Diane Roy
Director, Regulatory Services

Gas Regulatory Affairs Correspondence
Email: gas.regulatory.affairs@fortisbc.com

Electric Regulatory Affairs Correspondence
Email: electricity.regulatory.affairs@fortisbc.com

FortisBC
16705 Fraser Highway
Surrey, B.C. V4N 0E8
Tel: (604) 576-7349
Cell: (604) 908-2790
Fax: (604) 576-7074
Email: diane.roy@fortisbc.com
www.fortisbc.com

June 29, 2016

British Columbia Utilities Commission
6th Floor, 900 Howe Street
Vancouver, BC
V6Z 2N3

Attention: Ms. Laurel Ross, Acting Commission Secretary and Director

Dear Ms. Ross:

Re: FortisBC Inc. (FBC or the Company)

Application for a Certificate of Public Convenience and Necessity (CPCN) for Replacement of the Corra Linn Dam Spillway Gates (the Application)

Pursuant to sections 45 and 46 of the *Utilities Commission Act* (the Act), FBC applies to the British Columbia Utilities Commission (the Commission) for a CPCN to construct and operate fourteen replacement spillway gates and upgrade the associated structures at the Corra Linn Dam, as described in the Application.

Requests for Confidential Treatment of Certain Appendices

To support the Application, FBC has filed several Appendices, with the following ones being filed confidentially in accordance with the Commission Rules of Practice and Procedure, established by Order G-1-16.

- Appendix B Corra Linn Hydroelectric Project 2011/2012 Dam Safety Review
- Appendix D Structural Stability Analysis Corra Linn Dam
- Appendix E Preliminary Engineering Report
- Appendix F-1 Report on the Corra Linn Dam Visual Inspection
- Appendix F-2 Report on the Corra Linn Dam Electrical Visual Inspection
- Appendix F-3 Report on the Corra Linn Dam Gate Thickness
- Appendix F-4 Electrical Site Visit Report
- Appendix H Corra Linn Spillway Gate Project Risk Register
- Appendix J Financial Schedule: Alternative 3 Gate Refurbishment
- Appendix K Financial Schedule: Alternative 4 Gate Replacement
- Appendix L HMI AACE Class 3 Cost Estimate
- Appendix M Design Basis Memorandum for the Analysis of the Spillway Gates and Superstructures

FBC respectfully requests that the Commission hold the above listed documents confidential, and believes that such information should remain confidential even after the regulatory process for this Application is completed. Below, FBC will outline the reasons for keeping the information confidential.

Appendix B, D, E, Appendices F1 through F4, Appendix, H and M

Appendices B, D, E, F1 through F4, H and M are engineering documents. They should be kept confidential on the basis that they contain sensitive technical information pertaining to the Company's assets. In particular, they identify vulnerable points on the Company's electrification system. FBC reasonably expects that the release of this information may jeopardize the safety and security of the Company's assets.

Appendix J, K, and L

Appendices J, K and L are cost estimates, containing capital cost estimates for the Project. They should be kept confidential on the basis that FBC may be going to the market to seek competitive bids for the materials and construction work for the Project. If the estimated costs for the material and construction work are disclosed, FBC reasonably expects that its negotiating position may be prejudiced. For instance, the bidding parties with knowledge about the estimated costs may use the estimate costs as a reference for their bidding.

Access to Confidential Information for Interveners

Should parties that choose to register in the review of this Application require access to some or all of the information filed confidentially, FBC has provided a proposed Undertaking of Confidentiality in Appendix P-3, to be executed before confidential information may be released to registered parties under the terms of the undertaking. FBC has no objection to providing confidential information to its customary and routine intervener groups representing customer interests. FBC requests that the Commission provide it with the opportunity to file comments on any objections or concerns that it may have, should any other registered parties seek access to confidential information.

If further information is required, please contact the undersigned.

Sincerely,

FORTISBC INC.

Original signed:

Diane Roy

Attachments

cc (email only): Participants in the Annual Review for 2016 Rates

FortisBC Inc.

Application for a Certificate of Public Convenience and Necessity for Replacement of the Corra Linn Dam Spillway Gates

Volume 1 - Application

June 29, 2016

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List of Appendices

Index of Tables and Figures

1. APPROVAL SOUGHT AND EXECUTIVE SUMMARY

1.1 *Summary of Approval Sought*

FortisBC Inc. (FBC or the Company) hereby applies (the Application or Corra Linn Dam Spillway Gate Replacement Application) to the British Columbia Utilities Commission (BCUC or Commission), pursuant to Sections 45 and 46 of the *Utilities Commission Act* (UCA or the Act), for a Certificate of Public Convenience and Necessity (CPCN) for the construction and operation of 14 replacement spillway gates and upgrades to the associated structures at the Corra Linn Dam (the Project or the Corra Linn Dam Spillway Gate Replacement Project) as described in the Application. The estimated capital cost for the Project in as-spent dollars, including Allowance for Funds Used During Construction (AFUDC) and cost of removal, is $62.694 million[1] with design commencing Q3 2017 and construction scheduled to begin Q2 2018. The Project is planned to be completed in phases with the last spillway gate scheduled to be in-service by December 2020 and contractor demobilization and restoration to occur in early 2021.

1.2 *Confidential Filings Request*

Certain Appendices to the Application contain operationally sensitive information, including detailed information that, if disclosed, could impede FBC's ability to safely and reliably operate its electric system assets and could risk the safety of both its workers and the public. As well, the Confidential Appendices contain market sensitive information that the Company believes should be kept confidential so as not to influence the construction contractor selection process for the Project. FBC will mark all confidential information as such, where applicable.

In accordance with the Commission's Rules of Practice and Procedure established by Order G-1-16, regarding Confidential Documents, FBC requests that interveners requesting access to confidential information execute an Undertaking of Confidentiality. A sample of the Undertaking of Confidentiality is included in Appendix P-3.

1.3 *Executive Summary*

1.3.1 Introduction

The Corra Linn Dam is located on the Kootenay River in British Columbia and is owned and operated by FBC. It was commissioned in 1932 for the purpose of generating electrical energy from the portion of the Kootenay River flows allocated to FBC, and for regulating the level of the Kootenay Lake reservoir.

[1] $51.166 million of capital costs plus $5.434 million of AFUDC would be charged to the Electric Plant in Service; $6.094 million of removal costs would be charged to Accumulated Depreciation.

The Corra Linn Dam is comprised of five sections, including a spillway that consists of 14 vertical lift gates that control the release of flows from Kootenay Lake into the Kootenay River. The spillway also contains a steel superstructure (which is comprised of bridges and towers), and a gate hoisting system that is used for lifting and lowering the gates.

In this Application, FBC has proposed the replacement of the 14 spillway gates, as well as upgrades to associated structures at the Corra Linn Dam.

1.3.2 Need for Repair or Replacement of the Corra Linn Dam Spillway Gates

There are two key drivers behind the proposal of the Project: (1) recent amendments that have occurred with respect to industry standards and regulations, and (2) the current condition of the spillway gates.

The replacement or rehabilitation of the spillway gates and associated equipment is essential for the Corra Linn Dam to align with industry standards, meet current regulation and minimize the risks to public and employee safety. Since 2007, there have been amendments to the Canadian Dam Association Dam Safety Guideline (CDSG) and the British Columbia Dam Safety Regulation (BCDSR), which are relevant to the Corra Linn Dam.

These amendments revised the “Dam Failure Consequence Classification”, a measure that classifies dams based on the severity of the potential consequences of a dam failure, resulting in the Corra Linn Dam being reclassified from a “Very High” consequence classification to an “Extreme” consequence classification. The amendments have also updated the magnitude of the “design flood” and “design earthquake”, which are used to define the severity of hazards that the Corra Linn Dam is recommended to be able to withstand. The Corra Linn Dam spillway gates do not have the strength to withstand the recommended design earthquake for a dam with a consequence classification of “Extreme”. The spillway gate system does not meet present day requirements of the BCDSR and the recommendations for withstand capability requirements under the latest edition of the CDSG. Accordingly, the spillway gates and the associated structures require either significant refurbishment or replacement, to align with these amendments and to be able to withstand the design earthquake.

In order to validate the current structural conditions and the original design of the various spillway components, FBC recently completed inspections on three of the 14 spillway gates at the Corra Linn Dam. These inspections revealed that the spillway gates are in fair to poor condition, and FBC considers the gates to be approaching end of life, unless significant rehabilitation is performed. The findings of these inspections, therefore, have been used to establish the extent of the reinforcement requirements based on the existing structural integrity of each component.

1.3.3 The Recommended Solution

The Company identified four alternatives with respect to the spillway gates: Alternative 1: Do Nothing, Alternative 2: Deferral, Alternative 3: Gate Refurbishment, or Alternative 4: Gate Replacement.

To assess each of these alternatives, four technical criteria were identified: (1) the ability of the gates to withstand the design flood and design earthquake events, (2) the ability of the gates to remain operational following the design earthquake event, (3) the minimization of project risks, and (4) the minimization of possible failures of the gates and associated equipment.

Applying these four criteria, the Company determined that only Alternative 3: Gate Refurbishment and Alternative 4: Gate Replacement were feasible alternatives for the Project and will mitigate the reliability, safety and regulatory risk posed by the current condition of the spillway gates. While each of these alternatives were feasible, only Alternative 4: Gate Replacement satisfied each of the technical requirements, as it was assessed as having fewer project risks than Alternative 3: Gate Refurbishment.

To further compare the two feasible alternatives, a financial criterion of minimizing the financial impacts of the Project was used. While Alternative 3: Gate Refurbishment had lower initial capital costs than Alternative 4: Gate Replacement, this did not take into account the fact that the existing gates are 84 years old, and that, even with extensive refurbishment, the current gates are likely to need replacement by 2032, when they will be 100 years old. Taking into account the refurbishment costs and the estimated capital costs associated with this replacement in 2032 associated with Alternative 3: Gate Refurbishment, Alternative 4: Gate Replacement minimizes the financial impacts of the Project and is the most long term cost-effective solution.

As a result, FBC has selected Alternative 4: Gate Replacement as the preferred solution.

1.3.4 Project Costs and Rate Impact

The Corra Linn Dam Spillway Gate Replacement Project is estimated to have a capital cost of approximately $62.694 million, including AFUDC of $5.434 million and removal costs of $6.094 million. Table 1-1 and Table 1-2 below summarize the total forecast capital costs and financial analysis of the Project, respectively.

Based on the total Project costs, the rate impact in 2022 is estimated to be 1.49% when all assets have been transferred to their appropriate plant asset account. For a typical FBC residential customer consuming an average 991 kWh per month, this would equate to an approximate monthly bill increase of $1.83 in 2022.

Table 1-1: Summary of Forecast Capital Costs ($ millions)

Particular	2015 $	As-Spent $	AFUDC	Total
Total Additions Charged to Plant	47.950	51.166	5.434	56.599
Removal Costs[2]	5.598	6.094	-	6.094
Total Project Capital Cost	***53.548***	***57.260***	***5.434***	***62.694***

Table 1-2: Summary of Financial Measure ($ millions unless otherwise specified)

Particular	
2022 Incremental Rate Base	61.153
Present Value of Incremental Revenue Requirement	85.018
2022 Rate Increase %	1.49%
Levelized % Increase on Rate - 70 years	1.46%

Section 6 provides a summary of the Project capital cost estimate. The financial schedule for the analysis described in Table 1-2 can be found in Confidential Appendix K.

1.3.5 Stakeholder and First Nations Consultation

The permanent works of the Project will be entirely contained within the existing Corra Linn Dam generation facility, and Project execution will be carried out in a manner that isolates each gate from the Kootenay River while work is underway. As a result, the river flows will not be affected and FBC does not expect any impacts to the environment or fish populations.

As a result of the above, FBC does not expect any impact from the Project on stakeholders. FBC also believes that Aboriginal Rights and Title will not be affected by this Project, and therefore, that First Nation Consultation is not required. Despite this, FBC has discussed the Project with local First Nations during normal course of business through 2015 and 2016. FBC has also discussed the Project with the International Joint Commission (IJC)[3]and they have expressed no concerns with the Project to date. Additionally, the Company has discussed the Project with the Regional District of Central Kootenay (RDCK), which was identified as the only local stakeholder with a possible interest in the Project.

FBC will continue to update the IJC throughout the Project, and any concerns identified by stakeholders or First Nations will be appropriately addressed by FBC should they arise.

2 Removal costs will be charged to Accumulated Depreciation.

3 http://ijc.org/en_/Role_of_the_Commission - The IJC is guided by the Boundary Waters Treaty, signed by Canada and the United States in 1909. The treaty provides general principles, rather than detailed prescriptions, for preventing and resolving disputes over waters shared between the two countries and for settling other transboundary issues. The IJC has two main responsibilities: regulating shared water uses and investigating transboundary issues and recommending solutions.

Based on the information summarized above and provided in the Application, FBC believes it has demonstrated that the Project is in the Public interest and should be approved.

1.4 *RECOMMENDED REGULATORY REVIEW OF THE CPCN APPLICATION*

1.4.1 The CPCN Threshold & the PBR Materiality Threshold

Pursuant to the Company's Performance Based Ratemaking (PBR) Plan for the period 2014 through 2019 (which was approved by Order G-139-14) and the Capital Exclusion Criteria under Order G-120-15, the Commission set both a CPCN dollar threshold and a PBR materiality threshold of $20 million.[4]

With respect to the CPCN threshold, FBC will continue to apply to the Commission for a CPCN for projects that require in excess of $20 million in capital expenditures. As was noted above, the Corra Linn Dam Spillway Gate Replacement Project is estimated to have a capital cost of approximately $62.694 million, and FBC is therefore applying to the Commission for a CPCN for the Project.

Similarly, under the PBR materiality threshold, projects with capital expenditures over $20 million are excluded from the PBR formula-driven spending envelope. By Order G-120-15, FBC was directed to demonstrate to the Commission that the actual costs of this Project fall above the PBR materiality threshold of $20 million.[5] The Project is one single project, and is not the result of combining smaller projects.

FBC has always intended to file an application for a CPCN for the Project. In the Company's 2012 Integrated System Plan (2012 ISP), the Project (which was described at the time as the Corra Linn Spillgate and Spillway Concrete Rehabilitation Project) was identified in section 2.5.1.5 of the 2012 Long Term Capital Plan as being a "major" capital project.[6]

The Project was later discussed in FBC's 2014-2018 PBR Application (PBR Application) as a capital expenditure that would be the subject of a separate application for a CPCN. As is described in the PBR Application, the scope of the original project identified in the 2012 ISP had expanded due to a change in regulation. Specifically, section 5.4.2.2 of part C the PBR Application states:

> In mid-2011 the provincial government updated the BC Dam Safety Regulations to be consistent with the Canadian Dam Association Dam Safety Guidelines. Under the updated regulations dams are now classified under five categories instead of the four

[4] In the Decision accompanying Order G-139-14 (FBC Application for Approval of a Multi-Year PBR Plan for the years 2014 through 2018) at pp. 161-162, 175, the CPCN criteria was approved as the PBR materiality threshold, pending a further process. This further process occurred in FortisBC Energy Inc/FBC Capital Exclusion Criteria in PBR, and by Order G-120-15 the Commission ordered that FBC's CPCN dollar threshold will be maintained at $20 million and that the PBR materiality threshold be set at $20 million.

[5] Order G-120-15 at Order 3.

[6] FBC 2012 ISP, Vol. 1 2012 Long Term Capital Plan, pp. 54-55.

categories previously used. Each category has a corresponding design flood and design seismic event which are used when evaluating the safety of the dam as required under the regulation. FBC contracted a subject matter expert to conduct a Dam Safety Review and determine the consequence classification for the Corra Linn dam which resulted in a reclassification from the Very High to Extreme category. As a result of the reclassification, the specified design flood event and design seismic event against which the dam is evaluated have increased. Although FBC does not anticipate any issues with the increase in the design flood event associated with the reclassification, the change in the design seismic event is expected to result in some required structural modifications to enhance the withstand capacity of the Corra Linn dam.

As a result of the reclassification from "Very High" to "Extreme", and consistent with the information provided in the PBR Application, FBC's original plan of isolation, access, sandblasting and recoating the spill gates has now increased in scope to also include the work necessary to upgrade the strength of the spillway gates and associated equipment to withstand the design earthquake forces for a dam with a consequence classification of "Extreme".

1.4.2 Proposed Regulatory Process

The information presented in this Application accords with the guidelines set out in the Commission's *2015 Certificates of Public Convenience and Necessity Application Guidelines* (the CPCN Guidelines). Draft Procedural and Draft Final Orders are included as Appendix P-1 and Appendix P-2 respectively.

FBC believes that a written hearing process with two rounds of Information Requests from the Commission and interveners will provide for an appropriate and efficient review of the Application.

The alternatives available to FBC are straightforward and the alternative selected by the Company is the most cost-effective, as well as it is the only option which addresses all identified issues. The Corra Linn Dam Spillway Gate Replacement Project will replace all 14 of the 84 year old Corra Linn Dam gates and will be designed to have an adequate withstand strength to align with the CDSG for a dam with an "Extreme" consequence classification. Construction will be confined to property and facilities wholly owned by FBC. The Application provides information on all areas required by the CPCN Guidelines. Any additional areas of concern in this Application can be adequately addressed through a written process.

FBC proposes the regulatory timetable set out in Table 1-3 below. FBC respectfully requests a Commission decision on the Project within three months of the close of the submissions in order to maintain its schedule for tendering and contract award. If the Application is approved, FBC plans to initiate the detailed design and procurement for the Project in early Q3-2017. FBC plans to begin construction in early Q2-2018, and is expecting to have all 14 gates in-service by December 2020 with contractor demobilization to occur in early 2021.

Table 1-3: Proposed Regulatory Timetable

ACTION	DATE (2016)
BCUC Issues Procedural Order	Week of July 11
FBC Publishes Notice by	Week of July 25
Intervener and Interested Party Registration	Friday, August 12
Commission Information Requests No. 1	Thursday, August 18
Intervener Information Requests No. 1	Thursday, August 25
FBC Response to Information Requests No. 1	Thursday, September 22
Commission and Intervener Information Requests No. 2	Thursday, October 13
FBC Response to Information Requests No. 2	Friday, November 4
FBC Final Written Submission	Friday, November 18
Intervener Final Written Submission	Friday, December 2
FBC Written Reply Submission	Friday, December 16

1.5 *ORGANIZATION OF THE APPLICATION*

The Application provides detailed information in support of the Project. The remainder of the Application is organized into the following sections:

- Section 2 provides an overview of the Applicant, and provides information on its financial and technical capabilities for the Project;
- Section 3 provides an overview of the existing facilities and a summary of the justifications for the Project;
- Section 4 provides a review of the Project objectives, sets out the evaluation criteria, describes the alternatives considered, and details the technical and financial evaluation of each of the alternatives;
- Section 5 provides a detailed description of the proposed Project, including construction, design, resource planning and management, schedule, as well as setting out a risk analysis and discusses potential Project impacts;
- Section 6 provides the cost estimates, the assumptions upon which the financial analysis is based and the rate impacts;
- Section 7 discusses FBC's public consultation and communication efforts regarding the Project; and
- Section 8 provides an overview of the Project environment, including a discussion of the environmental and socio-economic impacts the Project may have and how British Columbia's energy objectives are advanced by the proposed Project.

2. APPLICANT

2.1 NAME, ADDRESS AND NATURE OF BUSINESS

FortisBC Inc.
Suite 100, 1975 Springfield Road
Kelowna, BC V1Y 7V7

FBC is an investor-owned utility engaged in the business of generation, transmission, distribution and bulk sale of electricity in the southern interior of British Columbia. It is an integrated utility serving approximately 167,500 customers directly and indirectly. FBC was incorporated in 1897 and is regulated by the Commission pursuant to the UCA.

2.2 FINANCIAL CAPACITY

FBC is capable of financing the Project either directly or through its parent, FortisBC Pacific Holdings Inc. FBC has credit ratings for senior unsecured debentures from DBRS and Moody's Investors Service of A (low) and Baa1 respectively.

2.3 TECHNICAL CAPACITY

The Company has a rate base of approximately $1.3 billion, including four hydroelectric generating plants with an aggregate capacity of 225 megawatts, and approximately 7,200 kilometres of transmission and distribution power lines for the delivery of electricity to major load centres and customers in its service area. FBC employs approximately 500 full-time and part-time people.

FBC will provide the necessary resources to manage the execution of the Corra Linn Dam Spillway Gate Replacement Project. The Company has considerable experience in the overall management in a number of large hydroelectric rehabilitation and upgrade projects. Specifically, FBC has managed the following hydroelectric projects:

- Unit life Extension projects for 11 of the company's 15 generators;
- Individual gate rehabilitation projects at two third party clients; and
- Concrete rehabilitation projects at FBC-owned facilities and at third party facilities.

In addition, in recent years the Company has completed several major projects including the Advanced Metering Infrastructure project (total value of approximately $51 million) and the Okanagan Transmission Reinforcement project (total value of approximately $104 million). FBC proposes that the construction for the Project be done by a reputable contractor, with specialized experience in the design, supply and installation of spillway gate systems. FBC engaged HMI Construction, a firm specializing in spillway gate systems, to complete the preliminary engineering and to support the development of the Project Cost Estimate. Engaging a specialized constructor at this early stage of the Project lends to improved project risk identification, ensuring constructability of the proposed solution and increased confidence in the Project Cost Estimate.

FBC intends to supplement its internal resources with a knowledgeable Owner's Engineer that is familiar with the design of spillway gate systems. The role of the Owner's Engineer will be to review the Contractor's design and provide Quality Assurance services during construction. For construction of the Project, FBC has set up a Project team consisting of both internal and external personnel, as detailed further in Section 4.5.1.

2.4 COMPANY CONTACT

Diane Roy
Director, Regulatory Services
FortisBC Inc.
Suite 100, 1975 Springfield Road
Kelowna, British Columbia, V1Y 7V7
Phone: 604-576-7349
Fax: 866-335-6295
electricity.regulatory.affairs@fortisbc.com

2.5 LEGAL COUNSEL

Erica C. Miller
Farris, Vaughan, Wills & Murphy LLP
2500 – 700 West Georgia Street
Vancouver, British Columbia V7Y 1B3
Phone: 604-684-9151
Fax: 604-661-9349
emiller@farris.com

3. PROJECT JUSTIFICATION

In this section, FBC will:

- provide a description of the dam and components relevant to the Application;
- describe the industry standards and regulatory framework that apply to hydroelectric dams in British Columbia, and recent changes that have occurred; and
- outline the drivers for the required upgrade of the spillway gates and associated equipment.

3.1 *DESCRIPTION OF FACILITIES*

3.1.1 Plant Overview and History

FBC owns four regulated hydro-electric generating plants on the Kootenay River with an aggregate capacity of 225 megawatts: the Corra Linn, Upper Bonnington, Lower Bonnington, and South Slocan Plants. The currently operating plants were completed in phases over a number of years ranging from 1907 to 1940.

The Corra Linn Dam, which is the subject of the Application, is owned and operated by FBC. It is a concrete mass gravity structure[7] comprised of five sections: the east dam, the spillway, the middle dam, the powerhouse and associated headworks, and the west dam. It is located on the Kootenay River, approximately 15 km downstream of the city of Nelson, BC. As shown in Figure 3-1, it is the uppermost dam of a series of FBC owned dams.

The Corra Linn Dam was commissioned in 1932 to control upstream storage by raising the Kootenay Lake level, and to generate power using three 16 megawatt units operating under a head of approximately 16 metres. Its purpose continues to be twofold: 1) the generation of electrical energy from the portion of the Kootenay River flows allocated to FBC, and 2) the regulation of the level of the Kootenay Lake reservoir.

The Dam has a spillway which is comprised of 14 vertical lift gates that control the release of flows from the Kootenay Lake through the Dam, into the Kootenay River. The spillway also includes a steel superstructure (comprised of bridges and towers) and a gate hoisting system.

In 1976, BC Hydro commissioned the 580 megawatt Kootenay Canal Generating Station adjacent to the Corra Linn Plant. Both plants share the same Kootenay Lake reservoir. However, it is important to note that the Kootenay Canal facility has no ability to spill water; any water entering the plant is used to produce electricity. Thus, the 14 spillway gates located at the Corra Linn Dam are the only means for the controlled release of excess water from Kootenay Lake, which is not used for electricity production at either plant.

[7] A concrete mass gravity dam is constructed from concrete and designed to hold back water by primarily utilizing the weight of the material alone to resist the horizontal pressure of water pushing against it.

Figure 3-1 below provides a map showing the location of FBC's four generation plants (including the Corra Linn Dam) on the lower Kootenay River, as well as the BC Hydro Kootenay Canal Generating Station. Figure 3-2 is an aerial photograph of the Corra Linn Dam and the Kootenay Canal Headworks and Figure 3-3 depicts the general arrangement of the Corra Linn Dam.

Figure 3-1: FBC Owned Dam locations

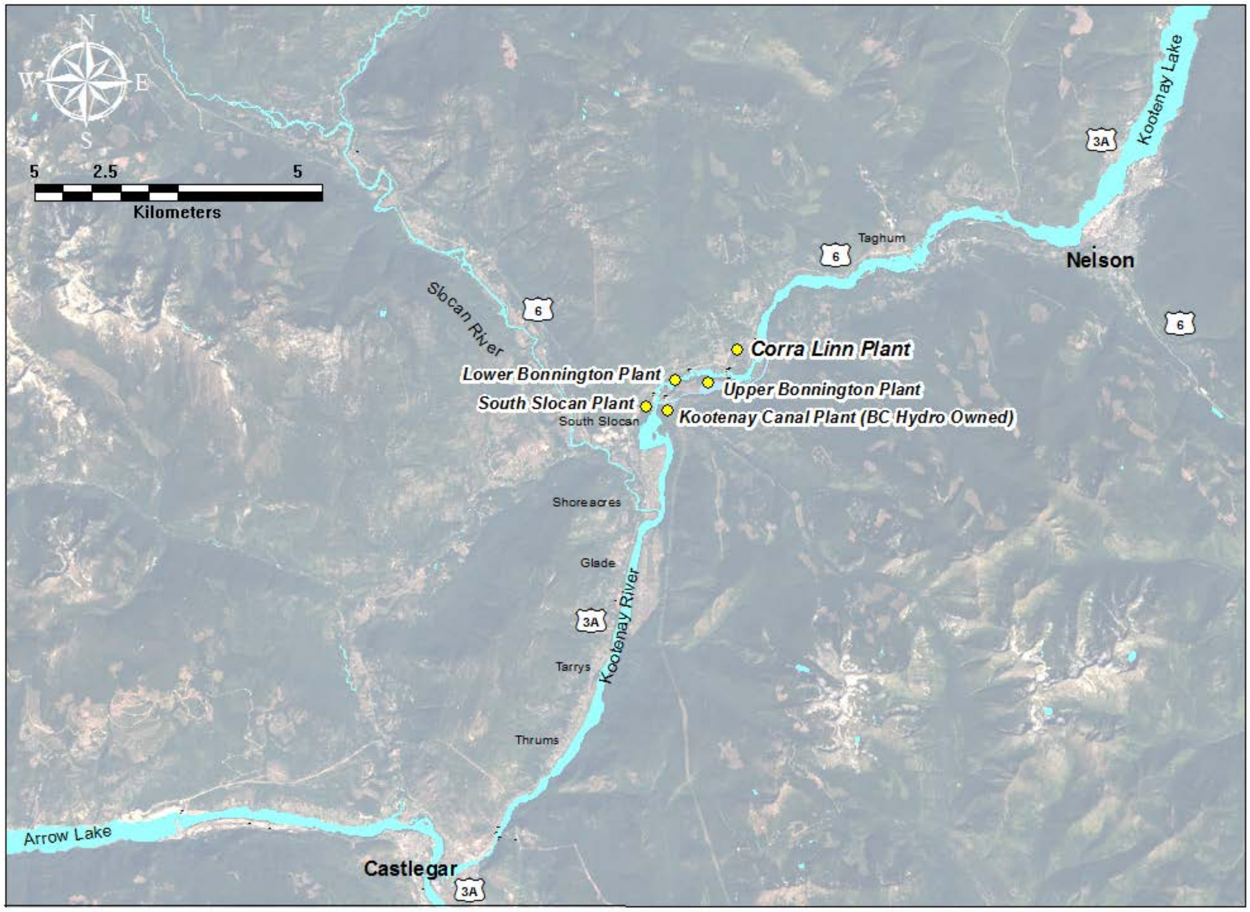
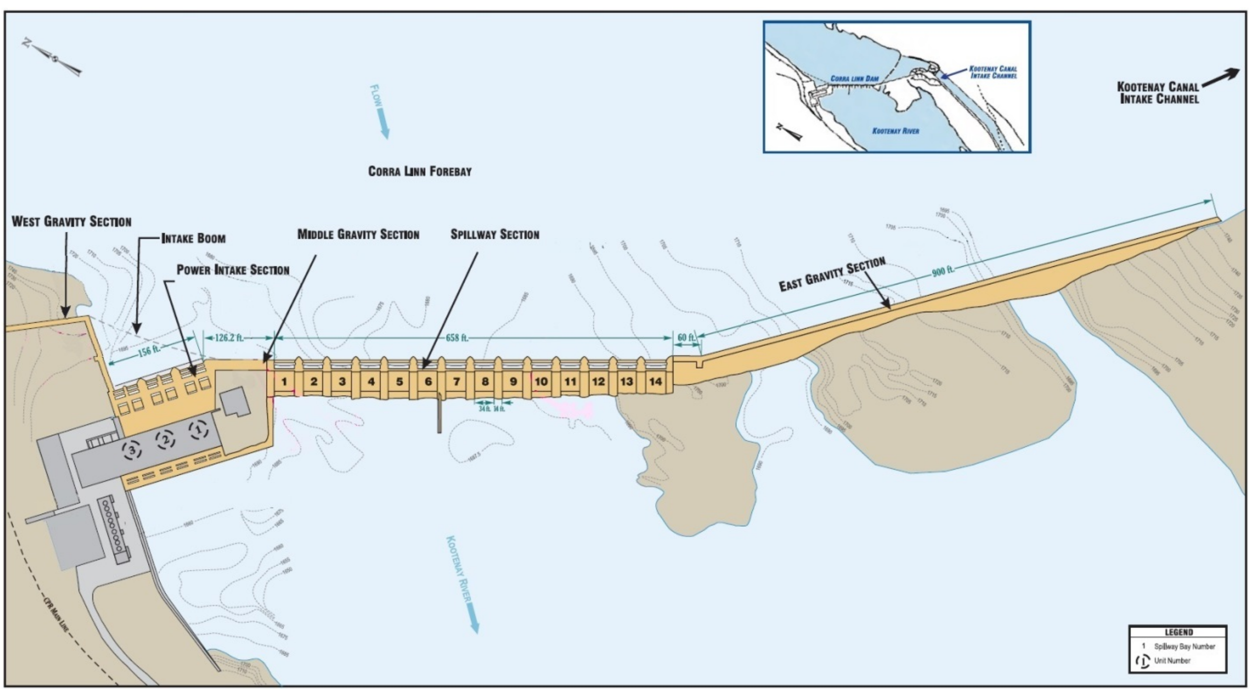


Figure 3-2: View of Corra Linn Dam and Powerhouse, with Kootenay Canal Headworks in Background

Figure 3-3: Corra Linn Dam General Arrangement



3.1.2 Spillway Gates

There are 14 identical spillway gates at the Corra Linn Dam, each approximately 10 metres wide by 10 metres high. The gates were installed in 1932, and they have now been in operation for 84 years. Six of the spillway gates can be seen in Figure 3-4 below.

The Corra Linn Dam spillway gate facilities are critical for the safe operation of the reservoir and dam and provide an essential means for controlling reservoir levels. The gates are also used to release water to safely lower the reservoir in a controlled manner when high flow conditions occur. The ability of the gates to safely pass this water to lower the reservoir level in a controlled manner, while simultaneously providing a barrier to retain water, is dependent on the reliability and the structural capacity of the gates. Assuring that the gates maintain their capacity under all reasonably foreseeable scenarios not only protects the dam itself, but also prevents potential negative effects on the downstream population, environment and infrastructure.

3.1.3 Steel Superstructure

In addition to the gates, the spillway includes a steel superstructure, which consists of 16 bridges and 17 towers. It is the support structure which is used to lift the spillway gates. A section of the dam showing 6 gates along with the towers and bridges is shown in Figure 3-4. 14 of the 16 bridges are located over the spillway gates while the two outer bridges are used to park the travelling hoists when not in use. Each bridge is comprised of two main beams that span the space between any two towers. Two crane rails on top of the main bridge allow the gate hoisting system, described next, to travel the full length of the spillway.

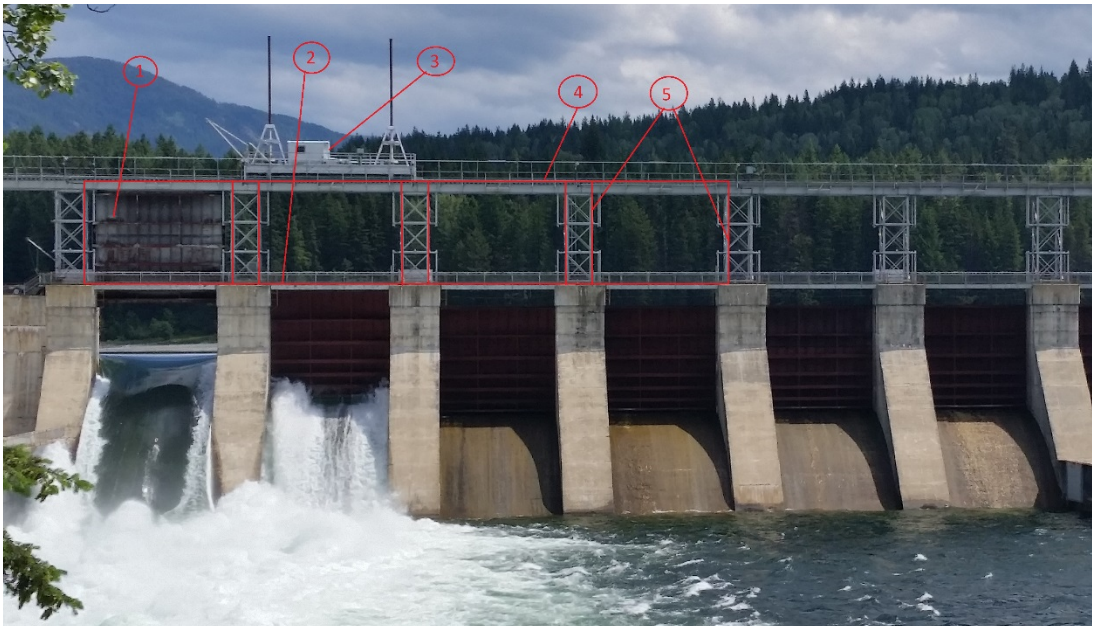
Dogging beams are located immediately below each spillway bridge and are used for hanging or “dogging” the gates in the full open position.

3.1.4 Gate Hoisting System

The 14 spillway gates are raised (opened) or lowered (closed) in order to regulate water flow. This is done using two electrically operated travelling screw hoists, which can be moved along the length of the steel superstructure to reach each of the gates.

A motor is used to move the hoist and is connected to a pair of wheels on the hoist through a series of gears and pinions.

Figure 3-4: Spillway Detail



Legend

1. Spillway gate hung (dogged) in the full open position
2. Spillway gate in partially open position, controlled by the spillway gate hoist
3. Spillway gate travelling screw hoist
4. Superstructure bridge
5. Superstructure tower

3.2 *NEED FOR THE PROJECT*

In this section, FBC will describe the key drivers for the Project including:

- industry standards and regulations have revised the safety consequence classification for the Corra Linn Dam;
- the spillway gate system does not meet present day requirements of the BCDSR and the recommendations for withstand capability requirements of a design earthquake event under the latest edition of the CDSG; and
- the spillway gates themselves are approaching end of life.

