Appendix R Faro Lagoons, Wells, and Pump Stations Conceptual Flood Mitigation Design Options

The contents of this appendix are subject to the project objectives, methods, assumptions, and limitations outlined in the main body of the Yukon Territory Flood Mitigation Conceptual Design Options report and in Appendix T.

R.1 Existing Conditions

The existing conditions presented in this section provide a brief summary of characteristics of the Study Area that are pertinent to the development of mitigation options and their evaluation. The contents of this section are not a comprehensive review of all existing conditions for Faro Lagoons, Wells, and Pump Stations.

R.1.1 POPULATION

Faro has a population of 440 with 423 private dwellings according to 2021 census data (Statistics Canada 2023c). The population has increased by approximately 26% from 2016 when the population was 348 (Statistics Canada 2023c).

R.1.2 STUDY AREA

The Study Area in Figure R2 outlines the areas that flood mitigations are being considered in this Project at Faro Lagoons, Wells, and Pump Stations. The boundaries of the Study Area are based on Stantec's understanding that the flood mitigations at Faro are to be considered for the lagoon, wells, and pump station and that the Town of Faro is not impacted by flooding of the Pelly River.

R.1.3 FIRST NATIONS

The Faro Lagoon & Water Wells area is within the Traditional Territory of the Kaska Dena Nation, which includes Ross River Dena Council (RRDC) and the Liard First Nation (LFN). The are no land claims near this area. Figure R2 illustrates the KDFN, C/TFN, and TKC settlement lands within the Study Area.

R.1.4 BATHYMETRY AND TOPOGRAPHY

The following data sources were provided to or obtained by Stantec:

- 2019 LiDAR derivative 1m horizontal resolution Digital Elevation Model (DEM), UTM Zone 8 CSRS NAD1983, CGVD1928 (Government of Yukon 2022d)

All elevations are reported in CGVD2013. The LiDAR accuracy is assumed to be sufficient for the preliminary flood inundation analysis and conceptual design presented in this Report. There is insufficient metadata to determine whether the LiDAR meets the base requirement in terms of accuracy or precision for flood mapping as per NRCan (2022b).

R.1.5 GEOLOGY

Based on the surficial geology mapping (Yukon Geological Survey 2020), the Study Area can be broken into three sediment types; glaciofluvial sediment that encompasses the majority of the Town of Faro, colluvium sediment which covers the banks of the Van Gorder Creek, and fluvial sediments which is found along the banks of the Pelly River. The glaciofluvial sediments likely consist of poorly to well-sorted, rounded, and stratified gravel and sand formed by kettled outwash plains. Within the Town of Faro area, variably thick glaciofluvial sediment overlies thick accumulations of glaciolacustrine material. The banks of the Van Gorder Creek, a creak flowing through the Study Area, likely consists of colluvium deposits made

up of sand, silt and mixed fragments. The sediments along the Pelly River consist of fluvial sediments deposited within floodplains. The sediments within this area are recorded as active fluvial deposits that have recently flooded or are subject to regular flooding. The sediments in this area consist of well-sorted, stratified sand and rounded gravel with varying amounts of silt and organic materials.

Based on the Permafrost Probability Model (Bonnaventure et al. 2012), the Study Area is located within a region of extensive discontinuous permafrost (50-60% of land area underlain by permafrost). The Canada Permafrost Map (National Atlas of Canada 1995) also indicates the Study Area is in a region of sporadic discontinuous permafrost (10-50% of land area underlain by permafrost) with a low (<10% by volume of visible ice) ground ice content in the upper 10-20 m of the ground.

R.1.6 HYDROGEOLOGY

The poorly sorted gravel and sands encountered within the Study Area are likely to result in relatively fast rates of groundwater flow. The deposits encompassing most of shoreline are likely to result in a groundwater table that would be highly dependant on the Pelly River and Van Gorder Creek levels. During flooding, the highwater levels would result in high groundwater levels and after flood waters recede, it is likely that the groundwater levels would recede relatively quickly based on the permeability of the soil conditions in the area.

