ICOLD committee F

Site C Clean Energy Project

Experience in planning (2007 to 2023)

June 11, 2023

Andrew Watson, P.Eng.

BC Hydro

Director Design Engineering – Site C

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My background:

- At BCHydro for about 22 years
- Background in geological/geotechnical engineering
- Leading the design work for BCHydro on site for 16 years. 8 of those years was before construction started
- Lead an integrated team of BCHydro engineers and consultants teams in the office and at the construction site.
- Report to the executive VP responsible for the project
- Coordinate the technical review boards for the project

Outline:

- **Project overview and history**
- **Staged approach to evaluation and approval**
- **Project organization**
- **Scope of stages and decision points**
- **Formal environmental review**
  - **Alternates to the project**
  - **Alternates within the project**
- **Decision to proceed to construction**
- **Procurement, permits and oversight**
- **Construction Update**

Site C Clean Energy Project - Location

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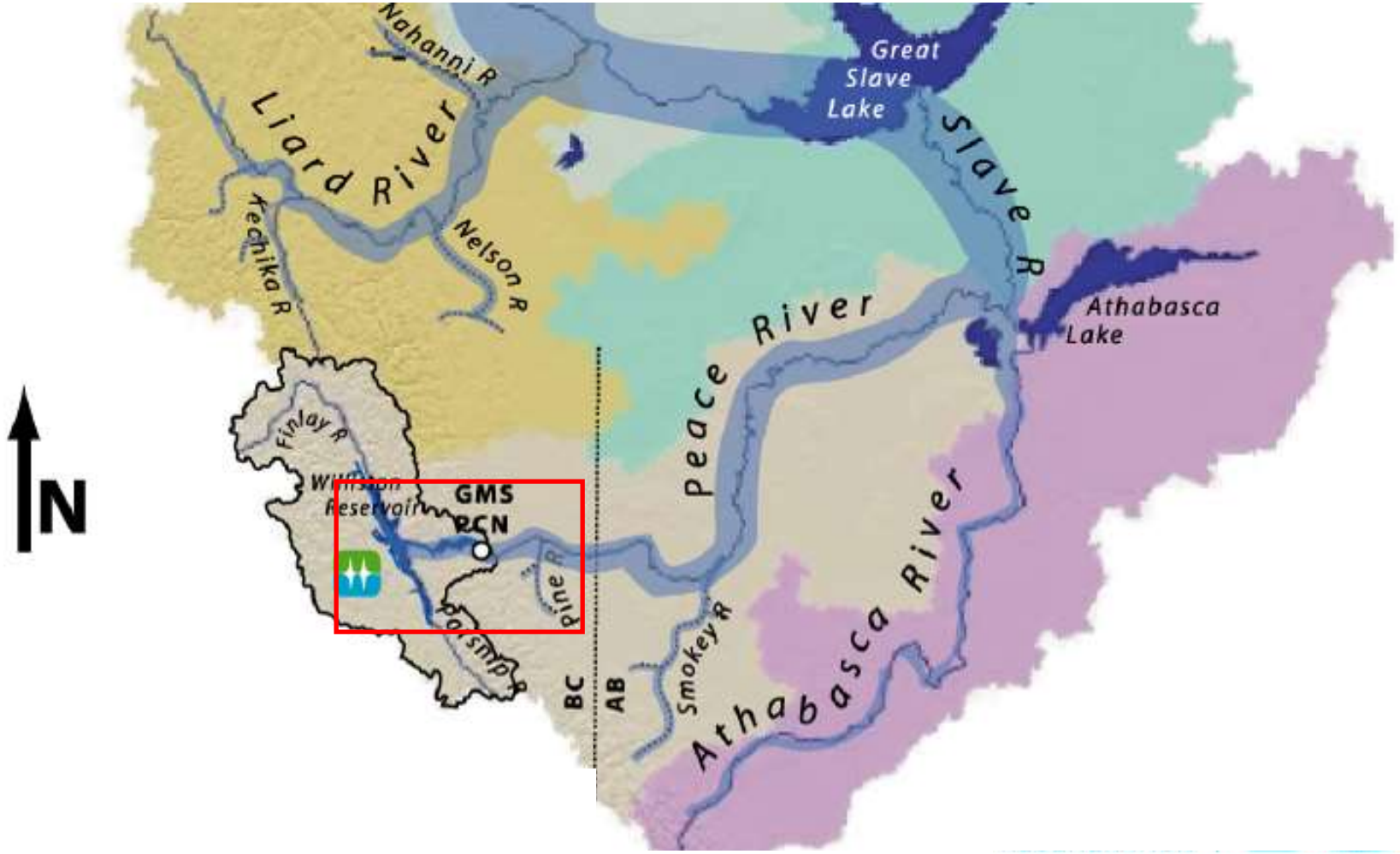
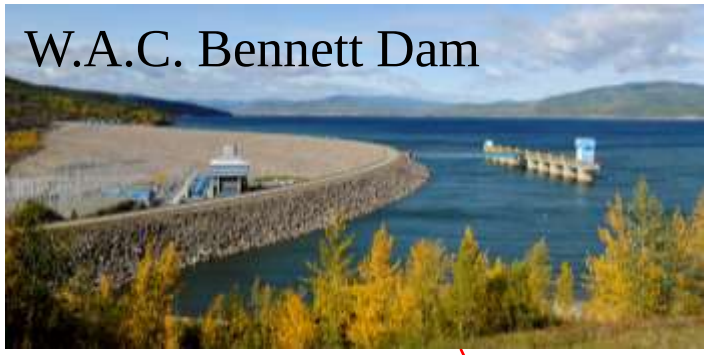
Peace River Flows



Peace River: Williston Reservoir, W.A.C. Bennett and Peace Canyon Dams



200 0 200 400 600 Kilometers

Peace Point

Peace-Athabasca Delta

High Level

Fort Vermillion

Vermillion Chutes

700 km

Tompkins Landing

British Columbia

Alberta

Peace River

400 km

Town of Peace River

Fort St. John

Williston Lake

W.A.C. Bennett Dam

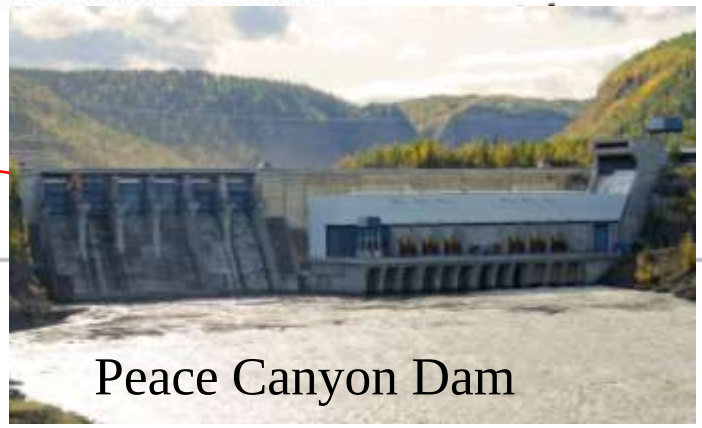
Hudson Hope

Peace Canyon Dam

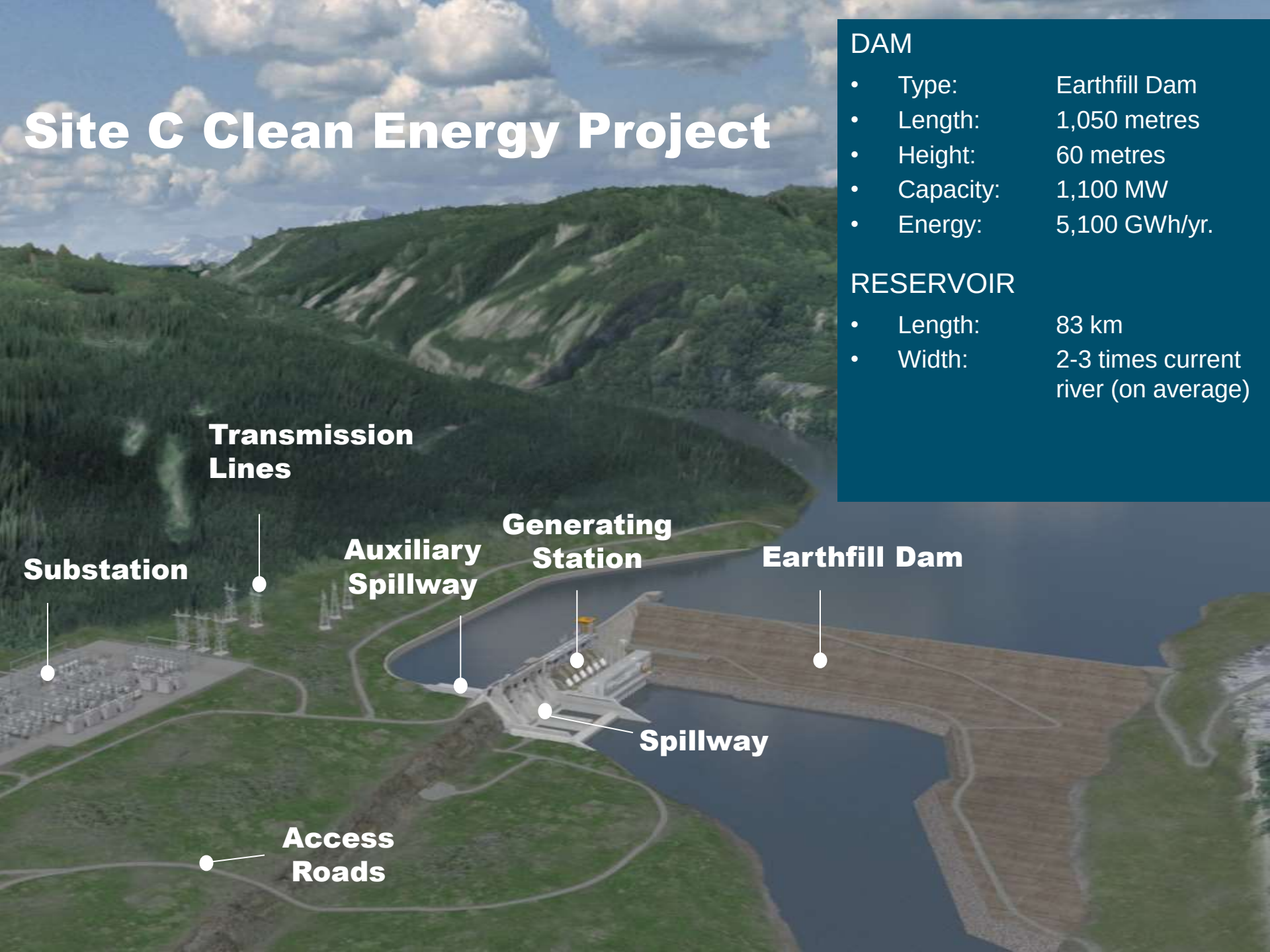
Taylor

Dunvegan

Smoky River



Site C Clean Energy Project



DAM

- Type: Earthfill Dam
- Length: 1,050 metres
- Height: 60 metres
- Capacity: 1,100 MW
- Energy: 5,100 GWh/yr.

