CORRECTIONS OF DESIGNER'S DETAIL NOTES

In the course of the detailing procedure, it may become necessary to make revisions to the design notes. It shall be the designer's responsibility to keep the design notes current. Computer aided drafting has increased the ability to speed up the detailing process, however the design should be as complete as possible before the detailer starts working on the project to minimize changes.

1.4 STRUCTURE NUMBER

Structure numbers shall be assigned by the Asset Management Unit. Refer to the BRIAR Manual & Bridge Design Manual for additional details. Typically, these shall be requested as soon as practical in the design process and used on all drawing references. Structure numbers for other ancillary structures such as signals, high mast lights and sign structures are assigned in a similar manner.

1.5 WALL STRUCTURE NUMBER

The Bridge Management Unit shall assign Wall Structure Numbers to both noise walls and structural retaining walls. For additional details, examples, wall qualification criteria, definitions, designation and naming procedures, refer to the BRIAR Manual, Bridge Design Manual, & Section 15.1 – Wall Details. Typically, these shall be requested when the wall geometry is finalized in the design process and shall be used on all drawing references.

1.6 ACCURACY OF DIMENSIONS AND ELEVATIONS

The degree of accuracy used on the drawings shall be as follows:

A) Structural dimensions to the nearest 1/8 inch with the following exceptions:

1. Bearing device dimensions on abutments and piers to the nearest .001 foot.
2. Top of concrete of the bearing seat to the nearest 1/16 inch.
3. Stations to the nearest .01 foot.
4. Foundation, Construction, Girder Layout dimensions (dimensions along tangents, etc.) to the nearest .01 foot.
5. Steel girder dimensions to the nearest 1/16 inch.
6. Dead load deflections to the nearest .0001 foot.
7. Tip elevations of caissons, and estimated pile tips, shall be given to the nearest foot.
8. Elevations for bottoms of footings shall be rounded to the nearest .01 foot.

B) Skew angles and bearings shall be given to the nearest second. Example: 69°38'13".

C) Other angles shall be given so that dependent dimensions meet the above criteria.

1.7 RESPONSIBILITY FOR PLAN DRAWINGS

Drawings shall be prepared and checked in the design unit. The graphic presentation of the information on these drawings shall be the responsibility of the individual preparing the drawings. Any differences of opinion for graphical presentation between designer and detailer not clearly delineated in the Detailing Manual shall be brought to the attention of the unit leader for clarification.

1.8 CHECKING PLAN DRAWINGS

The designer, detailer, and detail checker are each responsible for contributing to an acceptable, error free set of contract plan drawings. A conscientious cooperation among all three parties is required to accomplish this.

It is important to correct all errors in the plan drawings before a project is advertised. This will avoid contract revisions, Contractor claims, added construction costs, and additional time charged to projects to address construction problems caused by plan errors.

Because of the importance of checking the plans, adequate time shall be allowed for this process, even in high priority rush jobs.

The following outlines the various responsibilities of the designer, detailer, and detail checker during the plan checking process:

A) The designer shall check the plans to assure that the design was correctly conveyed in the plans and is constructible.

B) The detailer shall check every detail in the plans for neatness, correctness, completeness, constructability and clarity.

C) The designer and detail checker shall back check the plans, after the detailer has made the revisions to the plans to assure all changes have been made.

Additional information and instructions for checking will be discussed in subsequent chapters of this manual.

1.9 BORDER INFORMATION

A) TITLE BLOCK

The sheet title shall be a description of the details or information shown on the drawing. All letters in the sheet title shall be capitals.

The structure number, first initial and the last name of the Designer and Detailer, project number, sub-account number, Subset initial (e.g., “B”, “W” etc.) & number, and total number of subset drawings shall be filled in on each sheet. The total number of sheets in the subset can be placed either in the CAD drawing or could be placed in the Acrobat PDF version of the file that is submitted with the final detail letter. The full version of Adobe Acrobat is required for this capability. The Sheet Number should be left blank so it can be filled in later by the project manager.

