APPENDIX 1-D

Bromley Humps TMF Seepage and Stability Analysis

March 3, 2017

File No.:VA101-00594/04-A.01
Cont. No.:VA17-00261

FS 64925
EMS 550121
OHS 550122

Mr. Wayne Corso
V.P. Engineering
JDS Energy & Mining (Vancouver)
900 - 999 West Hastings Street
Vancouver, British Columbia
Canada, V6C 2W2

Dear Wayne,

Re: Bromley Humps TMF Seepage and Stability Analysis

1 – INTRODUCTION

Knight Piésold Ltd. (KP) is currently completing the Feasibility Level design of the Bromley Humps Tailings Management Facility (TMF), which will support the Environmental Assessment Application (EAA) for the Red Mountain Underground Gold Project (the Project).

A key component of the design is the assessment of the facility for geotechnical stability under seismic and static loading conditions, and an evaluation of potential seepage from the facility. This letter summarizes the results of the stability and seepage analyses during the construction and operations phase of the TMF.

A separate future analysis will assess seepage and stability of the TMF at closure.

2 – DAM HAZARD CLASSIFICATION

2.1 DAM HAZARD CLASSIFICATION AND DESIGN EVENT DETERMINATION

An assessment of the dam hazard classification was carried out to determine the appropriate design earthquake and flood events for the TMF. Selection of the design earthquake and flood events is based on the classification criteria provided by the Canadian Dam Association Dam Safety Guidelines (CDA, 2013 & 2014).

The TMF dam classification considers the potential incremental consequences of an embankment failure defined as the total damage from an event with dam failure minus the damage that would have resulted from the same event had the dam not failed. Three areas of losses are considered; loss of life, environmental and cultural values, and infrastructure and economics, as shown on Table 2.1 (reproduced from Table 2-1 of Dam Safety Guidelines (CDA, 2013)).

The selection of an Inflow Design Flood (IDF) and Earthquake Design Ground Motion (EDGM) is governed by the dam classification. The criteria for selection of dam classification are outlined in Table 2.2 (reproduced from the Guidance Document for Part 10 of the Health, Safety and Reclamation Code for Mines in British Columbia (BC MEM, 2016)).

Table 2.1 Dam Hazard Classification (CDA, 2013)

Dam Class	Population at Risk[1]	Incremental Losses		
		Loss of Life[2]	Environmental and Cultural Values	Infrastructure and Economics
Low	None	0	Minimal short-term loss. No long-term loss.	Low economic losses; area contains limited infrastructure or services.
Significant	Temporary only	Unspecified	No significant loss or deterioration of fish or wildlife habitat. Loss of marginal habitat only. Restoration in kind highly possible.	Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes.
High	Permanent	10 or fewer	Significant loss or deterioration of *important* fish or wildlife habitat. Restoration or compensation in kind highly possible.	High economic losses affecting infrastructure, public transportation, and commercial facilities.
Very High	Permanent	100 or fewer	Significant loss or deterioration of *critical* fish or wildlife habitat. Restoration or compensation in kind possible but impractical.	Very high economic losses affecting infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances).
Extreme	Permanent	More than 100	Major loss of *critical* fish or wildlife habitat. Restoration or compensation impossible.	Extreme losses affecting critical infrastructure or services (e.g. hospital, major industrial complex, major storage facilities for dangerous substances).

NOTES:

1. Definitions for population at risk:
   None – No identifiable population at risk, no possibility of loss of life other than through unforeseeable misadventure.
   Temporary – People are only temporarily in the dam-breach inundation zone (e.g. seasonal cottage use, transportation routes, recreation)
   Permanent – Population at risk is ordinarily located in the dam-breach inundation zone (e.g. permanent residents)
2. Implications for loss of life:
   Unspecified – The appropriate level of safety required at a dam where people are temporarily at risk depends on the number of people, exposure time, nature of activity and other conditions. Higher classes could be appropriate depending on requirements.

Table 2.2 Target Levels for Flood and Earthquake Hazards (BC MEM, 2016)

Dam Class	Annual Exceedance Probability (AEP)			
	Water Retaining Dams		Tailings Dams	
	IDF[2,3]	EDGM	IDF[2,3]	EDGM
Low	1/100	1/100	1/3 between 1/975 and PMF[4]	1/2,475[6]
Significant	Between 1/100 and 1/1,000	Between 1/100 and 1/1,000	1/3 between 1/975 and PMF[4]	1/2,475[6]
High	1/3 between 1/1,000 and PMF[4]	1/2,475[6]	1/3 between 1/1,000 and PMF[4]	1/2,475[6]
Very High	2/3 between 1/1,000 and PMF[4]	1/2 Between 1/2,475[6] and 1/10,000 or MCE[7]	2/3 between 1/1,000 and PMF[4]	1/2 Between 1/2,475[6] and 1/10,000 or MCE[7]
Extreme	PMF[4]	1/10,000 or MCE	PMF[4]	1/10,000 or MCE[7]

NOTES:

1. Acronyms: PMF (Probable Maximum Flood), AEP (Annual Exceedance Probability), MCE (Maximum Credible Earthquake)
2. Simple extrapolation of flood statistics beyond 1/1,000 AEP is not acceptable.
3. The Code requires that a facility that stores the inflow design flood use a minimum event duration of 72 hrs.
4. PMF has no associated AEP.
5. Mean values of the estimated range in AEP levels for earthquakes should be used. The earthquakes with the AEP as defined above are input as contributory earthquakes to develop Earthquake Design Ground Motion (EDGM) parameters.
6. The 1/2,475 AEP earthquake has been selected for consistency with seismic design levels given in the National Building Code of Canada (NBCC, 2010).
7. MCE has no associated AEP.

2.2 BROMLEY HUMPS TMF CLASSIFICATION

The TMF embankments have been designed for a HIGH dam safety classification. This classification considered the potential risks to population and potential incremental losses, which include:

- Loss of life (Loss to temporary population only – SIGNIFICANT (no permanent population directly downstream of TMF))
- Environmental and cultural values (Loss to *important* fish habitat with restoration highly possible – **HIGH** (anticipated impacts to Bitter Creek only)), and
- Infrastructure and economics (Losses to seasonal workplaces and infrequently used transportation routes – SIGNIFCANT (no public highway access directly downstream of TMF)).

The dam hazard classification is used to determine the Inflow Design Flood (IDF) and Earthquake Design Ground Motion (EDGM) for the TMF embankments. The following design flood and earthquake levels were adopted from the CDA guidelines (CDA, 2013 & 2014) and the BC Mining Code (BC MEM, 2016) for a HIGH dam hazard classification for the construction and operational phases of the project:

- IDF: 1/3 between 1/1,000 year return period event and the Probable Maximum Flood (PMF).
- EDGM: 1/2,475 year return period seismic event.

