

# Fish Passage Activity Engineering Standards

Effective April 1, 2013

This activity standards document is intended to outline the criteria for fish passage restoration projects. Activities are focused on the layout, design, construction and post-construction inspections for the restoration of fish passage at priority fish stream crossings on Forest Service roads (FSRs), Road Permit roads (pre-1995), and non-status roads.

It is presumed that project eligibility, including assessments, prioritization and habitat confirmation, is a prerequisite to the requirements of this document and has been carried out in accordance with the criteria of the Fish Passage Technical Working Group (FPTWG) (see <http://www.for.gov.bc.ca/hfp/fish/FishPassage.html> and <http://www.for.gov.bc.ca/ftp/HCP/external!/publish/Web/FIA/Phase1-Assessment.pdf>).

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## ARTICLE 1: DEFINITIONS

In this document:

**"backwatering weir"** means a weir constructed near a culvert outlet to raise the water level at the outlet of a culvert, thereby eliminating outlet drop and reducing the water velocity within the culvert;

**"bridge"** means a temporary or permanent structure carrying a road above a stream or other opening;

**"Closed Bottom Structure (CBS)"** is any manufactured pipe or pipe-like structure that has a contiguous bottom. Valid Subtypes of Closed Bottom Structure are: round culvert, oval culvert and concrete box culvert;

**"Coordinating Registered Professional (CRP)"** has the same meaning as given in the *Guidelines for Professional Services in the Forest Sector – Crossings, February 2009* <http://www.apeg.bc.ca/ppractice/documents/ppguidelines/guidelinesforestcrossings.pdf> ;

**"culvert"** means a pipe, arch or box, or a log structure not greater than 6 m in span, that is located below the surface of a road and is designed to carry water from one side of the road to the other;

**"DRM"** means the Forests District Manager and applicable staff working on his/her behalf;

**"D90"** means rock size for which 90% of the rocks are smaller;

**"embedded closed bottom structure"** means a culvert that is constructed of metal or plastic pipe that is embedded below the surface of the natural stream bed, and has a continuous substrate such that it simulates the natural stream bed;

**"Forest Service road (FSR)"** means a road owned by the BC Ministry of Forests, Lands and Natural Resource Operations (FLNR), and as defined in section 1 of the *Forest Act*;

**"FPTWG"** means the Fish Passage Technical Working Group that administers the LBIP Fish Passage program;

**"General Arrangement Drawing"** means a design/construction drawing of a structure that provides detailed layout, dimensions, connections and specifications normally superimposed on a site plan;

**"industrial use"** means access for harvesting, for tree planting requiring more than 12 months to complete, or silviculture treatments requiring transportation of machinery, in accordance with section 22.1 of the *Forest and Range Practices Act*;

**"non-status road"** means an existing forest road on Crown land that is not being used under any authorization;

**"Open Bottom Structure (OBS)"** is any crossing structure that is built on footings such that it spans the stream channel and does not interfere with the natural fish habitat. Valid subtypes of Open Bottom Structure are: bridge, pipe arch and wooden box culvert;

**"professional biologist"** means the same as given in the *College of Applied Biology Act*;

**"professional engineer"** means the same as given in the *Engineers and Geoscientists Act*;

**"professional forester"** means the same as given in the *Foresters Act*;

"**PSCIS**" (Provincial Stream Crossing Inventory System) means the BC provincial database where all culvert assessment, habitat confirmation, design and remediation data is stored;

"**Recipient**" means a party designated by LBIS to receive funding pursuant to a Recipient Agreement;

"**road permit**" is a permit issued under section 115 of the *Forest Act* to authorize road construction and maintenance by someone who has a right to harvest timber;

"**stakeholder**" means any individual, group, or private or public organization able to affect, be affected by, or believe might be affected by, a decision or activity;

"**stream channel width**" means the horizontal distance between the edges of rooted terrestrial vegetation on the stream banks on opposite sides of the stream, measured at right angles to the general orientation of the banks;

"**total station**" means a combination electronic transit and electronic distance measuring device;

"**turnout**" means a short auxiliary lane of sufficient width to provide space for safe passage of motor vehicles.

## **ARTICLE 2: GENERAL**

### **a) Contractual and Legal Requirements:**

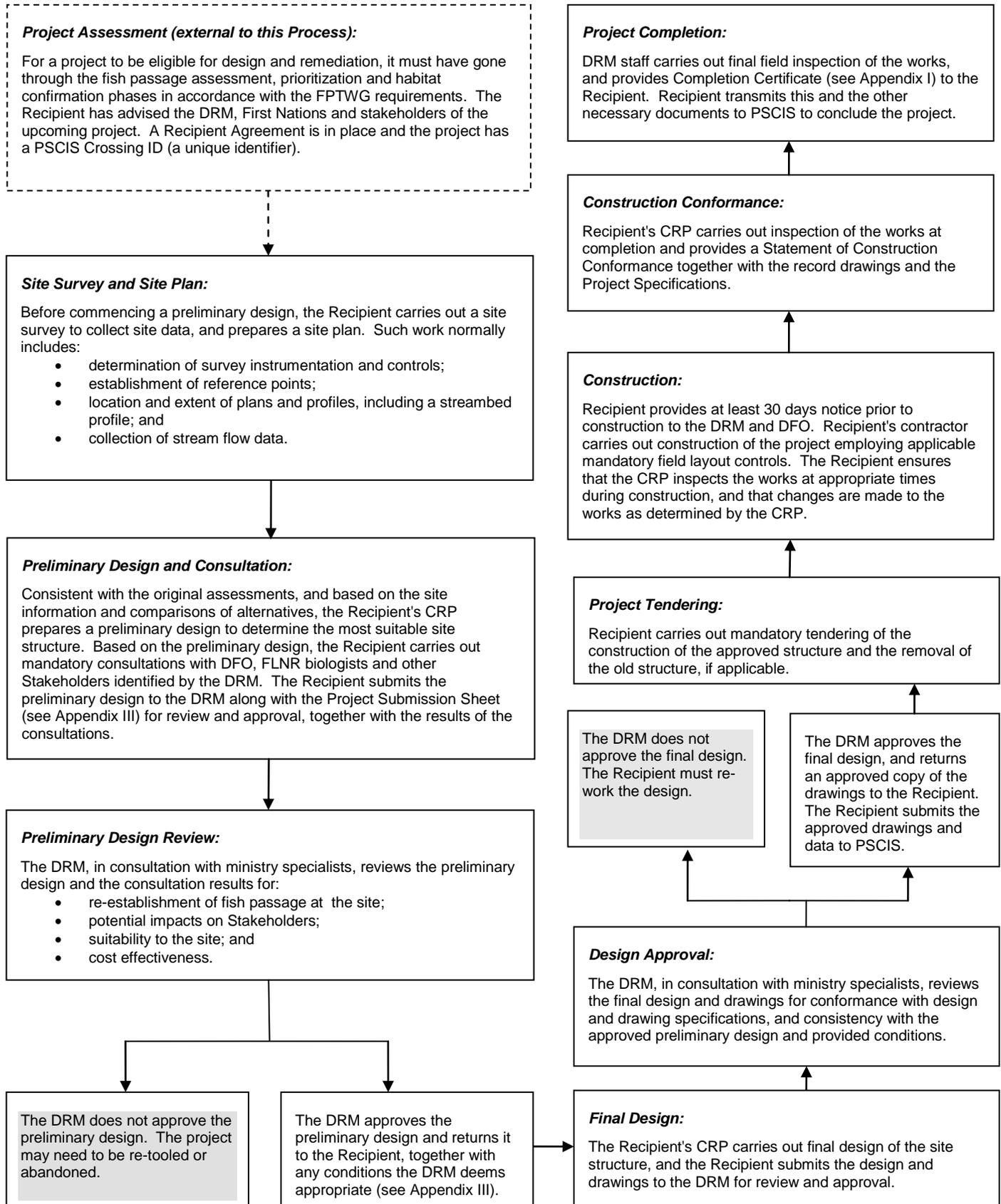
All project activities must be carried out in accordance with all applicable Federal and Provincial Statutes and Regulations, including but not limited to the *Forest and Range Practices Act* and its regulations respecting the design and construction of the crossings. In addition, all works and processes must be consistent with any licence or permit requirements and the Recipient Agreement.