FBC will also include an overview of the relevant progression of the regulation of dams and industry standards in BC, followed by a description of the changes in requirements that led to this Application for the replacement of the spillway gates, reinforcement of spillway hoists, support towers and upgrades to associated equipment.

3.2.1 Changes in Industry Standards and Regulation of Dams in British Columbia have changed the Corra Linn Dam Consequence Classification

Since 2007, there have been changes in industry standards and to the regulation of dams in British Columbia that impact the Corra Linn Dam. In this section, FBC will discuss these changes, specifically with respect to:

- the Canadian Dam Association (CDA) Dam Safety Guidelines (CDSG); and
- the BC Dam Safety Regulation (BCDSR).

The CDSG is considered to be the industry standard in Canada, and it outlines the recommended dam design loads that a facility must withstand. The BCDSR has been amended to adopt portions of the CDSG, and it lays out the requirements that dam owners must meet, and sets out penalties for non-compliance.

The following sections describe the evolution of the BCDSR and the CDSG, as they relate to the Corra Linn Dam and spillway gates.

3.2.1.1 Changes to the Canadian Dam Association Dam Safety Guidelines

The CDA is an organization dedicated to "advancing knowledge and practices related to dams, consistent with social and environmental values"[8]. The CDA is not a statutory or regulatory organization but rather serves to promote excellence in dam engineering, construction and operation. The CDA is a member society of the Engineering Institute of Canada and serves as the Canadian national committee of the International Commission on Large Dams (ICOLD).

The CDA has Technical Committees and Working Groups that produce publications such as the CDSG and issue guidelines and technical bulletins on topics such as Public Safety around dams. The CDSG describes the generally accepted engineering practice and expectation for the performance of dams. It is considered to be the industry standard within Canada, and it has been utilized in developing Canadian regulations, such as the BCDSR.

The CDSG establishes a "Dam Consequence Classification", which is a system for classifying Canadian dams into categories, based on the severity of the possible consequences of a dam failure. Prior to amendments in 2007, the Dam Consequence Classification was a four-tiered scale, ranging from "Low" to "Very High". For each consequence classification, the CDSG defines a "design flood" and a "design earthquake" (both described further below), which is a measure of the severity of hazards that each classification of dam is recommended to withstand.

[8] See "About CDA" on the CDA website at: http://www.imis100ca1.ca/cda/Main/About_CDA/About_CDA/CDA/About_CDA.aspx?hkey=dac6de9e-aae2-49c6-88a5-040029436de8.

In 2007, there were two key changes to the CDSG that are relevant to this Application and the Corra Linn Dam. The first change was the addition of an additional consequence classification category of "Extreme", and the second was an update to the design flood and design earthquake which define the "withstand capacity" for a dam with a classification of "Extreme" (the severity of hazard that an "Extreme" dam is recommended to withstand). These changes are described next.

3.2.1.1.1 ADDITION OF THE "EXTREME" DAM CONSEQUENCE CLASSIFICATION

As noted above, prior to 2007 the CDSG set out a four-tiered dam consequence classification: "Low", "Significant", "High" and "Very High". In 2007, the CDSG was revised to add an additional "Extreme" category, resulting in a five-tiered dam consequence classification: "Low", "Significant", "High", "Very High", and "Extreme" classifications.

The consequence classification of a dam is based on the possible incremental consequences of dam failure. The possible causes of failure are broadly broken into two categories: a "sunny day" failure (i.e. one that happens without warning as, for example, with an earthquake), and a "rainy day" failure (which is caused by floods). Consequences are assessed in each of the following categories:

- potential for the loss of life;
- loss or deterioration of critical fish or wildlife habitat, rare or endangered species, unique landscapes or sites of cultural significance; and
- economic losses affecting infrastructure, public transportation or services, commercial facilities, or destruction or damage to residential areas.

The more serious the incremental consequences of a dam failure, the higher the consequence classification of a dam will be.

Prior to the amendment in 2007, the Corra Linn Dam had a "Very High" consequence classification. With the amendment, it was reclassified into the "Extreme" category, based on the potential for loss of life as the result of a dam failure.

3.2.1.1.2 UPDATES TO THE DESIGN FLOOD AND DESIGN EARTHQUAKE VALUES

Under the CDSG, each consequence classification has a "design flood" and a "design earthquake" that is a measure of the severity of hazards that the structure is required to withstand. The 2007 updates to the CDSG included revisions to the design flood and design earthquake values for each of the five consequence classifications. For the "Extreme" classification, the design flood and design earthquake values are determined with reference to the Probable Maximum Flood (PMF[9]) and the Maximum Credible Earthquake (MCE[10]),

[9] As defined by the CDSG, the Probable Maximum Flood is the most severe flood than can be reasonably expected to occur at a particular location.

respectively. Specifically, the CDSG recommends that an “Extreme” dam and associated structures must remain stable in the event of a design flood with the maximum design flood load condition of the PMF or in the event of a design earthquake with the seismic load condition of either the 1/10,000 year event or the MCE.

Design earthquake values are specific to each facility and the design flood values are specific to a particular river and the associated watershed.

As a result of these changes to the CDSG, the Corra Linn Dam does not have sufficient capacity to withstand the design earthquake associated with the “Extreme” classification.

3.2.1.2 Changes to the BC Dam Safety Regulation (BCDSR)

The Corra Linn Dam was originally commissioned in 1932, however, over the years, regulatory requirements have been updated and changed.

Since the revisions to the CDSG, the BCDSR has also been amended to reflect current industry standards. The objective of the BCDSR[11] is to mitigate loss of life and damage to property, infrastructure, and the environment from a dam breach by requiring dam owners to inspect their own dams, undertake proper maintenance on them, and ensure that these dams meet ongoing engineering standards.

The Corra Linn Dam is licensed and is regulated under the Water Sustainability Act[12]. The dam owner, FBC, is required to meet the requirements specified within the BCDSR,[13] which has significant penalties for non-compliance[14]. FBC submits an annual Dam Safety Compliance Report to the Dam Safety Section of the Water Management Branch, Ministry of Forests, Lands and Natural Resources, which assesses and enforces compliance with the BCDSR.

The BC Dam Safety Regulation was first passed into law under the Water Act as BC Regulation 44/2000, effective February 11, 2000. Based on the criteria set out in the 2000 version of the BCDSR, the Corra Linn Dam had a consequence classification of “Very High”.

On November 30, 2011, the BCDSR was amended (see Appendix A-1 - BC Regulation 163/2011). As part of this amendment, a new consequence classification of “Extreme” was added to the BCDSR, to align the consequence classifications of BC dams with the current CDSG. A comparison of the changes to the BC Dam Failure Consequences Classification from

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[10] As defined by the CDSG, the Maximum Credible Earthquake is the largest possible earthquake anticipated for the site.

[11] http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/dam-safety/2016_info_sheet_ds_reg_17mar2016_final.pdf

[12] The Water Act was replaced with the Water Sustainability Act (Act) on February 29, 2016. The new Act has authority over dams (considered works) and holds owners of dams liable for any damage caused by the construction, operation or failure of their dam. Under the Act, owners of dams are responsible for obtaining a water licence and complying with its terms and conditions.

[13] http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/laws-rules/2016_dam_safety_regulation.pdf

[14] Ibid., 29(2)(b) “in the case of a continuing offence, a fine of not more than $1 000 000 for each day the offence is continued or imprisonment for not longer than one year, or both.”

the 2000 BCDSR (BC Reg. 44/2000) to the 2011 BCDSR (BC Reg. 163/2011) is provided in Appendix A-2. The 2011 amendment also added a requirement to complete more frequent periodic Dam Safety Reviews (DSRs).

The BCDSR was most recently updated on February 29, 2016 (BC Regulation 40/2016)[15], following the introduction of the Water Sustainability Act. Much like the 2011 version of the BCDSR, the current version continues to align with the consequence classifications set out in the current CDSG, and requires the completion of periodic DSRs.[16]

3.2.1.2.1 ADDITION OF A NEW "EXTREME" CONSEQUENCE CLASSIFICATION

With the amendment of the BCDSR in June 2011, the BCDSR has added an "Extreme" category as a consequence classification, in alignment with the CDSG.

The BCDSR defines the "Extreme" category as follows:

Classification:	Extreme
Population at Risk:	Permanent
Loss of Life:	More than 100
Environmental and cultural values:	Major loss or deterioration of:
	(a) critical fisheries habitat or critical wildlife habitat,
	(b) rare or endangered species, or
	(c) unique landscapes or
	(d) sites having significant cultural value, and restoration or compensation in kind is impossible.
Infrastructure and economics:	Extremely high economic losses affecting critical infrastructure, public transportation or services or commercial facilities, or some destruction of or some severe damage to residential areas.

This amendment resulted in a change to the consequence classification of the Corra Linn Dam from "Very High" to the newly created "Extreme" category, based on the loss of life in excess of 100 persons downstream of the dam.

[15] http://www.bclaws.ca/civix/document/id/complete/statreg/40_2016.
[16] As designed, the Project meets the requirements of the current version of the BCDSR, as well as the CDSG.

3.2.1.2.2 DAM SAFETY REVIEWS

The BCDSR also requires dam owners to undertake DSRs at a frequency that is determined by the dam's consequence classification. These DSRs are required to be conducted by an engineering professional with qualifications and experience in dam safety analysis.

Specifically, section 5 of the BCDSR sets out the responsibility of a dam owner for the condition and safety of the dam, as follows:

> 5 (1) An owner of a dam must properly inspect, maintain and repair the dam and related works in a manner that keeps the dam and works in good operating condition.
>
> (2) An owner of a dam must exercise reasonable care to avoid the risk of significant harm resulting from a defect, insufficiency or failure of the dam or other conditions at the dam or operations or actions at or in connection with the dam to any of the following:
>
> (a) public safety;
>
> (b) the environment;
>
> (c) land or other property.

The engineering profession in BC is regulated by the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC). With respect to dam safety, APEGBC publishes a Professional Practice Guideline for Legislated Dam Safety Reviews in BC[17] which was commissioned by the BC Ministry of Forests, Lands and Natural Resource Operations to assist in the development of DSRs. The guidelines define the professional services, standard of care and specific tasks to be provided by APEGBC members conducting this type of work, provide descriptions of the roles and responsibilities of the various participants/stakeholders involved in a dam safety review, and set out expectations for the appropriate knowledge, skill sets and experience to be held by APEGBC members working in this field. According to APEGBC, the practice guidelines "have been written with the intention of guiding professional practice for legislated dam safety reviews pursuant to British Columbia Dam Safety Regulation 44/2000, including revised amendments".

Section 2.2.2 of the Professional Practice Guidelines sets out the requirements for a qualified professional engineer:

[17] Legislated Dam Safety Reviews in BC – APEGBC Professional Practice Guidelines v. 2.0, March, 2014. https://www.apeg.bc.ca/getmedia/a373a764-1869-41b5-b07d-81d36a0698c3/APEGBC-Legislative-Dam-Safety-Reviews.pdf.aspx.

During the dam safety review the qualified professional engineer must:

- Conduct the dam safety review in compliance with applicable legislation, these guidelines and using guiding principles in the CDA Dam Safety Guidelines and associated technical bulletins.

3.2.2 Corra Linn Dam Upgrades are Required to Comply with Regulation and Industry Standard

In this section, FBC will describe the DSR completed in 2012, which considered whether the Corra Linn Dam met the requirements of the CDSG and BCDSR, including all amendments. This section also describes the recommendations from this DSR, and the subsequent studies that led to recommendations for the replacement or reinforcement of the spillway gates, spillway hoists, support towers and associated equipment, in order to align with the withstand requirements of the CDSG for a dam rated with a consequence classification of "Extreme".

3.2.2.1 2012 Corra Linn Dam Safety Review (2012 DSR), Recommendations and Withstand Capacity

Prior to the 2011 BCDSR changes, the most recent DSR conducted at the Corra Linn Dam was in 2002. At that time, the dam was rated as having a "Very High" consequence category, based on the BCDSR four-tiered consequence classification system, and dams with a "Very High" consequence classification required DSRs every ten years. Based on this DSR frequency requirement, FBC was next required to undertake a DSR by December 31, 2012.

In 2012, FBC contracted Knight Piésold Ltd. (KP) to undertake a DSR (2012 DSR) to determine if the Corra Linn Dam met the requirements of the BCDSR, including the recent 2011 amendments, and if it was in general conformity with the CDSG. A copy of the KP 2012 DSR is included as Confidential Appendix B.

The 2012 DSR concluded that the consequence classification of the Corra Linn Dam be updated from a "Very High" consequence category to the newly created "Extreme" consequence category, as a result of the amendments to the BCDSR, and the finding that there will be the likelihood of a permanent incremental population in excess of 100 at risk if the dam were to fail.

The conclusions and recommendations of the 2012 DSR also included the following:

- that the seismic stability of the Corra Linn Dam be reassessed, as a result of the updated design earthquake resulting in an increase in both the required return period and the ground motion associated with that return period;
- that the seismic withstand capacity of the spillway gates, gantry and hoists be assessed to ensure that the equipment will be operable after an earthquake; and
- that consideration be given to the redundancy of the power supply and electrical feed.

These key findings of the 2012 DSR are detailed on page 16 and 17 of the 2012 DSR (Confidential Appendix B).

Due to the potentially significant implications of the change in the Corra Linn consequence classification to "Extreme", FBC sought clarification from KP of the change. KP reviewed its assessment of the 2012 DSR and in early 2015 confirmed its original key findings that the "Extreme" classification would apply.

As a result, the Project elements are predicated on the Corra Linn Dam having a consequence classification of Extreme.

As summarized above, further studies were recommended by KP in the 2012 DSR which included a recommendation that FBC re-assess the seismic structural stability of the dam using the longer seismic return period and the increased ground motion acceleration associated with that return period (Dam Stability Study) and assess the seismic withstand capacity of the spillway gates and associated equipment to ensure they would be operable after an earthquake (Gate Withstand Study). These follow-up studies are discussed in the next sections.

3.2.2.2 Summary of the Dam Stability Study

In 2015, as a follow-up to the recommendations in the 2012 DSR, FBC engaged KP to perform the Dam Stability Study to re-assess the structural stability of the Corra Linn Dam.[18] This assessment was focussed on the structure of the Dam itself, and did not include the spillway gates and associated equipment within the scope of the analysis. KP considered previous upgrades completed on the Dam, together with the new "Extreme" dam failure consequence classification and the associated requirements for the design flood and design earthquake values outlined in the CDSG. As an additional input into the Dam Stability Study, KP engaged Wutec Geotechnical International in May 2015 to create a technical report that provided the earthquake design loads which would inform the design criteria to be used for dam and spillway gates: *Corra Linn Dam – Seismic Hazard Assessment and Input Ground Motions* (Wutec Report). A copy of the Wutec Report is attached as Appendix C.

The results of the Dam Stability Study are summarized in the Structural Stability Analysis Report of Corra Linn Dam, prepared by KP and included as Confidential Appendix D to this Application.

In the Dam Stability Study, KP concluded that the Corra Linn Dam concrete structure is expected to perform satisfactorily under the maximum design earthquake (MCE) and Maximum Design Flood (PMF) event if all the potential stabilizing forces can be relied upon.[19]

3.2.2.3 Summary of the Gate Withstand Study

Also as a follow-up to the 2012 DSR, FBC retained the services of a well-established spillway gate contractor, HMI Construction Inc. (HMI), to perform a Gate Withstand Study to assess the

[18] The previous stability analysis was performed as part of the 2002 DSR. The dam was found to meet all the requirements in effect at that time.

[19] Page 1 of Confidential Appendix D, Structural Stability Analysis – Corra Linn Dam.

seismic withstand capability of the spillway gates, towers, bridges, and hoists. FBC also retained HMI to assist in developing the spillway gate and superstructures reinforcement requirements, if any. HMI's report (HMI Preliminary Engineering Report) is included as Confidential Appendix E to the Application.

HMI's scope of work entailed reviewing the latest dam safety regulations and guidelines and determining if the current equipment meets the design withstand capacity. In the review process, the following equipment were analyzed and evaluated:

- the capacity of the gates to withstand the "Extreme" classification design earthquake event;
- the capacity of the gates to operate during the "Extreme" classification design flood event;
- the capacity of the superstructures to remain operable after the "Extreme" classification design earthquake event; and
- the capacity of the hoists to remain operable after the "Extreme" classification design earthquake event.

HMI also evaluated the reliability of the facility and the following potential safety hazards:

- structural failure of the spillway gates during a flood or seismic event which would lead to downstream water surges/uncontrolled release of water;
- structural failure or overturning of the superstructure during a seismic event that would render the gates inoperable which may potentially make the Dam vulnerable to overtopping and potential catastrophic failure of the Dam;
- structural failure or overturning of the travelling hoist during a seismic event would render the gates inoperable which may potentially make the Dam vulnerable to overtopping and potential catastrophic failure of the Dam; and
- mechanical failure of the hoist preventing the spillway gates operation that could be hazardous to facilities and public downstream of the Dam.

The key conclusions of HMI's evaluation in the Gate Withstand Study on the withstand capacity of the Corra Linn spillway gates are that:

- the gates require either replacement or significant refurbishment of the existing gate frame and skin plate;[20] and
- the towers and bridges of the superstructure require reinforcement.[21]

[20] See Confidential Appendix E, section 2.6.3, p. 19. "The skin plate has to be reinforced in some matter [sic]."
[21] See Confidential Appendix E, section 5.4 and 5.5. "The tower should be reinforced to resist the 1/10000 year recurrence earthquake. Multiple reinforcements are required" and "The limit state summary of the bridge remains

3.2.3 Corra Linn Dam Spillway Gates are Approaching End of Life

The recommended design life of a new gate is 100 years as per the US Army Corps of Engineers,[22] assuming appropriate repairs and rehabilitation projects are performed during the gate service life. Further, the Corra Linn Dam was not constructed with a means of isolating the spillway gates, such as a bulkhead,[23] making routine maintenance difficult. As such, maintenance and refurbishment activities on the gates have been appropriate but minimal due to limited access.

In January 2016, various inspections were performed both by FBC and external specialist consultants to assess the condition of the gates, to determine the extent of the refurbishment that would be required to reinforce or replace the components. The three major components inspected were the three spillway gates[24], the steel superstructure supporting the spillway gate hoists and the spillway gate hoists. The inspections included visual inspection, non-destructive testing, electrical testing and metallurgical testing. The inspections indicate that the condition of the spillway gates are in fair to poor condition. The inspection reports are presented in Confidential Appendix F and consist of:

- Dam Visual Inspection;
- Dam Electrical Visual Inspection;
- Dam Gate Thickness; and
- Electrical Site Visit.

On this basis, FBC considers the gates to be approaching end of life unless significant rehabilitation is performed.

While FBC would have preferred to also conduct an inspection of the embedded parts[25] of the spillway gates, this is not possible due to the Corra Linn Dam's design, which makes it challenging to isolate and dewater the spillway gates. In order to assess the extent and type of rehabilitation required, FBC used the results from the inspection of the embedded parts of the spillway gates at another plant which FBC considers to be comparable to the Corra Linn Dam, based on spillway gate size, design and age. The dam used as a proxy for the embedded parts inspection is approximately 12 years newer than the Corra Linn Dam, therefore more corrosion

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under the allowable values except for the dogging beams for the gate that are overstressed by approximately 150%. The dogging beam should be reinforced".

[22] US Army Corps of Engineers (USACE) Engineer Technical Literature (USACE ETL) 1110-2-584 and Design of Hydraulic Steel Structures and Engineering Manual (USACE EM) 11100-2-8159 Life Cycle Design and Performance.

[23] 'bulkheads, stoplogs or service gates' and similar structures are used to create a dry work environment to allow inspections or work to be completed.

[24] The three spillway gates that were selected for detailed inspection were chosen because they were assessed to be of the worst condition based on a visual inspection of the gates.

[25] The embedded parts are the underwater portion of the spillway gates such as the guides, sill beams and channels that are used to provide the water sealing surface between the gates and supporting structures.

may exist on the embedded parts at the Corra Linn Dam. This site was chosen because maintenance was underway and one of the gates was fully isolated, making a detailed inspection of the embedded parts, which are typically submerged in water, possible.

The general conclusion from the inspection is that there was heavy corrosion observed in most areas in contact with water.

3.2.4 Project Need Summary

There are two key drivers for the Project. The first, as described in Section 3.2.2, is that the spillway gates do not have the strength required to withstand the "Extreme" classification design earthquake event. The second, as described in section 3.2.3, is the current condition of the Corra Linn Dam spillway gates which are assessed to be in poor to fair condition and are approaching end of life.

As a result, the spillway gates require either replacement or significant refurbishment and the towers and bridges of the superstructure require reinforcement.

The replacement or refurbishment of the spillway gates and associated equipment is essential in order to align with the withstand requirements of the CDSG for a dam rated with a consequence classification of "Extreme" by the BCDSR. The required upgrades would mitigate the potential for a spillway gate failure and the associated consequences to populations downstream including any impacts to the environment or infrastructure.

4. ALTERNATIVES ANALYSIS

In this section, FBC will:

- identify the criteria used to evaluate the alternatives;
- provide a comparison of the four alternatives identified and considered for the Project; and
- describe the preferred solution for the Project.

4.1 PROJECT EVALUATION CRITERIA

Five criteria (four technical and one financial) were used to evaluate the alternatives.

4.1.1 Technical Evaluation Criteria

Criterion 1: Ability to Withstand the Design Flood and Design Earthquake Events

The alternative selected should ensure that the structure will withstand the design flood and the initial impact of the design earthquake event. This is to maintain the ability for the Corra Linn Dam to safely retain the stored water contained within the reservoir.

Criterion 2: Ability of the Spillway Gates to Remain Operational Post-Earthquake

The alternative selected should allow for the spillway gates to remain operable following the design earthquake event, so that they may safely pass water to maintain environmental water flows, maintain the reservoir level and supply water for downstream generating plants.

Criterion 3: Minimize Project Risks

The alternative selected should minimize Project risks, such as safety and environmental impacts, and minimize the potential for Project scope changes.

Criterion 4: Reliability of Gates and Associated Equipment

The selected alternative should minimize the number of possible failure modes and replace aging and obsolete equipment to minimize the risk of failure. A spillway gate system includes a number of associated equipment and components such as gates, hoists, columns, communications and power supply that degrade with age. Each of these associated systems must work in combination to ensure the gates can operate when commanded to do so.

4.1.2 Financial Evaluation Criterion

Criterion 5: Minimize Financial Impacts

The alternative selected should seek to minimize life-cycle capital, and operating and maintenance costs.

4.2 ALTERNATIVES DESCRIPTION

Four alternatives were identified and considered for the Project:

- Alternative 1: Do Nothing
- Alternative 2: Deferral
- Alternative 3: Gate Refurbishment
- Alternative 4: Gate Replacement

Each of these alternatives is briefly discussed in this section. Section 4.3 provides a summary of the evaluation of the alternatives against the criteria described in Section 4.1. Section 4.4 provides a summary of the financial comparison of the remaining feasible alternatives.

4.2.1 Alternative 1: Do Nothing

Under Alternative 1: Do Nothing, the Corra Linn Dam would remain as is and be exposed to the risk conditions identified in the 2012 DSR (Confidential Appendix B) and Preliminary Engineering Report (Confidential Appendix E).

4.2.2 Alternative 2: Deferral

Alternative 2: Deferral would postpone the spillway gate refurbishment or replacement and the Corra Linn Dam would be exposed to the risk conditions identified in the 2012 DSR (Confidential Appendix B) and Preliminary Engineering Report (Confidential Appendix E) until such time that the Project is completed.

4.2.3 Alternative 3: Gate Refurbishment

Alternative 3: Gate Refurbishment would include: refurbishment of the spillway gates structure, painting of all exposed steel to provide corrosion protection, replacement of the roller bushings, rehabilitation of the embedded parts,[26] refurbishment of the spillway gate hoists, reinforcement of the towers and bridges that support the spillway gate hoist, and upgrades to the power distribution and control systems for the spillway gates.

The Gate Refurbishment alternative would retain the majority of the spillway gate structure, with repairs and replacements to the various structural components of the spillway gate being done as needed. Each spillway gate would be thoroughly inspected to identify damage, determine the reduction in skin plate thickness and to determine the actual surface area to be repaired. Repairs would be completed through the removal of damaged or corroded areas and the addition of similar components such as structural steel shapes and structural steel plates. The actual percentage of skin plate replacement would vary from gate to gate. To increase the

[26] As was described above, the embedded parts are the underwater portion of the spillway gates such as the guides, sill beams and channels. They transfer forces from the gate into the concrete dam.

spillway gate capacity and to increase the stiffness to meet the strength required, the addition of new structural steel components would also be required; these additions would include both new horizontal and vertical structural members.

The associated spillway gate equipment would also be inspected to determine the actual condition, and repairs or replacement undertaken to upgrade the original design to meet current day design requirements.

4.2.4 Alternative 4: Gate Replacement

Alternative 4: Gate Replacement would include the construction of 14 new gates. The new gates would be manufactured offsite in a factory environment to present day design requirements. The existing embedded parts would be inspected and repaired or upgraded as required to support the new spillway gate. The towers and bridges that support the spillway gate hoist would require reinforcement. The spillway gate hoists would be inspected to determine the actual condition and any repairs or replacement would be done to upgrade the original design to meet current day design requirements. In addition, upgrades to the power distribution and control systems for the spillway hoists would be completed.

4.3 *ALTERNATIVES EVALUATION*

FBC conducted a technical and non-financial evaluation of the four alternatives discussed above against the technical criteria identified in Section 4.1.1, followed by a financial evaluation of the two remaining alternatives that were found to be feasible under the technical criteria (Alternative 3: Gate Refurbishment, and Alternative 4: Gate Replacement).

To further assess Alternative 3: Gate Refurbishment and Alternative 4: Gate Replacement, FBC sought HMI's assistance to conduct a detailed review of the risks for each feasible alternative. Project designs were developed to sufficient detail so that a fair comparison could be made with respect to overall risk reduction, project schedule risk, operational and maintenance considerations, reliability characteristics and potential environmental impacts. This analysis comprises the HMI Preliminary Engineering Report (PER) included as Confidential Appendix E.

HMI was also engaged to assist in preparing an AACE Class 3 Project estimate for both Alternative 3: Gate Refurbishment and Alternative 4: Gate Replacement. No cost estimates were prepared for Alternative 1: Do Nothing or Alternative 2: Deferral because these alternatives did not achieve the Project objectives or meet the technical criteria identified in Section 4.1.1.

The sections below summarize the evaluation of each alternative against the criteria provided in Section 4.1.1 above and describe the advantages and disadvantages of each.

4.3.1 Non-Financial and Technical Evaluation

4.3.1.1 Alternative 1 - Do Nothing

Dam Safety is an ongoing requirement for dam owners.

The 2012 DSR identified areas of concern in the spillway gates and associated equipment. In 2015 two studies were completed to determine the condition of the dam's concrete structure and the withstand capacity of the gates. The key conclusions of HMI's evaluation in the HMI Preliminary Engineering Report (Confidential Appendix E) on the withstand capacity of the Corra Linn spillway gates are that:

- the gates require either replacement or significant reinforcement of the existing gate frame and skin plate;[27] and
- The towers and bridges of the superstructure require reinforcement[28].

Advantages:

- There are no technical advantages.

Disadvantages:

- As demonstrated in the HMI Preliminary Engineering Report described in Section 3.2.2.3, the spillway gate system does not meet present day requirements of the BCDSR and the recommendations for withstand capability requirements under the latest edition of the CDSG. In the design earthquake event the spillway system would likely be rendered inoperable or unsafe to operate or discharge water in a controlled manner;
- If a dam breach occurred, there is a potential for significant loss of human life, and significant economic and environmental impacts;
- There are various deficiencies in the mechanical components of the spillway that impacts the reliable operation of the spillway system;
- Maintenance alone cannot reduce the potential for future spillway gate failure under extreme loadings such as an earthquake;
- This alternative is not an accepted long-term operating practice for management of potential safety risks to the public, plant, property and FBC personnel;
- The impact to the electrical generation capacity of the Kootenay River generating system if a spillway gate fails is unacceptably high; and,

[27] See Confidential Appendix E, section 2.6.3, p. 19. "The skin plate has to be reinforced in some matter [sic]."

[28] See Confidential Appendix E, section 5.4 and 5.5. "The tower should be reinforced to resist the 1/10000 year recurrence earthquake. Multiple reinforcements are required" and "The limit state summary of the bridge remains under the allowable values except for the dogging beams for the gate that are overstressed by approximately 150%. The dogging beam should be reinforced".

- FBC may be unable to meet the International Joint Commission (IJC) flood curve requirement as is required by FBC's water licence for the Kootenay River[29].

This alternative would not address the reliability, safety, or regulatory concerns associated with the unacceptable spillway gate condition and may eventually result in an inability to maintain reservoir control, prevent the occurrence of a "potential safety hazard"[30], or prevent the development of a "hazardous condition",[31] each of which is required of a Dam owner and Water License Holder under sections 14 and 15 of the BCDSR. As the alternative does not meet any of the Project Technical Criteria or the BCDSR requirements, FBC has concluded that this is not a feasible alternative.

4.3.1.2 Alternative 2 – Deferral

The deferral alternative has similar concerns as the 'do nothing' alternative outlined in the previous section. For completeness, the advantages and disadvantages are summarized below.

Advantages:

- There are no technical advantages.

Disadvantages:

- As demonstrated in the HMI Preliminary Engineering Report (Confidential Appendix E) described in Section 3.2.2.3, the spillway gate system does not meet present day requirements of the BCDSR and the recommendations for withstand capability requirements under the latest edition of the CDSG. In the design earthquake event the spillway system would likely be rendered inoperable or unsafe to safely operate or discharge water in a controlled manner;
- If a dam breach occurred, there is a potential for significant loss of human life, and significant economic and environmental impacts;
- There are various deficiencies in the mechanical components of the spillway that impacts the reliable operation of the spillway system;

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29 http://ijc.org/en_/iklbc.

30 Section 15 of the BCDSR requires an owner of a dam to develop and implement a remedial plan for the dam where a "potential safety hazard" has arisen, which is defined as being "conditions that are not yet, but have the potential to become hazardous conditions in relation to the dam", see sections 1(1) and 15 of the BCDSR http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/laws-rules/2016_dam_safety_regulation.pdf.

31 Section 14 of the BCDSR requires an owner of a dam to promptly take certain remedial steps where "hazardous conditions" have arisen. The BCDSR defines hazardous conditions as including defects or insufficiencies of the dam that are likely to be hazardous to the dam, or that may reasonably be anticipated to cause part or all of the dam to become potentially hazardous to public safety, the environment or land. See sections (1)(1) and 14 of the BCDSR, http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/laws-rules/2016_dam_safety_regulation.pdf.

- Maintenance alone cannot reduce the potential for future spillway gate failure under extreme loadings such as an earthquake;
- This alternative is not an accepted long-term operating practice for management of potential safety risks to the public, plant, property and FBC personnel;
- The impact to the electrical generation capacity of the Kootenay River generating system if a spillway gate fails is unacceptably high; and
- FBC may be unable to meet the International Joint Commission (IJC) flood curve requirement as is required by FBC's water licence for the Kootenay River [32].

This alternative would not address the reliability, safety, or regulatory concerns associated with the unacceptable spillway gate condition and may eventually result in an inability to maintain reservoir control, prevent occurrence of a "potential safety hazard"[33], or prevent development of a "hazardous condition"[34], each of which is required of a Dam owner and Water License Holder under the BCDSR. As the alternative does not meet any of the Project Technical Criteria or the BCDSR requirements, FBC has concluded that this is not a feasible alternative.

The continued operation of a spillway gate system that does not meet present day recommendations for withstand capacity requirements is not acceptable to FBC. In the design earthquake event the spillway system would likely be rendered inoperable or unsafe to operate, and discharge water in a controlled manner.

For these reasons, and particularly given that it is not possible to predict when a seismic event will occur, the Alternative 2: Deferral is not considered to be a feasible alternative and is unacceptable to FBC.

4.3.1.3 Alternative 3 – Gate Refurbishment

The technical evaluation of the Alternative 3: Gate Refurbishment is summarized as follows:

Advantages:

- The alternative would refurbish the structure to withstand the design flood and the initial impact of the design earthquake event (Criteria 1);
- With refurbishment, the spillway gates would remain operable following the design earthquake event (Criteria 2);
- Refurbishment would minimize the number of possible failure modes and replace aging and obsolete equipment to minimize the risk of failure to the auxiliary equipment such as

[32] http://ijc.org/en_/iklbc.
[33] Potential safety hazard as defined in the BCDSR, page 5, http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/laws-rules/2016_dam_safety_regulation.pdf.
[34] Hazardous conditions as defined in the BCDSR, page 4, http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/laws-rules/2016_dam_safety_regulation.pdf.

electrical power supply, hoists and towers (Criteria 4), however, there is the potential for latent defects to remain following refurbishment[35]; and

- Maintenance would be simplified through the installation of low maintenance equipment.

Disadvantages:

- The Project risks related to unexpected conditions are highest for this alternative (Criteria 3). Project risks would include:
  - The schedule could be negatively impacted because the construction method is expected to be more complex due to refurbishment activities of the spillway gates that are required to be undertaken in the field;
  - The Project scope could potentially be impacted once the actual extent of refurbishment work required is determined; the potential for scope variation during the construction period is more likely because the condition of each gate cannot be confirmed until it is be removed from service and inspected. While this risk is partially mitigated by the inspections done on three of the Corra Linn spillway gates, there continues to be uncertainty associated with each individual spillway gate and hence to the overall required refurbishment scope.
  - Refurbishment of the gates in situ requires removal of lead paint, repainting, and millwork in close proximity to or immediately above water and would require environmental mitigation measures;
  - Refurbishment of the gates in situ increases the safety risk to workers because this work would be performed at locations above or in close proximity to water or in constrained areas that are not easily accessible (i.e. the lower bay of the gate which is 1.1 m high and 1.4 m deep and where a significant amount of reinforcing steel would need to be installed). As a result, these activities would require extensive temporary scaffolding and associated complex work procedures; and
  - Cost variances could result from any of the above factors.
- It is expected that this alternative would extend the expected life of the existing gate by approximately 11-25 years, therefore replacement of the spillway gates would need to be considered within the next 15 years.

The Alternative 3: Gate Refurbishment of the spillway gates achieves three of the four Project Technical Criteria and is considered to be a feasible alternative.

