

# PEACE RIVER SITE C HYDRO PROJECT

## POWERHOUSE ACCESS ROAD & BRIDGE

Prepared by

Klohn Crippen Berger Ltd. and SNC-Lavalin Inc.

For

BC Hydro

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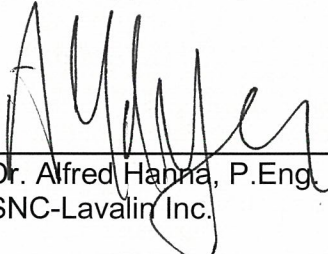
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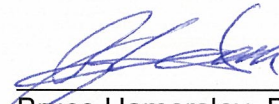
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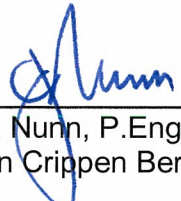
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SITE C HYDRO PROJECT**

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BRIDGE**

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## EXECUTIVE SUMMARY

Access to the proposed Site C dam site, specifically the powerhouse located on the south bank of the Peace River, would require construction of an access bridge over the Peace River downstream of the proposed dam site. In addition, an access road to and from the bridge on the north and south banks of the river would be required.

During Stage 2, Klohn Crippen Berger Ltd. (KCBL) and SNC-Lavalin Inc (SLI), together with Urban Systems (US), developed conceptual level and functional level designs for these aspects of the project.

The powerhouse access road and bridge have both been designed to current Ministry of Transportation and Infrastructure (MoT) design standards.

This report presents the functional design details of the powerhouse access road alignment and the conceptual design details of the powerhouse access bridge developed during Stage 2.

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## 1. INTRODUCTION

As part of the proposed “SITE C” hydroelectric project, a new powerhouse access bridge would need to be constructed across the Peace River. The new bridge would be located several hundred meters downstream from the dam and would also provide a link between Highway 29 and the railway siding at Septimus.

This report summarizes the conceptual design for the new bridge as well as the functional design for the powerhouse access road alignment. Design criteria for the access road and bridge are identified below. Conceptual drawings of the powerhouse access road alignment and bridge are provided in Appendix I, while details of the access road are contained in Appendix II.

The conceptual drawings show the right-of-way for the access road and span configurations for the bridge. This report also provides a short discussion of significant issues such as construction costs, construction scheduling and staging, and future maintenance, along with the geometric, environmental, and geotechnical constraints that would need to be considered during the detailed design.

## 2. DESIGN CRITERIA

The design of the proposed new powerhouse access bridge would be in accordance with the Canadian Highway Bridge Design Code (CHBDC) CAN/CSA-S6-06 and the BC Ministry of Transportation Supplement to CHBDC S6-06.

### 2.1 General:

- Design Service Life: 75 years
- Deck Widths: The bridge cross-section would consist of 2 – 3.5 m lanes with 0.5 m shoulders along with a 1.5 m sidewalk, cast-in-place concrete parapets for a total width of  $10.4 \pm$  m.
- Alignment: The new alignment would be as per the Highway Design Drawings, Urban Systems Ltd.
- Clearance: The bridge design would meet the requirements of the Navigable Waterway Requirements Protection Act and have a minimum vertical clearance of 2.0 m above the Probable Maximum Flood (PMF) level.
- Utilities: The structures would not carry any major utilities.
- Parapets & Railings: The parapets and railings would meet the Performance Level 2 requirements. Railings would consist of a standard combination bicycle/pedestrian rail mounted directly onto the parapets.
- Illumination: Illumination would not be provided.
- Bridge End Flares: End flares would be in accordance with the Highway Engineering Standards.

### 2.2 Design Loads:

- Design Live Loads: BCL-625 design truck and lane load; off-highway vehicle load (dump trucks, transport trucks) to be determined for detailed design.
- Future Allowance: Provision would be made for an additional dead load allowance for a future 50 mm concrete overlay.
- Wind Loads: Reference Wind Pressure  $q_{50} = 385$  Pa (return period for a bridge structure with a maximum span of 125 m).



