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VA101-126/24-9

MONTANA RESOURCES

YANKEE DOODLE TAILINGS IMPOUNDMENT - FAILURE MODES AND EFFECTS ASSESSMENT FOR 6,560 AMENDMENT DESIGN DOCUMENT

Rev	Description	Date
0	Issued in Final	February 21, 2025

EXECUTIVE SUMMARY

Montana Resources, LLC (MR) is in the process of preparing a permit amendment application (the 6,560 Amendment Application) for continued development of the Yankee Doodle Tailings Impoundment (YDTI) above the currently permitted maximum embankment crest elevation of 6,450 ft to facilitate continued operation of the mine after approximately 2034. The YDTI will continue to provide secure storage of mine tailings resulting from on-going mine operations.

This Failure Modes and Effects Assessment (FMEA) was completed to identify and characterize risks associated with the continued development of the YDTI to a crest elevation of 6,560 ft. The FMEA contemplates the intervening period between the configuration expected to be achieved prior to receiving the permit amendment (Prior to Permit) and the final proposed life of mine arrangement of the facility. The failure modes assessed during the FMEA were generally based on the potential failure modes (PFMs) previously identified, developed, and evaluated during the 2022 Risk Assessment. The PFMs included the potential for occurrence of earthquakes, severe flooding, fill and foundation material degradation, on-going construction and operations activities, and other geologic and environmental hazards. Recommended safety enhancements from the 2022 Risk Assessment are being implemented on site and will continue during ongoing mine operations.

Likelihood and consequence ratings for the FMEA were primarily determined using qualitative criteria. The likelihood ratings follow a verbal mapping scheme connecting the likelihood ratings with estimated annual probability of failure expressed in orders of magnitude. The framework is similar to other existing and draft U.S. guidelines. Several risks were evaluated for the Prior to Permit arrangement using the information developed during the 2022 Risk Assessment. Where appropriate, the sum of the likelihoods resulting from the relevant event tree analyses from the 2022 Risk Assessment were used to estimate the FMEA likelihood using the qualitative scale adopted for this FMEA. The subjective consequence criteria are similar to the criteria defined during the 2022 Risk Assessment. Qualitative descriptions were modified from the 2022 Risk Assessment criteria to include some additional environmental and operational considerations.

Risk ratings were assigned during a collaborative session involving KP staff, and the resulting failure modes relative to the East-West and North-South Embankment generally remained the same or improved between the Prior to Permit and Life of Mine arrangements. Select PFMs along the West Embankment increased in likelihood due to increasing embankment height above the West Ridge, potential impacts on the operability of the WED, and the potential for seepage flows to impact the groundwater system along the West Ridge. The construction of the extensive downstream RDS will provide improved resistance to limit potential for instability and corresponding reductions in likelihood for instability related PFMs around the YDTI. The relocation of the maintenance yard and truck maintenance workshop contemplated in the design, and identified in the 2022 Risk Assessment, is a key mitigation that will further reduce the potential consequences associated with all large-scale failure modes due to the relocation of the permanent workers out of the HsB area and buttressing of the embankment. The construction of the closure spillway will further reduce the likelihood of several flood-induced PFMs for the long-term following closure.

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ABBREVIATIONS

APF ..... annualized probability of failure
EL ..... elevation
EOR ..... Engineer of Record
FERC ..... Federal Energy Regulatory Commission
FMEA ..... Failure Modes and Effects Assessment
ft ..... feet
FS ..... factor of safety
GISTM ..... Global Industry Standard on Tailings Management
HsB ..... Horseshoe Bend
IFC ..... Issued for Construction
KP ..... Knight Piésold Ltd
LE ..... limit equilibrium
MCA ..... Montana Code Annotated
MDEQ ..... Montana Department of Environmental Quality
MR ..... Montana Resources, LLC
PFM ..... potential failure modes
QPP ..... quantitative performance parameters
RDS ..... Rock Disposal Site
TOMS ..... Tailings Operations, Maintenance, and Surveillance Manual
YDTI ..... Yankee Doodle Tailings Impoundment
WED ..... West Embankment Drain

1.0 INTRODUCTION

1.1 LOCATION

Montana Resources, LLC (MR) operates the Montana Resources open pit copper and molybdenum mine located in Butte, Montana. The ore throughput at the mill and processing facilities is approximately 49,000 short tons per day. The tailings from ore processing are conveyed to the Yankee Doodle Tailings Impoundment for disposal and permanent storage. The mine is located in Butte, Silver Bow County and is bounded by Interstate 15 and the Continental Divide on the east, Moulton Reservoir Road on the west, and Carrell Street, Continental Drive and Shields Avenue to the south.

The current general arrangement of the mine is shown on Figure 1.1 and includes the following key components:

- Yankee Doodle Tailings Impoundment (YDTI)
- Berkeley Pit
- Continental Pit
- Mill and processing facilities (the Concentrator)
- Horseshoe Bend (HsB) area and associated facilities

1.2 PROJECT BACKGROUND

The YDTI was originally constructed beginning in 1962 and the embankments have been continuously constructed using rockfill from the Berkeley Pit (until 1982) and from the Continental Pit (beginning in 1986). The YDTI comprises a valley-fill style impoundment created by a continuous rockfill embankment that for descriptive purposes is divided into three embankment sections: the North-South Embankment, the East-West Embankment, and the West Embankment. The embankments are raised using a combination of downstream and centreline construction methods. The current maximum embankment height is approximately 800 feet (ft) along the southern end of the impoundment upstream of the HsB area. The HsB area is shaped like an inverted ‘U’, bounded to both the east and west by historically leached mine rock and to the north by the East-West Embankment and contains infrastructure related to water management and various mine buildings, including the truck maintenance workshop.

The Amendment 10 permit was approved in August 2019 to allow for continued use of the YDTI to a crest elevation (EL.) of 6,450 ft and operation of the West Embankment Drain (WED). The EL. 6,450 ft embankment lift has been substantially completed and provides sufficient tailings storage capacity to support mining and ore processing until approximately December 2034.

MR is preparing a permit amendment application (the 6,560 Amendment Application) to facilitate continued mining operations thereafter by aligning approval for tailings storage at the YDTI with the estimated remaining ore reserves. Knight Piésold Ltd. (KP) is developing the 6,560 Amendment Design Document (the Design Document) to support the 6,560 Amendment Application. The Design Document presents the plan to progressively raise the crest elevation of the YDTI embankments to a maximum design crest of EL. 6,560 ft in two or more lifts to support continued mining and ore processing and includes the development of Rock Disposal Sites (RDS) located immediately downstream of the YDTI.

NOTES:

1. AERIAL IMAGE PROVIDED BY MONTANA RESOURCES, LLC IN JULY 2023.

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	07FEB'25	ISSUED WITH REPORT	JRG	RMM	DDF

MONTANA RESOURCES, LLC

MONTANA RESOURCES

YANKEE DOODLE TAILINGS IMPOUNDMENT CURRENT GENERAL ARRANGEMENT

Knight Piésold CONSULTING

P/A NO. VA101-126/24

REF NO. 9

FIGURE 1.1

REV 0

1.3 PURPOSE AND SCOPE

The Design Document comprises a series of technical reports covering the subject areas and content to meet the requirements specified in Montana State law as well as evaluating opportunities for continued risk reduction to enhance safety as part of the fundamental objective for on-going continuous improvement of the safety of the YDTI. The jurisdiction for the YDTI resides with the Montana Department of Environmental Quality (MDEQ). The laws governing tailings storage facility design, operation and reclamation are contained within sections of Montana Code Annotated (MCA) Title 82 Chapter 4 Part 3 (MCA, 2023).

- Title 82: Minerals, Oil, and Gas
  - Chapter 4: Reclamation
    - Part 3: Metal Mine Reclamation

This Failure Modes and Effects Assessment (FMEA) has been prepared by KP to meet the compliance obligations for risk assessment as stipulated in MCA Title 82, Chapter 4 Part 3 Section 376 (2), (n) and (x), which are outlined below. This report was prepared considering the continued construction and operation of the YDTI up to an embankment crest of EL. 6,560 ft.

> *(n) a dam breach analysis, a failure modes and effects analysis or other appropriate detailed risk assessment, and an observational method plan addressing residual risk;*
>
> *(x) a description of proposed risk management measures for each facility life-cycle stage, including construction, operation, and closure;*

The principal objectives of the FMEA are to:

- Review previously identified risks and identify new or changing risks associated with the YDTI for continued operating conditions and long-term following closure
- Evaluate risk in terms of likelihood and resulting consequences using a qualitative based approach
- Identify the main failure modes of concern and mitigation methods incorporated into the design to further reduce risk

1.4 SUPPORTING MATERIALS AND GUIDING DOCUMENTS

1.4.1 GENERAL

The following sections provide a summary of key reference information related to the design and safety assessments for the Design Document relevant for conducting the FMEA. Additional details related to the facility development history, previous risk analysis studies, summary of recent relevant trends, and other reference information are included in Appendix A.

1.4.2 LIFE OF MINE DESIGN REPORT

The continued development of the YDTI and supporting RDS is outlined in the Life of Mine Design Report (KP, 2024a). A summary of the embankment design and development sequence is provided below for context related to the risk assessment presented in this report. Refer to the design report for additional design details. The life of mine design for the YDTI is presented as a phased sequence to illustrate major development milestones. The phased designs of the embankment and RDS were developed considering the layout and construction criteria presented in the design report (KP, 2024a). These criteria were based

on historical construction practices and layout methodology with the objective to continuously enhance safety of the facility through slope flattening and progressive buttressing of the facility embankments where and when such enhancements were practicable.

The phases are summarized below with phases identified by bold text representing the bookends of this risk assessment. The FMEA contemplates the intervening period between Phases 1 and 6 as shown on Figures 1.2 and 1.3, respectively.

- **Phase 1: Ongoing construction activities to be completed prior to the permit amendment (Prior to Permit)**
- Phase 2: EL. 6,500 ft Embankment Crest Raise
- Phase 3: EL. 6,500 ft Lower Embankment Lifts
- Phase 4: EL. 6,500 ft Embankment Lifts and RDS Expansions
- Phase 5: EL. 6,560 ft Embankment Crest Raise
- **Phase 6: Final Life of Mine (Prior to Closure)**

Construction of the embankments and RDS will be completed as a continuous activity as rockfill is available from mine operations. The delivery of embankment construction materials will be scheduled to coincide with availability of rockfill from the mine to meet the phased lift construction requirements. The timing required for the completion of each phase will depend on rockfill availability, tailings production rates, variability of the tailings density throughout the facility, final beach slopes, and the supernatant pond area and volume. The filling of the YDTI will be monitored throughout operations, and construction timing will be adjusted as required.

Issued for Construction (IFC) designs for the various development stages will be progressively completed during ongoing mine development. The YDTI development sequence presented in the Design Document will be updated as required for the IFC designs. Activities attributed to the phases described above and may be adjusted in the future as part of the ongoing facility development process. Final design geometries will take into consideration additions to the knowledge base resulting from ongoing site investigations, material testing, analysis, construction and operational monitoring processes. The methods of analysis and design criteria for the IFC design stages will evolve, if required, to remain consistent with applicable, appropriate, and current techniques practicable for the conditions at the mine.

The design for the YDTI embankment raises consists of placing additional rockfill atop the existing crest and along the downstream side of the embankment. Rockfill used for embankment and RDS construction will continue to be heterogeneous with variable geotechnical and hydraulic conductivity properties. The embankment designs incorporate a combination of raising by centerline and downstream methods. General layout and construction criteria that apply to all embankment limbs are summarized below and additional details related to the various phases are presented in the design report (KP, 2024a).

- Embankment rockfill upstream slopes are specified at angle of repose or flatter in select areas to facilitate placement of facing materials along the upstream face of each lift. The facing material will be placed as required with a slope of 2H:1V or flatter to maintain a separation zone between the tailings and embankment rockfill.
- Overall embankment downstream slopes are specified and will be achieved (except along the West Embankment) by incorporating benches between successive 50 to 100 ft high angle of repose slopes (consistent with historical practices). The width and frequency of the benches control the overall slope

angle prior to reclamation. Target overall downstream slopes are generally 3H:1V or flatter with steeper slopes of up to approximately 2H:1V locally, where necessitated by embankment and ramp geometry.
- The overall embankment crest width may vary for each limb and crest elevation; however, a minimum width of 220 ft is generally specified.

Three areas (two existing and one new) located immediately downstream of the YDTI embankments are proposed for use as RDS for surplus rockfill from mine operations. The RDS will continue to enhance the stability of the YDTI by providing a buttressing effect in select areas and may provide opportunities for progressive reclamation at the mine site once the final footprints are established. A description and key layout criteria for the three RDS are as follows and additional details related to the RDS are presented in the design report (KP, 2024a):

HsB (East-West) RDS:

- Located within the HsB area and will be completed over the life of the mine to EL. 6,200 ft. Stage 1 of the RDS (to EL. 5,900 ft) is underway and anticipated to be constructed prior to the crest raise to EL. 6,500 ft.
- Progressive construction throughout the remaining mine life will further enhance stability of the East-West Embankment in the central pedestal area and may be required concurrently with construction of the relocated tailings pipeline ramp to maintain target factors of safety for embankment stability (KP, 2024b).
- Expansion of the HsB RDS above EL. 5,900 ft requires the relocation of the existing high voltage transmission line along the EL. 5,900 ft bench.
- Future expansion of the HsB RDS south of the Stage 1 RDS requires the relocation of the truck shop and maintenance yard.

North RDS:

- Located downstream of the North-South Embankment and initially permitted under Amendment 10.
- Construction of the EL. 6,200 ft lift is anticipated to be constructed prior to the crest raise to EL. 6,500 ft.
- Progressive construction throughout the remaining mine life will further enhance stability of the North-South Embankment with a maximum elevation of EL. 6,560 ft.

West RDS:

- Located along the northwest trending limb of the East-West Embankment in the area formerly known as the Northwest Dumps.
- Progressive construction throughout the remaining mine life will further enhance stability of the East-West Embankment limb with a maximum elevation of EL. 6,500 ft.

1.4.3 STABILITY ASSESSMENT REPORT

KP has completed an evaluation of the stability of the embankment configurations for different loading conditions that include normal operating, earthquake, and post-earthquake in the Stability Assessment Report (KP, 2024b). The report summarizes the results of analyses completed to evaluate the static limit equilibrium, liquefaction potential, and dynamic earthquake response and displacements. Evaluations of the extensive historical database and monitoring data were completed to inform the stability assessment approach and to develop input parameters for the analyses.

Static slope stability of the embankment design was assessed along five sections through the dam using the limit equilibrium (LE) method in two- and three-dimensions (2D and 3D, respectively) for normal operating and post-earthquake conditions. The target factors of safety (FS) were achieved for both loading conditions and at all analysis sections. The 3D analyses, which accounted for the lateral constraint of the HsB area, corroborated the 2D findings. The analyses also demonstrate the effectiveness of infilling the HsB area for continuous improvement of the dam stability and the consequential risk reduction for a variety of slip surface scales and associated potential failure modes. Dam stability is sensitive to the strength of the saturated overburden foundation, which controls the depth, dimension, and shape of the base of the critical slip surface. The LE analyses also identified the potential for surficial sloughing of the relocated pipeline ramp system and bench scale angle of repose slopes.

The dynamic analysis was completed on an interim construction stage and considered embankment response to five earthquake time histories. The results indicate earthquake-induced deformations are not expected to result in a loss of containment or uncontrolled release of impounded tailings or water. Excess pore pressure is generated in the unconfined overburden at the toe of the dam as a result of the seismic loading, suggesting possible liquefaction in response to earthquake loading and leading to an accumulation of shear strain. As a result, the dam is predicted to displace horizontally into the HsB area. Post-earthquake deformations are exacerbated in the absence of additional buttressing fill in the HsB area and in response to the strength loss of a continuous overburden foundation. These deformation results corroborate the key recommendation from the LE stability analyses of refining the configuration and fill sequencing during IFC design for mitigating deformations and thereby, increasing the FS of the dam.

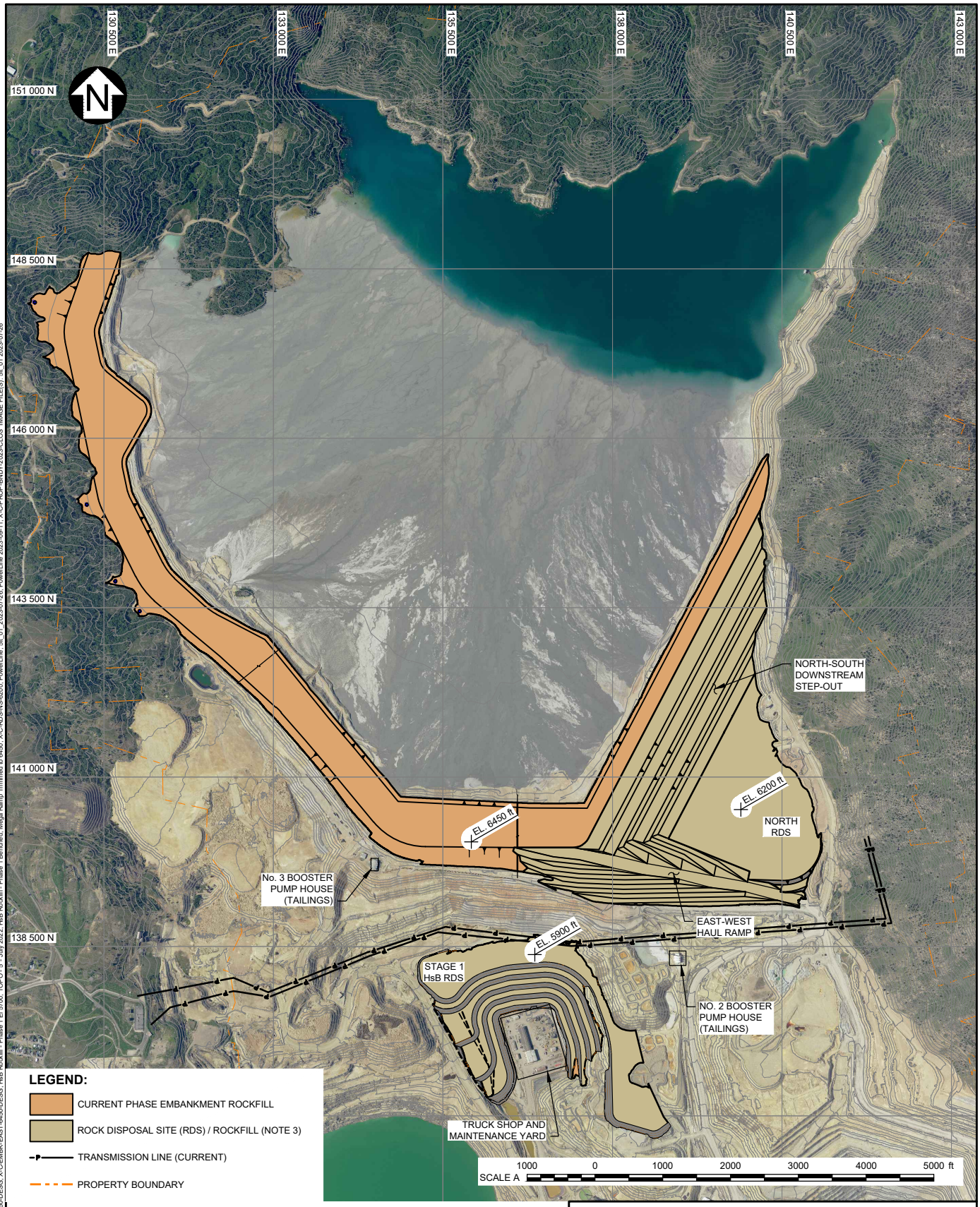
1.4.4 DAM BREACH INUNDATION STUDY

KP prepared a dam breach inundation study (KP, 2024c) to estimate the potential consequences of a hypothetical dam failure at the ultimate proposed life of mine configuration (prior to closure) of the YDTI to support the Design Document. The dam breach inundation study was not a risk assessment and explicitly did not include an assessment of the likelihood of a dam breach occurrence. The breach analysis was conducted for a hypothetical erosional flood-induced scenario. The inundation results downstream of the dam were presented on inundation maps in terms of maximum inundation extents, maximum inundation depths, peak discharges, as well as flood wave and peak discharge arrival times.

