MEMO

TO:	Scott Cosman, P.Eng.
COMPANY:	BC MoTI
FROM:	Bob Forsyth, P Eng
DATE:	11 October,2023
CC:	Wayne Byczek, P.Eng., Michael Carreira, P.Eng.
PROJECT NO.:	VG07794.304
SUBJECT:	**Silver Skagit Road, South of Hope, BC** **Memo Regarding our Geotechnical Opinion of the Fish Habitat Design at km 10.9 - Rev 1**

As requested, this memo provides our opinion regarding geotechnical aspects of the fish habitat design for the creek at km 10.9 of the Silver Skagit Road. We have visited the site from time to time during the 2022 and 2023 construction seasons. The creek avulsed its banks during the November 2021 flood event. The road was covered with sand and gravel and the channel moved several metres to the south. The previous channel was restored and five culverts were installed underneath the road at the location of the existing and temporary channels. The creek deposit extends several metres to the north and south of the present channel and channel migration/avulsion is believed to have occurred multiple times in the past.

The design, provided to us by Binnie, consists of four shallow ponds and related channel connections located downstream, to the west of the Silver Skagit Road. All ponds are connected to spillway channels including two channel outlets into Silverhope Creek to the west of the ponds. Pond and channel banks are typically less than 4 m high and inclined at 1.5H: 1V or flatter. We expect that they will be comprised of cuts into the native soil and/or reworked native granular soil. The typical design water level in the ponds is 1.0 m.

The native soil observed at the creek crossing is relatively clean sand and gravel as shown in the below photo of the culvert excavation. A sample of the material was found to contain 1.6% fines as shown in the attached grain size curve. The material is expected to be relatively permeable. Similar material is expected in the proposed pond area much of which appears to be in the creek avulsion/fan deposit. The material to the north and south of the fan is expected to consist of less permeable silty/clayey sand and gravel.

Photo 1: Looking west at the culvert excavation for the creek at km 10.9

It is our opinion that:

- The pond and creek banks, inclined at 1.5H: 1V in native mineral soil and/or well compacted granular fill will be stable with respect to large scale stability.

- The alluvial fan deposit is permeable and may not retain water for an extended time period, as required for fish habitat. We have discussed two options with the design team:

    - the relocation of the pond away from the alluvial fan into more impervious soil and
    - the use of an impervious liner at the bottom of the pond.

Both of these alternatives are not acceptable to the habitat designer.

Another alternative will be to maintain the ponds in their specified location but base the ponds at least one metre below the long term low groundwater level at each pond location. In this case the depth of the ponds will not be known at the time of tender. The increase in depth may result in an expansion of the pond boundaries, in order to achieve the required pond and creek bank geometry. Pond excavation should proceed in the late summer of 2024, and be witnessed by the Geotechnical Engineer of Record, to confirm that the pond bottom is at least one metre below the seasonally low groundwater table. Monitoring wells could be installed and monitored on a monthly basis to determine the low groundwater elevation prior to finalization of the plans.

CLOSURE

Comments and recommendations presented herein are based on a geotechnical evaluation of the available information as noted. If conditions other than those reported are noted in subsequent phases of the project, WSP E&I Canada Limited should be notified and be given the opportunity to review and revise the current comments and recommendations if necessary. Recommendations presented herein may not be valid if an adequate level of review or inspection is not provided during construction.

This memo has been prepared for the exclusive use of BC MOTI and their appointed agents for specific application to the area covered within this memo. Any use which a third party makes of this memo or any reliance on or decisions made based on it are the responsibility of such third parties. WSP accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this memo. It has been prepared in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.

Effective September 21, 2022, Wood Environment & Infrastructure Solutions Canada Limited is now operating as WSP E&I Canada Limited. No other aspects of our legal entity, contractual terms or capabilities have changed in relation to this memo submission.