Sheet Subset Name	Subset Acronym
Bridge	B
Bridge 1	BA
Bridge 2	BB
Bridge 3	BC
Wall	W
Wall 1	WA
Wall 2	WB
Anti-Icing	ICE
Sign	S
Tunnel	T

Fig. 1.9-1 Sheet Subset Names and Acronyms

Culverts can be included in the Bridge sheet subset to help with construction and compartmentalize information. Page numbering systems to create subsets such as W101-1XX and W201-2XX shall not be used.

The original detailer should make corrections if possible. Do not change detailer name or initials if you make changes to someone else's drawing. This would be changed only if another detailer makes major revisions to a sheet. Only one detailer should be listed.

GENERAL LAYOUT			Project No./Code
			FBR 0703-357
Designer: M. Yip	Structure Numbers	F-14-AZ	17671
Detailer: R. Olmos			
Sheet Subset: Bridge	Subset Sheets: B03 of 23		Sheet Number

Fig. 1.9-2 Sample Title Block

B) REGION INFORMATION

Provide the Resident Engineer information for the overall project. If there is no assigned Resident Engineer such as with repair plans, provide the Unit Leader information for the project or repair. The As-Constructed information to the right of the resident engineer information is not filled out by Staff Bridge.

Fig. 1.9-3 Sample Region Information

C) SHEET REVISIONS

When changes are required after the project has been advertised, it may be necessary to revise the drawings. The modifications made on the drawings shall be flagged and noted in the revision block on the modified sheet. Additional information may be found in the Project Development Manual and Section 121.2.3.2.1 of the Construction Manual. Verify with your Construction Engineer for preferences on revisions. The following information is in general conformance with these manuals.

The person initiating the revision shall give the date per Design Engineer, a brief notation indicating the nature of the revision, and the initiator's initials. If the initiator is the detailer correcting typos or measurement or quantity errors, the detailer's initials would be appropriate. If the revision involves engineering judgment, the Design engineer's initials would be appropriate.

At the left of the revision date are flagging symbols. The revision number such as R-1, R-2 used during the Ad period, or FR-1, FR-2 used during construction shall be placed into the symbol. This symbol, with the

revision number, shall be placed near the location on the drawing where the particular revision occurs. A revision cloud may be used to clarify the portions of revisions as well.

When a new drawing is added, the date and the notation "New Sheet" shall be placed in the revision block. Any sheets that are revised or replaced after the award of a project are given an X after the Sheet Number in the Title Block area such as 128X. Subset sheets will not be given the “X” designation. Since the overall sheet numbering is usually known at that time, the detailer should place this number on the sheet. Any sheets that are added are given letter numbers such as 128A, 128B, etc.. The original total number of sheets is not revised even though the actual total may be increased.

Coordination of revision dates with other departments shall be made through the Unit Leader. Figure 1.9-3 shows typical revision notes.

	Sheet Revisions		
	Date:	Comments	Init.
R-1	6/3/03	Added expansion joint note	SLW
FR-1	6/30/03	Corrected Dimension	BAF

Fig. 1.9-4 Typical Revision Notes

D) MISCELLANEOUS INFORMATION

The lower left-hand corner of the border contains miscellaneous information on print date, file name, scale as well as the responsible unit information. The scale should be filled out as appropriate. When all details or sections on a drawing layout are at the same scale, the scale information block on the border should be filled in or edited with the correct scale. If varying scales are used on the drawing, the scale information block on the border should be filled out with VARIES, NOT TO SCALE, NTS, NONE or other appropriate description. If a design is done by a consultant, the consultant information can be placed in the lower box.

A time stamp is useful for keeping track of different versions of the hard copy drawings during the detailing process. The preferred placement is at the left side of the drawing, displayed vertically as shown.