The results of the dam breach inundation study demonstrated that a hypothetical breach outflow could impact structures around the HsB area, including the HsB WTP, as well as pipelines, access roads, and open pits within the mine property boundary. The flood wave was predicted to be fully contained within the Berkeley and Continental Pits without reaching the city of Butte. The modeled inundation extent was largely controlled by the presence of the Berkeley Pit and the expanded limits of the Continental Pit, which allows the pits to intercept the potential outflow from the hypothetical breach. The expanded footprint of the Continental Pit is made possible by continued mining at the site.

1.4.5 TAILINGS AND WATER MANAGEMENT REPORT

KP prepared a report to outline key design criteria and infrastructure required for tailings and water management throughout the proposed life of mine contemplated in the Design Document (KP, 2025a). This report includes a summary of water management infrastructure, extreme storm management during operations and closure, critical controls for environmental containment, and preliminary Quantitative Performance Parameters (QPPs) related to tailings and water management.



LEGEND:

- CURRENT PHASE EMBANKMENT ROCKFILL
- ROCK DISPOSAL SITE (RDS) / ROCKFILL (NOTE 3)
- TRANSMISSION LINE (CURRENT)
- PROPERTY BOUNDARY

NOTES:

1. COORDINATE SYSTEM AND ELEVATIONS BASED ON ANACONDA MINE GRID.
2. AERIAL IMAGE PROVIDED BY MONTANA RESOURCES, LLC IN JULY 2023.
3. STAGE 1 HsB RDS, EAST-WEST HAUL RAMP, NORTH-SOUTH DOWNSTREAM STEP-OUT AND EL. 6,200 ft NORTH RDS CONSTRUCTION IS ONGOING AND IS EXPECTED TO BE COMPLETE PRIOR TO THE 6560 PERMIT AMENDMENT.
4. EL. 6450 FT EMBANKMENT LIFT SUBSTANTIALLY COMPLETED APRIL 2023.

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	07FEB'25	ISSUED WITH REPORT	JRG	RMM	DDF

MONTANA RESOURCES, LLC

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YANKEE DOODLE TAILINGS IMPOUNDMENT
GENERAL ARRANGEMENT
PHASE 1 - PRIOR TO PERMIT

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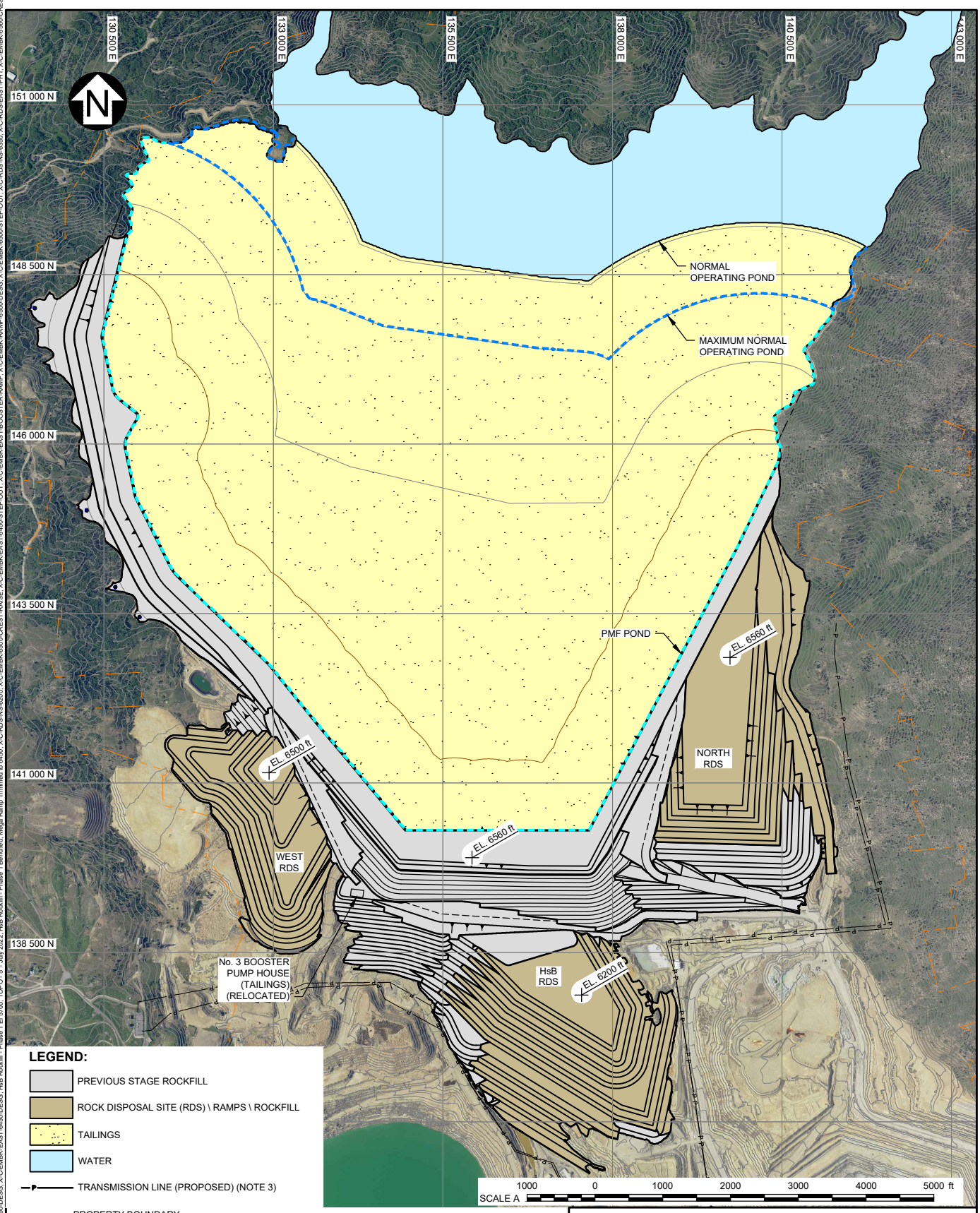
VA101-126/24	9

FIGURE 1.2 REV 0



LEGEND:

- PREVIOUS STAGE ROCKFILL
- ROCK DISPOSAL SITE (RDS) \ RAMPS \ ROCKFILL
- TAILINGS
- WATER
- TRANSMISSION LINE (PROPOSED) (NOTE 3)
- PROPERTY BOUNDARY

NOTES:

1. COORDINATE SYSTEM AND ELEVATIONS BASED ON ANACONDA MINE GRID.
2. AERIAL IMAGE PROVIDED BY MONTANA RESOURCES, LLC IN JULY 2023.
3. HIGH VOLTAGE TRANSMISSION LINE IS APPROXIMATE AS PROVIDED BY MR IN SEPTEMBER 2023. LAYOUT BY NORTHWEST ENERGY.

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	07FEB'25	ISSUED WITH REPORT	JRG	RMM	DDF

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YANKEE DOODLE TAILINGS IMPOUNDMENT
GENERAL ARRANGEMENT
PHASE 6 - LIFE OF MINE DESIGN

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P/A NO. VA101-126/24

REF NO. 9

FIGURE 1.3

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1.4.6 TOMS MANUAL

MCA 82-4-379 (3) is the legislation describing the requirement for and necessary content of the Tailings Operations, Maintenance, and Surveillance (TOMS) Manual for an operator of a tailings storage facility. The requirements include:

> *(i) "an emergency preparedness and response plan based on a failure modes and effects analysis or other appropriate risk assessment;"*
>
> *(j) "an identification of specific trigger levels or events when the department and the engineer of record are immediately notified. When possible, trigger levels must be sufficiently conservative to allow time for corrective actions to be implemented;"*

MCA 82-4-376 also outlines:

> *(t) "a list of quantitative performance parameters (QPPs) for construction, operation, and closure of the tailings storage facility. The QPPs may be expressed as minimums or maximums for the embankment crest width, embankment slopes, beach width, operating pool volume, phreatic surface elevation in the embankment and foundation, pore pressures, or other parameters appropriate for the facility and location;"*

The TOMS Manual (MR/KP, 2023) is reviewed annually by MR and KP to confirm that it reflects the current site conditions. Out-of-date information is identified and updated to incorporate new details, components, or changes in operational practices. The TOMS Manual will be updated in the future as required to incorporate any planned operational changes, adjustments to monitoring and surveillance protocols, and/or changes to emergency preparedness and response plans.

1.4.7 INDUSTRY GUIDELINES

There are many available national and international guidance documents, in addition to the MCA requirements, related to risk assessment and dam safety management, including some updated and newly emerging international best practice guidelines for tailings management which were reviewed when developing the framework for the FMEA. The goal was to incorporate international best practices to the extent practicable while taking into consideration site-specific conditions and concerns. Various industry and international guidelines were reviewed to guide the FMEA process, this includes:

- The Global Industry Standard on Tailings Management (GISTM) (GTR, 2020)
- Best Practices in Dam and Levee Safety Risk Analysis by the U.S. Department of the Interior Bureau of Reclamation (USBR, 2019)
- Engineering Guidelines for Evaluation of Hydropower Projects: Chapter 18 – Level 2 Risk Analysis (FERC, 2021)

2.0 FMEA PROCESS

2.1 ARRANGEMENTS EVALUATED

This FMEA was completed to identify and characterize risks associated with the continued development of the YDTI to a crest elevation of 6,560 ft. The FMEA contemplates the intervening period between the configuration expected to be achieved prior to receiving the permit amendment and the final proposed life of mine configuration of the facility:

Initial Arrangement – Prior to Permit

The prior to permit configuration, shown on Figure 1.2, outlines the expected areas of construction that will be progressively developed below EL. 6,450 ft over the next several years prior to the requirement for storage expansion. This arrangement provides the base for future construction activities following the permit amendment and construction in these areas is ongoing at the time of this report. MR will continue to develop the following areas as rockfill is available from mining:

- Construction of the Stage 1 HsB drainage system and the Stage 1 HsB RDS to approximately EL. 5,900 ft.
- Construction of the new East-West Haul ramp to EL. 6,450 ft.
- Construction of downstream lifts of the North-South Embankment to achieve a downstream slope of approximately 3H:1V for the EL. 6,500 ft embankment crest raise.
- Construction of the North RDS along the downstream toe of the existing North-South Embankment to approximately EL. 6,200 ft.

Life of Mine Arrangement:

The Life of Mine arrangement, shown on Figure 1.3, is assumed to present end of operations, prior to closure. This arrangement includes the full build out of the YDTI to EL. 6,560 ft, and HsB, North and West RDS construction to EL. 6,200 ft, EL.6,560 ft and EL. 6,500 ft, respectively.

This arrangement and FMEA evaluation do not consider the implementation any closure activities (spillway construction, final slope regrading, reduction to passive closure pond, etc.) which will occur following end of operations; however, the qualitative impacts of additional closure activities on the FMEA risk ratings are discussed in the results section.

2.2 FAILURE MODES

The failure modes assessed during the FMEA were generally based on the potential failure modes (PFMs) previously identified, developed, and evaluated during the 2022 Risk Assessment (KP, 2023). PFMs included the potential for occurrence of earthquakes, severe flooding, fill and foundation material degradation, on-going construction and operations activities, and other geologic and environmental hazards. A summary of the failure modes assessed in the FMEA is provided in Table 2.1, and a detailed description of the initiating/loading event, risk description, and primary means of risk control are presented for each failure mode in Appendix B.

Table 2.1 Summary of Failure Modes for FMEA Risk Ratings

Initiating / Loading Event		Simplified Failure Mode	Risk Indicator	FMEA Evaluation Location (Embankment)[1]
Category	**Sub-category**			
Flood	PMF	Global Instability (Foundation or Slope)	1-EW	East-West
			1-NS	North-South
			1-W	West
		Overtopping	2-All	All
		Internal Erosion / Piping	3-EW	East-West
			3-NS	North-South
			3-W	West
		Uncontrolled Seepage	4-W	West
Earthquake	84th-Percentile MCE	Global Instability (Foundation or Slope)	5-EW	East-West
			5-NS	North-South
			5-W	West
		Overtopping	6-EW	East-West
			6-NS	North-South
			6-W	West
		Undesirable Embankment Deformation	7-EW/NS	East-West/North-South
Construction	Ongoing Construction Activities	Global Instability (Foundation or Slope)	8-EWCPA	East-West (Central Pedestal Area)
			8-EW	East-West (Northwest Trending Limb)
			8-NS	North-South
			8-W	West
		Undesirable Embankment Deformation	9-EW	East-West
			9-NS	North-South
			9-W	West
			9-WED	West (WED)
Material Degradation	Induced strain softening, Acidic Drainage, Weathering	Global Instability (Foundation or Slope)	10-EW	East-West
		Undesirable Embankment Deformation	11-W	West
			11-A	All
			12-A	All
Operational Upset Malfunction	Tailings pipeline burst	Instability (Foundation or Slope)	13-EW	East-West
			13-All	All
Geological Hazards	Landslide	Overtopping	14-All	All
		Impacts on mine operations	15-All	All
	Wind	Air Quality	16-All	All
	Fire	Impacts on mine operations	17-All	All
	Drought	Impacts on mine operations	18-All	All

Note(s):

1. "All" indicates that each embankment limb was not evaluated individually.

2.3 DEFINITIONS

2.3.1 RISK

The FMEA defines risk as the product of the likelihood of an event occurring and the consequences of the event:

Risk = Likelihood x Consequence

Risk combines the probability and severity of an adverse event. To identify risk, three questions must be addressed:

1. What can happen?
2. How likely is it that it will happen?
3. If it does happen, what are the consequences?

In general terms, risk is higher when the likelihood and consequence of failure is higher, and risk is lower when the likelihood and consequence is lower; however, risk prediction is complex and uncertain, and dam failures often result from a complex series of adverse conditions, flaws, or errors in combination rather than a simple design or construction flaw (Hartford and Baecher, 2004).

2.3.2 LIKELIHOOD

Likelihood was evaluated qualitatively using a scale from 1 to 7, with 1 representing the highest relative likelihood and 7 representing the lowest. The likelihood rating criteria adopted for the FMEA were generally based on recreating the orders of magnitude displayed in risk portrayal charts from the 2022 Risk Assessment (KP, 2023) within a qualitative framework suitable for conducting the FMEA. The likelihood ratings follow a verbal mapping scheme connecting the likelihood ratings with estimated annual probability of failure (APF) expressed in orders of magnitude. The framework is similar to other existing U.S. guidelines (e.g. FERC, 2021) and consistent with pre-decisional draft U.S. guidelines currently being developed related to tailings dam safety.

The likelihood rating categories for the FMEA are summarized in Table 2.2.

Table 2.2 Subjective Likelihood Rating Criteria

Likelihood Ratings	Likelihood Category (Risk Assessment)	Annual Probability of Failure (APF)	Description
1	Very high	1/10 to 1/100	Direct evidence or substantial indirect evidence to suggest that failure has initiated or is very likely to occur during the life of the structure.
2	High	1/100 to 1/1,000	There is direct evidence or substantial indirect evidence to suggest it has initiated or is likely to occur in near future.
3	Moderate	1/1,000 to 1/10,000	The fundamental condition or defect is known to exist; indirect evidence suggests it is plausible; and key evidence is weighted more heavily toward "more likely" than "less likely."
4	Low	1/10,000 to 1/100,000	The fundamental condition or defect is known to exist; indirect evidence suggests it is plausible; and key evidence is weighted more heavily toward "less likely" than "more likely."
5	Very Low	1/100,000 to 1/1,000,000	The possibility cannot be ruled out; the fundamental condition or defect is postulated. Evidence indicates it is very unlikely.
6	Remote	1/1,000,000 to 1/10,000,000	The possibility cannot be ruled out; but there is no compelling evidence to suggest it has occurred or that a condition or flaw exists that could lead to initiation.
7	Negligible	More remote (less) than 1/10,000,000	Several events must occur concurrently or in series to cause failure, and most, if not all, have negligible likelihood such that the failure likelihood is negligible.

Note(s):

1. Table above was developed to create a quantitative version of risk portrayal framework from the 2022 Risk Assessment (KP, 2023). The verbal mapping scheme is generally similar to other existing U.S. guidelines (e.g. FERC, 2021).

2.3.3 CONSEQUENCE OF FAILURE

The subjective consequence criteria are shown in Table 2.3 and are similar to the criteria defined during the 2022 Risk Assessment (KP, 2023). Qualitative descriptions were modified from the 2022 Risk Assessment criteria to include environmental considerations if failure were to occur. The consequence descriptions include consideration for impact to mine operations and associated life safety risks. Consequences range from Minor/Low to Catastrophic/Extreme using a scale from 1 to 4, with 1 representing the lowest consequence and 4 representing the highest.

Table 2.3 Subjective Consequence Criteria

Consequence Score	Category	Impact on Mine Operations	Life Safety Risks
1	Minor/Low	No facilities impacted; resulting failure investigations may impact operations or have no impact on daily operations.	Minimal to no on-site worker safety risk
2	Moderate	Potential impact on the operability of WED, pipelines, mine haul ramps, and pump houses. Environmental consequences, including seepage beyond West Ridge, dusting events.	Potential impacts to transient on-site workers
3	Major	Potential physical impacts on truck maintenance workshop, water treatment facilities, and pump houses.	Potential impacts to permanent on-site workers
4	Catastrophic/Extreme	Potential to render key site facilities inoperable and cause off-site damages.	On-site worker and off-site public safety risks

The Low and Minor consequence categories are generally consistent with a Level 1 unusual occurrence, as currently defined in the TOMS Manual (MR/KP, 2023). These two levels of consequence do not lead to uncontrolled release of impounded materials and are acceptable if the level of deformation is expected for the loading condition under consideration. A minor consequence is considered to be a deformation that is aesthetic, easily repairable, and has no direct impact on mine operations. An example of a consequence with a minor severity is a ravelling or erosion of a local bench slope, localized failure of an angle of repose bench, or localized cracking on the embankment crest or slopes. This sort of deformation would typically require increased daily surveillance to monitor displacement until the problem is understood and minor repairs are completed.

