RYZUK GEOTECHNICAL
ENGINEERING & MATERIALS TESTING

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GEOTECHNICAL FIELD REVIEW / SITE INSTRUCTION

Project No: 10943-1
Project: Dam Assessment
Project Address: Morningstar Golf Club – Parksville, BC
Date: May 19, 2023

Client: Realcor Golf Ltd.
Contact: Neil Atchison, P.Eng (NP)
Email: na.aai@pm.me

Distribution:
David Johnson, DSO - David.A.Johnson@gov.bc.ca

Proposed Downstream Improvements - Spillway and Berm Construction

As requested, we attended the referenced site on March 21, 2023, to review the area of the proposed spillway and berm construction. We subsequently coordinated with the project surveyor and have completed hydrotechnical modeling and design drawings for the proposed dam safety improvements being carried forward from our Dam Safety Review (DSR) completed in 2021. Our associated comments and recommendations in this regard are contained herein. Our work has been carried out in accordance with the accepted Terms of Engagement.

The recently acquired survey information indicates the existing 200 mm outlet pipe located at the western portion of Dam 2 has an invert elevation of 38.10 m (geodetic). As noted in the DSR, we recommended a spillway be installed to reduce overtopping risks of Dams 2 and 3 in the event that the Saddle Dam (Dam 1) were to experience a rapid failure and breach. This theoretical occurrence would be considered as the Inflow Design Flood (IDF) for the lower Pond A as the reservoirs are not part of the natural waterways and associated flood influence from distal precipitation catchments. Our previous understanding was that the outlet pipe invert was just below elevation 37.9 m (such that free board of 0.5 m was preestablished). With this new information, upgraded modeling software and BC Open LiDAR data, we have completed further analyses and design work for the proposed downstream improvements.

We completed dam breach modeling using HEC-RAS 6.3.1 to review spillway design and performance requirements assuming that Pond A was at full operating capacity (approximate elevation 38.15m). The model simulated a breach of the saddle dam at overtopping conditions (water elevation 40.4 m) with a breach channel of 9 m base width, 0.5H:1V (Horizontal: Vertical) side slopes and down cut to elevation 37.0 m (full dewatering of upper Pond B). The timeframe of breach was assigned 15 minutes and the dewatering effect of the Pond A outlet pipe was neglected. We note the input parameters for this breach event are considered to be conservative as a worst-case scenario.

The results of this modeling indicated the surface of Pond A would rise to an elevation of slightly over 38.8 m inducing overtopping locally of Dam 2 and 3 based on these input parameters. However, the overtopping magnitude and duration would be significantly reduced by the dewatering capacity of the proposed spillway. It is noted that an identical breach simulation but at normal operating levels of Pond B (assumed as 39.6 m) produced negligible overtopping of the dams of Pond A and therefore the proposed spillway geometry detailed below is considered sufficient to mitigate the risk of overtopping of the dams during the IDF.

Based on the analyses, a spillway with a base width of 10 m and 3H:1V side slopes excavated in the natural terrain beyond the left (western) abutment of Dam 2 is proposed. As the spillway would only need to perform for a brief period to act as a dewatering slew in the event of failure, we consider that the design surface could be prepared with the typical rough grass of the golf course bordering the fairway. The flows within the flood model were indicated to be less than approximately 1 m/s for less than a 1hr period and therefore an established gently sloped (0.24%) coarse grass surface over competent mineral soils is expected to perform adequately to resist erosion for the short duration. However, the proposed design sill at 50 mm above the pipe invert may result in the spillway becoming active intermittently during full capacity conditions combined with significant rain fall. Therefore, we consider when the spillway becomes active some light sheet flows could occur in the channel and the area would need to be assessed for performance as part of the periodic maintenance directive. Local filling/fine tuning of the spillway may be anticipated in the long term, along with some periodic soggy grass conditions when active. It may be desirable to

provide a +/- 2 m wide swath of compacted crushed angular gravel at the spillway inlet to fine tune the sill elevation and provide a maintainable surface. This maintenance/review component should be included in the Operations Maintenance and Surveillance Manual (OMS).

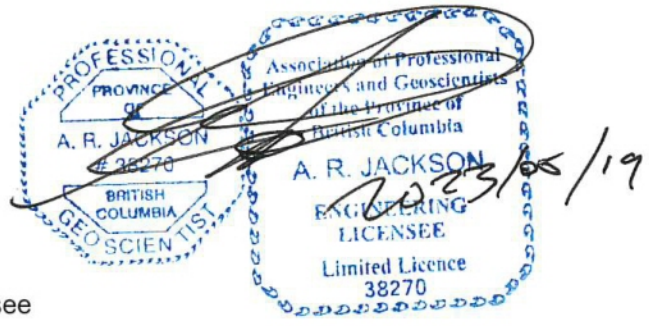
To mitigate flooding influence and repurpose the excavated soils generated from the spillway, a fill berm is proposed to the northwest of the spillway outlet as shown on the attached drawings. The berm was shown to provide flood protection to the adjacent houses to the north by directing the flow to the west to Morningstar Creek.

Water levels should be lowered by 500 mm below the design cut for several days prior to final excavation of the spillway. Once surface organics have been removed the mineral soil excavation is to be completed with careful grade control to excavate the design subgrade at 100 to 125 mm below the finished grass surface. The initial exposure will need to be monitored by Ryzuk to review the soil conditions and confirm the cut is completed within the native ground vs through embankment fill soils. Therefore, the alignment shown in the drawings is subject to field conditions and may require adjustment pending review.

The subgrade preparations for the fill berm would require removal of the surficial organic soils and inspection prior to placement of select mineral soils. Fill soils are to be placed in thin lifts with moisture control and compacted to 95% Standard Proctor Maximum Dry Density (SPMDD). We will need to periodically monitor the material compaction during placement for approval and direct compaction methodology at the time of construction based on soil performance and available equipment. Capping layer of topsoil to be prepared for rough grass surface per Morningstar Golf Club specifications. Surplus fill soils can be placed in surrounding areas to suit terrain adjustments to direct flow to south of adjacent 'Tee Off' area. Silt abatement to be provided on the downstream side of the work areas to ensure no sediment ingress into the riparian area until vegetation have developed to provide surface stability.

If there are any questions or comments with respect to the above, please contact us.

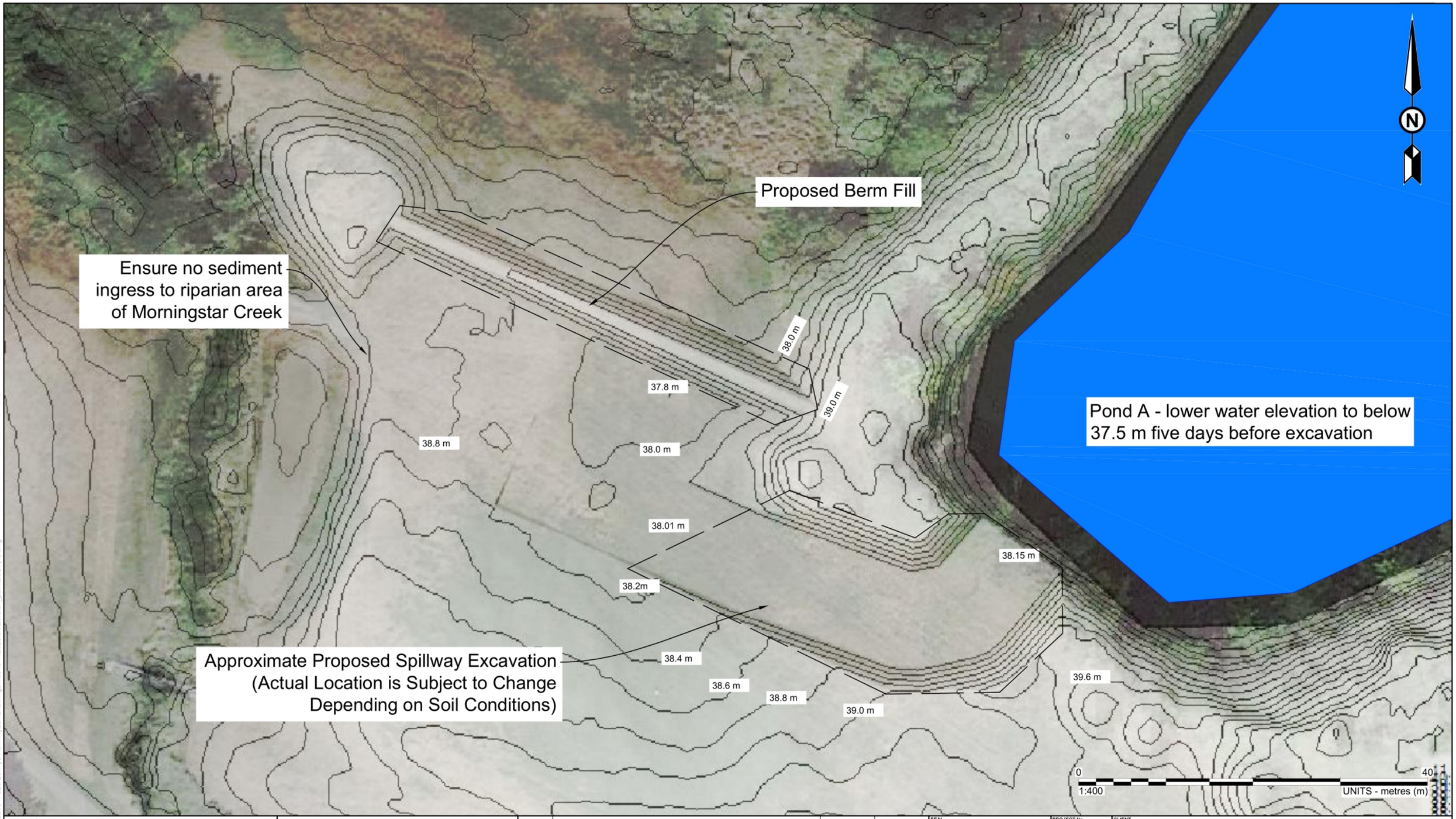
Regards,
Ryzuk Geotechnical



Andrew Jackson, P.Geo., P.L.Eng.
Lead Geoscientist / Engineering Licensee
PTPN: 1002996

Attached – Spillway and Berm Design Drawings

The above does not constitute approval to proceed with the noted work if such is perceived to be an extra to a Contract, or if the work requires approvals/permits from approving authorities.



NOTES

1. This drawing is scaled for 11x17 sheet and does not require further scaling to fit. Scales will differ if printed on different sheet size.
2. Background produced in HEC-RAS Rasmapper with BC LiDAR data and survey control checked with JE Anderson & Associates field work. Elevations in meters geodetic estimated contour accuracy +/- 100 mm.

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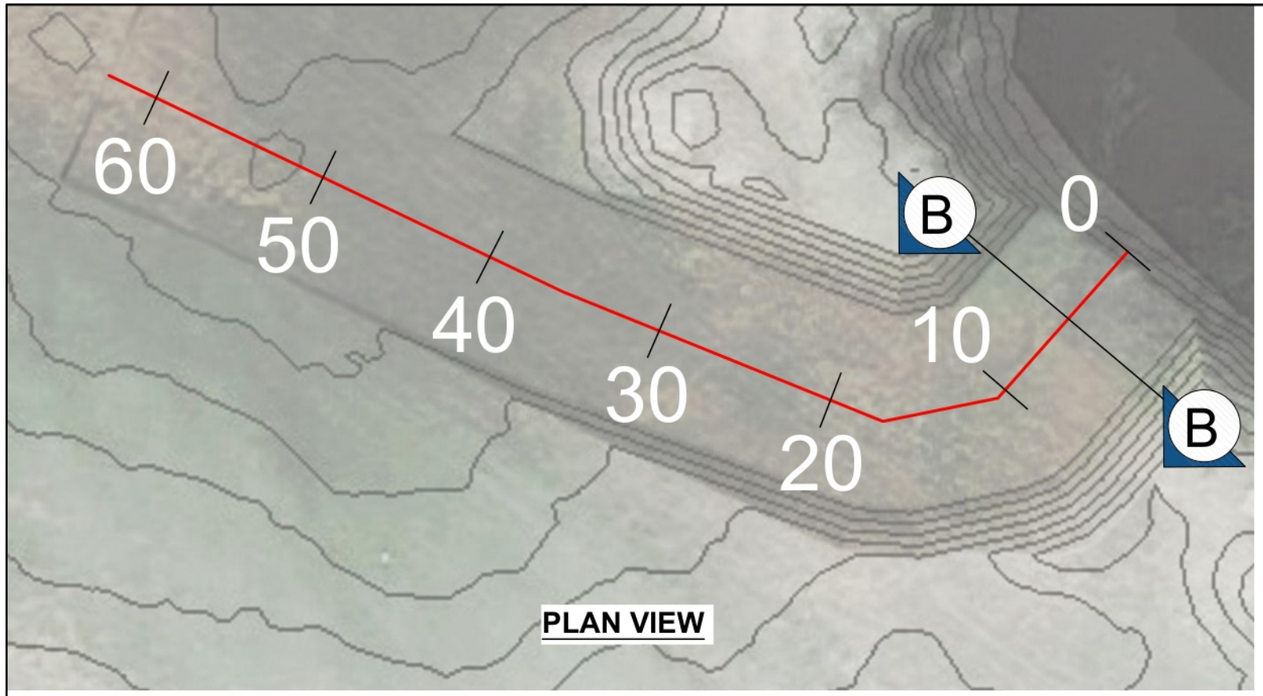
REV.	DESCRIPTION	YY/MM/DD	DRAWN BY
0	ISSUED FOR CONSTRUCTION	2023/05/19	JLV

SEAL

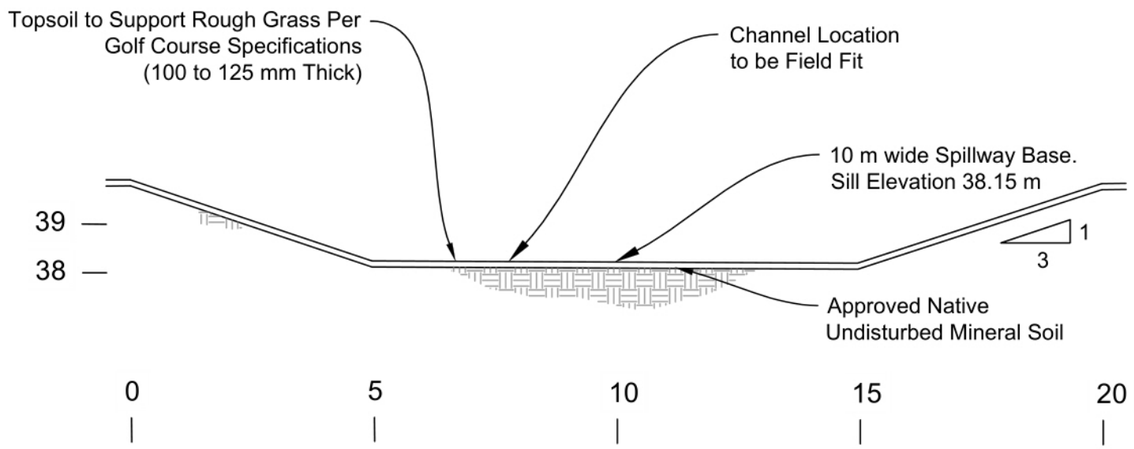
PTPN: 1002996

PROJECT No.	10943-1
CLIENT	Realcor Golf Ltd.
EOR/LEAD	ARJ
PROJECT TITLE	Dam Assessment
REVIEW	JAR
PROJECT ADDRESS	525 Lowrys Road - Parksville, BC
SCALE	1:400
DRAWING PACKAGE	**Proposed Spillway and Berm**
SHEET No.	01 of 03
SHEET NAME	**Site Plan**

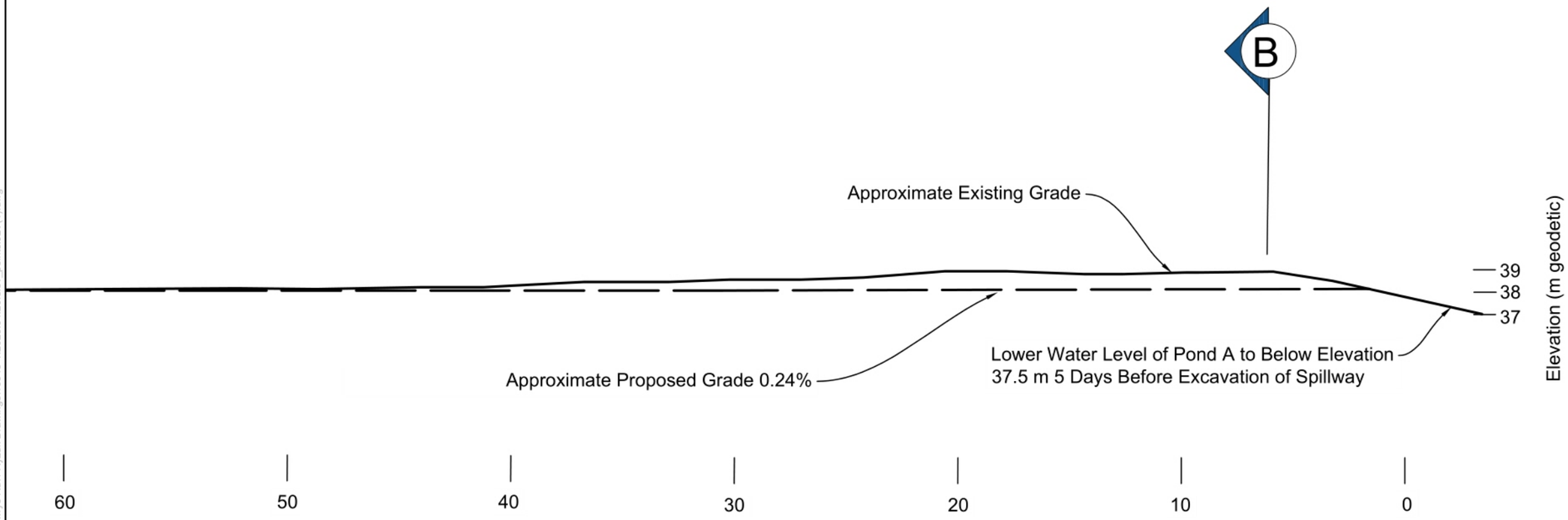
R:\Ryzuk Data\8-10000 to 8-10999\10943-1 525 Lowrys Rd\4 Ryzuk Drawings\10943-1.2023.04.20.elev_points.JLV(1).dwg



PLAN VIEW



SECTION B VIEW



PROFILE VIEW

NOTES:

1. Refer to Site Plan for the approximate Spillway location.
2. Excavation of the Spillway to be carried out with careful survey control to limit deviation from design surface. Lower water of Pond A below 37.5 m 5 days before excavation.
3. Ryzuk to inspect subgrade of the Spillway area following removal of surficial organics.
4. Organic soils can be set aside for potential reuse as capping soils or for general terrain incorporation pending field review.
5. Topsoil/Sod to be prepared in accordance with Morningstar Golf Course specifications.
6. Ensure no disturbance or sediment ingress over riparian boundary by means of grading, silt abatement measures, etc.

NOTES

1. This drawing is scaled for 11x17 sheet and does not require further scaling to fit. Scales will differ if printed on different sheet size.
2. See Notes Section.

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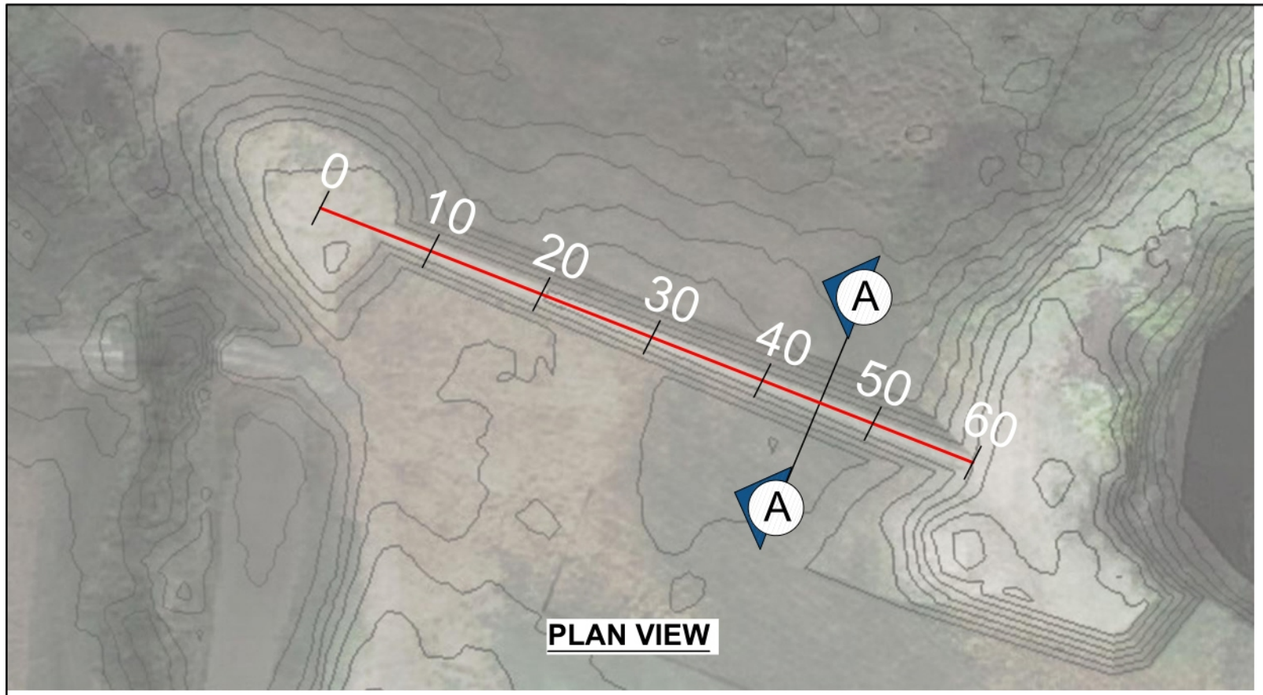
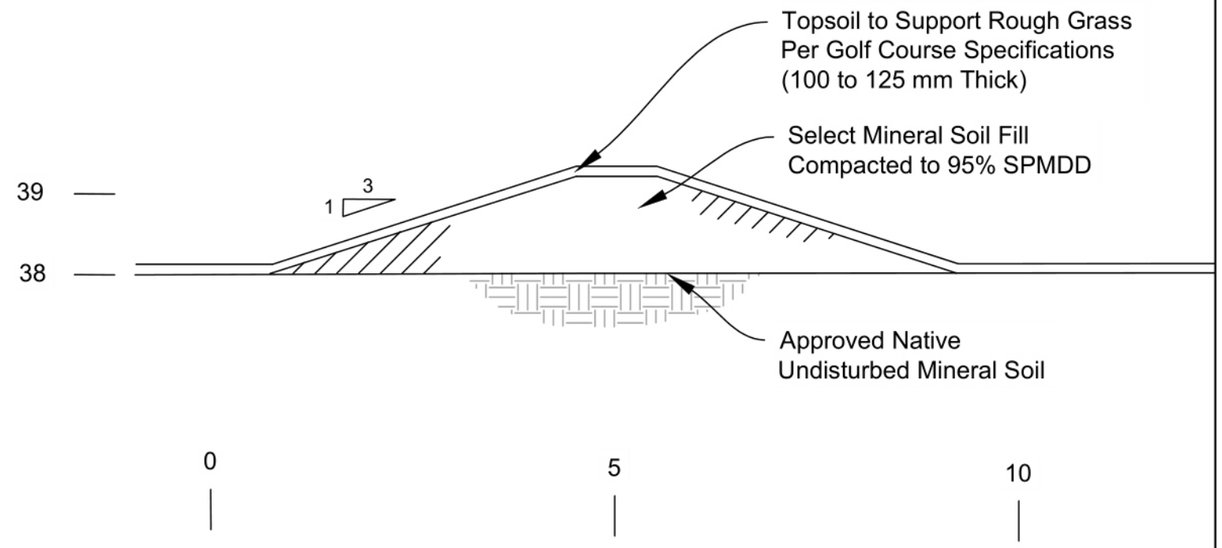
PTPN: 1002996

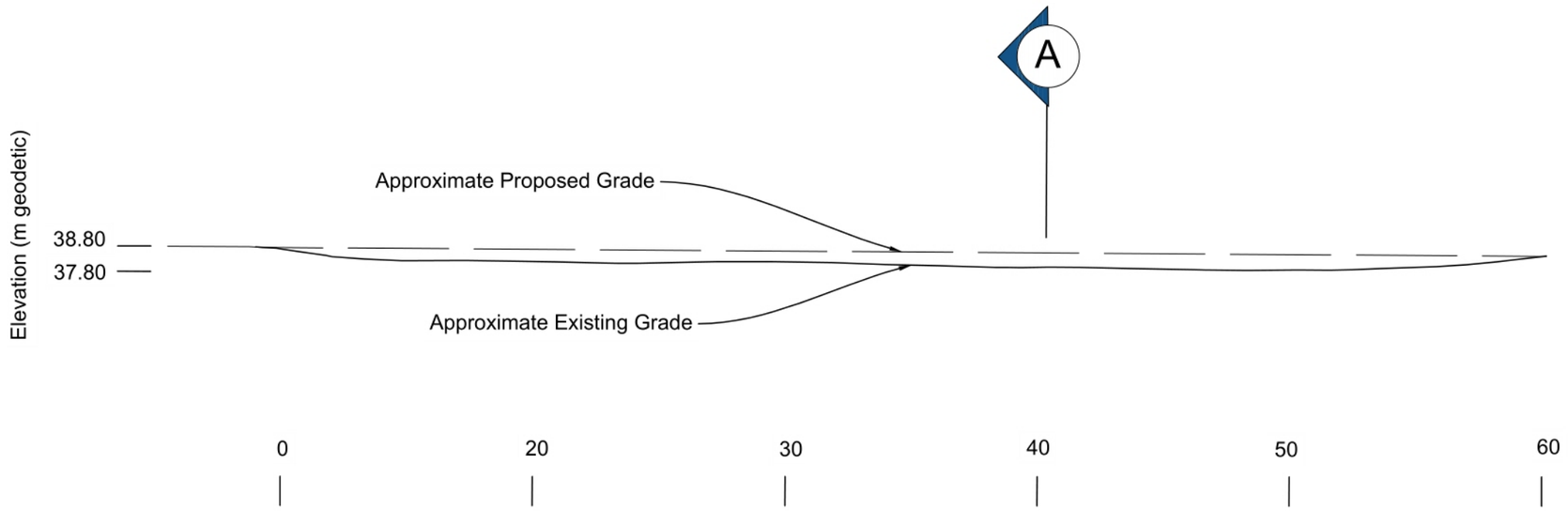
PROJECT No. 10943-1	CLIENT Realcor Golf Ltd.
EOR/LEAD ARJ	PROJECT TITLE Dam Assessment
REVIEW JAR	PROJECT ADDRESS 525 Lowrys Road - Parksville, BC
SCALE NTS	DRAWING PACKAGE **Spillway and Berm Design**
SHEET No. 03 of 03	SHEET NAME **Spillway Design**



PLAN VIEW



SECTION A VIEW



PROFILE VIEW

NOTES:

1. Refer to Site Plan for the Berm location.
2. Ryzuk to inspect subgrade of the Berm area following removal of surficial organics.
3. Organic soils can be set aside for potential reuse as capping soils or for general terrain incorporation pending field review.
4. Mineral soils to consist of select compactable soils generated from spillway excavation. Soil quality and conditions to be assessed by Ryzuk at initial stages for determination of placement methodology with available equipment.
5. Topsoil/Sod to be prepared in accordance with Morningstar Golf Course specifications.
6. Ensure no disturbance or sediment ingress over riparian boundary by means of grading, silt abatement measures etc.

