Checklist corresponds with Hydraulics Report Template v2022-10

General Format

Table of Contents, Figures, and Tables updated

All Figures that require a North Arrow, Flow Arrow, and Scale Bar have them

All Figure numbers have been updated in the text

All Table numbers have been updated in the text

No bookmark errors

All highlighted text deleted

Footers updated

Draft watermark

PDF created with bookmarks of headings, so reader can quickly jump between sections

Cover Page

SR/MP/Creek Title Correct

Cover photograph shows water in the creek channel

Names updated

Lower right corner title/date/etc. updated

Lower left corner submittal type selected from drop down

FPT number for all authors (Julie Heilman’s is FTP20-00157)

# Introduction

WDFW ID number correct

Milepost and State Route correct

WSDOT region correct

LF habitat gain listed

Brief description of what design method was used and why

General location described

Existing structure type, length, dia./width described

Minimum hydraulic opening stated

Any design deviations are described

Any structure recommendations described or stated that there are none

Vicinity Map included

# Watershed and Site Assessment

## Site Description

Current reason for barrier status and how does this negatively affect fish habitat

Is the crossing a CED/Failing Structure?

Maintenance/Repair history (frequency, nature of problem/repairs)

Is there any flooding history of the site, surrounding area, what is the extent?

Total length of habitat gain

## Watershed and Land Cover

Size and location of watershed

Major tributaries described

Topography described

Watershed map included

Land cover/land uses table and figure included

## Geology and Soils

Geology and soils and their relation to the watershed described

Sources for information described

If quality of data is sufficient and relevant, discussion how they influence the design

Reference to the Geotechnical Scoping memo

## Fish Presence in the Project Area

Native fish species table filled out

Available data described along with accuracy and completeness

## Wildlife Connectivity

Priority described

## Site Assessment

### Data Collection

Date of site visit(s) and survey

State whether a site visit occurred with WDFW/Tribes

Survey extents described

Field report summarized and placed in Appendix

Summary of data collected (number of bankfull widths, pebble counts, etc.). Refer reader to Section 2.7.2 for bankfull width measurements and Section 2.7.3 for pebble counts.

Figure illustrating locations of bankfull widths, pebble counts, and reference reach included

### Existing Conditions

Existing structure described (size, type, gradient, condition, alignment, fill depth, relevant history, any drop height at inlet/outlet, size of scour pool, etc.).

State whether as-builts were obtained

Stream conditions upstream and downstream described

Signs of maintenance activity described

How the existing conditions are impacting fish life

Photographs of the existing conditions provided (inlet, outlet, upstream, downstream, habitat features, etc.)

### Fish Habitat Character and Quality

Fish habitat and quality described in the vicinity of the crossing

Important habitat related features highlighted (gravels, pools, wood, riparian cover).

What species and lifestages are likely using the habitat features adjacent to the crossing

Describe type of fish use anticipated in the vicinity of the crossing (spawning, rearing, or migrating)?

Channel type and any associated wetlands, estuary function tidal influence, etc.

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

Vegetation described, including discussion of anticipate possible future tree recruitment

Large wood in the system quantified and described (amount, function, etc.)

Other channel forming features described

Beaver activity or potential for beaver activity discussed

## Geomorphology

### Reference Reach Selection

Reference Reach rationale explained and follows WSDOT HM detailed process for how to properly select a reference reach.

Reference Reach location described in detail

Photographs of reference reach

Reference to figure within Section 2.6.1 showing location of reference reach

Description of reference reach location good enough that you could find it?

