HYDRAULIC DESIGN REPORT TEMPLATE

MODULE 11 - HEATHER PITTMAN, P.E.

SEE APPENDICES FOR ATTACHMENTS
Heather Pittman, PE

Fish Passage Design Manager
Headquarter Hydraulics
WSDOT

Current duties: Oversee and manage fish passage projects in the Olympic Region and assist in updating fish passage policy.

Background & Experience: Heather started at WSDOT after graduating college in 2008 as a Transportation Engineer 1 in the Mount Baker Area. After several stormwater designs, she was able to move to the Headquarters Hydraulics office in 2013 through an in-training opportunity to learn how to do stream design and eventually became a fish passage design manager. As part of the Headquarters Hydraulics Office, Heather has designed several fish passage corrections, assisted with materials acceptance and placement during construction, reviewed hydraulic design reports, and worked with permitting agencies and the Tribes to find fish passage solutions that meet everyone’s needs.

Education: Michigan State University, May 2008, BS in Civil Engineering

Personal interests: Heather lives in Lacey with her husband, son and cat. She enjoys playing games, going for walks, and knitting.

Hydraulic Design Report Template

This module will inform Fish Passage designers, inspectors, engineers, biologists, geologists and other practitioners on how to take information from previous modules and integrate it into the preliminary and final hydraulic design report. Each section of the hydraulic design report template will be covered along with expectations of those sections and previous lessons learned.
Fish Passage and Stream Restoration Training
Hydraulic Design Report Template

Heather Pittman, PE
Fish Passage Design Manager-Olympic Region

Abbreviations

- SR = State Route
- MP = Mile Post
- WDFW = Washington Department of Fish and Wildlife
- PHD = Preliminary Hydraulic Design
- FHD = Final Hydraulic Design
- PEO = Project Engineering Office
- ESO = Environmental Services Office
- HQ = Headquarters
- LWM = Large Woody Material
- QC = Quality Control

Overview

- Brief overview of the goals & audience
- Brief overview of template history
- Expectations of each section of the PHD/FHD
- Examples of what is expected
Main Goals of PHD Process

- Bankfull Width
- Minimum Hydraulic Opening
- Preliminary Channel Geometry
- Preliminary Channel Shape
- LWM Layout
- Sediment
- Achieve agreement on the above with Tribes, Resource Agencies

Document Audience

- Audience
  - Biologists
  - Hydraulic Engineers
  - Habitat Engineers
  - Highway Engineers
  - Geotechnical Engineers
  - Structural Engineers
  - Permitting staff
  - Contractors

A Brief History

- PHD began as a memo in 2013 called a PBOD “Preliminary Basis of Design”
- Around 2015 made change from memo form to report form
- Name change from PBOD to PHD late 2017/early 2018
- Minor template updates periodically adding additional information
- Major Template Update 2020
Writing the PHD/FHD

- All design decisions documented
- All constraints documented
- Clear how the guidance and requirements are met
- Any recommendations/requirements clear
- If no structure recommended or obvious, both a bridge and culvert LWM design included
- How does the design help the species expected to use it?

Writing the PHD/FHD

- Newest Template to be followed
- All Table of Contents updated
- All map figures have scale bar and north arrow
- Table/Figure numbers updated
- No bookmark errors
- Footers updated
- "Draft" Watermark
- All Figures legible and of a high enough resolution

Writing the PHD/FHD

- Template general instructions
- Template section instructions

General Template form (Version 10/21 June 2021)

The Table/figure numbers in this document are italicised. If any new Table/figure are added, it is recommended to follow the same format as updating a slide. The table and figure numbers in the text can be updated automatically.

Version 2.79

A draft copy should also be highlighted in both the PHD and FHD. This is for a draft. Drafts with highlights are instructions that are to be completed prior to turning in the final version of the document.

Revision to this document will be made upon request in consultation with WSDOT WRC. The content of this template is to be maintained. A summary note for fish passage projects can be found in the review of the document written for the Tribes and WSDOT. Changes made to the document may warrant a template update.