[35] the skin plate stresses are inversely proportional to the square of the thickness and significantly increase as the material loss increases

4.3.1.4 Alternative 4 – Gate Replacement

This alternative involves the replacement of the Corra Linn Spillway Gates with new gates. The technical evaluation of Alternative 4: Gate Replacement is summarized as follows:

Advantages:

- This alternative would withstand the design flood and design earthquake (Criteria 1);
- This alternative would remain operational following the design earthquake event (Criteria 2);
- Replacement minimizes the Project risks (Criteria 3); there is a reduced environmental risk for a new gate already painted in a shop (off site) and the construction period is expected to be shorter compared to Alternative 3: Gate Refurbishment, and allows for the completed 14 gates to be back in operation sooner;
- Replacement would provide the most reliable flow control system of the identified alternatives through replacing aging and obsolete equipment significantly reducing the risk of future spillway gate failures (Criteria 4);
    - This approach would replace the entire spillway gate with a new gate and would therefore fully incorporate the 85 years of engineering development that has occurred since the original gate construction;
    - A new gate also provides advantages such as new rollers with new anti-friction bearings which facilitate ease of operation and increase reliability; and a centralized lubrication system allowing greasing of the bearings without having to raise the gate which reduces operational disruption;
    - In addition, the new rollers would be designed to be positioned at different locations than the existing ones, in order to provide an improved rolling path, mainly at the initial opening (cracking) of the gate. This would decrease the force required to lift the gates and improve operational reliability of the lifting components;
    - This alternative would significantly reduce the risk of future spillway gate failures because the new gates will have a thicker skin plate to conform to current standards and there is an additional safety factor inherent in the thicker skin plate[36];
- This alternative significantly reduces safety risks to the public, plant, property and FBC personnel;

[36] The skin plate on a new gate would be thicker. It would have a thickness of 22.2 mm, as compared to 9.5 mm for the existing gates, and would be able to better withstand the consequences of corrosion pitting. A loss of 1.5 mm of thickness due to corrosion represents 16% of the thickness of the plate for the existing gate but only 7% for the new gate. The skin plate stresses are inversely proportional to the square of the thickness and significantly increase as the material loss increases.

- This alternative would minimize the risk of generation interruption as a result of an unplanned spillway gate failure; and
- The alternative has the maximum lifetime extension of the alternatives.

Disadvantages:

- None identified.

Alternative 4: Gate Replacement achieves all of the Project Technical Criteria identified in Section 4.1.1, and is considered to be a feasible alternative.

4.3.1.5 Summary

Based on the technical evaluation of the alternatives, FBC has determined that, of the four alternatives considered, only two are feasible alternatives that allow the Company to meet most of the Project objectives and requirements:

- Alternative 3: Gate Refurbishment; and
- Alternative 4: Gate Replacement.

Each of the two feasible alternatives would mitigate the reliability, safety and regulatory risk posed by the current condition of the spillway gates and the expected withstand capacity to a seismic event. However, only Alternative 4: Gate Replacement achieves all of the Project Technical Criteria set out for the Project. Replacement would allow for the spillway gates to withstand the design flood and design earthquake and remain operational following the design earthquake event. It minimizes the Project risks and would also provide the most reliable flow control system of the identified feasible alternatives through replacing aging and obsolete auxiliary equipment and the spillway gates significantly reducing the risk of future failures.

The results confirm that Alternative 4: Gate Replacement is the preferred technical solution that will satisfy all the objectives and requirements outlined in Section 4.1.1. The comparative merits of the four alternatives are summarized in the table below as follows:

Table 4-1: Corra Linn Dam Spillway Gate Project Alternatives Comparison

Alternative		Project Technical Criteria (Notes 1 and 2)				
		1	2	3	4	
		Ability to Withstand the Design Flood and Design Earthquake Events	Ability of the Spillway Gates to Remain Operational Post-Earthquake	Minimize Project Risks	Reliability of Gates and Associated Equipment	Overall Assessment
1	Do Nothing	Does not meet Criterion	Does not meet Criterion	Does not meet Criterion	Does not meet Criterion	Not Feasible
2	Deferral	Does not meet Criterion	Does not meet Criterion	Does not meet Criterion	Does not meet Criterion	Not Feasible
3	Gate Refurbishment	Meets Criterion	Meets Criterion	Does not meet Criterion	Meets Criterion	Feasible
4	Gate Replacement	Meets Criterion	Meets Criterion	Meets Criterion	Meets Criterion	Feasible

(green)	Meets the Project Technical Criteria
(red)	Does not Meet the Project Technical Criteria

Notes:

(1) The Project Technical Criteria are described in Section 4.1.1

(2) Criteria 5 – Minimize Financial Impacts is assessed in following sections.

4.3.2 Financial Evaluation

Having identified the feasible alternatives (alternatives 3 and 4), a financial evaluation was performed, consisting of the following steps for each feasible alternative:

- Comparison of the initial capital costs between the alternatives, as presented in Table 4-2. The initial capital costs for both Alternative 3: Gate Refurbishment and Alternative 4: Gate Replacement are both determined based on AACE International Recommended Practice No. 69R-12 Class 3 estimate class(Class 3)[37]; and
- Comparison of revenue requirement between the alternatives, as presented in Table 4-3. The comparison is based on the financial schedules in Confidential Appendix J for Alternative 3: Gate Refurbishment and Confidential Appendix K for Alternative 4: Gate Replacement. The financial schedules of both alternatives provide details of the incremental cost of service, the present value of the discounted

[37] Because of the nature of the project scope, duration of the works (approximately 5 years), complexities in the constructability (i.e. the gates provide water control for five hydroelectric plants along the Kootenay River), and the presumption that the capital costs of both alternatives would be relative close to each other based on the scope of work, Class 3 cost estimates were developed for both alternatives for a fair comparison.

incremental cost of service over 70 years, the rate impact in 2022 as a percentage of 2016 Forecast Revenue Requirement, and the levelized rate impact in percentage based on the present value of the 2016 Forecast Revenue Requirement over 70 years[38].

Table 4-2: Comparison of Initial Capital Costs between Alternative 3 and 4 ($ millions)

	Alternative 3: Gate Refurbishment		Alternative 4: Gate Replacement	
	2015 $	As-Spent $	2015 $	As-Spent $
Engineering	2.492	2.665	2.349	2.506
Supply, Installation & Testing	20.278	21.687	18.098	19.302
Site-Support Work	7.732	8.269	9.443	10.071
Indirect Costs	0.720	0.770	0.624	0.666
Project Management	6.375	6.818	4.322	4.610
Subtotal Construction	*37.596*	*40.209*	*34.837*	*37.155*
Removal Cost[39]	-	-	5.331	5.804
Construction Contingency	2.255	2.412	2.008	2.148
Subtotal Construction & Removal	*39.851*	*42.620*	*42.177*	*45.108*
FBC – Project Management	2.920	3.155	2.920	3.155
Generation Admin Overhead	0.543	0.589	0.543	0.589
Project Contingency[40]	6.497	6.955	6.846	7.328
Pre-Approval Project Costs[41]	1.062	1.081	1.062	1.081
Subtotal (incl. Construction & Removal)	*50.873*	*54.400*	*53.548*	*57.260*
AFUDC	n/a	5.394	n/a	5.434
TOTAL Project Capital Costs	***50.873***	***59.794***	***53.548***	***62.694***

[38] Assumed revenue requirements remained the same over 70 years as the 2016 approved revenue requirement.
[39] Removal costs are charged to Accumulated Depreciation.
[40] Project Contingency includes owner's known risks and unknown risks, see Section 6.3.1.2 for details.
[41] Costs related to engineering work and CPCN development up to CPCN approval. See Section 6.3.1.1 for details.

Table 4-3: Financial Analysis of Alternatives ($ millions unless otherwise stated)

	Alternative 3: Gate Refurbishment	Alternative 4: Gate Replacement
As-spent Capital Costs (incl. AFUDC & Removal)	59.794	62.694
2022 Incremental Rate Base[42]	58.166	61.153
PV of Incremental Revenue Requirement - 70 years[43]	105.808	85.018
% Increase on Rate - Year 2022	1.41%	1.49%
Levelized % Increase on Rate - 70 years	1.81%	1.46%
Discounted Cash Flow NPV	1.598	1.868

As shown in the above Table 4-2, Alternative 4: Gate Replacement is more expensive by approximately $2.9 million (as-spent) in initial capital costs than Alternative 3: Gate Refurbishment; however, due to the complexities of the Project and because the spillway gates are expected to be in-service for a long period of time once the Project is complete, it is also important to evaluate the long term financial impact of both alternatives.

According to U.S. Army Corps of Engineers (USACE)[44], the recommended design life of a new spillway gate is 100 years assuming appropriate repairs and rehabilitation projects are performed routinely over the service life of the gates. Considering that the existing gates were originally commissioned in 1932 and had appropriate but minimal maintenance performed on the gates over the years due to limited access, it is reasonable to expect that new replacement gates will be needed when these existing gates reach approximately 100 years in age (even with refurbishment as contemplated as part of Alternative 3). In order to evaluate the long term financial impact of Alternative 3: Gate Refurbishment, FBC included the costs for installing new gates by year 2032 (i.e. when the existing gates reach 100 years old and 11 years from the final in-service date of the Project in 2021) in the financial analysis as shown in Table 4-3 above. The estimated capital cost for installing new gates by 2032 for Alternative 3: Gate Refurbishment would be approximately $33.723 million (as-spent) in additional costs plus $7.729 million for the removal costs of the existing gates.

When accounting for the costs of installing new gates by 2032 for Alternative 3: Gate Refurbishment as identified above, the net present value of the incremental revenue

[42] The 2022 Incremental Rate Base is less than the as-spent capital cost due to the Project is being completed and transfer to Rate Base in phases between 2020 and 2022 which results in some assets beginning to depreciate before 2022. See Section 6.4 for more detail.

[43] The alternative 3: Refurbishment analysis includes capital costs to install new spillway gates by year 2032 in anticipation of the existing (but reinforced) gates will be over 100 years old. As-spent capital costs to be charged to plant in service by 2032 for installing new gates is $33.723 million and the removal costs charged to Accumulated Depreciation for the existing gates are $7.729 million. All costs are prorated from the capital cost estimated for Alternative 4 - Gate Replacement, escalated at inflation per year.

[44] USACE ETL 1110-2-584 Design of Hydraulic Steel Structures (Jul 2014) and EM 11100-2-8159 Life Cycle Design and Performance (Oct 1997)

requirement over 70-year period[45] is approximately $105.808 million, which is approximately $21 million more expensive than Alternative 4: Gate Replacement that has a net present value of $85.018 million (which does not require new gates during the same 70-year period).

The levelized rate impact over 70 years for Alternative 3: Gate Refurbishment is a 1.81% increase, compared to a 1.46% increase for Alternative 4: Gate Replacement. As Alternative 4: Gate Replacement offers maximum lifetime extension while Alternative 3: Gate Refurbishment requires new gates to be installed after approximately 11 years, it is evident that Alternative 4: Gate Replacement is more cost effective over the 70-year analysis period.

Additionally, FBC sought to understand the impact to the net present value of Alternative 3: Gate Refurbishment should the refurbished gates have a longer lifetime extension than the expected 11 years identified above based on the USACE recommendation. As such, FBC also evaluated the financial impact assuming that the refurbished gates would require replacement in 25 years from the in-service date (i.e. year 2045)[46]. The net present value of the incremental revenue requirement over 70 years if refurbished gates are to be replaced by 2045 is $94.897 million, which is still approximately $10 million more expensive than Alternative 4: Gate Replacement which has a net present value of approximately $85.018 million.

Based on the financial analysis over 70 years, Alternative 4: Gate Replacement is the preferred alternative.

4.4 *RECOMMENDED SOLUTION*

Of the four alternatives considered, only two viable alternatives would allow the Company to meet most of the Project objectives and requirements:

- Alternative 3: Gate Refurbishment; and
- Alternative 4: Gate Replacement.

Each of the two feasible alternatives would mitigate the reliability, safety and regulatory risk posed by the current condition of the spillway gates and expected withstand capacity to a seismic event. However, Alternative 4: Gate Replacement is the preferred solution because it achieves each of the technical criteria set out for the Project. Replacement will allow for the spillway gates to withstand the design flood and design earthquake and remain operational following the design earthquake event. This alternative minimizes the Project risks and will also provide the most reliable flow control system of the identified feasible alternatives through replacing aging and obsolete auxiliary equipment and spillway gates significantly reducing the risk of future failures.

[45] FBC evaluated the financial impact of both alternatives over a 70-year period based on the FBC 2014 Depreciation Study by Gannett Fleming for Reservoirs, Dams & Waterways. See Section 6.4 for details.

[46] HMI has provided an opinion that the refurbishment of the Corra Linn Dam spillway gates could achieve a lifetime extension of up to 25 years.

Alternative 4: Gate Replacement is also the most long term cost effective solution. Alternative 3: Gate Refurbishment is approximately $2.9 million less expensive in initial capital costs compared to Alternative 4: Gate Replacement. However, when accounting for the life-cycle of the existing spillway gates and incorporating the costs associated with the estimated replacement of the gates in 2032 under Alternative 3: Gate Refurbishment, the net present value for Alternative 3: Gate Refurbishment is estimated to be $105.808 million, significantly more than the $85.018 million estimated for Alternative 4: Gate Replacement. The levelized rate impact over 70 years is a 1.46% increase for Alternative 4: Gate Replacement, compared to 1.81% increase for Alternative 3: Gate Refurbishment.

Alternative 4: Gate Replacement both meets all of the technical objectives identified in Section 4.1.1 and it is also the most long term cost effective solution when all factors are considered and results in the lowest levelized rate impact on a lifecycle basis. On this basis, it has been selected as the preferred alternative for the Project.

5. PROJECT DESCRIPTION

In this section, FBC will describe the proposed Corra Linn Spillway Gate Replacement Project in more detail, including information on project components, schedule, resources requirements, and risks and management.

5.1 *PROJECT COMPONENTS AND DESCRIPTION OF THE PROPOSED WORK*

As described in Section 4, the recommended alternative is comprised of replacement of the spillway gates and reinforcement or replacement of the spillway hoists, support towers and associated equipment. Alternative 4: Gate Replacement is recommended based on both a technical and financial evaluation of the feasible alternatives.

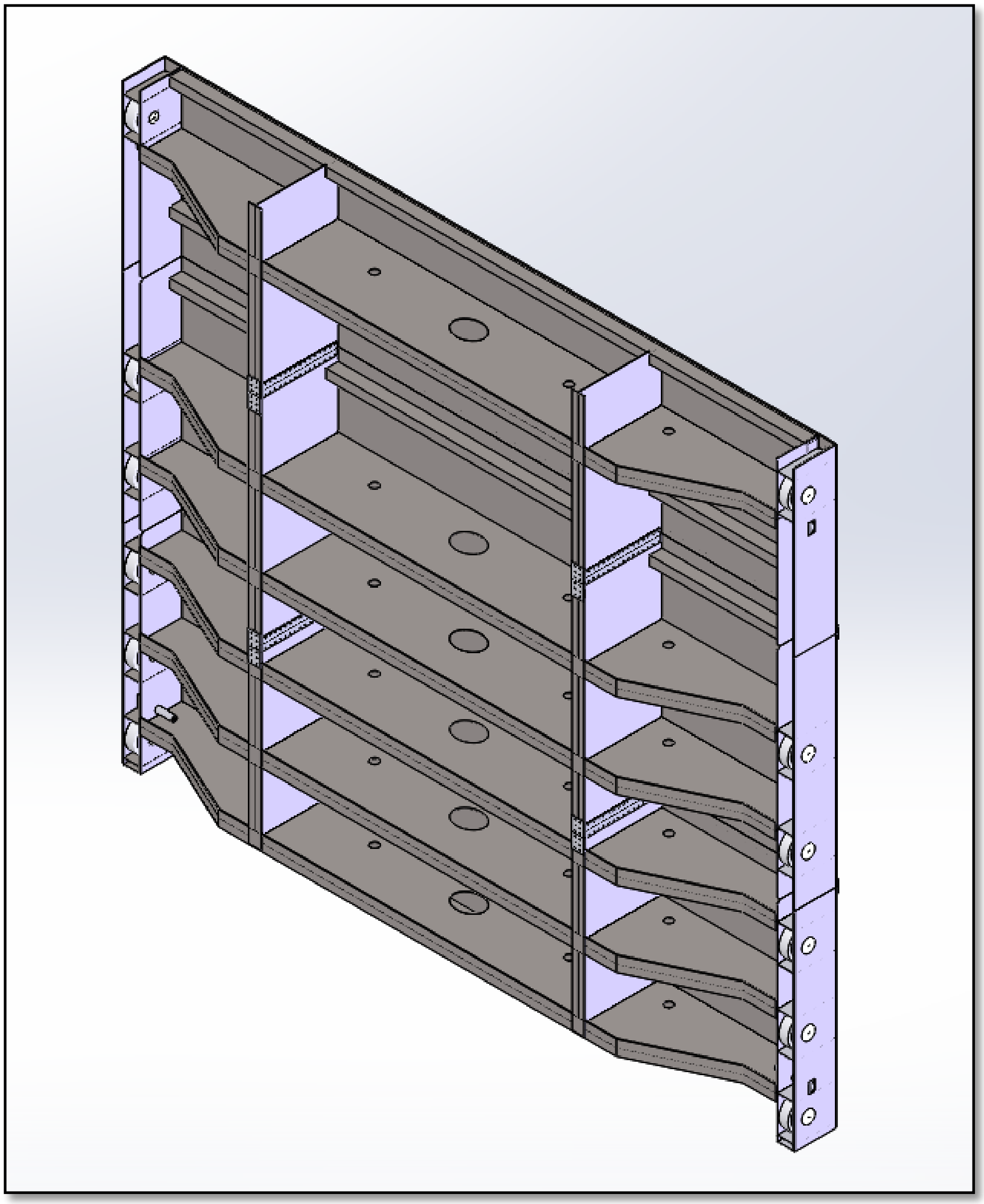
The Project scope will include the design, construction and commissioning of the Project components including:

- Replacement of 14 existing spillway gates to meet the seismic and flood withstand recommendations of the BCDSR and CDSG;
- Reinforcement of the existing towers and bridges to meet seismic and flood withstand recommendations of the BCDSR and CDSG;
- Refurbishment of the existing hoists; and
- Replacement of the existing embedded parts (gate guides, sill etc.).

5.1.1 Details of the Replacement Spillway Gates

Figure 5-1 shows the new gate's isometric view.

Figure 5-1: New Gate Isometric View



Each new gate will have six pairs of rollers and will be equipped with anti-friction roller bearings connected to a centralized lubrication system that will allow the lubrication of the rollers from the top of the gate with the gate sitting on the sill beam.

To facilitate the installation of the spillway gates, each new gate will be shipped in three sections and then the field joints will be bolted and welded together.

The new gate will re-use the existing screw hoists. The use of anti-friction bearings will lower gate lifting loads, ensuring the existing hoists have sufficient capacity to raise the gate. The gate will be equipped with bronze seal bars on the upstream side and rectangular rubber seals at the bottom to minimize leakage. The machined surface of the new gate will provide superior sealing over a re-furbished gate.

5.1.2 Existing Tower Reinforcement

The analysis in the HMI Preliminary Engineering Report confirms that reinforcement of the towers is required to achieve the strength necessary to support the spillway gates as shown in red on the images below (see section 5 of the HMI Engineering Report at Confidential Appendix E for more details). Figure 5-2 provides the isometric view while Figure 5-3 provides the side views.

Figure 5-2: Tower Reinforcement Isometric View

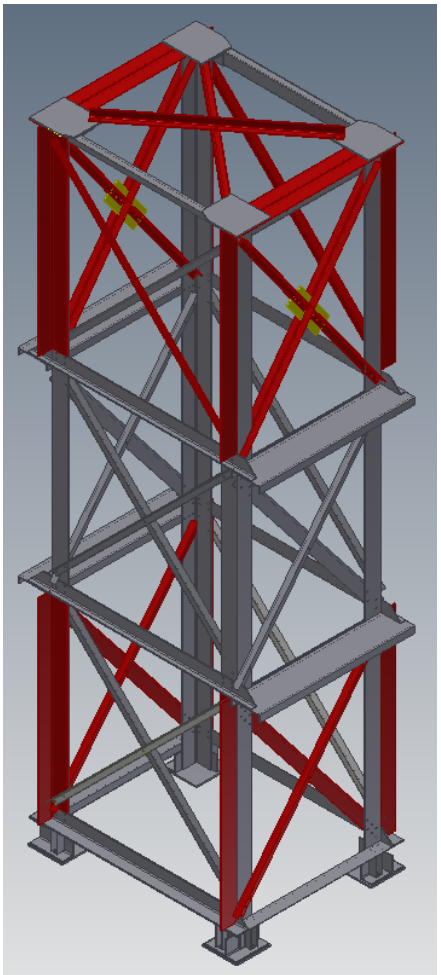
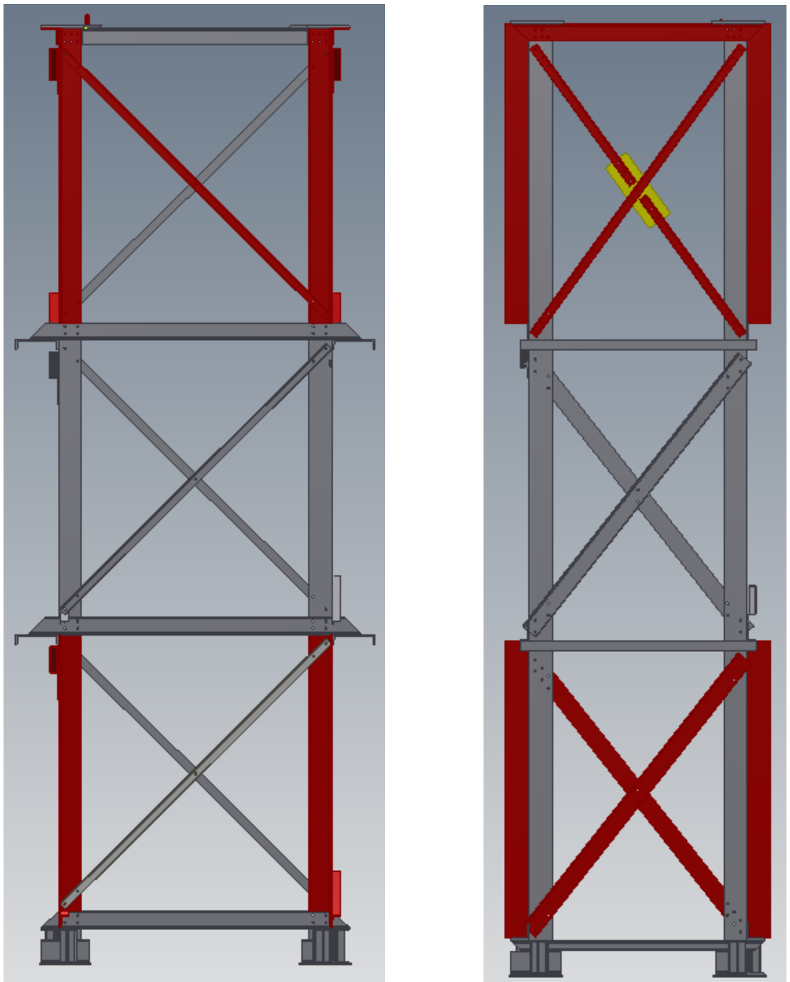


Figure 5-3: Tower Reinforcement Side Views



In addition to the locations where welded reinforcements are required, the scope of work also includes sandblasting and painting of the towers.

Specifically, the work on the towers will include the addition of reinforcement brackets and complete repainting of the structure including removal of the existing paint, reinforcement, sandblasting and painting. Additionally, the concrete/grout under the tower base plates will be inspected and assessed for any repairs as necessary.

5.1.3 Existing Bridges Reinforcement

The analysis in the HMI Preliminary Engineering Report confirms that each bridge section must be reinforced at two specific locations. Two stiffeners need to be welded at the two suspended beams of the bridge sections in the flow direction. See section 5 of the HMI Preliminary Engineering Report at Confidential Appendix E for more details.

In addition to locations where welded reinforcements are required, the scope of work also includes sandblasting and painting of the bridges, reinforcement brackets and complete repainting of the bridge structure including the removal of the existing paint, reinforcement, and sandblasting and repainting.

5.1.4 Existing Hoist Refurbishment

Since the existing gates will be replaced with new heavier gates, additional work on the two travelling hoists may be required as detailed further in section 4 of the HMI Preliminary Engineering Report (Confidential Appendix E). It is anticipated that the hoist refurbishment will encompass the following work scope:

- Installation of new motors, hoist brake and minor electrical upgrades; and
- Refurbishment of the existing reducer, including the installation of larger gearbox thrust bearings.

5.1.5 Refurbishment of the Existing Embedded Guide and Sill Replacement

Based on the inspection done on the embedded components located at a similar dam, the sills at the Corra Linn Dam will likely require replacement.

The required work will consist of removing the existing sill and adjacent concrete followed by installation of a new complete sill beam and concrete replacement, sandblasting and painting of the lateral embedded guide, and local concrete repairs as required.

Because the embedded parts including the sills and lateral guides could not be physically inspected, the final scope of work will be confirmed when the gate is dewatered and further inspection completed.

5.2 *MAIN EQUIPMENT REQUIRED FOR THE INSTALLATION*

The following isolation and lifting equipment will be required to perform all of the rehabilitation work as described above.

Floating bulkheads

- Four floating bulkheads units will be required to isolate the spillway gates from the water and to complete the work on site.

Lifting barge (or a temporary gantry) and a service barge

- Since space is limited near the gates during the work, one lifting barge (or a temporary gantry) that will travel to load/unload gate sections and be positioned directly on the spillway, and one service barge with trailer, cranes and container located near the working area will be used.

5.3 CONSTRUCTION AND OPERATING SCHEDULE

The preliminary Project schedule is based on receiving BCUC Project approvals by March 2017, and an assumed contract award date of Q3 2017. The schedule considers performance of the site work on a year-round schedule, without interruption.

Following the Application approval date, the Project activities will be subdivided into five main groups:

1. Contractor selection and Contract award;
2. Detailed design;
3. Procurement / manufacturing / delivery;
4. Mobilization to site; and
5. Site installation.

Specific milestone activities are estimated in Table 5-1 below.

Table 5-1: Corra Linn Dam Spillway Gate Replacement Project Schedule and Milestones

Activity	Date
CPCN Preparation	Mar. 2015 – June 2016
CPCN Filing	June 2016
CPCN Approval	Q1. 2017
Contract Evaluation	July 2016 – Feb. 2017
Contractor Selection and Contract Award	July 2017
Start of Detailed Engineering Design	July 2017
Procurement, Manufacturing and Delivery	
Temporary Equipment and Bulkhead	Aug. 2017 – May 2018
Mobilization to Site, Road Access, and Installation of Barge, Crane Barge and Crane and Temporary Equipment	June - July 2018
Site Installation	
Hoist Refurbishment	July - Sept. 2018
Phase #1 Installation - Sluice gate #14, 13, 12 & 11	Sept. 2018 – July 2019
Phase #2 Installation- Sluice gate #10, 9, 8 & 7	May 2019 – Jan. 2020
Phase #3 Installation - Sluice gate #6, 5, 4 & 3	Nov. 2019 – July 2020
Phase #4 Installation - Sluice gate #2 & 1	June 2020 – Dec. 2020
In Service	Dec. 2020
Restoration and Demobilization	Dec. 2020 – Jan. 2021

A more detailed schedule is included as Appendix G.

5.3.1 Contractor Selection and Award

Given the specialized nature of the Project, the Company is evaluating the merits of an alliance agreement with a contractor, as compared to using a traditional Design Build tender. Under this approach, the contractor is selected based on qualifications, experience and reputation. This process makes the contractor a member of the collaborative Project team, centralizing responsibility for design and construction under one contract, creating transparency in risk allocation, and leveraging the experience of the contractor to reduce schedule and cost. The Project achieves competitive market rates by tendering various construction and supply agreements, which are then subsequently evaluated and awarded by the collaborative Project team.

Alternatively, the Company may select a contractor based on a more traditional tender process.

5.3.2 Project Detailed Design

Design activities will encompass all engineering calculations, validations and drawings steps required to cover the Project needs and will commence in July 2017. Engineering activities will be organized in order of priority, in relation to the fabrication/procurement lead times and scheduled date for each component to be on the work site.

Engineering packages to be completed are:

- Temporary site installations;
- Temporary electrical site installations;
- Floating bulkhead;
- New spillway gates;
- New sill beams;
- Hoist bridge & towers reinforcement;
- Hoist mechanical refurbishment & upgrades; and
- Permanent electrical distribution upgrades.

Each engineering package will be reviewed by the Owner's Engineer and accepted by FBC. Environmental permits, approvals, and authorizations will be identified and application processes initiated. The design phase will be concluded by the final design review, planned for June 2018.

5.3.3 Procurement / Manufacturing

As soon as the design package for each element is finalized and approved, procurement and manufacturing activities will commence. Once the drawings and specifications are approved, a Request for Quotation (RFQ) document will be prepared, long lead items will be prioritized and the short list of selected Suppliers will be asked to confirm their prices and their production schedule. Conformance with materials, specifications and drawings tolerances will be closely monitored throughout the fabrication process by the Project team. The supplier will be tasked to provide all required quality assurance (QA) documentation and factory acceptance testing (FAT) to complete the validation process.

Procurement, fabrication and site delivery activities will range over a period starting from mid-August 2017 and conclude by September 2019.

5.3.4 Mobilization

Site mobilization will commence in June 2018 and last for approximately three (3) months.

5.3.5 Site Installation

While site installation activities will be finalized after contractor selection, FBC anticipates the work sequence and construction schedule will be similar to that set out in this section for site installation.

After completion of the mobilization activities, the first activity will be the complete refurbishment of the two existing travelling hoists including the new electrical hoist distribution and redundant work systems. These activities will be performed prior to the start of work in the water passages, and the work will be performed sequentially, so that one hoist is always in service.

As is detailed in Appendix G, the work in the water passages will start in August 2018 and will be performed on four gates at a time, from the right bank onto the left bank gates. The work will start with gates #14, 13, 12 and 11. Four temporary bulkheads will be installed first, to provide dry access to the gates. Once the work, including dry testing, is completed on a set of four gates, the bulkheads will be transferred to the next four gates and so on. The schedule is based on performing the work year-round, without interruption and with four gates out of service at the same time.

The proposed work sequence for each set of four gates is as follows:

1. Installation of floating bulkheads
2. Installing hoarding tarps, sealing of bulkheads and sump pump
3. Removal of existing gate
    i. Lift gate to position #1
    ii. Cut section of gate and dispose of section #1
    iii. Lift gate to position #2
    iv. Cut section of gate and dispose of section #2 & 3
4. Scaffolding

   i. Installation of the required scaffolding, temporary platforms and scissor lifts

5. Inspections
   i. Water blast embedded parts
   ii. Inspection of embedded parts
6. Towers and hoists
   i. Local paint stripping of tower and hoist (at reinforcement area only)
   ii. Installation of structural reinforcement steel on tower and hoist
   iii. Welding of structural reinforcement steel on tower
   iv. Welding inspection
7. Sill beam
   i. Remove existing sill beam
   ii. Install new sill beam
   iii. Concrete for new sill beam
   iv. Inspection and measurements
8. Embedded parts upgrade
   i. Welding of reinforcement steel plates (complete welds where required)
9. Sandblast and painting
   i. Sandblast embedded parts, towers and hoist bridge
   ii. Painting
   iii. Remove scaffolding and temporary working platforms
10. New gate
   i. Insert section #1 & 2
   ii. Bolt-up section #1 & 2
   iii. Insert section #3
   iv. Bolt-up section #2 & 3
   v. Lift gate to position #1
   vi. Final bolt-up of section #1 & 2

vii. Weld skin plate

viii. Paint touch-up

ix. Lift gate to position #2

x. Final bolt-up of section #2 & 3

xi. Weld skin plate

xii. Paint touch-up

xiii. Installation of seals

xiv. Lower gate to sill

11. Hoist bridge
    i. Electrical work
12. Testing and commissioning
    i. Dry test of new gate
    ii. Remove service barge
    iii. Remove floating bulkheads
    iv. Wet testing and commissioning
13. Demobilization from water passage and transfer to the next four gates.

The duration of the work activities described above is estimated to take approximately 11 months for each set of four gates. Factoring in two weeks per year for statutory holidays, the work in the water passages will span from September 2018 to December 2020. In addition, two months of demobilization is scheduled at the end to remove all temporary installations and clean-up of the site.

5.4 *PROJECT ACCESS AND STAGING AREA*

A new gravel road may be required to access the downstream side of the left bank's concrete dam. At the end of that road is a graveled area that potentially could serve as a staging area during construction. FBC has initiated discussions with the landowner to discuss temporary access and rights required for Project construction.

5.5 *PROJECT RESOURCES*

The resources that will be required to perform the Project are described below. They are separated into the following categories: Project Management, Design and Quality Control, and Construction.

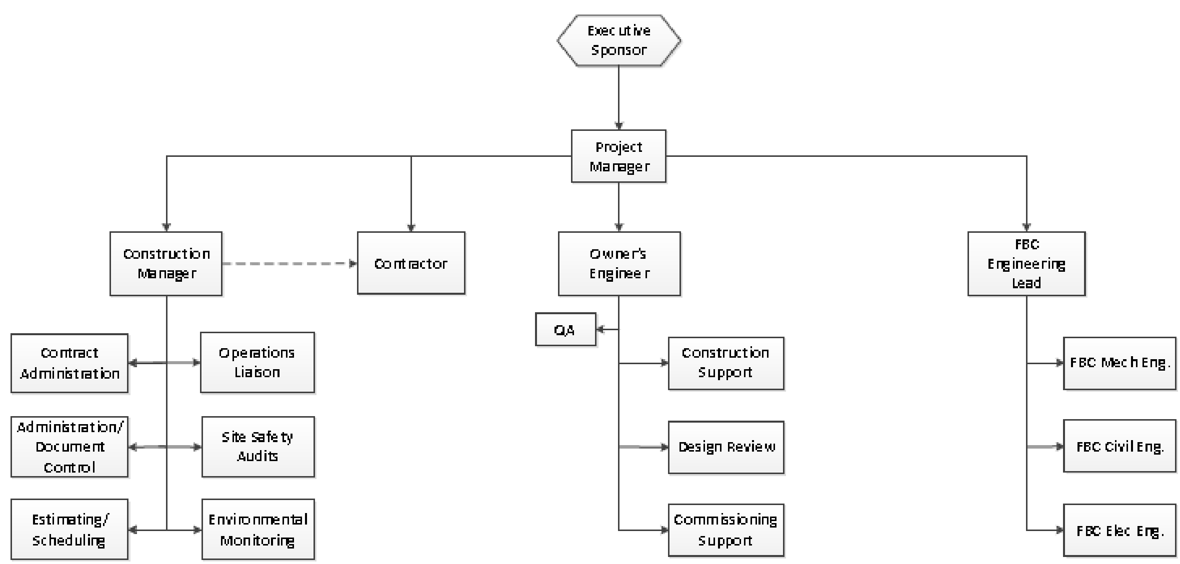
5.5.1 Project Management

FBC will assign a Project manager who will manage the construction contractor on a daily basis throughout the Project. An FBC Construction Manager will lead the Project site team and is accountable to the FBC Project manager for all aspects of construction. The Construction Manager will have support for each of the following disciplines: contract administration, administrative support including document control, safety audits and environmental monitoring. In order to minimize disruptions with operations and to have clear communications between the Project team and the operation team, an operations liaison will be assigned to the Project.

The construction contractor will also have a Project management team composed of qualified personnel including a Project manager, discipline Project engineers, a superintendent, a construction safety officer, a shop quality inspector and other support personnel. The Contractor Project manager and Project engineers will be involved from the beginning of the Project to also manage the engineering and procurement phases before mobilization on site.

The proposed overall organizational chart focusing on FBC's resources is:

Figure 5-4: Project Overall Organization Chart



5.5.2 Design and Quality Control

The construction contractor will be the Engineer of Record for all Project design. The engineering design will be reviewed by the Owner's Engineer prior to final FBC approval as required during the Project.

With responsibility for the design, the construction contractor will have a team of design engineers and drafters to perform the detailed design of the various elements of the Project. The contractor's Project engineers will be involved mostly at the beginning of the Project but will also be involved to support fabrication and construction in order to address any technical questions, provide technical support for these activities and respond adequately to any non-conformances detected during the course of fabrication or construction. The contractor's Project engineer will also be actively involved during construction to address any concerns and provide technical support.