### **b) Project Implementation:**

While it is not the intent to unduly restrict the options available to the Recipient or its CRP with respect to surveys, plans, designs and construction oversight, there are some mandatory requirements that are to be applied to each of the fish passage restoration projects. These are provided to ensure that the project outputs are complete, and are consistent with the expectations of the FPTWG and with the engineering standards of the ministry. Where it is inappropriate to apply a particular specification, the CRP must provide a rationale on the Project Specifications sheet (see Appendix II) to justify the variance.

The following flowchart and project tracking checklist show the linkage between project components, and the decision processes and submission requirements associated with the component stages. In addition, the checklist is a tool for the DRM and the Recipient to each track project implementation, and the DRM to record the information on the job file.

## PROCESS FLOWCHART



### LBIS Fish Passage Project Tracking Checklist

Copies of this checklist are provided for use by both the DRM and the Recipient to track key actions/decisions; the Recipient must forward its copy to the DRM at the conclusion of the project, and the DRM will place it in the project file. Shaded areas require no infill on this checklist. [DRM = FOREST DISTRICT MANAGER & STAFF ; RT = RECIPIENT; FPTWG = FISH PASSAGE TECHNICAL WORKING GROUP & PSCIS].

*Check each item as and when completed. Sign and date the completed checklist at the conclusion of the project.*

| <b>PSCIS Crossing ID:</b>  | <b>PROJECT COMPLETION DATE:</b>                             |                |
|--|---|----------------|
| <b>Project Element</b>   | <b>P.Eng required?</b>                                      | <b>Done by</b> |
| <b>PROJECT ADMINISTRATION</b>  |   |                |
| Ensuring that project has been assessed using FPTWG criteria <b>COMPLETED</b> <input type="checkbox"/>   |   | RT             |
| Ensuring that unique project identifier assigned (PSCIS ID) <b>COMPLETED</b> <input type="checkbox"/>  |   | FPTWG          |
| Ensuring that Recipient Agreement in place, together with budget estimate <b>COMPLETED</b> <input type="checkbox"/>  |   | RT             |
| Retaining/appointing a CRP for the crossing project <b>COMPLETED</b> <input type="checkbox"/>  | <input type="checkbox"/> YES<br><input type="checkbox"/> NO | RT             |
| <b>SITE SURVEY AND PLAN</b>  |   |                |
| Establishing of reference points in the field <b>COMPLETED</b> <input type="checkbox"/>  | <input type="checkbox"/> YES<br><input type="checkbox"/> NO | RT             |
| Carrying out measurements for plans, profiles and stream flow <b>COMPLETED</b> <input type="checkbox"/>  | <input type="checkbox"/> YES<br><input type="checkbox"/> NO | RT             |
| Preparing the site plan <b>COMPLETED</b> <input type="checkbox"/>  | <input type="checkbox"/> YES<br><input type="checkbox"/> NO | RT             |
| <b>PRELIMINARY DESIGN AND CONSULTATION</b>   |   |                |
| Providing a list of applicable First Nations and stakeholders to the Recipient <b>COMPLETED</b> <input type="checkbox"/>   |   | DRM            |
| Preparing a preliminary design <b>COMPLETED</b> <input type="checkbox"/>   | <input type="checkbox"/> YES<br><input type="checkbox"/> NO | RT             |
| Preparing a draft general arrangement drawing of the selected alternative <b>COMPLETED</b> <input type="checkbox"/>  | <input type="checkbox"/> YES<br><input type="checkbox"/> NO | RT             |
| Submitting a Project Submission Sheet and preliminary design to the DRM for review and approval <b>COMPLETED</b> <input type="checkbox"/>  |   | RT             |
| Reviewing and approving preliminary design and returning signed off copy of Project Submission Sheet to Recipient together with any design conditions for the crossing structure <b>COMPLETED</b> <input type="checkbox"/> | <input type="checkbox"/> YES<br><input type="checkbox"/> NO | DRM            |
| <b>FINAL DESIGN AND DRAWINGS</b>   |   |                |
| Preparing final design of the crossing works, consistent with the approved preliminary design and supplied conditions <b>COMPLETED</b> <input type="checkbox"/>  | <input type="checkbox"/> YES<br><input type="checkbox"/> NO | RT             |
| Submitting final design and drawings signed off by CRP to the DRM for review and approval <b>COMPLETED</b> <input type="checkbox"/>  |   | RT             |
| Reviewing and approving final design and drawings (including any specialist reviews), and return signed off documents as approved for construction to the Recipient <b>COMPLETED</b> <input type="checkbox"/>              | <input type="checkbox"/> YES<br><input type="checkbox"/> NO | DRM            |
| Submit approved final drawings and associated data to PSCIS <b>COMPLETED</b> <input type="checkbox"/>  |   | RT             |

