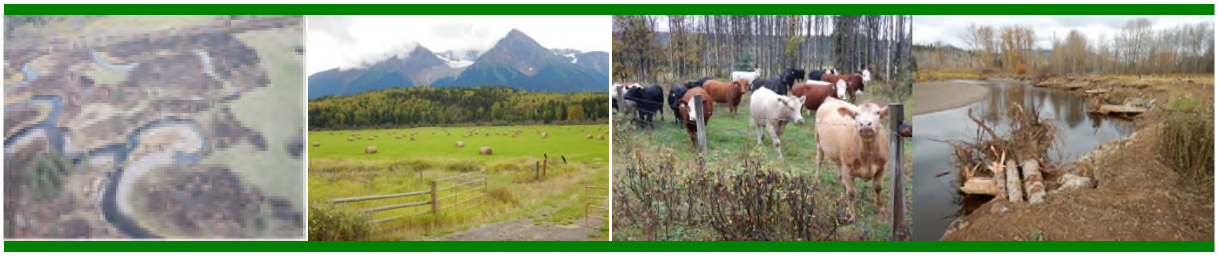
AS-BUILT REPORT OF AQUATIC RESTORATION AND ON-FARM CATTLE MANAGEMENT IMPROVEMENTS WITHIN THE WET'SUWET'EN FIRST NATION TERRITORY, 2017



Prepared for:

Fish Habitat Restoration Initiative
Fisheries and Oceans Canada
Ecosystem Management Branch
985 McGill Place
Kamloops, BC V2C 6X6

November 2017

LIMITED
environmental research associates

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AS-BUILT REPORT OF AQUATIC RESTORATION AND ON-FARM CATTLE MANAGEMENT IMPROVEMENTS WITHIN THE WET'SUWET'EN FIRST NATION TERRITORY, 2017

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ACKNOWLEDGMENTS

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1 INTRODUCTION

Aquatic and riparian habitat restoration within the upper Bulkley and upper Fraser (Francois Lake) river watersheds is considered a pre-requisite to the long-term survival and recovery of Chinook, Coho and Sockeye salmon, as well as Steelhead, Rainbow and Bull trout. Stream and riparian habitats within Wet'suwet'en First Nation (WFN) traditional territory (Figure 1) have been impacted by past forestry activities and linear corridor developments, and will be impacted in the future from liquefied natural gas (LNG) pipeline development.

Through Fisheries and Oceans Canada's (DFO's) Fish Habitat and Restoration Initiative (FHRI), Yinka Dene Economic Development Limited Partnership Inc. (YLP), in collaboration with LGL Limited environmental research associates (LGL), proposed to develop aquatic restoration designs and implement restoration works between 2015 and 2019 at high-priority sites within WFN territory. The objective of these restoration projects was to recover high-valued stream habitats to proper functioning condition. Habitat restoration within the WFN traditional territory is required to re-establish salmon and trout abundances to levels which were prevalent in the mid-20th century.

In 2015/2016, YLP and LGL developed aquatic habitat restoration designs and on-farm cattle management improvement plans for 16 high-priority sites within WFN territory (Figure 2). Site-specific construction drawings, implementation schedules, material specifications and quantities, and estimated construction costs were reported by Gaboury and Smith (2016).

The as-built report that follows describes physical works undertaken at the Craker Road (Lower) site in 2017 (Table 1). Included in this report are the constructed materials summary, ballast calculations, and photographic documentation of pre- and post-construction activities. Also described are repairs that were made in 2017 to two instream structures at the McKilligan Road (Lower) site that were originally constructed in 2016 (as described in Smith and Gaboury 2016; Table 1).

Table 1. Location of the aquatic restoration sites completed in 2017.

Site Name	Watershed Code	UTM Zone	Easting	Northing
Bulkley R - Craker Rd - Lower	460	9U	660323	6037285
Bulkley R - McKilligan Rd - Lower	460	9U	658880	6035831

2 RESTORATION OBJECTIVES

Survival during early freshwater life stages is critical for the maintenance of Steelhead, Chinook and Coho salmon populations. Lack of stable complex habitat in the upper Bulkley River is likely a limiting factor in the recovery of these species. Consequently, the restoration measures for this project were constructed to provide primarily high-quality salmonid summer rearing, overwintering and spawning habitat for the targeted anadromous salmonids in the Bulkley River drainage. These works will also reduce sediment sources (downstream benefits) and improve land management practices by riparian area landowners.

