Table of Contents

Chapter 1 Design Policy

1-1 General

Various types of drainage facilities are required to protect the highway against surface and subsurface water. Drainage facilities must be designed to convey the water across, along, or away from the highway in the most economical, efficient and safe manner without damaging the highway or adjacent property. The purpose of this manual is to provide detailed information on the subjects of hydrologic and hydraulic analysis related to highway design. This manual should be used in conjunction with the Washington State Department of Transportation (WSDOT) *Highway Runoff Manual* and the WSDOT *Design Manual*, specifically Section 1210.

Developers, external agencies, utilities, etc., designing stormwater facilities within WSDOT right of way (ROW), shall assume the same responsibility as the Project Engineer's Office and prepare Hydraulic Reports in compliance with Section 1-3 of this manual. Additionally, pipes and stormwater treatment features (bioswale, pond, etc.) on WSDOT ROW are considered utility structures. Therefore, anytime such a feature is located on WSDOT ROW, a utility permit will be required. For more information on utility permits, designers should consult the *Utility Manual*, the *Agreements Manual* and or the *Developer Services Manual*.

The chapters contained in this manual, provide information necessary to complete hydrologic and hydraulic analysis for nearly all the situations that will be encountered during normal highway design. When a designer encounters a situation that is not described in this manual, the Regional Hydraulics Engineer or the Headquarters (HQ) Hydraulics Office should be contacted for assistance. This manual is a summary of the FHWA's *Hydraulic Engineering Circulars*, for situations not discussed in this manual; designers can also consult FHWA's web site (http://www.fhwa.dot.gov/bridge/hydpub.htm). Designers are encouraged to request assistance as soon as questions or problems arise in a project, this will reduce the amount of redesign and if applicable allows more alternative solutions for the final design.

Designers should always keep in mind the legal and ethical obligations of WSDOT concerning hydraulic issues. The final project design should be carefully examined to determine if the project causes any significant changes to existing stormwater runoff and natural drainage facilities both upstream and downstream of the project. Care must be taken to ensure that the highway construction does not interfere with or damage any of these facilities.

1-2 Responsibility

The Project Engineer's Office is responsible for the preparation of correct and adequate drainage design. Actual design work may be performed in the Project Engineer's Office, by another WSDOT office, or by a private consulting engineer; however, in all cases, it is Project Engineer's responsibility to ensure that the design work is completed and that a hydraulic report is prepared as described in Section 1-3 of this manual. The Hydraulic Report should be completed during the early stages of design to allow adequate time for review prior to final Plans, Specifications and Estimates (PS&E) preparation. The Project Engineer's Office is also responsible for

initiating the application for hydraulic related permits required by various local, state, and federal agencies.

While the Region is responsible for the preparation of Hydraulic Reports and PS&E for all drainage facilities except bridges, assistance from the HQ Hydraulics Office may be requested for any drainage facility design, including the following:

1. Hydraulic design of unique drainage facilities (siphons, channel changes, etc.).
2. Structural design of hydraulic structures (culvert headwalls, fish ladders, etc.).
3. Analysis of streambank erosion and migration and design of stabilization countermeasures.
4. Special hydrological analysis (how snowmelt will/will not be considered, storm frequency prediction, etc.).
5. Analysis of closed drainage basins.
6. Providing the Washington State Attorney General's office with technical assistance on hydraulic issues.
7. Design of Large Woody Debris LWD for stream enhancement. If the Project Engineers Office or the Region Hydraulic Engineer performs the design, a WA State licensed civil or structural engineer shall affix their stamp to the plans.

The HQ Hydraulics Office takes primary responsibility in the following areas:

1. Ensuring that the information in the WSDOT *Hydraulics Manual* is accurate and current.
2. Ensuring that the engineering related information in the WSDOT *Highway Runoff Manual* is accurate and current.
3. Hydraulic analysis of bridges, including hydraulic conveyance, floodplain impacts, deck drainage, and foundation scour.
4. Hydraulic and structural design of all large span corrugated metal culverts.
5. Hydraulic design of large span concrete culverts.
6. Hydraulic design of pumping facilities.
7. River hydraulic and backwater analysis.
8. Maintaining WSDOT *Standard Plans* involving drainage items.
9. Design of water supply and sewage disposal systems for safety rest areas. The Project Engineer's Office is responsible for contacting individual fire districts to collect local standards and forward the information onto HQ Hydraulics.
10. Reviewing and approving Type A Hydraulic Reports, unless otherwise delegated to the Regional Administrator.
11. Providing the Regions with technical assistance on hydraulic issues that are the primary responsibility of the Region.
12. Providing basic hydrology and hydraulics training material to the Regions. Either Regional or HQ personnel can perform the actual training. See the HQ Hydraulics web page for information on course availability: (http://www.wsdot.wa.gov/eesc/design/hydraulics/training.htm)

13. The design of Engineered Log Jams throughout the state, including a monitoring plan to observe installation and collect data.