A Moderate consequence is defined as a relatively large deformation impacting mine operations or erosion impacting the crest width, or crest cracking that is progressively increasing provided there is no uncontrolled release of impounded materials. The moderate consequence category is consistent with a Level 2 unusual occurrence in the TOMS Manual. These are conditions that represent a potential emergency, if sustained or allowed to progress, but an emergency situation is not imminent. A field investigation to identify the cause of the deformation would typically be required, and corrective repairs would be performed to return the facility to operating condition. A Moderate consequence also includes a relatively minor environmental impact as a result of the loading event. This could include increased potential seepage along the West Ridge or dusting events.

Major and Catastrophic/Extreme consequence categories are consistent with Level 3 emergency conditions in the TOMS Manual, defined as an actual or imminent failure of containment. A consequence severity threshold adopted for this analysis defines the mine site boundary as one spatial limitation to the consequence definitions. A Major consequence is defined as a failure impacting only the mine site and without uncontrolled release of the supernatant pond or flowable tailings. An example of a major consequence would be a large embankment slip surface with the potential to impact permanent on-site workers, and the various tailings and water management pump houses positioned on or adjacent to the embankment.

The Catastrophic/Extreme consequence categories are reserved for failures that could result in a dam breach causing fluidized outflows (tailings or water driven) that have the potential to render key on-site facilities inoperable and cause off-site damages. Permanent on-site workers would be at considerable risk in such failure scenarios and off-site public safety risks would be possible depending on assumptions related to a variety of factors, such as the assumed location of the failure and assumed rate of breach development. Where uncertainty is large, a conservative assumption that failure consequences are potentially catastrophic can be made to simplify the risk analysis for dam safety decision making purposes.

2.4 RISK PORTRAYAL

This risk analysis results are portrayed in a simplified color matrix to easily present the results of the overall risk classification. An example of the risk matrix is presented on Figure 2.1. It is important to note that each risk that falls within the same square has the same likelihood and consequence score (i.e. all points within the Low-Moderate square have the same FMEA risk rating). The results presented in Section 3 have been plotted to clearly show the number of risks in each likelihood-consequence classification.

Likelihood		Subjective Consequence Category			
		1	2	3	4
		Minor	Moderate	Major	Extreme
1	Very high				
2	High				
3	Moderate				
4	Low				
5	Very Low				
6	Remote				
7	Negligible				

Figure 2.1 Risk Portrayal Template

3.0 RISK RATINGS

3.1 GENERAL

A risk evaluation table was prepared by KP, and risk ratings were assigned during a collaborative session involving KP staff Daniel Fontaine, P.E. (Engineer of Record (EOR) of the YDTI), Ken Brouwer, P.E. (former EOR) and Jason Gillespie, P.Eng. Risk ratings were completed for each of the potential failure modes described in Section 2.2, and results of the risk ratings are presented in Appendix B.

3.2 PRIOR TO PERMIT ARRANGEMENT

Several risks were evaluated for the Prior to Permit arrangement using the information developed during the 2022 Risk Assessment. Where appropriate, the sum of the likelihoods resulting from the relevant event trees analyses completed during the 2022 Risk Assessment were used to estimate the FMEA likelihood rating in Table 2.2.

For example, Figure 3.1 shows the 2022 Risk Assessment event tree analysis results by major hazards. The cumulative APF estimated for global instability of the East-West Embankment due to severe flooding was estimated to be 2.6E-07 for Extreme consequences and 2.5E-06 for Major consequences for the EL. 6,450 ft arrangement. The sum of these two categories results in an estimated cumulative APF of 2.8E-06. This equated to a likelihood rating of 5 for this PFM using the Table 2.2 mapping scheme. The potential consequences of failure were then rated using Table 2.3, which in this example was conservatively rated as a 4 (Extreme). The overall FMEA rating for this PFM is shown as point '1-EW' on Figure 3.2.

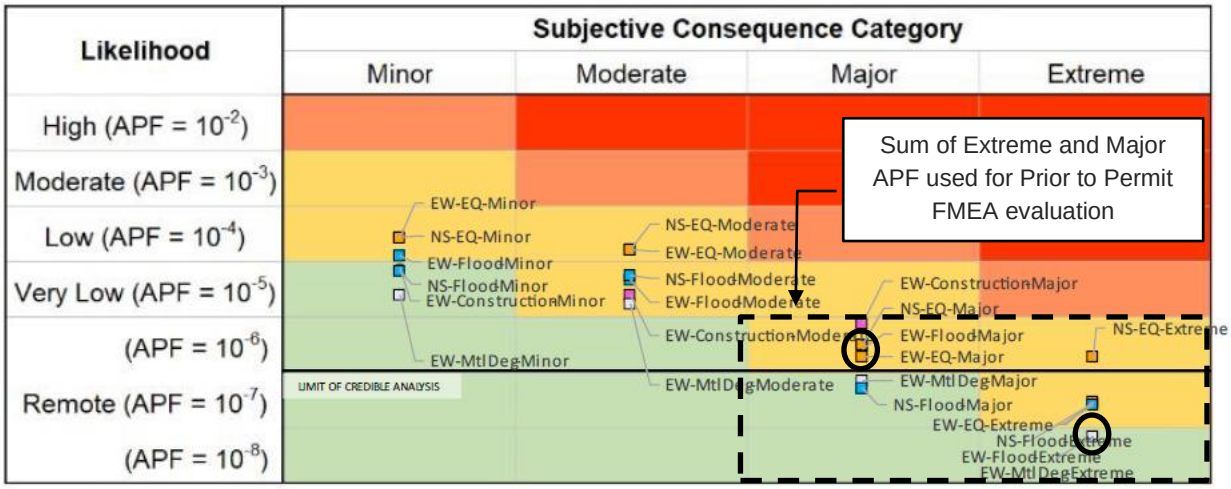

Figure 3.1 2022 Risk Assessment Report: Results – Risk Summary by Major Hazards (adapted from Figure 3.4 of KP, 2023)

PFMs that were not previously evaluated with event trees in the 2022 Risk Assessment were assigned FMEA ratings for the Prior to Permit condition using engineering judgement while following Table 2.2 and Table 2.3 to assign the likelihood and consequence ratings. PFMs that were not assessed quantitively in 2022 typically comprised operational upsets, geological hazards, and failure modes related to the West Embankment.

The results of the risk ratings for the Prior to Permit condition are presented on Figure 3.2.

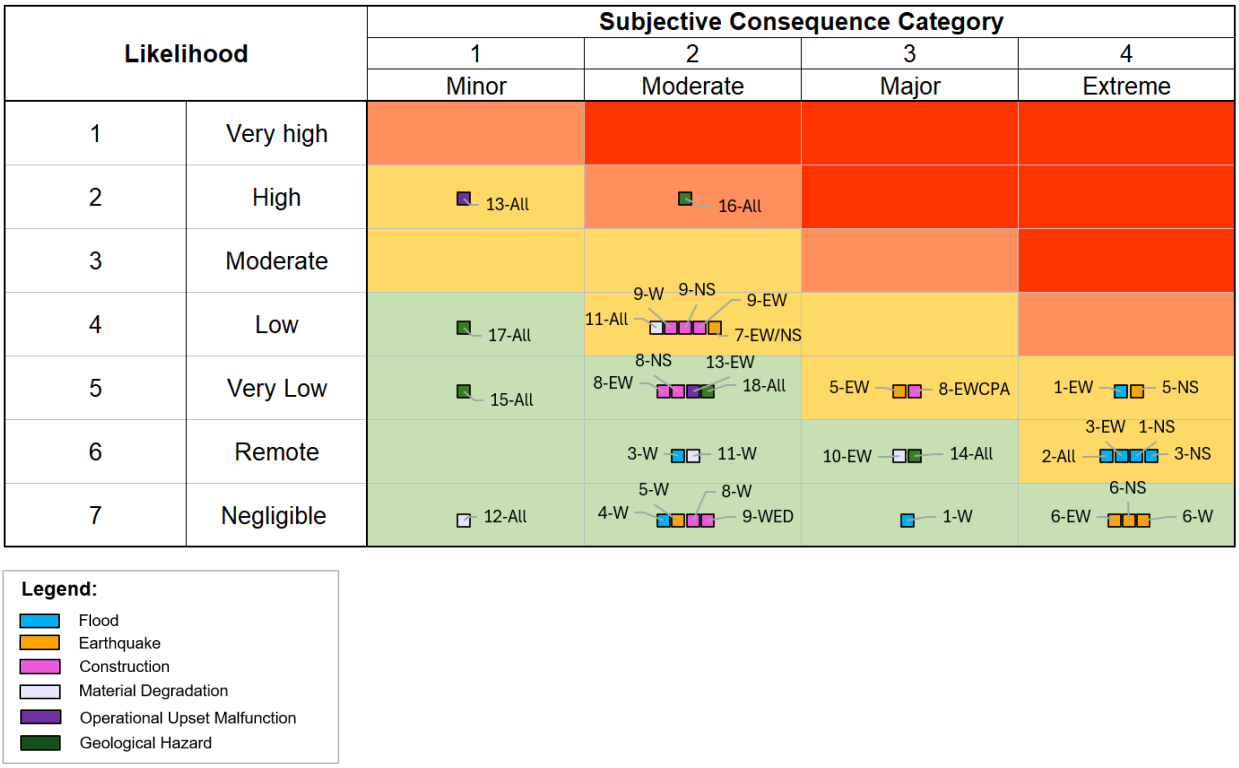

Figure 3.2 Prior to Permit Arrangement – FMEA Risk Ratings

3.3 LIFE OF MINE ARRANGEMENT

3.3.1 GENERAL

All failure modes considering the Life of Mine arrangement were rated using Tables 2.2 and 2.3 and the qualitative descriptions. Applicable likelihood and consequence ratings were supported by stability analysis presented in the Stability Assessment Report (KP, 2024b) prepared for the Design Document. Improvements in stability and resulting increases in FS values could indicate a reduction in likelihood when compared to the Prior to Permit arrangement.

For example, the inferred reduction in likelihood from Category 5 to 6 for the flood-induced instability along the East-West Embankment is based on improved resistance against global instability (FS increases from 1.5 to > 2.0 for Normal Operating (peak undrained strength) condition and FS increase from 1.2 to > 1.5 for Post Earthquake (residual undrained strength) condition. These improvements combined with the reasonable expectation of a smaller remnant pond and spillway to manage beach inundation at closure support the lower likelihood rating.

Several likelihood ratings were completed using engineering judgement. Consequence ratings for each failure mode were rated based on the changes in the YDTI operation and layout and engineering judgement. The Life of Mine arrangement includes a variety of design features which reduce the potential

likelihood and consequences of failure. These design features, primary means of risk control, and additional residual risks are summarized in subsequent sections and in Appendix B.

A summary of the risk ratings for the Life of Mine arrangement are presented on Figure 3.3.

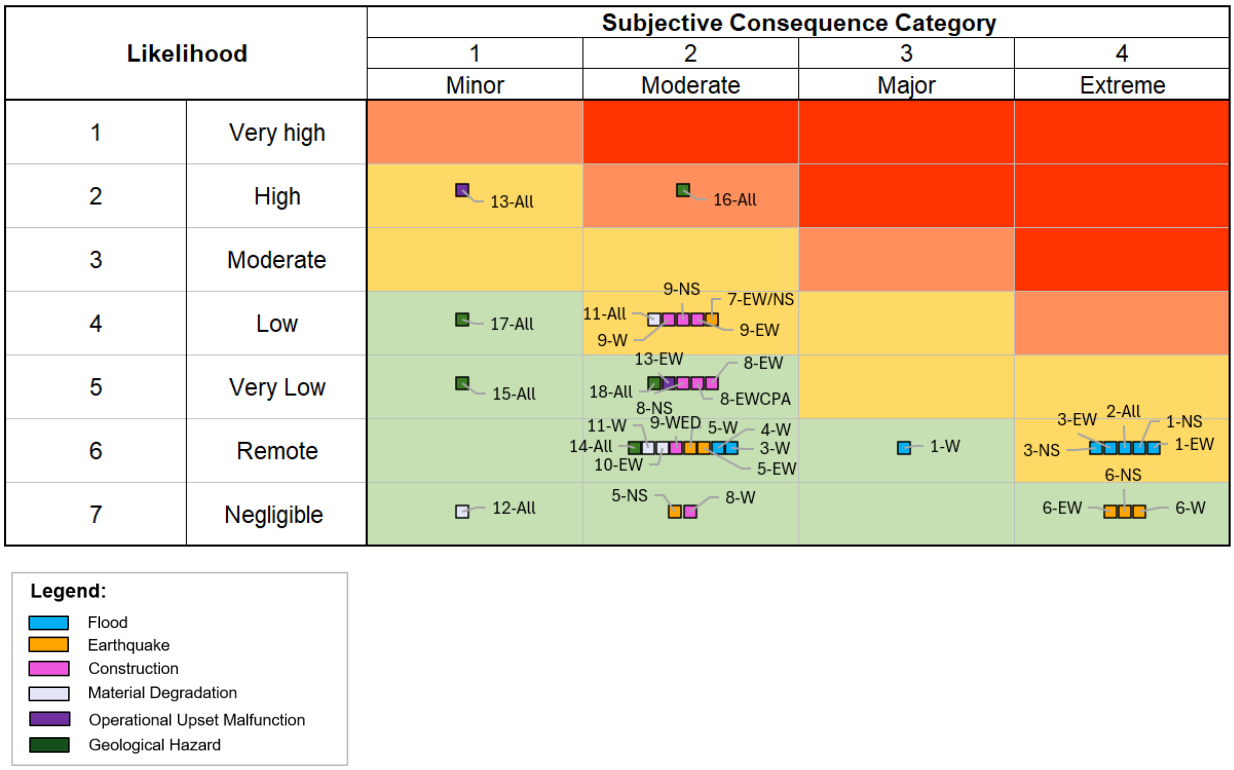

Figure 3.3 Life of Mine Arrangement – FMEA Risk Ratings

3.3.2 FLOOD

The potential for adverse facility response due to severe flooding was identified as a main hazard of concern in the FMEA, which is consistent with the results from the 2022 Risk Assessment. The potential for Major or Extreme consequences are conceivable if a severe flood event causes failure due to instability, overtopping or internal erosion/piping. A summary of the FMEA likelihood and consequence rankings for both arrangements is provided in Table 3.1, and key takeaways from the FMEA workshop and results are summarized below.

Table 3.1 Flood Event Risk Rating Summary

Simplified Failure Mode	Risk Indicator	Prior to Permit		Life of Mine	
		Likelihood	Consequence	Likelihood	Consequence
Global Instability (Foundation or Slope)	1-EW	Very Low	Catastrophic/Extreme	Remote	Catastrophic/Extreme
	1-NS	Remote	Catastrophic/Extreme	Remote	Catastrophic/Extreme
	1-W	Negligible	Major	Remote	Major
Overtopping	2-All	Remote	Catastrophic/Extreme	Remote[2]	Catastrophic/Extreme
Internal Erosion / Piping	3-EW	Remote	Catastrophic/Extreme	Remote	Catastrophic/Extreme
	3-NS	Remote	Catastrophic/Extreme	Remote	Catastrophic/Extreme
	3-W	Remote	Moderate	Remote	Moderate
Uncontrolled Seepage	4-W	Negligible	Moderate	Remote	Moderate

Note(s):

1. Green shading indicates a reduction and red indicates an increase in likelihood or consequence between the Prior to Permit and Life of Mine arrangements.
2. Likelihood reduces to Negligible following construction of the closure spillway.

Instability:

- The likelihood of failure along the East-West Embankment due to flood induced instability is reduced from Very Low to Remote for the Life of Mine arrangement relative to the Prior to Permit arrangement based on the improved resistance against instability from HsB RDS construction. The consequence rating remains consistent with Prior to Permit (Extreme) due to large volume of water under severe flooding; however, the dam breach inundation study for Life of Mine arrangement predicts outflow would be contained within the open pits reducing off-site safety risks. Relocation of the maintenance yard and truck shop would result in reduction in on-site safety risks; however, the hazard contemplated still qualifies as Catastrophic/Extreme due to the potential to render key site facilities inoperable.
- No change in likelihood of failure (Remote) due to flood induced instability along the North-South Embankment until construction of the closure spillway to limit beach inundation; however, there is improved stability following construction of the North RDS. The consequence rating was kept consistent with Prior to Permit (Extreme) due to the large volume of water under severe flooding and potential for impacts to site facilities.
- The likelihood of failure due to flood induced instability along West Embankment was increased from Negligible to Remote relative to Prior to Permit arrangement due to the increased height of the embankment and slight reduction in FS (still > 3.0). The potential consequences of a failure on the West Embankment were inferred to be Major for both arrangements due to potential physical impacts to mine facilities.

Overtopping:

- At final conditions prior to closure, freeboard is sufficient to manage the PMF with additional dry freeboard, and during most of operations the operating freeboard is much larger due to construction techniques (i.e. large lift thickness provides substantial additional freeboard until near end of facility filling). The potential for overtopping is inferred to be Remote during operations, and the likelihood would be considered Negligible once a closure spillway is constructed. Potential consequences were inferred to be Extreme based on the large volume of water associated with the PMF.

Internal Erosion:

- The likelihood of internal erosion along the East-West and North-South embankments is inferred to be Remote until the construction of the closure spillway to manage the PMF. The consequence rating (Extreme) remains consistent with the Prior to Permit arrangement for reasons described above for the instability failure mode.
- The likelihood along the West Embankment is consistent with the East-West and North-South Embankments; however, the consequence of failure along the West Embankment were rated as Moderate due to presence of the WED and other installed mitigation measures (Extraction Basin, Drain Pods) to control piezometric levels within the rockfill.

Uncontrolled Seepage

- The likelihood of uncontrolled seepage along the West Embankment and West Ridge was inferred to be Negligible for current operations as the WED is not required for hydrodynamic containment. The likelihood is increased to Remote for the Life of Mine arrangement based on the requirement for the WED to maintain hydrodynamic containment along the West Ridge.
- The consequences were inferred to be Moderate based on potential impacts to operations and the environment; however, installed/uninstalled mitigation measures (e.g., the Extraction Basin and drain pods) can be implemented to further control piezometric levels within the rockfill if the WED capabilities are reduced.

3.3.3 EARTHQUAKE

The potential for adverse facility response due to an earthquake event was also identified as a main hazard of concern in the FMEA, which is consistent with the 2022 Risk Assessment. The potential for Extreme consequences is conceivable if a large earthquake event causes failure due to overtopping or undesirable deformation.

A summary of the FMEA likelihood and consequence rankings for both arrangements is provided in Table 3.2, and key takeaways from the FMEA workshop and results are provided below.

