McElhanney

BEST MANAGED COMPANIES CANADA

OLD FORT ROAD OPTIONS ANALYSIS STUDY, OLD FORT, BC

December 3, 2021 | **FINAL**

Submitted to: BC Ministry of Transportation and Infrastructure, Northern Region
Prepared by: McElhanney

Contact
Parm Nahal, P.Eng.
Project Manager
604-424-4882
pnahal@mcelhanney.com

Address
Suite 2300 Central City Tower,
13450 – 102nd Avenue,
Surrey, BC Canada V3T 5X3

Reviewed By
Denny Leung, P.Eng.
Division Manager

Input Provided By
BGC Engineering Inc.
Suite 500 – 980 Howe Street
Vancouver, BC Canada V6Z 0C8

Our file: 2111-00412-07

Your Challenge.
Our Passion.

Contents

Figures

Tables

Appendices

1. Introduction

In June 2020, a heavy rainstorm caused a landslide which carried the existing Old Fort Road section more than 300 meters downslope leaving the community of Old Fort without vehicular access until a temporary gravel access road was constructed in July 2020 which is within the slide zone and debris.

Several high-level, single-line sketches of road realignment options were developed by BC Ministry of Transportation and Infrastructure (MoTI) in 2018 for discussion purposes and to address the long-term slope stability and access reliability for the community of Old Fort. MoTI engaged McElhanney Ltd. (McElhanney) to provide high-level geometric, structural, environmental, and hydrotechnical design input; BGC Engineering Inc. (BGC) to provide geotechnical review; and Stantec Inc. (Stantec) to provide overall project management.

The purpose of this report is to evaluate previously developed alignment options, develop several new alignments to bypass/mitigate the slide area, and conduct a high-level screening exercise to shortlist one or more suitable options. Options development included preparation of plan/profiles, typical sections, property impacts, and high-level cost estimates.

1.1. STUDY AREA

The study area is located approximately 5 kilometers south of Fort St. John near the community of Old Fort, BC. The area contains a 400 m wide and 1,300 m long slide area crossing at Old Fort Road which is the only road access serving the community. The slide area includes an approximately 150 m wide earthflow in addition to a landslide complex (i.e., the west slide complex) that is approximately 250 m wide. The slide has, at times, interrupted road access to Old Fort since September 2018.

An overview of the study area is shown in *Figure 1*.

1.2. STUDY SCOPE

The focus of this study is on long-term access reliability to the Old Fort community. This study does not address the geohazards associated with the west slide complex, Bouffioux Creek or the global stability of the area. Outstanding existing geotechnical hazards in other slide areas were not assessed as they are not part of the scope of this study.

240 Road

Sewage Lagoon Area

To Fort St John

92 Street

265 Road

OPTION D
(Not Carried Forward)

OPTION A
(Not Carried Forward)

Bouffioux Creek

Slide Area

Option F

Old Fort Road

To Fort St John

Old Fort Road

OPTION B
(Not Carried Forward)

River Drive

Old Fort Loop

Option C1

BC Hydro Access

Old Fort

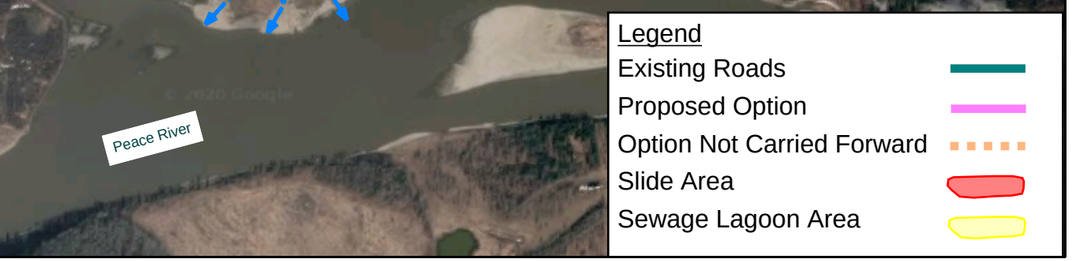
Option C2

Option C

Peace River Channel

Peace River Channel

Peace River



Rev	Date	Description	Drawn	Design	App'd

500 m

ORIGINAL DWG SIZE: ANSI D (22" x 34")

McElhanney

Suite 2300
13450 102nd Avenue
Surrey BC
Canada V3T 5X3
T 604 596 0391

Approved Sealed

Old Fort Road Alignment Options

Study Area

Drawing No.
Figure 1

Project Number
2111-00412-07

Rev.

DESTROY ALL PRINTS BEARING PREVIOUS REVISION

1.3. INDIGENOUS CONSULTATION

The Old Fort slide area is in northeastern BC and is covered by Treaty 8, which extends into northern Alberta, northern Saskatchewan, and the Northwest Territories. There are ten Treaty 8 Nations with territories in BC:

- Blueberry River First Nations
- Dene Thá First Nation
- Doig River First Nation
- Fort Nelson First Nation
- Halfway River First Nation
- Horse Lake First Nation (based in Alberta)
- McLeod Lake Indian Band (adhered to Treaty 8 in 2000)
- Prophet River First Nation
- Saulteau First Nations
- West Moberly First Nations

Work to date was at a conceptual level and will require extensive consultation efforts, should any design options or investigative activities move forward.

2. Options Development

Previously, Options A, B, C, D, and F (Base Case - existing alignment) were developed by MoTI in 2018 for discussion purposes and assessed by the project team during the August 11 and September 10, 2020 meetings to determine which options were viable to carry forward. These options are also illustrated in *Figure 1*. Options A, B, and D were considered not viable options and therefore not carried forward as described in *Section 2.1.1*. Option C was refined further, and hybrid options (options C1 and C2) were developed. LiDAR data supplied by MoTI and the City of Fort St. John was used in the planning and development of the alignment options.

Preliminary plan/profile design drawings and typical sections for each of the viable options are attached in *Appendix A*.

2.1. DRAFT PRELIMINARY DESIGN OPTIONS

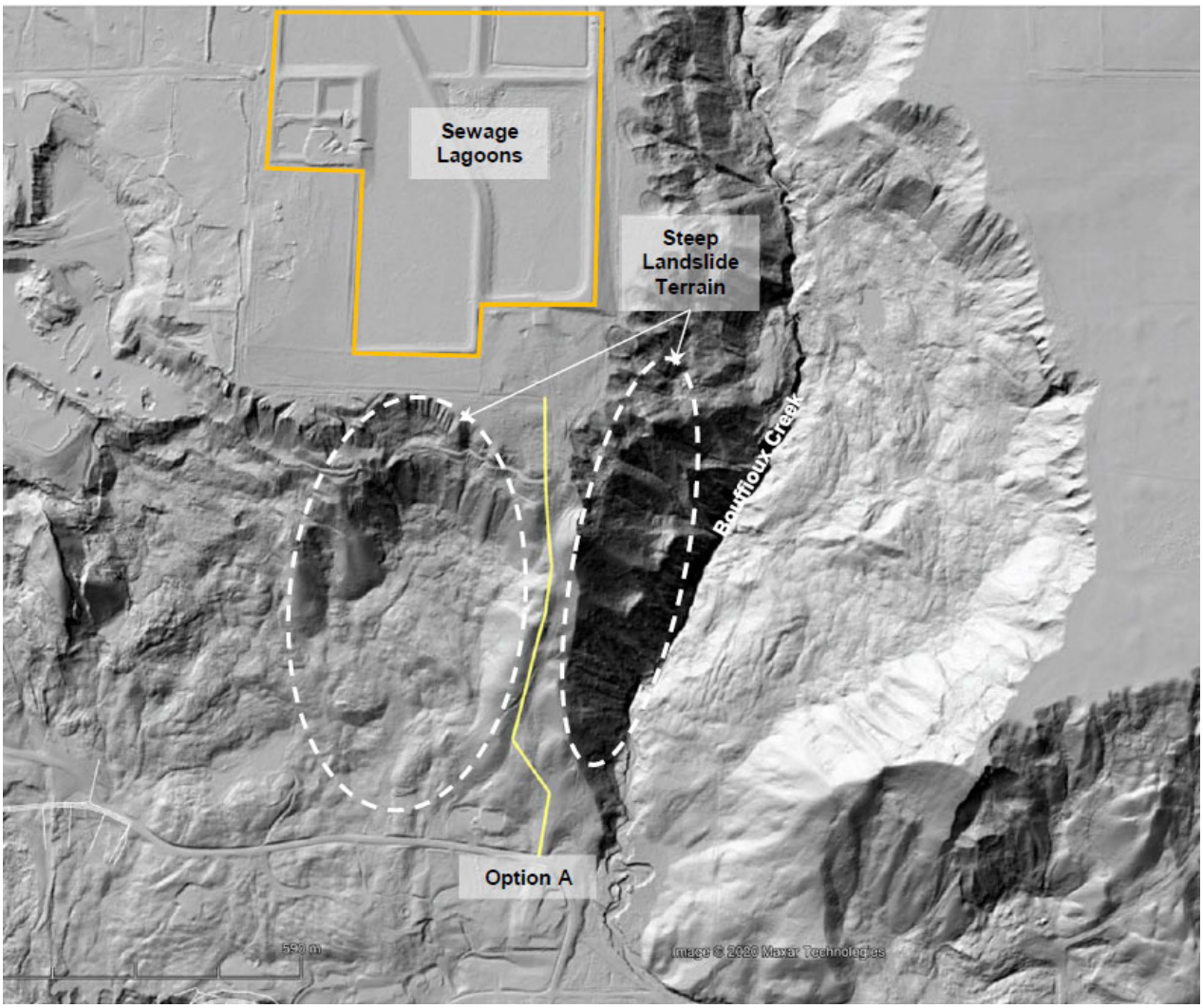
2.1.1. Options Not Carried Forward

The following provides a brief description of Options A, B, and D and reasons for not considering these options further to preliminary design. A desktop geotechnical assessment of these options is provided in BGC's *Old Fort Road – Geotechnical Evaluation of Potential Alignment Options – Updated FINAL* (dated March 26, 2021) attached in *Appendix B*.

Option A – New Access Point to the North

Option A was initially considered as a potential alignment option for a replacement access to Old Fort, as it provided the shortest route between Old Fort and the City of Fort St. John. The route was indicated along the ridgeline that runs west of Bouffioux Creek (*Figure 2*). However, such an option, if constructible along the ridgeline, would result in a very steep grade up to 25%. Therefore, to reduce grade, the road would need to be switch-backed up the hill across unstable landslide terrain. Costly geotechnical design options that may include ground anchors, anchored pile walls, and extensive drainage works would likely be required to mitigate the unstable ground conditions. This option could also increase the geohazard risk to the community of Old Fort by potentially destabilizing marginally stable landslide landforms on the slopes above the town. This would also encroach on the sewage lagoons on the plateau beyond the slope crest and potentially impact the City of Fort St. John's sanitary sewer outfall that runs along the ridgeline. Due to these geotechnical challenges compared with other options, this option was not considered beyond the preliminary review stages.

Figure 2: Option A Alignment



Option B – New Access Point to the West

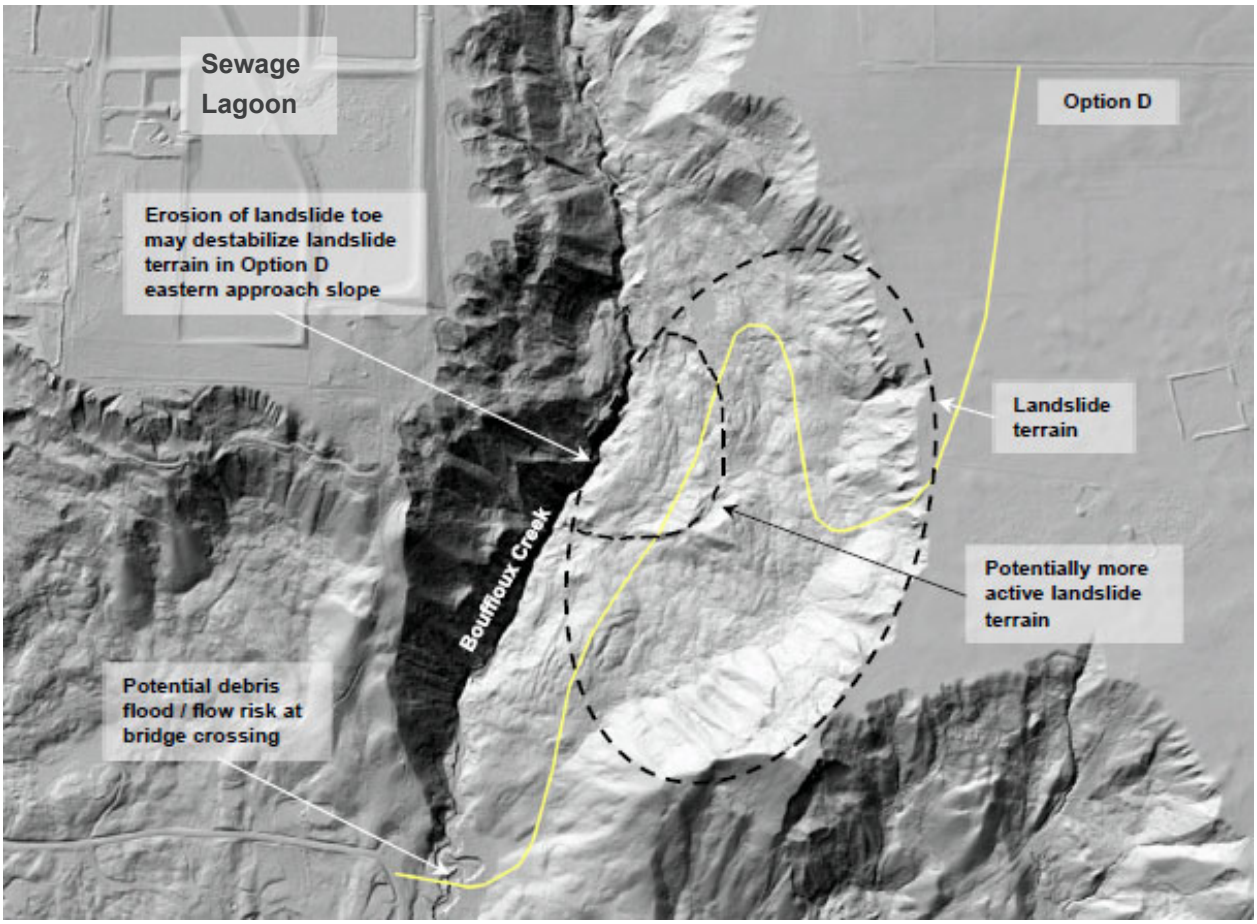
Option B provided an east-west crossing of the Old Fort landslide via the west end of River Drive (*Figure 3*). The alignment crosses the main 2018 and 2020 earthflow, an older dormant landslide complex to the east, and approaches the crest of steep unstable slopes on the steep lower left bank of the Peace River. This option was considered to provide no geotechnical advantages over mitigation of the existing access (Option F1), would require more extensive geotechnical measures, and would still be vulnerable to potential future advances of the earthflow. This option was therefore dropped from consideration.

Figure 3: Option B Alignment

Option D – New Access Point to the East Across Bouffioux Creek

Option D was proposed as a possible eastern access from Old Fort crossing Bouffioux Creek and continuing north over both active and dormant landslide terrain on the east slopes of Bouffioux Coulee, before crossing a landslide headscarp and joining with Cartier Road *(Figure 4)*. The proposed alignment across landslide terrain would present significant challenges for both design and construction and would require extensive geotechnical measures to stabilize. The threat of the road across landslide terrain being undermined as a result of toe erosion by Bouffioux Creek would also remain. Earthworks across the landslide terrain could increase the potential for landslide effects downstream in Old Fort, either as a result of direct landslide runout, or from landslide dam outburst floods. The bridge crossing over Bouffioux Creek would need to consider potential debris flow/flood risk emerging from the creek. Due to these geotechnical challenges compared with other options, this option was not considered beyond the preliminary review stages.

Figure 4: Option D Alignment



2.1.2. Options Considered

The following provides a brief description of Options F, F1, C1, C2, and C that are carried forward for further analysis and evaluation.

Option F – Base Case: Maintain Existing Road Access Without Stabilization

This first proposed option consists of leaving the recently constructed gravel road in its current alignment and grade. It is recognized that this option would be impacted by future landslides. The alignment is shown in *Figure 5* below.

Figure 5: Option F Alignment

Option F1 – Variant of Option F, Including Stabilization Works to Reduce the Likelihood of Future Landslide Movements Affecting Road Trafficability

The evaluation of Option F1 is based on a high-level desktop study and will require further geotechnical analysis. The outstanding existing geotechnical hazards in other slide areas were not assessed, including the landslide complex to the west of the earthflow, as they are not part of the scope of this study.

This road alignment option consists of upgrading the existing road along the current gravel road alignment to current MoTI standards. It starts approximately 150 m west of the slide at the existing Old Fort Road, crosses over the slide area, and then matches the eastern portion of Old Fort Road approximately 150 m from the east edge of the slide. 60 km/h horizontal curves were achieved, and vertical grades are quite flat for this option (2% to 2.5%). Significant stabilization efforts are required to reduce future earthflow movements. The alignment is the same as Option F and is shown in *Figure 5* above. More details regarding Option F1 can be found in *Section 6* of this report.

Some risks and/or unknowns for this option include:

- Extensive field investigation required to develop more robust understanding of existing geohazards
- Extensive drainage improvements required to mitigate hydrotechnical challenges due to steep slope
- Additional costs due to structure(s) (e.g., a long anchor pile wall) may be incurred

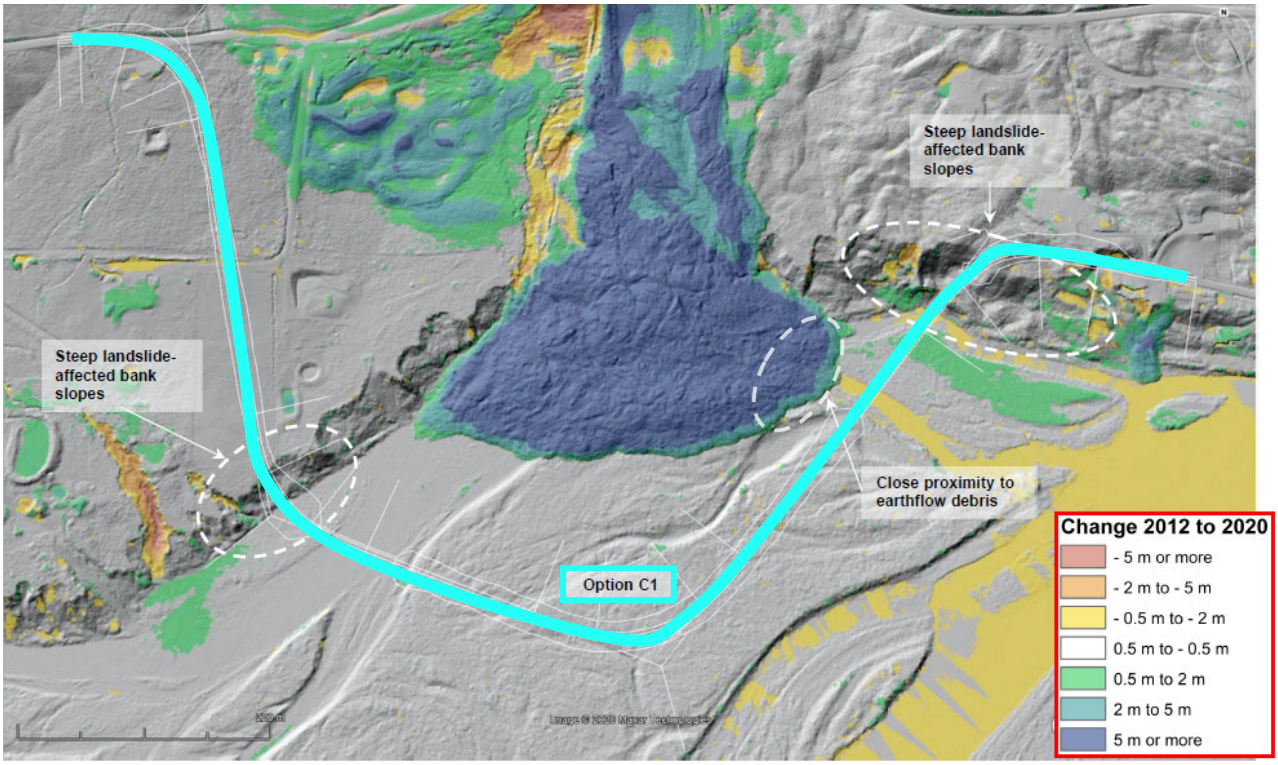
Option C1 – Variant of Option C, Crossing Only One Island in Peace River

This option connects to Old Fort Road approximately 500 m west of the existing slide area, continues south down a 10% grade across the Peace River back channel onto the island, and then east towards Old Fort before tying into River Drive. Two bridges are required for this option. The posted speed for portions of this alignment will be reduced from 60 km/h to 50 km/h due to steeper grades and horizontal alignment constraints (near the tie-ins at Old Fort Road and River Drive). Some risks and/or unknowns for this option include:

- Due to proximity to toe, road could be impacted by future slide activity
- Extensive field investigation required to develop more robust understanding of existing geohazards
- Potential for significant environmental impacts causing extensive permitting efforts and approvals and or costs for mitigation strategies

The alignment is shown in *Figure 6* below. The figure shows LiDAR change detection between years 2012 and 2020. The blue and green tones represent material accumulation while the yellow to red tones represent material.

Figure 6: Option C1 Alignment

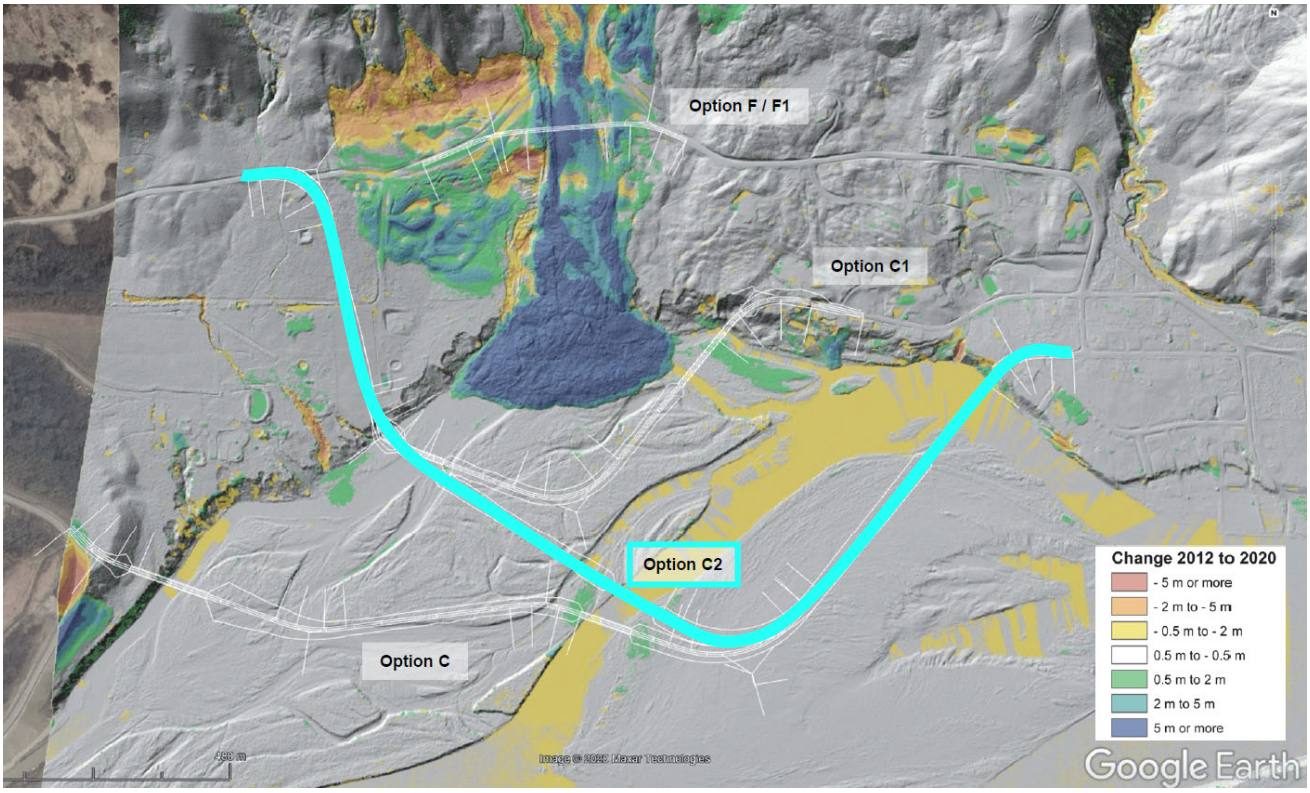


Option C2 – Variant of Options C and C1

Option C2 is a hybrid of Option C and Option C1, tying into Old Fort Road east of the slide, heading south down the 10% grade across the two islands to Old Fort, and tying into Old Fort Loop Road. Three bridges are required for this option. The posted speed of this alignment will be reduced from 60 km/h to 50 km/h due to steeper grades and horizontal alignment constraints (near the tie-in at Old Fort Road and River Drive). The alignment is shown in *Figure 7* below. Some risks and/or unknowns for this option include:

- Extensive field investigation required to develop more robust understanding of existing geohazards
- Potential for significant environmental impacts causing extensive permitting efforts and approvals and or costs for mitigation strategies

Figure 7: Option C2 Alignment

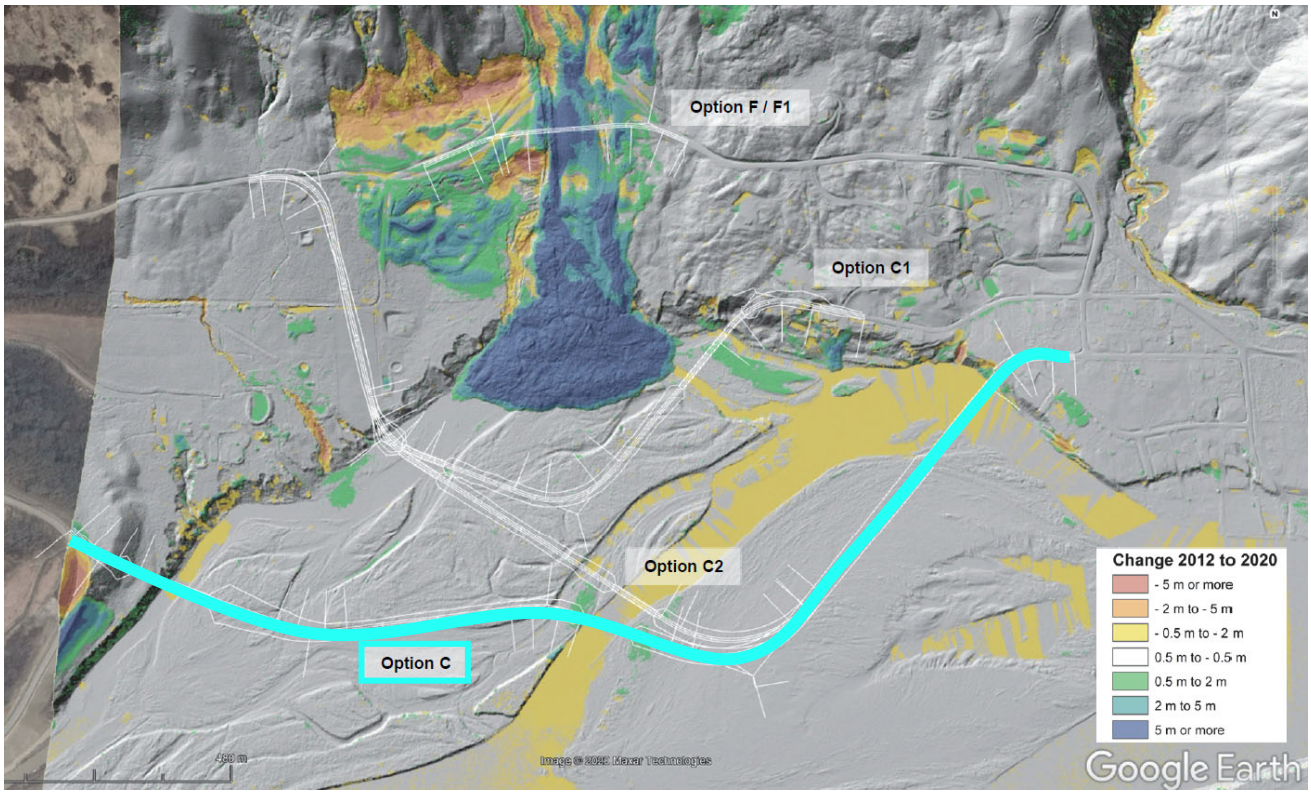


Option C – Crossing of Two Islands in Peace River

Option C starts at the BC Hydro access road and crosses the Peace River back channel with an 8% downgrade across a bridge onto the first of two islands. It continues east across the islands with two additional bridges before connecting to Old Fort Loop Road. The posted speed will be reduced from 60 km/h to 50 km/h due to horizontal alignment constraints near the tie-in at Old Fort Loop Road. The alignment is shown in *Figure 8* below. Some risks and/or unknowns for this option include:

- Extensive field investigation required to develop more robust understanding of existing geohazards
- BC Hydro access road may require improvements and agreement with BC Hydro
- Potential for significant environmental impacts causing extensive permitting efforts and approvals and or costs for reclamation work or mitigation strategies

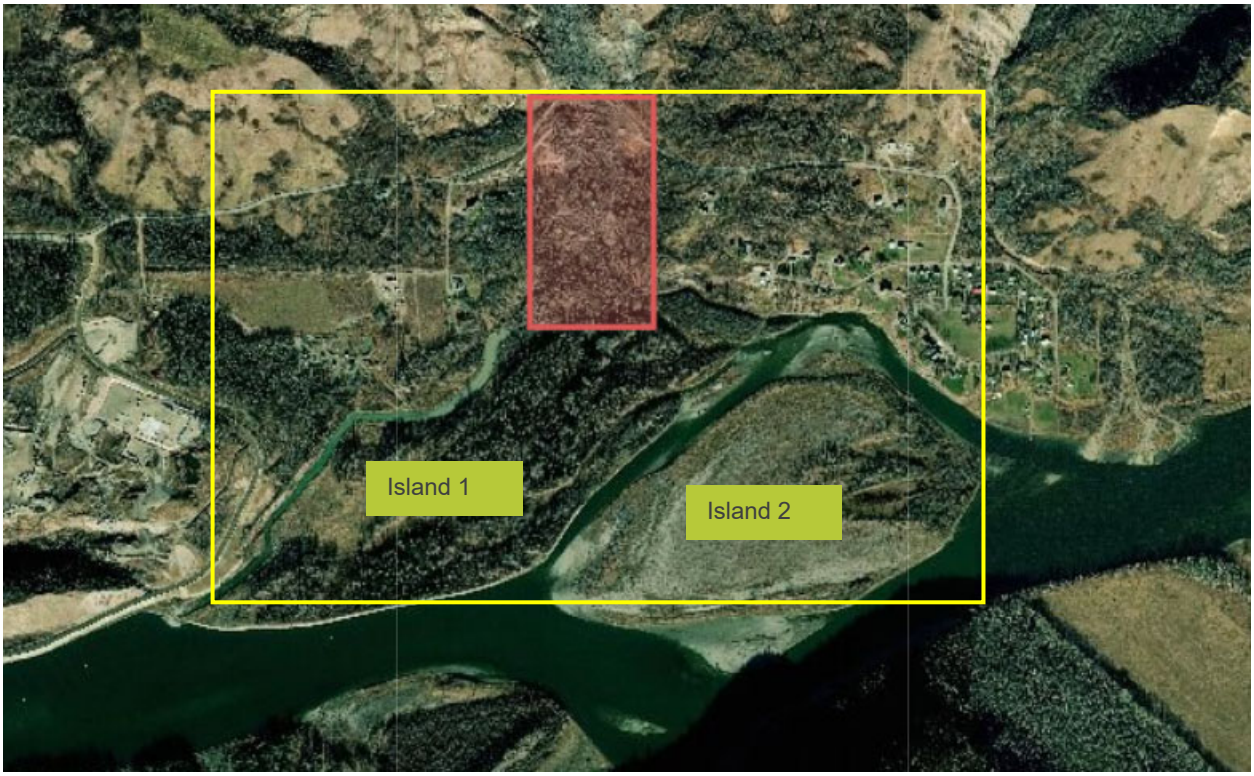
Figure 8: Option C Alignment



3. Environmental Assessment

Several Peace River side channels are present in the area below the slide. Two large, vegetated islands are present between the slide and the main stem of the Peace River; for ease of explanation, we have numbered the islands as shown in *Figure 9* below. The Old Fort slide, shown by the red box in the figure below, has now covered and blocked a 350 m long section of the northern side channel. Water can flow or back up into this channel from either the east or west end, but there is no longer a path for continuous water flow.

