



REPORT

Geotechnical Data Report

Cariboo Roads Recovery Project - Cache Creek Culvert Replacement

Submitted to:

Urban Systems Ltd.

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Submitted by:

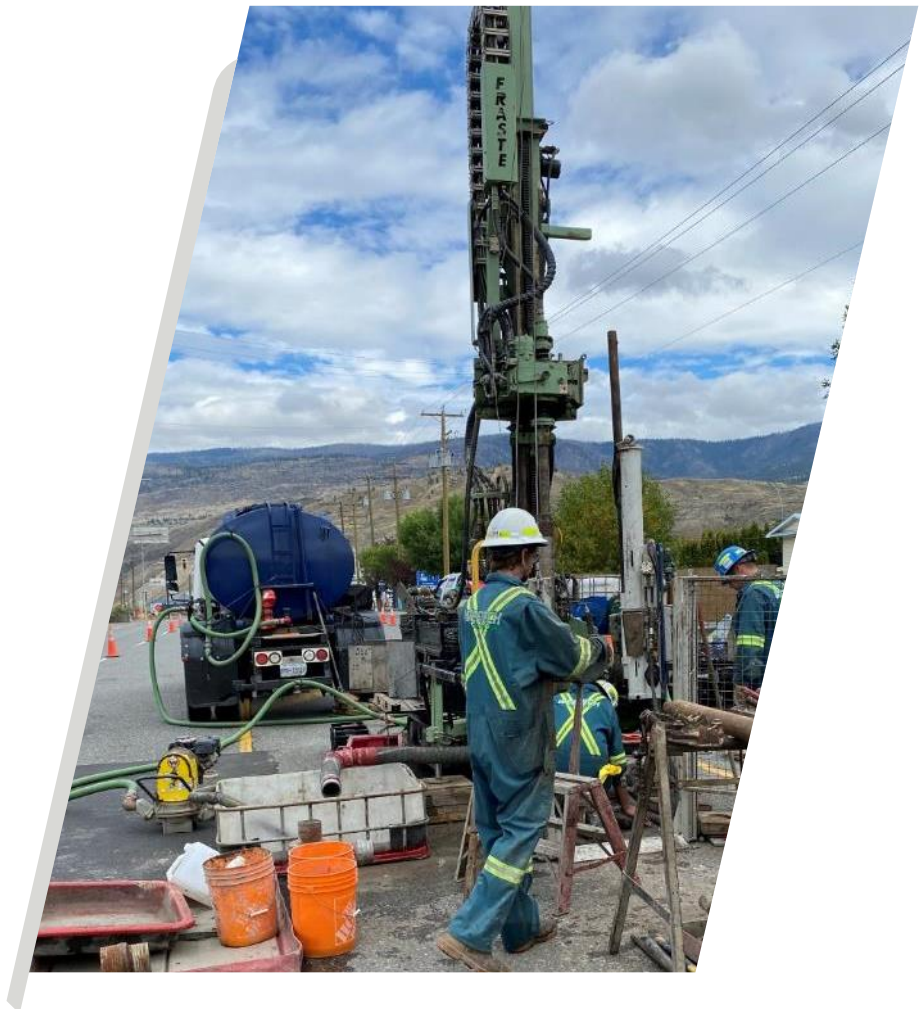
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26239_geo_report_0004_data_0

21 September 2023



Distribution List

eCopy - Urban Systems Ltd.

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1.0 INTRODUCTION

As per the request from Urban Systems Ltd. (USL), WSP Canada Inc. (WSP) has conducted a supplementary geotechnical investigation to obtain additional soil samples as well as to complement the findings of WSP E&I's Cache Creek Culvert Replacement Geotechnical Report dated 28 September 2022.

This supplementary investigation took place on 09 August 2023, as part of the Multi-Disciplinary Team (MDT) engaged in the 'Caribou Roads Recovery Project' contract. This contract, dated 28 October 2022, is between the Ministry of Transportation and Infrastructure (MoTI) and USL, identified by the contract reference number 268 CS 1825. Specifically, the focus of this report is on the Cache Creek culvert site (the Site).

WSP was granted authorization to carry out this supplementary geotechnical investigation following acceptance of WSP's work plan, reference number 26239_ge_sow_sampling_work-plan_20230809. This supplementary investigation involved drilling a single borehole (BH23-01) along the centerline of Highway 97, situated about 6.0 m north of the existing Cache Creek culvert. This effort complements the previous September 2021 investigation which entailed two boreholes (BH21-01 and BH21-02) drilled along Highway 97's centerline, about 1.0 m north and 2.5 m south of the existing culvert, respectively.

The primary objective of these investigations was to obtain soil samples and assess the sub-surface soil and groundwater conditions at the site. Based on our analysis of this information, we present the factual results of the geotechnical investigation.

It is important to note that the scope of work associated with this report is confined to geotechnical engineering services exclusively. It does not encompass investigations or interpretations of potential soil or groundwater contamination, archaeological findings, hydrogeological and hydrotechnical considerations, or bio-environmental factors.

We urge readers to review the "Important Information and Limitations of this Report" outlined in Appendix A. This section is pivotal for the accurate utilization and interpretation of this report.

2.0 SITE DESCRIPTION

The site is positioned approximately 120 meters north of the junction between Highway 97 and Highway 1 in Cache Creek, BC. At present, it features a single pipe culvert designed to facilitate the east-to-west flow of Cache Creek beneath Highway 97. This existing culvert intersects Highway 97 at a slight skew of approximately 75 to 80 degrees in relation to the highway's centerline and is approximately 1,900 mm by 2,400 mm in size. The highway's road surface spans roughly 20 meters in width, encompassing four lanes along with a delineated divider lane situated above the culvert crossing.

On the upstream side, the northern bank of the creek channel is vegetated and ascends to the adjacent parking lot with a slope gradient of roughly 2 horizontal units to 1 vertical unit (2H:1V). Conversely, the southern bank of the creek, situated upstream of the highway culvert crossing, is bordered by a nearly vertical gabion wall reaching heights of about 3 to 4 meters.

Moving downstream, the slopes flanking both sides of the creek channel maintain an inclination of approximately 2H:1V. These slopes adjacent to the highway culvert crossing are fortified by riprap and nonwoven geotextile. Notably, sections of these slope areas have experienced significant erosion, leading to the full exposure of the

underlying nonwoven geotextile material. Specifically, the southern side of the creek channel, perpendicular to Highway 97, has eroded to an extent where the asphalt of an adjoining parking lot has been substantially compromised. The chain-link fence that once bordered the side slope has also collapsed into the eroded area.

For visual reference, please consult Figure 1 following the text of this report, which displays the site location as well as the designated borehole positions.

3.0 PROJECT UNDERSTANDING

WSP recognizes that MoTI and the MDT are responsible for executing the functional design of the culvert replacement with a single span bridge to accommodate design flows of 46.2 m³/s. This geotechnical data report's purpose is to bolster these endeavors by supplying supplementary factual geotechnical investigation data closer to the planned north bridge abutment.

At the time preparing this report, detailed design information pertaining to the culvert replacement design were in draft form; however, it is understood that the culvert replacement will be a single span 4-lane bridge supported by a deep foundation system which will be described under separate cover.

4.0 SCOPE OF WORK

WSP's scope of work comprised the following tasks:

- Desktop review of available information pertaining to the geotechnical aspects of the proposed culvert replacement
- Supplementary geotechnical drilling investigation using a track mounted drill rig capable of mud rotary techniques to depths up to approximately 18.1 metres below ground surface (mbgs)
- Geotechnical index testing, soil resistivity, chloride content, and sulphate content on selected soil samples obtained from the investigation program
- Environmental water testing (excluding engineering interpretation or opinion)
- Provision of this geotechnical data report summarizing the investigation results.

5.0 BACKGROUND

WSP carried out a review of available background information on the Site to develop an understanding of geotechnical conditions that may impact the Project. The study consisted of a desktop review of information originating from internal WSP libraries and publicly available sources including:

- Surficial geology maps and papers
- Previous geotechnical reports

The findings of WSP's background information review are summarized in the following subsections.

5.1 Surficial Geology

WSP conducted a review of surficial geology maps from the British Columbia Geological Survey. The available map¹ indicated that the surficial geology at the site generally comprises of alluvial plain/floodplain deposits of gravels, sands, and minor overbank silt.

5.2 Existing Geotechnical Information

From 17-18 September 2021, WSP E&I completed a geotechnical investigation for MoTI comprising two drill holes completed within the vicinity of the existing culvert and general area of the south abutment for the proposed new bridge. Site-specific factual information from the 2021 investigation's report² dated 28 September 2022 were reviewed. The 2021 drilling was conducted by use of a sonic drill rig with large penetration test (LPT) capabilities.

6.0 GEOTECHNICAL INVESTIGATION

The supplementary geotechnical subsurface investigation was conducted between 9-10 August 2023. It consisted of the advancement of a single borehole within the centreline of Highway 97. The location of the 2023 borehole and the previous 2021 boreholes are presented in Table 1 below, and Figure 1.

Prior to commencement of the investigation, WSP completed a BC1Call and contacted the Village of Cache Creek for as-built records. The provided materials were reviewed in the assessment of the proposed borehole location for potential utilities and other infrastructure. With the proposed borehole location established, WSP retained Universal Traffic Management to develop and implement a traffic management plan in addition to acquiring the permits required for the investigation's scope of work. WSP contracted Quadra Utility Locating Ltd. to complete a utility sweep of the proposed borehole locations using Electromagnetic and Ground Penetrating Radar methods.

WSP retained Westech Drilling Corp. (Westech) to supply, mobilize and operate a Fraste Multidrill PL G track-mounted mini rotary drill rig for the duration of the investigation.

The geotechnical subsurface investigation was conducted with the full-time presence of a member of WSP's geotechnical team and two Bonaparte First Nation cultural monitors. The WSP geotechnical team member located the borehole in the field, logged the soil and groundwater conditions, and collected soil samples for visual classification and geotechnical laboratory testing.

Upon completion of the investigation, WSP located the as-drilled borehole locations using a hand-held GPS typically capable of +/- 5 m accuracy.

¹ Ryder, J.M. 1976. Surficial Geology, Ashcroft British Columbia. Geological Survey of Canada, Map 1405A, scale 1:126,720.

² Banks, C., Mohlmann, E. 2022. Geotechnical Data Report, Highway 97 – Cache Creek Culvert Replacement. WSP Canada Inc, project number KX13772C20.