14. Review and approval of LWD calculations due to the inherent risks and liability.

1-3 Hydraulic Reports

The Hydraulic Report is intended to serve as a complete documented record containing the engineering justification for all drainage modifications that occur as a result of the project. The primary use for a Hydraulic Report will be to allow review of the design and to assist in the preparation of the PS&E. The writer should approach the Hydraulic Report from the position of its defense in a court of law. It should be clearly written and show conditions before and after construction. The final copy of the Hydraulic Report must be stamped with a professional engineer's seal and signed by the project engineer.

Hydraulic Reports are one of three types; Type A, Type B or a Hydraulic Summary. Figure 1-3 provides guidance for selecting the report type, however the Regional Hydraulics Engineer should be consulted for verification prior to final selection.

Type of Report	Description	Approval		PE Stamp
		Regional	HQ[2]	
A	Projects with any of the following components: • Culverts greater than 48[3] inches • Over 10,000 sq ft of new impervious area • Storm sewer systems that discharge into a stormwater treatment facility. • Channel realignment and or modifications (including fish passage) • Any fills in floodways • Fills that include an excess of 1,000 cubic yards of displacement in the floodway fringe. • Rest Area modifications/pump stations	X	X	X
B[1]	Projects with any of the following components: • Culverts less than or equal to 48[3] inches in diameter • Less than or equal to 10,000 sq ft of new impervious area • Storm sewer systems with 10 or less hydraulic structures, that don't discharge into a stormwater treatment facility.	X		X

1. At the Regions discretion smaller projects may replace a Type B report with a Hydraulic Summary, see the Region Hydraulics Engineer for more information.
2. For the Urban Corridors Office, the HQ Hydraulics Representative shall have rejection authority as per the Request for Proposal (RFP) of both conceptual and final design.
3. Type of report also applies to culvert extensions of the size noted.

Hydraulic Report Selection Table
Figure 1-3

Hydraulic Reports should be submitted to the approving authority as follows:

Review Copies - Designers should submit a complete hard copy of the Hydraulic Report to the appropriate approving authority (Region and/or HQ Hydraulics, see Figure 1-3) for review. If the report requires HQ Hydraulics approval, it should be submitted to HQ after the Region Hydraulic Engineer has reviewed and approved the report, see Figure 1-5 for review schedule estimates.

Final Copies – Upon approval, two paper copies of the report, one CD copy of the report, and the original approval letter shall be sent to the following offices:

1. One paper copy of the Hydraulic Report should be sent to the Construction Office for reference during construction.
2. One paper copy should be sent to the Region Hydraulic Engineer and kept in a secure location as the record of copy for 10 years.
3. The entire contents of the Hydraulics Report, in PDF format, should be sent to HQ Hydraulics in the form of a CD. The copy sent to HQ Hydraulics will be kept for at least 10 years.
4. The original approval letter should be archived with the Design Documentation Package.

The 10 year time line begins after construction is complete.

1-3.1 Hydraulic Report Revisions and Supplements

At times, a Hydraulics Report may need to be revised due to various elements within a proposed project. There are two ways to submit a change:

1. Revision – A revision is a correction of the existing report either due to an error or omitted design documentation. The designer should submit the revision along with a new title page, stamped and signed by the PE with the same date or later as the revision.
2. Supplement – A supplement is a change that was not part of the original scope of work. The same approval process is required as with the original report, however the supplement should be a stand-alone document that references the original report.

Either type of change should be prepared documenting the changes to be made with backup documentation. Include revised plans, calculations, and other updates as warranted in a submittal package to the Regional Hydraulics Engineer (or HQ Hydraulics if a Type A report). An approval/concurrence letter will be issued for the supplement.