Figure 9: Environmental Study Area



A high-level desktop environmental review was undertaken; information was collected by reviewing web-based provincial and federal databases and interactive mapping for an area encompassing all new alignment options (the site; yellow outline in *Figure 9*). Online searches were conducted using the following sites:

- HabitatWizard online mapping tool [1]
- Fisheries Inventory Data Queries [2]
- BC Species and Ecosystems Explorer [3]
- iMapBC – various fish, wildlife, and vegetation layers [4]

A location-based search of BC Species and Ecosystems Explorer identified the potential for many red- and blue-listed species (threatened or endangered and special concern) to occur, including: 45 birds, ten mammals, one amphibian, 19 vascular plant species, and 12 ecological communities. A search of online data sources shows that the site falls within a critical habitat polygon for little brown myotis and northern myotis. The site is also just outside a polygon for the slender penstemon vascular plant. Open-source telemetry data shows one occurrence of mule deer on Island 2.

The slide area is immediately above and into the Peace River (Watershed Code 230), which is known to contain over 39 species of fish (HabitatWizard, 2020). Egg mats for mountain whitefish were also noted on the southwestern edge of Island 1. Five of the fish species, as well as two bivalve species, known to occur in the Peace River have been identified as red- or blue-listed species. Historic aerial photographs show large fluctuations in Peace River water levels. These fluctuations produce varying levels of inundation for both islands, but specifically for Island 2 which is flooded to varying degrees annually.

Side channels on large rivers generally provide refuge for smaller fish looking to avoid strong currents in the mainstem river. Side channels may also function as spawning, rearing, and overwintering habitat for fish [5]. Impacts to side channels should be minimized wherever possible as they generally provide valuable aquatic habitat.

3.1. REGULATORY CONSIDERATIONS

Instream works will likely be required for all options that include river crossings but may vary in impact for each crossing. Instream works may include site isolation, dewatering, river diversion works, erosion protection, and construction of the new structure. The Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) and the Department of Fisheries and Oceans (DFO) are the typical permitting agencies responsible for reviewing and providing permits for instream works within watercourses bearing fish. The type of permit required by each agency will be dependant on the proposed structure and its disturbance and footprint below the high water mark (HWM).

[1] https://maps.gov.bc.ca/ess/hm/habwiz/ Accessed Oct 9, 2020.
[2] https://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/fish/fish-and-fish-habitat-data-information/search-fish-fish-habitat-data-information/fisheries-inventory-data-queries
[3] http://a100.gov.bc.ca/pub/eswp/
[4] https://maps.gov.bc.ca/ess/hm/imap4m/
[5] https://people.wou.edu/~taylors/g407/restoration/WA_Dept_Forestory_2004_Side_Channel_Restoration_Techniques.pdf

At this time, we would anticipate new bridge crossings of the Peace River (including a backchannel) to require, at a minimum, a Request for Project Review from DFO, and an Approval from FLNRORD. Project reviews can take an average of 90 days for consent, while approvals can take up to 140 days. Consultation with local First Nations is generally required as part of the permitting process.

3.2. COMPARISON OF ALIGNMENT OPTIONS

Options C1, C2, and C will involve new road and bridge construction. From a wildlife and plant communities' perspective, the longer the length of new road, the greater the impact due to loss of vegetation and terrestrial habitat. Based on a high-level overview assessment, none of the options cross or impact specific areas of sensitive habitat anymore/less than others and are all within the same critical habitat polygons.

Options C1, C2, and C all require construction of multiple bridges, which will require permitting under the Water Act (FLNRORD) and the Fisheries Act (DFO). The longest bridges will likely require habitat offsetting/compensation for (assumed) instream piles/piers and/or erosion protection of abutments. Options C1, C2, and C would also provide access to previously undisturbed and inaccessible areas by crossing onto Island 1 and Island 2. This has the potential for secondary impacts such as access for invasive plant species and impacts from people accessing the area for recreational purposes (creating trails, beach areas, campfires, etc.). Of these three options, Option C1 has the shortest length of new road, does not cross to Island 2, and appears to require one shorter span bridge and one long span. Therefore, Option C1 has a lower potential environmental impact. Bridges crossing onto Island 2 would need to accommodate high levels of inundation and heavily fluctuating water levels that this island sees.

Option F would likely contain the lowest environmental impact of the five options due to the shortest length of newly build road, least amount of vegetation clearing, and no new stream crossings. This option does not cross the river or side channels, so potential impacts to aquatics are limited. The downfall to this option would be the continued slide and loss of gravel road.

The potential environmental impact of Option F1 is somewhat unknown without an identified footprint or extent of works. However, any degree of drainage works and grading/earthworks for geotechnical stabilization works creates some level of disturbance. Impacts from geotechnical works are assumed to be largely within the disturbed area (i.e. landslide), and the short length of newly built road significantly reduces the impact from civil works. This option does not cross the river or side channels, so potential impacts to aquatics are limited.

4. Hydrotechnical Assessment

A feasibility-level hydrotechnical assessment was completed for the Peace River adjacent to the Old Fort slide. The three alignment options (C1, C2, and C) that encroach onto the river floodplain were examined relative to the existing conditions. The following comments reflect our assessment of each option's potential impact on river hydraulics and associated water levels.

4.1. INFORMATION USED

The Peace River was the subject of numerous hydrologic and hydraulic studies over the past 80 years. Hydroelectric development of the WAC Bennet Dam and the Peace Canyon Dam by BC Hydro has produced hydrotechnical reports that contain information employed by subsequent studies. The Site C Dam project, which is located immediately upstream of the study area, also incorporated this information. Provincial flood mapping was produced in 1985 and relied on flow estimates from BC Hydro studies.

4.2. APPROACH

The water surface elevations reported in the 1985 provincial flood maps were used as initial design values for establishing the required elevation of roads and bridges proposed for each alignment. Using available LiDAR and provincial digital elevation model data, we developed a digital terrain model (DTM) for the 6 km reach of the river (see *Figure 10*).

The DTM, along with the estimated Q200 flow information, was the basis for a two-dimensional (2D) hydraulic model of the reach. The 2D hydraulic model predicts the water surface elevation, water velocity, and direction of flow, for a given flow, within the study area. The DTM was altered to include the proposed road and bridge openings for each alignment option. As a result, four separate DTMs were modeled (one for each alignment option, and the existing conditions).

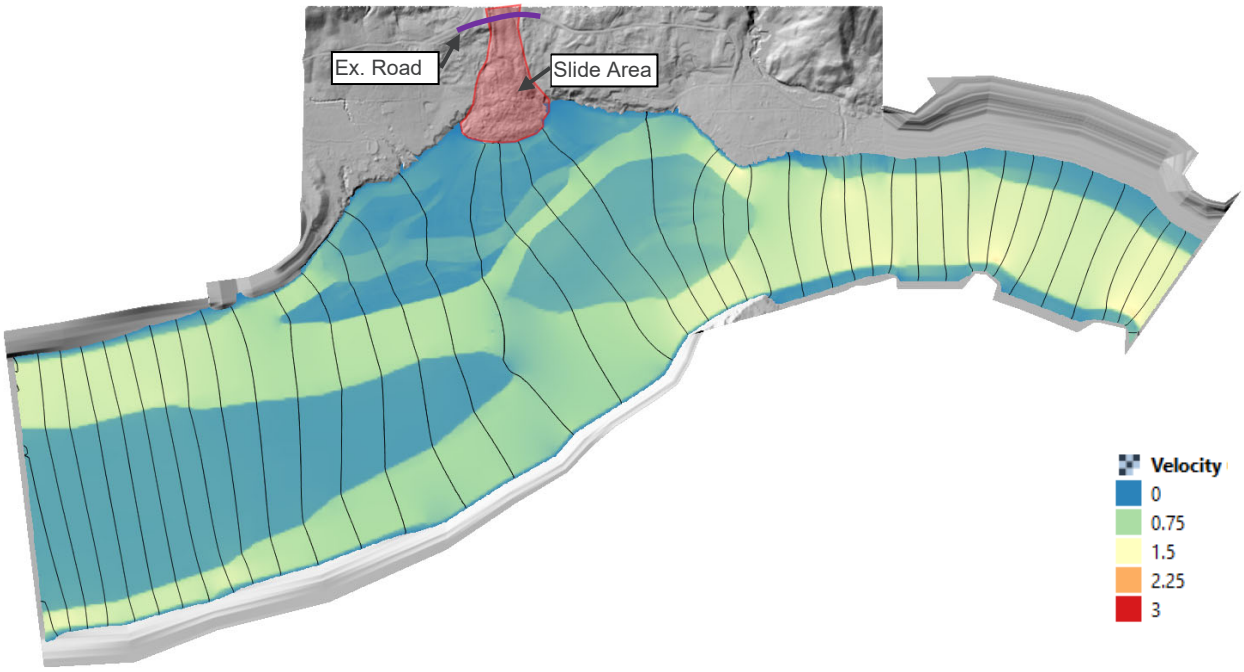
The results of the hydraulic model were compared and assessed to determine the potential hydraulic implications of each option.

4.3. RESULTS

4.3.1. Existing Conditions

Figure 10 shows the velocity distribution at the 200-year flood event during existing conditions.

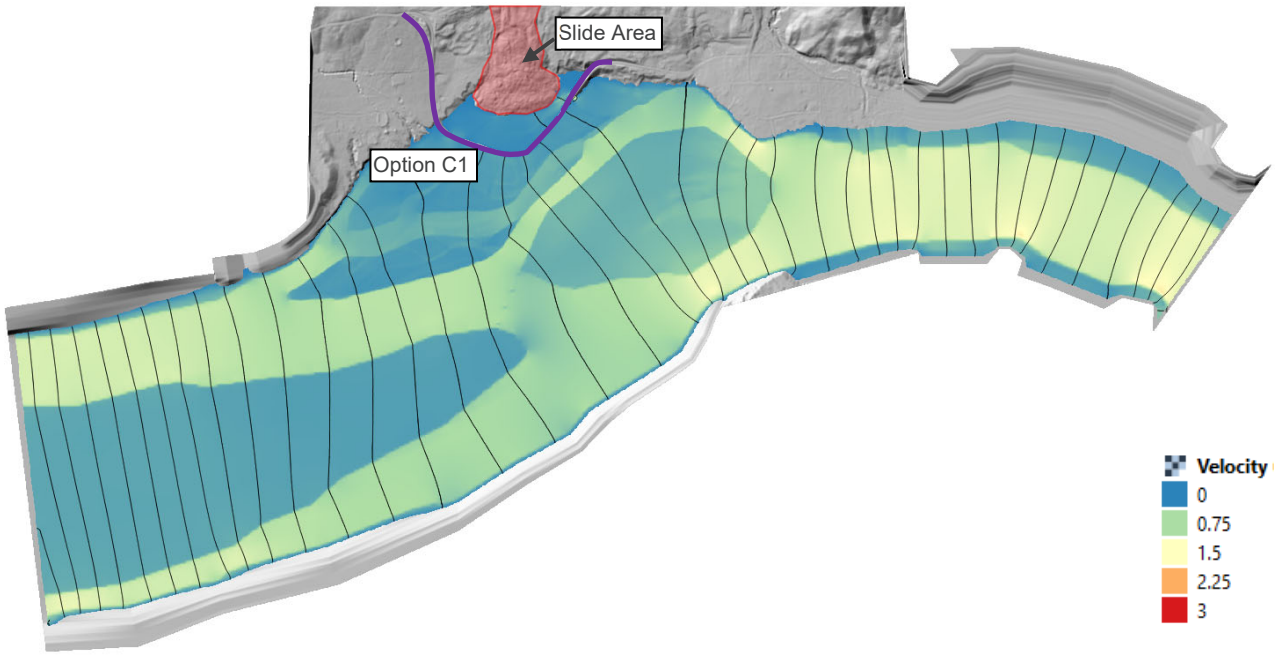
Figure 10: 200-Year Flood Event (Existing Conditions)



4.3.2. Option C1 – Variant of Option C, Crossing Only One Island in Peace River

Figure 11 presents the result for Option C1 conditions. As with the other options, no noticeable difference in water surface elevation through the study reach is observed. Water velocities also do not change, except for near the bridge crossings where standard inlet and outlet protection would be required.

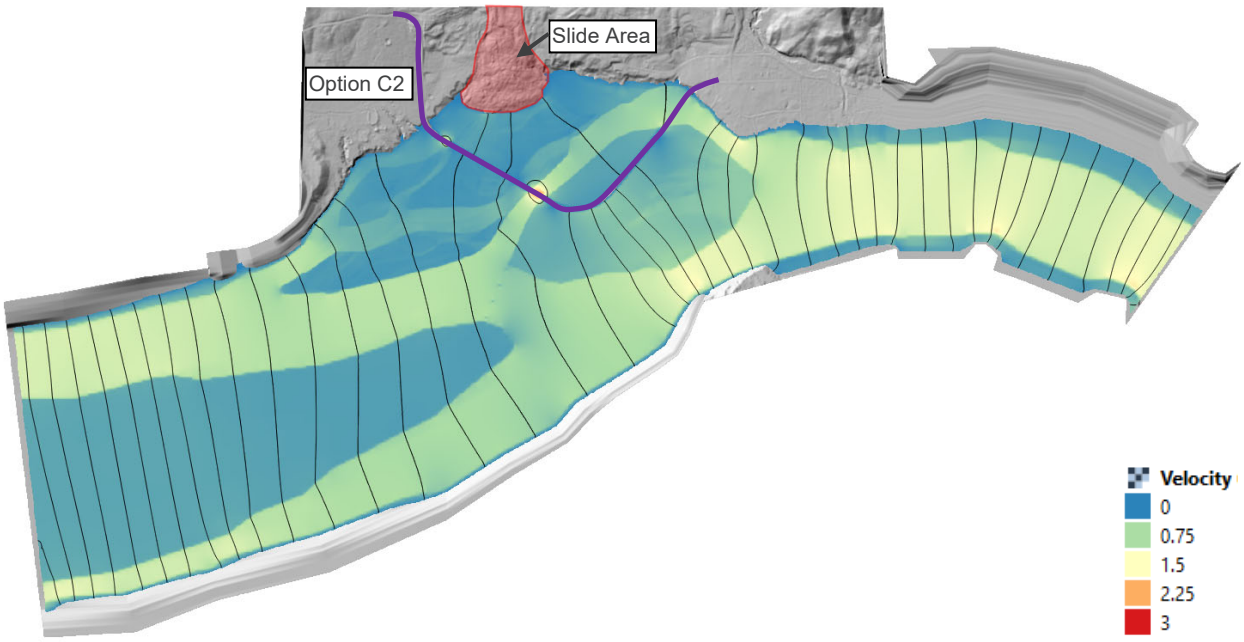
Figure 11: 200-Year Flood Event (Option C1)



4.3.3. Option C2 – Variant of Options C and C1

Option C2 is a variation of Option C. The velocity distribution at the 200-year flood event for Option C2 conditions is shown in *Figure 12*. From a river hydraulics perspective, options C and C2 are similar. Namely, no change in water surface elevations, and water velocities increase through the proposed bridge crossings.

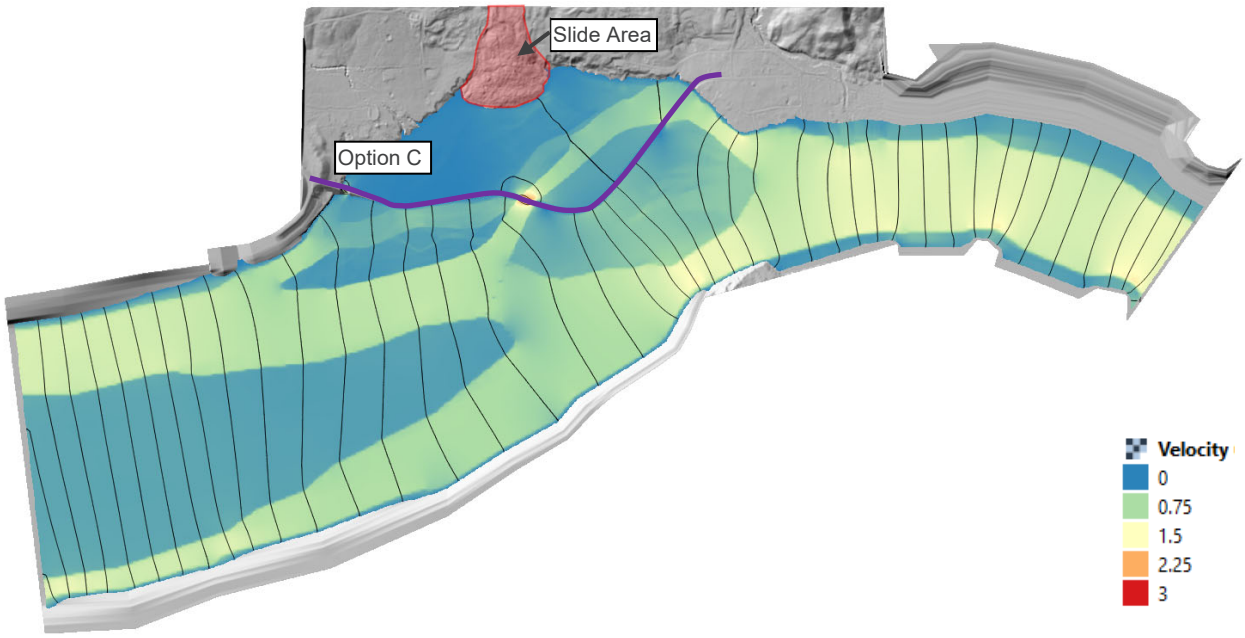
Figure 12: 200-Year Flood Event (Option C2)



4.3.4. Option C – Crossing of Two Islands in Peace River

The velocity distribution at the 200-year flood event for Option C conditions is presented in *Figure 13*. The alignment does not affect the water surface elevation of the Peace River through the reach. Significant increases in water velocity are noted through each of the proposed bridge openings. This is expected and erosion protection for the embankments will be required.

Figure 13: 200-Year Flood Event (Option C)



5. Structural Assessment

Three of the five realignment options will have bridges along their alignment (options C1, C2, and C).

For all the options with bridges, it is anticipated that one or more bridges will require the construction of piers in the Peace River channel. With generally high design flood water levels and several in-river piers, construction over the channel will be at risk of schedule delays and higher costs. Robust scour protection and environmental permitting will likely be required. All piers in water will likely require deep piled foundations.

Structural assessments for each of these three options (options C1, C2, and C) are discussed below.

5.1. OPTION C1 – VARIANT OF OPTION C, CROSSING ONLY ONE ISLAND IN PEACE RIVER

For this option, two bridges will be required along the alignment, at approximately Sta 35+00 and Sta 41+00.

The first bridge near Sta 35+00 will cross the Peace River channel. The total length of the bridge between abutments will be approximately 100 m assuming 2:1 headslopes in front of the abutments down to the river. The bridge will be on a profile with a grade of -3.3% and the roadway will be approximately 3 m above maximum flood water levels. The depth of the superstructure and roadway profile will be governed by the available freeboard above the design flood water levels. The bridge will be mainly straight with no significant skew.

The relatively long length of the bridge and low clearance will likely require at least two to three in-river piers to reduce individual spans and accommodate a shallow superstructure (concrete box girders or slab on girders), with a three to four span arrangement.

The second bridge near Sta 41+00 will cross two side channels of the Peace River. The total length of the bridge between abutments will be approximately 200 m. The bridge will be on a steep profile with a grade of +7.4% and the roadway will be approximately 5 m to 20 m above maximum flood water levels to tie into the existing north bank. The bridge will be mainly straight (except near the east end where a 130 m horizontal curve is proposed) with no significant skew.

The relatively long length of the bridge will likely require at least three to four piers to accommodate a superstructure with slab on girders, with a four to five span arrangement. Since vertical clearance is not an issue at this location, longer spans with deeper girders could be considered. Tall piers may be required near the east end of the bridge.

5.2. OPTION C2 – VARIANT OF OPTIONS C AND C1

For this option, three bridges will be required along the alignment, at approximately Sta 57+00, Sta 61+00, and Sta 69+00.

- The first bridge near Sta 57+00 will be similar to the first bridge in Option C1 (100 m).
- The second bridge near Sta 61+00 will be similar to the second bridge in Option C (95 m).
- The third bridge near Sta 69+00 will be similar to the third bridge in Option C (210 m).

5.3. OPTION C – CROSSING OF TWO ISLANDS IN PEACE RIVER

For this option, three bridges will be required along the alignment, at approximately Sta 72+00, Sta 80+00, and Sta 88+00.

The first bridge near Sta 72+00 will cross the Peace River channel. The total length of the bridge between abutments will be approximately 150 m assuming 2:1 headslopes in front of the abutments down to the river. The bridge will be on a steep grade of -8.0% and the roadway will be approximately 20 m above maximum flood water level. The new bridge will be significantly higher than the original ground (20+ meters) and may require tall retaining walls for the abutments and embankments. The bridge will be mainly straight with no significant skew.

The relatively long length of the bridge will be challenging to span the channel with a single span. Given the height of the bridge, an arch structure may be suitable. Otherwise, one or two river piers will likely be needed to reduce individual spans for a more traditional bridge system such as slab on steel or concrete girders, with either a two or three span arrangement. Since vertical clearance is not an issue at this location, longer spans with deeper girders could be considered.

The second bridge near Sta 80+00 will cross the Peace River channel. The total length of the bridge between abutments will be approximately 95 m. The bridge will be on a vertical crest curve with grades varying from -1.8% to +1.7% and the roadway will be approximately 3 m above maximum flood water levels. The depth of the superstructure and roadway profile will be governed by the available freeboard above the design flood water levels. The bridge will be mainly straight with no significant skew.

The relatively long length of the bridge and low clearance will likely require at least two to three in-river piers to reduce individual span lengths to accommodate a shallow superstructure (concrete box girders or slab on girders), with a three to four span arrangement.

The third bridge near Sta 88+00 will cross the Peace River where the channel widens. The total length of the bridge between abutments will be approximately 210 m. The bridge will be on a relatively flat profile with a grade varying from +0.2% to +4.3% and the roadway will be approximately 3 m above maximum flood water levels. The depth of the superstructure and roadway profile will be governed by the available freeboard above the design flood water levels. The bridge will be mainly straight with no significant skew.

The relatively long length of the bridge and low clearance will likely require several in-river piers to reduce individual spans and accommodate a shallow superstructure (concrete box girders or slab on girders), with likely six spans or more. The variable roadway profile on the east side (combination of constant grade plus vertical sag curve) will make the design and construction more complicated and expensive.

5.4. STRUCTURAL ASSESSMENT SUMMARY

The most challenging bridges to design and construct would be the first bridge in Option C (high elevation above ground) and the last bridge in Options C and C2 (long length, several in-river piers).

From a structural perspective only, Option C1 would be preferred since the bridges have regular geometry and do not cross a major channel. Tall piers required on the second bridge may, however, present a challenge.

6. Geotechnical Assessment

MoTI retained BGC to provide geotechnical review and evaluation of the proposed road alignment options. The desktop review took account of available LiDAR survey and aerial imagery, supported by local knowledge developed on other nearby project work for MoTI. There has been no ground investigation.

A high-level geotechnical evaluation of the proposed alignment options (*Figure 1* and *Section 2*) is provided in BGC's letter report presented in *Appendix B*, with a summary provided below.

6.1. OPTIONS CARRIED FORWARD

6.1.1. Option C – Crossing of Two Islands in Peace River

Option C crosses two islands in the Peace River and steep riverbanks near the eastern and western ends of the alignment *(Figure 8)*. While the banks are affected by landslides it was considered that the slope grading required to construct the road would result in removal of the landslide-affected portions of the slopes and require limited additional geotechnical mitigation. Therefore, from a geotechnical perspective, Option C provided the least geotechnical challenges. It is recognized that there is potential for the portions of the road crossing the islands to be susceptible to flooding in extreme release from upstream dams or other high flood conditions. There is also the potential for erosion at the proposed bridge abutments, given that the islands' extents tend to change following high floods, and that would need to be accounted for in the design.

6.1.2. Option C1 – Variant of Option C, Crossing Only One Island

Option C1 was developed as a shorter route crossing onto one island in the Peace River and follows an alignment that runs closer to the distal end of the 2018 and 2020 earthflow (*Figure 6*). Similar to Option C, where the alignment crosses the steep landslide-affected banks to the west of the earthflow, it was considered that grading for the road construction would remove the landslides in that area and limited additional geotechnical mitigation would be required.

The east end of Option C1 crosses 35 m-high landslide-impacted slopes and runs in close proximity to landslide-impacted slopes for a length of approximately 200 m. Thus, for the purposes of developing high-level geotechnical costs, it is assumed that a 200 m length of slope and landslide-impacted ground will need to be stabilized. It is further assumed that the 160 m-long cut slope in landslide terrain on the uphill side of the proposed road alignment will also need to be stabilized. Given the uncertainties in estimating geotechnical mitigation costs without a thorough understanding of the geological conditions, it is suggested that a sum of $10 M be adopted for the purposes of integrating potential geotechnical costs into the preliminary cost estimate for the Option C1 road alignment.

6.1.3. Option C2 – Variant of Options C and C1

Option C2 is a hybrid of Option C and C1 and also crosses two islands in the Peace River and steep riverbanks near the eastern and western ends of the alignment *(Figure 7)*. From a geotechnical perspective, Option C2 is assessed similarly to Option C with the same relative advantages and disadvantages.