For a HIGH dam classification during the passive care phase (i.e. post-closure), CDA guidelines recommend that the TMF be designed to withstand the following seismic and precipitation events.

- IDF: 2/3 between the 1/1,000 year return period event and the PMF.
- EDGM: 1/2 between the 1/2,475 year and 1/10,000 year (or Maximum Credible Earthquake) return period seismic events.

The TMF dam hazard classification may be re-evaluated based on the results of the planned TMF Dam Breach Assessment.

3 – MATERIALS AND PARAMETERS

3.1 MATERIAL DESCRIPTIONS

3.1.1 Embankment and Construction Materials

The TMF embankments have been designed with the following design criteria:

- Embankment side slopes of 2.5H:1V upstream and 2H:1V downstream.
- Embankment crest width of 10 m to allow one-way haul truck access with safety berms.
- TMF basin fully lined with a 100 mil HDPE geomembrane, with 16 oz. non-woven geotextile underlay and overlay to protect the liner from puncturing, installed on a processed bedding layer to provide a smooth surface for liner installation.
- Main embankment fill zone (Zone C) constructed using granular fill from local borrow.
- Processed Transition Zone (Zone T) and Filter Zone (Zone F) constructed on upstream embankment face, between the HDPE geomembrane bedding layer and the Zone C fill material. Each zone is approximately 1 m thick built in compacted horizontal lifts.
- An underdrain system will be installed on top of the geomembrane, to promote tailings consolidation, and will be constructed using granular fill from local borrow.

The critical section through the TMF North Embankment (i.e. the largest cross-section through the embankment), is shown on Figure 3.1. The tailings surface corresponds to the final tailings throughput (~2 Mtonnes) plus the supernatant pond volume.

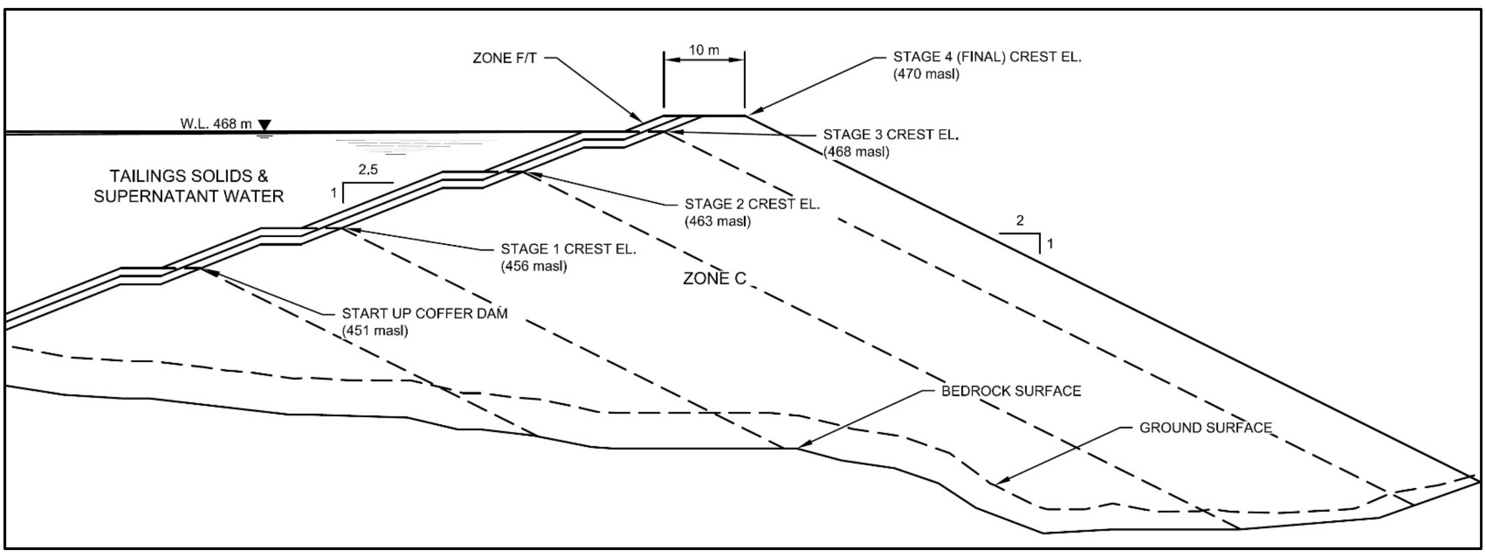

Figure 3.1 TMF North Embankment Critical Section

3.1.2 Tailings Materials

Thickened tailings will be deposited at a nominal solids content of 50% solids content by weight. Laboratory testing of the tailings material is on-going at the time of release of this document, therefore typical values were used for similar tailings (discussed further in Section 3.2.1 and 3.2.2).

3.1.3 Foundation Materials

The foundation conditions at the TMF were assessed based on the geological and geotechnical information presented in the 2016 Site Investigation Report (KP, 2016). Foundation conditions at the TMF embankments encountered an average thickness of overburden of approximately 1-2 m, with prevalent bedrock outcrops. Overburden is predominantly characterized by a layer of colluvium (well graded sandy gravel) overlain by a thin veneer (approx. 10 cm thick) of topsoil and organic material. Some thicker deposits of colluvium are underlain by deposits of glacial till.

Overburden beneath the TMF embankment footprints will be excavated, and the embankments constructed on bedrock.

3.2 MATERIAL PROPERTIES

3.2.1 Material Strength Properties

The material unit weights and effective strength parameters used in the analyses are provided in Table 3.1. Parameters incorporated into the stability analyses are described below:

3.2.1.1 TMF Embankment Fill Materials

The shear strength of the embankment fill is based on a function that defines the variation of shear strength with normal stress. The shear strength of rock materials typically reduces at higher stresses due to the crushing of particle contact points within the material and a reduction in material dilatancy. Shear strength is also related to the density and durability of the material and the particle size distribution. The strength function representative of lower shear strength rockfill (Leps, 1970) was selected based on the assumption that fill may comprise of low density, poorly graded, weak particles.

Bulk unit weights and effective friction angles for Zone F and Zone T materials were based on typical values for similar materials.

3.2.1.2 Thickened Tailings

Bulk unit weight of the tailings was assumed based on experience with similar tailings.

Table 3.1 Material Strength Properties

Material Type	Model	Unit Weight[1] γ kN/m^3	Effective Friction[1] ϕ' degrees	Effective Cohesion c' kPa	τ/σ Ratio
Embankment Fill	Shear/Normal Function (Lower Bound Leps)	19	-	-	-
Filter Zone	Mohr-Coulomb	18.5	37	0	-
HDPE Liner Bedding Layer	Mohr-Coulomb	17.5	37	0	-
Transition Zone	Mohr-Coulomb	20	38	0	-
Tailings	S=f(overburden)	19	-	-	0.25

4 – SEISMIC HAZARD EVALUATION

4.1 GENERAL

The Canadian Dam Association Dam Safety Guidelines (CDA, 2014) and the Health Safety and Reclamation Code for Mines in British Columbia (BC MEM, 2017) both state that for tailings dams, the minimum design criteria corresponds to that of the 1/2,475 year return period seismic event (i.e. a 2% probability of exceedance in 50 years) for a Dam Hazard Classification of HIGH or lower..