Based on the anticipated soils at this site, the need for seepage control measures (i.e. seepage cut-off below flood mitigation option, toe drains, sump pits and pumping, etc.) may be required for the proposed flood mitigation options and should be further evaluated in preliminary and detailed designs.

R.1.7 PAST FLOODING EVENTS AND RESPONSE

No background documentation was found on past flooding events and the associated response in the Study Area at the time of writing.

R.1.8 EXISTING FLOOD MITIGATION INFRASTRUCTURE

Faro Lagoons, Wells, and Pump Stations currently have no existing permanent flood mitigation infrastructure documented within the Study Area.

R.1.9 WIND, WAVES, AND EROSION

While floodplain mapping and associated hydraulic modelling of the DFSL has not been completed for the Study Area to date, it is likely that flow velocities in the Pelly River during flood conditions would likely require any flood mitigations to include erosion protection. In addition, bank erosion and river migration should be studied and considered in preliminary and detailed design phases of flood mitigations.

Wind and wave effects are not anticipated to occur at a scale which would require additional flood mitigation design in the Study Area.

R.1.10 HYDROLOGY

The Pelly River is the major water feature in the Study Area (Figure R2). The Pelly River originates on the western slopes of Selwyn Mountains. It flows south towards the Pelly Lakes, and then flows

west/northwest towards Ross River. The Pelly River passes the communities of Ross River, Faro and Pelly Crossing on its course.

WSC Station 09BC004 (Pelly River below Vangorda Creek) is located on the west side of the Pelly River, on the upstream side of the Mitchell Road bridge (Figure R2). Gross drainage area to WSC Station 09BC004 is not reported by GoC (2023). The hydrology reviewed considered the WSEs at WSC Station 09BC004. Flood frequency analysis for WSEs was performed by both Morrison Hershfield (2022) and Yukon University (2022) for WSEs at WSC Station 09BC004. Table R1 summarizes the frequency results of these two studies.

Table R1 Flood Frequency Analyses at WSC Station 09BC001 from Morrison Hershfield (2022) and Yukon University (2022)

	Morrison Hershfield (2022)	Yukon University (2022)
Years Included in Analysis	1973-2022	1973-2022
Number of Years	50	50
Selected Distribution	3 Parameter Lognormal	Log-Pearson Type 3 (openwater freshet data) and Gumbel (freeze-up and breakup ice jams)
Water Surface Elevation (m) [1]		
1:2 Event (50% AEP)	640.06	640.00
1:20 Event (5% AEP)	640.91	640.90
1:100 Event (1% AEP)	641.29	not provided
1:200 Event (0.5% AEP)	641.43	641.70
[1] Elevations provided in Geodetic Survey of Canada (GSC) for WSC Station 09BC004		

The Yukon University (2022) flood frequency analysis results were adopted for the Project because the 1:200-year event WSE was higher and would yield more conservative designs.

Figure R1 illustrates the on-record daily minimum, mean, and maximum WSEs, the WSE during the highest year on record (2013), and the WSEs for the 1:2-year and 1:200-year event at WSC Station 09BC004 from Yukon University (2022). Due to the limited exposure of Faro to floods, there are few observations about flooding processes at this region. Normally, the highest water levels in the Pelly River at Faro are attributed to open water freshet flows. However, breakup ice jams also form near this station (e.g., at 2009) and could cause floods (Yukon University 2022).