Both the PHD and FHD should be submitted at the end of the project.

Rounding to the nearest 10', as is the level of accuracy desired for all elevations, times, velocities, etc.
**Cover Page**

- Title correct
- Names updated
- Lower corner title updated
- Cover photo shows water in creek channel

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**Introduction**

- Fill in the yellow highlights
- Explain what design strategy was used and why
- Structural Dimensions
- Vicinity Map showing the:
  - North Arrow
  - Project Location
  - Location in state
  - Distance to nearest city/town
- Any design deviations
- Whether a structure type is recommended
Watershed & Site Assessment

- Covers background info:
  - Watershed & Landcover
  - Geology & Soils
  - Floodplains
  - Site Descriptions
  - Fish presence & Wildlife
  - Site Assessment
  - Geomorphology

Watershed & Landcover

- Size and location of watershed
- Major tributaries
- Topography
- Land Cover
- Prevailing land uses
- Include a watershed/landcover map

Geology & Soils

- Soils (if relevant) and geology
- Sources for any information gathered
**Floodplains**

- Mapped Floodplain?
- History of flooding (Extents/Frequency)
- Cite sources of information

![Floodplains Image]

**Site Description**

- Barrier status and impact to fish life
- Is the crossing a failing structure or CED
- Maintenance/Repair history
- Total length of habitat gain

![Site Description Image]

**Fish Presence in Project Area**

- Species identified
- Sources
  - Spawner Surveys
  - WDFW Fish Passage Database
  - RSFS data
  - Scoping Reports
  - Scoping bio
**Wildlife Connectivity**

- HQ Hydraulics does not make the decision to increase structure size
- Section was added because it can impact minimum opening/channel design
- PHD Documentation
  - Indicate the route priority
  - If any design decision has been made, state here

**Site Assessment**

- Data Collection
- Existing Conditions
- Fish Habitat
  - Character/Quality
- Geomorphology

**Data Collection**

- Date of site visit(s) and survey
- People/agencies on site visit
- Survey extents
- Field report summarized
- Field report referenced in Appendix B
- Reference to bankfull widths in 2.8.2
**Existing Conditions**

- Structure description
- As-builts
- Stream conditions
- Signs of maintenance activity
- Impact on fish life
- Photographs!

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- As-builts
- Stream conditions
- Signs of maintenance activity
- Impact on fish life
- Photographs!
Existing Conditions

Figure 18: Record Drawing for Existing Winter Creek Crossing - Plan View.

Family Conditions

Figure 19: Record Drawing for Existing Winter Creek Crossing - Elevation.

Fish Habitat Character & Quality

- Describe habitat character and quality
- Highlight any important features for rearing and spawning
- Which species/lifestages likely to use
- Describe Hankin & Reeves channel type, wetlands, estuary function, tidal influence, etc
**Geomorphology**

- Reference Reach
- Channel Geometry
- Sediment
- Vertical Stability
- Channel Migration
- Riparian Conditions

**Reference Reach Selection**

- Explain why reach is appropriate
- Clearly identify location
- Include photographs of reference reach
**Channel Geometry**

- Describe channel planform and cross section
- Reference reach slope and slope to be used for design
- Bankfull width and any agreements
- Photographs of bankfull
- Identify bankfull locations
- Survey sections
Sediment
• Location and method of sediment sample
• Sediment distribution
• Any boulders/large cobbles described
• Photographs of sediment or boulders

Vertical Channel Stability
• Long profile included
• Sediment supply in watershed discussed
• Potential for aggradation/degradation qualified
• Location & Description of grade controls

Vertical Channel Stability
**Vertical Channel Stability**

- Channel migration zone described (if applicable)
- Sinuosity described
- Channel erosion related to migration described
- Level of risk associated with migration (low or med/high)
- Floodplain flow paths explained

**Riparian Conditions, Large Wood, Other Habitat Features**

- Vegetation described
- Large wood described and quantified
- Other channel forming features described
Hydrology & Peak Flow Estimates