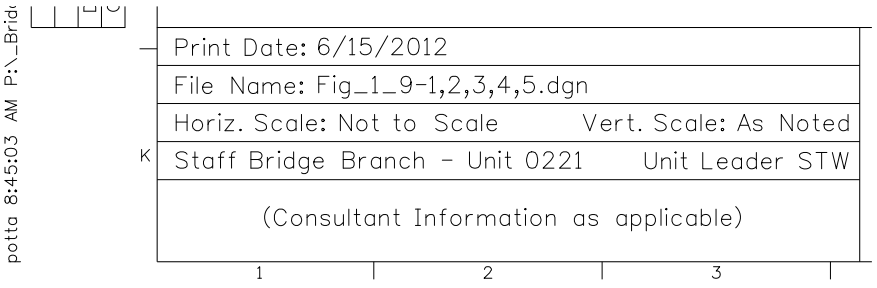

Fig. 1.9-5 Sample of Miscellaneous Information

E) SHEET GRID

The sheet grid as depicted in Fig. 1.9-5 is optional at the discretion of the detailer and/or designer. If the grid is used, it shall be used on all sheets of the subset.

F) INITIAL BLOCK

Give the initials of the person who performed each of these functions, along with the date on which these functions were completed. The Initial Block shall be completely filled out on each sheet.

INITIALS	DESIGN	DATE	DETAIL	DATE	QUANTITY	DATE
By						
Checked By						

Fig. 1.9-6 Sample of Initial Block

1.10 FILE NAMING CONVENTIONS

To assist the detailer and anyone else working on the drawings, a consistent file naming convention shall be used. The first two or, in rare cases, three characters in the filename should be the drawing number for the finished sheet in relation to the set, for example 01 for the first drawing, 02 for the second, etc. The rest of the filename should be a brief description of the drawing's contents. The file extension is typically a 3-letter code that is set by the software used to create the file. A complete filename looks something like this: "04GeneralLayout.xxx". In this case, "04" indicates that the file is the fourth file in the drawing set, it is the drawing titled General Layout. The xxx would be determined by the software used. Abbreviations of common terms may be acceptable so long as the meaning is clear. Although brevity is important in the drawing file name, it is possible to be too brief. Every attempt should be made to keep drawing file names between 10 and 25 characters not including the extension in order to fit in the border. For files with multiple borders (Bridge Deck Elevation sheets only) the file name should reflect the number of sheets, e.g. 22-27_ElevationSheets.dgn.

1.11 PROJECTWISE DIRECTORY STRUCTURE

A comprehensive directory structure shall be maintained throughout the project. Simplicity is the key to being able to maintain and back up all of the appropriate information. The Projectwise directory structure for projects with subaccounts is

