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Yukon Government  
Community Services - Lands Management Branch  
Box 2703 - Whitehorse, Yukon - Y1A 2C6

October 1<sup>st</sup>, 2019

**Attention: Mr. Kevin Fisher, Project Manager, Rural Land Development**

**Re: SOA# 2017/2018-2753  
Geotechnical Feasibility Assessments  
Proposed Lot Infill Developments  
Guggieville Industrial Subdivision Area  
Preliminary Findings  
Dawson City, Yukon - 2019**

Dear Mr. Fisher;

## **1.0 INTRODUCTION**

As per your request, we have prepared the following letter report to present our preliminary findings relative to geotechnical feasibility assessments we conducted at three (3) proposed infill areas (#1 through #3) located in the Guggieville Industrial Subdivision Area in Dawson City, Yukon.

As you're aware, the purpose of our geotechnical feasibility assessments was to delineate regions which may be geotechnically suitable for development and provide general recommendations regarding infrastructure development as may be deemed feasibility. As our assessment is preliminary in nature, further evaluation will be required through drilling/test pit methodologies to verify site specific geotechnical parameters if development is deemed feasible and so this should be considered.

Our preliminary findings presented herein are based upon data which has been collated to date. Specifically, this data was comprised of information retained during our literature review and site reconnaissance as described below.

The locations and approximate size of the three infill sites have been illustrated below for reference purposes.



## 2.0 METHODOLOGY

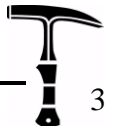
Our firm conducted a literature review and field work program to retain information regarding the respective sites.

### 2.1 Literature Review

The literature we reviewed was comprised of the following information;

#### *Surficial Geology Map*

A 1:25,000 surficial geology map (Open File 2014-12) entitled Surficial Geology, Dawson Region, Yukon – Parts of NTS 115O/14 & 15 and 116B/1, 2, 3 & 4 compiled by K.McKenna and P.Lipovsky - *Yukon Geological Survey* was reviewed to provide insight into the regional geomorphology.



In general, the surficial geology map indicated that the deposits which are predominately located in the study areas are comprised of anthropogenic deposits. These deposits are comprised of soils which have been significantly disturbed due to human activities. In the case of the study area, the anthropogenic materials are predominately comprised of mine tailings which were derived from fluvial deposits.

A region of fluvial deposits was identified in the eastern realms of Infill #3. These deposits are known to be comprised of a sequence of organics and fine-grained silts which overlie coarse grained sands and gravels. Fluvial flood overbank deposits were identified in the northern realms of Infill #2.

### ***Bedrock Geology Map***

A bedrock geology map, available through the *Yukon Geological Survey*, identified the regional bedrock types and characteristics within the study area. The map was entitled *Yukon Bedrock Geology Map – Yukon Geological Survey – Open File 2016-1 - 1:1,000,000* scale compiled by M.Colpron, S.Israel, D.Murphy, L.Pigage, and D.Moynihan. A more detailed delineation of these contacts was found on the *Yukon Geological Survey* website.

In brief, the geology maps indicate that the site is underlain by predominately, green schist to lower amphibolite facis metamorphic rocks of the Yukon-Tanana Terrane. While the depth to bedrock in the low-lying valley regions will vary, it is understood that it is typically encountered at depths of 20 to 30 meters in this region of the Klondike Valley.

### ***Topographical Information***

The regional topography was assessed by viewing a 1:50,000 scale topographical map (116 B03 Dawson) and the *YG- Water Placer Atlas* website.

These maps showed the study areas are located in a low-lying area in the Klondike River Valley.

### ***Aerial Photographs***

A selection of aerial photographs was obtained from *YG – Energy, Mines and Resources* to allow for a more detailed assessment through airphoto terrain analysis. These photos allowed for a relative assessment of regional development which has occurred in the region of the study areas.



### ***Satellite Imagery***

A review of satellite imagery available from *Google Earth* allowed for an assessment of the site conditions relative to the more recent imagery. The imagery which was viewed was dated between September 2006 and June 2019.

### ***Other Resources***

The *Yukon Government – Water Placer Atlas* website was reviewed as it provided the boundaries of various land dispositions, mining claims, drainage regimes and other similar types of information.