NOTES

1. This drawing is scaled for 11x17 sheet and does not require further scaling to fit. Scales will differ if printed on different sheet size.
2. See notes section.

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PTPN: 1002996

PROJECT No. 10943-1	CLIENT Realcor Golf Ltd.
EOR/LEAD ARJ	PROJECT TITLE Dam Assessment
REVIEW JAR	PROJECT ADDRESS 525 Lowrys Road - Parksville, BC
SCALE NTS	DRAWING PACKAGE **Spillway and Berm Design**
SHEET No. 02 of 03	SHEET NAME **Berm Design**

DAM SAFETY REVIEW

MORNINGSTAR GOLF COURSE

525 LOWRYS ROAD
PARKSVILLE, BC

Report To: Realcor Golf Inc.,
4333 Ledger Avenue
Burnaby, BC
V5G 3T3

Attention:
Mr. Lee Riggs, Administrator

Prepared By:

Ryzuk Geotechnical
Victoria, BC

January 5, 2022

10943-1

EXECUTIVE SUMMARY

Ryzuk Geotechnical were contacted in June of 2020 to review the requirements set forth by the Provincial Dam Safety Officer (DSO) for Dam Safety Review (DSR) of the three Morningstar Dams at Morningstar Golf Course located about 4 km northwest of Parksville, BC city center. Two of the dams are designated as having a 'High' Downstream Consequence of Failure Classification, and one as having a 'Significant' Classification.

We subsequently completed a preliminary background review of available information and noted the following:

- The dams were constructed in the early 1990's and appear to have been professionally designed in accordance with the standards of the era, though no approval documents of the installation were available.
- Unknowns were identified with respect to the seismic performance of the dams.
- Redundancy of overflow systems (proper spillways) were not present.
- Type of vegetation atop the embankments was atypical for such structures.

A proposal was submitted to complete a DSR and, following acceptance of engagement, we met with representatives of the Dam ownership and the DSO in October 2020 to review the conditions and formulate an investigation plan. An investigation was completed in February 2021 and a draft DSR was issued for client and DSO review in April 2021. Feedback from the DSO was provided in June 2021 and deficiencies identified to be resolved in a final DSR. Since that time the dam ownership has changed, and directions were received to finalize the report to satisfy the DSO requirement. We have augmented the content as specified by the DSO and completed internal independent review of the DSR and believe we have met the requirements in this regard. In conjunction with the finalized report, we have included below a description and experience qualification of the multidisciplinary team involved in the assessment.

A summary of the results and key recommendations of the completed DSR for consideration are as follows:

- The embankments were constructed of cohesive materials and generally appear to have been prepared in accordance with the original engineered design.
- The sections were confirmed through modeling to be seismically stable.
- Breach modeling showed that the flooding potential to downstream areas is relatively benign with respect to catastrophic large scale destruction of infrastructure and risk of lethality.
- Establish proper spillways for both ponds within native abutment areas.
- Reduce the height of trees and/or remove trees from the embankments.
- Review possible options in the future to establish flood protection berms around downstream permanently occupied areas to qualify a reduction from High to Significant of the western dam.

Further engineering work is anticipated with respect to design and construction drawings to be generated for proposed spillway upgrade installations.

MULTIDISCIPLINARY TEAM QUALIFICATIONS

Andrew Jackson, P.Geo., P.L. Eng. - *Project Manager*

Practicing Professional Geoscientist since 2013 and Engineering Licensee since 2018. 15 years experience in geotechnical related work.

Related Dam Experience

- Acland Pond Dam – Salt Spring Island, BC ; 2013-2014 - DSR and Decommission Plan submitted to and accepted by John Baldwin, DSO.
- Beaver Creek Dam – Lake Cowichan, BC; 2014 - Embankment and Spillway Upgrades submitted to and accepted by John Baldwin, DSO.
- Demamiel Creek Dam – Sooke, BC; 2014 - Spillway Reconstruction and IDF review, report submitted to client.
- Madrona Creek Dam – Salt Spring Island, BC; 2015 - Embankment and Spillway Upgrades, report submitted to client.
- Weisner Creek Dam – Salt Spring Island, BC; 2016 - Decommission Plan submitted and accepted by John Baldwin, DSO.
- McFadden Creek Dam – Salt Spring Island, BC; 2017 - Decommission Plan submitted and accepted by John Baldwin, DSO.
- Tahltan Dam – Dease Lake, BC; 2019/2020 - DSR and Decommission Plan submitted to Stuart (Ed) Bryson, DSO - with requirement for inclusion of further information from Department of Fisheries and Oceans to be provided for final decisions.
- Beckwith Dam – Saanich, BC; 2020/2021 - Decommission Plan submitted and approved by David Skarbo, DSO
- Swan Brook Dam – Shawnigan, BC; 2021 – Failure assessment and emergency spillway installation - approved by David Skarbo, DSO

Shane Moore, P.Geo. - *Senior Geoscientist / Managing Principal*

Practicing Professional Geoscientist since 2008. 25 years experience in geotechnical related work.

Related Dam Experience

- Gardom Pond Dam – Pender Island, BC; 2011-2012– Senior Review of DSR and Decommission Plan submitted to and accepted by John Baldwin, DSO.
- Parkdale Creek Dam (Upper and Lower) – Langford, BC; 2012-Current – Senior review of annual inspections.
- Acland Pond Dam – Salt Spring Island, BC ; 2013-2014 – Senior Review of DSR and Decommission Plan submitted to and accepted by John Baldwin, DSO.
- Beaver Creek Dam – Lake Cowichan, BC; 2014 - Senior Review of Embankment and Spillway Upgrades submitted to and accepted by John Baldwin, DSO.
- Demamiel Creek Dam – Sooke, BC; 2014 - Senior Review of Spillway Reconstruction and IDF review, report submitted to client.
- Madrona Creek Dam – Salt Spring Island, BC; 2015 - Senior Review of Embankment and Spillway Upgrades, report submitted to client.

- Weisner Creek Dam – Salt Spring Island, BC; 2016 - Senior Review of Decommission Plan submitted and accepted by John Baldwin, DSO.
- McFadden Creek Dam – Salt Spring Island, BC; 2017 - Senior Review of Decommission Plan submitted and accepted by John Baldwin, DSO.
- Beckwith Dam – Saanich, BC; 2020/2021 - Senior Review of Decommission Plan submitted and approved by David Skarbo, DSO

Lane Campbell, M.Eng., P.Eng. - *Senior Geotechnical Engineer*

Practicing Professional Geotechnical Engineer since 1992. 33 years of experience in geotechnical related work.

Related Dam Experience

- Parkdale Creek Dam (Upper and Lower) – Langford, BC; 2012-Current
- Irwin Road Dam Safety Review – Langford BC; 2012
- Masters of Engineering Project Report on Stability of East Embankment of Oldman Dam – 2004.

James Russell, M.Sc., P.Eng. – *Geotechnical Engineer/Project Manager*

Practicing Professional Engineer since 2016. 10 years of experience in geotechnical related work.

Related Dam Experience

- Bandeirinhas Gold Mine Tailings Dam – Mina Gerais, Brazil; 2011-2012 – Junior Engineer reviewing remote construction process and construction modeling under senior review of Angela Kupper, PhD, P.Eng. with Amec.
- Suncor Tar Island Dyke – For McMurray, AB, 2012-2014 – Junior Engineer reviewing instrumentation and preparing yearly dam review report under senior review of Tara Rothrock with Amec.
- Suncor Pond 2 – 9 For McMurray, AB, 2012-2014 – Junior Engineer reviewing instrumentation and preparing yearly dam review report under senior review of Tara Rothrock with Amec.
- Swan Brook Dam – Shawnigan, BC; 2021 – Failure assessment and emergency spillway installation - approved by David Skarbo, DSO Storm Water Management Ponds, Farrell Estates Subdivision – Sooke, BC, 2019-2021 – Geotechnical Professional Engineer of Record.
- Parkdale Creek Dam (Upper and Lower) – Langford, BC; 2021-Current. – Operational Review.

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LIST OF APPENDICES

1. INTRODUCTION

As requested, we have completed a Dam Safety Review of the existing dams at the Morningstar Golf Course. This review is required as ordered by the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD). The following report summarizes the results of our review and provides associated recommendations for dam safety. Our work in this regard has been carried out in accordance with, and is subject to, the attached Terms of Engagement contained in Appendix A.

Ryzuk Geotechnical was retained by G. Powroznik Group Inc. of G-Force Group (G-Force) in August 2020 to carry out this review. Following initial discussions and review of available information, a preliminary stability analysis was carried out as an initial screening. We subsequently attended site in October 2020 to meet with representatives of the Golf Course, G-Force, and the FLNRORD Dam Safety Officer to complete a visual reconnaissance of the existing dam conditions as well as the surrounding areas. In February 2021 we carried out a subsurface investigation to acquire soils information to support the Dam Safety Review.

Topographical information was gathered by JE Anderson dated September 21, 2020. This survey was completed to confirm the geometry of the dams and the pond water elevation. Bathymetric survey was conducted by Morningstar personnel and depth measurements were acquired on an approximately 15 m grid. Both bathymetric surveys and the topographic information were used to estimate the volume of the pond, stability analysis, and seepage analysis.

2. SITE DESCRIPTION

The Morningstar Golf Course is located within the Town of French Creek, BC, located within the central eastern portion of Vancouver Island. The dams are situated within the central portion of the golf course surrounding two man made ponds which were constructed in the early 1990's as both supply for the gold course irrigation and as polishing ponds to accept effluent from the district system. The dam locations are shown in Figure 1 below (acquired from the Regional District of Nanaimo GIS and Google Maps). The dams are generally bounded by Morningstar Drive to the northwest and golf course fairways to the northeast, west, and south. The overall terrain slopes gently down to the north, being in the order of 2 to 4% gradient.

Figure 1. Morningstar Dams Site Orthographic Images.

The two ponds cover a surface area of approximately 28,600 m^2 (2.86 Ha), with Pond A and Pond B contributing 18,300 m^2 and 10,300 m^2 respectively. We estimate the total volume of water for both ponds at full operating levels to be approximately 80,000 m^3 (64.9 Acre-feet). Approximately 28,600 m^3 (23.2 Acre-feet) is impounded by the earthen dams, while the dugout portions below grade hold 51,400 m^3 (41.7 Acre-feet) These values were based on provided bathymetry measurements, surrounding grade, and area calculations. The ponds are fed by treated effluent pumped from the Regional District of Nanaimo French Creek Pollution Control Center and supplied with fresh water seasonally harvested from Morningstar Creek.

The Morningstar Dams consist of three discrete earthen embankments, labelled 1, 2, and 3 in Figure 1 above. Dam 1 is a saddle dam located in between Pond A and Pond B, and Dams 2 and 3 bound the northern portions of Pond A. The dams range in length from 50 m to 300 m and have a typical height between 1.5 m and 2 m and a maximum height of 2.3 m above the surrounding grade. Crest width of between 3 m and 5 m and side slopes less than 30 degrees inclination from horizontal are typical. The ponds have an estimated maximum water depth of 3.0 m within the deepest localized dugout portion at the eastern side of Pond A proximal to the saddle dam. At full service load the retained pressure head is estimated to be up to approximately 1.5 m.

The water level can be increased or decreased to suit the needs of the golf course irrigation system, via the existing pumphouse at the northwestern corner of Pond A. The storage levels are increased in the springtime such that the freeboard is reduced to approximately 0.5 m of freeboard. In the wet season the water levels are decreased to approximately 1/3 of the volume, such that freeboard is approximately 1.5 m or more.

The dams are generally vegetated with low lying brush, grass, and some mature deciduous trees with trunk diameters up to approximately 0.2 m. A dual culvert spillway conveys overflow from Pond A to B and a small overflow pipe acts as an overflow for Pond A.

The geometry noted above was estimated based on our site review as well as the elevations provided on the survey drawing produced by JE Anderson dated September 21, 2020, attached in Appendix B.

The site surrounding the two ponds is lightly vegetated by grasses and low lying brush as well as submature tree stands. Beyond the property lines, to the south is a heavily vegetated area with mature deciduous and coniferous trees. Residential areas are present to the immediate west and north. Morningstar Creek is present to the west and north of the ponds. The creek meanders through the golf course, being about 80 m to the west of Pond A at the closest point. The flow travels to the north/northeast to an estuarine outfall within the Georgia Strait a few kilometers downstream. Morningstar Creek is an ephemeral stream channel about 3 to 5 m wide with a minimum depth of approximately 1.5 m. The creek bed is typically lined with lag gravel/cobbles and local boulders are present along the banks in the vicinity leading up to intersecting roadways where the flow is conveyed by box or arched culverts. The culverts were noted to have a minimum dimension of 1.9 m wide by 1.3 m high and the creek bed was assigned a 2% gradient throughout.

3. BACKGROUND REVIEW

Our background review involved an examination of available air imagery, geologic mapping, as well as search of our archival files from our previous involvement at and within the vicinity of Morningstar Golf Course. In addition, we reviewed previous annual dam inspection reports, drainage improvements, environmental report and the Dam Operation, Maintenance, and Surveillance Plan. A list of the documents reviewed is contained in Appendix J.

Our background study indicated that native soils in the vicinity of the Morningstar Dams consist of dense glaciofluvial gravels and sand, overlying glacial till comprising very hard clayey silt with trace gravel, or very dense gravelly silty sand. Sedimentary bedrock is anticipated at relatively shallow depth. The bedrock at the site is inferred to comprise sandstone of the Gabriola Formation of the Cretaceous Nanaimo Group.

Our previous work in the area indicates the subsurface soils before construction of the dams likely consisted of a veneer of topsoil atop an intermittent dense sand layer atop silty fine sand (inferred glacial till) at shallow depths (ranging from 0.3 m to 0.7 m below ground surface).

Although there are no available details documenting the dam construction, in our archives we observed a report with construction recommendations and specifications produced for the golf course by Hardy BBT Limited Consulting Engineers dated May 10, 1989. Design construction drawings were also noted, produced by Willis Cunliffe Tait Consulting Engineers. The design indicates the ponds were established by excavation of in situ soils to deepen an existing depression and create the earthen dam embankments. The information provided the design specifications of the earth dams and ponds, including the capacity of the ponds, the geometry of the earth dams, and material and methodology specifications for construction. We do not have record of the engineering inspections/certifications of the dam construction.

A conduit supplies fresh water from Morningstar Creek to the southwestern side of Pond A and Pond B. We observed a valve box on the surface in the vicinity of the conduit locations. There is an additional outlet and inlet at the pump house to service the irrigation system, which accepts effluent from the municipal inlet for dosing into the ponds. The pumphouse is located within the inferred natural terrain area proximal to the left abutment of Dam 3. We understand that the buried lines and submerged inlets/outlets are operational and no concerns about their function have been brought to our attention based on an interview with the course superintendent Gordon America. During the interview, the operational systems of the water supply systems were discussed as well as the monitoring and maintenance regime of the site.

4. SITE INVESTIGATION

Our investigation work comprised a site reconnaissance and a subsurface investigation of the dam and foundation materials. We also traversed the accessible areas downslope on foot to gather information on the surface vegetation, infrastructure, topography, and drainage channel conditions for the downstream consequence review.

We advanced nine test holes at select locations within the dam crest, optimally spaced throughout the dams surrounding Pond A. The test holes were advanced using a track mounted sonic drill rig supplied and operated by Blue Max Drilling Inc. of Comox, BC. We advanced all holes to a maximum of 6 m, taking note of soil color, consistency, constituents, and relative moisture. Additionally, we advanced five DCPT holes to gather strength information about the dam and foundation materials. In situ shear strength readings were also acquired periodically during test hole advancement with a hand operated torque vanes and penetrometer. The holes were backfilled with bentonite chips, and cuttings were disposed of on site. The locations of the test holes are shown on the attached drawing 9963-1-1 entitled Test Hole Location Plan (Appendix C).

Soils observed within the test holes were noted to comprise the embankment fills up to a depth of 2.8 m below the crest surface. The fill consisted of clayey silt with traces of sand, gravel, and organic materials. The clay was noted to be damp, becoming moist at depth. Shear strength readings showed a typical value of approximately 100 kPa.

The soils observed beneath the dam fill generally comprised a layer of compact to dense sand of varying thickness with intermittent layers of topsoil, atop very hard clayey silt with trace gravel (inferred glacial till). The soils generally conform with our anticipated soil conditions based on surficial geology mapping and our experience in the area. While the above is presumed to generally describe the dam composition and subgrade materials, it should be noted that soil conditions may vary between the tested locations. Detailed soils information is provided in the attached Test Hole Logs (Appendix D).

5. SURFACE AND SUBSURFACE DAM CONDITIONS

5.1 GENERAL DAM STRUCTURE

We expect that the dams were constructed by general removal of the organic topsoils followed by placement of imported silt and clay fill to build the embankment and line the dugouts. Based on the subsurface information it is reasonable to assume that the dams generally comprise brown clayey silt with traces of sand, gravel. Surface organics and trace organics/roots are also present. The foundation soils consist of very hard silt and clay with trace sand and gravel material (inferred glacial till).

We completed hydrometer tests on the dam fill materials collected on site at two test holes (TH21-02, 07), attached in Appendix E. The sample results indicate the bulk dam fill material comprises and average of 36.5% clay, 48.6% silt, 14.9% sand, with the maximum particle size noted around 0.6 mm. This soil is classified as a clayey silt with some sand. Based on our experience with these materials as well as published values the hydraulic conductivity is likely between 10^{-7} cm/s and 10^{-9} cm/s, classified as having very low permeability.

Stability analysis was carried out using Rocscience's Slide software which applies Limit Equilibrium methods. Modeling indicated that in the event of an earthquake with a 2 % probability of exceedance in 50 years the dam would not experience deformation as a result of full peak ground acceleration seismic loading. The modeled dam sections comply with current regulations having a minimum Factor of Safety of 1.2 response to seismic loading. Modelling results are attached in Appendix F and discussed further in Section 6.3.

5.2 DAM CREST CONDITIONS

The dam crests are generally at a uniform elevation, hosting a pathway typically vegetated with low grasses, while brush and stands of mature trees are present throughout. No indications of tension cracks or differential settlement were apparent. The conditions of the dam crests are shown in the photos below. Based on the site survey we infer the minimum crest elevation to be approximately 38.4 m within Dam 1 and 2 and approximately 40.3 m within Dam 3 (the saddle dam).

Figure 2.Photo of Dam 1 looking northeast from the left abutment.

Figure 3. Photo of Dam 2 looking southwest from the right abutment.

Figure 4. Photo of Dam 3 looking southeast from the left abutment.

5.3 Dam Upslope Conditions

The area upslope of the dams (south) is vegetated with low grasses and moderately undulates topographically, within the bounds of the golf course. A forested area further to the south and west is present beyond the extents of the property boundary. Morningstar Creek flows northeasterly and has a meandering channel. The ponds do not receive any significant surface flow from the surrounding areas due to the specific geometry of the surrounding terrain as the surface drainage slopes away from the ponds beyond the crest of the embankments.

5.4 Dam Downslope Conditions

The downslope areas are typically inclined at between approximately 2 % to 5 % and vegetated with low grasses and natural areas. Infrastructure consists locally of public roadways, drainage ditches, and single family residences. Morningstar Creek as described previously extends through the golf course and residential areas. We did not observe any signs of erosion caused by excessive seepage along the downstream slope of the embankment, however, the vegetated surface was typically moist. A trench toe drain exists along the western boundary of Dam 2. We understand this was installed in accordance with recommendations of EBA Engineering Consultants Ltd. from August 2000. This subsurface drain appears to be part of an overflow outlet system located in the southwestern corner of Pond A which directs flow to discharge to Morningstar Creek. The drawing provided for our review, produced by Koers & Associates

Engineering, indicates the design particulars of this system. We did not observe any portions of exposed soils near the dams or ponds that suggest significant erosion is occurring in proximity to the dams.

5.5 Low Level Outlet Conditions

A low level outlet typically consists of a pipe (minimum 0.6 m diameter) that can be opened by valve control to drain the reservoir in case of emergency. There does not appear to be any low level outlet present within the dams, however, the irrigation system (with backup power) could be considered to be capable of serving as an alternative for this system as this could be activated to assist dewatering in case of emergency. Confirmation of the siphon rate should be included in the operations manual.

5.6 Spillway Structure and Conditions

The two PVC culverts located in the saddle dam between Pond A and Pond B are approximately 0.34 m diameter and include a concrete segment headwall at the inlet. The headwall appears to have been subject to some differential settlement as the sections were noted to be leaning towards Pond A locally. The pipes have an overall length of approximately 20 m, generally following the geometry of the embankment surface, with the outfall discharging atop a wooden board armored surface close to the winter static levels of Pond A. The areas directly surrounding these culverts are lightly vegetated and the portions of the pipes on the downstream side are not buried. The photographs in Figures 5 and Figure 6 below show the PVC pipes. We note that PVC may be sensitive to ultra-violet light and such may deteriorate more quickly due to sun light exposure. No spillway exists for Pond A other than the two overflow pipes with sandbag headwalls which are denoted on the design drawing as a 150 mm and 200 mm diameter PVC. These pipes outfall to a 1.2 m diameter concrete barrel collector sump which in turn discharges to a 200 mm diameter leader extending close to Morningstar Creek within the golf course 18th hole fairway.

Figure 5. Photo view of culvert outlet at Pond A looking northeast.

Figure 6. Photo view of culverts exposed along the west side of Dam 1 looking northwest.