Table 3.2 Earthquake Event Risk Rating Summary

Simplified Failure Mode	Risk Indicator	Prior to Permit		Life of Mine	
		Likelihood	Consequence	Likelihood	Consequence
Global Instability (Foundation or Slope)	5-EW	Very Low	Major	Remote	Moderate
	5-NS	Very Low	Catastrophic/Extreme	Negligible	Moderate
	5-W	Negligible	Moderate	Remote	Moderate
Overtopping	6-EW	Negligible	Catastrophic/Extreme	Negligible	Catastrophic/Extreme
	6-NS	Negligible	Catastrophic/Extreme	Negligible	Catastrophic/Extreme
	6-W	Negligible	Catastrophic/Extreme	Negligible	Catastrophic/Extreme
Undesirable Embankment Deformation	7-EW/NS	Low	Moderate	Low	Moderate

Note(s):

1. Green shading indicates a reduction and red indicates an increase in likelihood or consequence between the Prior to Permit and Life of Mine arrangements.

Instability:

- The likelihood of instability along the East-West Embankment was reduced from Very Low to Remote for the Life of Mine arrangement. The construction of the HsB RDS and improved resistance to global stability is the driver of this change supported by a FS increase from 1.5 to > 2.0 for Normal Operating (peak undrained strength) conditions and FS increase from 1.2 to > 1.5 for Post Earthquake (residual undrained strength) conditions. The potential consequence of earthquake-induced instability was also reduced from Major to Moderate following the planned removal of the maintenance yard and truck maintenance workshop.
- The North-South Embankment is inferred to have a consequence of Moderate and likelihood of Negligible following the construction of the North RDS and resulting improved stability and expected smaller localized deformations. This is a reduction from Very Low likelihood and Extreme consequence for the Prior to Permit arrangement.
- The West Embankment likelihood was inferred to be Remote with a consequence rating of Moderate. This slight increase in likelihood from Negligible for the Prior to Permit conditions was due to the increase in embankment height and longer time frame of operations. The consequence rating was kept consistent with the Prior to Permit rating as only localized deformations (e.g. crest settlement) of the embankment would be expected following an earthquake.

Overtopping:

- Earthquake induced overtopping for all embankment limbs was inferred to have a Negligible likelihood due to the remote position of the supernatant pond, operating freeboard and beach length, and the sequence of events which would have to occur to result in an overtopping failure. A rating of Extreme for the potential consequences was assumed due to a hypothetical pond release. The potential consequences may be reduced during closure as the remnant pond size would be further reduced.

Undesirable Deformation:

- The likelihood of undesirable deformation due to a severe earthquake was rated as Low and consequences were inferred to be Moderate based on expected deformation patterns and potential impact on select mine infrastructure. The ratings applied to the Life of Mine arrangement were consistent with the Prior to Permit arrangement.
- The likelihood and consequences of this PFM may be further reduced following final slope regrading (i.e. obliteration/removal of benched arrangement with angle of repose slopes) and planned infrastructure removal during closure.

3.3.4 CONSTRUCTION

Construction related failure modes for the Life of Mine arrangement all have an inferred consequence of Moderate, with varying degrees of likelihood depending on the failure mode (instability or undesirable deformation) and location. This loading condition is guaranteed to occur during the operations period and is not relevant following closure activities (as there would be no further construction). A summary of the FMEA likelihood and consequence rankings for both arrangements is provided in Table 3.3, and key takeaways from the FMEA workshop and results are provided below.

Table 3.3 Construction Loading Risk Rating Summary

Simplified Failure Mode	Risk Indicator	Prior to Permit		Life of Mine	
		Likelihood	Consequence	Likelihood	Consequence
Global Instability (Foundation or Slope)	8-EWCPA	Very Low	Major	Very Low	Moderate
	8-EW	Very Low	Moderate	Very Low	Moderate
	8-NS	Very Low	Moderate	Very Low	Moderate
	8-W	Negligible	Moderate	Negligible	Moderate
Undesirable Embankment Deformation	9-EW	Low	Moderate	Low	Moderate
	9-NS	Low	Moderate	Low	Moderate
	9-W	Low	Moderate	Low	Moderate
	9-WED	Negligible	Moderate	Remote	Moderate

Note(s):

1. Green shading indicates a reduction and red indicates an increase in likelihood or consequence between the Prior to Permit and Life of Mine arrangements.

Instability:

- The central pedestal area of the East-West Embankment has a higher consequence rating (Major) for the Prior to Permit arrangement than the Life of Mine arrangement due to the location of the maintenance yard and truck maintenance workshop. The removal of this infrastructure lowers the consequence rating as permanent mine workers would no longer be present immediately downstream of the embankment. There was no inferred change in likelihood from Very Low even with improved resistance (increased FS) against global instability. Likelihood of loading persists as the condition is postulated but evidence from EL. 6,450 ft lift construction indicates excess pore pressure response to construction is very unlikely. The likelihood would reduce to Negligible once construction is completed (i.e. loading condition no longer relevant) and conditions observed (e.g. deformation rates and piezometric pressures) return to preconstruction conditions.
- In the remaining areas of the East-West Embankment and along the North-South Embankment, this failure mode requires excess pore pressure development in saturated fill deep within the embankment; however, limited pore pressure response to construction was observed in embankment fill during EL 6,450 ft construction (i.e. evidence indicates development of excess pore pressure due to construction is very unlikely) and the likelihood was rated as Very Low. The likelihood would reduce to Negligible once construction is completed (i.e. loading condition no longer relevant) and conditions observed (e.g. deformation rates and piezometric pressures) return to preconstruction conditions. The inferred consequence rating of Moderate is applied based on limited downstream infrastructure and only transient mine workers typically being present in the potentially impacted areas.
- A Negligible likelihood is applied to this failure mode along the West Embankment for both arrangements. The WED would need to fail to create saturated conditions in key resisting areas of the embankment; therefore, it is reasonable to assume two orders of magnitude lower likelihood than the previously discussed construction areas. The consequences were inferred to be Moderate based on limited downstream infrastructure and only transient mine workers typically being present in the potentially impacted areas.

Undesirable Deformation:

- The likelihood (Low) and consequence rating (Moderate) of deformation during construction were rated the same for both arrangements and for each embankment limb. There are known areas of saturation and excess pore pressure development due to loading is plausible; however, monitoring during the EL. 6,450 ft construction indicates it is less likely to occur. Piezometric and deformation monitoring programs and construction field reviews should continue throughout construction to manage residual risks (i.e. uncertainty in loading rates, sequencing and resulting response). Ongoing embankment monitoring during construction would identify any deformations and corrective measures (e.g. additional monitoring or regrading activities) could occur while mining equipment remains in operation.
- Construction loading from the additional embankment lifts leading to undesirable deformation of the WED is considered to have a Remote likelihood (increased from Negligible for Prior to Permit), with a consequence of Moderate. Installed mitigation measures (e.g., the Extraction Basin and drain pods) may be implemented to control piezometric levels within the rockfill if the WED capabilities are reduced due to increased loading.

3.3.5 MATERIAL DEGRADATION

The consequence of instability, undesirable deformation and loss of freeboard due to material degradation was rated relatively low in the FMEA. Instability along the East-West Embankment was rated with a likelihood of Remote for both arrangements. The potentially consequences of instability were inferred to reduce from Major to Moderate following the relocation of the maintenance yard and truck maintenance workshop located in the HsB area.

Undesirable deformation from material degradation of the WED is considered to have a Remote likelihood with a consequence of Moderate, similar to other WED related failure modes. Significant deformation along the embankment crest was deemed to have a Low likelihood as undulations along the crest are typically managed during normal operations. Deformation of this manner would be a Moderate consequence as there is potential to impact mine infrastructure. The likelihood for deformation to be significant enough to result in loss of freeboard was inferred to be Negligible due to inspection and monitoring procedures in place for the embankment. Moderate consequences such as impact to tailings lines and haul ramps could be expected. A summary of the FMEA likelihood and consequence rankings for both arrangements is provided in Table 3.4.

Table 3.4 Material Degradation Risk Rating Summary

Simplified Failure Mode	Risk Indicator	Prior to Permit		Life of Mine	
		Likelihood	Consequence	Likelihood	Consequence
Global Instability (Foundation or Slope)	10-EW	Remote	Major	Remote	Moderate
Undesirable Embankment Deformation	11-W	Remote	Moderate	Remote	Moderate
	11-A	Low	Moderate	Low	Moderate
	12-A	Negligible	Minor/Low	Negligible	Minor/Low

Note(s):
1. Green shading indicates a reduction in consequence between the Prior to Permit and Life of Mine arrangements.

3.3.6 OPERATIONAL UPSET

The likelihood of a tailings pipeline rupture around the facility was rated to be Very Low, with Moderate consequences if occurring under both arrangements, as presented in Table 3.5. The tailings systems are routinely monitored and maintained by operations where any significant tailings line rupture is expected to be detected in a short time. Additional monitoring at the mill (e.g. pipeline pressures, etc.) would assist in the detection of a rupture. The likelihood would reduce to Negligible during the closure phase once operations are completed (i.e. loading condition no longer relevant).

Table 3.5 Operational Upset Risk Rating Summary

Simplified Failure Mode	Risk Indicator	Prior to Permit		Life of Mine	
		Likelihood	Consequence	Likelihood	Consequence
Instability (Foundation or Slope)	13-EW	Very Low	Moderate	Very Low	Moderate
	13-All	High	Minor/Low	High	Minor/Low

3.3.7 GEOLOGICAL AND ENVIRONMENTAL HAZARDS

Several geological and environmental hazards were evaluated in the FMEA as summarized in Table 3.6. The only hazard with a reduction in risk rating is the potential for a large landslide leading to overtopping. The potential consequences of failure for this PFM were inferred to be reduced from Major to Moderate with the planned relocation of the maintenance yard and truck maintenance workshop and significant RDS buttressing around the YDTI. The impacts of wind, fire, and drought are not dam safety related hazards and are managed under established protocols in place at the site. The risks related to these geological and environmental hazards are well managed and current risk controls are adequate. The air quality risks related to blowing dust are considered the most likely to occur of these hazards. The residual risks and associated controls are further described in Section 4.3.

Table 3.6 Geological and Environmental Hazards Risk Rating Summary

Hazard	Simplified Failure Mode	Risk Indicator	Prior to Permit		Life of Mine	
			Likelihood	Consequence	Likelihood	Consequence
Landslide	Overtopping	14-All	Remote	Major	Remote	Moderate
	Impacts to mine operations	15-All	Very Low	Minor/Low	Very Low	Minor/Low
Wind	Air Quality	16-All	High	Moderate	High	Moderate
Fire	Impacts to mine operations	17-All	Low	Minor/Low	Low	Minor/Low
Drought	Impacts to mine operations	18-All	Very Low	Moderate	Very Low	Moderate

Note(s):

1. Green shading indicates a reduction and red indicates an increase in likelihood or consequence between the Prior to Permit and Life of Mine arrangements.

3.4 SUMMARY OF KEY RISK RATINGS

Risk ratings for failure modes related to the East-West and North-South Embankment generally remained the same or improved between the Prior to Permit and Life of Mine arrangements. Select PFMs along the West Embankment increased in likelihood due to increasing embankment height above the West Ridge, potential impacts to the operability of the WED, and the potential for seepage flows to impact the groundwater system in the West Ridge.

The highest consequence failure modes are related to the potential for severe flood and earthquake loading. The construction of the extensive downstream RDS will provide improved resistance to limit potential for instability and corresponding reductions in likelihood instability related PFMs. The relocation of the maintenance yard and truck maintenance workshop contemplated in the design will further reduce the consequences associated with all large-scale failure modes due to the relocation of the permanent workers out of the HsB area and additional buttressing of the embankment. The construction of the closure spillway, discussed further in the following section, will further reduce the likelihood of several flood-induced PFMs for the long-term following closure.

The highest likelihood events are operational upsets due to tailings pipeline rupture and wind related dusting. KP has identified various maintenance items (leaking valves, broken spigot pipelines, etc.) along the upstream face during regular field reviews, which supports the high likelihood of occurrence of these PFMs. The consequence due to discharge spigot leaks are low and do not present high dam safety related or life safety risks. MR currently monitors and manages the tailings discharge systems daily and continued monitoring and prompt maintenance of the tailings discharge system supports the risk ratings. Wind and dusting events have historically occurred at the YDTI. MR has installed additional tailings discharge locations in attempt to increase the area of wetted beach to control dusting, and frequently treats the tailings beach with magnesium chloride to further inhibit dusting. It is conceivable that dusting events will continue to have the potential to occur in the future due to the long beach length, which supports the likelihood rating. The consequence of the dusting will be depending on the wind loading and conditions of the beach at the time. Protocols to mange and report dusting are in place at the site and support the Moderate consequence rating.

4.0 MITIGATING RISK

4.1 ADDITIONAL RISK CONTROLS – PRIOR TO PERMIT

The 2022 Risk Assessment (KP, 2023) identified several mitigation measures that are currently underway at the YDTI, some of which are considered to be complete as part of the Prior to Permit arrangement. A summary of the 2022 recommended actions and their status relative to the Prior to Permit arrangement is provided below:

- Continued pond inventory management – current pond is maintained at approximately 15,000 ac-ft with minor seasonal fluctuations.
- On-site containment project – The on-site containment project was completed in 2023. The project was designed to enhance containment of hypothetical breach outflows by directing these modelled flows to the Berkeley and Continental Pits.
- Stage 1 HsB RDS – The construction of the Stage 1 drainage system was completed in 2024, and MR has initiated construction of the Stage 1 RDS in the HsB Area. The Prior to Permit arrangement considers that the Stage 1 RDS is fully constructed to EL. 5,900 ft. This RDS provides improved stability for the central section of the YDTI. The potential consequences of failure were also reduced by relocating the previous Precipitation Plant at the toe of the East-West Embankment and associated personnel.
- North-South Embankment Slope Fattening and North RDS – MR has initiated construction of the downstream step-outs of the RDS to flatten the overall slope of the embankment to 3H:1V, considering a crest elevation of EL. 6,450 ft. MR is also planning to place additional rockfill in the North RDS area to EL. 6,200 ft prior to the permit amendment approval being received. These activities improve the stability of the North-South Embankment and provide initial surcharge loading on the historically leached rock materials in this area.
- Truck Shop Relocation – This recommended action has not been initiated and is not considered in the Prior to Permit arrangement.
- Phase Site Investigations Objective – MR and KP complete annual investigation programs to further expand the monitoring network for the facility. Additional information on the long-term investigation and monitoring objectives are available in the Life of Mine Design Report (KP, 2024a).

The actions outlined above generally provided improved stability and risk reduction associated with ongoing operation of the YDTI in the near term; however, additional mitigations incorporated in the Life of Mine design further reduce risk and enhance safety of the facility. These additional measures are described in the subsequent section.

4.2 ADDITIONAL RISK CONTROLS – LIFE OF MINE

The continued development of the YDTI and supporting RDS is outlined in the Life of Mine Design Report (KP, 2024a) and includes several opportunities for continuous improvement and risk reduction at the facility. The primary risk controls implemented in the design are described below:

- Continued pond inventory management – Continue to maintain pond at approximately 15,000 ac-ft with minor seasonal fluctuations. This provides very long, well drained beaches and a remote location of the

supernatant pond. The large design freeboard for flood management reduces the risk associated with large storm events.

- Flatter overall slopes – Future embankment and RDS construction will continuously flatten the overall slopes of the YDTI to a minimum of 3H:1V, outside of selects areas where locally steepened slopes may be required during operations. The flatter overall slopes provide improved stability around the facility.
- Relocation of the maintenance yard and truck maintenance workshop – The relocation of the maintenance yard and workshop significantly reduces the potential consequences associated with several failure modes by removing permanent workers in the area. Relocation also allows for the continued construction of the HsB RDS which is required for future embankment construction. The significant volume of rockfill provides substantial buttressing in the central pedestal area of the embankment and provides additional resistance to erosion of the embankment. The relocation of the truck shop is a significant financial commitment from MR; however, the relocation provides the opportunity to further enhance safety of the facility and develop the life of mine configuration of the embankment.
- Expansion of the North RDS – Expansion of the North RDS between the North-South Embankment and Rampart Mountain provides improved stability along the embankment which results in further reduction of risk. The North RDS provides significant buttressing to the embankment and the large volume of rockfill provides additional resistance to erosion of the embankment and will enhance seismic performance.
- Construction of the West RDS – The construction of the West RDS downstream of the northwest trending limb of the East-West Embankment will provide improved stability along that section of the embankment. The West RDS provides storage of rockfill and buttressing of the embankment.
- Improved construction methodology of upstream facing materials – Placement of relatively low-permeability alluvium materials along the upstream face of the embankment at a minimum slope of 2H:1V. The alluvium materials provide separation between the tailings beach and the rockfill materials. This improvement has been implemented along the current East-West and North-South Embankment and will continue during future lifts around the entire facility. This facing reduces the risk of internal erosion and piping, both during regular operations (tailings discharge) and in the event of a very low likelihood flood event where ponding may be presented along the embankment face.

4.3 RESIDUAL RISKS AND CONTROLS

Residual risks associated with the facility for each potential failure mode, considering the Life of Mine arrangement, are summarized below. Additional engineering and administrative controls that may be implemented, including planned closure activities, are also presented and may further reduce these risks.

Flood (Instability, Overtopping, Internal Erosion, Uncontrolled Seepage):

- Residual Risks:
  - Natural flooding causing significant beach inundation remains until a closure spillway is constructed.
  - The uncertainty in piezometric response and resulting influence of embankment stability due to flooding also remains due to the complex site conditions.
  - Potential for WED to be overwhelmed or inoperable under large storm events.

- Controls:
  - Construction of the downstream RDS progressively enhance embankment stability in key areas during operations and assist in controlling the associated risks.
  - Maintain long, well drained tailings beach with remote supernatant pond. Construction of the closure spillway and reduction in the remnant pond volume to less than approximately 5,000 ac-ft during early closure further reduces risk associated with severe flooding over the long-term.
  - Incorporation of flatter upstream slopes and improved continuity of upstream facing reduces risks associated with internal erosion and piping through the embankment.
  - Continued monitoring of pond, tailings beach, and embankment elevations, and completing regular inspections of the facility.
  - Detection of large storm events is possible and ability to implement appropriate emergency actions and response plans as outlined in the TOMS Manual.
  - Monitoring equipment is installed throughout the embankment and near real-time piezometric information is available in critical areas of the embankment.
  - Capacity of WED is much larger than measured flows. Additional installed/uninstalled measures (Extraction Basin and drain pods) are included in the design and may be implemented to help manage flows within the drain.
  - Emergency warning systems are in place to alert staff of potential hazards.

