HEROLD ENGINEERING

Addendum

Attn: Bidders

DATE: July 3, 2020 **PROJECT No.:** 0837-067
PROJECT NAME:
Benson Falls Regional Park Access Improvement
Tender 20-037

From: Ali Sadeghi, P.Eng. 2 Pages Following

AD-02

1. *This Addendum shall be read in conjunction with and considered as an integral part of the Contract Documents; revisions supersede the information contained in the original drawings, specifications or previously issued Addendum.*
2. *Tender Price submitted shall include all items of this Addendum.*
3. *No consideration will be allowed for any extras due to any bidder not being familiar with the contents of this Addendum.*

Addendum Information: Changes noted in **RED**

CLARIFICATION:

Amended drawings have been issued with further clarification and new details, including revisions to the 'GENERAL NOTES'. **(attached)**

APPENDICES:

The following appendix has been ADDED **(attached)**:

- Tetra Tech – Preliminary Geotechnical Engineering Assessment for Benson Creek Falls Regional Park, December 2017;
- Tetra Tech – Construction Memo - Site Reconnaissance for Benson Creek Crossing and Falls Site, September 2019; and
- Tetra Tech – Foundation Recommendations for Benson Creek Crossing, July 2020.

QUESTIONS & ANSWERS

Q1: *The note on page S01 -5.0 states the contractor is to have their engineer do the design connections and to use min 19 mm bolts. Do we need to have an engineer review and design the connection details or was that accounted for in your design?*

A1: Section 5.7 refers to connections in stair and platform elements not detailed on their respective sheets. For the bridge, connections refer to notes and details on sheets S31 and S32. Bidders must retain the services of a professional engineer to provide sealed drawings for connection details that are different than shown.

Q2: *Will seal engineer plans be provided on the IFC plan set, or will the aluminum fabricator have to have a third party engineer seal the designs?*

A2: See Addendum 1 answer. Sealed IFC drawings will be provided to the successful bidder.

Q3: *How is the bridge decking attached to the bridge frame in the field?*

A3: For attachment of decking, contractors shall provide L51x51x4.8 mm ledger angles on floor beams as required and utilize clips, hold down brackets or welds as required to attach decking.

Types of decking besides “dimple tread” are acceptable provided that they are 300 mm x 50 mm x 3.2 mm sections. Fastening of decking at all floor beams is required

Q4: *Can root structures be compromised or is the work expected to be field fit around them?*

A4: It’s expected that the proposed works be field fit around the existing roots structures to ensure the least amount of damage to the existing trees. There may circumstances where this may not be practical or feasible and this will be reviewed by project consultants and RDN on a case by case basis.

Q5: *Will Steel stairs be acceptable as an alternative to aluminum stairs?*

A5: The bidders could include alternate structures in their proposal if they desired. Please note, all engineering for an alternate structure will have to be included in the bidder’s proposal and no additional compensation will be awarded for design. The designs shall be completed by a Professional Engineer registered in the province of British Columbia. The Owner (Regional District of Nanaimo) at their discretion may accept or reject the alternate structures.

Q6: *The drawings show a conflict of length in the bridge can you confirm which length is correct?*

A6: Please see attached amended drawings. Note the overall length of the structure remains unchanged. The changes reflect the location of the proposed splice locations.

Q7: *Sheet S23 stair 2 elevation has a note "concrete step and landing" pointing at the 4th stair tread from the bottom. Is this accurate?*

A7: Please see attached amended drawings. The concrete landing is located at the foot of the stairs only and no concrete steps are required.

Q8: *Is it acceptable to have a 3rd party engineer sign off the fabrication in lieu of the CWB qualifications?*

A8: Third-party engineer sign off will not be acceptable. CWB certification is a requirement for all fabricators for this project and this standard will not be omitted.

Q9: *In the posted AD-01, Q3 mentions PMI, is this meant to be Magnetic Particle Inspection or Positive Material Identification*

A9: PMI is Positive Material Identification and will be a requirement for this project.

Q10: *Please provide more detail on the fence mesh type on drawing S023 typical section Is this stairs only or stairs and bridge*

A10: There is no requirement for mesh fencing for the bridge and the requirements for the stairs have been removed for this project.

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Q11: *Will it be possible to long line the bridge into place with a helicopter or is the canyon too narrow?*

A11: It may very well be possible to navigate the structures through the canyon and the trees. That said, we advise the bidders to contact the helicopter companies specialized in longline transportation and discuss the site attributes and limits of their machines to ensure this approach is feasible. It is the responsibility of the bidders to ensure their method and approach to construction is feasible.

Q12: *What type of deck pattern do you want for the stair treads and bridge decking? It appears to be bar grating, but would you accept diamond or round grating?*

A12: Dimond or round grading for the bridge decking will be acceptable. “Plan Stair Detail” on sheet S23 provides the specification for the stairs tread and landings. Dimond or round grading will not be acceptable for these sections.

Q13: *Will animal transport ie/ Donkeys/ Horses be acceptable for material transport on this project?*

A13: The use of animals for the transportation of the material to the project site will be acceptable on the condition that all WorkSafe BC standards of care are followed and the welfare of the animals is effectively addressed and considered. Any damage to the trail surface or condition as a result of the use of animals for transportation is the responsibility of the bidder and will need to be repaired to the acceptance of RDN and Consultants.

Q14: *Our Surety agency would like to know which e-bond platform you would like them to use?*

A14: No preference. Surety Association of Canada lists these providers:
https://suretycanada.com/SAC/Surety-Bonds/E-Bonding-Assessments.aspx

END OF AD-02

Per: _____
Ali Sadeghi, P.Eng.

CC: Mark Dobb- RDN
Kurtis Felker- RDN

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GENERAL NOTES:

1.0 GENERAL

1.1 DESIGN LOADS

LIVE LOAD: 4.0 KPa PER CHBDC

SNOW LOAD: Ss = 2.1 KPa
Sr = 0.4 KPa

1.2 READ STRUCTURAL DRAWINGS IN CONJUNCTION WITH ALL OTHER CONTRACT DRAWINGS AND DOCUMENTS. REPORT ANY CONFLICTS TO THE ENGINEER BEFORE COMMENCING WORK.

1.3 VERIFY ALL DIMENSIONS AND ELEVATIONS PRIOR TO CONSTRUCTION.

1.4 NOTIFY ENGINEER 48 HOURS IN ADVANCE FOR INSPECTION OF STRUCTURAL CONNECTIONS BEFORE COVERING UP.

1.5 CONTRACTOR'S RESPONSIBILITY: THESE DRAWINGS SHOW COMPLETED STRUCTURAL COMPONENTS OF THE BRIDGE, STAIRS AND STEPS. THE REQUIRED TEMPORARY BRACING AND SHORING TO PERFORM THE WORK SAFELY IS THE RESPONSIBILITY OF THE CONTRACTOR.

1.6 ENVIRONMENTAL WORK PROCEDURES, TIMING, AND SPECIAL PRECAUTIONS SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS AND LIMITATIONS OF THE FEDERAL DEPARTMENT OF FISHERIES AND OCEANS, AND THE PROVINCIAL MINISTRY OF WATER, LAND AND AIR PROTECTION.

1.7 SUBMIT SHOP DRAWINGS FOR REVIEW PRIOR TO FABRICATION.

1.8 ELEVATIONS ARE IN METRES AND DIMENSIONS ARE IN MILLIMETRES.

1.9 UNDER NO CIRCUMSTANCES ARE DRAWINGS TO BE SCALED.

1.10 QUALITY ASSURANCE QUALIFICATION OF CONTRACTOR AND SUPERINTENDENT: THE CONTRACTOR SHALL BE FULLY CONVERSANT WITH ALL SAFETY PROCEDURES AND REGULATIONS RELATING TO CONSTRUCTION, AND SHALL EMPLOY STAGING AND OTHER SAFETY PROVISIONS AS SPECIFIED ELSEWHERE AND REQUIRED BY THE WORKERS COMPENSATION BOARD REGULATIONS. C

1.11 SHOP DRAWINGS MUST BE SUBMITTED FOR APPROVAL A MINIMUM OF 2 WEEKS PRIOR TO START OF FABRICATION, FABRICATION MUST NOT COMMENCE PRIOR TO APPROVAL OF THE SHOP DRAWINGS BY THE OWNER'S REPRESENTATIVE.

1.12 ALUMINUM MILL TEST CERTIFICATES AND WELD INSPECTION REPORTS MUST BE SUBMITTED A MINIMUM OF 72 HOURS PRIOR TO TRANSPORTING COMPONENTS TO SITE. COMPONENTS MUST NOT BE SHIPPED PRIOR TO APPROVAL OF CERTIFICATES AND REPORT BY OWNER'S REPRESENTATIVE.

1.13 THE CONTRACTOR MUST PROVIDE 48 HOURS NOTICE TO THE OWNER'S REPRESENTATIVE FOR THE FOLLOWING REVIEWS TO BE PERFORMED.

- FABRICATION REVIEW, TO BE PERFORMED ONCE FABRICATION IS SUBSTANTIALLY COMPLETE AND PRIOR TO SHIPPING OF COMPONENTS.
- CONCRETE PRE-POUR REVIEW, TO BE PERFORMED ONCE REINFORCEMENT IS PLACED AND PRIOR TO CASTING OF ITEMS.
- FINAL INSTALLATION REVIEW, TO BE PERFORMED ONCE MAJORITY OF THE STRUCTURE IS INSTALLED.

2.0 ENVIRONMENTAL CONSTRUCTION REQUIREMENTS

2.1 ALL TREES AND ROOTS TO BE PRESERVED UNLESS IDENTIFIED. LOWER BRANCHES ON EXISTING TREES MAY BE PRUNED IF NECESSARY, PER ISA PRUNING GUIDELINES.

ALL EXCESS MATERIAL FROM CONSTRUCTION TO BE DISPOSED OF BY CONTRACTOR OFF SITE, IN ACCORDANCE WITH ALL LOCAL, PROVINCIAL AND FEDERAL REGULATIONS.