6. HYDRAULIC ASSESSMENT

6.1 FLOOD CAPACITY ANALYSIS

The ponds receive inflow exclusively from the wastewater treatment plant or Morningstar Creek via controlled pumping. Morningstar Creek is fed by several roadside drainage swales, natural surface run off and groundwater. The gradient between Morningstar Ponds and the downstream areas is estimated at approximately 2% – 5%. Due to the properties of the dam construction materials and the depth of the local groundwater table (inferred between 4 m and 13 m) we consider the inflow of groundwater into the ponds to be marginal.

We consider the catchment area for the ponds to be approximately 3 m beyond the extents of the ponds, totaling an area of approximately 4.1 ha. Flood capacity analysis was carried out using the Rational Method (Ponce 1989). A conservative rainfall intensity value was considered based on the time of concentration of less than 5 minutes for the combined ponds and surrounding influence area. This value was estimated at 90 mm/hr (considering a 100 year return event) based on the short-term Intensity Duration Frequency data available for the Comox Airport and a runoff coefficient of 0.95 was assigned. This yields a theoretical Inflow Design Flood (IDF) discharge in the order of 1.1 m^3/s.

The maximum capacity of the existing outlet of Pond A is approximately 0.09 m^3/s based on a 200 mm diameter pipe sloped at 4%. However, given the available freeboard and the catchment area being only the surface area of the existing ponds and embankments, the rise in water levels would be negligible for any foreseeable discrete precipitation event and would not result in overtopping provided functional overflow outlets.

Due to the presence of Pond B being immediately above Pond A it was considered that a breach of Dam 1 would discharge directly into Pond A. As discussed below, the breach discharge for an extreme event would be significant and therefore the peak discharge (Q_p) can be considered as the controlling IDF for design purposes.

6.2 BREACH ASSESSMENT AND FLOOD ROUTING

We consider that a dam breach occurring as a result of either piping or overtopping would have a relatively low probability given the embankment materials, section, and retained pressure head. However, if the embankment structures were compromised by an unforeseen external influence, such as an act of vandalism, aircraft impact, or gross malfunction of inflow system, as well as a unique combination of natural events, it is foreseeable that a breach could occur as a remote risk.

Breach modeling was carried out using HydroCAD modeling software to review the impacts of the immediate downstream areas where inundation would theoretically be possible. Modeling applies rudimentary hydrologic analysis based on the Manning Equation (Ponce 1989) as a screening review to estimate flow depth and velocity of the flood water. This methodology was deemed sufficient as the terrain is reasonably uniform with respect to larger scale surface

roughness, and breach inundation areas can be modeled as simplified wide and flat reaches for the routing and estimation of pulse amplitude etc. Generally, breach of Dams 2 and 3 was considered to be the controller of downstream risk, while the implications of a breach of Dam 1 and the influence to Pond A was also examined. Breach development was conservatively modeled with consideration that the overflow outlet of Pond A was non-functional and overtopping of the full pond initiated the breach. The modeling discussed below considered development would occur rapidly over a time frame of only 15 minutes, which is at the lower bound of the time frames indicated in available literature (upper boundary suggested as 1 hour, Wahl 1998). Breach base width was assigned to extend to 3 times the height of the crest, and we judge this to be a median to conservative value given the specifics of this site. The pond internal geometry was assumed to have a minimum 33% gradient for the submerged slopes as specified on the design plans and generally as visible during low water levels.

Figure 7. Photo of western inundation area looking northeast toward wooded border along Dam 2

Breach of Dam 2 would be limited to a height of approximately 1.6 m based on the dam section. This occurrence would result in inundation flow impacting the treed boulevard area and adjacent roadway, the residential lots along the southern side of Morningstar Drive, as well as the golf course rough/fairway to the west of the ponds. The modeling suggests that Q_p would be approximately 11.5 m^3/s at the breach, but as the terrain is gentle and vegetated the flow would spread out radially from the hydraulic step and attenuate rapidly. In the case that the flow broke through the sparse woodland band within the central-eastern portions and spread onto the 10 m wide roadway bound by curbs and gently upsloped front lawns/driveways, the average depth (d_{avg})

and maximum velocity (V_{max}) was calculated to be 0.25 m and 1.3 m/s respectively. Routing through the woodland to the south of the residences onto the wide open golf course via the tall grasses, d_{avg} and V_{max} were calculated as 0.17 m and 1.2 m/s. In both of these scenarios the flow would inevitably be intercepted by the channel of Morningstar Creek, and some influence to the residential yards and low energy flow impact to the lower portions of the immediately adjacent buildings would be anticipated. The creek was calculated to have a conveyance capacity of approximately 38 m^3/s, and in both of these cases the collected overland flow would result in a d_{avg} of approximately 1 m and V_{max} of less than 3 m/s, and the box culverts were shown to have a capacity of over 21 m^3/s. Hydrographs showing the routing through the golf course/roadways (being similar) and Morningstar Creek provided below.

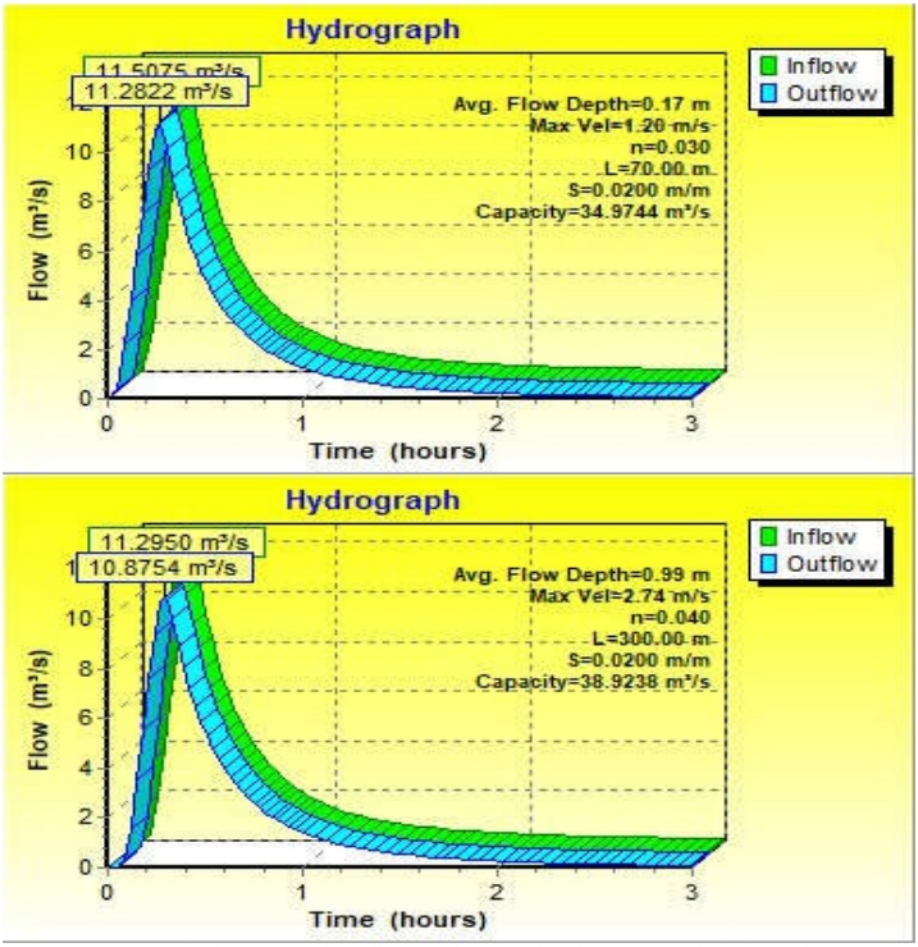


Figure 8. Hydrographs of breach inundation to southwest of Dam 2

Figure 9. Photo view of northern inundation zone looking south towards Dam 3

Breach of Dam 3 would realize a dam section rupture holding up to approximately 2.3 m of head, being the highest embankment area around Pond A. Breach of this portion would result in flow inundation and attenuation within the golf course area spreading down a natural swath of 20 m to 40 m width for some 80 m length through the short grass, outfalling to the roadway. The route continues north down the road laterally bound by curbs and gently rising lawns and local ditches, and would be intercepted by Morningstar Creek approximately 80 m to the north of Roberton Boulevard. Q_p of this breach was calculated to be approximately 24.7 m^3/s. Within the golf course rough d_{avg} and V_{max} were 0.21 m and 1.92 m/s, and within the roadway d_{avg} and V_{max} were 0.23 m and 3.1 m/s. Morningstar Creek within the interception area is confined within a much deeper channel and d_{avg} and V_{max} were 1.8 m and 3.4 m/s. The moderately energetic flow would possibly spread up against the existing residences at the eastern sides of the intersection. Hydrographs of this routing are provided below.

Breach of Dam 1 was modeled to extend to a depth of 2.5 m. Q_p was calculated to be about 23 m^3/s in this case and the resulting inundation to Pond A would initiate overtopping of Dams 2 and 3 assuming maximum service levels at the time. Overtopping breach initiation around Pond A could then occur as discussed above. The potential inundation zones are shown in Figure 11 below.

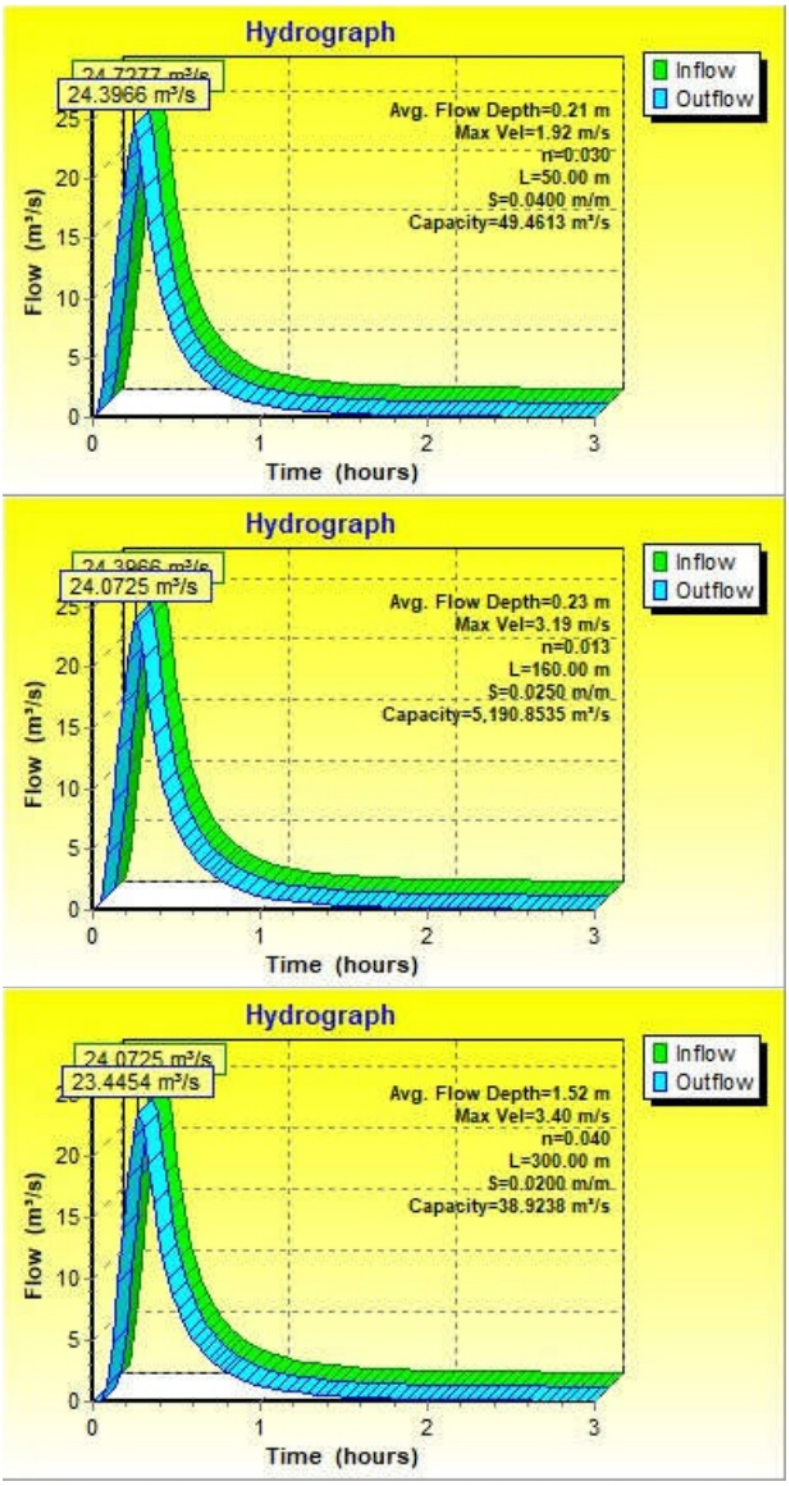


Figure 10. Hydrographs of breach inundation to north of Dam 3

Figure 11. Potential Inundation Zone of Dam Breach Flood Water (Existing Dams)

It is worth noting that when the minimum freeboard of 0.47 m was applied to the breach models Q_p was over 33% less than that of the overtopping condition. A similar reduction was observed if the breach development was modeled at a duration of 30 minutes. However, the model could not identify local variations in depth and velocity that may occur in reality. Further details of the dam breach modeling can be reviewed online at the HydroCAD web link provided in Appendix J.

7. ASSESSMENT OF PROBABLE MODE OF DAM FAILURE

Earthen dams have many different potential failure modes. Therefore, we have focused our investigation on the most relevant and probable modes of failure for the conditions of the Morningstar Dams. These failure modes include both static and seismic slope instability, and overtopping erosion. An explanation of each failure mode and reasons why we consider it as a relevant hazard follows.

7.1 STATIC AND SEISMIC SLOPE INSTABILITY

Slope instability of the dams may occur under normal reservoir storage conditions and more suddenly during and/or after an earthquake. Some of the main factors influencing slope instability are poor foundation material and/or irregularities in the foundations, surface erosion, seismically induced ground motions.

We believe the dams were likely constructed by placement of a combination of imported and site sourced excavated materials, placed directly atop the existing surface following removal of topsoils/organics. Since the dams have been in place for approximately 31 years, we consider that the subgrade / foundation soils are reasonably stable and similar to those observed in the test holes (TH21-01 to -09).

Surficial erosion indications were not observed during our site review. We do not expect that the slopes at the 33% inclination would be subject to long term soil creep. No review of the submerged slopes was available given the pond levels, however the design drawings suggest that such are uniform with the visible areas.

We carried out slope stability analysis under normal and extreme loading conditions using an elasto-plastic finite element stress analysis (FEM) software produced by Rocscience (RS2 and Slide). The geometry of the dam and soil parameters were assigned based on the survey drawing and the results of our subsurface investigation, with soil parameters chosen to reflect the sampled materials. The determination of the seismic loading used in the pseudo-static analyses was based upon the Earth Design Ground Motion acquired from the National Building Code of Canada (NBCC 2015) for a 2 % probability of exceedence in 50 years. The peak ground acceleration (PGA) applied for the pseudo-static analysis considered the full value of 0.399 g at the dam location. The reference information is attached in Appendix K. Based on the observed stiff/dense soils and local geology/geomorphology, we do not generally consider liquefaction hazard to be present.

The slope stability analysis indicates that the dams are stable under normal loading conditions. However, when seismic loading is added to the analysis the model suggests that the dams may experience some degree of plastic deformation during the PGA. This would be expected to be progressive in response to oscillatory loading, and some strain softening could potentially occur. We expect that the dam structure would stay relatively intact given the soils and geometry, however, zones of weakness may result which could lead to potential internal erosion and dam

breach. Therefore, inspection and monitoring of the embankments should be carried out immediately following such an event and dewatering measures should be prepared for readiness if required at that time.

7.2 PIPING

Piping failure in dams may occur many years after the dam has been in full operation and can occur relatively quickly with limited warning signs. This failure occurs when seepage is uncontrolled and causes internal erosion of the embankment. The water begins carrying material out of the dam, creating a small void which further allows water to enter and begin to flow, leading to erosion of the dam. This usually begins at the downstream side of the dam and progressively works its way to the upstream end where a breach occurs. It is referred to as piping not because it is a failure of a pipe inside of a dam, although this can often cause piping to occur, but because as the water erodes the material away it effectively leaves a tunnel or 'pipe' where the water flows freely out of the reservoir. Piping is also more likely to occur when overtopping conditions are present due to the increase in pore water pressure in the soils.

We carried out seepage analysis using FEM and assumed hydraulic conductivity values of 10^{-7} cm/s for the embankment fill consisting of clayey silt and 10^{-4} cm/s for the lined foundation soils comprised of glacial till being a heterogenous mix of clay, silt, sand and gravel. Conservative section geometry was applied to represent the thinnest potential thickness of the less permeable embankment fills in combination with pond levels at critical overtopping elevations. The critical hydraulic gradient for quick condition of the foundation soils is considered to be above a value of 1. This is the point where the effective stress in the soil is negated due to pore pressure which overcomes the buoyant weight of freely mobile particles at the seepage face. At this point erosion can occur and transport is then controlled by the seepage velocity leaving the face. The modeling indicated that a maximum hydraulic gradient within the downstream toe would not be experienced above 0.4. An order of magnitude value of maximum 3.2×10^{-7} m/sec was calculated for seepage through the downstream slope surfaces. Negative pore pressure values were observed along the downstream slope and we conclude that piping would not be a likely mode of failure based on the soil conditions of the embankment and the pressure head. See Appendix Fb for the results of our seepage analysis.

It is conceivable, however, that local heterogeneous zones of more permeable soils are present within the embankment fill and foundation soils, or root networks from previously removed trees, existing trees, or perhaps within the fill around the conduits beneath the dam. In fact, a lens of sand and gravel was encountered locally within an approximately 1 m thick zone below the embankment fills within the western portion of Dam 1 (see TH 21-01). As such, piping cannot be ruled out, although these soils are expected to be discontinuous and breach development would very likely take longer than the assigned 15 minutes to develop based on the low permeability and compaction conditions of the overlying embankment soils and the anticipated progressive process of erosion.

There was no discernible evidence of piping erosion within the downstream embankments during our site attendances. As the ponds levels are only raised to full operational volumes during the dry season the limited time when increased pore pressure is experienced further reduces the overall risk of piping failure.

7.3 Overtopping

Overtopping failure is one of the most common modes of failure for earthen dams. It generally occurs when the reservoir inflow surpasses the outflow/discharge capacity of the system for a significant period of time. Settlement of the crest may potentially be a factor as well. In rare occasions, waves caused by an earthquake have led to overtopping.

Once the overtopping occurs, it may cause the dam to breach. The breach will develop in time as a function of the erodibility of the materials, and further embankment failure and release of water can occur if the erosion is not dealt with immediately.

Overtopping failure is deemed to be a negligible risk as a result of precipitation provided all outlets are functioning properly. As discussed previously, the potential for overtopping would be most likely as a result of a rapid catastrophic breach of Dam 1 introducing significant discharge to Pond A which could exceed overflow capacity and result in overtopping of Dams 2 and 3.

8. Downstream Dam Failure Consequences Classification Review

We have reviewed the Dam Failure Consequences Classification of the Morningstar Dams which we understand are currently designated as ‘High’ (Dam 2 and 3) and ‘Significant’ (Saddle - Dam 1). In the current configuration this classification is considered appropriate. However, based on breach modeling, population proximity, and associated risk we conclude that, with some modifications to the redundant systems and surrounding terrain, the dams can be reassigned to all have a ‘Significant’ rating.

This would be defendable following modifications as the inundation zone would be limited to the golf course landscaping, roadways/boulevards and Morningstar Creek which would qualify as being areas that are only occasionally occupied. The current Schedule 1 - Dam Failure Consequence Classification Table is attached as Appendix H for reference. Further refined surface terrain data acquisition and flow modeling work, berm design, and installation would need to be completed to qualify the potential reclassification.

9. Dam Safety Management

9.1 Owner’s Commitment to Safety

We consider that continued use of the dam will require cooperation of the land owner and the water licensees to ensure that the OMS and EPP are prepared suitably and that an appropriate site surveillance personnel team is available.

9.2 Regular Inspection

In general accordance with the Schedule 2 of the BC Dam Safety Regulations (Minimum Frequency of Safety Activities) we maintain that regular weekly inspection of the dam by site appointed personnel be implemented for the Morningstar Dams. Inspection should also be conducted during / following extreme rainfall events and immediately following seismic events. Such inspections should be detailed within the OMS. Schedule 2 is attached for reference in Appendix I. The most recent inspection documentation is attached in Appendix M.

9.3 Emergency Procedures Plan

We understand that an EPP has recently been recently updated for the Morningstar Dams to be submitted in conjunction with this review. A typical plan should list whom should be notified and their phone numbers in order of first to last to be contacted; this list should include neighbors, local fire department, local RCMP, Ministry of Transportation and Infrastructure, the Regional Dam Safety Officer and the Provincial Emergency Program's regional and provincial offices. Additional information should also be included such as action to be taken in the event of any observed leaking, crest overtopping, spillway blockage, partial breach, etc, and should include warning and emergency procedures for the downstream residences. The Province has created a guide of suggested emergency procedures and we have included a copy of this document in Appendix L.

10. Recommendations for Existing Dams

The following sections outline our findings of our analyses and further recommendations to ensure the safety of these dams. It should be noted that there are unknowns with respect to the uniformity of the materials within the dams which can be considered as 'data gaps'. On the other hand, the embankment performance over the past 30 years, the unique situation of the dams, and the available surface and subsurface information we have collected support our consideration that the dams do not present an undue safety risk to the community at this time.

10.1 Seismic Stability

Our stability analysis modeling suggests that in the event of an earthquake (2 % probability of exceedance in 50 years) the dam will likely remain intact following the event. The existing geometry and material of the dam complies with current regulations for a Factor of Safety of 1.2 in the design seismic event. Some plastic deformation may occur during a design seismic event that may potentially lead to a dam breach. We recommend that in the event of an earthquake, the dams be inspected to determine the extents of the plastic deformation, that could then be remediated. We do not have any further recommendations to increase the seismic stability of these dams.

10.2 Vegetation Removal

In general vegetation should be cut down annually to ensure that growth does not affect the stability of the dam. We note that low ground cover vegetation is generally considered to be beneficial to surficial stability of the embankment soils. While we consider that root networks within the embankment may present a preferential avenue for piping, we also expect that the presence of such would significantly limit the global erodibility of the embankment soils and decrease the rate of breach propagation/widening. This has been shown in the modeling to be a significant controller of inundation severity due to the rate of reservoir dewatering and associated discharge rate. That said, if the trees get too large there may be an increased risk of windthrow which could result in removal of material along with the rotated root mass which would increase the risk of breach. Accordingly, a new spillway as discussed below should effectively mitigate the risk of overtopping, we consider that the trees could remain provided such are limited in height and tree health is managed by a qualified arborist on an annual basis as part of the OMS.

The risk associated with the approach to leave the trees within the structure of the embankment may be unacceptable and therefore removal would be required to mitigate the associated unknowns in this regard. If trees are to be removed permanently the root ball would need to be excavated and the embankment fill replaced with proper engineered clay fill under geotechnical supervision.

10.3 Culvert Maintenance

The two culverts conveying water from Pond B to Pond A, should be cleared of potential silt/debris annually. Additionally, the irrigation inlet acting as the low level outlet in the northwest area of Pond B should be inspected and cleared out annually. This work should be carried out prior to the Formal Inspection so that such can be noted by the inspector and detailed in the OMS. If the presence of the spillway alignment being atop the embankment is unacceptable to the DSO we recommend that a new spillway be provided, as described.

10.4 Downslope Improvements

In order to ensure that breach inundation areas are limited to terrain that can be qualified as being occupied as temporary only (in support of a revised classification), we recommend the following improvements be made to the downstream areas;

1. Construction of a 6 m wide spillway with the sill set at the same elevation as the maximum service elevation of the water within Pond A (as shown in Figure 11). The spillway to be located at the southwest side of Pond A such that, if activated, the discharge would be directed onto the grass fairway area leading towards Morningstar Creek. The engineered spillway could be lined with an armored bed of riprap over heavy geotextile, or lined with concrete.

2. Installation of clay soil berms of adequate geometry (or possibly a ditch and windrow configuration) around the perimeter areas of the residences along the southern side of Morningstar Drive (civic addresses 636 to 656). This would protect the residential lots from any foreseeable inundation against the buildings that cannot be qualified as temporarily occupied. To further review these improvements, we would recommend that a LIDAR survey be acquired if available from the Province, or be completed by professional surveyors around the block of houses to allow for additional flow modeling and subsequent flood protection berm design to occur.

3. Installation of a regulation conformant spillway between Pond B and Pond A. This would require a properly armored channel to be excavated through native soils around the saddle dam embankment. Based on the terrain conditions, we consider this would be situated beyond the left abutment of the saddle dam extending marginally into the rough of the 18th hole.