Earthquake (Instability, Overtopping, Undesirable Deformation):

- Residual Risks:
  - Project is in a high seismic region and potential for earthquake remains throughout life of mine.
  - The uncertainty in piezometric response and resulting influence of embankment stability due to earthquake remains due to the complex site conditions.
- Controls:
  - Construction of RDS downstream of the YDTI progressively enhances embankment stability as mining continues.
  - Overall downstream slopes progressively flattened to enhance stability as lower embankment lifts and downstream step-out for EL. 6,560 ft lift are constructed.
  - YDTI design criteria maintains large freeboard
  - Maintain long, well drained tailings beach and remote supernatant pond. Further reduction in pond volume during closure.
  - Regular monitoring of tailings beach length, pond volume, and downstream slopes. Seismic monitoring equipment available and linked with key staff alerts.
  - Can detect earthquake motion and intervene by activating emergency action and response plans as outlined in the TOMS Manual.
  - Emergency warning systems are in place to alert staff of potential hazards.

Construction (Instability, Undesirable Embankment Deformation):

- Residual Risks:
  - Construction loading will occur. Uncertainty in loading rates and construction sequencing.
  - The uncertainty in piezometric response to construction and resulting influence on embankment stability due to the complex site conditions.
  - Potential for WED operations to be inhibited if large deformations occur.

- Controls
  - Construction of RDS downstream of the YDTI progressively enhances embankment stability as mining continues.
  - Overall downstream slopes progressively flattened to enhance stability as lower embankment lifts and downstream step-out for EL. 6,560 ft lift are constructed.
  - Maintain long, well drained tailings beach and remote supernatant pond.
  - Capacity of WED is much larger than measured flows. Additional installed/uninstalled mitigation measures (Extraction Basin and drain pods) are included in the design and may be implemented to help manage flows within the drain.
  - Regular monitoring of embankment during construction, including visual inspections, surface and subsurface deformation monitoring, and near real-time piezometric information is available in critical areas of the embankment. Changing pore pressure conditions at key instrumentation linked with key staff alerts.
  - Emergency warning systems are in place to alert staff of potential hazards.

Material Degradation (Instability, Undesirable Embankment Deformation):

- Residual Risks:
  - The outcome of various material degradation physical processes and spatial variability (widespread or local) is uncertain due to complexity of site conditions and processes.
  - Uncertainty related to material breakdown/precipitate buildup within WED.
  - Material degradation resulting in crest settlement.
- Controls:
  - Construction of the downstream RDS progressively enhances embankment stability during operations and assists in controlling the associated risks.
  - Maintain long, well drained tailings beach with remote supernatant pond. Construction of the closure spillway and reduction in the remnant pond volume to less than approximately 5,000 ac-ft during closure.
  - Monitoring equipment is installed throughout the embankment and near real-time piezometric information is available in critical areas of the embankment.
  - Capacity of WED is much larger than measured flows. Additional installed/uninstalled mitigation measures (Extraction Basin and drain pods) are included in the design and may be implemented to help manage flows within the drain.
  - MR continue to complete regular inspections of the facility including embankment crest surveys. Equipment available to regrade crest and maintain design tolerances during operations.

Operational Upset Malfunction (Instability):

- Residual Risks:
  - Possibility of pipeline wear and rupture always present during operations phase. Risk does not exist following mine closure.
- Controls:
  - Rigid pipeline and pump system materials are used on site.
  - Maintenance and replacement of worn equipment completed as required.
  - Regular visual monitoring of pipeline and discharge conditions.
  - Systems in place through tailings operations to detect signs of issues (pipeline pressures, etc.).

Geologic and Environmental Hazards (Overtopping, Impacts to Mine Operations, Air Quality):

- Residual Risks:
  - Geologic and environmental hazards are out of control of the mine. Possibility of landslides, high winds, fires and drought remain throughout the life of mine.
- Controls:
  - Regular monitoring by site operations.
  - Climate monitoring and forecast predictions are available to predict conditions.
  - Dust management and emergency management plans are in place for the site.
  - Operations will be shut down in the event of evacuation.

5.0 SUMMARY

This FMEA was completed to identify and characterize risks associated with the continued development of the YDTI to a crest elevation of 6,560 ft. The FMEA contemplates the intervening period between the configuration expected to be achieved prior to receiving the permit amendment and the final proposed life of mine arrangement of the facility. The failure modes assessed during the FMEA were generally based on the PFMs previously identified, developed, and evaluated during the 2022 Risk Assessment (KP, 2023), and included the potential for occurrence of earthquakes, severe flooding, fill and foundation material degradation, on-going construction and operations activities, and other geologic and environmental hazards. Recommended controls from the 2022 Risk Assessment are being implemented on site and will continue during ongoing mine operations.

Likelihood and consequences were primarily determined using qualitative criteria for this FMEA; however, several risks were evaluated for the Prior to Permit arrangement using the information developed during the 2022 Risk Assessment. The highest consequence failure modes for the Life of Mine arrangement contemplated in this FMEA are related to severe flood and earthquake loading, similar to those identified in the 2022 Risk Assessment.

Risk ratings for failure modes related to the East-West and North-South Embankment generally remained the same or improved between the Prior to Permit and Life of Mine arrangements. Select PFMs along the West Embankment increased in likelihood due to increasing embankment height above the West Ridge, potential impacts on the operability of the WED, and the potential for seepage flows to impact the groundwater system along the West Ridge. The construction of the extensive downstream RDS (North RDS, West RDS, and HsB RDS) will provide improved resistance to limit potential for embankment instability and result in corresponding reductions to likelihood for instability related PFMs around the YDTI. The relocation of the maintenance yard and truck maintenance workshop contemplated in the design, and identified in the 2022 Risk Assessment, is a key mitigation that will further reduce the potential consequences associated with all large-scale failure modes due to the relocation of the permanent workers out of the HsB area and additional buttressing of the embankment. The construction of the closure spillway will further reduce the likelihood of several flood-induced PFMs for the long-term following closure.

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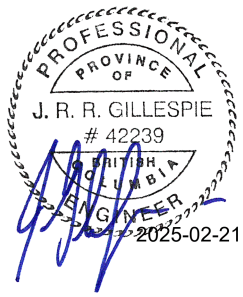
7.0 CERTIFICATION

This report was prepared and reviewed by the undersigned.



KNIGHT PIÉSOLD LTD.
PERMIT NUMBER
1001011
EGBC PERMIT TO PRACTICE

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APPENDIX A

Additional Reference Information

(Pages A-1 to A-11)

APPENDIX A
ADDITIONAL REFERENCE INFORMATION

1.0 FACILITY DEVLEOPMENT HISTORY

The construction and operational life of the YDTI spans over several owners and six decades from 1962 to present, and the available historical records tend to coincide with certain periods of project development. The Anaconda Company (TAC) was the original owner and operator of the YDTI and began construction of the facility in 1962.

Initial investigations of the facility were conducted, and design and construction recommendations were provided to TAC in the early 1960's by Dames and Moore (Dames and Moore, 1962; Dames and Moore, 1963). These initial investigations were significant because they provide a source of information related to the geological, geotechnical, and hydrogeological conditions at the outset of facility development.

Engineering Management, Inc. (EMI) was engaged by TAC in the early to mid-1970s to provide design and construction criteria guiding the continued development of the YDTI. In parallel, the first formal review board, termed the "Board of Consultants", was formed in 1972 and consisted of Arthur Casagrande, Leo Casagrande, and F.B. Slichter. Dames and Moore performed an additional site investigation program for TAC in 1972, which informed design and construction criteria developed by EMI. However, a report detailing the results of this investigation program is not contained within the currently available project records. The engineering department of TAC with support and guidance provided by EMI, Dames and Moore, the Board of Consultants, developed updated design criteria to guide the continued construction of the YDTI, which was envisaged at the time to reach about elevation (EL.) 6,350 ft over a 20-year period between approximately 1974 to 1994. Some relevant intercompany correspondence is available documenting the design criteria development during this phase.

TAC was purchased by Atlantic Richfield Company (AR) in 1977. Anaconda Minerals Company began as a TAC operating subsidiary in 1977 and operated the YDTI until 1983. The YDTI was inspected by officials from the United States Army Corps of Engineers (USACE), Mine Safety and Health Administration (MSHA), Montana Department of Natural Resources, and representatives of TAC in May 1978 and a report describing the inspection was issued in 1980 (USACE, 1980). The available intracompany correspondence at the time and external communications with the regulatory officials completing the inspection of the YDTI indicate that the on-going construction of the YDTI following the transfer of ownership continued in general accordance with the design criteria developed by TAC in the early 1970s.

The recommendations arising from the USACE inspection were as follows:

- Initiate immediate action to provide and continually maintain capability to handle projected probable maximum flood (PMF) runoff
- Develop, implement, and periodically test an emergency warning plan to alert downstream interests, inhabitants and mine workers in the event of possible dam failure
- Conduct detailed studies to determine the PMF and modify the project to safely handle the PMF
- Conduct field investigation, laboratory tests, and seismic and engineering studies of the dam embankment and foundation stability, and modify the dam embankment as required to provide for adequate factors of safety under steady state seepage and seismic loading conditions

TAC engaged International Engineering Company, Inc. (IECO) in 1980 to perform studies for the YDTI to address the recommendations arising from the USACE inspection. IECO completed geotechnical and hydrological studies of the impoundment for the facility configuration at the time and for the proposed future enlargement to approximately EL. 6,450 ft. The following tasks were completed by IECO for TAC to form the updated design basis for the facility:

- Estimated the PMF runoff volume and determine what facilities would be required to retain the runoff from the PMF
- Analyzed the effects of a hypothetical breach of the embankment
- Performed site investigations, laboratory testing, and seismicity studies
- Characterized the piezometric conditions prevalent in the embankment
- Characterized material strength properties and analyzed the static and dynamic stability of the embankment up to EL. 6,450 ft
- Developed updated design and construction criteria to guide YDTI development during continued operations up to EL. 6,450 ft
- Developed monitoring plans for on-going operations

MR began operating the YDTI in 1986 and has gradually increased the tailings elevation by about 200 ft since that time. The YDTI was developed since 1986 in general accordance with the design and construction criteria specified by IECO in 1981 and several of the design criteria developed by IECO are still in use today (e.g. minimum crest width and overall downstream slope angle). Certain design basis criteria, such as estimates of the PMF volume and the site-specific seismic hazard assessment that were initially developed by IECO following the USACE inspection in 1980, were updated periodically after MR began operating the YDTI (HLA, 1993; MR, 1999) along with the associated deterministic safety assessments of the impoundment. The first piezometric trigger elevations (action levels) were developed by MR in the late 1990s.

KP's involvement at the YDTI commenced in 2012 and 2013 as part of a failure modes assessment workshop. While elements of risk management are evident in the selected design criteria for the YDTI prior to 2013, KP is unaware of any pre-existing risk analysis documents prepared for the facility prior to the 2013 FMA workshop. KP's responsibilities for the on-going design and development of the YDTI were formalized in 2015, when Mr. Ken Brouwer, P.E. agreed to accept the role of Engineer of Record (EOR) for the YDTI. KP has since been actively involved in the design and development of the YDTI and has worked closely with MR to achieve the fundamental objective of on-going continuous improvement of the safety of the impoundment. Mr. Daniel Fontaine, P.E. of KP, succeeded Mr. Brouwer as the EOR for the YDTI beginning on September 10, 2021.

2.0 REFERENCE COORDINATE SYSTEM AND DATUM

Coordinates and elevations in this report are referenced to the site coordinate system known as the 'Anaconda Mine Grid' established by TAC in 1957. The Anaconda Mine Grid is based on the Anaconda Copper Company (ACC) Datum established in 1915. The MR Site Coordinate System is based on the Anaconda Mine Grid and utilizes International Feet. All elevations are stated in Anaconda Mine Grid coordinates with respect to the ACC Vertical Datum unless specifically indicated otherwise.

3.0 PREVIOUS RISK ANALYSIS STUDIES

3.1 FAILURE MODES ANALYSIS INFORMATION SUMMARY

KP completed a report titled “Failure Mode Analysis Information Summary” in early February 2013 (KP, 2013). The purpose of this report was to review the design and operation of the YDTI and to assist in the compilation of relevant information to support the simplified Failure Modes Analysis (FMA) workshop conducted by MR.

A summary of the FMA workshop conducted by MR was compiled by KirK Engineering and Natural Resources Inc. in late February 2013 (KirK, 2013). The FMA workshop assessed potential failure modes of the YDTI. Participants in the FMA workshop included representatives from MR, Butte-Silver Bow County government, the MDEQ, the Montana Department of Natural Resources and Conservation (MDNRC), the Montana Bureau of Mines and Geology (MBMG), and the United States Environmental Protection Agency (U.S. EPA).

3.2 2018 RISK ASSESSMENT AND ASSOCIATED MITIGATIONS

3.2.1 GENERAL

KP prepared a Dam Breach Risk Assessment (KP, 2018a) for the YDTI in 2018, which was a component of the design document associated with continued use of the YDTI and construction of the YDTI embankments to a crest elevation of 6,450 ft (i.e. the Amendment 10 Design Document). The risk assessment evaluated foundation and embankment instability, overtopping, and internal erosion and piping for the EL. 6,450 ft embankment and considered loading during maximum normal operating conditions, loading from seismic events, flood events, and malfunctions of the reclaim water and tailings distribution systems. The study examined potential failure modes and followed a generally qualitative framework to establish risk ratings based on the likelihood of an event occurring (e.g. the return period of an earthquake), probability of a failure occurring coincident with that event (e.g. how likely is it that the earthquake will cause deformation that constitutes a loss of containment), and consequence of an event occurring (e.g. severity of potential damage a loss of containment were to occur). The likelihood of an event occurring was generally defined quantitatively in this previous risk assessment, whereas the probability of coincident failure was generally defined qualitatively and informed by deterministic safety analyses.

The results of the risk assessment generally indicated the risk associated with the facility was very low; however, the potential for internal erosion and piping initiated by natural flooding carried the greatest risk for the YDTI (moderate to low). Reducing the normal operating pond volume or improving the uniformity of tailings beach development were identified as ways to increase the storm storage that can be contained on the tailings beach without reaching the embankment, which would decrease the potential for internal erosion and piping under flooded conditions for the YDTI and will further enhance the safety of the facility under normal operating conditions.

This risk assessment identified opportunities to utilize the observational method during ongoing development of the facility, which was noted to be particularly relevant for the transitional period between implementing the modifications to the tailings distribution system and achieving a new steady-state condition associated with the revised discharge strategy. There was uncertainty identified due to the reliance on modelling predictions related to tailings beach development and water balance modelling, and

foreseeable deviations were considered along with the planned observational monitoring related to several factors, including tailings beach development and water inventory changes. The trends related to these factors are regularly discussed in the quarterly and annual surveillance reporting, and a status update related to each is provided briefly below.

3.2.2 TAILINGS BEACH DEVELOPMENT

Tailings were historically discharged into the YDTI at a single location at the southern end of the impoundment near Section 8+00W on the East-West Embankment. Changes to the tailings distribution system were made between 2016 and 2017 with three discharge locations operational as of March 2017. Five additional discharge points were commissioned later in 2017 for a total of eight discharge locations. MR implemented a newly developed tailings operating philosophy and associated surveillance protocols during 2018 to guide and prioritize tailings beach development. Tailings beach development generally progressed in a manner consistent with the design objectives and modelling predictions with the beach transitioning from a deltaic fan shape to a 'U-shape'.

Beach development continues to be reviewed frequently to inform design and operating enhancements that could provide further opportunities for risk mitigation. Adjustments to the tailings distribution system were recommended during the last several annual inspections and changes were progressively implemented by MR. The tailings distribution system now includes twelve full size (24 and 26-inch) discharge locations distributed along the three tailings distribution lines and numerous 12-inch discharge lines (from Lines 1 and 3) distributed along the YDTI embankments. The system provides appropriate flexibility and redundancy for tailings beach development and management.

3.2.3 WATER INVENTORY MANAGEMENT

The YDTI supernatant pond provides a source of water to support continuous mill operations, and the elevation of the pond surface typically rises as the volume of tailings in the facility increases. The 2018 risk assessment (KP, 2018b) identified that reducing the normal operating pond volume towards a target volume of approximately 15,000 acre-ft would reduce risks associated with facility performance following natural flooding. MR implemented changes to the Silver Lake Water Supply (SLWS) use practices in 2016 and 2017 as part of the goal of gradually reducing the operating pond volume and substantially reduced freshwater and make-up water demands for ore processing. MR and KP recognized that changing SLWS practices was an achievable way to influence the water inventory in the YDTI and that other opportunities existed to further reduce water stored within the facility.

Ongoing reduced use of the SLWS (as practicable) along with the commissioning of the Polishing Plant in 2019 resulted in a notable impact on the supernatant pond volume. The Polishing Plant has been operated regularly since being commissioned in September 2019 and has resulted in gradual reduction in pond volume over the past several years. Annual bathymetric surveys completed between 2020 and 2024 confirmed the progressive reduction in YDTI pond volume. Results of the bathymetric evaluations in 2019 and 2024 indicate an estimated pond volume reduction of over 19,000 acre-ft between mid-2019 and mid-2024, resulting in an estimated pond volume of approximately 15,400 acre-ft in mid-2024. Reaching this target level is recognized as a significant risk reduction achievement.

The water inventory in the YDTI supernatant pond is currently specified to managed within a target range of 15,000 +/- 3,000 acre-ft (i.e. between 12,000 and 18,000 acre-ft) provided there is no adverse impacts to ongoing mine operations (KP, 2024a).

3.3 2022 RISK ASSESSMENT AND ASSOCIATED MITIGATIONS

3.3.1 GENERAL

An updated risk assessment was conducted in 2022 while focusing on near-term operating conditions with the embankments raised to a crest elevation of EL. 6,450 ft (KP, 2023c). The assessment focused on credible failure modes, including foundation and embankment instability, overtopping, and internal erosion and piping while considering relevant hazards for the mine (e.g. seismic events, flood events, and significant operational events). The guiding risk management objective for the YDTI is to continuously expand understanding of the facility and continuously improve management of the facility to enhance safety to the MR workforce, community, and environment.

The risk assessment was conducted through a series of meetings. A Potential Failure Modes Analysis (PFMA) was initially completed by the risk assessment team to evaluate site-specific potential failure modes (PFMs) for the YDTI and to identify major hazards considered to be of greatest significance that required further assessment. The PFMs were assigned to the categories based on the consensus of the risk assessment team. The major hazards identified by the failure modes analysis were then carried forward for further quantitative risk analysis using event tree analyses to quantify the risks and determine the main hazards of concern. Potential mitigation measures were then evaluated to identify and prioritize recommended mitigation measures that could further reduce risk associated with the major hazards and enhance safety of the facility.

The results of the quantitative risk analyses indicate that current normal operating conditions have low risk. The major hazards contributing to the normal operating risk profile include construction-loading, material degradation, and relatively small earthquakes and flooding that are expected to be manageable. The main hazards of concern identified were extreme earthquakes and floods, which have a very low likelihood of occurring; however, these events also have to the potential to result in severe consequences despite their low probability of occurrence.

The recommended actions developed by the risk assessment team were focused on mitigating the likelihood and potential consequences of failure related to low-probability, major hazards such as severe earthquakes and flooding. The recommendations include actions to enhance stability of the facility, to relocate infrastructure, review and update emergency planning, and to further investigate potential significant areas of uncertainty that could influence dam safety decision making in the future.