3.0 CAST-IN-PLACE CONCRETE

3.1 ALL CONCRETE WORK SHALL CONFORM TO THE REQUIREMENTS OF CAN/CSA A23.1-06 AND A23.2-06.

3.2 CONCRETE MIXES SHALL CONFORM TO CAN/CSA A23.1-06 AND A23.2-06 AND SHALL HAVE THE FOLLOWING PROPERTIES:

CLASS	28 DAY STRENGTH	MAXIMUM AGGREGATE SIZE	MAXIMUM SLUMP	AIR CONTENT	EXPOSURE
ALL ITEMS	35 MPa	19mm	75mm	4% TO 7%	F-1

3.4 REINFORCING STEEL TO CONFORM TO CSA SPECIFICATION G30.18M, GRADE 400, UNLESS NOTED OTHERWISE.

3.5 LAP OF BARS FOR SPLICES TO BE 40 x BAR DIAMETER, UNLESS NOTED OTHERWISE.

3.6 PROVIDE A 20mm CHAMFER ON ALL EXPOSED EDGES OF CONCRETE, UNLESS NOTED OTHERWISE.

3.7 CONCRETE FINISHES SHALL BE IN ACCORDANCE WITH CAN/CSA A23.1.

3.8 ALL CONCRETE CURING SHALL BE IN ACCORDANCE WITH CAN/CSA A23.1. SPECIAL PRECAUTIONS SHALL BE TAKEN AS NOTED IN CSA A23.1 FOR PLACING AND CURING CONCRETE ABOVE 27° C AND BELOW 5° C.

3.9 MINIMUM CONCRETE COVER TO REINFORCING SHALL BE 50mm, UNLESS NOTED OTHERWISE.

3.10 REINFORCEMENT ABBREVIATIONS:

H2E HOOK 2-ENDS, STANDARD HOOK
H1E HOOK 1-END, STANDARD HOOK
H2E600 HOOK 2-ENDS, 600 LONG HOOKS
15M1600 15M STRAIGHT BAR, 1600 LONG

4.0 GROUT

4.1 GROUT TO BE NON SHRINK, 50MPa.

5.0 ALUMINUM

5.1 ALL STAIR AND PLATFORM MATERIAL TO BE ALUMINUM UNLESS NOTED OTHERWISE. ALUMINUM SHALL BE 6061-T6.

5.2 STRUCTURES TO BE DESIGNED AND FABRICATED IN ACCORDANCE WITH CSA-S157-17.

5.3 WELDING SHALL BE IN ACCORDANCE WITH CSA W59.2-18. C

5.4 PROVIDE A MINIMUM 6mm FILLET WELD OR EQUIVALENT FOR CONNECTIONS, UNLESS NOTED OTHERWISE.

5.5 GRIND SMOOTH ALL SHARP EDGES AND THE WALKING SURFACE OF THE STAIR TREADS AND PLATFORMS.

5.6 FOR CORROSION PROTECTION: WHERE ALUMINUM IS IN CONTACT WITH CONCRETE, A UHMW PAD SHALL BE INSTALLED AS A BARRIER BETWEEN THE DISSIMILAR ITEMS.

5.7 BOLTED CONNECTIONS SHALL BE USED FOR ALL FIELD CONNECTIONS. CONTRACTOR TO DETERMINE LOCATIONS OF BOLTED CONNECTIONS SO AS TRANSPORTATION OF THE MEMBERS TO SITE IS AS EASY AS POSSIBLE. CONNECTIONS TO BE DESIGNED BY CONTRACTOR AND SHOP DRAWINGS SHALL BE SUBMITTED FOR REVIEW. A MINIMUM OF 2-19ø BOLTS, IS REQUIRED. ALL BOLTS TO ASTM A325 GALVANIZED.

6.0 STEEL

6.1 ALL FABRICATED AND MISCELLANEOUS METAL TO BE GRADE 300W AND GALVANIZED IN ACCORDANCE WITH ASTM A123M.

6.2 WHERE WELD SIZE NOT SHOWN, USE MINIMUM 6mm FILLET.

6.3 ALL WELDING SHALL BE IN ACCORDANCE WITH CSA W59-1989 (R2001) AND SHALL BE PERFORMED BY FABRICATORS "FULLY APPROVED" BY THE CANADIAN WELDING BUREAU UNDER CSA W55.3-19659 (R1998). FABRICATING SHOP TO HAVE A MINIMUM DIVISION 2.1 CERTIFICATION BY THE CANADIAN WELDING BUREAU TO THE REQUIREMENTS OF CSA W47.1-92 (R2001) AND CSA W55.3-1965 (R1998) FOR RESISTANCE WELDING OF STRUCTURAL COMPONENTS. THE FABRICATOR SHALL SUBMIT PROOF OF CERTIFICATION PRIOR TO START OF WORK.

7.0 WELDING INSPECTIONS

7.1 ALL WELD INSPECTIONS ARE TO BE PERFORMED BY A THIRD PARTY COMPANY RETAINED BY THE CONTRACTOR AND CERTIFIED TO CSA W178.2

7.2 WELDING SHALL BE INSPECTED AS FOLLOWS:

- FILLET WELDS - OTHER - VISUAL - 25%
- CP WELDS - RADIOGRAPHIC OR ULTRASONIC - 100% C

7.3 ALL FAILURES IDENTIFIED BY THE TESTING AND INSPECTIONS SHALL BE CORRECTED AT THE CONTRACTOR'S EXPENSE. COST OF ADDITIONAL TESTING TO CONFIRM CONFORMANCE WITH SPECIFICATIONS SHALL BE BORNE BY THE CONTRACTOR.

7.4 SUBMIT ALL TEST REPORTS TO HEROLD ENGINEERING FOR REVIEW. DO NOT COVER MEMBERS AND THEIR CONNECTIONS WITHOUT THE APPROVAL OF THE STRUCTURAL ENGINEER.

8.0 TIMBER

8.1 ALL NEW TIMBER TO CONFORM TO CSA-0141-91 "SOFTWOOD LUMBER" TIMBER GRADES AND SPECIES AS FOLLOWS:

MEMBER	(FINISH)	SPECIES	GRADE
CAP/RAILS	(S4S)	CEDAR	GROUP A No. 1, OR BETTER
POST	(ROUGH)	CEDAR	GROUP A No. 1, OR BETTER
STEPS	(ROUGH)	CEDAR	GROUP A No. 1, OR BETTER

8.2 ALL TIMBER CONSTRUCTION, DETAILS AND FASTENINGS SHALL CONFORM FULLY TO CSA 086, CURRENT EDITION.

8.3 PRE-DRILL ALL BOLT AND LAG SCREW SHANK HOLES (BUT NOT LEAD HOLES). BOLT HOLES SHOULD BE FULL LENGTH AND SIZE FOR MACHINE BOLTS.

9.0 MISCELLANEOUS STEEL CONNECTIONS

9.1 BOLTED CONNECTIONS SHALL UTILIZE ASTM A307 GALVANIZED. BOLTS COMPLETE WITH NUTS AND MALLEABLE IRON WASHERS AND RUBBER WASHERS (TO SEPARATE STEEL FROM ALUMINUM), UNLESS OTHERWISE SHOWN ON DRAWINGS.

9.2 ROUGH HARDWARE: BOLTS, NUTS, WASHERS, GALVANIZED FOR EXTERIOR USE. NAILS AND SPIKES TO CONFORM TO CSA B111-1974, S406-92.

9.3 PROVIDE TAPERED WASHERS WHERE CHANNELS HAVE TAPERED FLANGES.

10.0 ADHESIVE ANCHORS

10.1 ALL ANCHORS ARE TO BE INSTALLED IN STRICT ACCORDANCE WITH THE MANUFACTURER'S WRITTEN INSTRUCTIONS.

10.2 UNLESS NOTED OTHERWISE ADHESIVE ANCHORS SHALL BE HILTI 'HAS' ROD. REFER TO DRAWINGS FOR ANCHOR LOCATIONS, SIZES, CENTRES AND EMBEDMENT LENGTH. USE HILTI HY200 MAX OR HILTI HIT RE500 ADHESIVE AS NOTED BELOW.

USE HILTI HIT HY200 MAX WHEN;
A QUICK CURE IS REQUIRED,
CONDITIONS ARE DRY,
HOLES ARE HAMMER DRILLED,
HOLES ARE NOT OVER-SIZED,
BASE MATERIAL TEMPERATURE IS ABOVE 5° CELSIUS.

USE HILTI HIT RE500 WHEN;
EXTENDED WORKING TIME IS REQUIRED AND CURE TIME IS NOT CRITICAL,
HOLES ARE DRILLED USING DIAMOND CORE, PNEUMATIC OR HAMMER DRILLS,
DEEP EMBEDMENT IS SPECIFIED,
THE APPLICATION IS UNDERWATER, OR HOLES ARE OVERSIZED.

10.3 HOLES FOR ADHESIVE ANCHORS SHALL BE CLEANED OUT WITH HIGH PRESSURE AIR AND THEN A BRUSH PRIOR TO ANCHOR INSTALLATION.

10.4 INSTALLERS OF HILTI PRODUCTS SHALL HAVE RECEIVED TRAINING BY HILTI (CANADA) CORP. IN THE USE OF THE SPECIFIED PRODUCTS. THE GENERAL CONTRACTOR SHALL PROVIDE THE DESIGN ENGINEER WITH A LETTER STATING THAT THIS TRAINING HAS BEEN COMPLETED.

