

Appendix 1-3 – Hydraulic Report Outline

Title Page – The following items should be included on the title page: the project number and name, associated State Route (SR) and milepost(s), Type of Report (A, B or Hydraulic Summary), date report was completed, designers name(s) including the *Highway Runoff Manual* Training Certificate Number and both the project engineers professional engineers stamp and signature.

Table of Contents – Both the Hydraulic Report and Appendix contents should be listed in the Table of Contents. Number all pages including maps, figures, and tables both in the report and in the appendices.

1.0 Project Overview

- 1.1 Site Location – Note the following: MP limits, Section, Township, Range and reference location from nearest city.
- 1.2 Vicinity Map – Include a vicinity map with the project location clearly shown. Whenever possible, highlight major landmarks, delineate water bodies and label cross streets.
- 1.3 Scope of Work – Introduce the hydraulic features of the project and note why they are being installed. Describe project improvements and where they will occur, reference attached plan sheets where applicable. It may be necessary to discuss the overall purpose of the project especially if it is pertinent to some of the decisions made during the design of the hydraulics features. Provide a reference to Appendix A-1 for the areas impacted by the project.

2.0 Site Conditions

- 2.1 Existing Conditions – Include a discussion on the project site conditions and layout as observed during inspection of the site by the designer. The discussion should serve to confirm what is shown on the maps and site plans and identifies or highlights as well as notes any features that will influence the drainage design.
- 2.2 Existing Hydraulic Features – Note any existing drainage features and describe how they operate prior to construction. Also note how project improvements could impact their operation and how they will function once construction activities have been completed. If needed, use photographs to describe the site. Identify any bridges or culverts within the project limits and note how the project will impact them or how they will impact the project.
- 2.3 Threshold Discharge Areas (TDAs) – TDAs are used in stormwater design to determine which *Highway Runoff Manual* minimum requirements apply. A TDA is a delineation of all the drainage areas that contribute runoff to an on-site single natural or constructed discharge location or multiple natural or constructed discharge locations that combine within ¼ mile downstream (as determined by the shortest flow path) from the highway right of way. A TDA is not the same as a drainage basin. In fact, a TDA may contain portions of multiple drainage basins. See Section 4.1 of this outline for further discussion on drainage basins.

Each TDA must be delineated to account for the full extent of land cover changes that will occur once the project is complete. The delineation should be based on the existing on-site drainage patterns, and the existing outfall from the proposed highway right of way limits.

Include TDA maps in Appendix A-2 that clearly delineate the TDA boundaries and show how the drainage areas are tributary to individual outfalls and the flow paths combine to form one TDA. This requires that flow paths downstream of each outfall be shown on the maps.

For each TDA within the project, provide a complete description of the general drainage systems and flow patterns including any unusual or unique drainage patterns that extend beyond project limits or highway right of way. Each TDA description should list the eventual downstream receiving water body.

- 2.4 Soils – Discuss the soil testing that has been performed at the site. This includes soil pH and resistivity (to determine acceptable pipe alternatives), soil borings, soil type from SCS Maps, soil infiltration rates, well monitoring, groundwater level, etc. and any other soil testing required for stormwater BMP design.
- 2.5 Existing Stormwater Outfalls – All project stormwater outfalls should be noted in this section and entered into the Outfall Database. An outfall is anywhere concentrated stormwater: 1) directly leaves highway right of way via surface flows or underground connections to local storm drain systems; 2) enters state waters within highway right of way; or 3) flows are discharged to groundwater via an infiltration facility including underground injection control, infiltration ponds, and bioinfiltration ponds. For more guidance designers should consult the Hydraulic Staff Outfall Inventory Instructions and the Outfall Inventory spreadsheet. Both are located at the website listed below. The information detailed in the spreadsheet should be included in Appendix A-1 of the Hydraulic Report and sent directly to the HQ Environmental Services Office at simonc@wsdot.wa.gov or 360-570-2589.
<http://www.wsdot.wa.gov/Environment/WaterQuality/default.htm>
- 2.6 Existing Utilities – Note utility conflicts that have been investigated and either are or are not an issue. If there is a conflict, please note resolution. Utilities should be shown on the drainage plan and profile sheets.