- Earthquake Loads: Bridge Importance factor = "Other Bridges"; Zonal Acceleration Zone A = 0; Seismic Performance Zone = 1; Soil Profile Type III (depending on the depth of sound shale).
- Temperature: Maximum effective temperature = 41<sup>0</sup>C; minimum effective temperature = -37<sup>0</sup>C.

### 2.3 Materials:

- Reinforcing Steel: Reinforcing steel would meet the requirements of CAN/CSA-G30.18 Grade 400R. The top mat of deck reinforcing steel would be epoxy coated.
- Concrete: All substructure concrete would have a minimum 28 day strength of 30 MPa. Deck concrete would have a minimum 28 day strength of 35 MPa.
- Structural Steel: Superstructure members would be 350 AT, bracing members may be 350 A. Superstructure members located within a distance of 1.5 h of all deck joints would be coated for increased corrosion resistance. The parameter "h" would be the overall depth of the superstructure. The use of weathering steel would be in accordance with Technical Bulletin TB-307, 1990 by Bethlehem Steel as signed by Thomas Wouldett, Director, Office of Engineering, and FHWA. Surfaces of weathering steel would be painted at all locations that are in contact with galvanized steel. In general, all shop connections would be welded and all field connections shall be high strength bolted.
- Corrosion Rates: For steel below ground the sacrificial thickness would be computed for each surface exposed to the soil as follows:
  - Galvanization Loss = 15 micrometers /year for the first two years;  
= 4 micrometers /year for subsequent years;
  - Carbon Steel Loss = 12 micrometers /year
  - Design Service Life = 00 yrs.

#### **2.4 Drainage:**

Run-off from the bridge decks would be discharged at locations that are environmentally acceptable.

#### **2.5 Environmental:**

The design would meet the requirements of the environmental and fisheries agencies having jurisdiction.

### 3. CONCEPTUAL DESIGN

A fully detailed design of the powerhouse access bridge was produced by Klohn-Crippen Consultants Ltd. in 1989 for the British Columbia Hydro and Power Authority<sup>(1)</sup>. The design consisted of a 280 m long four-span steel box girder bridge with a composite concrete deck. Substructure elements (abutments, piers) were supported with steel H-piles driven into sound shale. The bridge deck elevation was approximately EL. 419 m. The 1989 design included filling the side channel between the small island and the north river bank to form a causeway leading up to the bridge structure.

Two major changes have occurred since the 1989 design:

- The vertical alignment of the roadway has been raised to decrease the amount of cut required for the roadway on the north shore, resulting in a bridge deck elevation of approximately EL. 435 m.
- Environmental considerations have changed since 1989; and it is now proposed that the river channel between the small island and the north bank remain, to preserve habitat.

These two changes result in a bridge structure that is substantially longer than the 1989 design. The proposed new powerhouse access bridge would now be a six-span steel plate girder structure approximately 520 m long. In present-day bridge design, steel plate girders are preferred over steel box girders for this span arrangement. This design also takes advantage of the use of “delta-frames”, large “V”-shaped columns at the intermediate piers that reduce the length of the main spans. A similar type of bridge structure is being used for the new Simon Fraser River Bridge in Prince George.

In addition to the changes discussed above, the 1989 design was intended for access to the new powerhouse for BC Hydro personnel only; the bridge would not be open to the public. The conceptual design presented herein makes allowance for the future possibility that the powerhouse access bridge can become part of the public highway system; therefore, the roadway alignment and bridge structure have been designed for the Category of “low-volume roads” accordingly.