1-3.2 Writing a Hydraulic Report

A Hydraulic Report outline has been provided in Appendix 1-3 as a starting point for designers. Use of the outline is not mandatory however, organizing reports in the outline format may expedite the review process. Since some regions have modified the outline to meet specific region needs and or requirements, designers should contact their Regional Hydraulic Engineer before starting a report. Once the applicable outline is selected, it is recommended that designers read through the outline and determine which sections are applicable to their project and delete those that are not. Both the Region or HQ Hydraulic Office's can be contacted for assistance in preparing a Hydraulic Report.

Regardless of whether or not the Hydraulic Report Outline is used, the Hydraulic Report should contain the elements listed in the outline that apply to the project. Designers should provide a well-organized report such that an engineer with no prior knowledge of the project could read and fully understand the hydraulic/hydrologic design of the project. The report should contain enough information to allow someone else to reproduce the design in its entirety, but at the same time designers should be brief and concise, careful not to provide duplicate information that could create confusion.

Following and completing the outline does not mean all of Minimum Requirements in the Highway Runoff Manual have been addressed. The outline is only a tool to aid the designer in developing a Hydraulics Report. To determine the applicability of the Minimum Requirements and BMPs for a project, designers should consult the *Highway Runoff Manual*.

Project Offices should use caution when referencing the Hydraulic Report Outline in contracts or scope of work for consultants. Never contract or scope a consultant to only finish or complete the Hydraulic Report Outline. The consultant should use the Hydraulic Report Outline to develop the Hydraulic Report per the *Hydraulics Manual* and the Hydraulic Report shall address all of the applicable Minimum Requirements per the *Highway Runoff Manual*. Please contact the Region Hydraulics Engineer to review the contract or scope prior to hiring a consultant.

1-4 Storm Frequency Policy

The design of a hydraulic structure requires an investigation to determine the runoff from the contributing flow. The rate of runoff from a drainage area will vary depending on the storm frequency that is being analyzed. The less frequent the storm is, the greater the associated precipitation will be and thus the greater the runoff will be.

Ideally every hydraulic structure would be designed for the largest possible amount of flow that could ever occur. Unfortunately this would require unusually large structures and would add an unjustifiably high cost to the projects; therefore hydraulic structures are analyzed for a specific storm frequency. When selecting a storm frequency for design purposes, consideration is given to the potential degree of damage to the roadway and adjacent property, potential hazard and inconvenience to the public, the number of users on the roadway, and the initial construction cost of the hydraulic structure.

The way in which these factors interrelate can become quite complex. WSDOT policy regarding design storm frequency for typical hydraulic structures has been established so the designer does not have to perform a risk analysis for each structure on each project. The design storm frequency is referred to in terms of mean recurrence interval (MRI) of precipitation.

MRI is the average interval between events equal to or greater than a given event. It can also be viewed as the probability that such an event will occur in any one year. For example, a peak flow having a 25-year recurrence interval has a 4 percent probability of being equaled or exceeded in any future year. A peak flow having a 2-year recurrence interval has a 50 percent probability of being equaled or exceeded in any future year. The greater the MRI, the lower the probability that the event will occur in any given year.

It is important to keep in mind that MRI does not indicate that events occur on a time schedule. MRI cannot be used to predict time of occurrence. Each event is independent of all others, so the chance that a 25-year peak flow will occur this year remains the same regardless of what flows occurred last year. The correct way to view MRI is that it predicts the average occurrence of events over an extended period of time. For example, a 25-year peak discharge is expected to be equaled or exceeded 4 times in 100 years.

Figure 1-4 lists the recommended MRIs for design of hydraulic structures. Based on past experience, these will give acceptable results in most cases. Occasionally the cost of damages may be so great, or the level of services using the roadway may be so important, that a higher MRI is appropriate. Good engineering judgment must be used to recognize these instances and the design modified accordingly. In high-risk areas a statistical risk analysis (benefit/cost) may be needed to arrive at the most suitable frequency.

Type Of Structure	**MRI (Years)[1]**
Gutters	10
Storm Drain Inlets – On Longitudinal Slope	10
Storm Drain Inlets - Vertical Curve Sag	50
Storm Drain Laterals	25
Storm Drain Trunk Lines	25
Laterals without Trunks	10
Ditches [2]	10
Standard Culverts - Design For HW/D Ratio	25
Standard Culverts - Check For High Flow Damage	100
Bottomless Culverts - Design For HW Depth	25 & 100
Bridges - Design For Flow Passage And Foundation Scour	100
Bridges - Check For High Flow Damage	500

1. See Chapter 4 of HRM for further guidance on selecting design storms.
2. More design guidance for roadside ditches can be found in section 4-3.

