BCMoT Hydrotechnical Engineering Design and Deliverable Guideline

The following is a suggested hydrotechnical engineering design process for a typical Ministry bridge project. Culvert and channel control works would follow a similar method.

1. Background Research

- As-builts (GAs)
- Inspection and Maintenance records (BMIS, Bridge Area Manager)
- Air photo – GeoBC, local universities (UBC Air Photo Library)
- Topographic map (1:50,000/1:250,000)
- Archived files and reports – HQ record room, regional and district offices
- Preliminary Estimate
    - Drainage Basin Area
    - Q200 based on office-research results
    - Design velocity and water levels
    - Channel Characteristics (w_{bf}, d_{bf}, s, D_{50})
    - Preliminary bridge waterway opening (bottom width, depth, end-key configuration)

2. Site Visit

- Watershed
    - Inspect upstream/downstream at a minimum distance of 10 x bankfull width for each direction
    - Inspect nearby bridges, culverts, and other hydraulic controls upstream and/or downstream on the same channel
    - Record vegetation type
- Channel
    - Confirm hydraulic assumption on channel characteristics (bankfull width, depth, channel slope, thalweg profile, sediment size)
    - Assess floodplain characteristics (overbank flow, risk of avulsion, road overtopping)
    - Assess potential debris, ice and sediment transport issues
    - Review morphological setting and potential for lateral migration
    - Measure high water marks
- Bridge
    - Check existing bridge height and bottom width, channel controls, channel skew angle, and scour protection works
    - Layout and confirm if the preliminary bridge waterway opening is appropriate
- Determine survey scope

3. Hydrological estimation and Morphological assessment

- Determine maximum instantaneous Q_{200} (or Q_{100})

- Confirm channel slope, horizontal channel alignment, hydraulic controls and all channel characteristics
- Morphological assessment: risk of avulsion, bank migration
- Estimate of preliminary design high water level
- Confirm sediment transport (aggradation or degradation) and debris risk
- Confirm ice conditions

4. Hydraulic design of waterway opening

- Confirm bridge skew and orientation of structure on channel (plan view layout)
- HEC-RAS modelling – using survey data and site visit measurement
- Calibrate HEC-RAS model using field measurement and flow records
- Determine HEC-RAS results for:
    - existing bridge
    - natural channel (no bridge and roadway on the floodplain)
    - new bridge
- Determine bridge waterway opening dimensions (stations and elevations required)
- Confirm the side slope of the new abutments with the Geotechnical Design Engineer
- Confirm if the backwater level is appropriate, if it is allowed
- Determine water elevation for design discharge; average flow velocity; freeboard and preliminary minimum soffit elevation (clearance envelope between the design water levels and soffit of the new bridge)

5. Scour evaluation and channel control works

- Estimate maximum distributed scour depth (elevation)
- Evaluate stream bed stability for the proposed bridge waterway opening
- Preliminary design of scour and erosion protection, and channel control works:
    - Bank armour, guidebanks, spurs and/or apron design
    - Riprap size, gradation and quality; evaluate protection alternatives
    - Layer thickness
    - Filter design
    - Protection height, slope, toe/end treatment
    - Work points required; toe elevation must be specified.
- Prepare a preliminary plan and elevation sketch of proposed bridge waterway opening

6. Sensitivity Analysis

7. Review of the preliminary design by the Ministry

- Site confirmation desirable

8. Preliminary Hydrotechnical Design Memo

- Provide preliminary bridge waterway opening information to the project team

9. Bridge design by others

- Advise on hydrotechnical constraints for all structural options
- Confirm abutment and pier arrangement, scour depth estimates, backwater levels, freeboard and scour and erosion protection requirements once the final structure choice is made
- Review 100% design drawings for hydrotechnical adequacy

10. Review the Final design by the Ministry

11. Final Hydrotechnical design report

- Design report with all calculations – for filing. Report to be stamped by a P.Eng.
- Tender documents as required (drawings/ special provision)
- BMIS Hydrotechnical input

12. Services during Construction

- Inspect critical activities by Field Reviewer
    - Hold point – Rock quality (size/gradation)
    - Hold point – Survey stake out of extent of protection works
    - Witness – Clearing and grubbing
    - Witness – Toe/terminal end key excavation
    - Witness – Preparation of back slope
    - Witness – Application of filters
    - Witness – Toe construction
    - Witness – Front slope, horizontal width of riprap layer, thickness
    - Witness – Design height
- Produce as-built drawings by Engineer of Record