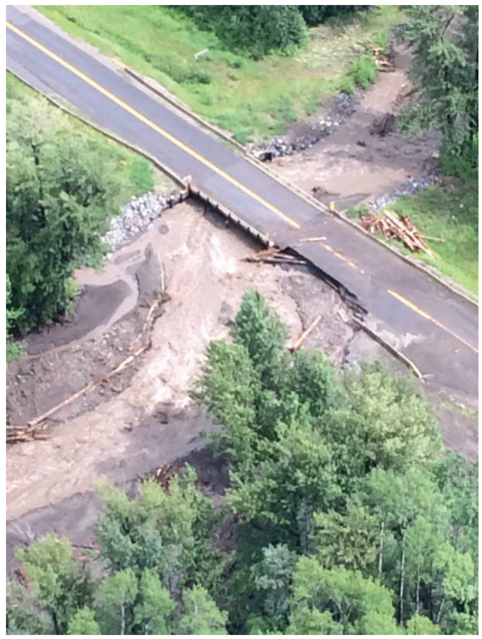
FISHER CREEK BRIDGE NO. 07117 REPLACEMENT
HYDROTECHNICAL DESIGN BRIEF
MOTI PROJECT 37479-0000



Prepared for:

BC Ministry of Transportation and Infrastructure
Northern Region
Prince George, BC

Prepared by:

Northwest Hydraulic Consultants Ltd.
North Vancouver, BC

14 April 2022 (Revised)

NHC Ref No. 3005858-09

Prepared under the direction of:

PROFESSIONAL
PROVINCE OF
D. J. GOOLD
28281
BRITISH COLUMBIA
ENGINEER

2022-04-13

Des Goold, P.Eng.
Principal

DISCLAIMER

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1 INTRODUCTION

Northwest Hydraulic Consultants Ltd. (NHC) has been retained by MoTI (under Contract No. 831CS1092) to carry out a hydrotechnical assessment of Fisher Creek and develop the hydrotechnical design for the replacement of Bridge No. 07117. This structure is undersized and was damaged by the 2011 and 2016 South Peace floods.

NHC developed hydrotechnical design constraints and a preliminary waterway opening design for replacement of the Bridge in July 2012, following the 2011 Peace Flood (NHC, 2012). In 2018 NHC was asked to update the waterway design and carry out the detailed hydrotechnical design.

1.1 Design codes and references

The following design codes and reference documents form the basis of the hydrotechnical design summarized in this report:

Design Codes:

- CAN/CSA-S6-19 in conjunction with the BC MoTI Supplement to CHBDC S6-14
- BC MoTI Supplement to 2019 TAC Geometric Design Guide (2021)

BC Ministry of Transportation and Infrastructure Standards and Guidelines:

- BC MoTI Standard Specifications for Highway Construction (2020)
- Resilient infrastructure Engineering Design – Adaptation to the Impacts of Climate Change and Weather Extremes (Technical Circular T-04/19).

Hydrotechnical Design Guidelines:

- TAC Guide to Bridge Hydraulics (2001)
- Hydraulic Design of Stable Flood Control Channels (NHC, 1984)
- Developing Climate Change-Resilient Designs for Highway Infrastrucure in British Columbia (Interim) (V2; EGBC, 2020)

1.2 Information provided by MoTI

The following reference drawings, reports and survey data were provided by MoTI:

- 07117 Fisher Creek Bridge; Development of Mitigation Options for Lateral Channel Instability (timeline compiled by D. Cossette, Oct. 2018)

1.3 Information from other sources

The following reference drawings, reports and survey data were obtained from other sources:

- Highway 97 crossing at Fisher Creek – Hydrotechnical assessment following the flood of June 2011 (NHC, 2012a)
- Fisher Creek Bridge No. 7117, Hydrotechnical Design Constraints for Bridge Replacement, (Ministry PEP Project No. 35153), Draft Report. (NHC, 2012)
- South Peace Flood Recovery Program, Report on the 2016 Flood Event and Regional Hydrology (NHC, 2017)
- Fisher Creek Riprap Construction 35479 (Associated Engineering, 2018)
- Ground survey and structural bridge drawings (McElhanney, 2018-19)

2 FISHER CREEK CHARACTERISTICS

2.1 Watershed and reach physical characteristics

The following information summarizes baseline physical characteristics of the watershed and the reach of the stream where the subject crossing exists.

- Watershed area to the crossing: 44.8 km^2
- Maximum watershed elevation: El. 1,900 m
- Minimum watershed elevation: El. 661 m
- Elevation at crossing: El. 660.8 m
- Channel morphology at crossing: Wandering planform on alluvial fan
- Channel slope: 3.5 percent (0.35 m/ km)
- Existing Channel bottom width: 10 m to 16 m (riprap controlled)
- Bed material D_{50} 110 mm

2.2 Streamflow estimates

Peak Flood flow estimates for Fisher Creek are based on a set of regional flood curves developed by NHC. For background on the development of the curves please refer to the *Report on the 2016 South Peace Flood Event and Regional Hydrology* (NHC, 2017). The following flow estimates were used in the design of the permanent crossing, with the future 200-year annual peak flow estimate being the basis for sizing the clear span bridge.

- 10-year annual peak flow: 62 m^3/s
- 100-year annual peak flow: 149 m^3/s
- 200-year annual peak flow: 173 m^3/s
- 200-year design flow: 207 m^3/s

The recommended design flow includes a 20 percent increase to account for the effects of climate change. A Design Criteria Sheet for Climate Change Resilience is attached as **Appendix A**.

3 HYDRAULIC ANALYSIS OF PROPOSED WATERWAY

Traditionally the waterway opening for a bridge is determined, at least in part, on the existing channel characteristics, collected survey data, hydrology and numerical modelling. In 2012, NHC established a preliminary waterway design using these methods. However, the channel of Fisher Creek within the Highway 97 reach has been affected by the undersized bridge and numerous flood recovery efforts that have occurred over its life. Consequently, a clear and consistent channel width is difficult to determine from observation and surveys, and the 2012 channel width recommended was conservatively wide as a result. NHC re-assessed the waterway width using a regime analysis, along with updated hydrology, and confirmed the results with numerical modelling. Every channel has a unique regime, though research has shown that regime can be generally defined by a set of curves that relate the bank full width, mean depth and gradient of the channel to its dominant discharge and the D_{50} size of its bedload (NHC 1984). The 10-year annual daily maximum flow has been adopted as the channel forming flow for the regime analysis, and a high resistance to erosion has been assumed since the waterway channel will be riprap-protected.

The following paragraphs describe the recommended channel improvements and training works. A copy of design drawings is provided in **Appendix B**.

The revised waterway opening has a trapezoidal channel with a 20.5 m bottom width and 2H: 1V side slopes (Table 2). The bottom width is reduced by 4.5 m relative to the 2012 waterway width. Given the required size of the waterway channel, the magnitude of the design flow and the volume of wood debris and bedload carried by the creek, a clear span replacement bridge is favoured over a mulit-span bridge. The selected option is a 37.8 m long, clear-span bridge. Channel widening and riprap protection are proposed for approximately 30 m upstream and 40 m downstream of Highway 97. The existing channel gradient will be maintained over this distance.

Training berms are recommended upstream of Highway 97 to gather flow from across the alluvial fan and guide it towards the new bridge. The main trunks of both training berms will extend upstream at angles of 30 to 35 degrees to Highway 97. The West Training Berm and East Training Berms are approximately 90 m long and 235 m long, respectively. The Training Berms will be riprap-armoured and tie to high ground (service roads) on either side of the fan, reducing the risk of a future channel avulsion.

On the west side of the alluvial fan, the West Containment Berm is a raised and riprap-protected berm extending approximately 170 north of the Enbridge pipeline crossing. It is offset from the main channel of Fisher Creek and is intended to contain high flows within the fan area and prevent avulsions from damaging highway infrastructure farther west. The top surface of the west containment berm is 3.2 m above the adjacent minimum elevation in the Creek, providing 1 to 1.5 m of freeboard over the expected 200-year flood profile.

3.1 Hydraulic summary

A HEC-RAS (USACE 2016) model of the Fisher Creek crossing was developed using cross-sections extracted from the provided survey data. The model has been used to assess hydraulics in the creek during floods and to size the appropriate replacement structure.

A Manning's 'n' roughness coefficient of 0.05 is used for the channel upstream and downstream of the crossing – the coefficient accounts for the coarse surficial material, irregular shape of the channel and the likelihood that debris will obstruct portions of the channel during flood events. The roughness coefficient used for the left and right overbanks range from 0.1 to 0.2. The roughness coefficients cannot be calibrated because flood flows and high-water marks have not been recorded at the site.

