Appendix I

Proposed KNP South Gate Redevelopment: Site Review and Revised Geotechnical Recommendations – May 2019

To	From
Karina Verhoeven, Project Manager	Ryan Gibbard, P.Eng., Geotechnical Engineer
Client	**Branch**
Parks Canada Agency	2441 – Cranbrook, BC
Re	**Date**
Proposed KNP South Gate Redevelopment: Site Review and Revised Geotechnical Recommendations	May 22, 2019
	File Number
	2121-00545-13 Task 2004

1. INTRODUCTION

On behalf of Parks Canada (the Client), McElhanney Ltd. (McElhanney) has prepared this technical memo to provide a summary of the changed conditions from a geotechnical perspective and provide revised recommendations for the proposed redevelopment of the site for the Kootenay National Park (KNP) South Gate site. The existing site, previously a parking lot, has had significant construction activity recently, with a large excavation and box culvert install for Sinclair Creek, of which is located beneath the north end of the parking area. The construction activity was halted last fall, with the culvert excavation complete, excavated materials stockpiled onsite, loose backfill material placed adjacent the culvert to half height, and the remainder left unfinished and exposed.

The results of the geotechnical site review, as well as our revised preliminary recommendations on geotechnical aspects of site development and foundation design and construction, are provided in this technical memo.

Authorization to proceed was provided by the Client, to the Project Manager, Simon Armstrong-Bayliss, P.Eng of McElhanney, on April 24, 2019.

This technical memo must be read with and appended to our initial Geotechnical Assessment Memorandum issued on August 17, 2016 (McElhanney 2016) and is also subject to the appended Statement of Limitations – Geotechnical Services.

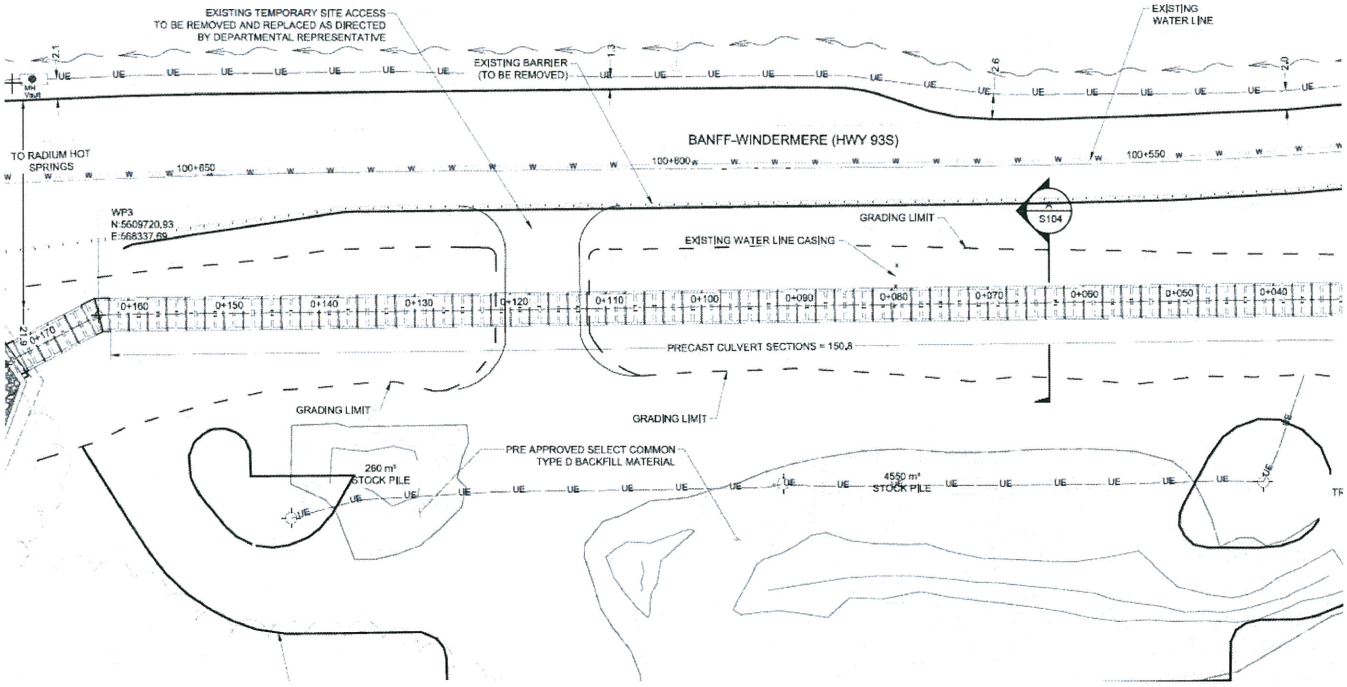
McElhanney has completed this geotechnical site review and memorandum in general accordance with our discussion and emails with the client in April 2019. In conducting the geotechnical site review and submitting this memo, McElhanney has:

- Reviewed preliminary AECOM drawings showing the box culvert design and installation works;
- Performed a field site review by the undersigned; and,
- Prepared this memo summarizing the changes to our initial geotechnical recommendations given the recent site disturbance for the design and construction of the proposed development.

2. PROJECT AND SITE DESCRIPTION

The proposed redevelopment design has been altered, with the removal of the previous underground creek culvert, and the installation of a new box culvert system, as designed by AECOM.

Figure 1: Proposed Creek Culvert Site Development (from AECOM, Drawing S-101, "Existing Culvert Layout", April 2019)



Picture 1: Current Status of Site Looking East (from May 1, 2019 Site Review)

3. OBSERVATIONS

A geotechnical field review assessment was carried out on May 1, 2019 and comprised of traversing/walking the site and visually assessing the current situation and conditions.

The site is currently in a suspended state of construction, with the box culvert excavated and installed in place, some loose backfill placed, the excavation slopes exposed, and the exhumed soils stockpiled south and adjacent the excavation in the remainder of the parking lot area. Of note, the disturbed area as noted on the AECOM design drawing as "Grading Limits" (Figure 1) appears to extend much wider in both directions than shown, and the stockpiles appear to be larger than shown as well. We understand from AECOM that that the limit shown on the drawing is in fact the toe of slope of the culvert excavation.

The excavated cut slopes for the culvert installation as observed were cut at approximately 55 to 70 degree slopes. These slopes have experienced a freeze thaw cycle and are eroding/unraveling. There are tension cracks forming behind the top of slope in a number of locations. The fill placed adjacent the box culvert has settled/moved significantly and contains organics and a substantial percentage of silt/clay.

The stockpile is large in size, has been placed over the existing asphalt on the southern half of the parking lot, and was observed to contain debris, organics, and mixed/variable quality of unsegregated soils. Visually it appears to consist of Gravelly Silt, with some sand to sandy, trace to some clay. It is estimated to be 5 to 6m in height.

Picture 2: Current Status of Site, Looking West (from May 1, 2019 Site Review)

4. COMPARISON OF CONDITIONS

The geotechnical study previously completed by McElhanney identified the following soil types beneath the asphalt:

1. Surficial Topsoil/Deleterious Fill
2. Sand and/or Gravel Fill
3. Glacial Till

During the construction activities on site these soils appear to have been mixed in a disorderly fashion into the stockpiles, with some debris present as well. We anticipate that the stockpile quality and consistency will vary considerably throughout.

5. RECOMMENDATIONS

The geotechnical recommendations provided here are based on the understanding of the new site conditions as described above. These should be read in conjunction with the previous report (McElhanney 2016).

Any further changes or alterations to the proposed development site should be brought to the attention of McElhanney to assess the applicability of the recommendations provided herein and/or recommendations for further geotechnical study be provided if required.

Based on our project understanding and the findings of this recent geotechnical assessment, the Site requires additional revised attention from a geotechnical perspective with consideration of the recommendations and discussion provided in this report in order to update the previous recommendations provided in our last report. The following sections provide preliminary discussion and revised recommendations as input for planning and revised design based on the current understanding of the redevelopment including current site conditions.

The sub-sections below are numbered and labelled as per the original report, such that the changes can easily be followed, and refer to the recently disturbed areas:

5.1 Subgrade Conditions

Based on the revised site excavation in the disturbance area of the culvert works, it is anticipated that Glacial Till will be the predominant soil at the base of the excavation.