The following return period events have been selected as the design earthquake events or the various phases of the TMF, based on the dam hazard classification:

- Construction and Operations Phases: 1/2,475 year.
- Passive Care Phase (i.e. Post Closure): 1/2 between 1/2,475 year and 1/10,000 year.

The EDGM for the Passive Care Phase has been adopted as the Maximum Design Earthquake (MDE) for the life of the TMF, while the EDGM for the Construction and Operations Phases will be used as the Operating Basis Earthquake (OBE).

4.2 METHODOLOGY

Spectral accelerations (Sa) and Peak Ground Accelerations (PGA) were obtained for the project site using the Natural Resources Canada Seismic Hazard Calculator (NRCAN, 2015). The calculator provides these parameters for events up to a 1/2,475 year seismic event. To obtain the 1/10,000 year seismic event parameters, the parameters for the 1/475 year and 1/2,475 year return period events were plotted on a log-log scale, and the values extrapolated to estimate the parameters for the 1/10,000 year seismic event, following procedures provided by NRCAN for estimating low-probability return period seismic events (NRCAN, 2016).

The Peak Ground Accelerations for the Project are as follows:

- 1/2,475 year return period seismic event = 0.064g (OBE).
- 1/10,000 year return period seismic event = 0.12g.

The MDE was evaluated as 1/2 between these two events, as follows:

- 1/2 between 1/2,475 year and 1/10,000 year return period seismic events = 0.092g (MDE).

A design earthquake magnitude of 7.5 has been estimated for the MDE.

5 – STABILITY ANALYSIS APPROACH AND METHODOLOGY

5.1 GENERAL

A stability analysis of the critical section through the TMF North Embankment (i.e. the maximum height of the TMF embankment) was completed to investigate the stability under static and seismic loading conditions. A brief discussion of the methodology and design criteria is presented below, with typical cross-sections and results.

5.2 MODELLING APPROACH

The following cases have been evaluated for stability analysis of the TMF:

- Static conditions at the end of construction (i.e. prior to basin filling) for all stages of embankment construction.
- Static conditions post deposition (i.e. long term conditions) for all stages of embankment construction.
- Earthquake loading from the Maximum Design Earthquake (MDE) and Operating Basis Earthquake (OBE) for all stages of embankment construction.

The recommended Factors of Safety (FOS) applicable to the design of the TMF, as per Table 6-2 and Table 6-3 of the Canadian Dam Association's Dam Safety Guidelines (CDA, 2013 & 2014) and Tables 3-1 and 3-2 of the BC Mines Code Guidance Document (BC MEM, 2016) are summarized on Table 5.1:

Table 5.1 Factors of Safety for Slope Stability

Loading Condition	Minimum FOS	Slope
End of construction, prior to filling	1.5	Upstream and downstream
Long term (steady-state seepage, normal reservoir level)	1.5	Downstream
Full or partial rapid drawdown	1.5	Upstream
Psuedo-static	1.0	Upstream and downstream
Post-earthquake	1.2 – 1.3	Upstream and downstream

Rapid drawdown conditions were not analyzed for the TMF as it is a fully lined facility and there would be no change in the pore water pressures within the embankment in the event of a drawdown.

The stability analysis was carried out using the limit equilibrium program SLOPE/W (Geostudio, 2012). This program uses a systematic search to obtain the minimum factor of safety associated with the critical slip surface. The FOS were calculated using the Morgenstern-Price method.

5.3 PIEZOMETRIC LEVELS AND PORE PRESSURE RESPONSE

The TMF is a fully lined facility, therefore it is expected that the TMF embankments will be unsaturated. For conservatism, the groundwater table was assumed to be at the top of the excavated ground surface, at the bedrock-overburden interface, and the piezometric line was fully specified in the model. The groundwater table was encountered at depths of between 10 m to 25 m beneath the TMF North Embankment during recent investigations.

The construction of the embankments could generate excess pore pressures in the overburden under saturated conditions, which could lead to instability of the embankments during operations prior to the dissipation of excess pore pressures. It is therefore assumed that the overburden materials will be excavated and the embankments will be constructed on bedrock.

5.4 SEISMIC STABILITY

Seismic loading was modelled by performing pseudo-static analyses for the MDE, as required by BC MEM regulations and CDA guidelines. Pseudo-static analyses apply a horizontal force (seismic coefficient) to the model to simulate earthquake loading. The horizontal seismic coefficients used in the seismic stability analysis were estimated using the formula developed by Melo and Sharma (2004), $K_H = 0.5 \times PGA$, as follows:

- OBE = 1/2475 year = 0.032g (PGA = 0.064g).
- MDE = 1/2 between 1/2,475 year and 1/10,000 year = 0.046g (PGA = 0.092g).

The minimum required FOS for the pseudo-static analysis and post-earthquake conditions are 1.0 and 1.2 respectively. Satisfying this requirement implies the design earthquake events would result in deformations that are acceptable and do not affect the integrity of the facilities (i.e. are not anticipated to affect required embankment freeboard and HDPE liner integrity).

6 – TMF STABILITY ANALYSIS RESULTS

6.1 GENERAL

The stability analysis for the TMF was based on the critical section through the North TMF Embankment (the larger of the two embankments). The final embankment has a crest elevation of 470 m, and the maximum height of the critical section is approx. 37 m. Steady state conditions for stability were assessed under two hydraulic loading conditions; a normal operating supernatant pond level, and a post-flood event pond level.

6.2 ASSUMPTIONS

The following assumptions were incorporated into the stability analyses for the TMF:

- Foundation conditions were developed using the drillhole logs located along the TMF embankment centreline and within the embankment footprint. The extent of the various units was estimated based on interpolation of the available data and engineering judgement.
- Topsoil and overburden materials below the embankment will be removed prior to construction.
- The embankment fill was assumed to be free-draining.
- Construction materials (excepting tailings) will be non-liquefiable.

6.3 STABILITY RESULTS

The calculated FOS for the TMF section exceed the minimum required FOS for both short term (i.e. end of construction) and long term (i.e. steady-state) stability of the embankment at all stages, during static and seismic conditions. The FOS for each loading condition of the TMF section are presented in Table 6.1. The critical slip surface and FOS for loading conditions and configurations for the final (Stage 4) embankment are shown on Figures 6.1 to 6.4.