RESERVOIR

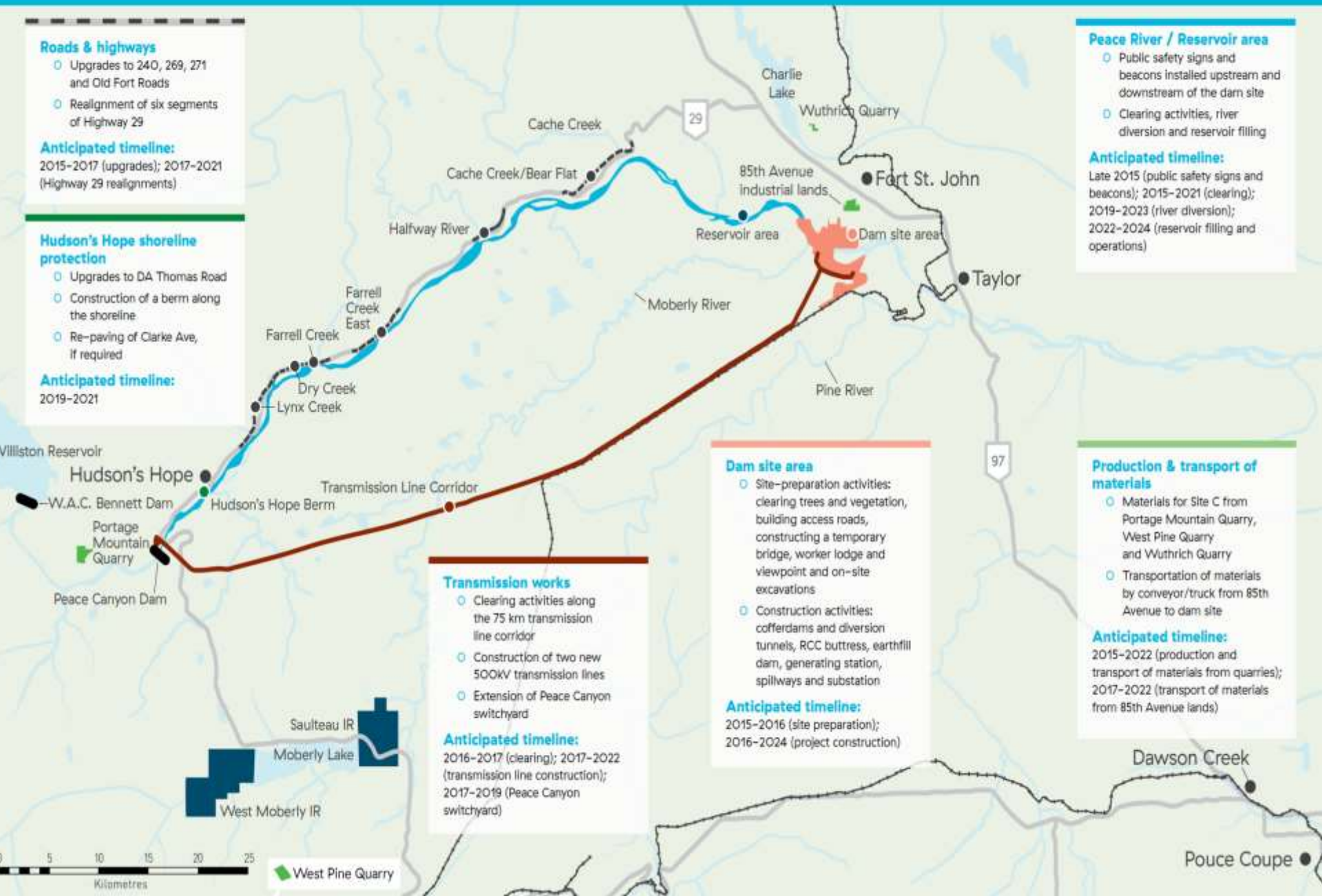
- Length: 83 km
- Width: 2-3 times current river (on average)

A Mid-Sized Hydroelectric Facility

HISTORY OF SITE C

- **1958**: Site C first identified as potential third dam on Peace
- **1976**: Site C confirmed best option for third dam
- **1978-1982**: Historic Design Developed
- **1989-1991**: Design transfer to KCBL/SNC and Shelf Ready Plan
- **2004 and 2006**: BC Hydro long term plans recommend Site C as potential supply option
- **2007-2014:** Staged approach to planning, decisions and regulatory
- **2014:** Project approval and investment decision
- **2015-2023:** Construction
- (2017 had mid construction decision review)
- (2020 Budget update)

Building the Site C Clean Energy Project



MULTI-STAGE EVALUATION PROCESS

Engineering in the planning phase

- Conceptual and feasibility designs
- Alternates assessment
- Project design ‘footprint’ for environmental assessment and comparison of alternates
- Mitigation options and design
- Construction planning and constructability
- Procurement planning and interfaces
- Operations and maintenance (Safety by design)
- Environmental considerations
- Support the project consultations and environmental review

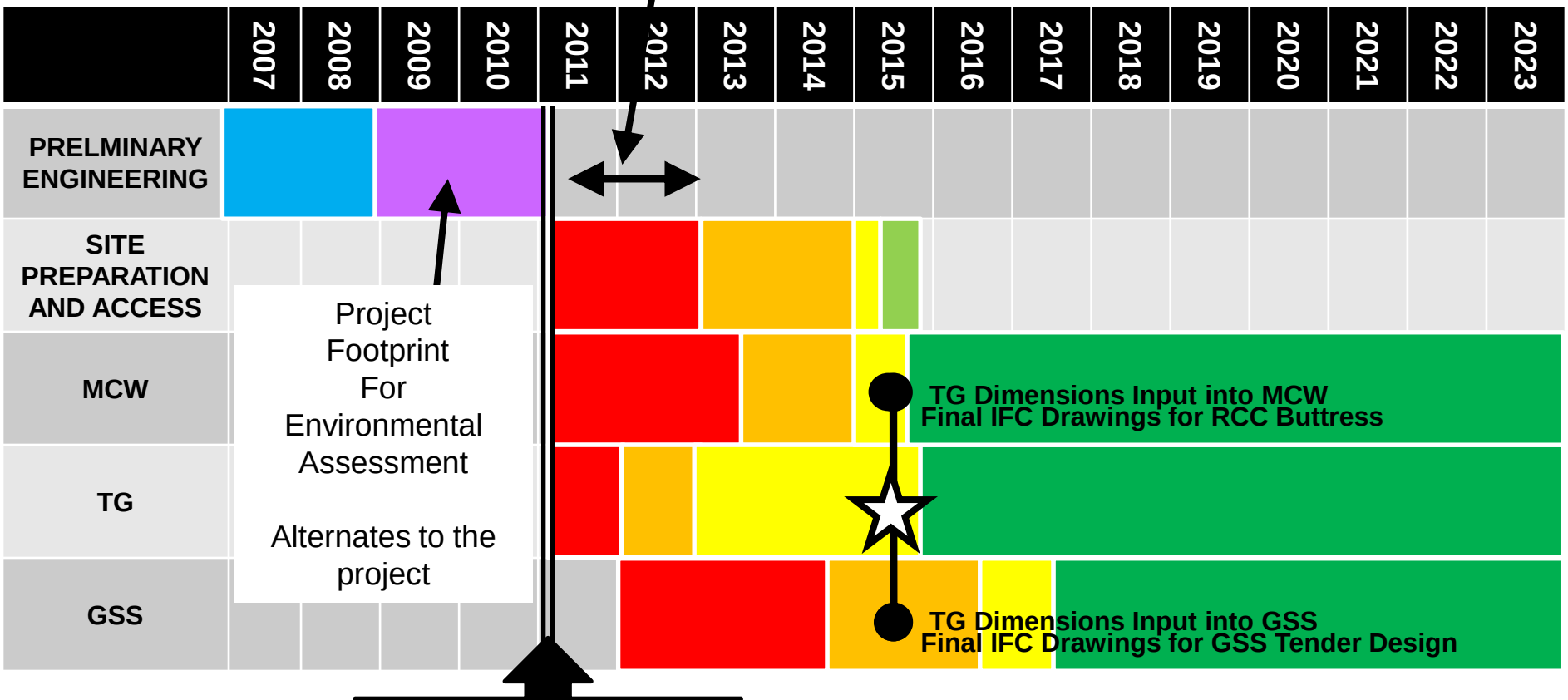
SITE C CLEAN ENERGY PROJECT

Engineering

Environmental Assessment Support and Consultations, Refine project footprint

Feasibility Studies | **Optimization And Configuration** | **Definition Design** | **Implementation Design** | **Procurement Support** | **Site Preparation** | **Construction**

Upon Award: Issue IFC Drawings; Provide Engineering Support to Fabrication and Construction