- Describe methodology
- Reason selected methodology appropriate
- Flows to be used
- Level of accuracy or uncertainty captured
- Summer low flow conditions known?
- Do not include the High and Low fish passage design flows

Hydraulic Analysis and Design

- Documentation of Hydraulic Analysis and Design
- Much of the Hydraulic Analysis portion covered in the Modelling with SRH 2D Module

Model Development

- Section should contain enough information to recreate the model
Topographic and Bathymetric Data

- Where was data obtained from
- When was data collected
- What is the datum
- Key topographic features and structural controls described

Model Extent and Computational Mesh

- Domain limits
- Reasoning for limits
- Limits appropriate
- Total area mesh covers/min number of elements
- Figures showing proposed and existing mesh limits

Materials/Roughness

- How was each manning's determined
- Figure(s) showing location of manning's areas
**Boundary Conditions**

- Describe boundary conditions
- Geometric data for culverts
- Any other conditions i.e. pressure flow
- Discharge values
- Figure showing BCs, culverts, pressure boundaries, etc
- Table or screenshot of HY-8 input
- All data needed to recreate conditions

**Model Run Controls / Assumptions**

- Model Run Controls
  - Start Time
  - Time Step
  - End Time
  - Initial Condition
  - Flow (if defaults not used)
- Model Assumptions
  - Assumptions
  - Limitations
  - Or state none

**Existing Conditions Model Results**

- Figure showing cross section locations and alignment
**Existing Conditions Model Results**

- Cross sections need to show
  - 2-year
  - 100-year
  - 500-year
- Should be taken at representative locations
- Can also be included in appendix

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**Existing Conditions Model Results**

- Alignment with Stationing
- Average Hydraulic Results for Existing conditions

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**Existing Conditions Model Results**

- Longitudinal profile with
  - 2-year
  - 100-year
  - 500-year
Existing Conditions Model Results

- Existing conditions velocity map with 100-year flow & cross section locations
- Whether overtopping occurs
- Table with cross section information

<table>
<thead>
<tr>
<th>Location</th>
<th>Flow Rate</th>
<th>Cross Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location 1</td>
<td>120</td>
<td>Section A</td>
</tr>
<tr>
<td>Location 2</td>
<td>150</td>
<td>Section B</td>
</tr>
<tr>
<td>Location 3</td>
<td>180</td>
<td>Section C</td>
</tr>
</tbody>
</table>

Natural Conditions Model Results

- Required to determine FUR
- All the same requirements as Existing Conditions Model plus 2080 Projected
- This model requires some assumptions on historical conditions

Channel Design

- Floodplain Utilization Ratio
- Channel Planform & Shape
- Channel Alignment
- Channel Gradient
- Design Methodology
Floodplain Utilization Ratio

- Explain how FUR Calculated
- Clearly state value
- State whether system is confined or unconfined

Channel Planform & Shape

- How was channel shape determined
- Channel shape should have low flow benches or an explanation on why they do not
- Performance expectation of channel section

- Proposed cross section shown along side reference reach (if possible)
**Channel Alignment**

- Grading limits discussed
- Any constraints restated and any design impacts stated
- Is the channel sinuosity similar to what would be expected?
- Can sharp bends in and out of structure be eliminated?

**Channel Gradient**

- Slope ratio identified
- If not within 25% of reference reach, reason given
- Long-term degradation expected?
- Long-term aggradation expected?
- Is there a reason to constrain degradation?

**Design Methodology**

- Methodology clearly identified
- Reason for method explained
- See WSDOT Hydraulics Manual Chapter 7 for more information

- FUR < 3
  - Stream Simulation
  - Confined Bridge

- FUR > 3
  - Unconfined Bridge
Future Conditions Model Results

- Figure showing cross section locations and alignment

Future Conditions Model Results

- Cross sections need to show
  - 2-year
  - 100-year
  - 500-year
  - 100-year 2080 projected
- Should be taken at representative locations
- Can also be included in appendix
- All the other same elements as Existing Conditions
- Need to show floodplain velocities

Water Crossing Design

- Structure Type
- Minimum Hydraulic Opening
- Freeboard
- Bed Material
- Channel Complexity
**Structure Type**

- Whether or not a structure type is recommended or assumed
  - High risk for long term degradation
  - High risk for aggradation
  - High risk for lateral migration
  - Extremely deep fill
  - Other reasons

**Minimum Hydraulic Opening Width and Length**

- Opening size rational explained appropriately
- Factor of safety or velocity ratio stated
- Climate Resilience was addressed
- Velocity tables updated
- Are there any length limitations on the recommendations?