Table 6.1: Summary of Borehole Locations and Depths

Borehole No.	Coordinates (UTM NAD83 Zone 9N) ^[1]		Geodetic Ground Surface Elevation (masl*) ^[2]	Termination Depth (mbgs**)
	Northing (m)	Easting (m)		
BH23-01	5630040	617985	463.2	18.1
BH21-01	5630030	617991	463.2	15.2
BH21-02	5630024	617992	463.2	30.2

masl* = meters above sea level

mbgs** = meters below ground surface

^[1] UTM NAD 83 10U

^[2] Based on 2022 Geotechnical Report

6.1 Drilling Methodology

The drilling methodology for BH23-01 was a combination of solid stem auger and mud rotary drilling. The initial 3.3 m of the borehole was drilled by use of solid stem auger. To advance the borehole and maintain verticality, a combination of fishtail and claw bits was used to penetrate the sandy gravel fill with cobbles up to 125 mm nominal diameter observed. To maintain borehole integrity, casing was then advanced to a depth of 3.3 m before the borehole was setup for mud rotary drilling. Mud rotary drilling in combination with standard penetration tests (SPT) with split-spoon sampling were continued to the termination depth of 18.1 m.

6.2 Standard Penetration Test

Standard Penetration Tests (SPT) were generally completed at 1.5 metre depth intervals after the first 3.3 metres to determine the relative density/compaction of overburden soils and to recover split-spoon samples. The split spoon sampling was carried out in general accordance with ASTM D1586, Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils.

The recorded blow counts for the individual soundings are presented on the Record of Borehole sheets in Appendix B. The relative density or consistency reported in the logs were generally based on the measured blow counts. It should be noted that in certain strata (i.e., where gravel or cobble-sized particles were encountered), the recorded blow counts may not be representative of the relative density or stiffness of the soil matrix, and a combination of engineering judgement and laboratory testing is required to evaluate the compactness/consistency of the material. The reader is also cautioned to consider overburden and energy loss effects (as well as other correction factors) when interpreting raw penetration test results.

Caution and judgement should therefore be exercised in the interpretation of the recorded blow counts presented on the Record of Borehole sheets and their correlation with standard or corrected "N" values.

It should be noted that the SPT tooling and samplers (50 mm OD split-spoon) utilized during the investigations limit the maximum particle size of recovered samples, and as such would not be representative of cobble or boulder contents.

6.3 Borehole Abandonment

BH23-01 was backfilled immediately after drilling with bentonite grout to 3.3 m depth. On August 10th, 2023 (07:30) the borehole was backfilled with bentonite chips to 1.4 m depth, road base to 0.4 m depth, and cold mix asphalt to surface.

7.0 LABORATORY TESTING

7.1 Geotechnical Testing

The following geotechnical tests were carried out on disturbed soil samples collected as part of the geotechnical investigation:

- Particle-Size Distribution (gradation) of Soils Using Sieve Analysis (ASTM D6913)
- Laboratory Determination of Water (moisture) Content of Soil and by Mass (ASTM D2216)
- Soil Resistivity using the Two-Electrode Soil Box Method (ASTM G187)
- Determination of Organic Material Content of Soil (ASTM D2974)

The results of the geotechnical soil testing conducted on disturbed samples collected during the subsurface geotechnical investigation are presented in Appendix C and summarized in Table 7.1 and Table 7.2.

Table 7.1: Summary of Laboratory Index Testing Results

Hole ID	Sample ID	Sample Depth Interval (mbgs)		Sieve Analysis			Moisture Content (%)
		Top	Bottom	Gravel (%)	Sand (%)	Fines (%)	
BH23-01	2	2.44	2.59	-	-	-	3.5
BH23-01	5A	7.01	7.25	-	-	-	8.7
BH23-01	5B	7.25	7.47	-	-	-	13.6
BH23-01	6	8.53	8.99	40.9	43.2	15.9	11.3
BH23-01	7	10.06	10.52	-	-	-	9.0
BH23-01	8	11.58	12.04	-	-	-	12.3
BH23-01	9	13.11	13.56	32.2	57.1	10.7	13.5
BH23-01	10	14.95	15.39	-	-	-	10.1
BH23-02	11	16.15	16.61	-	-	-	10.0
BH23-02	12	17.68	18.14	45.9	45.5	8.6	10.6

Table 7.2: Summary of Soil Resistivity Testing Results

Hole ID	Sample ID	Sample Depth Interval (mbgs)		Measured Resistance (ohm)	Calculated Resistivity (ohm-cm)
		Top	Bottom		
BH23-01	1	0.76	0.91	5,070	3,397
BH23-01	4	5.49	5.94	8,850	5,930

7.2 Environmental

The following primary analytical tests were carried out on disturbed soil samples collected as part of the geotechnical investigation:

- Water Soluble Chloride Ion Content (CSA A23.2-4B)
- Water Soluble Sulphate in Soil (CSA A23.2-3B)
- Soil pH Analysis (ASTM D4972)
- Organic content testing (ASTM D2974)

Additionally, surface water samples were taken from the creek for sulphate and pH testing.

The results of environmental analytical laboratory testing, including soil pH, water soluble chloride, sulphate content are presented in Appendix D. Testing of the materials was conducted in general accordance with ASTM and/or Canadian Standards Association (CSA) methods. The testing was carried out by CARO Analytical Services and WSP of Burnaby, BC.

8.0 SUBSURFACE GEOTECHNICAL CONDITIONS

Detailed descriptions of the subsurface soil and groundwater conditions encountered at the time of the field investigation are presented on the Summary Log sheets in Appendix B along with the MoTI 'Notes for Completion of Soil Field Logs' description of the soil classification system used and a list of symbols and abbreviations for the proper interpretation of the soil information. Classification and identification of soil involves judgment and WSP does not guarantee descriptions as exact but infers accuracy to the extent that is common in current geotechnical practice. The depths of stratigraphic changes are generally approximate and inferred since there is often a gradual transition between soil types. It should be noted that it is expected that variations in the subsurface conditions may occur between and beyond the location of the boreholes. The following presents a summary of the subsurface conditions encountered in the boreholes.

The subsurface soil stratigraphy encountered within BH23-01 generally comprised, in order of increasing depth:

- FILL – road structure and embankment fills were encountered to about 3.8 mbgs. Fill was found to consist of well graded sandy gravel, some fines, some cobbles. The compactness of the fill was inferred as dense soil based on drilling resistance and the presence of cobbles and boulders.

-
- Gravel and Sand – underlying the road and embankment fills, well graded gravel and sand, some fines, trace boulders and cobbles were encountered to termination depth of 18.1 mbgs. SPT N values indicated compact to very dense compactness for the granular deposit.

This stratigraphy was generally in agreement with the stratigraphy described in WSP E&I's 2022 report. The Summary Logs for the boreholes completed in 2021 have also been included in Appendix B.

8.1 Fill

Layers of fill were encountered at all borehole locations (both the 2022 and 2023 report). Generally, the thickness of this unit is in the order of 3.7 to 4.0 mbgs. In the case of BH23-01, the pavement structure and road embankment fill could only be broadly characterized due to the sloughing and churning of the soil upon extraction. Although the thicknesses of the base, subbase, and variable road embankment fill can be inferred from the 2022 report. BH23-01 encountered fills to a depth of about 3.8 mbgs.

8.2 Granular Deposits

Underlying the highway pavement structure and embankment fills were granular deposits of well graded gravel and sand with trace to some fines, and trace boulders. Based on SPT results, the granular soils were inferred to be in a compact to very dense state of relative density.

8.3 Groundwater

Groundwater levels generally could not be assessed while drilling due to the drill methodology that involved introduction of water into the borehole. Based on the 2021 drilling records, the groundwater level was approximately 6.1 to 6.2 m below surface. However, it is expected that the groundwater level is inherently variable at any given time and directly related to time of year and the flow of Cache Creek. Characterization of this variability would require a long-term groundwater monitoring program.

9.0 CLOSURE

We trust the foregoing provides you with the information that you require at this time. Should you require additional information or have any questions, please do not hesitate to contact the undersigned at your earliest convenience.

WSP Canada Inc.



Patrick Machibroda, MASC, EIT
Associate Geotechnical Engineer

Ben Dorsey, PEng
Senior Geotechnical Engineer

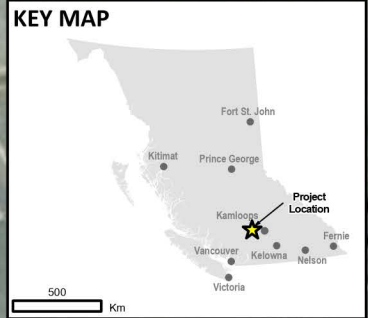
Reviewed By:




Nick Polysou, PEng
Senior Principal Geotechnical Engineer

PM/BD/NP/asd

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LEGEND
 BOREHOLE LOCATION

CLIENT
 URBAN SYSTEMS LTD.

PROJECT
 CARIBOO ROADS RECOVERY PROJECT CACHE CREEK CULVERT REPLACEMENT
 HWY 97, CACHE CREEK, BC

TITLE
 SITE PLAN

CONSULTANT



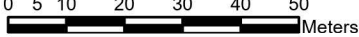
YYYY-MM-DD 2023-09-19

DESIGNED BD

PREPARED MY

REVIEWED BD

APPROVED NP

1:1,300  Meters

REFERENCES
 1. Parcel and hydrography data contain information licensed under the Open Government License – British Columbia

Spatial Reference: NAD 1983 UTM Zone 10N

PROJECT NO. 26239	PHASE	REV. 0	FIGURE 1
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APPENDIX A

**Important Information and
Limitation of this Report**

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: WSP Canada Inc. (WSP) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to WSP by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. WSP can not be responsible for use of this report, or portions thereof, unless WSP is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without WSP's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, WSP may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to WSP. The report, all plans, data, drawings and other documents as well as all electronic media prepared by WSP are considered its professional work product and shall remain the copyright property of WSP, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of WSP. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client cannot rely upon the electronic media versions of WSP's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to WSP by the Client, communications between WSP and the Client, and to any other reports prepared by WSP for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. WSP can not be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, WSP does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain

subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that WSP interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. **The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report.** The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: WSP will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of WSP's report. WSP should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of WSP's report.