While these measures would be necessary to qualify for support of a classification reassignment, we would generally suggest that such be considered to be implemented to improve the safety of the community in the immediate vicinity of the ponds. In any case we believe that implementation of the noted spillways would be a simple and economical alteration that would allow for continued service but would significantly reduce the risk of overtopping that poses the highest risk to the downstream areas. Any site work for proposed dam alterations would require a construction plan to be submitted to the DSO for approval prior to commencement and additional engineering design for such can be provided upon request.

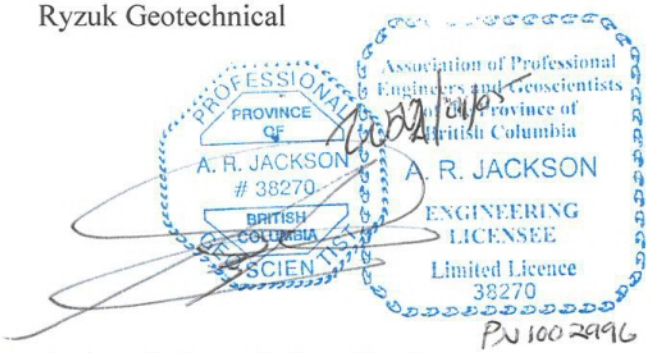
11. CLOSURE

Ryzuk Geotechnical was engaged to undertake a Dam Safety Review of Morningstar Pond Dams. Our involvement consisted of a geotechnical and hydraulic assessment, probable failure mode assessment / flood routing and associated recommendations to increase the level of safety of the dam to meet the safety requirements outlined in the Dam Safety Program.

Pursuant to EGBC's Legislated Dam Safety Reviews, Appendix C1 The Dam Safety Review Assurance Statement – Water Reservoir Dams is attached in Appendix M of this report.

We trust the preceding Dam Safety Review fulfills the requirements outlined by the Dam Safety Review Guidelines provided by Dam Safety Section of the provincial legislature of BC, and that it is suitable for your purposes at present. If you have any questions with respect to the above, or require further information or clarification, please contact us.

Sincerely,
Ryzuk Geotechnical



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APPENDIX A

Terms of Engagement

RYZUK GEOTECHNICAL
ENGINEERING & MATERIALS TESTING

TERMS OF ENGAGEMENT

1. GENERAL

1.1. Ryzuk Geotechnical Ltd., its principals and employees (collectively the "Consultant") shall render the Services to the Client for the Project in accordance with the following terms of engagement (the "Engagement").

1.2. The Consultant will provide the Services, and any other associated documents, records or data, in accordance with the standard of care, skill and diligence required of a geotechnical consulting firm providing similar services at the same time in the same geographic location and circumstances in British Columbia. The Services will be provided in accordance with procedures customarily provided in similar circumstances by similar professionals. No other representations or warranties, expressed or implied, are made by the Consultant.

1.3. The Consultant may, at its discretion and at any stage, engage sub-consultants to perform all or any part of the Services.

2. COMPENSATION

2.1. All fees billed to the Client by the Consultant are payable in Canadian dollars. Invoices are due and payable by the Client on receipt of the invoice, without holdback. Interest on overdue accounts is 24% per annum.

3. REPRESENTATIVES

3.1. Each party must designate a representative who is authorized to act on behalf of that party and receive notices under this Engagement.

4. TERMINATION

4.1. Either party may terminate this Engagement without cause upon providing 30 days' written notice to the other party. On termination by either party under this section, the Client shall forthwith pay to the Consultant all fees invoiced by the Consultant for the Services performed to the date of termination, including all expenses and other charges incurred by the Consultant in respect of the Consultant's Engagement by the Client.

4.2. If either party is in breach of any term of this Engagement, the non-defaulting party may give written notice of the breach to the other party and thereafter terminate this Engagement forthwith if the defaulting party does not remedy said breach within 7 days' of being provided written notice of the breach. On termination by the Consultant under this section, the Client shall forthwith pay to the Consultant all fees invoiced for the Services performed to the date of termination, including all expenses and other charges incurred by the Consultant in respect of the Consultant's Engagement by the Client.

5. ENVIRONMENTAL

5.1. The Consultant's field investigation, laboratory testing and engineering recommendations will not address or evaluate contamination or pollution of soil or groundwater. The Consultant will cooperate with any environmental consultant retained by the Client during the field work phase of the investigation.

6. INSURANCE

6.1 Ryzuk Geotechnical maintains Professional Indemnity Insurance as follows:

6.1.1 $3,000,000 each and every claim

6.1.2 $5,000,000 in the aggregate

6.1.3 $5,000,000 commercial/general liability coverage.

7. LIMITATION OF LIABILITY

7.1. The Consultant shall not be responsible for:

7.1.1. the negligence or failure of any contractor or other professional retained by the Client to perform work or provide services in respect of the Project in accordance with the applicable contract documents and/or advice provided by the Consultant;

7.1.2. the design of or defects in equipment or materials supplied or provided by the Client or its contractors for incorporation into the Project;

7.1.3. any cross-contamination resulting from subsurface investigations;

7.1.4. any Project decisions made by the Client if such decisions are made without the Client first seeking advice from the Consultant and/or decisions contrary to or inconsistent with advice provided by the Consultant;

7.1.5. any consequential loss, injury or damages suffered by the Client or its agents and contractors, including but not limited to loss of use, earnings and business interruption;

7.1.6. the unauthorized distribution of any confidential document or reports prepared by or on behalf of the Consultant for the exclusive use of the Client;

7.2. The Consultant will make all reasonable efforts prior to and during subsurface site investigations to minimize the risk of damaging any subsurface utilities/mains. If, in the unlikely event that damage is incurred where utilities are unmarked and/or undetected, the Consultant will not be held responsible for damages to the Project site or surrounding areas, utilities/mains or drilling equipment or the cost of any repairs thereto.

7.3. The Consultant's total liability to the Client for any errors, omissions, breaches of contract and/or negligence arising in connection with the Services is limited to the amount of the Consultant's fees for the Services and shall not exceed that amount under any circumstances. For greater clarity, this means that if the Client makes any claim, including any claim for contribution or indemnity, or brings any claims against the Consultant, then any damages for which the Consultant may be liable cannot exceed the total amount of fees paid to the Consultant by the Client.

7.4. The Client agrees to indemnify and to save and hold harmless the Consultant from any claim, demand, litigation, expense, legal fees, liability, damage, award or cost, of any form or type whatsoever, in respect of any claim for property damage, loss, or personal injury brought by any party including the Client's contractors, other professionals, or any third party, resulting from the Consultant's provision of the Services, except for such property damage, loss or personal injury that results directly from the gross negligence of the Consultant.

7.5. No claim may be brought against the Consultant in respect of the Consultant's provision of the Services, in contract, negligence or other civil wrong more than 2 years after any claim is discoverable.

8. DOCUMENTS AND REPORTING

8.1. All of the documents prepared by or on behalf of the Consultant in connection with the Project are instruments of service for execution of the Project and the Services. The Consultant retains the property and copyright in these documents, whether the Project is executed or not. These documents may not be used on any other project without the prior written agreement of the Consultant.

8.2. Documents that have been prepared specifically for the Project are applicable and may be relied upon only in the case where there has been no physical alteration to, or deviation from any of the information or plans provided to the Consultant by the Client or the Client's agents. If the Client makes any changes or deviations from original plans for the Project, the Client may request that the Consultant review and revise Project documents accordingly.

8.3. Identification and classification in respect of the extent, properties, or type of soils or other materials at the Project site will be based upon investigation and interpretation of results in a manner consistent with customarily accepted standard geotechnical consulting practices in the location where the Services were performed. Due to the nature of geotechnical consulting, there is an inherent risk that all potential conditions will not be detected at the Project site and that actual subsurface conditions may vary considerably from investigation points. The Client and any other party making use of any documents prepared by the Consultant in respect of the Project acknowledges and accepts this risk.

8.4. Any conclusions and recommendations provided within any document prepared by the Consultant for the Client will be based on the scope of investigation by the Consultant and any additional information provided to the Consultant by the Client or the Client's agents. The Consultant disclaims responsibility for any deficiency or inaccuracy resulting from the Consultant being provided with inaccurate or fraudulent information by the Client or the Client's agents.

9. JOBSITE SAFETY AND CONTROL

9.1. The Client acknowledges that control of the Project site remains solely with the Client, and/or the Client's agents and/or contractors. The presence of the Consultant's personnel on the Project site does not relieve the Client, the Client's agents and/or contractors from their responsibilities for Project site safety. The Client must inform the Consultant of all hazardous or otherwise dangerous conditions at the Project site of which the Client, its agents, and/or contractors are aware.

9.2. The Client acknowledges that during the course of a geotechnical investigation a previously unknown hazard or contaminant may be discovered. Discovery and/or identification of a hazard/contaminant may necessitate procedures to ensure the safety and protection of persons and/or the environment being undertaken. The Client shall be responsible for payment of any additional expenses incurred as a result of discovery of a hazard/contaminant. The Client acknowledges that certain circumstances require government and/or regulatory authorities to be notified of hazardous conditions and/or contaminants. The Client shall not make any claim or bring any action against the Consultant in the event the Consultant provides any required notification of a hazard and/or contaminant to a government and/or regulatory authority.

10. FIELD SERVICES

10.1. If the Consultant is requested or required to provide field reviews as part of the Services for the Project and the Client declines to authorize or otherwise limits the scope of same in a manner inconsistent with the Consultant's advice or recommendations, the Consultant may provide qualified certifications in respect of any work completed by the Client and/or its contractors that was not overseen by the Consultant.

11. DISPUTE RESOLUTION

11.1. If requested in writing by either the Client or the Consultant, the Client and the Consultant shall attempt to resolve any dispute between them arising out of or in connection with this Engagement by entering into

structured non-binding negotiations with the assistance of a mediator on a without prejudice basis. The mediator shall be appointed by agreement of the parties. If a dispute cannot be settled within a period of thirty (30) calendar days with assistance of a mediator, the dispute shall be referred to and finally resolved by a British Columbia Court.

12. CONFIDENTIALITY

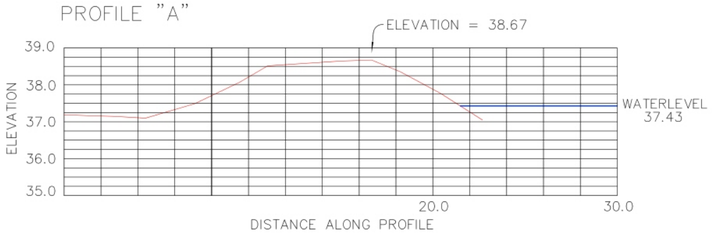
12.1. During the term of the Engagement, the Consultant shall not use or disclose any of the Client's confidential information to any third party other than the Consultants legal and/or financial advisors without authorization from the Client. The Consultant will use any confidential information for the sole purpose of carrying out the Services. The Consultant may share photos of the Project so long as such photos do not disclose any information not otherwise available or readily visible by the public. Unless already made public, the Consultant will not share Client or Project site address information on social media or with third parties.

APPENDIX B

JE Anderson Survey dated September 21, 2020

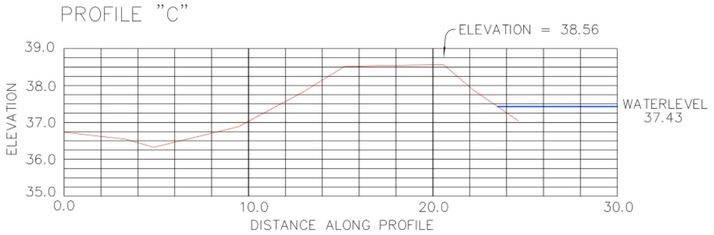
PROFILES ARE SHOWN NOT TO SCALE

PROFILE "A"



PROFILE "B"

PROFILE "C"



ELEVATIONS:
Orthometric Elevations are to CGVD28BC Geodetic Datum
and are derived from Natural Resources Canada
Precise Point Positioning Service (PPP)

× 36.22 Denotes spot elevation

All Dimensions are in Metres and decimals thereof

0 10 20 40 60 80 100

The Intended Scale of this Plan is 1:1000
when plotted on a 599 mm x 432 mm (22"x17") Sheet

This Plan has been Prepared in Accordance with the Professional Reference Manual and is Certified Correct this 21st Day of September, 2020.

This document is not valid unless digitally signed.

JEA JE ANDERSON & ASSOCIATES
SURVEYORS AND ENGINEERS
203 – 177 WELD ST., PO BOX 247
PARKSVILLE, B.C. V9P 2G4
250–248–5755 parksville@jeanderson.com

N

SITE PLAN AND PROFILE ELEVATIONS

LOT A, DISTRICT LOTS 29, 81, 83 & 126 NANOOSE DISTRICT PLAN 49145

PID 014–884–275

PREPARED FOR
MORNINGSTAR GOLF COURSE

OUR FILE : 61739–1	REVISION :

APPENDIX C

Location Plan

NOTES

1. This drawing is for the intended use of the client for the specified project, and should not be used elsewhere without the express permission of the client and/or Ryzuk Geotechnical.
2. This drawing is scaled for 8.5x11 sheet and does not require further scaling to fit. Scales will differ if printed on different sheet size.
3. Base plan taken from Regional District of Nanaimo Online GIS database.

RYZUK GEOTECHNICAL
ENGINEERING & MATERIALS TESTING
28 CREASE AVENUE - VICTORIA, BC V8Z 1S3
TEL: 250-475-3131 FAX: 250-475-3611
mail@ryzuk.com

SEAL

DRAWN BY: MPD	CLIENT: G FORCE GROUP
PROJECT MANAGER: ARJ	PROJECT TITLE: DAM ASSESSMENT
REVIEW: SWM	PROJECT ADDRESS: 525 LOWERYS ROAD - PARKSVILLE, BC
SCALE: 1:2500	DRAWING NAME: **TEST HOLE LOCATION PLAN**
DATE: 2021/03/17	PROJECT No.: 9963-1
	SHEET No.: 01 of 01
	REVISION: 00

R:\Ryzuk Data\8-9000 to 8-9999\9963-1 525 Lowrys Rd\4 Ryzuk Drawings\9963-1 2021.03.17 Test Hole Location Plan Updated GAH.dwg

APPENDIX D

Test Hole Logs

RYZUK GEOTECHNICAL
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TEST HOLE LOG

TH21-01

PROJECT: Dam Assessment
CLIENT: G-Force Group
LOCATION:
COORDINATES (m):
COMPLETION DATE: 2021-2-1

PROJECT NO.: 9963-1
METHOD: Sonic
ELEVATION (m):
CONTRACTOR: Blue Max
LOGGED/REVIEWED BY: MPD/ARJ

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	Recovery (%)	Dynamic Cone (Blows/300mm) 20 40 60 80 / C_{PEN} (kPa) 62.5 125.0 187.5 250.0	COMMENTS	DEPTH (m)
0		TOPSOIL - silty sand, organic, rootlets, brown						0
		FILL - silt and clay, trace sand, trace gravel, firm to stiff, light brown, moist, trace organics						
				1			C_{PEN} = 49 kPa	
							C_{PEN} = 98 kPa	
1							C_{PEN} = 171 kPa	1
							C_{PEN} = 196 kPa	
							C_{PEN} = 98 kPa	
				2			C_{PEN} = 49 kPa	
2							C_{PEN} = 73 kPa	2
		SAND - some silt, some gravel, dense, grey, moist					C_{PEN} = 49 kPa	
							C_{PEN} = 49 kPa	
							C_{PEN} = 49 kPa	
3 ▼				3			C_{PEN} = 49 kPa	3 ▼
							C_{PEN} = 220 kPa	
		SILT - clayey, trace sand, trace gravel, very hard, grey, moist, mottled (inferred glacial till)		4			C_{PEN} = 294 kPa	
4							C_{PEN} = 340 kPa	4
				5			C_{PEN} = 340 kPa	
							C_{PEN} = 440 kPa	
				6			C_{PEN} = 440 kPa	
5							C_{PEN} = 465 kPa	5
							C_{PEN} = 440 kPa	
							C_{PEN} = 490 kPa	
6		End of hole at 6.0 m - desired depth.						6
7								

SAMPLE TYPE ☒ SPLIT SPOON ■ GRAB ▥ SHELBY TUBE ▬ BULK ◧ CORE ⊘ NO RECOVERY

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TEST HOLE LOG

TH21-02

PROJECT: Dam Assessment
CLIENT: G-Force Group
LOCATION:
COORDINATES (m):
COMPLETION DATE: 2021-2-1

PROJECT NO.: 9963-1
METHOD: Sonic
ELEVATION (m):
CONTRACTOR: Blue Max
LOGGED/REVIEWED BY: MPD/ARJ

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	Recovery (%)	C_{PEN} (kPa) 62.5 125.0 187.5 250.0	COMMENTS	DEPTH (m)
0		TOPSOIL - silty sand, some organics, moist						
		FILL - clay and silt, trace snad, trace gravel, trace organics, firm to stiff, light brown, moist					C_{PEN} = 196 kPa	
1							C_{PEN} = 147 kPa	1
				7				
							C_{PEN} = 49 kPa	
2				8			C_{PEN} = 49 kPa	2
		SAND - compact, grey, wet, medium grained		9				
		SILT AND CLAY - trace sand, trace gravel, stiff to very hard, grey, moist, mottled					C_{PEN} = 440 kPa	
3								3
							C_{PEN} = 440 kPa	
4							C_{PEN} = 490 kPa	4
		Sand seam at 4.2 m		10				
							C_{PEN} = 440 kPa	
5							C_{PEN} = 390 kPa	5
				11				
							C_{PEN} = 290 kPa	
6		End of Hole at 6.0 m - desired depth.						6
7								

SAMPLE TYPE ☒ SPLIT SPOON ■ GRAB ▥ SHELBY TUBE ▬ BULK ◧ CORE ⊘ NO RECOVERY

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TEST HOLE LOG

TH21-03

PROJECT: Dam Assessment
CLIENT: G-Force Group
LOCATION:
COORDINATES (m):
COMPLETION DATE: 2021-2-1

PROJECT NO.: 9963-1
METHOD: Sonic
ELEVATION (m):
CONTRACTOR: Blue Max
LOGGED/REVIEWED BY: MPD/ARJ

DEPTH (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	Recovery (%)	Dynamic Cone (Blows/300mm) 20 40 60 80 / C_{PEN} (kPa) 62.5 125.0 187.5 250.0	COMMENTS
0	TOPSOIL - silty sand, some organics, dark brown, moist					
	FILL - clay and silt, trace sand, trace organics, firm, light brown, moist					C_{PEN} = 73 kPa
			12			
1						C_{PEN} = 196 kPa
			13			
						C_{PEN} = 147 kPa
2			14			
						C_{PEN} = 98 kPa
	TOPSOIL - silty sand, trace organics, dark brown, moist					
	SAND - some silt, compact, grey, moist					C_{PEN} = 290 kPa
3	SILT AND CLAY - trace sand, trace gravel, very hard, grey to brown, damp to moist, mottled					
						C_{PEN} = 440 kPa
						C_{PEN} = 340 kPa
4						
						C_{PEN} = 390 kPa
5	0.3 m thick Sand seam at 5.2 m					C_{PEN} = 490 kPa
6	End of Hole at 6.0 m - desired depth.					
7						

SAMPLE TYPE ☒ SPLIT SPOON ■ GRAB ▥ SHELBY TUBE ▬ BULK ◧ CORE ▨ NO RECOVERY

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TEST HOLE LOG

TH21-04

PROJECT: Dam Assessment
CLIENT: G-Force Group
LOCATION:
COORDINATES (m):
COMPLETION DATE: 2021-2-1

PROJECT NO.: 9963-1
METHOD: Sonic
ELEVATION (m):
CONTRACTOR: Blue Max
LOGGED/REVIEWED BY: MPD/ARJ

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	Recovery (%)	Dynamic Cone (Blows/300mm) 20 40 60 80 / C_{PEN} (kPa) 62.5 125.0 187.5 250.0	COMMENTS	DEPTH (m)
0		FILL - silt and clay, trace sand, trace gravel, trace organics, stiff, grey, damp						0
1			GRAB	15			C_{PEN} = 147 kPa	1
			GRAB	16			C_{PEN} = 147 kPa	
		TOPSOIL - silty sand, trace organics, dark brown, moist					C_{PEN} = 196 kPa	
2		SAND - some silt, trace clay, trace gravel, grey, moist						2
		SILT AND CLAY - trace gravel, trace sand, very hard, brown, moist, mottled (inferred glacial till)	GRAB	17			C_{PEN} = 440 kPa	
3							C_{PEN} = 490 kPa	3
							C_{PEN} = 490 kPa	
4							C_{PEN} = 490 kPa	4
5		Below 4.9 m transitions to grey with some cobbles inferred from pulverized rocks					C_{PEN} = 490 kPa	5
		End of hole at 5.5 m - refusal on dense stratum.						
6								6
7								

SAMPLE TYPE ☒ SPLIT SPOON ■ GRAB ▥ SHELBY TUBE ▬ BULK ◧ CORE ⊘ NO RECOVERY

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TEST HOLE LOG

TH21-05

PROJECT: Dam Assessment
CLIENT: G-Force Group
LOCATION:
COORDINATES (m):
COMPLETION DATE: 2021-2-2

PROJECT NO.: 9963-1
METHOD: Sonic
ELEVATION (m):
CONTRACTOR: Blue Max
LOGGED/REVIEWED BY: MPD/ARJ

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	Recovery (%)	Dynamic Cone (Blows/300mm) 20 40 60 80	COMMENTS	DEPTH (m)
0		TOPSOIL - silty sand, trace organics dark brown, moist						0
		FILL - silt and clay, trace sand, trace organics, firm to stiff, light brown, moist						
1								1
2				18				2
		SILT AND CLAY - trace sand, trace gravel, very hard, brown, damp, mottled						
3				19				3
4								4
5								5
		Below 5.5 m transitions to grey with trace cobbles inferred from pulverized rocks						
6		End of Hole at 6.0 m - desired depth.						6
7								

SAMPLE TYPE ☒ SPLIT SPOON ■ GRAB ▥ SHELBY TUBE ▬ BULK ◧ CORE ⊘ NO RECOVERY

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TEST HOLE LOG

TH21-06

PROJECT: Dam Assessment
CLIENT: G-Force Group
LOCATION:
COORDINATES (m):
COMPLETION DATE: 2021-2-2

PROJECT NO.: 9963-1
METHOD: Sonic
ELEVATION (m):
CONTRACTOR: Blue Max
LOGGED/REVIEWED BY: MPD/ARJ

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	Recovery (%)	C_{PEN} (kPa) 62.5 125.0 187.5 250.0	COMMENTS	DEPTH (m)
0		TOPSOIL - silty sand, trace organics, dark brown, moist						0
		FILL - clay and silt, trace sand, trace organics, firm, light brown, moist						
			GRAB	20			C_{PEN} = 98 kPa	
1			GRAB	21			C_{PEN} = 98 kPa	1
			GRAB	22			C_{PEN} = 98 kPa	
2		TOPSOIL - silty sand, trace clay, trace organics, dark brown, moist						2
		SILT AND CLAY - trace sand, trace gravel, very hard, grey, moist, mottled (inferred glacial till)						
3			GRAB	23				3
4								4
5								5
6		End of hole at 6.0 m - desired depth.						6
7								

SAMPLE TYPE ☒ SPLIT SPOON ■ GRAB ▥ SHELBY TUBE ▬ BULK ◧ CORE ⊘ NO RECOVERY

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TEST HOLE LOG

TH21-07

PROJECT: Dam Assessment
CLIENT: G-Force Group
LOCATION:
COORDINATES (m):
COMPLETION DATE: 2021-2-2

PROJECT NO.: 9963-1
METHOD: Sonic
ELEVATION (m):
CONTRACTOR: Blue Max
LOGGED/REVIEWED BY: MPD/ARJ

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	Recovery (%)	Dynamic Cone (Blows/300mm) 20 40 60 80 / C_{PEN} (kPa) 62.5 125.0 187.5 250.0	COMMENTS	DEPTH (m)
0		TOPSOIL - silty sand, some organics, dark brown, moist						0
		FILL - clay and silt, trace sand, trace organics, firm, brown, damp					C_{PEN} = 190 kPa	
				24			C_{PEN} = 245 kPa	
1							C_{PEN} = 190 kPa	1
				25			C_{PEN} = 98 kPa	
							C_{PEN} = 98 kPa	
2				26				2
				27			C_{PEN} = 190 kPa	
		TOPSOIL - silty sand, some organics, dark brown, moist					C_{PEN} = 122 kPa	
3		SILT AND CLAY - trace sand, trace gravel, very hard, grey, moist, mottled (inferred glacial till)					C_{PEN} = 490 kPa	3
				28			C_{PEN} = 490 kPa	
4								4
5								5
6		End of hole at 6.0 m - desired depth.						6
7								

