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1.1 Manual Description

1.1.1 Purpose

The *Bridge Design Manual* (BDM) M 23-50 is a guide for those who design bridges for the Washington State Department of Transportation (WSDOT). This manual supplements the AASHTO LRFD Specifications. It explains differences where it deviates from the AASHTO LRFD Specifications. It contains standardized design details and methods, which are based on years of experience.

The *Bridge Design Manual* is a dynamic document, which constantly changes because of the creativity and innovative skills of our bridge designers and structural detailers. It is not intended for the design of unusual structures or to inhibit the designer in the exercise of engineering judgment. There is no substitute for experience, good judgment, and common sense.

1.1.2 Specifications

This manual and the following AASHTO Specifications are the basic documents used to design highway bridges and structures in Washington State:

- AASHTO LRFD Bridge Design Specifications (AASHTO LRFD)
- AASHTO Guide Specifications for LRFD Seismic Bridge Design (AASHTO SEISMIC)

The *Bridge Design Manual* is not intended to duplicate the AASHTO Specifications. This manual supplements the AASHTO Specifications by providing additional direction, design aides, examples, and information on office practice. The *Bridge Design Manual* takes precedence where conflict exists with the AASHTO Specifications. The WSDOT Bridge Design Engineer will provide guidance as necessary.

References are listed at the end of each chapter.

1.1.3 Format

A. **General** – The Bridge Design Manual consists of one volume with each chapter organized as follows:

Criteria or other information (printed on white paper)

Appendix A (printed on yellow paper) Design Aids

Appendix B (printed on salmon paper) Design Examples

B. **Chapters**

1. General Information
2. Preliminary Design
3. Loads
4. Seismic Design and Retrofit
5. Concrete Structures
6. Steel Design
7. Substructure
8. Walls and Buried Structures
9. Bearings and Expansion Joints

10. Traffic Barriers, Sign Structures, Approach Slabs, Utility Supports
11. Detailing Practice
12. Quantities, Construction Costs, and Specifications
13. Bridge Rating

C. Numbering System

1. The numbering system for the criteria consists of a set of numbers followed by letters as required to designate individual subjects.

Example:

Chapter 5 Concrete Structures (Chapter)
5.3 Reinforced Concrete Box Girder Bridges (Section)
5.3.2 Reinforcement (Subsection)

A. Top Slab Reinforcement

1. Near Center of Span
 - a. Transverse Reinforcement
2. **Numbering of Sheets** – Each section starts a new page numbering sequence. The page numbers are located in the lower outside corners and begin with the chapter number, followed by the section number, then a sequential page number.

Example: 5-1, 5-2, etc.

3. **Appendices** – Appendices are included to provide the designer with design aids (Appendix A) and examples (Appendix B). Design aids are generally standard in nature, whereas examples are modified to meet specific job requirements.

An appendix is numbered using the chapter followed by section number and then a hyphen and the letter of the appendix followed by consecutive numbers.

Example: 5.3-A1 (Box Girder Bridges) designates a design aid required or useful to accomplish the work described in Chapter 5, Section 3.

4. **Numbering of Tables and Figures** – Tables and figures shall be numbered using the chapter, section, subsection in which they are located, and then a hyphen followed by consecutive numbers.

Example: Figure 5.3.2-1 is the first figure found in Chapter 5, section 3, subsection 2.

1.1.4 Revisions

Revisions to this manual are related to emerging concepts, new state or federal legislation, and comments forwarded to the Bridge Design Office. Some revisions are simple spot changes, while others are major chapter rewrites. The current version of the manual is available online at: www.wsdot.wa.gov/publications/manuals/m23-50.htm.

All pages include a revision number and publication date. When a page is revised, the revision number and publication date are revised. Revisions shall be clearly indicated in the text.

The process outlined below is followed for *Bridge Design Manual* revisions:

1. Revisions are prepared, checked and coordinated with chapter authors.
2. Revisions are submitted to the Bridge Design Engineer for approval. However, comments related to grammar and clarity can be sent directly to the BDM Coordinator without Bridge Design Engineer approval.
3. After approval from the Bridge Design Engineer, the BDM Coordinator works with WSDOT Engineering Publications to revise the manual.
4. Revised pages from Engineering Publications are checked for accuracy and corrected if necessary.
5. A Publication Transmittal is prepared by Engineering Publications. Publication Transmittals include remarks and instructions for updating the manual. After the Publications Transmittal has been signed by the State Bridge and Structures Engineer, Engineering Publications will post the complete manual and revision at: www.wsdot.wa.gov/publications/manuals/m23-50.htm.
6. Engineering Publications will coordinate electronic and hard copy distributions.

A Revision QA/QC Worksheet (see [Appendix 1.1-A1](#)) shall be prepared to document and track the revision process.

1.2 Bridge and Structures Office Organization

1.2.1 General

The responsibilities of the Bridge and Structures Office are:

Provides structural engineering services for WSDOT. Provides technical advice and assistance to other governmental agencies on such matters.

The WSDOT *Design Manual* M 22-01 states the following:

Bridge design is the responsibility of the Bridge and Structures Office in Olympia. Any design authorized at the Region level is subject to review and approval by the Bridge and Structures Office.

1.2.2 Organizational Elements of the Bridge Office

- A. **Bridge and Structures Engineer** – The Bridge and Structures Engineer is responsible for structural engineering services for the department and manages staff and programs for structural design, contract plan preparation, inspections and assessments of existing bridges.
- B. **Bridge Design Engineer** – The Bridge Design Engineer is directly responsible to the Bridge and Structures Engineer for structural design and review, and advises other divisions and agencies on such matters.
 1. **Structural Design Units** – The Structural Design Units are responsible for the final design of bridges and other structures. Final design includes preparation of contract plans. The units provide special design studies, develop design criteria, check shop plans, and review designs submitted by consultants. Frequently, the Bridge Projects Engineer assigns the units the responsibility for preparing preliminary bridge plans and other unscheduled work.

The Bridge Engineer Supervisor (Unit Supervisor) provides day-to-day leadership, project workforce planning, mentoring, and supervision for the design unit. Organization and job assignments within the unit are flexible and depend on projects underway at any particular time as well as the qualifications and experience level of individuals. The primary objective of the design units is to produce contract plans for bridges and structures within scope, schedule and budget. This involves designing, checking, reviewing, and detailing in an efficient and timely manner.

A bridge specialist is assigned to each design unit. Each specialist has a particular area of expertise. The four major areas are: concrete, steel, seismic design, and retrofit and expansion joints and bearings. The specialists act as a resource for the bridge office in their specialty and are responsible for keeping up-to-date on current AASHTO criteria, new design concepts and products, technical publications, construction and maintenance issues, and are the primary points of contact for industry representatives.

The design units are also responsible for the design and preparation of contract plans for modifications to bridges in service. These include bridge rail replacement, deck repair, seismic retrofits, emergency repairs when bridges are damaged by vehicle or ship collision or natural phenomenon, and expansion joint and drainage retrofits. They review proposed plans of utility attachments to existing bridges.

2. **Bridge Projects Unit** – The Bridge Projects Engineer directs preliminary design work, specification and cost estimates preparation, falsework review, project scoping, coordinates scheduling of bridge design projects and unscheduled work assignments with the Region Project Development Engineers, Bridge Design Engineer, and the Unit Supervisors.

The Preliminary Plan Engineers are responsible for bridge project planning from initial scoping to design type, size, and location (TSL) studies and reports. They are responsible for preliminary plan preparation of bridge and walls including assembly and analysis of site data, preliminary structural analysis, cost analysis, determination of structure type, and drawing preparation.

They also check preliminary plans prepared by others, review highway project environmental documents and design reports, and prepare U. S. Coast Guard Permits.

The Specifications and Estimate (S&E) Engineers develop and maintain construction specifications and cost estimates for bridge projects. They also develop specifications and cost estimates for bridge contracts prepared by consultants and other government agencies, which are administered by WSDOT. They assemble and review the completed bridge PS&E before submittal to the Regions. They also coordinate the PS&E preparation with the Regions and maintain bridge construction cost records.

The Construction Support Unit Engineers are responsible for checking the contractor's falsework, shoring, and forming plans. Shop plan review and approval are coordinated with the design units. Actual check of the shop plans is done in the design unit. Field requests for plan changes come through this office for a recommendation as to approval.

The Bridge Plans Engineer processes as-built plans in this unit. Region Project Engineers are responsible for preparing and submitting as-built plans at the completion of a contract.

The Scheduling Engineer monitors the design work schedule for the Bridge and Structures Office, updates the Bridge Design Schedule (BDS) and maintains records of bridge contract costs. Other duties include coordinating progress reports to Regions by the Unit Supervisors and S&E Engineers through the Project Delivery Information System (PDIS).