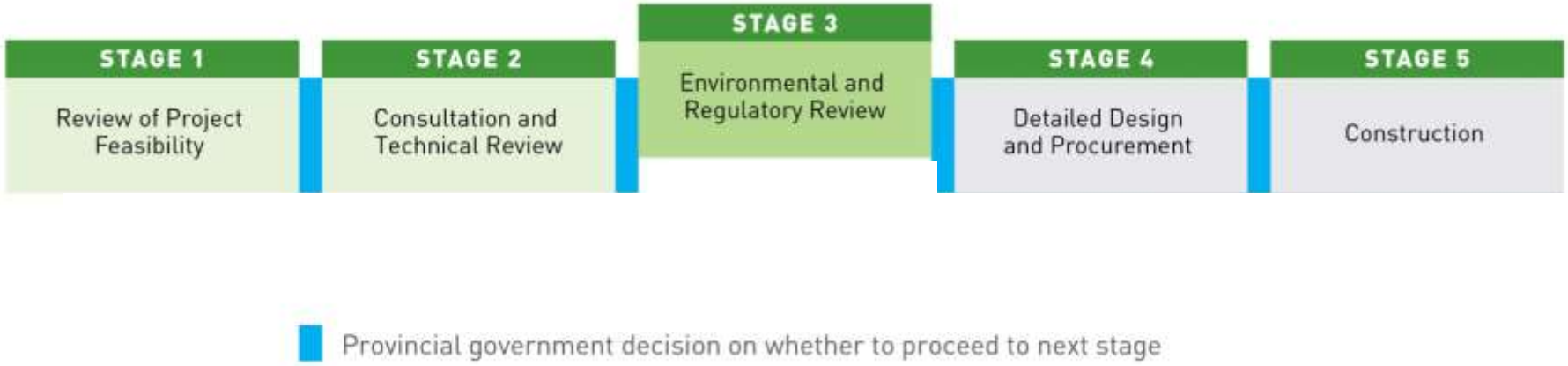


Project requires an investment decision by the Province and regulatory permits and authorizations before it can proceed to construction

JULY 2015

BC hydro REGENERATION

MULTI-STAGE EVALUATION PROCESS



Stage 2 Consultation and Technical review
2007 to 2009

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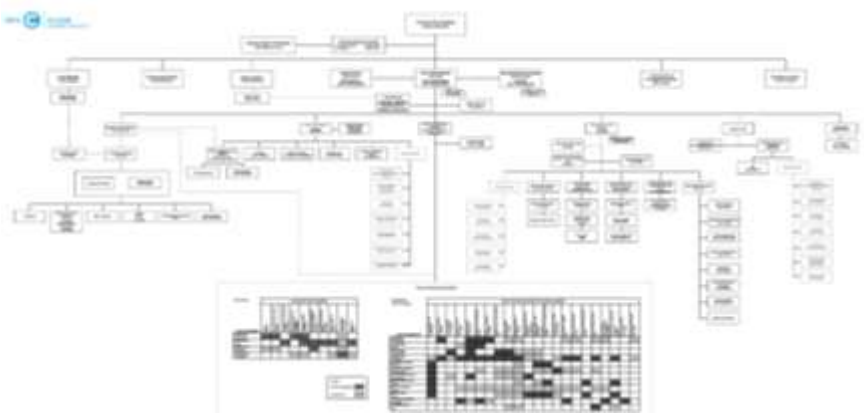
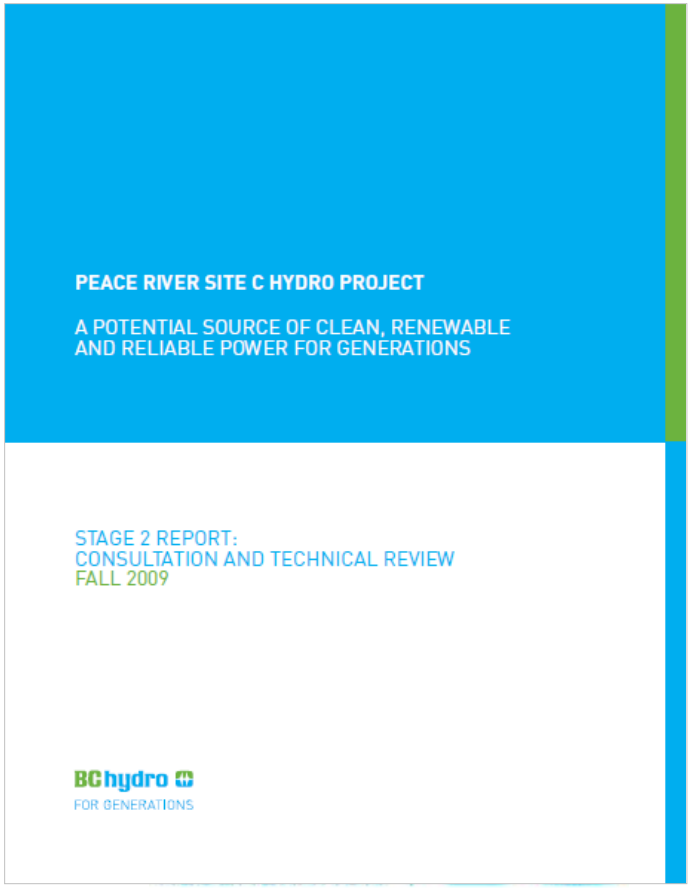
Integrated Consultant / Owner Team

- Integrated consultant and owner team for all phases
- Commercially achieved by owner employees seconded to consultant team and consultants seconded to owner team
- Embed operations expertise in the design team at early stage
- Our goal is generally could not identify owner employees from consultants “Leave your business card at the door approach”



Stage 2: Consultation and Technical Review

- Commenced in the fall of 2007 and concluded in fall 2009.
- Consultations with the public, stakeholders, communities, Aboriginal groups and property owners, as well as early discussions with the Province of Alberta and the Northwest Territories.
- Conducted environmental and socio-economic baseline studies, and gathered engineering and technical information regarding the design, construction and operation of the project.
- Stage 2 Report, and 35 appended studies and reports, at: www.bchydro.com/sitec



PUBLIC AND STAKEHOLDER CONSULTATION

- BC Hydro-led Consultations
  - Public open houses
  - Stakeholder meetings
  - Local Governments
  - Property Owners
  - Business Liaison
- Regulatory Consultations
  - Multiple public comment periods
  - Public hearings, as part of Joint Review Panel Process
- Community Consultation Offices

Stage 3 Regulatory and Environmental Review
2010 to 2014

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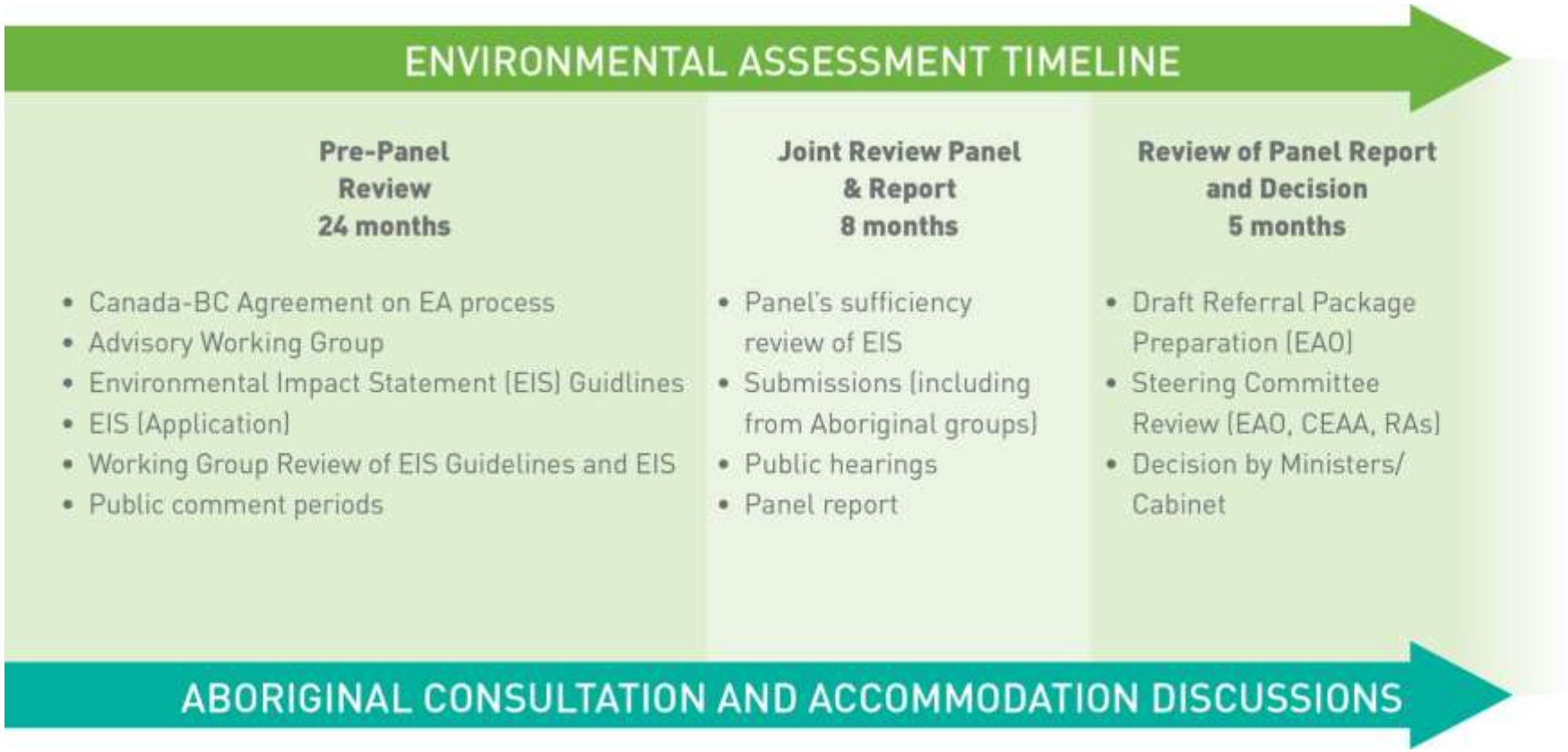
PROPOSED REGULATORY PROCESS