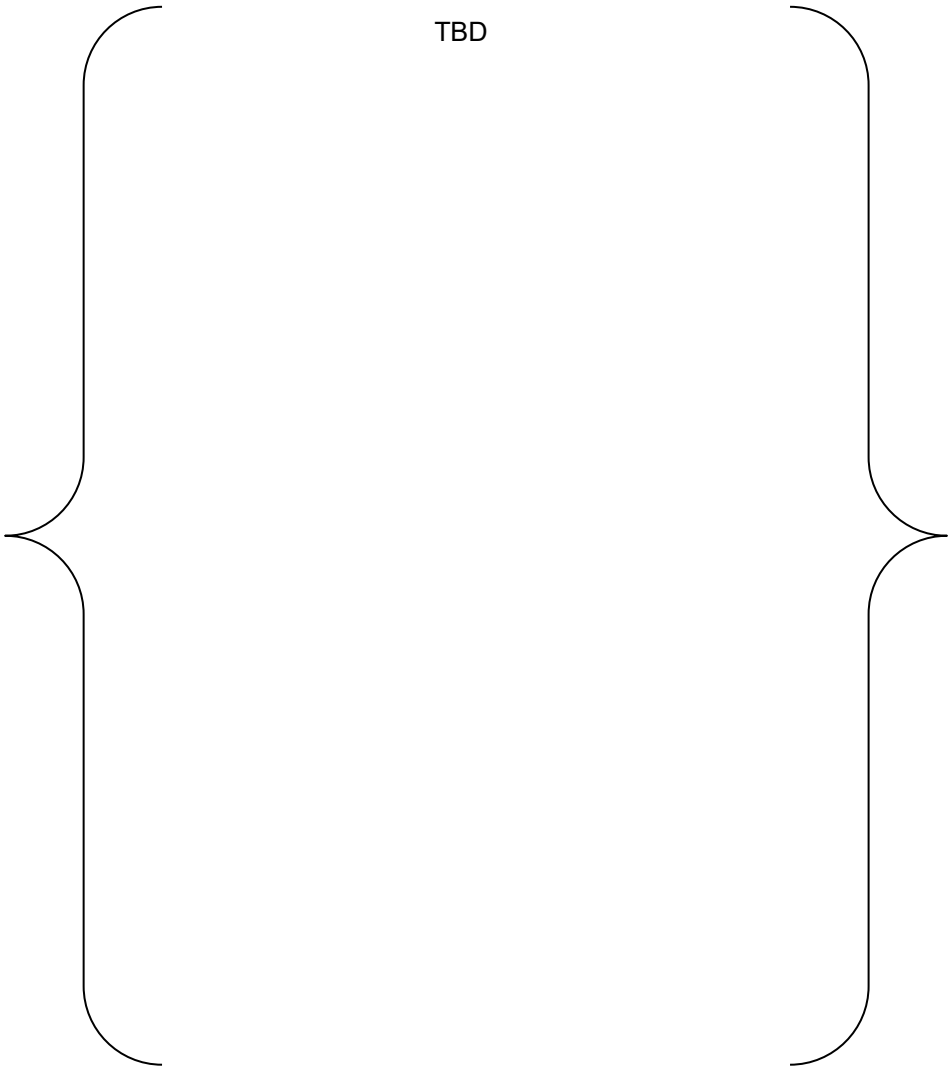

Fig. 1.11-1 Projectwise Directory Structure

The internal ProjectWise directory structure for projects without subaccounts and other information is:

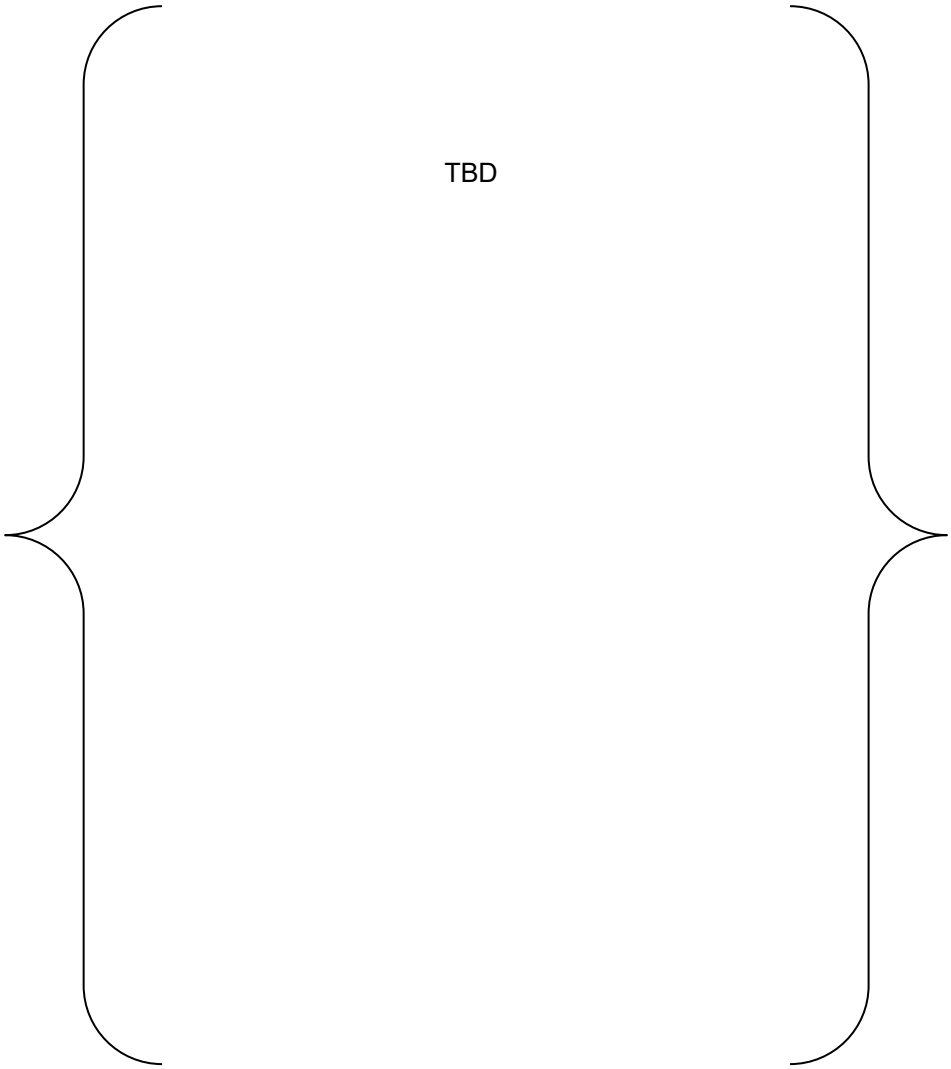

Fig. 1.11-2 Internal Projectwise Directory Structure

Responsibility for maintaining the drawing files and directory structure rests solely on the design team. All production files should be kept in Projectwise. See the Projectwise Manual for additional details.

Duplication of files is highly discouraged. The detailer should not copy a file from one location to another for the sole purpose of making changes and then copy the modified file back to its original location. This practice creates unnecessary multiple copies and increases the risk of losing information. A notification system shall be used whose purpose is to notify each user when a requested file is in use by another user.

1.12 STRUCTURAL WORKSHEETS

Structural worksheets that are currently in use are available on the Bridge website. The intent of these worksheets is to provide a starting point for generally used items on projects. It is necessary to modify them as needed to match project requirements. The website versions are the up-to-date versions and should be used on new projects. Any permanent corrections, changes or improvements to the worksheets should be coordinated with the Bridge Project Support Unit. The revision dates are included on the left-hand side of the border. This information should be deleted after FIR level plans are produced.

Revision Dates (Preliminary Stage Only)							
3/99	4/99	11/99	5/00	4/02	6/04	2/06	3/07

Fig. 1.12-1 Sample of Worksheet Revisions

1.13 STRUCTURE COMPONENT NAMING

To maintain the consistency between design drawings and information used in the inspection process and management of the finished structure, a similar naming convention for structural components shall be used. This includes girder naming as well as inventory stationing conventions. Girders and columns are lettered from left to right (looking in the direction of increasing milepoint). Bays in between girders or columns are labeled similarly. Bays and span numbers are typically not labeled for new construction. Diaphragms are labeled sequentially starting at 0 at the abutment or pier. Span number may be included in the girder description to clarify its location on the bridge as shown in Fig. 1.13-1. Chapter 9, Construction Layout, shows the standard naming convention for structural components. When project stationing is opposite of increasing inventory milepoint, the girders will be increasing alphabetically from right to left in order to match the final inspection notation. The piers and abutments will also increase numerically from right to left.

For widenings on the left side of an existing bridge, new girder lines shall be labelled with numeric characters added to the initial existing girder. If a girder is removed and replaced on a widening the same letter can be used but with a prime to indicate that it is a different girder than original, e.g. A', B'. Similarly, when doubling a girder, which generally occurs in Timber stringer bridges to achieve designed carrying capacity of an original split girder, the girder added shall be followed by prime of the original girder it is being added to.

Where two bridges are merged together, the letter of the last girder followed by prime is used for the first girder between the two bridges and subsequent new girders, e.g. F'1, F'2, F'3. The second bridge girders use the same lettering convention, but with adding a 1 and the letter of the original girder to the end, e.g. 2A1A, 2B1B, etc. Where two bridges are merged together and widened, the rules stated previously for widenings apply.

Existing Bridge A B C D E F

Bridge Widened to the Left Side … A3 A2 A1 A B C D E F

Bridge Widened to the Right Side A B C D E F G H I …

Bridge Widened to the Middle A B C C'1 C'2 …. D E F

Bridge with Doubled Girders (Timber Bridges)… A B C D E E'1 E'2
F G H I J …

Existing parallel bridges closing the median 2A 2B 2C 2D 2E 2F 2F'1
2F'2 2F'3 2A1A 2B1B 2C1C 2D1D 2E1E 2F1F