The Bridge Projects Unit dedicates one position to providing technical assistance for the design and detailing of expansion joint, bridge bearing and barrier/rail projects.

In addition, the unit is responsible for updating the *Bridge Design Manual* M 23-50. The unit coordinates changes to the WSDOT Standard Specifications and facilitates updates or revisions to WSDOT Bridge Office design standards.

3. **Mega Project Bridge Manager** – The Mega Project Bridge Manager provides leadership, guidance and project management responsibilities for various complex, unique and monumental bridge design and construction projects. Mega Bridge Projects are defined as suspension, cable-stayed, movable, segmental or a complex group of interchange/corridor bridges and include conventional and design-build project delivery methods. The Mega Project Bridge Manager represents the Bridge and Structures Office in Cost Estimate Validation Process activities, Value Engineering Studies and Research Projects regarding major bridge projects.
- C. **Bridge Preservation Engineer** – The Bridge Preservation Engineer directs activities and develops programs to assure the structural and functional integrity of all state bridges in service. The Bridge Preservation Engineer directs emergency response activities when bridges are damaged.
1. **Bridge Preservation Office (BPO)** – The Bridge Preservation Office is responsible for planning and implementing an inspection program for the more than 3,200 fixed and movable state highway bridges. In addition, BPO provides inspection services on some local agency bridges and on the state's ferry terminals. All inspections are conducted in accordance with the National Bridge Inspection Standards (NBIS).
- BPO maintains the computerized Washington State Bridge Inventory System (WSBIS) of current information on more than 7,300 state, county, and city bridges in accordance with the NBIS. This includes load ratings for all bridges. BPO prepares a *Bridge List* of the state's bridges, which is published every two years, maintains the intranet-based Bridge Engineering Information System (BEIST), and prepares the annual Recommended Bridge Repair List (RBRL) based on the latest inspection reports.
- BPO is responsible for the bridge load rating and risk reduction (SCOUR) programs. It provides damage assessments and emergency response services when bridges are damaged because of vehicle or ship collision or natural phenomenon such as: floods, wind, or earthquakes.

- D. **Bridge Management Engineer** – The Bridge Management Unit is responsible for the program development, planning and monitoring of all statewide bridge program activities. These include P2 funded bridge replacements and rehabilitation, bridge deck protection, major bridge repair, and bridge painting.

In addition, the Bridge Management Unit manages the bridge deck protection, deck testing and the bridge research programs. It is responsible for the planning, development, coordination, and implementation of new programs (e.g., Seismic Retrofit and Preventative Maintenance), experimental feature projects, new product evaluation, and technology transfer.

The Bridge Management Engineer is the Bridge and Structures Office’s official Public Disclosure contact. (See [Section 1.3.9 Public Disclosure Policy Regarding Bridge Plans](#)).

- E. **Computer Support Unit** – The Computer Support Unit is responsible for computer resource planning and implementation, computer user support, liaison with Management Information Systems (MIS), computer aided engineer operation support, and software development activities. In addition, the unit works closely with the Bridge Projects Unit in updating this manual and *Standard Plans*.
- F. **Consultant Liaison Engineer** – The Consultant Liaison Engineer prepares bridge consultant agreements and coordinates consultant PS&E development activities with those of the Bridge Office. The Consultant Liaison Engineer negotiates bridge design contracts with consultants.
- G. **State Bridge and Structures Architect** – The State Bridge and Structures Architect is responsible for reviewing and approving bridge preliminary plans, retaining walls, preparing renderings, coordinating aesthetic activities with Regions (i.e. suggesting corridor themes and approving public art), and other duties to improve the aesthetics of our bridges and structures. The State Bridge and Structures Architect works closely with bridge office and region staff. During the design phase, designers should get the Architect’s approval for any changes to architectural details shown on the approved preliminary plan.
- H. **Staff Support Unit** – The Staff Support Unit is responsible for many support functions, such as: typing, timekeeping, payroll, receptionist, vehicle management, mail, inventory management, and other duties requested by the Bridge and Structures Engineer. Other duties include: filing field data, plans for bridges under contract or constructed, and design calculations. This unit also maintains office supplies and provides other services.
- I. **Office Administrator** – The Office Administrator is responsible for coordinating personnel actions, updating the organizational chart, ordering technical materials, and other duties requested by the Bridge and Structures Engineer. Staff development and training are coordinated through the Office Administrator. The Office Administrator also handles logistical support, office and building maintenance issues.

1.2.3 Design Unit Responsibilities and Expertise

The following is an updated summary of the structural design, review and plan preparation responsibilities/expertise within the Bridge Design Section. Contact the Unit Supervisor for the name of the appropriate staff expert for the needed specialty.

Unit Supervisor	Responsibility/Expertise
Mark Anderson	Seismic Design Technical Support Emergency Slide Repairs Retaining Walls (including Structural Earth, Soldier Pile and Tie-Back, Geosynthetic, and Soil Nail) Pre-Approval of Retaining Wall Systems Noise Barrier Walls
Richard Stoddard	Bridge Traffic Barriers and Rail Retrofits Concrete Design Technical Support
Ron Lewis	Coast Guard Permits Special Provisions and Cost Estimates Preliminary Design Falsework, Forming and Temporary Structures Bridge Design Manual M 23-50 Bridge Projects Scheduling
Richard Zeldenrust	Overhead and Bridge-Mounted Sign Structures Light Standard & Traffic Signal Supports Repairs to Damaged Bridges Structural Steel Technical Support
Patrick Clarke	Floating Bridges Bearings and Expansion Joints Technical Support Special Structures
DeWayne Wilson	Bridge Preservation Program (P2 Funds) – Establish needs and priorities (including Seismic, Scour, Deck Overlay, Special Repairs, Painting, Replacement, Misc Structures Programs) Bridge Management System Bridge Engineering Software and CAD Consultant Liaison
Tim Moore	Mega Projects Manager
Paul Kinderman	Bridge Architect

1.3 Quality Control/Quality Assurance (QC/QA) Procedure

1.3.1 General

- A. The purpose of the QC/QA procedure is to improve the quality of the structural designs and plans. The key element to the success of this process is effective communication between all parties. The goals of the QC/QA procedure are:
- Designed structures that improve public safety and meet state regulations.
 - Designed structures which meet the requirements of the WSDOT *Bridge Design Manual* M 23-50, AASHTO LRFD Bridge Design Specifications, current structural engineering practices, and geometric criteria provided by the Region.
 - Designed structures that are aesthetically pleasing, constructible, durable, economical, inspectable, and require little maintenance.
 - Design contract documents that meet the customer's needs, schedule, budget, and construction staging requirements.
 - Structural design costs are minimized.
 - An organized and indexed set of design calculations are produced. Design criteria and assumptions are included in the front after the index.
 - Plan quality is maximized.
 - The QA/QC procedure allows for change, innovation, and continuous improvement.

The goals are listed in order of importance. If there is a conflict between goals, the more important goal takes precedence.

The Unit Supervisor determines project assignments and the QC/QA process to be used in preparation of the structural design. The intent of the QC/QA process is to facilitate plan production efficiency and cost-effectiveness while assuring the structural integrity of the design and maximizing the quality of the structural contract documents.

- B. The Bridge and Structures Office QC/QA procedure is a component of the general WSDOT template for project management process. Included as part of the current WSDOT project management process are project reviews at specific milestones along the project timeline. The expected content of the documents being reviewed at each specific milestone are described in the Deliverable Expectations Matrix developed and implemented by the WSDOT Design Office in May 2006. This matrix can be viewed via the link www.wsdot.wa.gov/projects/projectmgmt/online_guide/delivery_expectation_matrix/de_matrix.pdf.

The overall matrix is generic for WSDOT design, but there is a line in the matrix that outlines the specific content expectations for structures (bridges retaining walls, noise barrier walls, overhead sign structures, etc.). This "structures specific" matrix line includes a link to a separate matrix. This structures matrix can be viewed via the link www.wsdot.wa.gov/projects/projectmgmt/online_guide/delivery_expectation_matrix/bridge.pdf.

The Bridge Preliminary Plan as described in Chapter 2 is equivalent to the Geometric Review milestone of the generic WSDOT matrix and the Permitting Submittal Review milestone of the structure specific matrix.

Intermediate stage constructability reviews conducted for certain projects by Region Design PE Offices or Local Agencies are equivalent to the General Plans Review milestone of the generic WSDOT matrix and the Intermediate PS&E Submittal Review milestone of the structure specific matrix.

The Bridge Plans turn-in as described in [Section 12.4.3](#) is equivalent to the Preliminary Contract Review milestone of the generic WSDOT matrix and the PS&E Pre-submittal Review milestone of the structure specific matrix.

The Bridge PS&E turn-in as described in [Section 12.4.3](#) is equivalent to the Final Contract Review milestone of the generic WSDOT matrix and the Final PS&E Submittal Review milestone of the structure specific matrix.