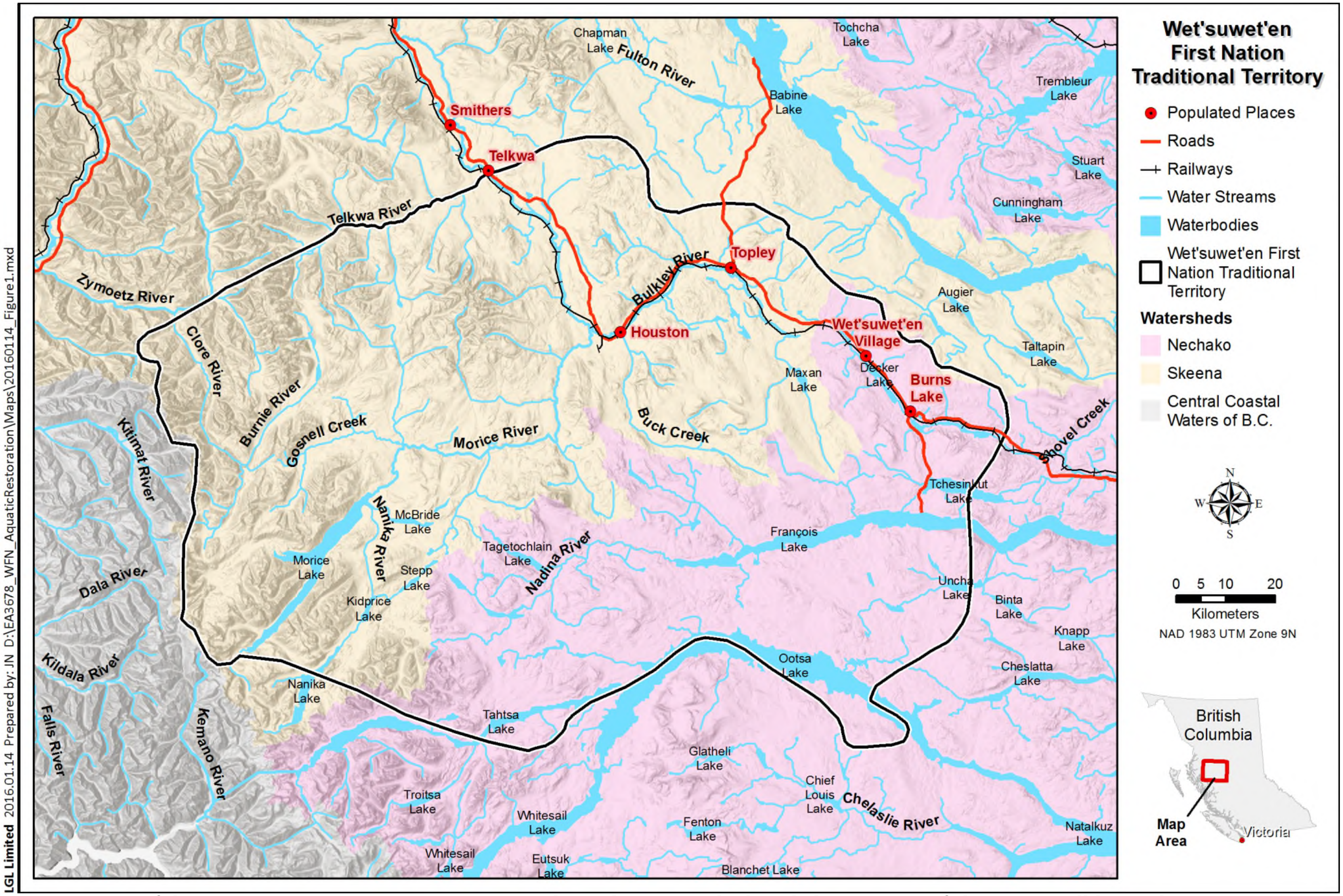


Figure 1. Map of the Wet'suwet'en First Nation (WFN) traditional territory which includes portions of the upper Bulkley and upper Fraser river watersheds.