Normal depth for slopes of 3.7 percent (0.037 m/m) and 3.3 percent (0.033 m/m) are used as boundary conditions at the upstream and downstream limits of the model, respectively.

The following table summarizes the hydraulics at the proposed replacement bridge.

Table 1. Summary of the hydraulic model results for the new channel and bridge

Peak Flow Return Period	Peak Flow (m^3/s)	Flood Level, (El., m^1)	Average Velocity (m/s^2)	Froude Number[2]
10-year	62	661.7	2.9	1.0
100-year	149	662.4	3.8	1.0
200-Year	173	662.6	4.0	1.0
200-Year Design Flow[3]	207	662.8	4.2	1.0

Notes:

1. The flood levels shown are at the upstream side of the proposed new bridge.
2. Average velocities and Froude Numbers s are average values within the hydraulic opening.
3. Includes a 20 percent increase to account for the effects of climate change.

3.2 Design flood level and required bridge clearance

MOTI standard for flood clearance is 1.5 m above the 200-year design flood level. The lowest point of the bridge soffit is at the east end of the upstream girder – the soffit elevation at that location will be 1.5 m above El. 662.8 m, or El. 664.3 m.

3.3 Aggradation, degradation and scour

3.3.1 Aggradation

Aggradation and degradation at the site will tend to be cyclical, though net long-term aggradation is expected. Larger floods in excess of a 10-year return period will mobilize significant amounts of debris and sediment (from bank scour, landslides etc.), which will form jams and cause short term aggradation of bed material in the bridge reach. Lesser, average floods in subsequent years will tend not to entrain much new sediment or debris but will rework and erode the aggraded bed material.

Even with the proposed new channel and bridge at Highway 97, the location of the highway crossing through the middle of a very active alluvial fan is not ideal, and aggradation through the crossing is expected to continue. Mechanical removal of debris and sediment may be required from time to time in order to maintain adequate clearance at the new bridge.

3.3.2 Degradation

Degradation is unlikely to occur due to the large amount of bedload supplied to the crossing. Any bed lowering will likely be offset by the aggradation trend.

3.3.3 Scour

Natural scour occurs in streams even if the channel is not constricted or controlled to a significant degree. The causes of natural scour can include: i) accelerated, deep flow along the outside of a bend; ii) lateral shifting of the channel thalweg; iii) flow alongside or impinging upon rock outcrops, debris jams, other hard points or rigid materials along the channel boundaries; and iv) sudden concentrations of flow such as at the confluence of two or more channels.

At the proposed bridge, the most likely form of natural scour will be accelerated flow along the rigid, riprap protected banks of the channel. If a debris jam forms within the waterway, the flow pattern would be similar to flow along the outside of a rigid bend or flow impinging at an angle against a rigid bank.

The 200-year natural scour elevation has been estimated using the Modified Blench procedure (TAC 2004) with the following inputs:

- Channel top width at approach and bridge waterway opening = 28.5 m
- Design flow = 207 m3/s
- Energy slope = 0.014 m/m (conservative for this scour estimate)
- D50 of bed material = 108 mm
- Z factor = 2.0 (upper range for flow along the outside of a bend where banks are rigid)

The natural scour depth is estimated to be 3.4 m below the 200-year flood level. Additionally, in the unlikely event that the bridge crossing is outflanked in the future (due to a significant blockage of the waterway), the bridge abutment piles could become exposed to scour. The riprap protection through the bridge will collapse around the piles and help limit the depth of local scour, but it is still prudent to design the abutment piles to be able to withstand exposure to the depth of natural scour.

There is no contraction or local scour potential at the bridge.

3.4 Riprap protection for streambanks

In NHC's 2012 report, 1000-kg riprap was recommended for erosion protection through the waterway. Due to concerns over being able to source riprap of that size, the size class was reduced to 500-kg, but the thickness was doubled (to 2.4 m) as compensation[1]. Increasing the placement thickness of riprap is a legitimate means of increasing its stability and long-term performance, however, it appears the

[1] Reductions in riprap class size in combination with thicker placement is an approach that has also been used at several other sites in the Peace (e.g. Commotion Creek and Bissett Creek)

thickness at Fisher Creek Bridge need only be increased to 2100 mm to achieve the necessary stability (factor of safety ~ 1.2).

For the bridge opening, MoTI Class 500 kg riprap, with nominal thickness of 2.1 m is recommended. The minimum slope for erosion protection is 2H: 1V and will extend to the design water level elevation plus 0.6 m.

Riprap bank protection is recommended to extend approximately 30 m upstream and 40 m downstream of the bridge.

The East and West Training berms are outside of the channel and therefore can be protected with a lower riprap class. Class 250-kg riprap is recommended to protect the upstream face of both west and east berms.

The West Containment Berm runs parallel to and at an offset from the main channel of Fisher Creek. However, in the future it is possible that the Creek will migrate west and flow directly against the berm; therefore, Class 500-kg riprap is recommended to protect the creek-side face of the berm.

APPENDIX A

Design Criteria Sheet for Climate Change Resilience
Fisher Creek

BCMoTI Design Criteria Sheet for Climate Change Resilience

Highway Infrastructure Design Engineering and Climate Change Resilience
Ministry of Transportation and Infrastructure
(Separate Criteria Sheet per Discipline)

Project:	*Fisher Creek Bridge (07117) Replacement*
Type of work:	*Bridge Replacement (Detailed Design)*
Location:	*Highway 97; BC MoTI Northern Region*
Discipline:	*Hydrotechnical*

Design Component	Design Life or Return Period	Design Criteria + (Units)	Design Value Without Climate Change	Change in Design Value from Future Climate	Design Value Including Climate Change	Comments / Notes / Deviations / Variances
Replacement Bridge (36 m clear span)	200yr	Flow Rate (m^3/s)	173	+20%	207	- Design Flood elevation rises by 0.2 m - 200-year average velocity increases by 0.2 m/s - Minor increase in riprap volume (~ 5%)

Explanatory Notes / Discussion:

The BC Ministry of Transportation and Infrastructure (MoTI) is intending to replace Fisher Creek Bridge No. 07117 located approximately 51 km west of Chetwynd on Highway 97. Highway 97 cuts across the middle of Fisher Creeks alluvial fan, which is a very active fan with high bedload and debris loads. There are privately operated gas pipeline crossings of Fisher Creek 130 m upstream and 75 m downstream of Highway 97. The existing bridge consists of 18.3 m long, concrete stringers supported on timber piles at the abutments and central pier. The bridge has a significantly undersized waterway opening relative to the channel width determined by regime analysis. Because of this, and the presence of a pier, the bridge traps a large amount of debris and bedload during floods, creating deep scour under the structure and a risk of avulsion upstream. The bridge was overwhelmed by flooding in both June 2011 and June 2016. MoTI's intent is to replace the existing bridge with a new, 36 m long, clear span bridge. The channel beneath the bridge will be enlarged to a minimum bottom width of 20.5 m and will have 500-kg riprap-protected banks rising at 2H: 1V. Training berms will extend diagonally upstream across the fan, tying into to both bridge abutments. The intent of the training berms is to capture all flood flow across the fan and re-direct it back towards the bridge. Northwest Hydraulic Consultants Ltd. (NHC) has been retained by MoTI under General Services Contract 831CS0995 to prepare a Hydrotechnical Design Brief for the new Fisher Creek Bridge Channel Improvements and Training Berms.

The effect of climate change on the flood hydrology for Fisher Creek has been assessed by analyzing future projections in rainfall intensity at nearby climate stations and well as future projections in streamflow for some of the larger rivers in the region (streamflow projections are not available for streams in the size range of Fisher Creek). The hydrologic impacts of climate change will be partly attributed to changes in rainfall intensity, but there are numerous other climate indicators that will be affected as well, including changes to temperature normals, and the spatial and temporal variation in precipitation throughout the year, etc.