5.5.3 Construction Services

The construction activities will be managed directly on site by the contractor. Construction itself will be performed by qualified construction workers and supervisors in the following trades: millwrights, ironworkers, welders, painters, labourers, carpenters, electricians, crane operators and divers.

Commissioning and start-up activities will consist of dry commissioning and wet testing. As these activities are relatively short in duration, they will be performed by the Project Team personnel and a small construction crew. FBC will be actively involved in this step with its operations personnel.

The procurement activities will consist mainly of placing orders for various components of the Project as well as sub-contracts for fabrication or specialty contracting. These activities will be mostly performed by the contractor under its overall responsibilities.

5.6 *OTHER APPLICATIONS FOR APPROVAL*

A Qualified Environmental Professional working in conjunction with the Company's Environmental group will assist in identifying if any permits, approvals or authorizations are required and in the development of a site-specific Environmental Management Plan (EMP).

The Project does not require an Environmental Assessment Certificate pursuant to the British Columbia Environmental Assessment Act nor does it require a screening under the Canadian Environmental Assessment Act[47].

[47] The Project is not a reviewable project as defined by Tables 7 and 9 of the Reviewable Projects Regulation, B.C. Reg. 370/2002, includes amendments up to B.C. Reg. 41/2016, February 29, 2016., http://www.bclaws.ca/Recon/document/ID/freeside/13_370_2002.

Environmental regulatory requirements will be identified pending review of the final construction detailed design with respect to, but not limited to, the Fisheries Act, Species at Risk Act, Water Sustainability Act, and Heritage Conservation Act.

Authorization from the Dam Safety Office as per the regulation will be initiated upon completion of detailed design.

5.7 RISK ANALYSIS

FBC has identified both general and Project-specific risks for the Project.

5.7.1 Risk Analysis and Management

FBC, with input from HMI, established the most likely risks that are typical for any spillway upgrade work, such as the Corra Linn spillway gates or an infrastructure upgrade project. A risk assessment was initiated early in the Project scoping phase to allow the Project team sufficient time to properly identify and manage the identified risks. Using the AACE IR No. 62R-11 *"Risk Assessment: Identification and Qualitative Analysis"* (Rev. May 11, 2013) (AACE 62R-11) for guidance, the risk assessment identified and qualitatively analysed the risk drivers.

5.7.2 Risk Identification Planning

The risks were identified through a collaborative process between HMI and FBC. The first step of the process was the identification of the general risks categories that are applicable to the various phases of the Project. These categories are: design, procurement, fabrication, construction, environment and transportation. A comprehensive list of risks was then identified in each category. This list forms the basis of the risk register. The next step of the process was to establish the context for the risk identification in terms of:

- Proposed mitigation measure;
- Risk likelihood and consequence scales; and
- Responsibility for each risk (FBC or Contractor).

The appropriate risk likelihood and consequence (probability and exposure) scales relevant to the Project are based on the 5x5 risk assessment matrix recommended in the AACE 62R-11 illustrated in the following figure.

Figure 5-5: Risk Assessment Matrix

RISK LEVEL (RISK EXPOSURE)

PROBABILITY					
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5

The final step in the identification process was to filter the various issues identified and separate risks from non-risk items (other issues and concerns etc.).

5.7.3 Risk Register and Action Plan

The risk identification process identified a number of risks which are tabulated in the risk register document included as Confidential Appendix H. In addition to recording the risks themselves, any existing controls and safeguards to deal with the identified risks were also recorded. This information formed the basis of the risk analysis. Once the risks were identified, a qualitative analysis was completed to prioritize or rank the risks so that the Project team could focus on treatments, action plans and recommendations. Through this qualitative process FBC applied a likelihood category and consequence rating to each risk identified. The product of the likelihood and consequence was then used to establish the overall risk score and ranking for each risk.

The financial impact of each of the identified risks was then computed by HMI and FBC. HMI used its knowledge from current projects it is undertaking to compute the expected financial impact of each risk occurrence. The expected cost of an individual risk item was then computed as the product of overall risk scores and the financial impact for each risk.

FBC then allocated the responsibility for each risk to either FBC or a contractor using the principle that risks are typically allocated to the party best able to manage a particular risk. The concept behind this principle is based on the fact that the party that manages the risk must also bear the financial cost, so as to provide that party an incentive to mitigate the risk.

5.7.3.1 Additional Risks Identified

FBC has also identified a hydrological risk associated with having spillway gates closed at any one time. The Project schedule requires four of the spillway gates to be closed and not available for routine operations. Two of these gates would be closed due to Project work and the adjacent two gates closed for equipment and worker safety. In an emergency event such as a flood, the two gates that would be closed for worker safety could be reopened.

To mitigate the risk, FBC conducted a hydrological analysis to address the probability of flows exceeding the spillway capacity when having one, two, three, four or five gates out of service, for two different reservoir headpond levels:

- Maximum operating pond level of 531.7 m; and
- Dam overtopping level of 532.3 m.

The most probable frequency of having to open the two gates was analysed by KP and is included as Appendix I titled: *Corra Linn Dam – Gate Capacity and Associated Flow Duration Curves*.

A primary constraint is the number of gates that can be held closed simultaneously during the Project. The study concluded that up to five gates can be closed simultaneously. FBC will isolate only four gates and to further mitigate the risks of overtopping, two of the four gates will be available on short recall.

5.8 PROJECT IMPACTS OR EFFECTS IDENTIFIED

5.8.1 Environmental

5.8.1.1 Physical Environment

Potential impacts to the natural environment include the potential for discharge of a deleterious substance to water during the demolition and construction of the gates and ancillary equipment as well as during the construction of the access road and landing. This includes the potential to release lead paint grit, paint, oils and greases, fuels, sediment laden water, uncured concrete, and wash water.

Hazardous and non-hazardous wastes will also be generated and must be managed appropriately including storage, containment, labelling, transport and disposal.

Mitigation measures are provided in Section 5.8.2.

5.8.1.2 Biological Environment

The use of barges and other aquatic equipment from out of area presents the potential risk of introducing aquatic invasive species such as zebra/quagga mussels. The risk of introducing aquatic invasive species will be mitigated through inspection and cleaning of any potentially contaminated equipment.

White sturgeon, a federal Species at Risk Act (SARA) listed species, is known to be present in the waters upstream of the Corra Linn dam. In-stream work will be limited and can be undertaken in isolation of flow with standard mitigation measures in place. In addition, there are no flow or water level changes related to this Project, so there are no anticipated effects to fish, including white sturgeon.

There is a seasonal risk of interaction with nesting birds. Where possible, vegetation clearing for access and laydown areas will be undertaken outside of the sensitive nesting window. If vegetation clearing occurs within the sensitive nesting window, bird surveys will be undertaken and active nests will be protected in accordance with federal and provincial regulatory requirements. This is an avoidable and manageable risk.

5.8.2 Mitigation Measures

A site-specific EMP will be developed to manage all potential environmental risks associated with the proposed construction activities and site conditions. The EMP will outline environmental protection measures to protect the sensitive aquatic ecosystem and upland riparian area within the Project area. Environmental requirements for hazardous materials management, waste management and disposal, erosion and sediment control, environmental incident/spill reporting, response, and cleanup will be outlined in the EMP. Environmental quality control inspection and monitoring will occur to ensure that the Contractor follows the environmental requirements outlined in the EMP.

Any required permits, approvals and authorizations will be obtained prior to construction and their terms and conditions adhered to. A third party consultant will be engaged to perform environmental monitoring. This work will be performed in compliance with relevant law and in conformance with the site-specific EMP. Reports to the Construction Manager and FBC Environment team will be provided.

Daily tailboard meetings will document the potential environment, health and safety risks expected for the day and the associated mitigation measures that will be applied.

To reduce the effects of deleterious substances entering the physical environment all work will be conducted on barges equipped with spill prevention equipment. Also, the work on the spillway gate will be performed by installing a floating bulkhead which will isolate the old spillway gate from the water passage. Risks will be assessed on a case by case basis and secondary containment will be installed to contain deleterious substances.

The potential for introduction of invasive species including zebra/quagga mussels, will be managed through contract conditions and inspection of barge and other aquatic equipment before it enters the water.

An inspection will occur for nesting birds prior to the disturbance of any gates during nesting season. If nesting birds are observed in the vicinity, work will be curtailed or adjusted on a case-by-case basis.

There are no flow or water level changes related to this Project. Fish recovery operations may be required during dewatering of the isolated work area. All required fish collection permits will be in place prior to any fish salvage operations. As the work will be isolated from the water column, the risk of harm to sturgeon or other fish is very low. Any sturgeon sightings will be required to be reported to FBC.

5.8.2.1 Social Environment

The scope of permanent works is entirely within the confines of the Corra Linn Dam and is on property owned by FBC so there will be no impact on the social environment.

5.8.3 Stakeholders

5.8.3.1 First Nations

No First Nations issues are foreseen because the Project does not alter, amend or restrict water flows and the Project will be on property owned by FBC. Section 7 provides an overview of discussions with First Nations.

5.8.3.2 Public

There will be no impact on the public. The scope of work is similar to works previously done by FBC on individual gates. There will be increased transportation on the various roads on days when equipment is brought to site during mobilization, when the new spillway gate is brought to site and during disposal of the old gates, but otherwise the public will not be impacted by the Project.

5.9 SUMMARY

In this section, FBC has described the proposed Corra Linn Spillway Gate Replacement Project in detail, including information on project components, schedule, resources requirements, and risks and management.

6. PROJECT COST ESTIMATE

The Company prepared the Project cost estimate based on AACE Class 3 specifications as defined by the AACE Recommended Practice[48], in accordance with the CPCN Guidelines.

The total capital cost of the Project is forecasted to be $62.694 million in as spent dollars (including AFUDC of $5.434 million and removal costs of $6.094 million)[49].

This section will address the following:

- Estimate preparation method;
- Basis of Estimate; and
- Project capital costs estimate details.

6.1 *ESTIMATE PREPARATION METHOD*

In the AACE guidelines a Class 3 estimate is defined based on the Maturity Level of Project Definition Deliverables. For an estimate to be classified as Class 3, the maturity level recommended is 10% to 40% of full project definition. AACE also clarifies that it is the maturity of the defining deliverables that is the determinant of estimate class, not the percentage. In Table 3 of AACE 69R the defining deliverables for a Class 3 estimate equates to engineering deliverables typically, 10% to 40% complete. This would comprise, at a minimum, the general arrangement drawings, preliminary spillway gates, towers and bridges and hoist design and outlines for the auxiliary mechanical and electrical systems. Furthermore, procurement strategy identifying long lead items of equipment should be defined.

This type of Project requires a specialized skillset, along with the consideration of construction complexities (i.e. the gates are currently providing water control for four hydroelectric plants along the Kootenay River), duration of the works (i.e. expected to be lengthy at approximately 4 years), and a cost estimate requirement of AACE Class 3 level. As a result, FBC opted to engage an experienced specialized contractor to support the development of the Project construction cost estimate.

FBC engaged HMI as the specialized contractor because they have unique understanding of BC construction labour, materials and equipment rates from their experience as a contractor to BC Hydro for similar spillway gates rehabilitation projects currently underway. In addition to their current work with BC Hydro, HMI has executed close to $900 million of contracts for Hydro-Quebec and/or la Société d'Énergie de la Baie James (SEBJ), as well as projects for many other clients, such as Manitoba Hydro.

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[48] AACE published recommended practices are specific to an industry and in this case the AACE International Recommended Practice No. 69-R12 *Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Hydropower Industry* is applicable.

[49] Of the total $62.694 million dollars, $51.166 million of capital and $5.434 million of AFUDC are charged to Electric Plant in Service; $6.094 million removal costs are charged to Accumulated Depreciation.

In the case of BC Hydro, HMI successfully responded to an international call for tender for the first phase of BC Hydro's Spillway Gate Rehabilitation Program. The first phase consisted of the rehabilitation of three spillways. After successfully completing the first phase of this project, HMI was then selected by BC Hydro for the rehabilitation of BC Hydro's remaining 19 sites including inspection, design, procurement as well as implementation. To date, HMI has completed spillway gate rehabilitation work at several of the BC Hydro dams; several of which are similar to the scope of work at the Corra Linn Dam with increased seismic loads.

6.2 *BASIS OF ESTIMATE*

HMI completed a Design Basis Memorandum (DBM) (Confidential Appendix M) and a Preliminary Engineering Report (PER) in 2015 (Confidential Appendix E) which in part form the basis of the cost estimate for the Project. The DBM provided the basis of analysis for the spillway gates and structures which allowed FBC to establish all the design criteria required to meet the new seismic requirements specified in the CDSG. The PER provided a detailed analysis of the current condition of the actual spillway structural as well as the electrical components established through various site inspections as described in Section 3.2.3 and included in Confidential Appendix F. The PER also included the actual design for various reinforcement measures to achieve the Project requirements and was used to develop the AACE Class 3 cost estimate for the Project.

To further improve the accuracy of the estimates, a separate site inspection was performed at a similar dam which allowed access to the embedded parts, concrete and upstream side of gate. The visit performed helped to establish the most probable conditions of the Corra Linn Dam's embedded structures and to develop the proposed refurbishment scope.

It is also crucial to determine the operations requirements and limitations of the Project that will affect all schedule related costs as part of the cost estimate. Examples of these requirements and constraints are the sequence of the work, duration, requirements for mobilization and demobilizations, recalls, temporary electrical feed to operate equipment temporarily, winter related costs, etc.

Following the various assessments as outlined above, a detailed breakdown of work required by the contractor was established for each alternative that will meet the Project needs. This allowed FBC and HMI to develop the contractor cost estimates collaboratively and comprises part of the AACE Class 3 cost estimate.

6.3 *COST ESTIMATE VALIDATION AND DETAILS*

To meet the requirements of the CPCN accuracy level of a minimum Class 3 (as per AACE Recommended Practice No. 69R-12) the cost estimating process performed by FBC and HMI can be summarized into the following major categories:

1. Front End Engineering costs have been included for all mechanical, electrical and civil components of the Project scope.
2. Supplies and fabrications costs have been evaluated based on HMI database prices which are premised on recent awarded tenders.
3. Transportation costs have been evaluated by allocating transportation costs to all the supplies and fabricated items to be delivered to site.
4. Construction costs have been evaluated based on HMI's experience and are composed of the following costs:
   i. Direct labor, which was estimated in detail for each activity part of the WBS. Labor cost is calculated on the number of hours per trade times the associated labor rate;
   ii. Supervision costs, which was evaluated as a percentage of the direct labor based on construction industry standards;
   iii. Lifting equipment, which was evaluated based on the various scenarios; and
   iv. Temporary access equipment such as scaffolding and temporary roads, which was evaluated based on the various scenarios analyzed.
5. Site establishment costs are composed of the equipment and temporary installations required to support construction. Site trailers, rest rooms, etc. were evaluated based on the number of workers estimated for the work and the duration of the work on site.
6. Commissioning and Start-up costs were evaluated based on HMI's experience and are mainly composed of the personnel, equipment and tools required for performing dry testing and wet testing activities.
7. Quality Assurance and Quality Control costs were evaluated based on the Project team's experience with other similar type projects. They involve shop inspections, laboratories (shop and site) and consultants required to ensure the delivery of a quality product.
8. Financial costs such as bonding and insurance have been included.
9. Project Management and Owner costs have been based on the proposed organizational chart, list of deliverables and contractual deliverables.

6.3.1 Project Capital Cost Estimate Details

The individual cost elements are based on the different categories as detailed in Section 6.3 above. The cost estimate meets a minimum of an AACE Class 3 level of Project definition and design. The expected accuracy of the cost estimate is as defined in AACE: Low: -10% to -20% and High: +10% to +30%.

As detailed in Section 6.2, the cost estimate is based on the most recent studies and information currently available to FBC. The Project is planned to be completed in phases with the last spillway gate scheduled to be in-service by December 2020 and contractor demobilization and restoration to occur in early 2021.

Table 6-1 presents a summary of the total estimated project capital costs that include all contractor's and FBC owner's costs. A detailed breakdown of the contractor's costs listed in Table 6-1 can be found in Confidential Appendix L. The estimated (as-spent) total capital cost of the Project is $62.694 million.

Table 6-1: Summary of Estimated Project Capital Costs ($ millions)

	2015 $	As-Spent $
Contractor's Costs		
Engineering	2.349	2.506
Supply, Installation & Testing	18.098	19.302
Site-Support Work	9.443	10.071
Indirect Costs	0.624	0.666
Project Management	4.322	4.610
Subtotal	*34.837*	*37.155*
Removal Cost[50]	5.331	5.804
Construction Contingency	2.008	2.148
Total Contractor Costs	*42.177*	*45.108*
FBC Owner's Costs		
FBC – Project Management	2.920	3.155
Generation Admin Overhead	0.543	0.589
Project Contingency[51]	6.846	7.328
Pre-Approval Project Costs	1.062	1.081
Subtotal (Contractor & Owner's Costs)	*53.548*	*57.260*
AFUDC	n/a	5.434
TOTAL Project Capital Costs	***53.548***	***62.694***

6.3.1.1 Pre-Approval Project Costs

The Pre-Approval Project Costs listed in Table 6-1 above are related to costs for engineering work and CPCN development up to CPCN approval. Upon Commission approval of the CPCN, these costs will be transferred to work-in-progress and included in the total Project capital costs. On January 1, 2020 when the first phase of completed spillway gates is to be placed into service as described in Table 6-5, these costs will be entered to FBC's Electric Plant in Service (EPIS) along with the remainder of the Project Costs. These costs are identified in Confidential Appendix K, Schedule 6 and summarized below.

[50] Removal costs are charged to Accumulated Depreciation.
[51] Project Contingency includes owner's known risks and unknown risks, see Section 6.3.1.2 for details.

Table 6-2: Pre-Approval Project Costs ($ millions)

Item	Particular	As-spent $
1	External Project Development Studies and CPCN Preparation Engineering Costs	0.507
2	Internal (FBC) Project Development Costs	0.370
3	CPCN Application and Approval	0.204
	Total	***1.081***

6.3.1.2 Project Contingency Model and Determination of Project Contingency

Contingency[52] has been applied to the Project to account for certain items, conditions, or events which may occur throughout the Project lifecycle. There are four generally acceptable methods of estimating contingency: expert judgment; predetermined guidelines; Monte Carlo or other simulation analysis; and parametric modelling[53].

Parametric risk modelling was not considered for the Project because there are few similar rehabilitation projects in Canada and as such the historical data to undertake this method is not readily available. The line-by-line Monte-Carlo range estimating method was also not undertaken for similar reasons to the parametric risk modelling method. Like parametric risk modelling, Monte Carlo analysis relies heavily on a reliable historical database.

Because of the limited historical data available, FBC sought guidance from HMI who has performed various contingency evaluations and risk assessments on similar projects they have recently undertaken.

To determine the Project contingency, a risk register (Confidential Appendix H) as described in Section 5.7 was established by FBC and HMI collaboratively for the risk elements that could be identified for the Project. These risks are commonly termed known risks and they were identified based on HMI's extensive experience in recent similar spillway rehabilitation work in the Province and FBC's experience on past projects. Examples of these known risks are: delay in obtaining necessary permits/approvals, unforeseen conditions of embedded structure, parts and concrete, unforeseen project management resourcing requirements, construction delays and re-work.

The risk register provided a ranking for the known risks identified based on the description, probability level of risk occurrence, impact level and estimated financial impacts. The table below shows the risk register format established for the Project.

[52] Contingency is defined in AACE 10R as: "An amount added to an estimate to allow for items, conditions, or events for which the state, occurrence, and/or effect is uncertain and that experience shows will likely result, in aggregate, in additional costs. Typically estimated using statistical analysis or judgment based on past asset or project experience."

[53] "The Monte-Carlo Challenge: A Better Approach" by John K. Hollman, PE CCE of Validation Estimating LLC from a 2007 AACE International Transaction.

Table 6-3: Format of Risk Register Established for Project

Probability rating (1 to 5)	Impact rating (1 to 5)	Overall Risk Level (1 to 25)	Estimated Financial impact of risk event ($)	Amount to add to project contingency (prob x cost)
Estimate based on experience and analysis	Estimate based on experience and analysis	*Probability rating* x *Impact rating*	HMI estimate based on experience and current analysis	*Probability (%)* x *Estimated Financial impact ($)*

The risk register also determined which of these known risks are most likely held by a contractor and the financial impacts of these contractor related risks. The sum of these financial impacts were included to the construction cost as contingency (i.e. Construction Contingency) in the AACE Class 3 cost estimate developed by HMI (Confidential Appendix L). This contingency is also shown in Table 6-1 above as Construction Contingency. All of the other known risks identified in the risk register that are not to be held by a contractor will be likely held by the owner (owner's known risks). The financial impact of these owner's known risks was included to the Project Contingency shown in Table 6-1 of Section 6.3.1 above.

In addition to the owner's known risks identified in the risk register, FBC also established a contingency for those risks that are commonly called unknown risk[54] to account for possible scope changes or unknown future events which cannot be anticipated and which were not quantified in the risk register. This additional contingency is added to the owner's known risks as described above together comprise the Project Contingency shown in Table 6-1 of Section 6.3.1 above.

It is worthwhile noting that there is no AACE standard that outlines the "correct" or "appropriate" level of contingency to include in a project. There are studies however, that suggest an appropriate contingency for projects with high complexity and medium technology in the process industry[55] and in 2014 AACE published a technical paper which presented a case study of estimating in the Canadian Hydropower Industry indicating that contingency and reserves estimated were lower than required[56].

6.3.1.3 Escalation Amounts (including inflation)

The as-spent capital cost estimates as shown in Table 6-1 include inflation escalation based on BC CPI (April 2016) listed in the table below for all costs.

[54] As stated on page 7 of AACE 41R-08: "It must be noted that the contingency which is determined is total required contingency. It does not reflect what is sometimes called "management reserve," a discretionary amount which is added to the estimate for possible scope changes or unknown future events which cannot be anticipated by the project team unless an allowance for this purpose has specifically been included in the estimate as a line item."

[55] Hollmann, J. "Improve Your Contingency Cost Estimates For More Realistic Budgets", Chemical Engineering, Dec 2014. http://www.chemengonline.com/improve-your-contingency-estimates-for-more-realistic-project-budgets/?printmode=1.

[56] 2014 AACE International Technical Paper, Risk.1721 "Variability in Accuracy Ranges: A Case Study in the Canadian Hydropower Industry.

Table 6-4: Inflation Factor based on BC CPI (April 2016)

	2016	2017	2018	2019	2020	2021
Inflation – BC CPI (April 2016)	1.8%	2.2%	2.0%	2.0%	2.0%	2.0%

6.3.1.4 Estimate Exclusions

The cost estimates exclude First Nations Capacity Funding and Accommodation Costs as no such costs are anticipated at this time.

6.4 *FINANCIAL EVALUATION AND ACCOUNTING TREATMENT*

The financial evaluation of the Project consists of the following:

- Project capital cost estimate, including financing costs and removal costs, as described in Section 6.3.1; and
- Incremental cost of service (revenue requirements), present value of the incremental cost of service, rate impact as a percentage of 2016 Revenue Requirement, and levelized rate impact over a 70-year analysis period. Table 6-6 presents the financial and rate impacts of the Project and the financial schedule for the analysis is included in Confidential Appendix K.

FBC evaluated the incremental cost of service, cash flow, and rate impacts associated with the Project over a 70 year period plus five preceding years during the planning and construction phase. The 70 year period was chosen based on the FBC 2014 Depreciation Study by Gannett Fleming for Reservoirs, Dams & Waterways (Account 332.00).

Per the BCUC Uniform Code of Accounts, FBC will account for the capital costs associated with the construction of the Project in Construction Work-in-Progress, attracting AFUDC[57]. FBC will transfer the costs to the appropriate plant asset accounts on January 1 of the year following construction completion and in-service. The specific asset will begin depreciating at the start of that year. The Project is scheduled to be completed and placed in-service in three phases between 2019 and 2021. Table 6-5 below shows the year and the planned construction work to be completed at each phase, the estimated asset amounts as well as when they will be transferred to their appropriate plant asset accounts. The amount and timing of the transfer to plant asset account for each phase are also identified in Confidential Appendix K, Schedule 7.

[57] FBC's 2015 AFUDC rate is 5.90 percent, equal to the after-tax weighted average cost of capital.

Table 6-5: Schedule of Phased Completion Inclusion in Rate Base

Year of Construction Complete	Construction Work to be completed	Estimated amount of capital (As-Spent) transfer to Plant-in-Service ($ millions)	Date transfer to Opening Balance of Plant-in-Service
2019	7 gates in-service	$ 27.897	January 1, 2020
2020	7 gates in-service	$ 27.901	January 1, 2021
2021	Demobilization Work	$ 0.802	January 1, 2022
	TOTAL	**$56.599**	

6.4.1 Abandonment/Removal Costs

Abandonment/removal costs related to the 14 existing Corra Linn Spillway gates are charged to Accumulated Depreciation. The abandonment/removal costs are estimated to be $6.094 million in as-spent dollars. These costs are identified in Confidential Appendix K, Schedule 8. The net book value of the Corra Linn Spillway gates is zero therefore no plant retirements are included in the financial analysis.

6.5 REVENUE REQUIREMENTS IMPACT

Table 6-6 presents the financial and the rate impacts associated with the completion of the Project. The impact to customer rates in 2022 (when all assets have been entered to rate base as described in Table 6-5 above) is an approximate increase of 1.49% over the 2016 Approved Revenue Requirement. Over a 70 years analysis period, the levelized rate impact to customers is an approximate increase of 1.46%. For a typical FBC residential customer consuming an average 991 kWh per month, this would equate to approximately a bill increase of $1.83 per month in 2022. The details of the bill increase calculation can be found in Confidential Appendix K, Schedule 10.

Table 6-6: Financial Analysis and Rate Impact of Project

AACE Class 3	Corra Linn Spillgates
Total Charged to Electric Plant in Service ($ millions)	56.599
Cost of Removal ($ millions)	6.094
Total Capital Costs incl. Cost of Removal ($ millions)	62.694
% Increase on Rate - Year 2022	1.49%
Levelized % Increase on Rate - 70 years	1.46%
PV of Incremental Revenue Requirement - 70 years ($ millions)	85.018
Discounted Cash Flow NPV ($ millions)	1.868
2022 Incremental Rate Base ($ millions)	61.153

6.6 *SUMMARY*

In this section, FBC has described the Project cost estimate, the financial evaluation and accounting treatment and the revenue requirements impact in detail.

7. CONSULTATION

FBC regards its responsibility to engage stakeholders in a meaningful and comprehensive consultation process as a key consideration in the successful development and execution of its projects necessary to provide electrical service that is safe, reliable, and cost effective.

Stakeholders who may have an interest in capital projects in general may include local and Provincial governments and agencies, potentially affected landowners, other local groups such as tourism associations, and community and/or residents' associations. Consultation activities are determined on a project by project basis.

As the permanent works of the Project is entirely contained within the existing generation facility, public consultation for the Project was limited. All of the planned construction activities for the permanent works of the Project are within FBC facilities. Project execution will be carried out in a manner that isolates each gate from the Kootenay River while work is underway. The river flows will not be affected nor does FBC expect any impacts to the environment or fish populations.

FBC has discussed the potential for this Project with the International Joint Commission (IJC)[58] since 2013, with the last update occurring at the IJC Kootenay Lake Board of Control meeting on October 6th 2015. The IJC has expressed no concerns with the Project to date. FBC will continue to update the IJC throughout the Project duration during these annual meetings.

The Regional District of Central Kootenay (RDCK) was identified as the only local stakeholder with a possible interest in the Project. On September 9, 2015, FBC representatives discussed the Project with the General Manager of Environmental Services at RDCK and then followed up with a letter outlining the Project on November 3, 2015 (Appendix N). On November 30, 2015, FBC received a phone call from the RDCK regarding the potential for disturbance of any contaminated soils. FBC confirmed to the RDCK by phone call the following day that there is no contaminated soil to be disturbed during the Project.

7.1 *FIRST NATIONS CONSULTATION*

FBC is committed to building effective relationships with Aboriginal Communities and that it has the structure, resources and skills necessary to maintain these relationships. As an integral part of its Aboriginal Consultation approach, FBC acknowledges, respects and understands that Aboriginal people have unique histories, cultures, protocols, values, beliefs and governments. FBC is committed to continued and active engagement with Aboriginal Groups who have interests that may potentially be affected by the Company's projects, and routinely communicates with First Nations during Project proposal and implementation.

[58] On November 11, 1938 the international Joint Commission granted an Order of Approval to FortisBC predecessor the West Kootenay Power and Light Company to operate Corra Linn dam at Granite, B.C. to store six feet of water in Kootenay Lake. The Order stipulated that the works be operated subject to a number of conditions, and established the International Kootenay Lake Board of Control to supervise the construction and subsequent operation of the works. http://ijc.org/en_/iklbc/Mandate.

7.1.1 There are No First Nations Potentially Affected

FBC believes Aboriginal Rights and Title will not be affected by this Project, and therefore, First Nation Consultation is not required. This is because all of the planned construction activities for the permanent works of the Project will occur entirely within already existing FBC facilities. Project execution will be carried out in a manner that isolates each gate from the Kootenay River while work is underway. The river flows will not be affected, and FBC does not expect any impacts to the environment or fish populations.

The Company, via the provincial Consultative Area Database (CAD) Public Map Service, identified the following 12 First Nations that have an interest in the Corra Linn area:

- Secwepemc Nation;
- Shuswap Indian Band;
- Okanagan Nation Alliance;
- Penticton Indian Band;
- Upper Nicola Indian Band;
- Lower Similkameen Indian Band;
- Okanagan Indian Band;
- Ktunaxa Nation Council ;
- Akisqnuk First Nation;
- Lower Kootenay Band;
- St Mary's Indian Band; and
- Tobacco Plains Indian Band.

Again, FBC does not believe that any of the above First Nations will be impacted by the Project. If during detailed Project design any potential impacts arise, or the Project requires any permitting that triggers consultation, FBC will work with the Crown and the identified First Nations through the Consultation process.

7.1.2 Description of Consultation to Date

While FBC does not believe that any Aboriginal Rights or Title will be affected by the Project, the Company has identified the Project to and discussed it with local First Nations during normal course of business in 2015 and 2016. Specifically, FBC has discussed and is still discussing the Project with representatives of the Ktunaxa Nation, Lower Kootenay Band, Shuswap Band, Penticton Indian Band and Okanagan Nation Alliance, all whose claimed traditional territory includes the Project site location. These discussions have centred on the details of Project, the spill response plan and potential Project work for First Nation owned businesses.

As a result of one of these meetings, a site visit and Project discussion was held with FBC Environment and Dam Safety representatives and Senior Fisheries Biologist from the Canadian Columbia River Intertribal Fisheries Commission (CCRIFC). CCRFIC was formed in 1993 by the Okanagan, Ktunaxa and Swecwepemc Nations and is a collaborative group committed to the restoration and conservation of fish and the aquatic ecosystems in the upper Columbia River basin. CCRIFIC cited no concerns with the Project and FBC committed to updates during the detailed design stage as well as Project implementation.

FBC continues to have ongoing discussions as and where desired by the First Nations. Any issues or concerns identified by First Nations will be appropriately addressed by FBC should they arise.

Concurrently to the Application being submitted to the Commission, FBC will send a Notice of Filing letter to all First Nations with an interest in the Project area, as identified above. The Notice of Filing will provide instructions for First Nations interested in participating in the BCUC proceeding for the Project, as well as a FBC contact for posing any Project-related questions. A draft of the First Nations notification letter is also included in Appendix O.

7.2 *SUMMARY*

FBC believes that to date it has adequately engaged and consulted with key stakeholders and First Nations. FBC has addressed and will continue to address issues that may arise, and will continue to engage stakeholders and First Nations throughout Project detailed design and implementation.

8. PROVINCIAL GOVERNMENT ENERGY OBJECTIVES AND POLICY CONSIDERATIONS

Section 46 (3.1)(a) and (b) of the UCA states that in considering whether to issue a CPCN, the Commission must consider: (a) the applicable of British Columbia's energy objectives, and (b) the most recent long-term resource plan filed by the public utility under section 44.1, if any.

With respect to section 46(3.1)(a), British Columbia's energy objectives as provided in the *Clean Energy Act* (CEA). The Company was mindful of these energy objectives when designing the Project and the following of British Columbia's energy objectives were identified as being applicable to the present Application, as defined in section 2 of the CEA:

(a) to achieve electricity self-sufficiency;

(c) to generate at least 93 percent of the electricity in British Columbia from clean or renewable resources and to build the infrastructure necessary to transmit that electricity;

(g) to reduce BC greenhouse gas emissions…;

(k) to encourage economic development and the creation and retention of jobs; and

(m) to maximize the value, including the incremental value of the resources being clean or renewable resources, of British Columbia's generation and transmission assets for the benefit of British Columbia.

The Project will assist in achieving each of these energy objectives. In particular, the Corra Linn Dam is integral in supplying clean, renewable hydroelectric power. Ensuring that the spillway gates continue to be operational and safe is important to the overall operation of the Dam in continuing to supply this clean energy. The Project therefore contributes to FBC achieving electricity self-sufficiency, the generation of clean or renewable energy in BC, the reduction of greenhouse gas emissions for alternative energy sources, and maximizing the value of BC's clean energy generation assets. In addition, the implementation of the Project and the associated construction will create jobs, encouraging economic development in the province.

Under section 46(3.1)(b), the Commission must consider the most recent long-term resource plan filed by the public utility. As was discussed in section 1 of the Application, the Project (which was described at the time as the Corra Linn Spillgate and Spillway Concrete Rehabilitation Project) was identified in section 2.5.1.5 of the 2012 Long Term Capital Plan, FBC's most recent long-term resource plan, as being a "major" capital project to be completed.

9. CONCLUSION

The Company respectfully submits that the Corra Linn Dam Spillway Gate Replacement Project is necessary for the public convenience and properly conserves the public interest. Completion of the Project will replace the existing spillway gates that are near end of life, while also ensuring that the Corra Linn Dam complies with regulatory requirements and is aligned with industry standards. The proposed replacement of the gates achieves all of the technical criteria defined for the Project, while also being the most cost-effective solution over a 70 year analysis period.

The Company requests that the Commission approve the Project as it is set out in the Application. If the Application is approved, FBC plans to initiate the detailed design and procurement for the Project in early Q3-2017, and to begin construction in early Q2-2018. The Project is planned to be completed in phases with the last spillway gate scheduled to be in-service by December 2020 and contractor demobilization and restoration to occur in early 2021.