Design Frequency for Hydraulic Structures
Figure 1-4

1-5 Schedule

WSDOT has developed the Project Delivery Information System (PDIS) to track and manage projects. PDIS utilizes a Master Deliverables List (MDL) to identify major elements that occur during most projects. The MDL is intended to be a starting point for creating a work breakdown structure (WBS) and identifies specific offices the designer should communicate with during the development of the project schedule. Figure 1-5 summarizes estimated time requirements for hydraulic review, however times can vary depending on; staffing, project impacts and complexity of the project. Additionally this should not be a substitution for communication, before finalizing the project schedule, designers should verify time lines with the offices mentioned in the figure.

The design team should determine preparation time for a Hydraulic Report. Both the Region and HQ Hydraulic Offices can provide assistance if needed.

Report Type	Region Review	HQ Review	Description
A	8 weeks	4 weeks	Assumes Regional review and approval precedes HQ review and HQ is contacted when the Hydraulics Report is received for Region Review. The 8-week Region review includes 4 weeks for initial review, 2 weeks for designer changes and 2 weeks for final review. The 4 week HQ review assumes 2 weeks for initial review, 1 week for designer changes and 1 week for final review.
B	4 weeks	N/A	Assumes 2 weeks for initial review, 1 week for changes and 1 week for final review.
Supplement	4 weeks	4 weeks (only Type A)	Regional Hydraulics (and if a Type A Report, HQ Hydraulics) should be contacted as soon as it is determined a Supplemental Report is required.
Design Build	-	-	Coordinate with Field Operations Support Service Center (FOSSC), Region Hydraulics and HQ Hydraulics.

Hydraulic Report Review Schedule
Figure 1-5

More information on PDIS can be found at the following web site: (http://wwwi.wsdot.wa.gov/projects/PDIS/)

Appendix 1-1 - Conversion Table

English to Metric Conversions	English to English Conversions	Metric to Metric Conversions
Length		
1 inch = 25.4 millimeters 1 foot = 0.3048 meters 1 mile = 1.609 kilometers **1 yard = 0.914 meters**	1 mile = 5,280 feet 1 yard = 3 feet	1 centimeter = 10 millimeters 1 meter = 100 centimeters 1 kilometer = 100 meters
Area		
1 square inches = 645.16 sq. millimeters 1 square feet = 0.093 sq. meters 1 acres = 0.4047 hectares 1 square miles = 2.59 square kilometers	1 acre (acre ft) = 43,560 sq. feet 1 sq. mile = 640 acres 1 sq. mile = 1 section of land	1 sq. centimeter = 100 sq. millimeters 1 sq. meter = 10000 sq. centimeters 1 hectare = 10,000 sq. meters 1 square kilometer = 1000000 sq. meters
Volume		
1 ounce = 29.57 milliliters 1 gallon = 3.785 liters 1 cubic foot = 0.0283 cubic meters 1 acre-foot = 1,233.6 cubic meters	1 cubic foot = 7.48 gallons 1 acre-foot = 43,560 cubic feet	1 cubic centimeter = 1000 cubic millimeters 1 cubic meter = 1000000 cubic centimeters 1 cubic meter = 1000 liters
Flowing Water Rates:		
1 cubic foot/second = 0.0283 cubic meters/second 1 cubic foot/second = 28.32 liters/second	**1 cubic foot/second = 448.83 gallons/minute** **1 cubic foot/second = 0.646 million gal./day** 1 cubic foot/second = 1.984 acre-feet per day	
Pressure		
1 pound force = 4.45 Newtons 1 pound force/sq.in = 6.89 kilopascals 1 foot of water = 2.988 Kilopascals 1 atmosphere = 101.4 Kilopascals	1 foot of water = 0.433 pounds/square in. 1 foot of water = 62.4 pounds/square ft. 1 atmosphere = 14.70 pounds/square in. 1 atmosphere = 33.94 feet of water	
Mass		
1 ounces = 28.35 grams 1 pounds = 0.454 kilograms	1 ton = 2000 pounds	1 kilogram = 1000 grams 1 tonne = 1000 kilograms
Temperature		
°F = 1.8*°C + 32	N/A	N/A

Appendix 1-2 - Environmental Documentation

ENVIRONMENTAL DOCUMENTATION

PROJECT NUMBER AND TITLE:

ITEM #	DATE	LOCATION (MP)	DESCRIPTION	RESOLUTION	REFERENCES	OWNER	APPROVED BY

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) and both the project engineers professional civil 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

1.1.0 Site Location – Note the following: MP limits, Section, Township, Range and reference location from nearest city.

1.2.0 Vicinity Map – Include a vicinity map with the project location clearly shown. Whenever possible, highlight major landmarks, delineate water bodies and label cross streets.