### Channel Geometry

Channel planform description

Channel cross section description

Reference reach slope and what is the slope that should be used as a comparison for design

Bankfull width to be utilized for design & minimum structure size, if different, explained why

Bankfull width that is agreed upon by WSDOT/WDFW/Tribes

Stream width: depth ratio, and channel evolution stage

Photographs of where bankfull width was measured that clearly depict channel shape

Survey sections of the existing channel in a representative reach (state where data is from)

Bankfull width measurement table completed

#### Floodplain Utilization Ratio

Explained how the FUR was calculated

Clearly illustrate FUR measurement locations

FUR was taken at an appropriate location

Clearly stated what the FUR is

Stated whether system was confined or not confined

### Sediment

Location and method of sediment sample described (minimum 3 unless otherwise justified)

Sediment size distribution described and illustrated in figure

Sediment size table completed

Any boulders described and whether or not they are mobile

Photographs of sediment and boulders

### Vertical Channel Stability

Long profile included with sources and quality of sources. Label crossing, other crossings, significant grade control features (e.g. competent bedrock), assumed base-level control, and reach average slopes. Illustrate equilibrium slopes on figure, to assist in evaluating long-term degradation. Illustrate in more detail in Section 7.2.

Degradation discussion brief in this section, refer to Section 7.2 for detailed analysis. Detailed discussion and analysis for long-term degradation should be in Section 7.2.

Sediment supply in the watershed discussed

Potential for aggradation quantified (range)

Location and description of any existing grade controls, and their anticipated stability

### Channel Migration

Channel migration zone described

Sinuosity described

Channel erosion related to migration described

Level of risk associated with channel migration

Floodplain flow paths described if they exist

# Hydrology and Peak Flow Estimates

Describe methodology used to determine peak flows

Reason methodology used is most appropriate

Clearly shows which flows are to be used (Table filled out, bold method selected)

Level of accuracy/uncertainty in calculations (if possible)

Discussion of any field verification/validation of modeled conditions

Are summer low flow conditions known?

High and Low Fish Passage Design Flows (Appendix G of WCDG) **not** included

Projected 2080 100-year percent increase and flow identified

# Water Crossing Design

All highlights filled in

## Channel Design

### Channel Planform and Shape

Channel shape explanation

Channel benches and if not an explanation as to why benches are not appropriate

Proposed cross section shown superimposed over reference reach cross sections

Performance expectation of the channel cross section as compared to the adjacent reaches

Was a meander belt amplitude assessment considered?

### Channel Alignment

Length of grading, horizontal alignment, and sinuosity described

Constraints identified

### Channel Gradient

Slope ratio identified and within 25% of reference reach

If not within 25%, explanation of why

Is long-term degradation or aggradation expected (quantified if so?)

If long-term degradation is a risk, is there a reason to constrain it?

## Minimum Hydraulic Opening

### Design Methodology

Design methodology clearly defined

Reason for design methodology clearly discussed

### Hydraulic Width

Width size rational explained adequately

Climate Resilience was addressed

Velocity tables updated

### Vertical Clearance

Minimum required freeboard clear

Additional freeboard requirements clear (for debris/aggradation/climate change)

Maintenance clearance clearly states whether required or recommended

If freeboard is not able to be met, clearly stated why

Vertical clearance summary table filled in. Including recommended vs required low chords.

### Hydraulic Length

Select one of two pre-written options and fills in hydraulic yellow highlights.

### Future Corridor Plans

States whether long-term plans are anticipated.

### Structure Type

Clearly stated whether a structural recommendation was made if so, why

## Streambed Design

### Bed Material

Methodology chosen to determine size (if not pebble count, why)

Describe when D50 and D84 are mobile and method used for assessing stability

Table comparing existing and proposed

Are we within 20% of D50, if not, why

### Channel Complexity

#### Design Concept

Channel planform that is expected to form

State total length of proposed stream grading (including channel length within structure)

List 75th percentile LWM targets for: # of key pieces, total # of pieces, and wood volume

List of proposed LWM (# of key pieces, total # of pieces, and wood volume) for two concepts (buried structure and bridge). Only need one if recommending a specific structure type.

Describe how key pieces and volume compare to Fox & Bolton for each of the two concepts (only one if requiring a bridge).

What flows are the mobile wood mobile at

Recommendations for non-lwm structures for complexity (pools, bars, etc.)