Appendix A

BC DAM SAFETY REGULATIONS

Appendix A-1

BC DAM SAFETY REGULATION

B.C. Reg. 44/2000 Deposited February 10, 2000

O.C. 131/2000

Water Act

BRITISH COLUMBIA DAM SAFETY REGULATION

[includes amendments up to B.C. Reg. 163/2011, November 30, 2011]

Contents

Definitions

1 In this regulation:

"Act" means the *Water Act*;

"classification" means the dam failure consequences classification of a dam under Schedule 1;

"dam" means

(a) a barrier constructed across a stream, or

(b) a barrier constructed off-stream and supplied by diversion of water from a stream,

for the purpose of enabling the storage or diversion of water, and includes all works which are incidental to or necessary for the barrier;

"dam owner" means, with respect to a dam, any or all of the following:

(a) the person who holds the current licence or is required to hold a licence for the dam;

(b) the person who last held a licence for the dam, including a licence that has been suspended, cancelled, abandoned or terminated;

(c) if there is no person to whom paragraph (a) or (b) applies, the owner of the land on which the dam is located or the person who had the dam constructed;

"dam safety officer" means an engineer or officer who is designated in writing by the comptroller as a dam safety officer;

"dam safety review" means a review carried out by a professional engineer under section 7 or 14;

"emergency preparedness plan" means

(a) a plan prepared by a dam owner under section 3.1 (1) and accepted by a dam safety officer, and

(b) any revisions to the plan prepared by the dam owner and accepted by a dam safety officer;

"height" means the vertical distance to the top (crest) of a dam measured,

(a) in the case of a dam across a stream, from the natural bed of the stream at the downstream outside limit of the dam, or

(b) in the case of a dam that is not across a stream, from the lowest elevation at the outside limit of the dam;

"instrumentation" means, but is not limited to, survey monuments and stations, inclinometers, extensometers, piezometers or measuring weirs;

"maintain" or **"maintenance"** means the performance of those tasks required to keep the dam in good operating condition;

"operation, maintenance and surveillance manual" means

(a) a manual prepared by a dam owner under section 3 (2) and accepted by a dam safety officer, and

(b) any revisions to the manual prepared by the dam owner and accepted by a dam safety officer;

"professional engineer" means a person registered, and in good standing, as a professional engineer under the *Engineers and Geoscientists Act*;

"Provincial Emergency Program" means the Provincial Emergency Program continued under the *Emergency Program Act*; **.**

"Schedule 2 table" means the table in section 2 of Schedule 2;

"volume of water" means the total storage volume of the reservoir at full supply level measured in accordance with one of the following:

(a) between the natural bed of the stream and the spillway crest;

(b) between the upstream outside limit of the dam and the spillway crest;

(c) if a low level outlet is excavated to an elevation lower than the general foundation of the dam, between the bottom of that outlet and the spillway crest.

[am. B.C. Reg. 108/2011, App. 1, s. 1; App. 2, s. 1.]

Application

2 (1) This regulation applies to all of the following:

(a) a dam 1 metre or more in height that is capable of impounding a volume of water greater than 1 000 000 m3;

(b) a dam 2.5 metres or more in height that is capable of impounding a volume of water greater than 30 000 m3;

(c) a dam 7.5 metres or more in height;

(d) a dam that does not meet the criteria under paragraph (a), (b) or (c) but has a classification of significant, high, very high or extreme.

(2) This regulation does not relieve a dam owner from any other requirements that may be imposed under the Act, the Water Regulation or any other applicable enactment.

[am. B.C. Reg. 108/2011, App. 1, s. 2.]

Operation and maintenance of a dam

3 (1) A dam owner must operate and maintain a dam in accordance with all of the following:

(a) this regulation;

(b) any applicable licence or approval;

(c) any order made by the comptroller, a regional water manager or an engineer under the Act or this regulation or any requirement specified by a dam safety officer under this regulation;

(d) the emergency preparedness plan for the dam;

(e) the operation, maintenance and surveillance manual for the dam.

(2) A dam owner of a dam that has a classification of significant, high, very high or extreme must, in the form and manner and within the time period specified by the comptroller or regional water manager,

(a) prepare a manual that describes the dam owner's operation, maintenance and surveillance procedures for the dam, and

(b) submit the manual to a dam safety officer for acceptance by the dam safety officer.

(3) Subsection (2) applies whether or not there is a term or condition in an approval granted or licence issued that requires the preparation of such a manual for the dam.

(3.1) A dam owner of a dam that has a classification of significant, high, very high or extreme must

(a) review, and revise if necessary, the operation, maintenance and surveillance manual for the dam no less frequently than is specified for the classification of the dam in item 6 in the Schedule 2 table, and

(b) submit any revisions to a dam safety officer for acceptance by the dam safety officer.

(4) A dam owner must ensure that the dam is adequately safeguarded to prevent unauthorized operation of the dam by someone other than the dam owner or an agent of the dam owner.

(5) A dam owner of a dam that is located partially or entirely on Crown land and that has a classification of significant, high, very high or extreme must ensure that there is at all times posted on the land at both ends of the top of the dam a sign that meets all of the following criteria:

(a) the sign must contain, in lettering that is clearly visible from 15 metres, the following information:

(i) the name of the dam;

(ii) the name of the stream that is dammed;

(iii) the following words: "If you see any dam safety concerns, please contact:", followed by

(A) the name and emergency telephone numbers for both day and night of a dam owner, and

(B) the emergency telephone number for the Provincial Emergency Program;

(b) the sign must be at least 75 centimetres high and 60 centimetres wide;

(c) the sign must be clearly visible under seasonal conditions to persons approaching the dam;

(d) the sign and post must be constructed from metal or other durable materials having strength suited to the location and environment of the sign;

(e) the sign must meet any other requirement specified by the comptroller or a regional water manager.

(6) Subsection (5) applies whether or not the dam owner has an authorization or other right to use or occupy the Crown land on which the dam is partially or entirely located.

(7) For the purposes of subsection (5) (a) (iii) (A), if there is more than one dam owner, the dam owner whose name and emergency telephone numbers must be on the sign is the dam owner who

(a) the dam owners agree is the emergency contact for the dam, or

(b) if there is no agreement by the owners, the dam owner specified by a dam safety officer.

[am. B.C. Reg. 108/2011, App. 1, s. 3; App. 2, s. 2.]

Emergency preparedness plan

3.1 (1) A dam owner of a dam that has a classification of significant, high, very high or extreme must, in the form and manner and within the time period specified by the comptroller or regional water manager,

(a) prepare a plan that describes the actions to be taken by the dam owner in the event of an emergency at the dam, and

(b) submit the plan to a dam safety officer for acceptance by the dam safety officer.

(2) Subsection (1) applies whether or not there is a term or condition in an approval granted or licence issued that requires the preparation of such a plan for the dam.

(3) A dam owner of a dam that has a classification of significant, high, very high or extreme must

(a) review, and revise if necessary, the emergency preparedness plan for the dam no less frequently than is specified for the classification of the dam in items 5 and 6 in the Schedule 2 table, and

(b) submit any revisions to a dam safety officer for acceptance by the dam safety officer.

[en. B.C. Reg. 108/2011, App. 1, s. 4.]

Change of classification

3.2 If the classification of a dam changes, a dam owner must, in a timely manner,

(a) meet the requirements of this regulation that apply in respect of the new classification, and

(b) review, and revise if necessary, the operation, maintenance and surveillance manual and the emergency preparedness plan, if any, for the dam and submit any revisions to a dam safety officer for acceptance by the dam safety officer.

[en. B.C. Reg. 108/2011, App. 1, s. 4.]

Alteration of a dam

4 (1) Any alteration, improvement or replacement to all or any part of a dam must be authorized by an approval, licence or order.

(2) Subsection (1) does not apply to an alteration, improvement or replacement for the purpose of

(a) maintaining the dam as authorized under section 3, or

(b) addressing a hazardous condition under section 8.

(3) On completion of an alteration, improvement or replacement to all or any part of a dam, a dam owner must, in a timely manner,

(a) submit to a dam safety officer a report on the work and the manner in which the alteration, improvement or replacement was performed, and

(b) review, and revise if necessary, the operation, maintenance and surveillance manual and the emergency preparedness plan, if any, for the dam and submit any revisions to a dam safety officer for acceptance by the dam safety officer.

[am. B.C. Reg. 108/2011, App. 1, s. 5.]

Inspections and tests

5 A dam owner must do all of the following:

(a) inspect the dam and dam site no less frequently than is specified for the classification of the dam in items 1 and 2 in the Schedule 2 table in order to assess the condition of the dam during the construction, operation or alteration of the dam;

(b) test the operation of the outlet facilities, spillway gates and other mechanical components of the dam no less frequently than is specified for the classification of the dam in item 4 in the Schedule 2 table;

(c) record the results of every inspection or test performed under this section;

(d) comply with section 7.1 or 8, if applicable.

[en. B.C. Reg. 108/2011, App. 1, s. 6.]

Reporting

6 (1) If an inspection or test is carried out under section 5 or any other inspection, test or review is carried out with respect to a dam, a dam owner must, if required by a dam safety officer, submit to the dam safety officer, in the form and manner and within the time period specified by the dam safety officer,

(a) a record of the results of the inspection, test or review, and

(b) the results and analysis of any test or measurement taken including, but not limited to,

(i) instrumentation readings and analysis,

(ii) visual records or observations,

(iii) drawings,

(iv) soil, aggregate and concrete test results, and

(v) any other test results.

(2) Despite subsection (1), if an inspection, test or review carried out with respect to a dam reveals a potential safety hazard referred to in section 7.1 or a hazardous condition referred to in section 8, a dam owner must promptly submit to a dam safety officer the records referred to in subsection (1).

(3) A dam owner must, if required by a dam safety officer, submit to the dam safety officer copies of the following records relating to the design, construction or alteration of the dam:

(a) all design notes, drawings and specifications;

(b) hydraulic, hydrologic, geological and geotechnical data;

(c) reports and other similar records.

[en. B.C. Reg. 108/2011, App. 1, s. 6.]

Review of downstream conditions

6.1 A dam owner must

(a) annually conduct a review of conditions downstream of the dam to assess whether there has been any change to the classification of the dam, and

(b) immediately notify a dam safety officer if there has been a change to the classification of the dam.

[en. B.C. Reg. 108/2011, App. 1, s. 6.]

Dam safety review and report

7 (1) A dam owner of a dam that has a classification of high, very high or extreme must, no less frequently than is specified for the classification of the dam in item 7 in the Schedule 2 table,

(a) have a professional engineer with qualifications and experience in dam safety analysis,

(i) carry out a review, in accordance with the requirements of the comptroller or regional water manager,

(A) to determine whether the dam is safe, and

(B) if it is determined that the dam is not safe, to determine what actions are required to make the dam safe; and

(ii) prepare, in the form and manner specified by the comptroller or regional water manager, a dam safety report, and

(b) submit to a dam safety officer, for acceptance by the dam safety officer, a copy of the dam safety report prepared by the professional engineer.

(2) Despite subsection (1), if a dam classification increases due to an increase in the consequences of a failure of the dam, other than an increase from a low classification to a significant classification, the dam owner must meet the requirements of paragraphs (a) and (b) of subsection (1) no later than 2 years from the earlier of the following dates:

(a) the date on which a dam safety officer notifies the dam owner of the change in classification;

(b) the date on which the dam owner notifies a dam safety officer of the change in classification;

unless the comptroller, regional manager or a dam safety officer specifies that the requirements must be met by another date.

(3) For the purposes of subsections (1) and (2), if a dam owner meets the requirements of paragraphs (a) and (b) of subsection (1) on or before December 31 of the year in which the requirements must be met under those subsections, the dam owner is deemed to have met the requirements within the time required.

(4) After completion of a dam safety review the dam owner must comply with section 7.1 or 8, if applicable.

[en. B.C. Reg. 108/2011, App. 1, s. 6.]

Potential safety hazard at a dam

7.1 If

(a) an inspection or test under section 5,

(b) a dam safety review,

(c) monitoring, under section 11, the instrumentation installed at a dam, or

(d) any other inspection, test or review carried out with respect to a dam

reveals a potential safety hazard to which section 8 does not apply, a dam owner must prepare a plan that identifies and prioritizes any actions required to correct the potential safety hazard and, in accordance with section 4, if applicable, must implement the plan in a timely manner based on the priorities identified in the plan.

[en. B.C. Reg. 108/2011, App. 1, s. 6.]

Hazardous conditions at a dam

8 If conditions exist which are or are likely to be hazardous to a dam, or if conditions may reasonably be anticipated to cause a dam, or any part of a dam, or any operation or action at or in connection with a dam, to be or become potentially hazardous to public safety, the infrastructure or works, other property or the environment, a dam owner must promptly do all of the following:

(a) if an emergency preparedness plan exists, modify the operation of the dam, or any part of the dam, in accordance with the emergency preparedness plan;

(b) if an emergency preparedness plan does not exist, operate the dam in a manner, and initiate any remedial actions, that will

(i) safeguard the public,

(ii) minimize damage to the infrastructure or works or to other property, including that not owned by the dam owner, and

(iii) minimize damage to the environment;

(c) contact the Provincial Emergency Program;

(d) notify a dam safety officer, or the comptroller or regional water manager, of

(i) the nature of the existing or anticipated conditions,

(ii) all things done by the dam owner to rectify the conditions, and

(iii) the time and exact nature of any information or warning of existing or anticipated conditions issued to any person under this section;

(e) inform local authorities, and persons who may be in immediate danger from the potential failure of the dam, of the nature of the existing or anticipated conditions and, if necessary, advise those persons who may be in immediate danger to vacate and remove any property from the endangered area;

(f) modify the operation of the dam to minimize or prevent damage which may be caused by the failure of the dam, and undertake any other hazard response activity required by a dam safety officer or engineer or by the comptroller or regional water manager.

[am. B.C. Reg. 108/2011, App. 2, s. 3.]

Suspension of normal operation or removal of a dam

9 (1) A dam owner must give the comptroller or regional water manager at least 60 days written notice before undertaking any of the following activities:

(a) removing all or a significant part of a dam;

(b) decommissioning or abandoning a dam;

(c) stopping the normal operation of a dam for a period of time longer than one year.

(2) The dam owner must prepare, and submit to a dam safety officer for approval,

(a) a plan respecting an activity under subsection (1) (a) or (b), or

(b) if required by the dam safety officer, a plan respecting an activity under subsection (1) (c).

(3) The dam owner must, at least 14 days before the date on which the work is expected to commence, notify a dam safety officer before commencing any work under the approved plan.

(4) The dam owner must submit to a dam safety officer, on the completion of the work performed under the approved plan, a report on the work and the manner in which it was performed.

(5) The dam owner must undertake any further actions that the comptroller or regional water manager requires to alleviate any adverse consequences to any person, the infrastructure or works, other property or the environment that may be affected by any work performed on the dam.

(6) An approval under subsection (2) respecting the decommissioning of a dam is subject to the *Environmental Assessment Act* and to approvals, if any, required under that Act.

Information and evaluation

10 (1) A dam owner must, if required by a dam safety officer, submit to the dam safety officer the following information in order to evaluate the condition or hazard potential of a dam:

(a) information with respect to the dam including, but not limited to,

(i) foundation investigation results,

(ii) design details and as-built plans,

(iii) construction records,

(iv) operation manuals,

(v) records of instrumentation,

(vi) inspection reports,

(vii) safety reports, and

(viii) inundation studies and emergency preparedness plans;

(b) information with respect to the nature of the land and the stream, and the use of the land and the stream, downstream from or adjacent to the dam or reservoir, including the hydraulic, hydrologic, geological and geotechnical characteristics and the uses of the land and stream;

(c) information with respect to the watershed upstream of the dam.

(2) The information required under subsection (1) must be submitted to a dam safety officer, in the form and manner and within the time period specified by the comptroller or regional water manager.

(3) The dam owner must conduct any inspection, investigation, survey or test that is necessary to provide the information required by subsection (1).

(4) If a dam owner conducts an investigation that involves drilling, trenching, excavating a test pit or other invasive activity within the dam or in close proximity to the dam, the dam owner must ensure that the activity is directly supervised by a professional engineer with qualifications and experience in dam design, construction and analysis.

[am. B.C. Reg. 108/2011, App. 1, s. 7.]

Instrumentation

11 A dam owner must do all of the following:

(a) install any instrumentation necessary to adequately monitor the performance of a dam;

(b) maintain or replace instrumentation installed at a dam to ensure continuity of readings;

(b.1) monitor the instrumentation installed at a dam no less frequently than is specified for the classification of the dam in item 3 in the Schedule 2 table;

(c) if required by a dam safety officer, submit to the dam safety officer instrumentation readings and evaluations in the form and manner and within the time period specified by the dam safety officer;

(c.1) comply with section 7.1 or 8, if applicable;

(d) submit, to a dam safety officer for acceptance by the dam safety officer,

(i) notice of any planned modifications to, changes to or removal of the instrumentation at least 60 days before the proposed modification, change or removal, or

(ii) an annual plan outlining intended changes to the instrumentation.

[am. B.C. Reg. 108/2011, App. 1, s. 8.]

Expert opinion

12 (1) If, based on information submitted in respect of a dam or related works, the comptroller or regional water manager considers that a question has arisen as to what is proper practice for resolving an issue involving a dam or related works, the comptroller or regional water manager may require a dam owner to retain an independent expert, satisfactory to the comptroller or regional water manager, with qualifications and experience as follows:

(a) in the case of a dam, in dam design, construction and analysis;

(b) in the case of related works, in hydraulic, hydrological, geological, geotechnical, mechanical or structural engineering or other appropriate disciplines.

(2) The expert retained under subsection (1) must provide a report to the comptroller or regional water manager on the issue.

[am. B.C. Reg. 108/2011, App. 1, s. 9.]

Acceptance by dam safety officer

13 (1) If a record that is submitted under this regulation by a dam owner to a dam safety officer for acceptance by the dam safety officer is not in a form that is acceptable to the dam safety officer, the dam safety officer may return the record to the dam owner together with a written notice specifying the deficiencies in the record and requiring that they be corrected.

(2) If a dam safety officer provides a written notice to a dam owner under subsection (1)

(a) the dam owner must correct the deficiencies identified in the notice in a timely manner, and

(b) the dam safety officer is not required to accept the record referred to in subsection (1) until the dam owner has corrected the deficiencies set out in the notice.

[en. B.C. Reg. 108/2011, App. 1, s. 10.]

Transition — dam safety review and report

14 (1) Despite section 7, if a dam

(a) had a downstream consequence classification of low or very low under this regulation as it read immediately before June 9, 2011, and

(b) had a classification of high, very high or extreme on June 9, 2011,

the dam owner must meet the requirements of paragraphs (a) and (b) of section 7 (1) no later than December 31, 2013.

(2) Despite section 7, subsection (3) of this section applies to a dam if

(a) the dam had a downstream consequence classification of high or very high under this regulation as it read immediately before June 9, 2011,

(b) the dam had a classification of extreme on June 9, 2011, and

(c) on June 9, 2011 the immediately preceding dam safety review in respect of the dam was conducted in a year set out in column 1 of the table in subsection (3).

(3) For the purposes of subsection (2) of this section, the dam owner must meet the requirements of paragraphs (a) and (b) of section 7 (1) no later than the date specified in column 2 in the table below opposite the year in which the immediately preceding dam safety review was conducted as set out in column 1 of the table below:

Item	Column 1 Year of immediately preceding dam safety review	Column 2 Date by which requirements in paragraphs (a) and (b) of section 7 (1) must be met
1	2001 or 2002	10 years from the date on which the dam safety report in respect of the immediately preceding review was submitted to a dam safety officer.
2	2003, 2004 or 2005	December 31, 2013.
3	2006 and thereafter	The date specified for the classification of the dam in item 7 in the Schedule 2 table.

(4) In respect of Items 1 and 3 of the table in subsection (3) of this section, if a dam owner meets the requirements of paragraphs (a) and (b) of section 7 (1) on or before December 31 of the year in which the requirements must be met under subsection (3) of this section, the dam owner is deemed to have met those requirements within the time required.

[en. B.C. Reg. 163/2011.]

Schedule 1

[en. B.C. Reg. 108/2011, App. 1, s. 11.]

(sections 1, 2 (1) (d), 3 (2) and (3.1), 3.1 (1) and (3), 3.2, 5, 6.1, 7, 11 (b.1) and 14)

Dam Classification

Definitions

1 In this Schedule:

"category" , with respect to consequences of failure, means one of the following:

(a) loss of life;

(b) environment and cultural values;

(c) infrastructure and economics;

"consequences of failure" means losses or damages that

(a) are caused by the failure of a dam, and

(b) result from impacts on areas that are at the dam or are downstream or upstream of the dam;

"failure" , in respect of a dam, means the partial or complete collapse of the dam and the uncontrolled release of all or part of the water stored by the dam, caused by either flood-induced failure or non flood-induced failure;

"flood-induced failure" means a dam failure that is caused by a natural flood of a magnitude that is greater than the magnitude that the dam can pass at the time of the failure;

"non flood-induced failure" means a dam failure that occurs during normal dam operation that is caused by conditions such as internal erosion, piping, an earthquake or an error in operation leading to overtopping.

Determination of classification

2 The dam failure consequences classification of a dam is determined in accordance with the following steps:

(a) for each category of consequences of failure in the following table, identify the losses or damages specified in the table that most closely describe the losses or damages that are the worst potential consequences of a failure of the dam;

(b) identify the classification that is specified in the following table for the losses or damages referred to in paragraph (a) for each category;

(c) the classification identified under paragraph (b) with the worst potential consequences is the classification of the dam.

Table

Dam failure consequences classification	Population at risk	Consequences of failure		
		Loss of life	Environment and cultural values	Infrastructure and economics
Low	None[1]	There is no possibility of loss of life other than through unforeseeable misadventure.	Minimal short-term loss or deterioration and no long-term loss or deterioration of (a) fisheries habitat or wildlife habitat, (b) rare or endangered species, or (c) unique landscapes or sites of cultural significance.	Minimal economic losses mostly limited to the dam owner's property, with virtually no pre-existing potential for development within the dam inundation zone.
Significant	Temporary only[2]	Low potential for multiple loss of life.	No significant loss or deterioration of (a) important fisheries habitat or important wildlife habitat, (b) rare or endangered species, or (c) unique landscapes or sites of cultural significance, and restoration or compensation in kind is highly possible.	Low economic losses affecting limited infrastructure and residential buildings, public transportation or services or commercial facilities, or some destruction of or damage to locations used occasionally and irregularly for temporary purposes.
High	Permanent[3]	10 or fewer	Significant loss or deterioration of (a) important fisheries habitat or important wildlife habitat, (b) rare or endangered species, or	High economic losses affecting infrastructure, public transportation or services or commercial facilities, or some destruction of or some severe damage to scattered residential buildings.

			(c) unique landscapes or sites of cultural significance, and restoration or compensation in kind is highly possible.	
Very high	Permanent[3]	100 or fewer	Significant loss or deterioration of (a) critical fisheries habitat or critical wildlife habitat, (b) rare or endangered species, or (c) unique landscapes or sites of cultural significance, and restoration or compensation in kind is possible but impractical.	Very high economic losses affecting important infrastructure, public transportation or services or commercial facilities, or some destruction of or some severe damage to residential areas.
Extreme	Permanent[3]	More than 100	Major loss or deterioration of (a) critical fisheries habitat or critical wildlife habitat, (b) rare or endangered species, or (c) unique landscapes or sites of cultural significance, and restoration or compensation in kind is impossible.	Extremely high economic losses affecting critical infrastructure, public transportation or services or commercial facilities, or some destruction of or some severe damage to residential areas.

[1] There is no identifiable population at risk.

[2] People are only occasionally and irregularly in the dam-breach inundation zone, for example stopping temporarily, passing through on transportation routes or participating in recreational activities.

[3] The population at risk is ordinarily or regularly located in the dam-breach inundation zone, whether to live, work or recreate.

Schedule 2

[en. B.C. Reg. 108/2011, App. 1, s. 11; am. B.C. Reg. 163/2011.]

(sections 1, 3 (3.1), 3.1 (3), 5, 7, 11 (b.1) and 14)

Minimum Frequency of Safety Activities

Interpretation of Schedule

1 In this Schedule:

"EPP" means the emergency preparedness plan for a dam;

"formal inspection" means a thorough on-site inspection performed by the representative of the dam owner who is responsible for dam safety;

"OMS manual" means the operation, maintenance and surveillance manual for a dam;

"site surveillance" means the close monitoring of dam behaviour through visual inspections and, in addition, may include the systematic collection, analysis and interpretation of data obtained through automated instrumentation.

Frequency of activities

2 In the following table, column 1 sets out an activity that must be carried out by a dam owner under a provision in this regulation and columns 2, 3, 4 and 5 set out the minimum frequency with which the activity must be carried out for each classification.

Item	Column 1 Activity	Column 2	Column 3 Frequency of activity	Column 4	Column 5
		Extreme classification	Very high and high classifications	Significant classification	Low classification
1	Site surveillance	Weekly[1]	Weekly[1]	Monthly[1]	Quarterly
2	Formal inspection	Semi-annually	Annually	Annually	Annually
3	Monitor instrumentation	Annually unless otherwise specified in the OMS manual	Annually unless otherwise specified in the OMS manual	Annually unless otherwise specified in the OMS manual	If and when required by a dam safety officer
4	Test operation of outlet facilities, spillway gates	Annually unless otherwise	Annually unless otherwise	Annually unless otherwise	Annually

	and other mechanical components	specified in the OMS manual	specified in the OMS manual	specified in the OMS manual	
5	Update the emergency contact information in the EPP	Annually	Annually	Annually	Not applicable
6	Review, and revise if necessary, the OMS manual and the EPP	Every 7 years	Every 10 years	Every 10 years	Not applicable
7	Conduct dam safety review and submit dam safety report	Every 7 years	Every 10 years	Not applicable	Not applicable
8	Review downstream conditions, as set out in section 6.1, and notify a dam safety officer of any change in classification	Annually	Annually	Annually	Annually

[1] The frequency of visual inspections may be reduced if provided for in the OMS manual.

[Provisions relevant to the enactment of this regulation: *Water Act*, R.S.B.C. 1996, c. 483, section 101 (1), (2), (3), (5) and (8)]

Appendix A-2

COMPARISON OF CHANGES TO THE BC DAM SAFETY REGULATION FAILURE CONSEQUENCES CLASSIFICATION

Ministry of Forests, Lands and Natural Resource Operations

INFORMATION SHEET

Dam Failure Consequence Classification Conversion Guideline
For Dams in British Columbia
(BC Reg. 163/2011, November 30, 2011)

Background to Dam Classification in BC

In 1999 the Canadian Dam Association (CDA) published Dam Safety Guidelines to establish safety requirements for new and existing dams, enable the consistent evaluation of dam safety deficiencies and to provide a basis for dam safety legislation and regulation. The Guidelines included a 4-tier failure consequence classification system: very low, low, high and very high. In February 2000, the BC Dam Safety Regulation (44/2000), under the *Water Act* of BC, was enacted. Schedule 1 of the Regulation defined 4 dam classifications similar to those provided by the CDA. In 2007, the CDA Guidelines were rewritten and the consequence classification system changed to 5 tiers: low, significant, high, very high and extreme. The Province has recently amended the BC Dam Safety Regulation bringing the provincial consequence classification system in-line with the CDA Guidelines.

2011 BC Dam Safety Regulation Amendment

On November 30, 2011, the BC Dam Safety Regulation was amended. Schedule 1 of the amended Regulation includes a 5-tier dam failure consequence classification (Attachment 1). This change aligns the consequence classification of BC dams with the current CDA Guidelines thus ensuring BC's dam safety requirements are consistent with the current CDA Guidelines.

Conversion to the New 2011 Dam Failure Consequences Classifications

The dam failure consequence classifications for all dams in BC have been converted to the new 5-tier classifications as per Schedule 1 of the BC Regulation 163/2011 (Attachment 1). The conversions are based on the Dam Consequence Conversion Table provided in Attachment 2. Dam owners are being advised of the Regulation change and provided with confirmation of their dam failure consequence classification by registered letter during August and September 2011. Many dam owners have undertaken dam break inundation studies to confirm the consequence classification or to provide evidence for a revised classification. If a dam owner does not receive notice of their new dam classification by October 2011, or if you have additional information that might influence the dam failure consequence classification, please contact your local Dam Safety Officer.

Additional Information

It is important to note that the BC Dam Safety Regulation dam failure consequence classification determines the requirements that a **dam owner** must meet. The CDA Guidelines classifications are for **dam design** criteria. Please refer to the CDA website to order the CDA Guidelines (http://www.cda.ca/).

Please note that under the amended BC Dam Safety Regulation (163/2011), there are some additional dam safety requirements for dam owners based on the consequence classifications. For example, owners of Significant Consequence Classification dams (formally Low Consequence Classification dams, BC Reg. 44/2000) are now required to prepare Emergency Preparedness Plans. Also, effective November 30, 2011, all owners of dams located on Crown land, except those dams classified as Low Consequence, are required to post signs at their dams. For further information please refer to the Dam Signage Requirement Information Sheet and OIC 237/2011 available on the BC Dam Safety website.

BC Dam Safety Website: http://www.env.gov.bc.ca/wsd/public_safety/dam_safety/index.html

Attachments:
Attachment 1 –BC Dam Safety Regulation (163/2011), Schedule 1. November 30, 2011.
Attachment 2 – BC Dam Consequence Classification Conversion Table. March 27, 2012.

Attachment 1

Schedule 1 – Dam Safety Regulation (163/2011), November 30. 2011[1]

Downstream Dam Failure Consequences Classification Table

Dam failure consequences classification	Population at risk	Consequences of failure		
		Loss of life	Environment and cultural values	Infrastructure and economics
Low	None[2]	There is no possibility of loss of life other than through unforeseeable misadventure.	Minimal short-term loss or deterioration and no long-term loss or deterioration of (a) fisheries habitat or wildlife habitat, (b) rare or endangered species, or (c) unique landscapes or sites of cultural significance.	Minimal economic losses mostly limited to the dam owner's property, with virtually no pre-existing potential for development within the dam inundation zone.
Significant	Temporary only[3]	Low potential for multiple loss of life.	No significant loss or deterioration of (a) important fisheries habitat or important wildlife habitat, (b) rare or endangered species, or (c) unique landscapes or sites of cultural significance, and restoration or compensation in kind is highly possible.	Low economic losses affecting limited infrastructure and residential buildings, public transportation or services or commercial facilities, or some destruction of or damage to locations used occasionally and irregularly for temporary purposes.
High	Permanent[4]	10 or fewer	Significant loss or deterioration of (a) important fisheries habitat or important wildlife habitat, (b) rare or endangered species, or (c) unique landscapes or sites of cultural significance, and restoration or compensation in kind is highly possible.	High economic losses affecting infrastructure, public transportation or services or commercial facilities, or some destruction of or some severe damage to scattered residential buildings.
Very high	Permanent[4]	100 or fewer	Significant loss or deterioration of (a) critical fisheries habitat or critical wildlife habitat, (b) rare or endangered species, or (c) unique landscapes or sites of cultural significance, and restoration or compensation in kind is possible but impractical.	Very high economic losses affecting important infrastructure, public transportation or services or commercial facilities, or some destruction of or some severe damage to residential areas.
Extreme	Permanent[4]	More than 100	Major loss or deterioration of (a) critical fisheries habitat or critical wildlife habitat, (b) rare or endangered species, or (c) unique landscapes or sites of cultural significance, and restoration or compensation in kind is impossible.	Extremely high economic losses affecting critical infrastructure, public transportation or services or commercial facilities, or some destruction of or some severe damage to residential areas.

[1] This table is a copy of Schedule 1 of the Dam Safety Regulation 163/2011. In case of discrepancy between this table and the approved Regulation, the Regulation takes precedence.
[2] There is no identifiable population at risk.
[3] People are only occasionally and irregularly in the dam-breach inundation zone, for example stopping temporarily, passing through on transportation routes or participating in recreational activities.
[4] The population at risk is ordinarily or regularly located in the dam-breach inundation zone, whether to live, work or recreate.

BC Dam Failure Consequences Classification Conversion Table (March 27, 2012)[1]								
Consequence Classification NEW BC Dam Safety Regulation 163/2011	**Population at Risk**	**Loss of Life**		**Environment and Cultural Values[2]**		**Infrastructure & Economics[2]**		**Consequence Classification OLD BC Dam Safety Regulation 44/2000**
	BC Reg. 163/2011 Only	**BC Reg. 163/2011**	**BC Reg. 44/2000[(3)]**	**BC Reg. 163/2011**	**BC Reg. 44/2000**	**BC Reg 163/2011**	**BC Reg. 44/2000**	
Low	None	No possibility of loss of life	Minimal	Minimal short-term and no long-term loss or deterioration	No significant loss of habitat or sites	Minimal economic losses mostly limited to dam owner's property	< $100K Minimal	**Very Low**
Significant	Temporary Only	Low potential for multiple loss of life[6]	Some Possible	No significant loss or deterioration incl. Important habitat Restoration or compensation possible	Loss or deterioration of regionally important habitat & sites – High chance for restoration or compensation	Low economic losses to buildings, services, public transportation, infrastructure, etc.	< $1M Limited Infrastructure, Public, Commercial	**Low**
High	Permanent Residents	< 10	< 10[(4)]	Significant loss or deterioration incl. Important habitat Restoration or compensation possible	Same as below	High economic losses to buildings, services, public transportation, commerce, infrastructure, etc.	< $10M[(4)] Same as below	**High (Low[4])**
Very High	Permanent Residents	< 100	< 100	Significant loss or deterioration incl. critical habitat Restoration or compensation impractical	Loss or deterioration of Nationally & Provincially important habitat & sites – High chance for restoration or compensation	Very high economic losses to **important** buildings, services, transportation, infrastructure, commerce etc. **Or** severe damage to residential areas	< $100M Substantial Infrastructure, Public, Commercial	**High (High[4])**
Extreme	Permanent Residents	>100	>100	Major loss or deterioration incl. critical habitat Restoration or compensation impossible	Loss or deterioration of Nationally & Provincially important habitat & sites – Low chance for restoration or compensation	Extremely high economic losses to **critical** buildings, services, transportation, infrastructure, commerce etc. **Or** destruction or severe damage to residential areas	>$100M Very High Infrastructure, Public, Commercial, Residential	**Very High**

[1] This table contains abridged descriptions of the dam failure consequences. Attachment 1 contains the full descriptions from BC Regulation 163/2011. In all cases the Regulation takes precedence over information contained in this table.
[2] Names for these categories in BC Reg. 44/2000 are "Environmental and Cultural Losses" and "Economic and Social Losses" respectively.
[3] Conservative estimate of loss of life amongst population affected by the flood waters (may equal Population at Risk).
[4] Sub-classifications of "High (Low)" and "High (High)" and associated thresholds were established by policy in 1998 for use in the BC Dam Safety Program risk-based assessment.
[5] A temporary population (e.g. in recreational areas) could be quite large and a "sunny-day" failure could result in multiple fatalities.

Appendix B

CORRA LINN HYDROELECTRIC PROJECT
2011/2012 DAM SAFETY REVIEW

FILED CONFIDENTIALLY

Appendix C

SEISMIC HAZARD ASSESSMENT AND INPUT GROUND MOTIONS

May 10, 2015

Mr. Doug Grimes, P. Geo.
Project Manager
Knight Piésold Ltd.
Suite 1400 - 750 West Pender
Vancouver, British Columbia, V6C 2T8
Phone: +1 604 685 0543

RE: CORRA LINN DAM – SEISMIC HAZARD ASSESSMENT AND INPUT GROUND MOTIONS

1.0 INTRODUCTION

The Corra Linn Hydroelectric Project, owned and operated by FortisBC, is located on the Kootenay River approximately 15 km downstream of the city of Nelson in south eastern BC. A mass concrete gravity structure, it comprises east, middle and west dams, and spillway and powerhouse sections.

The Corra Linn Seismic Upgrade Project was initiated in 2014 to evaluate the seismic withstand capability of the spillway gates, hoists and gantries, and the dam structures. Knight and Piesold Ltd. (KP) is the Owner's Engineer for the Seismic Upgrade Project. KP's 2011/2012 Dam Safety Review of the Corra Linn Facility indicated that the Consequence Classification of the facility is Extreme (KP, 2012).