11.0 ABBREVIATIONS

CL.	–	CLEAR
℄	–	CENTRELINE
CP.	–	COMPLETE PENETRATION
C/W	–	COMPLETE WITH
DWG.	–	DRAWING
EL.	–	ELEVATION
I.D.	–	INSIDE DIAMETER
LLH	–	LONG LEG HORIZONTAL
LLV	–	LONG LEG VERTICAL
MAX.	–	MAXIMUM
MIN.	–	MINIMUM
N.T.S.	–	NOT TO SCALE
OPP.	–	OPPOSITE
PL	–	PLATE
R	–	RADIUS
SIM.	–	SIMILAR
S.S.	–	STAINLESS STEEL
T.O.	–	TOP OF
TYP.	–	TYPICAL
U/S	–	UNDERSIDE
U.N.O.	–	UNLESS NOTED OTHERWISE
WP	–	WORK POINT

ISSUED FOR ADDENDUM

ISSUES

No.	DATE YYYY.MM.DD	ISSUED FOR
A	2020.04.08	PERMIT
B	2020.06.10	CLIENT REVIEW
C	2020.07.03	ADDENDUM

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DRAFTING REVIEW –
DESIGNED MGCS
DESIGN REVIEW –

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ENGINEERS SEAL

GENERAL NOTES

BENSON CREEK FALLS REGIONAL PARK
FEASIBILITY ASSESSMENT & CONCEPTUAL DESIGN
RECREATION & PARKS PARKSVILLE BC V9P 2X4
REGIONAL DISTRICT OF NANAIMO

HEL PROJECT No.	CLIENT DWG. No.
0837-048	N/A
SCALE: AS SHOWN	PERMIT No.: N/A
HEL DRAWING No.: S01	REVISION: C

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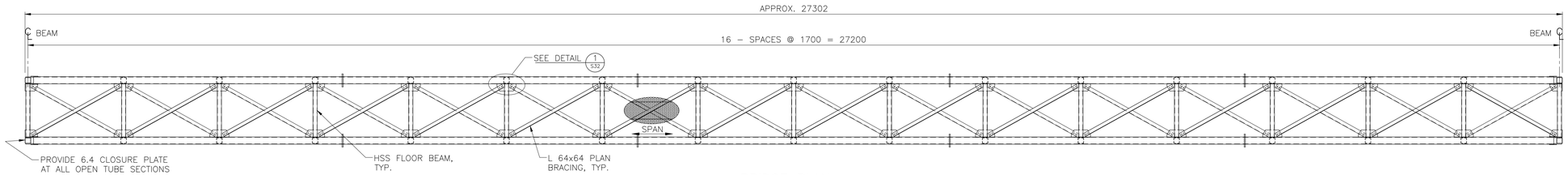
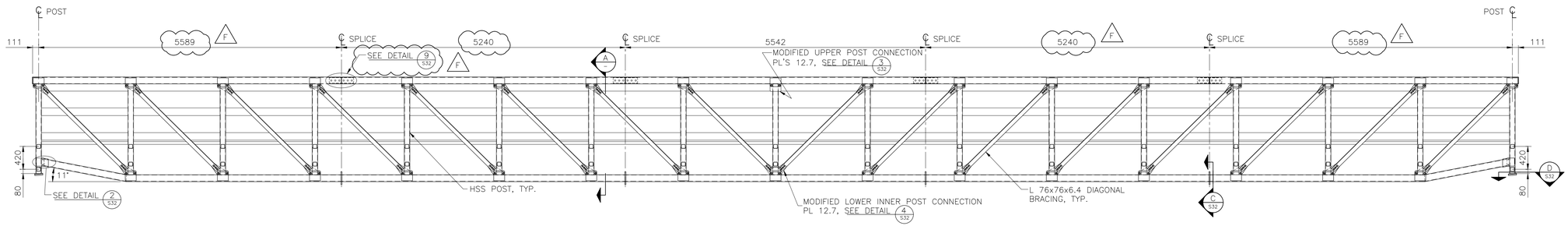
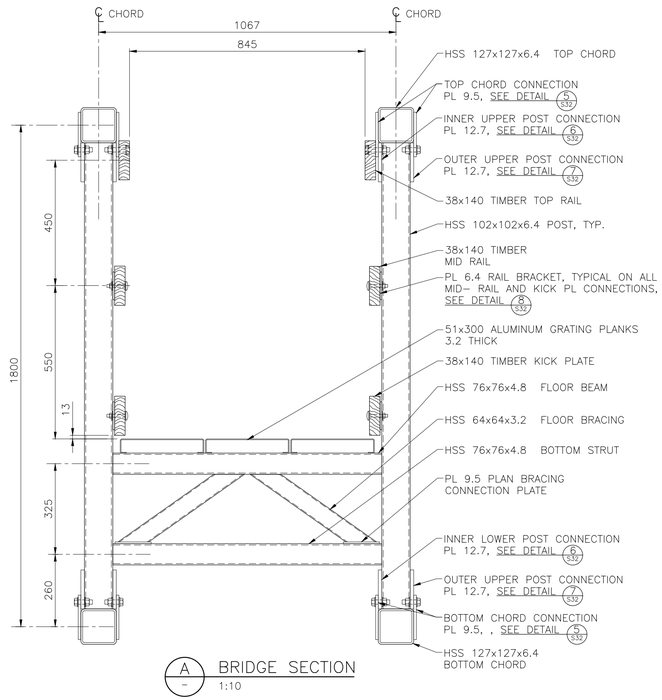


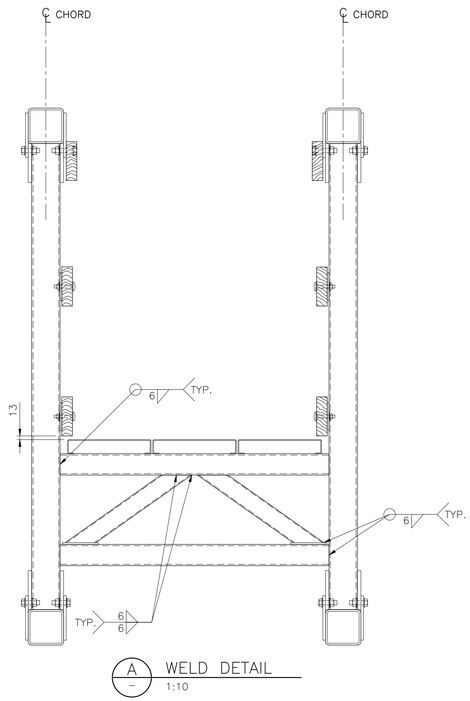
BRIDGE PLAN
1:40



BRIDGE ELEVATION
1:40



A – BRIDGE SECTION
1:10



A – WELD DETAIL
1:10

ISSUED FOR ADDENDUM

NOTES:

1. FOR GENERAL NOTES, SEE DWG. S01
2. ALL ELEVATIONS ARE BASED ON A LOCAL DATUM.
3. PROPOSED CONFIGURATION FOR THE TRUSS SHOWS CHORDS, BRACES AND CROSS FRAMES FABRICATED SEPARATELY AND FIELD ASSEMBLED. CONTRACTOR MAY SUBMIT ALTERNATE SCHEME FOR FABRICATION AND ASSEMBLY TO PROJECT ENGINEER FOR APPROVAL. CONTRACTOR'S ENGINEER TO DESIGN AND SEAL ANY PROPOSED ALTERNATE CONNECTION.

ISSUES

No.	DATE YYY.MM.DD	ISSUED FOR	No.	DATE YYY.MM.DD	ISSUED FOR	No.	DATE YYY.MM.DD	ISSUED FOR
A	2019.09.18	CLIENT REVIEW	F	2020.07.03	ADDENDUM			
B	2020.01.20	CLIENT REVIEW						
C	2020.04.07	PERMIT						
D	2020.06.10	CLIENT REVIEW						
E	2020.06.11	TENDER						

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ENGINEERS SEAL

CREEK CROSSING - SITE 1 -TRUSS BRIDGE, PLAN ELEVATION AND SECTION

BENSON CREEK FALLS REGIONAL PARK ACCESS IMPROVEMENTS

RECREATION & PARKS PARKSVILLE BC V9P 2X4

REGIONAL DISTRICT OF NANAIMO

HEL PROJECT No.	CLIENT DWG. No.
0837–067	N/A
SCALE: AS SHOWN	PERMIT No.: N/A
HEL DRAWING No.: S31	REVISION: F

DESTROY ALL DRAWINGS SHOWING PREVIOUS REVISION

ARCHITECTURAL D 24" x 36"
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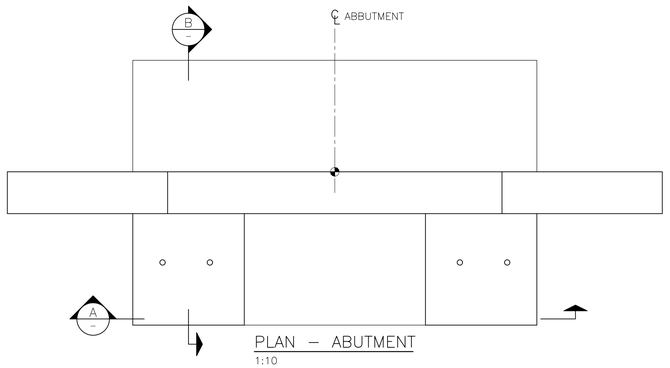

PLAN – ABUTMENT
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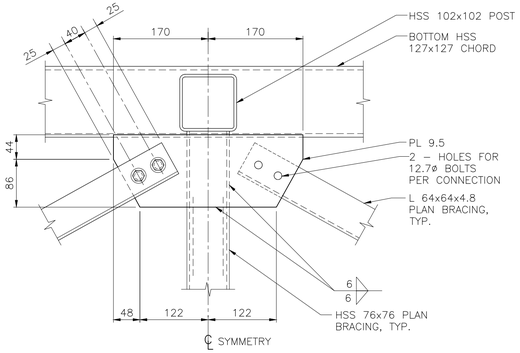
NOTE: 2 LOCATIONS



1 / S31 DETAIL
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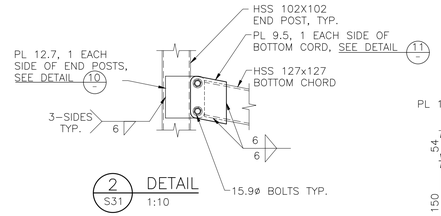

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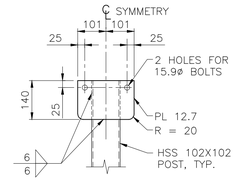

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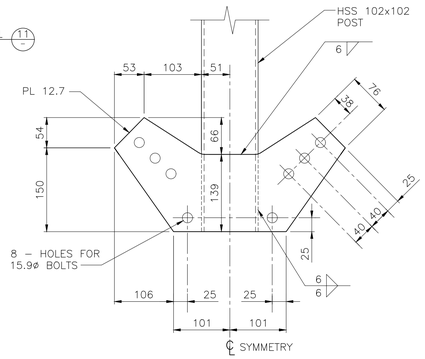