5.2 Subgrade Preparation and 5.3 Pavement Structure

Given the recent site development, McElhanney recommends the following site preparation activities:

- Sub-excavation of any newly placed fills within the proposed building and asphalt surface development area is required.
- Excavation of the building foundation area of influence (extent of foundations, extended out and downwards at a 45 degree angle) down to level approved native compact-dense subgrade surface. In the location of the culvert works, this will involve excavation down to the original limits of excavation.
- Excavation of the cut slopes back to an appropriate angle of repose for the purposes of backfill tie-in. Based on site observations, we recommend that this angle not exceed 40 degrees (or 1.2 H:1.0 V).

For future asphalt parking/roadway areas containing sub-excavation from the culvert installation construction, and now requiring backfill, the following recommendations are provided:

- All prepared subgrades shall be reviewed by a Geotechnical Engineer as noted in the report prior to any fill placement.
- Any fill soil placed to support structural or vehicular traffic areas of the development shall be considered Engineered Fill. Engineered Fill should consist of well-graded sand and gravel with less than 8% fines (material passing the 0.075 mm sieve) and a maximum aggregate size not exceeding 75 mm. Any granular materials proposed for use as Engineered Fill should be tested and approved by the Geotechnical Engineer before placement. See Table 1 for recommended gradations for granular base, granular sub-base (well graded gravel) and drain rock materials. The gradation for Well Graded Gravel is considered an approved gradation for Engineered Fill.
- General site grading fills if required to raise local site grades should consist of Engineered Fill comprising clean inorganic granular materials that meets the sub-base specification below (Table 1) or an approved common fill alternative from approved local or imported. The previously stockpiled material is not recommended for this use (see further commentary below).
- Engineered Fill materials (meeting the specifications noted below) for asphalt surface areas may be placed in uniform layers not exceeding 300 mm loose thickness and compacted to a minimum of 98% Standard Proctor Maximum Dry Density (SPMDD), with the upper 300mm of subgrade compacted to 100% SPMDD. Density testing is required on each lift, with one test per min. 150m^2 compacted area.

Table 1: Specification for Engineered Fill – Crushed Granular Base, Granular Sub Base and Drain Rock

SIEVE SIZE (mm)	CRUSH GRANULAR BASE[1] (WELL GRADED BASE)	WELL GRADED GRAVEL[1] – SELECT GRANULAR SUB-BASE (PIT RUN)	DRAIN ROCK
	PERCENT PASSING (%)		
75	-	100	-
50	-	-	
25	100	-	100
19	80-100	15-100	25-100
12.5	-	-	-
9.5	50-85	0-100	-
4.75	35-70	-	0-5
2.36	25-50	-	-
1.18	15-35	-	-
0.6	-	0-100	-
0.3	5-20	0-15	-
0.075	0-5	0-5	0-1

Note: 1. Gradations are based on BC Ministry of Transportation and Infrastructure Standard Specifications for Highway Construction 2016, Section 202 .