Environmental Assessment

Engineering Investigations

Forestry

Physical Environment

Wildlife

Fish and Aquatics

Heritage

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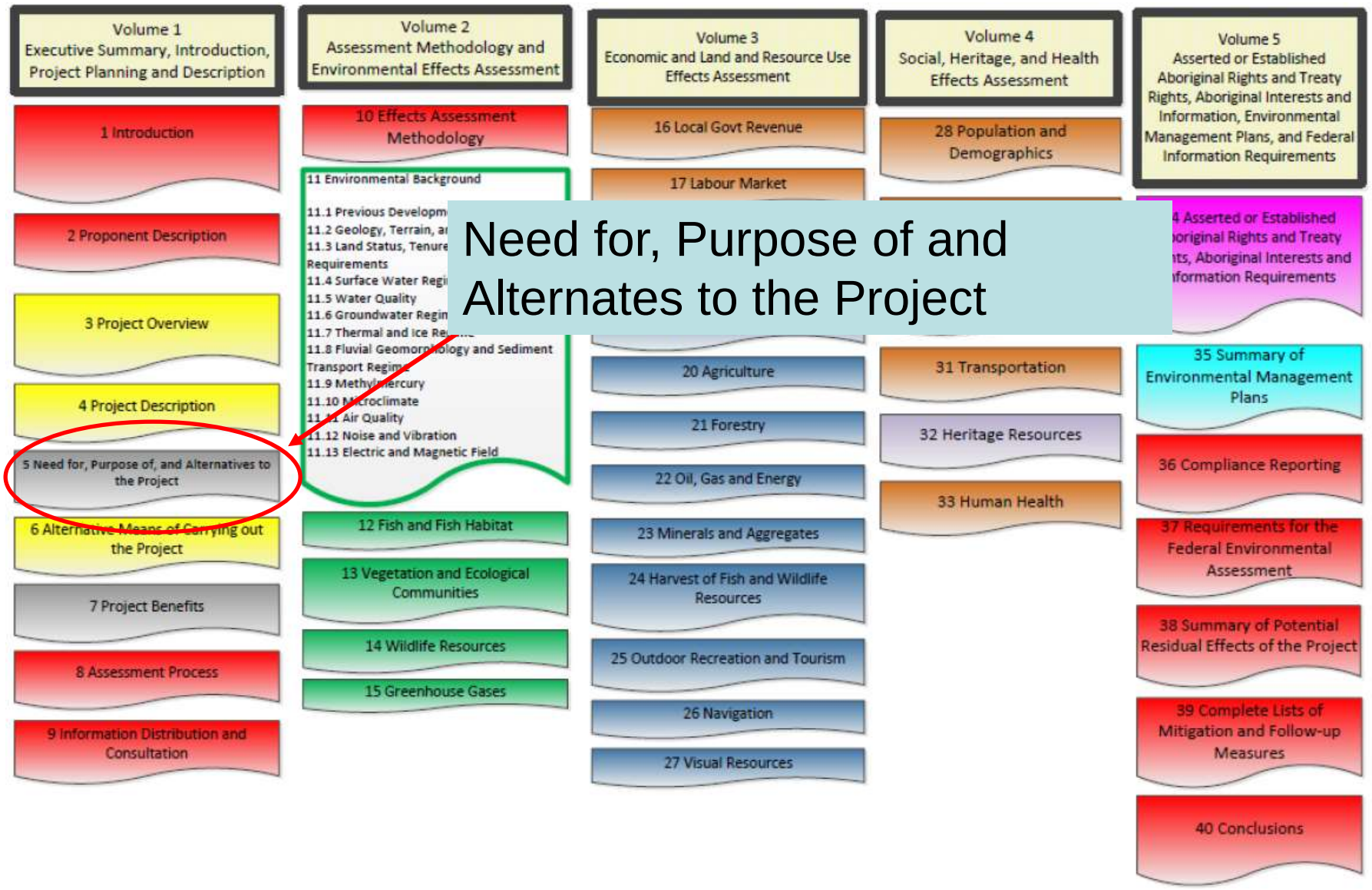
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8 Assessment Process
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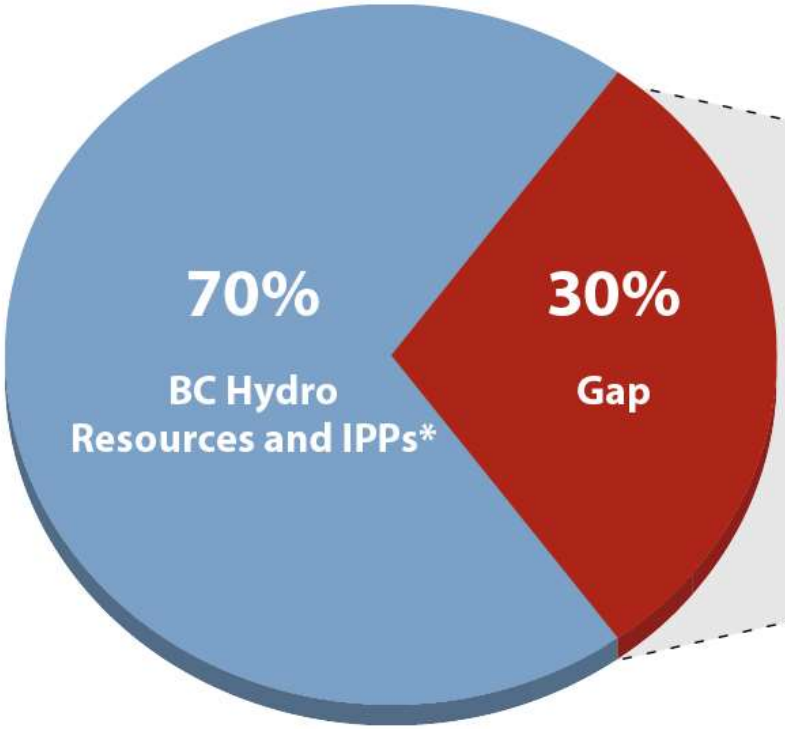
39 Complete Lists of Mitigation and Follow-up Measures
40 Conclusions
Need for, Purpose of and Alternates to the Project

WHY BUILD SITE C (Business Case)

- Site C adds 5,100 GWh/yr. of energy and up to 1,100 MW of capacity
- Ability to back up intermittent resources (e.g., wind, run-of-river hydro)
- Clean, reliable power for more than 100 years
- Low GHGs per megawatt hour
- Cost-effective option for ratepayers
- Fosters economic development

Looking ahead to 2025



Filling the Gap:

Potential Future Resources:

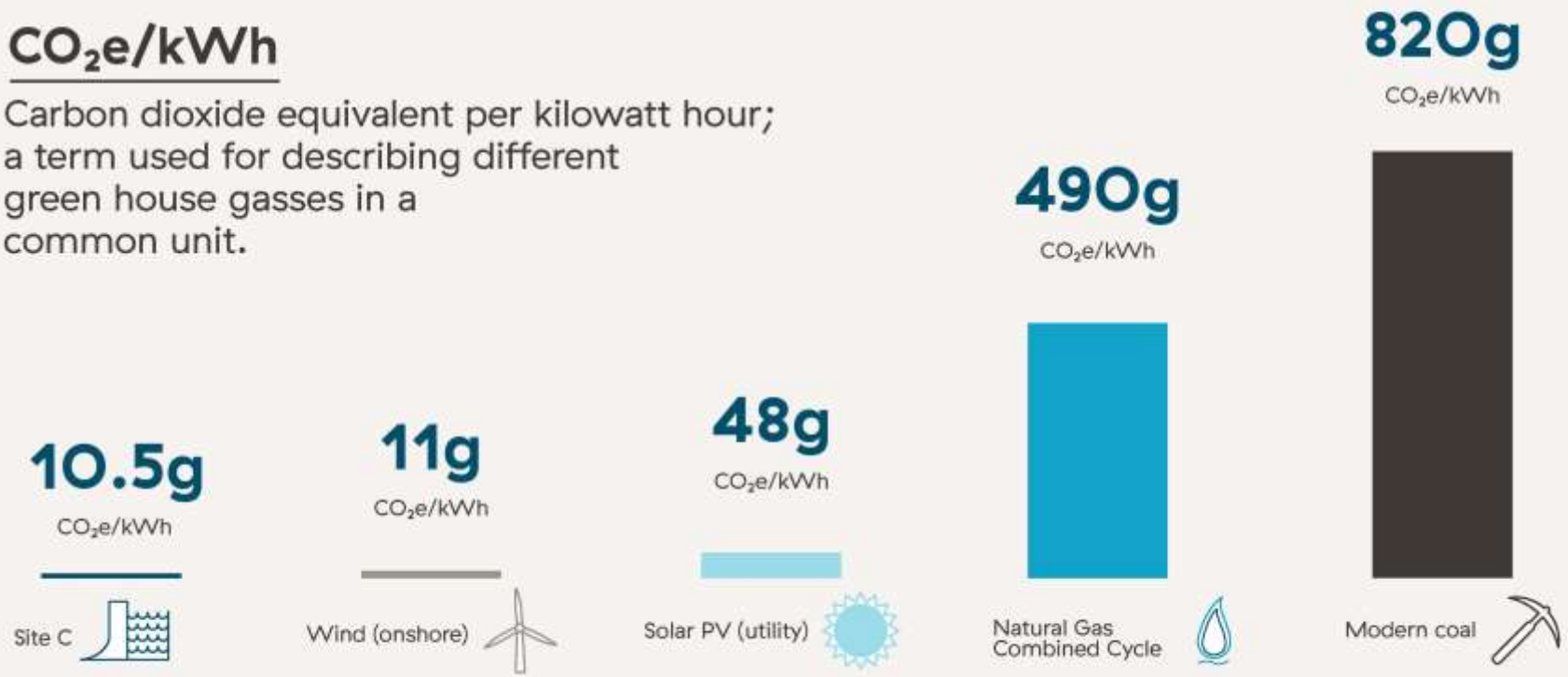
- Wind
- Small Hydro
- Bioenergy
- Geothermal
- Site C

*Includes BC Hydro heritage assets and contracted amounts with independent power producers (adjusted for attrition).