### ***Technical Studies***

A report entitled Dawson Natural Landscape Hazards – Geoscience Mapping for Climate Change Adaptation Planning Report compiled by the *Northern Climate ExChange – Yukon Research Center – Yukon College* (B.Benkert, K.Kennedy, D.Fortier, A.Lewkowicz, L.Roy, K.Grandmont, I.de Grandpre, S.Laxton, L.McKenna and K.Moote), 2015 was reviewed to provide additional background regarding the natural hazard potential in the regions of the study areas.

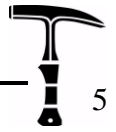
This report was compiled to serve as a baseline to allow for climate change adaptation planning as adverse effects of a warming environment have become a reality in northern Yukon. The intent was to generate a hazards map to help identify the potential for permafrost thaw, landslides and flooding. Their study area paralleled the limits of a 1:25,000 surficial geology map (Open File 2014-12).

In general, the report classified the terrain in the region of the infill areas as having a low hazard potential. The exception to this was Infill #3 where a moderate hazard rating was identified in the region which coincided with the presence of the fluvial deposits located in the eastern realms of the site.

The above noted information was collated prior to conducting the field work program such that site specific geological features could be assessed during the field work program.

## **2.2 Field Work Program**

The field work program involved conducting a site reconnaissance. This work was conducted by the undersigned on September 19<sup>th</sup> and 20<sup>th</sup>, 2019. During this time, the study areas were traversed on foot such that the site conditions, geological features and other points of interest



could be observed. These observations were documented through a combination of field notes, GPS waypoints and photographs.

### **3.0 DISCUSSIONS & SITE CONDITIONS**

The following discussions provide an outline of typical considerations which are required during development of similar types of sites which are located in the Klondike Valley. In addition, we've provided discussions regarding the anticipated soil deposits and subsurface conditions. In general, similar site conditions were encountered within each of the three (3) study areas. The exception to this was Infill #1 where there was no indication of undisturbed naturally occurring soil deposits.

As the development potential of each of the three (3) study areas is largely dependent upon the presence of remnant mine 'tailings' and 'disturbed areas', we have delineated the distribution of these areas along with those of local 'ponds' and 'undisturbed areas' as illustrated in Figures 1A through 1C. In addition, the locations of trails, foot paths, seasonal drainage courses and other points of interest were identified in these figures.

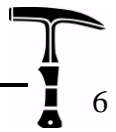
#### **3.1 Pre-grading/Grading Operations**

In general, where other sites in the Klondike Valley have been developed where remnant mine tailings are located, these lots are prepared through cut/fill construction methodologies which utilize the granular materials within the mine tailings to infill nearby adjacent tailings ponds. Additional consideration would be required to assess the subgrade suitability in regions denoted as 'Undisturbed Areas', 'Disturbed Areas' or naturally occurring ponds as the soil conditions in these regions may not be suitable to allow for fill placement. This would be due to the presence of organics, fine-grained materials and/or frozen soils.

Caution will need to be exercised during backfill operations as the mine tailings may also harbor organics, fine-grained or frozen soils and ice. These deleterious materials will not be suitable for backfill use and would need to be wasted in designated areas.

#### **3.2 Site Surveys & Design Elevations**

Detailed site surveys (which includes compilation of bathymetric charts and extend beyond the limits of the study areas) should be conducted to better assess development options where



cut/fill operations are to be considered. Specifically, the intent would be to determine the volume of granular mine tailings which are available to fill the tailings ponds and potentially other areas.

If there are not sufficient quantities of mine tailings to establish the required design elevations, then granular fills would need to be imported. The finished design elevations should be established to parallel elevations which have been established in other nearby developed areas located in the Guggieville Industrial Subdivision Area.

The completed site surveys should be assessed from a geotechnical perspective upon completion as the scale of mapping in available topographical maps was too large to note site subtle variations in local elevations. The delineation of these subtle variations is useful to help assist in the identification of differing soil types and site conditions.

### **3.3 Road Construction**

In general, the anticipated composition of the tailing materials should be suitable for use as the road subgrade following site grading. Imported 80 mm minus sub-base and 20 minus base course aggregates would need to be imported at the time of road construction to establish the roadways. As with all roadways, ditches and CSP culverts would need to be incorporated into the road designs.