SAMPLE TYPE ☒ SPLIT SPOON ■ GRAB ▥ SHELBY TUBE ▬ BULK ◧ CORE ▨ NO RECOVERY

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TEST HOLE LOG

TH21-08

PROJECT: Dam Assessment
CLIENT: G-Force Group
LOCATION:
COORDINATES (m):
COMPLETION DATE: 2021-2-2

PROJECT NO.: 9963-1
METHOD: Sonic
ELEVATION (m):
CONTRACTOR: Blue Max
LOGGED/REVIEWED BY: MPD/ARJ

DEPTH (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	Recovery (%)	Field Vane (kPa) 50 100 150 200 / C_{PEN} (kPa) 62.5 125.0 187.5 250.0	COMMENTS
0	TOPSOIL - silty sand, some organics, dark brown, moist					
	FILL - silt and clay, trace sand, trace gravels, trace organics, stiff, brown, moist					C_{PEN} = 190 kPa
						C_{PEN} = 290 kPa
			29			C_{PEN} = 190 kPa
1						C_{PEN} = 172 kPa
						C_{PEN} = 147 kPa FIELD VANE = 62 kPa FIELD VANE(r) = 8 kPa
			30			C_{PEN} = 49 kPa
2	Firm below 2.1 m					C_{PEN} = 49 kPa
						C_{PEN} = 49 kPa
	SILT AND CLAY - trace gravel, trace sand, grey, very hard, moist, mottled, sand seams (inferred glacial till)					C_{PEN} = 340 kPa
3						C_{PEN} = 440 kPa
						C_{PEN} = 490 kPa
			31			C_{PEN} = 490 kPa
4						
5						
6	End of hole at 6.0 m - desired depth.					
7						

SAMPLE TYPE ☒ SPLIT SPOON ■ GRAB ▥ SHELBY TUBE ▬ BULK ◧ CORE ▨ NO RECOVERY

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TEST HOLE LOG

TH21-09

PROJECT: Dam Assessment
CLIENT: G-Force Group
LOCATION:
COORDINATES (m):
COMPLETION DATE: 2021-2-2

PROJECT NO.: 9963-1
METHOD: Sonic
ELEVATION (m):
CONTRACTOR: Blue Max
LOGGED/REVIEWED BY: MPD/ARJ

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	Recovery (%)	Dynamic Cone (Blows/300mm) 20 40 60 80 / C_{PEN} (kPa) 62.5 125.0 187.5 250.0	COMMENTS	DEPTH (m)
0		TOPSOIL - silty sand, some organics, dark brown, moist						0
		FILL - clay and silt, trace sand, trace organics, firm to stiff, light brown, moist		32			C_{PEN} = 240 kPa	
1							C_{PEN} = 290 kPa	1
				33			C_{PEN} = 270 kPa	
2				34			C_{PEN} = 190 kPa	2
		SAND - silty, dense, grey, mosit to wet, medium to fine grained		35				
		SILT AND CLAY - trace sand, very hard, grey, moist, mottled					C_{PEN} = 490 kPa	
3				36			C_{PEN} = 490 kPa	3
							C_{PEN} = 490 kPa	
4		Trace gravel below 4.0 m						4
5								5
6		End of Hole at 6.0 m - desired depth.						6
7								

SAMPLE TYPE ☒ SPLIT SPOON ■ GRAB ▥ SHELBY TUBE ▬ BULK ◧ CORE ▨ NO RECOVERY

APPENDIX E

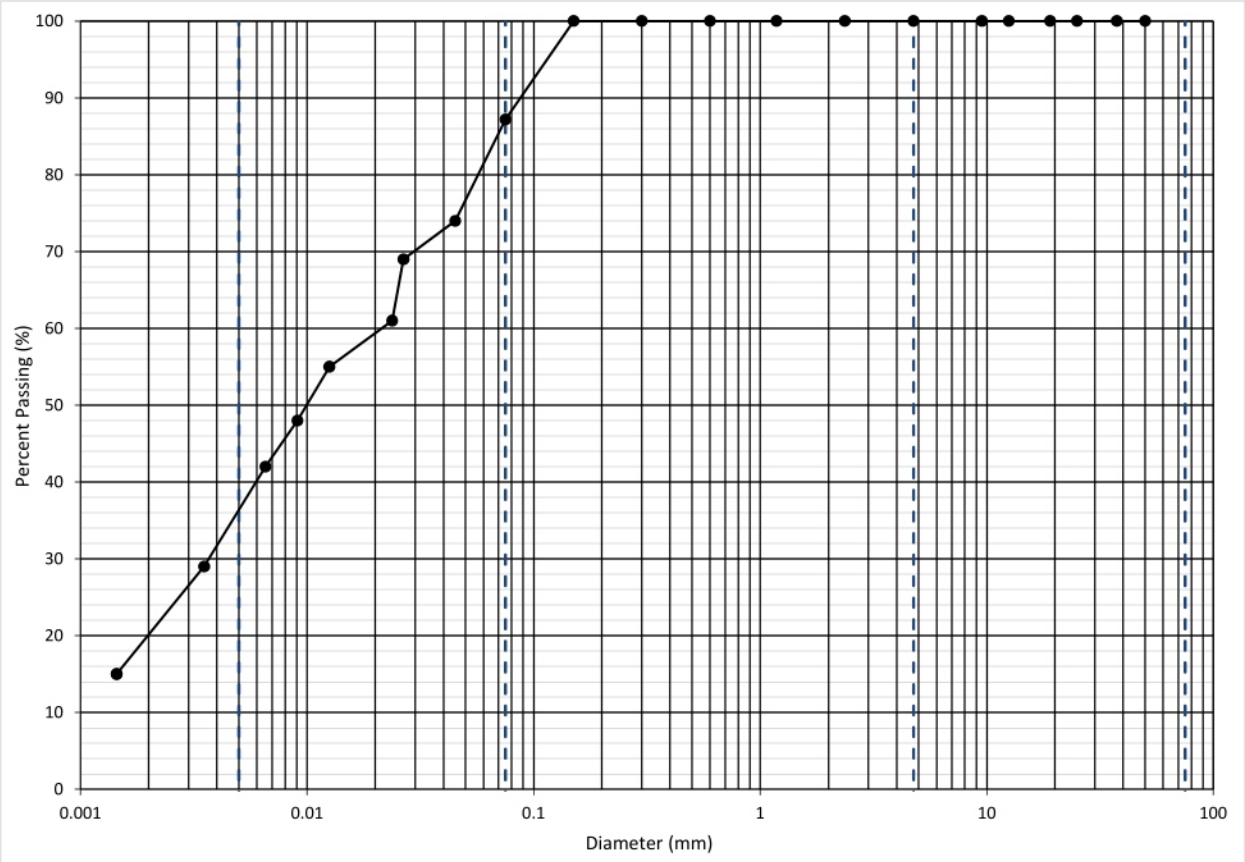
Hydrometer Results

Ryzuk Geotechnical
28 Crease Avenue
Victoria, BC, Canada V8Z 1S3
250-475-3131 250-475-3611
mail@ryzuk.com

SOIL TESTS - HYDROMETER TEST - ASTM D422-63 & D7928-17

Project No:	9963-1	**Client:**	G-Force Group
Project:	Dam Assessment - Morningstar Golf Course	**Contact:**	David Lindsay, Associate Senior Manager
Project Address:	525 Lowrys Road - Parksville, BC	**Email/Fax:**	dlindsay@g-forcegroup.ca
Date Sampled:	2021-02-04	**Date Tested:**	2021-03-04
Sampled By:	MPD	**Tested By:**	SAW
Hydrometer Type:	152H	**Prep Method:**	☐ Wet ☑ Dry
Specific Gravity:	2.66 ☑ Assumed ☐ Measured	**Amount of Dispersant Used (g):**	5 g

ASTM D422-63 and D7928-17						
CLAY (0.001 to 0.005 mm)	SILT 0.005 to 0.075mm	SAND			Gravel 4.75 to 75 mm	+
		Fine 0.075 to 0.425 mm	Medium 0.425 to 2.0 mm	Coarse 2.0 to 4.75 mm		



Borehole No.	*Sample No.*	*Depth(m)*	*Gravel*	*Sand*	*Silt*	*Clay*	*Moisture*
TH21-02	L# 1187	1.3	0.0	12.8	51.2	36.0	32.2
Unified Soil Classification Description (ASTM D2487-11 & D2488-17):							

Comments:

Testing of Hydrometer conducted in accordance with ASTM D422-63, with adjustments in calculations according with ASTM D7928-17. Sieve testing conducted in accordance with ASTM D422-63.

Reviewed by:

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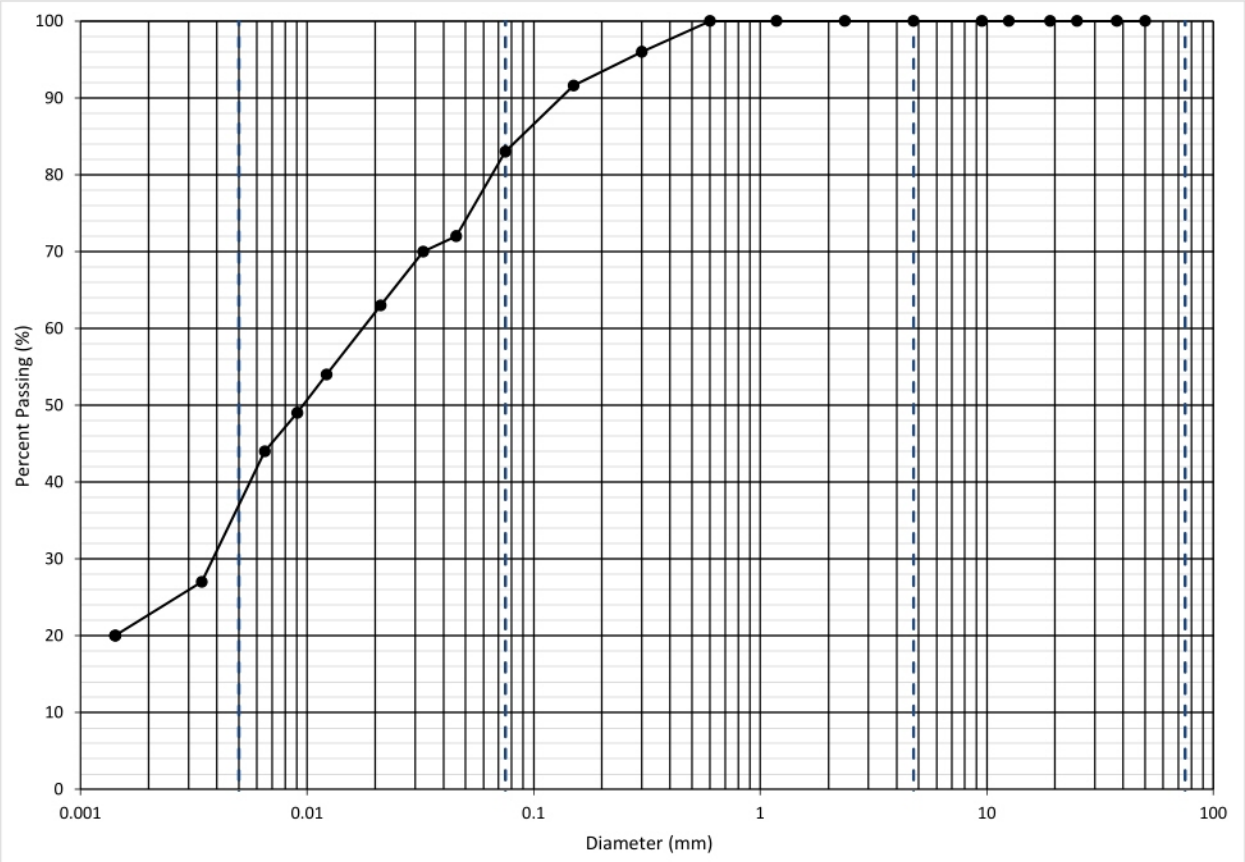
Victoria, BC, Canada V8Z 1S3
250-475-3131 250-475-3611
mail@ryzuk.com

SOIL TESTS - HYDROMETER TEST - ASTM D422-63 & D7928-17

Project No:	9963-1	**Client:**	G-Force Group
Project:	Dam Assessment - Morningstar Golf Course	**Contact:**	David Lindsay, Associate Senior Manager
Project Address:	525 Lowrys Road - Parksville, BC	**Email/Fax:**	dlindsay@g-forcegroup.ca
Date Sampled:	2021-02-04	**Date Tested:**	2021-03-01
Sampled By:	MPD	**Tested By:**	SAW
Hydrometer Type:	152H	**Prep Method:**	☐ Wet ☑ Dry
Specific Gravity:	2.66 ☑ Assumed ☐ Measured	**Amount of Dispersant Used (g):**	5 g

ASTM D422-63 and D7928-17						
CLAY (0.001 to 0.005 mm)	SILT 0.005 to 0.075mm	SAND			Gravel 4.75 to 75 mm	+
		Fine 0.075 to 0.425 mm	Medium 0.425 to 2.0 mm	Coarse 2.0 to 4.75 mm		



Borehole No.	*Sample No.*	*Depth(m)*	*Gravel*	*Sand*	*Silt*	*Clay*	*Moisture*
TH21-07	L# 1187	1.3	0.0	17.0	46.0	37.0	34.4
Unified Soil Classification Description (ASTM D2487-11 & D2488-17):							

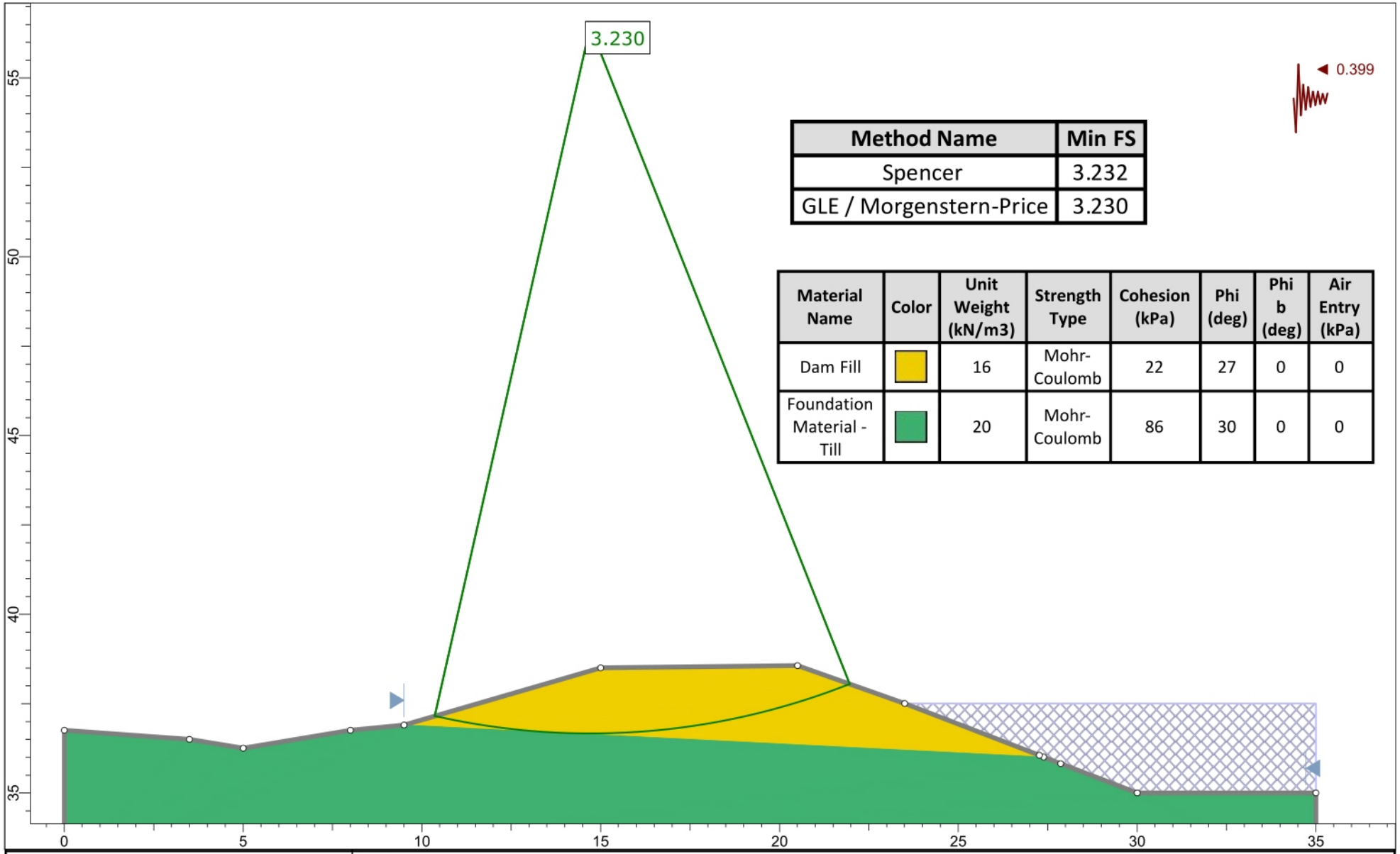
Comments:

Testing of Hydrometer conducted in accordance with ASTM D422-63, with adjustments in calculations according with ASTM D7928-17. Sieve testing conducted in accordance with ASTM D422-63.

Reviewed by:

APPENDIX Fa

Seismic Modelling



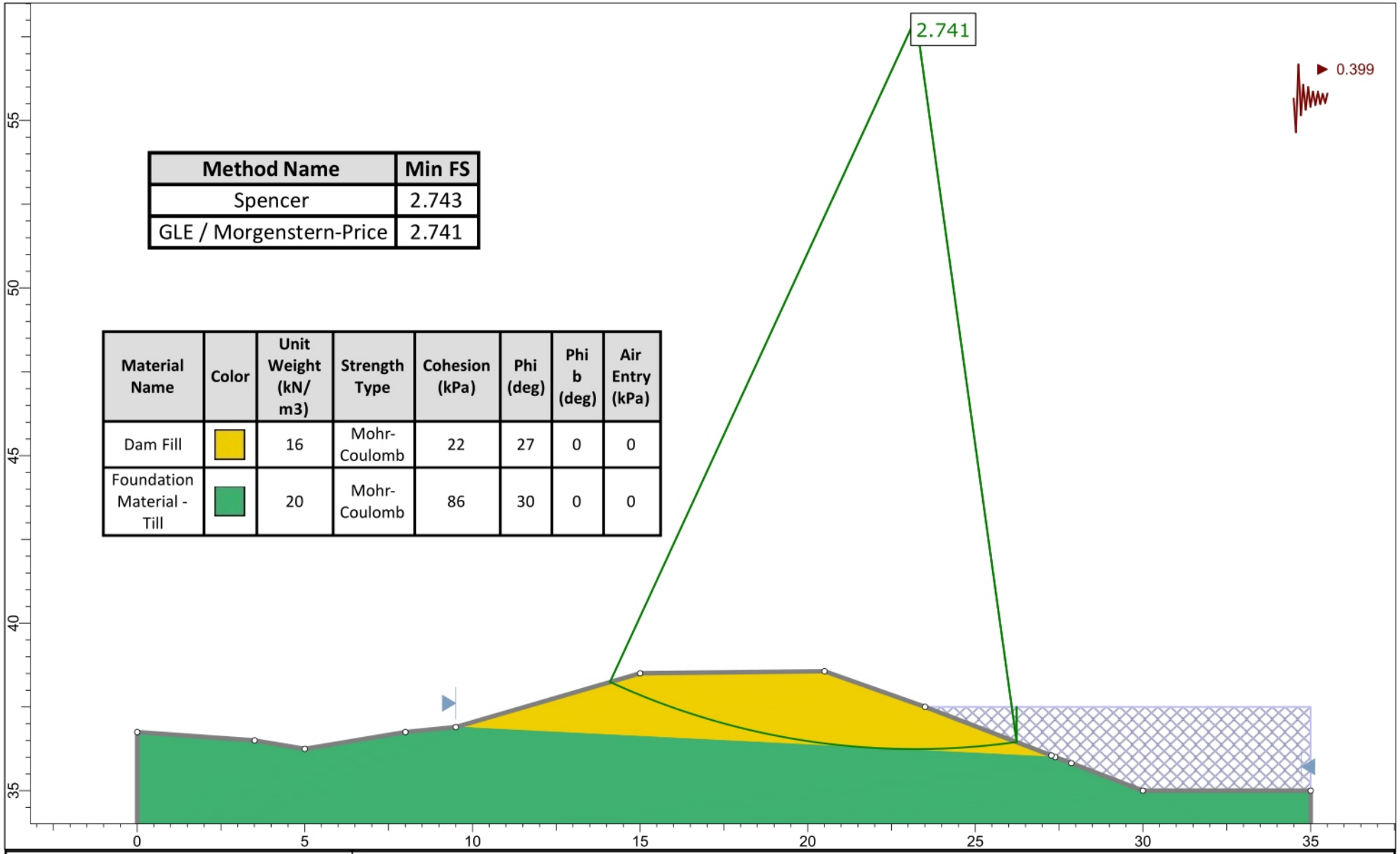
Method Name	Min FS
Spencer	3.232
GLE / Morgenstern-Price	3.230

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Phi b (deg)	Air Entry (kPa)
Dam Fill		16	Mohr-Coulomb	22	27	0	0
Foundation Material - Till		20	Mohr-Coulomb	86	30	0	0

rocscience

SLIDEINTERPRET 9.005

Project	Dam Assessment - Morningstar Golf Course		
Group	Dam 3 - Section C	Failure Direction	Right to Left
Drawn By	MPD	Company	Ryzuk Geotechnical
Date	2021-03-19	File Name	9963-1.2020.10.13.Section C.mpd.slmd



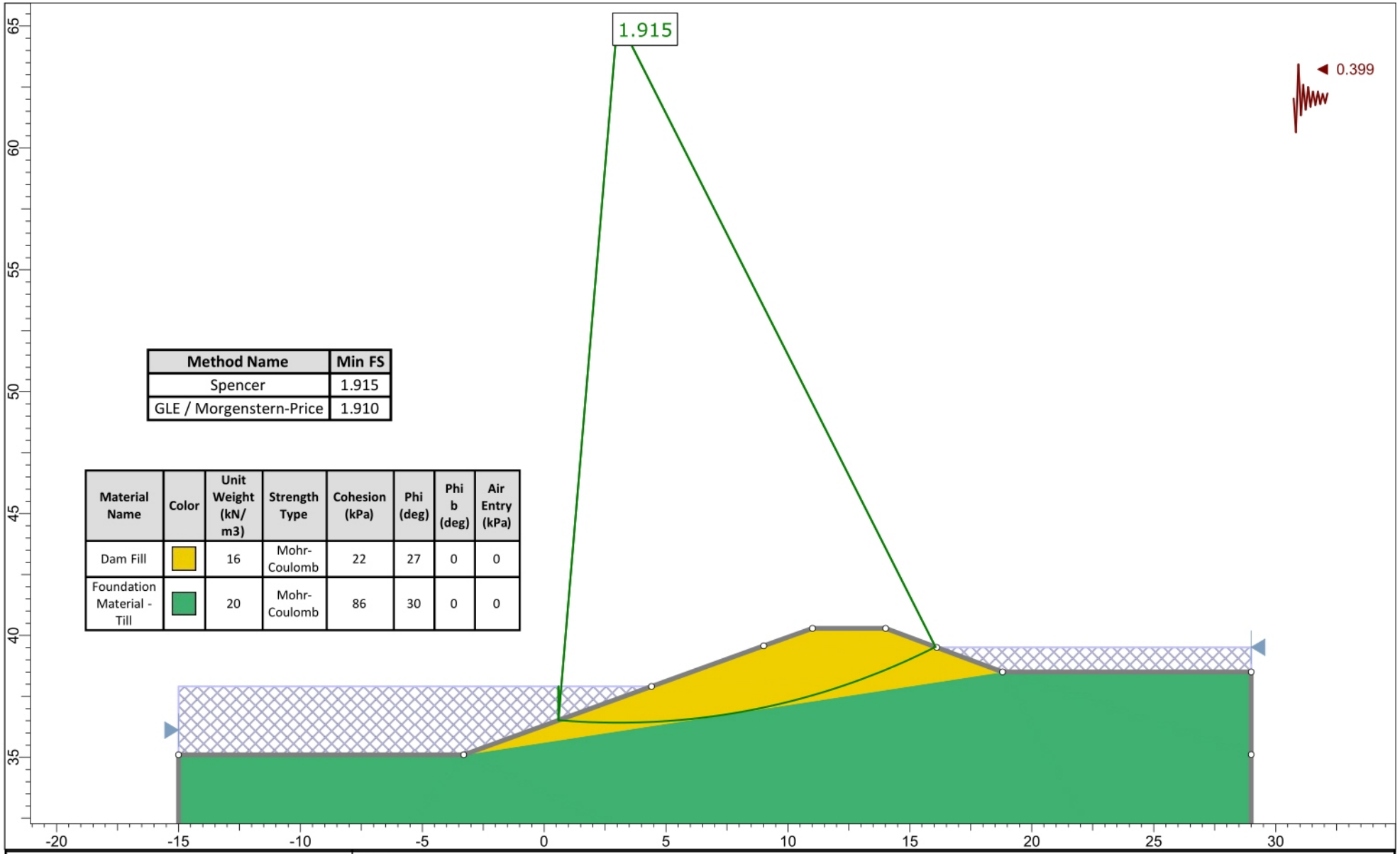
Method Name	Min FS
Spencer	2.743
GLE / Morgenstern-Price	2.741