| <b>CONSTRUCTION</b>  |   |                 |
|--|---|-----------------|
| Preparing tender documents and soliciting bids for construction, including removal of the old structure (if applicable); selecting successful bidder and awarding contract <b>COMPLETED</b> <input type="checkbox"/> |   | RT              |
| Providing at least 30 days notice of construction to DRM, DFO and MOE <b>COMPLETED</b> <input type="checkbox"/>  |   | RT              |
| Laying out and constructing the works <b>COMPLETED</b> <input type="checkbox"/>  |   | RT              |
| Inspecting the works at key times during construction, including the work of an Environmental Monitor, when required <b>COMPLETED</b> <input type="checkbox"/>   | <input type="checkbox"/> YES<br><input type="checkbox"/> NO | RT              |
| <b>PROJECT COMPLETION</b>  |   |                 |
| Inspecting the completed works and providing a Statement of Construction Conformance (see Appendix III) and Project Specifications (see Appendix II) to the DRM <b>COMPLETED</b> <input type="checkbox"/>            | <input type="checkbox"/> YES<br><input type="checkbox"/> NO | RT              |
| Inspecting the completed project and providing a Completion Certificate (see Appendix IV) to the Recipient <b>COMPLETED</b> <input type="checkbox"/>   |   | DRM             |
| Forwarding completion documents to PSCIS <b>COMPLETED</b> <input type="checkbox"/>   |   | RT              |
| Signing off project completion and releasing any remaining funding to Recipient <b>COMPLETED</b> <input type="checkbox"/>  |   | FPTWG Designate |

|   |
|---|
| <p><b>DRM/RT REPRESENTATIVE:</b></p> <p><b>NAME:</b> _____</p> <p><b>SIGNATURE:</b> _____</p> |
|---|



## ARTICLE 3: SITE SURVEY AND SITE PLAN

In order to design a crossing structure, it is necessary to first determine accurate information about the site of the new structure, including:

- vertical and horizontal control points at or adjacent to the crossing;
- stream and streamflow characteristics;
- topography and soil characteristics of the crossing site and surrounding area; and
- details of existing structure(s).

This information is recorded and used to prepare a graphic representation of the crossing in the form of a site plan.

### a) General:

#### *Bridges and Culverts:*

This standards document provides direction to the Recipient and its consultants and contractors in collecting and utilizing site information for bridges and culverts. For new or replacement structures, the Recipient must carry out a site survey and prepare a site plan in accordance with the following requirements. Any variations must be carefully considered by the CRP such that the modifications or additions are necessary for the proper design and layout of the new structure, or elements being eliminated are superfluous to the design and construction of the specific structure being considered.

#### *Backwatering Weirs and Baffles:*

Any proposal to construct backwatering weirs (adjacent either to new culverts or existing ones) or to place baffles in a culvert pipe must be pre-approved by the FPTWG.

For any approved backwatering projects, the information gathered at the site must be sufficient to allow the CRP in consultation with a Hydrologist / Geomorphologist and Professional Biologist to:

- address the necessary location, configuration and dimensions of the weirs, including their elevations; and
- design the size and gradation of the rock being used to retain the flow.

### b) Survey Requirements:

In carrying out site surveys, consideration should be made to facilitate simplified field referencing for the construction phase and subsequent long term monitoring. Site surveys should consider that the typical complement of survey instruments (for non-complex sites) used during construction would be:

- standard construction level and level rod; and
- tape measures (for linear measurements).

Site surveyors should ensure that elevation benchmarks are established to promote longevity, placed outside of the potential construction zone and in a manner to provide for ease of use in construction. To facilitate construction, benchmarks should be placed at elevations close to the anticipated foundation for the proposed structure and provide for a level rod to be placed vertically on the benchmark, and be clearly identified on the site plan (e.g., “spike in blazed 300 diameter cedar”).

Consideration for other site referencing for establishing the new structure should be simplified to allow for straight line measures between reference points using tape measures without the need to have a total station, particularly for small and non-complicated crossings.

Site surveys must be conducted consistent with guidance provided in Appendix E, Bridge and Major Culvert Site Plan Specifications, of the *Forest Service Bridge Design and Construction Manual*:

[http://www.for.gov.bc.ca/hth/engineering/documents/publications\\_guidebooks/manuals\\_standard\\_s/Bridge%20Manual-Web%20version%20Aug%2002-Rev.Mar.11.pdf](http://www.for.gov.bc.ca/hth/engineering/documents/publications_guidebooks/manuals_standard_s/Bridge%20Manual-Web%20version%20Aug%2002-Rev.Mar.11.pdf)

In addition:

- a long profile of the existing streambed for 100 m upstream and downstream of the proposed crossing must be captured to be used to determine design grade and foundation elevations, unless the design engineer determines otherwise; and
- for proposed embedded culvert or open bottom culverts, measure stream widths upstream and outside of the influence of the road and existing crossing structure. Take and average at least three measurements spaced at least a stream width apart. This average will be used to determine the stream channel width.

**c) Site plan contents:**

An accurate site plan is required to properly display the site survey information, and to place the new structure so that it does not:

- constrict the stream channel width; or
- modify the natural streambed slope.

Site plans must be consistent with guidance provided in Appendix E, Bridge and Major Culvert Site Plan Specifications, of the *Forest Service Bridge Design and Construction Manual*:

[http://www.for.gov.bc.ca/hth/engineering/documents/publications\\_guidebooks/manuals\\_standard\\_s/Bridge%20Manual-Web%20version%20Aug%2002-Rev.Mar.11.pdf](http://www.for.gov.bc.ca/hth/engineering/documents/publications_guidebooks/manuals_standard_s/Bridge%20Manual-Web%20version%20Aug%2002-Rev.Mar.11.pdf).

In addition, the following elements are to be captured on site plan drawings:

- PSCIS Crossing ID;
- UTM co-ordinates (zone, easting, northing);
- size and location of existing crossing structure(s);
- site location key map.

## ARTICLE 4: PRELIMINARY DESIGN AND CONSULTATION

At the outset of the preliminary design phase of the work, the DRM must provide the Recipient with a list of stakeholders with whom consultations must be carried out. The stakeholder list must always include DFO and MOE.

The Recipient, through its CRP, must consider various options for the remedial work at a site in order to facilitate fish passage, and then determine the approximate size, layout and arrangement of the proposed structure.

For the fish passage restoration activity, the CRP for a bridge or major culvert must be a professional engineer.