1.3.2 Design/Check Procedures

A. PS&E Prepared by WSDOT Bridge and Structures Office

1. **Design Team** – The design team usually consists of the Designer(s), Checker(s), Structural Detailer(s), and a Specification and Estimate Engineer, who are responsible for preparing a set of contract documents on or before the scheduled due date(s) and within the budget allocated for the project. On large projects, the Unit Supervisor may designate a designer to be a Project Coordinator with additional duties, such as: assisting the supervisor in communicating with the Region, coordinating and communicating with the Geotechnical Branch, and monitoring the activities of the design team.

The QC/QA procedures may vary depending on the type and complexity of the structure being designed, and the experience level of the design team members. More supervision, review, and checking may be required when the design team members are less experienced. In general, it is a good practice to have some experienced designers on every design team. All design team members should have the opportunity to provide input to maximize the quality of the design plans.

2. **Designer Responsibility** – The designer is responsible for the content of the contract plan sheets, including structural analysis, completeness and correctness. A good set of example plans, which is representative of the bridge type, is indispensable as an aid to less experienced designers and detailers.

During the design phase of a project, the designer will need to communicate frequently with the Unit Supervisor and other stakeholders. This includes acquiring, finalizing or revising roadway geometrics, soil reports, hydraulics recommendations, and utility requirements. Constructability issues may also require that the designer communicate with the Region or Construction Office. The designer may have to organize face-to-face meetings to resolve constructability issues early in the design phase. The bridge plans must be coordinated with the PS&E packages produced concurrently by the Region.

The designer shall advise the Unit Supervisor as soon as possible of any scope and project cost increases and the reasons for the increases. The Unit Supervisor will then notify the Region project office if the delivery schedule will have to be changed. If Region concurs with a change in the delivery date, the Unit Supervisor will notify the Bridge Projects Engineer or the Bridge Scheduling Engineer of the revised delivery dates.

The designer or Project Coordinator is responsible for project planning which involves the following:

- a. Determines scope of work, identifies tasks and plans order of work.
- b. Prepare design criteria that are included in the front of the design calculations.
Compares tasks with BDM office practice and AASHTO bridge design specifications.
 - (1) Insures that design guidelines are sufficient?
 - (2) Justification for deviation from [Bridge Design Manual](#)/AASHTO?

- (3) Justification for design approach?
 - (4) Justification for deviation from office practices regarding design and details?
 - (5) Other differences.
- c. Meet with the Region design staff and other project stakeholders early in the design process to resolve as many issues as possible before proceeding with final design and detailing.
 - d. Identify coordination needs with other designers, units, and offices.
 - e. Early in the project, the bridge sheet numbering system should be coordinated with the Region design staff. For projects with multiple bridges, each set of bridge sheets should have a unique set of bridge sheet numbers.
 - f. At least monthly or as directed by the design Unit Supervisor:
 - (1) Update Project Schedule and List of Sheets.
 - (2) Estimate percent complete.
 - (3) Estimate time to complete.
 - (4) Work with Unit Supervisor to adjust resources, if necessary.
 - g. Develop preliminary quantities for all cost estimates after the Preliminary Plan stage.
 - h. Near end of project:
 - (1) Develop quantities, *Not Included in Bridge Quantity List, and Special Provisions Checklist* that are to be turned in with the plans. (See [Section 12.4.4](#)).
 - (2) Prepare the Bar List.
 - (3) Coordinate all final changes, including review comments received from the Bridge Specifications and Estimates Engineer. Refer to [Section 12.4.3 \(B\)](#).
 - (4) Meet with Region design staff and other project stakeholders at the constructability review/round table review meetings to address final project coordination issues.

The designer should inform the Unit Supervisor of any areas of the design, which should receive special attention during checking and review.
 - (5) Prepare the QA/QC Checklist, and obtain signatures/initials as required. This applies to all projects regardless of type or importance (bridges, walls, sign structures, overlay, traffic barrier, etc.). Refer to [Appendix 1.5-A3-1](#).

The design calculations are prepared by the designer and become a very important record document. Design calculations will be a reference document during the construction of the structure and throughout the life of the structure. It is critical that the design calculations be user friendly. The design calculations shall be well organized, clear, properly referenced, and include numbered pages along with a table of contents. The design calculations shall be archived. Computer files should be archived for use during construction, in the event that changed conditions arise. Archive-ready design and check calculations shall be bound and submitted to the Unit Supervisor concurrently with the turn-in of the Bridge PS&E submittal. Calculations shall be stored in the design unit until completion of construction. After construction, they shall be sent to archives. (See [Section 1.3.8 Archiving Design Calculations, Design Files, and S&E Files](#)).

The designer or another assigned individual is also responsible for resolving construction problems referred to the Bridge Office during the life of the contract. These issues will generally be referred through the Bridge Technical Advisor, the Unit Supervisor, the Construction Support Unit, or the HQ Construction-Bridge.

3. **Checker Responsibility** – The checker is responsible to the Unit Supervisor for “quality assurance” of the structural design, which includes checking the design, plans and specifications to assure accuracy and constructability. The Unit Supervisor works with the checker to establish the level of checking required. The checking procedure for assuring the quality of the design will vary from project to project. Following are some general checking guidelines:
 - a. **Design Calculations** – may be checked by either of two methods:
 - (1) Design calculations may be checked with a line-by-line review and initialing by the checker. If it is more efficient, the checker may choose to perform his/her own independent calculations.
 - (2) Iterative design methods may be best checked by review of the designer’s calculations, while standard and straight-forward designs may be most efficiently checked with independent calculations. All the designer and checker calculations shall be placed in one design set.
 - (3) Revision of design calculations, if required, is the responsibility of the designer.
 - b. **Structural Plans**
 - (1) The checker’s plan review comments are recorded on a copy of the structural plans, including details and bar lists, and returned to the designer for consideration. These check prints are a vital part of the checking process, and shall be preserved. If the checker’s comments are not incorporated, the designer should provide justification for not doing so. If there is a difference of opinion that cannot be resolved between the designer and checker, the Unit Supervisor shall resolve any issues. Check prints shall be submitted to the Unit Supervisor at the time of 100% PS&E turn-in.
 - (2) If assigned by the Unit Supervisor, a structural detailer shall perform a complete check of the geometry using CADD or hand calculations.
 - (3) Revision of plans, if required, is the responsibility of the designer.
 - c. **Quantities and Barlist**
 - (1) The checker shall provide an independent set of quantity calculations. These together with the designer’s quantity calculations shall be placed in the job file.
 - (2) Resolution of differences between the designer and checker shall be completed before the Bridge PS&E submittal. The checker shall also check the barlist.
4. **Structural Detailer Responsibility** – The structural detailer is responsible for the quality and consistency of the contract plan sheets. The structural detailer shall ensure that the Bridge Office drafting standards as explained in Chapter 11 of this manual are upheld.
 - a. Refer to [Chapter 11](#), for detailing practices.
 - b. Provide necessary and adequate information to ensure the contract plans are accurate, complete, and readable.
 - c. Detail plan sheets in a consistent manner and follow accepted detailing practices.
 - d. Check plans for geometry, reinforcing steel congestion, consistency, and verify control dimensions.
 - e. Check for proper grammar and spelling.

- f. On multiple bridge contracts, work with the Designer/Project Coordinator to ensure that the structural detailing of all bridges within the contract shall be coordinated to maximize consistency of detailing from bridge to bridge. Extra effort will be required to ensure uniformity of details, particularly if multiple design units and/or consultants are involved in preparing bridge plans.
 - g. Maintain an ongoing understanding of bridge construction techniques and practices.
5. **Specialist Responsibility** – All bridge and wall projects initiated with a signed Bridge Preliminary Plan.

The primary responsibility of the specialist is to act as a knowledge resource for the Bridge and Structures Office, WSDOT, other governmental agencies and consultants. Designers are encouraged to consult specialists for complex projects early in the design process. Supervisors overseeing a design project should actively identify any complex or unusual features, early in the design process, and encourage the designers involved to seek input from the suitable Specialist. The Specialists maintain an active knowledge of their specialty area, along with a current file of products and design procedures. The Specialists maintain industry contacts. Specialists provide training in their area of expertise.