- Given the unproven and likely disorderly mixture of variable quality materials in the site stockpile presently, we do not recommend the use of this material as backfill. It will be very difficult to employ the use of nuclear densometers to test the density of the backfill due to the variable soil conditions and the results will be of inconsistent quality and use. For future excavation and stockpiling onsite, the materials should be separately sorted and segregated to ensure that mixing of and contamination of poor-quality material with good quality backfill material does not occur. If the Client wishes to proceed with using this material as common fill backfill beneath the pavement structure, we provide the following commentary and additional recommendations:
    - Note that we cannot quantify the level of settlement that may occur due to its variable nature (containing varying percentages of fines, organics, and debris). We estimate that it may exceed 50mm of long term and differential settlement.
    - For placement and backfill with the stockpiled material, we recommend that the stockpile be mixed/blended with heavy equipment. Sieve Analysis and Proctor samples shall be taken as appropriate. Moisture conditioning to within +/- 2% of Optimum Moisture content shall occur to minimize long term movements (settlement, consolidation, collapse).
    - If the % fines (silt/clay) exceeds 15% of the gradation of the material, the base of the approved subgrade shall be covered with a medium grade non-woven geotextile, as per Section 5.3.7 of our report.
    - The material shall be placed in maximum 200mm thick lifts and compacted to minimum 98% SPMDD. The upper 300mm of subgrade compacted to 100% SPMDD. Density testing is required on each lift, with one test per minimum 75m^2 compacted area.
    - The pavement structure shall be increased to include a 250mm layer of sub-base gravel, or an additional layer of geogrid as noted below.
- In the location of the current stockpiles, given the level of site disturbance as well as the large and sustained loading presented from these large piles, following removal of the stockpiles we recommend the removal of the old asphalt layer, regrading/replacement of the granular base gravels, and reinstatement of the asphalt.
- In order to mitigate future differential settlements due to the variable site disturbances, we recommend that a second layer of geogrid (Tensar TX-160 or TX-7) be placed directly beneath the new granular pavement structure across the site.
- Other asphalt reinforcing products may be considered as well to improve longevity and minimize differential settlements and surficial cracking/deformities on the site, such as the Nilex Aramid Fiber Reinforcement product for asphalt, or the Glasgrid product.

5.5 Building Recommendations

Footings and load-bearing points within the proposed building footprints should be founded directly on native dense granular soil or glacial till as per McElhanney 2016, and in the case of the disturbed excavated culvert construction area, extended down to full depth as per the excavation requirements noted. If the preference is to place the foundations on structural fill, then footings must be placed over imported subbase or base gravel (Engineered Fill) that has been prepared in accordance with below:

- Further excavation as noted to extend building bearing footprint down at 45 degree or 1:1 slope from 1.5 m from edge of footings down to level approved native dense subgrade.
- Subgrade surfaces supporting building structures must be reviewed and approved by the Geotechnical Engineer of record (as per BC Building Code, current edition, and associated Letters of Assurance) prior to any fill placement.
- Foundation subgrade bearing surfaces should be prepared as per the recommendations in Section **Error! Reference source not found.** in our Initial Report. The subgrade bearing surfaces for all foundation construction must be inspected and approved by a Geotechnical Engineer or their representative prior to placing any Engineered Fill.
- If the % fines (silt/clay) exceeds 15% of the gradation of the material, the base of the approved subgrade shall be covered with a medium grade non-woven geotextile, as per Section 5.3.7 of our Initial Report.
- To ensure a uniform stress distribution, the entire foundation must be constructed on a uniform bearing surface (e.g. entirely on native subgrade or on Engineered Fill as described above). Bearing portions of the foundation on varying subgrade materials and others on fill may result in differential settlement and are not acceptable.
- Engineered Fill should be placed in horizontal lifts not exceeding 150 mm vertical thickness when compacted under foundations, dependent on the type of compaction equipment used. Engineered Fill should be placed at moisture conditions conducive to achieving compaction specifications (typically within 2% of the optimum moisture content) as determined by a Standard Proctor Moisture-Density Test (ASTM D698).
- Engineered Fill areas should extend downwards from the proposed foundation at a minimum of a 45 degree (1H:1V) slope starting at least 1.5 meters (horizontally) from the structural element to allow for the distribution of stresses.
- Structural Engineered Fill for building areas must consist of material meeting the gradations noted in Table 1 above. The native soils, or stockpiled materials are not suitable for structural fill.
- Continuous Quality Control (QC) compaction testing and construction reviews should be performed by the Geotechnical Engineer's representative or a qualified testing agency during placement of all Structural Engineered Fill to verify compliance with the above recommendations. Minimum testing shall be a minimum of 2 tests per lift of material, and at a minimum 1 test for every 100m^2 of material.
- Draintile is not required around buildings that are situated on at least 0.6m of structural fill.

5.5.7 Seismic Site Classification

Seismic site classification according to the 2015 National Building Code of Canada (NBCC) was determined based on native dense soils. It is noted that the variable soil conditions and possible fill program have resulted in a revision to this category. Based on the assumption that the foundations will be placed in some instances over a significant fill thickness, as well as our previous understanding of the geological history and surficial geology in the area, the Site is classified as Site Class D "Stiff Soil" for seismic design purposes for the building structures.