The projected impact on rainfall intensity has been evaluated by using IDF-CC, an online tool developed by Srivastav, Schaardong, and Simonovic (2014) that applies the downscaled global circulation model(GCM)'s output to modify present intensity-duration-frequency (/OF) curves published by (ECCC)1. The IDF-CC tool produces ensemble predictions from the full suite of climate projections from Assessment Report 5 (AR5) of the United Nations Intergovernmental Panel on the Climate Change (IPCC 2014). AR5 output is produced for three Representative Concentration Pathway (RCP) scenarios (RCP 8.5, RCP 4.5 and RCP 2.6). RCP 8.5, for example, refers to the projected change in radiative forcings (+8.5 Wlm2) in the year 2100 relative to pre- industrial levels. While RCP 8.5 is the *worst case scenario of greenhouse gas concentration trajectories referred to in the IPCC report, it is the general consensus by local climate change scientists that RCP 8.5 is the likely pathway given the current state of anthropogenic (human) activity.*

The online IDF-CC tool also allows the user to input historical rainfall data, which can be used to generate locally relevant updated IDF curves and adjust for climate change based off the same method for the ECCC data. NHC used the IDF-CC tool to produce estimates of changes in rainfall intensities over different durations, time periods and RCPs for the BCFF Stations at Lemoray, Hudson's Hope and Noel, and the ECCC Stations at Chetwynd and Dawson Creek. The results of the analysis show that for RCP 8.5, the increase in rainfall intensities by the end of the 2151 Century could be as much as 25%.

To assess the impacts of climate change on larger rivers, NHC carried out non-stationary flood frequency analysis on the Pine River (12,000 km^2) and Moberly River (1,520 km^2). The projections were developed by the Pacific Climatic Impacts Consortium (PCIC). Unfortunately, there are no projections for streams of an intermediate size. The analysis results show that there is not a consistent regional signal in terms of the magnitude and direction of changes in peak flows on the larger rivers in the region. In NHC's judgement, it is prudent to assume that a maximum ensemble median percent increase similar to the Pine River (11%) will apply to other large river systems in the mountainous region of the South Peace that have physiography similar to the Pine River (i.e. Murray River, Sukunka River).

For smaller watersheds in the mountainous region, and for all watersheds on the Alberta Plateau, large floods tend to be rainfall driven as opposed to snowmelt driven. Therefore the estimated median increases in rainfall intensity should be directly applied to design flows for those streams. There should be some reduction in the percent increase in flows as watershed size increases. At this time, NHC recommends applying a 25 percent increase in the 100- and 200-year flow for the smallest watersheds (under 25 km^2 in size), a 15 percent increase for larger watersheds (1000's km^2 and larger) , and a 20 percent increase for watershed sizes in between those limits. According, the 200-year design flood for Fisher Creek should incorporate a 20% increase to account for climate change. NHC recommends that 200-year peak discharge of 207 m^3/s be adopted as the design discharge for the replacement structure for future phases of design. The impacts of climate change on 200-year hydraulics are noted in the table above.

For a more complete discussion of the results, please refer to NHC's 2017 report entitled: "Report on the 2016 Flood Event and Regional Hydrology".

Recommended by: Engineer of Record: Des Goold, P.Eng.

Date: April 4, 2019

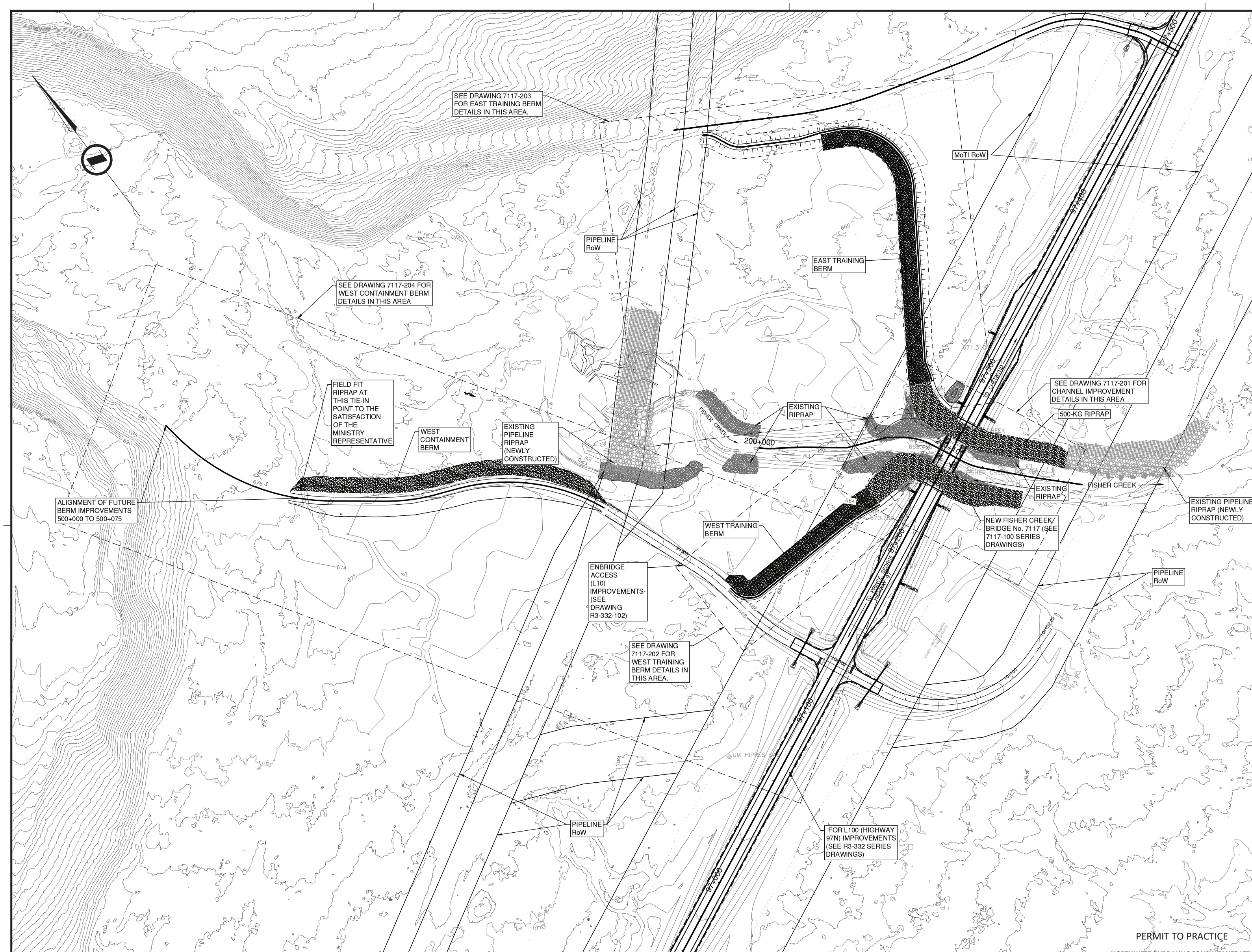
Engineering Firm: Northwest Hydraulic Consultants Ltd.

Accepted by BCMoTI Consultant Liaison: Dan Cossette [signature] Apr. 4, 2019
(For External Design)

Deviations and Variances Approved by the Chief Engineer: ______
Program Contact: Dirk Nyland, Chief Engineer BCMoTI

APPENDIX B

Set of Five (5) Drawings
Channel Improvements and Berms



PLAN
SCALE = 1:1000

NOTES:

1. SURVEY COMPLETED BY McELHANNEY CONSULTING SERVICES LTD. (2012, 2013 and 2018)
2. LIDAR DATA FLOWN IN 2018
3. ALL COORDINATES ARE IN UTM (SEE SURVEY CONTROL TABLE DWG R3-332-001)
4. CONTOUR INTERVAL IS 1.0 m
5. ALL ELEVATIONS AND DISTANCES ARE GIVEN IN METRES

nhc northwest hydraulic consultants
30 Gostick Place
North Vancouver, BC V7M 3G3
Canada
Office: 604.980.6011
Fax: 604.980.9264
www.nhcweb.com

Rev	Date	Description	Init

R E V I S I O N S

BRITISH COLUMBIA
Ministry of Transportation & Infrastructure
Southern Interior Region

NORTH PEACE DISTRICT
HIGHWAY No. 97

FISHER CREEK BRIDGE No. 7117 CHANNEL AND BERMS PLAN

PERMIT TO PRACTICE
NORTHWEST HYDRAULIC CONSULTANTS LTD.
Signature ____________
Date ____________
PERMIT NUMBER: 1003221
The Association of Professional Engineers and Geoscientists of British Columbia

