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18-11

**WFS PHARMAGREEN INC.**
12293 Cardinal St
Mission, BC, V4S 1L3

**Attention:** **Peter Wojcik**
CEO/Director

**Via email:** pwojcik@telus.net
cc: Gary Fields (gary@garyfields.ca)
Dawn Smith, FVRD (Dsmith@fvrd.ca)

**Subject:** **38482 Bell Road, Deroche, BC**
**Natural Hazards Mitigation Scenario Analysis**

## 1 INTRODUCTION AND BACKGROUND

This letter report is a supplemental document to the Natural Hazards Assessment for the property at 38482 Bell Road, Deroche, BC (the Subject Property) dated May 15, 2018 by Stirling Geoscience. The purpose of this follow-up letter report is to provide a brief summary of the May 15, 2018 report followed by an analysis of five mitigation scenarios for protecting the proposed development and the Subject Property from the identified natural hazards. The objective of the May 15, 2018 Natural Hazards Assessment was to identify and assess the flood and erosion hazards that may affect the safe development and use of the Subject Property.

The Subject Property is within the Fraser Valley Regional District (FVRD) Electoral Area "G" where a 40,000 square foot industrial building is proposed. The Natural Hazards Assessment is intended to support the Development Permit, the Building Permit and the Site Specific Exemption (SSE) applications for the proposed development. The SSE is required because the Subject Property is on the floodplain of the Fraser River and in a non-diked area. The primary hazards addressed in the May 15, 2018 report are flooding and scour from the Fraser River and Norrish Creek.

The Subject Property is situated north of Highway 7 near Dewdney and east of Hatzic and west of Deroche, 3.1 km north of the Fraser River (Figure 1). The property is on the alluvial fan of Norrish Creek and the Floodplain of the Fraser River between Norrish Creek 500 m to the east and Chilqua Creek 400 m to the west (Figure 2). The legal description of the property is:

*Lot 4 Plan NWP29269 Section 33 Township 20 Land District 36 & OF NW 1/4 SEC 34; EXC PCL A REF PL 53267.*

The proposed development is a licensed medicinal marijuana grow operation. Phase 1 will include a federal government licensed marijuana tissue culture laboratory and Phase 2 will include a federal government licensed marijuana grow operation. The Subject Property is approximately 24.4 ha, all of which is on the alluvial fan of Norrish Creek and most of the property is on the floodplain of the Fraser River except for the northeast portion.