The review of options will normally include relative effectiveness in achieving the objectives, and comparisons of costs. In addition, there may be potential issues as illustrated below related to choices of bridges or culverts, or whether a culvert is open or closed bottom:

| ISSUE                        | STRUCTURE TYPE   |   |   |
|------------------------------|--|---|---|
|                              | BRIDGE   | PIPE ARCH OR WOODEN BOX CULVERT   | CLOSED BOTTOM STRUCTURE   |
| Working in the dry           | Not usually an issue   | Usually needs stream diversion but can avoid this at very low water levels          | Needs stream diversion  |
| Steep gradient stream (> 6%) | No issue   | No issue  | Needs special attention and approvals   |
| Streambed simulation         | Requires attention   | Requires attention  | Requires attention  |
| Project timing               | May not need to address fish timing windows                          | Needs to address fish timing windows  | Needs to address fish timing windows  |
| Professional responsibility  | CRP may need to be P.Eng depending on site and structure constraints | CRP may need to be P.Eng depending on whether or not the culvert is a major culvert | CRP may need to be P.Eng depending on whether or not the culvert is a major culvert |
| Foundation conditions        | Conditions will drive selection of footings and costs                | Needs to be founded on erosion resistant material                                   | soft marshy sites may need to be excavated to firm ground                           |

After considering the foregoing items and developing a favoured option for the site, the CRP must prepare a preliminary General Arrangement drawing for the crossing structure. This drawing will normally involve overlaying the plan of the proposed new structure on the site plan, to illustrate:

- its location relative to the stream and road; and
- the impact of the construction on the adjacent land base.

Stream crossing design practices and drawings must be consistent with ministry standards and guidance provided in Chapter 5, of the FLNR *Engineering Manual*:

[http://www.for.gov.bc.ca/hth/engineering/documents/publications\\_guidebooks/manuals\\_standards/Eng-Manual.pdf](http://www.for.gov.bc.ca/hth/engineering/documents/publications_guidebooks/manuals_standards/Eng-Manual.pdf).

The Recipient must forward a copy of the Preliminary Design information to the DRM along with a Project Submission Sheet (see Appendix I). The DRM, in consultation with the regional bridge engineer, will review the preliminary design, and return a signed copy of the Project Submission Sheet to the Recipient. The DRM will also provide any additional design conditions that must be applied to this project.

## **ARTICLE 5: FINAL DESIGN AND DRAWINGS**

Once the DRM has approved the preliminary design, the Recipient's CRP will carry out the detailed design of the proposed structure, including size, location, arrangement and connections of component parts, incorporating any design conditions provided by the DRM. Typically, the CRP will complete and assemble a set of design notes and a drawing and specifications package appropriate for the type and complexity of the proposed structure.

Stream crossing design practices and drawings must be consistent with ministry standards and guidance provided in Chapter 5, of the FLNR *Engineering Manual*:

[http://www.for.gov.bc.ca/hth/engineering/documents/publications\\_guidebooks/manuals\\_standards/Eng-Manual.pdf](http://www.for.gov.bc.ca/hth/engineering/documents/publications_guidebooks/manuals_standards/Eng-Manual.pdf).

A crossing design must incorporate practices, features or mechanisms to either:

- direct ditch water away from the stream; or
- provide sumps to minimize sediment transport to the stream.

### **a) Bridges and Culverts:**

Generally, fish stream culverts and bridges are to be designed in accordance with Chapter 5, of the FLNR *Engineering Manual*:

([http://www.for.gov.bc.ca/hth/engineering/documents/publications\\_guidebooks/manuals\\_standards/Eng-Manual.pdf](http://www.for.gov.bc.ca/hth/engineering/documents/publications_guidebooks/manuals_standards/Eng-Manual.pdf)); and the *Fish Stream Crossing Guidebook*

(<https://www.for.gov.bc.ca/HFP/Fish/Fish-stream%20Crossing%20Guidebook%20Print.pdf>)

with a further proviso that the following are mandatory practices for these crossing structures.

## **Streambed Simulation:**

A key to success in restoring or repairing fish passage at a site is an outcome that provides for streambed simulation and hydraulic diversity. This means that the stream substrate and morphology (including depth, velocity and turbulence) in the stream segment that flows under (or through) the new structure must replicate the natural substrate and morphology as seen in adjacent natural stream segment.

Use a heterogeneous mixture of substrate sizes that contains enough fine material to seal the streambed and avoid subsurface flow.

Further, in streams with gradients between 3 and 6%, the physical placement of supplemental larger material (D90+) is even more important. The placement and orientation of these larger elements should assist in retaining substrate and preventing scour in the culvert.

As such, it is essential that detailed materials and construction specifications be provided in the designs for reconstructing or restoring streambeds, including the dimensions and quantity of any additional larger material.

## **Design of Structure:**

*Closed Bottom Structures (normally embedded closed bottom culverts):*

Closed Bottom Structures are not allowed in critical fish habitat, but are a viable option in important or marginal streams with a stream channel width 2.5 m or less (small S3 and S4 streams) and 6% average stream gradients or less.

Closed Bottom Structures must be designed and installed at the same slope as the natural stream. The structure grade and invert elevations are determined from the long profile of the streambed to ensure that the culvert invert is located sufficiently deep so that it is below the depth of scour.

These structures should be placed to allow the natural meander pattern of a stream to be retained, and must not be placed at the bend of a stream, as this leads to bank erosion and debris problems. Where this cannot be achieved, the crossing structure must be relocated or an Open Bottom Structure chosen.

The width of the replicated or simulated streambed within the structure must be equal to or greater than the stream channel width, to emulate the natural stream and to prevent deposition, scouring, or other damage at the outlet.

Closed Bottom Structures must be sized to accommodate the 100-year return period peak flow after embedment. The length of the structure depends upon:

- depth of fill;
- skew angle of the culvert to the road;
- gradient of the culvert; and
- required road width.

Closed Bottom Structures must be designed to avoid letting side slope and backfill material enter

the culvert or flow channel. Riprap or similar materials are be used to provide scour protection for materials potentially exposed to erosion.

For circular culverts, the embedment must make up at least 40% of the culvert diameter or 0.6 m, whichever is greater. For pipe-arch or box culverts, embedment depth must be at least 20% of the vertical rise of the arch.

Based on a design specification for gradation, the Closed Bottom Structures must be filled with substrate material that replicates the natural stream substrate and elevation, as well as supplemental material that is equal to or greater than the stream channel D90 particle size. The design must clearly specify the substrate materials and their sizes.

If the appropriate professional (biologist/hydrologist) determines that low flow fish passage issues may exist, then re-establish an appropriate stream thalweg (low-flow channel).

Designs must provide for select granular road surface material for culvert cover, to stabilize the road surface and reduce the risk of sediment transport to the stream.

#### *Open Bottom Structures:*

Open Bottom Structures are designed to minimize modifications to the natural stream channel, and are characterized by their spanning the entire stream channel width, and being founded on footings that are placed outside the stream channel width. Open Bottom Structures will be either culverts or bridges, and constructed using wood, concrete, steel or plastic.

##### i. open bottom culverts

These types of culverts are particularly advantageous where the culvert is to be founded on rock, thus precluding the need to rip or blast rock. Also, because open bottom culverts allow the use of large rock for substrate and scour protection, these structures can reasonably provide streambed simulation for steeper gradients.