The new bridge has been sized for sufficient clearances and passage for both the 200-year return flood and the Probable Maximum Flood (PMF), however, some substructure elements such as the bottom of the delta-frame V-shaped columns may be exposed to water during the PMF. Although it is standard Ministry practice for scour protection to be provided for a 200-year return flood only, for the purposes of the conceptual level design a full rip-rap blanket is

provided to prevent erosion at the bridge end-fills to an elevation approximately 2 m above the PMF level. The final size and distribution of the rip-rap protection would be determined in detailed design, but at this time a conservative Class 500 kg rip-rap with a blanket depth of 2 m has been used for quantities and preliminary cost estimates. The slope of the rip-rap protection is 1.5:1 at the bridge abutments.

Preliminary foundation design has been based on the limited geotechnical information available from the 1989 design, i.e., the soil conditions for the foundations are predominately silts and clays overlying shale bedrock. The competent shale bedrock is assumed to be within 2 – 3 m in depth from the surface. Rock-socketed concrete filled steel pipe piles would be used for the bridge abutments, outside piers and middle delta-frame piers.

The construction of the new bridge would require the use of a temporary work bridge(s) with removable working platforms in order to construct the cofferdams required for the in-stream piers. The work bridge(s) could be supported on steel pipe piles driven into sound shale. The design of the temporary works would need to consider river levels and flows at the time of construction.

The conceptual design shows cast-in-place concrete abutments supported by 610 mm diameter rock-socketed piles, however, simple spread footings may be used in detailed design if the results of the geotechnical investigation prove favorable. As previously discussed, the bridge end-fills would have rip-rap protection against scour regardless of what type of foundations are used.

The effect of ice loads on the piers has not been studied in detail for the conceptual design.

It is anticipated that the erection of the steel bridge girders would be done by cranes situated on the temporary work bridge.

### 3.1 Powerhouse Access Bridge - Configuration

The conceptual design for the new powerhouse access bridge consists of the following:

- A 520 m long six-span bridge with two 125 m long central spans, two 90 m long outer spans and two 45 m long end spans to the abutments at each end. The superstructure uses 3 - 3000 mm deep steel girders with a cast-in-place composite concrete deck, cast-in-place parapets and steel bicycle/pedestrian railings.
- Cast-in-place reinforced concrete abutments and wing walls supported by

610 mm diameter rock-socketed concrete-filled steel pipe piles.

- Three middle piers (delta-frames) each supported by 6 – 1.2 m diameter rock-socketed concrete-filled steel pipe piles. Cofferdams would be required for the standard method of constructing the in-stream piers, i.e., steel piles, sheet-piled cofferdam, tremie concrete plug, and reinforced concrete pile cap and wall pier.
- Two side piers each supported by a pair of 2.0 m diameter rock-socketed concrete-filled steel pipe piles. The steel pipe pile would be cut off a metre above the river bed and the reinforced core would extend up to the underside of the cap beam as a concrete column. Cast-in-place concrete diaphragms would be constructed between the columns to provide lateral stiffness and protection from debris. It is anticipated that these two piers can be built in the dry depending on the time of year.
- 500 kg class rip-rap protection for the abutments (sloped at 1.5H:1V).
- A 250 mm thick cast-in-place concrete composite deck with allowance for a future 50 mm concrete overlay.
- Steel reinforced laminated elastomeric bearings supporting the girders at each of the piers and abutments.
- Large steel finger-type deck joints at each abutment.

### 3.2 Powerhouse Access Bridge - Construction

The construction sequence is described as follows:

- Construct access to and a staging area for the temporary works down in the lower portion of the river.
- Construct low level temporary work bridge to in-stream pier locations. Construct working platforms in order to install piling, sheet piling and perform excavation or dredging operations.
- Drive permanent piles to support the in-stream piers.
- Place rock at base for tremie seal, construct tremie seal.
- De-water the cofferdam and construct the pile cap.
- Construct 1<sup>st</sup> level of wall pier, flood cofferdam and remove or cut-off sheet piling.
- Install rip-rap around base of in-stream pier.
- Install the 610 mm diameter piles for the north and south abutment footings.