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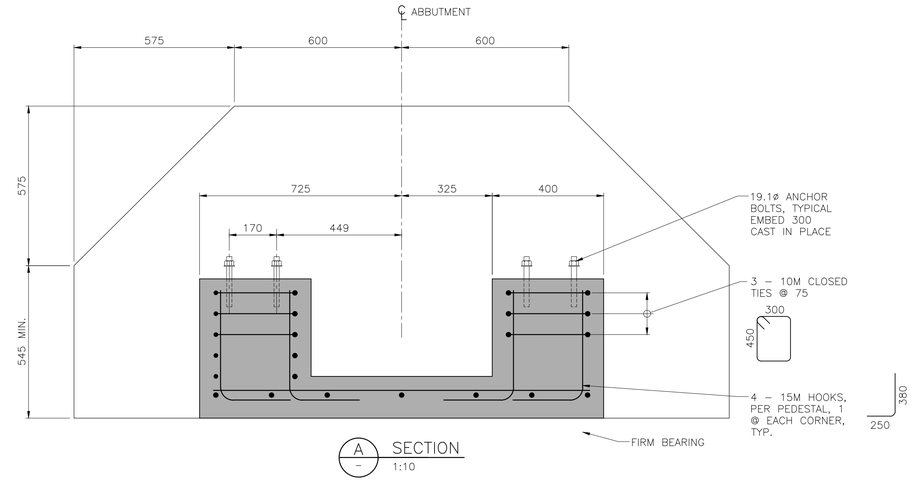

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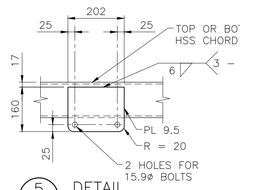

5 / S31 DETAIL
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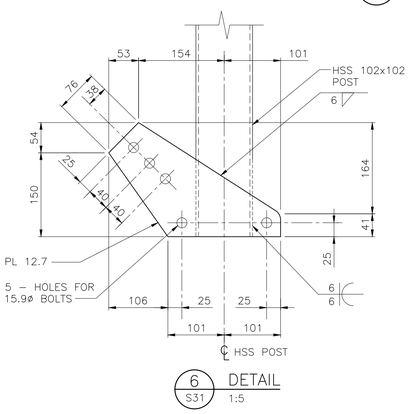

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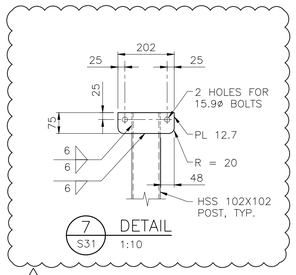

7 / S31 DETAIL
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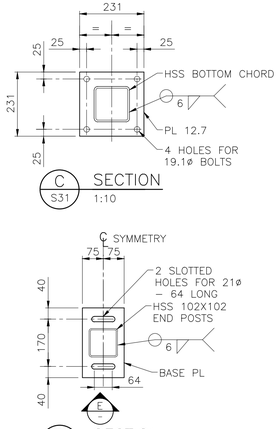

C / S31 SECTION
1:10

D / S31 SECTION
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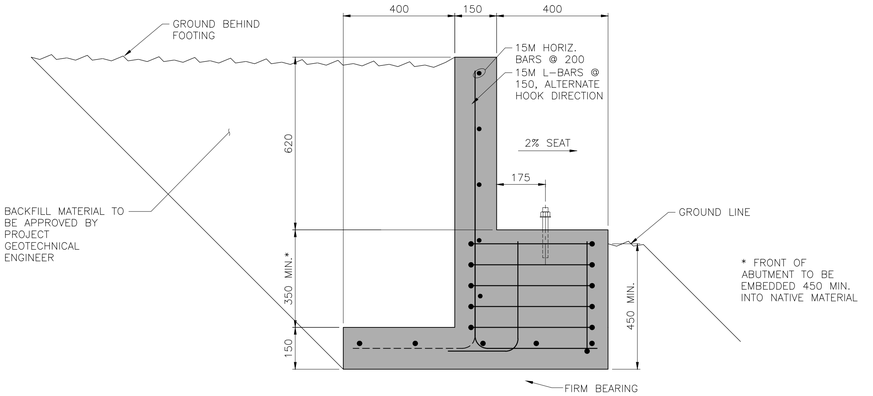

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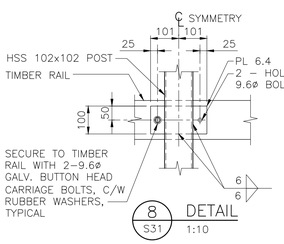

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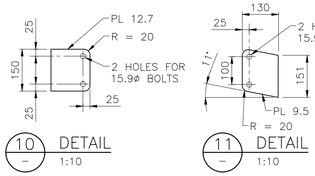

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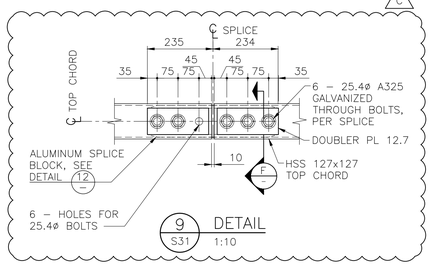

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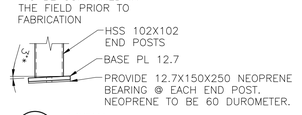

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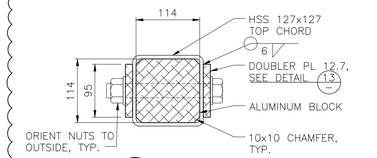

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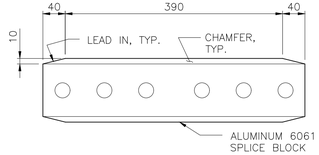

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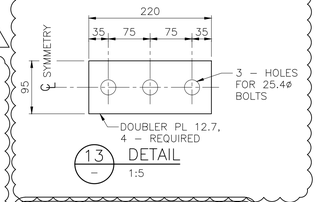

13 / – DETAIL
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ISSUED FOR ADDENDUM

NOTES:
1. FOR GENERAL NOTES, SEE DWG. S01
2. ALL ELEVATIONS ARE BASED ON A LOCAL DATUM.

ISSUES								
No.	DATE YYYY.MM.DD	ISSUED FOR	No.	DATE YYYY.MM.DD	ISSUED FOR	No.	DATE YYYY.MM.DD	ISSUED FOR
A	2020.04.07	PERMIT						
B	2020.06.11	TENDER						
C	2020.07.03	ADDENDUM						

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SUB CONSULTANT

DRAFTED PHU
DRAFTING REVIEW –
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DESIGN REVIEW –

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Email: mail@heroldengineering.com

ENGINEERS SEAL

CREEK CROSSING - SITE 1 -TRUSS BRIDGE ABUTMENTS AND DETAILS

BENSON CREEK FALLS REGIONAL PARK ACCESS IMPROVEMENTS

RECREATION & PARKS PARKSVILLE BC V9P 2X4
REGIONAL DISTRICT OF NANAIMO

HEL PROJECT No.	CLIENT DWG. No.
0837–067	N/A
SCALE: AS SHOWN	PERMIT No.: N/A
HEL DRAWING No.: S32	REVISION: C

DESTROY ALL DRAWINGS SHOWING PREVIOUS REVISION

File: V:\Projects\0837-067 BSFP Access Improvements\CAD Drawings\Latest\Bonus Creek Trail – Bridge\0837-067 S32.dwg Par Time: Jul. 3, 20 11:02 AM User: Peter Voight

TETRA TECH

September 25, 2018

ISSUED FOR USE
FILE: 704-ENG.VGEO03287-01
Via Email: mseyd@heroldengineering.com

Herold Engineering Limited
3701 Shenton Road
Nanaimo BC, V9T 2H1

Attention: Mr. Matt Seyd, P.Eng.

Subject: Preliminary Geotechnical Engineering Assessment for Benson Creek Falls Regional Park

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by Herold Engineering Limited (Herold) for the provision of geotechnical engineering services at Benson Creek Falls Regional Park (BCFRP).

A preliminary geotechnical engineering assessment is required as part of the feasibility assessment and conceptual design for two sites within Benson Creek Falls Regional Park.

These two sites are:

- Site 1 – The descent to Ammonite Falls; and
- Site 2 – The crossing of Benson Creek.

The preliminary geotechnical engineering assessment at the Ammonite Falls descent and the Benson Creek crossing (hereby referred to as the Sites) is to identify options and potential issues related to developing stair access to Ammonite Falls and a bridge crossing over Benson Creek.

2.0 BACKGROUND

Tetra Tech understands from the Benson Creek Falls Management Plan that the next phase of park development will include the following:

- A primary 'maintained' trail route from Weigles Road, crossing Benson Creek, extending to Ammonite Falls, and out to Jameson Road is the future goal;
- Upgrades and addition of amenities to support user safety, limit liability and reduce ongoing erosion and vegetation damage associated with access to steep slopes and sensitive areas;
- A viewing platform and stair access to Ammonite Falls; and
- A proper bridge crossing at Benson Creek to replace the current fallen log crossing.

BCFRP is located less than 2 km for the Nanaimo City Limits as shown on Figure 1. The general locations of the Benson Creek crossing and Ammonite Falls are indicated on the figure as well.

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#1 - 4376 Boban Drive
Nanaimo, BC V9T 6A7 CANADA
Tel 250.756.2256 Fax 250.756.2686

As outlined in the BCFRP Management Plan, the elevations in the park range from 110 m to 210 m above sea level. Figure 2 shows some representative cross-sections of the Benson Creek crossing and Ammonite Falls ravine. The gradient change at the Benson Creek crossing is estimated as being up to 50 m and up to 1.5H:1V along the steepest sections of the slope. The gradient change at Ammonite Falls is 15 m to 20 m and is also up to 1.5H:1V in the steepest sections of the slope. It should be noted that localized sections of both sites are steeper than 1H:1V in some soil slope areas. The Ammonite Falls site also has a vertical rock face up to 15 m high. The topographical map used to create the cross-sections in Figure 2 were provided to Herold by the RDN.