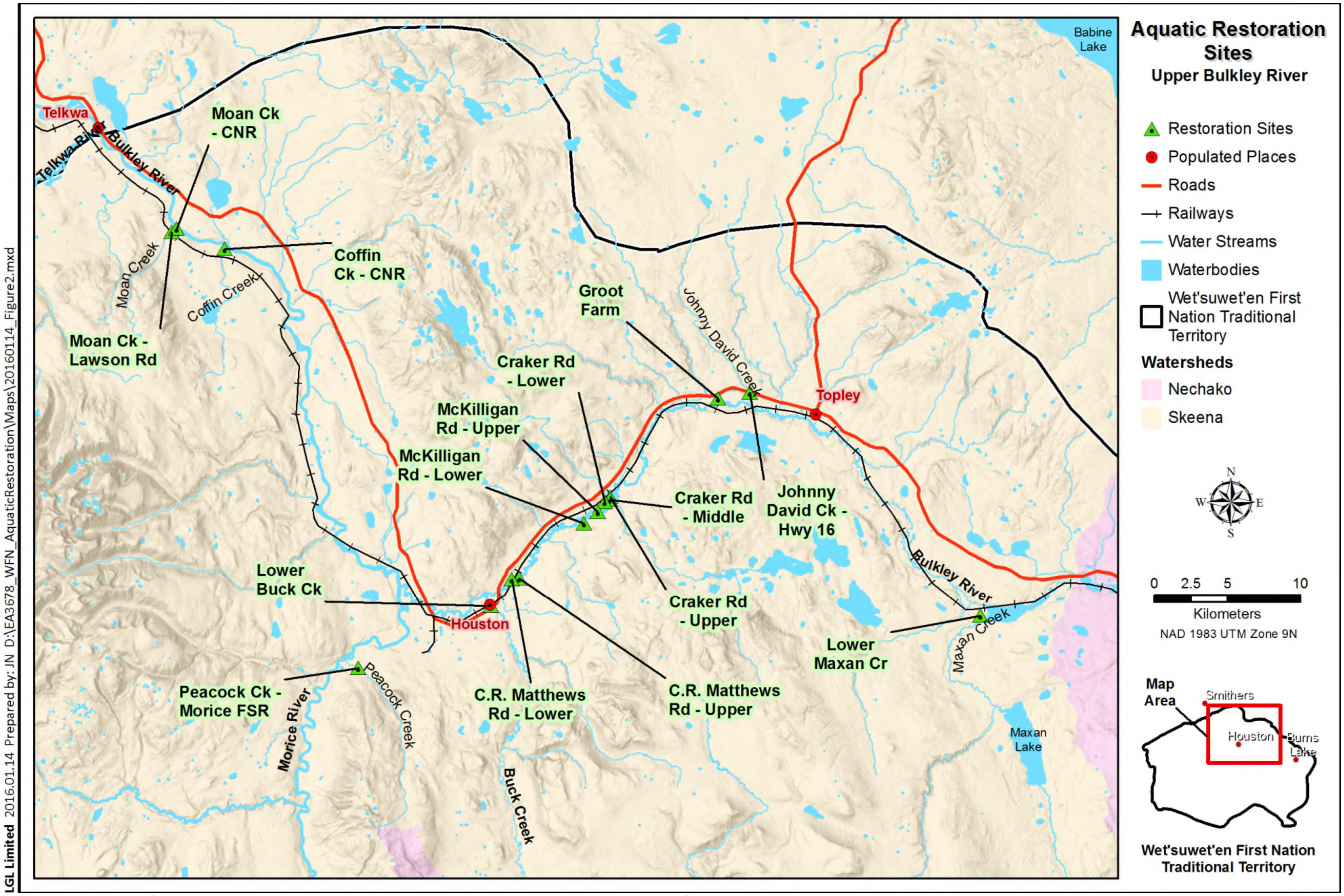


Figure 2. Map of the Bulkley and Morice rivers showing the location of 15 potential restoration sites within the Wet'suwet'en First Nation traditional territory that were identified in 2015/2016 (a site on Tchesinkut Creek at Highway 35 was excluded from the map). In 2017, instream work was completed at the Craker Rd – Lower site, as well as some repair work at the McKilligan Rd – Lower site.

For the constructed restoration works, the biological objectives were to:

- provide significant improvements in the useable area and function of spawning, rearing, and overwintering habitats for native salmon, steelhead, trout and char; and
- increase fry-to-smolt survival and smolt production per spawning pair.