Yours sincerely,

WSP E&I Canada Limited

Bob Forsyth, P.Eng.
Principal Geotechnical Engineer

Reviewed by:

John Laxdal, P.Eng.
Senior Principal Geotechnical Engineer

Attachments: Limitations
Result of Grain Size Analysis

Attachment: Limitations

Limitations

1 The work performed in the preparation of this report and the conclusions presented are subject to the following:

   a) The contract between WSP and the Client, including any subsequent written amendment or Change Order duly signed by the parties (hereinafter together referred as the "Contract");

   b) Any and all time, budgetary, access and/or site disturbance, risk management preferences, constraints or restrictions as described in the contract, in this report, or in any subsequent communication sent by WSP to the Client in connection to the Contract; and

   c) The limitations stated herein.

2 **Standard of care:** WSP has prepared this report in a manner consistent with the level of skill and are ordinarily exercised by reputable members of WSP's profession, practicing in the same or similar locality at the time of performance, and subject to the time limits and physical constraints applicable to the scope of work, and terms and conditions for this assignment. No other warranty, guaranty, or representation, expressed or implied, is made or intended in this report, or in any other communication (oral or written) related to this project. The same are specifically disclaimed, including the implied warranties of merchantability and fitness for a particular purpose.

3 **Limited locations:** The information contained in this report is restricted to the site and structures evaluated by WSP and to the topics specifically discussed in it, and is not applicable to any other aspects, areas, or locations.

4 **Information utilized:** The information, conclusions and estimates contained in this report are based exclusively on: i) information available at the time of preparation, ii) the accuracy and completeness of data supplied by the Client or by third parties as instructed by the Client, and iii) the assumptions, conditions, and qualifications/limitations set forth in this report.

5 **Accuracy of information:** No attempt has been made to verify the accuracy of any information provided by the Client or third parties, except as specifically stated in this report (hereinafter "Supplied Data"). WSP cannot be held responsible for any loss or damage, of either contractual or extra-contractual nature, resulting from conclusions that are based upon reliance on the Supplied Data.

6 **Report interpretation:** This report must be read and interpreted in its entirety, as some sections could be inaccurately interpreted when taken individually or out-of-context. The contents of this report are based upon the conditions known and information provided as of the date of preparation. The text of the final version of this report supersedes any other previous versions produced by WSP.

7 **No legal representations:** WSP makes no representations whatsoever concerning the legal significance of its findings, or as to other legal matters touched on in this report, including but not limited to, ownership of any property, or the application of any law to the facts set forth herein. With respect to regulatory compliance issues, regulatory statutes are subject to interpretation and change. Such interpretations and regulatory changes should be reviewed with legal counsel.

8 **Decrease in property value:** WSP shall not be responsible for any decrease, real or perceived, of the property or site's value or failure to complete a transaction, as a consequence of the information contained in this report.

9 **No third-party reliance:** This report is for the sole use of the party to whom it is addressed unless expressly stated otherwise in the report or Contract. Any use or reproduction which any third party makes of the report, in whole or in part, or any reliance thereon or decisions made based on any information or conclusions in the report is the sole responsibility of such third party. WSP does not represent or warrant the accuracy, completeness, merchantability, fitness for purpose or usefulness of this document, or any information contained in this document, for use or consideration by any third party. WSP accepts no responsibility whatsoever for damages or loss of any nature or kind suffered by any such third party as a result of actions taken or not taken or decisions made in reliance on this report or anything set out therein. including without limitation, any indirect, special, incidental, punitive, or consequential loss, liability or damage of any kind.

10 **Assumptions:** Where design recommendations are given in this report, they apply only if the project contemplated by the Client is constructed substantially in accordance with the details stated in this report. It is the sole responsibility of the Client to provide to WSP changes made in the project, including but not limited to, details in the design, conditions, engineering, or construction that could in any manner whatsoever impact the validity of the recommendations made in the report. WSP shall be entitled to additional compensation from Client to review and assess the effect of such changes to the project.