Table 6.1 TMF Stability Analysis Results

Slope Stability Conditions	Slip Surface Direction	Required Minimum FOS	FOS for Stage of Construction			
			Starter	Stage 1	Stage 2	Stage 4
Pseudo-static (MDE = 0.092g)	Upstream	**1.0**	1.610	1.610	1.610	1.608
	Downstream	**1.0**	1.778	1.702	1.655	1.659
Post-Earthquake (OBE = 0.064g)	Upstream	**1.2**	1.734	1.732	1.733	1.733
	Downstream	**1.2**	1.894	1.833	1.763	1.762
End of Construction	Upstream	**1.5**	1.897	1.898	1.895	1.895
	Downstream	**1.5**	2.043	1.955	1.898	1.905
Long-term Steady State Conditions (Normal Operating Conditions)	Downstream Only	**1.5**	2.042	1.955	1.902	1.900
Long-term Steady State Conditions (Flood Event Conditions)	Downstream Only	**1.5**	2.045	1.954	1.906	1.902

NOTES:

1. End of construction conditions analyse full stage construction with tailings and pond level representative of end of previous stage of construction.
2. Flood conditions assume pond volume is full to base of emergency discharge spillway in TMF embankment.
3. Assumes overburden excavated prior to construction.

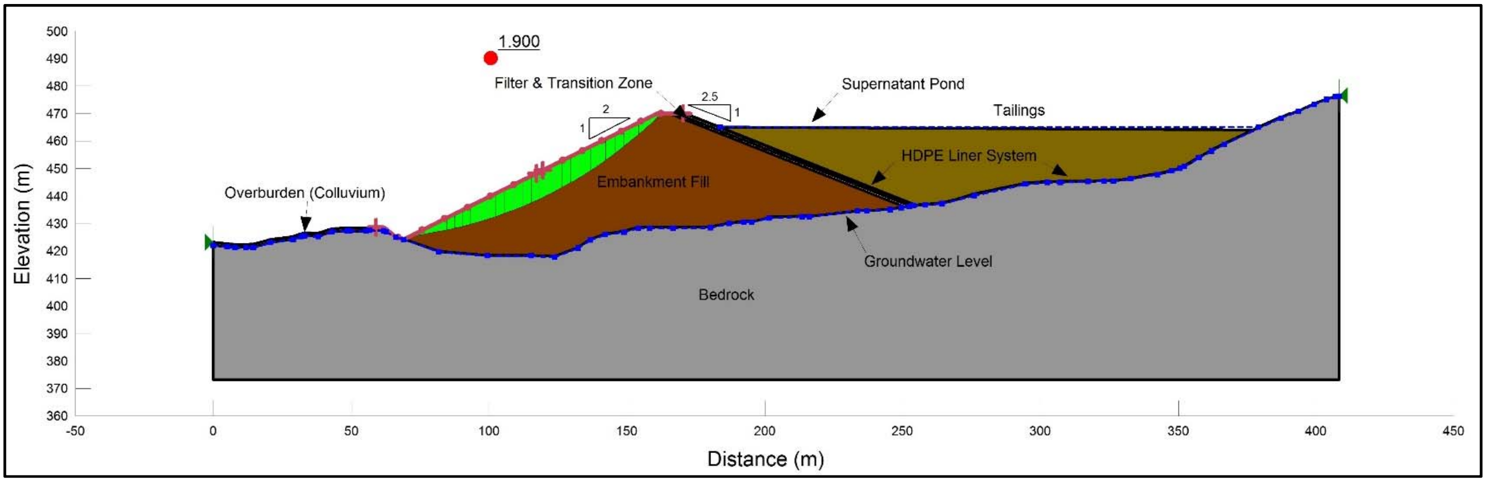

Figure 6.1 Long-Term Steady State Conditions (Normal Operating Conditions)

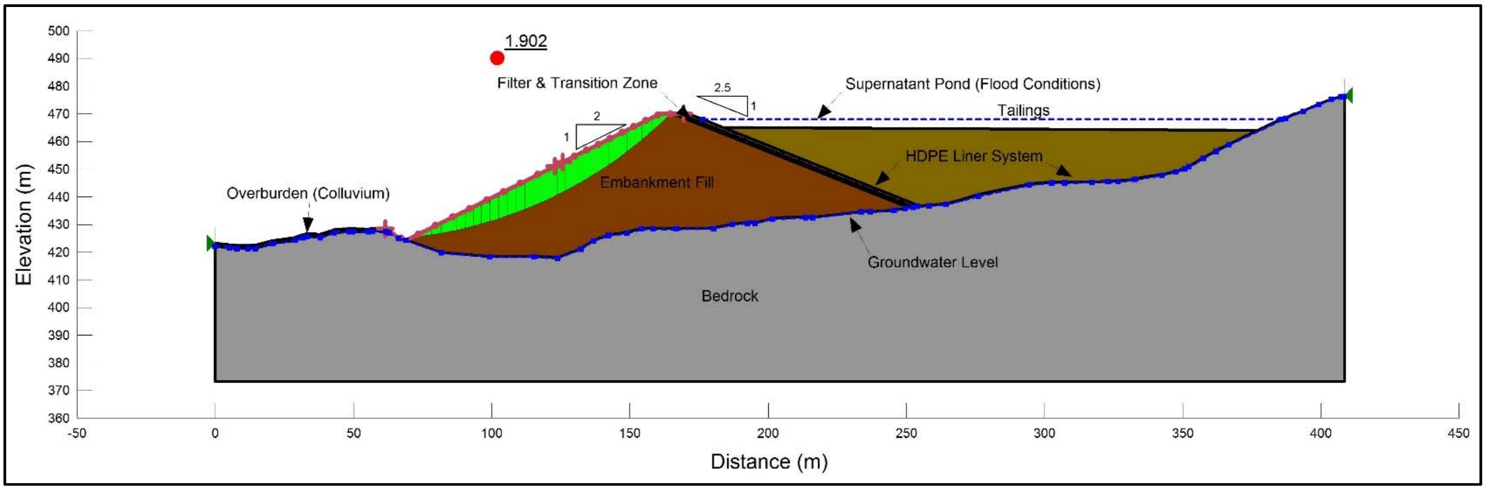

Figure 6.2 Long Term Steady-State Conditions (Post-Flood Conditions)