The surficial soils map from the BC Ministry of Environment, "Soils of Southern Vancouver Island, BC Soil Survey (Report No. 44", 1985, Scale: 1:100,000), indicates that the soil in the area is colluvium and is described as 'stony soils on steep slopes'. The "Surficial Geology, Nanaimo, BC Map 27-1963" (1 inch to 1 mile scale), indicates that the 'Vashon Drift' deposit in the area is a glacio-fluvial deposit consisting of gravel, sand, lenses of till or a ground moraine deposit with till, lenses of gravel, sand and silt. This map also described the area as having areas of bedrock outcrop and outcrop with thin patches of overburden.

As outlined above, the surficial and bedrock geological maps of the area indicate the local geology to be a veneer of glacial and glacio-fluvial sediments, overlying sedimentary rocks of the Nanaimo group. This preliminary background review coincides with the observations made during the site reconnaissance.

It is our understanding that the trails are to be 'Type 3' according to the RDN report for Community Parks & Trails Strategic Plan – Electoral Areas E, F, G & H (January 2013, Report No. 13-1444-0019). Some of the typical characteristics for this type of trail is that the surface should be natural (gravel where needed), with low maintenance and construction costs.

3.0 SITE RECONNAISSANCE

Tetra Tech attended the June 20, 2017 site meeting with the Regional District of Nanaimo. The site meeting involved hiking from the Northern site access (off of Weigles Road) along the existing trail to the Southern site access at the Creekside Place Parking Lot. The Benson Creek crossing and the descent to Ammonite Falls were both observed as part of this site meeting. Tetra Tech observed that much of the BCFRP consists of a surficial soil layer of sand and gravel, overlying weak to very weak bedrock (siltstone/shale).

A follow-up site reconnaissance was carried out by Tetra Tech, Herold and Lanarc Consultants on August 31, 2017, as well as a site reconnaissance with some test probes by Tetra Tech on October 2, 2017. The routes taken were similar to the original June 20, 2017 site meeting. The locations of key features were recorded with a handheld GPS, and field measurements were collected with handheld equipment. The cross-sections shown in Figure 2 show a representation of the topography encountered during the site reconnaissance with the approximate locations of the Benson Creek crossing and Ammonite Falls being shown in Figure 1. UTM coordinates or key GPS points are not shown on the map as they are not considered accurate due to the dense canopy and the small scale of the study areas.

3.1 DESCENT TO AMMONITE FALLS

During the various site reconnaissance and probing along the descent to Ammonite Falls, Tetra Tech noted the following:

- The material along the slope was generally loose to dense colluvium material described as Sand and Silt with gravel and cobbles. The trails were constructed from native materials or were just formed from heavy traffic;

- Probing into the side of the slopes, where no foot traffic had occurred, would occasionally encounter little to no resistance for the full length of the probe (i.e., 500 mm), indicating loose soils;
- Probing into the areas of the upper slopes where foot traffic had occurred would generally penetrate 100 mm to 300 mm prior to refusal;
- Probing along the bottom portion of the trail where heavy foot traffic occurred would encounter near surface refusal, whereas areas that have not experienced heavy foot traffic would occasionally encounter almost full penetration prior to refusal;
- The steepest section of the soil slope was the direct descent to the falls that required rope assist. A gentler gradient could be found by trailblazing back and forth along the slope; and
- Bedrock was observed outcropping in various areas along the descent and is exposed along the creek bed where water erosion occurs. Severely weathered bedrock that was degraded to soil were also observed.

Photo 1: Descent to Ammonite Falls – Probe barely penetrating into soil at heavy foot traffic area.

It was noted that although the direct descent area was heavy eroded, it seemed to be primarily from heavy foot traffic combined with wetting and drying. There were no obvious signs of deep scouring from heavy precipitation. The foot packed soils seem to be generally resilient to localized water erosion. The dense canopy as well as the steep topography generally seem to prevent large collections of water in the area.

3.2 BENSON CREEK CROSSING

During the various site reconnaissance and probing along the ravine in the descent and ascent from the Benson Creek crossing, Tetra Tech noted the following:

- The material along the slope was generally loose to dense colluvium material described as Sand and Silt with gravel and cobbles. Some outcropping bedrock as well as severely weathered bedrock degrading to soil was also observed. The trails were constructed / formed from native materials;
- Probing into the side of the slopes, where no foot traffic had occurred, would occasionally encounter little to no resistance for the full length of the probe (i.e., 500 mm), indicating loose soils;
- Probing into the trail would generally penetrate 100 mm to 300 mm prior to encountering refusal, deeper penetration would often be encountered in the vicinity of tree roots;
- Some fallen trees exposed their root wads, indicating a shallow root system (i.e., shallow dense soils and / or bedrock);
- Some of the slopes downstream and upstream of the current trail had recent debris flow slides (i.e., shallow surficial slides) that are consistent with steep slopes having a thin layer of loose material. The trigger for these slides was interpreted to be large trees falling over and destabilizing the shallow slope. The majority of material in these failures seemed to be wood debris with minimal amounts of soil mobilizing;

Photo 2: Shallow surficial debris flow failure downstream of log crossing area.

- The soils within the proposed crossing areas on the north and south sides of the slope were generally dense with probes penetrating 350 mm to 500 mm prior to encountering refusal. A pin was hammered into the likely foundation area on the north slope and 7 blows were counted over 150 mm prior to refusal;

Photo 3: North slope probe – note fallen log used to flatten slope in this area.

Photo 4: South slope probe in likely foundation area.

- Underlying the soil layer on the north slope some fractured bedrock was observed approximately 1 m to 1.5 m below surface;

Photo 5: Fractured bedrock underlying the south end of the fallen log at Benson Creek.

- An alternative bridge crossing area was identified downstream of the fallen log crossing. The location was marked by Herold during the August 31, 2017 site visit; and

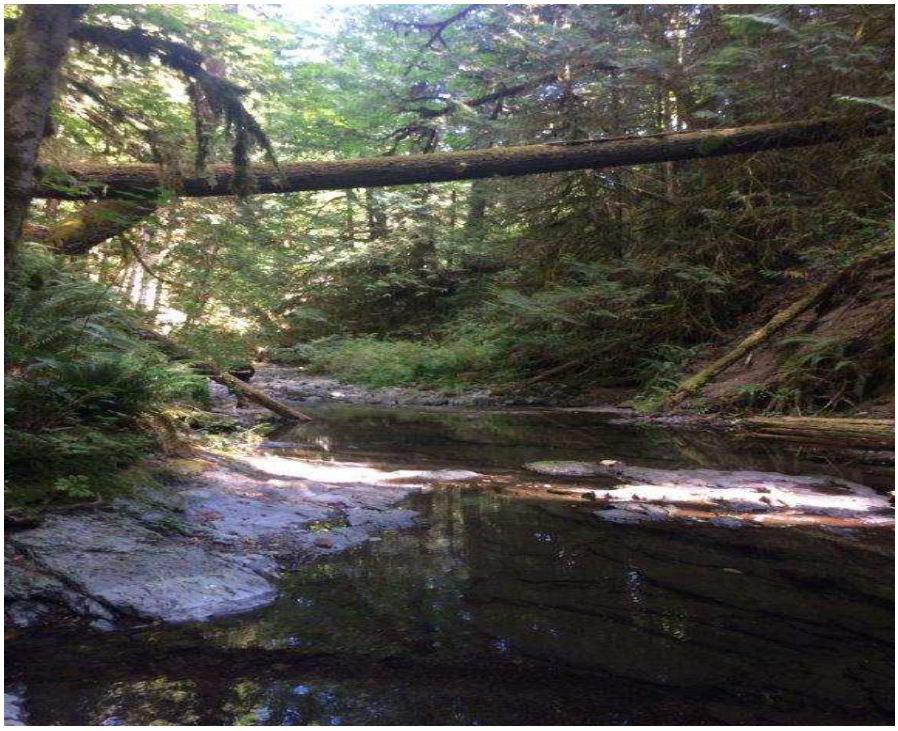

Photo 6: Fallen log downstream of current log crossing indicating general location of alternative crossing.

- Although the downstream fallen log crossing was not probed, the August 31, 2017 site reconnaissance in this area indicated that the material was similar to the current fallen log crossing.

4.0 SLOPE STABILITY

The slopes at these sites do not have the mechanism for a deep failure. With shallow bedrock and / or soils, the potential for a large scale landslide is minimal. However, as shown during the site reconnaissance, the potential for shallow surficial failures (i.e., debris flow) exists at these sites. It is difficult to determine the localized factor of safety of these slopes as the trigger mechanism for failure seems to be large trees toppling. It is expected that these debris failures would occur during storm events with high winds and / or heavy precipitation. Therefore, it is expected that risk of a debris flow slide to the general public would be reduced as the park trails would likely not be used during these type of events.

To ensure that the bridge crossing is not at risk of damage during a shallow slope failure, the existing slope vegetation and trees should be disturbed as little as possible. When constructing trails, drainage during heavy precipitation events should also be considered.

5.0 COMMENTS AND RECOMMENDATIONS

Based on the results of our site reconnaissance and probing, the proposed bridge foundations and potential stairs should be appropriately founded on/within dense sand/silt/gravel underlying the active root zone at the site. The following comments and recommendations are given with regards to construction of the foundations / stairs:

1. Stair or bridge foundations could consist of shallow piles (screw or concrete) extended to the underlying dense soil or bedrock or shallow foundations on the dense soil or bedrock (timber or concrete);

2. Excavation to a competent, dense founding soil or rock should occur prior to placing foundations. These exposed subgrades for the foundations should be inspected by Tetra Tech to ensure suitability prior to placement;

3. The allowable soil bearing capacity for vertical loads founded on the dense sand at the site is 75 kPa. It should be noted that the allowable bearing for this type of soil would normally be around 150 kPa, however, it is expected that some sloughing will occur during excavation, so a reduced bearing is recommended. Some settlement (15 mm to 30 mm) may be expected due to difficulties cleaning out augered holes or hand excavated sites.