2 scenarios shown if no structural recommendation is made and a buried structure could be used. Clearly label proposed log sizes in figures.

Anchoring anticipated?

Special considerations for LWM/Structure interactions

Any low flow considerations/fish stranding risks identified

Fish use clearly identified on how they will use the habitat

Layouts in figure

Pre-approval obtained for anything not in the HM guidance

Conceptual Restoration figure for PHD. FHD to include detailed plan and sections. FHD to also include text describing restoration efforts and their objectives (erosion control, bank stability, etc.).

# Hydraulic Analysis

## Model Development

### Topographic and Bathymetric Data

Where the topography/bathymetric data was supplied from

When was the data collected?

What is the datum?

Key topographic/structural controls discussed

If LiDAR was used, it should be described

### Model Extent and Computational Mesh

Upstream and Downstream Domain Limits for existing and proposed (if different)

Reason limits were chosen

Limits are far enough away not to influence results

Total area mesh covers, minimum number of elements (rect + triang)

Figures showing existing and proposed mesh limits

### Material/Roughness

Describe each Manning’s n value used

Figure showing where the Manning’s n values are (two figures if existing/proposed different)

Describe how LWM was modeled in both existing and proposed conditions

### Boundary Conditions

Boundary Conditions described

Geometric data for culverts described

Any other boundary conditions described (pressure flow)

Discharge values

Figure showing all BCs, labeling any culverts, pressure boundaries, etc.

Table or screenshot of inputs for Linear BC or HY-8

All data included to recreate boundary conditions/rating curves

### Model Run Controls

SRH-2D model control (Start Time, Time Step, End Time, Initial Condition, Flow (if defaults not used)

State whether the model reached a stable steady state result

### Model Assumptions and Limitations

Assumptions listed, states no assumptions if there are none

## Existing Condition

Figure showing location of cross sections and alignment stationing used for results reporting

Average Hydraulic Results for Existing Conditions

Longitudinal Profile with 2-year, 100-year, 500-year

Existing conditions velocity map with 100-year flow & Cross section locations

Existing conditions channel and floodplain velocities filled out

Whether overtopping occurs, if so, when and does it match with maintenance records?

## Natural Conditions (if applicable)

Figure showing location of cross sections and alignment stationing used for results reporting

Average Hydraulic Results for Natural Conditions

Longitudinal Profile with 2-year, 100-year, 500-year, 2080 100-year

Natural conditions velocity map with 100-year flow & Cross section locations

Natural conditions channel and floodplain velocities filled out

## Proposed Conditions

Figure showing location of cross sections and alignment stationing used for results reporting

Average Hydraulic Results for Proposed Conditions

Longitudinal Profile with 2-year, 100-year, 500-year, 2080 100-year

Proposed conditions velocity map with 100-year flow & Cross section locations

Proposed conditions channel and floodplain velocities filled out

# Floodplain Evaluation

Is the roadway in a mapped floodplain?

## Water Surface Elevations (PHD only)

WSE changes described and where 100-yr existing and proposed WSEs converge

Risks to properties/infrastructure further explained

Profile depicting changes (100yr existing and proposed WSE)

Plan view depicting changes. Label existing inlet and outlet, FEMA zones (if applicable), and parcels.

# Scour Analysis

Identify what data is available and being used for the scour analysis (geotechnical scoping memorandum or data package, final geotechnical report, etc.)

State the assumed structure geometry (minimum hydraulic opening, structure free zone, or final structure) used for the scour calculations.

Evaluated all flows up to the scour design flood and scour check flood to determine the deepest depth of scour for each scour component. Documented the flow that causes the maximum depth of scour for each scour component for the scour design flood and scour check flood

## Lateral Migration

*At the PHD stage, the risk to lateral migration in relation to the structure is assumed to occur (i.e. not a low risk) unless detailed geotechnical data (i.e., competent bedrock, geotechnical evaluation for soil erodibility, stream power vs. soil erodibility, etc.) is available to support the assessment of no lateral migration is anticipated over the life (75+ years) of the proposed structure(s).*

Are any scour countermeasures recommended at the various infrastructure components? If so, mention in this section and refer to Section 8 for more detailed description and analysis.