1.3.0 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 is not necessary to discuss the overall purpose of the project unless it is pertinent to some of the decisions made during the design of the hydraulics features.

1.4.0 Areas Impacted – List the following total areas (in acres): New impervious surfaces, replaced impervious surfaces, total existing impervious surfaces, net new impervious surfaces (if applicable), total areas being converted from native vegetation to lawn or landscaped (if applicable).

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 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 post-construction activities. If needed, use photographs to describe the site. Identify any bridges within the project limits.

2.3 Existing Threshold Discharge Areas (TDA) – For each TDA within the project, provide a description of the general drainage systems and flow patterns. (See Chapter 4 of the *Highway Runoff Manual* for a detailed description of TDAs). Unusual or unique drainage patterns should be discussed. The TDA may extend beyond WSDOT right of way. These areas should also be part of the description. The designer should also list any Off-site flows. Each TDA description should list the eventual downstream water body. Maps delineating entire TDAs (i.e. beyond WSDOT right of way) should be included in the report appendices, as well as individual basin area calculations. This section should refer to where the basin information is located in the appendices.

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 and groundwater level, etc. for storm water BMP design.

2.5 Outfalls - An outfall can be any structure (man-made or natural) where stormwater from WSDOT highways is conveyed off the ROW. All outfalls should be noted here and entered into the Outfall Database. (If no stormwater outfalls leave WSDOT right of way, the designer should note that instead). Designers should follow the Hydraulic Staff Outfall Inventory Instructions and use the spreadsheet provided 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 Water Quality Team Lead at tvetenr@wsdot.wa.gov or 360-570-6648. http://www.wsdot.wa.gov/Environment/waterquality/ A copy of the spreadsheet should be included in the Hydraulics Report

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 Developed Conditions

3.1 Proposed Drainage Basins - Maps showing all TDAs and drainage basin areas significant to the project (including portions that are off WSDOT right of way) should be included in the report appendices along with all basin calculations. 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.

Drainage basin maps should show flow direction arrows and each drainage basin should be clearly labeled with the same label referenced to in the hydrologic and hydraulic calculations. When the change between existing and post construction conditions is important to the calculations, the maps should show both conditions, on separate maps if necessary for clarity. Maps should always be of an adequate and noted scale to allow reviewers to verify all basin calculations.

3.2 Design Standards

3.2.1 Design Frequency – Note the appropriate design frequencies used to size hydraulic features on the project and where applicable show calculations. Include a discussion of the climate and chosen precipitation values for the project, including copies Isopluvial and MAP maps highlighting the project location. Where applicable, discuss how or if snow was considered in the design. See Chapter 2 for further design guidance.

3.2.2 Stormwater Management Guidelines – State the stormwater management guidelines used for flow control, basic runoff treatment and enhanced runoff treatment (if applicable). Include a summary table noting the BMP and the project location (including structure note for each drainage feature), organized by alignment, drainage basin, station and offset and/or milepost. The table should

include threshold discharge areas (TDAs) specific pre-project and post-project pervious and impervious surface areas. Also note what percentage of the new (and "replaced" if applicable) impervious surface areas and retrofitted existing impervious surface areas are addressed for flow control and runoff treatment according to the stormwater management guidelines used for this report. Wherever possible, use the same structure note in the hydrologic and hydraulic calculations.

3.2.3 Other Requirements – Note any additional requirements used in the hydraulic calculations that differ or are in addition to those found in the Hydraulics and Highway Runoff Manual (such as local agency guidelines). Provide a list of References for the guidelines, manuals, basin plans, local agency code or technical documents used to develop the Hydraulics Report and where possible include a web link to the reference.