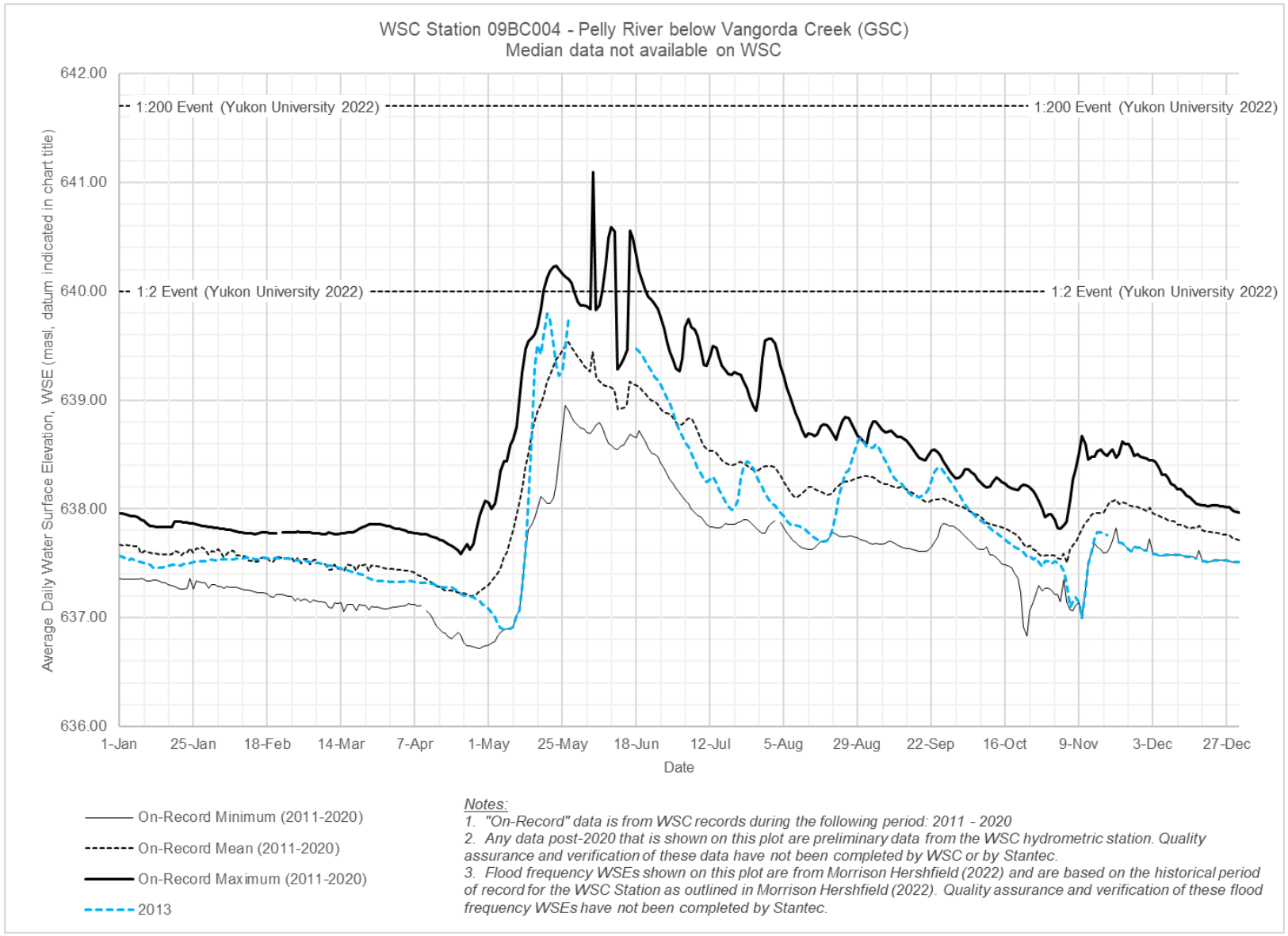


Figure R1 Historical Water Surface Elevations at WSC 09BC004 (Pelly River below Vangorda Creek)

The contents of this appendix are subject to the project objectives, methods, assumptions, and limitations outlined in the main body of the Yukon Territory Flood Mitigation Conceptual Design Options report and in Appendix T.