## Long-term Degradation

Long-term degradation estimated, state what geotechnical data was used for the analysis and whether additional information is needed to refine estimate as design progresses.

Describe methodology used to determine anticipated long-term degradation and how the base-level control was determined.

Provide figure showing existing grade, proposed grade, equilibrium slope, base-level control, other significant features and how long-term degradation was measured at various locations.

## Contraction Scour

Described type of contraction scour (clear-water or live-bed) and how much is anticipated for the scour design flood and scour check flood.

## Local Scour

Described type and amount of local scour (e.g., pier scour, bend scour, abutment scour, etc.) for scour design flood and scour check flood.

For each type of applicable local scour, include description of which infrastructure component (e.g., left/right, upstream/downstream abutment foundation, left/right, upstream/downstream walls, etc.) the local scour should be applied to.

## Total Scour

Total scour quantified for each infrastructure component (e.g., left/right, upstream/downstream abutment foundation, left/right, upstream/downstream walls, etc.).

At the structure free zone and final structure phases, documented the coordination with the Project Office, HQ Geotechnical and HQ Bridge to ensure the provided depths of total scour are being correctly applied to determine the total scour elevations at each infrastructure component.

# Scour Countermeasures

Scour countermeasures should not encroach within the minimum hydraulic opening unless there has been additional coordination and acceptance from WDFW and Tribes and is documented in Section 8 .

Scour countermeasures are required if key piece LWM are proposed or accumulation of LWM is anticipated inside the crossing structure.

PHD to document preliminary extents for proposed scour countermeasures to facilitate discussion. Including plan view extents and typical section.

FHD to document details on the countermeasure design (final typical section, sizing, and extents) and calculations.

# Summary

Describe and document any hydraulic commitments made throughout PHD/FHD review process

Summary Table Updated

Appendices

No appendices deleted to maintain appendices lettering of template. Okay to leave an appendix blank if not used.

Appendix A: FEMA Map

FEMA Floodplain Map (if in floodplain)

Appendix B: Hydraulic Field Report Form

Hydraulic Field Report Form

Appendix C: Streambed Material Sizing Calculations

Mobility Calculated

Combined Gradation

Pebble Counts Compared to Proposed Gradation

Appendix D: Stream Plans Sheets, Profile, Details

D1. Existing Conditions Plan

North Arrow Shown

Scale Bar Shown

Legend contains all line types/symbols shown on plan (no items in legend that are not in plan sheet)

Linetype text and callouts are masked where overlapping with other lines

Stream labeled and flow direction shown

Line Types shown and appropriately scaled for the sheet:

Existing Contours

Stream Alignment (starting downstream with stationing)

Roadway features

Roadway or right of way alignment

Existing culvert

Existing stream lines

Existing wetland lines

Proposed Alignment shown (no other proposed stream features)

Existing Culvert labeled with type/size

Existing Relevant Hydraulic Features labeled (fishways, lwm, etc.)

D2. Proposed Conditions Plan

North Arrow Shown

Note: “PRELIMINARY – NOT FOR CONSTRUCTION” at bottom of sheet.