At the request of KP, Wutec Geotechnical International is to provide a seismic hazard evaluation and provide input ground motions, in support to seismic response analysis of the gates, hoists, and the concrete dam to be carried out by others. The scope of work includes the following:

- Review seismicity data from Natural Resources Canada probabilistic seismic hazard database and the BC Hydro Probabilistic Seismic Hazard Analysis (PSHA) study report, and make recommendations on uniform hazard response spectra (UHRS, including PGAs) for horizontal ground motions under AEF of 1/10,000, 1/2475, 1/1000 and 1/475
- Develop seismic response spectra (including PGAs) for vertical ground motions under AEF of 1/10,000, 1/2475, 1/1000 and 1/475
- Select earthquake time history records from past real earthquakes, to be used as root records from which input ground motions will be developed
- Develop 2D ground motions (one horizontal and one vertical component in each set) for each of the target earthquake events with AEF of 1/10,000, 1/2475, 1/1000 and 1/475

This letter report provides a brief summary of the methodology used in the analysis and presents the results of seismic hazard evaluation and input ground motions.

2.0 SEISMIC HAZARD AT THE DAM SITE

Earthquake ground motion parameters for Corra Linn Dam site were first obtained from the probabilistic seismic hazard database provided by Natural Resources Canada (NRC) (http://www.earthquakescanada.nrcan.gc.ca/hazard-alea). The NRC database employs the fourth generation seismic hazard maps of Canada developed by Geological Survey of Canada (GSC), and it provides peak ground acceleration (PGA) and spectral accelerations at periods of 0.2, 0.5, 1.0 and 2.0 sec for ground motions with annual exceedance frequency (AEF) of 1/100, 1/475, 1/1000 and 1/2475. The seismic hazard data for Corra Linn Dam from the GSC hazard model are included in Appendix A, which include median (50^{th} percentile) PGA values of 0.070 g, 0.095 g and 0.136 g for AEF of 1/475, 1/1000 and 1/2475, respectively, and for firm ground (National Building Code of Canada, i.e., NBCC 2010: Soil Class C – average shear wave velocity 360-750 m/s).

Seismic hazard data for horizontal ground motions were also obtained from the Probabilistic Seismic Hazard Analysis (PSHA) Report E658 (BC Hydro 2012) published by BC Hydro Dam Safety. The BC Hydro PSHA was a Level 3 study carried out following the methodology developed by the Senior Seismic Hazard Analysis Committee (SSHAC), and it provides peak ground acceleration (PGA) and spectral accelerations at 12 periods from 0.03 to 5.0 sec for ground motions with annual exceedance probability (AEF) of 1/100, 1/475, 1/1000, 1/2475 and 1/10,000. The seismic hazard data for BC Hydro Kootenay Canal generating facility extracted from Report E658 are included in Appendix A, which include mean PGA values of 0.035g, 0.056 g, 0.098 g and 0.236 g for AEF of 1/475, 1/1000 , 1/2475, and 1/10,000, respectively, and for a reference ground condition of V_{s30}=760 m/s. This average shear wave velocity corresponds to Soil Class B/C boundary in NBCC 2010, and is typically described as “rock” or “firm ground condition”.

Upon review of available data and its methodology, it is recommended to use seismic hazard data from BC Hydro PSHA study which can also provide **mean** hazard values for 1/10,000 seismic event. As a comparison, the BC Hydro PSHA model results in lower hazard values than the GSC seismic hazard model, probably due to the difference in reference ground conditions. It is further recommended that seismic hazard data for BC Hydro Kootenay Canal generating facility be applied to Corra Linn Dam. The two sites are approximately 5 km away from each other.

The mean uniform hazard response spectra (UHRS, including PGAs) for horizontal and vertical ground motions under AEF of 1/10,000, 1/2475, 1/1000 and 1/475 are presented in Table 1 and shown in Figure 1. The UHRS for vertical ground motions were computed based on the vertical-to-horizontal (V/H) ratio model (GA11) developed by Gülerce and Abrahamson (2011) as recommended by BC Hydro (2012). The mean values of M=6.2 and R=13 km from the de-aggregation of the mean 1/10,000 seismic hazard data has been used in the calculation of V/H ratios.

Table 1 Mean Uniform Hazard Response Spectra (mean UHRS) for Corra Linn Dam Site (assumed V_{s30}=760 m/s)

Period (sec)	5% damped spectral accelerations (g)							
	AEF:1/10000		AEF:1/1000		AEF:1/2475		AEF:1/1475	
	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical
PGA	0.236	0.142	0.098	0.059	0.056	0.033	0.035	0.021
0.03	0.260	0.185	0.107	0.076	0.059	0.042	0.037	0.026
0.05	0.316	0.267	0.127	0.107	0.069	0.059	0.042	0.036
0.075	0.407	0.311	0.162	0.124	0.087	0.066	0.052	0.040
0.10	0.484	0.302	0.191	0.119	0.102	0.063	0.060	0.038
0.15	0.562	0.273	0.226	0.110	0.122	0.059	0.073	0.036
0.2	0.553	0.235	0.228	0.097	0.127	0.054	0.079	0.033
0.3	0.451	0.184	0.195	0.080	0.114	0.047	0.073	0.030
0.5	0.299	0.123	0.135	0.055	0.081	0.033	0.054	0.022
1	0.144	0.071	0.068	0.034	0.042	0.021	0.028	0.014
2	0.057	0.031	0.028	0.015	0.017	0.009	0.011	0.006
3	0.032	0.017	0.016	0.008	0.010	0.005	0.006	0.003
5	0.017	0.008	0.008	0.004	0.005	0.002	0.003	0.002

3.0 INPUT GROUND MOTIONS FOR 1/10,000 EVENT

De-aggregation analysis of the mean 1/10,000 seismic hazard (see Appendix A) from BC Hydro PSHA model results in two scenario earthquake events (Mean event with magnitude and distance: M=6.2 and R=13 km; and Modal event: M=6.7 and R=2.5 km). Selection of historical earthquake records was targeted on earthquakes with magnitude from M=6.0 to M=6.9 and occurring in similar tectonic setting as the Corra Linn Dam. The original time histories were downloaded from the NGA West2 database (http://ngawest2.berkeley.edu/).

The selected earthquake records, to be used as root records for developing input ground motions, consist of the following 5 records from 3 earthquakes:

- Loma Prieta Earthquake of 10/18/1989, at San Jose - Santa Teresa Hills, 225 and UP (Vertical)
- Northridge Earthquake of 1/17/1994, at LA - Chalon Rd, 70 and UP (Vertical)
- Northridge Earthquake of 1/17/1994, at San Gabriel - E Grand Ave, 270 and UP (Vertical)
- Parkfield Earthquake of 9/28/2004, at Bear Valley Ranch CA, 360 and UP (Vertical)
- Parkfield Earthquake of 9/28/2004, at Turkey Flat #1 (0M), 270 and UP (Vertical)

Linear scale factors for the five records (horizontal and vertical, separately) were determined to minimize the mean square error between the scaled record spectrum and the target UHRS spectrum over the period range of 0.05 to 1.0 second. A summary of earthquake records selected for seismic response analysis of the concrete dam, the gates and hoists at Corra Linn Dam, including the linear scale factors and PGAs after scaling for the 1/10,000 earthquake event, is presented in Table 2. The PGA, Peak Ground Velocity (PGV), Peak Ground Displacement (PGD) and Arias Intensity (AI) of the scaled time histories, including the file name used in the digital data, are listed in Table 3.

Table 2 Summary of Earthquake Records Selected for Concrete Dam, Gates and Hoists

Record #	Earthquake	Station	Magnitude	Vs30 (m/s)	Component	Duration 5%-95% (s)	Scale factor [1]	PGA after scaling (g)
1	Loma Prieta 10/18/1989	Santa Teresa Hills	6.9	672	225	10.13	0.63	0.174
					Vertical	11.08	0.59	0.134
2	Northridge 1/17/1994	Chalon Rd	6.7	740	70	8.97	0.98	0.211
					Vertical	8.65	0.71	0.109
3	Northridge 1/17/1994	San Gabriel	6.7	401	270	12.88	0.99	0.256
					Vertical	19.05	1.34	0.102
4	Parkfield, CA 9/28/2004	Bear Valley Ranch	6.0	528	360	6.99	1.38	0.222
					Vertical	5.8	1.15	0.116
5	Parkfield, CA 9/28/2004	Turkey Flat #1	6.0	907	270	8.34	1.23	0.303
					Vertical	13.8	1.78	0.134

(1) These are scale factors applied on original earthquake records to obtain 1/10,000 ground motions.

Table 3 Summary of Linearly Scaled Time Histories for Concrete Dam, Gates and Hoists Under 1/10,000 Earthquake

Record #	Earthquake & Station	Component	File Name	PGA (g)	PGV (m/s)	PGD (m)	Arias Intensity (m/s)
1	Loma Prieta, Santa Teresa Hills	225	SJTE225.avd	0.174	0.178	0.146	0.518
		Vertical	SJTE-UP.avd	0.134	0.11	0.055	0.178
2	Northridge, Chalon Rd	70	CHL070.avd	0.211	0.188	0.036	0.597
		Vertical	CHL-UP.avd	0.109	0.047	0.008	0.13
3	Northridge, San Gabriel	270	GRN270.avd	0.256	0.117	0.022	0.456
		Vertical	GRN-UP.avd	0.102	0.06	0.021	0.23
4	Parkfield, Bear Valley Ranch	360	BVR360.avd	0.222	0.128	0.045	0.313
		Vertical	BVR-UP.avd	0.116	0.054	0.015	0.109
5	Parkfield, Turkey Flat #1	270	TF1_270.avd	0.303	0.18	0.018	0.26
		Vertical	TF1-UP.avd	0.134	0.09	0.026	0.139

Acceleration time histories of the five record after being scaled for the 1/10,000 event are shown in Figures 2 to 6. In Figures 7 and 8, response spectra of the five scaled records (horizontal and vertical) are shown and compared with the respective 1/10,000 UHRS horizontal and vertical curves. The average spectra of the five scaled records are compared with 1/10,000 UHRS spectra in Figure 9, indicating a reasonably good match over the period range of interest from 0.05 – 1.0 sec.

4.0 INPUT GROUND MOTIONS FOR 1/2475, 1/1000 AND 1/475 EVENTS

The input ground motions for 1/2475, 1/1000 and 1/475 are obtained by linearly scaling down the 1/10,000 input ground motions (presented in Section 3.0). The scale factors to be applied on the 1/10,000 ground motions are presented in Table 4 below. The average spectra of the five scaled records are compared with the target UHRS spectra in Figures 10, 11, and 12 for input ground motions with AEF of 1/2475, 1/1000 and 1/475, respectively.

Table 4 Linear Scale Factors for 1/2475, 1/1000 and 1/475 Ground Motions

AEF of Input Ground Motions	Scale Factors to be applied on 1/10,000 Input Ground Motions	
	Horizontal	Vertical
1/10,000	1.00	1.00
1/2475	0.41	0.41
1/1000	0.23	0.23
1/475	0.14	0.14

5.0 CLOSURE

We trust that the information presented in the report meets your current project requirements. Should you require any further assistance, please contact the undersigned. We thank you for the opportunity to provide this service.

Yours Truly,

Wutec Geotechnical International

PROFESSIONAL PROVINCE OF G. WU BRITISH COLUMBIA ENGINEER

May 10, 2015

Guoxi Wu, Ph.D., P.Eng.
Principal

Attachments:
Figures 1 to 12
Appendix A (3 pages)

REFERENCE

1. BC Hydro 2012. "Probabilistic Seismic Hazard Analysis (PSHA) Model", BC Hydro Report No. E658, November

2. Gülerce, Z. and Abrahamson, N.A. 2011. "Site-specific design spectra for vertical ground motion", Earthquake Spectra, Vol. 27, No. 4, pp. 1023 – 1047

3. Knight and Piesold (KP) 2012. "CORRA LINN HYDROELECTRIC PROJECT: 2011/2012 Dam Safety Review", A report prepared for FORTISBC INC., KP Ref. No. VA103-353/1-1

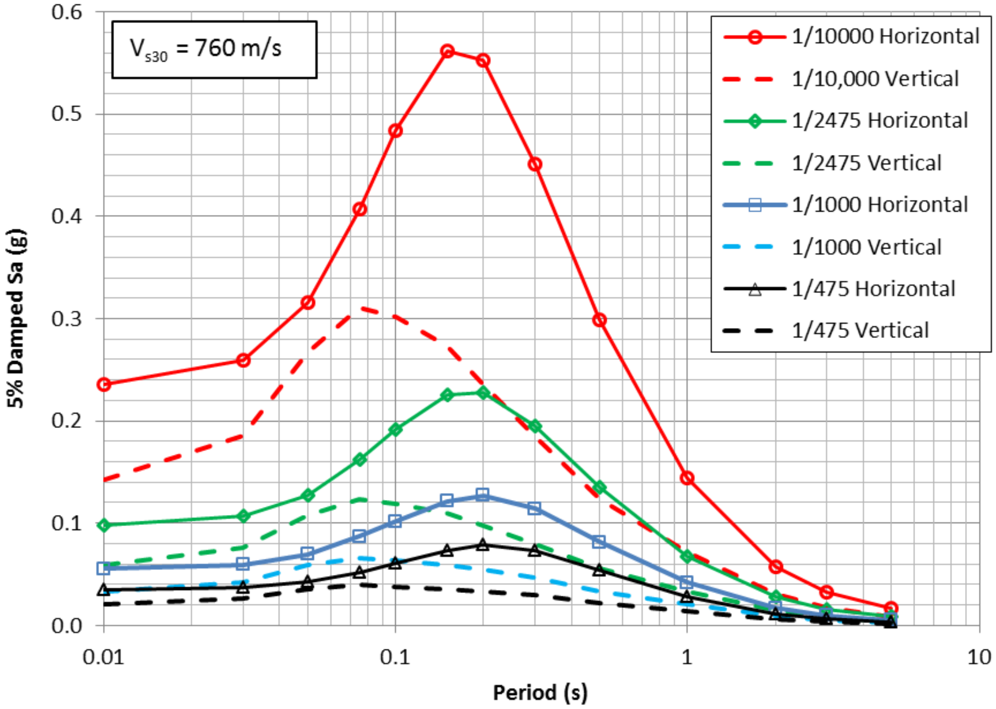

Figure 1 Horizontal and vertical mean UHRS for Corra Linn Dam Site with AEF of 1/10,000, 1/2475, 1/1000 and 1/475 and a reference ground condition with Vs30=760 m/s

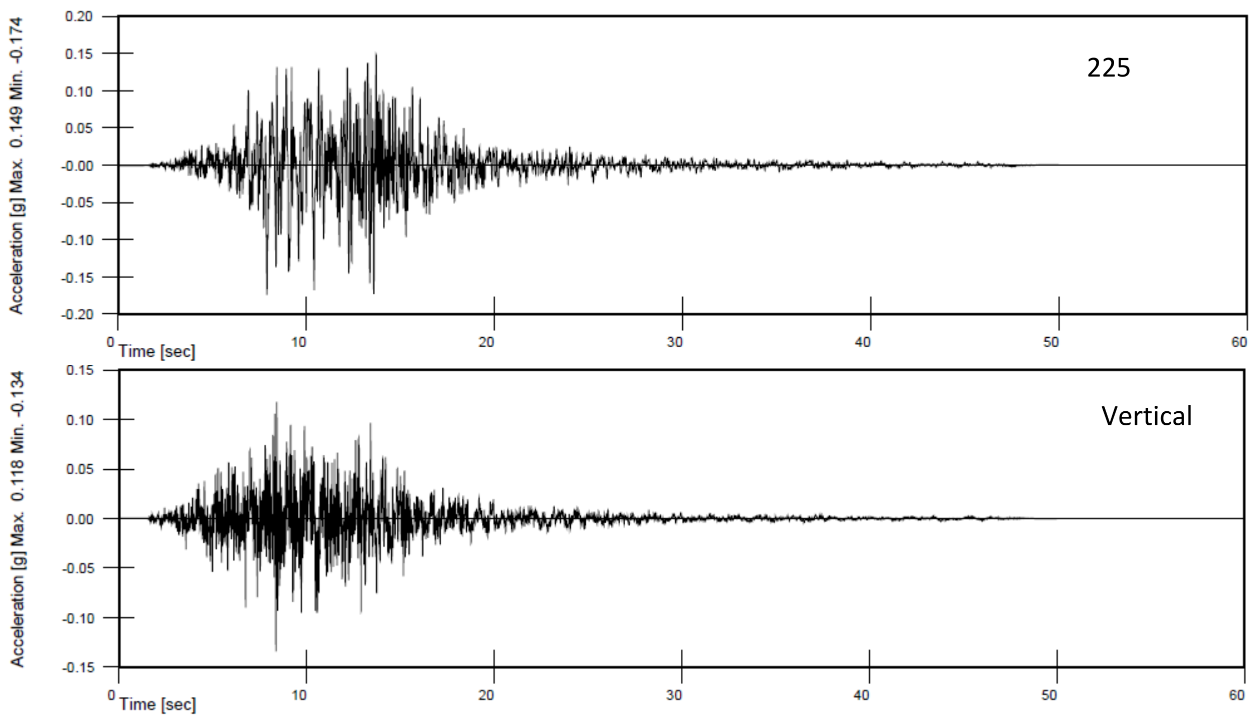

Figure 2 Acceleration Time Histories of Loma Prieta Records at Santa Teresa Hills (225 and Vertical) Scaled for 1/10,000 Event

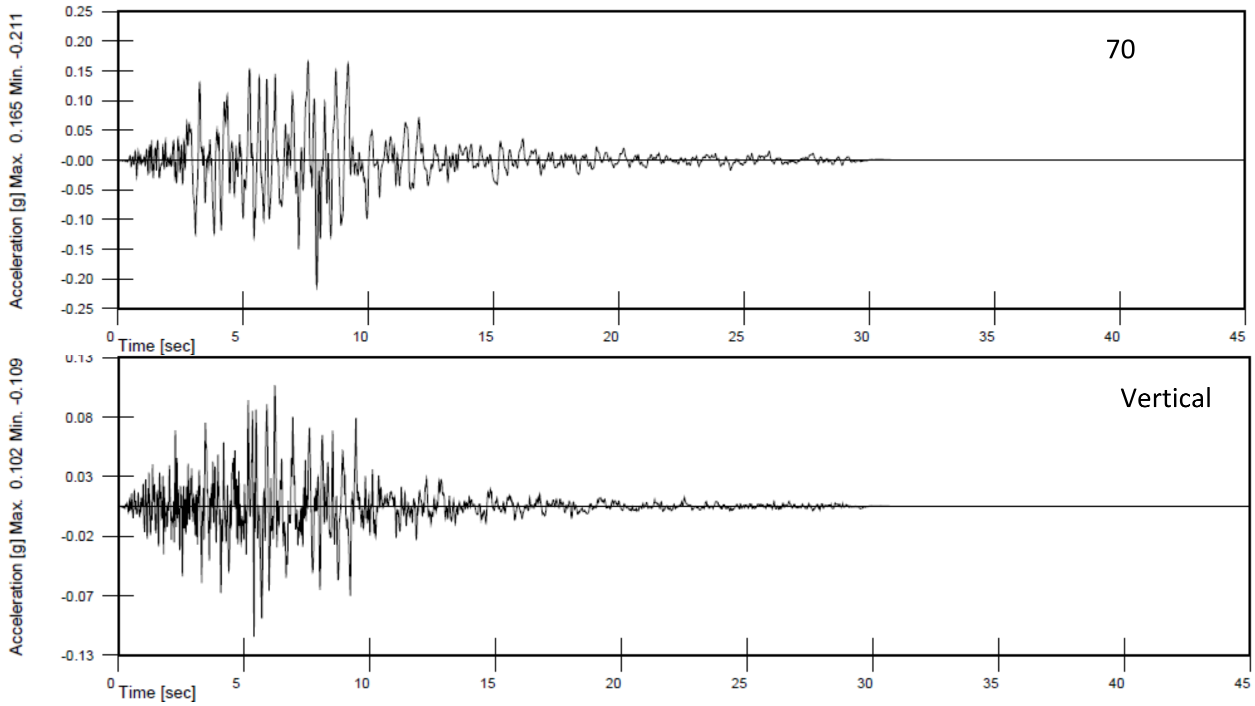

Figure 3 Acceleration Time Histories of Northridge Records at Chalon Rd (70 and Vertical) Scaled for 1/10,000 Event

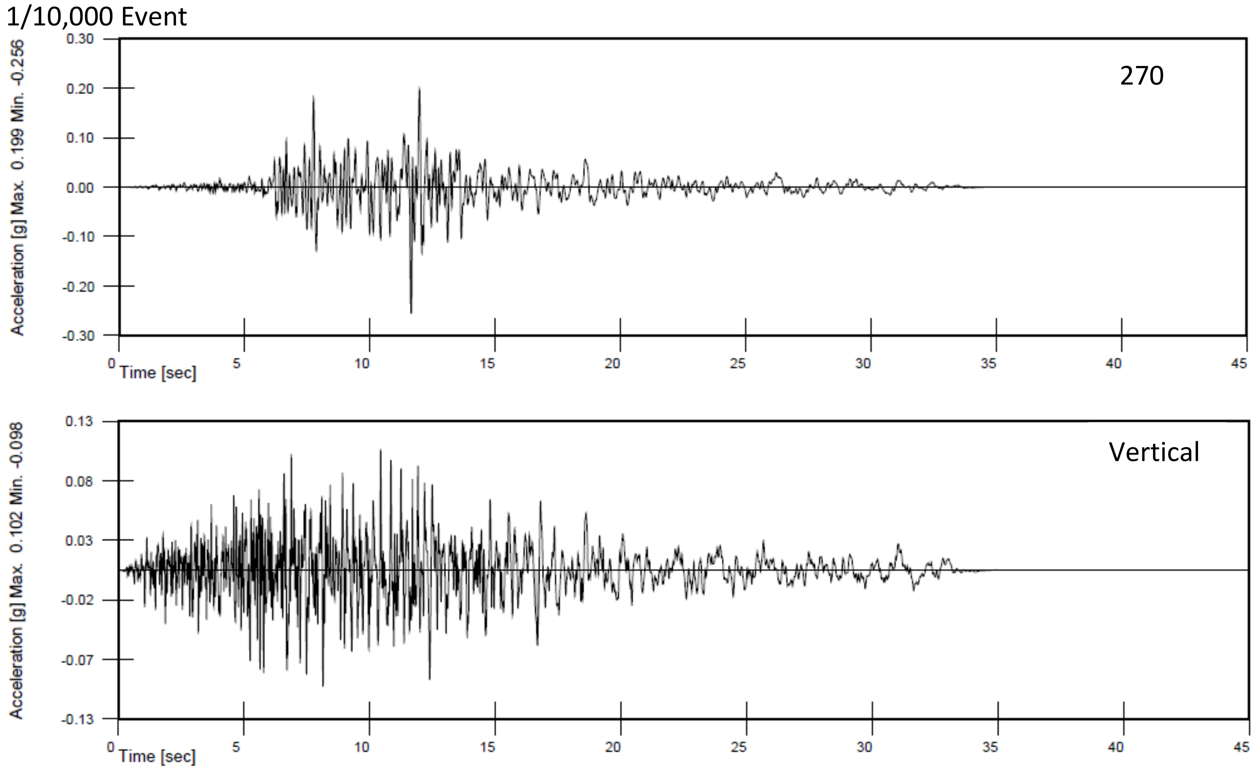

Figure 4 Acceleration Time Histories of Northridge Records at San Gabriel (270 and Vertical) Scaled for 1/10,000 Event

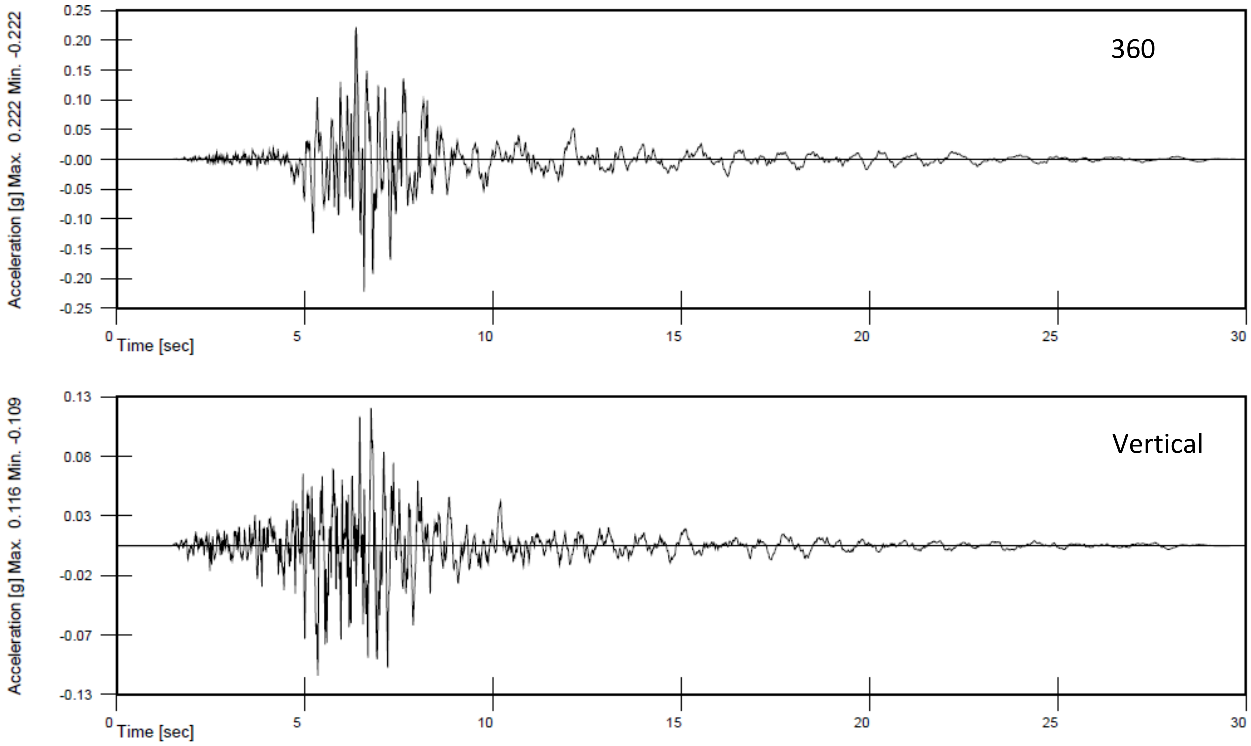

Figure 5 Acceleration Time Histories of Parkfield Records at Bear Valley Ranch (360 and Vertical) Scaled for 1/10,000 Event

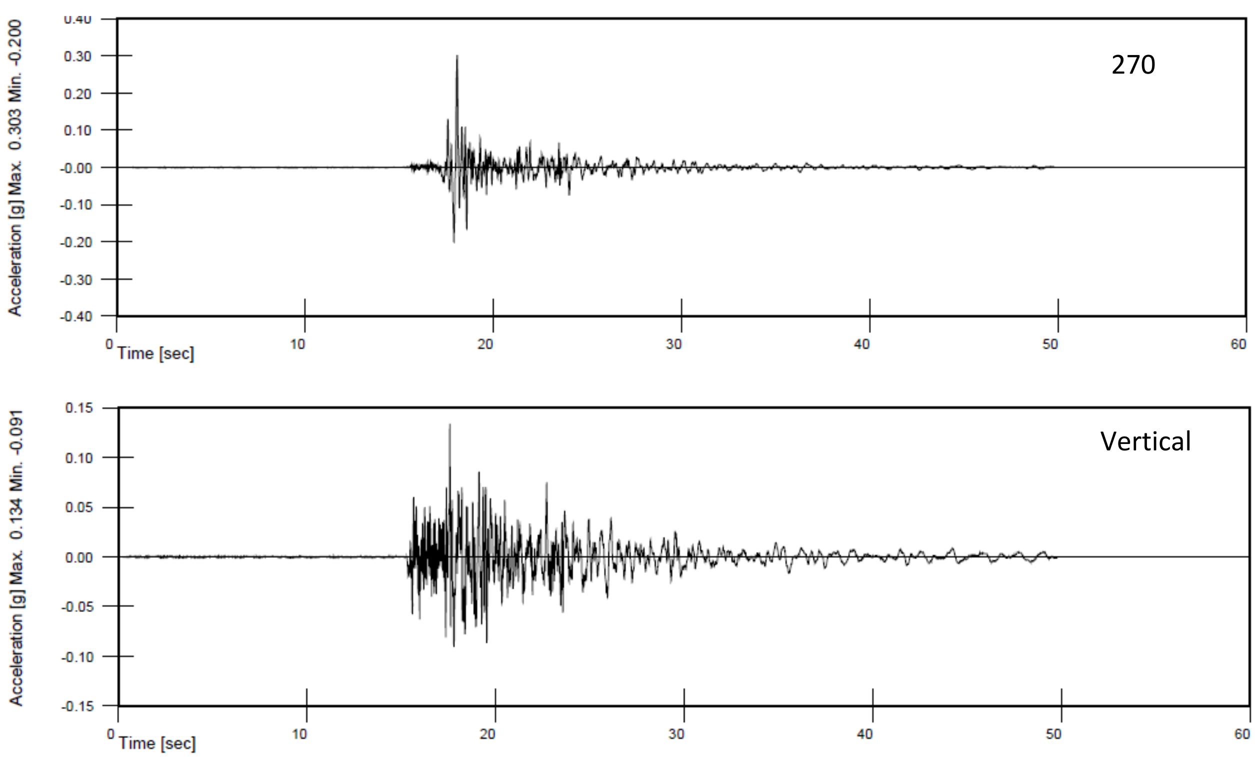

Figure 6 Acceleration Time Histories of Parkfield Records at Turkey Flat #1 (270 and Vertical) Scaled for 1/10,000 Event

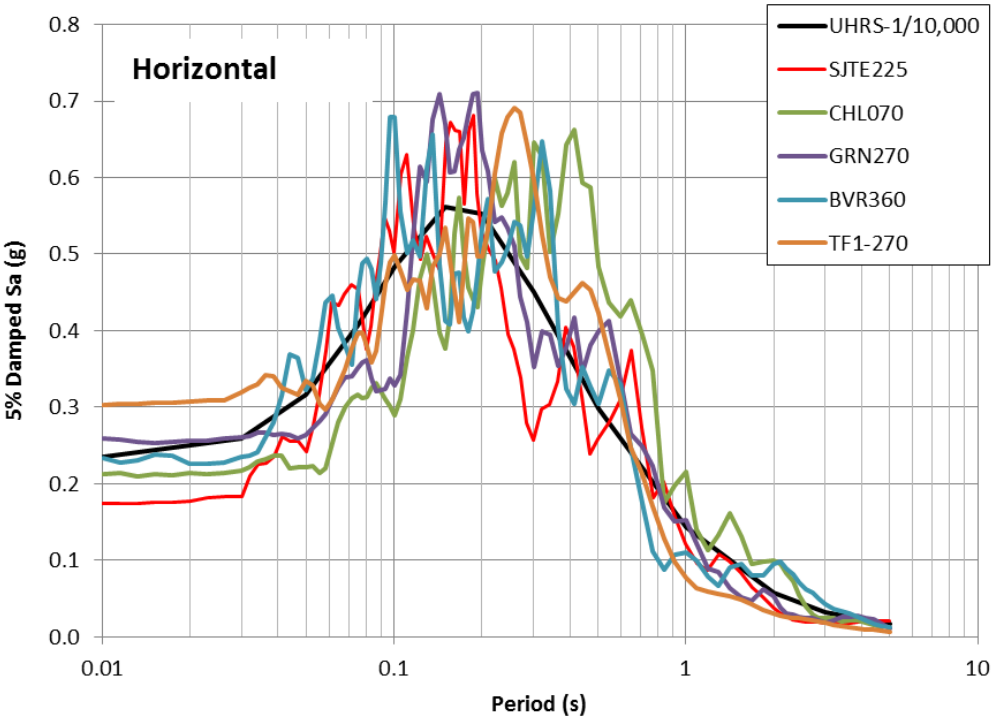

Figure 7 Comparison of response spectra of the five linearly scaled records (horizontal) with the target UHRS-1/10,000

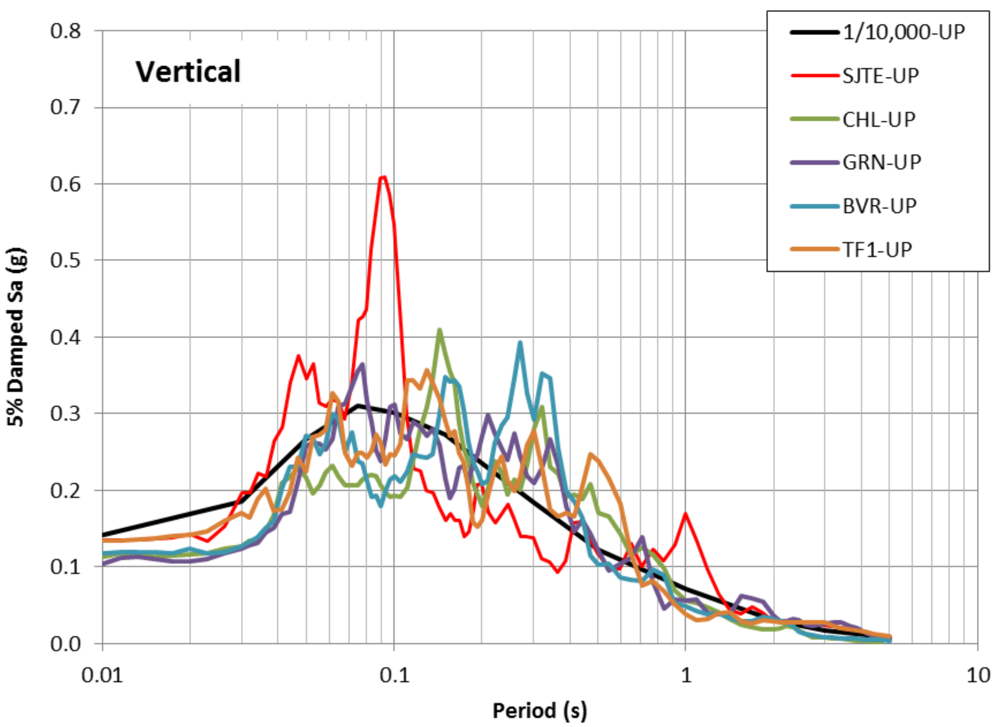

Figure 8 Comparison of response spectra of the five linearly scaled records (vertical) with the target UHRS-1/10,000

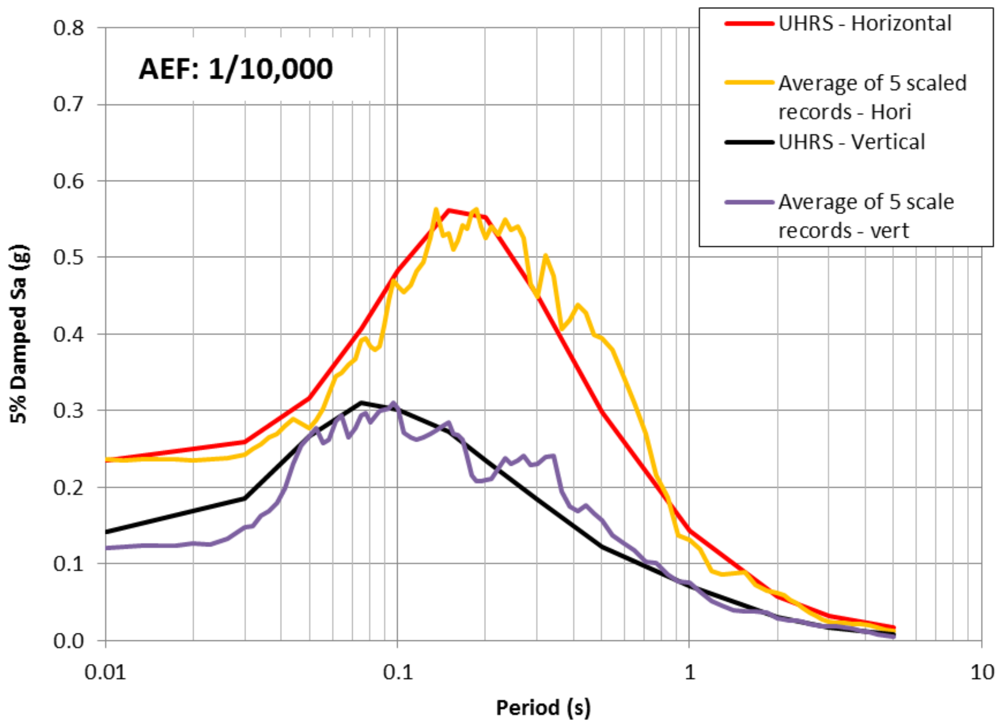

Figure 9 Comparison of average response spectra of the five linearly scaled records (horizontal and vertical) with the target UHRS-1/10,000