- 
- Form and place 1st stage concrete for the footings at the abutments.
  - Form and place concrete for the east and west abutments and wing walls.
  - Complete the earthwork for the bridge endfills. Place the rip-rap protection at the abutments (sloped at 1.5H:1V).
  - Install the 2.0 m diameter piles for the two outer piers. Form and place 1st stage concrete for the diaphragms between the piles.
  - Form and place concrete for the outer pier cap beams.
  - Install bearing assemblies.
  - Assemble the steelwork and erect the three girders onto the bridge seats. The secondary steelwork would be assembled between the girders in place.
  - Install deck formwork.
  - Place concrete for the deck and haunches.
  - Cast the parapets.
  - Install deck drainage system and deck joints.
  - Install the steel parapet railings and approach barriers.

#### 4. CONCEPTUAL DRAWINGS

The conceptual drawings for the new powerhouse access road and bridge are provided in Appendix I.

## 5. DISCUSSION

The conceptual design for the new powerhouse access bridge uses current, proven methods of construction from a temporary low level working bridge to build in-stream piers to allow crane erection of multiple steel plate girders.

Careful choice of the location of the splice in the steel girders between Piers 4 and 5 would allow the horizontal curve in the alignment while keeping the girders in straight segments, preventing the expensive fabrication and launching of curved girders. Camber in the steel girders in addition to adjustments in the height of the haunches would allow the vertical curve in the alignment.

As previously discussed the conceptual design and cost estimate account for the height of the rip-rap blanket at the bridge end-fills being at a level approximately 2 m above the PMF level. Substructure components such as the base of the delta-frame piers may be under as much as 3 m of water (Pier 4) during the PMF, however, the delta-frame V-shaped columns and their bases can be designed for debris impact during detailed design.

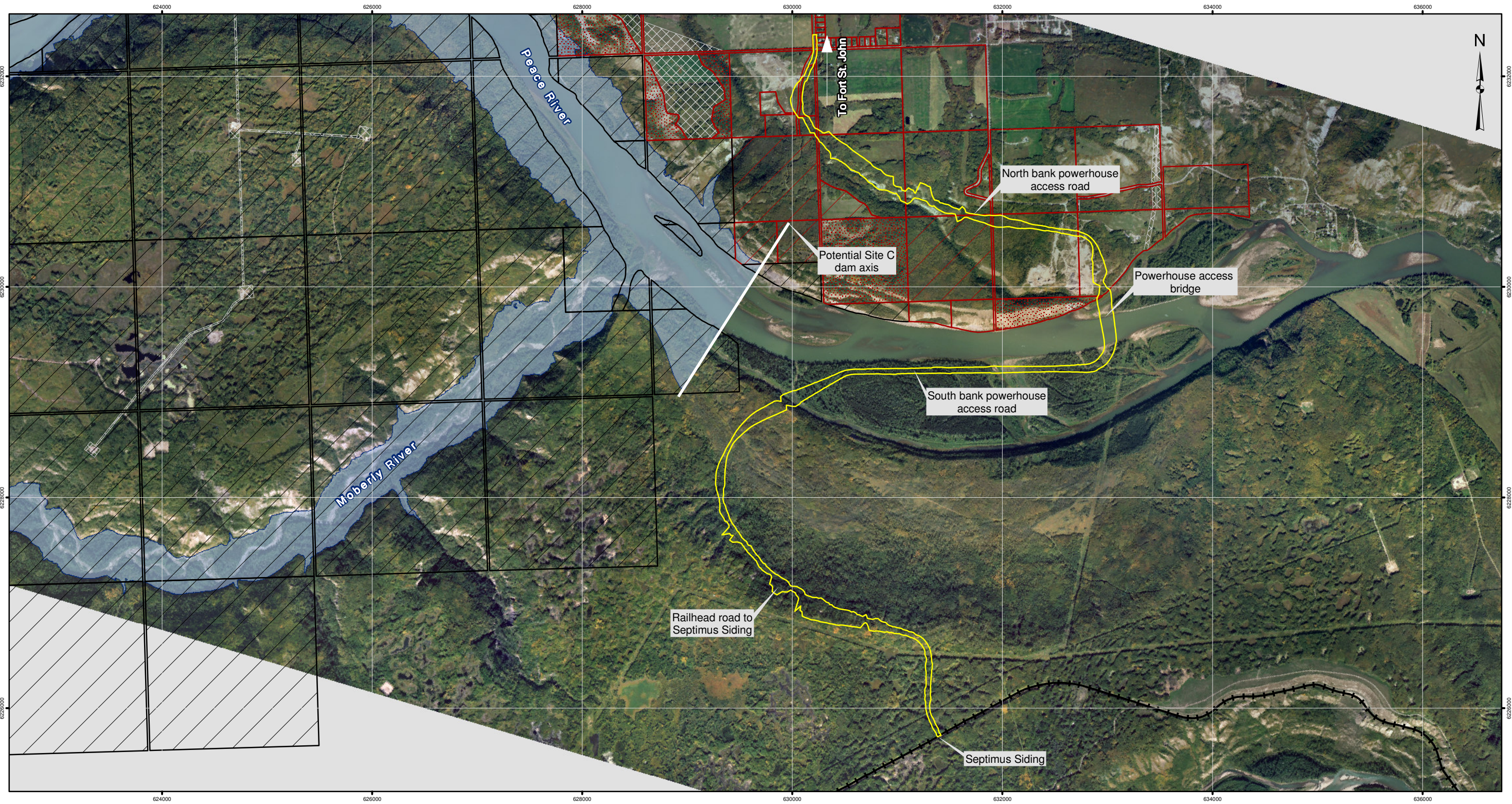
The conceptual design of the powerhouse access bridge and functional design of the powerhouse access road are considered to be appropriate given the requirements and objectives of the access road and crossing over the Peace River at the current stage of the project. It is recommended that these conceptual level and functional level designs be advanced to the preliminary design level during the next stage of the project, should it proceed.