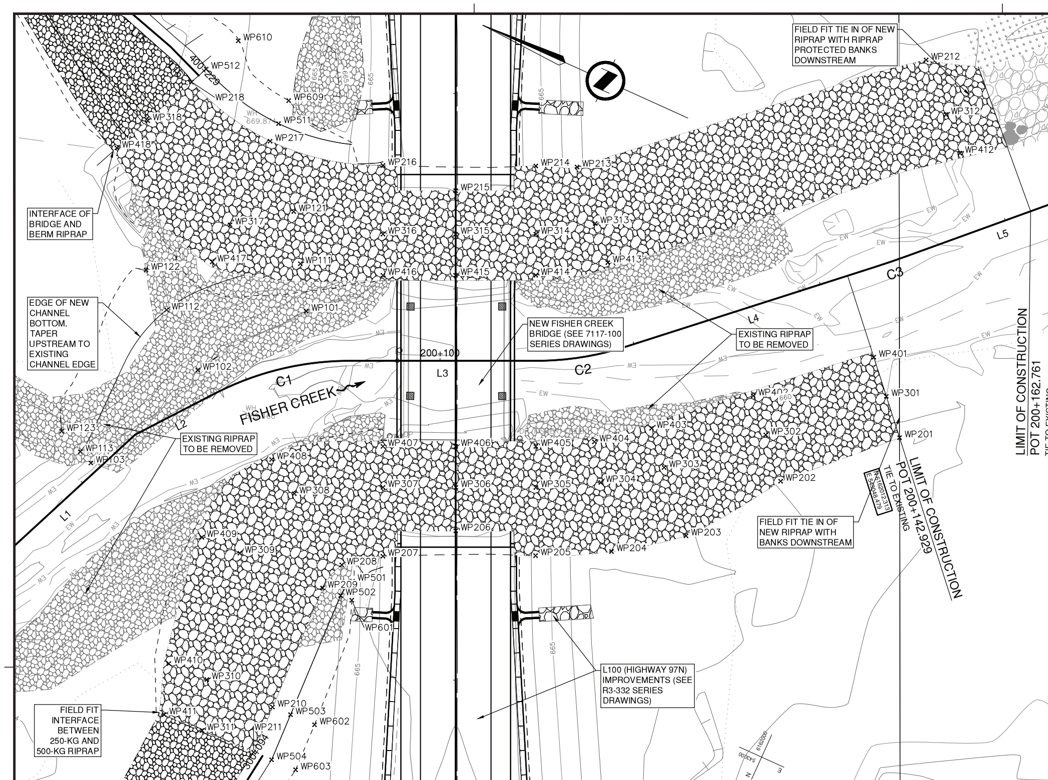
PREPARED UNDER THE DIRECTION OF
DES GOOLD, P.ENG.
ENGINEER OF RECORD
DATE

DESIGNED	DJG	DATE	DEC. 2021
CHECKED	DJG	DATE	DEC. 2021
DRAWN	CZZ	DATE	DEC. 2021
SCALE	AS SHOWN		
NEGATIVE No.			

FILE No.	PROJECT No.	REG.	DRAWING No.
	37479-0000	NR	7117-200

CANCEL PRINTS BEARING PREVIOUS LETTER

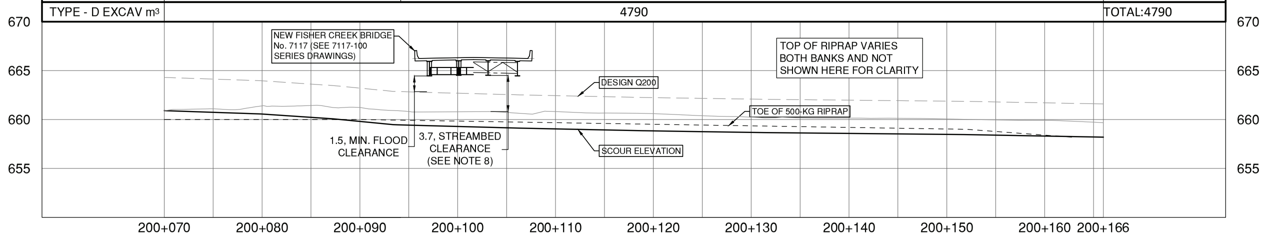
H-308J-r2-c(07-08)



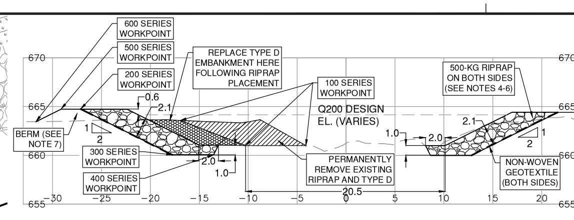
PLAN - CHANNEL IMPROVEMENTS
SCALE = 1:250

CENTRELINE OF FISHER CREEK CHANNEL						
SEGMENT	START STA.	START E.	START N.	START TANGENT	L.	R.
L1	200+045.50	542983.58	6162080.42	112°59'05.75"	21.83	
L2	200+067.33	543003.67	6162071.89	128°21'39.90"	9.16	
C1	200+076.49	543010.85	6162066.21	128°21'39.90"	14.28	30.00
L3	200+090.77	543019.56	6162055.07	155°37'56.86"	19.02	
C2	200+109.79	543027.41	6162037.74	155°37'56.86"	9.30	30.00
L4	200+119.09	543032.49	6162029.99	137°52'10.08"	26.71	
C3	200+145.80	543050.40	6162010.18	137°52'10.08"	3.60	95.00
L5	200+149.39	543052.87	6162007.56	135°42'04.16"	23.13	

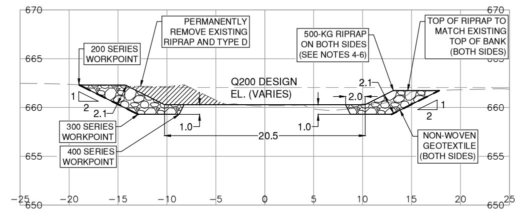
500-KG RIPRAP m³	2965	TOTAL:2965
EMBANKMENT m³	370	TOTAL:370
TYPE - D EXCAV m³	4790	TOTAL:4790



PROFILE - FISHER CREEK
SCALE = 1:250



TYPICAL SECTION - UPSTREAM OF BRIDGE (LOOKING DOWNSTREAM)
SCALE = 1:250



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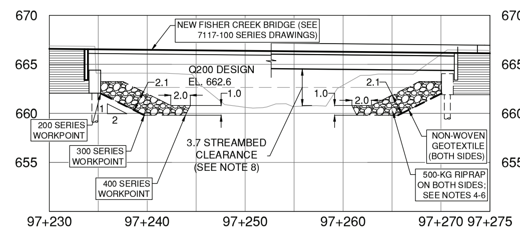


PROFILE - HIGHWAY 97N (LOOKING UPSTREAM)
SCALE = 1:250

CHANNEL WORKPOINTS				CHANNEL WORKPOINTS			
WP	EASTING	NORTHING	ELEV.	WP	EASTING	NORTHING	ELEV.
WP101	543022.36	6162061.20	661.00	WP311	542978.89	6162053.20	662.21
WP102	543012.29	6162068.82	661.00	WP312	543067.64	6162009.96	658.55
WP103	542999.13	6162074.84	661.29	WP313	543042.71	6162038.01	659.50
WP111	543026.53	6162063.76	661.00	WP314	543039.21	6162043.09	659.67
WP112	543016.59	6162074.25	661.00	WP315	543035.83	6162050.56	659.81
WP113	542999.74	6162076.29	661.29	WP316	543032.77	6162057.31	659.94
WP121	543031.11	6162066.57	663.69	WP317	543027.19	6162071.94	660.01
WP122	543019.44	6162077.85	663.29	WP318	543033.42	6162083.99	661.89
WP123	543000.85	6162078.90	662.71	WP401	543041.99	6162006.44	659.12
WP201	543035.58	6162000.64	661.34	WP402	543033.32	6162016.03	659.33
WP202	543026.51	6162009.88	661.82	WP403	543026.00	6162024.12	659.52
WP203	543017.44	6162016.38	663.19	WP404	543022.33	6162028.87	659.59
WP204	543012.83	6162022.65	663.17	WP405	543019.44	6162034.13	659.67
WP205	543009.25	6162029.54	663.16	WP406	543016.06	6162041.58	659.81
WP206	543008.20	6162038.02	662.02	WP407	543012.99	6162048.35	659.93
WP207	543002.76	6162043.72	663.45	WP408	543007.07	6162058.16	660.00
WP208	543000.21	6162047.19	664.37	WP409	542996.88	6162061.38	660.27
WP209	542997.25	6162048.00	664.86	WP410	542983.73	6162059.12	661.36
WP210	542984.04	6162047.64	665.00	WP411	542978.77	6162057.39	662.71
WP211	542979.05	6162047.49	665.06	WP412	543064.64	6162007.03	658.55
WP212	543071.90	6162014.12	661.53	WP413	543039.59	6162035.19	659.50
WP213	543047.21	6162042.08	662.53	WP414	543035.38	6162041.35	659.67
WP214	543045.57	6162045.97	663.16	WP415	543032.00	6162048.82	659.81
WP215	543039.88	6162052.38	662.03	WP416	543028.93	6162055.57	659.93
WP216	543039.17	6162060.21	663.45	WP417	543022.98	6162072.03	660.00
WP217	543036.67	6162071.74	664.75	WP418	543029.59	6162085.71	661.88
WP218	543038.87	6162081.55	664.87	WP501	542999.15	6162045.50	664.37
WP301	543038.87	6162003.62	659.12	WP502	542997.31	6162046.00	664.86
WP302	543030.20	6162013.21	659.33	WP503	542984.10	6162045.64	665.00
WP303	543022.88	6162021.30	659.52	WP504	542979.10	6162045.50	665.06
WP304	543018.81	6162026.57	659.59	WP511	543038.67	6162071.70	664.75
WP305	543015.61	6162032.40	659.67	WP512	543040.70	6162080.73	664.87
WP306	543012.25	6162039.84	659.81	WP601	542997.34	6162044.77	664.23
WP307	543009.17	6162046.62	659.93	WP602	542984.17	6162042.97	663.67
WP308	543004.85	6162054.60	660.00	WP603	542979.17	6162042.84	663.73
WP309	542997.00	6162057.17	660.27	WP609	543041.24	6162071.72	663.46
WP310	542983.84	6162054.91	661.36	WP610	543044.69	6162078.95	662.66