Low greenhouse gas emissions

CO_2e/kWh

Carbon dioxide equivalent per kilowatt hour; a term used for describing different green house gasses in a common unit.



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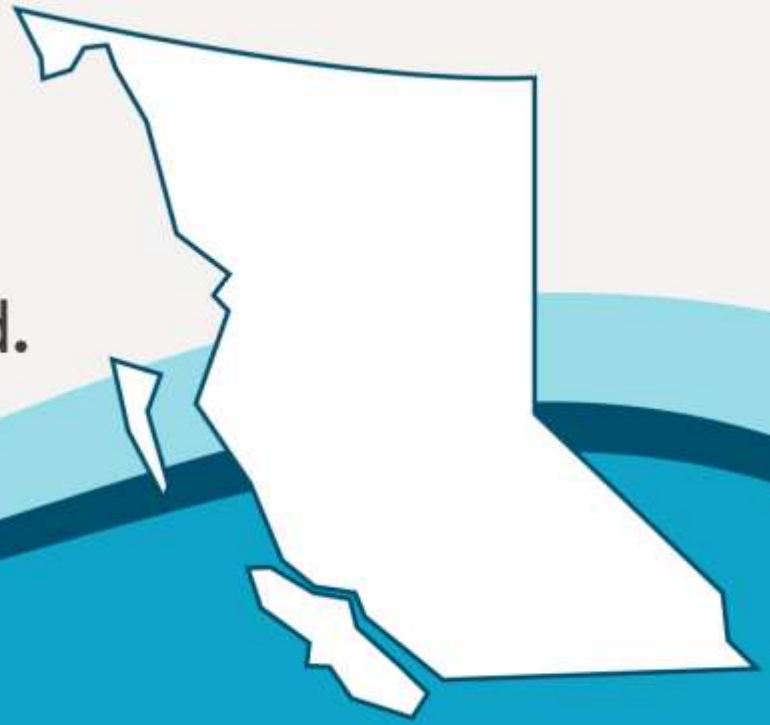
A dependable, 24/7 resource

Site C can quickly

increase or decrease

generation to match demand.



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SITE C: COMPARING THE OPTIONS

- Lowest cost:
- Energy and capacity
- Fewer greenhouse gas emissions: Site C will have the lowest greenhouse gas emissions
- Economic development

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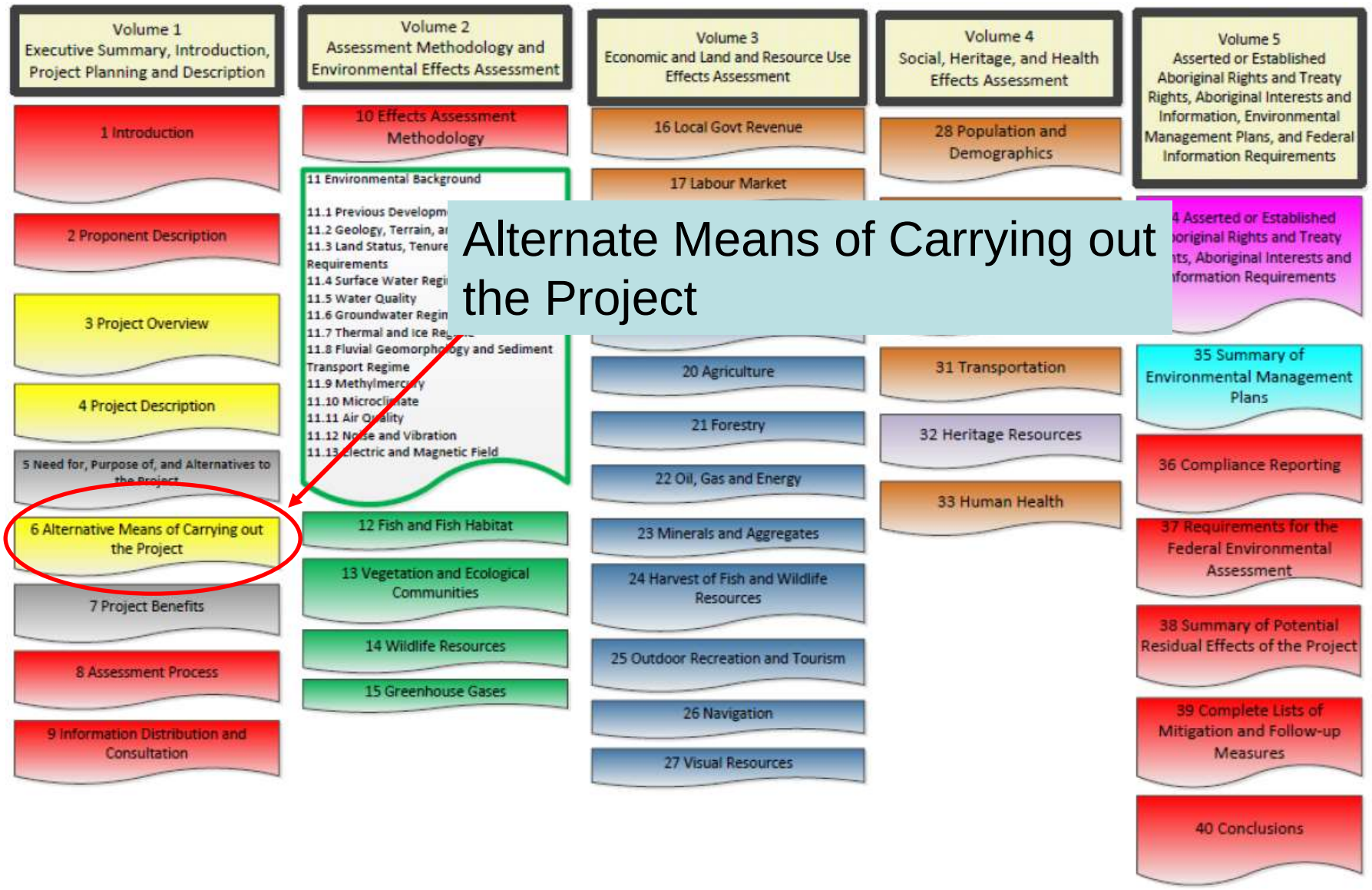
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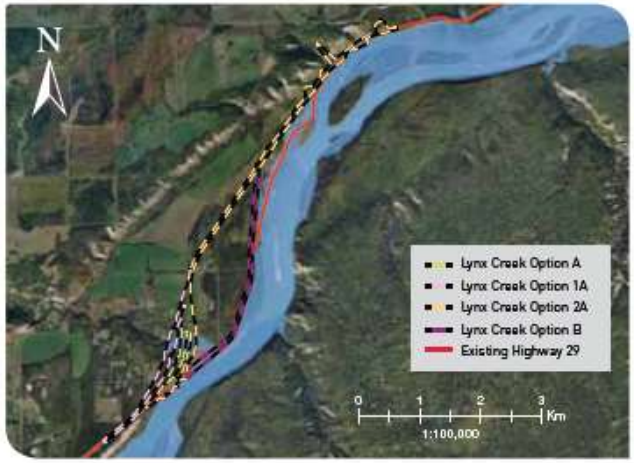
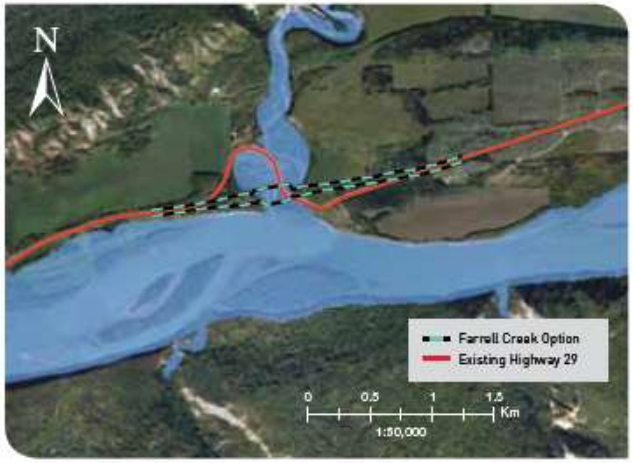
Alternate Means of Carrying out the Project

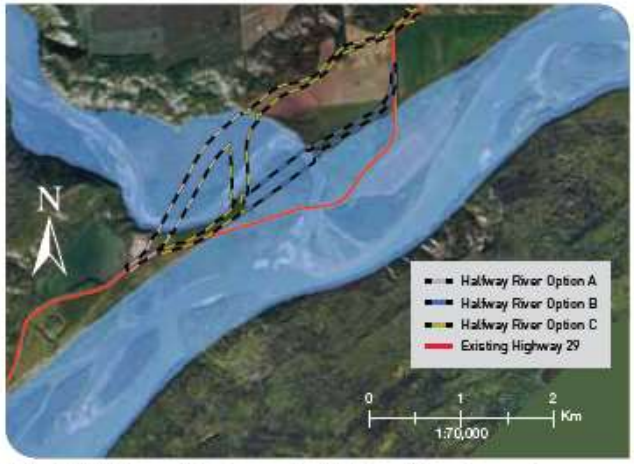
Highway 29 Realignment Options



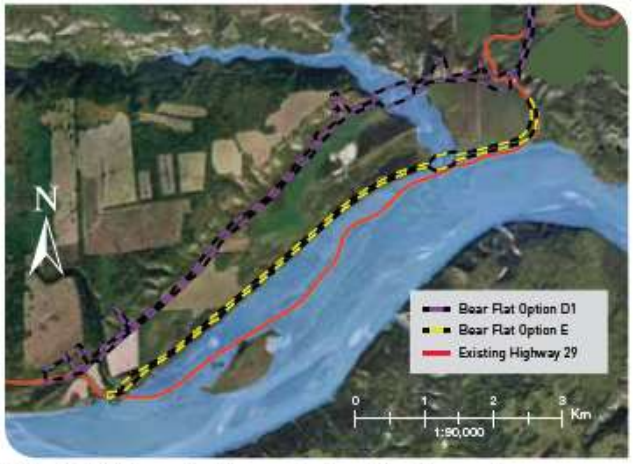
Potential Highway Realignment – Lynx Creek Segment