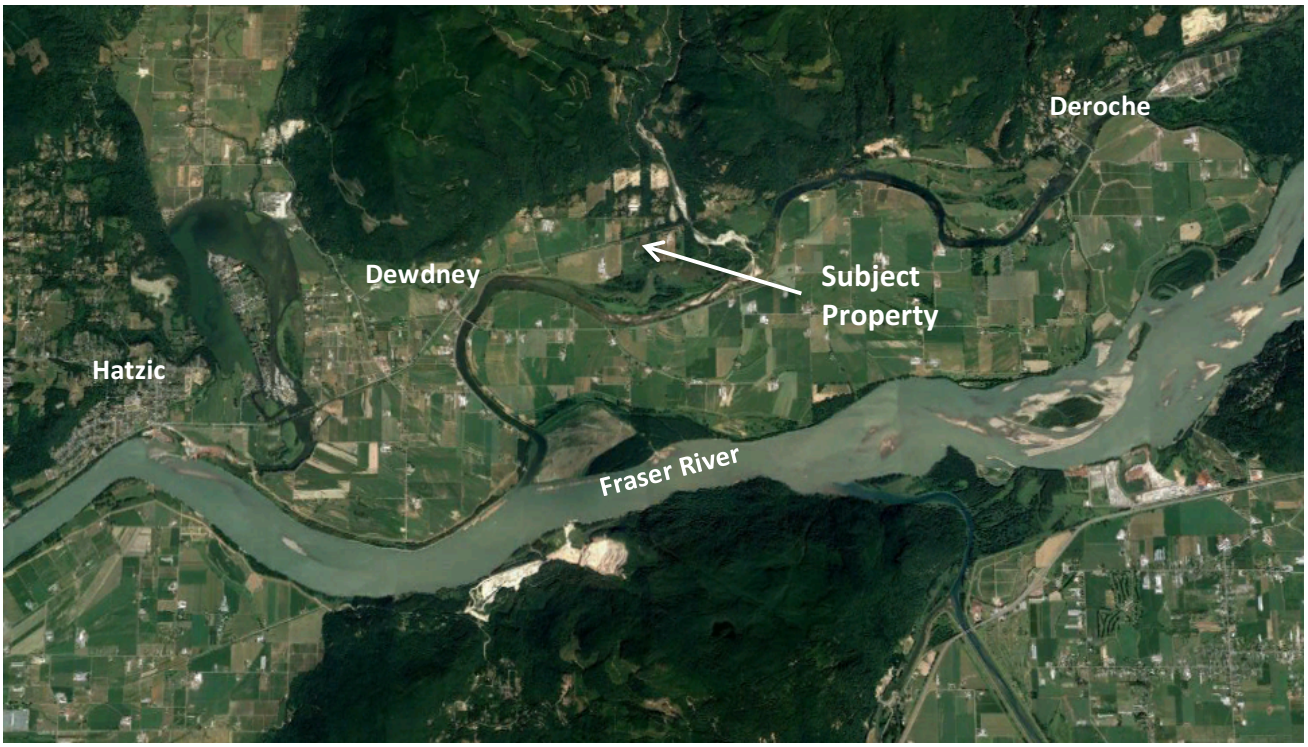


**Figure 1: 38482 Bell Road Study Site (Google Earth 2017)**

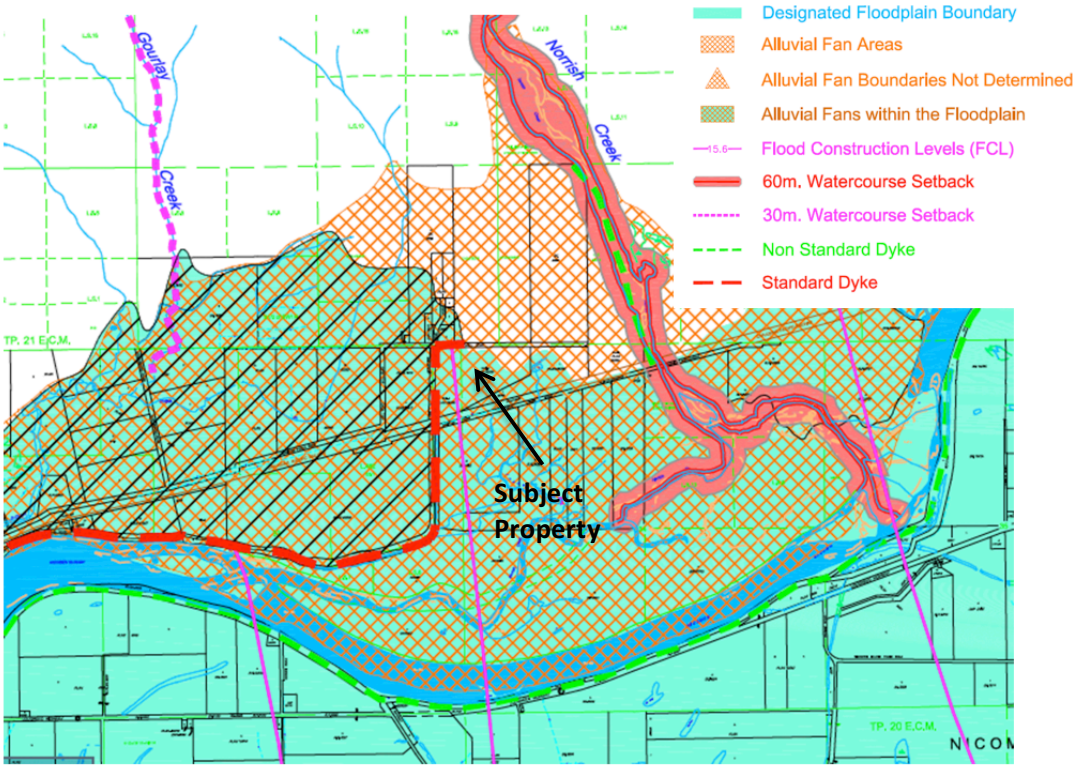


**Figure 2: Subject Property and the Norrish Creek Fan (FVRD Flood Hazard Bylaw No. 0681-2005, Sch A, Map 8)**

The site is within a non-diked area of the Fraser River. The Dewdney Dike, which is a Standard Dike, is immediately to the west of the property protecting land to the west and south (Figure 2).

The Subject Property is susceptible to high water levels due to flooding on the Fraser River and potential hydrotechnical hazards emanating from nearby Norrish Creek. Hydrotechnical hazards are defined as flooding, debris floods, debris flows, erosion, deposition, scour and avulsion, typically due to channelized flow.

With regards to flood and erosion hazards from Norrish Creek, no modelling was done as part of the May 15, 2018 assessment. Potential hazards could include flooding, erosion, debris floods, debris flows and avulsions. Due to the nature of alluvial fans, hazards from Norrish Creek exist at the Subject Property. These hazards are partially mitigated because of the armoured Norrish Creek Dike along the right (west) bank (Figure 2 and Figure 3). The hazards are only partially mitigated because the dike is classified as a Non-Standard Dike and therefore cannot be relied upon to fully protect the Subject Property from creek hazards.