The following additional site-specific mitigation opportunities (and implementation status) for the YDTI were discussed and evaluated during the risk assessment:

- On-site Containment Project (completed)
- HsB RDS (buttress) (in progress; ongoing)
- North-South Embankment slope flattening and North RDS (in progress; ongoing)
- Truck shop relocation (planning phase; not yet implemented)

Details related to these structural controls and other non-structural mitigations are reported in the 2022 Risk Assessment Report (KP, 2023c). A summary of the mitigations implemented or in-progress during 2024 is provided in the sections that follow.

3.3.2 ON-SITE CONTAINMENT PROJECT

The On-Site Containment Project involved raising a haul road and haul truck parking lot as a deflection berm in a corridor of relatively low-lying infrastructure between the Pittsmont Dump and the Continental Pit and adjusting haul road grading towards the YDTI. These actions together result in topography that was suitable to direct hypothetical modelled breach flows toward the Continental and Berkeley Pits. The project was completed during 2023.

3.3.3 STAGE 1 HSB RDS (BUTTRESS)

The Stage 1 HsB RDS involves progressive placement of approximately 20 million tons of excess rockfill generating during mining of the Continental Pit to enhance embankment stability along the maximum section of the embankment over the next several years. Construction of the Stage 1 drainage system was substantially completed in 2024 and the RDS footprint is ready to receive bulk rockfill. It is anticipated that bulk rockfill placement in the HsB RDS will commence in late 2024 or early 2025.

3.3.4 NORTH-SOUTH EMBANKMENT SLOPE FLATTENING AND NORTH RDS

This mitigation involves incorporation of flatter overall slope angles and progressive development of the previously permitted North RDS downstream of the North-South Embankment as rockfill becomes available from mining. The North RDS is planned to be developed to progressively surcharge the historically leach materials in this area and ultimately infill the area downstream of the majority of the North-South Embankment between the embankment and the Rampart Mountain to a similar elevation as the embankment.

Initial development of the North RDS includes construction of a new mine haul ramp to the corner of the EL. 6,450 lift of the embankment and additional downstream buttressing along the North-South Embankment with overall slope angles of approximately 3H:1V. Development commenced in 2023 and continued throughout 2024. Approximately 22 million tons of rockfill were placed in the North RDS through November 2024.

4.0 REVIEW OF RECENT IMPORTANT TRENDS

4.1 EMBANKMENT PIEZOMETRIC CONDITIONS

The conceptual hydrogeological model for the YDTI embankments presented in the Site Characterization Report (KP, 2017) suggests that a basal saturated zone exists within the bottom 50 to 200 ft of embankment rockfill and that isolated perched saturated zones are present within the overlying rockfill. Site investigation programs completed since 2016 and piezometric data collected continue to refine and corroborate this conceptual hydrogeological model. Pore water pressure trends associated with both tailings discharge and embankment construction continue to be observed by the monitoring instrumentation.

Detailed analysis of pore water pressure trends were most recently presented in the 2023 Data Analysis Report (KP, 2024d). Key piezometric trends monitored during 2023 for the YDTI embankment and tailings mass are summarized below.

Piezometric conditions within the East-West Embankment have generally continued to decrease slightly or remained stable in 2023, continuing the long-term trends observed since late-2016. Influence from construction (fluctuating water levels) was observed at two sites in a perched saturated zone within or in

proximity to the historical 1982 embankment lift. No significant increases were observed in the basal saturated zone following substantial completion of EL. 6,450 ft embankment construction.

Piezometric conditions within the North-South Embankment were relatively stable or increased slightly with some fluctuations observed throughout 2023. The behavior was interpreted to be associated with alluvial placement along the upstream slope of the North-South Embankment and/or related to local tailings discharge. Several pore pressure monitoring instruments along the North-South Embankment were damaged by embankment construction in 2023, and available monitoring data was therefore limited for the second half of 2023. Two of these instruments were replaced in 2024.

Pore water pressure instrumentation installed within the tailings mass monitored mixed piezometric responses during 2023 that were consistent with expectations. The piezometric responses were generally inferred to be associated with tailings deposition practices. Sensors located in proximity to active tailings discharges generally monitored increasing pore pressure conditions. Stable or decreasing pore pressure conditions were typically observed during periods of discharge inactivity.

Slightly increasing pore pressures were observed within the West Embankment and WED in 2023 that were attributed to active tailings discharge from the 12-inch lines in this area, which is inferred to result in more tailings slurry water infiltrating into the tailings beach and embankment than when the full-size tailings discharge points are operated. Pore water pressures remain well below their prescribed trigger thresholds. Piezometric monitoring between the West Embankment and West Ridge continues to indicate that hydrodynamic containment (eastward flow gradient from the West Ridge towards the YDTI) remains present within both critical monitoring areas (the Deep Isolated Fracture System and West Ridge Potentiometric Low). Comparison of West Ridge piezometric data and YDTI pond elevation indicates that the WED is not presently required to maintain hydrodynamic containment; however, it does enhance the security of the hydrodynamic seepage containment system along the West Ridge.

4.2 EMBANKMENT DEFORMATION TRENDS

KP and MR have monitored embankment surface and subsurface deformations since 2020 to characterize deformation conditions and monitor elevated deformations associated with ongoing embankment construction. Additional monitoring techniques were introduced and reporting rigor increased between June 2021 and March 2023 during construction along the Central Pedestal Area of the East-West Embankment and the North-South Embankment. Deformation monitoring relies on both in-situ instrumentation and remote sensing techniques and results have been formally reported in quarterly YDTI instrumentation and monitoring letters and the annual data analysis reports since 2020. Key deformation monitoring findings through 2023 included:

- Observed surface deformations within regions of historical rockfill generally continue to occur at constant rates without observation of progressive (accelerating) deformations. Deformation magnitudes are consistent with expectations for end-dumped rockfill, and settlement rates are interpreted to vary based on rockfill thickness and time following placement.
- Elevated surface and subsurface deformation rates were observed localized within and around the footprints of newly placed rockfill within the EL. 6,450 ft rockfill surcharge and Central Pedestal Area embankment lifts. The onset of elevated deformation rates corresponded with the advancement of construction and rates began to slow upon completion of construction in a given area, as expected. Findings do not indicate the development of unexpected deformations within the downstream

embankment slope nor evidence of progressive (accelerating) deformations. Observed deformation rates were approaching pre-construction rates towards by the end of 2023.

4.3 RECENT REFERENCE INFORMATION

A list of the relevant historical reference material, in addition to the reference information described above, is as follows:

- Site Investigation Reports and Memos:
  - 2012 Geotechnical Site Investigation Report (KP, 2013)
  - 2013 Geotechnical Site Investigation Report (KP, 2014)
  - 2014 Geotechnical Site Investigation Report (KP, 2016a)
  - 2015-2016 Geotechnical Site Investigation Memos (KP, 2017a – Appendix D)
  - 2017 Geotechnical Site Investigation Report (KP, 2018b)
  - 2018 Embankment Geotechnical Site Investigation Report (KP, 2019a)
  - 2018 Horseshoe Bend Geotechnical Site Investigation (KP, 2019b)
  - 2019 Embankment Geotechnical Site Investigation Report (KP, 2020a)
  - 2019 Horseshoe Bend Geotechnical Site Investigation (KP, 2020b)
  - 2020 Embankment Geotechnical Site Investigation Report (KP, 2021c)
  - 2021 Embankment Geotechnical Site Investigation Report (KP, 2023d)
  - 2021 Tailings SCPT Site Investigation (KP, 2023e)
  - 2022 Embankment Geotechnical Site Investigation Report (KP, 2024b)
  - 2023 Embankment Geotechnical Site Investigation Report (KP, 2024c)
- Site Characterization Report (KP, 2017a)
- Annual Inspection Reports
  - 2015 Annual Inspection Report (KP, 2016b)
  - 2016 Annual Inspection Report (KP, 2017b)
  - 2017 Annual Inspection Report (KP, 2018c)
  - 2018 Annual Inspection Report (KP, 2019c)
  - 2019 Annual Inspection Report (KP, 2020c)
  - 2020 Annual Inspection Report (KP, 2021a)
  - 2021 Annual Inspection Report (KP, 2022a)
  - 2022 Annual Inspection Report (KP, 2023a)
  - 2023 Annual Inspection Report (KP, 2024a)
- Data Analysis Reports
  - 2017 Data Analysis Report (KP, 2018d)
  - 2018 Data Analysis Report (KP, 2019d)
  - 2019 Data Analysis Report (KP, 2020d)
  - 2020 Data Analysis Report (KP, 2021b)
  - 2021 Data Analysis Report (KP, 2022b)
  - 2022 Data Analysis Report (KP, 2023b)
  - 2023 Data Analysis Report (KP, 2024d)
- Dam Breach Risk Assessment (KP, 2018a)
- 2022 Seismic Response and Deformation Analysis Update (KP, 2022c)
- 2022 Risk Assessment Report (KP, 2023c)

- TOMS Manual (MR/KP, 2023; MR/KP 2019)
- MR Emergency Action Plan (MR, 2021)

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International Engineering Company, Inc. (IECO, 1981). Geotechnical and Hydrologic Studies of Yankee Doodle Tailings Dam. Denver, Colorado.

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Knight Piésold Ltd. (KP, 2013a). Yankee Doodle Tailings Dam – Failure Modes Analysis Information Summary, KP Ref. No. VA101-126/7-1 Rev 0, dated February 1, 2013.

Knight Piésold Ltd. (KP, 2013b). Yankee Doodle Tailings Impoundment – 2012 Geotechnical Site Investigation Report, KP Ref. No. VA101-126/7-2 Rev 0, dated March 12, 2013.

Knight Piésold Ltd. (KP, 2014). Yankee Doodle Tailings Impoundment – 2013 Geotechnical Site Investigation Report, KP Ref. No. VA101-126/7-3 Rev 0, dated November 24, 2014.

Knight Piésold Ltd. (KP, 2016a). Yankee Doodle Tailings Impoundment – 2014 Geotechnical Site Investigation Report, KP Ref. No. VA101-126/8-3 Rev 0, dated March 10, 2016.

Knight Piésold Ltd. (KP, 2016b). Yankee Doodle Tailings Impoundment – 2015 Annual Inspection Report, KP Ref. No. VA101-126/13-2 Rev 0, dated June 8, 2016.

Knight Piésold Ltd. (KP, 2017a). Yankee Doodle Tailings Impoundment – Site Characterization Report, KP Ref. No. VA101-126/14-2 Rev 2, dated August 11, 2017.

Knight Piésold Ltd. (KP, 2017b). Yankee Doodle Tailings Impoundment – 2016 Annual Inspection Report, Rev 1, dated June 29, 2017. Vancouver, BC. Ref. No. VA101-126/15-1.

Knight Piésold Ltd. (KP, 2018a). Yankee Doodle Tailings Impoundment – Dam Breach Risk Assessment, KP Ref. No. VA101-126/12-3 Rev 3, dated March 13, 2018.

Knight Piésold Ltd. (KP, 2018b). Yankee Doodle Tailings Impoundment – 2017 Geotechnical Site Investigation Report, KP Ref. No. VA101-126/16-2 Rev 0, dated May 2, 2018.

Knight Piésold Ltd. (KP, 2018c). Yankee Doodle Tailings Impoundment – 2017 Annual Inspection Report, KP Ref. No. VA101-126/16-3 Rev 0, dated February 9, 2018.

Knight Piésold Ltd. (KP, 2018d). Yankee Doodle Tailings Impoundment – 2017 Data Analysis Report, KP Ref. No. VA101-126/16-5 Rev 0, dated July 20, 2018.

Knight Piésold Ltd. (KP, 2019a). Yankee Doodle Tailings Impoundment – 2018 Embankment Geotechnical Site Investigation Report, KP Ref. No. VA101-126/19-1 Rev 0, dated May 22, 2019.

Knight Piésold Ltd. (KP, 2019b). Yankee Doodle Tailings Impoundment – 2018 Horseshoe Bend Geotechnical Site Investigation, KP Ref. No. VA101-126/20-1 Rev 0, dated May 27, 2019.

Knight Piésold Ltd. (KP, 2019c). Yankee Doodle Tailings Impoundment – 2018 Annual Inspection Report, KP Ref. No. VA101-126/19-2 Rev 1, dated January 31, 2019.

Knight Piésold Ltd. (KP, 2019d). Yankee Doodle Tailings Impoundment – 2018 Data Analysis Report, KP Ref. No. VA101-126/19-4 Rev 0, dated August 15, 2019.

Knight Piésold Ltd. (KP, 2020a). Yankee Doodle Tailings Impoundment – 2019 Embankment Geotechnical Site Investigation Report, KP Ref. No. VA101-126/21-1 Rev 0, dated July 16, 2020.

Knight Piésold Ltd. (KP, 2020b). Yankee Doodle Tailings Impoundment – 2019 Horseshoe Bend Geotechnical Site Investigation, KP Ref. No. VA101-126/22-1 Rev 0, dated December 1, 2020.

Knight Piésold Ltd. (KP, 2020c). Yankee Doodle Tailings Impoundment – 2019 Annual Inspection Report, KP Ref. No. VA101-126/21-2 Rev 0, dated January 31, 2020.

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Knight Piésold Ltd. (KP, 2021a). Yankee Doodle Tailings Impoundment – 2020 Annual Inspection Report, KP Ref. No. VA101-126/23-2 Rev 0, dated February 11, 2021.

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Knight Piésold Ltd. (KP, 2022a). Yankee Doodle Tailings Impoundment – 2021 Annual Inspection Report, KP Ref. No. VA101-126/25-2 Rev 0, dated January 11, 2022.

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Knight Piésold Ltd. (KP, 2023d). Yankee Doodle Tailings Impoundment – 2021 Embankment Geotechnical Site Investigation Report, KP Ref. No. VA101-126/25-4 Rev 0, dated December 19, 2023.

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Knight Piésold Ltd. (KP, 2024a). Yankee Doodle Tailings Impoundment – 2023 Annual Inspection Report, KP Ref. No. VA101-126/29-4 Rev 0, dated January 26, 2024.

Knight Piésold Ltd. (KP, 2024b). Yankee Doodle Tailings Impoundment – 2022 Embankment Geotechnical Site Investigation Report, KP Ref. No. VA101-126/27-5 Rev 0, dated October 25, 2024.

Knight Piésold Ltd. (KP, 2024c). Yankee Doodle Tailings Impoundment – 2023 Embankment Geotechnical Site Investigation Report, KP Ref. No. VA101-126/29-6 Rev 0, dated November 1, 2024.

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APPENDIX B

Risk Evaluation

(Table B1)

Knight Piésold CONSULTING

TABLE B1

MONTANA RESOURCES, LLC
MONTANA RESOURCES

YANKEE DOODLE TAILINGS IMPOUNDMENT - FAILURE MODES AND EFFECTS ASSESSMENT FOR 6560 AMENDMENT DESIGN DOCUMENT
SUMMARY OF HAZARDS