Potential Highway Realignment – Farrell Creek Segment

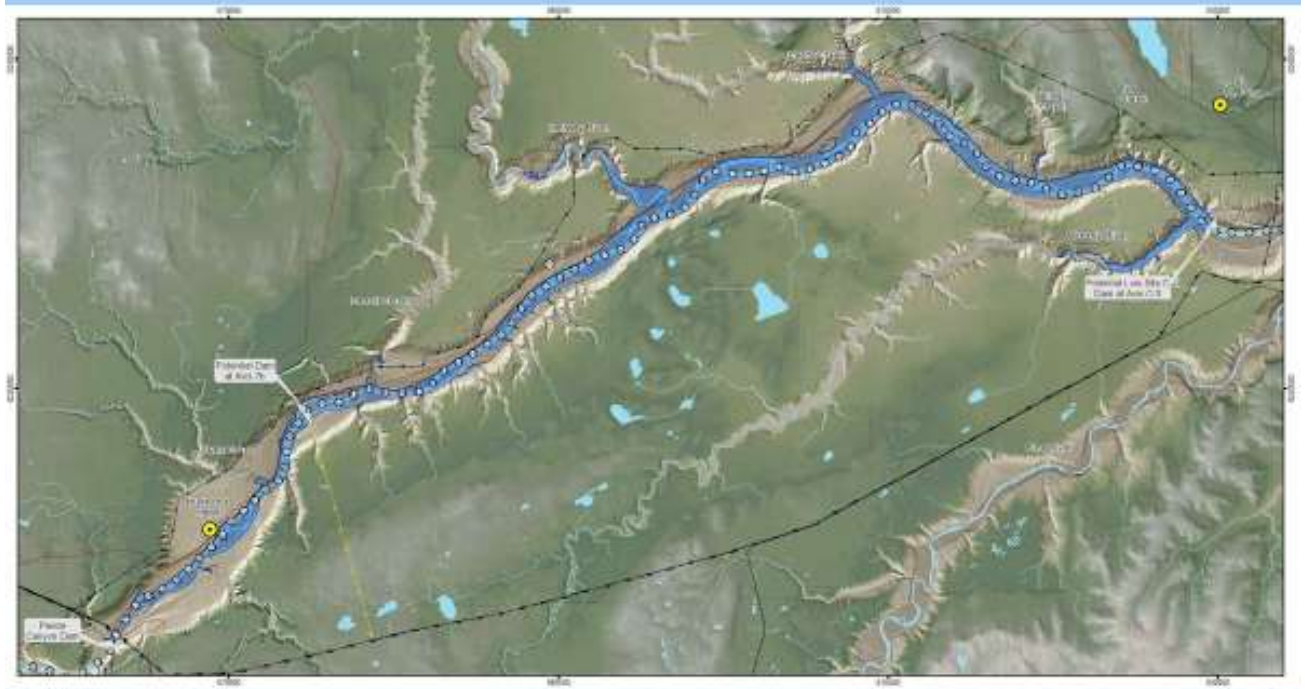


Potential Highway Realignment – Halfway River Segment



Potential Highway Realignment – Bear Flat Segment

2 Dam Cascade – 7b + Low C3

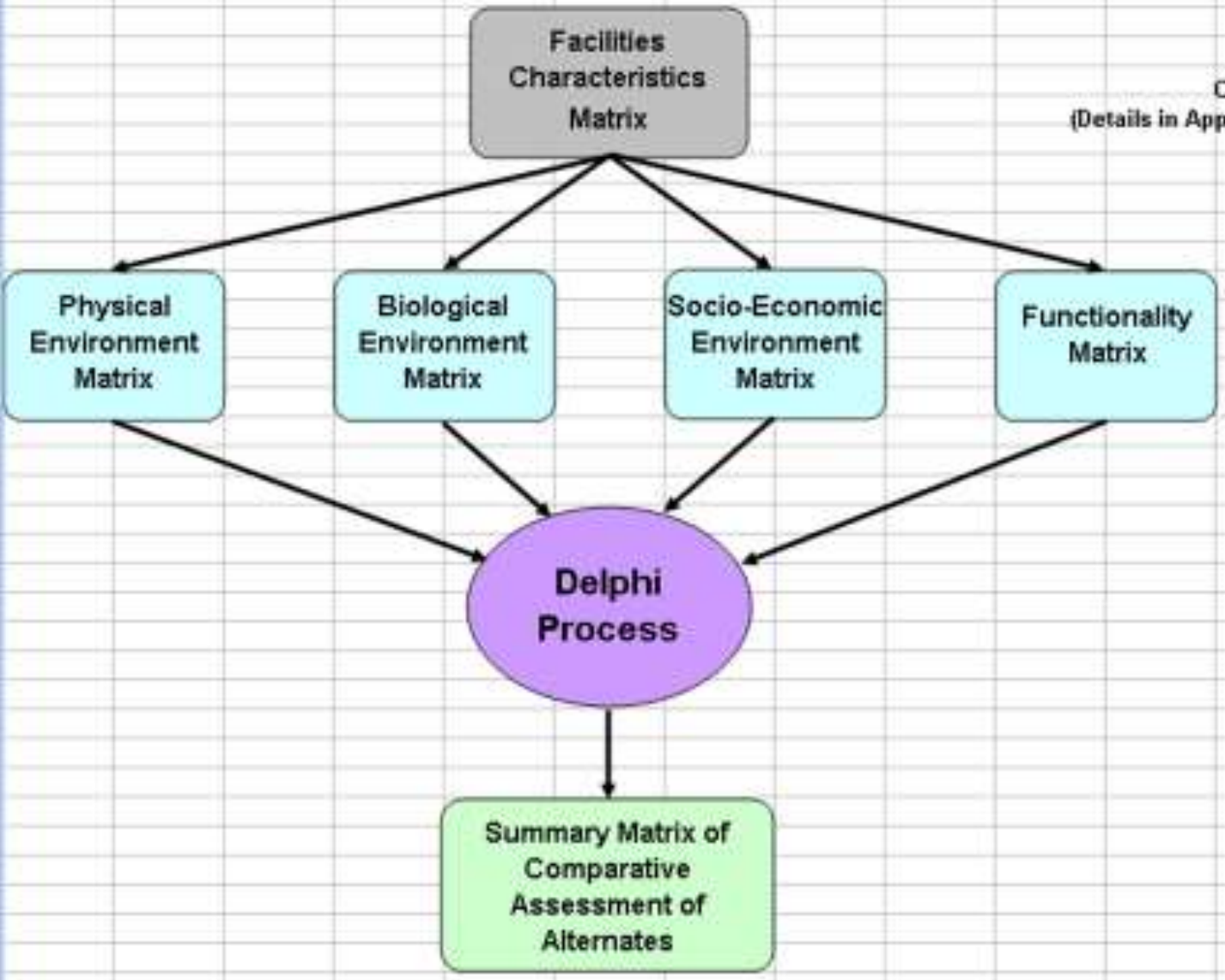


Klohn Crippen Berger

SNC·LAVALIN

HATCH

Multi-Attribute Framework



Description of Project Components by Alternate (Details in Appendix - Key Characteristics in Matrix)

Comparison of Discipline Specific Attributes Relative to Site C3 (Base Case)

SNC-L / KCG / Hatch Multidisciplinary Decision Making Workshop

Comparison of Combined Discipline Specific Attributes Relative to Site C3 (Base Case)

Major Design alternates underwent multi-attribute analysis, for example:

- General arrangement
- Dam Type
- Spillway type, basin type, gate types
- Transmission corridor
- Number of units
- Arrangement of powerhouse
- Reservoir filling option

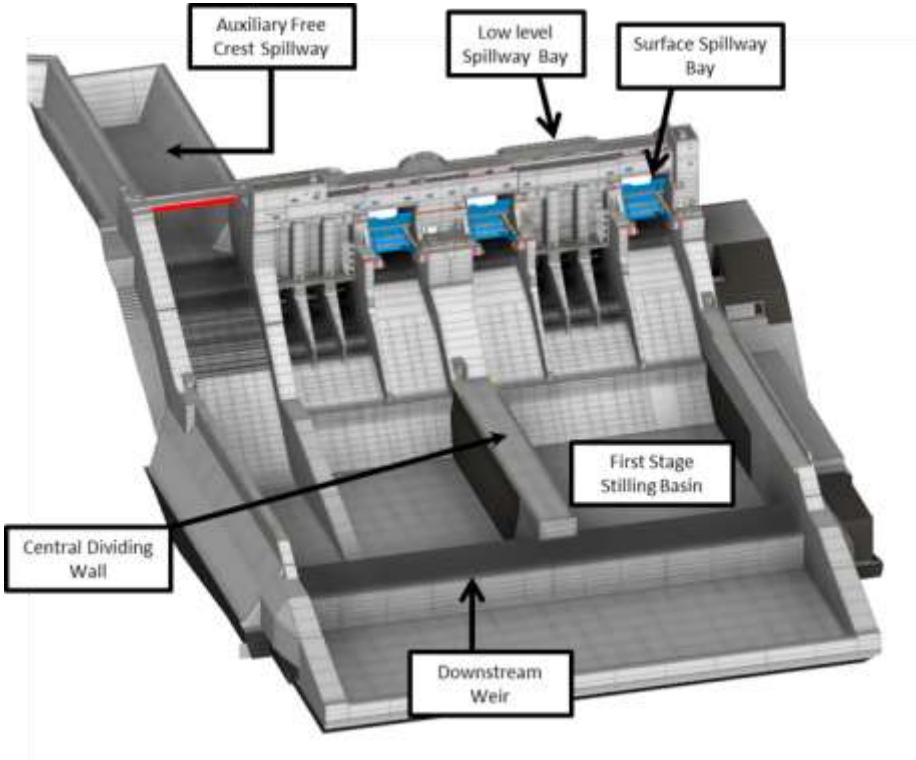
- Also used for foundation enhancements during construction

Example, for the selection of the generation arrangement involved:

1) A comparative Failure Modes and Effects Analysis (FMEA);
2) A comparative Robustness and Functionality assessment;
3) An Environmental and Socio-Economic impact evaluation; and
4) Cost and schedule and risk.