Specialists are expected to remain engaged with the design efforts being carried out in the office related to their specialty. At the discretion of the Design Unit Supervisor, the Specialists may be requested to review, comment on and initial plans in their area of expertise prepared by other designers. Specialists are expected to review selected design work for consistency with other WSDOT projects, and for adherence to current office practice and current industry practice. Specialist reviews are typically cursory in nature, and are not intended to fulfill the role of structural checker. Specialists shall initial the Project Turn-In QA/QC Worksheet of BDM Appendix 1.5-A3 at the 100% completion stage of certain projects including:

- a. **Bearing and Expansion Joint Specialist** – All expansion joint or bearing rehab projects. All new bridges with modular expansion joints, unique strip seal joints (high skew, raised steel sliding plates at sidewalk, traffic islands, etc.), and bearings other than plain elastomeric pads.
- b. **Concrete Specialist** – All post-tensioned super and substructures, and complex prestressed girder superstructures (long spans, large skews, tapered girders, etc.). All structures utilizing mass concrete, self-consolidating concrete (SCC), shotcrete or Grade 80 reinforcement.
- c. **Steel Specialist** – All new and retrofit steel superstructure projects, or projects involving significant or complex welding.
- d. **Seismic Specialist** – All retrofit projects, and new bridges with complex seismic design requirements.

Specialists assist the Bridge and Structures Engineer in reviewing and voting on amendments to AASHTO specifications.

Specialists are responsible for keeping their respective chapters of the *Bridge Design Manual* M 23-50 up to date.

The Concrete, Steel, and Seismic Specialists act as Supervisors for the Structural Detailers within their unit. They are responsible for the day-to-day supervision of the Structural Detailers, including timesheet and evaluation responsibilities. The Specialists are also relied upon to assist the Design Unit Supervisor in allocating detailing staff, and completing Structural Detailer staffing projections.

A secondary responsibility of the Specialist is to serve as Unit Supervisor when the supervisor is absent.

Sign Structure design, Wall design, and Traffic Barrier & Rail design are three specialty areas where design and review work has traditionally been directed to dedicated staff in each of the three main design groups within the Bridge Design Office (see BDM 1.2.3). Design guidance or review requests for unusual or unique projects involving these three specialty areas should be directed to the applicable Design Unit Supervisor for design or review.

6. **Specification and Estimating Engineer Responsibilities** – There are currently four specialist positions in the Bridge and Structures Office. The four specialty areas in the Design Section are bearings and expansion joints, concrete (including prestressed concrete), seismic design and retrofit, and structural steel.
7. **Design Unit Supervisor Responsibility**
 - a. The Unit Supervisor is responsible to the Bridge Design Engineer for the timely completion and quality of the bridge plans.
 - b. The Unit Supervisor works closely with the Project Coordinator and the design team (designer, checker, and structural detailer) during the design and plan preparation phases to help avoid major changes late in the design process. Activities during the course of design include:
 - (1) Evaluate the complexity of the project and the designer’s skill and classification level to deliver the project in a timely manner. Determine both the degree of supervision necessary for the designer and the amount of checking required by the checker.
 - (2) Assist the design team in defining the scope of work, identifying the tasks to be accomplished and developing a project work plan.
 - (3) Make suitable staffing assignments and develop a design team time estimate to ensure that the project can be completed on time and within budget.
 - (4) Review and approve design criteria before start of design.
 - (5) Help lead designer conduct face-to-face project meetings, such as: project “kick-off” and “wrap-up” meetings with Region, geotechnical staff, bridge construction, and consultants to resolve outstanding issues.
 - (6) Participate in coordinating, scheduling, and communicating with stakeholders, customers, and outside agencies relating to major structural design issues.
 - (7) Facilitate resolution of major project design issues.
 - (8) Assist the design team with planning, anticipating possible problems, collectively identifying solutions, and facilitating timely delivery of needed information, such as geometrics, hydraulics, foundation information, etc.
 - (9) Interact with design team regularly to discuss progress, problems, schedule and budget, analysis techniques, constructability and design issues. Always encourage forward thinking, innovative ideas and suggestions for quality improvement.
 - (10) Arrange for and provide the necessary resources, time and tools for the design team to do the job right the first time. Offer assistance to help resolve questions or problems.
 - (11) Help document and disseminate information on special features and lessons learned for the benefit of others and future projects.
 - (12) Mentor and train designers and detailers through the assignment of a variety of structure types.

- c. The Unit Supervisor works closely with the design team during the plan review phase. Review efforts should concentrate on reviewing the completed plan details and design calculations for completeness and for agreement with office criteria and office practices. Review the following periodically and at the end of the project:
- (1) Design Criteria
 - Seismic design methodology, acceleration coefficient (“a” value), and any seismic analysis assumptions.
 - Foundation report recommendations, selection of alternates.
 - Deviations from AASHTO, this manual, and proper consideration of any applicable Design Memorandums.
 - (2) Design Time and Budget
- d. Estimate time to complete the project. Plan resource allocation for completing the project to meet the scheduled Ad Date and budget. Monitor monthly time spent on the project.
- At the end of each month, estimate time remaining to complete project, percent completed, and whether project is on or behind schedule.
- Plan and assign workforce to ensure a timely delivery of the project within the estimated time and budget. At monthly supervisors’ scheduling meetings, notify the Bridge Projects Engineer if a project is behind schedule.
- e. Advise Region of any project scope creep and construction cost increases. As a minimum, use quarterly status reports to update Region on project progress.
- f. Use appropriate computer scheduling software or other means to monitor time usage, to allocate resources, and to plan projects.
- g. Review constructability issues. Are there any problems unique to the project?
- h. Review the final plans for the following:
- (1) Scan the job file for unusual items relating to geometrics, hydraulics, geotechnical, environmental, etc.
 - (2) Overall review of sheet #1, the bridge layout for:
 - Consistency — especially for multiple bridge project
 - Missing information
 - (3) Review footing layout for conformance to Bridge Plan and for adequacy of information given. Generally, the field personnel shall be given enough information to “layout” the footings in the field without referring to any other sheets. Plan details shall be clear, precise, and dimensions tied to base references, such as: a survey line or defined centerline of bridge.
 - (4) Review the sequence of the plan sheets. The plan sheets should adhere to the following order: layout, footing layout, substructures, superstructures, miscellaneous details, barriers, and barlist. Also check for appropriateness of the titles.
 - (5) Review overall dimensions and elevations, spot check for compatibility. For example, check compatibility between superstructures and substructure. Also spot check bar marks.
 - (6) Use common sense and experience to review structural dimensions and reinforcement for structural adequacy. When in doubt, question the designer and checker.
- i. Stamp and sign the plans in blue ink.

8. **Bridge Design Engineer's Responsibilities** – The Bridge Design Engineer is the coach, mentor, and facilitator for the WSDOT QC/QA Bridge Design Procedure. The leadership and support provided by this position is a major influence in assuring bridge design quality for structural designs performed by both WSDOT and consultants. The following summarizes the key responsibilities of the Bridge Design Engineer related to QC/QA:
- Prior to the Bridge Design Engineer stamping and signing any plans, he/she shall perform a structural/constructability review of the plans. This is a quality assurance (QA) function as well as meeting the “responsible charge” requirements of state laws relating to Professional Engineers.
 - Review and approve the Preliminary Bridge Plans. The primary focus for this responsibility is to assure that the most cost-effective and appropriate structure type is selected for a particular bridge site.
 - Review unique project special provisions and Standard Specification modifications relating to structures.
 - Facilitate partnerships between WSDOT, consultants, and the construction industry stakeholders to facilitate and improve design quality.
 - Encourage designer creativity and innovation through forward thinking.
 - Exercise leadership and direction for maintaining a progressive and up to date *Bridge Design Manual* M 23-50.
 - Create an open and supportive office environment in which Design Section staff are empowered to do high quality structural design work.
 - Create professional growth opportunities through an office culture where learning is emphasized.
 - Encourage continuing professional development through training opportunities, attendance at seminars and conferences, formal education opportunities, and technical writing.
9. **General Bridge Plan Stamping and Signature Policy** – The stamping and signing of bridge plans is the final step in the Bridge QC/QA procedure. It signifies a review of the plans and details by those in responsible charge for the bridge plans. At least one Licensed Structural Engineer shall stamp and sign each contract plan sheet (except the bar list).

For contract plans prepared by a licensed Civil or Licensed Structural Engineer, the Unit Manager and the licensed Civil or Licensed Structural Engineer co-seal and sign the plans, except the bridge layout sheet. The bridge layout sheet is sealed and signed by the State Bridge and Structures Engineer or, in the absence of the State Bridge and Structures Engineer, the Bridge Design Engineer.

For contract plans not prepared by a licensed Civil or Licensed Structural Engineer, the Unit Manager and the Bridge Design Engineer co-seal and sign the plans except the bridge layout sheet. The bridge layout sheet is sealed and signed by the State Bridge and Structures Engineer or, in the absence of the State Bridge and Structures Engineer, the Bridge Design Engineer.

For Non-Standard Retaining Walls and Noise Barrier Walls, Sign Structures, Seismic Retrofits, Expansion Joint and Bearing Modifications, Traffic Barrier and Rail Retrofits, and other special projects, the Unit Manager with either the licensed designer or the Bridge Design Engineer (if the designer is not licensed) co-seal and sign the plans except for the layout sheet. The layout sheets for these plans are sealed and signed by the State Bridge and Structures Engineer, or in the absence of the State Bridge and Structures Engineer, the Bridge Design Engineer.