11 **Time dependence:** If the project contemplated by the Client is not undertaken within a period of 18 months following the submission of this report, or within the time frame understood by WSP to be contemplated by the Client at the commencement of WSP's assignment, and/or, if any changes are made, for example, to the elevation, design or nature of any development on the site, its size and configuration, the location of any development on the site and its orientation, the use of the site, performance criteria and the location of any physical infrastructure, the conclusions and recommendations presented herein should not be considered valid unless the impact of the said changes is evaluated by WSP, and the conclusions of the report are amended or are validated in writing accordingly.

Advancements in the practice of geotechnical engineering, engineering geology and hydrogeology and changes in applicable regulations, standards, codes or criteria could impact the contents of the report, in which case, a supplementary report may be required. The requirements for such a review remain the sole responsibility of the Client or their agents.

WSP will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

12 **Limitations of visual inspections:** Where conclusions and recommendations are given based on a visual inspection conducted by WSP, they relate only to the natural or man-made structures, slopes, etc. inspected at the time the site visit was performed. These conclusions cannot and are not extended to include those portions of the site or structures, which were not reasonably available, in WSP's opinion, for direct observation.

13 **Limitations of site investigations:** Site exploration identifies specific subsurface conditions only at those points from which samples have been taken and only at the time of the site investigation. Site investigation programs are a professional estimate of the scope of investigation required to provide a general profile of subsurface conditions.

The data derived from the site investigation program and subsequent laboratory testing are interpreted by trained personnel and extrapolated across the site to form an inferred geological representation and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour with regard to the proposed development. Despite this investigation, conditions between and beyond the borehole/test hole locations may differ from those encountered at the borehole/test hole locations and the actual conditions at the site might differ from those inferred to exist, since no subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies.

Final sub-surface/bore/profile logs are developed by geotechnical engineers based upon their interpretation of field logs and laboratory evaluation of field samples. Customarily, only the final bore/profile logs are included in geotechnical engineering reports.

Bedrock, soil properties and groundwater conditions can be significantly altered by environmental remediation and/or construction activities such as the use of heavy equipment or machinery, excavation, blasting, pile-driving or draining or other activities conducted either directly on site or on adjacent terrain. These properties can also be indirectly affected by exposure to unfavorable natural events or weather conditions, including freezing, drought, precipitation and snowmelt.

During construction, excavation is frequently undertaken which exposes the actual subsurface and groundwater conditions between and beyond the test locations, which may differ from those encountered at the test locations. It is recommended that WSP be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered at the test locations, that construction work has no negative impact on the geotechnical aspects of the design, to adjust

recommendations in accordance with conditions as additional site information is gained, and to deal quickly with geotechnical considerations if they arise.

Interpretations and recommendations presented herein may not be valid if an adequate level of review or inspection by WSP is not provided during construction.

14 **Factors that may affect construction methods, costs and scheduling:** The performance of rock and soil materials during construction is greatly influenced by the means and methods of construction. Where comments are made relating to possible methods of construction, construction costs, construction techniques, sequencing, equipment or scheduling, they are intended only for the guidance of the project design professionals, and those responsible for construction monitoring. The number of test holes may not be sufficient to determine the local underground conditions between test locations that may affect construction costs, construction techniques, sequencing, equipment, scheduling, operational planning, etc.

Any contractors bidding on or undertaking the works should draw their own conclusions as to how the subsurface and groundwater conditions may affect their work, based on their own investigations and interpretations of the factual soil data, groundwater observations, and other factual information.

15 **Groundwater and Dewatering:** WSP will accept no responsibility for the effects of drainage and/or dewatering measures if WSP has not been specifically consulted and involved in the design and monitoring of the drainage and/or dewatering system.