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Phi b (deg)	Air Entry (kPa)
Dam Fill		16	Mohr-Coulomb	22	27	0	0
Foundation Material - Till		20	Mohr-Coulomb	86	30	0	0

rocscience

SLIDEINTERPRET 9.005

Project	Dam Assessment - Morningstar Golf Course		
Group	Dam 3	Scenario	Master Scenario
Drawn By	MPD	Company	Ryzuk Geotechnical
Date	2021-03-19	File Name	9963-1.2020.10.13.Section C.mpd.slmd



Method Name	Min FS
Spencer	1.915
GLE / Morgenstern-Price	1.910

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Phi b (deg)	Air Entry (kPa)
Dam Fill		16	Mohr-Coulomb	22	27	0	0
Foundation Material - Till		20	Mohr-Coulomb	86	30	0	0

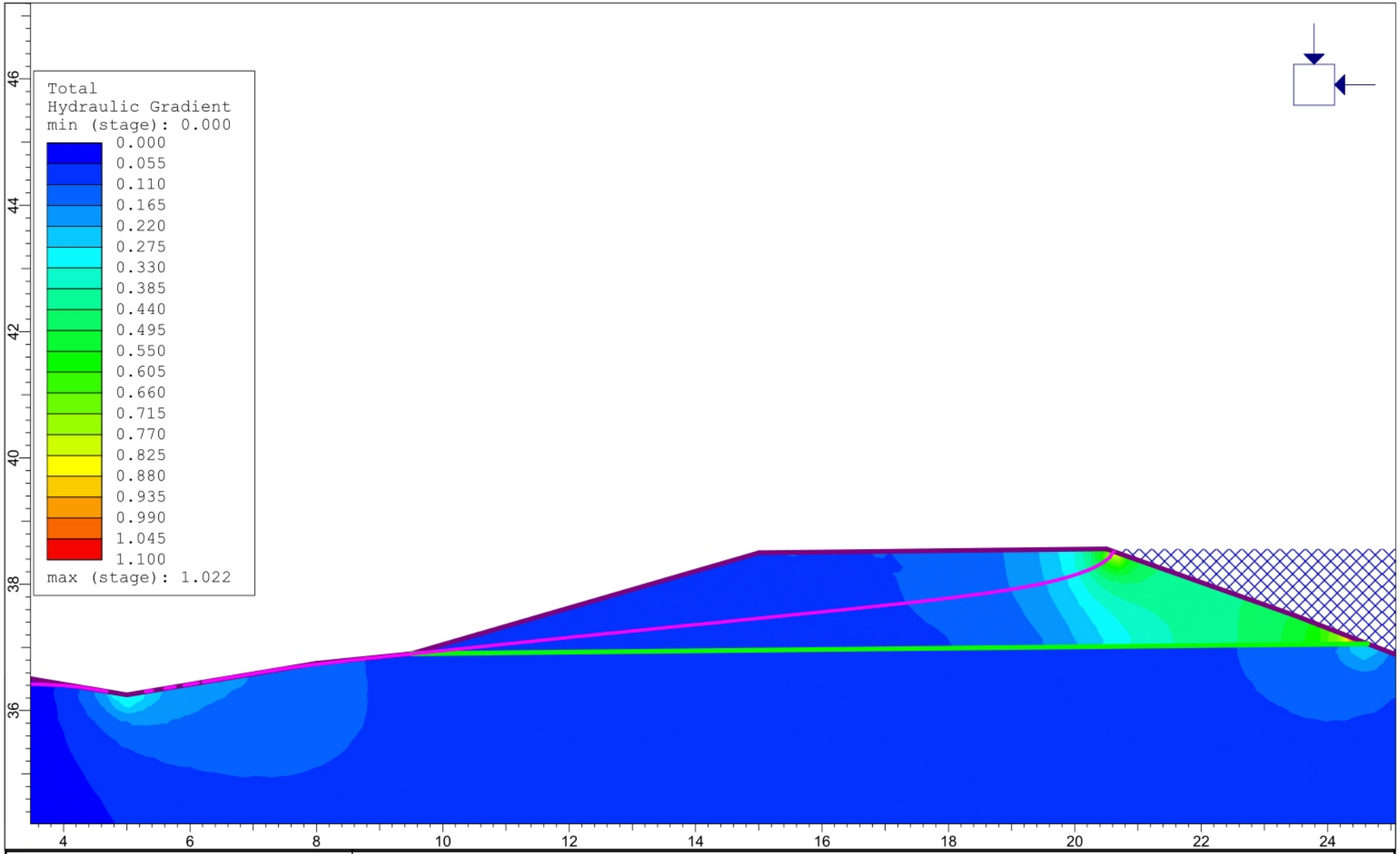
rocscience

SLIDEINTERPRET 9.005

Project	Dam Assessment - Morningstar Golf Course		
Group	Saddle Dam	*Scenario*	Master Scenario
Drawn By	MPD	*Company*	Ryzuk Geotechnical
Date	2021-03-19	*File Name*	9963-1.2021.02.18.Saddle Dam.mpd.slmd

APPENDIX Fb

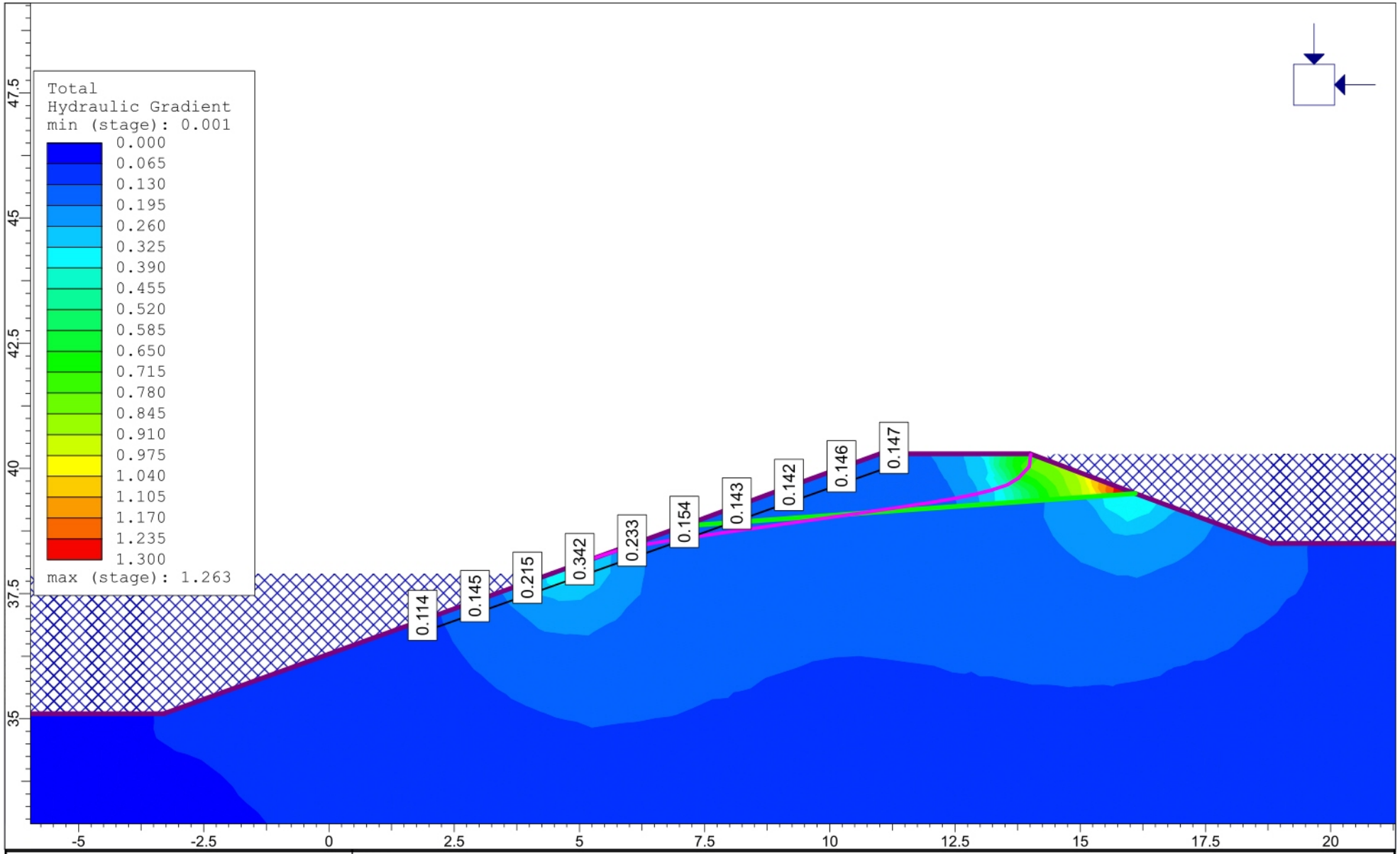
Seepage Modelling



rocscience

INTERPRET 11.012

Project	Morningstar Dam Assessment		
Analysis Description	Section C - Seepage Analysis		
Drawn By ARJ	*Scale* 1:85	*Company*	
Date		*File Name*	9963-1.2020.10.13.Section C.fez



rocscience	Project: Morningstar Dam Assessment		
	Analysis Description: Saddle Dam Seepage Analysis		
	Drawn By: ARJ	Scale: 1:107	Company:
	Date:		File Name: 9963-1.2021.02.18.Saddle Dam.seepage.fez

INTERPRET 11.012

APPENDIX G

Schedule 1 – Table of Downstream Dam Failure Consequences

Schedule 1

(sections 3 (1) and (2) and 31 (1))

Dam Classification

Definitions

1 In this Schedule:

"category", in relation to consequences of failure, means one of the following:

(a) loss of life;

(b) environmental and cultural values;

(c) infrastructure and economics;

"consequences of failure" means losses or damages that are caused by a failure of a dam;

"failure", in relation to a dam, means an uncontrolled release of all or part of the water impounded by the dam, whether or not caused by a collapse of the dam.

Determination of classification

2 (1) For the purposes of this regulation, the classification of a dam is to be determined in accordance with the following steps:

(a) for each category of consequences of failure in columns 3, 4 and 5 of the table, identify the losses or damages specified in the applicable column that most closely describe the losses or damages that are the most severe potential consequences of a failure of the dam;

(b) identify the dam failure consequences classification that is specified in column 1 of the table for the losses or damages referred to in paragraph (a) for each category;

(c) the dam failure consequences classification identified under paragraph (b) with the most severe potential consequences is the classification of the dam.

(2) For the purposes of identifying the consequences of failure in column 3 of the table, the descriptions in column 2 of the table of the population of individuals that may be at risk if there were a failure of the dam are to be considered.

Table

Item	Column 1	Column 2	Column 3	Column 4	Column 5
	Dam failure consequences classification	Population at risk	Consequences of failure		
			Loss of life	Environmental and cultural values	Infrastructure and economics
1	low	none[1]	no possibility of loss of life other than through unforeseeable misadventure	minimal short-term loss or deterioration and no long-term loss or deterioration of (a) fisheries habitat or wildlife habitat, (b) rare or endangered species, (c) unique landscapes, or (d) sites having significant cultural value	minimal economic losses mostly limited to the dam owner's property, with virtually no pre-existing potential for development within the dam inundation zone
2	significant	temporary only[2]	low potential for multiple loss of life	no significant loss or deterioration of (a) important fisheries habitat or important wildlife habitat, (b) rare or endangered species, (c) unique landscapes, or (d) sites having significant cultural value, and restoration or compensation in kind is highly possible	low economic losses affecting limited infrastructure and residential buildings, public transportation or services or commercial facilities, or some destruction of or damage to locations used occasionally and irregularly for temporary purposes
3	high	permanent[3]	10 or fewer	significant loss or deterioration of (a) important fisheries habitat or important wildlife habitat, (b) rare or endangered species, (c) unique landscapes, or (d) sites having significant cultural value, and restoration or compensation in kind is highly possible	high economic losses affecting infrastructure, public transportation or services or commercial facilities, or some destruction of or some severe damage to scattered residential buildings
4	very high	permanent[3]	100 or fewer	significant loss or deterioration of (a) critical fisheries habitat or critical wildlife habitat, (b) rare or endangered species, (c) unique landscapes, or (d) sites having significant cultural value, and restoration or compensation in kind is possible but impractical	very high economic losses affecting important infrastructure, public transportation or services or commercial facilities, or some destruction of or some severe damage to residential areas
5	extreme	permanent[3]	more than 100	major loss or deterioration of (a) critical fisheries habitat or critical wildlife habitat, (b) rare or endangered species, (c) unique landscapes, or (d) sites having significant cultural value, and restoration or compensation in kind is impossible.	extremely high economic losses affecting critical infrastructure, public transportation or services or commercial facilities, or some destruction of or some severe damage to residential areas

1. There is no identifiable population at risk.

2. People are only occasionally and irregularly in the dam-breach inundation zone, for example stopping temporarily, passing through on transportation routes or participating in recreational activities.

3. The population at risk is ordinarily or regularly located in the dam-breach inundation zone, whether to live, work or recreate.

APPENDIX H

Schedule 2 – Minimum Frequency of Safety Activities

Schedule 2

(sections 3 (2), 8 (4), 9 (7) and (8), 10 (4), 18, 19 (1) and 20 (1))

Minimum Frequency of Safety Activities

Interpretation of Schedule

1 In this Schedule:

"annually" means once in each calendar year;

"dam safety review" means a review carried out by an engineering professional under section 20 *[dam safety review and report]*;

"DEP" means the emergency plan for a dam;

"DSO" means a dam safety officer;

"monthly" means once in each calendar month;

"OMS manual" means the operation, maintenance and surveillance manual for a dam;

"quarterly" means once in each calendar quarter;

"semi-annually" means once in the period between January 1 and June 30 and once in the period between July 1 and December 31 of each calendar year.

Frequency of activities

2 (1) Column 1 of the table sets out an activity that must be carried out by an owner of a dam under Part 2 *[Requirements Applicable to All Dams]* or 3 *[Requirements Applicable to Certain Dams]*, as indicated in the table, and column 2, 3, 4, 5 or 6 of the table sets out the minimum frequency with which the activity must be carried out for each classification.

(2) If the minimum frequency with which an activity referred to in column 1 of the table must be carried out under subsection (1) is every 7 years or every 10 years, the minimum frequency is once in the period between the date on which the activity was previously carried out and December 31 of the calendar year that is 7 years or 10 years, as the case may be, after the calendar year that includes the date on which the activity was previously carried out.

Table

Item	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
	Activity	Frequency of Activity				
		Extreme classification	Very high classification	High classification	Significant classification	Low classification
Requirements under Part 2						
1	redetermine classification of dam and, if necessary submit to DSO written notice of proposed new classification	annually	annually	annually	annually	annually
Requirements under Part 3						
2	conduct site surveillance	weekly unless otherwise specified in the OMS manual	weekly unless otherwise specified in the OMS manual	weekly unless otherwise specified in the OMS manual	monthly unless otherwise specified in the OMS manual	quarterly
3	conduct formal inspection	semi-annually	annually	annually	annually	annually
4	test operation of (a) mechanical components of dam, and (b) electrical and communication equipment	annually unless otherwise specified in the OMS manual	annually unless otherwise specified in the OMS manual	annually unless otherwise specified in the OMS manual	annually unless otherwise specified in the OMS manual	annually
5	collect readings from instrumentation and analyze and interpret the readings	annually unless otherwise specified in the OMS manual	annually unless otherwise specified in the OMS manual	annually unless otherwise specified in the OMS manual	annually unless otherwise specified in the OMS manual	if and when required by a dam safety officer
6	review contact information in DEP, revise if necessary and report to DSO	annually	annually	annually	annually	not applicable
7	review emergency contact information and, if necessary, revise and submit revision to DSO	not applicable	not applicable	not applicable	not applicable	annually
8	review OMS manual and DEP, revise if necessary and report to DSO	every 7 years	every 7 years	every 10 years	every 10 years	not applicable
9	ensure dam safety review carried out and submit report to DSO	every 7 years	every 10 years	every 10 years	not applicable	not applicable

[Provisions relevant to the enactment of this regulation: *Water Sustainability Act*, S.B.C. 2014, c. 15, sections 124, 126, 127, 129, 130 and 131]

APPENDIX I

Emergency Dam Assessment

Emergency Dam Assessment
and
Immediate Response Plan

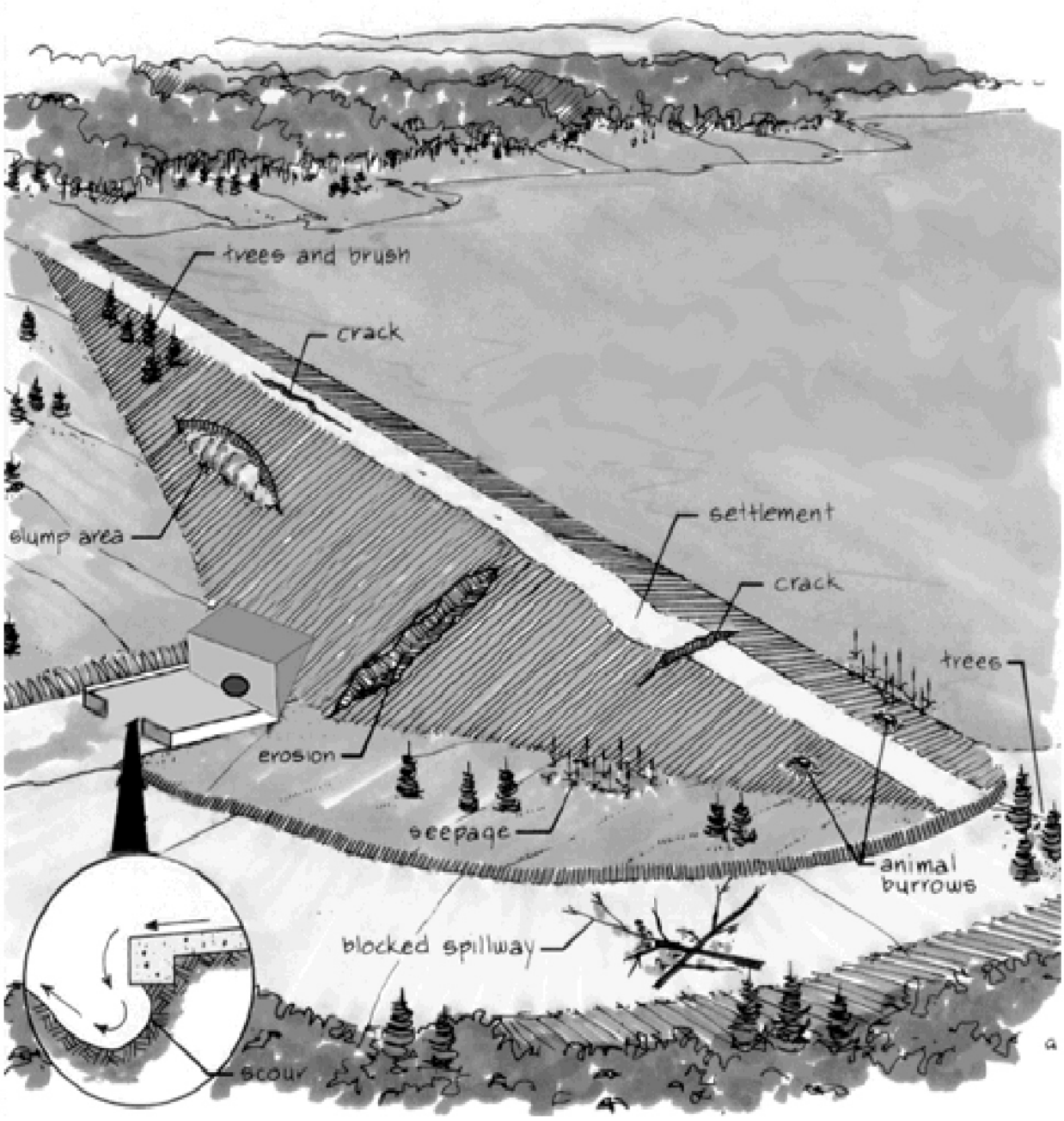
If you have a concern about the safety of a dam
call the BC Dam Safety Program
at 250 952 6790 during office hours.

If you have a serious concern and it is outside office hours
call Emergency Management BC at 1-800-663-3456.

Emergency Dam Assessment

Dam Safety Deficiencies

The following diagram illustrates a number of dam safety deficiencies. During times of high reservoir levels and large spillway flows, these deficiencies pose a greater threat to the safety of the dam and should be investigated thoroughly. If the deficiency is considered a threat to the integrity of the dam, it should be reported immediately and appropriate action taken to alleviate the problem. Note: The area downstream of the dam should be considered when determining the potential risk the dam poses (i.e. what is the risk to life, property and/or the environment?).



EMERGENCY DAM ASSESSMENT

Dam Name: _____ Date: _____

Your Name: _____ Weather Condition:_____

Was the spillway flowing? ***N Y*** If yes, what was the approximate flow rate? _____

If no, then how far was the reservoir drawn down below the spillway sill level? _____

Was the outlet open? ***N Y*** If yes, what was the approximate discharge rate? _____

Refer to the *DAM SAFETY EMERGENCIES AND IMMEDIATE RESPONSE ACTIONS* list on Pages 4 and 5, if any of the following *DEFICIENCIES* are found? (Circle Deficiency)

Refer to *DAM DEFICIENCIES*, Page 6, for an explanation of Problems and Causes.

DEFICIENCIES	*POTENTIAL PROBLEM AND IMMEDIATE RESPONSE*		
	EMBANKMENT	OUTLET	SPILLWAY
OVERTOPPING	A or B	——	——
SEEPAGE	G or H	G or H	G or H
EXCESSIVE DEBRIS	——	D	B or D
EROSION	C or G	D	D or E
SETTLEMENT	C or I	——	——
CRACKS	F or I	——	——
EXCESSIVE GROWTH	G or H	——	B
SLIDES/SLOUGHING	F	F	B
BOILS	G or H	G or H	G or H
RODENT BURROWS	G or H or I	——	——
CONCRETE DAMAGE	J	D	D

NOTES:

DAM SAFETY EMERGENCIES & IMMEDIATE RESPONSE ACTIONS

A. OVERTOPPING BY FLOODWATER

- Open outlet to its maximum safe capacity.
- Place sandbags along the crest to increase freeboard and force more water through the spillway and outlet.
- Provide erosion-resistant protection to the downstream slope by placing plastic sheets or other materials over eroding areas.
- Divert floodwater around the reservoir basin if possible.
- Create additional spillway capacity by making a controlled breach in a low embankment or dyke section where the foundation materials are erosion resistant.

B. OVERTOPPING DUE TO BLOCKED SPILLWAY CHANNEL

- Open outlet to its maximum safe capacity.
- If the reservoir does not drop with outlet open then slowly remove debris blocking the spillway channel to allow more water through the spillway. (Note, rapid removal of the spillway blockage may result in extensive flooding downstream. Only if there is an immediate threat to the integrity of the dam should the blockage be removed rapidly.)
- If debris cannot be removed then follow the response action noted above under 'Overtopping by Floodwater'. (Note: During times of large storm events, high inflow and high reservoir levels, debris resting along the reservoir shoreline can be washed into the reservoir and drawn up to the spillway entrance. This debris should be monitored and removed if it threatens to block the spillway or break the log boom.)

C. LOSS OF FREEBOARD OR DAM CROSS SECTION DUE TO STORM WAVE EROSION

- Place additional riprap or sandbags in damaged areas to prevent further embankment erosion.
- Lower the water level to an elevation below the damaged area.
- Restore freeboard with sandbags or earth and rock fill.
- Continue close inspection of the damaged area until the storm is over.