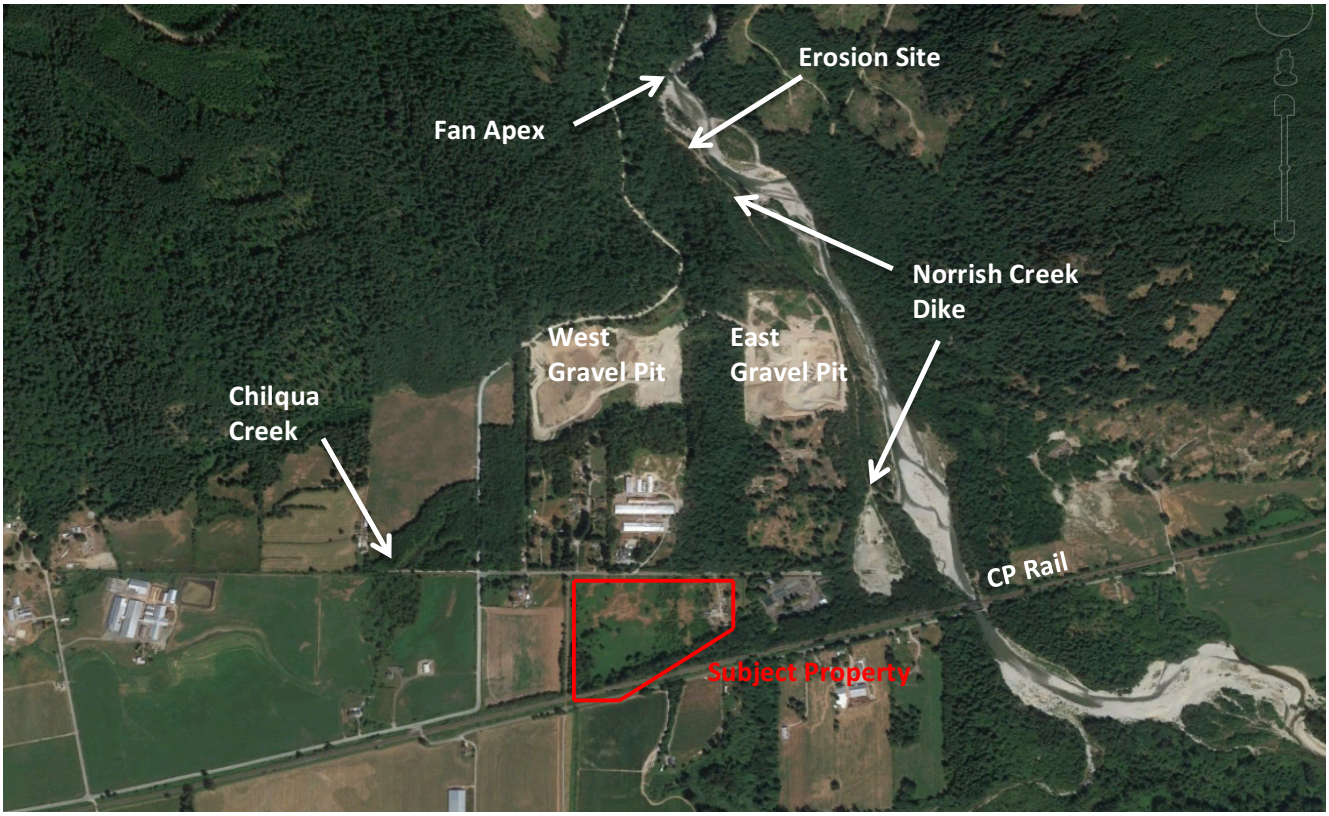


**Figure 3: Norrish Creek Fan (Google Earth 2017)**

## 2 MITIGATION MEASURES FOR THE SUBJECT PROPERTY AND THE PROPOSED DEVELOPMENT

As detailed in the May 15, 2018 report, it is recommended that a Flood Construction Level (FCL) of 10.8 m be adopted for the Subject Property for the proposed industrial building. This FCL would apply to the entire Subject Property. This is based on a water level of 10.2 m representing the 1894 flood of record corresponding to a 500-year flood (FLNRO, March 2014) plus 0.6 m freeboard. This freeboard will also allow for sufficient elevation above the existing surrounding ground to account for potential inundation from flooding or an avulsion from

Norrish Creek. In general, all development on fans such as the Norrish Creek fan should have an FCL of at least 0.6 m above the surrounding ground. This value is recommended in the absence of a 2D model that could identify flood depths on the fan from Norrish Creek in the event of an avulsion or breach of the dike. This recommendation of an FCL 0.6 m above the existing ground on fans is suggested in other site specific reports in the area and is also documented in a report prepared by FEMA titled *Engineering Principles and Practices for Retrofitting Flood-Prone Residential Structures, Appendix D Alluvial Fan Flooding*.

The proposed building should include scour protection along the perimeter concrete foundation. This will protect the building from scour from Norrish Creek during an avulsion or dike overtopping as well as scour from extreme flooding from the Fraser River. Potential scour from the river would likely be less than that from the creek. The design criteria for the mitigation include the following: the scour protection should be durable, angular, quarried rock, which is well-graded with a $D_{50}$ of 350 mm. Rock of this size represents 50 kg class riprap. The rock should be placed around the proposed concrete foundation walls. The protection should extend to the base of the proposed foundation walls/footings. This protection should be a minimum of 0.6 m thick and a minimum of 1.5 m wide. If the rock is placed on a slope then the slope should be no steeper than 2H:1V. The rock can be covered with soil (e.g., 0.3 m thick) and grass and or landscaping.

Scour would be greatest on the north (upslope) and east (upstream) facing sides of the building from an event on Norrish Creek and less on the west and south sides from an event on the Fraser River. If concrete sidewalks or asphalt parking lots are proposed on the west or south sides of the building, this may suffice for scour protection, depending on the design, but would not be suitable for the north and east sides alone.

## 3 MITIGATION SCENARIOS

Mitigation for the Subject Property and the proposed development from flooding and scour hazards is detailed in the May 15, 2018 report and summarized above in Section 2. This mitigation pertains to the entire Subject Property and the proposed industrial building regardless of where on the property the building is situated. Five scenarios were considered regarding where on the Subject Property the proposed building could be constructed and how the building will be protected. The five scenarios include:

- Scenario 1: Development situated in the Northeast portion of the property outside of the Standard Dike area. Building footprint to be raised to the recommended FCL with scour protection.
- Scenario 2: Development situated in the Northwest portion of the property. Building footprint to be raised to the recommended FCL with scour protection and integrated into the Dewdney Dike along the West Property line. This would result in an extension of the Dewdney Area Improvement District (DAID) Standard Dike.
- Scenario 3: Development of a new Standard Dike to protect the property and the proposed development.
- Scenario 4: Alternative property within the Standard Dike area.
- Scenario 5: Subdivision – Create additional lots and construct a Standard Dike.