Existing parallel bridges closing the median and widening 2A3 2A2 2A1 2A 2B
2C 2D 2E 2F 2F'1 2F'2 2F'3 2A1A 2B1B 2C1C 2D1D 2E1E
2F1F 2G 2H 2I

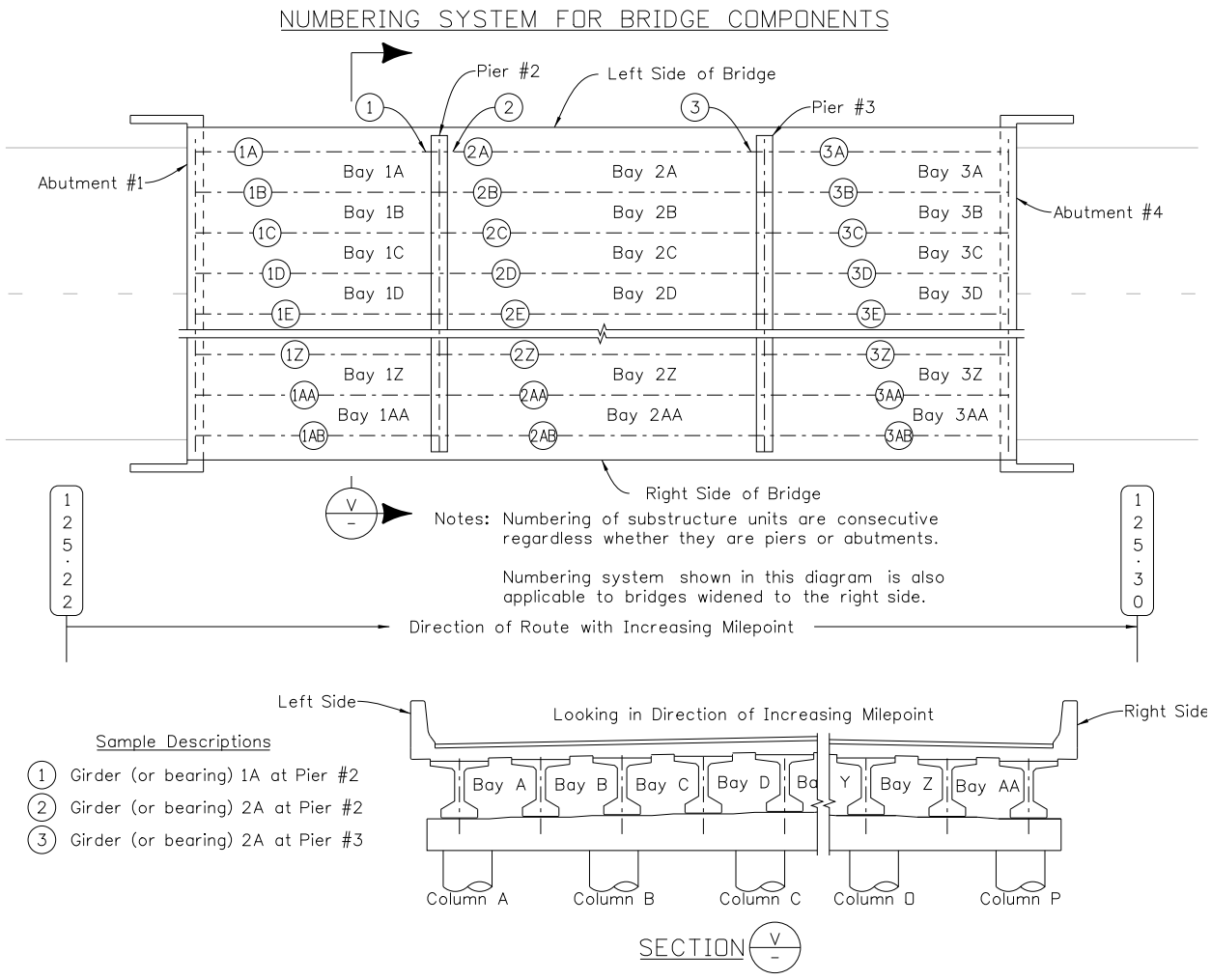

Fig. 1.13-1 Structure Component Naming Convention

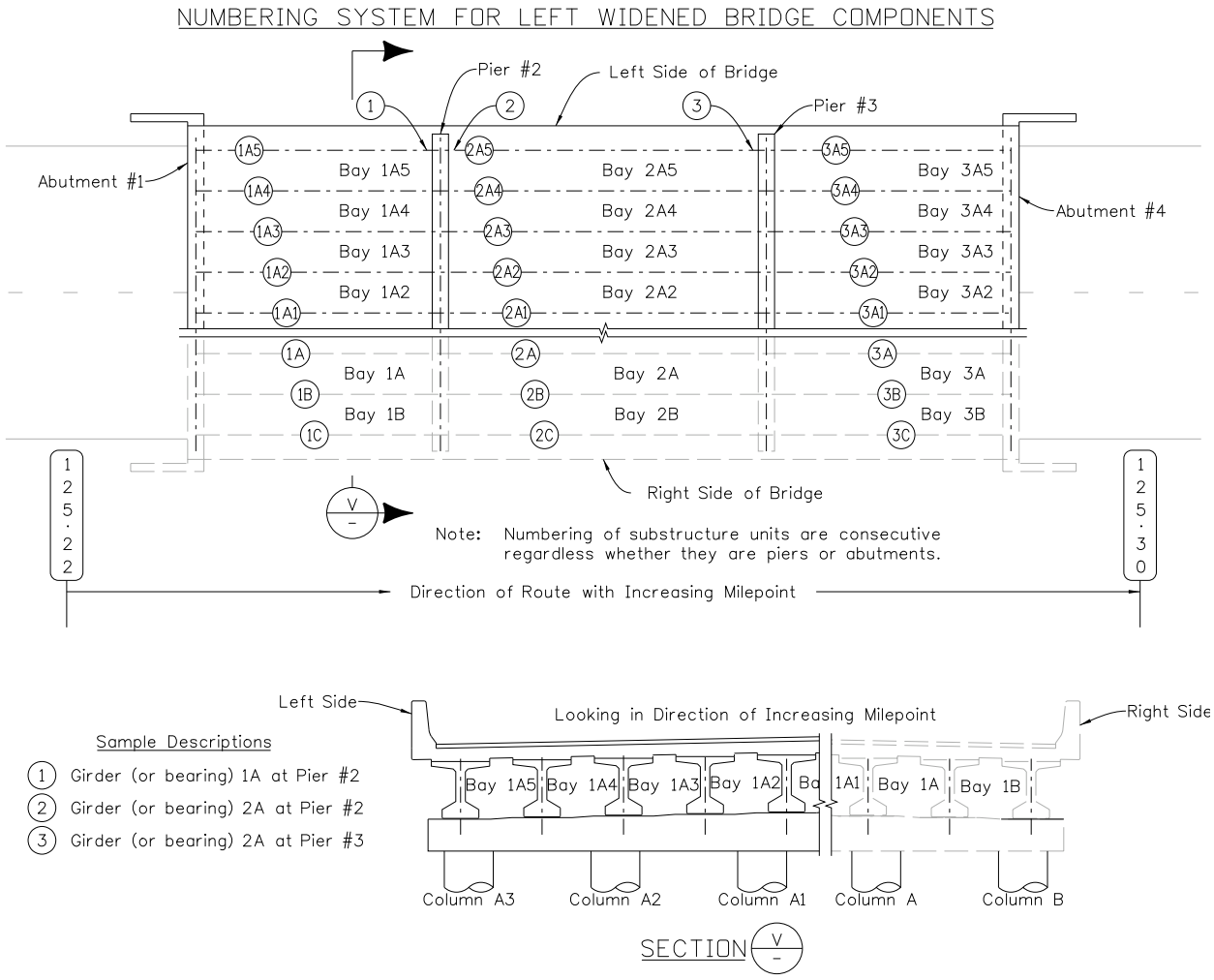

Fig. 1.13-2 Structure Component Naming Convention for Left Widened Bridges

1.14 EXAMPLES

Examples in this manual may contain old styles of girders, barrier, and other details. They may not meet all of the current detailing standards. All plan sets for new bridges shall use the latest worksheet and standards available.