4. The depth of the non-structural embedment is generally expected to be 0.3 m to 0.5 m which is the depth of the active root zone and loose/compact soil. It should be noted that some discretion will need to be used on site during installation as some areas may have deeper root zones and/or loose soil than expected. It should also be noted that thick tree roots or wood debris may cause excavation refusal / difficulties in some areas. It is recommended that tree roots be disturbed as little as possible. Therefore, some flexibility in design for different foundations locations and allowing for some field fitting would reduce the risk of deeper foundation requirements.

5. The depth of structural embedment should be 0.3 m below the non-structural embedment. This would be generally described as the area where the active root zone or loose soils are no longer encountered and hand augering / excavation becomes more difficult. Therefore, combined with the non-structural embedment, it is expected that the embedment of foundations to be a minimum depth of 0.6 m to 0.8 m This embedment depth will help ensure that the influence of the active overlying soil zone is mitigated.

6. Resistance to horizontal loading is not discussed in this report, however, if required, could be provided.

7. If a complete staircase with multiple stairs attached is to be constructed (as opposed to individual stairs), it is recommended that a deeper foundation of 1 m to 2 m be placed at the top of banks to ensure that it is securely anchored in native material.

8. From a geotechnical perspective, if the above recommendations are followed, the stairway/bridge would be considered safe for the use intended. Because of the steep nature of the terrain, ongoing slope deformation and movement is likely to occur over the long term (10 to 50 years), such that the stairway and / or bridge structure could be impacted. Such impacts can likely be resolved through routine maintenance. It should be noted that during a seismic event of sufficient magnitude, this slope is expected to have some movement, which would impact the stairway and bridge structure.

9. Generally, construction of the stairway or bridge structures should not negatively impact the stability of the slope. Because the new structures would create an elevated walking surface, the new structures may actually enhance slope stability. It is possible that over time, vegetation may grow over the old trail, under any elevated walkways or bridges, which would also assist in overall slope stability and erosion control.

The next steps in design will be to review various conceptual designs with Herold. This may require additional site visits with Herold as well as a number of meetings. Tetra Tech will provide a short memo and conceptual drawings based on the outcome of these meetings.

5.1 ROCK ANCHORS

An alternative preliminary foundation type for the bridge over Benson Creek may consist of tensioned rock anchors. The relatively high tensile and shear strengths of rock allows rock foundations to support substantial tensional loads. These loads are transferred from the structure to the foundation rock by steel anchors, comprising rigid bars. The anchors are secured with cement grout in a hole drilled into the foundation, and the head of the anchor is then embedded in, or bolted to, the structure.

Discussions with Herold have indicated that each rock anchor should be able to resist 210 kN loads. It is understood that each end of the bridge will require two rock anchors and four in total. Given the application for a bridge foundation, the recommended anchor type should be a double corrosion protected DYWIDAG 517/690 MPa hot-rolled thread bar with a nominal bar diameter of 32 mm.

Amongst other factors which will be assessed during the detailed design, the hole diameter should be large enough to fit all components including plastic sleeve and is typically 1.5 to 2.5 times the diameter of the anchor. At present it is thought a 6 m long anchor should be sufficient with 3 m of fixed length in a weak to moderately strong sandstone. Further information on the anchor head completion details and required stickup will also determine the length.

In order to go forward in more detail with this concept it is important to address and collect some key information from the project location. An additional site investigation will be required to obtain details on:

- Depth to bedrock;
- Mapping of rock structure and joint sets of nearby outcrops;
- Geomechanical properties and classification (RMR and GSI); and
- Depth to groundwater.

It is understood from Herold that mobilizing a drill for the purpose of investigation is not feasible for this project given the difficult access. Therefore, it is suggested that hand tools or probes are used to explore as deep as possible (shovels, augers and or probes). Probing and or auguring a series of holes within the location of the structure should then give us confidence in confirming our assumption regarding the shallow depth to bedrock. However, no information on the geotechnical properties of the rock can be gathered in this manner. From our previous site visits we note that there is also a lack of surface rock exposure available for geotechnical mapping. As rock conditions can vary in quality and weathering from location to location, there is a potential risk with this foundation type in not collecting information through rock cores.

Further aspects in regards to detailed design will include: Assessing the uplift capacity of the anchor; Pre-stress load at lock off; Assessment of the group anchor effect; Corrosion protection assessment. A detailed review of the anchor head and surface completion components is also critical.

Some questions remain in regards to the constructability due to the limited access. The types of drilling equipment selected to mobilize may have some implications to the hole length and diameter. If, for example, the anchor needed to be extended beyond 6 m then couplers would be required, thereby potentially needing to increase the hole diameter. Discussions with a reputable contractor specializing in drilling on slopes with the use of hand held pluggers or bencher drills would be advisable.

During the construction, monitoring penetration rates and drill cuttings will be required to assess whether ground conditions remain suitable as per the design, ensuring no shear zones or faults have been encountered in the bond zone. Water testing may be employed to ascertain the permeability of the borehole such that proper grouting of the anchor can be completed. As an alternative following drilling, the holes could be fully grouted and then re-drilled, this would ensure the most optimum bond of the grout to rock interface. Such a technique is particularly advisable in cases where there is a lack of exposure of the rock and little intrusive investigation. Load testing should also be carried out on all anchors, this includes performance, proof, creep and lift-off tests.

In summary, notwithstanding some of the risks associated with not conducting an intrusive exploration of the underlying rock, Tetra Tech believes a rock anchor foundation for the proposed Benson Creek bridge is feasible with a limited surface exploration, a conservative design approach and ability to improvise to changing ground conditions.

6.0 LIMITATIONS OF REPORT

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7.0 CLOSURE

We trust this document meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

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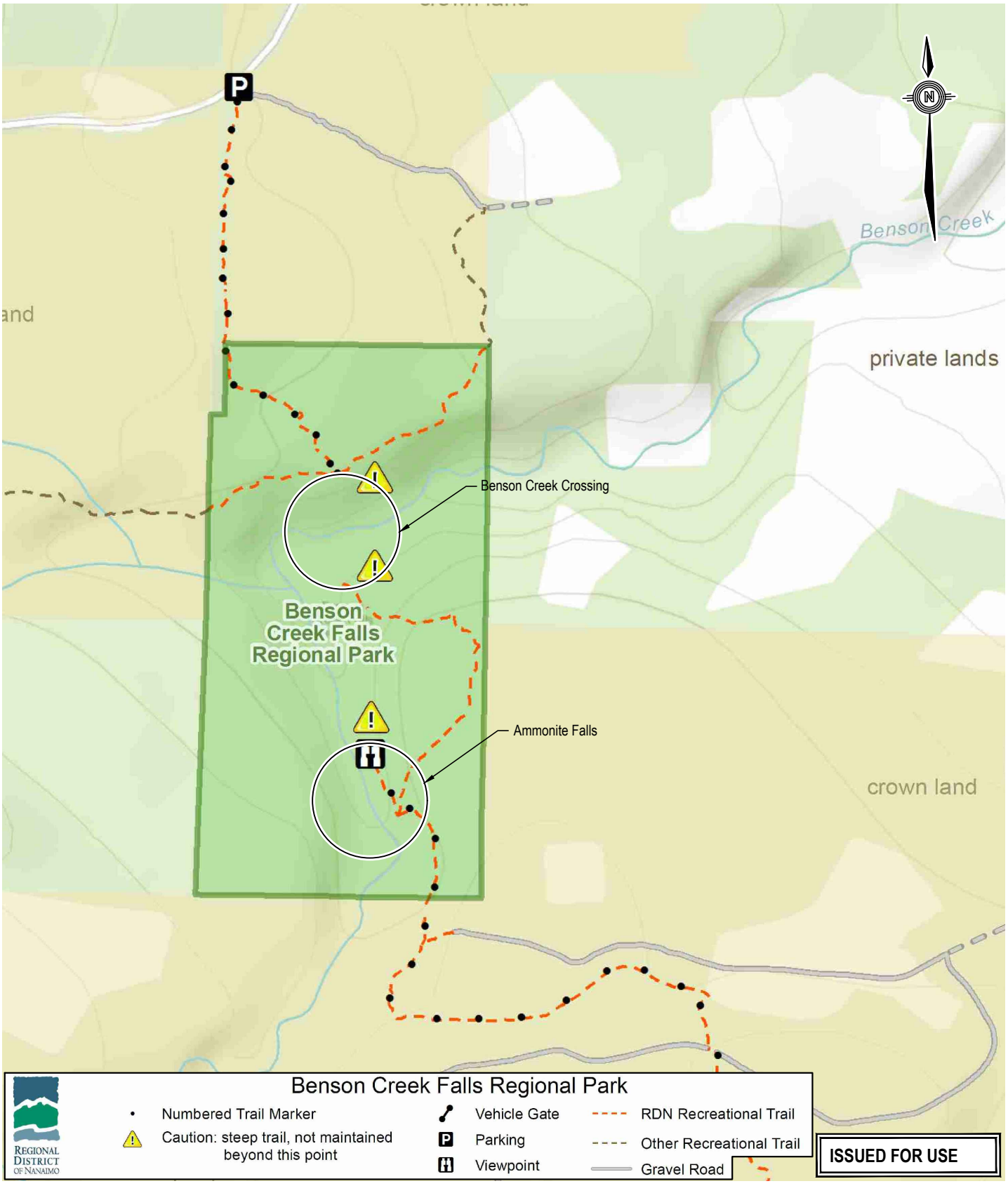
/dr

Attachments: Figure 1 – Site Location Plan
Figure 2 - Benson Creek and Ammonite Falls Crossing Sections
Appendix A - Limitations on the Use of this Document