6.1.4. Option F – Base Case: Maintain Existing Road Access Without Stabilization

The existing access crosses the main body of the 2018 and 2020 earthflow, an older, mainly dormant but locally active landslide complex to the east, and a landslide to the west that was active in 2018 but either to a lesser extent or not active in 2020. Maintaining the existing access across the main body of the 2018 and 2020 earthflow will need to allow for periodic reconstruction of the road in response to future acceleration of the landslide destroying the road. The potential for the future movement of the landslide immediately west of the earthflow also needs to be considered. Landslide movements that prevent road use may be expected to occur in the absence of stabilization. The potential for the future movement of the landslide immediately west of the earthflow (i.e., the west slide complex), also needs to be considered. Landslide movements that prevent road use may be expected to occur in the absence of stabilization measures with an unknown frequency; the potential impacts of a changing climate on landslide frequency at this location are also unknown. Additional geotechnical assessment is required to improve the understanding of the geohazards and associated risks. Such assessment will also allow for identification of potential options to provide minor drainage and regrading improvement.

6.1.5. Option F1 – Variant of Option F, Including Stabilization Works to Reduce the Likelihood of Future Landslide Movements Affecting Road Trafficability

This option maintains the existing road alignment but assumes that measures have been implemented to stabilize the landslide, reducing the frequency of damaging landslide movements. At present, adequate geotechnical data are not available to support the design of such stabilization measures, so the following discussion is largely conjectural pending further detailed investigation and analysis.

Stabilizing the earthflow will be geotechnically very challenging and would require a detailed assessment to understand the landslide mechanisms and contributing factors, such as ground and subsurface water flow conditions. In this evaluation it is assumed that a combination of surface and subsurface drainage measures, combined with grading works of the slide mass, would be the most likely stabilizing option. It must be recognized that completely arresting the earthflow is unlikely be technically or economically feasible, but that a reduction in the frequency and rate of future movements may be achievable, depending on the findings of further investigation.

Therefore, to estimate geotechnical costs to mitigate the earthflow movements it is assumed that stabilization works would likely comprise extensive drainage works including extensive surface drainage combined with horizontal drains, vertical drains and potentially even pumping wells or drainage galleries into bedrock. The width of the earthflow at the road crossing is approximately 150 m and should drainage options alone be insufficient to slow the earthflow at the road then options to mitigate the earthflow impact on the road may also require extensive regrading works combined with approximately 200 to 400 post

tensioned ground anchors in a cut adjacent to the road. Alternatively, if it is determined that structural support is required, a 150 m-long anchor pile wall could be built for a similar cost to the ground anchors. Given the uncertainties in developing costs at this stage it is suggested that $40M be adopted for the purposes of integrating potential geotechnical construction costs into the preliminary cost estimate for the Option F1 road alignment. The estimated cost (i.e., $40M) assumes that drainage, extensive regrading and a structural solution (e.g., anchors, pile wall) will be required.

6.2. ADDITIONAL GEOTECHNICAL CONSIDERATIONS

Geotechnical measures required for any of the access options taken forward would be dependent on the findings of extensive ground investigation, costs for which have not been included. The actual design and geotechnical costs may vary substantially from what has been assumed.

This high-level geotechnical evaluation did not consider the potential for future accelerated landslide movements from other landslide terrain in the vicinity of the community which may impact Old Fort Road (e.g., the reactivation of the west slide complex). This may potentially result in reduced serviceability, the need for substantial repair, or require realignment. These and other geohazard threats to the community of Old Fort, such as debris flood threat from Bouffioux Creek, should be considered in any comparative assessment of options for long-term access to the community.

7. Cost Estimate

Conceptual cost estimates were produced for each option using the Wolski cost estimating procedure and are summarized in *Table 1* for each option. Detailed Wolski cost estimates are included in *Appendix C.*

The standard unit price for each work unit is based on the most recent available tender data in the vicinity of the proposed project, provided on MoTI's website. The average bid prices were used to determine unit prices including the geotechnical and environmental risks associated with each alignment.

The Wolski cost estimate spreadsheet included the following costs:

- Construction
- Land Acquisition
- Planning, Project Management, and Engineering
- Resident Engineering/Construction Supervision
- Environment and Archaeological Mitigations
    - Indigenous Consultation
- Contingency (50%) – a high contingency is used due to unknown risks/uncertainties and thorough understanding of the geotechnical conditions

The cost estimate for Option F (*Base Case: Maintain Existing Road Access Without Stabilization*) projected over 25 years (resulting in approximately $30 M) consists of minor land acquisition, ongoing rehabilitative costs based on the 2018 slide data and to conduct detailed geotechnical investigation of the existing alignment to better understand geohazards and risks. The Option F cost estimate was also used to aid in the Multiple Criteria Evaluation (MCE) for this option; however detailed cost analysis of Option F is not part of the study scope.

As shown in *Table 1*, Option F1 was also used to aid in the MCE and is estimated to cost $200 M including the slope stabilization and ongoing geotechnical rehabilitation cost. Options C and C2 are similar in cost with Option C being the most expensive option at about $243 M. Options C1 and C2 are estimated to cost about $187 M and $237 M, respectively.

It should be noted that the cost estimates are in 2021 dollars and will increase in the future due to escalation.

Table 1: Cost Estimate

Description	Estimated Cost				
	Option F Base Case: Maintain Existing Road Access Without Stabilization	**Option F1** Variant of Option F, Incl. Stabilization Works to Reduce the Likelihood of Future Landslide Movements Affecting Road Trafficability	**Option C1** Variant of Option C, Crossing Only One Island in Peace River	**Option C2** Variant of Options C and C1	**Option C** Crossing of Two Islands in Peace River
Construction	-	$67.7 M	$62.1 M	$78.7 M	$81.4 M
Land Acquisition	-	$0.06 M	$1.6 M	$2.0 M	$1.4 M
Planning & Prelim Design, PM, Engineering and Construction Supervision	-	$21.4 M	$21.8 M	$27.5 M	$28.2 M
Environment and Archaeological and First Nations	-	$41.0 M	$39.3 M	$49.8 M	$51.1 M
Ongoing Geotechnical Rehabilitation Cost	***$20.0 M*** ***over 25 years*** ***(0.8 M/year)***	***$5.0 M*** ***over 25 years*** ***(0.2 M/year)***	**-**	**-**	**-**
Contingency (50%)	***$10.0 M*** ***over 25 years***	***$65.1 M***	***$62.4 M***	***$79.0 M***	***$81.1 M***
Total Capital Costs [2, 3]	***$30 M [1]*** ***over 25 years***	***$200 M [1]***	***$187 M***	***$237 M***	***$243 M***

Note: 1) Includes ongoing geotechnical rehabilitation cost
2) Cost estimate is based on 2021 dollars and will increase with escalation in the future
3) Cost estimate subject to change upon detailed field investigation

8. Options Evaluation

The options evaluation was undertaken using unweighted rankings as described in *Table 2*, using a five-point scale, with scores totaled for each option. The Multiple Criteria Evaluation (MCE) table provides a brief discussion of advantages and disadvantages for various criteria, compared relatively to each option with no weighting applied. Each criterion is also ranked with a colour symbol (dot) that provides a visual indication of preference: more green dots is favourable, more red/orange dots is less favourable, and yellow is neutral.

Table 2: Options Evaluation Rankings

Visual Graphic	Description	Points
🟢	Highly Favourable	5
🟢	Favourable	4
🟡	Good / Little or No Impact	3
🟠	Acceptable / Some Impact	2
🔴	Unfavourable / Undesirable Impact	1

The high-level screening of key features for each alignment option was conducted with MCE, summarized in *Table 3*.

The MCE considered the following attributes:

- design elements/components
- constructability
- access reliability
- environmental impact
- ongoing rehabilitation and economic impact
- property impact/acquisition
- total cost

The scoring for **design elements/components** describes the type of road improvements, alignment characteristics, bridge requirements, utilities impacts, and connectivity to the existing road network. For this criteria, Option F was given 3 points as it may not be built to current design standards. The other design options were given higher scores as they will be built to the current Ministry standards.

The **constructability criteria** consider the previously completed relevant construction work, complexity of mitigations and new roadway/bridge construction. Option F received a high score for constructability as it is a gravel road and already constructed, whereas the other design options had scores from 2 to 3 points due to permitting challenges and/or construction complexity coupled with geotechnical mitigations.

Access reliability, a focus for this study, is influenced by the geotechnical investigation findings such as the risk of future slides and flooding potential. Option F received the lowest score due to its vulnerability to further earthflow movement. Option F1 received a higher score than Option F as it has associated geotechnical mitigations to overcome some of the geohazards, however potential future slides may still occur. Bridge options C1, C2, and C each received a score of 5 points as their proximity to slide areas allow for more reliable access and fewer landslide-induced road closures that could isolate the community.

Ongoing geotechnical rehabilitation, economic impact, property acquisition, and total cost were criteria scored through quantitative assessments, with lower associated costs scoring higher. Impacts to the **environment, economy, and properties** were scored according to their projected effect. Lastly, the **total cost** score includes items such as construction, planning, project management and engineering, environmental & archaeological mitigation, indigenous consultation, and contingency.

With regards to **environmental impact**, Option F scored highly with 5 points as it requires the shortest length of newly build infrastructure and has limited potential environmental damages. Option F1 received a slightly lower score than Option F as drainage works and earthworks for geotechnical stabilization can create environmental impacts. The bridge options (C1, C2, and C) each received a score of 1 point since river and channel crossings are involved, impacting previously undisturbed and inaccessible areas and their respective ecosystems.

Option F – Base Case: Maintain Existing Road Access Without Stabilization

Option F is a direct route that has flat grades, requires no construction, has minimal property and environmental impacts, and has the lowest cost. However, future slide repairs, economic cost (temporary accommodation), and geotechnical risk is high for this option. Access reliability is also lower with this option. Overall, Option F has the highest score of 26 points from the MCE (*Table 3*).

Option F1 – Variant of Option F, Including Stabilization Works to Reduce the Likelihood of Future Landslide Movements Affecting Road Trafficability

Option F1 is a short (0.52 km) and direct route with marginal grades and minimal property/environmental impacts. However, this option crosses the existing slide area and there is a potential risk of being impacted by future slides. Therefore, this option requires extensive geotechnical mitigation to prevent future earthflow movements. The stabilization works would comprise extensive drainage improvements including surface drainage combined with horizontal drains, vertical drains, and potentially even pumping wells or drainage galleries into bedrock. There is also the potential to use structures to stabilize the slide. This option has the second lowest cost of the design options. Future slide repairs, economic cost (temporary accommodation), and geotechnical risk is also high for this option. This option has the second highest score of 23 points (*Table 3*).

Option C1 – Variant of Option C, Crossing Only One Island in Peace River

Option C1 is a medium-length route compared to the other alignments (1.68 km) and has some steeper grades, two bridges, and is the third most expensive to construct. It avoids the slide area completely, but does have environmental (flood zone construction), geotechnical, and some property impacts along with some secondary impacts to previously undisturbed and inaccessible areas. This option resulted in a score of 22 points from the MCE (*Table 3*).

Option C2 – Variant of Options C and C1

Option C2 is a hybrid of options C and C1 and is the second longest (1.92 km) option. Like Option C, Option C2 has three bridges, steep grades, and a significant environmental impact. Potential for road flooding on the islands from upstream dams or other flood conditions is also possible. Structural challenges for the three bridges create a second lowest rating and second highest overall cost out of all the bridge design options. This option received the lowest score of 19 points from the MCE (*Table 3*).

Option C – Crossing of Two Islands in Peace River

Option C crosses two islands in the Peace River and steep riverbanks near the eastern and western ends of the alignment. It is the longest (2.12 km) and most expensive option to construct and, like Option C2, has three bridges, moderately steep grades, and a high environmental impact. Also, this option connects to the BC Hydro access road at the west end, which will require consultation and approval by BC Hydro to tie-in at this location. Structural challenges for the three bridges create a low rating for this option along with the highest cost. This option resulted in a score of 20 points from the MCE (*Table 3*).

As shown in *Table 3*, option F is the most favourable design option with a score of 26 points. Options F1 ranked second with a score of 23 points. Options C1 and C ranked third and fourth in the design options with 22 and 20 points, respectively, while Option C2 has the lowest score of 19 points.

Table 3: Multiple Criteria Evaluation

Criteria	Option F (Base Case: Maintain Existing Road Access Without Stabilization)		Option F1 (Variant of Option F, Including Stabilization Works to Reduce the Likelihood of Future Landslide Movements Affecting Road Trafficability)		Option C1 (Variant of Option C, Crossing Only One Island in Peace River)		Option C2 (Variant of Options C and C1)		Option C (Crossing of Two Islands in Peace River)	
Design Elements/Components - Roadworks - Structures - Utilities	• Recently constructed road after June 2020 slide • Gravel road • Flat grades • Direct route • May require upgrade to current standards • Tie to existing road at both ends • No bridges required	3	• Upgrade existing road to 3.6 m paved lanes and 0.5 m gravel shoulders • Flat grades (2 to 2.4%) • Alignment utilizes the existing recently constructed road • Direct route • Tie to existing road at both ends • No bridges required • Design to MoTI standards • Road alignment is ~ 520 m long	4	• 3.6m lanes and 0.5 m gravel shoulders • Medium length curvilinear alignment • Steep grade at west end • 50km/h at tie-in at start of the alignment at Old Fort Rd and at east tie-in to River Drive • Two (2) medium to large bridges required • Bridge construction not impacted by main river channel. • Design to MoTI standards • Road alignment is ~ 1,680 m long	4	• 3.6m lanes and 0.5 m gravel shoulders • Long curvilinear route • Steep grade at west end • 50km/h at tie-in at start of the alignment at Old Fort Rd and at east tie-in to Old Fort Loop Rd • At station 52+00, may impact the hydro lines • Three (3) medium to large bridges required • Design to MoTI standards • Road alignment is ~ 1,920 m long	4	• 3.6m lanes and 0.5 m gravel shoulders • 50km/h at tie-in to Old Fort Loop Rd • Long curvilinear route • Steep grade at west end • West access starts on private (BC Hydro) road; permission may be needed • Crosses overhead Hydro line; some relocation required • Three (3) large bridges required crossing the Peace River channels • Design to MoTI standards • Road alignment is ~ 2,120 m long	4
Constructability - Complexity - Access to material - Mitigations required	• Already constructed. • Potentially future slide will require construction. • Gravel road easy to construct	5	• Access is good –construction complexity depends on drainage works and geotechnical structures to stabilize roadway and reduce future earthflow movements • Significant geotechnical mitigations required • Detailed subsurface investigation will be required	3	• Substantial embankment fill at west end abutment • Potential challenges with environmental permitting • Crosses deep-seated landslides between east side of the earthflow debris and the west end connection with River Drive, also challenging for construction. (See Figure 2-2 of BGC Geotechnical Comments on Old Fort Road Options Letter Report)	2	• Medium embankment fill at east end abutment • Potential challenges with environmental permitting • One bridge will be a multi-span bridge requiring in-river pier construction (environmental permitting, scour protection, etc.)	2	• Medium embankment fill at east end abutment • Potential challenges with environmental permitting • Tie at Site C dam private road on the west end may be difficult to obtain approval • One bridge will be s multi-span bridge requiring in-river pier construction (environmental permitting, scour protection, etc.)	2
Access Reliability - Geotechnical risks - Community Impact (physical impact on homeowners)	• Crosses main slide area • Flat grades • Prone to impacts from remobilization of earthflow • Crosses main earth flow and west slide flow of the 2018 and 2020 landslide complex; crosses older dormant landslide complex to the east. • Risk of a future slides will remain • Potential for continual road repairs • Potential higher community impact due to unknown stability	2	• Crosses main slide area • Flat grades • Crosses main earth flow and west slide flow of the 2018 and 2020 landslide complex; crosses older dormant landslide complex to the east • Risk of a future slides will remain. • An additional $40 million will be required for this option to overcome the geotechnical challenges of crossing the landslides • Potential future slide still a risk • Some impact to community as future slides may still occur	3	• Flood potential within lower areas • Section of road is close to slide debris; a future landslide may impact the road section • Riprap protection required in flood zone • An additional $10 million will be required for this option to overcome the geotechnical challenges of crossing the landslides • Little chance of road closure isolating the community	5	• Flood potential within lower areas • East connection at Old Fort Loop Rd is in a residential area • Avoids slide area • Riprap protection required in flood zone • Potential for road to flood on islands in extreme release from upstream dams or other high flood conditions • Little chance of road closure isolating the community	5	• Flood potential within lower areas • East connection at Old Fort Loop Rd is in a residential area • Avoids slide area • Riprap protection required in flood zone • Two of the structures require large embankments • Minimal additional geotechnical related cost • Potential for road to flood on islands in extreme release from upstream dams or other high flood conditions • Little chance of road closure isolating the community	5
Environmental Impact - New disturbances	• Lowest impact, shortest length of newly build road, least amount of vegetation clearing and no new stream crossings • Does not cross the river or side channels, the potential impacts to aquatics are limited	5	• Impacts from geotechnical works are assumed to be largely within the disturbed area (i.e. landslide) • Does not cross the river or side channels, the potential impacts to aquatics are limited • Any degree of drainage works and grading/earthworks for geotechnical stabilization works creates an impact	4	• Two river crossings • Construction within the flood zone • Require permitting under Water Act (FLNRORD) and Fisheries Act (DFO) • Providing access to previously undisturbed and inaccessible areas potential for secondary impacts – invasive plant species, impacts from people accessing the area for recreational purposes (creating trails, beach areas, campfires etc.	1	• Three river crossings • Construction within the flood zone • Require permitting under Water Act (FLNRORD) and Fisheries Act (DFO) • Providing access to previously undisturbed and inaccessible areas potential for secondary impacts – invasive plant species, impacts from people accessing the area for recreational purposes (creating trails, beach areas, campfires etc.	1	• Three river crossings • Construction within the flood zone • Require permitting under Water Act (FLNRORD) & Fisheries Act (DFO) • Providing access to previously undisturbed and inaccessible areas potential for secondary impacts – invasive plant species, impacts from people accessing the area for recreational purposes (creating trails, beach areas, campfires etc.	1
Ongoing Geotechnical Rehab and Economic Impact - Impact to property values due to slide - Temporary accommodations - Cost to government to assist community	**Ongoing Geotechnical Rehab Cost** • $30.0 M – Over 25 Years (assuming $1.2 M/year based on 2018 slide data with 50% contingency) **Economic Impact** • $ 33.8 M – Over 25 Years (assuming $1.4 M/year based on 2018 slide data with 50% contingency)	1	**Ongoing Geotechnical Rehab Cost** • ~$5 M (assuming $1 M/5 years over 25 years) **Economic Impact** • ~$5 M (assuming $1 M/5 years over 25 years)	2	• Relatively minor ongoing geotechnical rehabilitation cost • No economic impact	4	• Relatively minor ongoing geotechnical rehabilitation cost • No economic impact	4	• Relatively minor ongoing geotechnical rehabilitation cost • No economic impact	4

Criteria	Option F (Base Case: Maintain Existing Road Access Without Stabilization)		Option F1 (Variant of Option F, Including Stabilization Works to Reduce the Likelihood of Future Landslide Movements Affecting Road Trafficability)		Option C1 (Variant of Option C, Crossing Only One Island in Peace River)		Option C2 (Variant of Options C and C1)		Option C (Crossing of Two Islands in Peace River)	
Property Impact/Acquisition	• Minor impact • $0.1 M	5 ●	• Minor impact • $0.1 M	5 ●	• Property take required at west and east tie-in • $1.6 M	3 ●	• Property take required at west and east tie-in • $2.0 M	2 ●	• Property take required at east tie-in • West access starts on private (BC Hydro) road; permission may be needed • $1.4 M	3 ●
Total Cost - Construction - Planning - Eng, PM, Res. Eng. - Environmental & Archaeological and First Nations - Ongoing Geotechnical Rehab and Economic Impact	• No new construction cost • Ongoing geotechnical rehab cost over 25 years ($30.0 M) • Ongoing economic impact cost over 25 years ($33.8 M)	5 ●	• $200 M (total capital cost – heavy geotechnical mitigation including ongoing geotechnical rehab cost over 25 years ($5.0M) • Ongoing economic impact cost over 25 years ($5.0 M)	2 ●	• $187 M (total capital cost)	3 ●	• $237 M (total capital cost)	1 ●	• $243 M (total capital cost)	1 ●
Scoring Summary		**26**		**23**		**22**		**19**		**20**

Legend

● **Favourable (5 points)** ● **Little or no impact (4 points)** ● **Neutral (3 points)** ● **Some impact (2 points)** ● **Most Impact / Unfavourable (1 point)**

9. Summary

The purpose of this report is to review previously developed alignment options, develop several new alignments to bypass/mitigate the landslide complex, and conduct a high-level screening exercise to shortlist suitable options for the currently impacted Old Fort Road section in the community of Old Fort, BC. Outstanding existing geotechnical hazards in other slide areas were not assessed as they are not part of the scope of this study.

Option F (base case) is the lowest cost option and has the lowest environmental impact when compared to the other four design-related options (options F1, C1, C2, and C) and this option received the highest MCE score of 26. This option does not require any new construction, but future ongoing rehabilitation will likely be required for this option due to its unknown access reliability associated with ongoing slide risks. Further geotechnical assessment is required to improve the understanding of the geohazards and associated risks. Such assessment will also allow for identification of potential options to provide minor drainage and regrading improvement

Option F1 builds on the existing alignment but requires extensive geotechnical mitigations which will likely not eliminate the risk of future slides. It costs $200 M and received a score of 23 points, three points less than Option F.

The bridge options (options C1, C2, and C) provide a new access away from the existing slide zone and improve reliability for this community. However, these bridge options are costly, ranging from $187 M to $243 M. In addition, the significant infrastructure required for option C1, C2, and C would create environmental impacts and pose a challenge for environmental permitting and geotechnical mitigation. All three bridge options scored similarly between 19 and 22 points. Option C1, crossing one island, has a slightly higher score of 22 as it is the least expensive bridge option ($187 M). In summary, these bridge options scored low due to potential environmental impacts and high capital costs.

Geotechnical measures required for any of the access options taken forward would be dependent on the findings of extensive ground investigation, costs for which have not been included. The actual design and geotechnical costs may vary substantially from what has been assumed.

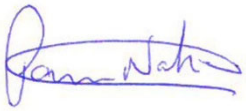
10. Closing

The information within this memo is true and accurate to the best of our knowledge, as described in our Statement of Limitations in *Appendix D*. If you have any questions regarding this report, please contact the undersigned.

Yours Truly,

McELHANNEY LTD.

Prepared by:



Parm Nahal, P.Eng.
Senior Traffic Engineer
Traffic & Road Safety Division
pnahal@mcelhanney.com
604-424-4881

Reviewed by:

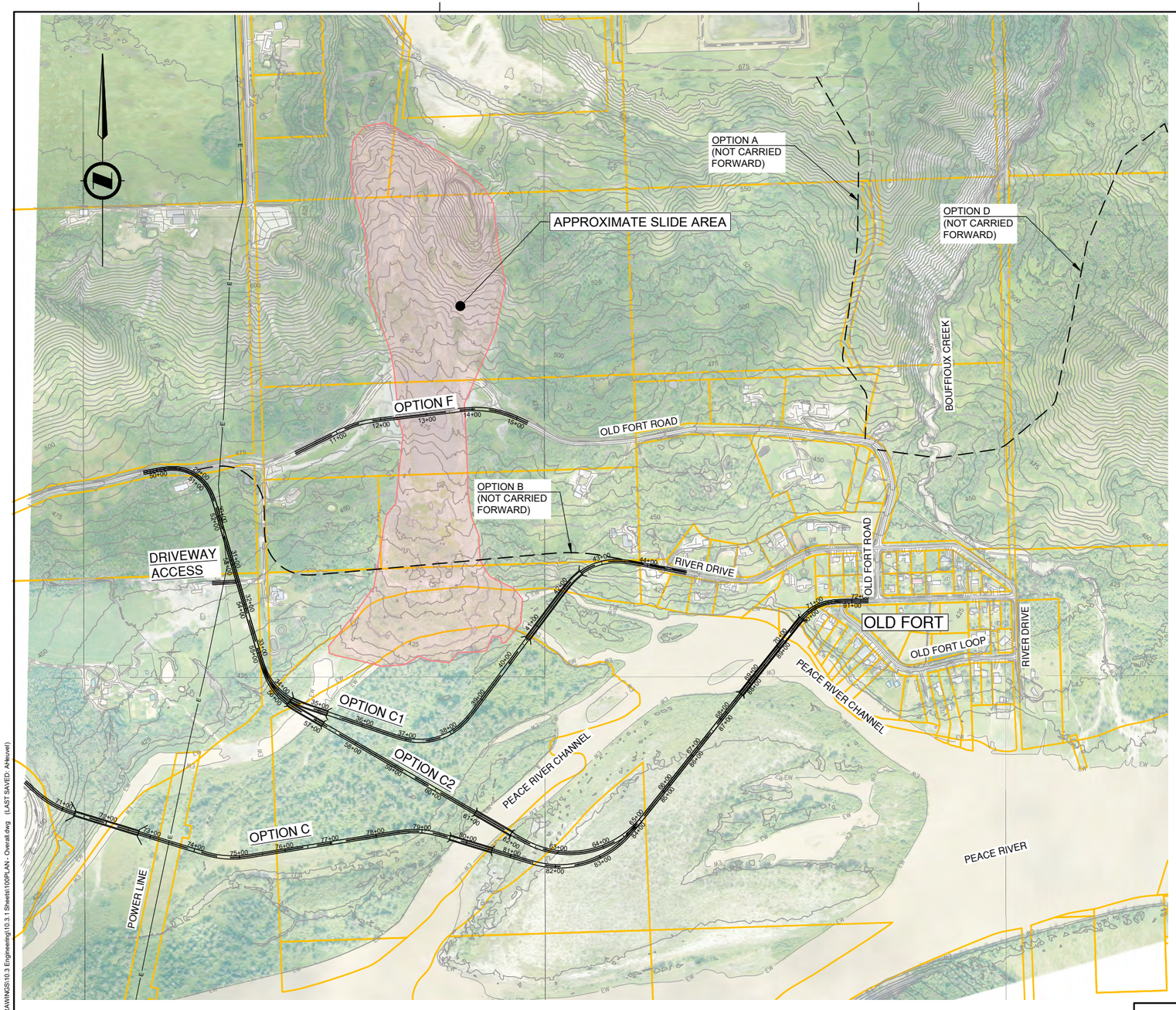
Denny Leung, P.Eng.
Division Manager
Traffic & Road Safety Division
dleung@mcelhanney.com
604-424-4860

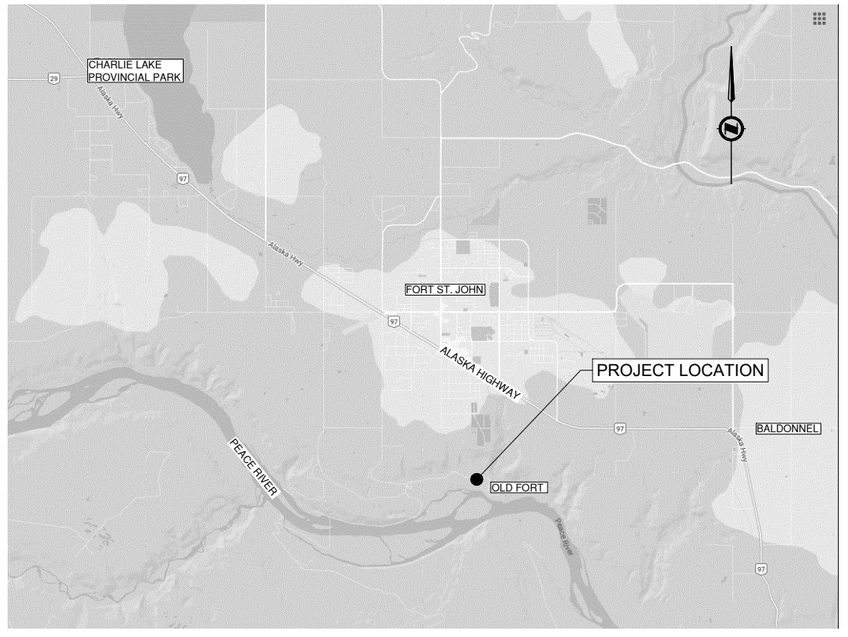
2021-12-03

PERMIT TO PRACTICE
McElhanney Ltd.
PERMIT NUMBER: 1003299
Engineers and Geoscientists of BC

APPENDIX A

Design Options





LOCATION MAP
N.T.S.