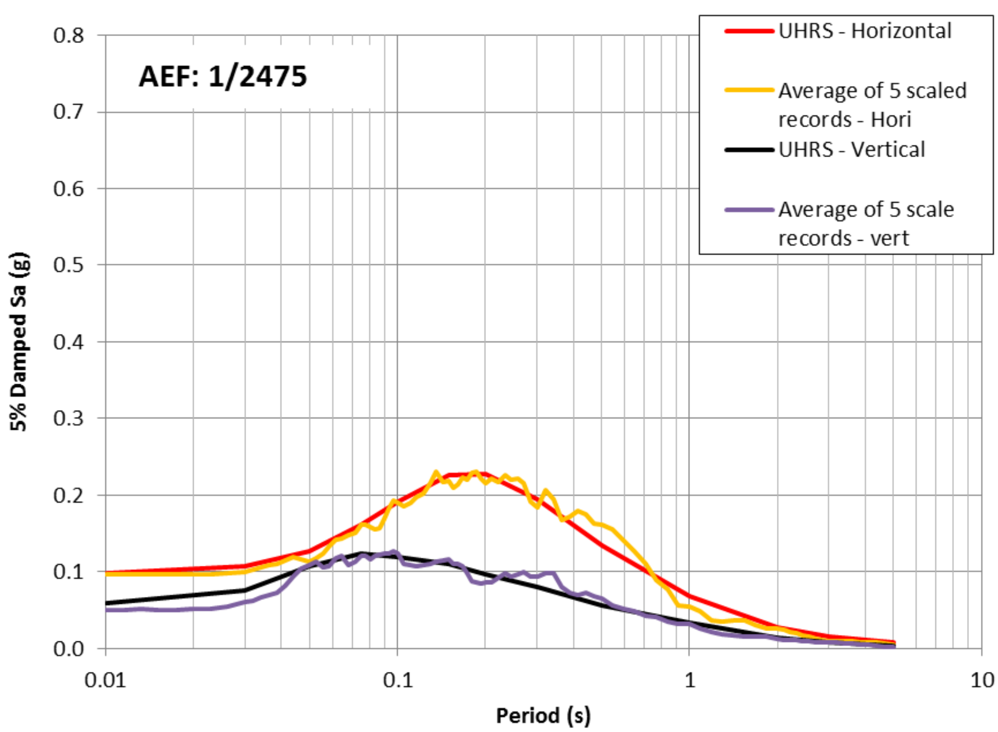

Figure 10 Comparison of average response spectra of the five linearly scaled records (horizontal and vertical) with the target UHRS-1/2475

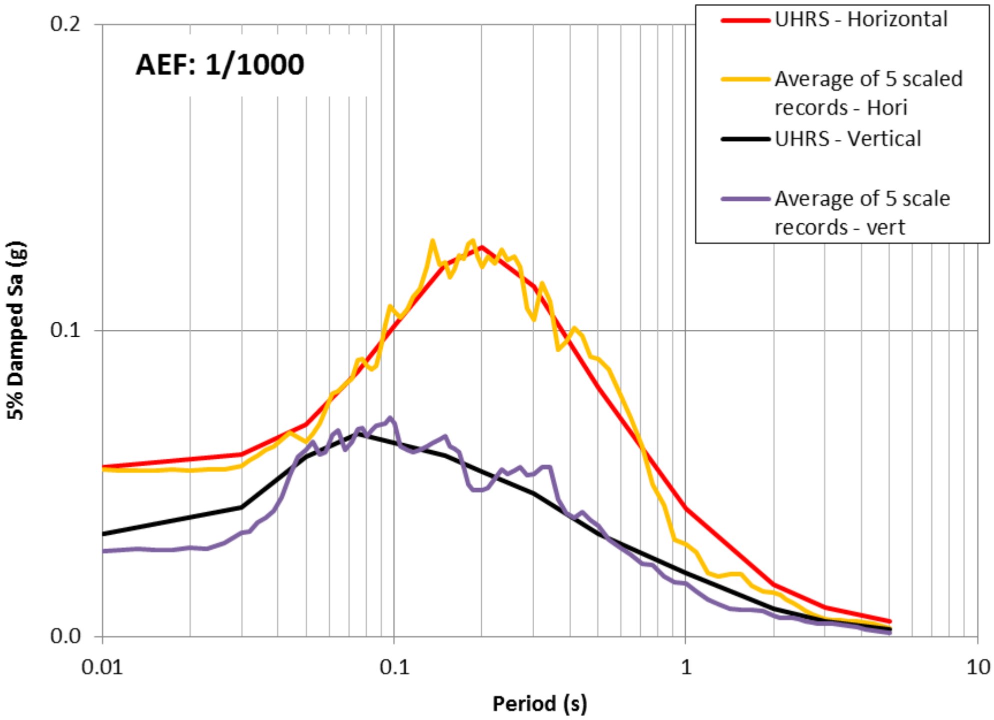

Figure 11 Comparison of average response spectra of the five linearly scaled records (horizontal and vertical) with the target UHRS-1/1000

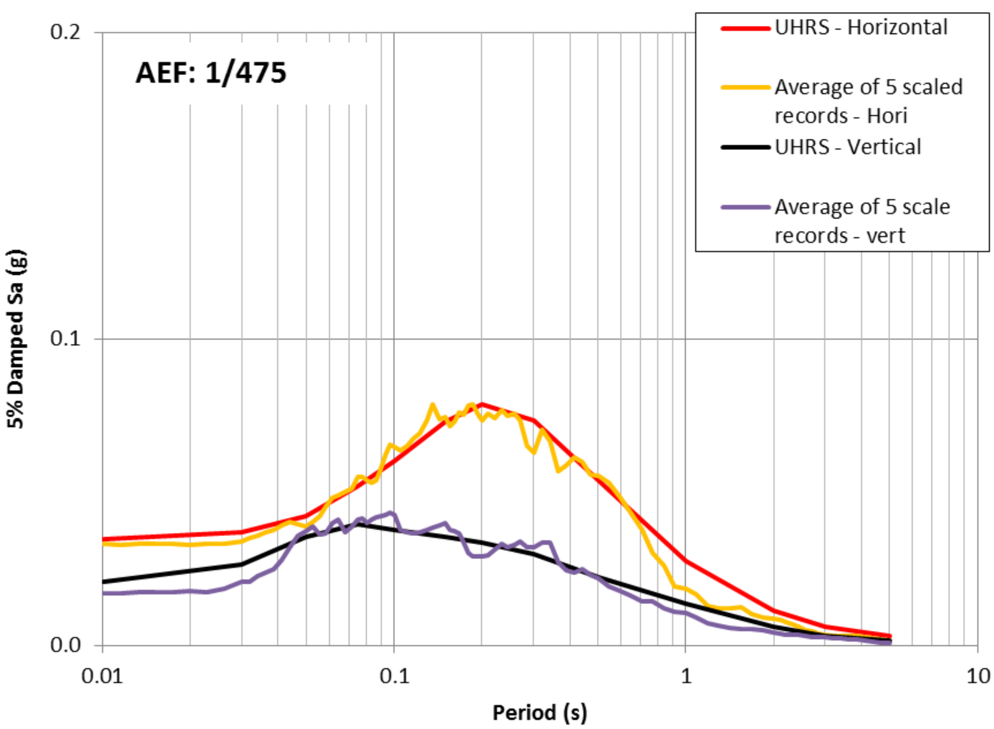

Figure 12 Comparison of average response spectra of the five linearly scaled records (horizontal and vertical) with the target UHRS-1/475

APPENDIX A

2010 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Requested by: Guoxi Wu, May 02, 2015

Site Coordinates: 49.467 North 117.467 West

User File Reference: Corra Linn Dam

National Building Code ground motions:
2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA (g)
0.272	0.163	0.080	0.045	0.136

Notes. Spectral and peak hazard values are determined for firm ground (NBCC 2010 soil class C - average shear wave velocity 360-750 m/s). Median (50th percentile) values are given in units of g. 5% damped spectral acceleration (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are tabulated. Only 2 significant figures are to be used. ***These values have been interpolated from a 10 km spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the calculated values.***

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.2)	0.054	0.128	0.183
Sa(0.5)	0.034	0.078	0.110
Sa(1.0)	0.017	0.038	0.054
Sa(2.0)	0.010	0.022	0.030
PGA	0.031	0.070	0.095

References

National Building Code of Canada 2010 NRCC no. 53301; sections 4.1.8, 9.20.1.2, 9.23.10.2, 9.31.6.2, and 6.2.1.3
Appendix C: Climatic Information for Building Design in Canada - table in Appendix C starting on page C-11 of Division B, volume 2

User's Guide - NBC 2010, Structural Commentaries NRCC no. 53543 (in preparation)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File xxxx
Fourth generation seismic hazard maps of Canada: Maps and grid values to be used with the 2010 National Building Code of Canada (in preparation)

See the websites *www.EarthquakesCanada.ca* and *www.nationalcodes.ca* for more information

Aussi disponible en français

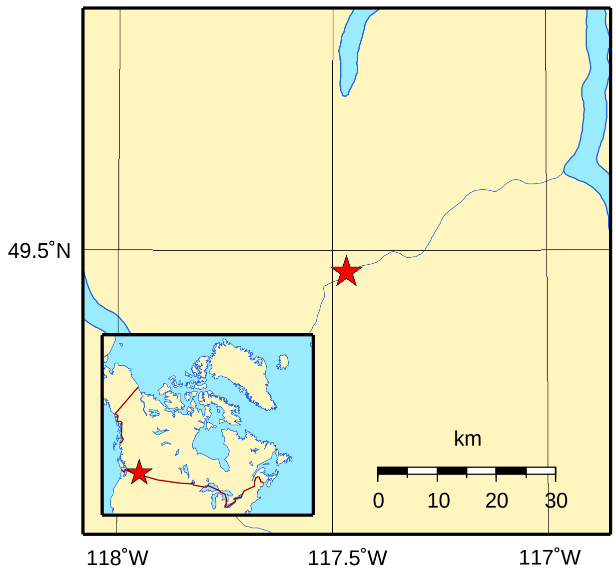

Table C-KCL-05: Kootenay Canal 10,000 year Return Period Mean UHRS Incorporating Site-to-Site Variability

Spectral Period (sec)	Spectral Acceleration (g)	Shallow Crustal WNA Earthquakes				
		Fraction of Total Hazard	$\bar{M}$	$\bar{R}$	Modal **M**	Modal *R*
0.01	0.2357	1.00	6.2	14.0	6.7	2.5
0.03	0.2596	1.00	6.2	13.8	6.7	2.5
0.05	0.3157	1.00	6.2	13.2	6.7	2.5
0.075	0.4068	1.00	6.2	13.8	6.7	2.5
0.1	0.4835	1.00	6.2	13.2	6.7	2.5
0.15	0.5616	1.00	6.2	14.2	6.7	2.5
0.2	0.5527	1.00	6.2	15.1	6.7	2.5
0.3	0.4506	1.00	6.3	17.9	6.7	2.5
0.5	0.2988	1.00	6.4	20.6	6.7	2.5
1	0.1438	1.00	6.6	37.6	6.7	2.5
2	0.0571	1.00	6.7	47.2	6.7	2.5
3	0.0322	1.00	6.8	67.3	6.7	2.5
5	0.0171	1.00	6.9	77.6	6.7	2.5

Table C-KCL-04: Kootenay Canal 2,475 year Return Period Mean UHRS Incorporating Site-to-Site Variability

Spectral Period (sec)	Spectral Acceleration (g)	Shallow Crustal WNA Earthquakes				
		Fraction of Total Hazard	$\bar{M}$	$\bar{R}$	Modal **M**	Modal *R*
0.01	0.0984	1.00	6.1	31.3	6.7	40.0
0.03	0.1067	1.00	6.1	31.3	6.7	40.0
0.05	0.1269	1.00	6.1	32.2	5.1	12.5
0.075	0.1621	1.00	6.0	31.4	5.1	12.5
0.1	0.1913	1.00	6.0	28.9	5.1	12.5
0.15	0.2260	1.00	6.0	29.9	5.1	12.5
0.2	0.2280	1.00	6.1	33.5	6.7	40.0
0.3	0.1949	1.00	6.2	41.3	6.7	40.0
0.5	0.1349	1.00	6.4	59.7	6.7	40.0
1	0.0678	1.00	6.5	82.5	6.8	125.0
2	0.0275	1.00	6.7	104.5	6.9	175.0
3	0.0155	1.00	6.7	111.5	6.9	175.0
5	0.0083	1.00	6.8	134.5	7.0	250.0

Table C-KCL-03: Kootenay Canal 1,000 year Return Period Mean UHRS Incorporating Site-to-Site Variability

Spectral Period (sec)	Spectral Acceleration (g)	Shallow Crustal WNA Earthquakes				
		Fraction of Total Hazard	$\bar{M}$	$\bar{R}$	Modal **M**	Modal *R*
0.01	0.0555	1.00	6.1	55.6	5.3	40.0
0.03	0.0594	1.00	6.1	55.9	5.2	40.0
0.05	0.0694	1.00	6.0	55.6	5.1	40.0
0.075	0.0868	1.00	6.0	51.6	5.1	40.0
0.1	0.1016	1.00	6.0	47.4	5.1	40.0
0.15	0.1216	1.00	6.0	52.4	5.1	40.0
0.2	0.1272	1.00	6.1	59.3	5.2	40.0
0.3	0.1143	1.00	6.2	69.8	6.7	125.0
0.5	0.0814	1.00	6.3	89.5	6.7	125.0
1	0.0418	1.00	6.5	116.2	6.7	175.0
2	0.0170	1.00	6.6	131.4	6.9	175.0
3	0.0096	1.00	6.7	140.0	6.9	175.0
5	0.0050	1.00	6.7	169.9	6.7	250.0

Dam Safety - Probabilistic Seismic Hazard Analysis (PSHA) Report
Volume 4: Implementation and Results

Table C-KCL-02: Kootenay Canal 475 year Return Period Mean UHRS Incorporating Site-to-Site Variability

Spectral Period (sec)	Spectral Acceleration (g)	Shallow Crustal WNA Earthquakes				
		Fraction of Total Hazard	$\bar{M}$	$\bar{R}$	Modal **M**	Modal *R*
0.01	0.0347	1.00	6.1	90.1	5.1	40.0
0.03	0.0368	1.00	6.1	88.1	5.1	40.0
0.05	0.0422	1.00	6.0	82.4	5.1	40.0
0.075	0.0519	1.00	6.0	72.7	5.1	40.0
0.1	0.0604	1.00	6.0	74.6	5.1	40.0
0.15	0.0730	1.00	6.0	78.3	5.1	40.0
0.2	0.0787	1.00	6.1	85.1	5.1	40.0
0.3	0.0733	1.00	6.2	98.6	6.7	125.0
0.5	0.0538	1.00	6.3	112.1	6.7	175.0
1	0.0277	1.00	6.5	144.1	6.7	175.0
2	0.0113	1.00	6.6	155.7	6.7	250.0
3	0.0061	1.00	6.6	178.4	6.7	250.0
5	0.0033	1.00	6.7	182.6	6.7	250.0

Appendix D

STRUCTURAL STABILITY ANALYSIS OF THE CORRA LINN DAM

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Appendix E

PRELIMINARY ENGINEERING REPORT

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Appendix F

INSPECTION REPORTS

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Appendix F-1

REPORT ON THE CORRA LINN DAM VISUAL INSPECTION

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Appendix F-2

REPORT ON THE CORRA LINN DAM ELECTRICAL VISUAL INSPECTION

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Appendix F-3

REPORT ON THE CORRA LINN DAM GATE THICKNESS

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Appendix F-4

ELECTRICAL SITE VISIT REPORT

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Appendix F-5

CORRA LINN SPILLWAY GANTRY HOIST LOAD MEASUREMENT

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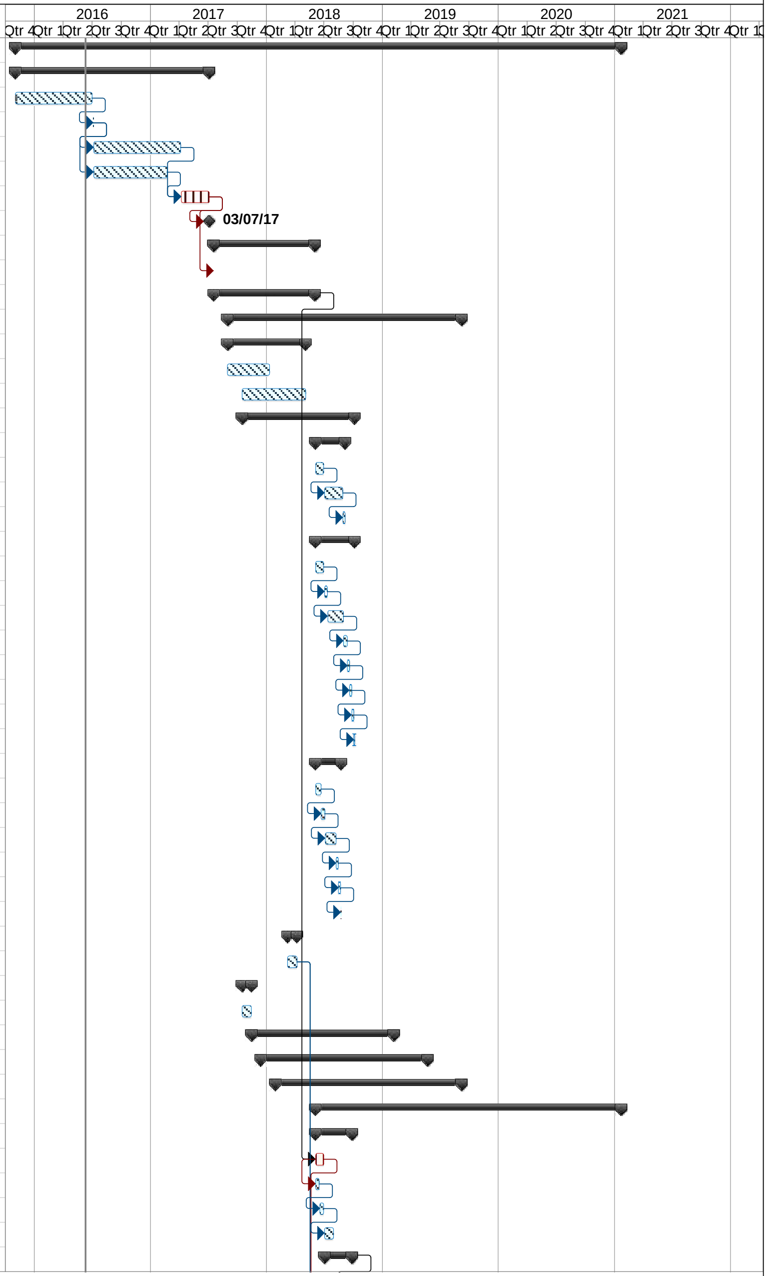
Appendix G

PROJECT SCHEDULE

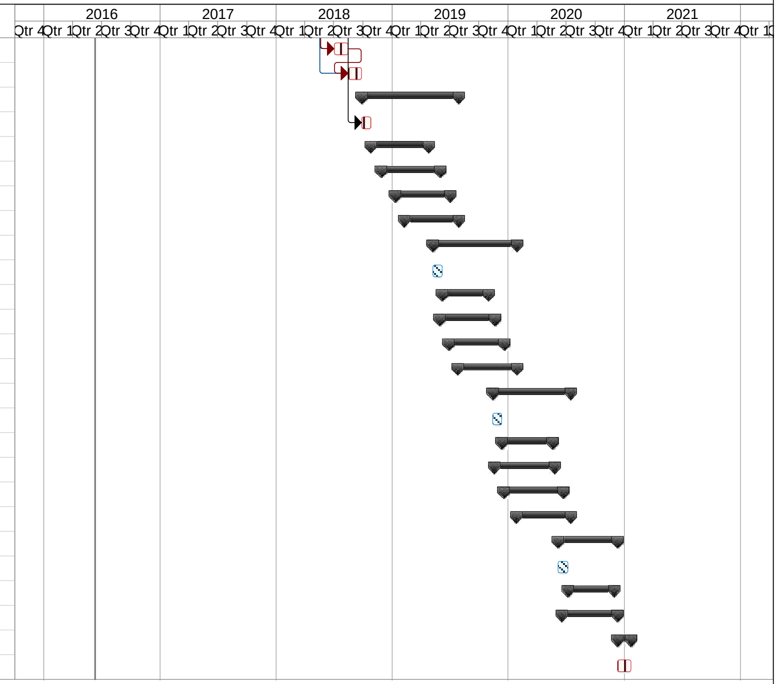
ID	Activity	Duration	Start	Finish	Predecessor
1	**Fortis BC - Corra Linn Spillway**	**1269 days**	**Mon 02/11/15**	**Wed 20/01/21**	
2	**OWNER'S ACTIVITIES**	**413 days**	**Mon 02/11/15**	**Mon 03/07/17**	
3	CPCN review and preparation	171 days	Mon 02/11/15	Thu 30/06/16	
4	CPCN submision to BCUC	1 day	Mon 04/07/16	Mon 04/07/16	3
5	BCUC review, questions/answers and decision	180 days	Tue 05/07/16	Wed 05/04/17	4
6	Evaluate ECI Partnership or develop DB RFP	150 days	Tue 05/07/16	Tue 21/02/17	4
7	Contract Negotiation & Award by Fortis	60 days	Fri 07/04/17	Mon 03/07/17	6,5
8	Contract Award	0 days	Mon 03/07/17	Mon 03/07/17	7
9	**ENGINEERING**	**211 days**	**Tue 18/07/17**	**Fri 01/06/18**	
10	Kick-off meeting with Fortis BC	1 day	Tue 18/07/17	Tue 18/07/17	7FS+10 days
11	**Design**	**210 days**	**Wed 19/07/17**	**Fri 01/06/18**	
21	**SUPPLY, MANUFACTURING and/or REFURBISHMENT & DELIVERY**	**488 days**	**Thu 31/08/17**	**Fri 06/09/19**	
22	**Temporary equipment**	**160 days**	**Thu 31/08/17**	**Thu 03/05/18**	
23	Temporary installations	16 wks	Thu 31/08/17	Tue 09/01/18	12
24	Floating bulkhead	26 wks	Mon 16/10/17	Thu 03/05/18	13
25	**Phase #1 - Sluice gate #14, 13, 12 & 11**	**236 days**	**Mon 16/10/17**	**Thu 04/10/18**	
26	**New sill beam**	**65 days**	**Mon 04/06/18**	**Wed 05/09/18**	
27	Material order	20 days	Mon 04/06/18	Fri 29/06/18	20
28	Machining	40 days	Tue 03/07/18	Tue 28/08/18	27
29	Packaging and shipping	5 days	Wed 29/08/18	Wed 05/09/18	28
30	**New sluice gates (3 sections)**	**86 days**	**Mon 04/06/18**	**Thu 04/10/18**	
31	Material Order	20 days	Mon 04/06/18	Fri 29/06/18	20
32	Material Receipt	7 days	Tue 03/07/18	Wed 11/07/18	31
33	Fabrication	35 days	Thu 12/07/18	Thu 30/08/18	32
34	Machining	7 days	Fri 31/08/18	Tue 11/09/18	33
35	Painting	5 days	Wed 12/09/18	Tue 18/09/18	34
36	Pre-assembly	5 days	Wed 19/09/18	Tue 25/09/18	35
37	Packaging	5 days	Wed 26/09/18	Tue 02/10/18	36
38	Shipping to Site	2 days	Wed 03/10/18	Thu 04/10/18	37
39	**Hoist bridge and tower structural reinforcement**	**57 days**	**Mon 04/06/18**	**Thu 23/08/18**	
40	Material Order	14 days	Mon 04/06/18	Thu 21/06/18	20
41	Material Receipt	7 days	Fri 22/06/18	Tue 03/07/18	40
42	Fabrication	24 days	Wed 04/07/18	Tue 07/08/18	41
43	Painting	5 days	Wed 08/08/18	Tue 14/08/18	42
44	Packaging	5 days	Wed 15/08/18	Tue 21/08/18	43
45	Shipping to Site	2 days	Wed 22/08/18	Thu 23/08/18	44
46	**Hoisting mechanisms and motors**	**21 days**	**Thu 08/03/18**	**Fri 06/04/18**	
47	Purchase hoist components as needed	21 days	Thu 08/03/18	Fri 06/04/18	17
48	**Electrical upgrades**	**21 days**	**Mon 16/10/17**	**Tue 14/11/17**	
49	Electrical components	21 days	Mon 16/10/17	Tue 14/11/17	18
50	**Phase #2 - Sluice gate #10, 9, 8 & 7**	**289 days**	**Wed 15/11/17**	**Mon 04/02/19**	
73	**Phase #3 - Sluice gate #6, 5, 4 & 3**	**342 days**	**Thu 14/12/17**	**Wed 22/05/19**	
96	**Phase #4 - Sluice gate #2 & 1**	**395 days**	**Mon 29/01/18**	**Fri 06/09/19**	
119	**INSTALLATION**	**635 days**	**Mon 04/06/18**	**Wed 20/01/21**	
120	**Mobilization**	**80 days**	**Mon 04/06/18**	**Wed 26/09/18**	
121	Mobilization at Site	4 wks	Mon 04/06/18	Fri 29/06/18	11
122	Build road to access the loading area	2 wks	Mon 04/06/18	Fri 15/06/18	121SS
123	Installation of service barge, crane barge and crane	2 wks	Mon 18/06/18	Fri 29/06/18	122
124	Installation of temporary equipment	4 wks	Tue 03/07/18	Mon 30/07/18	123
125	**Hoist refurbishment**	**60 days**	**Tue 03/07/18**	**Wed 26/09/18**	



Prepared by: Gino Leriche
Impression date: 2016-03-17

Planned Activity | Milestone | Summary | Critical activity | Progress

ID	Activity	Duration	Start	Finish	Predecessor
126	Hoist #1 refurbishment work	30 days	Tue 03/07/18	Tue 14/08/18	121,47,17
127	Hoist #2 refurbishment work	30 days	Wed 15/08/18	Wed 26/09/18	126,47
128	**Phase #1 - Sluice gate #14, 13, 12 & 11**	**201.25 days**	**Thu 27/09/18**	**Tue 30/07/19**	
129	Phase #1 - Set-up	20 days	Thu 27/09/18	Thu 25/10/18	125
130	**Sluice gate #14**	**116.75 days**	**Fri 26/10/18**	**Fri 26/04/19**	
187	**Sluice gate #13**	**119.75 days**	**Tue 27/11/18**	**Fri 31/05/19**	
244	**Sluice gate #12**	**119.75 days**	**Thu 10/01/19**	**Tue 02/07/19**	
301	**Sluice gate #11**	**118.25 days**	**Fri 08/02/19**	**Tue 30/07/19**	
357	**Phase #2 - Sluice gate #10, 9, 8 & 7**	**172.75 days**	**Wed 08/05/19**	**Wed 29/01/20**	
358	Phase #2 - Set-up	20 days	Wed 08/05/19	Thu 06/06/19	185FS+10 days
359	**Sluice gate #10**	**100.75 days**	**Thu 06/06/19**	**Thu 31/10/19**	
416	**Sluice gate #9**	**119.75 days**	**Wed 29/05/19**	**Wed 20/11/19**	
473	**Sluice gate #8**	**119.75 days**	**Thu 27/06/19**	**Thu 19/12/19**	
530	**Sluice gate #7**	**118.25 days**	**Fri 26/07/19**	**Wed 29/01/20**	
586	**Phase #3 - Sluice gate #6, 5, 4 & 3**	**160.75 days**	**Wed 13/11/19**	**Thu 16/07/20**	
587	Phase #3 - Set-up	20 days	Wed 13/11/19	Wed 11/12/19	414FS+10 days
588	**Sluice gate #6**	**100.75 days**	**Wed 11/12/19**	**Tue 19/05/20**	
645	**Sluice gate #5**	**122.25 days**	**Mon 18/11/19**	**Tue 26/05/20**	
702	**Sluice gate #4**	**119.75 days**	**Tue 17/12/19**	**Mon 22/06/20**	
759	**Sluice gate #3**	**118.75 days**	**Mon 27/01/20**	**Thu 16/07/20**	
816	**Phase #4 - Sluice gate #2 & 1**	**128.25 days**	**Fri 05/06/20**	**Wed 09/12/20**	
817	Phase #4 - Set-up	20 days	Fri 05/06/20	Mon 06/07/20	700FS+10 days
818	**Sluice gate #2**	**100.75 days**	**Mon 06/07/20**	**Mon 30/11/20**	
875	**Sluice gate #1**	**119.75 days**	**Thu 18/06/20**	**Wed 09/12/20**	
932	**Demobilization**	**20 days**	**Thu 10/12/20**	**Wed 20/01/21**	
933	Complete demobilisation	4 wks	Thu 10/12/20	Wed 20/01/21	931



Prepared by: Gino Leriche
Impression date: 2016-03-17

Planned Activity | Milestone | Summary | Critical activity | Progress

Appendix H

RISK REGISTER

FILED CONFIDENTIALLY

Appendix I

GATE CAPACITY ANALYSIS

December 17, 2015

File No.:VA103-00353/03-A.01
Cont. No.:VA15-03484

Mr. Greg Johnston
Senior Dam Safety Engineer - Generation Group
FortisBC Inc. (Trail)
3100 West Kootenay Road
South Slocan, British Columbia
Canada, V0G 2G1

Dear Greg,

Re: Corra Linn Dam – Gate Capacity and Associated Flow Duration Curves

Knight Piésold Ltd. (KP) has completed an evaluation of the discharge capacity of the spillway gates for FortisBC's Corra Linn Dam for different combinations of operating gates and reservoir water levels. It is our understanding that FortisBC is considering two construction schedule scenarios for the gate replacement for Corra Linn. These two scenarios would result in the following combination of gate closures:

1. Four gates closed for year round construction schedule (two gates completely closed with cofferdams and adjacent two gates closed but available with recall time for emergency service), and
2. Five gates closed for five month construction schedule (three gates completely closed with cofferdams and two adjacent gates closed but available with recall time for emergency service).

KP has been asked to address the probability of flows exceeding the spillway capacity when having one, two, three, four or five gates out of service, for two different reservoir headpond levels defined as follows:

- Maximum operating pond level of 531.7 m, and
- Dam overtopping level of 532.3 m.

1 – INTRODUCTION

The Corra Linn Dam is the most upstream dam of the five dams located on the Kootenay River between Kootenay Lake and the river's confluence with the Columbia River. There are two hydroelectric facilities located upstream of Kootenay Lake, which are the Duncan Dam (operational since 1967) and the Libby Dam (operational since 1976). These two projects are operated under the terms of the Columbia River Treaty and the operation of these facilities directly impacts the inflows to the Kootenay River dams, including the Corra Linn Dam. It was assumed that these facilities are operated based on the international agreements, and that historical flows in the Kootenay River are reasonably representative of flow patterns that could be expected in the foreseeable future.

The Kootenay Canal, which is owned and operated by BC Hydro, is also located on the Kootenay River and diverts flows from the Corra Linn reservoir towards the Kootenay Canal Generating Station.

The Corra Linn Dam facility has the following structures that can pass flow:

- A 14 bay, gated, mass gravity and reinforced concrete spillway, and
- A powerhouse with six turbine generators and associated headworks.

2 – METHODOLOGY

The major inflows to the Corra Linn Dam are equal to the outflows from Kootenay Lake. The inflows to Kootenay Lake are regulated by two dams upstream of the lake, as discussed above.

To determine various probabilities of exceedance, flow duration curves were developed for the project based on historically recorded outflows from the Kootenay Lake. The flow duration curve is a cumulative frequency curve that shows the percent of time for which specified discharges were equalled or exceeded during a given time period. The flow duration curve may be considered a probability curve and used to estimate the percent of time that a specified discharge will be equaled or exceeded in the future, but it does not rely on statistical methods to predict larger flow events (e.g. 200 year flood event).

Long-term flow records were obtained for the Water Survey of Canada (WSC) gauge at the outlet of Kootenay Lake (WSC gauge 08NJ158 – Kootenay Lake outflow near Corra Linn). Flow duration curves were completed for the post-Libby dam period (1976 to 2013), with a conservative uplift factor of 1.2 applied to the regulated daily flows to convert them to instantaneous flows. The computed flow duration curves were compared to the Corra Linn gated spillway capacity values to determine the probability of exceedance of flows that can be safely passed for various operating conditions.

A flood frequency analysis was also completed to provide some assessment of return periods. Typically, regulated flows are excluded from a flood frequency analysis because they are affected by reservoir operating procedures and are therefore not appropriate for statistical approaches. Upstream reservoir conditions and operating procedures influence flow releases and therefore violate criteria that are fundamental to standard flood frequency analysis. Nonetheless, the historical flow data are considered to be reasonably representative of expected flow conditions, and therefore the flood frequency analysis was completed using the annual peak flows from the same flow dataset as the flow duration curve analysis.

Various return period flood flows entering the Corra Linn reservoir were then determined using the HEC-SSP software. The computed return period flood flows were compared to the Corra Linn gated spillway capacity values to provide a reasonable basis for assessing the return periods of flows that would exceed the Corra Linn spillway capacity for various gate configurations and operating conditions. It should be noted that estimated flood flows with return periods of greater than 50 years, which is the length of the streamflow record post-Libby dam construction, should be considered with additional caution.

3 – RESULTS OF THE SPILLWAY GATE CAPACITY ANALYSIS

The spillway gate capacity depends on the reservoir headpond level. The spillway gate capacity was obtained from the Corra Linn Dam Operation, Maintenance and Surveillance Manual (Hatch, 2009) and was determined to be:

- 530 m3/s per gate at the maximum operating level of 531.7 m, and
- 665 m3/s per gate at the dam overtopping level of 532.3 m.

These spillway gate capacities were used to determine the discharge capacity of the spillway when one, two, three, four and five gates are out of commission, and to estimate the probability of exceedance and return periods associated with flows equivalent to those capacities.

The Corra Linn facility has additional discharge capabilities through the turbine-generator units and through the diversion of water from the reservoir through the Kootenay Canal. The full capacity of all six turbine-generator units is 357 m^3/s (Hatch, 2009), while the maximum capacity for the Kootenay Canal is 765 m^3/s (BC Hydro, 2015).

The total capacity of the Corra Linn facility based on the spillway gate capacity, the turbine-generator capacity and the Kootenay Canal capacity, for both reservoir headpond conditions, is summarized in Table 3.1.