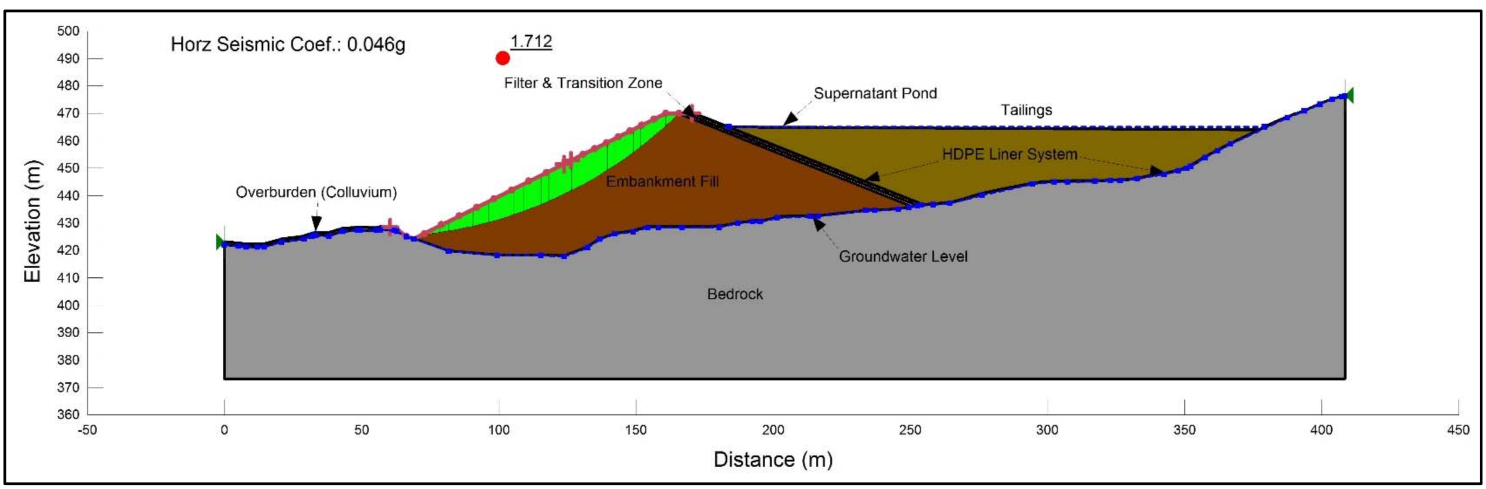

Figure 6.3 Pseudo-Static (MDE) Conditions (Downstream Analysis)

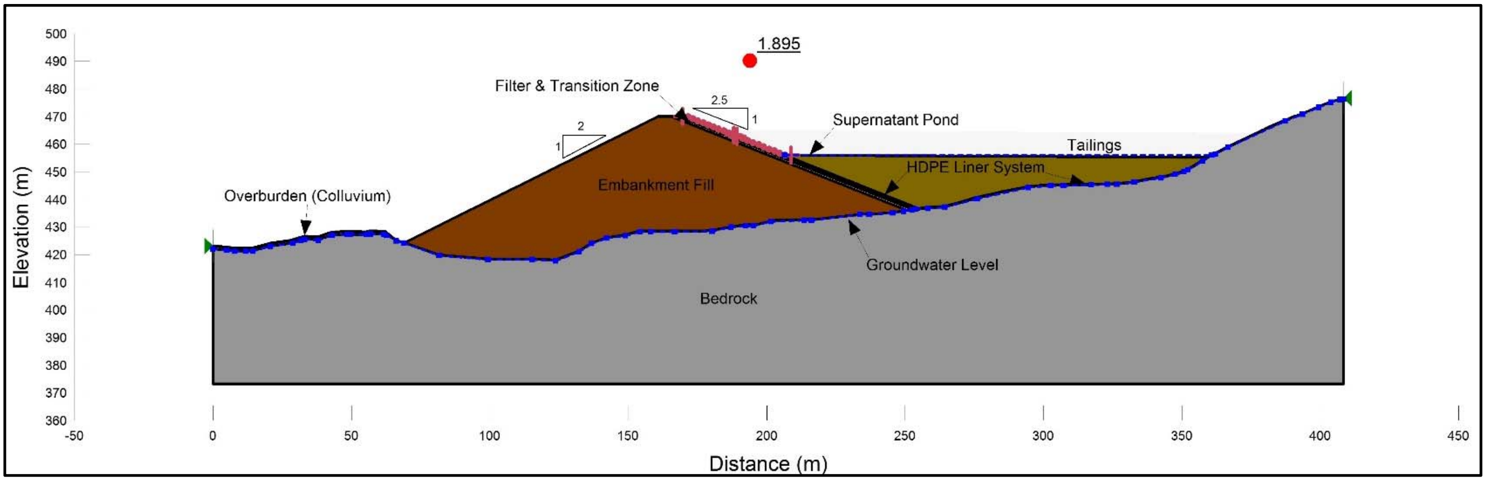

Figure 6.4 Short-Term Conditions (End of Stage Construction) (Upstream Analysis)

6.4 SEISMIC DISPLACEMENTS AND DEFORMATIONS

Seismic displacements and deformations are typically calculated when the FOS under seismic loading conditions is less than 1.0. In this scenario, where the FOS is higher than 1.0, the peak ground acceleration was adjusted until a FOS of 1.0 was achieved (i.e. the yield acceleration) and seismic displacements and deformations estimated along potential slip surfaces using a combination of empirical methods, including:

- Newmark Method (1965)
- Makdisi-Seed Method (1978)
- Bray Method (2007), and
- Swaisgood Method (2003).

Potential deformations resulting from a 1/10,000 year seismic event were calculated using the Newmark (1965), Makdisi-Seed (1978), and Bray (2007) methods, and are predicted to be less than 1 cm while potential crest settlements under seismic loading were estimated to be less than 2 cm using the Swaisgood (2003) method.

The resulting embankment deformations or crest settlements are not large enough to cause a release of stored water or tailings, and the overall stability and integrity of the embankments is maintained.

7 – TMF SEEPAGE ANALYSIS

7.1 METHODOLOGY

The seepage analysis assumes that during the effective life of the liner system, seepage from the TMF would be limited to leakage from potential defects in the HDPE geomembrane. Leakage through the HDPE geomembrane because of defects was estimated using Bernoulli's equation for free flow through an orifice (Giroud and Bonaparte, 1989). This analysis considered one defect (2 mm diameter) per acre (~4,000 m^2) of geomembrane (Giroud and Bonaparte, 1989) having a reasonable potential to exist for various geomembrane installation methods.

The total seepage rate through the geomembrane was calculated by multiplying the results of the analysis by the surface area of the TMF, assuming that a single defect (2 mm diameter) is present for every acre of geomembrane liner (Giroud & Bonaparte, 1989).

The equation has the form:

$$Q = C_B a \sqrt{2gh_w}$$

Where:

- Q = leakage rate through geomembrane defect
- C_B = dimensionless coefficient related to shape of edges of the aperture (assumes C_B = 0.6 for sharp edges)
- a = area of hole in geomembrane (3.1 mm^2 for 2 mm diameter hole)
- g = acceleration due to gravity, and
- h_w = liquid depth on geomembrane

7.2 RESULTS

In summary, the total seepage through the TMF geomembrane liner during operations is estimated to be less than 1 L/s (1.5 US gpm) for a hydraulic head of 15 m or less acting directly on the liner. This is an upper bound estimate assuming unrestricted flow through an orifice as per Giroud & Bonaparte (1989) (i.e. does not consider the effect of liner bedding layer, tailings deposition, etc. on the analysis).