Risk ID	Initiating / Loading Event		Simplified Failure Mode	Location	Risk ID-Embankment	Risk Description	Primary Means of Risk Control	PFMA Risk Categorization		FMEA Risk Rating (Prior to Permit)			FMEA Risk Rating (Life of Mine)		Residual Risks	Plans for Addressing Residual Risks	
	Category	Sub-category						Preliminary Screening Assessment	Category	2022 RA Cumulative Likelihood Extreme/Major	Likelihood L	Consequence C	Likelihood L	Consequence C		Engineering Controls	Administrative Controls
1	Flood	PMF	Global Instability (Foundation or Slope)	EW	1-EW	(1) Severe natural flooding occurs resulting from some combination of extreme rainfall and snowpack. (2) Flood waters lead to rising pond surface inundating the long, drained tailings beaches and flooding the upstream facing of the embankment. (3) Embankment facing sufficient to prevent concentrated leakage, but excess drainage into the embankments results in rising pore pressures within the rockfill. (4) Rise in pore pressures within the embankment rockfill is sufficient to decrease effective stress in critical resisting areas near the downstream side of the embankment resulting in slope instability.	- Very low likelihood of flood event - Means to maintain water inventory within the target operating range for a wide range of climate conditions storage on beach in the event of flooding - Rockfill surcharge provides offset to flooded pond position - Relatively modest slope angles - Substantial Stage 1 buttress being constructed now at HsB RDS	Potential failure mode that requires design consideration during all mine phases.	1	2.8E-06	5	4	6	4	- Risk of natural flooding causing significant beach inundation remains until closure spillway constructed - Uncertainty in piezometric response and resulting influence on embankment stability due to complex site conditions	- Construction of HsB RDS and West RDS to progressively enhance stability (i.e. buttressing) as mining continues - Pond volume management during operations to maintain flood storage capacity - Spillway to be constructed following mine closure to limit long-term risk	- Can detect the intervene by activating emergency action plans - Climate monitoring to detect large snowpack - Extreme rainfall event of this magnitude would result in regional scale flooding and evacuations already - Rising pond surface would be physically visible by staff - Monitoring equipment is available to detect changing piezometric conditions in near real-time within critical areas of the embankment - Changing pore pressure conditions at key instruments are linked with key staff alerts
	Flood			NS	1-NS	(1) Severe natural flooding occurs resulting from some combination of extreme rainfall and snowpack. (2) Flood waters lead to rising pond surface inundating the long, drained tailings beaches and flooding the upstream facing of the embankment. (3) Embankment facing sufficient to prevent concentrated leakage, but excess drainage into the embankments results in rising pore pressures within the rockfill. (4) Rise in pore pressures within the embankment rockfill is sufficient to decrease effective stress in critical resisting areas near the downstream side of the embankment resulting in slope instability.	- Very low likelihood of flood event - Means to maintain water inventory within the target operating range for a wide range of climate conditions - Relatively modest slope angles - Substantial buttress being constructed now at North RDS	Potential failure mode that requires design consideration during all mine phases.	1	7.5E-07	6	4	6	4	- Risk of natural flooding causing significant beach inundation remains until closure spillway constructed - Uncertainty in piezometric response and resulting influence on embankment stability due to complex site conditions	- Ongoing construction of North RDS to progressively enhance stability (i.e. buttressing) as mining continues - Pond volume management during operations to maintain flood storage capacity. - Spillway to be constructed following mine closure to limit long-term risk	- Can detect the intervene by activating emergency action plans - Climate monitoring to detect large snowpack - Extreme rainfall event of this magnitude would result in regional scale flooding and evacuations already - Rising pond surface would be physically visible by staff - Monitoring equipment is available to detect changing piezometric conditions in near real-time within critical areas of the embankment - Changing pore pressure conditions at key instruments are linked with key staff alerts
	Flood			W	1-W	(1) Severe natural flooding occurs resulting from some combination of extreme rainfall and snowpack. (2) Flood waters lead to rising pond surface inundating the long, drained tailings beaches and flooding the upstream facing of the embankment. (3) Seepage overwhelms capacity of the West Embankment Drain (WED). (4) Rise in pore pressures within the embankment rockfill is sufficient to decrease effective stress in critical resisting areas near the downstream side of the embankment resulting in slope instability.	- Very low likelihood of flood event - Means to maintain water inventory within the target operating range for a wide range of climate conditions - Design capacity of the WED sufficient to manage anticipated flows - Modest slope angles and foundation conditions result in slope stability factors of safety ranging from >5.0 to >3.0	Sufficient risk controls are in place. Judged to be not credible due to embankment geometry, foundation conditions, and design capacity of the WED.	2	N/A	7	3	6	3	- Risk of natural flooding causing significant beach inundation remains until closure spillway constructed - Long-term performance of the WED.	- Installed/uninstalled mitigation measures (e.g. Extraction Basin and drain pods) are included in the WED design to address reasonable range of possible outcomes, including potential changes to performance in the long-term	- Rising pond surface would be physically visible by staff. - Monitoring equipment is available to detect changing piezometric conditions in near real-time within critical areas of the WED and embankment. - Changing pore pressure conditions at key instruments are linked with key staff alerts.
2	Flood		Overtopping	All	2-All	(1) Severe natural flooding occurs resulting from some combination of extreme rainfall and snowpack. (2) Flood waters lead to rising pond surface, which exceeds lowest crest elevation of the embankment. (3) Overtopping at lowest point results in erosion and downcutting through the embankment ultimately leading to a full breach of the facility.	- Very low likelihood of flood event - Means to maintain water inventory within the target operating range for a wide range of climate conditions - Minimum freeboard design criteria based on storage of PMF with additional 5 ft minimum dry freeboard - Additional freeboard generally present during operations due to lift thickness	Sufficient risk controls are in place. Inflow too small relative to freeboard allowance. Very unlikely and not a risk driver; judged to be not credible unless PMF is substantially underestimated.	4	N/A	6	4	6	4	- Potential for underestimate of snowpack and precipitation inputs to determination of the PMF - Climate change	- Maintain adequate freeboard during future operations as per the design criteria - Spillway to be constructed following mine closure to limit long-term risk	- Ongoing climate monitoring to evaluate site specific conditions - Periodic updates to return period snowpack, rainfall, and probable maximum precipitation/snow accumulation to inform updates to the PMF estimate
3	Flood		Internal Erosion / Piping	EW	3-EW	(1) Severe natural flooding occurs resulting from some combination of extreme rainfall and snowpack. (2) Flood waters lead to rising pond surface inundating the long, drained tailings beaches and flooding the upstream facing of the embankment. (3) Leakage begins through the embankment facing material, extensive rockfill surcharge, and permeable rockfill resulting flow discharging along the downstream slope or benches of the embankment. (4) (i) Flow discharge results in erosion to downstream slopes and retrogressive slope instability, or (ii) leakage concentrates in an area that is not internally stable resulting in internal erosion, pipe development, and ultimately failure. (5) Full breach of the facility occurs.	- Very low likelihood of flood event - Means to maintain water inventory within the target operating range for a wide range of climate conditions - Beach development criteria to protect most critical areas of the embankment (i.e. which area of the beach is kept highest) - Rockfill surcharge provides offset to flooded pond position - Enhancement of embankment facing material continuity and stability by slope flattening	Potential failure mode that requires design consideration during all mine phases.	1	6.8E-07	6	4	6	4	- Risk of natural flooding causing significant beach inundation remains until closure spillway constructed - Uncertainty in flow pathways and resulting impacts on embankment due to complex construction history	- Prioritize beach management to push flood inundation preferentially towards West Embankment - Incorporated flatter upstream slopes and better continuity in facing for future raises; consistent with recent adjustments - Pond volume management during operations to maintain flood storage capacity - Spillway to be constructed following mine closure to limit long-term risk	- Can detect the intervene by activating emergency action plans - Climate monitoring to detect large snowpack - Extreme rainfall event of this magnitude would result in regional scale flooding and evacuations already - Rising pond surface would be physically visible by staff
	Flood			NS	3-NS	(1) Severe natural flooding occurs resulting from some combination of extreme rainfall and snowpack. (2) Flood waters lead to rising pond surface inundating the long, drained tailings beaches and flooding the upstream facing of the embankment. (3) Leakage begins through the embankment facing material and permeable rockfill resulting flow discharging along the downstream slope or benches of the embankment. (4) (i) Flow discharge results in erosion to downstream slopes and retrogressive slope instability, or (ii) leakage concentrates in an area that is not internally stable resulting in internal erosion, pipe development, and ultimately failure. (5) Full breach of the facility occurs.	- Very low likelihood of flood event - Means to maintain water inventory within the target operating range for a wide range of climate conditions - Beach development criteria to protect most critical areas of the embankment (i.e. which area of the beach is kept highest) - Enhancement of embankment facing material continuity and stability by slope flattening	Potential failure mode that requires design consideration during all mine phases.	1	6.7E-07	6	4	6	4	- Risk of natural flooding causing significant beach inundation remains until closure spillway constructed - Uncertainty in flow pathways and resulting impacts on embankment due to complex construction history	- Prioritize beach management to push flood inundation preferentially towards West Embankment - Incorporated flatter upstream slopes and better continuity in facing for future raises; consistent with recent adjustments - Pond volume management during operations to maintain flood storage capacity - Spillway to be constructed following mine closure to limit long-term risk	- Can detect the intervene by activating emergency action plans - Climate monitoring to detect large snowpack - Extreme rainfall event of this magnitude would result in regional scale flooding and evacuations already - Rising pond surface would be physically visible by staff
	Flood			W	3-W	(1) Severe natural flooding occurs resulting from some combination of extreme rainfall and snowpack. (2) Flood waters lead to rising pond surface inundating the long, drained tailings beaches and flooding the upstream facing of the embankment. (3) Leakage begins through the embankment facing material and permeable rockfill to the WED. (4) Seepage at the interface between the WED and overlying materials causes suffusion with finer soil particles washed into the highly porous drainage zone. (5) WED becomes plugged by fines, preventing drainage towards the Extraction Pond, and rendering the WED ineffective.	- Very low likelihood of flood event - Means to maintain water inventory within the target operating range for a wide range of climate conditions - Filter relationships between WED and surrounding materials.	Sufficient risk controls are in place. Very unlikely and not a risk driver unless an unknown defect is present.	2	N/A	6	2	6	2	- Not practical to test WED performance for the conditions contemplated; therefore, some uncertainty related to performance	- WED design flow capacity much larger than current normal operating flows - Zoned aggregate drain includes filters to prevent ingress of fines into the WED - Installed/uninstalled mitigation measures (e.g. Extraction Basin and drain pods) are included in the WED design and can be activated if effectiveness decreases	- Monitoring equipment is available to detect changing piezometric conditions in near real-time within critical areas of the WED and embankment - Changing pore pressure conditions at key instruments are linked with key staff alerts. - Flows pumped from the Extraction Pond are recorded continuously and reported daily
4	Flood		Uncontrolled Seepage	W	4-W	(1) Severe natural flooding occurs resulting from some combination of extreme rainfall and snowpack. (2) Flood waters lead to rising pond surface inundating the long, drained tailings beaches and flooding the upstream facing of the embankment. (3) Seepage overwhelms capacity of the West Embankment Drain (WED). (4) Rise in pore pressures within the embankment rockfill and foundation materials increases to above Potentiometric Low (PL) or Deep Isolated Facture System (DIFS) in the West Ridge. (5) Elevated pore pressures within the PL or DIFS are sustained for sufficient period of time, such that uncontrolled seepage from the YDTI occurs towards/beyond the West Ridge.	- Very low likelihood of flood event - Design capacity of the WED sufficient to manage anticipated flows	Sufficient risk controls are in place. Judged to be highly unlikely due to the capacity of the WED, and installed / uninstalled mitigation measures are included in the design to address a reasonable range of possible outcomes.	2	N/A	7	2	6	2	- Not practical to test WED performance for the conditions contemplated; therefore, some uncertainty related to performance - Magnitude and timing of response in the PL and DIFS if the contemplated condition occurred is not known.	- WED design flow capacity much larger than current normal operating flows - Installed/uninstalled mitigation measures (e.g. Extraction Basin and drain pods) are included in the WED design and can be activated if effectiveness decreases	- Monitoring equipment is available to detect changing piezometric conditions in near real-time within critical areas of the WED, embankment, and West Ridge - Changing pore pressure conditions at key instruments are linked with key staff alerts. - Flows pumped from the Extraction Pond are recorded continuously and reported daily

Knight Piésold CONSULTING

TABLE B1

MONTANA RESOURCES, LLC
MONTANA RESOURCES

YANKEE DOODLE TAILINGS IMPOUNDMENT - FAILURE MODES AND EFFECTS ASSESSMENT FOR 6560 AMENDMENT DESIGN DOCUMENT
SUMMARY OF HAZARDS

Risk ID	Initiating / Loading Event		Simplified Failure Mode	Location	Risk ID-Embankment	Risk Description	Primary Means of Risk Control	PFMA Risk Categorization		FMEA Risk Rating (Prior to Permit)			FMEA Risk Rating (Life of Mine)		Residual Risks	Plans for Addressing Residual Risks	
	Category	Sub-category						Preliminary Screening Assessment	Category	2022 RA Cumulative Likelihood Extreme/Major	Likelihood L	Consequence C	Likelihood L	Consequence C		Engineering Controls	Administrative Controls
5	Earthquake	84th-Percentile MCE	Global Instability (Foundation or Slope)	EW	5-EW	(1) Severe earthquake occurs. (2) Seismic loading results in excess pore pressure development within critical resisting areas of the embankment or foundation soils. (3) Increasing pore pressures result in decreasing shear resistance leading to slope instability. (4) Embankment instability occurs through a deeply seated slip surface and/or retrogressive failure sequence impacting the full embankment height.	- Very low likelihood of seismic event - Rockfill surcharge enhances seismic performance - Relatively modest slope angles - Substantial Stage 1 buttress being constructed now at HsB RDS - Reasonably competent rockfill that drains well - Large design freeboard	Potential failure mode that requires design consideration during all mine phases.	1	2.1E-06	5	3	6	2	- High seismic region with design event exceeding recorded historical seismic events in the region - Uncertainty in piezometric response and resulting influence on embankment stability due to complex site conditions	- Construction of HsB RDS and West RDS to progressively enhance stability (i.e. buttressing) as mining continues '- Maintain long, well drained tailings beaches and supernatant pond position consistent with current conditions - Maintain adequate freeboard during future operations as per the design criteria	- Tailings beach length regularly monitored - Downstream slopes regularly assessed with QPPs - Seismic monitoring equipment available and linked with key staff alerts - Can detect the intervene by activating emergency action plans
	Earthquake			NS	5-NS	(1) Severe earthquake occurs. (2) Seismic loading results in excess pore pressure development within critical resisting areas of the embankment or foundation soils. (3) Increasing pore pressures result in decreasing shear resistance leading to slope instability. (4) Embankment instability occurs through a deeply seated slip surface impacting the full embankment height.	- Very low likelihood of seismic event - Relatively modest slope angles - Substantial buttress being constructed now at North RDS - Reasonably competent rockfill that drains well - Large design freeboard	Potential failure mode that requires design consideration during all mine phases.	1	4.9E-06	5	4	7	2	- High seismic region with design event exceeding recorded historical seismic events in the region - Uncertainty in piezometric response and resulting influence on embankment stability due to complex site conditions	- Ongoing construction of North RDS to progressively enhance stability (i.e. buttressing) as mining continues - Maintain long, well drained tailings beaches and supernatant pond position consistent with current conditions - Maintain adequate freeboard during future operations as per the design criteria	- Tailings beach length regularly monitored - Downstream slopes regularly assessed with QPPs - Seismic monitoring equipment available and linked with key staff alerts - Can detect the intervene by activating emergency action plans
	Earthquake			W	5-W	(1) Severe earthquake occurs. (2) Seismic loading results in excess pore pressure development within critical resisting areas of the embankment or foundation materials. (3) Increasing pore pressures result in decreasing shear resistance leading to slope instability. (4) Embankment instability occurs and slumping deformation occurs in one or more areas where the embankment is not completely buttressed by the West Ridge.	- Very low likelihood of seismic event - Modest slope angles and foundation conditions result in slope stability factors of safety ranging from >5.0 to >3.0 - Large design freeboard - WED maintains unsaturated conditions in critical resisting areas of embankment	Very unlikely and not a risk driver. Loss of containment failure judged to be not credible at this location due to sequence of events, height and width of the embankment in this area, foundation conditions, and WED performance.	4	N/A	7	2	6	2	- High seismic region with design event exceeding recorded historical seismic events in the region	- Continue to construct West Embankment using centerline method over existing wider base with final layout achieving configuration like a downstream constructed embankment - Maintain adequate freeboard during future operations as per the design criteria - Maintain long, well drained tailings beaches and supernatant pond position consistent with current conditions	- Tailings beach length regularly monitored - Downstream slopes regularly assessed with QPPs - Seismic monitoring equipment available and linked with key staff alerts - Can detect the intervene by activating emergency action plans
6	Earthquake		Overtopping	EW	6-EW	(1) Design maximum credible earthquake (84th-Percentile MCE) occurs along the Continental Fault. (2) The embankment deforms and crest settles due to the seismic loading of the embankment. (3) Tailings upstream of the embankment experience seismic liquefaction causing settlement and allowing the supernatant pond to come southward to the embankment. (4) Embankment crest settles to a final position that is lower than the resulting supernatant pond elevation and the tailings settlement allows the pond to reach the embankment. (5) Overtopping at the lowest point results in erosion and downcutting through the embankment ultimately leading to a full breach of the facility.	- Very low likelihood of seismic event - Very long, well drained beaches and remote location of the supernatant pond - Large design freeboard for flood management and additional freeboard generally present during operations due to lift thickness	Sufficient risk controls are in place. Judged to be highly unlikely; however, considered a potential failure mode that requires design consideration during all mine phases.	1	Negligible	7	4	7	4	- High seismic region with design event exceeding recorded historical seismic events in the region - Uncertainty in estimating the magnitude of earthquake-induced settlement and material compressibility (and spatial variability thereof)	- Maintain long, well drained tailings beaches and supernatant pond position consistent with current conditions - Maintain adequate freeboard during future operations as per the design criteria - Construction of HsB RDS and West RDS to progressively enhance slope stability (i.e. buttressing) will also improve seismic performance	- Tailings beach length regularly monitored - Crest elevation/freeboard regularly assessed with QPPs - Seismic monitoring equipment available and linked with key staff alerts - Seismic event of this magnitude would result in regional scale damage and evacuations already - Can detect the intervene by activating emergency action plans
	Earthquake			NS	6-NS	(1) Severe earthquake occurs. (2) Response to earthquake results in compression of the buried leach materials on the downstream side of the embankment. (3) Undesirable embankment crest settlement. (4) Results in overtopping of supernatant pond and breach of the facility.	- Very low likelihood of seismic event - Very long, well drained beaches and remote location of the supernatant pond - Large design freeboard for flood management and additional freeboard generally present during operations due to lift thickness	Sufficient risk controls are in place. Judged to be highly unlikely; however, considered a potential failure mode that requires design consideration during all mine phases.	1	Negligible	7	4	7	4	- High seismic region with design event exceeding recorded historical seismic events in the region - Uncertainty in estimating the magnitude of earthquake-induced settlement and material compressibility (and spatial variability thereof) - Potential for vertical displacement associated with fault rupture near north abutment	- Maintain long, well drained tailings beaches and supernatant pond position consistent with current conditions - Maintain adequate freeboard during future operations as per the design criteria - Construction of North RDS to progressively enhance slope stability (i.e. buttressing) will also improve seismic performance	- Tailings beach length regularly monitored - Crest elevation/freeboard regularly assessed with QPPs - Seismic monitoring equipment available and linked with key staff alerts - Seismic event of this magnitude would result in regional scale damage and evacuations already - Can detect the intervene by activating emergency action plans
	Earthquake			W	6-W	(1) Severe earthquake occurs. (2) The embankment deforms and crest settles due to the seismic loading of the embankment. (3) Tailings upstream of the embankment experience seismic liquefaction causing settlement and allowing the supernatant pond to come westward to the embankment. (4) Embankment crest settles to a final position that is lower than the resulting supernatant pond elevation and the tailings settlement allows the pond to reach the embankment. (5) Overtopping at lowest point results in erosion and downcutting through the embankment ultimately leading to a full breach of the facility.	- Very low likelihood of seismic event - Very long, well drained beaches and remote location of the supernatant pond - Modest slope angles and bedrock foundation - Large design freeboard for flood management and additional freeboard generally present during operations due to lift thickness	Very unlikely and not a risk driver. Judged to be not credible at this location due to sequence of events, height and width of the embankment in this area, foundation conditions, and long tailings beach.	4	N/A	7	4	7	4	- High seismic region with design event exceeding recorded historical seismic events in the region - Uncertainty in estimating the magnitude of earthquake-induced settlement and material compressibility (and spatial variability thereof)	- Continue to construct West Embankment using centerline method over existing wider base with final layout achieving configuration like a downstream constructed embankment - Maintain adequate freeboard during future operations as per the design criteria - Maintain long, well drained tailings beaches and supernatant pond position consistent with current conditions	- Tailings beach length regularly monitored - Crest elevation/freeboard regularly assessed with QPPs - Seismic monitoring equipment available and linked with key staff alerts - Seismic event of this magnitude would result in regional scale damage and evacuations already - Can detect the intervene by activating emergency action plans
7	Earthquake		Undesirable Embankment Deformation	EW/NS	7-EW/NS	(1) Severe earthquake occurs. (2) The embankment deforms due to the seismic loading of the embankment. (3) Resulting deformations cause slope adjustments, cracking, and/or embankment bench settlement impacting the pipelines, haul ramps, or other infrastructure.	- Very low likelihood of seismic event - Relatively modest slope angles - Substantial Stage 1 buttress being constructed now at HsB RDS and North RDS enhances stability in toe regions. - Reasonably competent rockfill that drains well	Potential failure mode that requires design consideration during all mine phases. Potential risk for on site operations that requires consideration.	1	3.1E-05	4	2	4	2	- High seismic region with design event exceeding recorded historical seismic events in the region - Uncertainty in estimating the magnitude of earthquake-induced settlement and material compressibility (and spatial variability thereof)	- Construction of HsB RDS, North RDS, and West RDS to progressively enhance stability (i.e. buttressing) as mining continues - Overall downstream slopes progressively flattened as lower embankment lifts and downstream step-out for EL. 6,560 ft lift are constructed	- Downstream slopes regularly assessed with QPPs - Seismic monitoring equipment available and linked with key staff alerts - Can detect the intervene by activating emergency action plans

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TABLE B1

MONTANA RESOURCES, LLC
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YANKEE DOODLE TAILINGS IMPOUNDMENT - FAILURE MODES AND EFFECTS ASSESSMENT FOR 6560 AMENDMENT DESIGN DOCUMENT
SUMMARY OF HAZARDS