- B. **Consultant PS&E — Projects on WSDOT Right of Way** – PS&E prepared by consultants will follow a similar QC/QA procedure as that shown above for WSDOT prepared PS&E's and, as a minimum, shall include the following elements:
1. **WSDOT Consultant Liaison Engineer's Responsibilities**
 - a. Review scope of work.
 - b. Negotiate contract and consultant's Task Assignments.
 - c. Coordinate/Negotiate Changes to Scope of Work.
 2. **Bridge Scheduling Engineer Responsibilities**
 - a. Add review to the bridge schedule.
 - b. Assign review to a bridge unit supervisor.
 - c. Make 2 copies of the review plans and specifications – 1 for the design reviewer and 1 for the Specifications Engineer Reviewer
 - d. Make a copy of the Layout for the Bridge Inventory Engineer.
 3. **WSDOT Design Reviewer's or Coordinator's Responsibilities**
 - a. Early in the project, review consultant's design criteria, and standard details for consistency with WSDOT practices and other bridge designs in project.
 - b. Review the job file as prepared by the Preliminary Plan Engineer.
 - c. Identify resources needed to complete work.
 - d. Initiate a project start-up meeting with the Consultant to discuss design criteria, submittal schedule and expectations, and also to familiarize himself/herself with the Consultant's designers.
 - e. Reach agreement early in the design process regarding structural concepts and design methods to be used.
 - f. Identify who is responsible for what and when all intermediate constructability, Bridge Plans, and Bridge PS&E review submittals are to be made.
 - g. Monitor progress.
 - h. Facilitate communication, including face-to-face meetings.
 - i. Verify that the Consultant's design has been checked by the Consultant's checker at the 100% submittal. The checker's calculations should be included in the designer's calculation set.
 - j. Review consultant's design calculations and plans for completeness and conformance to Bridge Office design practice. The plans shall be checked for constructability, consistency, clarity and compliance. Also, selectively check dimensions and elevations.
 - k. Resolve differences.
 4. **WSDOT Design Unit Supervisor's Responsibilities**
 - a. Encourage and facilitate communication.
 - b. Early involvement to assure that design concepts are appropriate.
 - c. Empower Design Reviewer or Coordinator.
 - d. Facilitate resolution of issues beyond authority of WSDOT Reviewer or Coordinator.
 - e. Facilitate face-to-face meetings.

5. **WSDOT S&E Engineer's Responsibilities** – See [Section 12.4.8](#).

6. **WSDOT Bridge Design Engineer's Responsibilities**

- a. Cursory review of design plans.
- b. Signature approval of S&E bridge contract package.

C. **Consultant PS&E** — Projects on County and City Right of Way

Counties and cities frequently hire Consultants to design bridges. WSDOT Highways and Local Programs Office determine which projects are to be reviewed by the Bridge and Structures Office.

WSDOT Highways and Local Programs send the PS&E to the Bridge Projects Engineer for assignment when a review is required. The Bridge and Structures Office's Consultant Liaison Engineer is not involved.

A WSDOT Design Reviewer or Coordinator will be assigned to the project and will review the project as outlined for Consultant PS&E — Projects on WSDOT Right of Way (see [Section 1.3.2.B](#)).

Two sets of plans with the reviewers' comments marked in red should be returned to the Bridge Projects Unit. One set of plans will be returned to Highways and Local Programs. The Bridge Scheduling Engineer will file the other set in the Bridge Projects Unit.

The first review should be made of the Preliminary Plan followed later by review of the PS&E and design calculations. Comments are treated as advisory, although major structural issues must be addressed and corrected. An engineer from the county, city, or consultant may contact the reviewer to discuss the comments.

1.3.3 Design/Check Calculation File

A. **File of Calculations** – The Bridge and Structures Office maintains a file of all pertinent design/check calculations for documentation and future reference. (See [Section 1.3.8 Archiving Design Calculations, Design Files, and S&E Files](#)).

B. **Procedures** – After an assigned project is completed and the bridge is built, the designer shall turn in a bound file containing the design/check calculations for archiving. The front cover should have a label (See [Figure 1.3.8-1](#)).

C. **File Inclusions** – The following items should be included in the file:

1. **Index Sheets** – Number all calculation sheets and prepare an index by subject with the corresponding sheet numbers.

List the name of the project, SR Number, designer/checker initials, date (month, day, and year), and Unit Supervisor's initials.

2. **Design Calculations** – The design calculations should include design criteria, design assumptions, loadings, structural analysis, one set of moment and shear diagrams and pertinent computer input and output data (reduced to 8½" by 11" sheet size).

The design criteria, design assumptions, and special design features should follow in that order behind the index.

Computer-generated design calculations may be used instead of longhand calculations. The calculation sheets shall be formatted similar to WSDOT standard calculation sheets (WSDOT Form 232-007) for longhand designs. The header for electronic calculation sheets shall carry WSDOT logo along with project name, S.R. number, designer and checker's name, date, supervising engineer, and sheet numbers.

All computer-generated or longhand design calculations shall be initialed by the designer and checker. Checker's initial may not be necessary if separate check calculations are provided.

Output from commercial software shall be integrated into design calculations with a cover sheet that includes the WSDOT logo along with project name, S.R. number, designer and checker's name, date, supervising engineer, and sheet numbers.

Consultant submitted design calculations shall comply with the above requirements.

Design calculations prepared by the Bridge Design Office or Consultants need not be sealed and signed. Design calculations are considered part of the process that develops contract plans which are the final documents.

See [Appendix 1.5-A4-1](#) for examples of Excel template for computer-generated design calculations. Code and other references used in developing calculations shall be specified. In general, when using Excel spreadsheet, enough information and equations shall be provided/shown in the spreadsheet so that an independent checker can follow the calculations.

3. **Special Design Features** – Brief narrative of major design decisions or revisions and the reasons for them.
4. **Construction Problems or Revisions** – Not all construction problems can be anticipated during the design of the structure; therefore, construction problems arise during construction, which will require revisions. Calculations for revisions made during construction should be included in the design/check calculation file when construction is completed.

D. **File Exclusions** – The following items should not be included in the file:

1. Geometric calculations.
2. Irrelevant computer information.
3. Prints of Office Standard Sheets.
4. Irrelevant sketches.
5. Voided sheets.
6. Preliminary design calculations and drawings unless used in the final design.
7. Test hole logs.
8. Quantity calculations.

1.3.4 PS&E Review Period

See [Section 12.4.10](#) for PS&E Review Period and Turn-in for AD Copy activities.

1.3.5 Addenda

Plan or specification revisions during the advertising period require an addendum. The Specifications and Estimate Engineer will evaluate the need for the addendum after consultation with the HQ Construction — Bridge, Region, and the HQ or Region Plans Branch. The Bridge Design Engineer or the Unit Supervisor must initial all addenda.

For addenda to contract plans, obtain the original drawing from the Bridge Projects Unit. Use shading to mark all changes (except deletions) and place a revision note at the bottom of the sheet (Region and HQ Plans Branch jointly determine addendum date) and a description of the change. Return the 11" by 17" signed original and copy to the Specifications and Estimate Engineer who will submit the copy to the HQ Plans Branch for processing. [See Chapter 12](#) for additional information.

For changes to specifications, submit a copy of the page with the change to the Specifications and Estimate Engineer for processing.

1.3.6 Shop Plans and Permanent Structure Construction Procedures

This section pertains to fabrication shop plans, weld procedures, electrical and mechanical items, geotechnical procedures, such as: drilled shafts and tieback walls, and other miscellaneous items related to permanent construction.

The following is a guide for checking shop plans and permanent structure construction procedures.

A. Bridge Shop Plans and Procedures

1. Mark one copy of each sheet with the following, near the title block, in red pen or with a rubber stamp:
 - Office Copy
 - Contract (number)
 - (Checker's initials) (Date)
 - Approval Status (A, AAN, RFC or Structurally Acceptable)
2. On the Bridge Office copy, mark with red pen any errors or corrections. Yellow shall be used for highlighting the checked items. The red pen marks will be copied onto the other copies and returned to the Region Project Engineer. Comments made with red pen, especially for 8½" by 11" or 11" by 17" size sheets, shall be clear, neat, and conducive to being reproduced by Xerox. These comments should be "bubbled" so they stand out on a black and white Xerox copy. Use of large sheets should be discouraged because these require extra staff assistance and time to make these copies by hand.
3. Items to be checked are typically as follows: Check against Contract Plans and Addenda, Special Provisions, Previously Approved Changes and Standard Specifications.
 - a. Material specifications (ASTM specifications, hardness, alloy and temper, etc.).
 - b. Size of member and fasteners.
 - c. Length dimensions, if shown on the Contract Plans.
 - d. Finish (surface finish, galvanizing, anodizing, painting, etc.).
 - e. Weld size and type and welding procedure if required.
 - f. Strand or rebar placement, jacking procedure, stress calculations, elongations, etc.
 - g. Fabrication — reaming, drilling, and assembly procedures.
 - h. Adequacy of details.
 - i. Erection procedures.