PERMIT TO PRACTICE

NORTHWEST HYDRAULIC CONSULTANTS LTD.

Signature ______________________

Date ______________________

PERMIT NUMBER: 1003221

The Association of Professional Engineers and Geoscientists of British Columbia

LEGEND

- FINISHED CHANNEL/ BERM SURFACE
- NON-WOVEN GEOTEXTILE
- EXISTING RIPRAP
- 500-KG RIPRAP
- 250-KG RIPRAP
- PERMANENT EXCAVATION WITHIN NEW CHANNEL
- EMBANKMENT WITHIN NEW CHANNEL

NOTES:

1. ALL ELEVATIONS AND DISTANCES ARE GIVEN IN METRES
2. HYDROTECHNICAL DESIGN PARAMETERS
   a. 200-YEAR DESIGN FLOW (Q200): 207 m3/s
   b. 200-YR DESIGN FLOW VELOCITY: 4.9 m/s
   c. 200-YR DESIGN FLOW DEPTH: 1.8 m
3. CROSS-SECTIONS ARE PLOTTED LOOKING IN THE DIRECTION NOTED.
4. RIPRAP SPECIFICATIONS AND INSTALLATION SHALL CONFORM TO THE MINISTRY STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION SECTION 205
5. THE BACKSLOPE OF ALL RIPRAP SHALL BE LINED WITH A CLASS I NON-WOVEN GEOTEXTILE (NILEX 4512 OR EQUIVALENT). NO GEOTEXTILE SHALL BE PLACED BENEATH THE HORIZONTAL TOES OF RIPRAP
6. EXISTING RIPRAP SHALL BE COMPLETELY REMOVED TO THE WORKPOINTS BEFORE PLACING ANY NEW RIPRAP. EXISTING RIPRAP CAN BE RE-USED IF APPROVED BY THE MINISTRY REPRESENTATIVE.
7. BERM EXMANKMENTS SHALL BE CONSTRUCTED ON A CLEARED, GRUBBED AND STRIPPED SURFACE; FILL SHALL BE PLACED IN CONFORMANCE WITH THE MINISTRY STANDARD SPECIFICATION FOR HIGHWAY CONSTRUCTION SECTION 201.37
8. WHEN THE AVERAGE STREAMBED CLEARANCE AT THE BRIDGE IS REDUCED TO 2.7m, THE STREAM CHANNEL SHALL BE DREDGED OVER THE ENTIRE CHANNEL IMPROVEMENTS PLAN AREA TO RE-ESTABLISH THE MINIMUM CLEARANCE OF 3.7m.

nhc northwest hydraulic consultants
30 Gostick Place
North Vancouver, BC V7M 3G3
Canada
Office: 604.980.6011
Fax: 604.980.9264
www.nhcweb.com

Rev	Date	Description	Init

REVISIONS

BRITISH COLUMBIA

Ministry of Transportation & Infrastructure
Southern Interior Region

NORTH PEACE DISTRICT
HIGHWAY No. 97

FISHER CREEK BRIDGE No. 7117
CHANNEL IMPROVEMENTS DETAILS

PREPARED UNDER THE DIRECTION OF

DES GOOLD, P.ENG.
ENGINEER OF RECORD

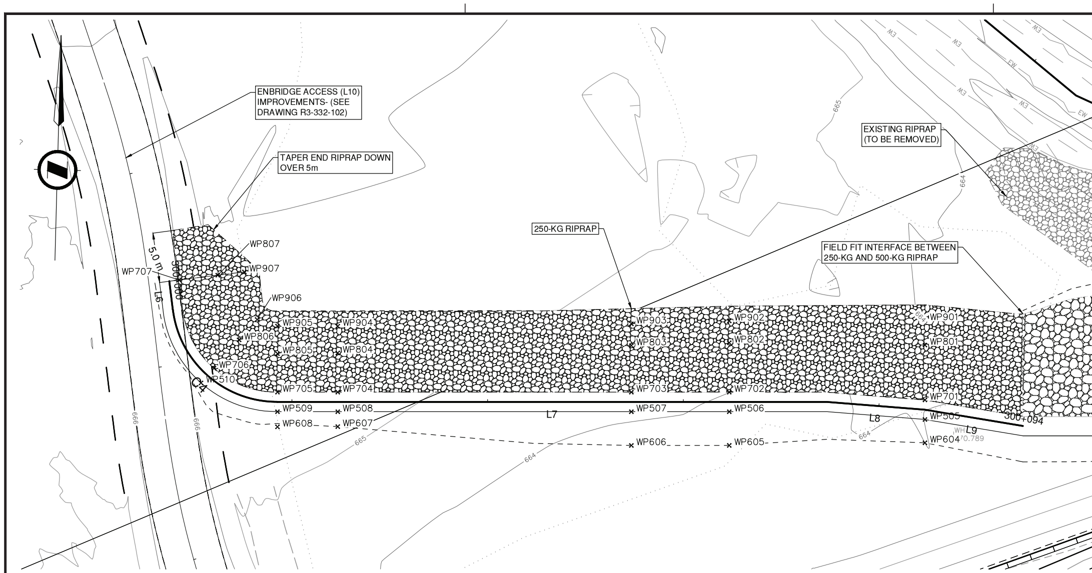
DATE

DESIGNED DJG DATE DEC. 2021
CHECKED DJG DATE DEC. 2021
DRAWN CZZ DATE DEC. 2021
SCALE AS SHOWN
NEGATIVE No.

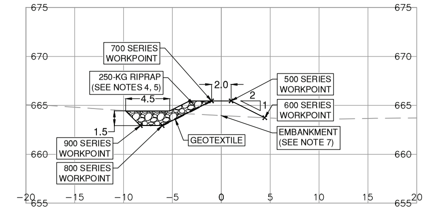
FILE No.	PROJECT No.	REG.	DRAWING No.
	37479-0000	NR	7117-201

CANCEL PRINTS BEARING PREVIOUS LETTER

H-308j-r2-c(07-08)