The structural objectives at each restoration site were to:

- stabilize chronic sediment sources (i.e., streambank erosion);
- improve holding and rearing habitat for salmonids by increasing pool frequency and the amount of functional large woody debris (LWD) cover in pools;
- re-establish a more stable channel with appropriate bankfull widths; and
- reduce the rate of meander migration.

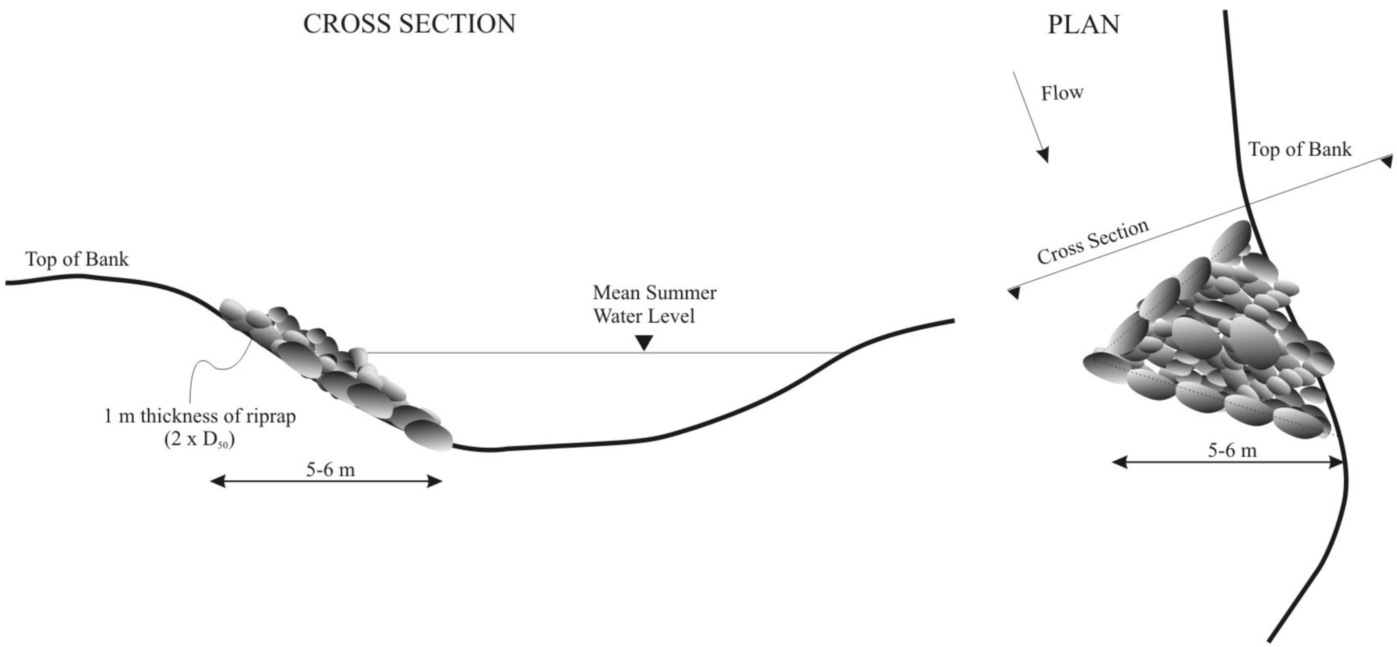
3 GENERAL RESTORATION DESIGN

Restoration structure type designs included LWD structures consisting of five logs each (3 with rootwads, 2 without rootwads) and rock groins (Figure 3 and Figure 4). Structures were spaced approximately 10–20 m apart. The short spacing between the structures ensured that the river's energy was deflected away from the eroding streambank. Native riparian vegetation will be planted in the spring of 2018 along the entire length of the reconstructed bank to provide shading, bank stability, and food and nutrients to downstream fish habitats.

Constructed works at the Craker Road (Lower) site generally followed structural designs and specifications as per Gaboury and Smith (2016), although the total number of each structure type constructed was reduced. The locations for the constructed LWD structures and rock groins were adjusted in the field as a consequence of the water depths of the existing habitat along the restored section and the anticipated functional benefit of each structure type at each designated instream site. Large woody debris structures were placed in existing deep pools where instream cover would be most beneficial to rearing, overwintering and holding habitats. Rock groins were placed in shallower riffle habitats where boulder cover would be most beneficial to rearing salmonids, such as Steelhead parr.