Scale and position same as Existing Conditions Plan

Scale Bar Shown

Line Types appropriately scaled for the sheet

Stream labeled and flow direction shown

Legend contains all line types/symbols shown on plan (no items in legend that are not in plan sheet)

Linetype text and callouts are masked where overlapping with other lines

Stream labeled and flow direction shown

Proposed Alignment shown and labeled (stationing begins at downstream end)

All line types oriented right-side-up

Cut and fill lines shown

Within Cut & Fill Lines:

Line Types shown and appropriately scaled for the sheet:

No existing features or contours shown

Begin/End Stream Grading with stationing and alignment name

Stream Slope Breaks shown and labeled

Minimum Hydraulic Opening Clearly Identified (MHO)

Slopes between MHO and cut hatched with note “To be determined by others”

Outside Cut & Fill Lines:

Line Types shown and appropriately scaled for the sheet:

Existing Contours (or proposed + existing if roadway drastically different)

Roadway features

Roadway or right of way alignment

Existing culvert

Existing stream lines

Existing wetland lines

Existing Relevant Hydraulic Features labeled (fishways, lwm, etc.)

Note: “EXACT STRUCTURE TYPE, SIZE, LOCATION, AND WALLS TO BE DETERMINED”.

Note: “GRADING LIMITS SHOWN ARE FOR ILLUSTRATION PURPOSES ONLY. FINAL LIMITS TO BE DETERMINED BASED ON FINAL STRUCTURE, TYPE, SIZE, AND LOCATION”.

D3. Profile

Datum Shown

Note: “PRELIMINARY – NOT FOR CONSTRUCTION” at bottom of sheet.

Vertical/Horizontal Stations and Elevations shown

Alignment named “EN LINE PROFILE” as example if stream alignment “EN LINE”

Elevations line up with grid lines

Whole Stations line up with grid lines

Profile extends beyond proposed stream grading limits ~100 ft upstream and downstream

Use vertical and horizontal scale that utilizes the majority of the sheet

label significant existing grade control features and whether they are to remain or be removed

Existing ground shown through the proposed section

Roadway Centerlines Identified

Approximate structure location shown

Section limits clearly labeled at the top of the sheet that correspond/match detail sheets

Channel slope identified

Bid Items Correct/Shown over correct stationing (Quantities may not be known)

Minimum Thickness of Bed Material shown

Begin/End Channel Grading called out with station, elevation and “Match Existing”

Note: “SEE SPECIAL PROVISION “AGGREGATES FOR STREAMS, RIVERS, AND WATERBODIES” FOR STREAMBED MATERIAL AND MATERIAL LIFTS

Note: “MATERIAL DEPTH IS APPROXIMATE. FINAL DEPTH TO BE DETERMINED FOLLOWING SCOUR ANALYSIS.”

Note: “EXACT STRUCTURE TYPE, SIZE, LOCATION, AND WALLS TO BE DETERMINED”.

D4. Detail Sheets

Note: “PRELIMINARY – NOT FOR CONSTRUCTION” at bottom of sheet.

Note: “SEE SPECIAL PROVISION “AGGREGATES FOR STREAMS, RIVERS, AND WATERBODIES” FOR STREAMBED MATERIAL AND MATERIAL LIFTS

Note: “FROM XX XX+XX.00 TO XX XX+XX.00, EVENLY TAPER SECTION X TO MATCH EXISTING CHANNEL.” For both begin/end construction.

Note: “MATERIAL DEPTH IS APPROXIMATE. FINAL DEPTH TO BE DETERMINED FOLLOWING SCOUR ANALYSIS.”

Note: “SLOPES SHOWN OUTSIDE OF THE MINIMUM CHANNEL SECTION ARE FOR ILLUSTRATIVE PURPOSES ONLY TO DEPICT ESTIMATED AREA OF POTENTIAL IMPACT. FINAL AREAS OF IMPACT TO BE DETERMINED PENDING GEOTECHNICAL AND STRUCTURAL INVESTIGATION, STRUCTURE TYPE, AND STRUCTURE LOCATION.”

Each Section:

Sections scalable

Sections named (Convention is Section A, B, C, etc.)