Details regarding the five scenarios and the advantages and disadvantages of each are summarized in Table 1 and Figure 4 shows the location Scenarios 1 and 2. Scenarios 3 and 5 would include the entire Subject Property. The scenarios are listed in order of preference for the various reasons detailed in Table 1. Scenario 1:

**TABLE 1: Evaluation of Hazard Mitigation Scenarios**

| Scenario | Description | Anticipated Process and Approvals | Advantages | Disadvantages |
|---|---|---|---|---|
| 1 | Development situated in the Northeast portion of the property outside of the Standard Dike area. Building footprint to be raised to the recommended Flood Construction Level (FCL) with scour protection. | Site Specific Exemption (SSE), Building Permit, and Development Permit required by the Fraser Valley Regional District (FVRD).<br><br>Covenant required and possibly will be considered a FVRD Service Area. | 1. The proposed FCL and scour protection for the development would provide greater protection than provided by the Dewdney Dike. The recommended building footprint FCL of 10.8 m is higher than the Dewdney Dike crest of 10.1 m and the fill pad would be armored to protect against scour whereas the Dewdney Dike is not armoured. Therefore, the building would have a higher level of protection compared to being inside the existing dike.<br>2. The higher FCL of the proposed development compared to the existing dike would not be visibly noticeable as the structures would not be connected to each other which is not the case with Scenario 2.<br>3. The Northeast portion of the property is on the highest ground on the property, which is outside of the Fraser River floodplain as shown on the FVRD Flood Hazard Bylaw No. 0681-2005, Schedule A, Map 8.<br>4. By raising just the building footprint we minimize the potential to transfer flood and scour risk to neighboring properties compared to raising the entire property or diking the entire property.<br>5. Approval and oversight process is limited to the FVRD and does not require approval from Forest, Lands, Natural Resource Operations (FLNRO), only their review.<br>6. Mitigation construction as well as operation and maintenance would be the responsibility of the property owner, therefore less onerous for the FVRD and FLNRO.<br>7. Mitigation is independent of the Dewdney Dike and does not tie into or result in an extension of the existing dike.<br>8. Development on the Northeast portion of the property results in the least fill pad volume and smallest raised footprint compared to the other Scenarios. In general, the smaller the raised footprint the less likely of transferring flood and scour hazards to neighbouring properties.<br>9. In the event of flooding or an avulsion from Norrish Creek, flow could be directed around both the east and west side of the raised building footprint and potentially remain on the Subject Property, hence potentially minimizing impact to neighbouring properties.<br>10. Long term Operation and Maintenance will be addressed if the site becomes a FVRD Service Area. | 1. In general, this scenario is a concern to the FVRD as it is contrary to the Official Community Plan (OCP) policy which directs development to within standard diked areas.<br>2. FVRD has liability concerns due to issuance of SSE approval and potential service area responsibility.<br>3. Requires Regional Board discretionary approval for SSE, covenant and service area. There may likely be a high level of concern from the Board and support from the Board is uncertain.<br>4. Based on the disadvantages, there is a risk of this scenario not being approved. |
| 2 | Development situated in the Northwest portion of the property. Building footprint to be raised to the recommended FCL with scour protection and integrated into the Dewdney Dike along the West property line.<br><br>This would result in an extension of the Dewdney Area Improvement District (DAID) Standard Dike. | Building Permit and Development Permit required by the FVRD. Dike Maintenance Act approval required by FLNRO. Dike extension approval required by DAID.<br><br>Possibly will be considered a FVRD Service Area. | 1. No SSE approval required from the FVRD.<br>2. No FVRD Regional Board approval required.<br>3. Delegated FVRD staff approval. | 1. Development on lower ground on the West portion of the property will result in a larger (higher and wider) fill pad to reach the FCL compared to Scenario 1.<br>2. In general, the larger the raised footprint the more likely the potential to transfer flood and scour hazards to neighbouring properties.<br>3. Requires processes and approvals from FLNRO and DAID to tie into or extend the existing dike which could be challenging.<br>4. The west side of the property is lower in elevation than the east side and is entirely within the Fraser River floodplain.<br>5. The higher FCL of the proposed development compared to the existing dike would be visibly noticeable as the structures would be connected to each other.<br>6. In the event of flooding or an avulsion from Norrish Creek, flow could be directed around either the east side of the raised building footprint or to the west of the Dewdney Dike potentially affecting the neighbouring property. |