Open bottom culverts must be designed for placement on foundations such as a gravel or rock that have high bearing capacity and low potential for settlement. In addition, foundations must be erosion resistant. Do not design open bottom culverts to be placed on soft or erodible soils.

Design footings supported on soil or degradable rock strata must be embedded below the maximum computed scour depth, or protected with rock as a scour countermeasure if this rock will not constrict the channel. Where required, additional lateral resistance can be provided by drilling and grouting steel dowels into the rock surface.

Designs must provide for select granular road surface material for culvert cover, to stabilize the road surface and reduce the risk of sediment transport to the stream.

Where wood box/log culverts are implemented, they must be comprised only of cedar species components (no other log/puncheon species are acceptable) for stringer or crib components works. To be eligible, cedar wood box/log culverts must:

- utilize logs free of defects (such as rot);
- be planned to last an expected 40 years;

- not exceed 6 metres in span length (centre-to-centre of bearing) when completed;
- be consistent with the practices provided for in the *Forest Road Engineering Guidebook* (June 2002), <http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/Road/FRE.pdf>, (pages 106 - 113);
- have a CRP responsible for its design and construction who is a professional engineer if the culvert has a maximum design discharge of 6 m<sup>3</sup>/sec or greater, or a CRP who is a professional engineer or professional forester, if the culvert does not have a maximum design discharge of 6 m<sup>3</sup>/sec or greater.

## ii bridges:

All bridges within this activity must have a CRP responsible for its design and construction who is a professional engineer. When designed and constructed with abutments that do not constrict the stream channel, bridges have the least impact on fish passage and fish habitat, compared to open and closed bottom culverts. The selection of a bridge rather than a culvert is dependent upon economics, engineering requirements, site parameters, environmental or hydraulic concerns, or bedload and debris transport factors.

Bridge types range from log stringer bridges with gravel or timber decks, to steel girder bridges with timber or pre-cast concrete decks. Bridges can be supported by various means, including log cribs, steel pipes, steel bin walls, cast-in-place concrete, and pre-cast lock block walls, or timber posts or piles. For the purposes of fish passage restoration, simple single span bridges only need be considered, thus precluding the use of instream piers.

New bridges must be designed such that their footings and protective riprap are located outside of the stream channel width. The structural design of bridges must be carried out in accordance with the *Forest Service Bridge Design and Construction Manual* [http://www.for.gov.bc.ca/hth/engineering/documents/publications\\_guidebooks/manuals\\_standard\\_s/bridge\\_manual.pdf](http://www.for.gov.bc.ca/hth/engineering/documents/publications_guidebooks/manuals_standard_s/bridge_manual.pdf). Any variations must be discussed with and approved in writing by a ministry bridge engineer prior to completion of the final design.

Bridge approach roads must be designed to be level and tangent with bridge decks, where feasible, for a minimum of 15 metres, and accommodate industrial vehicles side tracking on and off the bridge. Designs must provide for select granular material for surfacing on these approach roads.

Riprap must be designed such that it is properly graded for the application.

### **Bridge and Culvert Drawings:**

Both bridges and culverts require the preparation of a General Arrangement Drawing. In addition, for certain types of bridge superstructures there is a need to have a Superstructure Drawing to guide the fabricator and to ensure sufficient attention to details to the constructor respecting field fabrication and installation during construction. The bridge drawing requirements are:

| Bridge Type  | General Arrangement Drawing                    | Superstructure Drawing  |
|--|--|---|
| Permanent bridge span (including first-use portable spans) | Required                                       | Required  |
| Log stringer bridges                                       | Required                                       | Not Required  |
| Re-used portable spans                                     | Required<br>(see also Superstructure Drawings) | <p><b>Optional</b> (to be included where there may be insufficient space on the General Arrangement Drawing to provide a schematic of the portable span incorporating sufficient details to:</p> <ul style="list-style-type: none"> <li>• identify the types and dimensions of components of the re-used superstructure, including girders or stringers and deck;</li> <li>• confirm the identity of the re-used structure; and</li> <li>• list any transportation requirements that may need to be followed</li> </ul> |

*Bridge and Culvert General Arrangement Drawing details:*

The mandatory contents requirements for these drawings are:

| <b>REQUIREMENTS FOR BOTH CULVERTS AND BRIDGES:</b>  |
|---|
| <ul style="list-style-type: none"> <li>• standard title block with: <ul style="list-style-type: none"> <li>○ site and structure number noted;</li> <li>○ PSCIS Crossing ID;</li> <li>○ CRP's name and seal, taking professional responsibility for the overall layout and design of the bridge;</li> <li>○ name of the stream and UTM co-ordinates (zone, easting, northing);</li> <li>○ drawing scale (typically 1:200 unless greater detail is required);</li> </ul> </li> <li>• site location key map;</li> <li>• design vehicle configuration for both load and alignment;</li> <li>• design high-water elevation;</li> <li>• dimensioning and labelling of component parts;</li> <li>• location and nature of field reference points;</li> <li>• location (vertical and horizontal) of proposed structure relative to field reference points;</li> </ul> |

**REQUIREMENTS FOR BOTH CULVERTS AND BRIDGES:**

- streambed profile;
- dimensions and sizes of components;
- component field connection details;
- field fabrication details, where applicable;
- foundation requirements, material types and depth, and compaction level;
- footing types, dimensions and specifications, including connection details;
- limit of construction for contract purposes;
- specifications for foundation/fill materials and those materials not specified on other drawings, where applicable;
- special instructions relating to material erection, installation standards, requirements, or methods as deemed necessary; and
- references to other design aids or drawings, where applicable.

| <b>ADDITIONAL REQUIREMENTS FOR BRIDGES ONLY:</b>   | <b>ADDITIONAL REQUIREMENTS FOR CULVERTS ONLY:</b>  |
|--|--|
| <ul style="list-style-type: none"> <li>● design code references (the most recent version of the CAN/CSA S6-00 – Canadian Highway Bridge Design Code and the Canadian Foundation Engineering Manual);</li> <li>● materials specification;</li> <li>● clearance between the design high-water level and soffit (low point of underside of superstructure) of the bridge;</li> <li>● road approaches and grades, including width requirements (e.g., allowance for vehicle side tracking) and side slopes, to a sufficient distance back from the bridge to show potential problems, or to the end of the first cut or fill;</li> <li>● standard arrangement of log stringers, curbs, needle beams, decking and cribs or sills, and connection details to each other;</li> <li>● where applicable, standard arrangement of portable superstructure and connection details to substructure;</li> </ul> | <ul style="list-style-type: none"> <li>● standard arrangement of log culvert stringers, cribs or sills, and connection details to each other;</li> <li>● profile of the culvert, showing pipe and footings (where applicable), detailing:               <ul style="list-style-type: none"> <li>○ pipe length and slope;</li> <li>○ culvert inlet and outlet culvert bottom elevations;</li> <li>○ fill slopes and heights;</li> <li>○ where applicable, depth of embedment of pipe;</li> <li>○ bed materials;</li> <li>○ footing location and dimensions;</li> <li>○ riprap specifications and placement;</li> <li>○ backwater weir composition, location and dimensions (note: utilizations of weirs requires specific approval from FPTWG).</li> </ul> </li> </ul> |