Structures were constructed from shore so no equipment entered the wetted perimeter of the stream. Trenching and placement of rootwads and boulders were done with excavators. All logs with rootwads attached used in the LWD structures were from locally obtained spruce trees. LWD structures were ballasted by cabling logs to oversized boulders using epoxy (Red Head Epcon Ceramic 6+). The epoxy-cabling attachment technique is described by Melville (1997). Boulders were drilled using 15.9 mm (5/8 in.) diameter bits to accommodate 12.7 mm (1/2 in.) diameter galvanized cable. An environmental monitor was on site during all periods of instream construction. Particular care was taken to minimize disturbance to the riparian area. Containment equipment was kept on site in the event of a fuel or oil spill.

Ballast requirements for the LWD structures at the Craker Road (Lower) site were determined during the design phase following guidelines provided in D'Aoust and Millar (1999). It is



Construction Notes:

1) Construct low height triangular riprap groin with 3:1 or shallower slope face.
2) Class 250 kg riprap: 0.3 to 0.8 m diameter with a D_{50} of 0.6 m.
3) Riprap gradation for Class 250 kg riprap: 85% larger than 25 kg (0.3 m); 50% larger than 250 kg (0.6 m); and 15% larger than 750 kg (0.8 m) (Northwest Hydraulic Consultants Ltd. 2000)
4) Minimum thickness of riprap equal to 1.2 m, or 2 times the median diameter (D_{50}) of the riprap.
5) Riprap at the streambank should extend vertically to a minimum elevation equal to bankfull discharge.

Typical Riprap Groin Structure
Plan & Cross Section

LGL Limited

Scale : Not to Scale

Figure 3. Typical plan and cross-section views of a riprap groin structure.