FIGURES



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CLIENT

REGIONAL DISTRICT OF NANAIMO

TETRA TECH

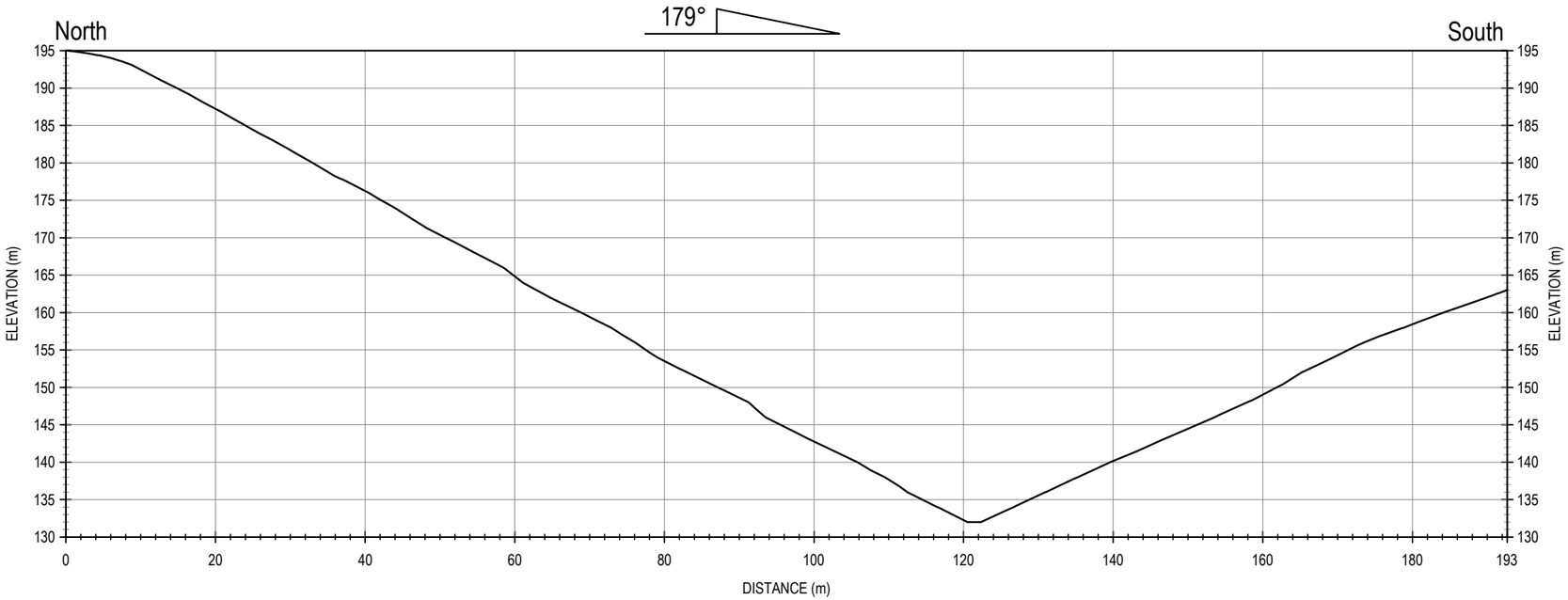
PRELIMINARY GEOTECHNICAL ENGINEERING ASSESSMENT FOR BENSON CREEK FALLS REGIONAL PARK

Site Location Plan

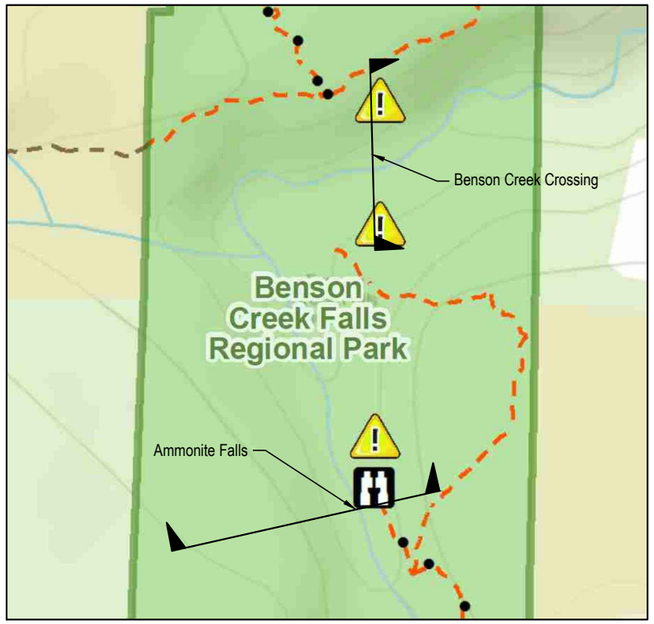
PROJECT NO.	DWN	CKD	REV
VGEO03287-01	IK	AW	0

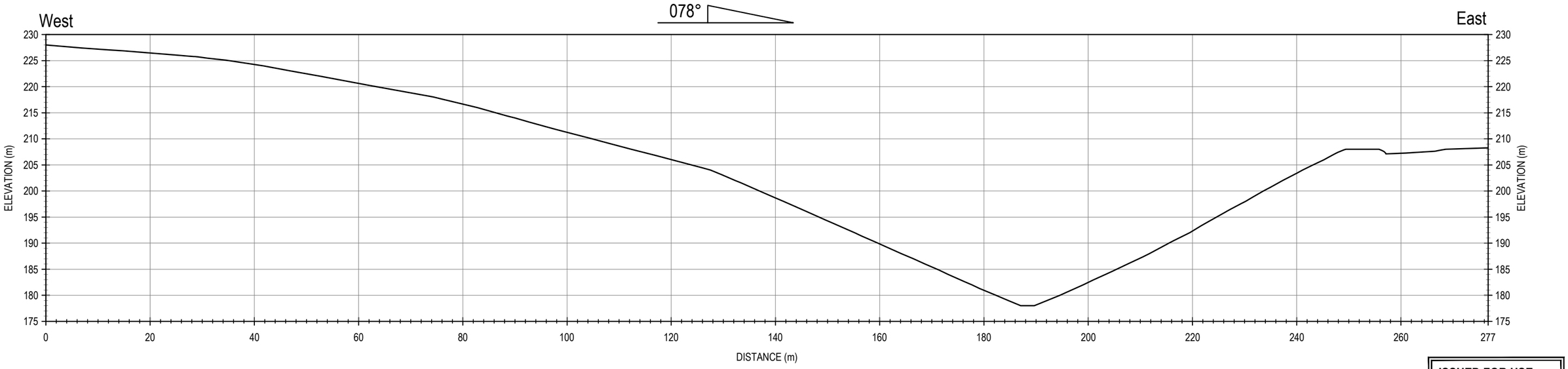
OFFICE	DATE
Nanaimo	October 12, 2017

Figure 1



Benson Creek Crossing





Ammonite Falls

ISSUED FOR USE

NOTES
BASED ON GIS 2 m CONTOUR DATA PROVIDED BY THE RDN

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Scale: 1:750 @ 11"x17"

CLIENT
REGIONAL DISTRICT OF NANAIMO

TETRA TECH

PRELIMINARY GEOTECHNICAL ENGINEERING ASSESSMENT FOR BENSON CREEK FALLS REGIONAL PARK

Benson Creek and Ammonite Falls Crossing Sections

PROJECT NO.	DWN	CKD	REV
VGEO03287-01	IK	AW	0
OFFICE: Nanaimo	DATE: October 12, 2017		

Figure 2

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APPENDIX A

TETRA TECH'S LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

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Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by persons other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary investigation and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, TETRA TECH has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.9 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. TETRA TECH does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

1.11 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.15 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

1.16 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

1.17 SAMPLES

TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

TETRA TECH

CONSTRUCTION MEMO

ISSUED FOR USE

To:	Ali Sadeghi, P.Eng.	**Date:**	July 3, 2020
		Memo No.:	002
From:	Andrew Walker, P.Eng.	**File:**	704-ENG.VGEO3287-02
Subject:	Foundation Recommendations for Benson Creek Crossing		

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by Herold Engineering Limited (Herold) for the provision of geotechnical engineering services at Benson Creek Falls Regional Park (BCFRP).

Tetra Tech has previously provided the following reports:

- 'Preliminary Geotechnical Engineering Assessment for Benson Creek Falls Regional Park' (September 2018) which discussed slope stability and various options / recommendations for trail and bridge development.
- 'Site Reconnaissance Memo' (September 2019) which reviewed conditions at the site since the original report was provided as well as focusing on specific conceptual design options for crib steps, aluminum stairs, bridge, trail development, and strip footing foundations for stairs and bridge.

This memo provides comments and recommendations concerning the specific foundation footing designs proposed for the bridge abutments and stairways at Benson Creek provided by Herold on June 30, 2020 (Herold Drawings No. 0837-067). The footing designs were developed in consultation with Tetra Tech.

2.0 FOUNDATION DESIGN

The proposed foundation design at the bridge abutments are shown on the Herold Drawing Sheet No. 0837-067-S24 (Stairway Foundations) and 0837-067-S32 (Abutment Foundations). Some typical details and comments concerning the foundations are summarized as follows:

- Typical stairway concrete footings are a minimum 460 mm L x 460 mm W x 300 mm H when situated on approved soil subgrade. The minimum depth of embedment into native material is 457 mm from the from the front of the footing.
- If the minimum depth of embedment can't be achieved due to shallow bedrock, the typical stairway concrete footings are to be a minimum 305 mm L x 305 mm W on rock, attached to 2 x 15M dowels drilled a minimum 305 mm into rock.
- Specific footings have been designed for the top of Stair 2 and the bottom of Stairs 1 & 2, as shown on S24.
- The abutment concrete footings are designed to be 950 mm W x 2350 L, with the front of the abutment footings to be embedded a minimum of 450 mm into native material, as shown on S32.
- The design loads for the abutment footings at ULS are 116 kN per abutment footing (58 kN per endpost) with an average end bearing of 105 kPa. These are acceptable design loads provided the recommendations in this memo are followed.

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- The footings should be situated entirely within native non-creeping soil or on competent bedrock below the potential frost zone. This would mean that the footing depths may vary based on site specific conditions, if they are embedded within the native soils to the minimum depths designed. Boulders and/or roots may require some field fit adjustments. Footings should not be placed under or above roots to prevent potential root jacking.
- A geotechnical engineer will be required to assess all foundation bearing subgrades prior to pouring concrete.