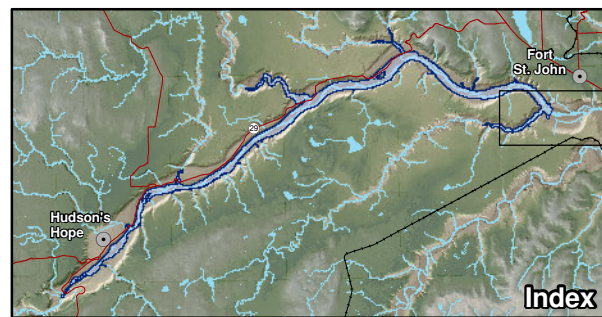
## 6. REFERENCES

- 1) “Peace River Site C Project – Construction Bridge”, Drawing No. 1016-C09-D5 through 1016-E09-D4, Klohn-Crippen Consultants Ltd. in Association with Shawinigan Integ Inc. for the British Columbia Hydro and Power Authority, 1989.

**APPENDIX I**  
**Conceptual Drawings**



P:\PI\05032 A02 Site C - 2006 to 2008 Eng Studies\400 Drawings\GIS\_data\MAXD\BCH\_Stage\_2\_Report\DamSite\_1016\_C14\_D3184.mxd



- Map Notes:**
1. Orthophotos created from 1:40,000, 1:20,000, and 1:5,000 scale photography taken June and Sept, 2007.
  2. Proposed reservoir flood line (461.8m maximum derived normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July and August, 2006.
  3. Property status information represents BC Hydro's current ownership records.
  4. Property boundaries shown are the result of computations and adjustment to GPS field observations. The estimate positional accuracy is less than 1.0 metre.
  5. Datum/Projection: NAD83/UTM Zone 10N.