| Scenario | Description | Anticipated Process and Approvals | Advantages | Disadvantages |
|---|---|---|---|---|
| 3 | Development of a new Standard Dike to protect the property and the proposed development. | Building Permit and Development Permit required by the FVRD. Dike Maintenance Act approval required by FLNRO. Dike extension approval required by DAID. Possibly will be considered a FVRD Service Area. | 1. No SSE approval required from the FVRD.<br>2. No FVRD Regional Board approval required.<br>3. Delegated FVRD staff approval. | 1. This scenario would be difficult as it requires multiple property involvement and it would have a large footprint, especially along the low lying Southwest portion of the property. This scenario may require dealing CP Rail and the Fish Hatchery (DFO) which could be challenging.<br>2. In order for the mitigation structure to be considered a Standard Dike it must protect multiple properties as per FLNRO requirements.<br>3. Requires processes and approvals from FLNRO and DAID to tie into or extend the existing dike which could be challenging. |
| 4 | Alternative property within the Standard Dike area. | Building Permit and Development Permit required by the FVRD. | 1. No SSE approval required from the FVRD.<br>2. No FVRD Regional Board approval required.<br>3. Delegated FVRD staff approval.<br>4. No FLNRO or DAID approval required. | 1. It would be challenging to construct to the Fraser River FCL behind the Dewdney Dike which is several meters above the existing ground in most areas.<br>2. Would require a SSE if it is not feasible to construct to the Fraser River FCL. |
| 5 | Subdivision – Create additional lots and construct a Standard Dike. | Building Permit and Development Permit required by the FVRD.<br><br>Possibly will be considered a FVRD Service Area. | 1. No SSE approval required from the FVRD.<br>2. No FVRD Regional Board approval required. | 1. Subdivision is not permitted under current R-3 zone.<br>2. Zoning requires public hearing and OCP amendment.<br>3. As per FVRD requirements, R-3 zone requires 8.0 hectare minimum parcel size and the Subject Property lot is too small for subdivision. |

Development situated in the Northeast portion of the property is preferred from a hydrotechnical, engineering and hazard mitigation perspective. Scenario 2: Development situated in the Northwest portion of the property would be proposed if approval for Scenario 1 were to be rejected by the FVRD. Scenarios 3, 4 and 5 would be challenging but will be pursued if Scenarios 1 and 2 were both rejected.