6. CLOSURE

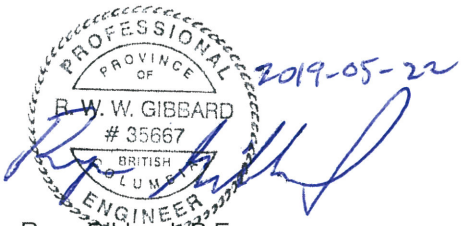
We trust that this information is sufficient for your present needs. Should you have any questions or require additional information, please do not hesitate to contact the author of the document.

Please refer to the attached Statement of Limitations.

Sincerely,

McElhanney Ltd.

Prepared By:



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Effect of Changes. All evaluations and conclusions stated in this report are based on facts, observations, site-specific details, legislation and regulations as they existed at the time of the site assessment. Some conditions are subject to change over time, and the Client recognizes that the passage of time, natural occurrences, and direct or indirect human intervention at or near the site may substantially alter such evaluations and conclusions. Construction activities can significantly alter soil, rock and other geologic conditions on the site. McElhanney should be requested to re-evaluate the conclusions of this report and to provide amendments as required prior to any reliance upon the information presented herein upon any of the following events: a) any changes (or possible changes) as to the site, purpose, or development plans upon which this report was based, b) any changes to applicable laws subsequent to the issuance of the report, c) new information is discovered in the future during site excavations, construction, building demolition or other activities, or d) additional subsurface assessments or testing conducted by others.

Subsurface Risks. Soil, rock and groundwater data were collected in general accordance with the standards and methods described in the document. The classification and identification of soils, rocks, and geologic formations was based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Interpretations of groundwater levels and flow direction are based on water level observations at selected test hole locations and are expected to fluctuate. Observations at test holes indicate the approximate subsurface conditions at those locations only. Subsurface conditions between test holes were based, by necessity, on judgement and assumptions of what exists between the actual locations sampled and may vary significantly from actual site conditions and all persons making use of this report should be aware of and accept this risk. Even a comprehensive sampling and testing program, implemented in accordance with appropriate equipment by experienced personnel, may fail to detect all or certain conditions.

Information from Client and Third Parties. McElhanney has relied in good faith on information provided by the Client and third parties noted in this report and has assumed such information to be accurate, complete, reliable, non-fringing, and fit for the intended purpose without independent verification. McElhanney accepts no responsibility for any deficiency, misstatements or inaccuracy contained in this report as a result of omissions or errors in information provided by third parties or for omissions, misstatements or fraudulent acts of persons interviewed.

Underground Utilities and Damages. In the performance of the services, McElhanney has taken reasonable precautions to avoid damage or injury to subterranean structures or utilities. Subsurface sampling may result in unavoidable contamination of certain subsurface areas not known to be previously contaminated such as, but not limited to, a geologic formation, the groundwater or other hydrous body. McElhanney will adhere to an appropriate standard of care during the conduct of any subsurface sampling.

Independent Judgments. McElhanney will not be responsible for the independent conclusions, interpretations, interpolations and/or decisions of the Client, or others, who may come into possession of this report, or any part thereof. This restriction of liability includes decisions made to purchase, finance or sell land or with respect to public offerings for the sale of securities.

Construction. The subsurface information contained in this report were obtained for the owner's information and design. The extent and detail of assessments necessary to determine all relevant conditions that may affect construction costs would normally be greater than the assessments carried out for this report. Accordingly, a contingency fund to allow for the possibility of variations of subsurface conditions should be included in the construction budget to cover costs associated with modifications of the design and construction procedures resulting from conditions that vary from the assumptions in this report. If during construction, subsurface conditions are found to be other than those described in this report, McElhanney is to be notified and may alter or modify the geotechnical report recommendations. If McElhanney is not retained to provide services during construction, then McElhanney is not responsible for confirming or recording that subsurface conditions do not materially differ from those interpreted conditions contained in this report or for confirming or recording that construction activities have not adversely affected subsurface conditions, or the recommendations contained in this report.