DESIGN SPEED 60 km/h

HALFSIZE

FOR DISCUSSION ONLY

McElhanney
Suite 2300
13450 - 102 Avenue
Surrey BC
Canada V3T 5X3
Tel 604 596 0391

SCALE 0 20 1:2000 100m

CAD FILENAME 100PLAN - OVERALL

PLOT DATE 2020-10-13

REV	DATE	REVISIONS	NAME
A	2020-09-02	PLANNING DESIGN STAGE - ISSUED FOR REVIEW	
B	2020-10-13	REVISED OPTIONS C, C1 AND C2 - ISSUED FOR REVIEW	

BRITISH COLUMBIA

MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE
NORTHERN REGION
HIGHWAY ENGINEERING AND GEOMATICS

ALIGNMENT OPTIONS

OLD FORT ROAD REALIGNMENT
OPTION B, C, C1, F ALIGNMENTS

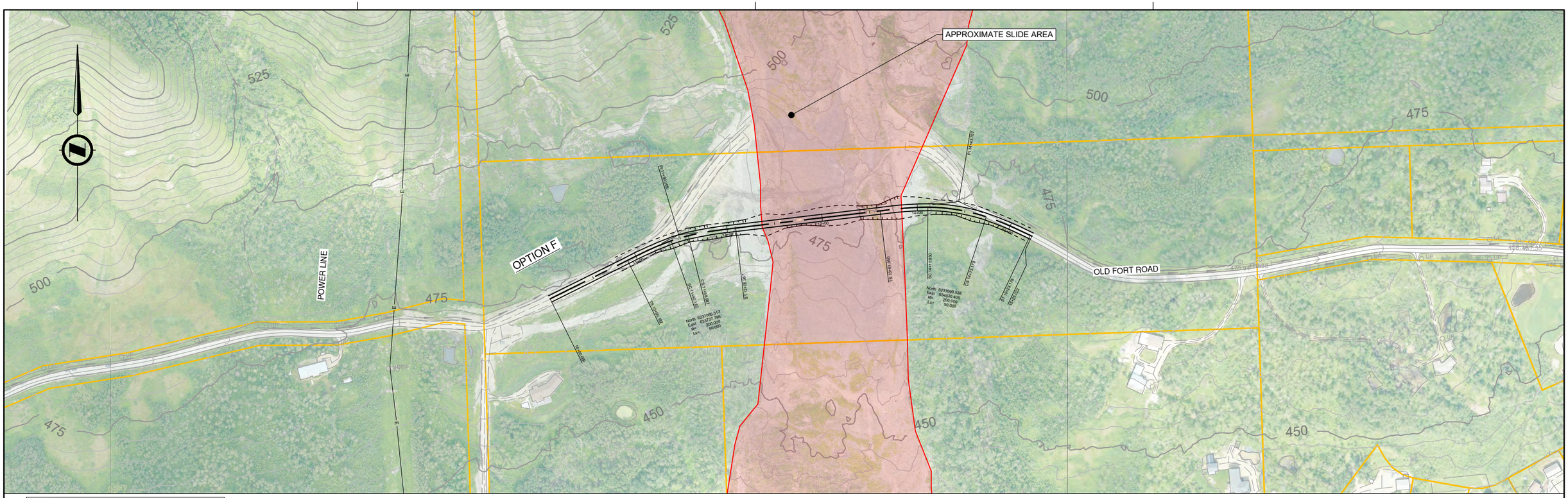
SENIOR DESIGNER -

DATE -

DESIGNED G.S. DATE 2020.10.13
QUALITY CONTROL P.N. DATE 2020.10.13
QUALITY ASSURANCE D.L. DATE 2020.10.13
DRAWN M.B. DATE 2020.10.13

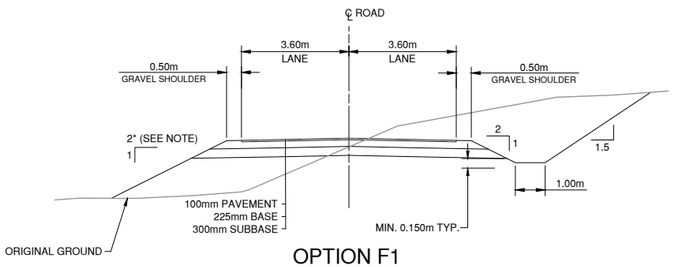
FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
2111-00412-07	NNNN	1	R1-NNN-101	B

PRINTED: October 13, 2020 - 5:25 PM
CAD FILE: X:\2111\2011\1004\12-07 Mdl\1 - Old Fort Rd Realignment\10.0 DRAWINGS\10.3 Engineering\10.3.1 Sheets\100PLAN - Overall.dwg (LAST SAVED: AHeuvel)

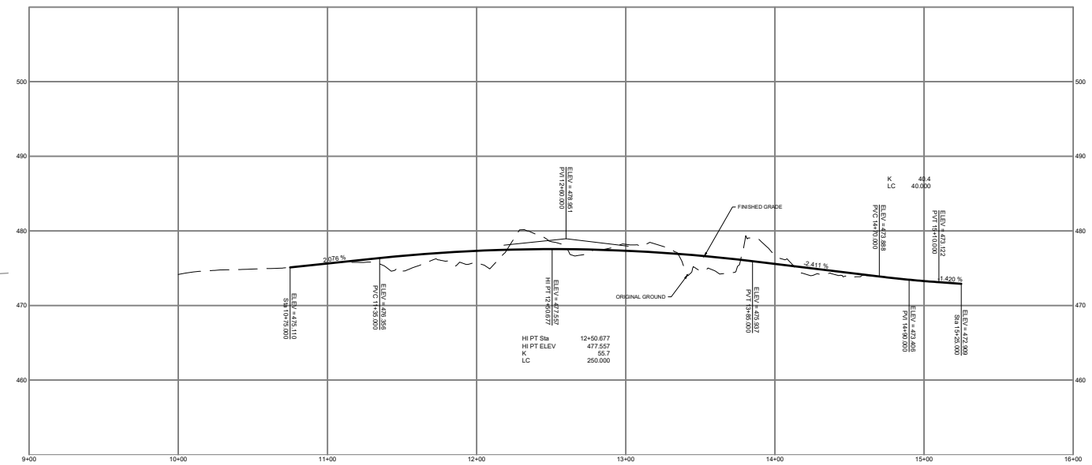


NOTES.

- FLAT GRADES
- LOW ENVIRONMENTAL IMPACT
- FUTURE SLIDE RISK AND ONGOING MAINTENANCE
- ADDITIONAL GEOTECHNICAL WORK REQUIRED TO STABILIZE THE SLIDE AREA
- NO BRIDGE REQUIRED
- NO PROPERTY IMPACTS
- LOW INITIAL INVESTMENT



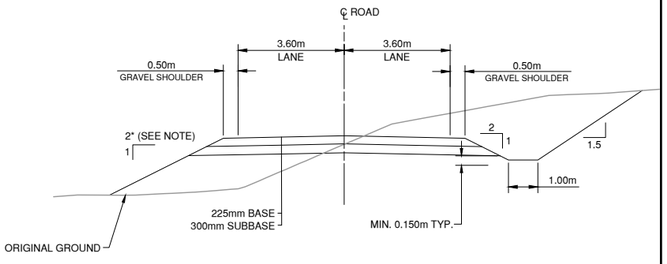
OPTION F1
TYPICAL ROAD SECTION - PAVED
SCALE 1:100



OPTION F

LEGEND

- FILL
- CUT



TYPICAL ROAD SECTION - GRAVEL
SCALE 1:100

DESIGN SPEED 60 km/h

NOTE:
1.5:1 SLOPE (WITH CRB) TO BE USED FOR FILLS > 5.0m IN HEIGHT

HALFSIZE

FOR DISCUSSION ONLY

McElhanney
Suite 2300
13450 - 102 Avenue
Surrey BC
Canada V3T 5X3
Tel 604 596 0391

BRITISH COLUMBIA
MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE
NORTHERN REGION
HIGHWAY ENGINEERING AND GEOMATICS

SCALE 0 20 H 1:2000 100m
0 2 V 1:400 10m

CAD FILENAME 100PLAN - OPT F
PLOT DATE 2020-10-19

REV	DATE	REVISIONS	NAME
A	2020-09-02	PLANNING DESIGN STAGE - ISSUED FOR REVIEW	

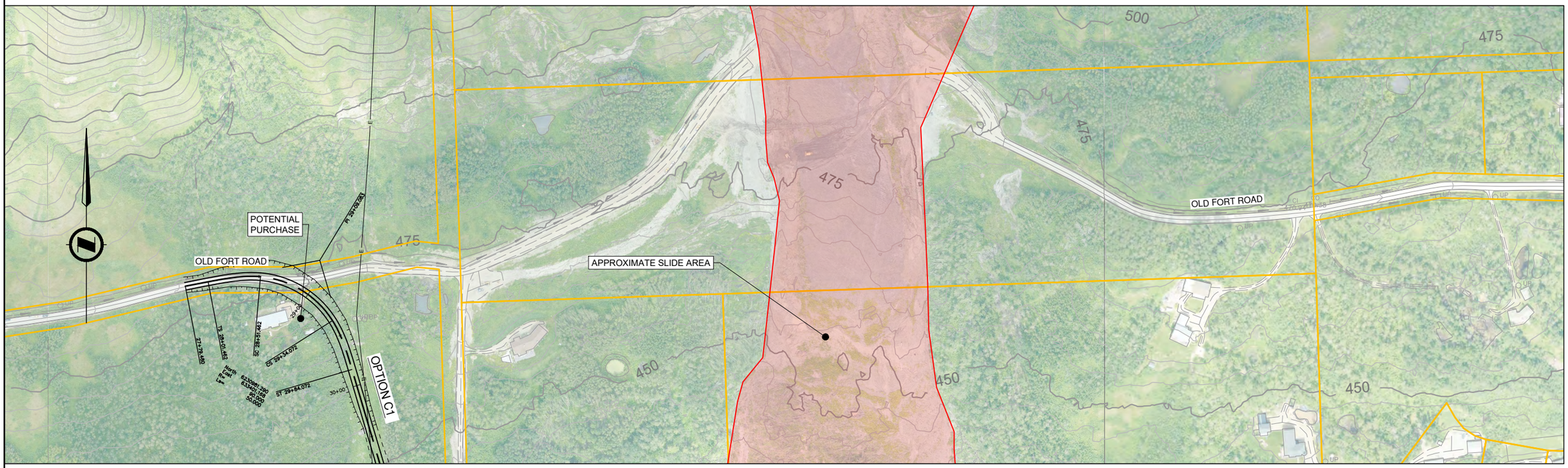
PLAN & PROFILE
OLD FORT ROAD REALIGNMENT
OPTION F ALIGNMENT
STA. 10+00.000 TO STA. 15+25.022

- SENIOR DESIGNER
DATE -

DESIGNED G.S. DATE 2020.09.02
QUALITY CONTROL P.N. DATE 2020.09.02
QUALITY ASSURANCE D.L. DATE 2020.09.02
DRAWN M.B. DATE 2020.09.02

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
2111-00412-07	NNNN	1	R1-NNN-108	A

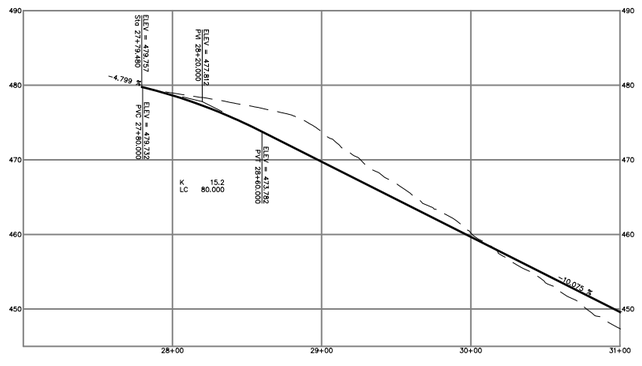
PRINTED: October 19, 2020 - 2:28 PM
CAD FILE: X:\2111\211-00412-07 Mot1 - Old Fort Rd Realignment\10.0 DRAWINGS\10.3 Engineering\10.3.1 Sheets\100PLAN - OPT F.dwg (LAST SAVED: GStewart)



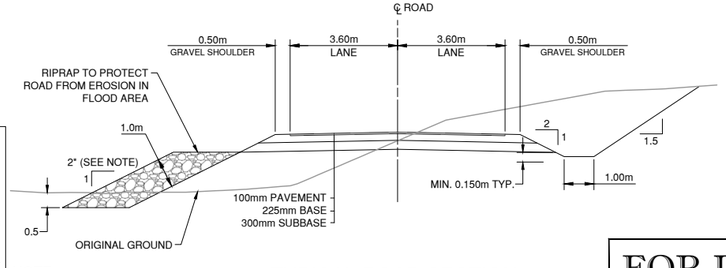
LEGEND

FILL

CUT



OPTION C1



NOTE:
1.5:1 SLOPE (with CRB) TO BE USED FOR FILLS > 5.0m IN HEIGHT

TYPICAL ROAD SECTION
SCALE 1:100

DESIGN SPEED 60 km/h

HALFSIZE

FOR DISCUSSION ONLY

McElhanney
Suite 2300
13450 - 102 Avenue
Surrey BC
Canada V3T 5X3
Tel 604 596 0391

BRITISH COLUMBIA
MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE
NORTHERN REGION
HIGHWAY ENGINEERING AND GEOMATICS

SCALE 0 20 H 1:2000 100m
0 2 V 1:400 10m

CAD FILENAME 100PLAN - OPT C1
PLOT DATE 2020-10-19

REV	DATE	REVISIONS	NAME
A	2020-09-02	PLANNING DESIGN STAGE - ISSUED FOR REVIEW	
B	2020-10-13	REVISED PROFILE GRADE - ISSUED FOR REVIEW	

PLAN & PROFILE

OLD FORT ROAD REALIGNMENT
OPTION C1 ALIGNMENT
STA. 28+13.214 TO STA. 31+00.000

SENIOR DESIGNER -
DATE -

DESIGNED G.S. DATE 2020.10.13
QUALITY CONTROL P.N. DATE 2020.10.13
QUALITY ASSURANCE D.L. DATE 2020.10.13
DRAWN M.B. DATE 2020.10.13

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
2111-00412-07	NNNN	1	R1-NNN-104	B

PRINTED: October 19, 2020 - 2:33 PM
CAD FILE: X:\2111\211-00412-07 Mbf1 - Old Fort Rd Realignment\10.0 DRAWINGS\10.3 Engineering\10.3.1 Sheets\100PLAN - OPT C1.dwg (LAST SAVED: GStewart)

MATCHLINE - SEE 104

APPROXIMATE SLIDE AREA

RIVER DRIVE

FULL PROPERTY TAKE

SIDE CHANNEL OF PEACE RIVER

SIDE CHANNEL OF PEACE RIVER

PEACE RIVER

BRIDGE

POWER LINE

OPTION C1

SIDE CHANNEL OF PEACE RIVER

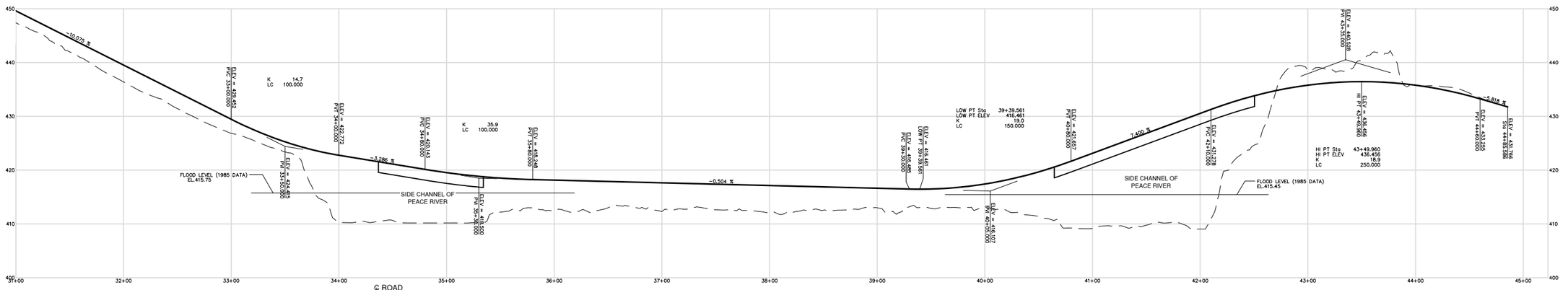
NOTES.

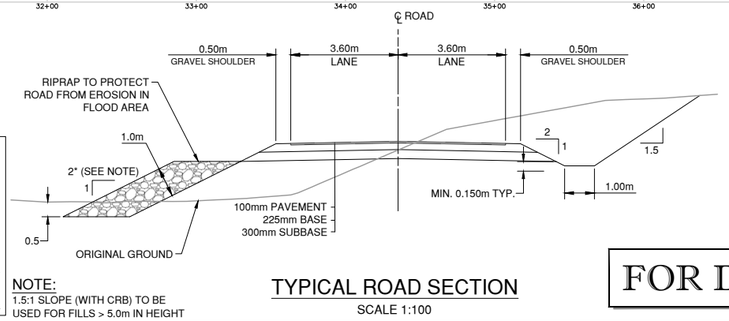
- STEEP GRADE (10% OVER 500m)
- 2 BRIDGES REQUIRED
- MEDIUM COST
- HIGH ENVIRONMENTAL IMPACT
- MEDIUM LENGTH ROUTE
- MINOR PROPERTY IMPACTS
- APROACHES THE TOE OF THE EARTHFLOW DEBRIS AND ACROSS LANDSLIDE TERRAIN BEFORE CONNECTING TO W END OF RIVER DRIVE

LEGEND

FILL

CUT





NOTE:
1.5:1 SLOPE (WITH CRB) TO BE USED FOR FILLS > 5.0m IN HEIGHT

TYPICAL ROAD SECTION
SCALE 1:100

OPTION C1

DESIGN SPEED 60 km/h

HALFSIZE

FOR DISCUSSION ONLY

McElhanney
Suite 2300
13450 - 102 Avenue
Surrey BC
Canada V3T 5X3
Tel 604 596 0391

BRITISH COLUMBIA
MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE
NORTHERN REGION
HIGHWAY ENGINEERING AND GEOMATICS

SCALE 0 20 H 1:2000 100m
0 2 V 1:400 10m

CAD FILENAME 100PLAN - OPT C1
PLOT DATE 2020-10-19

REV	DATE	REVISIONS	NAME
A	2020-09-02	PLANNING DESIGN STAGE - ISSUED FOR REVIEW	
B	2020-10-13	REVISED PROFILE GRADE - ISSUED FOR REVIEW	

PLAN & PROFILE

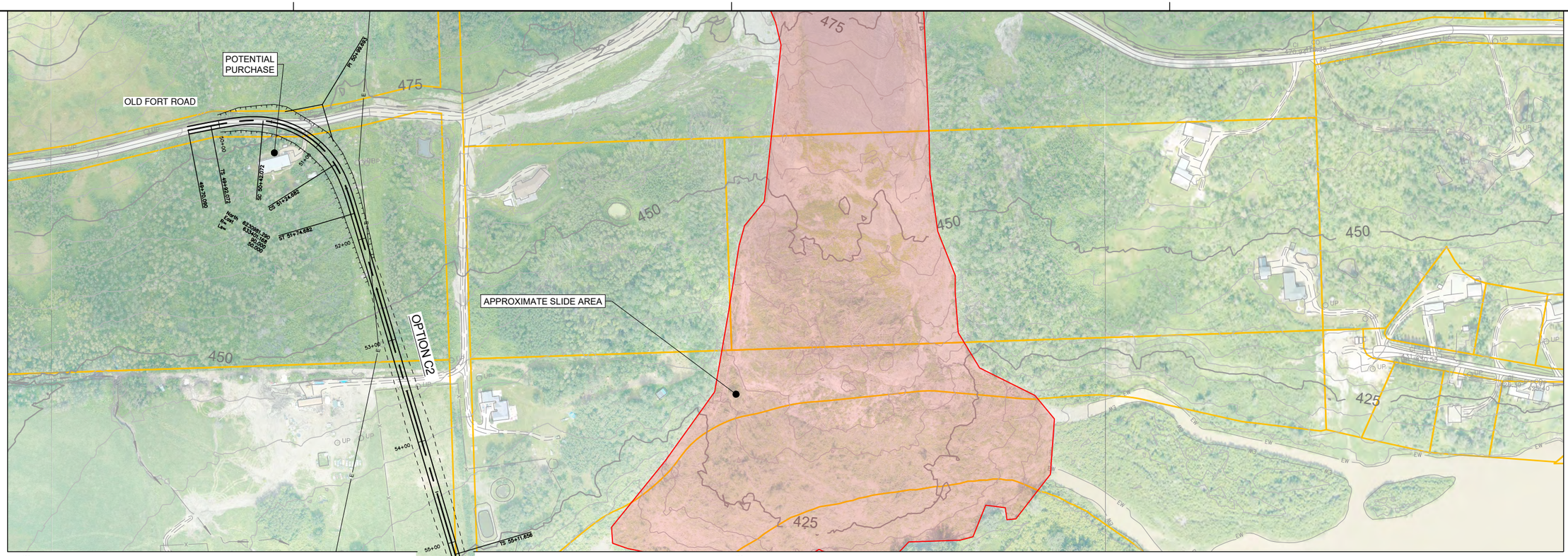
OLD FORT ROAD REALIGNMENT
OPTION C1 ALIGNMENT
STA. 31+00.000 TO STA. 44+85.586

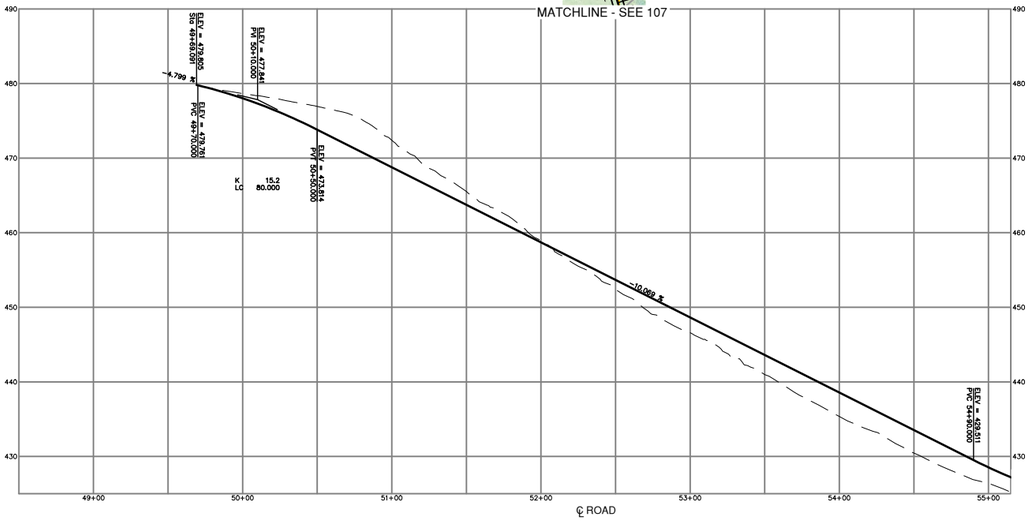
- SENIOR DESIGNER
DATE -

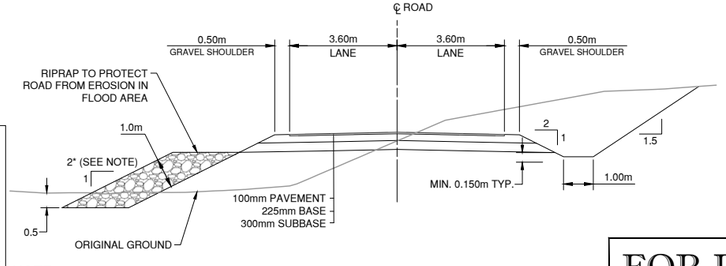
DESIGNED G.S. DATE 2020.10.13
QUALITY CONTROL P.N. DATE 2020.10.13
QUALITY ASSURANCE D.L. DATE 2020.10.13
DRAWN M.B. DATE 2020.10.13

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
2111-00412-07	NNNN	1	R1-NNN-105	B

PRINTED: October 19, 2020 - 2:03 PM
CAD FILE: X:\2111\211104\12-07 Mdl\1 - Old Fort Rd Realignment\10.0 DRAWINGS\10.3 Engineering\10.3.1 Sheets\100PLAN - OPT C1.dwg (LAST SAVED: GStewart)







TYPICAL ROAD SECTION
SCALE 1:100

NOTE:
1.5:1 SLOPE (WITH CRB) TO BE USED FOR FILLS > 5.0m IN HEIGHT

OPTION C2

LEGEND
FILL
CUT

DESIGN SPEED 60 km/h

HALFSIZE

FOR DISCUSSION ONLY

McElhanney
Suite 2300
13450 - 102 Avenue
Surrey BC
Canada V3T 5X3
Tel 604 596 0391

BRITISH COLUMBIA
MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE
NORTHERN REGION
HIGHWAY ENGINEERING AND GEOMATICS

SCALE 0 20 H 1:2000 100m / 0 2 V 1:400 10m
CAD FILENAME 100PLAN - OPT C2
PLOT DATE 2020-10-19

REV	DATE	REVISIONS	NAME
A	2020-09-02	PLANNING DESIGN STAGE - ISSUED FOR REVIEW	
B	2020-10-13	REVISED PROFILE GRADE - ISSUED FOR REVIEW	

PLAN & PROFILE

OLD FORT ROAD REALIGNMENT
OPTION C2 ALIGNMENT
STA. 50+00.000 TO STA. 55+16.500

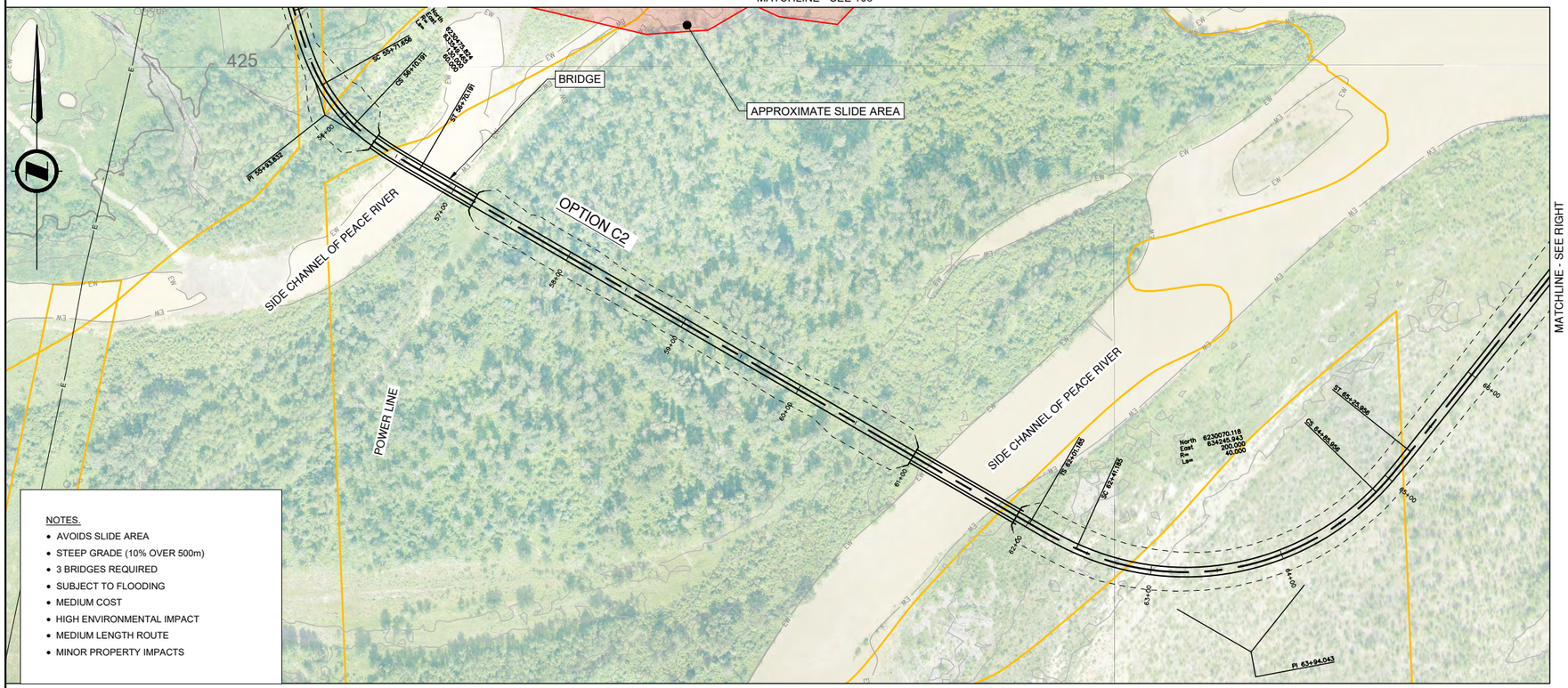
SENIOR DESIGNER -
DATE -

DESIGNED G.S. DATE 2020.10.13
QUALITY CONTROL P.N. DATE 2020.10.13
QUALITY ASSURANCE D.L. DATE 2020.10.13
DRAWN M.B. DATE 2020.10.13

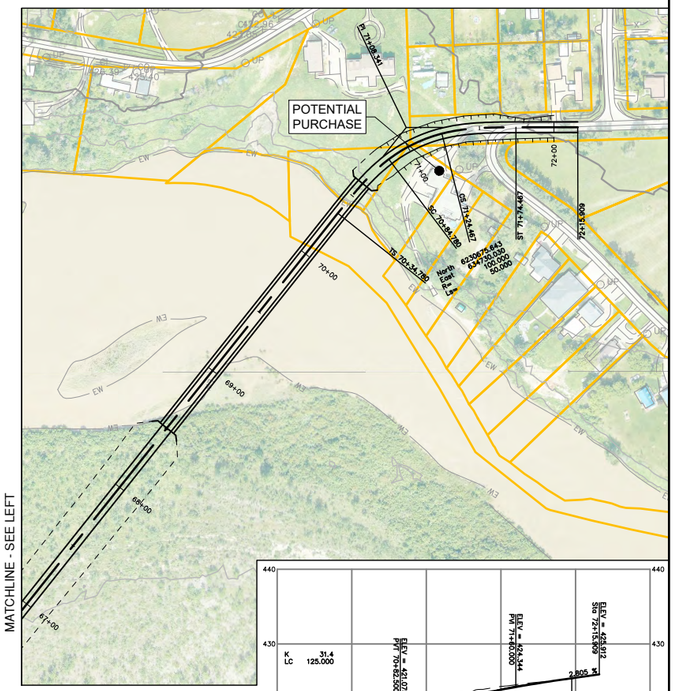
FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
2111-00412-07	NNNN	1	R1-NNN-106	B