R.1.11 PRELIMINARY INUNDATION MAPPING

Floodplain mapping and the associated flood policy is ultimately what is required for design and implementation of flood mitigations at communities. Hydraulic analysis and floodplain mapping has not been completed to date for the Study Area and is beyond the scope of this Project. However, an understanding of inundation extents under the 1:200-year event is required for conceptual design of flood mitigations.

In lieu of floodplain mapping, Stantec performed preliminary existing conditions (no mitigation) inundation analysis for Faro using WSEs. This analysis considered the 1:200-year event WSE (641.70 m) developed by Yukon University (2022) and an assumed WSE slope of 0.05% m/m (based on survey from Underhill 2022). The resulting water surface was overlain on the existing conditions topographic/bathymetric elevation data (McElhanney Ltd.; GeoYukon 2023) and the limits of inundation were mapped (Figure R2). The inundation analysis performed herein is provided for information only and is considered a high-level estimate of the flood inundation under the 1:200-year WSE from Yukon University (2022). The preliminary inundation analysis does not take into account flow pathways and blockages. That is, if the land in a given location is below the 1:200 WSE surface, it presents as inundated whether or not there is an overland flow path for the water to arrive there.

The preliminary inundation analysis indicated that no properties were inundated by overland flooding in the Study Area.

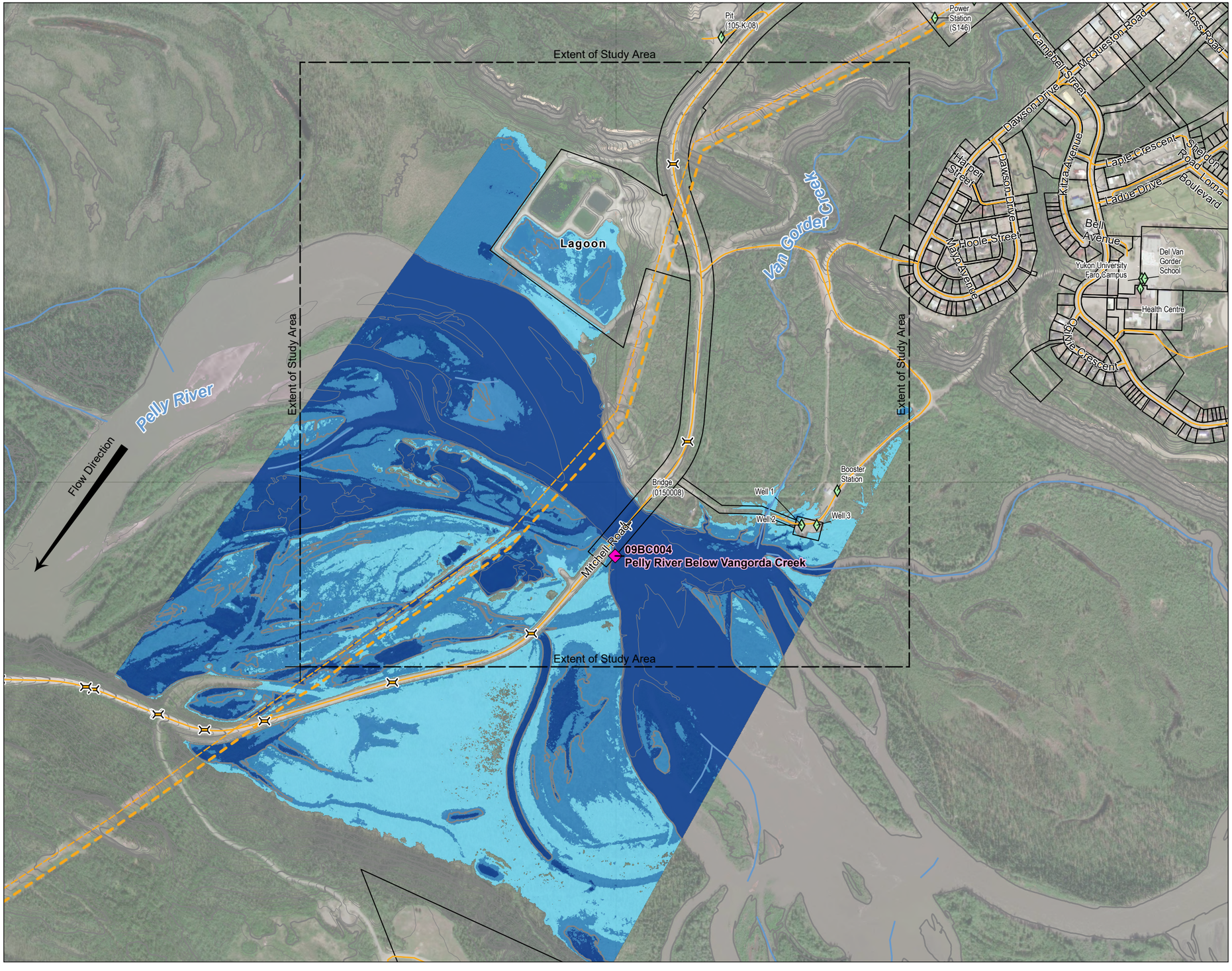


Figure No.

R2

Title

Existing Conditions and Preliminary Flood Inundation at Faro Lagoons, Wells & Pump Station

Client/Project 144903232

Government of Yukon
Community Services | Infrastructure Development Branch
Yukon Territory Flood Mitigation Conceptual Design Options

Project Location
Faro,
Yukon

Prepared by LLT on 2023-05-08
TR by JD on 2023-05-08

N

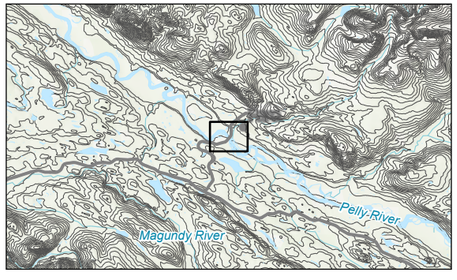
0 50 100 150 200 m
(At original document size of 11x17)
1:10,000

- WSC Station
- Culvert/ Bridge