We trust that the information contained within this letter meets your requirements at this time for seepage and stability analyses for the Bromley Humps Tailings Management Facility. Please do not hesitate to contact the undersigned if you have any queries or concerns relating to this letter.

Yours truly,
Knight Piésold Ltd.

<Original signed by> 3-Mar-2017

Prepared: Jim Fogarty, P.Eng.
Project Engineer

<Original signed by>

Reviewed: Les Galbraith, P.Eng.
Specialist Engineer | Associate

Approval that this document adheres to Knight Piésold Quality Systems: <Original signed by>

Attachments:
Appendix A Stability Analysis Results

Copy To: Trevor Herd (JDS), Max Brownhill (BCS), Kelly Sexsmith (SRK)

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APPENDIX A

STABILITY ANALYSIS RESULTS

(Pages A-1 to A-6)

Knight Piésold CONSULTING

TABLE A.1

IDM MINING LTD.
RED MOUNTAIN UNDERGROUND GOLD PROJECT

BROMLEY HUMPS TMF STABILITY ANALYSIS
MATERIAL STRENGTH PROPERTIES

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Material Type	Model	Unit Weight[1] γ kN/m³	Effective Friction[1] φ' degrees	Effective Cohesion[1] c' kPa	τ/σ Ratio
Overburden (Colluvium (Well graded sandy gravel with <10% fines))[2]	Mohr-Coulomb	20	33	0	-
Embankment Fill[3]	Shear/Normal Function (Lower Bound Leps)	19	-	-	-
Filter Zone (Well graded clean sand, compacted)	Mohr-Coulomb	18.5	37	0	-
HDPE Liner Bedding Layer (Clean Sand)	Mohr-Coulomb	17.5	37	0	-
Transition Zone (Sandy gravel, dense)	Mohr-Coulomb	20	38	0	-
Tailings (Fine grind (silt) whole ore leach slurry tailings)	S=f(overburden)	19	-	-	0.25

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NOTES:
1. UNIT WEIGHT AND EFFECTIVE FRICTION ANGLE ARE TYPICAL VALUES AS PROVIDED BY WWW.GEOTECHDATA.INFO.
2. STRATIGRAPHIC UNITS AS ENCOUNTERED DURING THE 2016 GEOTECHNICAL SITE INVESTIGATION PROGRAM (KP, 2016).
3. SHEAR STRENGTH OF ROCKFILL BASED ON LEPS (1970) AND YANAGUCHI (2012).

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Knight Piésold CONSULTING

TABLE A.2

IDM MINING LTD.
RED MOUNTAIN UNDERGROUND GOLD PROJECT

BROMLEY HUMPS TMF STABILITY ANALYSIS
SLOPE STABILITY ANALYSIS RESULTS FOR TMF CRITICAL SECTION

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Slope Stability Conditions	Slip Surface Direction	Required Minimum Factor of Safety	Stage of Construction			
			Starter	Stage 1	Stage 2	Stage 4
Pseudo-static (MDE = 0.092g)	Upstream	**1.0**	1.670	1.670	1.670	1.669
	Downstream	**1.0**	1.834	1.756	1.708	1.712
Post-Earthquake (OBE = 0.064g)	Upstream	**1.2**	1.734	1.732	1.733	1.733
	Downstream	**1.2**	1.894	1.833	1.763	1.762
End of Construction	Upstream	**1.5**	1.897	1.898	1.895	1.895
	Downstream	**1.5**	2.043	1.955	1.898	1.905
Long-term Steady State Conditions (Normal Operating Conditions)	Downstream Only	**1.5**	2.042	1.955	1.902	1.900
Long-term Steady State Conditions (Flood Event Conditions)	Downstream Only	**1.5**	2.045	1.954	1.906	1.902

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NOTES:

1. RAPID DRAWDOWN CONDITIONS NOT CONSIDERED FOR ANALYSIS DUE TO PRESENCE OF HDPE GEOMEMBRANE LINER SYSTEM.
2. ASSUMES THIN OVERBURDEN COVER IS EXCAVATED PRIOR TO CONSTRUCTION.
3. MINIMUM FACTORS OF SAFETY AS PER CANADIAN DAM ASSOCIATION (CDA) DAM SAFETY GUIDELINES (CDA, 2013) AND MINING CODE OF BC (MOE, 2016).
4. END OF CONSTRUCTION CONDITIONS ANALYSE FULL STAGE CONSTRUCTION WITH TAILINGS & POND LEVEL REPRESENTATIVE OF END OF PREVIOUS STAGE.
5. FLOOD CONDITIONS ASSUMES POND VOLUME IS TO BASE OF EMERGENCY SPILLWAY (I.E. 2 m BELOW CREST OF DAM).
6. HORIZONTAL SEISMIC COEFFICIENT USED IN SEISMIC ANALYSIS (1/2 BETWEEN 1/2,475 YEAR AND 1/10,000 YEAR SEISMIC EVENT) ASSUMED TO BE 0.5 x PEAK GROUND ACCELERATION = 0.046g
7. HORIZONTAL SEISMIC COEFFICIENT USED IN POST-EARTHQUAKE ANALYSIS (OBE = 1/2,475 YEAR SEISMIC EVENT) ASSUMED TO BE 0.5 x PEAK GROUND ACCELERATION = 0.032g