**Freeboard**

- Minimum requirement clear
- Additional recommendations clear
- If freeboard is not able to be met, clearly stated why
Bed Material

- Methodology chosen to determine size (if not pebble count, why)
- Describe when D50 and D84 are mobile
- Table comparing existing and proposed
- Are we within 25% of D50, if not, why

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<th>Proposed Material Diameter (inches)</th>
<th>Observed Material Diameter (inches)</th>
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<td>0.75</td>
</tr>
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</tr>
<tr>
<td>D12.5</td>
<td>0.7</td>
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<td>D6.6</td>
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Table 1: Comparison of observed and proposed streambed material

Channel Complexity

- Describe channel planform expected
- Recommendations for non-LWM Structures for complexity
- Any low flow considerations
- Fish stranding risks
- Clearly state how fish will use the habitat
- Pre-approval obtained for anything not in the HM or other WSDOT guidance

Channel Complexity

- How key pieces/volume compare to Fox & Bolton
- What flows is the mobile wood mobile at
- Anchoring anticipated?
- Any special considerations for LWM/Structural interactions
- If structure type unknown, then two scenarios to be shown
**Floodplain Changes/Storage**

**Floodplain Changes**
- Any changes to the floodplain noted in this section

**Floodplain Storage**
- Quantify changes
- Any risks to infrastructure noted
Water Surface Elevations

- WSE Changes noted
- Any risks explained in relation to WSE impacts
- Graphic depicting changes

Climate Resilience

- Recap of any changes made to the design as a result of climate resilience
- Explanation as to why Climate Resilience was not incorporated in cases where it is not practicable
- If no changes were necessary, note that
- Fill in the yellow highlights

Scour Analysis

- Different between PHD & FHD
- Green Highlights PHD only
- Pink Highlights FHD
**Lateral Migration**

- PHD
  - Low risk or med/high risk?
  - Dependent on structure?

- FHD
  - Any countermeasures?
  - Risk to structure itself
  - If countermeasures only needed if structure not designed to scour, state
  - Discuss for each abutment/pier

**Long-term Aggradation/ Degradation**

- PHD
  - Describe risk
  - Conceptual level (3-5ft)
  - Sediment Tree relevance
  - If additional info necessary to determine

- FHD
  - Describe risk
  - Quantify

**Other Scour**

- All quantified at FHD
- Contraction Scour
- Abutment Scour
- Local Scour
- Bend Scour
- Scour summarized in table with final elevations and where those elevations are
References

Update the Reference List.

Appendix A – FEMA Floodplain Map

Appendix B – Hydraulic Field Report Form

- Attach most recent version of report
- Reference it in the existing conditions
- Info in report should match field report
Appendix C – SRH 2D Model Results

Appendix D – Streambed Material Calculation

- Backup of sediment mobility calculations
- Graph showing the Pebble Counts vs Proposed Mix

Appendix E – Stream Plan, Profile, & Detail Sheets

- All elements in checklist
- Clearly depict what is required
- Clearly depict what the minimums are
- Clearly depict what is not required
- These are not rough drafts
Stream Plan with LWM

LWM Details

LWM Details
QC of PHD

- Author needs to:
  - Make sure all checklist elements addressed
  - Verify all appendices are attached and readable
  - PHD has been reviewed by a peer or company QC process
  - Any design deviations have already been discussed with HQ Hydraulics

Summary

- Summarizes all design elements
- Values
- Location in Report
- Check bookmarks
- Enter all values

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<td>Y/N</td>
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Day 3  
Fish Passage and Stream Restoration Training