3.0 CLOSING REMARKS

Since the initial site visits in 2017, the site conditions have changed considerably, largely due to storms that have occurred in the interim. With the shallow bedrock and dense soil at these sites, tree root systems tend to be shallow and when trees reach a certain size they are susceptible to falling during windstorms and / or periods of high precipitation or seismic events. When these trees fall they can trigger shallow debris flow failures. This is a part of the life cycle of trees at these sites and therefore, while every effort can be made to design and build long term infrastructure, the nature of these sites means that some uncertainty with any design remains.

The bridge abutments have been located to factor in creek levels due to flooding conditions (i.e., 1 in 200 year event). Tetra Tech was not involved with determining these flood levels. The abutment foundations will need to be situated as far into the slopes as is practical to account for possible erosion during flood events. It is expected that some field fitting will occur to help protect the abutments from erosion / flooding events.

4.0 LIMITATIONS OF REPORT

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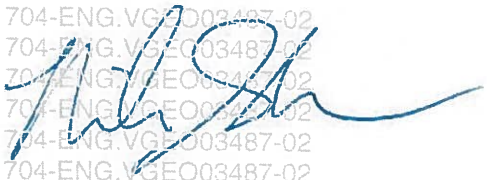
5.0 CLOSURE

We trust this technical memo meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully Submitted,
Tetra Tech Canada Inc.

704-ENG.VGEO03487-02



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APPENDIX A

TETRA TECH'S LIMITATIONS ON THE USE OF THIS DOCUMENT

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Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

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1.7 ENVIRONMENTAL AND REGULATORY ISSUES

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1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

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Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.9 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

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1.11 PROTECTION OF EXPOSED GROUND

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1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

Construction activity can impact structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques, and construction sequence are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, and the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.15 DRAINAGE SYSTEMS

Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function. Where temporary or permanent drainage systems are installed within or around a structure, these systems must protect the structure from loss of ground due to mechanisms such as internal erosion and must be designed so as to assure continued satisfactory performance of the drains. Specific design details regarding the geotechnical aspects of such systems (e.g. bedding material, surrounding soil, soil cover, geotextile type) should be reviewed by the geotechnical engineer to confirm the performance of the system is consistent with the conditions used in the geotechnical design.

1.16 DESIGN PARAMETERS

Bearing capacities for Limit States or Allowable Stress Design, strength/stiffness properties and similar geotechnical design parameters quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition used in this report. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions considered in this report in fact exist at the site.

1.17 SAMPLES

TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

1.18 APPLICABLE CODES, STANDARDS, GUIDELINES & BEST PRACTICE

This document has been prepared based on the applicable codes, standards, guidelines or best practice as identified in the report. Some mandated codes, standards and guidelines (such as ASTM, AASHTO Bridge Design/Construction Codes, Canadian Highway Bridge Design Code, National/Provincial Building Codes) are routinely updated and corrections made. TETRA TECH cannot predict nor be held liable for any such future changes, amendments, errors or omissions in these documents that may have a bearing on the assessment, design or analyses included in this report.

TETRA TECH

CONSTRUCTION MEMO

ISSUED FOR USE

To:	Ali Sadeghi, P.Eng.	**Date:**	July 3, 2020
		Memo No.:	001
From:	Andrew Walker, P.Eng.	**File:**	704-ENG.VGEO3287-02
Subject:	Site Reconnaissance for Benson Creek Crossing and Falls Site		

1.0 INTRODUCTION

Tetra Tech Canada (Tetra Tech) was retained by Herold Engineering Limited (Herold) for the provision of geotechnical engineering services at Benson Creek Falls Regional Park (BCFRP).

Tetra Tech had previously provided a report titled 'Preliminary Geotechnical Engineering Assessment for Benson Creek Falls Regional Park' which discussed slope stability and various options / recommendations for trail and bridge development at these sites.

This memo outlines the findings of a site reconnaissance that took place on September 12, 2019 with Mr. Andrew Walker, P.Eng. of Tetra Tech and Messrs. Ali Sadeghi, P.Eng. and Matt Seyd, P.Eng. of Herold which focused on specific conceptual design options for crib steps, aluminum stairs, bridge, trail development, and strip footing foundations for stairs and bridge.

Herold Issued for Review drawings titled "Falls Site – Option 2 Plan and Profile" No. S12, "Creek Crossing – Proposed Site Plan" No. S21, and "Creek Crossing – Proposed Site Plan and Profile" no. S21 were reviewed during the creation of this memo.

2.0 SITE RECONNAISSANCE

Waypoints were provided at specific points of development. Most of the points were straightforward from a geotechnical point of view, however some specific waypoints were focused on for the purposes of this reconnaissance:

- Waypoints 3, 4, 12, 13, 14, 16, and 18 – areas with some steep grades along the path requiring crib steps. Some field fitting will be required to situate crib steps around potential roots or boulders and in native, non-creeping soil. It is our understanding that the crib steps will be anchored in place with rebar – it is recommended that large diameter rebar (e.g., 20 mm) be utilized so that it has less potential to bend during installation with a sledge hammer. These crib step areas should be constructed in a manner to discourage the accumulation and flow of rainwater where they are situated.

- Waypoint 6 – an area with a large diameter tree and root mass blocking the trail. An alternative path has started to develop above the root mass, however this requires walking along a very steep grade which is not safe for walking and will erode over time. It is recommended that the tree is cut and removed so the original path can be used. The root mass should be left in place to discourage further erosion. A large shallow debris flow failure has recently taken place below this area; however, it appears that a large diameter tree's root system (at the top of the debris flow) has interrupted the failure. It is our assessment that the failure has stabilized for the time being, however, if the tree at the top of the debris flow failure were to fall over it is possible that the failure would

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extend into the path. It is recommended that the path route be reassessed and repaired or rerouted, if this should occur.

- Bridge and aluminum stair footing locations – it is our understanding that strip footings are proposed for the foundations. The footings should be situated entirely within native non-creeping soil or on competent bedrock below the potential frost zone. Typically, this would mean that footings would need to be at a 1.0 m to 1.5 m depth but may vary based on site specific conditions. Boulders and/or roots may require some field fit adjustments. Footings should not be placed under roots to prevent potential root jacking. If shallow bedrock is encountered, footings may need to be anchored to the bedrock. A geotechnical engineer will be required to assess all foundations prior to pouring concrete.

- Viewing platform – the proposed viewing platform area is expected to be underlain by competent native soil. Shallow piles or footings should be a viable foundation option in this area, however, large near surface boulders may cause some difficulties during construction. A geotechnical engineer will be required to assess the foundations in this area during construction.

- Proposed new access path (0+080 to 0+132) – due to the steep grade in this area, cuts into the slope to create the new path are expected to be approximately 0.5H:1V. The natural slope is currently at approximately 1H:1V and consists of till in this area. This area will require some field fitting as boulders and roots are expected to be encountered throughout. Some areas may be able to have a full cut, whereas some areas may require a cut/fill balance. Due to the steep slope in the area, it may be difficult to place fill so timber cribbing at the fill side (i.e., downslope) or some type of MSE support of the path could be considered.

3.0 CLOSING REMARKS

Since the initial site visits in 2017, the site conditions have changed considerably, largely due to a windstorm that occurred late last year. With the shallow bedrock and dense soil at these sites, tree root systems tend to be shallow and when trees reach a certain size they are susceptible to falling during windstorms and periods of high precipitation. When these trees fall they can trigger shallow debris flow failures. This is a part of the life cycle of trees at these sites and therefore, while every effort can be made to design and build long term infrastructure, the nature of these sites means that some uncertainty with any design remains.

It is our understanding that Herold will be providing typical horizontal and vertical loads for foundations. Once Tetra Tech receives these values we will provide a separate memo outlining typical footing features such as dimensions, depth of footing, and distance from slope surface.

4.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Herold Engineering Limited and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Herold Engineering Limited, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on the Use of this Document attached in the Appendix or Contractual Terms and Conditions executed by both parties.

5.0 CLOSURE

We trust this technical memo meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully Submitted,
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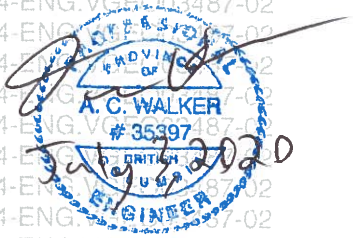

704-ENG.VGEO03487-02

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1.2 ALTERNATIVE DOCUMENT FORMAT

Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

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Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by third parties other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this document, at or on the development proposed as of the date of the Professional Document requires a supplementary exploration, investigation, and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, TETRA TECH has not been retained to explore, address or consider and has not explored, addressed or considered any environmental or regulatory issues associated with development on the subject site.

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems, methods and standards employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.9 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historical environment. TETRA TECH does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional exploration and review may be necessary.

1.11 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

Construction activity can impact structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques, and construction sequence are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, and the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.15 DRAINAGE SYSTEMS

Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function. Where temporary or permanent drainage systems are installed within or around a structure, these systems must protect the structure from loss of ground due to mechanisms such as internal erosion and must be designed so as to assure continued satisfactory performance of the drains. Specific design details regarding the geotechnical aspects of such systems (e.g. bedding material, surrounding soil, soil cover, geotextile type) should be reviewed by the geotechnical engineer to confirm the performance of the system is consistent with the conditions used in the geotechnical design.

1.16 DESIGN PARAMETERS

Bearing capacities for Limit States or Allowable Stress Design, strength/stiffness properties and similar geotechnical design parameters quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition used in this report. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions considered in this report in fact exist at the site.

1.17 SAMPLES

TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

1.18 APPLICABLE CODES, STANDARDS, GUIDELINES & BEST PRACTICE

This document has been prepared based on the applicable codes, standards, guidelines or best practice as identified in the report. Some mandated codes, standards and guidelines (such as ASTM, AASHTO Bridge Design/Construction Codes, Canadian Highway Bridge Design Code, National/Provincial Building Codes) are routinely updated and corrections made. TETRA TECH cannot predict nor be held liable for any such future changes, amendments, errors or omissions in these documents that may have a bearing on the assessment, design or analyses included in this report.