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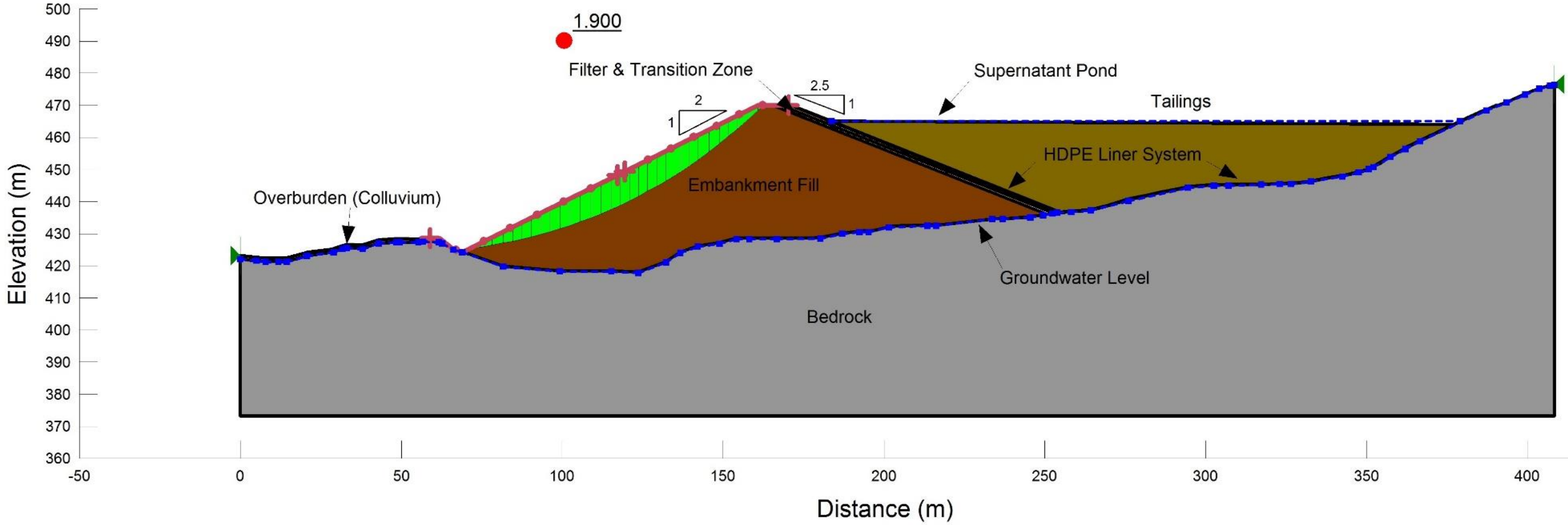

NOTES:

1. A RELATIONSHIP FOR FRICTION ANGLE AND EFFECTIVE STRENGTH WAS DEVELOPED FOR THE EMBANKMENT FILL MATERIAL, BASED ON PUBLISHED INFORMATION ON THE SHEAR STRENGTH PROPERTIES OF ROCKFILL (LEPS, 1970).
2. PHREATIC SURFACES WERE FULLY SPECIFIED.

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	03MAR'17	ISSUED WITH LETTER	JEF	KDE

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RED MOUNTAIN UNDERGROUND GOLD PROJECT

BROMLEY HUMPS TMF STABILITY ANALYSIS
STEADY STATE CONDITIONS
STAGE 4 - NORMAL OPERATING CONDITIONS

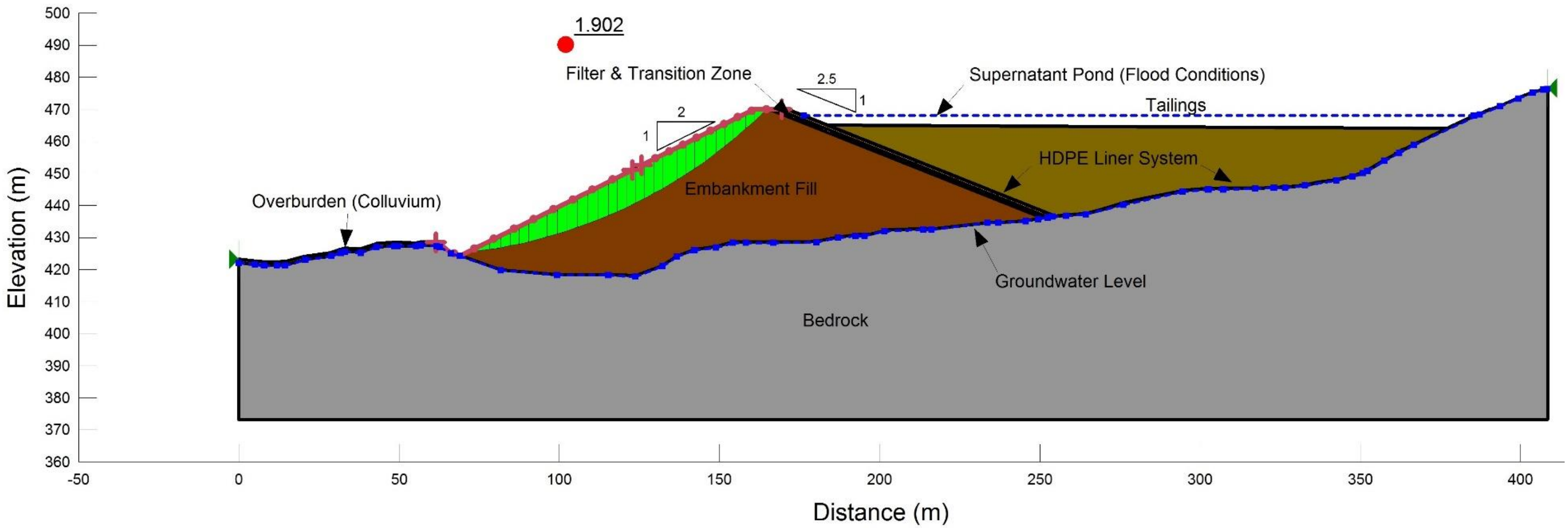
Knight Piésold CONSULTING

P/A NO. VA101-594/4

REF. NO. VA17-00261

FIGURE A.1

REV 0



NOTES:

1. A RELATIONSHIP FOR FRICTION ANGLE AND EFFECTIVE STRENGTH WAS DEVELOPED FOR THE EMBANKMENT FILL MATERIAL, BASED ON PUBLISHED INFORMATION ON THE SHEAR STRENGTH PROPERTIES OF ROCKFILL (LEPS, 1970).
2. PHREATIC SURFACES WERE FULLY SPECIFIED.