D. FAILURE OF APPURTENANT STRUCTURES SUCH AS OUTLETS OR SPILLWAYS

- Implement temporary measures to protect the damaged structure, such as closing an outlet or providing temporary protection for a damaged spillway.
- Lower the water level to a safe elevation. If the outlet is inoperable, pumping, siphoning or a controlled breach may be required.
- Uncontrolled seepage alongside the structure may cause damage or failure.

E. SPILLWAY CHANNEL EROSION THREATENING RESERVOIR EVACUATION

- Reduce the flow over the spillway by fully opening the main outlet
- Provide temporary protection at the point of erosion by placing sandbags, riprap materials or plastic sheets weighted with sandbags.
- When inflow subsides, lower the water to a safe level.
- Continue operating at a low water level in order to minimize spillway flow.

F. SLIDES ON THE UPSTREAM OR DOWNSTREAM SLOPE OF THE EMBANKMENT

- Lower the water level at a rate and to an elevation considered safe given the slide condition. If the outlet is damaged or blocked, pumping, siphoning or a controlled breach may be required.
- Restore lost freeboard if required by placing sandbags or filling in the top of the slide.
- Stabilize slides on the downstream slope by weighting the toe area with additional soil, rock or gravel.

G. EROSIONAL FLOWS (PIPING) THROUGH THE EMBANKMENT, FOUNDATION OR ABUTMENTS

- Plug the flow with whatever material is available (hay bales, bentonite or plastic sheeting if the entrance to the leak is in the reservoir basin).
- Lower the water level until the flow decreases to a non-erosive velocity or until it stops.
- Place protective sand and gravel filter over the exit area to hold materials in place.
- Continue lowering the water level until a safe elevation is reached.
- Continue operating at a reduced level until repairs can be made.
- Note: this flow may originate alongside an outlet of spillway structure (see section D).

H. EXCESSIVE (NON-EROSIONAL) SEEPAGE AND HIGH LEVEL SATURATION OF THE EMBANKMENT

- Lower the water to a safe level.
- Continue frequent monitoring for signs of slides, cracking or concentrated seepage.
- Continue operation at a reduced level until repairs can be made.

I. EXCESSIVE SETTLEMENT OF THE EMBANKMENT

- Lower the water level by releasing it through the outlet or by pumping, siphoning or a controlled breach.
- If necessary, restore freeboard, preferably by placing sandbags.
- Lower water to a safe level.
- Continue operating at a reduced level until repairs can be made.

J. LOSS OF ABUTMENT SUPPORT OR EXTENSIVE CRACKING IN CONCRETE DAMS

- Lower the water to a safe level by releasing it through the outlet.
- Implement notification procedures.
- Attempt to block water movement through the dam by placing plastic sheets on the upstream face.

DAM SAFETY PROBLEM INDICATORS: Causes & Potential Problem

The following table lists some *Potential Problems* (worst case scenario) associated with *Problem Indicators* that may be seen during an Assessment of a Dam along with some likely *Causes*:

PROBLEM INDICATORS	CAUSE	POTENTIAL PROBLEM
Reduced Freeboard	Flood Water	Overtopping/Embankment Failure
Reduced Freeboard	Blocked Spillway Channel	Overtopping/Embankment Failure
Reduced Freeboard or Dam Cross Section	Storm Wave Erosion	Overtopping/Embankment Failure
Cloudy Seepage through the Embankment, Foundation or Abutments	Poor Internal Drainage, Seepage Removing Embankment Material (Piping)	Piping/Embankment Failure
Excessive Clear Seepage and High Level Saturation of the Embankment	Poor Internal Drainage	May Lead to Piping Failure
Damage to Appurtenant Works	Poor Maintenance, Flood Water and/or Debris Damage etc.	Safe Operation of the Dam Impaired
Spillway Channel Erosion	High Spillway Flows, Poor Spillway Construction etc.	Uncontrolled Reservoir Release
Embankment Slides/Sloughs	Structural Deficiency, Saturated Embankment etc.	Embankment Failure
Excessive Settlement of the Embankment	Structural Deficiency, Foundation Deficiency etc.	Overtopping/Embankment Failure
Extensive Cracking in Concrete Dams	Structural Deficiency	Uncontrolled Reservoir Release
Broken Log Boom	Poor Construction or Maintenance, Excessive Force on Boom due to Excessive Debris etc.	Spillway Channel Blocked, Safe Operation and Maintenance of Dam Impaired.

APPENDIX J

List of Documents Reviewed and Referenced

Appendix J – List of Documents Reviewed and Referenced File No: 9963-1

The following documents were reviewed by Ryzuk Geotechnical in preparation of the Dam Safety Review of the existing dams at Morningstar Golf Course, listed in order of publication:

- Geological Survey of Canada "A" Series Map 1112A, Surficial Geology, Parksville, Vancouver Island, British Columbia, dated 1963;
- Morningstar Creek Golf Course, Polishing Ponds Subsurface Exploration Report prepared by Hardy BBT Ltd., dated May 10, 1989;
- Willis Cunliffe Tait Consulting Engineers Morningstar Creek Golf Course Polishing Ponds design drawings:
    - 31-2151-3/31-1 Plan of Polishing Ponds for Morningstar Creek Golf Course Rev. 1, dated September 5, 1989;
    - 31-2151-3/31-2 Sections of Polishing Ponds for Morningstar Creek Golf Course, dated April 30, 1989;
    - 31-2151-3/31-3 Details, dated September 5, 1989;
- Ponce, Victor Miguel. 1989. *Engineering Hydrology: Principles and Practices*. Upper Saddle River, N.J.: Prentice Hall.
- U.S. Department of the Interior Bureau of Reclamation Dam Safety Office. Wahl, Tony. 1998. *Prediction of Embankment Dam Breach Parameters*. https://www.nrc.gov/docs/ML0901/ML090150051.pdf
- Morningstar Golf Course, Retention Pond Report prepared by BBA Engineering Consultants Ltd., dated August 24, 2000;
- Koers & Associates Engineering Morningstar Pond Drainage design drawing D0033-01 Relief Drain STA. 0+000 to 0+159.35 / Overflow Drain STA. 1+000 to 1+117.42 Plan and Profile, dated September 2000;
- Murthy, V. N. S. 2003. *Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering*. New York, N.Y.: Marcel Dekker
- Morningstar Golf Club Dams Annual Dam Inspection prepared by Tetra Tech, dated February 23, 2018;
- Phase One Hydro Geological Assessment for Morningstar Golf Club Parksville, BC report prepared by Waterline Resources, dated October 7, 2019;
- Main Retention and Holding Ponds Dam Safety--Project Work Plan prepared by Morningstar Golf Club, dated October 17, 2018 (updated May 30th, 2019);
- Formal Annual Inspection prepared by Morningstar Golf Club, dated December 2019;
- Environment Canada Short Duration Rainfall Intensity-Duration-Frequency Data for Comox Airport, British Columbia, published February 27, 2019;
- HydroCAD Software Solutions LLC. 2020. *Modelling a Dam Breach*. https://www.hydrocad.net/dambreach.htm
- Dam Safety Report submission by Morningstar Golf Club Ltd, dated February 19, 2020;
- British Columbia Water Resource Atlas Historical Groundwater Well Lithology Data (Well Tag Numbers 27689, 83392, 109318, 109701, 109706, 109708, 109725), accessed February 24, 2021;
- 2004, 2007, 2010, 2016, 2020 Orthophotos, accessed using City of Parksville GIS in February 2021;
- 2002, 2005, 2007, 2009, 2011, 2014, 2016, 2018, 2020 Orthophotos, accessed using Regional District of Nanaimo GIS in March 2021.

APPENDIX K

2015 National Building Code Seismic Hazard Calculation Information

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Site: 49.336N 124.368W **User File Reference:** Morning Star Golf Course 2020-10-13 15:25 UT

Requested by: McKenzie Douglas, Ryzuk Geotechnical Engineering

Probability of exceedance per annum	0.000404	0.001	0.0021	0.01
Probability of exceedance in 50 years	2 %	5 %	10 %	40 %
Sa (0.05)	0.463	0.323	0.229	0.092
Sa (0.1)	0.723	0.501	0.354	0.141
Sa (0.2)	0.895	0.629	0.445	0.178
Sa (0.3)	0.923	0.646	0.453	0.178
Sa (0.5)	0.841	0.577	0.397	0.147
Sa (1.0)	0.516	0.335	0.218	0.076
Sa (2.0)	0.321	0.201	0.126	0.041
Sa (5.0)	0.107	0.061	0.032	0.010
Sa (10.0)	0.038	0.021	0.011	0.004
PGA (g)	0.399	0.278	0.195	0.076
PGV (m/s)	0.635	0.418	0.276	0.093

Notes: Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are highlighted in yellow. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. **These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.**

References

National Building Code of Canada 2015 NRCC no. 56190; Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

Structural Commentaries (User's Guide - NBC 2015: Part 4 of Division B)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information

APPENDIX L

February 2020 Annual Dam Status Report
Morningstar Golf Club – Dam Operation, Maintenance, and Surveillance Plan
December 2019 Formal Annual Inspection

Dam Safety Report Submission

Tracking Number: 100311148
Job Number: 113060
Request Type: Annual Dam Status Report

Dam Information

Is this Dam Report being reported for an Individual or Company/Organization?	Company/Organization
What is your relationship to the company/organization?	Employee

COMPANY / ORGANIZATION CONTACT INFORMATION

Name:	MORNINGSTAR GOLF CLUB LTD.
Doing Business As:	
Phone:	250-248-4778
Fax:	
Email:	info@morningstargolf.com
BC Incorporation Number:	BC0789885
Extra Provincial Inc. No:	
Society Number:	
GST Registration Number:	85102 9595 RT0002
Contact Name:	Gord America
Mailing Address:	525 Lowry's Road Parksville BC V9P 2R8

CORRESPONDENCE E-MAIL ADDRESS

Email:	info@morningstargolf.com
Contact Name:	Gord America

TECHNICAL INFORMATION

Please enter your Dam File Number before proceeding.

Dam File Number: D720178 01

The following dams are associated with this Dam File Number. Please select the dams upon which you will be reporting.

Selected	Dam
☑	D720178-01 Morningstar Golf Course Dam
☐	D720178-02 Morningstar Golf Course Dam
☐	D720178-03 Morningstar Golf Course Dam

Is this Report Submission due to an Information Request?	Yes
Please enter the Information Request Job Number:	113060
Request Type:	Annual Dam Status Report

Questions

Question	Response

1a_Has your Formal Inspection for 2019 been completed?	Yes
1b_Did the owner conduct the 2019 Formal Inspection?	Yes
1c_If not the owner, who conducted the Formal Inspection?	
1d_Any comments on the 2019 Formal Inspection?	
2a_Did you undertake regular Site Surveillance?	Yes
2b_Any comments on Site Surveillance?	
3a_Have any dam safety concerns been identified in 2019?	Yes
3b_If Yes, please elaborate on dam safety concerns.	MOLES - HOLES PLUGGED
3c_If Yes to dam safety concerns identified, has a plan been prepared to address the safety concerns?	UNDER REVIEW
3d_Any comments on the plan to address dam safety concerns?	
4a_Has a Dam Safety Review been conducted by a qualified Professional Engineer?	Yes
4b_If Yes to Dam Safety Review conducted by a Professional Engineer, what year was it completed? (eg. 1956)	FEBRUARY 2018
5a_In what year was your Operation, Maintenance and Surveillance manual last updated? (eg.1956)	2018
6a_In what year was your last Dam Emergency Plan (DEP) updated? (eg. 1956)	2018
6b_Have you submitted the required DEP information to the local emergency authority?	Yes
6c_Is the emergency contact information in your DEP up-to-date?	Yes
7a_Has there been any land use development downstream of your dam in 2019 that might affect the failure consequence classification of your dam?	No
7b_If Yes to downstream development, please elaborate.	
8a_Have you, or your designate, taken any dam safety training?	Yes
8b_If Yes, in what year was the most recent dam safety training taken? (eg. 2018)	DECEMBER 2018
8c_Who provided the dam safety training (ie. BC Dam Safety, Canadian Dam Association(CDA) etc)?	BC DAM SAFETY
8d_If a response was provided to 8c, can you provide the course name or a brief description of the training?	BC DAM SAFETY - TRAVEL TO DAM IN SOUTH OKANAGAN - COMPLETED MANUAL
9a_Are there any other comments or suggestions related to dam safety?	
10a_Is there a change in contact information for this dam?	No

10b_If Yes to a new contact, provide the correct dam contact information.

Additional Comments:

PRIVACY DECLARATION

PRIVACY NOTE FOR THE COLLECTION, USE AND DISCLOSURE OF PERSONAL INFORMATIONPersonal information is collected by FrontCounter BC under the legal authority of section 26 (c) and 21(1)(a)(i) of the Freedom of Information and Protection of Privacy Act (the Act). The collection, use, and disclosure of personal information is subject to the provisions of the Act. The personal information collected by FrontCounter BC will be used to process your inquiry or application(s). It may also be shared when strictly necessary with partner agencies that are also subject to the provisions of the Act. The personal information supplied in the application package may be used for referrals or notifications as required. Personal information may be used by FrontCounter BC for survey purposes.For more information regarding the collection, use, and/or disclosure of your personal information by FrontCounter BC, please contact FrontCounter BC at 1-877-855-3222 or at:FrontCounter BC Program DirectorFrontCounter BC, Provincial Operation441 Columbia StreetKamloops, BC V2C 2T3

☑ Check here to indicate that you have read and agree to the privacy declaration stated above.

IMPORTANT NOTICES

DECLARATION

☑ By submitting this report form, I, declare that the information contained on this form is complete and accurate.

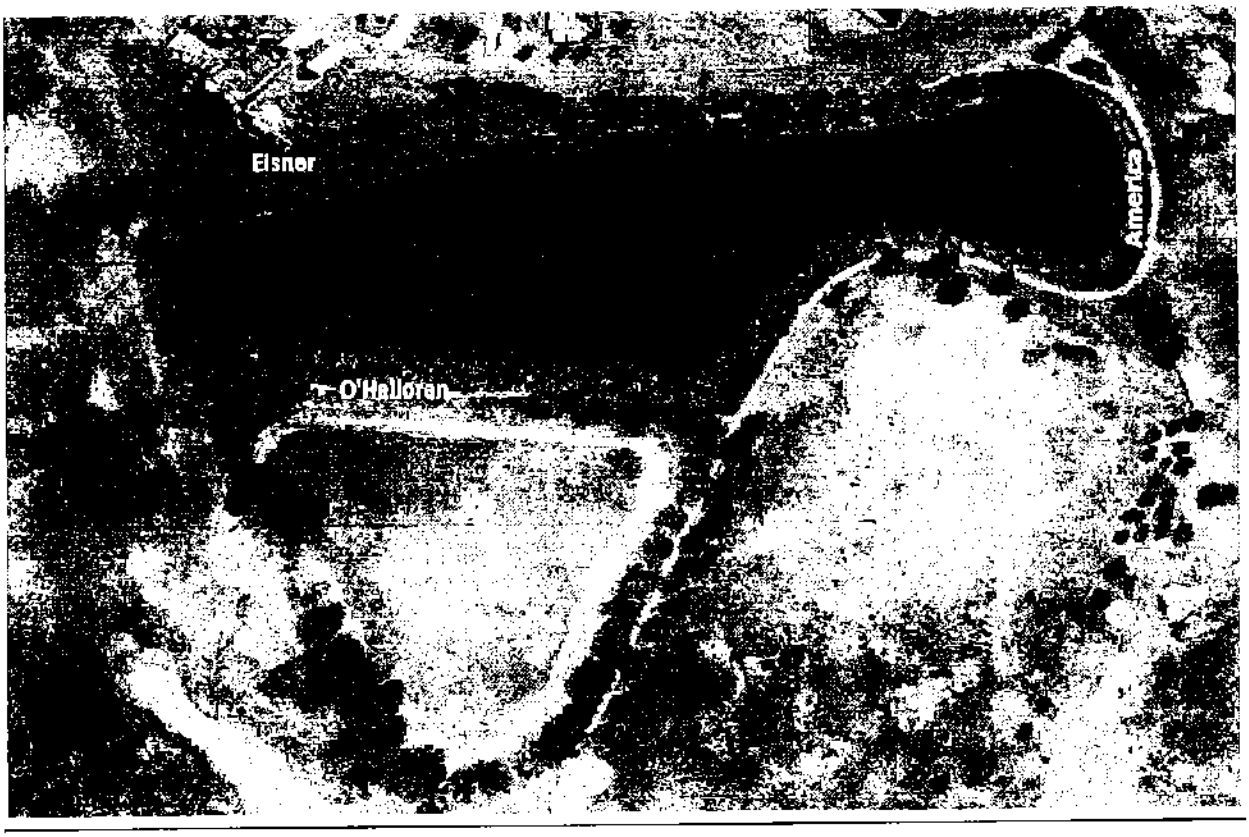
OFFICE USE ONLY		
Office	**File Number**	**Project Number**
	Disposition ID	**Client Number**

Morningstar Golf Club

Dam Operation, Maintenance, and Surveillance Plan

Table of Contents

Dam Locations



Basic Dam Information

Dam Name: O'Halloran,

Water License: # C132333

Owners Name:

Owners Phone #:

Dam Location. 49°20'08" N 124°21'58" W

Map Sheet #

List of Individuals who are Responsible for:

Operation: Gord America, s. 22 BARRIE McWHA

Maintenance: Gord America, s. 22 "

Inspections: Gord America, s. 22 "

Instrumentation: s. 22 GORD AMERICA

Physical Description:

Dam Height: 4.27M

Dam Type: Earth Emabnkment

Length: 160m

Crest Width: 15m

Reservoir Capacity: 15141.64m^3

Reservoir Area: 10680m^2

Spillway Capacity 1' times 2

Design Flood Inflow: NA

Watershed Area: NA

Purpose of Dam: Irrigation

Consequence Classification: Extreme

Basic Dam Information

Dam Name: Eisner

Water License: # C132333

Owners Name:

Owners Phone #:

Dam Location. 49°20'10.9"N 124°22'2.78"W

Map Sheet #

List of Individuals who are Responsible for:

Operation: Gord America,- s. 22

Maintenance: Gord America, s. 22

Inspections: Gord America, s. 22

Instrumentation: s. 22

Physical Description:

Dam Height: 4.27M

Dam Type: Earth Emabnkment

Length: 250m

Crest Width: 6-7m

Reservoir Capacity: 64352m^3

Reservoir Area: 18490m^2

Spillway Capacity 1'

Design Flood Inflow: NA

Watershed Area: NA

Purpose of Dam: Irrigation

Consequence Classification: Extreme

Basic Dam Information

Dam Name: America

Water License: # C132333

Owners Name:

Owners Phone #:

Dam Location. 49°20.13',94"N 124°21.53'59"w

Map Sheet #

List of Individuals who are Responsible for:

Operation: Gord America, s. 22

Maintenance: Gord America, s. 22

Inspections: Gord America, s. 22

Instrumentation: s. 22

Physical Description:

Dam Height: 4.27M

Dam Type: Earth Emabnkment

Length: 80M

Crest Width: 6-7m

Reservoir Capacity: 64352m^3

Reservoir Area: 18490m^2

Spillway Capacity NA

Design Flood Inflow: NA

Watershed Area: NA

Purpose of Dam: Irrigation

Consequence Classification: Extreme

Access to Dam

Directions to Dam O'Halloran

Location 49°20'08"N 124°21'58"W

Turn off Trans-Canada Hwy/BC-1N

Turn left onto Alberni Hwy/BC-4A W (signs for Coombs)

2.6 km

Slight right toward Church Rd
54 m

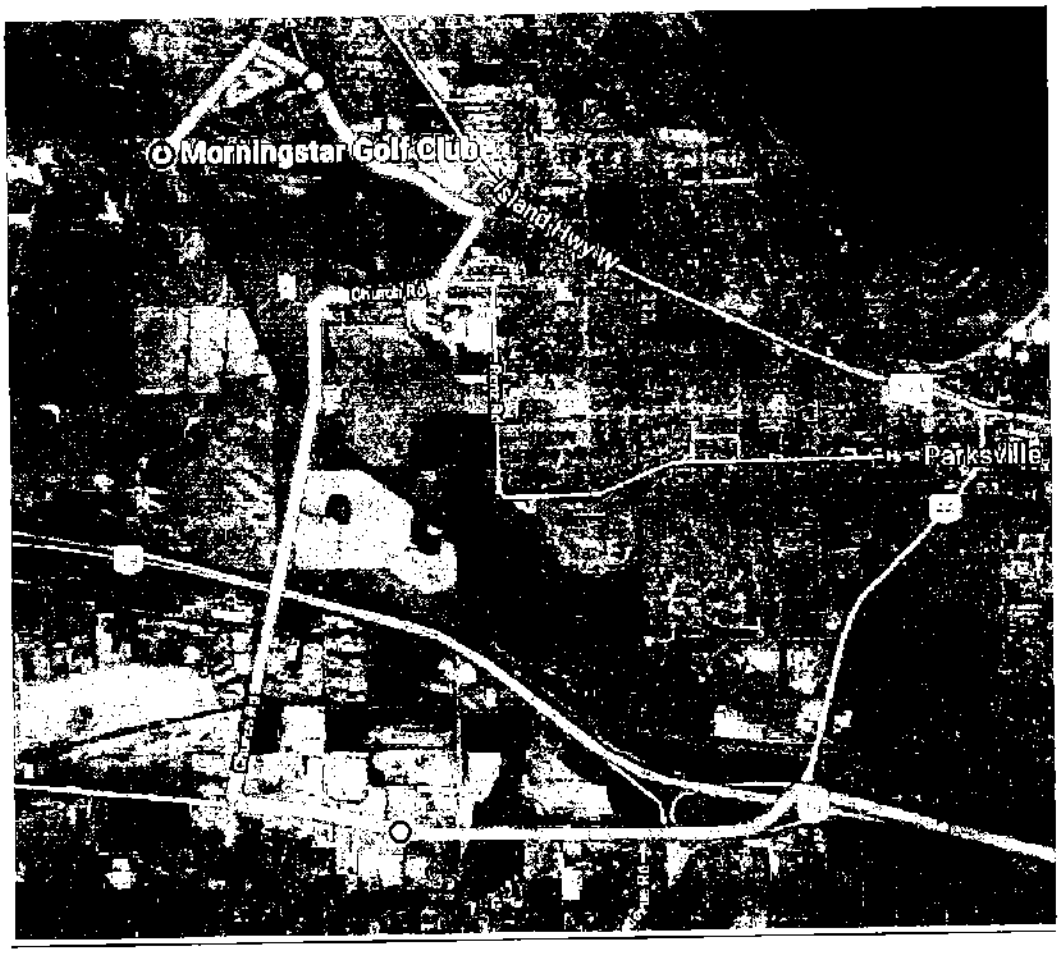
Turn right onto Church Rd
2.8 km

Turn left to stay on Church Rd
350 m

Turn left onto Wembley Rd
1.0 k

Slight left onto Roberton Blvd
300 m

Turn left onto Lowrys Rd
650 m
Morningstar Golf Club



Once in the parking lot a Morningstar management member will show the two different access points to Dam 1.

Access point 1 is on the north east side of the secondary irrigation pond.

Access point 2 is on the south west side of the secondary irrigation pond.