Roadways which are constructed over 'Disturbed Areas' and tailings 'Ponds' will require additional time to stabilize. Additional assessment would be required to determine the feasibility of road construction through 'Undisturbed Areas' and naturally occurring ponds.

### **3.4 Building Construction**

Following site pre-grading and road construction, building sites will need to be situated in regions where mine tailings were originally located, provided the tailings exposed at the subgrade elevation(s) are considered suitable for foundation construction. Additional consideration would be required to determine whether or not regions which were identified as 'Disturbed Areas' would be suitable to allow for building construction depending upon the composition and nature of the subgrade materials located in these areas. Otherwise regions which were identified as being comprised of 'Undisturbed Areas' or 'Ponds' will not be suitable to allow for building construction due to consolidation settlement which would be anticipated in these areas following backfill.



### **3.5 Septic Field Suitability**

While additional consideration will be required relative to the installation of septic fields, given the proximity to the groundwater table and generally coarse/porous nature of the tailings. In general however, septic fields have been developed at other nearby locations where mine tailings have been previously levelled. These fields may have been developed by importing filter sands to slow down the rate of percolation.

The regions denoted as being comprised of 'Ponds' will not be suitable septic field placement. Additional assessment of the 'Undisturbed Areas' and 'Disturbed Areas' would be required to assess their suitability for septic field construction.

### **3.6 Groundwater**

Shallow groundwater would be expected in the form of seepage zones and sheet-wash flows given the nature of the terrain and anticipated soil types. The groundwater elevation would closely parallel local pond elevations which are heavily influenced by those of the Klondike River.

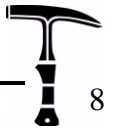
### **3.7 Seasonal Tributaries (Infill #2 & Infill #3)**

The presence of seasonal tributaries was noted in Infill #2 and Infill #3 study areas. These tributaries assist in regional drainage and flow regimes associated with the Klondike River (Infill #2) and surrounding areas (Infill #3).

### **3.8 Setbacks (Infill #2 & Infill #3)**

Setbacks may be required relative to the presence of mining claims which are partially located within the Infill #2 and Infill #3 study areas.

In addition, geotechnical setbacks will need to be observed relative to development adjacent to the Klondike River during development of Infill #2. The setback(s) would be required to allow for a factor of safety relative to ongoing shoreline erosion which was identified during our assessment.



### **3.9 Riparian Areas (Infill #2 & Infill #3)**

As potential riparian areas were identified in Infill #2 and Infill #3 in ponds located in 'Undisturbed Areas' and adjacent to the Klondike River (Infill #2), environmental assessments should be conducted by qualified personnel to identify any potential setbacks and mitigative measures relative to the impacts of site development.

### **3.10 Bedrock**

There was no indication of near surface bedrock in any of the study areas.

### **3.11 Permafrost**

Considering Dawson City is located in a region identified as having extensive discontinuous permafrost, frozen soils may be present within the study areas.

## **4.0 PRELIMINARY DEVELOPMENT POTENTIAL**

The site conditions which were delineated in Figures 1A through 1C were in part utilized to assess the overall development potential of the study areas relative to subdivision development utilizing conventional construction methodologies. Considering that each of the three (3) sites are located in regions which have been historically disturbed to some degree through mining activities which created remnant dredge/mine tailings piles, the primary criteria to which each of the sites was considered to be suitable relative to development was the overall presence of these tailings piles as development in these regions typically involves levelling the tailings to allow for subsequent infrastructure development. Additional consideration was given on a case-by-case basis relative to other factors which were identified as discussed herein;

### **4.1 Infill #1**

This study area is comprised of tailings piles, disturbed areas and ponds as noted in Figure 1A.

This site will be relatively straightforward to develop utilize cut/fill construction methodologies. Although a cut/fill balance has not been conducted, visually, the amount of

imported fill which will be required to develop the site varies. The mine tailings materials which are available in regions located west of the existing through road appear to be balanced and only minimal amounts of imported materials would be required in this region. By contrast, the majority of the region located east of the through road will require relatively large amounts of imported fills to backfill the ponds which are located in this region.