For prestressed girders and post-tensioning shop plan review see [Sections 5.6.3A](#) and [5.8.6C](#) respectively.

4. Items Not Requiring Check
 - a. Quantities in bill of materials.
 - b. Length dimensions not shown on Contract Plans except for spot checking and is emphasized by stamping the plans: *Geometry Not Reviewed by the Bridge and Structures Office.*
5. Project Engineer's Copy

Do not use the Project Engineer's copy (comments or corrections are in green) as the office copy. Transfer the Project Engineer's corrections, if pertinent, to the office copy using red pen. The Project Engineer's comments may also be received by e-mail.

6. Marking Copies

When finished, mark the office copy with one of five categories in red pen, lower right corner.

a. “A”

Approved, No Corrections required.

b. “AAN”

Approved As Noted — minor corrections only. Do not place written questions on an approved as noted sheet.

c. “RFC”

Returned for Correction — major corrections are required which requires a complete resubmittal.

d. “Structurally Acceptable”

This is appropriate for items that are not required to be “Approved” per the contract, such as: work platforms, submittals from various local agencies or developers, and other items that are reviewed as a courtesy.

e. “Structurally Acceptable But Does Not Conform to the Contract Requirements”

This is appropriate when a deviation from the contract is found but is determined to be structurally acceptable.

If in doubt between AAN and RFC, check with the Unit Supervisor or Construction Support Engineer. An acceptable detail may be shown in red. Mark the plans *Approved As Noted* provided that the detail is clearly noted *Suggested Correction — Otherwise Revise and Resubmit*.

Do not mark the other copies. The Construction Support Unit will do this.

Notify the Construction Support Engineer if there are any structurally acceptable deviations to the contract plans. The Construction Support Engineer will notify both the Region Project Engineer and HQ Construction-Bridge, who may have to approve a change order and provide justification for the change order.

Notify the Unit Supervisor and the Construction Support Engineer if problems are encountered which may cause a delay in the checking of the shop plans or completion of the contract. Typically, WSDOT administered contracts require reviews to be completed within 30 days. The review time starts when the Project Engineer first receives the submittal from the Contractor and ends when the Contractor has received the submittal back from the Project Engineer. The Bridge Office does not have the entire 30-day review period to complete the review. Therefore, designers should give construction reviews high priority and complete reviews in a timely manner so costly construction delays are avoided. Time is also required for marking, mailing and other processing. It is the goal of the Bridge and Structures Office to return reviewed submittals back to the Project Engineer within 7 to 14 days of their receipt by the Bridge Construction Support Unit.

Return all shop drawings and Contract Plans to the Construction Support Unit when checking is completed. Include a list of any deviations from the Contract Plans that are allowed and a list of any disagreements with the Project Engineer’s comments (regardless of how minor they may be).

If deviations from the Contract Plans are to be allowed, a Change Order may be required. Alert the Construction Support Unit so that their transmittal letter may inform the Region and the HQ Construction - Bridge.

Under no circumstances should the reviewer mark on the shop plans that a change order is required or notify the Project Engineer that a change order is required. The authority for determining whether a change order is required rests with HQ Construction - Bridge.

- B. **Sign Structure, Signal, and Illumination Shop Plans** – In addition to the instructions described under [Section 1.3.6A Bridge Shop Plans and Procedures](#), the following instructions apply:
1. Review the shop plans to ensure that the pole sizes conform to the Contract Plans. Determine if the fabricator has supplied plans for each pole or type of pole called for in the contract.
 2. The Project Engineer's copy may show shaft lengths where not shown on Contract Plans or whether a change from Contract Plans is required. Manufacturer's details may vary slightly from contract plan requirements, but must be structurally adequate to be acceptable.
- C. **Geotechnical Submittals** – The Bridge Office and the Geotechnical Services Branch concurrently review these submittals which may include special design proprietary retaining walls, drilled shafts, ground anchors, and soldier piles. HQ Construction Office - Bridge is included for the review of drill shaft installation plans. The Construction Support Unit combines these comments and prepares a unified reply that is returned to the Project Engineer

1.3.7 Contract Plan Changes (Change Orders and As-Builts)

- A. **Request for Changes** – The following is intended as a guide for processing changes to the design plans after a project has been awarded.

For projects which have been assigned a Bridge Technical Advisor (BTA), structural design change orders can be approved at the Project Engineer's level provided the instructions outlined in the [Construction Manual M 41-01](#) are followed.

For all other projects, all changes are to be forwarded through the Construction Support Unit, which will inform the HQ Construction Engineer - Bridge. Responses to inquiries should be handled as follows:

1. **Request by Contractor or Supplier** – A designer, BTA, or Unit Supervisor contacted directly by a contractor/supplier may discuss a proposed change with the contractor/supplier, but shall clearly tell the contractor/supplier to formally submit the proposed change through the Project Engineer and that the discussion in no way implies approval of the proposed change. Designers are to inform their Unit Supervisor if they are contacted.
 2. **Request From the Region Project Engineer** – Requests for changes directly from the Project Engineer to designer or the Unit Supervisor should be discouraged. The Project Engineer should contact HQ Construction - Bridge, who in turn will contact the designer or Unit Supervisor if clarification is needed regarding changes. The Construction Support Unit should be informed of any changes.
 3. **Request From the Region Construction Engineer** – Requests from the Region Construction Engineer are to be handled like requests from the Region Project Engineer.
 4. **Request From the HQ Construction - Bridge** – Requests for changes from HQ Construction - Bridge are usually made through the Construction Support Unit and not directly to the Design Unit. However, sometimes, it is necessary to work directly with the Design Unit. The Construction Support Unit should be informed of any decisions made involving changes to the Contract Plans.
 5. **Request From the Design Unit** – Request for changes from the Design Unit due to plan errors or omissions shall be discussed with the Bridge Design Engineer prior to revising and issuing new plan sheets.
- B. **Processing Contract Revisions** – Changes to the Contract Plans or Specifications subsequent to the award of the contract may require a contract plan revision. Revised or additional plan sheets, which clearly identify the change on the plans, may be needed. When a revision or an additional drawing is necessary, request the original plan sheets from the Construction Support Unit's Bridge Plans Engineer and prepare revised or new original plan sheets.

Sign, date, and send the new plan sheets to the Bridge Plans Engineer. Send two paper copies to HQ Construction-Bridge. The Construction Support Unit requires one paper copy. The Design Unit requires one or more paper copies. One paper print, stamped “*As Constructed Plans*”, shall be sent to the Project Engineer, who shall use it to mark construction changes and forward them as “*As-Built Plans*” to the Bridge Plans Engineer upon project completion. The Designer is responsible for making the prints and distributing them.

This process applies to all contracts including HQ Ad and Award, Region Ad and Award, or Local Agency Ad and Award.

Whenever new plan sheets are required as part of a contract revision, the information in the title blocks of these sheets must be identical to the title blocks of the contract they are for (e.g., Job Number, Contract No., Fed. Aid Proj. No., Approved by, and the Project Name). These title blocks shall also be initialed by the Bridge Design Engineer, Unit Supervisor, designer, and reviewer before they are distributed. If the changes are modifications made to an existing sheet, the sheet number will remain the same. A new sheet shall be assigned the same number as the one in the originals that it most closely resembles and shall be given a letter after the number (e.g., if the new sheet applies to the original sheet 25 of 53, then it will have number 25A of 53). The Bridge Plans Engineer in the Construction Support Unit shall store the 11" by 17" original revision sheets.

Every revision will be assigned a number, which shall be enclosed inside a triangle. The assigned number shall be located both at the location of the change on the sheet and in the revision block of the plan sheet along with an explanation of the change.

Any revised sheets shall be sent to HQ Construction-Bridge with a written explanation describing the changes to the contract, justification for the changes, and a list of material quantity additions or deletions.

- C. **As-Built Plan Process** – For more information on the as-built plan process for bridges, see the *As-Built Plans Manual*, prepared by the Bridge and Structures Office, dated August 2003. Copies are available from the Bridge Plans Engineer.

1.3.8 Archiving Design Calculations, Design Files, and S&E Files

- A. **Upon Award** – The Bridge Plans Engineer will collect the Design File (Job File), S&E File and Design Calculations. Files will be placed in a temporary storage space marked as “Design Unit Document Temporary Storage”. These cabinets will be locked, and only the Bridge Plans Engineer, the Scheduling Engineer, and the Office Administrator will have keys to them. The Design Files, S&E Files, and Design Calculations are stored under the contract number.