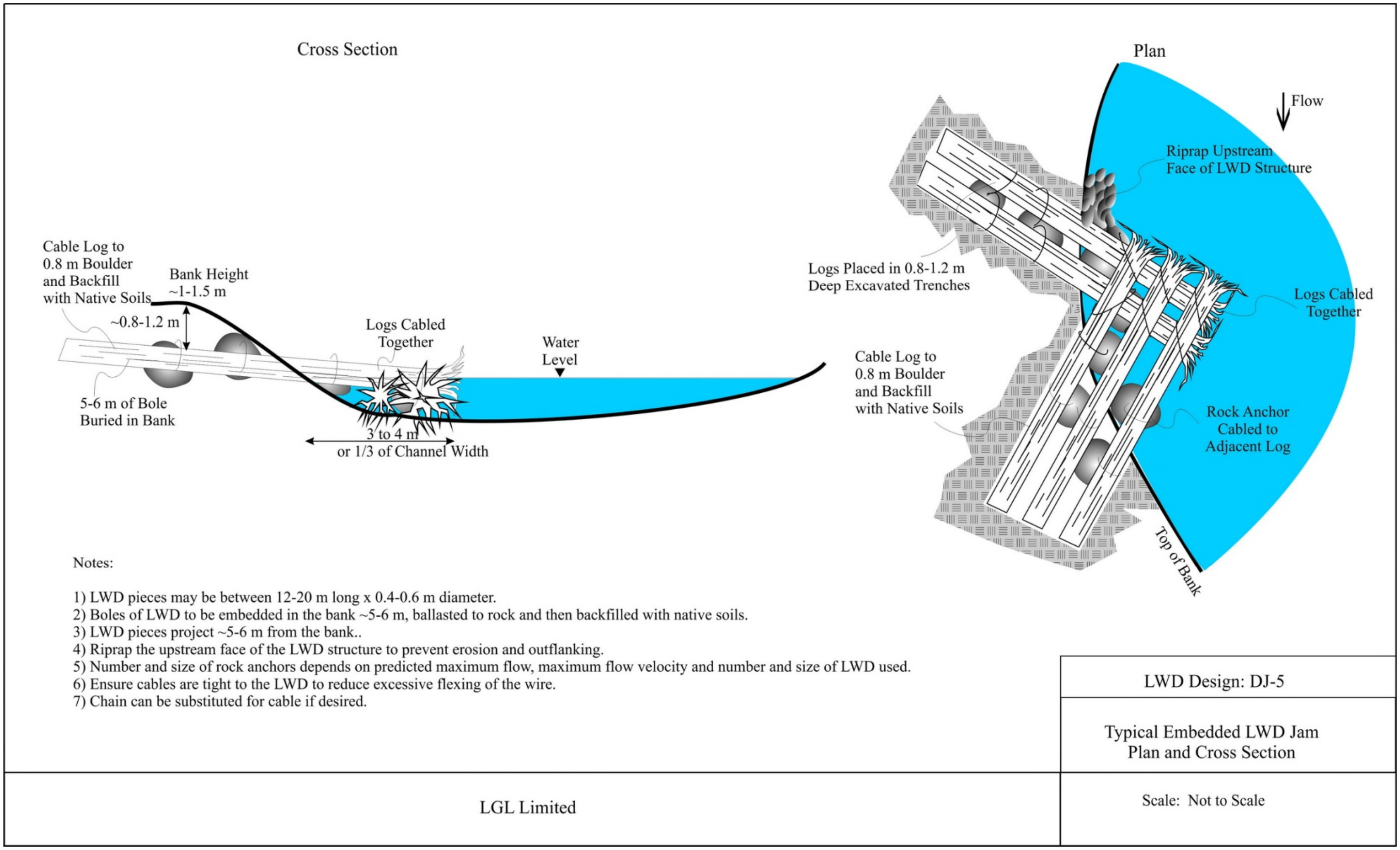


Figure 4. Typical plan and cross-section views of a large woody debris (LWD) structure, DJ-5.

important to note that the ballast estimate calculation assumed a multiple-LWD structure with all logs being cut logs. The calculation also assumed that the structures were anchored to live trees on the streambank with a factor of safety for buoyancy of 1.5, and a design velocity of 2.5 m/s (D'Aoust and Millar 1999). All of the LWD at the sites was buried in trenches in the streambank as no large riparian trees existed proximal to the structures. Also, three of the five trees in each LWD structure had rootwads attached. The boulder ballast provided to anchor the structures was in all cases more than the minimum required as specified through the calculations. Boulder ballast that was attached to the LWD in the trenches was subsequently buried. The ballast provided, which appears to be in excess of that required, therefore accounts for rootwad drag, buoyancy, and potential differences between anchoring LWD to live trees versus being ballasted and buried in the bank

4 CONSTRUCTED WORKS

4.1 Bulkley River at Craker Road (Lower)

The Craker Road (Lower) site was located on the right bank of the upper Bulkley River approximately 11.5 km northeast of Houston, BC (Table 1; Figure 2). As described in Gaboury and Smith (2016), channel type at the site would be characterized as riffle-pool morphology with predominantly gravel substrate. The channel would be considered as over-widened and moderately aggraded with eroding streambanks (RPg-w: A2; Hogan et al. 1996). Evidence of chronic bank erosion and meander migration was apparent from the encroachment along the right bank into the adjacent hay field. Channel widths ranged from ~56-70 m while wetted widths ranged from ~23-35 m. There was a narrow band of riparian vegetation (including conifers) along the upper section on the right bank of the restored reach. In the lower section, riparian vegetation is sparse so there is a high likelihood that right bank erosion and channel overwidening will increase significantly in the next 5-10 years. Also, the channel currently lacks complexity and there is limited instream and riparian cover to provide shade, refuge areas, or terrestrial insect contribution. Consequently, rearing and holding habitats are of relatively poor quality.

Constructed works at the Craker Road (Lower) site involved six LWD structures and two rock groins installed along a 105-m reach (Figure 5). Acquisition and transporting of construction materials to the site was initiated on 22 September 2017, and construction of the instream structures occurred from 25 September to 1 October 2017 (Photo 1 to Photo 8). A Caterpillar 320B hydraulic excavator was used for the work. The quantity of materials used in construction of the LWD structures was compared to the design requirements for ballast in Table 2.

4.2 Bulkley River at McKilligan Road (Lower)

In late September 2016, 7 LWD structures and 2 rock groins were installed at the McKilligan Road (Lower) site along the left bank of the Bulkley River, approximately 8.8 km northeast of Houston (Figure 2; Smith and Gaboury 2016). During a high-water event in mid-May 2017 when Bulkley River discharges reached 201 m^3/s near Houston (Figure 6), one LWD structure (0+000 m) and one rock groin (0+018 m) were significantly damaged (Photo 9). On 2 October 2017, both the LWD structure and rock groin were repaired, and some additional riprap material was added between the two structures (Photo 10).