Additional consideration may be required if access to the nearby residence located east of the site or through road is to be maintained. If these roadways are to be maintained, then consideration could be given to leaving the ponded regions east of the through road undeveloped to reduce development costs and create a buffer relative to the nearby residence(s) located east of the study area.

#### **4.2 Infill #2**

This study area is comprised of tailings piles, disturbed areas, overbank/river deposits and ponds as noted in Figure 1B.

In general, the region within the study area located south of the demarcation line should allow for lot development utilizing conventional cut/fill construction methodologies. However, a geotechnical setback would need to be established within this region relative to the Klondike River where shoreline erosion was identified.

The region north of the demarcation line would need to be assessed from a hydrogeological perspective utilizing flow modeling and/or other techniques as a considerable amount of groundwater and surface water flows through this region. The disruption of this flow may impact the Klondike River, particularly with respect to freeze-up and spring break-up, which given the close (~200 m) proximity to the Klondike River bridge could be of concern.

Access to the region of the study area located north of the existing lots will be challenging and so additional consideration will be required if this region (south of the demarcation line) is to be developed.

#### **4.3 Infill #3**

This study area is comprised of tailings piles, disturbed and undisturbed areas and ponds as noted in Figure 1C.

Overall, the development potential of this infill region is poor as the majority of the site will require large volumes of imported fills in order to allow for road construction and establish the envisioned finished grades. Development of the larger ‘Undisturbed Area’ identified in the eastern realms of the study area may not be possible due to the poorly drained conditions and presence of organic and fine-grained soil deposits which may be present in this area.

While the central regions harbor tailings (some of which have been levelled), access to this region will also likely require considerable volumes of imported fills to establish road access either from the western or central realms of the site. The number of potential lots within this central region is expected to be small relative to the degree of road construction that will be required to access them.

## **5.0 ADDITIONAL ASSESSMENTS**

As the findings of our assessment are preliminary in nature, additional consideration may be required once we’ve completed our geotechnical feasibility assessments. However, at this stage, we envision the following additional assessments will be required if lot development is to proceed;

### **5.1 Geotechnical Evaluations (Infill #1 – Infill #3)**

Geotechnical evaluations utilizing subsurface investigation methodologies would need to be conducted to verify site specific parameters related to surface and sub-surface infrastructure prior to subdivision development.

### **5.2 Site Surveys (Infill #1 – Infill #3)**

Detailed site surveys (which include compilation of bathymetric charts and extend beyond the limits of the study areas) should be conducted to better assess development options where cut/fill operations are to be considered.

### **5.3 Environmental Site Assessment (Infill #2)**

A Phase I Environmental Site Assessment (ESA) should be conducted to identify potential environmental liabilities which may be associated with Infill #2 given the presence of two fuel barrels and a D-8 Caterpillar bulldozer which were identified within the limits of the site.



While the barrel located on the levelled tailings area appeared to be empty and staining was not evident, the second barrel located within the pond (as noted in Figure 1C) would be of greater concern relative to potential environmental liabilities. A limited amount of oil staining was observed below the bulldozer.

#### **5.4 Hydrogeological Study (Infill #2)**

A hydrogeological study should be conducted if the region located north of the demarcation line is to be developed to assess whether or not development in this region may have an impact upon the flow regime of the Klondike River from a seasonal freeze/thaw and flow perspective, particularly considering the relatively close (~200 m) proximity to the Klondike River bridge.

#### **5.5 Other Plans (Infill #1 – Infill #3)**

Other development plans should be compiled to identify site grading, surface drainage and erosion control requirements if development is to proceed.

### **6.0 LIMITATIONS**

While we have provided discussions regarding the anticipated development potential of the respective study areas based upon data which has been collated to date, as our findings are preliminary in nature, the information provided herein should be considered accordingly from a project management perspective.



## 7.0 CLOSURE

We trust the information we have provided at this time will be suitable for your purposes. However, if you should have any questions regarding the information provided herein, kindly feel free to contact the undersigned at your convenience.

Sincerely,

**CHILKOOT GEOLOGICAL ENGINEERS LTD.**

A handwritten signature in black ink, appearing to read 'Tares Dhara', with a horizontal line underneath.

Tares Dhara, P.Eng.