PRINTED: October 19, 2020 - 1:42 PM
CAD FILE: X:\2111\211\00412-07 Mott - Old Fort Rd Realignment\10.0 DRAWINGS\10.3 Engineering\10.3.1 Sheets\100PLAN - OPT C2.dwg (LAST SAVED: GStewart)

MATCHLINE - SEE 106



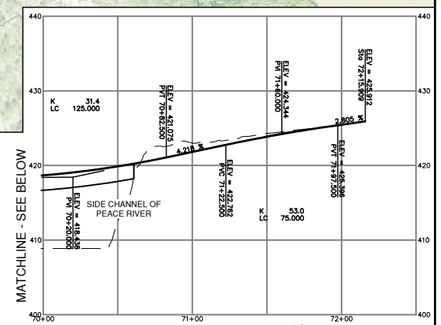
NOTES.
- AVOIDS SLIDE AREA
- STEEP GRADE (10% OVER 500m)
- 3 BRIDGES REQUIRED
- SUBJECT TO FLOODING
- MEDIUM COST
- HIGH ENVIRONMENTAL IMPACT
- MEDIUM LENGTH ROUTE
- MINOR PROPERTY IMPACTS

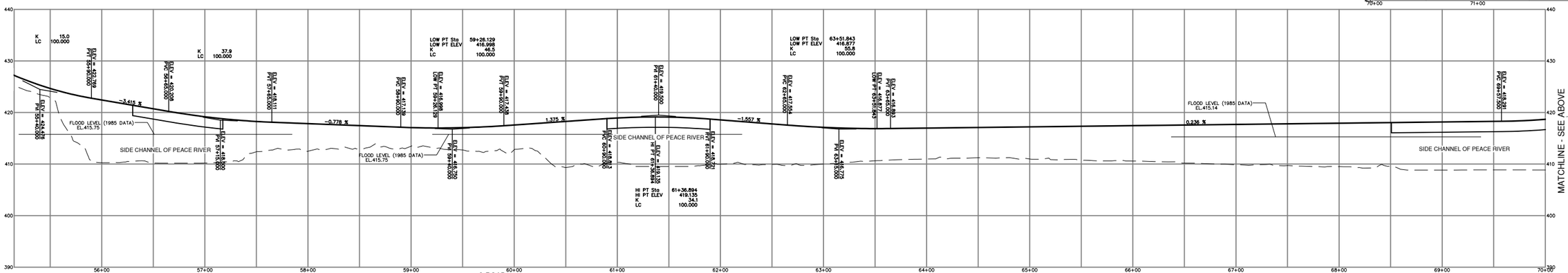


LEGEND

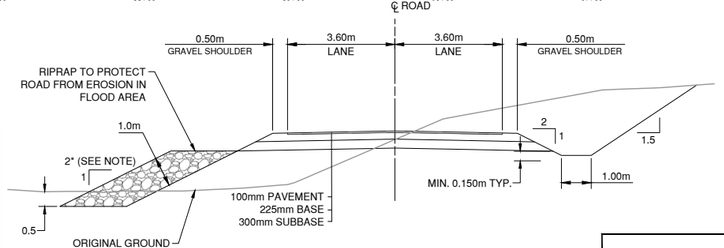
FILL

CUT





OPTION C2



NOTE:
1.5:1 SLOPE (with CRB) TO BE USED FOR FILLS > 5.0m IN HEIGHT

TYPICAL ROAD SECTION
SCALE 1:100

DESIGN SPEED 60 km/h

HALFSIZE

FOR DISCUSSION ONLY

McElhanney
Suite 2300
13450 - 102 Avenue
Surrey BC
Canada V3T 5X3
Tel 604 596 0391

BRITISH COLUMBIA
MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE
NORTHERN REGION
HIGHWAY ENGINEERING AND GEOMATICS

SCALE 0 20 H 1:2000 100m
0 2 V 1:400 10m

CAD FILENAME 100PLAN - OPT C2
PLOT DATE 2020-10-19

REV	DATE	REVISIONS	NAME
A	2020-09-02	PLANNING DESIGN STAGE - ISSUED FOR REVIEW	
B	2020-10-13	REVISED PROFILE GRADE - ISSUED FOR REVIEW	

PLAN & PROFILE

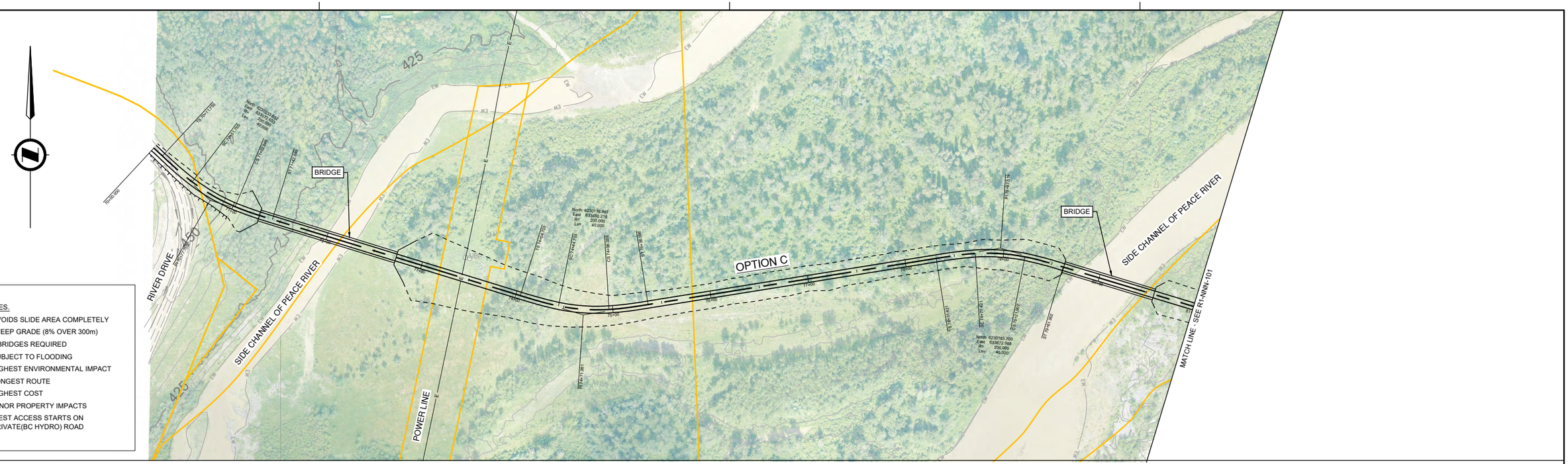
OLD FORT ROAD REALIGNMENT
OPTION C2 ALIGNMENT
STA. 55+16.500 TO STA. 72+15.909

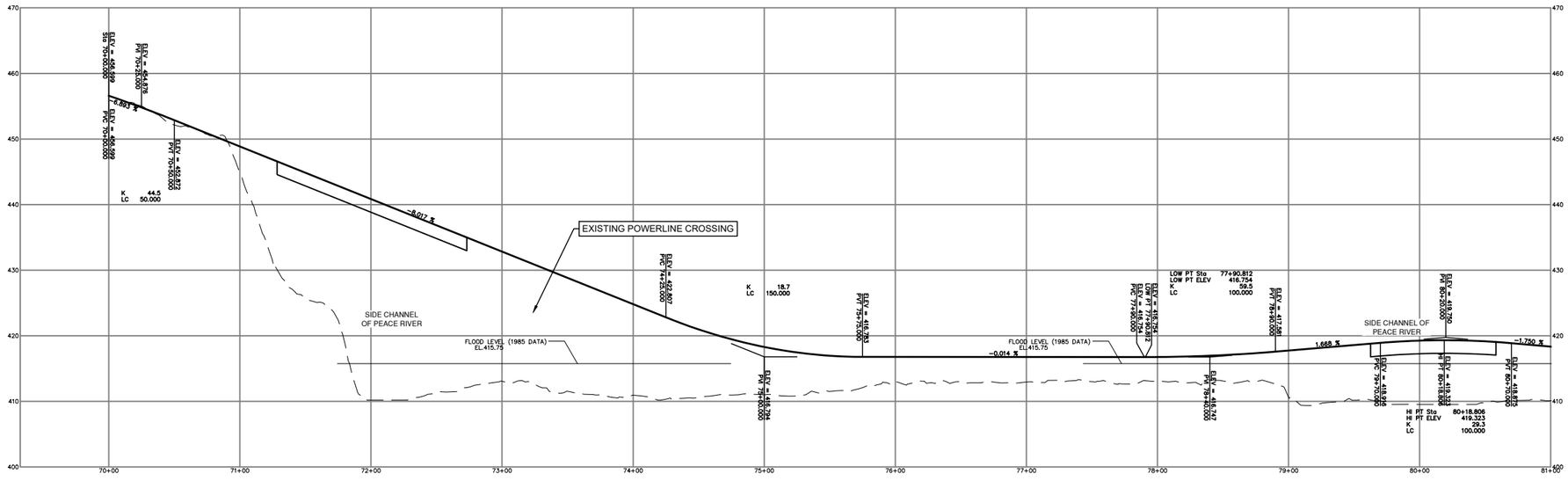
SENIOR DESIGNER -
DATE -

DESIGNED G.S. DATE 2020.10.13
QUALITY CONTROL P.N. DATE 2020.10.13
QUALITY ASSURANCE D.L. DATE 2020.10.13
DRAWN M.B. DATE 2020.10.13

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
2111-00412-07	NNNN	1	R1-NNN-107	B

PRINTED: October 19, 2020 - 1:46 PM
CAD FILE: X:\2111\2111-00412-07 Mott - Old Fort Rd Realignment\10.0 DRAWINGS\10.3 Engineering\10.3.1 Sheets\100PLAN - OPT C2.dwg (LAST SAVED: GStewart)



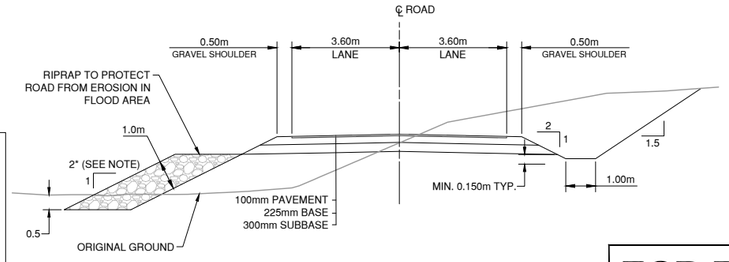


LEGEND

FILL

CUT

OPTION C



TYPICAL ROAD SECTION

SCALE 1:100

NOTE:
1.5:1 SLOPE (WITH CRB) TO BE USED FOR FILLS > 5.0m IN HEIGHT

DESIGN SPEED 60 km/h

HALFSIZE

FOR DISCUSSION ONLY

McElhanney
Suite 2300
13450 - 102 Avenue
Surrey BC
Canada V3T 5X3
Tel 604 596 0391

BRITISH COLUMBIA

MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE
NORTHERN REGION
HIGHWAY ENGINEERING AND GEOMATICS

SCALE 0 20 H 1:2000 100m
0 2 V 1:400 10m

CAD FILENAME 100PLAN - OPT C

PLOT DATE 10/19/2020

REV	DATE	REVISIONS	NAME
A	2020-09-02	PLANNING DESIGN STAGE - ISSUED FOR REVIEW	
B	2020-10-13	REVISED PROFILE GRADE - ISSUED FOR REVIEW	

PLAN & PROFILE

OLD FORT ROAD REALIGNMENT
OPTION C ALIGNMENT
STA. 70+00.000 TO STA. 81+000

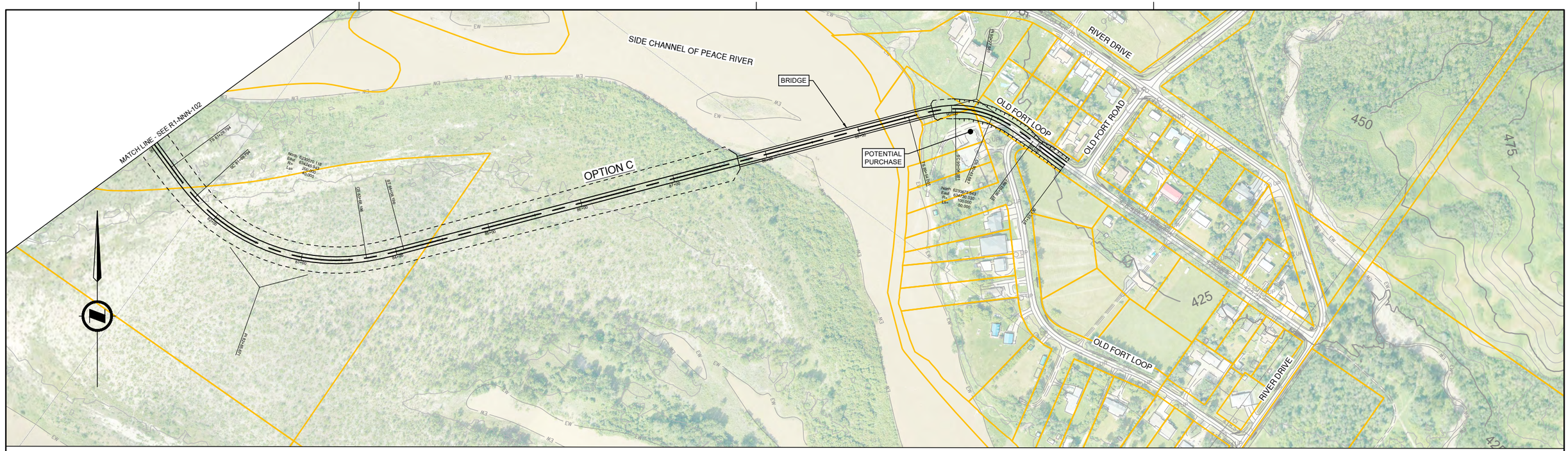
- SENIOR DESIGNER

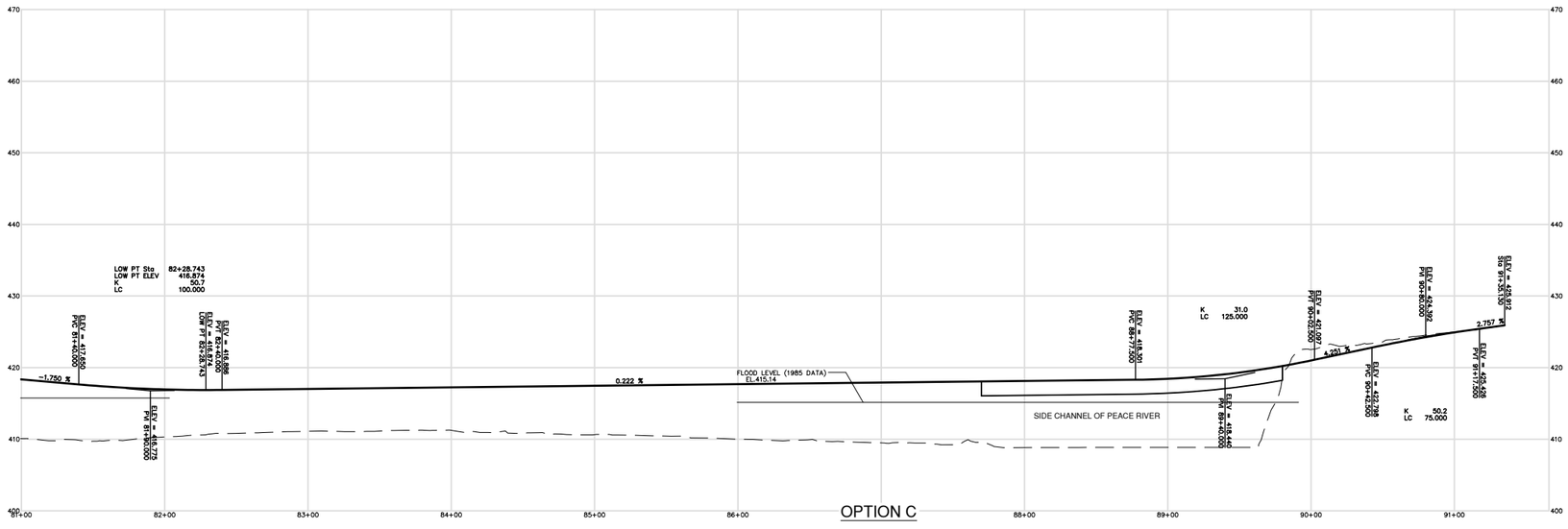
DATE -

DESIGNED G.S. DATE 2020.10.13
QUALITY CONTROL P.N. DATE 2020.10.13
QUALITY ASSURANCE D.L. DATE 2020.10.13
DRAWN M.B. DATE 2020.10.13

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
2111-00412-07	NNNN	1	R1-NNN-102	B

PRINTED: October 19, 2020 - 12:24 PM
CAD FILE: X:\2111\211-00412-07 Mdl\1 - Old Fort Rd Realignment\10.0 DRAWINGS\10.3 Engineering\10.3.1 Sheets\100PLAN - OPT C.dwg (LAST SAVED: GShewat)





OPTION C

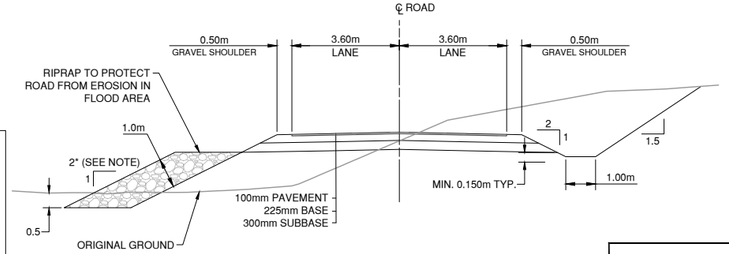
LEGEND

FILL

CUT

NOTES.

- AVOIDS SLIDE AREA COMPLETELY
- STEEP GRADE (8% OVER 300m)
- 3 BRIDGES REQUIRED
- SUBJECT TO FLOODING
- HIGHEST ENVIRONMENTAL IMPACT
- LONGEST ROUTE
- HIGHEST COST
- MINOR PROPERTY IMPACTS
- WEST ACCESS STARTS ON PRIVATE(BC HYDRO) ROAD



NOTE:
1.5:1 SLOPE (WITH CRB) TO BE USED FOR FILLS > 5.0m IN HEIGHT

TYPICAL ROAD SECTION
SCALE 1:100

DESIGN SPEED 60 km/h

HALFSIZE

FOR DISCUSSION ONLY

McElhanney
Suite 2300
13450 - 102 Avenue
Surrey BC
Canada V3T 5X3
Tel 604 596 0391

BRITISH COLUMBIA
MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE
NORTHERN REGION
HIGHWAY ENGINEERING AND GEOMATICS

SCALE 0 20 H 1:2000 100m
0 2 V 1:400 10m

CAD FILENAME 100PLAN - OPT C
PLOT DATE 2020-10-19

REV	DATE	REVISIONS	NAME
A	2020-09-02	PLANNING DESIGN STAGE - ISSUED FOR REVIEW	
B	2020-10-13	REVISED PROFILE GRADE - ISSUED FOR REVIEW	

PLAN & PROFILE

OLD FORT ROAD
OPTION C ALIGNMENT
STA. 81+00.000 TO STA. 91+35.130

SENIOR DESIGNER
DATE

DESIGNED G.S. DATE 2020.10.13
QUALITY CONTROL P.N. DATE 2020.10.13
QUALITY ASSURANCE D.L. DATE 2020.10.13
DRAWN M.B. DATE 2020.10.13

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
2111-00412-07	NNNN	1	R1-NNN-103	B

PRINTED: October 19, 2020 - 12:26 PM
CAD FILE: X:\2111\211-00412-07 Mot1 - Old Fort Rd Realignment\10.0 DRAWINGS\10.3 Engineering\10.3.1 Sheets\100PLAN - OPT C.dwg (LAST SAVED: GStewart)

APPENDIX B

Old Fort Road – Geotechnical Evaluation of Potential Alignment Options – Updated FINAL (BGC, May 5, 2021)

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY
Suite 500 - 980 Howe Street
Vancouver, BC Canada V6Z 0C8
Telephone (604) 684-5900
Fax (604) 684-5909

May 05, 2021
Project No.: 0272061

Brent Case, P.Eng.
Manager Geotech Design & Foundations
BC Ministry of Transportation and Infrastructure
Suite 213, 1011 4th Avenue
Prince George, BC V2L 3H9

Dear Mr. Case,

Re: Old Fort Road – Geotechnical Evaluation of Potential Alignment Options – Updated FINAL

On June 18, 2020, the BC Ministry of Transportation and Infrastructure (MoTI) reported re-activation of the Old Fort landslide along the Old Fort Road near Fort St John, BC. The landslide movements destroyed Old Fort Road, the sole road access to the community of Old Fort.

Once the landslide had slowed sufficiently, MoTI restored access crossing the landslide at approximately the same location as the Old Fort Road was located prior to the landslide.

MoTI are currently in the process of exploring and evaluating options to provide longer-term road access to the community of Old Fort. MoTI subsequently retained BGC Engineering Inc. (BGC) to provide geotechnical review and comment on proposed road alignment options, with McElhanney Ltd. (McElhanney) retained as geometric designer to develop and cost potential alignment options and Stantec Inc. (Stantec) retained to provide overall project management.

The scope of the assignment is to evaluate several potential road alignment options into the community of Old Fort from a cost and geotechnical complexity perspective. The intent is to identify a small number of viable options for which costs will be estimated to a Class C level (+/- 35%) to facilitate comparison of each option. It is understood that options will be presented to the Assistant Deputy Minister of Transportation for a decision on the way forward.

This assignment is governed by the terms and conditions of the As & When Geotechnical Engineering and Laboratory Services contract No. 863-CS-1091 between BGC and MoTI dated May 24, 2019.

1.0 INTRODUCTION

MoTI initially developed five possible road alignment options to provide access to the community of Old Fort; in collaboration with Stantec and McElhanney these options were labeled Option A through Option D and Option F. An additional Option E was a placeholder to propose a

new option not previously considered and Option G was a property buy-out of the residences in Old Fort; Options E and G are not discussed further in this letter.

Route alignments considered are shown in Figure 1-1. Following discussions on August 11 and September 10 some options were eliminated from consideration. The road alignment options currently under consideration for potential feasibility were issued for review by McElhanney on October 13, 2020. Digital files for these alignment options were received from McElhanney on October 18, 2020 and are shown in Figure 1-2 and over lidar change detection imagery in Figure 1-3. Comment on all road alignment options considered is presented in Section 2.0, and estimated geotechnical construction costs for a subset of options are presented in Section 3.0.

2.0 GEOTECHNICAL EVALUATION

A high-level geotechnical evaluation of each of the options is provided in Table 2-1. The following options are no longer considered feasible for the purposes of this study, but have been included in Table 2-1 to provide a basis for their exclusion:

- Option A – ascent of ridge north of Old Fort toward City of Fort St. John sewage lagoons.
- Option B – east-west crossing of the Old Fort landslide via the west end of River Drive.
- Option D – ascent of east wall of Bouffioux Coulee across Bouffioux Creek.

The following options remain in consideration:

- Option C – crossing of two islands in Peace River.
- Option C1 – variant of Option C, crossing only one island.
- Option C2 – variant of Options C and C1.
- Option F – “Base Case” option, retaining existing road access across body of Old Fort landslide and including periodic rebuilding of the road in response to future landslide movement.
- Option F1 – variant of Option F, including stabilization works to reduce the likelihood of future landslide movements affecting road trafficability.

More detailed discussion on Options A, C1, and D is provided in Section 2.1, Section 2.2, and Section 2.3, respectively, and additional geotechnical considerations are outlined in Section 2.4.

Table 2-1. Geotechnical assessment of Old Fort Road alignment options.

Option	Description	Needed structures	Geohazard issues	Other Considerations	Cons	Pros	Estimated Additional Geotechnical Construction Cost	Summary
A	Follow ridge to north	None	Crosses dormant landslide landforms that may be easily encouraged to move by poor grading or drainage.	City has a right-of-way for their primary sewer outfall, which would need to be protected. It is a welded plastic pipe with several concrete manholes.	Very challenging design and construction. In order to reduce road grade several switchbacks across landslide landslide-affected terrain would be required (see Figure 2-1). Extensive geotechnical measures (e.g., ground anchors, pile walls, drainage etc.) would be required to stabilize the hillside. Potential to increase landslide risk that could affect the City of Fort St John sewage lagoons and waterline as well as increase landslide risk to Old Fort.	Shortest route between Old Fort and Fort St. John	Not estimated	Geotechnical uncertainty and risk. **(Not carried forward after August 11, 2020)**
B	East west access south of existing	None	Crosses main earth flow of the 2018 and 2020 landslide complex; crosses older dormant landslide complex to the east; approaches unstable slopes above Peace River.		Potentially reduced exposure to landslide compared to Option F, but not immune to future landslide movement; Greater depth of excavation through earthflow debris; Earth flow from the colluvial slopes in the older dormant landslide complex (to the east of the earthflow) has unknown potential to reactivate and destroy the road again.	Direct route to Old Fort	Not Estimated	No obvious advantages over Option F, with likely higher cost. A large landslide emerging from the older dormant landslide complex (to the east of the earthflow) would impact this option. **(Not carried forward after September 10, 2020)**
C	South across two islands in the Peace River	Three bridge crossings of Peace River channels.	Potential for road to flood on islands in extreme release from upstream dams or other high flood conditions. Potential for erosion of perimeters of islands which could threaten bridge abutments.	West access starts on private (BC Hydro) road; permission may be needed. Anticipate challenging environmental permitting. Islands may be considered “streams” under the BC Water Sustainability Act if they flood regularly.	Longest option – three bridges; Potential for flooding; Potential challenges with environmental permitting.	Lowest exposure to landslide hazards	Minimal additional geotechnical cost over and above the normal civil construction costs are anticipated for this option	The key geotechnical considerations will be the foundations for the three bridge crossings and the landslide-affected banks of the Peace River at the east and west ends of this option. Some geotechnical investigation of soil and rock conditions and suitable cut and fill angles will be required. Lowest landslide risk, would need to consider flooding risk.
C1	South across one island in the Peace River	Two bridge crossings of back channels of Peace River.	Continued movement of the earthflow could encroach and override road. Crosses landslide terrain at the east end before connecting to the west end of River Drive; Potential for road to flood on island in extreme release from upstream	Anticipate challenging environmental permitting as per Option C.	First river channel crossing may be more challenging than that for Option C given greater grade changes and local instability; Potential for flooding; Potential challenges with environmental permitting. Approaches toe of earthflow which could be a threat in future significant landslide reactivation; Crosses deep-seated landslides between east side of the earthflow debris and the	Shorter option compared with Option C	An additional $5 - $10 million is expected to be required for this option to overcome the geotechnical challenges of crossing the landslides (see Section 3.0). Additional works may include more extensive grading and stabilising measures such as earthen berms, anchors and retaining walls as well as drainage works.	Unknown risk approaching distal end of earthflow debris on island, and landslide terrain near River Drive. Would also need to consider flooding risk. A large landslide emerging from the older dormant landslide complex to the east could impact this option

Option	Description	Needed structures	Geohazard issues	Other Considerations	Cons	Pros	Estimated Additional Geotechnical Construction Cost	Summary
			dams or other high flood conditions. Potential for erosion of perimeters of islands which could threaten bridge abutments.		west end connection with River Drive, also challenging for construction (see Figure 2-2).			
C2	South across two islands in the Peace River	Three bridge crossings of Peace River channels	Potential for road to flood on islands in extreme release from upstream dams or other high flood conditions. Potential for erosion of perimeters of islands which could threaten bridge abutments.	Anticipate challenging environmental permitting as per Option C.	Long option – three bridges; First river channel crossing may be more challenging than that for Option C given greater grade changes and local instability; Potential for flooding; Potential challenges with environmental permitting.	Intermediate exposure to landslide hazards between Options C and C1.	Minimal additional geotechnical related cost over and above the normal civil construction costs are anticipated for this option.	This option offers a shorter route than that of Option C with otherwise similar pros and cons.
D	East across Bouffioux Creek	One crossing of Bouffioux Creek	Crosses Bouffioux Creek which is affected by flood, debris flood and debris flow. Crosses dormant and active landslide landforms.		Very challenging design and construction, across landslide terrain that would require extensive geotechnical measures to stabilize but ultimately still be at threat from undermining of the landslide by the erosive action at Bouffioux Creek (see Figure 2-3). There is also the potential to destabilize the walls of Bouffioux Coulee and increase landslide risk to Old Fort.	No obvious advantages over other options.	Not Estimated.	Geotechnical uncertainty and risk. **(Not carried forward after August 11, 2020)**
F	Maintain / improve existing access.	None	Crosses main 2018 and 2020 earth flow and west landslide complex; crosses older dormant landslide complex to the east.	Additional geotechnical assessment to improve the understanding of the geohazards and associated risks. Such assessment will also allow for identification of potential options to provide minor drainage and regrading improvement.	Crosses landslides on both the west and east sides of the earthflow; West slide, which was active in 2018 but not noticeable in 2020, has unknown potential to reactivate and destroy road; Earth flow from the colluvial slopes in the older dormant landslide complex to the east has unknown potential to reactivate and destroy the road again.	Narrowest Crossing of the earthflow; Relatively simple, construction.	Maintenance costs for maintaining access not estimated.	Prone to impacts from remobilization of earthflow; A large landslide emerging from the older dormant landslide complex to the east would impact this option.
F1	Option F1 includes stabilization efforts to reduce future earthflow movements.	To be determined.	See Option F.	Ongoing studies and efforts to stabilize Old Fort landslide complex could make this alignment option more attractive, if successful. A detailed subsurface investigation will be required within the slide area to determine the nature, extent and feasibility of stabilization options.	See Option F.	Narrowest Crossing of the earthflow.	The estimated additional cost of geotechnical works for this option is $40 million (see Section 3.0). Mitigation options will likely include extensive drainage works and grading works, and may include geotechnical structures such as anchored pile walls, retaining walls and/or ground anchors.	Mitigative efforts would likely aim to substantially reduce slide movements but will likely not completely arrest earthflow movement. Long-term maintenance costs will need to be considered.