During construction, WSP should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of WSP's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in WSP's report. Adequate field review, observation and testing during construction are necessary for WSP to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, WSP's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that WSP be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that WSP be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. WSP takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

APPENDIX B

Borehole Summary Logs



Ministry of Transportation and Infrastructure

SUMMARY LOG

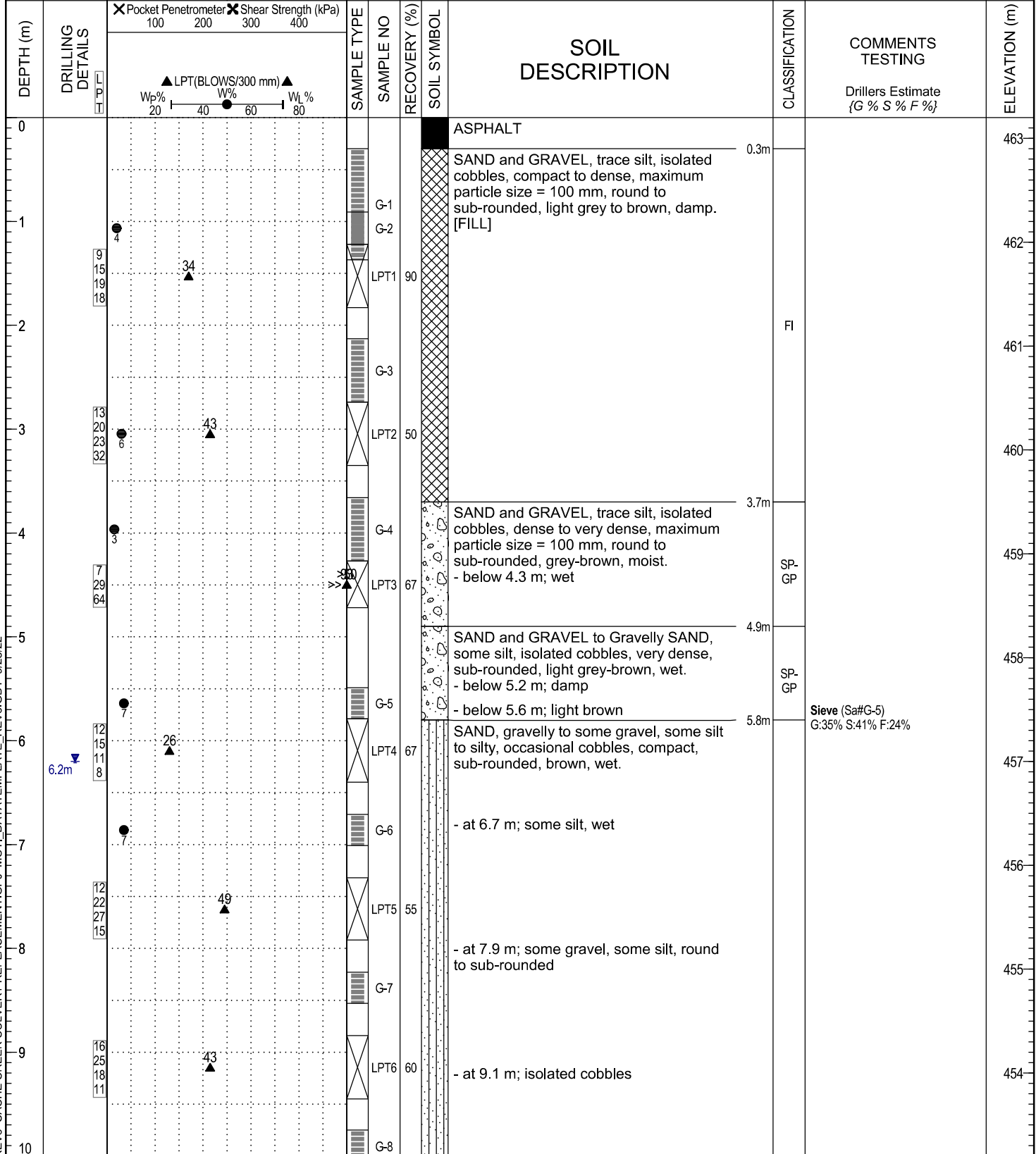
Drill Hole #: **BH21-01**

Project: **Cache Creek Culvert Replacement**
 Location: Cache Creek, BC

Date(s) Drilled: 09/17/2021
 Company: MudBay Drilling
 Driller:
 Drill Make/Model: Track
 Drilling Method: Sonic with LPT

Prepared by: WSP E&I Canada Ltd
 KX13772C20
 Logged by: DL Reviewed by: CB

Datum: NAD83
 Northing/Easting: 5630030, 617991
 Elevation: 463.2 m
 Alignment: n/a
 Station/Offset: Hwy C/L
Coordinates taken with GPS



MOTI-SOIL-REV3 CACHE CREEK CULVERT REPLACEMENT.GPJ MOTI_DATATEMPLATE.REV3.GDT 9/28/22

Legend	
	A-Auger
	B-Becker
	C-Core
	G-Grab
	V-Vane
	L#-Lab Sample
	S-Split Spoon
	O-Odex (air rotary)
	W-Wash (mud return)
	T-Shelby Tube

Final Depth of Hole: 15.2 m
 Depth to Top of Rock:
 Page 1 of 2



Ministry of
Transportation
and Infrastructure

SUMMARY LOG

Drill Hole #: **BH21-01**

Project: **Cache Creek Culvert Replacement**

Date(s) Drilled: 09/17/2021

Location: Cache Creek, BC

Company: MudBay Drilling

Prepared by: KX13772C20
WSP E&I Canada Ltd

Datum: NAD83
Northing/Easting: 5630030, 617991

Alignment: n/a
Station/Offset: Hwy C/L

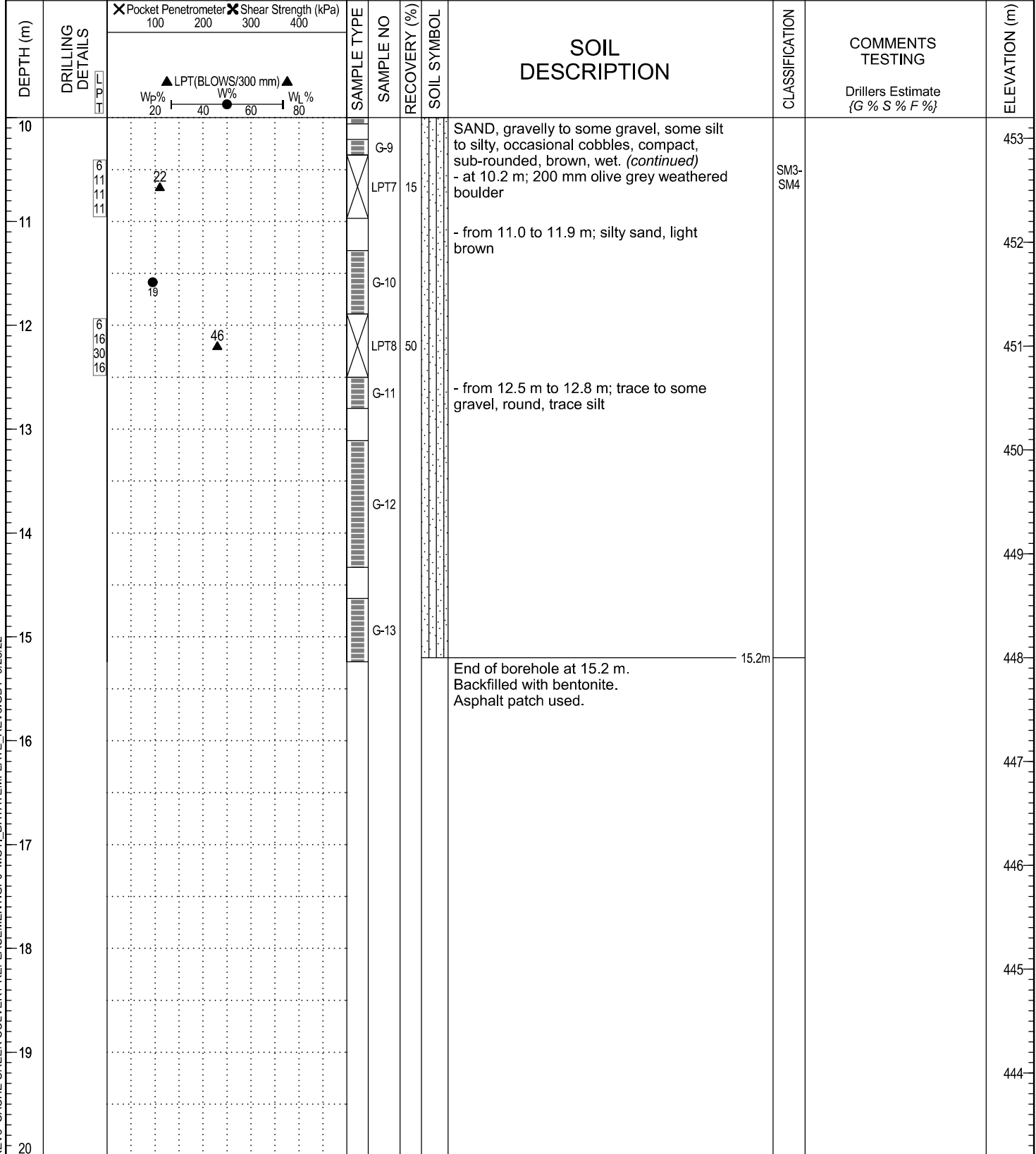
Driller:
Drill Make/Model: Track

Logged by: DL Reviewed by: CB

Elevation: 463.2 m

Coordinates taken with GPS

Drilling Method: Sonic with LPT



MOTI-SOIL-REV3 CACHE CREEK CULVERT REPLACEMENT.GPJ MOTI_DATATEMPLATE_REV3.GDT 9/28/22

Legend	
	A-Auger
	B-Becker
	C-Core
	G-Grab
	V-Vane
	L#-Lab Sample
	S-Split Spoon
	O-Odex (air rotary)
	W-Wash (mud return)
	T-Shelby Tube