Access to Dam Continued

Access to Dams America, and Eisner

Location 49°20'13"N 124°21'57"W

Turn off Trans-Canada Hwy/BC-1N

Continue on Alberni Hwy/BC-4A W. Take Church Rd to Morningstar

Dr in Nanaimo G
10 min (8.0 km)

Turn left onto Alberni Hwy/BC-4A W (signs for Coombs)
2.6 km

Slight right toward Church Rd
54 m

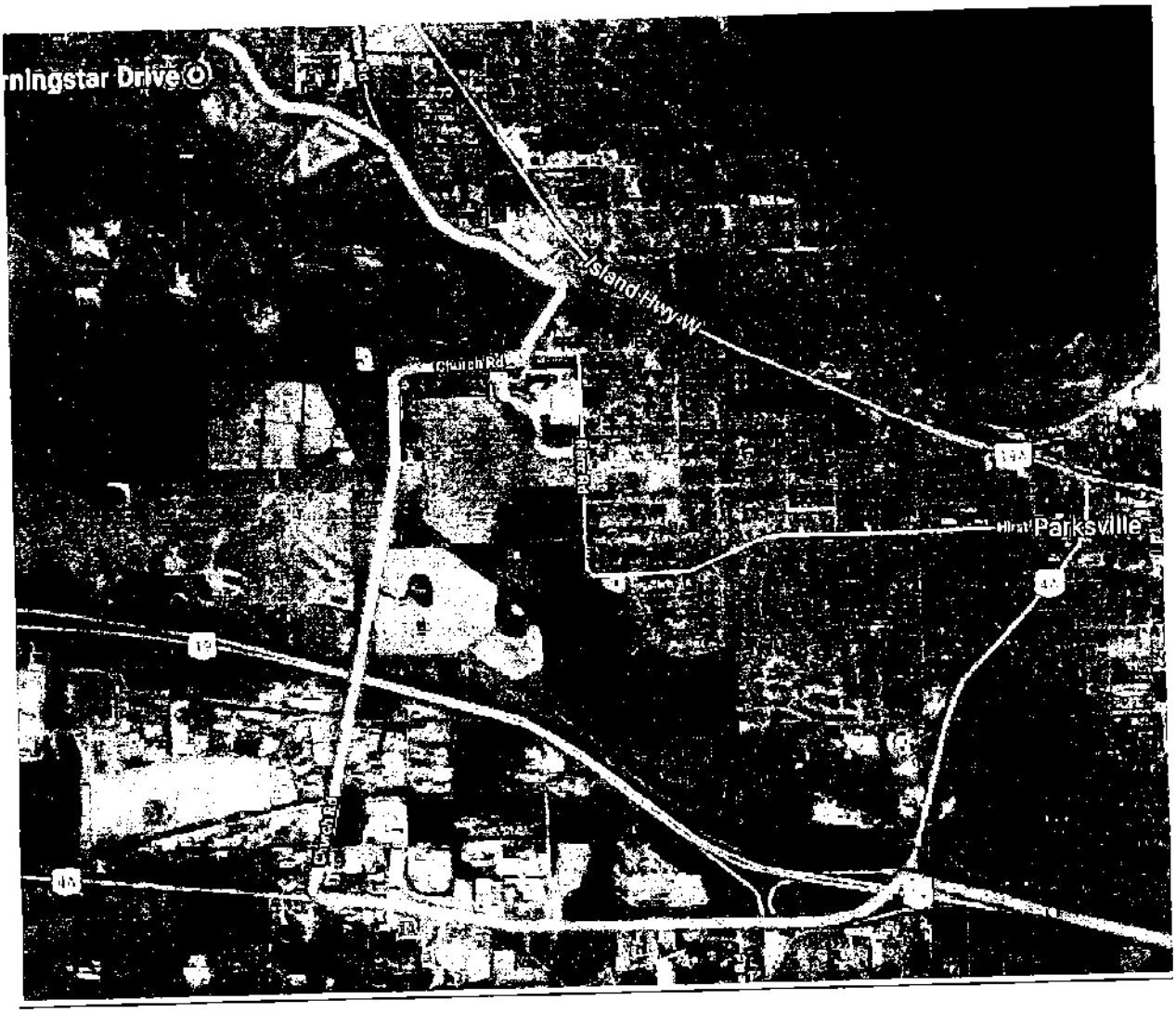
Turn right onto Church Rd
2.8 km

Turn left to stay on Church Rd
350 m

Turn left onto Wembley Rd
1.0 km

Slight left onto Roberton Blvd
1.0 km

Turn left onto Morningstar Dr
150 m



Morningstar Golf Club Dams 2 and 3 had the same access points. Once at the access points to Dams 2 and 3 a Morningstar management member will meet the emergency response crews.

Significant Structures down Stream of Dam

Dam ~~O'Halloran~~ #1

Down steam of Dam O'Halloran there is the Primary Irrigation pond.

Dam ~~America~~ #3

Morningstar hole 10

9 Homes off of Roberton Blvd

Morningstar Rd

Dam ~~Eisner~~ #2

21 Homes

Agusta Cl

Turnberruy Rd

Morningstar Dr

List of Hydraulic Works

Dam O'Halloran

Inlet from waste water facility

Overflow Spillway into Primary irrigation pond

Various drainage inlets

6 inch inlet infrastructure for transferring water from other ponds and Morningstar creek

List of Hydraulic Works Cont

Dam America, and Eisner

Pump House intake

High Level Overflow

Spillway from Secondary Pond

6 inch inlet infrastructure for transferring water from other ponds and Morningstar creek

Various drainage inlets

List of Procedures for Reservoir Operation

Winter

During the winter months there are no scheduled draw downs from the irrigation ponds. In high rain events when the water levels may reach the high level overflow the pump infrastructure is used to draw down the pond level to combat possible overflow. During the months of February and March Morningstar has the ability to transfer water from Morningstar creek to top up both irrigation ponds. This occurs during the final weeks of March to ensure maximum allowed water levels are in both irrigation ponds. The anticipated water level in the primary irrigation pond is close to full during the winter months. The water level of the secondary irrigation pond will be empty at the beginning of winter and full by the end of March

List of Procedures Cont

Spring

During spring the irrigation pond levels will both be full. There would only be expected draw down on the irrigation ponds if the weather dictates the use of irrigation water.

Summer

Summer is the season were the irrigation drawdown on the ponds increases dramatically. During this time of year the ponds will have daily drawdown for the purpose of watering the golf course. The secondary pond will be transferred into the primary pond over the course of the season. In addition water from other ponds on the property will also be transferred to the primary irrigation pond.

Fall

During fall the water levels in both ponds will be at its lowest over the season. The secondary irrigation pond will be empty of all water while the primary pond will be at the low level warning for the pump house. This means that the level will be dictated by the pumping station on the primary pond.

All Items Requiring Routine Maintenance

The routine maintenance of the Dams at Morningstar has not commenced yet. This is due to major maintenance needing to be completed before routine maintenance can commence. This major maintenance includes the reconstruction of a spillway, and the clearing of brush around the dams to ground cover level. Record keeping will be competed using Microsoft Word, Excell, and with photo and video. Once the major maintenance is completed the dams will be maintained to a ground cover level.

List of all Components Requiring Routine Surveillance Inspections

All three dams (O'Halloran, America, and Eisner) are monitored weekly. The monitoring process includes water levels, cracking, seepage, animal burrows, and ground cover. In conjunction with the maintenance plans the ground cover and trees will be monitored for possible root issues.

In addition to the weekly monitoring a yearly full inspection will be completed. This inspection will cover the full operation of all three dams (O'Halloran, America, and Eisner). The maintenance plans for the upcoming year will be reviewed at this time and possibly changed depending on need.

Annual Formal Inspection by Owner

The Superintendant of the property will be conducting the formal yearly inspection. This inspection will be conducted at the beginning of each year. Special items to be inspected include the yearly maintenance goals, erosion, water usage and levels, cracks, seepage, and any new issues that arise. Once the inspection is complete the Superintendant will review and compare from previous years and forward that information to the owner.

Formal Annual Inspection

It is recommended that you customize this form to fit your dam.

Pre-Inspection Information

Name of Dam: 1, 2, 3 Inspection Date: Dec 2019
Current Weather: _____ Weather During Last Week: _____
Name of Creek, Stream, River: _____ Water Licence #: _____
Dam Owner: MORNINGSTAR GOLF CLUB
Address: 525 LOWRY'S ROAD
City, Province: PARKSVILLE BC Postal Code: V9P 2R8
Name of Principle Contact Person: GORD AMERICA / BARRIE MCNHA
Principle Contact's Bus Phone: 604 741 3920 Principle Contact's Cell Phone: _____
Principle Contact's Email: BMCNHA@MORNINGSTARGOLF.COM
Person Responsible for this Inspection: GORD AMERICA Phone #: 250 248 4778
Other Inspection Participants: _____

Date of Last Annual Inspection: DEC 2018 Was last Annual Inspection Report reviewed?: _____
Were dam deficiences identified that required follow-up? _____
Date of Last Dam Safety Report(DSR): 2018 Was last DSR Report reviewed? YES
Were recommendations from the last DSR Report implemented? _____
Repairs or modifications since last formal inspection? (where, when) _____
Failures/Incidents/Breaches since last formal inspection? _____
Has all the maintenance done in the last year been documented? _____
Are the Works Currently Fully Operational? YES

Dam Information

Type of Dam: _____ Max. Height of Dam: _____
Are dam materials well known? _____ Are foundation conditions well known? _____
Are dam construction details well known? _____ Construction Date: _____

Failure Consequence Classification

Circle current Failure Consequence Classification (based on BC Dam Safety Regulation)
Low Significant High VeryHigh Extreme

Hydrology

Drainage Area Size: _____ Reservoir Area: _____
Inflow Design Flood (IDF): _____ m^3/s IDF Return Period: _____
1000 yr Flood: _____ m^3/s (If available): _____
Probable Maximum Flood: _____ m^3/s (If available): _____
Spillway Crest Elevation: _____ Spillway Width: _____
Spillway Capacity: _____ Net Freeboard (while spillway passing IDF): _____
Gross Freeboard (@ full supply level): _____ Freeboard (at time of visit): _____
Reservoir Storage Volume: _____ Licenced Storage Volume: _____

Emergency Preparedness Plan (EPP)

Has the emergency contact information in the EPP been updated this year and distributed as required? _____

Other Key Information

Person Responsible for Formal Inspection: GORD AMERICA **Date:** DEC. 2019

	Required Action					Photo #s
	None	Monitor	Maintenance	Repair	N/A	

Embankment Dam

1. Upstream Slope

VEGETATION (Yes/No)
Type ALDERS Location DOWN SLOPES of #2&1 — ☐ ☐ ☑ ☐ ☐ ____
Recommendations: CLEARING ON GOING

SLOPE PROTECTION — ☐ ☐ ☒ ☐ ☐ ____
Type None/Grass/Riprap/Other
Notes CLEAN-UP ON GOING

EROSION Yes/No Location — ☒ ☐ ☐ ☐ ☐ ____
Type Wave/Runoff/Unknown
Length ____ Width ____
Notes

INSTABILITIES — ☒ ☐ ☐ ☐ ☐ ____
Slides Yes/No/Could not Inspect
Length ____ Width ____ Location ____
Notes/Causes
Cracks Yes/No Transverse/Longitudinal/Other — ☑ ☐ ☐ ☐ ☐ ____
Quantity ____ Length ____ Width ____
Location
Notes/Causes
Bulges/Depressions/Hummocky Yes/No — ☑ ☐ ☐ ☐ ☐ ____
Size ____ Height ____ Depth ____
Location
Notes/Causes

OTHER — ☑ ☐ ☐ ☐ ☐ ____
Burrows, Ruts, Other Concerns
Location
Notes/Causes

2. Crest

ACCESS — ☑ ☐ ☐ ☐ ☐ ____
Is there public access to the crest? (Yes/No)
Is the crest marked or signed? (Yes/No)
Is vehicle access to the crest restricted? (Yes/No)

VEGETATION
Trees (Yes/No) — ☐ ☐ ☒ ☐ ☐ ____
Location SOME ON DOWNSLOPES
Notes
Brush None/Sparse/Dense — ☐ ☐ ☒ ☐ ☐ ____
Location ON CREST
Notes SOME CLEARING DONE
Ground Cover Bare/Grass/Other — ☐ ☐ ☒ ☐ ☐ ____
Quantity (bare/sparse/adequate/dense)
Appearance (too tall/too short/good)
Notes MOW CLOSE TO THE GROUND

EROSION Yes/No Location — ☒ ☐ ☐ ☐ ☐ ____
Type Wave/Runoff/Unknown
Length ____ Width ____
Notes

SETTLEMENT — ☒ ☐ ☐ ☐ ☐ ____
Location
Notes/Causes

	Required Action					Photo #s
	None	Monitor	Maintenance	Repair	N/A	
INSTABILITIES	☑	☐	☐	☐	☐	
Cracks Transverse/Longitudinal/Other						
Quantity ____ Length ____ Width ____						
Location ____						
Notes/Causes ____						
OTHER						
Burrows, Ruts, Other Concerns	☑	☐	☐	☐	☐	
Location ____						
Notes/Causes ____						

3. Downstream Slope

VEGETATION	☐	☐	☑	☐	☐	
Trees Yes/No ALDERS						
Location ____						
Notes SOME TREES LAT DOWN						
Brush None/Sparse/Dense	☐	☐	☑	☐	☐	
Location CREST AND SLOPE						
Notes ____						
Ground Cover Bare/Grass/Other	☐	☐	☒	☐	☐	
Notes ____						
SLOPE PROTECTION	☐	☒	☐	☐	☐	
Type None/Grass/Other						
Notes ____						
EROSION Yes/No Location ____	☒	☐	☐	☐	☐	
Location ____						
Notes ____						
INSTABILITIES	☒	☐	☐	☐	☐	
Slides Length ____ Width ____ Location ____						
Notes/Causes ____						
Cracks Yes/No Transverse/Longitudinal/Other	☒	☐	☐	☐	☐	
Quantity ____ Length ____ Width ____						
Location ____						
Notes/Causes ____						
Bulges/Depressions/Hummocky Yes/No	☒	☐	☐	☐	☐	
Size ____ Height ____ Depth ____						
Location ____						
Notes/Causes ____						
OTHER						
Burrows, Ruts, Other Concerns	☒	☐	☐	☐	☐	
Location ____						
Notes/Causes ____						
SEEPAGE	☒	☐	☐	☐	☐	
Wet Area/Flow/Boil/Sinkhole						
Flow Rate ____						
Location ____						
Aquatic Vegetation Yes/No						
Rust Colored Deposits Yes/No						
Sediment in Flow Yes/No						
Other ____						
Notes/Causes ____						
EMBANKMENT DRAINS Yes/No	☐	☒	☐	☐	☐	
Type ____						
Flow rate ____ Size ____ Number ____						
Location ____						
Notes ____						
MONITORING INSTRUMENTATION CONDITION	☑	☐	☐	☐	☐	
☐ None found ☐ Piezometers ☐ Weir ☐ Flume						
Notes ____						

	Required Action					Photo #s
	None	Monitor	Maintenance	Repair	N/A	
Concrete Dam						
1. Upstream Side and Crest						
ALIGNMENT/OFFSETS	☐	☐	☐	☐	☐	____
Movement at Joints? ____						
Settlement?						
JOINT FILLER ____	☐	☐	☐	☐	☐	____
Any Loss?						
Vegetation?						
UNUSUAL CRACKS	☐	☐	☐	☐	☐	____
New? ____						
Efflorescence? ____						
Displacement? ____						
DETERIORATION	☐	☐	☐	☐	☐	____
Concrete Breakdown? ____ Diagnosis: ____						
Erosion ____						
Scour ____						
2. Downstream Side						
ALIGNMENT/OFFSETS	☐	☐	☐	☐	☐	____
Movement at Joints? ____						
Settlement? ____						
JOINT FILLER	☐	☐	☐	☐	☐	____
Any Loss? ____						
Vegetation? ____						
UNUSUAL CRACKS	☐	☐	☐	☐	☐	____
New? ____ Type? ____						
Efflorescence? ____ ____						
Displacement? ____						
DETERIORATION	☐	☐	☐	☐	☐	____
Concrete Breakdown? ____ Diagnosis: ____						
Erosion ____						
Scour ____						
UNUSUAL LEAKAGE	☐	☐	☐	☐	☐	____
Increase? ____ Clear? ____						
Weir? ____ Flow Estimate? ____						
DRAINS	☐	☐	☐	☐	☐	____
Flow? ____ Calcite Build-up? ____						

	Required Action					Photo #s
	None	Monitor	Maintenance	Repair	N/A	

Spillway

GENERAL CONDITIONS

Type _____ Gated? - Yes/No

Notes _____

1. Spillway Crest or Control Section

OBSTRUCTION ☐ ☑ ☐ ☐ ☐ _____

Debris Yes/No

Location _____

Notes _____

Vegetation None/Sparse/Dense

Location _____

Notes BRUSH TRIM

Other (beaver activity, trash rack problems, etc.)

_____

LOG BOOM Yes/No Required? Yes/No

Condition: Logs _____ Connections _____ Anchors _____

Notes _____

SPILLWAY CREST MATERIALS ☒ ☐ ☐ ☐ ☐ _____

Condition _____

Notes _____

SPILLWAY GATES Yes/No _____ Type: _____

Condition _____

Notes _____

OTHER SPILLWAY CREST PROBLEMS

Damage _____ ☒ ☐ ☐ ☐ ☐ _____

Location _____

Notes/Cause _____

2. Spillway Conveyance Section: Channel, Chute or Conduit

OPEN CHANNEL CROSS SECTION _____ ☐ ☐ ☐ ☐ ☐ _____

CHANNEL OBSTRUCTION _____ ☐ ☐ ☐ ☐ ☐ _____

SPILLWAY CONVEYANCE MATERIALS HEAVY-DUTY PVC ☐ ☑ ☐ ☐ ☐ _____

OTHER SPILLWAY CONVEYANCE PROBLEMS _____ ☒ ☐ ☐ ☐ ☐ _____

Damage _____

Location _____

Notes/Cause _____

3. Energy-Dissipating or Terminal Section

EROSION CONTROL STRUCTURE ☒ ☐ ☐ ☐ ☐ _____

Type Endwall/Headwall/Plunge pool/Impact basin/Baffled chute/Rock lined channel/Other/None

_____

Notes _____

	Required Action					Photo #s
	None	Monitor	Maintenance	Repair	N / A	

Low Level Outlet

GENERAL

Gate Type _____ ☒ None — ☒ | ☐ | ☐ | ☐ | ☐ | ____

ACCESS TO VALVE/GATE Under all circumstances? Yes/No — ☒ | ☐ | ☐ | ☐ | ☐ | ____

☐ Not accessible ☐ From shore ☐ Walkway ☐ By boat ☐ Other

Notes _____

Walkway Condition _____

LOW LEVEL OUTLET COMPONENTS

Valve Control Device — ☒ | ☐ | ☐ | ☐ | ☐ | ____

☐ Yes ☒ None ☐ No Stem ☐ Damaged stem ☐ Other

Other/Notes _____

Operational under all conditions? — ☒ | ☐ | ☐ | ☐ | ☐ | ____

☐ Yes ☐ No ☐ Poorly

Tested Annually? Yes/No Tested as per OMS manual? Yes/No

Notes _____

Valve / Gate — ☒ | ☐ | ☐ | ☐ | ☐ | ____

Location _____

Condition _____

Leakage ☐ Yes ☐ No — ☒ | ☐ | ☐ | ☐ | ☐ | ____

Flow Rate _____

Outlet Pipe — ☐ | ☒ | ☐ | ☐ | ☐ | ____

☐ Metal ☒ Plastic ☐ Concrete ☐ Other

Diameter 8" P.V.C

Condition _____

Outlet Obstruction (note vegetation, sediment blockage, etc.)

Notes _____

OUTLET EROSION CONTROL STRUCTURE — ☐ | ☐ | ☐ | ☐ | ☐ | ____

Type _____

Concrete Condition — ☐ | ☐ | ☐ | ☐ | ☐ | ____

Outlet Area Seepage — ☐ | ☐ | ☐ | ☐ | ☐ | ____

Description _____

Flow Estimate _____

Location _____

Undermining — ☐ | ☐ | ☐ | ☐ | ☐ | ____

Location _____

Notes/Cause: _____

Downstream Channel — ☐ | ☐ | ☐ | ☐ | ☐ | ____

Free Draining? _____

Blockages or Potential Blockages? _____

Erosion Control? Rip-Rap? _____

	Required Action					Photo #s
	None	Monitor	Maintenance	Repair	N/A	

Other Key Information

Is site access adequate for safe operation, maintenance and surveillance? YES
Instrumentation adequate for site conditions? _____
Are there concerns about reservoir slope stability? NO
Any there other concerns in the watershed that could impact the dam? NO
Operational Constraints that impact Dam Safety? _____
Are the required Public Safety signs in place (for dams on Crown land)? _____
Other comments on Public Safety: SIGNS POSTED
Should new development in the downstream inundation zone initiate a review of the Failure Consequence Classification?:
Yes/no? _____ Comments: _____

Maintenance

In the last year have the spillway gates been exercised and tested in accordance with the OMS? _____
If so, when and by whom? _____
In the last year has the low level outlet gate been exercised and tested in accordance with the OMS? _____
If so, when and by whom? _____
Is the instrumentation well maintained? _____

NOTES:

	Required Action				Photo #s
None	Monitor	Maintenance	Repair	N / A	

SKETCH OF ISSUES:

APPENDIX M

Dam Safety Review Assurance Statement – Water Reservoir Dams

APPENDIX C1: DAM SAFETY REVIEW ASSURANCE STATEMENT – WATER RESERVOIR DAMS

Note: This statement is to be read and completed in conjunction with the current *APEGBC Professional Practice Guidelines – Legislated Dam Safety Reviews in British Columbia*, ("APEGBC Guidelines") and is to be provided for dam safety review reports for the purposes of the *Dam Safety Regulation*, BC Reg. 40/2016 as amended. Italicized words are defined in the APEGBC Guidelines.

To: The Owner(s)

Date: January 5, 2022

Reakor Golf Inc.

Name

4333 Ledger Ave

Burnaby, BC V5G 3T3

Address

With reference to the *Dam Safety Regulation*, B.C. Reg. 40/2016 as amended.

For the dam:

UTM (Location): (1) 4007194N 5465654W 10U; (2) 4006686N 5465744W 10U; (3) 4006450N 5465839W 10U

Located at (Description): Morningstar Golf Club, French Creek, BC

Name of dam or description: (1) Dam 1 (O'Halloran); Dam 2 (Eisner); Dam 3 (America)

Provincial dam number: (1) D720178-01; (2) D720178-02; (3) D720178-03

Dam function: Irrigation Reservoir

Owned by: Reakor Golf Inc.

(the "Dam")

Current Dam classification is:

Check one

- ☐ Low
- ☑ Significant .. (1)
- ☑ High .. (2), (3)
- ☐ Very High
- ☐ Extreme

The undersigned hereby gives assurance that he/she is a Qualified Professional Engineer.

I have signed, sealed and dated the attached dam safety review report on the Dam in accordance with the APEGBC Guidelines. That report must be read in conjunction with this Statement. In preparing that report I have:

Check to the left of applicable items (see Guideline Section 3.2):

✓ 1. Collected and reviewed available and relevant background information, documentation and data

✓ 2. Understood the current classification for the Dam, including performance expectations

✓ 3. Undertaken an initial facility review

✓ 4. Reviewed and assessed the Dam safety management obligations and procedures

✓ 5. Reviewed the condition of the Dam, reservoir and relevant upstream and downstream portions of the river

✓ 6. Interviewed operations and maintenance personnel

✓ 7. Reviewed available maintenance records, the Operations, Maintenance and Surveillance (OMS) Manual and the Dam Emergency Plan

✓ 8. Confirmed proper functioning of flow control equipment

✓ 9. After the above, reassess the consequence classification, including the identification of required dam safety criteria

✓ 10. Carried out a dam safety analysis based on the classification in 9. above

✓ 11. Evaluated facility performance

✓ 12. Identified, characterized and determined the severity of deficiencies in the safe operation of the Dam and non-conformances in dam safety management system

✓ 13. Recommended and prioritized actions to be taken in relation to deficiencies and non-conformances

✓ 14. Prepared a dam safety review report for submittal to the regulatory authority by the Owner and reviewed the report with the Owner

✓ 15. The dam safety review report has been reviewed in meeting the intent of APEGBC Bylaw 14(b)(2)

Based on my dam safety review, the current dam classification is:

Check one

☑ Appropriate

☐ Should be reviewed and amended

I undertook the following type of dam safety review:

Check one

☐ Audit

☑ Comprehensive

☐ Detailed design-based multi-disciplinary

☐ Comprehensive, detailed design and performance

I hereby give my assurance that, based on the attached dam safety review report, at this point in time:

Check one

☐ The Dam is reasonably safe in that the dam safety review did not reveal any unsafe or unacceptable conditions in relation to the design, construction, maintenance and operation of the Dam as set out in the attached dam safety review report

☐ The Dam is reasonably safe but the dam safety review did reveal non-conformances with the *Dam Safety Regulation* as set out in section(s) ____ of the attached dam safety review report.

☑ The Dam is reasonably safe but the dam safety review did reveal deficiencies and non-conformances as set out in section(s) 10 of the attached dam safety review report.

☐ The Dam is not safe in that the dam safety review did reveal deficiencies and/or non-conformances which require urgent action as set out in section(s) ____ of the attached dam safety review report.

JAMES RUSSELL, M.Sc., P.Eng. — Name

2022/01/05 — Date

Signature

#6 - 40 CADILLAC AVE, VICTORIA, BC V8Z 1T2 — Address

250-475-3131 — Telephone

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA J. A. RUSSELL # 44111

(Affix Professional Seal here)

If the Qualified Professional Engineer is a member of a firm, complete the following:

I am a member of the firm RYZUK GEOTECHNICAL and I sign this letter on behalf of the firm. (Print name of firm)