2.1. Option A

Option A was initially considered as a potential alignment option for a replacement access to Old Fort, as it provided the shortest route between Old Fort and the City of Fort St. John. The route was indicated along the ridge line that runs west of Bouffioux Creek (Figure 2-1). However, such an option, if constructible along the ridgeline, would result in a very steep grade at over 15%. Therefore, to reduce grade the road would need to be switch-backed up the hill across unstable landslide terrain (Figure 2-1). Costly geotechnical design options that may include ground anchors, anchored pile walls and extensive drainage works would likely be required to mitigate the unstable ground conditions. The option could increase the geohazard risk to the community of Old Fort and would also encroach on the sewage lagoons on the plateau beyond the slope crest. Due to the geotechnical challenges compared with other options, this option was not considered beyond the preliminary review stages.

2.2. Option C1

Option C1 is the shortest of the three alignment options that cross onto islands in the Peace River. This option offers limited advantage over Option C, due to the additional cost of crossing steep landslide-affected riverbank slopes at the eastern end of the alignment. The proximity of this alignment to the toe of the earth flow potentially exposes this option to impact from future advances of the earth flow debris (Figure 2-2).

2.3. Option D

Option D was proposed as a possible eastern access from Old Fort crossing Bouffioux Creek and continuing north over landslide terrain on the east approach slopes to Bouffioux Creek, before crossing the landslide headscarp and joining with Cartier Road. The proposed alignment across landslide terrain would present significant challenges for both design and construction, that would require extensive geotechnical measures to stabilize. The threat of the landslide terrain being undermined as a result of toe erosion by Bouffioux Creek would remain (Figure 2-3). The bridge crossing over Bouffioux Creek would need to consider potential debris flow/flood risk emerging from the creek. Due to these geotechnical challenges compared with other options, this option was not considered beyond the preliminary review stages.

2.4. Additional Geotechnical Considerations

The high-level geotechnical evaluation presented in this letter does not consider the potential for future accelerated landslide movements which may impact Old Fort Road, such as reactivation of the west slide complex, and that may result in reduced serviceability, need substantial repair, or potentially require realignment. These and other geohazard threats to the community of Old Fort, such as debris flood threat from Bouffioux Creek, should be considered in any comparative assessment of options for long-term access to the community.

3.0 ESTIMATED GEOTECHNICAL COSTS

The following provides an outline of the assumptions made with respect to geotechnical mitigation options that may be considered for Options C1 and F1. These assumptions have been made such that high-level cost estimates for the additional geotechnical costs can be developed. Geotechnical measures required would be dependent on the findings of extensive ground investigation, costs for which have not been included. The actual design and geotechnical costs may vary substantially from what has been assumed herein.

3.1. Option C1

The east end of Option C1 crosses 35 m high landslide-impacted slopes and runs in close proximity to landslide-impacted slopes for a length of approximately 200 m. Thus, for the purposes of developing high level geotechnical construction costs, it is assumed that a 200 m length of slope and landslide-impacted ground will need to be stabilized. It is further assumed that the 160 m long cut slope in landslide terrain on the uphill side of the proposed road alignment will also need to be stabilized. Estimated costs are summarized in Table 3-1.

Table 3-1. High level geotechnical construction costs for Option C1.

Geotechnical Mitigation	Estimated Cost
Anchor pile wall. 200 m at $26,500/m	$5.3M
Single row of ground anchors in uphill cut. 65 anchors at $40K per anchor	$2.6M
Additional grading of uphill cuts 160 m of 10 m^3/m at $30/$m^3$	$50K
Total	$7.95M

It is suggested that a sum of $10M be adopted for the purposes of integrating potential geotechnical construction costs into the preliminary cost estimate for the Option C1 road alignment.

3.2. Option F1

Options to mitigate the earthflow would likely comprise extensive drainage works including extensive surface drainage combined with horizontal drains, vertical drains and potentially even pumping wells or drainage galleries into bedrock. The width of the earthflow at the road crossing is approximately 150 m and should drainage options alone be insufficient to slow the earthflow at the road then additional mitigation (e.g., extensive regrading works combined with approximately 200 to 400 post tensioned ground anchors in a cut adjacent to the road) may also be required. Alternatively, if it is determined that structural support is required, a 150 m-long anchor pile wall could be built for a similar cost to the ground anchors. Estimated costs are summarized in Table 3-2.

Table 3-2. High level geotechnical construction costs for Option F1.

Geotechnical Mitigation	Estimated Cost
Drainage measures (horizontal drains, vertical drains, drainage galleries)	$10M
400 post-tensioned ground anchors at $40K per anchor	$16.0M
1500 m of riprapped drainage channel (geotextile, excavator time etc.).	$4.0M
Grading of debris at $30/$m^3$	$10.0M
Total	$40M

Given the uncertainties in developing costs at this stage it is suggested that $40M be adopted for the purposes of integrating potential geotechnical construction costs into the preliminary cost estimate for the Option F1 road alignment. The estimated cost (i.e., $40M) assumes that drainage, extensive regrading and a structural solution (e.g., anchors, pile wall) will be required.

4.0 CLOSURE

BGC Engineering Inc. (BGC) prepared this document for the account of BC Ministry of Transportation and Infrastructure. The material in it reflects the judgment of BGC staff in light of the information available to BGC at the time of document preparation. Any use which a third party makes of this document or any reliance on decisions to be based on it is the responsibility of such third parties. BGC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this document.

As a mutual protection to our client, the public, and ourselves all documents and drawings are submitted for the confidential information of our client for a specific project. Authorization for any use and/or publication of this document or any data, statements, conclusions or abstracts from or regarding our documents and drawings, through any form of print or electronic media, including without limitation, posting or reproduction of same on any website, is reserved pending BGC's written approval. A record copy of this document is on file at BGC. That copy takes precedence over any other copy or reproduction of this document.

Yours sincerely,

BGC ENGINEERING INC.
per:

Martin Devonald, M.Sc., P.Eng.
Principal Geotechnical Engineer

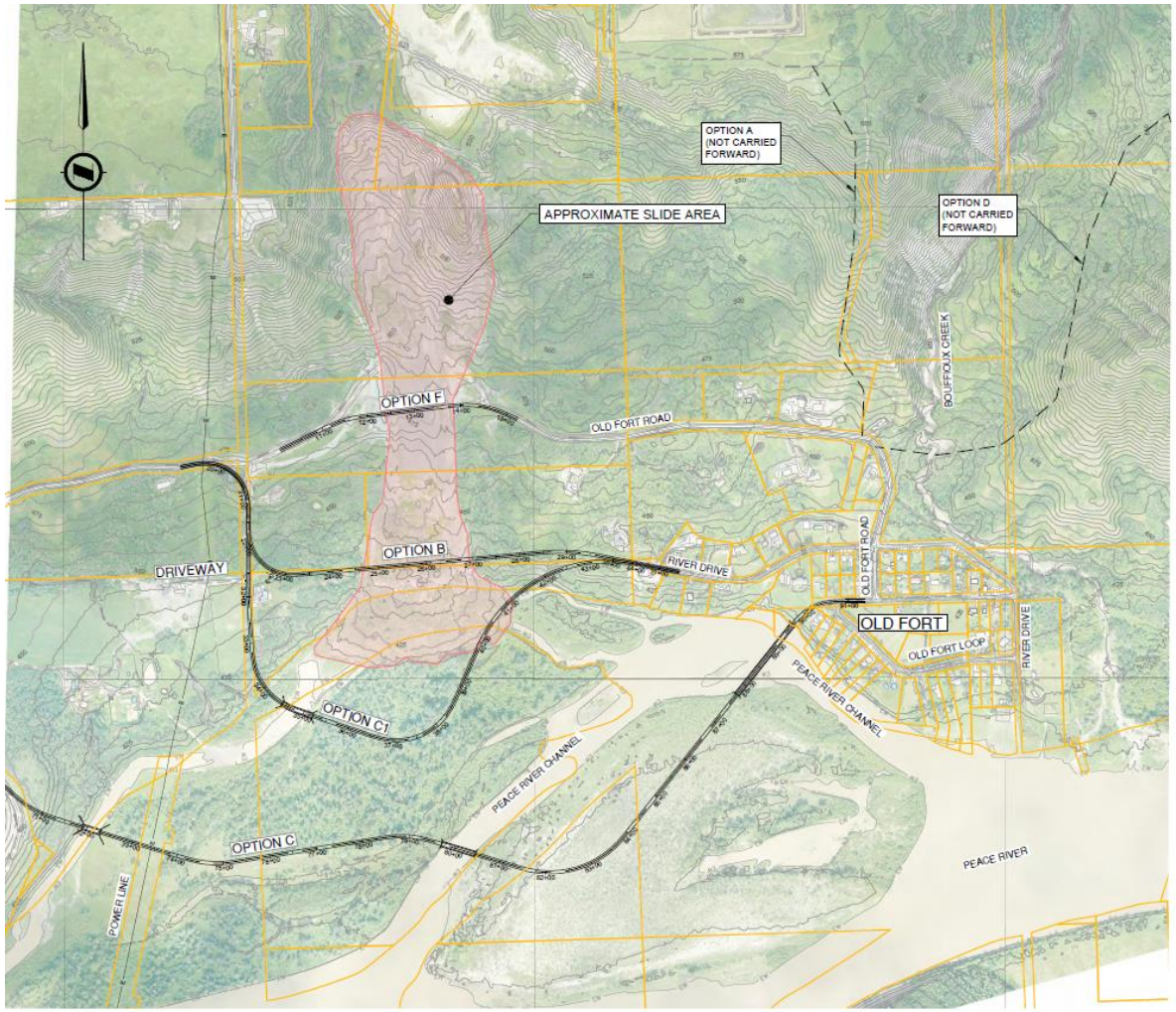
Reviewed by:

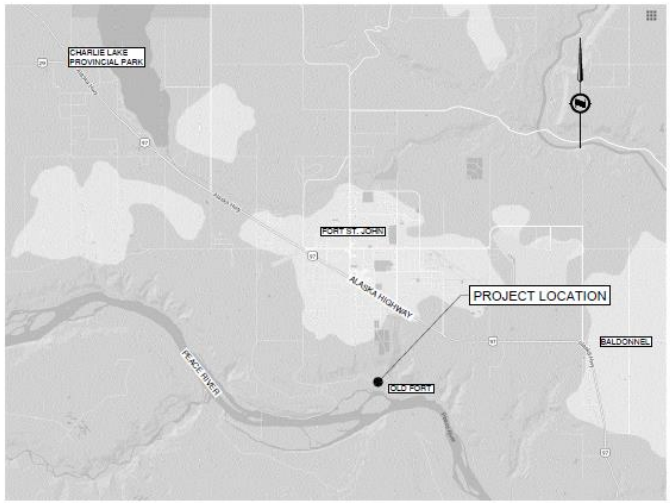
Pete Quinn, Ph.D., ing., P.Eng.
Principal Geotechnical Engineer

DP/PQ/mjp/syt

Attachment(s): Figures

FIGURES





LOCATION MAP
N.T.S.

1. This Figure should be read in conjunction with BGC's letter report titled *Old Fort Road – Geotechnical Evaluation of Potential Alignment Options – Updated FINAL* and dated May 5, 2021.
2. Initial Old Fort Road alignment options issued for review by McElhanney on September 2, 2020 and received from Stantec on September 4, 2020.

PREPARED BY:	FIGURE TITLE		
DP	Initial Old Fort Road Alignment Options		
CHECKED BY:	CLIENT:		
MD	BC Ministry of Transportation and Infrastructure		
APPROVED BY:	SCALE:	PROJECT NO:	FIGURE NO:
PQ	N.T.S.	0272061	1-1

0 5 10 mm in ANSI A sized paper

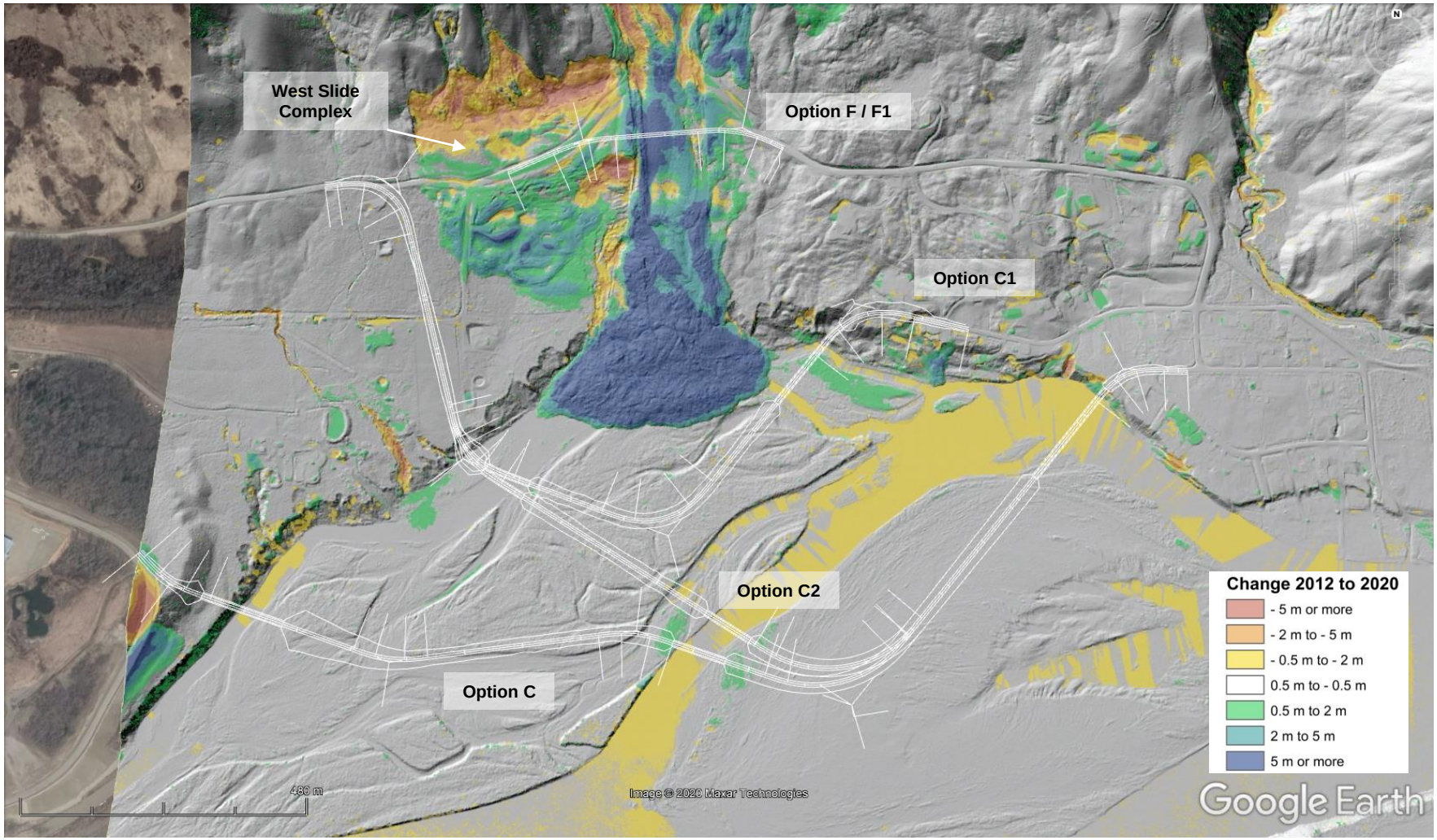
BGC ENGINEERING INC.

1. This Figure should be read in conjunction with BGC's letter report titled *Old Fort Road – Geotechnical Evaluation of Potential Alignment Options – Updated FINAL* and dated May 5, 2021.
2. Digital files for updated Old Fort Road alignment options received from McElhanney on October 18, 2020.

PREPARED BY: DP	FIGURE TITLE: Updated Old Fort Road Alignment Options		
CHECKED BY: MD	CLIENT: BC Ministry of Transportation and Infrastructure		
APPROVED BY: PQ	SCALE: AS SHOWN	PROJECT NO: 0272061	FIGURE NO: 1-2

0 5 10 mm in ANSI A sized paper

BGC ENGINEERING INC.

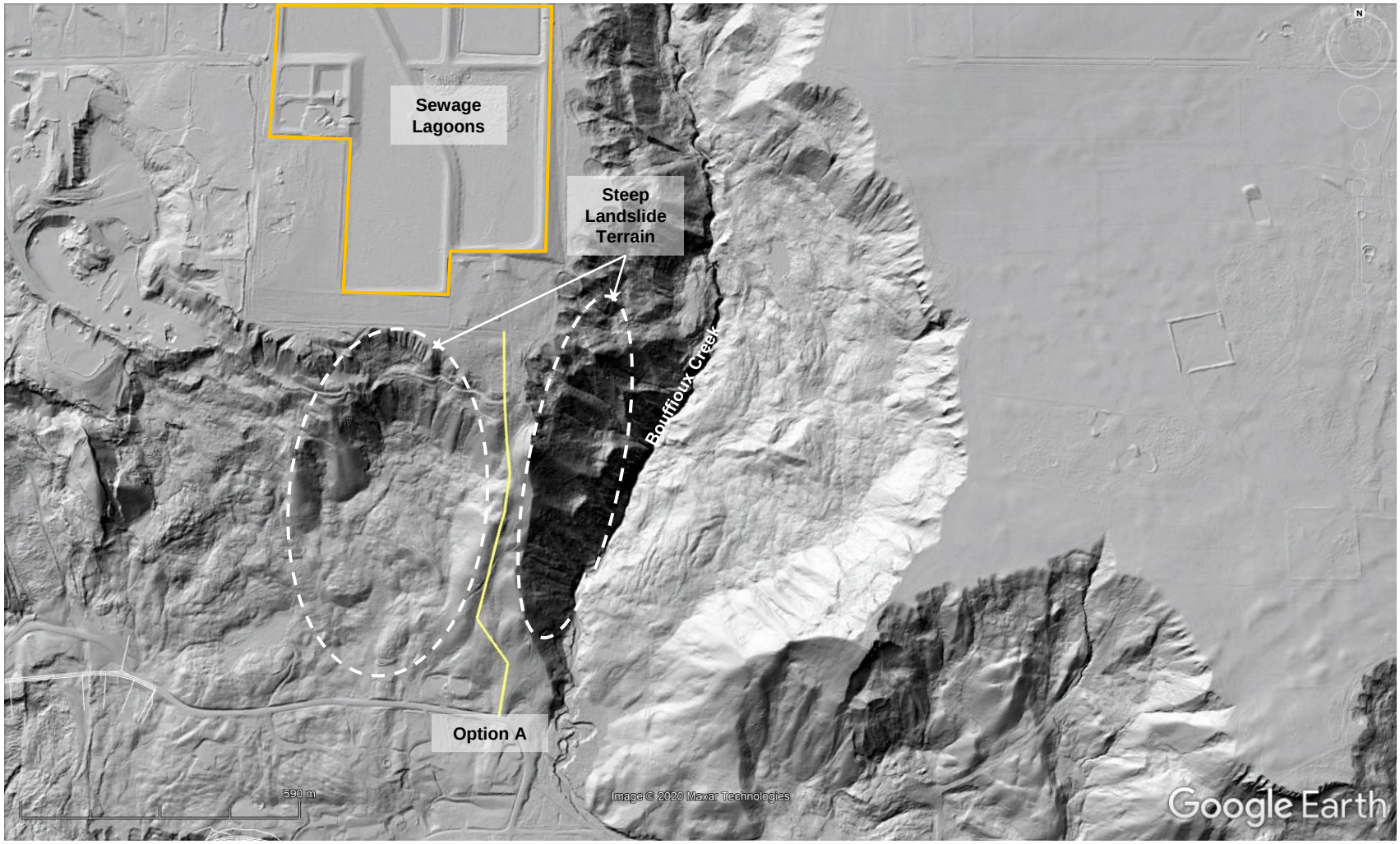


1. This Figure should be read in conjunction with BGC's letter report titled *Old Fort Road – Geotechnical Evaluation of Potential Alignment Options – Updated FINAL* and dated May 5, 2021.
2. Digital files for updated Old Fort Road alignment options received from McElhanney on October 18, 2020.
3. Old Fort Road alignment options shown over 2012 to July 2020 lidar change detection. Blue and green tones represent material accumulation; yellow to red tones represent material depletion.

PREPARED BY:	FIGURE TITLE		
DP	Updated Old Fort Road Alignment Options with Lidar Change Detection		
CHECKED BY:	CLIENT:		
MD	BC Ministry of Transportation and Infrastructure		
APPROVED BY:	SCALE:	PROJECT NO:	FIGURE NO:
PQ	AS SHOWN	0272061	1-3

0 5 10 mm in ANSI A sized paper

BGC ENGINEERING INC.

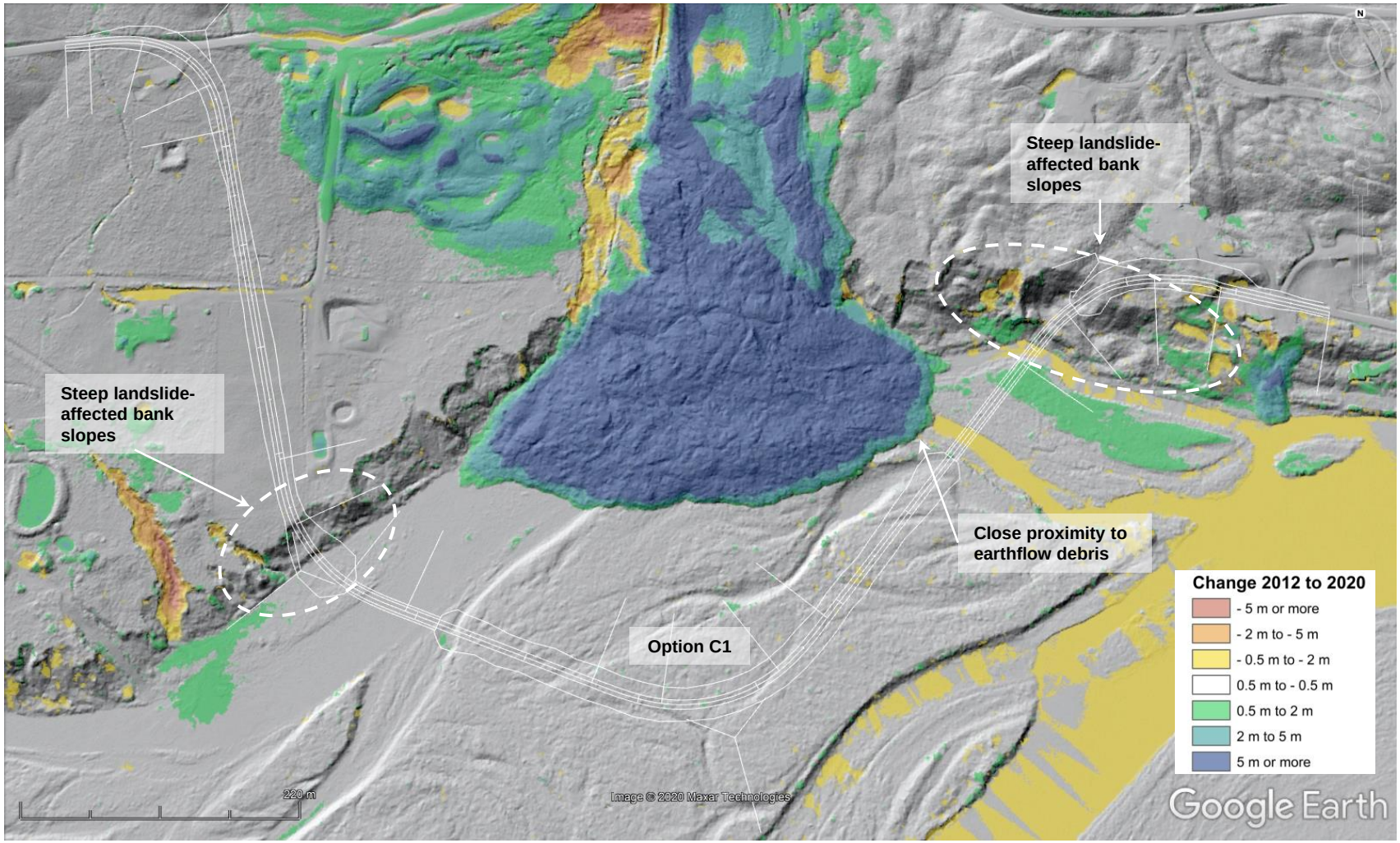


1. This Figure should be read in conjunction with BGC's letter report titled *Old Fort Road – Geotechnical Evaluation of Potential Alignment Options – Updated FINAL* and dated May 5, 2021.
2. Old Fort Road alignment Option A digitized based on files received from Stantec and projected over August 2019 lidar survey provided by the City of Fort St. John.

PREPARED BY: DP	FIGURE TITLE: Old Fort Road Alignment Option A with 2019 Lidar Survey		
CHECKED BY: MD	CLIENT: BC Ministry of Transportation and Infrastructure		
APPROVED BY: PQ	SCALE: AS SHOWN	PROJECT NO: 0272061	FIGURE NO: 2-1

0 5 10 mm in ANSI A sized paper

BGC ENGINEERING INC.

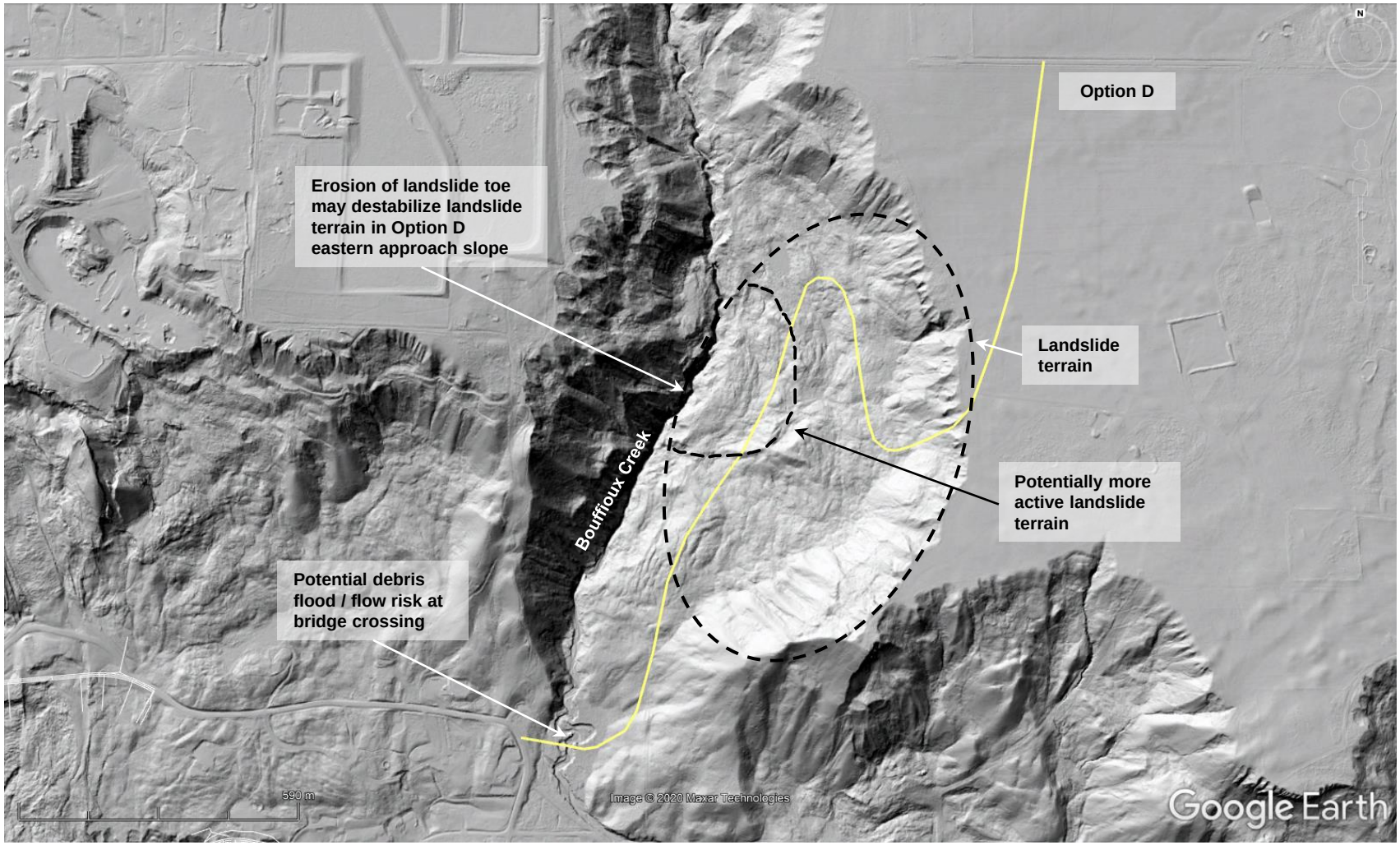


1. This Figure should be read in conjunction with BGC's letter report titled *Old Fort Road – Geotechnical Evaluation of Potential Alignment Options – Updated FINAL* and dated May 5, 2021.
2. Digital files for updated Old Fort Road alignment options received from McElhanney on October 18, 2020.
3. Old Fort Road alignment Option C1 shown over 2012 to July 2020 lidar change detection. Blue and green tones represent material accumulation; yellow to red tones represent material depletion.