3.2.4. Level of Retrofit – Where any existing structure or facility is renovated to meet the changed conditions or improve performance. This percentage change needs to be quantified. An example would be: This project will provide <minimum> <____ % of a full retrofit> for flow control, and <minimum> <___ % of a full retrofit> for runoff treatment. Practicability is discussed __ in this report.

3.2.3.1 I-4 Stormwater Retrofits – Describe any stormwater retrofits on this project. This includes fish passage barrier removal issues.

3.2.3.2 Provide a brief discussion explaining for or against retrofitting (flow control and runoff treatment) for existing impervious surfaces. The discussion could include specific costs, right of way needs, sensitive area impacts and necessary BMP locations.

3.3 Pipe Alternatives – Note all acceptable pipe alternatives for the project and provide engineering justification for any alternatives that are excluded. See the Hydraulics Manual section 8-2 for further guidance.

3.4 Downstream Analysis – This section focuses on what impact, if any, a project will have on the hydraulic conveyance systems down stream 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. See Chapter 4 of this manual for further guidance on when a Downstream Analysis is required and what should be included in the report.

4.0 Hydrologic and Hydraulic Design – 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). Where applicable, it is recommended that the design be broken down into the sections noted on the next page. The

locations of the items on the next page should also be noted and where there are multiple locations, designers should consider using a table for clarity.

Calculations should include: tributary area quantities and assumptions dealing with equivalent area trading, the equations used for the actual numerical calculations, a discussion of what assumptions were made to perform the calculations and how the input parameters were determined. The calculations should always 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. Section 4-1 is a suggested order for the calculations.

Whenever possible calculation methodologies described in this manual should be followed including: figures from this manual, 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 prior to submitting the report. 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/eesc/design/hydraulics/downloads.htm)

4.1 Calculations – All calculations included in the report should be initialed as checked by an individual other then the person who prepared the report.

- 4.1.1 Flow Control BMPs
- 4.1.2 Runoff Treatment BMPs
- 4.1.3 Gutter Design
- 4.1.4 Sag Design
- 4.1.5 Enclosed Drainage Design
- 4.1.6 Culvert Design
- 4.1.7 Ditch Design
- 4.1.8 Special Stream Design
- 4.1.9 Flood Plain Mitigation
- 4.1.10 Bridge Scour Evaluation
- 4.1.11 Channel Changes
- 4.1.12 Downstream Analysis
- 4.1.13 Traffic Analysis Data (Design Year ADT)

5.0 Permits and Associated Reports

5.1 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 with culverts within the project limits. Note if fish surveys were conducted and what was

determined. Also note if there are any threatened or endangered species within the project limits.

5.2 Permits/Approvals – List any permits, variances or approvals required by local jurisdiction or resource agencies that are necessary to complete the project.

5.3 Easements – Note any drainage or slope easements that may be required for the project, noting whether the easement is for construction or maintenance. Highlighting and referencing the area on the attached plan sheets is helpful.

5.4 Additional Reports or Studies – Where applicable note other reports and studies conducted and prepared for this project. One example is the Geotechnical Report to note drainage related special studies needed for the project, including but not limited to soils tests, infiltration rates and well monitoring. Contact the Regional Hydraulics Engineer to determine which reports need to be included in the Hydraulics Report and which only need referencing.

6.0 Inspection and Maintenance Summary – Maintenance should be consulted prior to starting a project concerning any existing drainage problems or requirements including inlet spacing.

Appendix

A-1 Environmental Documentation – The purpose of this section is to document environmental decisions made during the design including; why decisions were made, who made them and note any references used. See Appendix 1-1-2 of the Hydraulics Manual for a copy of the spreadsheet.

Outfall Inventory Spread Sheet – See section 2-5 of this outline.

A-2 Basin Calculations and Plan Sheets – See section 4.1.2 in the Hydraulics Manual for more guidance.

A-3 Calculations and Program Output – Include all calculations used to create the Hydraulics Report including; Storm Shed, MGS Flood, Inlet Calculation Spreadsheets, Sag Analysis, etc. All calculations should be clearly labeled with a file name and initialed as being checked by an individual other than the one who prepared the report.

A-4 Drainage Plan Sheets, Details, and Structure Notes. – 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 Plan Sheets

A-6 Roadway Cross Sections and Profiles

A-7 Misc. Contract Plan Sheets – Include any plan sheets that will aid the reviewer to completely understand the project, this may include utility plan sheets.