Senior Geotechnical Engineer

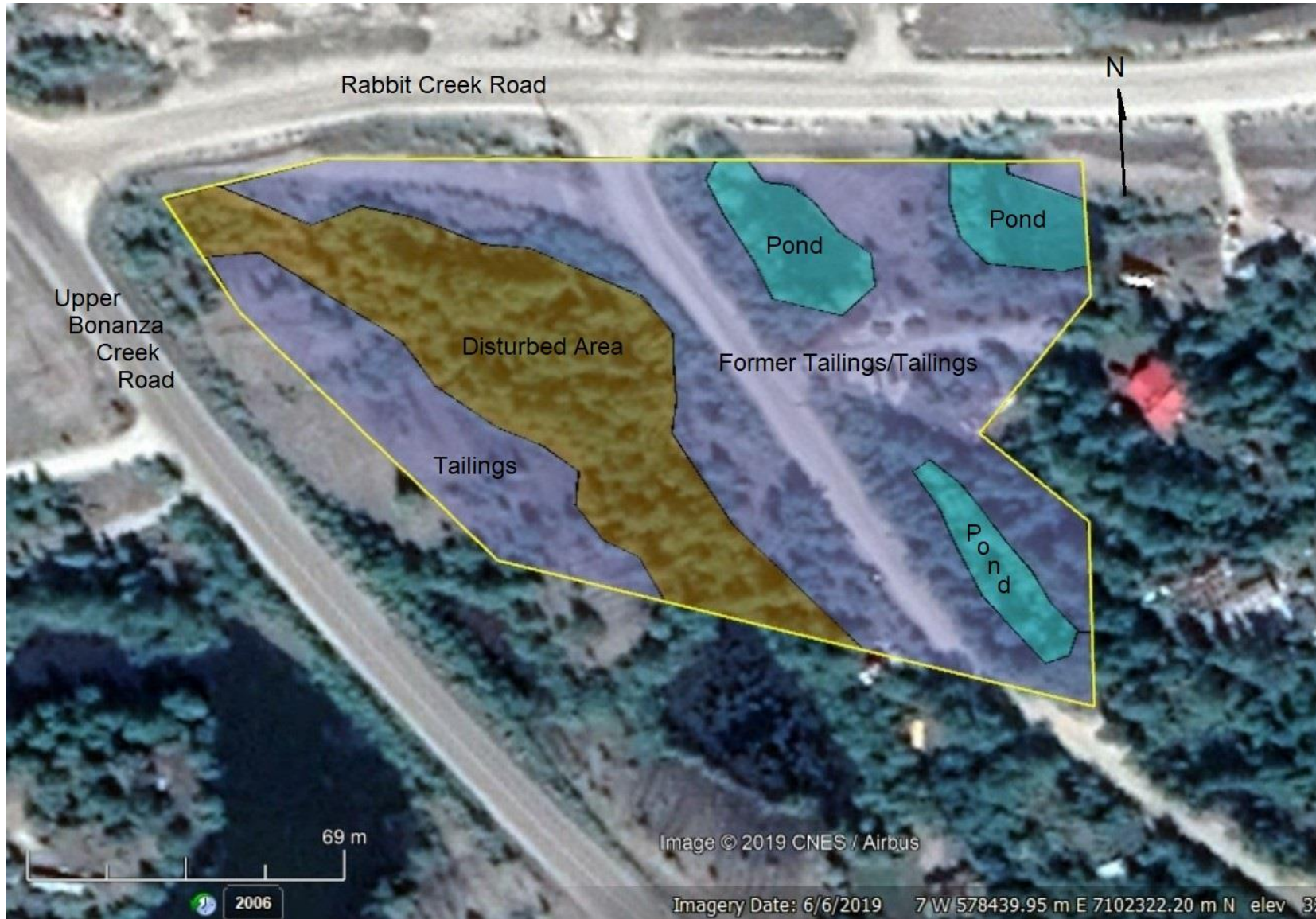
Figure 1A through 1C – Site Conditions

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Geotechnical Feasibility Assessment  
Proposed Lot Infill #1 Development – Guggieville Industrial Subdivision Area  
Dawson City, Yukon - 2019