Table 3.1 Corra Linn Facility Capacity

Headpond Condition	Number of Gates Closed	Spillway Gate Capacity (m^3/s)	Spillway Gate Capacity + Maximum Turbine Capacity (m^3/s)	Spillway Gate Capacity + Maximum Turbine Capacity + Maximum Kootenay Canal Capacity (m^3/s)
Maximum Operating Level	0	7,400	7,757	8,522
	1	6,871	7,228	7,993
	2	6,343	6,700	7,465
	3	5,814	6,171	6,936
	4	5,286	5,643	6,408
	5	4,757	5,114	5,879
Dam Overtopping Level	0	9,300	9,657	10,422
	1	8,636	8,993	9,758
	2	7,971	8,328	9,093
	3	7,307	7,664	8,429
	4	6,643	7,000	7,765
	5	5,979	6,336	7,101

The flow duration curve and flood frequency analyses presented below assume that only the spillway gate capacity is available to pass flows over the Corra Linn dam, as this was considered to be the most conservative scenario.

3.1 FLOW DURATION CURVES

The results of the flow duration curve analysis that include all daily data for the post-Libby operating period (referred to as Post-Regulation) are summarized in Table 3.2, and corresponding flow duration curves for the post-Libby Dam regulation period are shown on Figures 3.1 and 3.2. Figure 3.1 shows the spillway gate capacities when the reservoir level is at the maximum operating water level and Figure 3.2 shows the spillway gate capacities when it is at the dam overtopping level. Note that the estimated probable maximum flood (PMF) value is shown in the table and on the figures; however, the PMF does not have an associated probability of exceedance and is shown for reference purposes only.

The flow duration curve analysis indicates that the Corra Linn facility will be able to easily pass the largest flows experienced since the Libby dam was constructed, even with five gates closed during any period of the year. The largest post-regulation flow on record is approximately 3,275 m^3/s, which occurred in 2012. In comparison, the highest pre-regulation flow on record is approximately 6,000 m^3/s and occurred in 1961. The Corra Linn facility is able to pass approximately 4,760 m^3/s with five gates closed when the reservoir is at the maximum normal operating level and approximately 5,980 m^3/s when the reservoir is at the dam overtopping level.

Table 3.2 Results of Flow Duration Curve Analysis

Probability of Exceedance	Inflow to Corra Linn Reservoir (m^3/s)
10%	1,500
5%	1,890
2%	2,290
1%	2,570
0.5%	2,800
0.2%	3,080
PMF	7,800

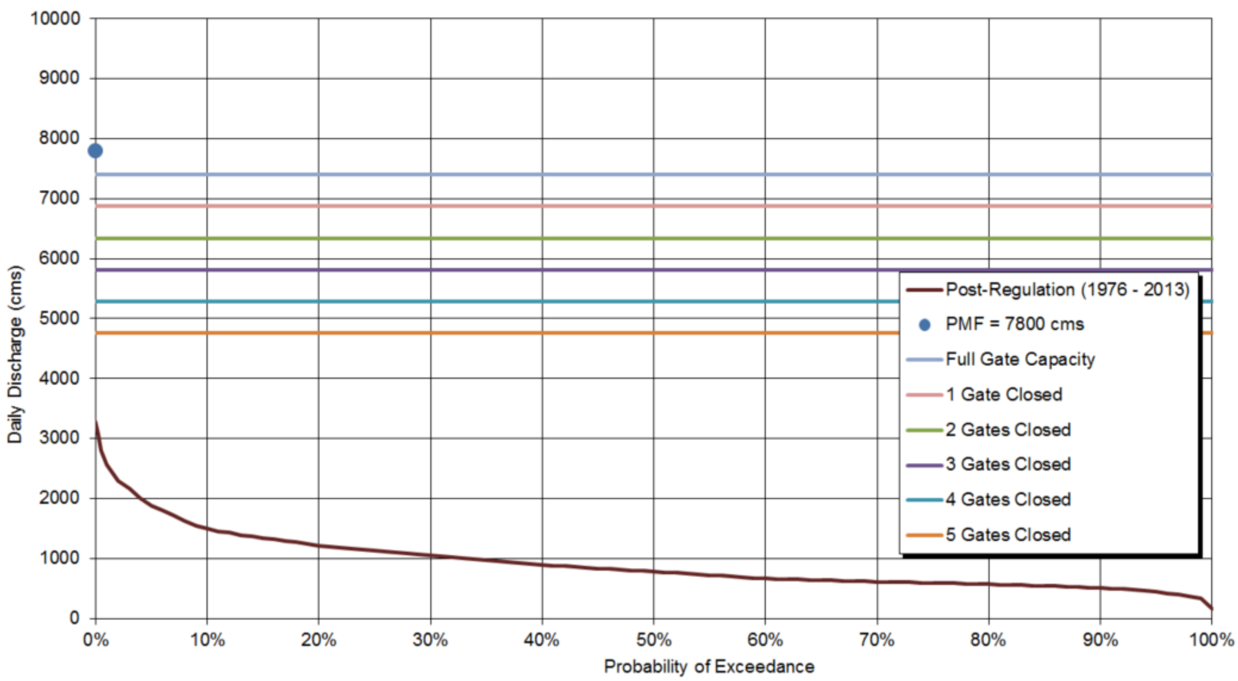


Figure 3.1 Flow Duration Curve for Post-Libby Dam Regulation (1976 – 2013) with Corra Linn Gate Capacity at Maximum Operating Level

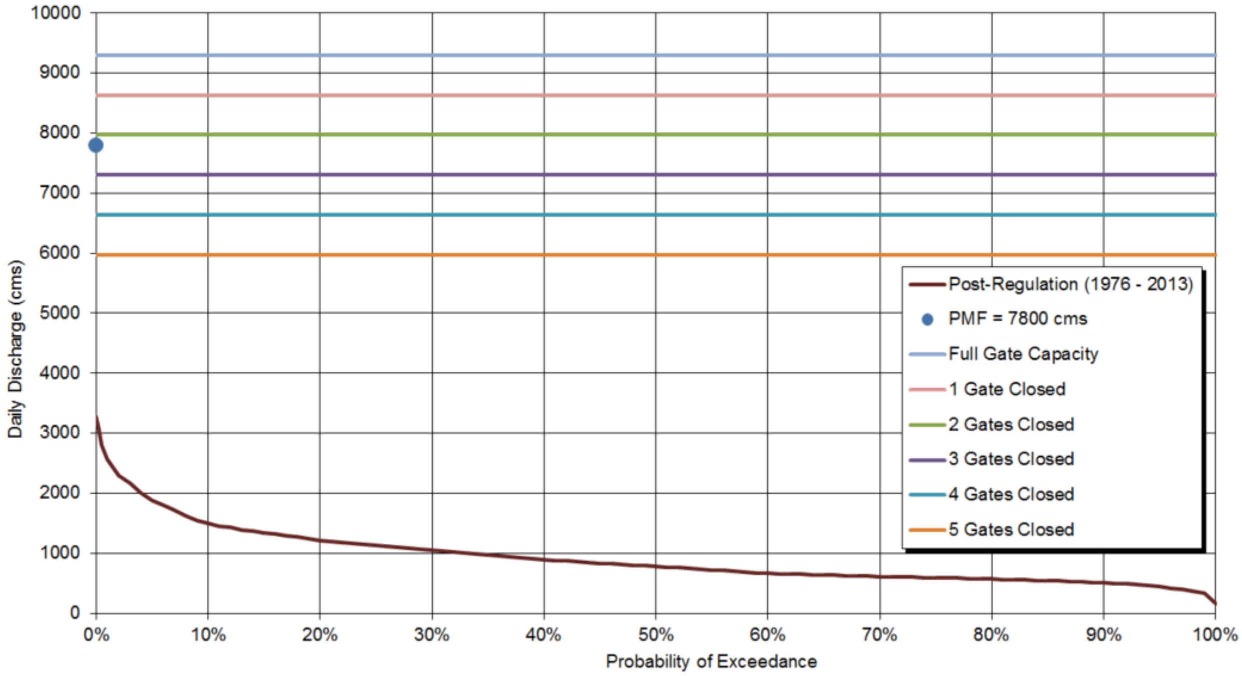


Figure 3.2 Flow Duration Curve for Post-Libby Dam Regulation (1976 – 2013) with Corra Linn Gate Capacity at Dam Overtopping Level

In addition to annual flow duration curves (Figure 3.1 and 3.2), five-month sliding schedules were also considered for the maximum operating condition, which is representative of normal operating conditions during construction and is considered more critical as the gates have a lower capacity. Figure 3.3 shows the results of this analysis, where the annual Post-Regulation curve includes all daily data from 1976 to 2013 (thicker dark red line). The other curves include data for the same period of record, but only for specific five-month periods. All curves that contain the month of June, which is the highest freshet flow month, plot above the annual Post-Regulation curve; however, the maximum flow of 3,275 m^3/s is not exceeded in any period (as expected). This maximum flow is considerably below the capacity of the spillway with five gates closed.

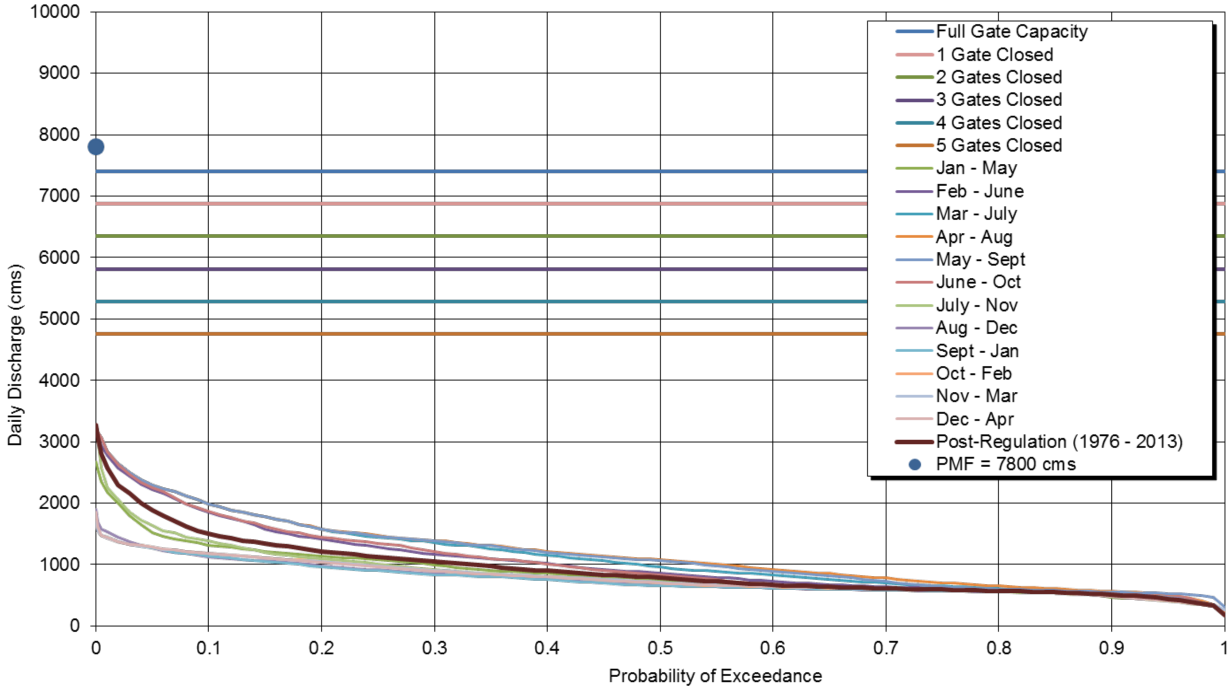


Figure 3.3 Five-Month Flow Duration Curves for Post-Libby Dam Regulation (1976 – 2013) with Corra Linn Gate Capacity at Maximum Operating Level

3.2 FLOOD FREQUENCY ANALYSIS

The estimated 5, 10, 20, and 50 year return period peak instantaneous flows, which are based on an assumed Log Pearson Type III distribution, are shown in Table 3.3. Corresponding frequency curves, with the spillway gate capacities superimposed, are shown on Figure 3.4 for the reservoir at the maximum operating level and on Figure 3.5 for the reservoir at the dam overtopping level. As stated previously, the results of the frequency analysis are not technically correct because of the effect that reservoir operations have had on the historical flows, but the results are nonetheless considered indicative of probabilities of occurrence. Furthermore, estimated flood flows with return periods greater than 50 years, which is the length of the post-Libby streamflow record, should be considered with additional caution. Accordingly, these flows are shaded out on these figures.

Table 3.3 Results of Flood Frequency Analysis

Return Period	Inflow to Corra Linn Reservoir (m^3/s)
50	3,484
20	3,120
10	2,831
5	2,517

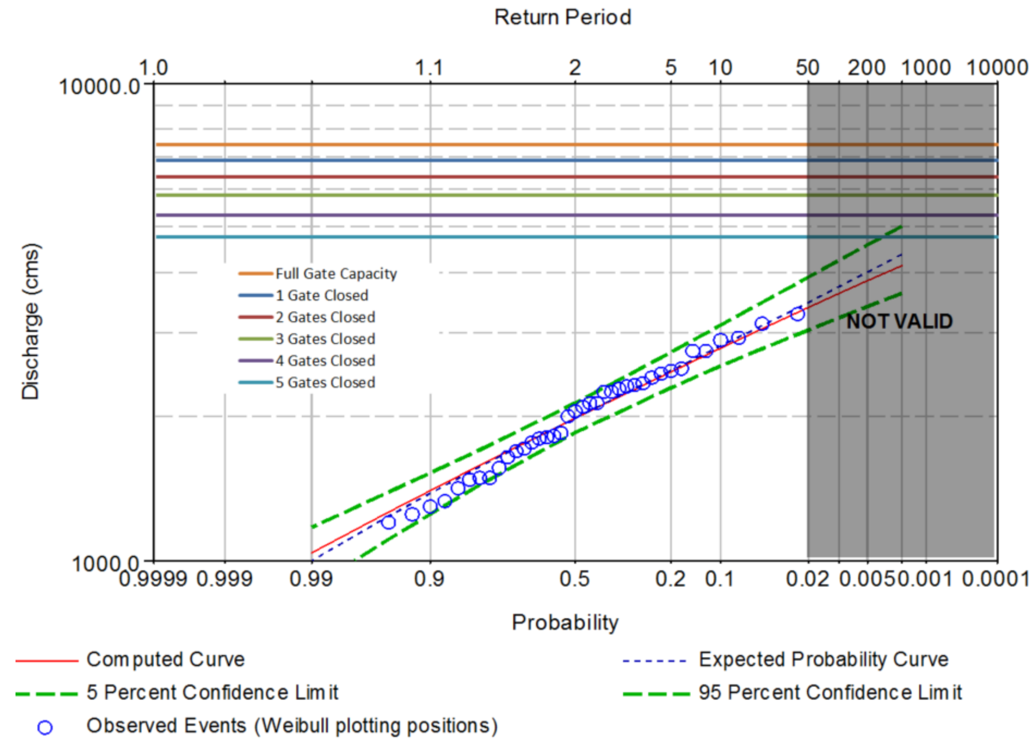


Figure 3.4 Flood Frequency Curve for Post-Libby Regulation (1976 – 2013) with Corra Linn Gate Capacity at Maximum Operating Level

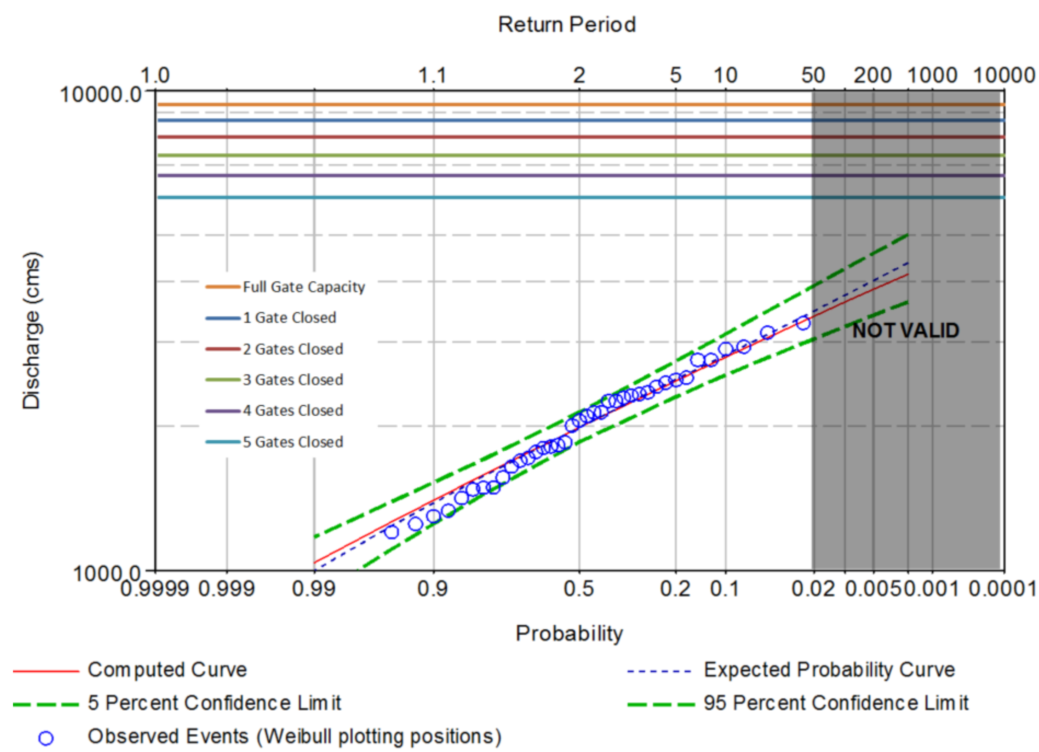


Figure 3.5 Flood Frequency Curve for Post-Libby Regulation (1976 – 2013) with Corra Linn Gate Capacity at Dam Overtopping Level

Similar to the flow duration curves, the plots on Figures 3.4 and 3.5 also indicate that even with five gates closed the Corra Linn facility has enough spillway gate capacity to pass up to the 50 year flood event (which is the maximum return period used in this analysis), based on post-Libby dam regulated flows, for both the maximum operating reservoir level and the dam overtopping reservoir level.

4 – CONCLUSION

With five spillway gates closed, the discharge capacity of the Corra Linn facility is sufficient to pass the largest post-Libby Dam flow on record of 3,275 m^3/s, which occurred in 2012. For this gate closure scenario, which is considered the most constrictive, the Corra Linn facility is able to pass approximately 4,760 m^3/s with the reservoir at the maximum normal operating level, and approximately 5,980 m^3/s with the reservoir at the dam overtopping level. These flow capacities are well in excess of the estimated 50 year flood of 3,484 m^3/s. Additional capacity to pass flow is also available through the turbine-generators, which increase the respective capacities of the facility to approximately 5,100 m^3/s and 6,300 m^3/s. Furthermore, diverting flows through the Kootenay Canal would increase these capacities to 5,880 m^3/s and 7,100 m^3/s.

We trust that this information is sufficient for your needs. If you have any questions or comments please contact the undersigned.

Yours truly,
Knight Piésold Ltd.

PROFESSIONAL PROVINCE OF BRITISH COLUMBIA A. SHEWAN # 36661 ENGINEER 17 DEC 2015

Prepared: Alana Shewan, MASc., P.Eng.
Senior Engineer

Reviewed: Jaime Cathcart, Ph.D., P.Eng.
Specialist Hydrotechnical Engineer | Associate

Approval that this document adheres to Knight Piésold Quality Systems:

References:

BC Hydro, 2015. *Kootenay Canal*. Available at:
https://www.bchydro.com/community/recreation_areas/kootenay_canal.html Accessed November 2015.

Hatch, 2009. Corra Linn Dam OMS Manual.

Appendix J

FINANCIAL SCHEDULES
ALTERNATIVE 3 – GATE REFURBISHMENT

REFER TO LIVE SPREADSHEET MODEL

Provided in electronic format

FILED CONFIDENTIALLY

(accessible by opening the Attachments Tab in Adobe)

Appendix K

FINANCIAL SCHEDULES
ALTERNATIVE 4 – GATE REPLACEMENT
(PREFERRED ALTERNATIVE)

REFER TO LIVE SPREADSHEET MODEL
Provided in electronic format

FILED CONFIDENTIALLY

(accessible by opening the Attachments Tab in Adobe)

Appendix L

HMI AACE CLASS 3 COST ESTIMATE

FILED CONFIDENTIALLY

Appendix M

DESIGN BASIS MEMORANDUM FOR THE ANALYSIS OF THE SPILLWAY GATES AND SUPERSTRUCTURES

FILED CONFIDENTIALLY

Appendix N

REGIONAL DISTRICT OF CENTRAL KOOTENAY CONSULTATION LETTER

Blair Weston
Community and Aboriginal Relations Manager
FortisBC

FortisBC Inc.
3100 West Kootenay Rd
South Slocan BC, V0G 2G0
250-368-2920
blair.weston@fortisbc.com
www.fortisbc.com

Nov 3rd 2015

Uli Wolfe
General Manager of Environmental Services
Box 590,
202 Lakeside Dr,
Nelson, BC
V1L 5R4

RE: CORRA LINN SPILL GATES PROJECT

Hi Uli,

Thanks for the time on the phone the other day. As we discussed FortisBC is planning on replacing the spill gates at the Corra Linn dam located on the Kootenay River between Nelson and Castlegar. These gates have reached their end of life and need to be replaced to ensure the safe operation of FortisBC facilities. The project includes isolating individual spill gates from the river and replacing them like for like. River flows will not be affected nor does FBC expect any impacts to the environment or fish populations.

FortisBC will be applying for a Certificate of Public Convenience and Necessity from the British Columbia Utilities Commission (BCUC) for approval of this project. Should you wish to be part of the process you can contact the BCUC directly at www.bcuc.com Commission.Secretary@bcuc.com or 1-800-663-1385.

If you would rather speak with directly with FortisBC about the project, I can be contacted by telephone 250.231.0176 or email at blair.weston@fortisbc.com

Respectfully;

Blair Weston
Community and Aboriginal Relations Manager
FortisBC

Appendix O

FIRST NATIONS CONSULTATION LETTER

Blair Weston
Community and Aboriginal
Relations Manager
FortisBC

FortisBC Inc.
3100 West Kootenay Rd
South Slocan BC, V0G 2G0
250-368-2920
blair.weston@fortisbc.com
www.fortisbc.com

Sample Filing Notice
c/o Kinbasket Group of Companies
PO Box 170
Invermere, BC V0A 1K0

RE: NOTICE OF FILING FOR FORTISBC CORRA LINN SPILL GATES PROJECT

FortisBC remains committed to ongoing communication as we move forward with plans for replacing the spill gates at the Corra Linn dam located on the Kootenay River between Nelson and Castlegar. These gates have reached their end of life and need to be replaced to ensure the safe operation of FortisBC facilities. The project includes isolating individual spill gates from the river and replacing them like for like. River flows will not be affected nor does FBC expect any impacts to the environment or fish populations.

FortisBC is applying for a Certificate of Public Convenience and Necessity from the British Columbia Utilities Commission (BCUC) for approval of this project. Should you wish to be part of the process you can contact the BCUC directly at www.bcuc.com Commission.Secretary@bcuc.com or 1-800-663-1385.

If you would rather speak with directly with FortisBC about the project, please contact me at the numbers below. I look forward to your feedback, and if you would like to be kept informed of the project's progress, please let me know.

The expected BCUC decision for this is late 2016 to early 2017. The work will take place commencing spring 2018 through early 2021.

I can be contacted by telephone 250.231.0176 or email at blair.weston@fortisbc.com

Respectfully;

Blair Weston
Community and Aboriginal Relations Manager
FortisBC

Appendix P

DRAFT ORDERS AND UNDERTAKING OF CONFIDENTIALITY

Appendix P-1

DRAFT PROCEDURAL ORDER

British Columbia Utilities Commission

Sixth floor, 900 Howe Street
Vancouver, BC Canada V6Z 2N3
TEL: (604) 660-4700
BC Toll Free: 1-800-663-1385
FAX: (604) 660-1102

ORDER NUMBER
G-xx-xx

IN THE MATTER OF
the *Utilities Commission Act*, RSBC 1996, Chapter 473

and

FortisBC Inc.
Application for a Certificate of Public Convenience and Necessity for the Corra Linn Dam Spillway Gate Replacement Project

BEFORE:
Panel Chair/Commissioner
Commissioner
Commissioner

on Date

ORDER

WHEREAS:

A. On June 29, FortisBC Inc. (FBC) submitted an Application for a Certificate of Public Convenience and Necessity (CPCN) to the British Columbia Utilities Commission (Commission) under sections 45 and 46 of the *Utilities Commission Act* (UCA) for the construction and operation of fourteen replacement spillway gates and upgrades to the associated structures at the Corra Linn Dam (Application or Project);

B. In the Application, FBC describes that the Project scope will include the design, construction and commissioning of the Project components including:

   1. Replacement of the fourteen existing spillway gates at the Corra Linn Dam to meet seismic and flood withstand recommendations of the British Columbia Dam Safety Regulation (BCDSR) and Canadian Dam Association Dam Safety Guidelines (CDSG);

   2. Reinforcement of the existing towers and bridges to meet seismic and flood withstand recommendations of the BCDSR and CDSG;

   3. Refurbishment of the existing hoists; and

   4. Replacement of the existing embedded parts (gate guides, sill etc.);

C. The estimated capital cost for the Project in as-spent dollars, including Allowance for Funds Used During Construction and abandonment/demolition costs of $5.434 million and removal costs of $6.094 million is $62.694;

D. The Project is planned to complete in phases with the last spillway gate scheduled to be in-service by December 2020 and contractor demobilization and restoration to occur in early 2021;

E. FBC requests that certain Appendices relating to engineering, risk assessments, and cost estimates for the Project be treated as confidential due to commercial sensitivity and to maintain the safety and security of the Company's assets;

F. The Commission has determined that a written public hearing is necessary for the review of the Application.

NOW THEREFORE the British Columbia Utilities Commission orders as follows:

1. A written public hearing process shall proceed according to the Regulatory Timetable attached as Appendix A to this Order).

2. The British Columbia Utilities Commission (Commission) considers FBC's request for confidentiality to be reasonably necessary to protect FEI's business interests and to maintain the safety and security of the Company's assets. The Commission will hold detailed information related to engineering, risk assessments, and cost estimates for the Project confidential. Consumer group Interveners may request access to this information upon executing standard form undertakings of confidentiality. The Commission will consider requests by any other Interveners to access such information and FBC will have an opportunity to comment on any request.

3. FBC is to publish, as soon as possible, the Public Notice, attached as Appendix B to this Order, in such local and community newspapers as to provide adequate notice to those parties who may have an interest in or be affected by the Application.

4. The Application, together with any supporting materials, will be available for inspection at the FBC Office, 16705 Fraser Highway, Surrey, BC, V4N 0E8. The Application and supporting materials will also be available on the FortisBC Utilities' website at www.fortisbc.com.

5. Interveners and Interested Parties must register with the Commission, in writing or by electronic submission, by August 12, 2016 in accordance with the Commission's Rules of Practice and Procedure made effective January 15, 2016. Interveners should specifically state the nature of their interest in the Application and identify generally the nature of the issues that they may intend to pursue during the proceeding and the nature and extent of their anticipated involvement in the review process.

DATED at the City of Vancouver, in the Province of British Columbia, this (XX) day of (Month 2016).

BY ORDER

(X. X. last name)
Commissioner

Attachments

FortisBC Inc.
Certificate of Public Convenience and Necessity Application
for the Corra Linn Dam Spillway Gate Replacement Project

REGULATORY TIMETABLE

ACTION	DATE (2016)
Intervener and Interested Party Registration	Friday, August 12
Commission Information Request No. 1	Thursday, August 18
Intervener Information Requests No. 1	Thursday, August 25
FBC Responses to Information Requests No. 1	Thursday, September 22
Commission and Intervener Information Requests No. 2	Thursday, October 13
FBC Responses to Information Requests No. 2	Friday, November 4
FBC Final Written Submission	Friday, November 18
Intervener Final Written Submissions	Friday, December 2
FBC Written Reply Submission	Friday, December 16

British Columbia Utilities Commission

Public Notice of the Corra Linn Dam Spillway Gate Replacement Project

On June 29, 2016, FortisBC Inc. (FBC) applied to the British Columbia Utilities Commission (Commission) for a Certificate of Public Convenience and Necessity (CPCN), pursuant to sections 45 and 46 of the *Utilities Commission Act*, for the construction and operation of fourteen replacement spillway gates and upgrades to the associated structures at the Corra Linn Dam (the Application or the Project). The estimated capital cost for the Project in as-spent dollars, including Allowance for Funds Used During Construction and cost of removal, is $62.694 million. The Project is planned to complete in phases with the last spillway gate scheduled to be in-service by December 2020 and contractor demobilization and restoration to occur in early 2021.

Comment [JJ1]: Confirm filing date before finalizing.

In the Application, FBC describes that the Project scope will include the design, construction and commissioning of the Project components including:

1. Replacement of the fourteen existing spillway gates at the Corra Linn Dam to meet seismic and flood withstand recommendations of the British Columbia Dam Safety Regulation (BCDSR) and Canadian Dam Association Dam Safety Guidelines (CDSG);

2. Reinforcement of the existing towers and bridges to meet seismic and flood withstand recommendations of the BCDSR and CDSG;

3. Refurbishment of the existing hoists; and

4. Replacement of the existing embedded parts (gate guides, sill etc.).

How to get involved

Persons who are directly or sufficiently affected by the Commission's decision or have relevant information, or expertise and who wish to actively participate in the proceeding can request intervener status by submitting a completed Request to Intervene Form by Friday, August 12, 2016. Forms are available on the Commission's website at www.bcuc.com. Interveners will receive notification of all non-confidential correspondence and filed documentation, and should provide an email address if available.

Persons not expecting to participate, but who have an interest in the proceeding, should register as interested parties through the Commission's website. Interested parties receive electronic notice of submissions and the decision when it is released.

Letters of comment may also be submitted using the Letter of Comment Form found online at www.bcuc.com. By participating and/or providing comment on the application, you agree to your comments being placed on the public record and posted on the Commission's website. All submissions and/or correspondence received, including letters of comment are placed on the public record, posted on the Commission's website, and provided to the Panel and all participants in the proceeding.

For more information about participating in a Commission proceeding please see the Rules of Practice and Procedure available at www.bcuc.com. Alternatively, persons can request a copy of the Rules of Practice and Procedure in writing. All forms are available on the Commission's website or can be requested in writing.

View the application
The application and all supporting documentation are available on the Commission's website on the "Current Applications" page. If you would like to review the material in hard copy, it is available to be viewed at the locations below:

British Columbia Utilities Commission Sixth Floor, 900 Howe Street Vancouver, BC V6Z 2N3 Commission.Secretary@bcuc.com Telephone: 604-660-4700 Toll Free: 1-800-663-1385	**FortisBC Inc.** 16705 Fraser Highway Surrey, BC V4N 0E8

For more information please contact Laurel Ross, Acting Commission Secretary using the contact information above.

Appendix P-2

DRAFT C ORDER

British Columbia Utilities Commission

Sixth floor, 900 Howe Street
Vancouver, BC Canada V6Z 2N3
TEL: (604) 660-4700
BC Toll Free: 1-800-663-1385
FAX: (604) 660-1102

ORDER NUMBER
C-xx-xx

IN THE MATTER OF
the *Utilities Commission Act*, RSBC 1996, Chapter 473

and

FortisBC Inc.
Application for a Certificate of Public Convenience and Necessity for the Corra Linn Dam Spillway Gate Replacement Project

BEFORE:
Panel Chair/Commissioner
Commissioner
Commissioner

on Date

CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY

WHEREAS:

A. On June 29, FortisBC Inc. (FBC) submitted an Application for a Certificate of Public Convenience and Necessity (CPCN) to the British Columbia Utilities Commission (Commission) under sections 45 and 46 of the *Utilities Commission Act* (UCA) for the construction and operation of fourteen replacement spillway gates and upgrades to the associated structures at the Corra Linn Dam (Application or Project);

B. In the Application, FBC proposes:

   1. Replacement of the 14 spillway gates at the Corra Linn Dam to meet seismic and flood withstand recommendations of the British Columbia Dam Safety Regulation (BCDSR) and Canadian Dam Association Dam Safety Guidelines (CDSG);

   2. Reinforce the existing towers and bridges to meet seismic and flood withstand recommendations of the BCDSR and CDSG;

   3. Refurbish the existing hoists; and

   4. Replacement of the existing embedded parts (gate guides, sill etc.).;

C. The estimated capital cost for the Project in as-spent dollars, including Allowance for Funds Used During Construction and abandonment/demolition costs of $5.434 million and removal costs of $6.094 million is $62.694;

D. The Project is planned to complete in phases with the last spillway gate scheduled to be in-service by December 2020 and contractor demobilization and restoration to occur in early 2021;

…/2

E. FBC requests that certain Appendices relating to engineering, risk assessments, and cost estimates for the Project be treated as confidential due to commercial sensitivity and to maintain public safety;

F. By Order G-XX-16 dated <date>, the Commission granted FEI's request for confidentiality and established a regulatory review process and regulatory timetable;

G. The Commission has considered the evidence concludes that the Project is in the public interest and that a CPCN for the Project should be granted.

NOW THEREFORE the British Columbia Utilities Commission orders as follows:

1. Pursuant to Sections 45 and 46 of the *Utilities Commission Act*, a Certificate of Public Convenience and Necessity is granted to FortisBC Inc. (FBC) to construct and operate the Corra Linn Dam Spillway Gate Replacement Project, as applied for in the Application.

2. FBC shall file with the Commission within 30 days of the end of each reporting period a Quarterly Progress Report on the Project. The Quarterly Progress Report will provide the risks that the Project is experiencing, the options available to address the risks, the actions that FEI is taking to deal with the risks and the likely impact on Projects' schedule and cost.

3. FBC shall file with the Commission a Final Report, within six months of the actual completion of the Project, that provides a complete breakdown of the final costs of the Project, compares these costs to the cost estimate in the Application, and provides an explanation and justification of material cost variances.

DATED at the City of Vancouver, in the Province of British Columbia, this (XX) day of (Month Year).

BY ORDER

(X. X. last name)
Commissioner

Appendix P-3

UNDERTAKING OF CONFIDENTIALITY

FortisBC Inc.
Application for a Certificate of Public Convenience and Necessity for Replacement of the Corra Linn Dam Spillway Gates

CONFIDENTIAL Undertaking

I, ______________________, am a participant acting for ______________________________ in the matter of the review of the FBC's Application for a Certificate of Public Convenience and Necessity for the Corra Linn Dam Spillway Gate Replacement Project.

In this capacity, I request access to the confidential information. I understand that the execution of this undertaking is a condition of an Order of the Commission, and the Commission may enforce this Undertaking pursuant to the provisions of the *ATA.*

I hereby undertake

a) to use the information disclosed under the conditions of the Undertaking exclusively for duties performed in respect of this proceeding;

b) not to divulge information disclosed under the conditions of this Undertaking except to a person granted access to such information or to staff of the Commission;

c) not to reproduce, in any manner, information disclosed under the conditions of this Undertaking except for purposes of the proceeding;

d) to keep confidential and to protect the information disclosed under the conditions of this Undertaking;

e) to return to FBC, under the direction of the Commission, all documents and materials containing information disclosed under the conditions of this Undertaking, including notes and memoranda based on such information, or to destroy such documents and materials and to file with the Commission a certification of destruction at the end of the proceeding or within a reasonable time after the end of my participation in the proceeding; and

f) to report promptly to the Commission any violation of this Undertaking.

Dated at __________________________ this ______day of ____________, 2016.

Signature: ______________________________

Name: ______________________________
(please print)

Address: ______________________________

Telephone: ______________________________

Fax: ______________________________

E-mail: ______________________________