A Bridge and Structures staff member may access the Design Files, S&E Files, or Design Calculations by requesting the files from the Bridge Plans Engineer or the Scheduling Engineer, who will check out the files and note the date and person’s name. If a person other than a Bridge and Structures Office staff member requests these documents, the approval of the Bridge Design Engineer or Bridge Projects Engineer will be required for release of the documents.

- B. **Upon Contract Completion** – The designer will place a job file cover label on the file folder (see [Figure 1-3.8-1](#)) and update the file with any contract plan changes that have occurred during construction.

Two years after physical completion of the contract, the Bridge Plans Engineer will box and send the documents to the Office of Secretary of State for archive storage, except as otherwise approved by the Bridge Design Engineer.

The Bridge Plans Engineer will maintain a record of the documents location and archive status.

SR # _____ County _____ CS # _____

Bridge Name _____

Bridge # _____ Contract # _____

Contents _____

Designed by _____ Checked by _____

Archive Box # _____ Vol. # _____

Cover Label
Figure 1.3.8-1

1.3.9 Public Disclosure Policy Regarding Bridge Plans

The Bridge Management Engineer is the Bridge and Structures Office's official Public Disclosure contact and shall be contacted for clarification and/or direction.

Executive Order, E1023.0 *Public Disclosure*, which replaced Directive D 72-21 *Release of Public Records*, provides a specific procedure to follow when there is a request for public records. (See wwwi.wsdot.wa.gov/Publications/Policies/default.htm.)

The Bridge and Structures Office is the "owner" of only two types of "official" records: (1) Design Calculations (until they are turned over to the State Archives Office) and (2) Bridge Inspection Documents.

No records will be disclosed without a written request. This request is to be specific.

As-built plans available on the Bridge and Structures website are not "official" as-built plans. The Regions are the owners of the "official" as-built plans and the procedure for providing requested copies of these plans is similar to the procedure outlined above with the following modifications:

- If you receive a written or verbal request for a set of plans from a person indirectly working for WSDOT (i.e. contractor, consultant), advise them to contact and request the plans from the WSDOT Project Engineer.
- If the request comes from a person directly working on a Bridge Office project as an on-call consultant, have them contact and request the plans from the Bridge and Structures Office's Consultant Liaison Engineer.
- If the request comes from a person not working for WSDOT, they must submit their written request to the person and address noted below and it will be forwarded to the appropriate Region to provide the requested documents.

Written requests must be sent to:

Records and Information Service Office
Washington State Department of Transportation
310 Maple Park Avenue
P. O. Box 47410
Olympia, WA 98504-7410
Attn: Ms. Cathy Downs

1.3.10 Use of Computer Software

- A. **Protection of Intellectual Property** – Many of the software tools used by the Bridge and Structures Office are licensed from commercial software vendors. WSDOT is committed to using these tools only as allowed by law and as permitted by software license. WSDOT employees shall comply with the terms and conditions of all licensing agreements and provisions of the Copyright Act and other applicable laws.

Before using any software tools WSDOT employees shall read and understand Instructional Letter 4032.00 *Computer Software Piracy Prevention, and the Protection of Intellectual Property*.¹

- B. **Policy on Open Source Software** – It is the policy of the Bridge and Structures Office to license its own engineering software as open source, and to prefer and promote the use of open source software, within the bridge engineering community.

To support this policy on open source bridge engineering software, the Bridge and Structures Office is a founding and participating member of the Alternate Route Project. The purpose of the Alternate Route Project is to serve as a focal point for the collaborative and cooperative development of open source bridge engineering software tools.

- C. **Approved Software Tools** – A list of approved software tools available for use by WSDOT bridge design engineers is available at wwwi.wsdot.wa.gov/eesc/bridge/software. Note that this list is only available on the WSDOT intranet. WSDOT does not require consulting engineers to use any specific software tools, so long as the use of the tools are in accordance with sound engineering practice, and does not violate software licensing agreements and Copyright law.

When using personal design tools created by others, such as a spreadsheet or MathCAD document, the designer is responsible for thoroughly checking the tool to ensure the integrity of the structural analysis and design.

1.4 Coordination With Other Divisions and Agencies

During the various phases of design, it is necessary to coordinate the elements of the bridge design function with the requirements of other divisions and agencies. E-mail messages, telephone calls, and other direct communication with other offices are necessary and appropriate. Adequate communications are essential but organizational format and lines of responsibility must be recognized. However, a written request sent through proper channels is required before work can be done or design changes made on projects.

1.4.1 Preliminary Planning Phase

See [Chapter 2.1](#) of this manual for coordination required at the preliminary planning phase.

1.4.2 Final Design Phase

- A. **Coordination With Region** – Final coordination of the bridge design with Region requirements must be accomplished during the final design phase. This is normally done with the Region Project Engineer, Region Design Engineer, or Region Plans Engineer. Details such as division of quantity items between the Region PS&E and bridge PS&E are very important to a final contract plan set. The Region PS&E and bridge PS&E are combined by the Region Plans Branch. However, coordination should be accomplished before this time.

During the design of a project for a Region level contract, the Region shall provide a copy of the proposed structural plans (such as retaining walls, barrier, large culverts, etc.) to the Bridge and Structures Office. The Bridge and Structures Office will review these plans and indicate any required changes and then send them back to the Region.

The Region shall incorporate the changes prior to contract advertisement.

After contract advertisement, the Region shall return the original plan sheets to Bridge and Structures Office. These sheets shall be held in temporary storage until the Region completes the “As Constructed Plans” for them.

The Region shall then transmit the “As Constructed Plans” to Bridge and Structures Office where they will be transferred to the original plans for permanent storage. Upon request, the Region will be provided copies of these plans by the Bridge and Structures Office.

- B. **Technical Design Matters** – Technical coordination must be done with the HQ Materials Laboratory Foundation Engineer and with the HQ Hydraulic Engineer for matters pertaining to their responsibilities. A portion of the criteria for a project design may be derived from this coordination; otherwise it shall be developed by the designer and approved by the Bridge Design Engineer.

The designer should ensure uniformity of structural details, bid items, specifications, and other items when two or more structures are to be advertised under the same contract.

1.5 Bridge Design Scheduling

1.5.1 General

The Bridge Projects Engineer is responsible for workforce projections, scheduling, and monitoring progress of projects. The *Bridge Design Schedule (BDS)* is used to track the progress of a project and is updated monthly by the Bridge Scheduling Engineer. A typical project would involve the following steps:

- A. Regions advise Bridge and Structures Office of an upcoming project.
- B. The Bridge Projects Unit determines the scope of work, estimates design time and cost to prepare preliminary plans, design, and S&E (see [Section 1.5.2](#)). The Unit Supervisor may also do this and notify the Bridge Projects Engineer.
- C. The project is entered into the BDS with start and due dates for site data preliminary plan, project design, PS&E, and the Ad Date.
- D. Bridge site data received.
- E. Preliminary design started.
- F. Final Design Started — Designer estimates time required for final plans (see [Section 1.5.3](#)).
- G. Monthly Schedule Update — Each Unit Supervisor is responsible for maintaining a workforce projection, monitoring monthly progress for assigned projects, and reporting progress or any changes to the scope of work or schedule to the Bridge Projects Engineer.
- H. Project turned in to S&E unit.

1.5.2 Preliminary Design Schedule

The preliminary design estimate done by the Bridge Projects Unit is based on historical records from past projects taking into consideration the unique features of each project, the efficiencies of designing similar and multiple bridges on the same project, designer's experience, and other appropriate factors.

1.5.3 Final Design Schedule

- A. **Breakdown of Project Man-Hours Required** – Using a spreadsheet, list each item of work required to complete the project and the man-hours required to accomplish them. Certain items of work may have been partially completed during the preliminary design, and this partial completion should be reflected in the columns “% Completed” and “Date Completed.” See [Appendix 1.5-A1](#) and [1.5-A2](#).

The designer or design team leader should research several sources when making the final design time estimate. The following are possible sources that may be used:

The “Bridge Design Summary” contains records of design time and costs for past projects. This summary is kept in the Bridge Projects Unit. The times given include preliminary plan, design, check, drafting, and supervision.

The Bridge Projects Unit has “Bridge Construction Cost Summary” books. These are grouped according to bridge types and have records of design time, number of drawings, and bridge cost.

- B. **Estimate Design Time Required** – The designer or design team leader shall determine an estimate of design time required to complete the project. The use of a spreadsheet, or other means is encouraged to ensure timely completion and adherence to the schedule. Use 150 hours for one man month.

The following percentages should be used for the following activities:

Activity No.	Percentage
1	40
2	20
3	20
4	5
5	5
6	5
7	5
Total	100%

The individual activities include the specific items as follows under each major activity.