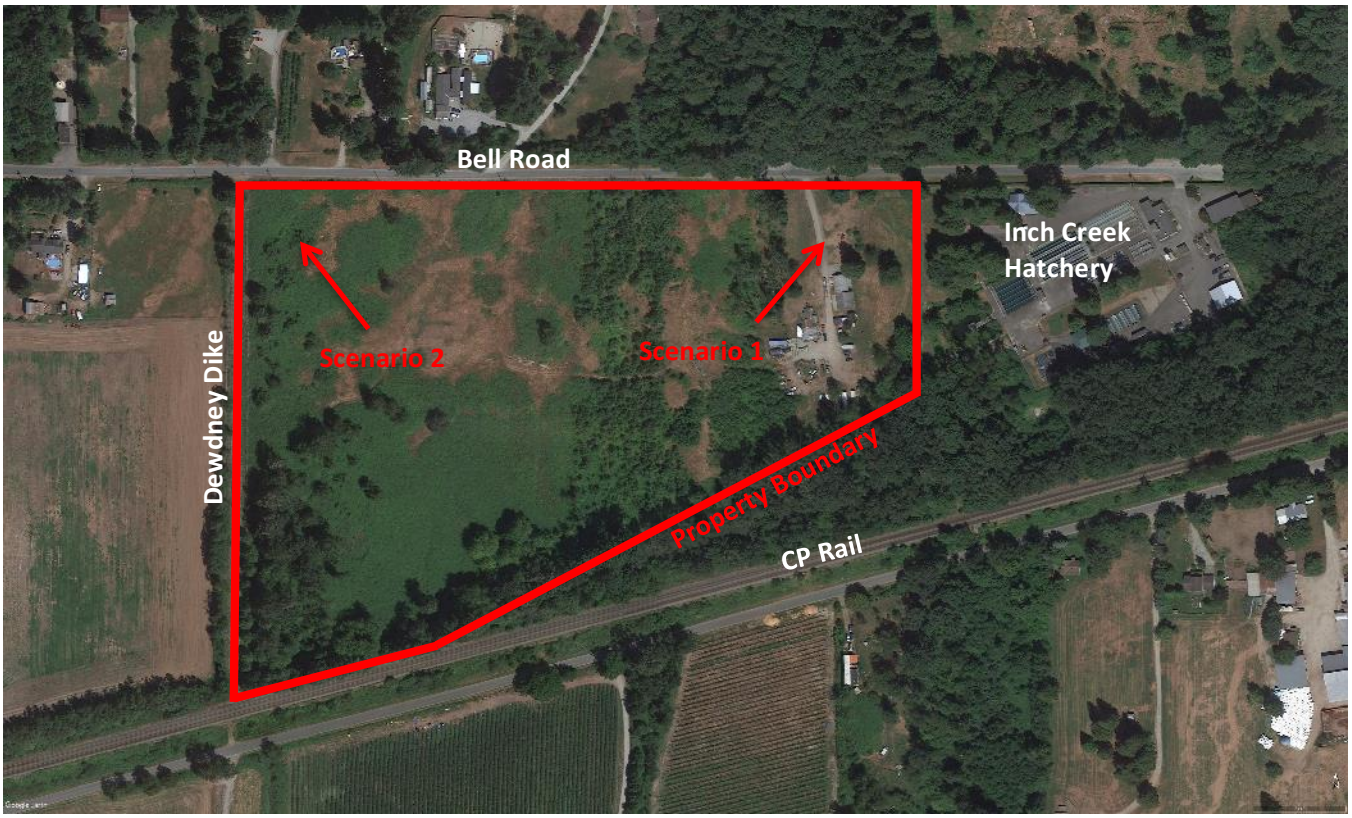


**Figure 4: Subject Property and the Location of Scenarios 1 and 2 (Google Earth 2017)**

## 4 CLOSURE

The author trusts this work and report meets your current needs. If you have any questions or would like to further discuss these findings, please do not hesitate to contact Jamie Stirling by email (Jamie@stirlinggeoscience.com) or by telephone (604) 349-7709.

Sincerely,

**Stirling Geoscience**

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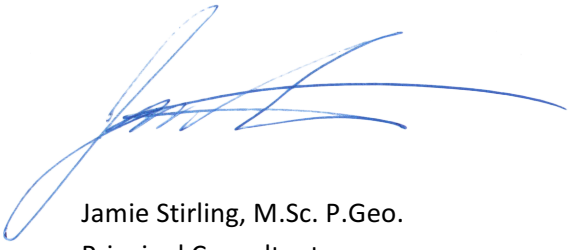

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Principal Consultant

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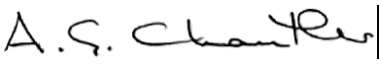

Adrian Chantler, Ph.D. P.Eng.

Consulting Hydrotechnical Engineer

**DISCLAIMER**

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## 5 REFERENCES

BC Ministry of Forest, Lands, and Natural Resource Operations. Fraser River Design Flood Level Update – Hope to Mission, Final Report. Flood Safety Section. March 2014.

Stirling Geoscience. 38482 Bell Road, Deroche, BC Natural Hazards Assessment. May 15, 2108.