3.0 Design Standards

- 3.1 Design Frequency – Note the appropriate design frequencies used to size hydraulic features on the project and where relevant calculations. Include a discussion of the climate and chosen precipitation values for the project, including copies of Isopluvial and Mean Annual Precipitation maps highlighting the project location. Where applicable, discuss how or if snow was considered in the design. Refer to Section 2-4, Cold Climate Considerations, for further design guidance.
- 3.2 Stormwater Management Guidelines – Use the Stormwater Design Documentation Spreadsheet located in Appendix A-1 to document which Minimum Requirements apply. Clearly state which Minimum Requirements apply at both the project and TDA level. Reference the Flow Control and Runoff Treatment selection charts in Figures 5.3.1 and 5.3.2 of the *Highway Runoff Manual* to describe which BMPs were selected for the project.
- 3.3 Stormwater Retrofit Analysis – Document all project related stormwater retrofit activity where an existing structure or facility will be renovated to meet changed conditions or improve performance. This section should also include discussion regarding equivalent areas, stand alone stormwater retrofits, and/or justification for not providing a retrofit for a replaced impervious surface. Section 3-4 of the *Highway Runoff Manual* provides additional stormwater retrofit guidance. The Stormwater Design Documentation Spreadsheet noted in Appendix A-1 of this

outline will also assist designers in organizing retrofit information required for this section.

- 3.4 Other Requirements – Note any requirements used in the hydraulic calculations that are in addition to those found in the *Hydraulics* and *Highway Runoff Manuals*. This would include: local agency guidelines, TMDL and Local Area Ordinances, and/or other agreements or commitments that affect the hydraulic analysis. Provide a list of references for the guidelines, manuals, basin plans, local agency code, technical documents or Memoranda of Agreement or Understanding used to develop the hydraulic scope of work and the Hydraulics Report. In addition, it should be clearly documented how each of these other requirements will be addressed in the Hydraulic Design. Where applicable, include a web link to the reference.
- 3.5 Hydraulics Manual Deviations – Clearly state the year the manual used for design was published. Any deviation from this manual requires approval by the State Hydraulic Engineer and should be summarized in this section. Refer to Section 1-3.2 for additional guidance.
- 3.6 Highway Runoff Manual Deviations – Clearly state the year the manual used for design was published. Any deviation to the HRM requires an Engineering and Economic Feasibility (EEF) evaluation and approval from the DAT (see Appendix 2A of the HRM). Include a summary of the deviation and the outcome of the EEF in this section. A copy of the EEF along with any correspondence should be included in Appendix A-11 of this outline.
- 3.7 Pipe Alternatives – Note all acceptable schedule pipe alternatives (see Division 7-04 of the WSDOT *Standard Specifications*) for the project and provide engineering justification for any alternatives that are excluded. Refer to Section 8-2 for further guidance.
- 3.8 Downstream Analysis – Summarize what impact, if any, a project will have on the hydraulic conveyance systems downstream of the project section. The analysis should be broken into three sections: 1) Review of Resources; 2) Inspection of Drainage Conveyance Systems in the Site Area; and 3) Analysis of Offsite Effects. Refer to Section 4-7 for further guidance on when a Downstream Analysis is required and what should be included in the report.
- 3.9 New Stormwater Outfalls – Follow the directions listed in Section 2.5 of this outline.

4.0 Developed Conditions

This section should serve to confirm what is shown on the (current or future) PS&E drainage plans, profiles and details. Note that PS&E level plans may not yet be completed but will be checked against the hydraulic report during the PS&E review.