Figure 5. As-built plan view of restoration works at the Craker Road (Lower) site on the upper Bulkley River, 2017.

Table 2. Quantities of materials used during construction of the LWD structures at the Craker Road (Lower) restoration site on the upper Bulkley River, 2017.

		Large Woody Debris				Estimated Total Mass of Ballast Required (kg) [a]	Boulder Ballast Provided		
Structure Number	Type of Structure	Diameter (m)	Log Type - Rootwad (RW), No Rootwad (NRW)	Buried Length (m)	Potentially Submerged Length (m)		Number of Boulders	Mean Diameter (m)	Total Mass of Ballast Provided (kg)
0+000	DJ-5	0.40	RW	5	6				
		0.40	NRW	5	6				
		0.45	RW	6	6				
		0.45	NRW	6	6				
		0.45	RW	6	6	6,639	9	0.90	10,380
0+015	DJ-5	0.45	NRW	6	6				
		0.45	RW	6	6				
		0.45	RW	6	6				
		0.50	NRW	6	6				
		0.45	RW	6	6	7,769	9	1.04	14,780
0+030	DJ-5	0.45	RW	6	6				
		0.45	NRW	6	6				
		0.45	RW	6	6				
		0.45	NRW	6	6				
		0.45	RW	6	6	7,459	10	0.85	8,850
0+045	DJ-5	0.45	RW	6	6				
		0.40	NRW	6	6				
		0.45	RW	6	6				
		0.45	NRW	6	6				
		0.45	RW	6	6	6,915	10	0.83	7,870
0+060	DJ-5	0.50	NRW	6	6				
		0.50	RW	6	6				
		0.45	RW	6	6				
		0.40	NRW	6	6				
		0.50	RW	6	6	8,145	9	0.94	11,270
0+075	DJ-5	0.45	NRW	6	6				
		0.45	RW	6	6				
		0.45	RW	6	6				
		0.65	NRW	6	6				
		0.45	RW	6	6	9,024	10	0.85	8,530

[a] Ballast estimate calculation assumes a multiple-LWD structure (assumes all logs are cut logs only) that is anchored to live trees on the streambank, factor of safety for buoyancy of 1.5, and design velocity of 2.5 m/s (D'Aoust and Miller 1999).