| ADDITIONAL REQUIREMENTS FOR BRIDGES ONLY:  | ADDITIONAL REQUIREMENTS FOR CULVERTS ONLY: |
|--|--|
| <ul style="list-style-type: none"> <li>• for bridges on a grade, deck elevations at bridge ends relative to field reference points;</li> <li>• approach barriers, if required;</li> <li>• abutment elements, configuration, and connections;</li> <li>• riprap scour protection: dimensions, composition, extent of placement, design slope and other considerations;</li> <li>• references to those professional design aids that are used and in the public domain; professional design aids that are proprietary are to be attached to the design notes.</li> </ul> |  |

*Bridge Superstructure Drawing details:*

For those bridge types where such a drawing is required, the mandatory contents are:

| REQUIREMENTS FOR BOTH CULVERTS AND BRIDGES:   |
|---|
| <ul style="list-style-type: none"> <li>• standard title block with: <ul style="list-style-type: none"> <li>○ site and structure number noted;</li> <li>○ P.Eng's name and seal, taking professional responsibility for the design and drawing of the superstructure elements;</li> <li>○ name of the stream, road, and station (km) and adequate information to detail the location of the structure;</li> <li>○ drawing scale;</li> </ul> </li> <li>• component details, including dimensions, sizes and connections (including connections to substructure);</li> <li>• materials specifications and CSA references, including but not limited to: <ul style="list-style-type: none"> <li>○ steel grades, impact category, finish;</li> <li>○ timber species, grades, preservative treatment;</li> <li>○ concrete strength, slump, and air entrainment, related to both precast and cast in place items;</li> <li>○ girder to sill bearings;</li> <li>○ superstructure elements, configuration, and field connections;</li> <li>○ girder or stringer arrangements and connections;</li> <li>○ curb configuration, connections, and component elements;</li> <li>○ field fabrication details (including grout placement), where applicable.</li> </ul> </li> </ul> |

## **b) Backwatering Weirs and Baffles:**

For those projects incorporating backwatering weirs and/or pipe baffles (require pre-approval by the FPTWG), the location and design of the project elements need to be carefully determined by the CRP in consultation with a Professional Biologist.

Generally, a General Arrangement Drawing will be required for backwatering weirs, and the contents will be consistent with those of culverts as described in this section, together with any site-specific details as required by the CRP.

## **ARTICLE 6: CONSTRUCTION**

### **a) General:**

Once the final design and drawings have been approved, the Recipient must publicly tender the construction work, and select the lowest qualified bidder to carry out the work.

The Recipient must provide at least 30 days notice of construction start-up to DFO, MOE and the DRM.

A key element in the successful construction of a fish passage structure, whether it be a backwatering weir, a culvert or a bridge, is conformance with the approved design drawings and specifications. To achieve this goal, it is imperative that the CRP provides clear instructions to the constructor, and continues to monitor and oversee the construction work to ensure general conformance, and to review and approve any changes that are necessitated by site conditions or other factors.

### **b) Open bottom culverts:**

Open bottom culverts must be assembled and placed in accordance with the provisions of the *Fish Stream Crossing Guidebook*, and according to the manufacturer's instructions. In addition, the following items discussed in the guidebook are to be considered mandatory construction requirements for this program:

- all construction, including the footings, must take place outside the stream channel width; and
- geotextiles must be used to prevent loss of fines and gravel through seepage along the culvert wall; and
- foundations must be constructed to be impermeable to prevent loss of fines and seepage through foundation elements.

### **c) Bridges:**

All bridge construction must be carried out in accordance with the *Forest Service Bridge Design and Construction Manual*. Turnouts must be constructed a sufficient distance from the bridge to prevent road material from entering the stream and to minimize impacts on riparian vegetation. Non-woven geotextile fabric must be placed under all riprap.

Structural field grout used in bridge construction, placement and sampling practices must be in accordance with Section 4.13.3 and Appendix 4.5 of the ministry *Engineering Manual*:

- placement must be in accordance with the manufacturer's instructions, particularly for appropriate hot or cold weather procedures;
- the grout must be kept moist during the initial set period; and
- grout samples must be collected at various times, placed in a safe area that is representative of the setting conditions for the grouted works for a minimum of 12 hours, and then tested at an appropriate testing facility.

Structural field welding must be carried out by Canadian Welding Bureau certified firms as per Section 4.13.2 of the ministry *Engineering Manual*.

**d) Closed Bottom Culverts:**

Closed bottom culverts must be placed in accordance with the provisions of the *Fish Stream Crossing Guidebook*, so that the provision of fish passage is obtained, and the stream channel and vegetation is protected during the construction work. The following items discussed in the guidebook are to be considered mandatory construction requirements for this program:

- the work must be carried out during the approved timing window on a dry bed;
- the work site must be laid out with a construction level to accurately locate the culvert invert elevation and slope during construction;
- the culvert must be installed at the same slope as the stream;
- the stream substrate characteristics must be replicated within the culvert;
- the width of the replicated or simulated streambed within the culvert must be equal to or greater than the stream channel width;
- a thalweg (low-flow channel) must be constructed through the culvert to enable fish passage at low flow;
- there must be no baffles placed in the culvert;
- geotextiles must be used to prevent loss of fines and gravel through seepage along the culvert wall; and
- an outlet control boulder weir must be constructed within one and a half to two channel widths downstream of the culvert outlet.

**e) Backwatering weirs:**

A backwatering weir constructed adjacent to an existing culvert to promote fish passage must be built during low flow conditions and within applicable timing windows. The rock used in the weir must be placed with the proper equipment and never simply dumped into the stream.

**f) Construction Inspections:**

For any fish passage remediation project, the CRP (or a person carrying out the field work on his/her behalf) must carry out field inspections during the bridge construction process, such that

the number and timing of such inspections are suitable to ensure that the project is progressing as expected, and in accordance with the approved design. This enables the CRP to direct and sign off timely amendments to the design (and hence the construction) due to unforeseen site conditions. Prior to commencement of construction, the CRP must determine the proposed number and timing of inspections.