**Legend:**

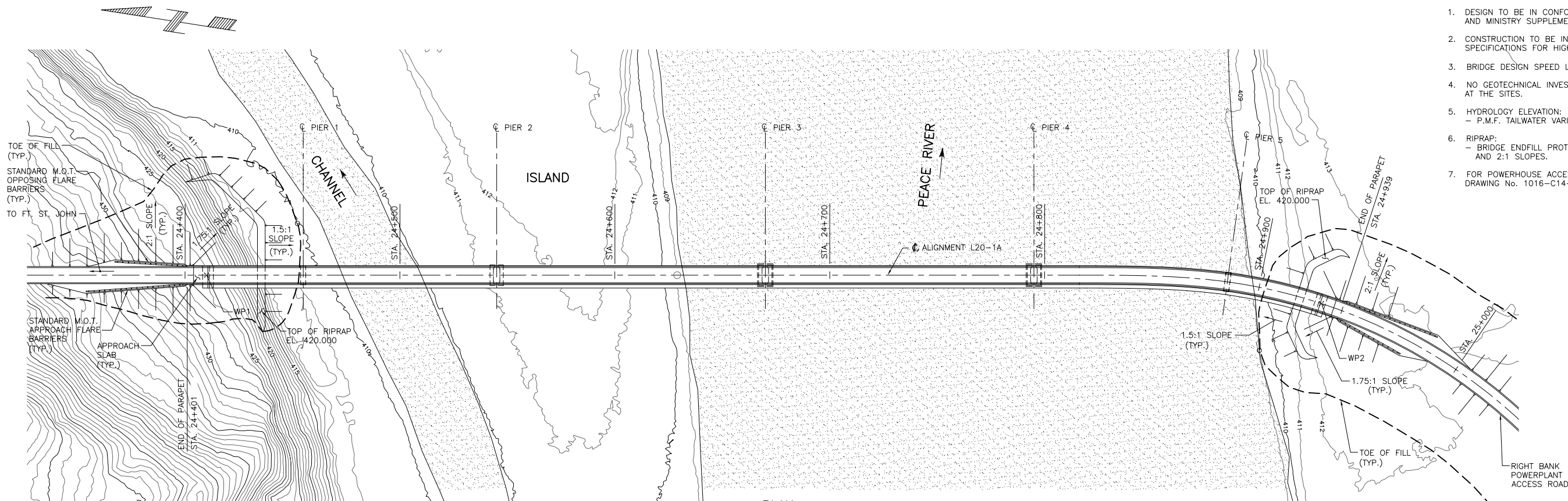
- Potential flooded area (for reservoir at EL. 461.8m)
- Crown land
- BC Hydro owned land (leased)
- BC Hydro owned land
- Private land
- BC Hydro, Oil & Gas, Telephone, Municipal & Misc. ROWs
- Railway
- Powerhouse access road & railhead road to Septimus Siding

Scale: 1:37,000  0 1,500 m

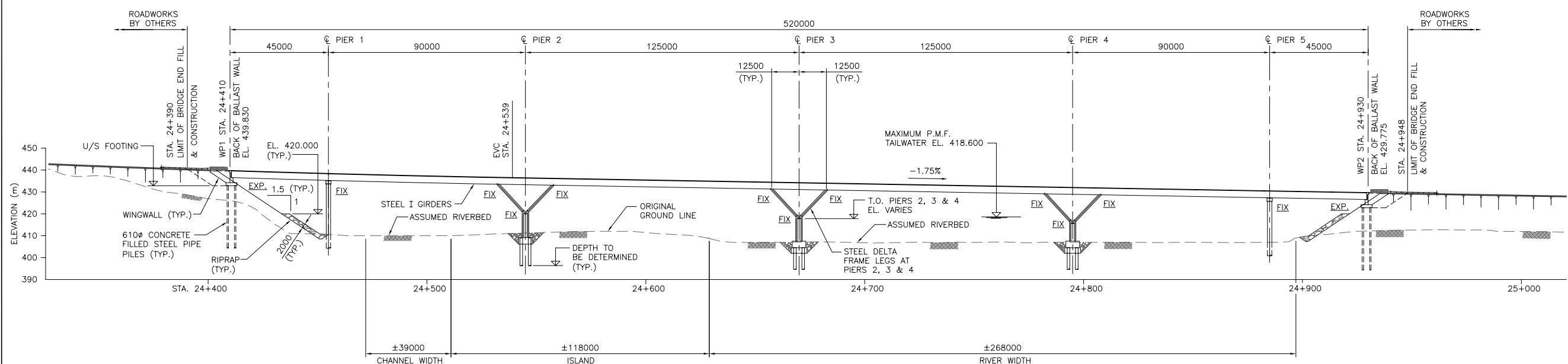
 	 <b>POWERHOUSE ACCESS ROAD &amp; RAILHEAD ROAD TO SEPTIMUS SIDING</b>
DATE: JUNE, 2009	DWG NO: 1016-C14-D3184