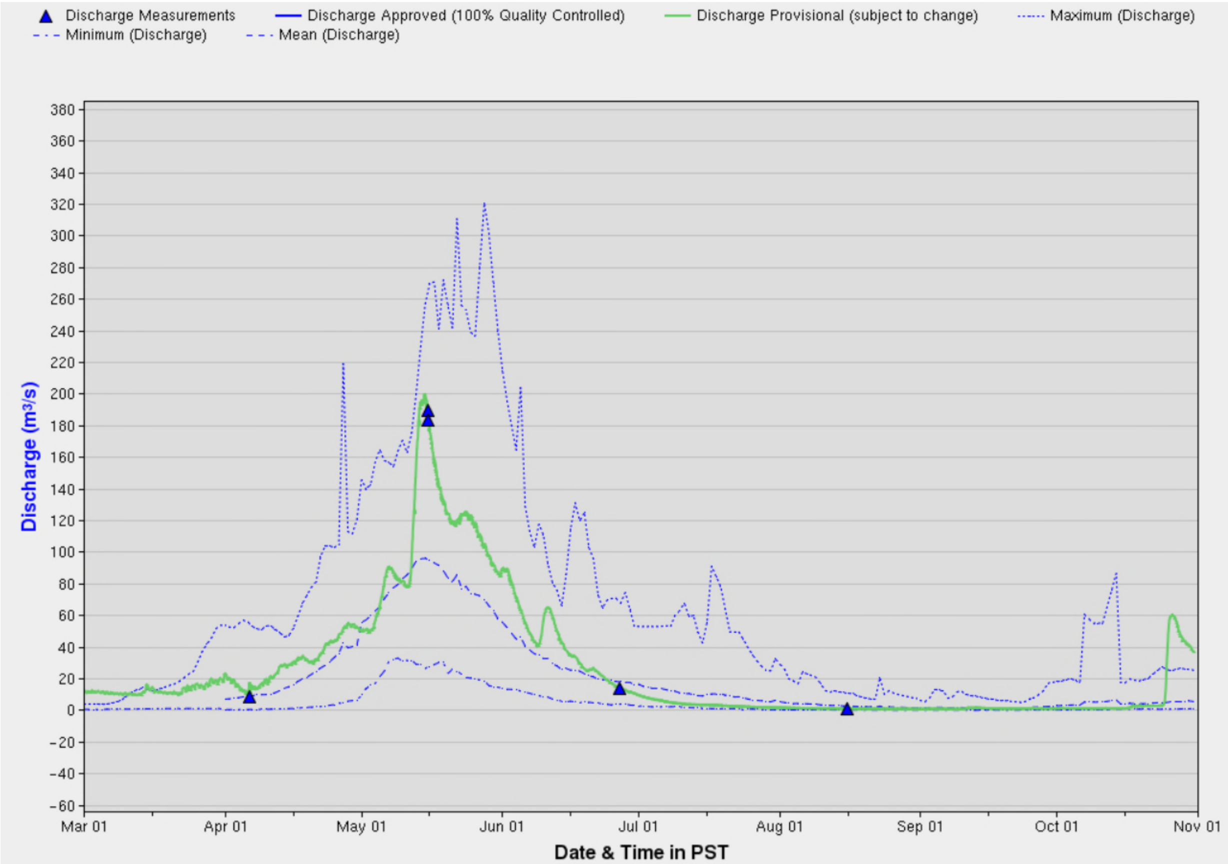


Figure 6. Discharge of the Bulkley River near Houston (station 08EE003), 1 March to 31 October 2017.

5 CONSTRUCTION MONITORING

An environmental monitor (Jason Smith, LGL) was on site daily throughout the project. The environmental monitor ensured that the proposed works had minimal or no impact on the fish habitat of the upper Bulkley River, as per the environmental protocol outlined in Appendices A and B in Gaboury and Smith (2016). All land-based equipment or machinery operated from the streambank and thus did not enter the watercourse. Visual observations at all sites showed no significant increases in turbidity as a result of construction activities. No fuel or oil spills occurred during construction, and all construction equipment was fueled at least 30 m from the river.

6 SITE RE-ASSESSMENTS

Three potential restoration sites on the Bulkley River that were assessed by Gaboury and Smith (2016) in the fall of 2015 were re-assessed in 2017 and deemed unsuitable for restoration using LWD structures and rock groins due to their excessive bank heights (> 3 m). These included the Craker Road Upper, Craker Road Middle, and C.R. Matthews Road Lower sites (Figure 2; Photo 11 and Photo 12).

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8 PHOTOS

Photo 1. Bulkley River at Craker Rd (Lower) – Excavating the 3-log trench of the LWD structure at 0+000 m (26 September 2017).

Photo 2. Bulkley River at Craker Rd (Lower) – Ballasted logs in the upstream-facing trench of the LWD structure at 0+030 m (26 September 2017).

Photo 3. Bulkley River at Craker Rd (Lower) – View from the right bank of the rock groin at 0+105 m (3 October 2017).

Photo 4. Bulkley River at Craker Rd (Lower) – View from the riverbed towards the right bank at the rock groin at 0+105 m (3 October 2017).

Photo 5. Bulkley River at Craker Rd (Lower) – Looking upstream from 0+015 m prior to construction (23 July 2017).

Photo 6. Bulkley River at Craker Rd (Lower) – Looking upstream from 0+015 m after construction was completed (3 October 2017).

Photo 7. Bulkley River at Craker Rd (Lower) – Looking downstream from 0+090 m prior to construction (23 July 2017).

Photo 8. Bulkley River at Craker Rd (Lower) – Looking downstream from 0+090 m after construction was completed (3 October 2017).

Photo 9. Bulkley River at McKilligan Rd (Lower) – Upstream view of the damaged LWD structure (0+000 m) and groin (0+018 m; 19 July 2017).

Photo 10. Bulkley River at McKilligan Rd (Lower) – Upstream view of the repaired LWD structure (0+000 m) and groin (0+018 m; 2 October 2017).

Photo 11. Bulkley River at C.R. Matthews Rd (Lower) – Downstream view of the potential restoration site on the right bank (23 June 2017).

Photo 12. Bulkley River at Craker Rd (Lower) – Downstream view of the potential restoration site on the right bank (23 July 2017).