PLAN - WEST TRAINING BERM
SCALE = 1:250



TYPICAL SECTION - WEST BERM
SCALE = 1:250

LEGEND

FINISHED CHANNEL/ BERM SURFACE

NON-WOVEN GEOTEXTILE

BERM EMBANKMENT TOES

EXISTING RIPRAP

500-KG RIPRAP

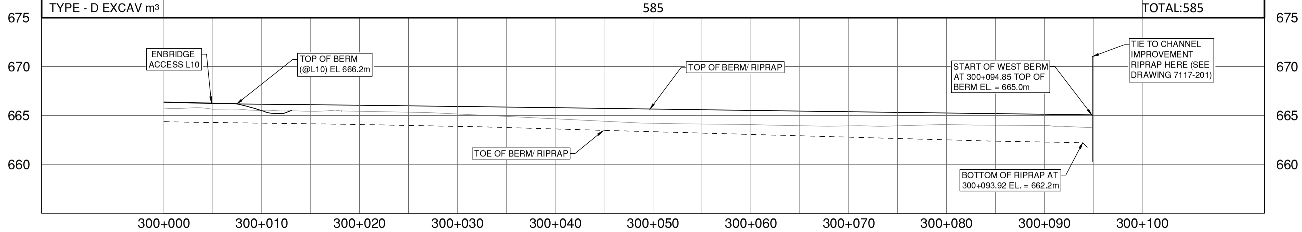
250-KG RIPRAP

WEST TRAINING BERM WORKPOINTS				WEST TRAINING BERM WORKPOINTS			
WP	EASTING	NORTHING	ELEVATION	WP	EASTING	NORTHING	ELEVATION
WP505	542969.06	6162046.89	665.19	WP706	542896.30	6162050.12	666.14
WP506	542949.05	6162047.13	665.45	WP707	542892.49	6162059.04	666.35
WP507	542939.05	6162046.85	665.59	WP801	542968.85	6162054.49	662.39
WP508	542909.06	6162046.03	665.98	WP802	542948.86	6162054.17	662.93
WP509	542902.90	6162045.86	666.06	WP803	542938.86	6162053.60	663.21
WP510	542895.02	6162048.58	666.14	WP804	542908.89	6162052.03	663.98
WP604	542969.12	6162044.50	664.00	WP805	542902.74	6162051.79	664.10
WP605	542949.14	6162043.69	663.73	WP806	542898.78	6162053.09	664.20
WP606	542939.14	6162043.40	663.86	WP807	542896.42	6162059.64	664.36
WP607	542909.10	6162044.50	665.22	WP901	542968.78	6162057.01	662.38
WP608	542902.95	6162044.31	665.29	WP902	542948.79	6162056.41	662.93
WP701	542969.00	6162048.89	665.19	WP903	542938.80	6162055.84	663.21
WP702	542948.99	6162049.13	665.45	WP904	542908.82	6162054.76	663.98
WP703	542938.99	6162048.85	665.59	WP905	542902.66	6162054.60	664.10
WP704	542909.00	6162048.02	665.98	WP906	542900.56	6162055.22	664.20
WP705	542902.85	6162047.85	666.06	WP907	542899.12	6162060.05	664.36

500 SERIES WORKPOINTS DEFINE THE TOP OF BERMS
600 SERIES WORKPOINTS DEFINE THE TOE OF BERMS
700 SERIES WORKPOINTS DEFINE THE TOP OF 250-KG RIPRAP BACKSLOPE
800 SERIES WORKPOINTS DEFINE THE BOTTOM OF 250-KG RIPRAP BACKSLOPE
900 SERIES WORKPOINTS DEFINE THE TOE OF 250-KG RIPRAP APRON

WEST BERM ALIGNMENT						
SEGMENT	START STA.	START E.	START N.	START TANGENT	LENGTH	RADIUS
L6	300+000.00	542891.49	6162058.89	171°22'53.51"	2.95	
C4	300+002.95	542891.93	6162055.98	171°22'53.51"	15.55	10.736
L7	300+018.49	542902.84	6162046.85	088°25'09.25"	56.19	
L8	300+074.69	542959.01	6162048.40	092°57'38.45"	10.03	
L9	300+084.71	542969.03	6162047.89	097°52'12.33"	10.14	

250-KG RIPRAP m³	820	TOTAL:820
EMBANKMENT m³	450	TOTAL:450
TYPE - D EXCAV m³	585	TOTAL:585



PROFILE - WEST TRAINING BERM
SCALE = 1:250

NOTES:

1. ALL ELEVATIONS AND DISTANCES ARE GIVEN IN METRES
2. EMBANKMENT QUANTITIES SHOWN REPRESENT COMPACTED (NEATLINE) CONDITIONS.
3. CROSS-SECTIONS ARE PLOTTED LOOKING EAST
4. RIPRAP SPECIFICATIONS AND INSTALLATION SHALL CONFORM TO THE MINISTRY STANDARD SPECIFCATIONS FOR HIGHWAY CONSTRUCTION SECTION 205
5. THE BACKSLOPE OF ALL RIPRAP SHALL BE LINED WITH A CLASS I NON-WOVEN GEOTEXTILE (NILEX 4512 OR EQUIVALENT). NO GEOTEXTILE SHALL BE PLACED HORIZONTALLY ON THE UNDERSIDE OF THE TRENCH
6. EXSITING RIPRAP SHALL BE REMOVED AS NOTED AND CAN BE RE-USED IF APPROVED BY THE MINISTRY REPRESENTATIVE
7. BERM EMBANKMENTS SHALL BE CONSTRUCTED ON A CLEARED, GRUBBED AND STRIPPED SURFACE; FILL SHALL BE PLACED IN CONFORMANCE WITH THE MINISTRY STANDARD SPECIFICATION FOR HIGHWAY CONSTRUCTION SECTION 201.37

nhc northwest hydraulic consultants
30 Gostick Place
North Vancouver, BC V7M 3G3
Canada
Office: 604.980.6011
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R E V I S I O N S

BRITISH COLUMBIA

Ministry of Transportation & Infrastructure
Southern Interior Region

NORTH PEACE DISTRICT
HIGHWAY No. 97

FISHER CREEK BRIDGE No. 7117
WEST TRAINING BERM DETAILS

PERMIT TO PRACTICE
NORTHWEST HYDRAULIC CONSULTANTS LTD.
Signature ______________________
Date ______________________
PERMIT NUMBER: 1003221
The Association of Professional Engineers and Geoscientists of British Columbia

PREPARED UNDER THE DIRECTION OF
DES GOOLD, P.ENG.
ENGINEER OF RECORD
DATE

DESIGNED DJG DATE DEC. 2021
CHECKED DJG DATE DEC. 2021
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FILE No.	PROJECT No.	REG.	DRAWING No.
	37479-0000	NR	7117-202

CANCEL PRINTS BEARING PREVIOUS LETTER

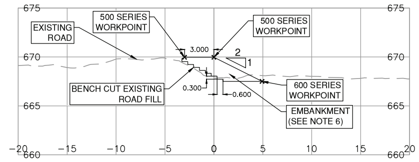
H-308J-r2-c(07-08)

PLAN - EAST TRAINING BERM

SCALE = 1:500

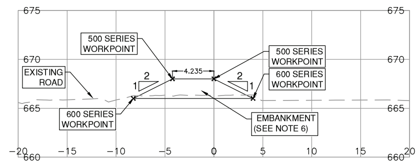
LEGEND

FINISHED CHANNEL/ BERM SURFACE	
NON-WOVEN GEOTEXTILE	
BERM EMBANKMENT TOES	
EXISTING RIPRAP	
500-KG RIPRAP	
250-KG RIPRAP	



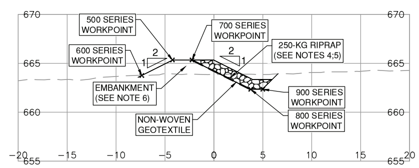
TYPICAL SECTION - TIE-IN TO EAST SERVICE ROAD

SCALE = 1:250



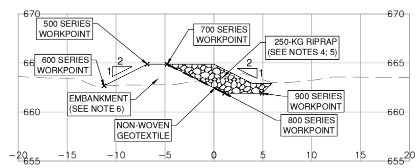
TYPICAL SECTION - STA 400+007.284 TO STA400+063.188