Station Limits of each Section Identified (should match profile)

Creek CL Called out and labeled same as alignment in plan

Minimum Hydraulic Opening clearly labeled

Existing/Finished ground called out

“Match Existing” labeled where finished grade meets existing

All break line dimensions shown

All slopes labeled

Varies includes ranges

Construction “wedges” shown (Angle of repose, typically 1:1 that connects bottom of streambed material to top of streambed material)

Hatch area between minimum hydraulic opening and match existing in the area that is “To Be Determined” and label as “Estimated area of potential impact”

In area of “TO BE DETERMINED” Note “TO BE DETERMINED, X:1 SHOWN, SEE NOTE X”

Minimum material thickness identified

Minimum Thickness of Bed Material shown

Begin/End Channel Grading called out with station, elevation and “Match Existing”

Appropriate notes referenced

Appendix E: Manning’s Calculations If needed to support values chosen

Appendix F: Large Woody Material Calculations

LWM density and volume calculations based on stream grading length (including within structure)

LWM stability calculations (FHD only)

Appendix G: Future Projections for Climate-Adapted Culvert Design

Printout of WDFW projections report for watershed

Appendix H: SRH-2D Model Results

Plan views of existing, natural, and proposed WSEs, depth, velocity, and shear. Include stationing.

Profiles of existing, natural, and proposed showing all modeled flows.

Cross sections of existing, natural, and proposed at all locations where section results are summarized within the report.

Stationing between plan views, figures, and sections should match. Stationing may vary between existing, natural, and proposed especially if the channel was realigned.

Appendix I: SRH-2D Model Stability and Continuity

Plan view of existing, natural, and proposed illustrating locations of monitor lines and points.

Monitoring point plots (Y=WSE and X=time) for each model simulation, minimum 3 monitor points

Monitoring line plots (Y=flow and X=time) for each model simulation, minimum 3 monitor lines

Appendix J: Reach Assessment

This is only used if a Reach Assessment already exists and has been validated by the hydraulic/hydrology staff

Appendix K: Scour Calculations

FHWA Hydraulic Toolbox Report printouts of scour calculations. This is required for PHDs and FHDs.

.hyd file is included for draft PHD to HQ Hydraulics

Appendix L: Floodplain Analysis *(FHD ONLY)*

For FHD only, include floodplain analysis, No-Rise, Zero-Rise, CLOMR, etc. (as applicable)

Appendix M: Scour Countermeasure Calculations *(FHD ONLY)*

For FHD only, FHWA Hydraulic Toolbox Report printouts of scour countermeasure calculations.

.hyd file is included with draft FHD report to HQ Hydraulics

Final PHD & FHD Deliverables

Below is a summary of deliverables required to be submitted once PHDs/FHDs are finalized, as well as instructions on where the files should be uploaded to WSDOT ProjectWise.

**Final Report**

* **Word and PDF File**
* **Excel Files for Figures in text**
  + Long Profile and Long Term Degradation
  + Pebble Counts and sediment mobility calculations
  + Reference Reach XS comparison figure
  + Others
* **GIS Data**
* Field Visit data including Bankfull Width, Pebble Count and Reference Reach Locations
* Basin Boundary
* **Appendix Files**
  + LWM Calculator
  + Sediment Size and Mobility
  + Manning’s n roughness
  + Excel files for Model Results at Cross Sections and Profiles
  + Scour calculations FHWA Toolbox Report and .hyd files
  + Scour countermeasure calculations FHWA Toolbox Report and .hyd files
* **Field Visit Photos** (including ones not included in the PHD)

**Hydrology**

* MGSFlood Model if used
* Any other hydrology models

**Hydraulic Model**

* Zipped up SRH Model
  + All Input and Output files.
  + Remove extraneous or working files/simulations. Coverages and simulations should be clearly named.
  + Coverages used for Results reporting including observation lines and 1D Centerline and XS.

**CADD Files**

* Sheets and Basefiles
* Inroads Files (Surface, Alignments and Corridors)
* Project information form.  This was requested by PEO.  See here for example.  **Error! Hyperlink reference not valid.**

**Posting to ProjectWise**

Save all files in **PHD > Final** folder or **FHD > Final** folder

See example below:

Graphical user interface

Description automatically generated with low confidence