**GENERAL NOTES:**

- DESIGN TO BE IN CONFORMANCE WITH CAN/CSA-S6-06 AND MINISTRY SUPPLEMENT.
- CONSTRUCTION TO BE IN CONFORMANCE WITH M.O.T. STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION.
- BRIDGE DESIGN SPEED LVR: 80 km/h.
- NO GEOTECHNICAL INVESTIGATION HAS BEEN PERFORMED AT THE SITES.
- HYDROLOGY ELEVATION:  
- P.M.F. TAILWATER VARIES EL. 416.600 TO EL. 418.600
- RIPRAP:  
- BRIDGE ENDFILL PROTECTION CLASS 500 kg. @ 1.5:1, 1.75:1 AND 2:1 SLOPES.
- FOR POWERHOUSE ACCESS BRIDGE ALIGNMENT PLAN, SEE DRAWING No. 1016-C14-D3184.



**PLAN**  
SCALE 1:1000



**ELEVATION**  
SCALE 1:1000

NOT FOR CONSTRUCTION

**Disclaimer:**  
These drawings have been prepared as part of Stage 2 of the Site C Hydro Project. These drawings serve the sole purpose of providing conceptual level design options and would be updated, should the project proceed to future stages. These are not construction level drawings.

DSGN	B.H.
INDEP CHK	
DFTG	W.N.
DFTG CHK	
INSP	
REV	
ACPT	

DATE JUNE, 2009



**BChydro** ENGINEERING

PEACE RIVER - SITE C HYDRO PROJECT

POWERHOUSE ACCESS BRIDGE  
520m SPAN BRIDGE  
PLAN AND ELEVATION

DWG NO	1016-C14-D3185	R
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## **APPENDIX II**

### **Site C Dam Access Road & Rd. 269 to Septimus Siding – Urban Systems Report**



# PEACE RIVER SITE C HYDRO PROJECT

## SITE C DAM ACCESS ROAD


RD. 269 TO SEPTIMUS SIDING



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## 1.0 EXECUTIVE SUMMARY

Urban Systems (USL) has been requested by Klohn Crippen Berger Ltd. (KCBL) to provide a new alignment design for the powerhouse access road as part of Stage 2 of the proposed BC Hydro Peace River Site C Hydro Project. This report has been prepared to summarize the work undertaken for this assignment.

The access road is primarily intended as a construction access road for the proposed Site C Dam and to access the proposed powerhouse located on the south bank of the Peace River. The option to potentially use this access road as a public road to provide another crossing of the Peace River was discussed with BC MoT, as requested by BC Hydro. As a result of this possible future use, the design criteria used provides for a low speed rural highway which meets current BC MoT standards. The road extends from existing Road 269 on the north bank, across Peace River toward the proposed Site C Dam location and continuing south, terminating at the CN Rail Septimus Siding location.

Various alignment options were considered in coordination with the structural options for the powerhouse access bridge design developed by KCBL. These options were reviewed and a single option was chosen that best suited the topography and the structural options investigated at this time. This selected alignment has been carried forward to a functional design stage in this assignment.