SCALE = 1:250



TYPICAL SECTION - STA 400+063.188 TO STA 40219.300

SCALE = 1:250



TYPICAL SECTION - END-KEY

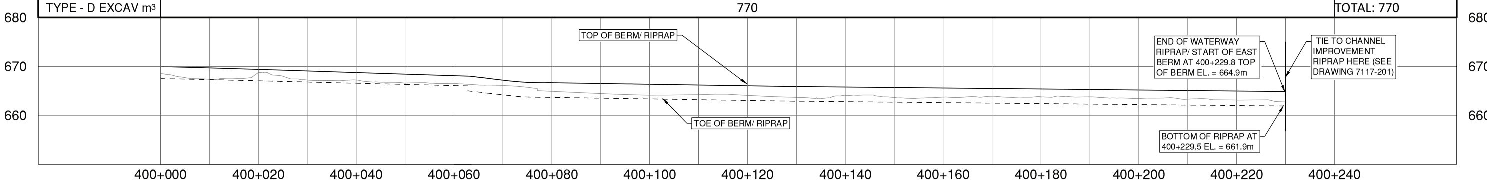
SCALE = 1:250

EAST TRAINING BERM WORKPOINTS				EAST TRAINING BERM WORKPOINTS			
WP	EASTING	NORTHING	ELEVATION	WP	EASTING	NORTHING	ELEVATION
WP513	543043.92	6162090.58	664.98	WP619	543064.26	6162227.20	667.19
WP514	543094.08	6162165.85	665.90	WP620	543032.36	6162232.07	667.43
WP515	543099.49	6162180.00	666.13	WP621	543038.84	6162242.48	667.11
WP516	543098.51	6162194.25	666.35	WP622	543029.20	6162234.40	667.69
WP517	543091.22	6162207.54	666.58	WP623	543037.29	6162243.16	667.29
WP518	543079.73	6162216.02	667.05	WP624	543025.82	6162238.40	667.77
WP519	543072.49	6162219.47	668.00	WP625	543036.29	6162244.34	667.35
WP520	543070.59	6162215.68	666.89	WP626	543024.11	6162241.67	667.93
WP521	543062.20	6162223.58	668.36	WP627	543035.49	6162245.78	667.44
WP522	543060.71	6162220.97	668.36	WP628	543020.86	6162248.18	668.10
WP523	543036.52	6162238.48	669.31	WP629	543030.88	6162250.81	668.74
WP524	543035.01	6162235.88	669.31	WP708	543042.25	6162091.69	664.98
WP525	543034.41	6162240.04	669.41	WP709	543092.42	6162166.96	665.90
WP526	543032.37	6162237.83	669.41	WP710	543097.51	6162180.29	666.13
WP527	543032.37	6162242.49	669.53	WP711	543097.54	6162194.02	666.35
WP528	543029.83	6162240.90	669.53	WP712	543089.72	6162206.21	666.58
WP529	543031.55	6162244.06	669.59	WP713	543078.91	6162214.20	667.05
WP530	543028.80	6162242.86	669.59	WP714	543071.60	6162217.68	668.00
WP531	543028.97	6162249.97	669.78	WP808	543037.35	6162094.96	662.04
WP532	543026.22	6162248.77	669.78	WP809	543087.43	6162170.28	662.91
WP533	543026.75	6162253.43	669.87	WP810	543091.58	6162181.13	663.14
WP534	543024.51	6162251.43	669.87	WP811	543090.83	6162192.06	663.35
WP535	543023.58	6162256.02	669.97	WP812	543085.23	6162202.24	663.58
WP536	543022.07	6162253.42	669.97	WP813	543076.43	6162208.74	664.05
WP611	543047.23	6162088.37	662.99	WP814	543068.80	6162212.11	665.00
WP612	543098.03	6162163.22	663.53	WP908	543036.32	6162095.65	662.01
WP613	543103.42	6162179.44	664.15	WP909	543086.40	6162170.97	662.90
WP614	543102.79	6162195.48	664.12	WP910	543090.34	6162181.31	663.13
WP615	543094.18	6162210.16	664.60	WP911	543089.63	6162191.71	663.35
WP616	543080.56	6162217.84	666.04	WP912	543084.31	6162201.42	663.58
WP617	543074.28	6162223.05	666.41	WP913	543075.92	6162207.61	664.05
WP618	543058.64	6162217.35	666.81	WP914	543068.35	6162211.21	665.00

NOTES:

1. ALL ELEVATIONS AND DISTANCES ARE GIVEN IN METRES
2. EMBANKMENT QUANTITIES SHOWN REPRESENT COMPACTED (NEATLINE) CONDITIONS.
3. CROSS-SECTIONS ARE PLOTTED LOOKING SOUTH OR WEST
4. RIPRAP SPECIFICATIONS AND INSTALLATION SHALL CONFORM TO THE MINISTRY STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION SECTION 205
5. THE BACKSLOPE OF ALL RIPRAP SHALL BE LINED WITH A CLASS I NON-WOVEN GEOTEXTILE (NILEX 4512 OR EQUIVALENT). NO GEOTEXTILE SHALL BE PLACED BENEATH THE HORIZONTAL TOES OF RIPRAP
6. BERM EMBANKMENTS SHALL BE CONSTRUCTED ON A CLEARED, GRUBBED AND STRIPPED SURFACE; FILL SHALL BE PLACED IN CONFORMANCE WITH THE MINISTRY STANDARD SPECIFICATION FOR HIGHWAY CONSTRUCTION SECTION 201.37

250-KG RIPRAP m^3	1200	TOTAL: 1200
EMBANKMENT m^3	1720	TOTAL: 1720
TYPE - D EXCAV m^3	770	TOTAL: 770



PROFILE VIEW - EAST TRAINING BERM

SCALE=1:500

EAST BERM ALIGNMENT							EAST BERM ALIGNMENT						
SEGMENT	START STA.	START E.	START N.	START TANGENT	LENGTH	RADIUS	SEGMENT	START STA.	START E.	START N.	START TANGENT	LENGTH	RADIUS
C8	400+000.00	543022.82	6162254.72	120°08'14.90"	7.28	11.500	C5	400+063.19	543072.04	6162218.58	116°37'15.08"	8.06	206.764
L12	400+007.28	543027.59	6162249.37	156°25'40.62"	6.46		C6	400+071.25	543079.32	6162215.11	114°23'15.20"	57.60	33.236
C7	400+013.74	543030.17	6162243.46	156°25'40.62"	8.55	13.500	L10	400+128.85	543093.25	6162166.40	213°40'59.26"	90.45	
L13	400+022.29	543035.77	6162237.18	120°08'14.90"	27.97		L15	400+219.30	543043.09	6162091.14	196°21'39.67"	6.40	
C9	400+050.26	543059.96	6162223.14	120°08'14.90"	1.77	10.000	L16	400+225.70	543041.28	6162084.99	201°13'41.67"	4.13	
L14	400+052.04	543061.57	6162222.38	109°58'06.82"	11.15								

PERMIT TO PRACTICE

NORTHWEST HYDRAULIC CONSULTANTS LTD.

Signature ____________________

Date ____________________

PERMIT NUMBER: 1003221

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R E V I S I O N S

BRITISH COLUMBIA

Ministry of Transportation & Infrastructure
Southern Interior Region

NORTH PEACE DISTRICT

HIGHWAY No. 97

FISHER CREEK BRIDGE No. 7117
EAST TRAINING BERM DETAILS

PREPARED UNDER THE DIRECTION OF

DES GOOLD, P.ENG.

ENGINEER OF RECORD

DATE

DESIGNED	DJG	DATE	DEC. 2021
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	37479-0000	NR	7117-203

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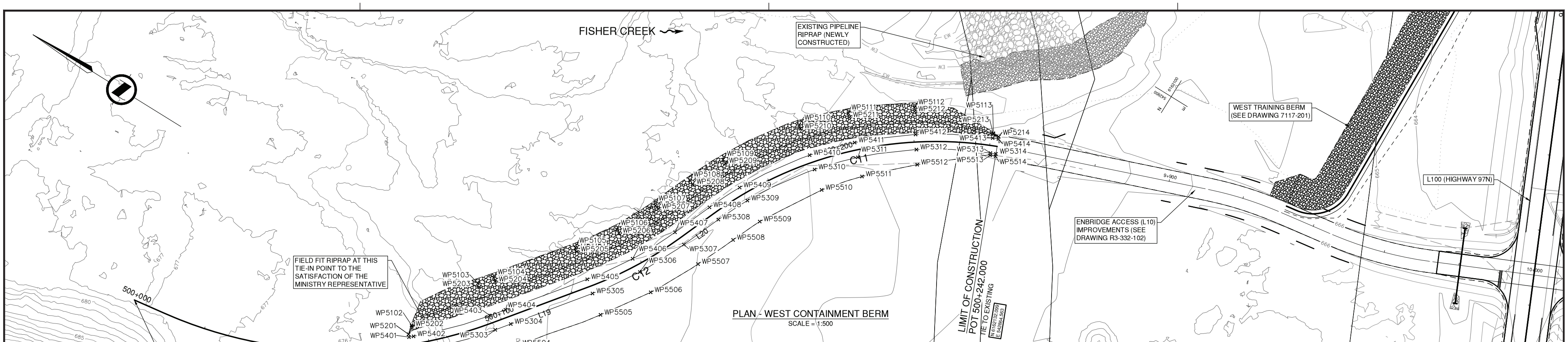


PLAN - WEST CONTAINMENT BERM

SCALE = 1:500

WEST CONTAINMENT BERM WORKPOINTS			
WP	EASTING	NORTHING	ELEV.
WP5101	542740.38	6162237.92	675.20
WP5102	542742.85	6162238.49	674.55
WP5103	542761.49	6162229.50	671.21
WP5104	542764.88	6162226.71	671.14
WP5105	542783.03	6162212.52	670.78
WP5106	542792.95	6162205.78	670.57
WP5107	542803.70	6162200.43	670.36
WP5108	542814.07	6162196.11	670.19
WP5109	542823.42	6162191.71	670.04
WP5110	542841.83	6162179.52	669.09
WP5111	542851.27	6162170.10	668.39
WP5112	542861.78	6162156.16	667.47
WP5113	542867.00	6162134.79	668.86
WP5114	542866.97	6162133.10	669.09