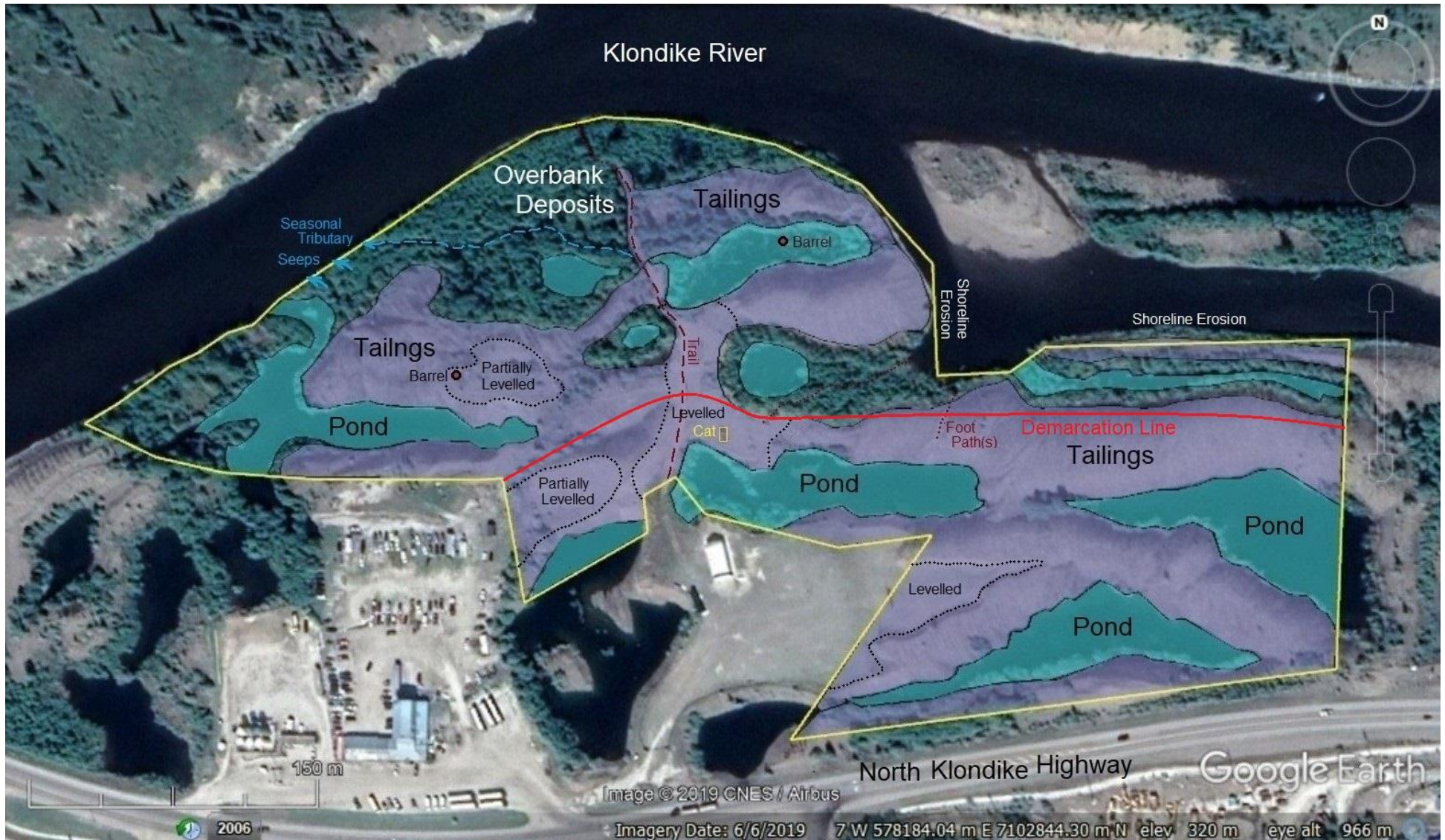
Figure 1A – Site Conditions - Preliminary Findings





Geotechnical Feasibility Assessment  
Proposed Lot Infill #2 Development - Guggieville Industrial Subdivision Area  
Dawson City, Yukon - 2019

Figure 1B – Site Conditions – Preliminary Findings





Geotechnical Feasibility Assessment  
Proposed Lot Infill #3 Development – Guggieville Industrial Subdivision Area  
Dawson City, Yukon - 2019

Figure 1C – Site Conditions – Preliminary Findings