PREPARED BY:	FIGURE TITLE		
DP	Old Fort Road Alignment Option C1 with Lidar Change Detection		
CHECKED BY:	CLIENT:		
MD	BC Ministry of Transportation and Infrastructure		
APPROVED BY:	SCALE:	PROJECT NO:	FIGURE NO:
PQ	AS SHOWN	0272061	2-2

0 5 10 mm in ANSI A sized paper

BGC ENGINEERING INC.



1. This Figure should be read in conjunction with BGC's letter report titled *Old Fort Road – Geotechnical Evaluation of Potential Alignment Options – Updated FINAL* and dated May 5, 2021.
2. Old Fort Road alignment Option D digitized based on files received from Stantec and projected over August 2019 lidar survey provided by the City of Fort St. John.

PREPARED BY: DP	FIGURE TITLE: Old Fort Road Alignment Option D with 2019 Lidar Survey		
CHECKED BY: MD	CLIENT: BC Ministry of Transportation and Infrastructure		
APPROVED BY: PQ	SCALE: AS SHOWN	PROJECT NO: 0272061	FIGURE NO: 2-3

0 5 10 mm in ANSI A sized paper

BGC ENGINEERING INC.

APPENDIX C

Wolski Cost Estimates

Old Fort Road Options Analysis

Conceptual Design Project Cost Estimate

FOR DISCUSSION ONLY

ML Proj #: 2111-00412-07

Estimate Date: June 2021

Description	Option F1 - Mitigate Existing Alignment Pave & improve slope stability, drainage, etc.	Option C1 New Access to West; South of Ex. Rd.	Option C2 South across one Island of Peace River	Option C South across two Islands of Peace River
Road Length	520	1,679	1,923	2,120
Grade Construction (Includes geotechnical, drainage)	$53,861,036	$32,404,678	$35,028,411	$33,508,229
Other Construction (Environmental Mitigation & Archaeological)	$631,350	$2,110,365	$2,362,905	$1,941,660
Drainage	$12,190,351	$4,713,239	$10,750,774	$10,971,489
Structural Construction (Including Retaining Walls)		$20,520,000	$27,702,000	$31,122,000
Paving Construction	$502,354	$1,253,127	$1,500,510	$2,073,575
Signing & Pavement Markings / Operational Construction (Signing, Pavement Marking and Guard Rail ie. Barriers)	$427,114	$1,012,396	$1,235,674	$1,361,252
Electrical (Lighting and Signal)				
Landscaping	$46,866	$97,114	$116,786	$139,327
Utility Construction (hydro, telephone, pipelines etc.)				$302,400
Subtotal Construction Cost	***$67,659,072***	***$62,110,919***	***$78,697,060***	***$81,419,932***
Land acquisition	$62,400	$1,560,000	$1,950,000	$1,430,000
Planning & Prelm Dgn, Eng., PM, Const Supv, Env & Archae and First Nations	$62,436,474	$61,071,967	$77,293,304	$79,299,127
Contingency 50%	***$65,078,973***	***$62,371,443***	***$78,970,182***	***$81,074,529***
Total Costs	***$195,236,918***	***$187,114,329***	***$236,910,545***	***$243,223,588***

File: X:\2111\2111-00412-07 MoTI - Old Fort Rd Realignment\4.0 ENGINEERING DESIGN\4.3 Estimates\[2021-06-22 Old Fort Road Wolski Cost Estimate.xlsm]SUMOFEST

Company **McElhanney**

2021 Dollars **Old Fort Road Options Analysis**

ACTIVITY **Proposed Design Concept**

CODE Estimate Date: June 2021

Conceptual Est.

Blk Est. # 6.14A

Version Sept.1, 2002

	ID-1	ID-2	ID-3	ID-4	
Divison\site	Old Fort	Old Fort	Old Fort	Old Fort	MR
Road Type	Option F1 - Mitigate Existing Alignment Pave & improve slope stability, drainage, etc.	Option C1 New Access to West; South of Ex. Rd.	Option C2 South across one Island of Peace River	Option C South across two Islands of Peace River	OR
DESCRIPTION \Length	1	1	1	1	TR
	520 MR	1679 MR	1923 MR	2120 MR	
Engineering	22,841,294	21,486,971	27,147,663	27,732,104	
Land	0	0	0	0	
Construction	111,456,456	104,346,345	132,211,060	136,731,054	
Management Reserve	0	0	0	0	
Escalation	0	0	0	0	
Total	134,297,750	125,833,316	159,358,723	164,463,158	
BASIC QUANTITY SUMMARY					
Construct.Cost ONLY Per L.M.	214,339	62,148	68,753	64,496	$/LM
Land Area	1.1	2.5	3.0	3.9	ha
Mobilization	2,243,487	2,100,369	2,661,253	2,743,105	
Land Cont.	0	0	0	0	
Construction Cont.	33,171,564	31,055,460	39,348,530	40,709,966	
Engineering Cont.	7,613,765	7,162,324	9,049,221	9,244,035	
Supervision Cont.	3,980,588	3,726,655	4,721,824	4,867,052	
Total Cont.	44,765,917	41,944,439	53,119,574	54,821,053	
S.G.S.B.	378	4,247	5,549	5,099	m3
C.B.C.	365	3,074	4,006	3,695	m3
Asphalt	1,075	2,608	3,137	4,381	t
Concrete Barrier	1,040	2,519	3,077	3,392	lm
Noise Attentuation Wall	0	0	0	0	m2
No. of Light Poles	0	0	0	0	ea
Sidewalk	0	0	0	0	lm
Curb and Gutter	0	0	0	0	lm
Signals	0	0	0	0	ea
Bridge total area	0	0	0	0	m2
Total Rock	0	7,502	4,147	826	m3
Total OM	9,152	22,507	12,441	2,478	m3
Total Stripping	1,650	10,524	14,375	15,635	m3
Total Borrow	0	64,017	187,155	259,190	m3
Total Cut/Excavation	10,802	104,550	218,118	278,130	m3
Total Fill	0	77,146	194,412	260,636	m3
Surplus or Deficit	10,802	27,404	23,706	17,494	m3
ENG & PM	**22.841**	**21.487**	**27.148**	**27.732**	
LAND	**0.000**	**0.000**	**0.000**	**0.000**	
CONST.	**111.456**	**69.872**	**85.672**	**84.446**	
BRIDGES-R/W	**0.000**	**34.474**	**46.539**	**52.285**	
MANAGEMENT RESERVE	**0.000**	**0.000**	**0.000**	**0.000**	
ESCALATION	**0.000**	**0.000**	**0.000**	**0.000**	
TOTAL (Millions) 2021 Dollars	**134.297**	**125.833**	**159.359**	**164.463**	
TOTAL Cost per meter	**$ 258,265**	**$ 74,945**	**$ 82,870**	**$ 77,577**	
Construction cost per meter	**$ 214,338**	**$ 62,148**	**$ 68,752**	**$ 64,496**	

191.216

Land

Construction

Total

File: X:\2111\2111-00412-07 MoTI - Old Fort Rd Realignment\4.0 ENGINEERING DESIGN\4.3 Estimates\[2021-06-22 Old Fort Road Wolski Cost Estimate.xlsm]SUMOFEST

Company **McElhanney**

2021 Dollars **Old Fort Road Options Analysis**

ACTIVITY **Proposed Design Concept**

CODE Estimate Date: June 2021

Conceptual Est.

Blk Est. # 6.14A

Version Sept.1, 2002

ACTIVITY CODE		Divison\site	ID-1 Old Fort	ID-2 Old Fort	ID-3 Old Fort	ID-4 Old Fort	
			Option F1 - Mitigate Existing Alignment Pave & improve slope stability, drainage, etc.	Option C1 New Access to West; South of Ex. Rd.	Option C2 South across one Island of Peace River	Option C South across two Islands of Peace River	MR
		Road Type	1	1	1	1	OR
		DESCRIPTION \Length	520 MR	1679 MR	1923 MR	2120 MR	TR
	SUMMARY BY ACTIVITY LEVEL						
2000		PROJECT MANAGEMENT	5,778,949	5,414,717	6,857,345	7,076,993	
2500		PLANNING	149,058	192,514	236,241	208,354	
3000		PRELIMINARY DESIGN	343,200	332,442	380,754	251,856	
3500		DETAILED DESIGN	8,956,322	8,384,974	10,624,103	10,950,867	
		Total Engineering	9,448,580	8,909,930	11,241,098	11,411,076	
4000		LAND ACQUISITION	0	0	0	0	
5000		GRADE CONSTRUCTION	64,782,310	37,215,031	45,895,971	44,619,045	
5200		ROAD SIDE CONSTRUCTION	0	0	0	0	
5300		OTHER CONSTRUCTION	631,350	2,110,365	2,362,905	1,941,660	
5500		STRUCTURAL CONSTRUCTION	0	20,520,000	27,702,000	31,122,000	
6000		PAVING CONSTRUCTION	502,354	1,253,127	1,500,510	2,073,575	
6500		OPERATIONAL CONSTRUCTION	427,114	1,012,396	1,235,674	1,361,252	
6700		UTILITY CONSTRUCTION	0	0	0	302,400	
6800		RESIDENT ENGINEERING	7,961,175	7,453,310	9,443,647	9,734,104	
			0	0	0	0	
		Total Construction	74,304,304	69,564,230	88,140,707	91,154,036	
9700		CONTINGENCY	44,765,917	41,944,439	53,119,574	54,821,053	
		SUB-TOTAL	134,297,750	125,833,316	159,358,723	164,463,158	
9800		MANAGEMENT RESERVE	0	0	0	0	
		TOTAL	134,297,750	125,833,316	159,358,723	164,463,158	
9900		ESCALATION	0	0	0	0	
		TOTAL COST	134,297,750	125,833,316	159,358,723	164,463,158	
		Const. Less Resident Eng.	66,343,129	62,110,919	78,697,060	81,419,932	

File: X:\2111\2111-00412-07 MoTI - Old Fort Rd Realignment\4.0 ENGINEERING DESIGN\4.3 Estimates\[2021-06-22 Old Fort Road Wolski Cost Estimate.xlsm]SUMOFEST

Company **McElhanney**

2021 Dollars **Old Fort Road Options Analysis**

ACTIVITY **Proposed Design Concept**

CODE Estimate Date: June 2021

Conceptual Est.

Blk Est. # 6.14A

Version Sept.1, 2002

			ID-1	ID-2	ID-3	ID-4	
		Divison\site	Old Fort	Old Fort	Old Fort	Old Fort	MR
		Road Type	Option F1 - Mitigate Existing Alignment Pave & improve slope stability, drainage, etc.	Option C1 New Access to West; South of Ex. Rd.	Option C2 South across one Island of Peace River	Option C South across two Islands of Peace River	OR
		DESCRIPTION \Length	1 520 MR	1 1679 MR	1 1923 MR	1 2120 MR	TR
2500		PLANNING					
2521	Consultant	- transport. planning study	18,200	23,506	28,845	25,440	
2531	Consultant	- corridor study	18,200	23,506	28,845	25,440	
2541	Consultant	- functional plan. study	18,200	23,506	28,845	25,440	
2502	Consultant	- functional plan. study	2,730	3,526	4,327	3,816	
	Consultant sub-total		57,330	74,044	90,862	80,136	
2510	Client	- project ident.	18,200	23,506	28,845	25,440	
2520	Client	- transport. planning study	18,200	23,506	28,845	25,440	
2530	Client	- corridor study	25,480	32,908	40,383	35,616	
2540	Client	- functional plan. study	25,480	32,908	40,383	35,616	
2501	Client	- general	4,368	5,641	6,923	6,106	
	Client Sub-total		91,728	118,470	145,379	128,218	
2599	Planning Contingency		74,529	96,257	118,120	104,177	
		TOTAL PLANNING	223,587	288,771	354,361	312,530	
3000		PRELIMINARY DESIGN					
3013	Consultant	- aerial base plan	26,000	25,185	28,845	19,080	
3014	Consultant	- prel. design	31,200	30,222	34,614	22,896	
3015	Consultant	- control survey	26,000	25,185	28,845	19,080	
3021	Consultant	- environmental impact	52,000	50,370	57,690	38,160	
3031	Consultant	- funct.-road field survey	26,000	25,185	28,845	19,080	
3041	Consultant	- functional design	20,800	20,148	23,076	15,264	
3051	Consultant	- funct. structural des.	15,600	15,111	17,307	11,448	
3061	Consultant	- geotechnical design	130,000	125,925	144,225	95,400	
3071	Consultant	- right-of-way research	15,600	15,111	17,307	11,448	
3002	Consultant	- general	0	0	0	0	
	Consultant sub-total		343,200	332,442	380,754	251,856	
3010	Client	- aerial base plan	0	0	0	0	
3011	Client	- prel. design	0	0	0	0	
3012	Client	- control survey	0	0	0	0	
3020	Client	- environmental impact	0	0	0	0	
3030	Client	- funct.-road field survey	0	0	0	0	
3040	Client	- functional design	0	0	0	0	
3050	Client	- funct. structural des.	0	0	0	0	
3060	Client	- geotechnical design	0	0	0	0	
3070	Client	- right-of-way research	0	0	0	0	
3001	Client	- general	0	0	0	0	
	Client Sub-total		0	0	0	0	
3099	Preliminary design Contingency		171,600	166,221	190,377	125,928	
		TOTAL PRELIMINARY DESIGN	514,800	498,663	571,131	377,784	

File: X:\2111\2111-00412-07 MoTI - Old Fort Rd Realignment\4.0 ENGINEERING DESIGN\4.3 Estimates\[2021-06-22 Old Fort Road Wolski Cost Estimate.xlsm]SUMOFEST

Company **McElhanney**

2021 Dollars **Old Fort Road Options Analysis**

ACTIVITY **Proposed Design Concept**

CODE Estimate Date: June 2021

Conceptual Est.

Blk Est. # 6.14A

Version Sept.1, 2002

			ID-1	ID-2	ID-3	ID-4	
		Divison\site	Old Fort	Old Fort	Old Fort	Old Fort	MR
		Road Type	Option F1 - Mitigate Existing Alignment Pave & improve slope stability, drainage, etc.	Option C1 New Access to West; South of Ex. Rd.	Option C2 South across one Island of Peace River	Option C South across two Islands of Peace River	OR
		DESCRIPTION \Length	1	1	1	1	TR
			520 MR	1679 MR	1923 MR	2120 MR	
6700		UTILITIES					
6710	Util. Prov.	- Hydro	0	0	0	201,600	
6711	Util. Prov.	- Telephone	0	0	0	100,800	
	Util. Prov.	sub-total	0	0	0	302,400	
6712	Util.Others	- pipelines	0	0	0	0	
6713	Util.Others	- telecommunication	0	0	0	0	
6714	Util.Others	- storm & sewer inspect.	0	0	0	0	
6715	Util.Others	- waterworks inspect.	0	0	0	0	
6716	Util.Others	- engineering services	0	0	0	0	
6717	Util.Others	- parks/recreation-prel.	0	0	0	0	
6718	Util.Others	- transit	0	0	0	0	
6719	Util.Others	- tr-ops/signs & detours	0	0	0	0	
6701	Util.Others	- general	0	0	0	0	
	Util.Others	sub-total	0	0	0	0	
6799	Util.Others Contingency		0	0	0	151,200	
	TOTAL UTILITIES		0	0	0	453,600	
5000		GRADE CONSTRUCTION					
5032	Grade Const.	- water	0	0	0	0	
5033	Grade Const.	- sanitary	0	0	0	0	
5034	Grade Const.	- storm	0	0	0	0	
5031	Grade Const.	- mobilization	0	0	0	0	
5039	Grade Const.	- utility contingency	0	0	0	0	
	Grade Const. Utilities Sub-total		0	0	0	0	
5010	Grade Const.	- site prep./clear,grubbing	24,102	54,307	65,076	82,742	
5020	Grade Const.	- road grade/exc,placing,fill	47,544,803	27,722,175	29,298,094	27,888,151	
5030	Grade Const.	- drainage/pipe,cul.	11,778,117	4,553,854	10,387,221	10,600,472	
5040	Grade Const.	- muiltiplate	0	0	0	0	
5050	Grade Const.	-SGSB/produce,place,comp	43,913	494,007	645,454	593,111	
5051	Grade Const.	-CBC/produce,place,comp	49,433	416,713	543,077	500,834	
5060	Grade Const.	- grade finishing landscaping	22,635	46,904	56,405	67,292	
5061	Grade Const.	- grade finishing hydro seed.	22,646	46,926	56,432	67,323	
5062	Grade Const.	- grade finishing fencing	0	0	0	0	
5063	Grade Const.	- noise barriers	0	0	0	0	
5064	Grade Const.	- passing lanes	0	0	0	0	
5090	Grade Const.	- sidewalks,curb & gutter	0	0	0	0	
5005	Grade Const.	-detours c/w ex,bf,paving	3,105,955	2,621,666	3,292,174	3,310,263	
5001	Grade Const.	- mobilization	2,190,706	1,258,479	1,552,038	1,508,857	
5099	Grade Const.	- Contingency	32,391,155	18,607,516	22,947,986	22,309,522	
	Grade Construction Sub-total		97,173,465	55,822,547	68,843,957	66,928,567	
	GRADE CONSTRUCTION COSTS		97,173,465	55,822,547	68,843,957	66,928,567	
3510	Grade Eng.	- detailed design	7,288,010	4,186,691	5,163,297	5,019,643	
3519	Grade Eng.	- detailed design/Contingency	3,644,005	2,093,346	2,581,648	2,509,821	
6810	Grade Eng.	- general const. supervision	3,401,071	1,953,789	2,409,538	2,342,500	
6811	Grade Eng.	- quality assurance	2,429,337	1,395,564	1,721,099	1,673,214	
6812	Grade Eng.	- surveying	1,943,469	1,116,451	1,376,879	1,338,571	
6819	Grade Eng.	- Residency Contingency	3,886,939	2,232,902	2,753,758	2,677,143	
	Grade Engineering Sub-total		22,592,831	12,978,742	16,006,220	15,560,892	
	Total Grade Const. & Eng. Costs		119,766,296	68,801,289	84,850,177	82,489,459	

File: X:\2111\2111-00412-07 MoTI - Old Fort Rd Realignment\4.0 ENGINEERING DESIGN\4.3 Estimates\[2021-06-22 Old Fort Road Wolski Cost Estimate.xlsm]SUMOFEST

Company **McElhanney**

2021 Dollars **Old Fort Road Options Analysis**

ACTIVITY **Proposed Design Concept**

CODE Estimate Date: June 2021

Conceptual Est.

Blk Est. # 6.14A

Version Sept.1, 2002

			ID-1	ID-2	ID-3	ID-4	
		Divison\site	Old Fort	Old Fort	Old Fort	Old Fort	MR
		Road Type	Option F1 - Mitigate Existing Alignment Pave & improve slope stability, drainage, etc.	Option C1 New Access to West; South of Ex. Rd.	Option C2 South across one Island of Peace River	Option C South across two Islands of Peace River	OR
		DESCRIPTION \Length	1	1	1	1	TR
			520 MR	1679 MR	1923 MR	2120 MR	
5500		STRUCTURAL CONSTRUCTION					
5522	Struct.Const.	- water	0	0	0	0	
5523	Struct.Const.	- sanitary	0	0	0	0	
5524	Struct.Const.	- storm	0	0	0	0	
5521	Struct.Const.	- mobilization	0	0	0	0	
5599	Struct.Const.	- utility contingency	0	0	0	0	
	Structural Const. Utilities Sub-total		0	0	0	0	
5510	Struct.Const.	- tunnel site preparation	0	0	0	0	
5511	Struct.Const.	- tunnel construction	0	0	0	0	
5512	Struct.Const.	- snow shed site prep.	0	0	0	0	
5513	Struct.Const.	- snow shed site const.	0	0	0	0	
5514	Struct.Const.	- bridge site preparation	0	1,802,372	2,433,202	2,733,597	
5515	Struct.Const.	- bridge piers	0	577,048	1,215,612	1,228,089	
5516	Struct.Const.	- bridge abutments	0	219,600	415,800	415,800	
5517	Struct.Const.	- bridge superstructure	0	17,227,067	22,700,604	25,692,080	
5518	Struct.Const.	- retain. wall site prep.	0	0	0	0	
5519	Struct.Const.	- retaining wall const.	0	0	0	0	
5501	Struct.Const.	- mobilization	0	693,913	936,783	1,052,435	
5529	Struct.Const.	- Contingency	0	10,260,000	13,851,000	15,561,000	
	Structural Construction Sub-total		0	30,780,000	41,553,000	46,683,000	
	STRUCTURAL CONSTRUCTION COSTS		0	30,780,000	41,553,000	46,683,000	
3520	Struct. Eng.	- detailed design	0	2,308,500	3,116,475	3,501,225	
3529	Struct. Eng.	- detailed design/Contingency	0	1,154,250	1,558,238	1,750,613	
6820	Struct. Eng.	- general const. supervision	0	1,077,300	1,454,355	1,633,905	
6821	Struct. Eng.	- quality assurance	0	769,500	1,038,825	1,167,075	
6822	Struct. Eng.	- surveying	0	615,600	831,060	933,660	
6829	Struct. Eng.	- Residency Contingency	0	1,231,200	1,662,120	1,867,320	
	Structural Engineering Sub-total		0	7,156,350	9,661,073	10,853,798	
	Total Structural & Eng. Costs		0	37,936,350	51,214,073	57,536,798	

File: X:\2111\2111-00412-07 MoTI - Old Fort Rd Realignment\4.0 ENGINEERING DESIGN\4.3 Estimates\[2021-06-22 Old Fort Road Wolski Cost Estimate.xlsm]SUMOFEST

Company **McElhanney**

2021 Dollars **Old Fort Road Options Analysis**

ACTIVITY **Proposed Design Concept**

CODE Estimate Date: June 2021

Conceptual Est.

Blk Est. # 6.14A

Version Sept.1, 2002

			ID-1	ID-2	ID-3	ID-4	
		Divison\site	Old Fort	Old Fort	Old Fort	Old Fort	MR
		Road Type	Option F1 - Mitigate Existing Alignment Pave & improve slope stability, drainage, etc.	Option C1 New Access to West; South of Ex. Rd.	Option C2 South across one Island of Peace River	Option C South across two Islands of Peace River	OR
		DESCRIPTION \Length	1	1	1	1	TR
			520 MR	1679 MR	1923 MR	2120 MR	
6000		PAVING CONSTRUCTION					
6020	Paving Const.	- machine paving asphalt	485,366	1,210,750	1,449,768	2,003,455	
6030	Paving Const.	- machine paving concrete	0	0	0	0	
6040	Paving Const.	- hot reprofiling	0	0	0	0	
6050	Paving Const.	- shoulder paving	0	0	0	0	
6060	Paving Const.	- pavement finishing	0	0	0	0	
6070	Paving Const.	- seal coating	0	0	0	0	
6001	Paving Const.	- mobilization	16,988	42,376	50,742	70,121	
6010	Paving Const.	- pavement design	0	0	0	0	
6099	Paving Const.	- Contingency	251,177	626,563	750,255	1,036,788	
		PAVING CONSTRUCTION COSTS	753,531	1,879,690	2,250,765	3,110,363	
3560	Paving Eng.	- detailed design	56,515	140,977	168,807	233,277	
3569	Paving Eng.	- detailed design/Contingency	28,257	70,488	84,404	116,639	
6860	Paving Eng.	- general const. supervision	26,374	65,789	78,777	108,863	
6861	Paving Eng.	- quality assurance	18,838	46,992	56,269	77,759	
6862	Paving Eng.	- surveying	15,071	37,594	45,015	62,207	
6869	Paving Eng.	- Residency Contingency	30,141	75,188	90,031	124,415	
	Paving Engineering Sub-total		175,196	437,028	523,303	723,159	
	Total Paving Const. & Eng. Costs		928,727	2,316,718	2,774,068	3,833,523	
6500		OPERATIONAL CONSTRUCTION					
6510	Operat.Const.	- lighting	0	0	0	0	
6520	Operat.Const.	- signals	0	0	0	0	
6530	Operat.Const.	- signing	16,906	19,744	23,175	21,449	
6540	Operat.Const.	- guard rail	392,125	949,583	1,160,086	1,278,930	
6550	Operat.Const.	- pavement markings	3,640	8,833	10,626	14,840	
6501	Operat.Const.	- mobilization	14,443	34,236	41,786	46,033	
6599	Operat.Const.	- contingency	213,557	506,198	617,837	680,626	
		OPERATIONAL CONSTRUCTION COSTS	640,672	1,518,595	1,853,510	2,041,878	
3540	Operat. Eng.	- detailed design	48,050	113,895	139,013	153,141	
3549	Operat. Eng.	- detailed design/Contingency	24,025	56,947	69,507	76,570	
6840	Operat. Eng.	- general const. supervision	22,424	53,151	64,873	71,466	
6841	Operat. Eng.	- quality assurance	16,017	37,965	46,338	51,047	
6842	Operat. Eng.	- surveying	12,813	30,372	37,070	40,838	
6849	Operat. Eng.	- Residency Contingency	25,627	60,744	74,140	81,675	
	Operational Enginering Sub-total		148,956	353,073	430,941	474,737	
	Total Operational Const.& Eng.Costs		789,628	1,871,668	2,284,452	2,516,615	

File: X:\2111\2111-00412-07 MoTI - Old Fort Rd Realignment\4.0 ENGINEERING DESIGN\4.3 Estimates\[2021-06-22 Old Fort Road Wolski Cost Estimate.xlsm]SUMOFEST

Company **McElhanney**

2021 Dollars **Old Fort Road Options Analysis**

ACTIVITY **Proposed Design Concept**

CODE Estimate Date: June 2021

Conceptual Est.