Various approaches used all similar themes:
Process used to both screen out alternates, conduct sensitivities analysis in terms of what could change the decision and ultimately develop a narrative documenting the decision.

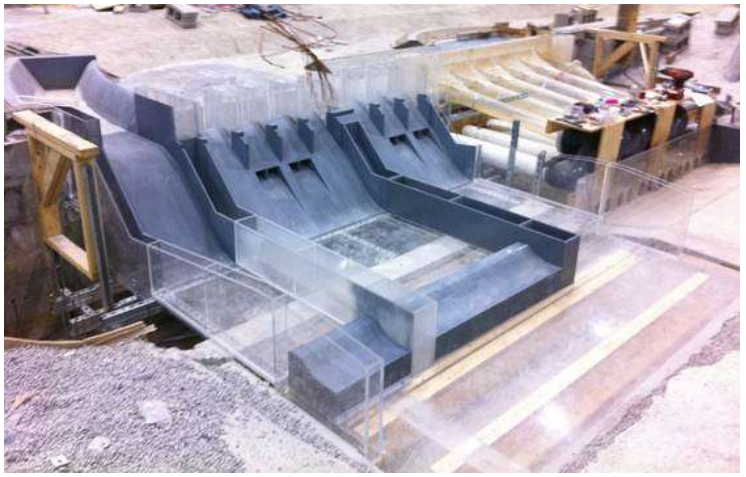
Spillways



Spillway:

- 3 surface radial spillway gates, each 16.5 m wide by 12.7 m high;
- 6 low level vertical lift gates, each 6.5 m wide by 9.0 m high;
- 137 m long auxiliary free crest spillway;
- two-stage stilling basin separated by downstream weir;
- central dividing wall;
- jet deflectors for mitigation of total dissolved gas;
- 16,500 m^3/s at the maximum reservoir surcharge

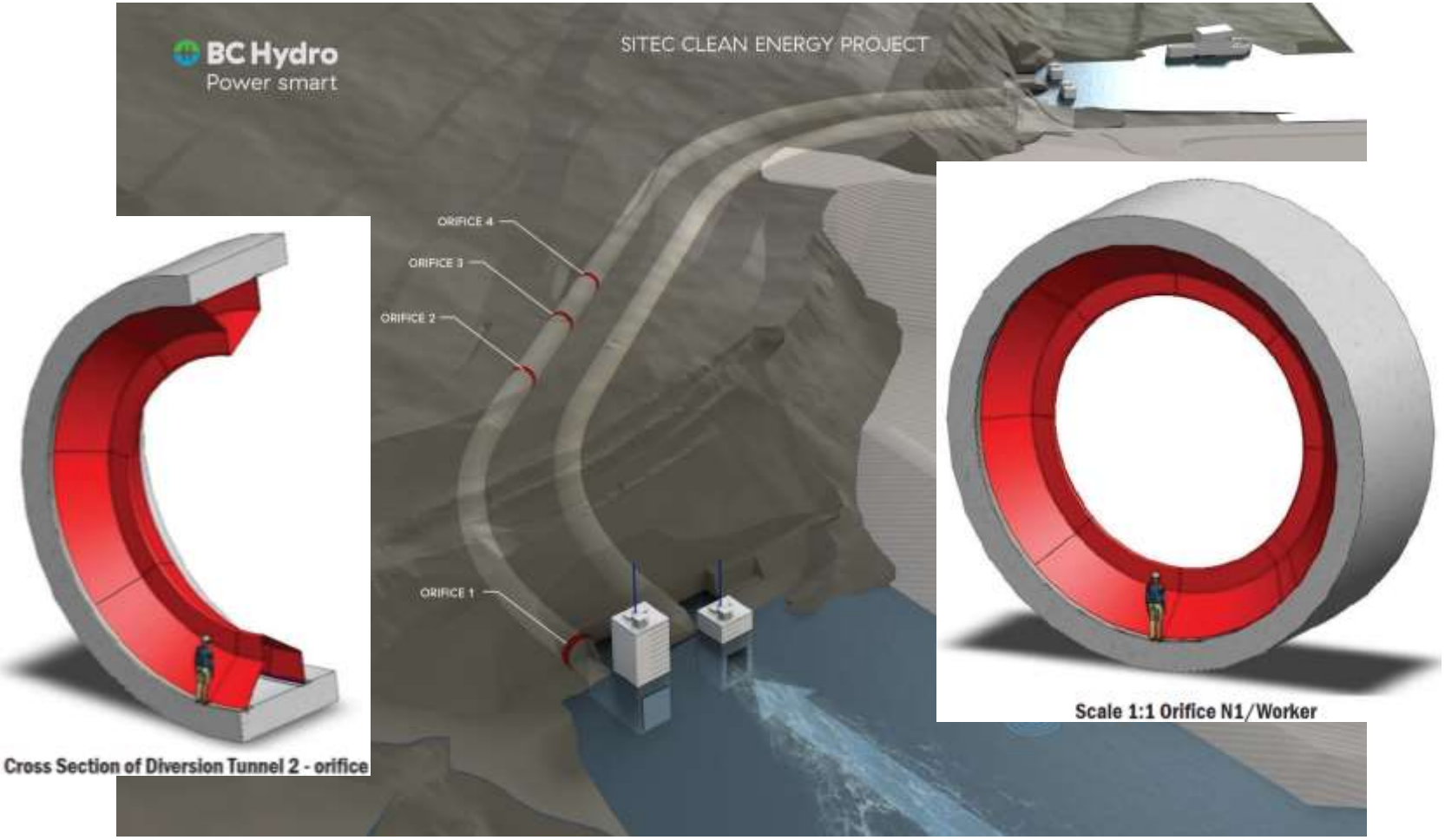
Design Components



Spillway PMF discharge in General Model

BC hydro REGENERATION

Option selection: Orifice installation in Tunnel 2 for reservoir filling



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ENVIRONMENTAL ASSESSMENT COMPLETE

- **7+ years** of consultation with First Nations, public and communities
- **14,000+** entries in First Nations consultation log
- **500+** consultation meetings with the public and stakeholders, property owners, and local governments
- **Multiple years** of field studies for fish, wildlife, socio-economic, environment
- **15,000+** pages in the Site C Environmental Impact Statement
- **70+** pages of mitigation, management and monitoring measures proposed
- **7,094** information requests responded to
- **Two-month** public hearing process (December 2013 to January 2014)
- **29,572** pages of evidence filed

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PROJECT APPROVED

- Project received approval from the provincial government in December 2014.
- Approval followed extensive due diligence process that found Site C provides most affordable clean electricity, compared to alternatives.
- Construction planned to start in summer 2015.

Procurement support

Driver	Measurable Procurement Objectives
Cost/Value & Finance	• Deliver project within budget, maximize cost certainty • Optimize UEC
Schedule	• Minimize schedule interfaces; incentives to meet or exceed schedule milestones
Interfaces	• Does the packaging minimize the number and criticality of interfaces that BC Hydro has to manage?
Risk	• Allocate risk to party best able to manage that risk
Contractor Capability and Capacity	• Maximize interest from qualified proponents; minimum of three competitive bids to be received for each package from qualified proponents
First Nations and Regional Participation	• Meet project objectives and obligations
Governance	• Ensure fit between BC Hydro's competencies and the requirements of the contractors' role
Quality	• Maximize owner's responsibility for level of quality and oversight of QM

Interfaces and Contract packaging

The Site C project design includes the following key components:

DAM SITE COMPONENTS	OFF-SITE COMPONENTS	EARLY WORKS
• Earthworks • Generating Station and Spillways • Turbines and Generators	• Clearing • Public Road Infrastructure • Transmission • Site C Substation	• Early Clearing • Early Civil Works • Worker Accommodation and Site Services

Constructability and Operations and Maintenance

- Constructability review of designs
  - Part of design process
  - An element early procurement engagement
  - Alternate assessments
- Operations and maintenance review and input into design (environmental mgmt. included ops)
  - Documentation of owner requirements
  - Input into alternates
  - Safety by design (assess, confined spaces, etc)
  - Review of designs and checking design to owner requirements

Procurement Analysis and Support

- Technical and design input into contract packaging, contract type and procurement
- Design risks and technical risk to be transferred was important part of packaging, contract type and evaluation
- Design and construction interfaces
- Potential for design changes during construction

Engineering oversight and quality

- Design review boards, 4 member board
- Added an additional 2 member board mid-construction
- Independent specialist design reviews on a risk basis
- Owner review for maintenance and operability
- Quality planning
  - Engineering quality plan
  - Manufacturing
  - Construction (Quality Control and Quality Assurance and Site Engineering)

Construction Update

- **Construction stared mid 2015**
- **River diversion fall 2020 during covid 19**
- **Reservoir filling schedule for fall 2023**


Approach Channel Flights
May 27, 2023
UNDERHILL GEOMATICS
SCROLL OR PINCH TO ZOOM


Downstream Cofferdam
UNDERHILL
GEOMATICS

Highway 29 Realignment
Cache Creek Bridge Concrete Complete

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SITE C | CLEAN ENERGY PROJECT

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(Always) In the News: Typical Google News search results

First Nations challenge of **Site C** permits denied by BC Su…
CBC.ca - 4 hours ago
The province's highest court rejected a petition by two B.C. First Nations on Monday to overturn provincial permits issued for construction of the ...