Final Depth of Hole: 15.2 m
Depth to Top of Rock:
Page 2 of 2



Ministry of
Transportation
and Infrastructure

SUMMARY LOG

Drill Hole #: **BH21-02**

Project: **Cache Creek Culvert Replacement**

Date(s) Drilled: 09/16/2021

Location: Cache Creek, BC

Company: MudBay Drilling

Prepared by: WSP E&I Canada Ltd
KX13772C20

Datum: NAD83
Northing/Easting: 5630024, 617992

Alignment: n/a
Station/Offset: Hwy C/L

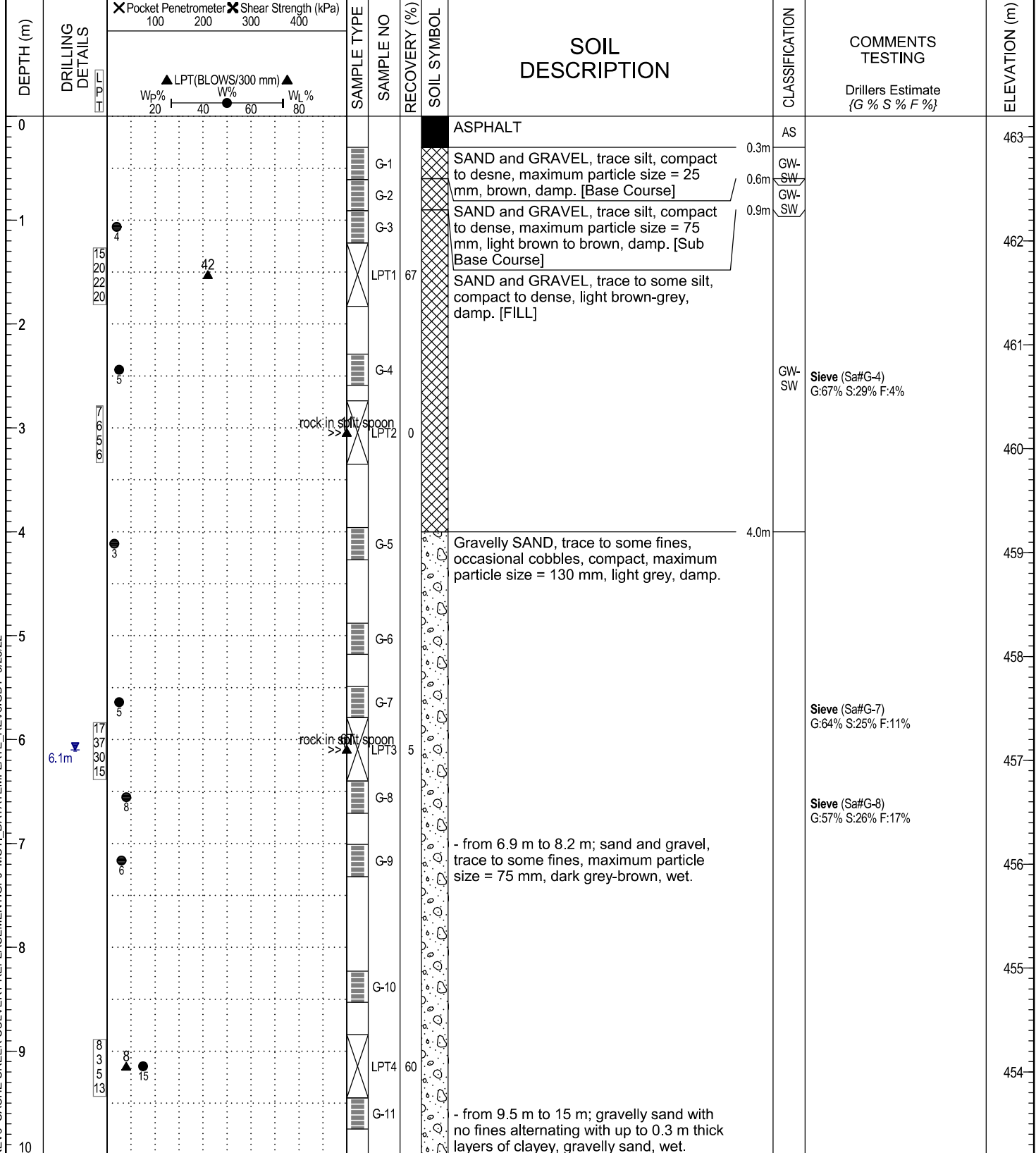
Driller:
Drill Make/Model: Track

Logged by: DL Reviewed by: CB

Elevation: 463.2 m

Coordinates taken with GPS

Drilling Method: Sonic with LPT



Legend

Sample Type: A-Auger, B-Becker, C-Core, G-Grab, V-Vane, L#-Lab Sample, S-Split Spoon, O-Odex (air rotary), W-Wash (mud return), T-Shelby Tube

Final Depth of Hole: 30.2 m
Depth to Top of Rock:
Page 1 of 4



Ministry of
Transportation
and Infrastructure

SUMMARY LOG

Drill Hole #: **BH21-02**

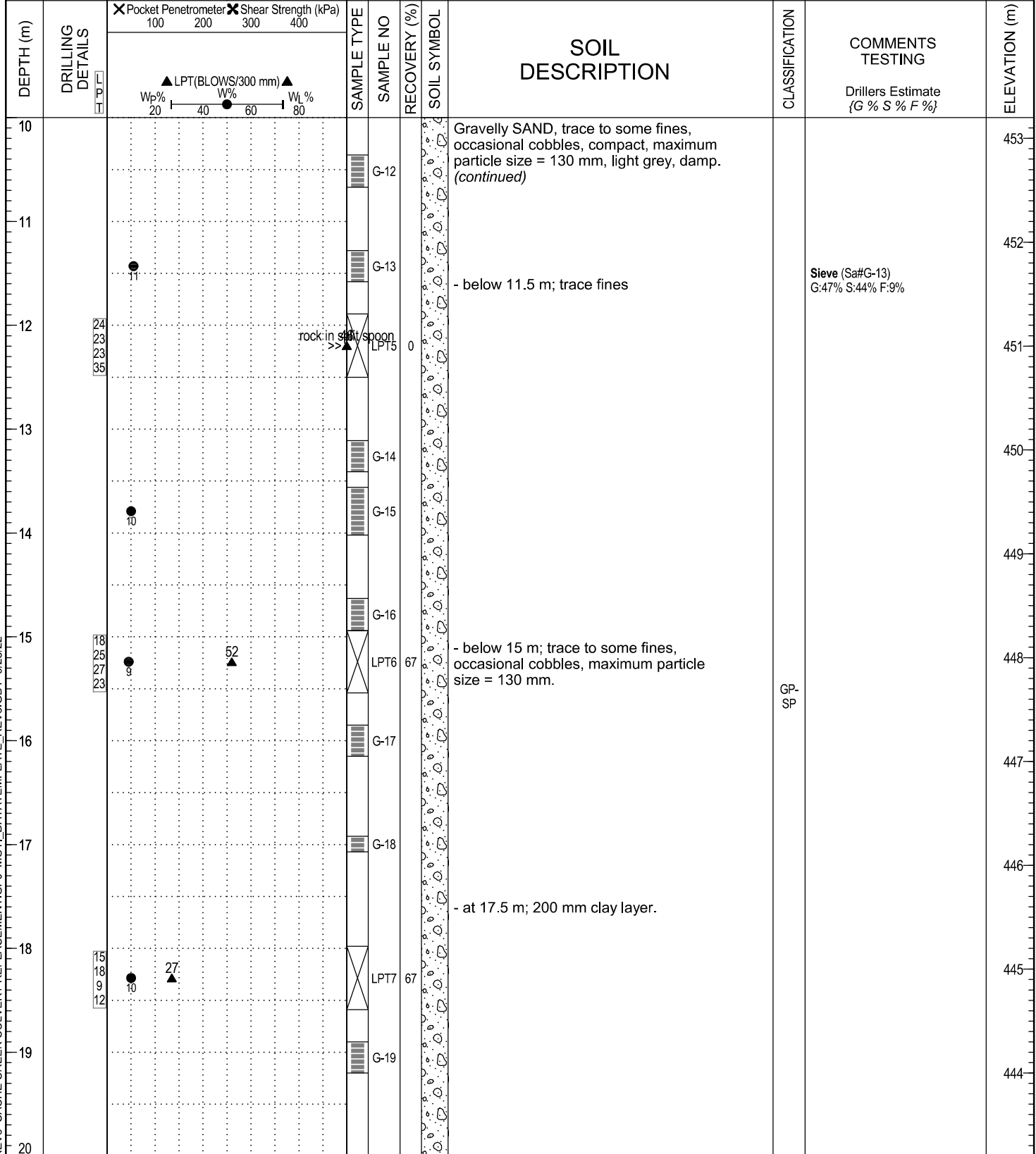
Project: **Cache Creek Culvert Replacement**
Location: Cache Creek, BC

Date(s) Drilled: 09/16/2021
Company: MudBay Drilling
Driller:
Drill Make/Model: Track
Drilling Method: Sonic with LPT

Prepared by: KX13772C20
WSP E&I Canada Ltd

Datum: NAD83
Northing/Easting: 5630024 , 617992
Elevation: 463.2 m
Alignment: n/a
Station/Offset: Hwy C/L
Coordinates taken with GPS

Logged by: DL Reviewed by: CB



MOTI-SOIL-REV3 CACHE CREEK CULVERT REPLACEMENT.GPJ MOTI_DATATEMPLATE.REV3.GDT 9/28/22

Legend

A-Auger	B-Becker	C-Core	G-Grab	V-Vane
L#-Lab Sample	S-Split Spoon	O-Odex (air rotary)	W-Wash (mud return)	T-Shelby Tube