WEST CONTAINMENT BERM WORKPOINTS			
WP	EASTING	NORTHING	ELEV.
WP5201	542740.38	6162237.92	675.20
WP5202	542742.65	6162238.31	674.55
WP5203	542760.83	6162228.64	671.21
WP5204	542764.22	6162225.85	671.14
WP5205	542782.37	6162211.66	670.78
WP5206	542792.41	6162204.84	670.57
WP5207	542803.29	6162199.42	670.36
WP5208	542813.66	6162195.11	670.19
WP5209	542822.92	6162190.75	670.04
WP5210	542841.14	6162178.68	669.09
WP5211	542850.49	6162169.34	668.39
WP5212	542860.89	6162155.54	667.47
WP5213	542866.85	6162134.72	668.86
WP5214	542866.97	6162133.10	669.09

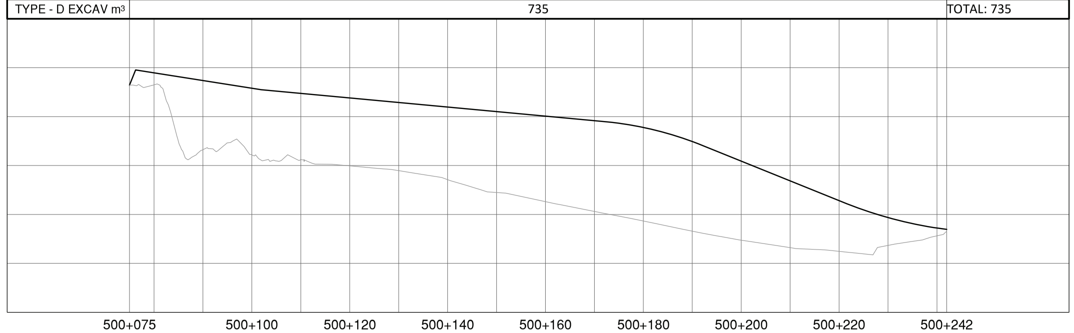
WEST CONTAINMENT BERM WORKPOINTS			
WP	EASTING	NORTHING	ELEV.
WP5301	542736.79	6162234.78	675.29
WP5302	542737.63	6162233.83	675.91
WP5303	542753.46	6162219.09	675.24
WP5304	542756.94	6162216.41	675.10
WP5305	542775.18	6162202.34	674.67
WP5306	542786.58	6162194.71	674.42
WP5307	542798.90	6162188.68	674.17
WP5308	542809.30	6162184.43	673.96
WP5309	542817.61	6162180.57	673.79
WP5310	542833.96	6162169.82	672.79
WP5311	542842.70	6162161.81	671.81
WP5312	542852.61	6162149.77	670.52
WP5313	542862.14	6162132.68	669.43
WP5314	542862.72	6162131.33	669.39

WEST CONTAINMENT BERM WORKPOINTS			
WP	EASTING	NORTHING	ELEV.
WP5401	542739.81	6162237.41	675.29
WP5402	542740.62	6162236.50	675.91
WP5403	542755.91	6162222.26	675.24
WP5404	542759.38	6162219.58	675.10
WP5405	542777.62	6162205.51	674.67
WP5406	542788.57	6162198.18	674.42
WP5407	542800.41	6162192.38	674.17
WP5408	542810.81	6162188.13	673.96
WP5409	542819.46	6162184.12	673.79
WP5410	542836.48	6162172.93	672.79
WP5411	542845.58	6162164.59	671.81
WP5412	542855.89	6162152.06	670.52
WP5413	542865.81	6162134.27	669.43
WP5414	542866.41	6162132.87	669.39

WEST CONTAINMENT BERM WORKPOINTS			
WP	EASTING	NORTHING	ELEV.
WP5501	542736.24	6162234.30	675.22
WP5502	542736.56	6162232.88	675.19
WP5503	542750.01	6162214.61	672.41
WP5504	542753.24	6162211.62	672.08
WP5505	542771.50	6162197.57	671.66
WP5506	542783.55	6162189.45	671.39
WP5507	542796.49	6162182.78	670.98
WP5508	542806.79	6162178.28	670.64
WP5509	542814.63	6162174.87	670.57
WP5510	542830.35	6162165.38	669.93
WP5511	542838.98	6162158.22	669.23
WP5512	542849.33	6162147.48	668.52
WP5513	542861.59	6162132.44	669.13
WP5514	542862.16	6162131.10	669.09

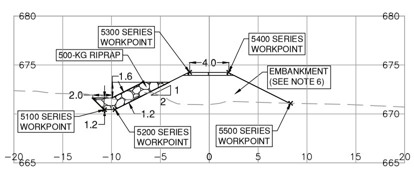
WEST CONTAINMENT BERM ALIGNMENT						
SEGMENT	START STA.	START E.	START N.	START TANGENT	L.	R.
L19	500+097.54	542754.69	6162220.68	127°39'05.60"	27.42	
C12	500+124.96	542776.40	6162203.92	127°39'05.60"	26.92	100.00
L20	500+151.88	542799.65	6162190.53	112°13'40.75"	11.24	
C11	500+163.12	542810.05	6162186.28	112°13'40.75"	82.92	100.00

500-KG RIPRAP m^3	1205	TOTAL: 1205
EMBANKMENT m^3	3900	TOTAL: 3900
TYPE - D EXCAV m^3	735	TOTAL: 735



PROFILE VIEW - WEST CONTAINMENT BERM

SCALE=1:500
V. EX. = 5X



TYPICAL SECTION - WEST CONTAINMENT BERM

SCALE = 1:250

LEGEND

FINISHED CHANNEL/ BERM SURFACE
NON-WOVEN GEOTEXTILE
BERM EMBANKMENT TOES
EXISTING RIPRAP
500-KG RIPRAP
250-KG RIPRAP

NOTES:

1. ALL ELEVATIONS AND DISTANCES ARE GIVEN IN METRES
2. EMBANKMENT QUANTITIES SHOWN REPRESENT COMPACTED (NEATLINE) CONDITIONS.
3. CROSS-SECTIONS ARE PLOTTED LOOKING SOUTH OR WEST
4. RIPRAP SPECIFICATIONS AND INSTALLATION SHALL CONFORM TO THE MINISTRY STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION SECTION 205
5. THE BACKSLOPE OF ALL RIPRAP SHALL BE LINED WITH A CLASS I NON-WOVEN GEOTEXTILE (NILEX 4512 OR EQUIVALENT). NO GEOTEXTILE SHALL BE PLACED BENEATH THE HORIZONTAL TOES OF RIPRAP
6. BERM EMBANKMENTS SHALL BE CONSTRUCTED ON A CLEARED, GRUBBED AND STRIPPED SURFACE; FILL SHALL BE PLACED IN CONFORMANCE WITH THE MINISTRY STANDARD SPECIFICATION FOR HIGHWAY CONSTRUCTION SECTION 201.37

nhc northwest hydraulic consultants
30 Gostick Place
North Vancouver, BC V7M 3G3
Canada
Office: 604.980.6011
Fax: 604.980.9264
www.nhcweb.com

Rev	Date	Description	Init

REVISIONS

BRITISH COLUMBIA
Ministry of Transportation & Infrastructure
Southern Interior Region

NORTH PEACE DISTRICT
HIGHWAY No. 97

FISHER CREEK BRIDGE No. 7117
WEST CONTAINMENT BERM DETAILS

PERMIT TO PRACTICE
NORTHWEST HYDRAULIC CONSULTANTS LTD.
Signature ____________
Date ____________
PERMIT NUMBER: 1003221
The Association of Professional Engineers and Geoscientists of British Columbia

PREPARED UNDER THE DIRECTION OF
DES GOOLD, P.ENG.
ENGINEER OF RECORD
DATE

DESIGNED DJG DATE DEC. 2021
CHECKED DJG DATE DEC. 2021
DRAWN CZZ DATE DEC. 2021
SCALE AS SHOWN
NEGATIVE No.

FILE No.	PROJECT No.	REG.	DRAWING No.
	37479-0000	NR	7117-204

CANCEL PRINTS BEARING PREVIOUS LETTER

H-308j-r2-c(07-08)