- 4.1 Drainage Basins – The size of each drainage basin is one of the most important parameters in sizing hydraulic and stormwater features. Drainage basins are the areas that contribute runoff to a point of interest such as catch basins, inlets, culverts, drainage ditches, detention ponds, bioswales, etc. These areas may include both on-site and off-site runoff and areas that extend outside of highway right of way and beyond the project.

Each drainage basin should be described in this section including: land cover, size, slope, and general drainage patterns. Include drainage basin maps in Appendix A-2 with each drainage basin clearly delineated and showing the flow direction arrows. It should be clear on the drainage basin maps which basins contribute runoff to which

hydraulic or stormwater features. All new and permanent stormwater BMPs should also be located on the maps and clearly labeled. The drainage basin designations should be held consistent in all subsequent calculations in the hydraulic report. Maps should always be of an adequate and noted scale to allow reviewers to verify all calculations.

- 4.2 Post Developed Drainage Patterns– As a general rule, flow patterns within a TDA should not change as a result of project improvements. However, there are unique situations from time to time that can result in runoff being diverted from one TDA to another TDA in the proposed condition. Such cases include an outfall that has been eliminated or moved or when runoff from one TDA has been combined with runoff from another TDA. For example, consider a bridge deck that uses existing downspouts to discharge runoff directly into a river. In order for the proposed project to meet runoff treatment requirements the bridge runoff may need to be captured and conveyed to another TDA for treatment. This situation would require the designer to modify or combine the runoff from these TDAs. Another example is a roadway that is widened next to a wetland. The roadway runoff that previously sheet flowed into the wetland might need to be captured and conveyed to a treatment facility before being discharged from the project site. If that roadway runoff is shifted to a different TDA to receive runoff treatment, the design will have to account for this additional flow.

In the report appendix include TDA maps that clearly delineate any modified drainage patterns and/or discharge locations. If a project modifies the existing flow patterns, the designer will have to show the impacts of these changes through the downstream analysis (see Section 3.6 of this outline for further guidance). If there is a change in the amount of area contributing runoff to a TDA, the minimum requirements are still based on the existing TDA delineations and appropriate measures must be taken to ensure that full compliance with flow control and runoff treatment requirements occurs. TDA mapping of any modified drainage patterns are for future project use.

5.0 Hydrologic and Hydraulic Design

- 5.1 Calculation Discussion - Hydrologic and hydraulic design calculations for all hydraulic features should be discussed and the results summarized in this section (e.g., culverts, storm drains, stormwater BMPs, inlets, gutters, ditches, streambank stabilization, etc), actual calculations should be included in Appendix A-3. Where applicable, it is recommended that the design be broken down by TDA and discussed in the order shown in Appendix A-3. Calculation locations should be referenced in this section. For large reports, designers should consider using a table summarizing the calculations for clarity.

Calculations should include: references to manuals that were followed during the design phase and a discussion of what assumptions were made to perform the calculations and how the input parameters were determined. All calculations should include enough supporting information to allow reviewers to completely duplicate the process used through the original design; however, excessive data which duplicates information already provided can often make the calculation process less understandable

Whenever possible calculation methodologies described in this manual and the *Highway Runoff Manual* should be followed including: figures from these manuals, standard WSDOT design forms, and suggested software. If a different method or

software is selected, the reason for not using the standard WSDOT method should be explained and approved as part of the 10% milestone for the Hydraulic Report Review Process. Actual calculations, design forms and output from software used in the project design should be included as part of the report appendices. Visit the following web link for a description of current programs and download information. (<http://www.wsdot.wa.gov/Design/Hydraulics/ProgramDownloads.htm>)