Final Depth of Hole: 30.2 m
Depth to Top of Rock:
Page 2 of 4



Ministry of
Transportation
and Infrastructure

SUMMARY LOG

Drill Hole #: **BH21-02**

Project: **Cache Creek Culvert Replacement**

Date(s) Drilled: 09/16/2021

Location: Cache Creek, BC

Company: MudBay Drilling

Prepared by: KX13772C20
WSP E&I Canada Ltd

Datum: NAD83
Northing/Easting: 5630024 , 617992

Alignment: n/a
Station/Offset: Hwy C/L

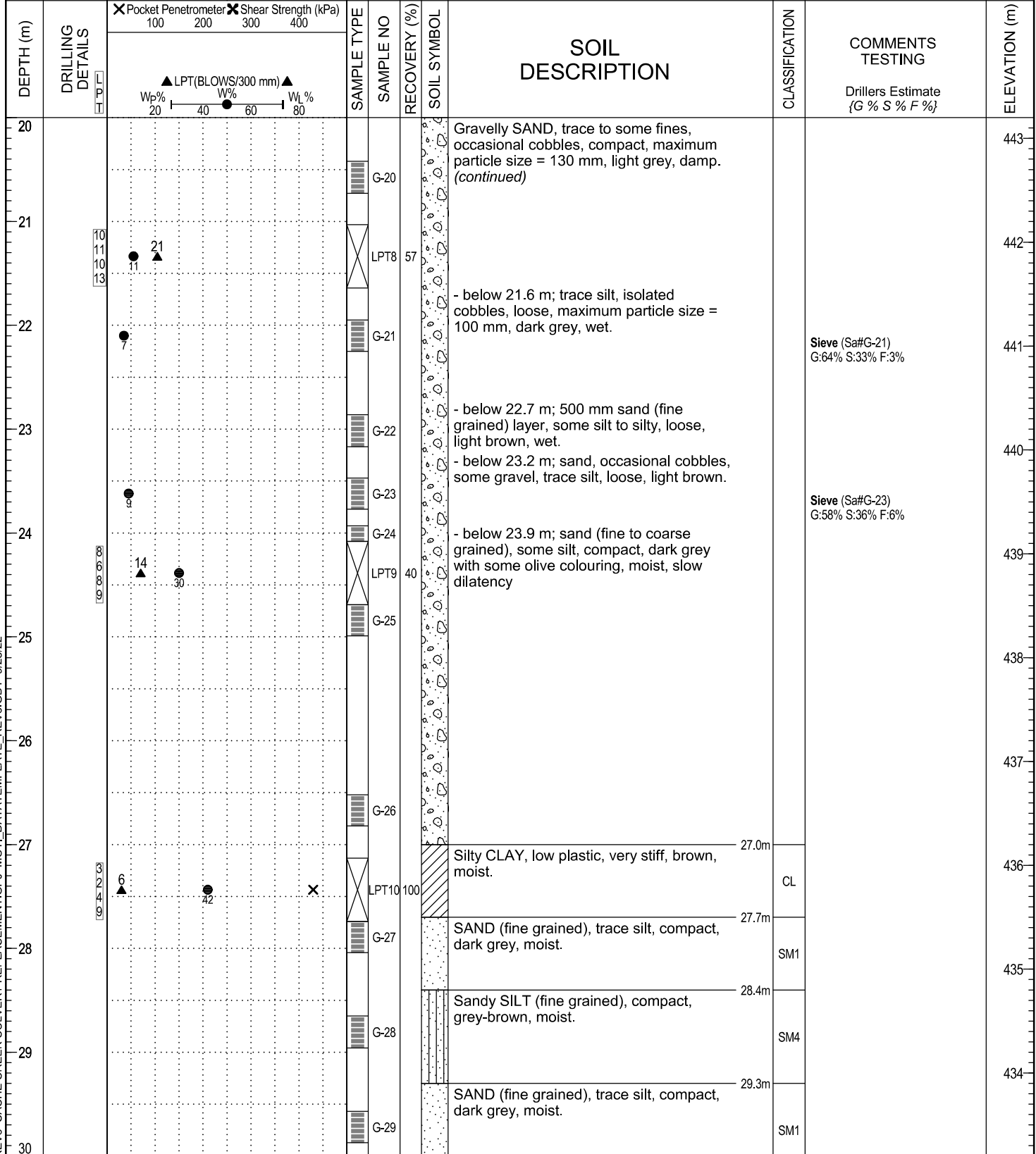
Driller:
Drill Make/Model: Track

Logged by: DL Reviewed by: CB

Elevation: 463.2 m

Coordinates taken with GPS

Drilling Method: Sonic with LPT



Legend

Sample Type:

- A-Auger
- B-Becker
- C-Core
- G-Grab
- V-Vane
- L#-Lab Sample
- S-Split Spoon
- O-Odex (air rotary)
- W-Wash (mud return)
- T-Shelby Tube

Final Depth of Hole: 30.2 m
Depth to Top of Rock:
Page 3 of 4

MOTI-SOIL-REV3 CACHE CREEK CULVERT REPLACEMENT.GPJ MOTI_DATATEMPLATE.REV3.GDT 9/28/22



Ministry of
Transportation
and Infrastructure

SUMMARY LOG

Drill Hole #: **BH21-02**

Project: **Cache Creek Culvert Replacement**
Location: Cache Creek, BC

Date(s) Drilled: 09/16/2021
Company: MudBay Drilling
Driller:
Drill Make/Model: Track
Drilling Method: Sonic with LPT

Prepared by: KX13772C20
WSP E&I Canada Ltd

Datum: NAD83
Northing/Easting: 5630024 , 617992
Elevation: 463.2 m
Alignment: n/a
Station/Offset: Hwy C/L
Coordinates taken with GPS

Logged by: DL Reviewed by: CB

DEPTH (m)	DRILLING DETAILS	X Pocket Penetrometer 100 200 X Shear Strength (kPa) 300 400	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	ELEVATION (m)
30							End of borehole at 30.2 m. Backfilled with bentonite. Asphalt patch used.			433
31										432
32										431
33										430
34										429
35										428
36										427
37										426
38										425
39										424
40										

MOTI-SOIL-REV3 CACHE CREEK CULVERT REPLACEMENT.GPJ MOTI_DATATEMPLATE_REV3.GDT 9/28/22

Legend

Sample Type:

- A-Auger
- B-Becker
- C-Core
- G-Grab
- V-Vane
- L#-Lab Sample
- S-Split Spoon
- O-Odex (air rotary)
- W-Wash (mud return)
- T-Shelby Tube

Final Depth of Hole: 30.2 m
Depth to Top of Rock:
Page 4 of 4



Ministry of
Transportation
and Infrastructure

SUMMARY LOG

Drill Hole#: **BH23-01**

Project: **Cache Creek Culvert Replacement**

Date(s) Drilled: 09 Aug 2023

Location: Cache Creek, British Columbia

Company: Westech

Prepared by: 221-11730-00.3680

Datum: UTM Zone 10N, NAD83

Alignment:

Driller: Dan

WSP Canada Inc.

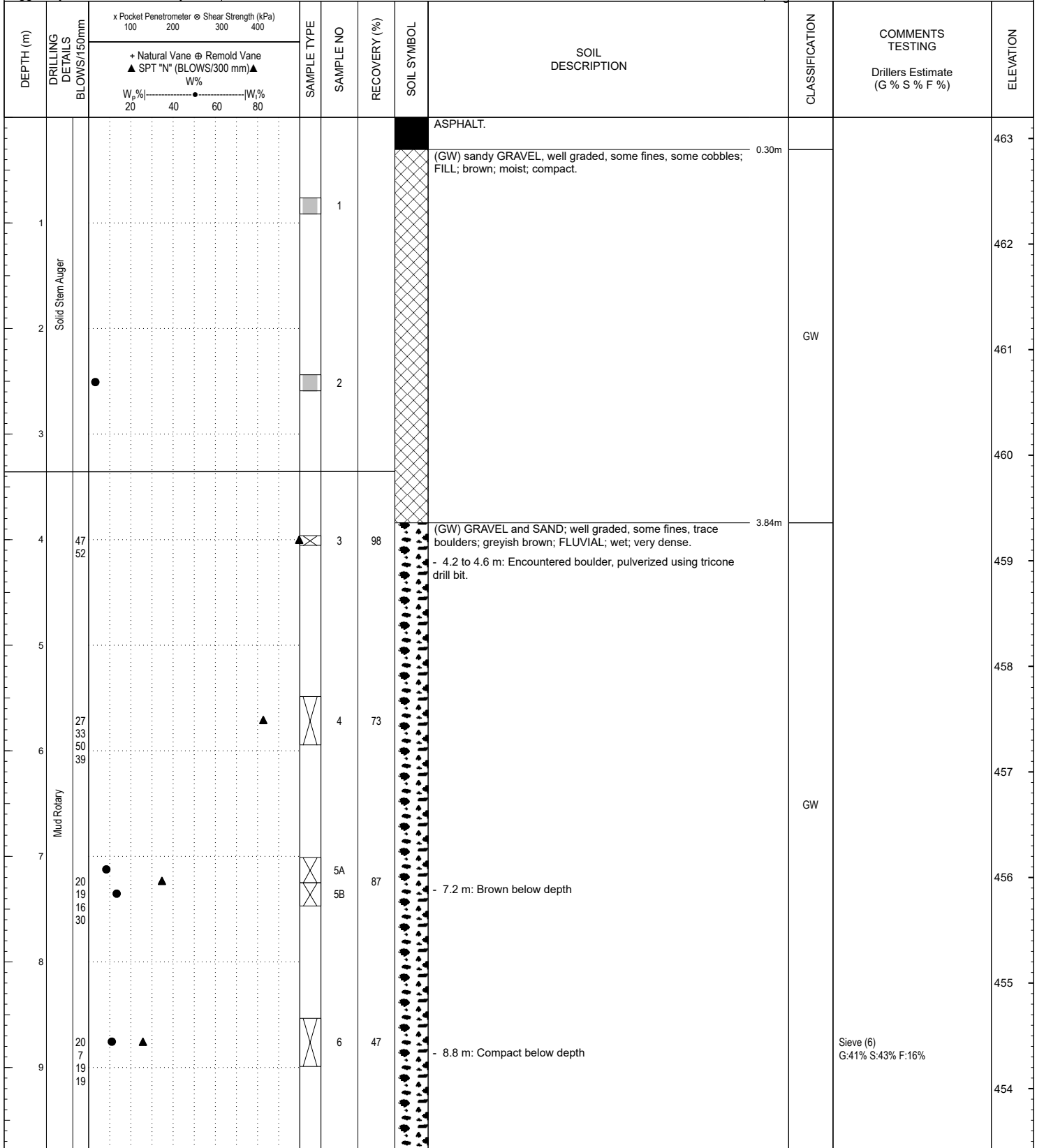
Northing/Easting: 5630039.99 m, 617985.37 m Station/Offset:

Drill Make/Model: MULTIDRILL PL-G

Logged by: PM Reviewed by: BD

Elevation: 463.2 m

Drilling Method: Mud Rotary / Solid Stem Auger



Legend

A-Auger	B-Becker	C-Core	G-Grab	V-Vane
L#-Lab Sample	S-Split Spoon	O-Odex (air rotary)	W-Wash (mud return)	T-Shelby Tube

Continued on Next Page

Final Depth of Hole: 18.1



Ministry of
Transportation
and Infrastructure

SUMMARY LOG

Drill Hole#: **BH23-01**

Project: **Cache Creek Culvert Replacement**

Date(s) Drilled: 09 Aug 2023

Location: Cache Creek, British Columbia

Company: Westech

Prepared by: 221-11730-00.3680

Datum: UTM Zone 10N, NAD83

Alignment:

Driller: Dan

WSP Canada Inc.

Northing/Easting: 5630048.5 m, 618362.2 m Station/Offset:

Drill Make/Model: MULTIDRILL PL-G

Logged by: PM

Reviewed by: BD

Elevation: 463.2 m

Drilling Method: Mud Rotary / Solid Stem Auger

DEPTH (m)	DRILLING DETAILS BLOWS/150mm	x Pocket Penetrometer @ Shear Strength (kPa)		SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate (G % S % F %)	ELEVATION
		100	200								
10	18				7	47		- 10.3 m: Dense below depth			453
11	19										452
12	26				8	22					451
13	18										450
14	13				9	52			GW	Sieve (9) G:32% S:57% F:11%	449
15	12										448
16	20				10	57					447
17	21				11	20		- 16.2 m: Very dense below depth			446
18	16				12	90				Sieve (12) G:46% S:45% F:9%	445
19	17							End of hole at 18.14 m.			444
Borehole backfilled immediately with bentonite grout to 3.35 m depth. On August 10, 2023 (07:30) borehole backfilled with bentonite chips to 1.42 m depth, road base to 0.37 m depth, and cold mix asphalt to surface.											