The results of the functional design carried out are summarized in this report together with the design drawings and design issues associated with them.





## 2.0 DESIGN CONSIDERATIONS

The design considerations made at this stage of design which have influenced alignment selection include:

- Property Impacts
- The latest BC MoT Standards
- Structural Requirements for the river crossing

The functional design prepared has been based on recent Lidar survey. This level of survey detail provided accurate information to help determine a suitable alignment and calculate cut/fill quantities based on the current geotechnical assumptions.

### 2.1 Land-Use

The selected alignment has been set to avoid direct impact to dwellings at the north end tie to Rd. 269. The remaining alignment north of the river crossing passes through mostly wooded areas. The alignment south of the river passes through undeveloped wooded areas. No specific investigation was carried out for land use or availability during this stage of design and this information should be investigated during the next stage of design, should the project advance.

### 2.2 Design standards

Design standards used for this assignment are based on the BC supplement to TAC. The design speed used was 70 km/h based on discussions with BC MoT.

The design criteria used for the selected alignment is shown in Table 1 below.



**Table 1**  
**Design Criteria**

	Present Conditions	Proposed Criteria	Achieved Criteria	Notes/ Comments
Classification	n/a	LVR	LVR	
Posted Speed	n/a	n/a	n/a	
Design Speed	n/a	70 km/h	70 km/h	
Basic Lanes	n/a	2	2	
Design Vehicle	n/a	n/a		Note 1.
Basic Lane Width	n/a	3.5 m	3.5 m	
Shoulder Width	n/a	0.5 m	0.5 m	
Minimum Radius	n/a	190 m	200 m	
Maximum Grade	n/a	7 %	5.9 %	
Minimum Sag Curve	n/a	24	87	
Minimum Crest Curve	n/a	36	89	
Minimum S.S.D.	n/a	110 m	>110 m	Note 2.
Clear Zone	n/a	7.5 m	7.5 m	

*\* Note 1. Details for intersections have not been designed under this assignment. A design vehicle was not required for the design prepared.*

*\* Note 2. The minimum S.S.D. (stopping sight distance) was derived from the horizontal and vertical curve criteria used.*



### **3.0 OTHER ISSUES AND IMPACTS**

#### **3.1 Heritage Resources and Archaeology**

No investigation on these items has been carried out at this stage. This work should be carried out at the next stage of design, if the project proceeds.

#### **3.2 Geotechnical – Soil and Rock Stabilization**

The use of 1V:3H cut slopes and 1V:2H fill slopes was recommended at this stage to determine cut/fill toes and quantities. No specific additional geotechnical site investigation has been incorporated into the design at this stage. The requirements for stable slopes in both cut and fill will have to be investigated further during the preliminary and detailed design process.

#### **3.3 Right of Way & Property Impacts**

Approximate Right of Way boundaries have been indicated on the plans at this time. These boundaries were set using a 10 m offset from the calculated cut/fill toe lines which are expected to cover the required ROW for the alignment as currently shown. Due to the limits of the functional design carried out at this stage, these ROW lines should not be used for anything other than a rough estimate of the actual property requirements.

The areas shown north and south of the river cannot be used for property acquisition at this stage due to the limited level of design and uncertainty of actual areas that will be required.

#### **3.4 Drainage and Utilities**

Storm culverts along the proposed new road will be required. Storm design has not been carried out and quantities for storm at this stage are based on cross culverts every 300 m.

No underground utility impacts have been identified during the course of this assignment.



#### 4.0 RECOMMENDATIONS AND NEXT STEPS

Based on the work carried out for this assignment, it is recommended that the alignment identified in this report be carried forward to the preliminary design stage for further evaluation.

The current alignment will require further investigation to clarify or update issues noted in this report that have not been addressed at this stage. Some of these issues include environmental, heritage resources and archaeology, geotechnical investigation and property.

The preliminary and detailed stages of design will be required to provide better detail on highway and drainage design, local road connections, cut/fill slopes and ROW requirements.

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