BC Supreme Court rejects **Site C** permits challenge
Alaska Highway News - 3 hours ago

View all

Landowners fight **Site C** deadline from BC Hydro
CBC.ca - Oct 31, 2016
It is the final day for some landowners to sign a deal with BC Hydro to make way for construction of the **Site C** dam, but at least one couple is ...

Taxpayers on the hook for **Site C** dam until 2094
Alaska Highway News - 3 hours ago
Excavation crews dredge the Peace River near Old Fort in April as part of fish enhancement work just downstream of the **Site C** dam site.

B.C. Supreme Court rules against anti-**Site C** First Nations
MetroNews Canada - 15 hours ago
Construction continues on the **Site C** Clean Energy Project, pictured here in July, an estimated $9-billion hydroelectric dam that BC Hydro says ...

BC Supreme Court dismisses challenge to provincial permits issued ...
CKNW News Talk 980 - 20 hours ago

View all

NWT Dene leaders call for halt to BC's **Site C** dam constr…
CBC.ca - Oct 25, 2016
Dene leaders in the N.W.T. are calling for an immediate halt on construction of the **Site C** Dam in northern B.C., saying it violates treaty rights on ...

BC Supreme Court throws out First Nations **Site C** challenge
MY PG NOW - 20 hours ago
The BC Supreme Court has thrown out a challenge by the Prophet River First Nation and West Moberly First Nations against the provincial ...

Site C worker lodge ready to house 1600 employees in F…
CBC.ca - Oct 19, 2016
Approximately a year after construction began, BC Hydro's **Site C** emplolyee accommodation lodge is ready to house 1,600 workers in Fort St.

BC Hydro opens $470m camp for **Site C** workers
Calgary Herald - Oct 20, 2016

View all

Vaughn Palmer: Bill Bennett says **Site C** is right thing, but …
Vancouver Sun - Oct 30, 2016
"**Site C** is probably the most important thing that I was associated with in my 16 years," says the Kootenay East MLA and current minister of ...

Local businesses slow to benefit from **Site C's** growing ec…
Vancouver Sun - Oct 25, 2016
JOHN — Construction on B.C. Hydro's $8.8-billion **Site C** dam project has ramped up to a 24/7 operation that is leaving an increasing, if uneven ...

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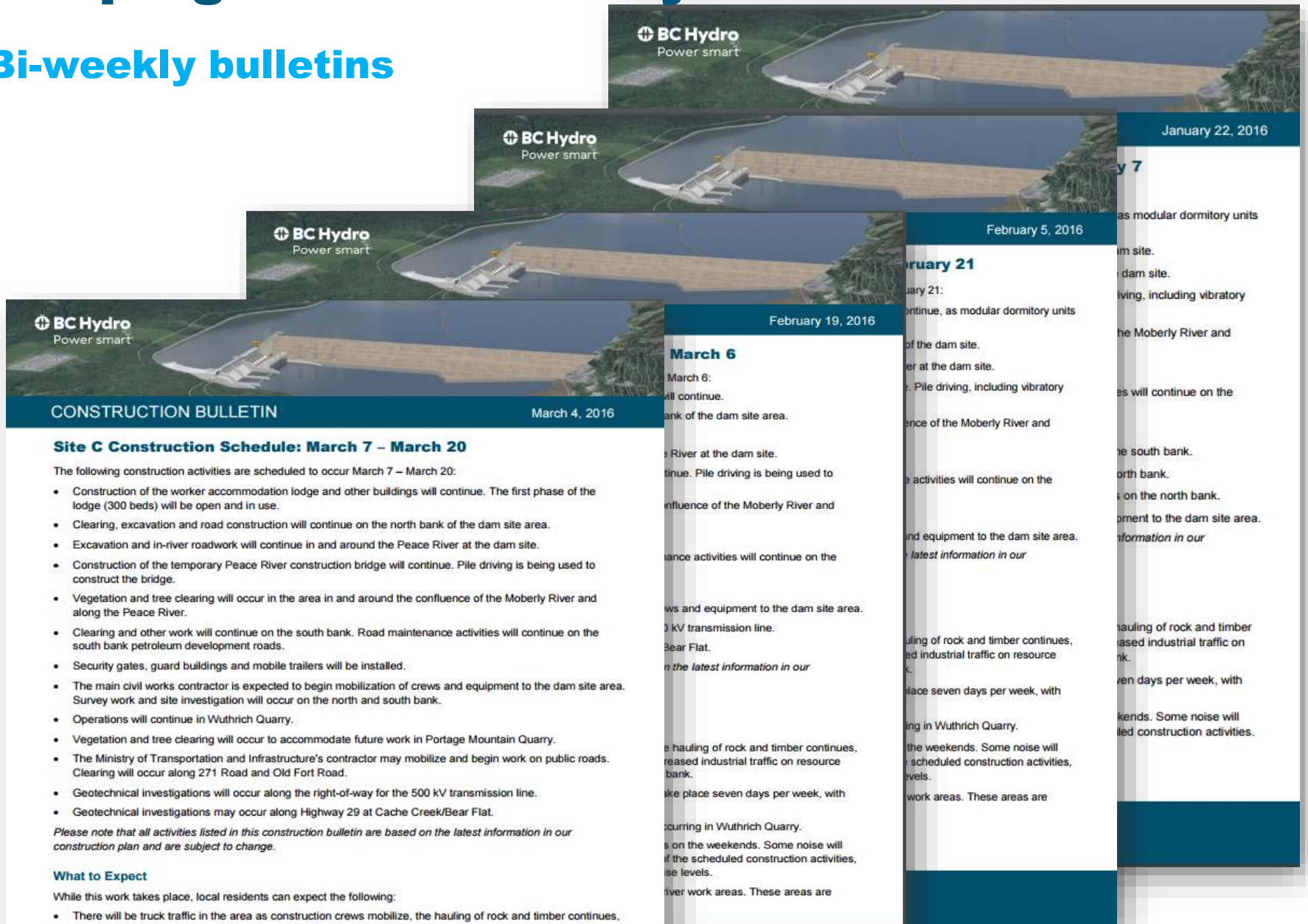
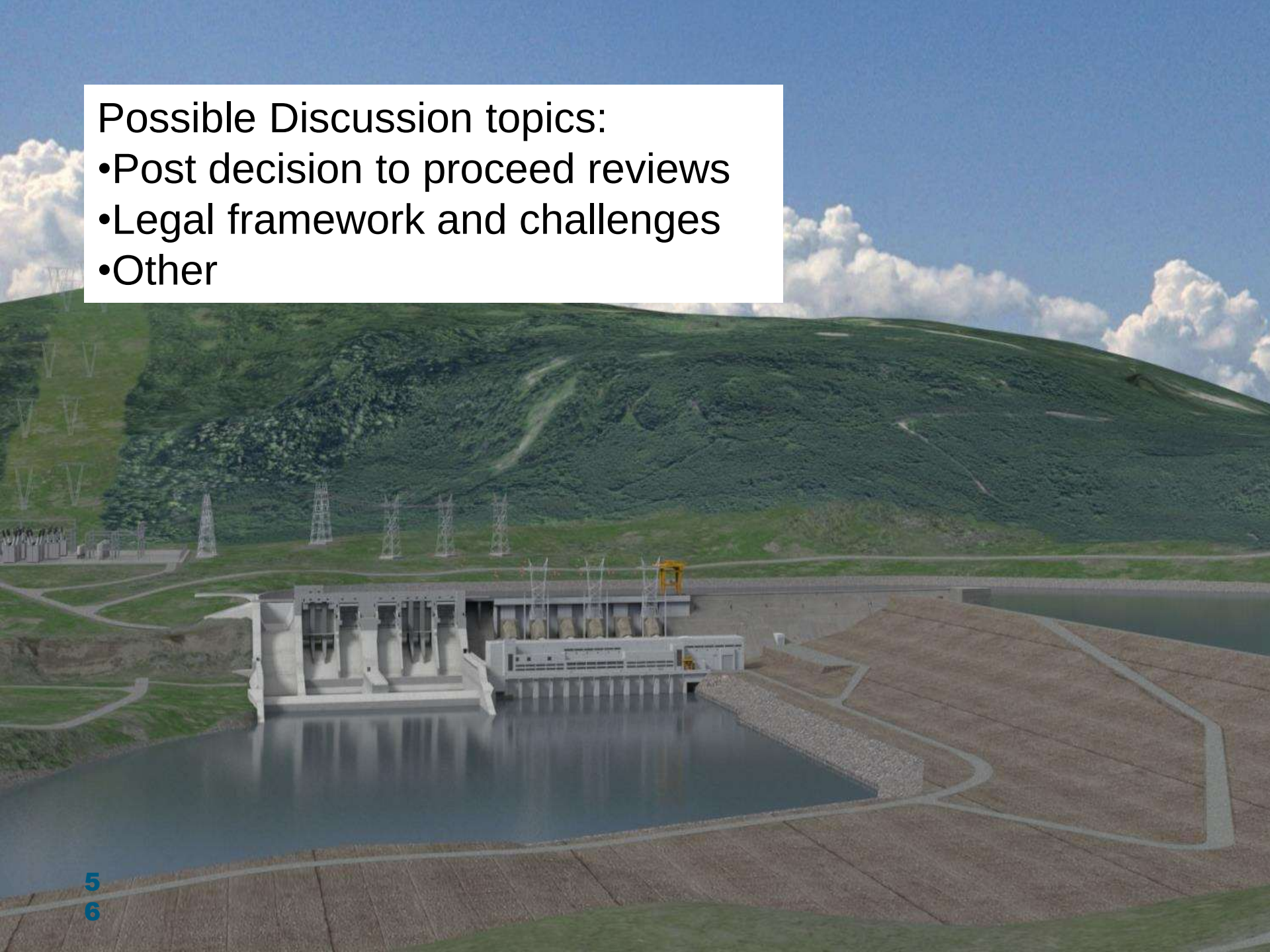
Keeping the community informed

Bi-weekly bulletins





Possible Discussion topics:

- Post decision to proceed reviews
- Legal framework and challenges
- Other

For more information:

www.bchydro.com/sitec