Legend

- A-Auger
- B-Becker
- C-Core
- G-grab
- V-Vane
- L#-Lab Sample
- S-Split Spoon
- O-Odex (air rotary)
- W-Wash (mud return)
- T-Shelby Tube

Final Depth of Hole: 18.1

APPENDIX C

Geotechnical Laboratory Testing



Test Request # K23-116 Client: MoTI Project Name: Cache Creek Culvert Replacement	Project Number: 221-11730-00.3680 Project Location: Cache Creek, British Columbia
---	--

Sample Location	Sample				Soil Description	Water Content %	Method	Remarks
	Ref	Top (m)	Base (m)	Type				
BH23-01	2	2.44	2.59	GS		3.5	B	
BH23-01	5A	7.01	7.25	SS		8.7	B	
BH23-01	5B	7.25	7.47	SS		13.6	B	
BH23-01	6	8.53	8.99	SS		11.3	B	
BH23-01	7	10.06	10.52	SS		9.0	B	
BH23-01	8	11.58	12.04	SS		12.3	B	
BH23-01	9	13.11	13.56	SS		13.5	B	
BH23-01	10	14.94	15.39	SS		10.1	B	
BH23-01	11	16.15	16.61	SS		10.0	B	
BH23-01	12	17.68	18.14	SS		10.6	B	

Notes:

Disclaimer:

The laboratory testing services reported herein have been performed in accordance with the terms of a contract with WSP's client, and with the recognized standards indicated in this report, or local industry practice. This laboratory testing services report is for the sole use of WSP's client, relates only to the sample(s) tested and does not represent any (actual or implied) interpretation or opinion regarding specification compliance or materials suitability for any specific purpose.

Tested by: JSingh **Date:** 24 Aug 2023
Checked by: JSingh **Date:** 28 Aug 2023

Reviewed by: BRush **Date:** 28 Aug 2023



PARTICLE SIZE DISTRIBUTION

ASTM D6913

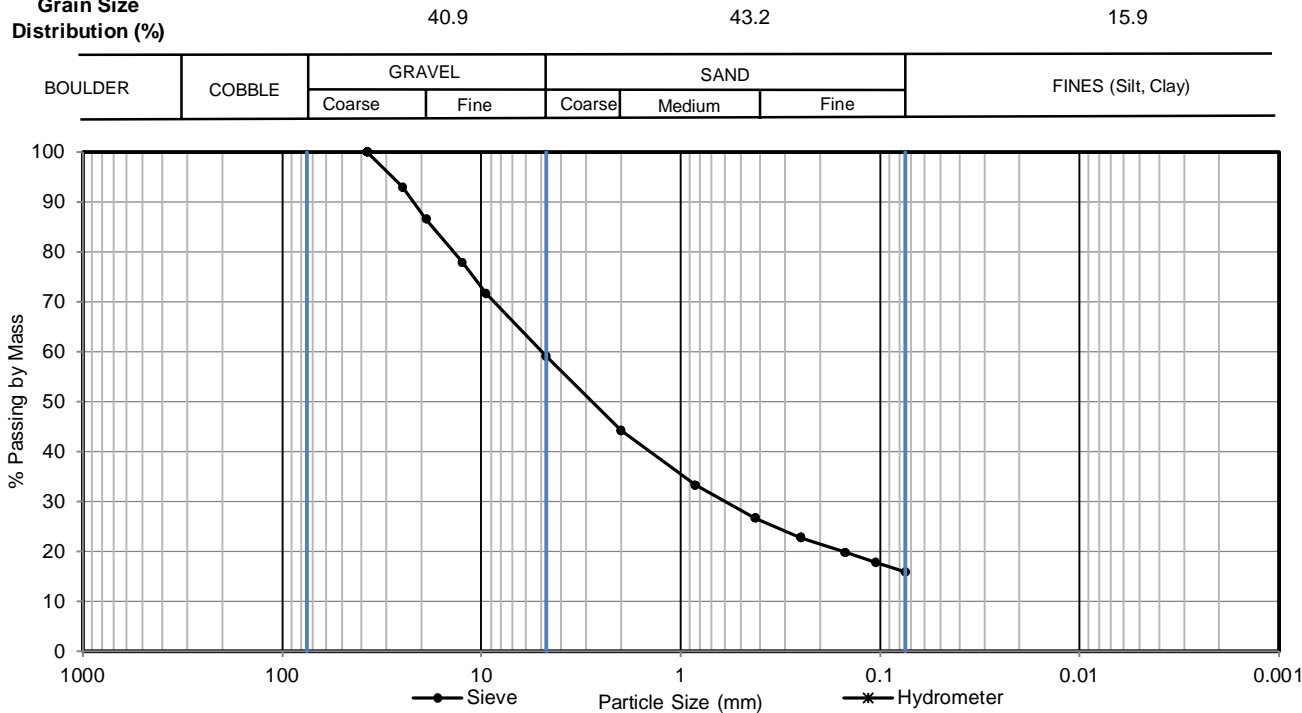
Method B

Test Request # K23-116
 Client: MoTI
 Project Name: Cache Creek Culvert Replacement
 Source:
 Soil Description:

Project Number: 221-11730-00.3680
 Project Location: Cache Creek, British Columbia
 Sample Location: BH23-01
 Sample No.: 6
 Type: SS
 Depth (m): 8.53 - 8.99

Specimen Reference NA Specimen Depth (m): NA Date of Test 8/25/2023
 Specimen Description NA

Grain Size Distribution (%)



Sieve			Hydrometer Sedimentation	
Sieve No.	Particle Size mm	% Passing	Particle Size mm	% Passing
1 1/2"	37.5	100.0		
1"	25	93.0		
3/4"	19	86.6		
1/2"	12.5	77.9		
3/8"	9.5	71.7		
#4	4.75	59.1		
#10	2	44.2		
#20	0.85	33.3		
#40	0.425	26.7		
#60	0.25	22.8		
#100	0.15	19.8		
#140	0.106	17.8		
#200	0.075	15.9		
			0.005 mm	
			0.002 mm	
			D60	4.99
			D30	0.60
			D10	
			Cu	
			Cc	

Notes:

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Tested by: JSingh **Date:** 25-Aug-23

Checked by: JSingh **Date:** 28-Aug-23

Reviewed by: BRush **Date:** 28-Aug-23

WSP Canada Inc.
 590 McKay Avenue, Suite 300 Kelowna, British Columbia, V1Y 5A8
 Canada

[+1] (250) 860 8424

Rev57-12052023



PARTICLE SIZE DISTRIBUTION

ASTM D6913

Method B

Test Request # K23-116
 Client: MoTI
 Project Name: Cache Creek Culvert Replacement
 Source:
 Soil Description:

Project Number: 221-11730-00.3680
 Project Location: Cache Creek, British Columbia
 Sample Location: BH23-01
 Sample No.: 9
 Type: SS
 Depth (m): 13.11 - 13.56

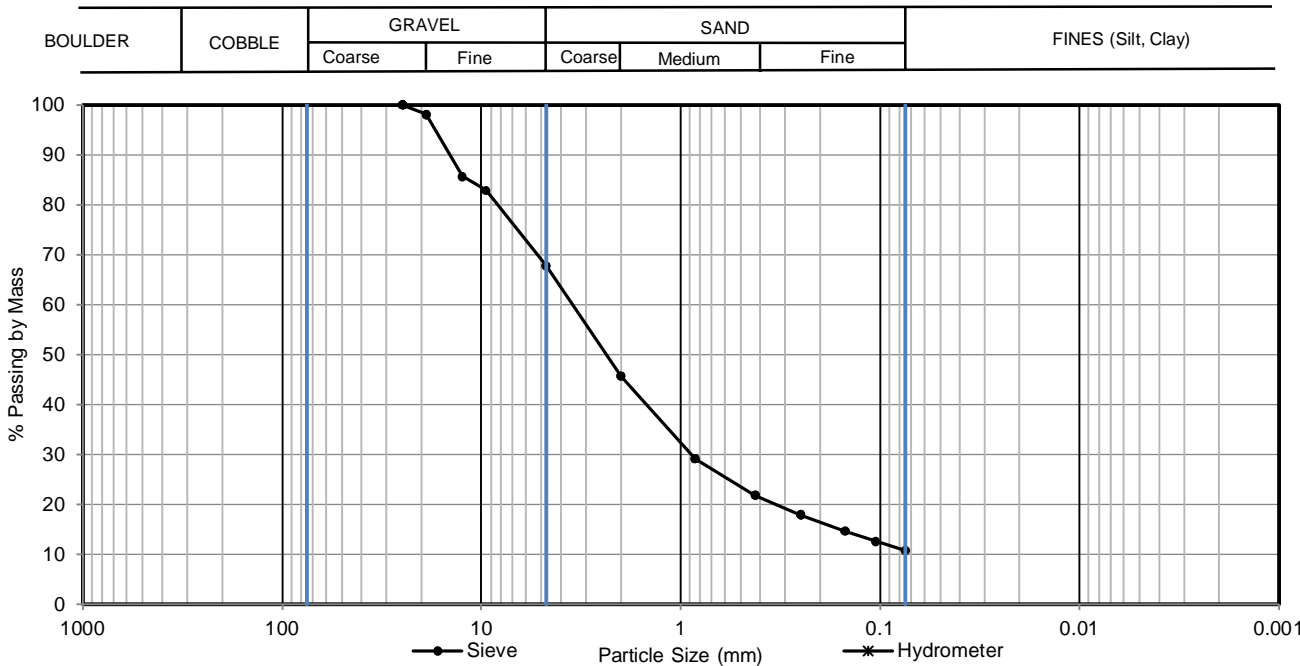
Specimen Reference NA Specimen Depth (m): NA Date of Test 8/25/2023
 Specimen Description NA

Grain Size Distribution (%)

32.2

57.1

10.7



Sieve			Hydrometer Sedimentation	
Sieve No.	Particle Size mm	% Passing	Particle Size mm	% Passing
1"	25	100.0		
3/4"	19	98.1		
1/2"	12.5	85.7		
3/8"	9.5	82.9		
#4	4.75	67.8		
#10	2	45.7		
#20	0.85	29.1		
#40	0.425	21.8		
#60	0.25	17.9		
#100	0.15	14.6		
#140	0.106	12.6		
#200	0.075	10.7		
			0.005 mm	
			0.002 mm	
			D60	3.50
			D30	0.89
			D10	
			Cu	
			Cc	

Notes:

Disclaimer:

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Tested by: JSingh **Date:** 25-Aug-23

Checked by: JSingh **Date:** 28-Aug-23

Reviewed by: BRush **Date:** 28-Aug-23

WSP Canada Inc.
 590 McKay Avenue, Suite 300 Kelowna, British Columbia, V1Y 5A8
 Canada