Risk ID	Initiating / Loading Event		Simplified Failure Mode	Location	Risk ID-Embankment	Risk Description	Primary Means of Risk Control	PFMA Risk Categorization		FMEA Risk Rating (Prior to Permit)			FMEA Risk Rating (Life of Mine)		Residual Risks	Plans for Addressing Residual Risks	
	Category	Sub-category						Preliminary Screening Assessment	Category	2022 RA Cumulative Likelihood Extreme/Major	Likelihood L	Consequence C	Likelihood L	Consequence C		Engineering Controls	Administrative Controls
8	Construction	Ongoing Construction Activities	Global Instability (Foundation or Slope)	EWCPA	8-EWCPA	(1) Construction loading during placement of embankment lifts along the East-West Embankment in the Central Pedestal Area. (2) Loading results in increased shear stresses and excess pore pressure development within saturated zones of the embankment fill within critical resisting areas of the embankment exceeding shear resistance. (3) Embankment instability occurs through a deeply seated slip surface impacting the full embankment height. (4) Large-scale landsliding and/or slumping deformation occurs in the central pedestal area resulting in potential loss of tailings containment.	- Massive nature of the structure and extensive drained tailings beaches upstream - Reasonably competent rockfill that drains well - Stage 1 buttress being constructed now at HsB RDS substantially improves factors of safety with progressive improvements thereafter with ongoing RDS construction	Judged to be highly unlikely based on limited observation of excess pore pressure during construction of the EL. 6,450 ft embankment. However, considered a potential failure mode that requires design consideration during all mine phases.	2	7.0E-06	5	3	5	2	- Uncertainty in loading rates and construction sequencing - Uncertainty in piezometric response and resulting influence on embankment stability due to complex site conditions	- Construction of HsB RDS to progressively enhance stability (i.e. buttressing) as mining continues - Gradual downstream slope flattening during ongoing construction - Maintain long, well drained tailings beaches - Maintain adequate freeboard during future operations as per the design criteria	- Regular visual inspections by site operations and engineering teams - Surface and subsurface deformation monitoring programs - Monitoring equipment is available to detect changing piezometric conditions in near real-time within critical areas of the embankment - Changing pore pressure conditions at key instruments are linked with key staff alerts
	Construction			EW	8-EW	(1) Construction loading during placement of embankment lifts along the East-West Embankment and West RDS. (2) Loading results in increased shear stresses and excess pore pressure development within saturated zones of the embankment fill within critical resisting areas of the embankment exceeding shear resistance. (3) Embankment instability occurs through a deeply seated slip surface impacting the full embankment height. (4) Large-scale landsliding and/or slumping deformation occurs resulting in potential loss of tailings containment.		Judged to be highly unlikely based on limited observation of excess pore pressure during construction of the EL. 6,450 ft embankment. However, considered a potential failure mode that requires design consideration during all mine phases.	2	N/A	5	2	5	2		- Construction of West RDS to progressively enhance stability (i.e. buttressing) as mining continues - Gradual downstream slope flattening during ongoing construction - Maintain long, well drained tailings beaches - Maintain adequate freeboard during future operations as per the design criteria	
	Construction			NS	8-NS	(1) Construction loading during placement of embankment lifts along the North-South Embankment and North RDS. (2) Loading results in increased shear stresses and excess pore pressure development within saturated zones of the embankment fill within critical resisting areas of the embankment exceeding shear resistance. (3) Embankment instability occurs through a deeply seated slip surface impacting the full embankment height. (4) Large-scale landsliding and/or slumping deformation occurs resulting in potential loss of tailings containment.		Judged to be highly unlikely based on limited observation of excess pore pressure during construction of the EL. 6,450 ft embankment. However, considered a potential failure mode that requires design consideration during all mine phases.	2	N/A	5	2	5	2		- Ongoing construction of North RDS to progressively enhance stability (i.e. buttressing) as mining continues - Gradual downstream slope flattening during ongoing construction - Maintain long, well drained tailings beaches - Maintain adequate freeboard during future operations as per the design criteria	
	Construction			W	8-W	(1) Construction loading during placement of embankment lifts along the West Embankment. (2) Loading results in increased shear stresses and excess pore pressure development within saturated zones of the embankment fill within critical resisting areas of the embankment exceeding shear resistance. (3) Embankment instability occurs through a deeply seated slip surface impacting the full embankment height. (4) Large-scale landsliding and/or slumping deformation occurs resulting in potential loss of tailings containment.	- Modest slope angles and foundation conditions result in slope stability factors of safety ranging from >5.0 to >3.0 - Large design freeboard - WED maintains unsaturated conditions in critical resisting areas of embankment	Very unlikely and not a risk driver. Loss of containment failure judged to be not credible at this location due to height and width of the embankment in this area, foundation conditions, and WED performance.	2	N/A	7	2	7	2	- Long-term performance of the WED	- Continue to construct West Embankment using centerline method over existing wider base with final layout achieving configuration like a downstream constructed embankment - Maintain adequate freeboard during future operations as per the design criteria - Maintain long, well drained tailings beaches and supernatant pond position consistent with current conditions	- Monitoring equipment is available to detect changing piezometric conditions in near real-time within critical areas of the WED and embankment - Changing pore pressure conditions at key instruments are linked with key staff alerts
9	Construction		Undesirable Embankment Deformation	EW	9-EW	(1) Construction loading during placement of embankment lifts along the East-West Embankment. (2) Loading results in increased shear stresses exceeding shear resistance. (3) Embankment instability cause slope adjustments, cracking, and/or embankment bench settlement impacting the pipelines, haul ramps, or other infrastructure.	- Modest overall slope angles - Reasonably competent rockfill that drains well - Controlled loading possible based on piezometric/deformation response observed	Potential failure mode that requires design consideration during all mine phases. However, judged to be unlikely based on observations during construction of the EL. 6,450 ft embankment.	1	2.3E-05	4	2	4	2	- Uncertainty in loading rates and construction sequencing - Uncertainty in piezometric response and resulting influence on embankment stability due to complex site conditions	- Construction of HsB RDS and West RDS to progressively enhance stability (i.e. buttressing) as mining continues - Gradual downstream slope flattening during ongoing construction - Maintain long, well drained tailings beaches - Maintain adequate freeboard during future operations as per the design criteria	- Regular visual inspections by site operations and engineering teams - Surface and subsurface deformation monitoring programs - Monitoring equipment is available to detect changing piezometric conditions in near real-time within critical areas of the embankment - Changing pore pressure conditions at key instruments are linked with key staff alerts - Emergency warning systems
	Construction			NS	9-NS	(1) Construction loading during placement of embankment lifts along the North-South Embankment and North RDS. (2) Loading results in increased shear stresses exceeding shear resistance. (3) Embankment instability cause slope adjustments, cracking, and/or embankment bench settlement impacting the pipelines, haul ramps, or other infrastructure.	- Modest overall slope angles - Reasonably competent rockfill that drains well - Basal saturated zone is deep within embankment with no observations of seepage on the downstream side of embankment (drainage towards central maximum section)	Potential failure mode that requires design consideration during all mine phases. However, judged to be unlikely based on observations during construction of the EL. 6,450 ft embankment.	2	N/A	4	2	4	2	- Uncertainty in loading rates and construction sequencing	- Ongoing construction of North RDS to progressively enhance stability (i.e. buttressing) as mining continues - Gradual downstream slope flattening during ongoing construction	- Regular visual inspections by site operations and engineering teams - Surface and subsurface deformation monitoring programs
	Construction			W	9-W	(1) Construction loading during placement of embankment lifts along the West Embankment. (2) Loading results in increased shear stresses exceeding shear resistance. (3) Embankment instability occurs through a relatively shallow slip surface with no loss of tailings containment.	- Modest slope angles and foundation conditions result in slope stability factors of safety >2.5 - WED maintains unsaturated conditions in critical resisting areas of embankment	Sufficient risk controls are in place. Very unlikely and not a risk driver.	2	N/A	4	2	4	2	- Uncertainty in loading rates and construction sequencing	- Continue to construct West Embankment using centerline method over existing wider base with final layout achieving configuration like a downstream constructed embankment	- Regular visual inspections by site operations and engineering teams - Surface deformation monitoring programs
	Construction			WED	9-WED	(1) Construction loading during placement of embankment lifts along the West Embankment. (2) Settlement within WED leads to a decrease in porosity within the WED. (3) WED becomes less effective at conveying seepage to the Extraction Pond and leading to increased pore pressures within the embankment.	- Design capacity of the WED sufficient to manage anticipated flows even with some decrease in porosity - EL. 6,450 ft embankment lift already constructed and WED operating as designed	Sufficient risk controls are in place. Judged to be highly unlikely due to the capacity of the WED, and installed / uninstalled mitigation measures are included in the design to address a reasonable range of possible outcomes.	2	N/A	7	2	6	2	- Uncertainty in loading rates and construction sequencing - Uncertainty in deformation response and resulting influence on WED porosity due to complex site conditions	- WED design flow capacity much larger than current normal operating flows - Installed/uninstalled mitigation measures (e.g. Extraction Basin and drain pods) are included in the WED design and can be activated if effectiveness decreases - Aggregates used for WED drainage zone are strong and reasonably resistant to wear	- Monitoring equipment is available to detect changing piezometric conditions in near real-time within critical areas of the WED and embankment - Changing pore pressure conditions at key instruments are linked with key staff alerts

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	Category	Sub-category						Preliminary Screening Assessment	Category	2022 RA Cumulative Likelihood Extreme/Major	Likelihood L	Consequence C	Likelihood L	Consequence C		Engineering Controls	Administrative Controls
10	Material Degradation	Embankment (Induced strain softening, Acidic Drainage, Weathering)	Global Instability (Foundation or Slope)	EW	10-EW	(1) Creep occurs within basal saturated zone or a perched saturated zone within the embankment or chemical weathering (degradation) results in decreasing strength properties within critical resisting areas of the embankment. (2) Deformation causes either: (i) excess pore pressure development or (ii) reduced confining pressures resulting in induced strain softening within critical resisting areas of the embankment. (3) Embankment instability occurs either through (i) a deeply seated slip surface impacting the full embankment height or (ii) hypothetical perched saturated condition aligned with the Seep 10 bench (iii) instability occurs locally at the Seep 10 bench. (4) Large-scale landslide and/or slumping deformation occurs within the HsB area potentially impacting mine infrastructure in the area or retrogressive slope instability follows the initial instability causing deformation within the HsB area potentially impacting mine infrastructure in the area.	- Massive nature of the structure and extensive drained tailings beaches upstream - Reasonably competent rockfill that drains well - Stage 1 buttress being constructed now at HsB RDS substantially improves factors of safety with progressive improvements thereafter with ongoing RDS construction	Potential failure mode that requires design consideration during all mine phases.	1	7.3E-07	6	3	6	2	- The outcome of various material degradation physical processes and spatial variability (widespread or local) is uncertain due to complexity of site conditions and processes; however, instability would likely manifest in a way similar to other failure modes.	- Construction of HsB RDS to progressively enhance stability (i.e. buttressing) as mining continues - Gradual downstream slope flattening during ongoing construction - Maintain long, well drained tailings beaches - Maintain adequate freeboard during future operations as per the design criteria	Regular visual inspections by site operations and engineering teams - Surface and subsurface deformation monitoring programs - Monitoring equipment is available to detect changing piezometric conditions in near real-time within critical areas of the embankment - Changing pore pressure conditions at key instruments are linked with key staff alerts - Emergency warning systems
11	Material Degradation		Undesirable Embankment Deformation	W	11-W	(1) Continuous acidic drainage within WED. (2) Chemical weathering results in decreasing porosity within the highly porous zone of the WED due to material breakdown and/or precipitate build up. (3) WED becomes plugged, preventing drainage towards the Extraction Pond, and rendering the WED ineffective.	- Design capacity of the WED sufficient to manage anticipated flows - Installed / uninstalled mitigation measures are included in the design to address a reasonable range of possible outcomes. - Aggregates selected for WED construction were best available from external borrow	Sufficient risk controls are in place. Judged to be highly unlikely due to the capacity of the WED and available mitigation measures.	2	N/A	6	2	6	2	- Drainage exiting WED at Extraction Pond known to be acidic with some precipitate buildup - Uncertainty will continue to exist related to material breakdown/precipitate buildup within WED	- WED design flow capacity much larger than current normal operating flows - Installed/uninstalled mitigation measures (e.g. Extraction Basin and drain pods) are included in the WED design and can be activated if effectiveness decreases - Aggregates used for WED drainage zone reasonably resistant to chemical weathering	- Monitoring equipment is available to detect changing piezometric conditions in near real-time within critical areas of the WED, embankment, and West Ridge - Changing pore pressure conditions at key instruments are linked with key staff alerts. - Flows pumped from the Extraction Pond are recorded continuously and reported daily
	Material Degradation			All	11-All	(1) Exposure of embankment fill materials near surface to atmospheric conditions (air, snow, rain, freeze-thaw, etc.). (2) Physical and chemical weathering results in slope creep, strength reduction, and/or erosion. (3) Resulting deformations cause slope adjustments, cracking and/or bench settlement potentially impacting the tailings distribution systems, mine haul ramps, and/or embankment crest trafficability.	- Modest overall slope angles with regular catch benches to manage material from weathering/erosion - Reasonably competent rockfill that drains well - Mining equipment available during operations to regrade areas as needed	Possibility exists of ongoing material weathering, erosion, settlement, and/or slope creep. Primarily a maintenance and operations issue with potential impacts to site operations.	2	N/A	4	2	4	2	- Exposure of near surface materials to atmospheric conditions	- Regular catch benches to manage slope erosion - Mining equipment available during operations to regrade areas as needed - Flatter overall slope angles incorporated in the design of future stages - RDS construction in areas of old slopes - Closure capping will include placement of soil and revegetation	- Regular visual inspection and aerial survey to detect cracking, settlement, and other surface deformations
12	Material Degradation			All	12-All	Embankment and/or foundation material degradation/weathering results in unwanted crest settlement leading to loss of freeboard.	- Very long, well drained beaches and remote location of the supernatant pond - Large design freeboard for flood management and additional freeboard generally present during operations due to lift thickness	Possibility exists of material weathering and settlement; however, magnitude of settlement required to result embankment failure is not credible.	4	N/A	7	1	7	1	- Material degradation / weathering resulting in crest settlement	- Mining equipment available during operations to regrade crest and maintain elevation within design tolerances	- Regular visual inspection and aerial survey to detect settlement
13	Operational Upset Malfunction	Tailings pipeline burst	Instability (Foundation or Slope)	EW	13-EW	(1) Tailings pipeline rupture occurs between No. 2 and No. 3 Booster Pump Stations. (2) Tailings slurry discharging from ruptured pipeline erodes downstream slope within the central pedestal area. (3) Erosion of slope progresses through a combination of down-cutting and shallow rotational slip surfaces resulting in material deposition on slopes/benches and/or within the HsB area.	- Massive nature of the structure and upper more recent fill materials not particularly erodible - Pipeline operations monitoring (e.g. pipeline pressures, etc.) allows for shutdown in event of rupture with discharge limited thereafter	Possibility exists of pipeline rupture, but not a dam failure risk-driver. Primarily a maintenance and operations issue with potential impacts to site operations.	2	N/A	5	2	5	2	- Possibility of pipeline wear and rupture always present during operations phase - Risk does not exist following mine closure	- Pipeline and pump system materials - Maintenance and replacement of worn pipelines as required	- Detection through tailings pipeline operations monitoring, e.g. pipeline pressures, etc. - Regular visual inspection by site operations and maintenance teams
	Operational Upset Malfunction			All	13-All	Tailings pipeline rupture near the discharge points could result in slurry flowing down the upstream facing material resulting in erosion and slumping locally on the upstream side of the embankment.	- Massive nature of the structure and upper more recent fill materials not particularly erodible	Possibility exists of pipeline rupture, but not a dam failure risk-driver. Primarily a maintenance and operations issue with potential impacts to site operations.	2	N/A	2	1	2	1	- Possibility of pipeline wear and rupture always present during operations phase - Risk does not exist following mine closure	- Pipeline and discharge valve materials - Maintenance and replacement of worn pipelines and valves as required	- Regular visual inspection by site operations and maintenance teams
14	Geological Hazards	Landslide	Overtopping	All	14-All	(1) Landslide occurs from Rampart Mountain along the eastern side of the YDTI. (2) Slide reaches the supernatant pond and causes a wave. (3) Wave runs up the tailings beach and overtops the embankment causing erosion and damage on the downstream side of the embankment.	- Inferred low likelihood of large landslides on Rampart Mountain based on existing knowledge base - Large design freeboard during most of operations and in closure - Long tailings beach may attenuate hypothetical wave	May be difficult to comment on likelihood based on existing knowledge base; possibility cannot be ruled out but no compelling evidence to suggest it is a failure mode of concern.	3	N/A	6	3	6	2	- Uncertainty regarding potential for landslides along Rampart Mountain could warrant future study	None identified	- Periodic visual inspection by site operations team with external engineering support if required due to unusual observations
15	Geological Hazards		Impacts on mine operations	All	15-All	Landslide on Rampart Mountain blocks access to the pump-back barge.	- Inferred low likelihood of landslides on Rampart Mountain based on existing knowledge base - Multiple points of access to barge area. - Mine equipment available to clear blockages or could create access from the west side along existing trails within days	Not a dam safety issue; could upset operations.	2	N/A	5	1	5	1	- Uncertainty regarding potential for landslides along Rampart Mountain could warrant future study	None identified	- Periodic visual inspection by site operations team with external engineering support if required due to unusual observations
16	Geological Hazards	Wind	Air Quality	All	16-All	High, sustained winds generate dust that impacts mine operations and adjacent population.	- Climate monitoring provides prediction of upcoming dusting events and dust management plans are in place including proactive management measures	Possibility exists of high wind events generating dust. Sequence of events required to result in embankment failure is not credible.	4	N/A	2	2	2	2	- Possibility of high winds resulting in potential for windblown dust	None identified	- Climate monitoring and forecast predictions - Dust management measures and emergency response plans well developed
17	Geological Hazards	Fire	Impacts on mine operations	All	17-All	Fire in immediate vicinity results in site evacuation with visual monitoring interrupted.	- Emergency management plans in place. Automated remote monitoring systems are powered by batteries and communicate using radio signals and cellular telemetry	Possibility exists of fires. Sequence of events required to result in embankment failure is not credible.	4	N/A	4	1	4	1	- Possibility of fires impacting operations	None identified	- Emergency management plans are in place - Operations shut down in event of evacuation
18	Geological Hazards	Drought	Impacts on mine operations	All	18-All	Severe, sustained drought results in lack of water for mine operations and dust suppression.	- Water rights on fresh water supply and adequate contingency	Not a dam safety issue; could upset operations.	2	N/A	5	2	5	2	- Possibility of drought impacting water availability	None identified	- Climate monitoring and forecast predictions - Dust management measures and emergency response plans well developed

REV	DATE	DESCRIPTION	PREP'D	RVW'D
0	21FEB25	ISSUED WITH REPORT VA101-00129/24-9	JRG	DCF