*As-built Information:*

Following construction of the structure, the CRP must record details of the actual in-situ structure, and such details normally include as-built drawings and any additional materials and construction information that may impact the strength and durability of the structure.

As-built drawings must be marked up approved construction drawings that show the changes, if any, to the approved design, and include the CRP's seal and signature. These drawings must include:

- actual sizes of included materials;
- any changes to fabricated materials;
- actual elevations of culvert inverts, bridge footings, roadway elevation, and alignment location; and
- confirmation of scour protection requirements.

Additional as-built information must include applicable:

- fabrication plant inspection reports, including mill test certificates and concrete test results; and
- any other pertinent fabrication, field, and construction data.

|   |
|---|
| <b>ARTICLE 7: CONSTRUCTION CONFORMANCE AND PROJECT COMPLETION</b> |
|---|

**a) Construction Conformance:**

Based on the results of his/her field inspections and the as-built information, the CRP must sign and seal the completed Statement of Construction Conformance (see Appendix III), which provides for assurance that the completed bridge is in general conformance with the approved design/construction drawings and specifications, as amended for any material changes to the bridge during construction.

**b) Project Completion:**

The Recipient (or Recipient's CRP) must submit the CRP's Statement of Construction Conformance, along with the relevant as-built information, to the DRM. Once the DRM's staff has inspected and accepted the completed works, and confirmed that all of the data submission requirements have been met, the DRM must forward a Completion Certificate (see Appendix IV) to the Recipient.

The Recipient (or Recipient's CRP) must transmit the Completion Certificate and any other required document to PSCIS, to initiate any remaining payments and formally conclude the project. The following table provides the information that must be submitted to PSCIS.

| <b>PSCIS SUBMISSIONS</b>  |  |   |
|---|--|---|
| <b>FISH PASSAGE ACTIVITY ENGINEERING STANDARDS</b>  |  |   |
| <b>DOCUMENT<br/>(WHERE APPLICABLE)</b>  | <b>TIMING OF<br/>SUBMISSION</b>                                | <b>APPROVAL<br/>AUTHORITY PRIOR TO<br/>SUBMISSION</b> |
| Fish passage assessment, prioritization and habitat confirmation (see <a href="#">Fish Passage Activity - Land Based Investment - FIA - MFR - Province of BC</a> )  | Prior to carrying out preliminary design of the crossing works | FPTWG   |
| <ul style="list-style-type: none"> <li>• Project Submission Sheet</li> <li>• Preliminary General Arrangement Drawing</li> </ul>   | After completion of the preliminary design and consultation    | DRM   |
| Design report, specifications and final drawings  | After completion of the final design and drawings              | DRM   |
| <ul style="list-style-type: none"> <li>• Statement of Construction Conformance,</li> <li>• Record drawings</li> <li>• Fabrication plant inspection reports, including mill test certificates and concrete test results;</li> <li>• Shop or as-built fabrication drawings;</li> <li>• Concrete and grout test results;</li> <li>• Field compaction results;</li> </ul> | After completion of the project                                | DRM   |

# APPENDIX I: PROJECT SUBMISSION SHEET

|  |  |  |
|--|--|--|
| <b>PROJECT SUBMISSION SHEET</b><br><b>LBIS Fish Passage Restoration Project</b>  |  | <b>PSCIS Crossing ID</b>   |
| <i>THIS FORM IS TO BE INITIALLY COMPLETED BY THE RECIPIENT AND FORWARDED TO THE DRM FOR APPROVAL. THE DRM WILL RETURN THE DOCUMENT TO THE RECIPIENT AFTER REVIEW AND COUNTERSIGNING.</i>   |  |  |
| <b>Crossing Name:</b><br>_____   | <b>Projected Start Date:</b><br>_____  | <b>Projected Completion Date:</b><br>_____                       |
| <b>RECIPIENT:</b> _____<br>Check appropriate box below and complete Recipient information:<br><input type="checkbox"/> <b>BCTS :</b> TSO _____<br><input type="checkbox"/> <b>LICENSEE:</b> _____<br><input type="checkbox"/> <b>OTHER:</b> _____              |  | <b>FOREST REGION:</b> _____<br><br><b>FOREST DISTRICT:</b> _____ |
| <b>Road Type:</b> (check one) <input type="checkbox"/> Forest Service Road <input type="checkbox"/> Road Permit Road (pre-1995) <input type="checkbox"/> Non-status road   |  |  |
| <b>Crossing Type:</b> (check applicable below)<br><input type="checkbox"/> OBS Open Bottom Structure<br><br><input type="checkbox"/> CBS Closed Bottom Structure<br><br><input type="checkbox"/> OTHER   | <b>Crossing Sub-Type:</b> (check applicable below)<br><input type="checkbox"/> BRIDGE<br><input type="checkbox"/> PIPE ARCH<br><input type="checkbox"/> WOOD BOX CULVERT<br><br><input type="checkbox"/> ROUND CULVERT<br><input type="checkbox"/> OVAL CULVERT<br><br><input type="checkbox"/> FORD |  |
| Will motor vehicle access be precluded until appropriate repairs or structure replacements are made in accordance with the design plans? <input type="checkbox"/> Yes <input type="checkbox"/> No  |  |  |
| <b>Other Comments/Issues:</b> ___ Note: copy of preliminary design is attached ___<br>_____<br>_____   |  |  |
| <b>Recipient Signature:</b><br>_____   | <b>Date:</b><br>_____  |  |
| <b>DRM Signature:</b><br>_____<br><input type="checkbox"/> Preliminary Design is not approved (reasons attached)<br><input type="checkbox"/> Preliminary Design is approved<br><input type="checkbox"/> Conditions to be included in final design are attached | <b>Date:</b><br>_____  |  |