Blk Est. # 6.14A

Version Sept.1, 2002

			ID-1	ID-2	ID-3	ID-4	
			Old Fort	Old Fort	Old Fort	Old Fort	
		Divison\site	Option F1 - Mitigate Existing Alignment Pave & improve slope stability, drainage, etc.	Option C1 New Access to West; South of Ex. Rd.	Option C2 South across one Island of Peace River	Option C South across two Islands of Peace River	MR
		Road Type	1	1	1	1	OR
		DESCRIPTION \Length	520 MR	1679 MR	1923 MR	2120 MR	TR
5200		ROAD SIDE CONSTRUCTION					
5203	RoadSide Const	- water	0	0	0	0	
5204	RoadSide Const	- sanitary	0	0	0	0	
5205	RoadSide Const	- storm	0	0	0	0	
5202	RoadSide Const	- mobilization	0	0	0	0	
5209	RoadSide Const	- Utility Contingency	0	0	0	0	
	Road Side Const. Utilities Sub-total		0	0	0	0	
5210	RoadSide Const	- weighscales	0	0	0	0	
5220	RoadSide Const	- safety rest areas	0	0	0	0	
5230	RoadSide Const	- tourist rest & view areas	0	0	0	0	
5201	RoadSide Const	- mobilization	0	0	0	0	
5299	RoadSide Const	- Contingency	0	0	0	0	
	Road Side Construction Sub-total		0	0	0	0	
	ROAD SIDE CONSTRUCTION COSTS		0	0	0	0	
3550	RoadSide Eng.	- detailed design	0	0	0	0	
3559	RoadSide Eng.	- detailed design/Contingency	0	0	0	0	
6850	RoadSide Eng.	- general const. supervision	0	0	0	0	
6851	RoadSide Eng.	- quality assurance	0	0	0	0	
6852	RoadSide Eng.	- surveying	0	0	0	0	
6859	RoadSide Eng.	- Residency Contingency	0	0	0	0	
	Road Side Engineering Sub-total		0	0	0	0	
	Total Road Side Const.& Eng.Costs		0	0	0	0	
5300		OTHER CONSTRUCTION					
5303	Other Const.	- water	0	0	0	0	
5304	Other Const.	- sanitary	0	0	0	0	
5305	Other Const.	- storm	0	0	0	0	
5302	Other Const.	- mobilization	0	0	0	0	
5309	Other Const.	- utility contingency	0	0	0	0	
	Other Const. Utilities Sub-total		0	0	0	0	
5310	Other Const.	- railroads main & spur lines	0	0	0	0	
5320	Other Const.	- railroad crossings	0	0	0	0	
5330	Other Const.	- marine work	0	0	0	0	
5340	Other Const.	- environmental mitigations	610,000	2,039,000	2,283,000	1,876,000	
5301	Other Const.	- mobilization	21,350	71,365	79,905	65,660	
5399	Other Const.	- Contingency	315,675	1,055,182	1,181,452	970,830	
	Other Construction Sub-total		947,025	3,165,547	3,544,357	2,912,490	
	OTHER CONSTRUCTION COSTS		947,025	3,165,547	3,544,357	2,912,490	
3570	Other Eng.	- detailed design	71,027	237,416	265,827	218,437	
3579	Other Eng.	- detailed design/Contingency	35,513	118,708	132,913	109,218	
6870	Other Eng.	- general const. supervision	33,146	110,794	124,053	101,937	
6871	Other Eng.	- quality assurance	23,676	79,139	88,609	72,812	
6872	Other Eng.	- surveying	18,940	63,311	70,887	58,250	
6879	Other Eng.	- Residency Contingency	37,881	126,622	141,774	116,500	
	Other Engineering Sub-total		220,183	735,990	824,063	677,154	
	Total Other Const.& Eng.Costs		1,167,208	3,901,537	4,368,421	3,589,644	

File: X:\2111\2111-00412-07 MoTI - Old Fort Rd Realignment\4.0 ENGINEERING DESIGN\4.3 Estimates\[2021-06-22 Old Fort Road Wolski Cost Estimate.xlsm]SUMOFEST

Company **McElhanney**

2021 Dollars **Old Fort Road Options Analysis**

ACTIVITY **Proposed Design Concept**

CODE Estimate Date: June 2021

Conceptual Est.

Blk Est. # 6.14A

Version Sept.1, 2002

			ID-1	ID-2	ID-3	ID-4	
		Divison\site	Old Fort	Old Fort	Old Fort	Old Fort	MR
		Road Type	Option F1 - Mitigate Existing Alignment Pave & improve slope stability, drainage, etc.	Option C1 New Access to West; South of Ex. Rd.	Option C2 South across one Island of Peace River	Option C South across two Islands of Peace River	OR
		DESCRIPTION \Length	1	1	1	1	TR
			520 MR	1679 MR	1923 MR	2120 MR	
3500		DETAILED DESIGN					
	from 3510,3520,3540,3550,3570		11,195,403	10,481,218	13,280,129	13,688,584	
3530	Geotech. Eng.	- detailed design	1,492,720	1,397,496	1,770,684	1,825,144	
3539	Geotech. Eng.	- Contingency	746,360	698,748	885,342	912,572	
	TOTAL DETAILED DESIGN COSTS		13,434,484	12,577,461	15,936,155	16,426,300	
6800		RESIDENT ENGINEERING	0	0	0	0	
	from 6810,6820,6840,6850,6860,6870		11,941,763	11,179,965	14,165,471	14,601,156	
	TOTAL RESIDENT ENG. COSTS		11,941,763	11,179,965	14,165,471	14,601,156	
			0	0	0	0	
			0	0	0	0	
			0	0	0	0	
	PART 1	SUMMARY					
		CONSTRUCTION	66,343,129	62,110,919	78,697,060	81,419,932	
		ENGINEERING & SUPERVISION	17,409,756	16,363,241	20,684,745	21,145,180	
		CONTRACTUAL CONTINGENCY	41,876,442	39,237,080	49,690,902	51,282,556	
			0	0	0	0	
	CONSTRUCTION COST TOTAL		125,629,327	117,711,240	149,072,707	153,847,669	

File: X:\2111\2111-00412-07 MoTI - Old Fort Rd Realignment\4.0 ENGINEERING DESIGN\4.3 Estimates\[2021-06-22 Old Fort Road Wolski Cost Estimate.xlsm]SUMOFEST

Company **McElhanney**

2021 Dollars **Old Fort Road Options Analysis**

ACTIVITY **Proposed Design Concept**

CODE Estimate Date: June 2021

Conceptual Est. Divison\site

Blk Est. # 6.14A Road Type

Version Sept.1, 2002 DESCRIPTION \Length

			ID-1	ID-2	ID-3	ID-4	
			Old Fort	Old Fort	Old Fort	Old Fort	
			Option F1 - Mitigate Existing Alignment Pave & improve slope stability, drainage, etc.	Option C1 New Access to West; South of Ex. Rd.	Option C2 South across one Island of Peace River	Option C South across two Islands of Peace River	MR
			1	1	1	1	OR
			520 MR	1679 MR	1923 MR	2120 MR	TR
2000		PROJECT MANAGEMENT					
2060	Project Man.	- office costs wages	2,512,587	2,354,225	2,981,454	3,076,953	
2062	Project Man.	- office costs - expenses	1,256,293	1,177,112	1,490,727	1,538,477	
2063	Project Man.	- printing costs	0	0	0	0	
2061	Project Man.	- general	0	0	0	0	
	Project Manager Sub-total		3,768,880	3,531,337	4,472,181	4,615,430	
2010	Client	- office costs wages	1,256,293	1,177,112	1,490,727	1,538,477	
2012	Client	- office costs - expenses	628,147	588,556	745,364	769,238	
2030	Client	- printing costs	0	0	0	0	
2011	Client	- general	0	0	0	0	
	Client Sub-total		1,884,440	1,765,669	2,236,091	2,307,715	
2070	Public Rel.	- wages & expenses	0	0	0	0	
2072	Public Rel.	- adv., media, displays	0	0	0	0	
2073	Public Rel.	- opening ceremonies	0	0	0	0	
2071	Public Rel.	- general	0	0	0	0	
	Public Relations Sub-total		0	0	0	0	
2040	Legal Costs	- lawyers fees	125,629	117,711	149,073	153,848	
2041	Legal Costs	- general	0	0	0	0	
	Legal Costs Sub-total		125,629	117,711	149,073	153,848	
2080	Insurance	- const./ liability, E&O	0	0	0	0	
2081	Insurance	- general	0	0	0	0	
	Legal Costs Sub-total		0	0	0	0	
2099	Project Management Contingency		2,889,475	2,707,359	3,428,672	3,538,496	
	TOTAL PROJECT MANAGEMENT COSTS		8,668,424	8,122,076	10,286,017	10,615,489	
4000		LAND	0	0	0	0	
4010	Land(Code 401)	-Mrkt,ROW,Serv,Imp.V,Ease.C,T	0	0	0	0	
	Acquisition Sub-total		0	0	0	0	
4020	Land(Code 402)	-Bus.,5%,Mrg.P,Rel$,P/Tax,Etc	0	0	0	0	
4030	Land(Code 403)	-Owners(LS,Apprsl,Rprt,Lgl,In	0	0	0	0	
4040	Land(Code 404)	-Demolition	0	0	0	0	
4050	Land(Code 405)	-Pro.Man,P.Tax,Util,Security	0	0	0	0	
4060	Land(Code 406)	-Not Used	0	0	0	0	
4070	Land(Code 407)	-Not Used	0	0	0	0	
4080	Land(Code 408)	-Acq.F,M/Sal,TrvlV,Cntr.S,Appr.	0	0	0	0	
4090	Land(Code 409)	-Surveys	0	0	0	0	
			0	0	0	0	
			0	0	0	0	
			0	0	0	0	
			0	0	0	0	
	Associated costs-sub-total		0	0	0	0	
4099	Land Contingency Sub-total		0	0	0	0	
	TOTAL LAND COSTS		0	0	0	0	

File: X:\2111\2111-00412-07 MoTI - Old Fort Rd Realignment\4.0 ENGINEERING DESIGN\4.3 Estimates\[2021-06-22 Old Fort Road Wolski Cost Estimate.xlsm]SUMOFEST

Company **McElhanney**

2021 Dollars **Old Fort Road Options Analysis**

ACTIVITY CODE **Proposed Design Concept**

Estimate Date: June 2021

Conceptual Est.

Blk Est. # 6.14A

Version Sept.1, 2002

			ID-1	ID-2	ID-3	ID-4	
		Divison\site	Old Fort	Old Fort	Old Fort	Old Fort	MR
		Road Type	Option F1 - Mitigate Existing Alignment Pave & improve slope stability, drainage, etc.	Option C1 New Access to West; South of Ex. Rd.	Option C2 South across one Island of Peace River	Option C South across two Islands of Peace River	OR
		DESCRIPTION \Length	1	1	1	1	TR
			520 MR	1679 MR	1923 MR	2120 MR	
9800		MANAGEMENT RESERVE	0	0	0	0	
	MAN. RES.	- planning	0	0	0	0	
	MAN. RES.	- preliminary design	0	0	0	0	
	MAN. RES.	- utility construction	0	0	0	0	
	MAN. RES.	- grade construction	0	0	0	0	
	MAN. RES.	- structural construction	0	0	0	0	
	MAN. RES.	- paving construction	0	0	0	0	
	MAN. RES.	- operation construction	0	0	0	0	
	MAN. RES.	- roadside construction	0	0	0	0	
	MAN. RES.	- other construction	0	0	0	0	
	MAN. RES.	- project management	0	0	0	0	
	MAN. RES.	- land	0	0	0	0	
	MAN. RES.	- detailed eng.	0	0	0	0	
	MAN. RES.	- residency eng.	0	0	0	0	
	MAN. RES.	- risk contingency	0	0	0	0	
	TOTAL MANAGEMENT RESERVE		0	0	0	0	
	TOTAL LESS ESCALATION						
9900	FISCAL ESCALATION YEAR	PROJECTED ESCALATION					
	2020-2021		0	0	0	0	
	2021-2022		0	0	0	0	
	2022-2023		0	0	0	0	
	2023-2024		0	0	0	0	
	2024-2025		0	0	0	0	
	2025-2026		0	0	0	0	
	2026-2027		0	0	0	0	
	2027-2028		0	0	0	0	
	2028-2029		0	0	0	0	
	TOTAL ESCALATION		0	0	0	0	
	PART 2 SUMMARY NON-CONSTRUCTION COSTS		0	0	0	0	
		Non-Construction	5,778,949	5,414,717	6,857,345	7,076,993	
		Non-Const. Contingency	2,889,475	2,707,359	3,428,672	3,538,496	
		TOTAL NON-CONSTRUCTION COSTS	8,668,424	8,122,076	10,286,017	10,615,489	
	DIVISION TOTAL FOR ROAD TYPE		134,297,750	125,833,316	159,358,723	164,463,158	

Old Fort Road Options Analysis

Conceptual Design Design volumes

ML Proj #: 2111-00412-07

Estimate Date: June 2021

Option ID		ID-1	ID-2	ID-3	ID-4
Option	Unit of Measure	Option F1 - Mitigate Existing Alignment Pave & improve slope	Option C1 Old Fort	Option C2 Old Fort	Option C
Dist	km	0.52	1.68	1.92	2.12
No. Lanes	ea	2.00	2.00	2.00	2.00
Lane Width	m	3.60	3.60	3.60	3.60
Median Width	m	0.00	0.00	0.00	0.00
Shoulder Width Total	m	1.00	1.00	1.00	1.00
Asphalt Thickness	mm	100	100	100	100
Road Width	m	8.2	8.2	8.2	8.2
Site Preparation					
Clearing and Grubbing	ha	0.63	1.54	1.58	1.74
Pavement Cutting	m		20	20	20
Pavement Removal	m^2		1200	1200	900
Grading					
Organic Stripping	m^3	1,500	10,524	14,375	15,635
Type D Excavation (Re-Use On Site)	m^3	8,320	22,507	12,441	2,478
Type A Excavation (Disposal Off Site)	m^3	0	7,502	4,147	826
Granular Borrow (Fill)	m^3	0	77,146	194,412	260,636
Shouldering	m^3	20	63	72	80
Select Granular Sub-Base	m^3	343	4,247	5,549	5,099
25mm Well Graded Base	m^3	312	3,011	3,934	3,615
Paving					
Supply and Apply Tack Coat	m^2	4,680	15,111	17,307	19,080
Class 1 Medium Mix Asphalt	tonne	1,032	3,332	3,816	4,207
Concrete Works					
Concrete Barrier (All Types)	m	1040	2519	3077	3392
Drainage					
Culverts (600mm)	m	21	67	77	85
Riprap - Class 100	m^3				
Riprap - Class 250	m^3	30	11,200	25,800	26,400
Bridge and Retaining Wall					
Bridge Demolition	m^2				
Bridge 1	m^2		1,140	1,140	1,710
Bridge 2	m^2		2,280	1,083	1,083
Bridge 3	m^2			2,394	2,394
Bridge Cost	m^2	**0**	**3,420**	**4,617**	**5,187**
Bridge Retaining Wall	m^2				
Demolition of Existing Bridge	L.S.				
Wall 1	m^2				
Retaining Wall	m^2	0	0	0	0
Lock Block Wall	m^2				
Signing and Pavement Markings					
Supply and Install Regulatory and Warning Sign	ea	4	4	6	6
Project Sign	ea	2	2	2	2
Paint Lines	m	1,560	5,037	5,769	6,360
Pavement Markings (i.e. stop bars, gores)	m^2				
Fencing and Landscaping					
Hydraulic Revegetation Seeding	m^2	5,200	16,790	19,230	21,200
Revegetation Planting	m^2				

Old Fort Road Options Analysis

Conceptual Design Design volumes

ML Proj #: 2111-00412-07

Estimate Date: June 2021

Option ID		ID-1	ID-2	ID-3	ID-4
Option	Unit of Measure	Option F1 - Mitigate Existing Alignment Pave & improve slope	Option C1 Old Fort	Option C2 Old Fort	Option C
Dist	km	0.52	1.68	1.92	2.12
No. Lanes	ea	2.00	2.00	2.00	2.00
Lane Width	m	3.60	3.60	3.60	3.60
Median Width	m	0.00	0.00	0.00	0.00
Shoulder Width Total	m	1.00	1.00	1.00	1.00
Asphalt Thickness	mm	100	100	100	100
Road Width	m	8.2	8.2	8.2	8.2
Electrical					
Traffic Signals	ea				
Luminaire Poles	ea				
Junction Boxes and Vaults	L.S.				
Utilites					
Overhead Hydro Relocation	m				600
Overhead TELUS Relocation	m				600
Hydro Duct Bank	m				
TELUS Duct Bank	m				
Utility Relocation - Sanitary	m				
Utility Relocation - Gas	m				
Utility Relocation - Water	m				
Utility Relocation - Storm Sewer	m				
Utility Relocation - Manhole (1050mm)	ea				
Rock Treatments					
Rock Scaling	m^3				
Rock Bolting	ea				
Rock Trimming	m^3				
Rock Wire Mesh	m^2				
Shotcrete	m^3				
Rock Trimming	m^2				

Old Fort Road Options Analysis
Average Unit Rates

ML Proj #: 2111-00412-07
Estimate Date: June 2021

Project Location:		Northern - Northeast																
Description	Unit of Measure	Unit Cost used for Cost Estimate	Avg.	Average Unit Rates From Projects in the Northeast Region														
				Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.
SITE PREPARATION																		
Clearing and Grubbing	ha	**$21,050**		$14,526	$32,401	$28,049		$20,459	$15,249	$8,368	$33,699		$9,002	$15,532			$32,000	$17,100
Remove Existing Concrete Catch Basins	ea	**$1,050**	$500	$500														
Removal and Disposal of Existing Concrete Barriers	m	**$126**						$63		$60	$58			$56				
Remove Existing Curbs & Gutters	m	**$32**	$15	$15														
Remove Existing Sidewalks	m^2	**$53**	$25	$25														
Remove and Dispose Existing Signs	ea	**$315**	$150	$150														
Pavement Cutting	m	**$59**	$10		$14			$31		$85	$21	$50	$7	$7		$8		$13
Pavement Removal	m^2	**$27**	$5		$12		$17	$18	$23	$7	$13		$6	$8	$17	$10	$5	
Cold Milling	m^2	**$43**	$6		$13						$15		$18	$13			$8	$13
GRADING																		
Organic Stripping	m^3	**$44**	$61	$19	$16	$20		$18	$27		$22	$26	$8	$16	$12	$9		$11
Type D Excavation (Re-Use On Site)	m^3	**$43**		$24		$20	$19	$37	$28	$13	$20	$16	$11	$17		$12		$15
Type A Excavation (Disposal Off Site)	m^3	**$114**	$55	$26	$54													
Granular Borrow (Fill)	m^3	**$104**					$20		$139	$13	$35	$48		$72	$20			
Shouldering	m^3	**$475**	$120		$197		$155		$292	$143	$182							
Select Granular Sub-Base	m^3	**$116**	$68		$36		$54	$49	$151		$43	$47	$40	$60	$54	$49	$26	
25mm Well Graded Base	m^3	**$136**	$72	$70	$50		$63	$65	$157		$47	$57	$47	$72	$63	$57	$35	$65
PAVING																		
Supply and Apply Tack Coat	m^2	**$3.2**	$1.5	$2								$2	$1	$1.30	$1.42	$0.33		
Class 1 Medium Mix Asphalt	tonne	**$441**						$232		$223		$256	$191	$159	$141	$210		$201
HP150 Asphalt Emulsion	L	**$4**	$1				$2			$2								
Produce Class "B" Double Graded Seal Coat Aggregate	m^3	**$11**	$5	$5														
Apply Class "B" Double Graded Seal Coat Aggregate	m^2	**$11**	$5	$5														
CONCRETE WORKS																		
Curb, Combined C&G	m	**$768**	$150		$366													
Curb, Mountable	m	**$315**	$150	$150														
Concrete Island	m^2	**$315**	$150	$150														
Curb, Median or Island	m	**$360**	$150	$150									$190					$174
Supply and Install Impact Attenuators	ea	**$31,500**	$15,000	$15,000														
Concrete Sidewalk	m^2	**$378**	$150		$180													
Concrete Barrier (All Types)	m	**$377**	$191	$150			$139	$111	$211	$205	$111	$172		$249	$191			
DRAINAGE																		
Culverts (600mm)	m	**$1,025**	$500							$530		$404	$300	$412	$727			
Culverts (900mm)	m	**$1,685**								$821				$560	$1,179		$680	$520
Culverts (1400mm)	m	**$4,240**	$1												$2,019			
Catch Basin	ea	**$4,830**	$2,300														$1,735	
Double Catch Basin	ea	**$6,458**	$2,800	$3,350													$2,678	
1050mm Manhole (c/w Frame and Cover)	ea	**$9,450**	$4,500	$4,500														
Catch Basin Lead	m	**$735**	$350														$156	
Headwall, Culvert	ea	**$8,925**	$2,200	$5,000	$3,500													
Headwall, Box Culvert	ea	**$347,550**	$16,500	$165,500														
Oil Grate Separator	ea	**$63,000**	$30,000	$1														
300mm HDPE Storm Sewer	m	**$630**	$300	$1														
375mm HDPE Storm Sewer	m	**$683**	$325	$1														
450mm HDPE Storm Sewer	m	**$840**	$400	$1														
525mm HDPE Storm Sewer	m	**$1,050**	$500	$1														
600mm HDPE Storm Sewer	m	**$1,155**	$550	$1														
750mm HDPE Storm Sewer	m	**$1,260**	$600	$1														

Old Fort Road Options Analysis
Average Unit Rates

ML Proj #: 2111-00412-07
Estimate Date: June 2021

Project Location:		Northern - Northeast																
Description	Unit of Measure	Unit Cost used for Cost Estimate	Avg.	Average Unit Rates From Projects in the Northeast Region														
				Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.
1050mm HDPE Storm Sewer	m	$1,680	$800	$1														
Swales c/w Sand & Gravel, Non-Woven Geotextile and Hydroseed	m	$567	$270	$1														
4500 x 2300 Concrete Box Culvert	m	$31,500	$15,000	$1														
3000 x 1800 Concrete Box Culvert	m	$17,325	$8,250	$1														
2400 x 1500 Concrete Box Culvert	m	$11,046	$5,260	$1														
Asphalt Spillways	ea	$4,136	$660				$1,900	$1,672	$1,418	$1,064	$2,228						$985	
Non-Woven Geotextile	m^2	$16	$7	$11			$6	$29	$7	$2			$2		$6	$3		$4
Treatment Devices	ea																	
Splash Pads for Conc Lock Block RW	m^2	$945	$450	$1														
Riprap - Class 100	m^3	$300	$60				$158		$207	$182	$93				$158		$45	
Riprap - Class 250	m^3	$393	$150	$142			$195			$220					$195			
Riprap - Class 500	m^3	$415					$180			$216					$180			
BRIDGE AND RETAINING WALL																		
Bridge Demolition	m^2	$3,150	$1,500	$1														
Bridge 1		$14,700	$7,000	$1														
Bridge 2		$14,700	$7,000	$1														
Bridge 3		$14,700	$7,000	$1														
Bridge 4		$14,700	$7,000	$1														
Bridge 5		$14,700	$7,000	$1														
Bridge Cost	m^2	$14,700	$7,000	$1														
Bridge Retaining Wall	m^2	$3,150	$1,500	$1														
Demolition of Existing Bridge	L.S.	$840,000	$400,000	$1														
Bridge Demolition - Timber	L.S.																	
Foundation Excavation and Backfill	m^3	$121		$38			$66				$55							
Bridge End Fill	m^3	$229		$86			$71	$87	$228	$131	$66							
Deck Formwork	m^2	$1,251		$463			$636	$329		$356	$463							
Substructure Formwork	m^2	$1,051		$463			$820	$360		$257	$367							
Uncoated Deck Reinforcing Steel	kg																	
Uncoated Substructure Reinforcing Steel	kg																	
Stainless Deck Reinforcing Steel	kg																	
Cast-In-Place Concrete - Superstructure	m^3																	
Deck Concrete	m^3	$4,969		$1,331			$1,366	$2,411		$956	$1,618							
Substructure Concrete	m^3	$2,354		$999			$1,029	$1,218		$698	$1,134							
Supply and Fabrication of Structural Steelwork	tonne																	
Shipping and Erection of Structural Steelwork	tonne																	
Deck Joints	m																	
Elastomeric Bearings - Abutments	ea																	
Elastomeric Bearings - Piers	ea																	
Standard Bridge Parapet Bicycle Railing	m	$849						$549		$349	$283							
Deck Drains	ea																	
Parapet Surface Treatment	m^2																	
Wall 1																		
Wall 2																		
Wall 3																		
Wall 4																		
Wall 5																		
Retaining Wall	m^2	$2,898	$1,560								$738						$1,200	
Lock Block Wall	m^2	$1,218	$500														$580	

Old Fort Road Options Analysis
Average Unit Rates

ML Proj #: 2111-00412-07
Estimate Date: June 2021

Project Location:		Northern - Northeast																	
Description	Unit of Measure	Unit Cost used for Cost Estimate		Average Unit Rates From Projects in the Northeast Region															
			Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.
SIGNING AND PAVEMENT MARKINGS																			
Supply and Install Regulatory and Warning Sign	ea	**$1,472**	$475	$678	$950		$1,247	$538	$936	$541	$726	$767	$488	$344		$354			
Project Sign	ea	**$5,250**	$2,500	$1															
Supply and Install Post Mounted Guide Sign	ea	**$9,146**	$5,500		$3,210					$1,887									
Supply and Install Cantilever Sign Structure	ea	**$210,000**	$100,000	$1															
Supply and Install Guide Sign Bridge	ea	**$315,000**	$150,000	$1															
Remove and Dispose of Existing Regulatory and Warning Sign	ea	**$439**		$1						$209									
Remove and Dispose of Existing Post Mounted Guide Sign	ea	**$1,050**	$500	$1															
Remove and Dispose of Existing Guide Sign Structure	ea	**$4,999**		$1						$2,380									
Paint Lines	m																		
Pavement Markings (i.e. stop bars, gores)	m^2	**$53**	$25	$1															
Supply and Install Yellow Recessed Pavement Reflectors	ea	**$32**	$15	$1															
Supply and Install Raised Pavement Markers	ea	**$32**	$15	$1															
Rumble Strips	km	**$6,510**	$3,100	$1															
Install White Delineator Posts	ea	**$32**	$15	$1															
Install White Delineator Posts-Gravel	ea	**$32**	$15	$1															
FENCING AND LANDSCAPING																			
Hydraulic Revegetation Seeding	m^2	**$3**	$1	$1	$1	$1	$1		$5	$1	$1	$0.90	$0.67						
Revegetation Planting	m^2	**$3**	$2							$0									
Habitat Protection Fence	m	**$420**	$200	$1															
Steel Bicycle Sidewalk Fence	m	**$509**	$211	$1			$273												
Steel Pedestrian Sidewalk Fence	m	**$443**	$211	$1															
Chainlink Fence	m	**$195**	$93	$1															
Soundwall	m^2	**$1,533**	$730	$1															
ELECTRICAL																			
Traffic Signals	ea	**$577,500**	$275,000	$1															
Luminaire Poles	ea	**$17,850**	$8,500	$1															
Junction Boxes and Vaults	L.S.	**$1,459**		$1	$695														
Conduit	L.S.																		
Wiring	L.S.	**$18,915**		$9,007	$9,007														
Service Equipment	L.S.																		
Intelligent Transportation System Devices	L.S.																		
Detection Loops	L.S.																		
Traffic Signals	L.S.																		
Post Mounted Flashers	L.S.	**$94,500**	$45,000	$1															
LED Fixtures (not supplied by MoTI)	L.S.																		
Fibre Optic Works (Third Party/MoTI)	L.S.																		
UTILITIES																			
Overhead Hydro Relocation	pole	**$8,400**	$4,000	$4,000															
Overhead TELUS Relocation	pole	**$8,400**	$4,000	$4,000															
Hydro Duct Bank	m	**$336**	$160	$130															
TELUS Duct Bank	m	**$168**	$80	$80															
Utility Relocation - Sanitary	m	**$525**	$250								$0								
Utility Relocation - Gas	m	**$462**	$220	$220															
Utility Relocation - Water	m	**$462**	$220								$0								

Old Fort Road Options Analysis

Average Unit Rates

ML Proj #: 2111-00412-07
Estimate Date: June 2021

Project Location:		Northern - Northeast																
Description	Unit of Measure	Unit Cost used for Cost Estimate	Avg.	Average Unit Rates From Projects in the Northeast Region														
				Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.
Utility Relocation - Storm Sewer	m	**$1,050**	$500	$1														
Utility Relocation - Manhole (1050mm)	ea	**$8,610**									$0						$4,100	
ROCK TREATMENTS																		
Rock Scaling	m^3	**$210**	$100	$1														
Rock Bolting	ea	**$1,197**	$570	$1														
Rock Trimming	m^3	**$628**	$299	$299														
Rock Wire Mesh	m^2	**$122**	$58	$58														
Shotcrete	m^3	**$4,043**	$1,485	$1,925														
Rock Trimming	m^2																	
RAILWAY																		
Rail Removal	m																	
Rail - New	m																	
Ballast	m^3																	
Subballast	m^3																	
DETOURS																		
Temporary Detours During Construction	L.S.	**$210,000**	$100,000	$100,000														

Purple text - guesstimate

Red text - placeholder, does not represent true value

APPENDIX D

Statement of Limitations

Statement of Limitations

Use of this Report. This report was prepared by McElhanney Ltd. ("**McElhanney**") for the particular site, design objective, development and purpose (the "**Project**") described in this report and for the exclusive use of the client identified in this report (the "**Client**"). The data, interpretations and recommendations pertain to the Project and are not applicable to any other project or site location and this report may not be reproduced, used or relied upon, in whole or in part, by a party other than the Client, without the prior written consent of McElhanney. The Client may provide copies of this report to its affiliates, contractors, subcontractors and regulatory authorities for use in relation to and in connection with the Project provided that any reliance, unauthorized use, and/or decisions made based on the information contained within this report are at the sole risk of such parties. McElhanney will not be responsible for the use of this report on projects other than the Project, where this report or the contents hereof have been modified without McElhanney's consent, to the extent that the content is in the nature of an opinion, and if the report is preliminary or draft. This is a technical report and is not a legal representation or interpretation of laws, rules, regulations, or policies of governmental agencies.

Standard of Care and Disclaimer of Warranties. This report was prepared with the degree of care, skill, and diligence as would reasonably be expected from a qualified member of the same profession, providing a similar report for similar projects, and under similar circumstances, and in accordance with generally accepted engineering and scientific judgments, principles and practices. McElhanney expressly disclaims any and all warranties in connection with this report.

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.

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/report preparation. 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.

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 Cost Estimates. This construction cost estimate has been prepared using the design and technical information currently available. Furthermore, McElhanney cannot predict the competitive environment, weather or other unforeseen conditions that will prevail at the time that contractors will prepare their bids. The cost estimate is therefore subject to factors over which McElhanney has no control, and McElhanney does not guarantee or warranty the accuracy of such estimate.

Contact
Parm Nahal, P.Eng.
604-424-4882
pnahal@mcelhanney.com

McElhanney

CANADA BEST MANAGED COMPANIES