- Community Infrastructure and Points of Interest
- Highway Kilometre Post
- Road
- Power Distribution Line
- Powerline
- Topographic Contour (10 m)
- Topographic Contour (2 m)
- Land Parcel - Surveyed

Water Depth at 1:200 WSE Inundation (m)

- 0 - 1
- 1 - 2
- > 2

The preliminary inundation analysis does not take into account flow pathways and blockages. That is, if the land in a given location is below the 1:200 WSE surface, it presents as inundated whether or not there is an overland flow path for the water to arrive there.



Notes
1. Coordinate System: NAD 1983 Yukon Albers
2. Data Sources: Government of Yukon; Government of Canada
3. Imagery Government of Yukon Geomatics Yukon; ESRI World Imagery

Stantec Yukon

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R.2 Mitigation Options and Evaluation

Based on the objectives and assumptions presented in the main body of this Report and the Preliminary Inundation Mapping (Figure R2), there are no properties or critical infrastructure that are anticipated to be inundated in a 1:200-year flood at Faro Lagoons, Wells and Pump Station. Therefore, no flood mitigation options were developed in the Study Area.

As illustrated in Figure R2, the access road to the lagoon acts as a dike and would mitigate against surface water entering the lagoon under 1:200-year event conditions. However, the land inside the road (i.e., in the lagoon) is below 1:200-year WSE meaning it is susceptible to seepage during flood conditions. Seepage may also be a concern for the wells and pump stations and may cause lagoon liners to float and dislodge. Seepage-specific designs are outside the scope of this Project. It is recommended that geotechnical and hydrogeological study be performed to evaluate the seepage and stability risk to the road, lagoons, wells, and pump stations.

Areas which are above the 1:200-year WSE in the preliminary inundation analysis but below the DFSL are not included in this Project. These areas may need to be included in future design advancements depending on the requirements of future territorial flood policy.