## APPENDIX II: PROJECT SPECIFICATIONS

### FISH PASSAGE RESTORATION PROJECT' BRIDGE AND CULVERT PROJECT SPECIFICATIONS

*(The following are mandatory requirements for bridges and culverts, and by checking each, the CRP confirms that they have been carried out, or reasons given if not; the form is to be prepared by the CRP and attached to the Statement of Construction Conformance upon project completion)*

|  |  |   |
|--|--|---|
| <p><b>Site Survey Practices:</b></p> <p><input type="checkbox"/> at least two x-sections to measure flow;</p> <p><input type="checkbox"/> streambed profile at least 100m each side of road centre-line</p> <p><input type="checkbox"/> road centre-line profile at least 50m each side of stream;</p>   | <p><b>Site Plan Contents:</b></p> <p><input type="checkbox"/> scale 1: 200;</p> <p><input type="checkbox"/> UTM location</p> <p><input type="checkbox"/> edges of stream channel width;</p> <p><input type="checkbox"/> stream flow information;</p> <p><input type="checkbox"/> stream cross-section locations;</p> <p><input type="checkbox"/> reference points;</p> <p><input type="checkbox"/> boundaries/locations of rock, soil and vegetation types;</p> <p><input type="checkbox"/> key map;</p> | <p><b>Preliminary Design Contents:</b></p> <p><input type="checkbox"/> options described;</p> <p><input type="checkbox"/> budget estimate provided;</p> <p><input type="checkbox"/> general arrangement drawing prepared;</p> <p><input type="checkbox"/> Project Submission Sheet completed;</p> <p><input type="checkbox"/> data submitted to PSCIS</p> |
| <p><b>Final Design Practices:</b></p> <p><input type="checkbox"/> design flood is 100 year return;</p> <p><input type="checkbox"/> no intrusion on the stream channel width;</p> <p><input type="checkbox"/> closed bottom structures at same slope as stream; or <input type="checkbox"/> <b>N/A</b></p> <p><input type="checkbox"/> closed bottom structures embedded; or <input type="checkbox"/> <b>N/A</b></p> <p><input type="checkbox"/> outlet control boulder weir; or <input type="checkbox"/> <b>N/A</b></p> <p><input type="checkbox"/> select granular road surface material for culvert cover; or <input type="checkbox"/> <b>N/A</b></p> <p><input type="checkbox"/> structural design of bridges in accordance with the Forest Service Bridge Design and Construction Manual; or <input type="checkbox"/> <b>N/A</b></p> <p><input type="checkbox"/> select granular material for surfacing on bridge approaches; or <input type="checkbox"/> <b>N/A</b></p> <p><input type="checkbox"/> riprap gradation provided; or <input type="checkbox"/> <b>N/A</b></p> |  |   |

**Final Drawing Contents:**

- general arrangement drawing provided, with title block, key map, streambed profile, design loading and other required details;
- professional seals applied;
- bridge superstructure drawing provided; or  **N/A**
- design code references for bridges; or  **N/A**
- culvert profile with required details; or  **N/A**
- connection details provided;
- structure elements labelled and configured;
- references to professional design aids for bridges; or  **N/A**
- field fabrication details provided;
- data submitted to PSCIS

**Construction Practices:**

- construction work publicly tendered;
- 30 days notice of construction provided;
- work carried out within timing windows and on a dry bed; or  **N/A**
- geotextiles used along culvert wall; or  **N/A**
- non-woven geotextile fabric placed under all riprap; or  **N/A**
- field grout properly placed, cured and tested; or  **N/A**
- outlet control boulder weir constructed; or  **N/A**
- construction inspections carried out at key times;

**Project Completion Practices and Contents:**

- record drawings, fabrication data and other pertinent field information forwarded to DRM ;
- Statement of Construction Conformance completed and forwarded to DRM;
- data submitted to PSCIS

I certify that the above mandatory requirements have been carried out, except in the following circumstances, and I have provided the rationale for the variances below:

VARIANCE:

RATIONALE:

CRP NAME:

CRP SIGNATURE:

DATE:

**APPENDIX III: STATEMENT OF CONSTRUCTION CONFORMANCE**

**Statement of Construction Conformance**  
*TO BE SUBMITTED AFTER COMPLETION OF THE PROJECT*

|   |   |   |                           |
|---|---|---|---------------------------|
| <b>Forest District &amp; Forest Region</b>  |   | <b>Crossing Name</b> (as applicable)  | <b>PSCIS Crossing ID:</b> |
| <b>Crossing Type:</b> <i>(check applicable below)</i><br><input type="checkbox"/> OBS Open Bottom Structure<br><br><input type="checkbox"/> CBS Closed Bottom Structure<br><br><input type="checkbox"/> OTHER | <b>Crossing Sub-Type:</b> <i>(check applicable below)</i><br><input type="checkbox"/> BRIDGE<br><input type="checkbox"/> PIPE ARCH<br><input type="checkbox"/> WOOD BOX CULVERT<br><br><input type="checkbox"/> ROUND CULVERT<br><input type="checkbox"/> OVAL CULVERT<br><br><input type="checkbox"/> FORD | <b>List of Approved Design Drawings:</b><br>Drawing and Revision No. / Name of Designer/Date: |                           |

This is to advise that I am the Coordinating Registered Professional for the above described project and I am a (check appropriate);

- Registered Professional Forester registered with the Association of British Columbia Forest Professional (ABCFP),
- Professional Engineer, registered with the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC).

I am responsible for the planning or design and field reviews required with respect to this project. I have taken the appropriate steps as required under the Legislation for my profession and by good practice in order to sign and seal this Statement.

"Field review", for the purposes of this statement, means such reviews of the work at the project site (and/or at the fabrication locations, if/as applicable) considered necessary, in my professional opinion, to ascertain whether or not the significant aspects of the work are considered to be in general conformance with the plans and supporting documents for this project.

Based on the results of the field reviews, I hereby give my assurance that, in my professional opinion, the significant aspects of the construction work, generally conform with the plans and supporting documents for this project, including all revisions.

Significant revisions to the plans and supporting documents have been documented and marked on the plans or described In documents, and have been noted on the as-built plans and documents.

|  |                    |                                       |
|--|--------------------|---------------------------------------|
| <b>Signature of Coordinating Registered Professional:</b>  |                    |                                       |
| <b>Name of Professional Engineer</b> <i>(please print)</i> | <b>Date Signed</b> | <i>(affix professional seal here)</i> |
|  |                    |                                       |

## APPENDIX IV: COMPLETION CERTIFICATE

### FISH PASSAGE RESTORATION PROJECT COMPLETION CERTIFICATE

|  |   |
|--|---|
| RECIPIENT NAME   | PSCIS Crossing ID   |
| RECIPIENT'S ADDRESS  |   |
| <b>Crossing Type:</b> <i>(check applicable below)</i><br><input type="checkbox"/> OBS Open Bottom Structure  | <b>Crossing Sub-Type:</b> <i>(check applicable below)</i><br><input type="checkbox"/> BRIDGE<br><input type="checkbox"/> PIPE ARCH<br><input type="checkbox"/> WOOD BOX CULVERT |
| <input type="checkbox"/> CBS Closed Bottom Structure   | <input type="checkbox"/> ROUND CULVERT<br><input type="checkbox"/> OVAL CULVERT   |
| <input type="checkbox"/> OTHER   | <input type="checkbox"/> FORD   |
| This is to certify that, as of _____, 20____, the work has been carried out to the Province's satisfaction in accordance with the Fish Passage Activity Standards. |   |
| DATED THE _____ DAY OF _____, 20____.  | MINISTRY REPRESENTATIVE'S SIGNATURE:  |