[+1] (250) 860 8424

Rev57-12052023



PARTICLE SIZE DISTRIBUTION

ASTM D6913

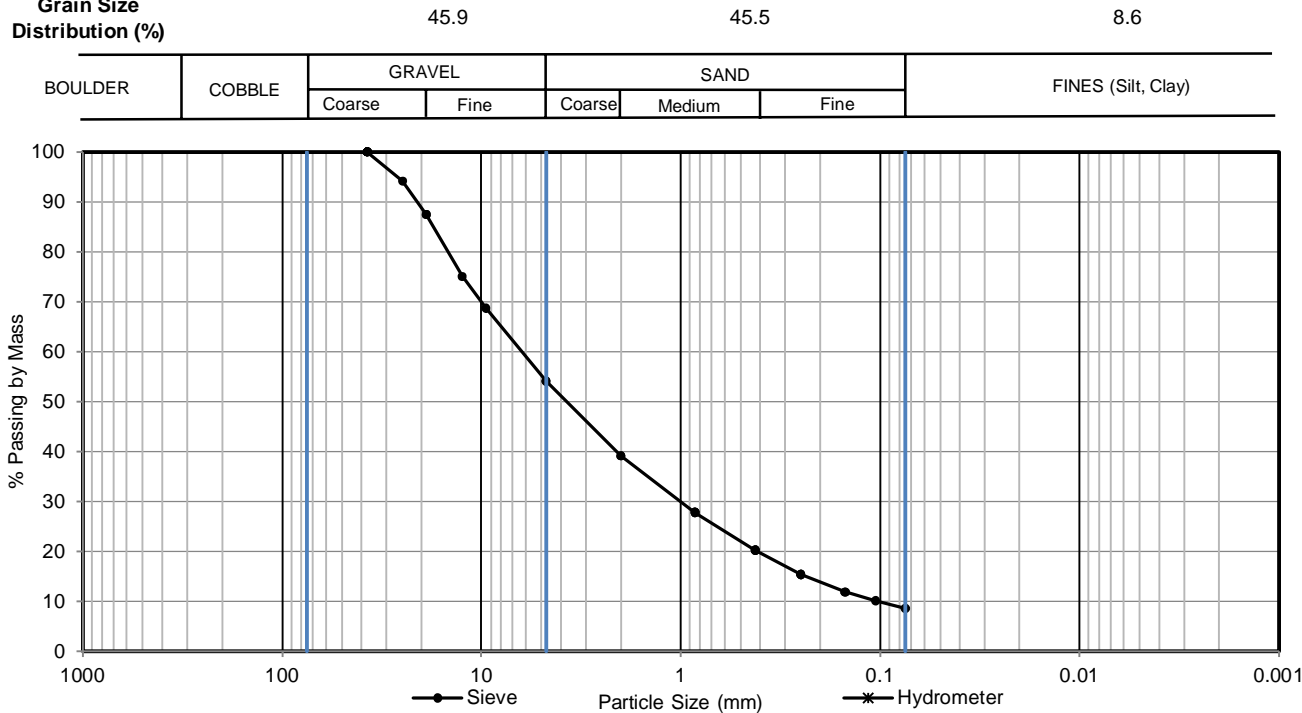
Method B

Test Request # K23-116
 Client: MoTI
 Project Name: Cache Creek Culvert Replacement
 Source:
 Soil Description:

Project Number: 221-11730-00.3680
 Project Location: Cache Creek, British Columbia
 Sample Location: BH23-01
 Sample No.: 12
 Type: SS
 Depth (m): 17.68 - 18.14

Specimen Reference NA Specimen Depth (m): NA Date of Test 8/25/2023
 Specimen Description NA

Grain Size Distribution (%)



Sieve			Hydrometer Sedimentation	
Sieve No.	Particle Size mm	% Passing	Particle Size mm	% Passing
1 1/2"	37.5	100.0		
1"	25	94.2		
3/4"	19	87.5		
1/2"	12.5	75.1		
3/8"	9.5	68.7		
#4	4.75	54.1		
#10	2	39.1		
#20	0.85	27.8		
#40	0.425	20.3		
#60	0.25	15.4		
#100	0.15	11.9		
#140	0.106	10.1		
#200	0.075	8.6		
			0.005 mm	
			0.002 mm	
			D60	6.29
			D30	1.00
			D10	0.10
			Cu	61.00
			Cc	1.50

Notes:

Disclaimer:

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Tested by: JSingh **Date:** 25-Aug-23

Checked by: JSingh **Date:** 28-Aug-23

Reviewed by: BRush **Date:** 28-Aug-23

WSP Canada Inc.
 590 McKay Avenue, Suite 300 Kelowna, British Columbia, V1Y 5A8
 Canada

[+1] (250) 860 8424

Rev57-12052023



MEASUREMENT OF SOIL RESISTIVITY USING THE TWO-ELECTRODE SOIL BOX METHOD ASTM G187

Project No.: 221-11730-00.3680	Lab Sch No.: B23-248
Client: MoTI	Sheet: 1 of 1
Project: Cache Creek Culvert Replacement	Sampled By: WSP - PM
Location: Cache Creek, British Columbia	Date Sampled: Not Given

BOREHOLE ID	SAMPLE ID	DEPTH (m)	MEASURED RESISTANCE (ohm)	CALCULATED RESISTIVITY (ohm-cm)	TEMPERATURE (°C)	REMARKS
BH23-01	GS1	0.76 - 0.91	5,070	3,397	21.0	Saturated
BH23-01	GS4	5.49 - 5.94	8,850	5,930	21.0	Saturated

Notes: 1. Miller 400D Digital Resistance Meter used.
 2. Soil box factor: 0.67 cm.
 3. Material retained on 4.75 mm screen removed prior to testing.

SJohn	August 28, 2023	IChung	September 5, 2023
TESTED BY	DATE	CHECKED BY	DATE



CERTIFICATE OF ANALYSIS

REPORTED TO	WSP Canada Inc - Burnaby Lab 300-3811 North Fraser Way Burnaby, BC V5J 5J2	WORK ORDER	23H3720
ATTENTION	Siny John	RECEIVED / TEMP REPORTED	2023-08-29 14:30 / 19.1°C 2023-09-06 14:11
PO NUMBER		COC NUMBER	No #
PROJECT	CA-WSP-221-11730-00.3680		
PROJECT INFO	MoTI Cache Creek Culvert Replacement		

Introduction:

CARO Analytical Services is a testing laboratory full of smart, engaged scientists driven to make the world a safer and healthier place. Through our clients' projects we become an essential element for a better world. We employ methods conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts. CARO is accredited by the Canadian Association for Laboratories Accreditation (CALA) to ISO/IEC 17025:2017 for specific tests listed in the scope of accreditation approved by CALA.

Big Picture Sidekicks



You know that the sample you collected after snowshoeing to site, digging 5 meters, and racing to get it on a plane so you can submit it to the lab for time sensitive results needed to make important and expensive decisions (whew) is VERY important. We know that too.

We've Got Chemistry



It's simple. We figure the more you enjoy working with our fun and engaged team members; the more likely you are to give us continued opportunities to support you.

Ahead of the Curve



Through research, regulation knowledge, and instrumentation, we are your analytical centre for the technical knowledge you need, BEFORE you need it, so you can stay up to date and in the know.

Work Order Comments:

Results for pH ASTM D4972 with DDI:

23H3720-01: 7.82
23H3720-03: 7.89
DUP (3720-01): 7.84

By engaging our services, you are agreeing to CARO Analytical Service's Standard Terms and Conditions outlined here: <https://www.caro.ca/terms-conditions>

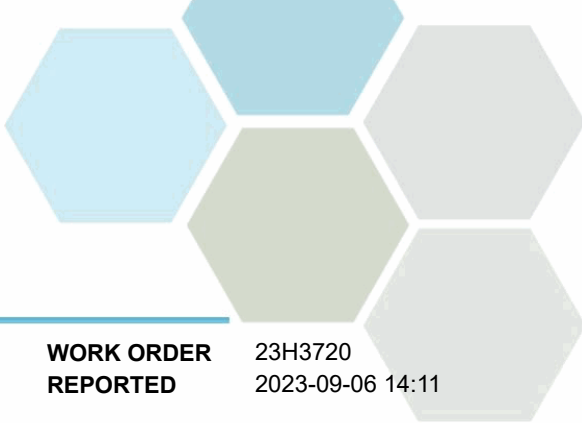
If you have any questions or concerns, please contact me at rpschyk@caro.ca

Authorized By:

Regan Pshyk
Account Manager

1-888-311-8846 | www.caro.ca

#110 4011 Viking Way Richmond, BC V6V 2K9 | #102 3677 Highway 97N Kelowna, BC V1X 5C3 | 17225 109 Avenue Edmonton, AB T5S 1H7 | #108 4475 Wayburne Drive Burnaby, BC V5G 4X4



TEST RESULTS

REPORTED TO PROJECT WSP Canada Inc - Burnaby Lab
CA-WSP-221-11730-00.3680

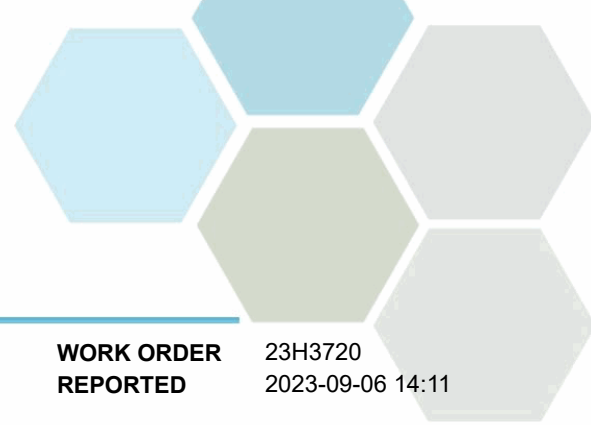
WORK ORDER REPORTED 23H3720
2023-09-06 14:11

Analyte	Result	RL	Units	Analyzed	Qualifier
BH23-01 GS1 at 0.76-0.91m (23H3720-01) Matrix: Soil Sampled: 2023-08-29					
<i>General Parameters</i>					
Sulfate, Water-Soluble	0.089	0.050	%	2023-09-05	
pH	7.65	0.10	pH units	2023-09-06	CST2
Chloride, Water-Soluble	0.014	0.002	%	2023-09-06	

BH23-01 GS3 at 3.96-4.22m (23H3720-02) Matrix: Soil Sampled: 2023-08-29					
<i>General Parameters</i>					
Sulfate, Water-Soluble	< 0.050	0.050	%	2023-09-05	
Chloride, Water-Soluble	0.018	0.002	%	2023-09-06	

BH23-01 GS4 at 5.49-5.94m (23H3720-03) Matrix: Soil Sampled: 2023-08-29					
<i>General Parameters</i>					
Sulfate, Water-Soluble	< 0.050	0.050	%	2023-09-05	
pH	7.33	0.10	pH units	2023-09-06	CST2
Chloride, Water-Soluble	0.003	0.002	%	2023-09-06	