16 **Environmental and Hazardous Materials Aspects:** Unless otherwise stated, the information contained in this report in no way reflects on the environmental aspects of this project, since this aspect is beyond the Scope of Work and the Contract. Unless expressly included in the Scope of Work, this report specifically excludes the identification or interpretation of environmental conditions such as contamination, hazardous materials, wild life conditions, rare plants or archeology conditions that may affect use or design at the site. This report specifically excludes the investigation, detection, prevention or assessment of conditions that can contribute to moisture, mould or other microbial contaminant growth and/or other moisture related deterioration, such as corrosion, decay, rot in buildings or their surroundings. Any statements in this report or on the boring logs regarding odours, colours, and unusual or suspicious items or conditions are strictly for informational purposes.

17 **Sample Disposal:** WSP will dispose of all uncontaminated soil and rock samples after 30 days following the release of the final geotechnical report. Should the Client request that the samples be retained for a longer time, the Client will be billed for such storage at an agreed upon rate. Contaminated samples of soil, rock or groundwater are the property of the Client, and the Client will be responsible for the proper disposal of these samples, unless previously arranged for with WSP or a third party.

Attachment: Result of Grain Size Analysis

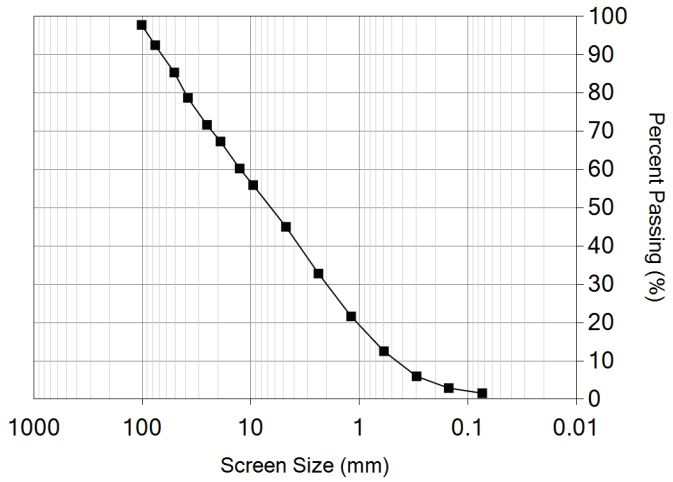
Sieve Analysis

Report Date: April 27, 2022

Client		Project	
Name:	BC Ministry Of Transportation and Infrastructure	**Name:**	(VG07794.300) South Coast As and When
Address:	310 - 1500 Woolridge Street Coquitlam, BC V3K 0B8	**Address:**	1500 Woolridge St, Coquitlam, BC
Attention:	Salem Bahamdun	**Phase:**	**Task:**
PO Number:		**Manager:**	Eric Mohlmann
Sample Date:	4/4/2022 by David Love	**Lab/Ref. #:**	L6758 - SA1
Source:	KM 10.9 sampled from Native Grade	**Description:**	Poorly Graded Gravel with Sand and Cobbles

Type of Specification: No project specification was provided.

Cumulative Particle Distribution



Sieve Analysis: (ASTM C117-17/C136-19)

200 Wash Procedure: A

	Sieve Size	Passing	Specification Min	Specification Max
Coarse Portion:	100mm	98%		
	75mm	92%		
	50mm	85%		
	37.5mm	79%		
	25mm	72%		
	19.0mm	67%		
	12.5mm	60%		
	9.5mm	56%		
	4.75mm	45%		
Fine Portion:	**Sieve Size**	**Passing**	**Min**	**Max**
	2.36mm	33%		
	1.18mm	22%		
	600µm	13%		
	300µm	6%		
	150µm	3%		
	75µm	1.6%		

Particle Size (bold indicates value was interpolated)							
Over 3" / 76mm	Gravel		Sand			Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
8.0%	25.0%	22.0%	**16.0%**	**20.0%**	**7.4%**	1.6%	

Remarks:

Distribution: Surrey, Wood

Reviewed By: David Love

David Love

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