6.0 Permits and Associated Reports

- 6.1 Environmental Issues, Fish and Other Endangered Habitat – Describe any water quality receiving bodies, flood plains, stream crossings, wetlands, steep slopes or other sensitive areas within the project limits, noting project impacts. Describe any fish passage design issues including culverts within the project limits or fish passage barrier removal issues. Note if fish surveys were conducted and what was determined. Also note if there are any threatened or endangered species within the project limits.
- 6.2 Permits/Approvals – List all permits, variances or approvals required by local jurisdiction or resource agencies that are necessary to complete the project.
- 6.3 Easements – Note any drainage or slope easements that may be required for the project, including whether the easement is for construction or maintenance. Highlighting and referencing the easement area on the attached plan sheets is helpful.
- 6.4 Specialty Design – If the project requires any specialty design that must be performed by HQ Hydraulics or a consultant (refer to Section 1-2), the nature of the work that was performed should be described in this section and indicate who provided the design. Include any specialty design reports in Appendix A-10.
- 6.5 Additional Reports or Studies – Where applicable note other reports and studies conducted and prepared for this project. Include correspondence with the Regional Hydraulics Engineer to determine which reports need to be included in the Hydraulics Report and which only need referencing.

7.0 Inspection and Maintenance Summary

Maintenance should be consulted prior to starting a project concerning any existing drainage problems and/or proposed BMPs. All discussion with maintenance, including email correspondence, should be described and included in this section.

Appendix

- A-1 Stormwater Design Documentation Spreadsheet - has been developed to assist designers in organizing the information required in hydraulic report as well as meeting the inventory requirements of the *Highway Runoff Manual*. The spreadsheet should be completed and placed in this section of the appendix. (<http://www.wsdot.wa.gov/NR/rdonlyres/6DE749BC-209C-4BFD-80D9-BCC86DCB868A/0/StormwaterDesignDocumentation.xls>)
- A-2 TDA Maps, Drainage Basin Maps, and Area Calculations – These maps should show those TDAs and drainage basins referenced in Section 2.3, 4.1, and 4.2 of this outline. Refer to Section 4-2.5 in the *Highway Runoff Manual* for more guidance on delineation of TDAs.
- A-3 Calculations and Program Output – All calculations included in the report should be checked by a qualified individual other than the person who prepared the report. The following is a list of calculations or program output that, where applicable, is needed

to complete a hydraulic report. See Section 1-3.3 for requirements on the report format that should be submitted (electronic vs. hard copy).

- A-3.1 StormShed
- A-3.2 MGSFlood Output Reports
- A-3.3 BMPs Design
- A-3.4 Inlet Spreadsheet
- A-3.5 Sag Design
- A-3.6 Storm Drain Design
- A-3.7 Culvert Design (including Fish passage if applicable)
- A-3.8 Ditch Design
- A-3.9 Downstream Analysis (if calculations are required)
- A-3.10 Special Stream Design/Channel Changes
- A-3.11 Flood Plain Mitigation
- A-3.12 Bridge Scour Evaluation
- A-4 Drainage Plan Sheets and Details (at level applicable when Hydraulic Report is submitted) – For culverts and bridge projects include the WSEL (water surface elevation) and design flow rates for the 25, 100 and (where applicable) 500 year storms.
- A-5 Drainage Profile Sheets (if applicable)
- A-6 Roadway Cross Sections and Profiles (if applicable)
- A-7 Misc. Contract Plan Sheets (if applicable) – Include any plan sheets that will aid the reviewer to completely understand the project, this may include utility plan sheets.
- A-8 Traffic Analysis Data (Design Year ADT)
- A-9 Environmental Documentation – Environmental issues that have not already been discussed should be documented in this section including; why decisions were made, who made them and note any references used. See Appendix A1-2-1 for a copy of a spreadsheet that will assist in the organization of these issues. Additionally, any environmental documentation that has not already been included in this report should be included in this section including relevant emails or other correspondence, etc.
- A-10 Specialty Design Reports – Include any reports requiring the expertise of the HQ Hydraulics office or a consultant to compile
- A-11 Engineering Economic Feasibility Evaluation – The EEF should be included along with any correspondence and an approval letter from the Demonstrative Approach Team (DAT)
- A-12 UIC Registration Forms
- A-13 Supplements and Revisions