Sample Qualifiers:
CST2 These results are with CaCl2



APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO PROJECT WSP Canada Inc - Burnaby Lab
CA-WSP-221-11730-00.3680

WORK ORDER REPORTED 23H3720
2023-09-06 14:11

Analysis Description	Method Ref.	Technique	Accredited	Location
Chloride, Water Soluble in Soil	ASTM C1218-17	Hot Water Extraction / Hot Water Extraction		Richmond
pH in Soil	ASTM D4972-01*	1:1 Soil/Water Slurry / Electrode		Richmond
Sulfate, Water-Soluble in Soil	CSA A23.2-3B / CSA A23.2-2B	Extraction (HCl) / Gravimetry (Barium Sulfate Precipitation)		Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

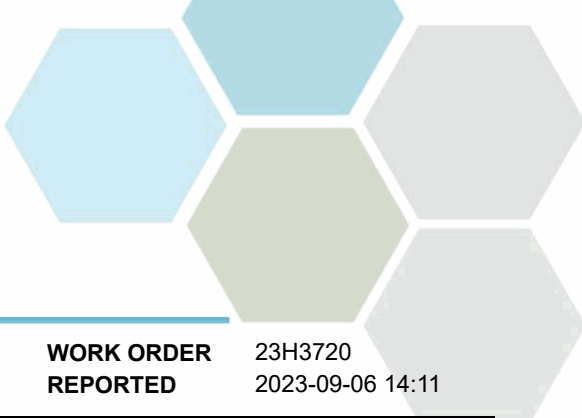
Glossary of Terms:

RL	Reporting Limit (default)
%	Percent
<	Less than the specified Reporting Limit (RL) - the actual RL may be higher than the default RL due to various factors
pH units	pH < 7 = acidic, pH > 7 = basic
ASTM	ASTM International Test Methods
CSA	Canadian Standards Association Chemical Test Methods

General Comments:

The results in this report apply to the received samples analyzed in accordance with the Chain of Custody document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Caro will dispose of all samples within 30 days of sample receipt, unless otherwise agreed.

Please note any regulatory guidelines applied to this report are added as a convenience to the client, at their request, to help provide some initial context to analytical results obtained. Although CARO makes every effort to ensure accuracy of the associated regulatory guideline(s) applied, the guidelines applied cannot be assumed to be correct due to a variety of factors and as such CARO Analytical Services assumes no liability or responsibility for the use of those guidelines to make any decisions. The original source of the regulation should be verified and a review of the guideline(s) should be validated as correct in order to make any decisions arising from the comparison of the analytical data obtained to the relevant regulatory guideline for one's particular circumstances. Further, CARO Analytical Services assumes no liability or responsibility for any loss attributed from the use of these guidelines in any way.



APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO PROJECT WSP Canada Inc - Burnaby Lab
CA-WSP-221-11730-00.3680

WORK ORDER REPORTED 23H3720
2023-09-06 14:11

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk):** A blank sample that undergoes sample processing identical to that carried out for the test samples. Method blank results are used to assess contamination from the laboratory environment and reagents.
- **Duplicate (Dup):** An additional or second portion of a randomly selected sample in the analytical run carried through the entire analytical process. Duplicates provide a measure of the analytical method's precision (reproducibility).
- **Blank Spike (BS):** A sample of known concentration which undergoes processing identical to that carried out for test samples, also referred to as a laboratory control sample (LCS). Blank spikes provide a measure of the analytical method's accuracy.
- **Matrix Spike (MS):** A second aliquot of sample is fortified with a known concentration of target analytes and carried through the entire analytical process. Matrix spikes evaluate potential matrix effects that may affect the analyte recovery.
- **Reference Material (SRM):** A homogenous material of similar matrix to the samples, certified for the parameter(s) listed. Reference Materials ensure that the analytical process is adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10-20 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B3H3135									
Blank (B3H3135-BLK1)			Prepared: 2023-08-30, Analyzed: 2023-09-05						
Sulfate, Water-Soluble	< 0.050	0.050 %							
General Parameters, Batch B3H3368									
Blank (B3H3368-BLK1)			Prepared: 2023-08-31, Analyzed: 2023-09-06						
Chloride, Water-Soluble	< 0.002	0.002 %							
Duplicate (B3H3368-DUP1)			Source: 23H3720-01		Prepared: 2023-08-31, Analyzed: 2023-09-06				
Chloride, Water-Soluble	0.014	0.002 %		0.014			< 1	20	
General Parameters, Batch B3I0342									
Duplicate (B3I0342-DUP1)			Source: 23H3720-01		Prepared: 2023-09-06, Analyzed: 2023-09-06				
pH	7.64	0.10 pH units		7.65			< 1	20	CST2

QC Qualifiers:

CST2 These results are with CaCl2

APPENDIX D

Environmental Laboratory Testing

CERTIFICATE OF ANALYSIS

REPORTED TO WSP Canada Inc. - Kelowna
108-3677 Highway 97N
Kelowna, BC V1X 5C3

ATTENTION Patrick Machibroda

PO NUMBER

PROJECT 221-11730-00.3680

PROJECT INFO

WORK ORDER 23H1650

RECEIVED / TEMP 2023-08-10 13:58 / 21.2°C

REPORTED 2023-08-17 12:41

COC NUMBER B134947

Introduction:

CARO Analytical Services is a testing laboratory full of smart, engaged scientists driven to make the world a safer and healthier place. Through our clients' projects we become an essential element for a better world. We employ methods conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts. CARO is accredited by the Canadian Association for Laboratories Accreditation (CALA) to ISO/IEC 17025:2017 for specific tests listed in the scope of accreditation approved by CALA.

Big Picture Sidekicks



You know that the sample you collected after snowshoeing to site, digging 5 meters, and racing to get it on a plane so you can submit it to the lab for time sensitive results needed to make important and expensive decisions (whew) is VERY important. We know that too.

We've Got Chemistry



It's simple. We figure the more you enjoy working with our fun and engaged team members; the more likely you are to give us continued opportunities to support you.

Ahead of the Curve



Through research, regulation knowledge, and instrumentation, we are your analytical centre for the technical knowledge you need, BEFORE you need it, so you can stay up to date and in the know.

By engaging our services, you are agreeing to CARO Analytical Service's Standard Terms and Conditions outlined here: <https://www.caro.ca/terms-conditions>

If you have any questions or concerns, please contact me at rpschyk@caro.ca

Authorized By:

Regan Pshyk
Account Manager

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TEST RESULTS

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Analyte	Result	RL	Units	Analyzed	Qualifier
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1A (23H1650-01) | Matrix: Water | Sampled: 2023-08-10 06:30

Anions

Sulfate	117	1.0	mg/L	2023-08-11	
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General Parameters

pH	8.40	0.10	pH units	2023-08-12	HT2
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1B (23H1650-02) | Matrix: Water | Sampled: 2023-08-10 06:31

Anions

Sulfate	115	1.0	mg/L	2023-08-11	
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General Parameters

pH	8.41	0.10	pH units	2023-08-12	HT2
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Sample Qualifiers:

HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.



APPENDIX 1: SUPPORTING INFORMATION

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Analysis Description	Method Ref.	Technique	Accredited	Location
Anions in Water	SM 4110 B (2020)	Ion Chromatography	✓	Kelowna
pH in Water	SM 4500-H+ B (2021)	Electrometry	✓	Kelowna

Glossary of Terms:

RL	Reporting Limit (default)
mg/L	Milligrams per litre
pH units	pH < 7 = acidic, pH > 7 = basic
SM	Standard Methods for the Examination of Water and Wastewater, American Public Health Association

General Comments:

The results in this report apply to the received samples analyzed in accordance with the Chain of Custody document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Caro will dispose of all samples within 30 days of sample receipt, unless otherwise agreed.

Results in **Bold** indicate values that are above CARO's method reporting limits. Any results that are above regulatory limits are highlighted **red**. Please note that results will only be highlighted red if the regulatory limits are included on the CARO report. Any Bold and/or highlighted results do not take into account method uncertainty. If you would like method uncertainty or regulatory limits to be included on your report, please contact your Account Manager: rpschyk@caro.ca

Please note any regulatory guidelines applied to this report are added as a convenience to the client, at their request, to help provide some initial context to analytical results obtained. Although CARO makes every effort to ensure accuracy of the associated regulatory guideline(s) applied, the guidelines applied cannot be assumed to be correct due to a variety of factors and as such CARO Analytical Services assumes no liability or responsibility for the use of those guidelines to make any decisions. The original source of the regulation should be verified and a review of the guideline(s) should be validated as correct in order to make any decisions arising from the comparison of the analytical data obtained to the relevant regulatory guideline for one's particular circumstances. Further, CARO Analytical Services assumes no liability or responsibility for any loss attributed from the use of these guidelines in any way.



APPENDIX 2: QUALITY CONTROL RESULTS

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The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in “batches” and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk):** A blank sample that undergoes sample processing identical to that carried out for the test samples. Method blank results are used to assess contamination from the laboratory environment and reagents.
- **Duplicate (Dup):** An additional or second portion of a randomly selected sample in the analytical run carried through the entire analytical process. Duplicates provide a measure of the analytical method's precision (reproducibility).
- **Blank Spike (BS):** A sample of known concentration which undergoes processing identical to that carried out for test samples, also referred to as a laboratory control sample (LCS). Blank spikes provide a measure of the analytical method's accuracy.
- **Matrix Spike (MS):** A second aliquot of sample is fortified with a known concentration of target analytes and carried through the entire analytical process. Matrix spikes evaluate potential matrix effects that may affect the analyte recovery.
- **Reference Material (SRM):** A homogenous material of similar matrix to the samples, certified for the parameter(s) listed. Reference Materials ensure that the analytical process is adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10-20 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Anions, Batch B3H1176									
Blank (B3H1176-BLK1)			Prepared: 2023-08-11, Analyzed: 2023-08-11						
Sulfate	< 1.0	1.0 mg/L							
Blank (B3H1176-BLK2)			Prepared: 2023-08-13, Analyzed: 2023-08-13						
Sulfate	< 1.0	1.0 mg/L							
LCS (B3H1176-BS1)			Prepared: 2023-08-11, Analyzed: 2023-08-11						
Sulfate	16.0	1.0 mg/L	16.0		100	90-110			
LCS (B3H1176-BS2)			Prepared: 2023-08-13, Analyzed: 2023-08-13						
Sulfate	16.0	1.0 mg/L	16.0		100	90-110			
General Parameters, Batch B3H1238									
Reference (B3H1238-SRM1)			Prepared: 2023-08-12, Analyzed: 2023-08-12						
pH	7.04	0.10 pH units	7.01		100	98-102			
Reference (B3H1238-SRM2)			Prepared: 2023-08-12, Analyzed: 2023-08-12						
pH	7.04	0.10 pH units	7.01		100	98-102			

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