0	03MAR'17	ISSUED WITH LETTER	JEF	KDE
REV	DATE	DESCRIPTION	PREP'D	RVW'D

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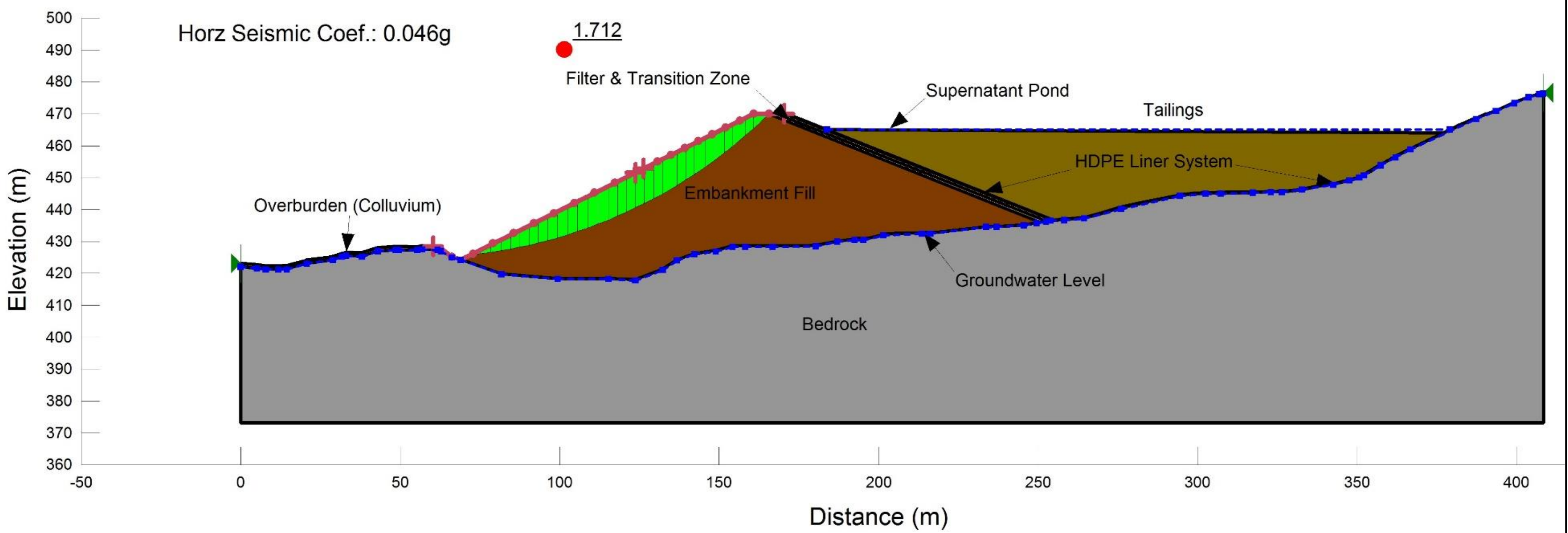
RED MOUNTAIN UNDERGROUND GOLD PROJECT

BROMLEY HUMPS TMF STABILITY ANALYSIS
STEADY STATE CONDITIONS
STAGE 4 - FLOOD EVENT CONDITIONS

Knight Piésold CONSULTING

P/A NO. VA101-594/4	REF. NO. VA17-00261	
FIGURE A.2		REV 0



NOTES:

1. A RELATIONSHIP FOR FRICTION ANGLE AND EFFECTIVE STRENGTH WAS DEVELOPED FOR THE EMBANKMENT FILL MATERIAL, BASED ON PUBLISHED INFORMATION ON THE SHEAR STRENGTH PROPERTIES OF ROCKFILL (LEPS, 1970).
2. PHREATIC SURFACES WERE FULLY SPECIFIED.
3. HORIZONTAL SEISMIC (MDE) LOAD EQUIVALENT TO 0.5 x PEAK GROUND ACCLERATION APPLIED (MELO & SHARMA, 2004).

0	03MAR'17	ISSUED WITH LETTER	JEF	KDE
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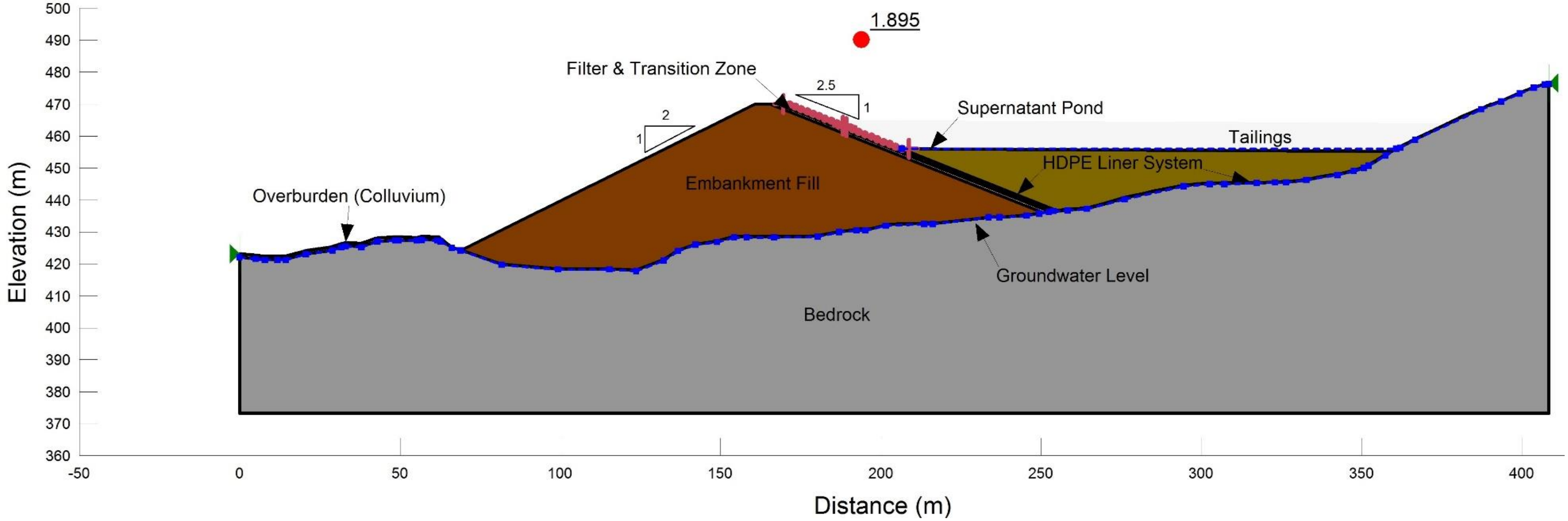
RED MOUNTAIN UNDERGROUND GOLD PROJECT

BROMLEY HUMPS TMF STABILITY ANALYSIS
PSEUDO-STATIC (MDE) ANALYSIS
STAGE 4 - DOWNSTREAM ANALYSIS

Knight Piésold CONSULTING

P/A NO.	REF. NO.	
VA101-594/4	VA17-00261	
FIGURE A.3		REV 0



NOTES:

1. A RELATIONSHIP FOR FRICTION ANGLE AND EFFECTIVE STRENGTH WAS DEVELOPED FOR THE EMBANKMENT FILL MATERIAL, BASED ON PUBLISHED INFORMATION ON THE SHEAR STRENGTH PROPERTIES OF ROCKFILL (LEPS, 1970).
2. PHREATIC SURFACES WERE FULLY SPECIFIED.

0	03MAR'17	ISSUED WITH LETTER	JEF	KDE
REV	DATE	DESCRIPTION	PREP'D	RVW'D

IDM MINING LTD.

RED MOUNTAIN UNDERGROUND GOLD PROJECT

BROMLEY HUMPS TMF STABILITY ANALYSIS
STEADY STATE CONDITIONS
STAGE 4 - END OF CONSTRUCTION - UPSTREAM

Knight Piésold CONSULTING

P/A NO. VA101-594/4	REF. NO. VA17-00261	
FIGURE A.4		REV 0