Activity No. 1 Design — See [Section 1.3.2.A.2](#) — Includes:

1. Project coordination and maintaining the Design File.
2. Geometric computations.
3. Design calculations.
4. Complete check of all plan sheets by the designer.
5. Compute quantities and prepare barlist.
6. Preparing special provisions checklist.
7. Assemble backup data covering any unusual feature in the Design File.

Activity No. 2 Design Check — See [Section 1.3.2.A.3](#) — Includes:

1. Checking design at maximum stress locations.
2. Checking major items on the drawings, including geometrics.
3. Additional checking required.

Activity No. 3 Drawings — See [Section 1.3.2.A.4](#) — Includes:

1. Preparation of all drawings.

Activity No. 4 Revisions — Includes:

1. Revisions resulting from the checker's check.
2. Revisions resulting from the Unit Supervisor's review.
3. Revisions from S&E Engineer's review.
4. Revisions from Region's review.

Activity No. 5 Quantities — Includes:

1. Compute quantities including barlist.
2. Check quantities and barlist.

Activity No. 6 S&E — See [Section 12.4](#) — Includes:

1. Prepare S&E.
2. Prepare working day schedule.

Activity No. 7 Project Review — Includes:

1. Unit Supervisor and Specialist's review.

- C. **Monthly Project Progress Report** – The designer or design team leader is responsible for determining monthly project progress and reporting the results to the Unit Supervisor. The Unit Supervisor is responsible for monthly progress reports using information from the designer or design team leader. Any discrepancies between actual progress and the project schedule must be addressed. Report any revisions to the workforce assigned to the project, hours assigned to activities, or project schedule revisions to the Bridge Projects Engineer and Region.

The designer may use a computer spreadsheet, to track the progress of the project and as an aid in evaluating the percent complete. Other tools include using an Excel spreadsheet listing bridge sheet plans by title, bridge sheet number, percent design complete, percent design check, percent plan details completed, and percent plan details checked. This data allows the designer or design team leader to rapidly determine percent of project completion and where resources need to be allocated to complete the project on schedule.

1.6 Guidelines for Bridge Site Visits

The following guidelines are established to help all staff in determining the need for visiting bridge sites prior to final design. These guidelines should apply to consultants as well as to our own staff. In all cases, the Region project engineer should be made aware of the site visit so they may have the opportunity to participate. Region participation is very useful prior to preparing the preliminary bridge plans.

1.6.1 Bridge Rehabilitation Projects

This section pertains to major bridge rehabilitation projects and excludes rail and minor expansion joint rehabilitation projects. It is critical that the design team know as much as possible about the bridge which is to be rehabilitated. Recent bridge inspection reports, prepared by inspectors from the Bridge Preservation Office (BPO), contain useful information on the condition of existing bridges. The bridge inspection reports, as well as as-built plans, are available on the Intranet through *Bridge Engineering Information System (BEIST)*. BPO maintains *BEIST*.

As-built drawings and contract documents are also helpful, but may not necessarily be accurate. At least one bridge site visit is necessary for this type of project. In some cases, an in-depth inspection with experienced BPO inspectors is appropriate. The decision to perform an in-depth inspection should include the Unit Supervisor, Region, the Bridge Design Engineer, and the Bridge Preservation Engineer.

It may be necessary to use BPO's Under Bridge Inspection Truck (UBIT) if there is a need to access details and obtain measurements during the field visit. Advance planning and coordination with BPO will be necessary if UBIT equipment is required because of BPO's heavy workload and the need to provide traffic control well in advance of the site visit.

1.6.2 Bridge Widening and Seismic Retrofits

For this type of bridge project, it is important that the design team is familiar with the features and condition of the existing bridge. There is good information regarding the condition of existing bridges on *BEIST* and at the Bridge Preservation Office. As-built drawings and contract documents are also helpful, but may not necessarily be accurate. A site visit is recommended for this type of project if the bridge to be widened has unique features or is other than a standard prestressed girder bridge with elastomeric bearings.

1.6.3 Rail and Minor Expansion Joint Retrofits

Generally, photographs and site information from the Region along with as-built plans and condition survey information are adequate for most of these types of projects. However, if there is any doubt about the adequacy of the available information or concern about accelerated deterioration of the structural elements to be retrofitted, a site visit is recommended.

1.6.4 New Bridges

Generally, photographs and site data from the Region are adequate for most new bridge designs. However, if the new bridge is a replacement for an existing bridge, a site visit is recommended, particularly if the project requires staged removal of the existing bridge and/or staged construction of the new bridge.

1.6.5 Bridge Demolition

If bridge demolition is required as part of a project, a site visit would help the design team determine if there are unique site restrictions that could affect the demolition. If unique site restrictions are observed, they should be documented, included in the job file, and noted on the special provisions checklist.

Before making a site visit, the Bridge Preservation Office and the Region should be contacted to determine if there are any unique site conditions or safety hazards. Proper safety equipment and procedures should always be followed during any site visit.

When making a site visit, it is important to obtain as much information as possible. Digital photographs, video records with spoken commentary, field measurements, and field notes are appropriate forms of field information. A written or pictorial record should be made of any observed problems with an existing bridge or obvious site problems. The site visit data would then be incorporated into the job file. This information will be a valuable asset in preparing constructible and cost-effective structural designs.

It is important to include site visits as part of the consultant's scope of work when negotiating for structural design work.

1.6.6 Proximity of Railroads Adjacent to the Bridge Site

During the site visit, it should be noted if there are railroad tracks or railroad structures adjacent to the proposed bridge site. If there are, this will require that a *Railroad Shoring Plan* be included in the bridge plans for any foundation excavation adjacent to the railroad. The reason for including the *Railroad Shoring Plan* is to obtain advance approval of the shoring plan from the railroad so that waiting for the railroad's approval will not cause a delay during construction. The contractor will have to resubmit a revised *Railroad Shoring Plan* to the railroad for approval if the contractor wishes to change any details of the approved *Railroad Shoring Plan* during construction.

At the PS&E submittal phase, the Specifications and Estimates Engineer will send copies of the *Railroad Shoring Plan* to the WSDOT Railroad Liaison Engineer so it can be sent to the railroad for approval.

1.99 References

1. *LRFD Bridge Design Specifications*, Latest Edition and Interims. American Association of State Highway and Transportation Officials (AASHTO), Washington, D.C.
2. *Design Manual*, WSDOT M 22-01.
3. *Construction Manual*, WSDOT M 41-01.
4. *As-Built Plans Manual*, WSDOT Bridge and Structures Office, August 2003.
5. *AASHTO Guide Specifications for LRFD Seismic Bridge Design*, Latest Edition and Interims. American Association of State Highway and Transportation Officials (AASHTO), Washington, D.C.

Breakdown of Project Manhours Required



Job No.	SR	Project	Date									
No.	Drawing or Item	Design		Check		Draw		Check Drawing		Comments		
		By	% Completed	Hours Required	Date Completed	By	% Completed	Hours Required	Date Completed			
		1										
		2										
		3										
		4										
		5										
		6										
		7										
		8										
		9										
		10										
		11										
		12										
		13										
		14										
		15										
		16										
		17										
		18										
		19										
		20										
21												
22												

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Rev 3/01

Monthly Project Progress Report



SR Job No. Project

Activity No.	Reference No.				Man Hours Used to Date	% of Total Time Used	% of Activity Complete	% of Total Project Complete
	As of							
1								
2								
3								
4								
5								
6								
7								
8								
9								
Totals								

DOT 232-004 (formerly C1M4)
Rev 3/91

PROJECT TURN-IN QA/QC WORKSHEET (per BDM Chapter 1.3)

Project Name:	CHECKLIST (Initials required under respective title)										
	Names Listed			SPECIALIST APPROVAL							JOB FILE COMPLETE
Charge Number:	DESIGNER	CHECKER	DETAILER	SPECIFICATION WRITER	ARCHITECT	BEARING AND EXPANSION JOINT	CONCRETE	STEEL	SEISMIC		
Design Lead:											
Date:											
Design Item											

Bridge Design Engineer Check at 90%: Date: _____ Supervisor Plan Review: Date: _____

NOTES:

- * Only Bridges are archived. Sign Structures and Walls are kept on file in the office by designer of record.
- Required Actions for each Design Item:
- 1) Elevations and Dimensions
 - 2) Quantities and Barlist
 - 3) Detailing Sheet Consistency
 - 4) Detailing Plan Consistency
 - 5) Detailing Office Practices
 - 6) Specification Review
 - 7) 100% region Comments Incorporated



**Washington State
Department of Transportation**

**Bridge & Structures
Design Calculations**

Project				Sheet No.	1	of	1	Sheets	Code
S.R.	Made By	Check By	Date		7/7/10	Supv			Reference

