

Saraji Mine PRCP Risk Assessment

Risk Event	Scenario #	Scenario	Causes	Impact Description	Highest MFL Level	Mitigating Controls	Highest Impact	Preventative Controls	Likelihood Basis (chance of the risk occurring at impact level - used in the calculation of the RRR, taking into account the effectiveness of preventative controls)	Likelihood	Likelihood Factor	RRR
Stable condition for land described as a post-mining land use (cattle grazing, grassland, woodland habitat, watercourse) is not achieved	PMLU 1	Landform failure	1. Erosional instability 2. Geotechnical instability 3. Incorrect geotechnical assessment 4. Differential settlement (spoil and backfilled dams) 5. Insufficient materials to achieve design (rock, growth media) 6. Unsuitable materials used on final landform surface 7. Flooding 8. Not achieving design 9. Selection of inappropriate PMLU	- Erosion - Growth media loss - Failure of vegetation - Slumping and settlement - Mass movement of landform	4	- Monitoring of landform stability and rehabilitation success to be undertaken post rehabilitation - Identify requirements for rectification works - Complete maintenance	2	- Ongoing materials characterisation - Selective handling of materials for placement - Review the topsoil and rock material balance periodically during operations to ensure sufficient volumes for the rehabilitation needs - No permanent berms or water management on slopes - Landform surrounding the spoil dumps and voids to be reshaped to be free-draining where required to prevent impacts - Groundcover including vegetation to provide erosion resistance - Compliance to plan - Sufficient spoil capping depths over tailings materials - Growth media and spoil assessment by Appropriately Qualified Person (APQ) to determine ameliorant and fertiliser requirements	With all controls in place, including ongoing monitoring and maintenance, landform failure on a large scale is unlikely	Unlikely	0.1	3
Stable condition for land described as a post-mining land use (cattle grazing, grassland, woodland habitat, watercourse) is not achieved	PMLU 2	Alteration of hydrogeological conditions	1. Release of contaminants to groundwater 2. Change in groundwater flow, recharge and/or discharge characteristics resulting in changes to the hydrogeological system 3. Drawdown of groundwater due to void lakes acting as a sink due to losses associated with evaporation	- Groundwater chemistry altered rendering it not suitable for extraction and/or to support PMLU - Groundwater quality not supporting the establishment/maintenance of Environmental Values and Water Quality Objectives for the basins in which the site is located - AMD, NDM, SD reporting to shallow and deep groundwater systems - Reduction of groundwater height within surrounding extraction bores - Degradation of terrestrial and aquatic groundwater dependant ecosystems (GDEs)	3	- Assessment and remediation of impacted material, where appropriate - Development and approval of a Site Management Plan to assist with ongoing management and restriction to future land use activities where appropriate - Implementation of management controls and monitoring programs outlined in an approved Site Management Plan - Re-establishment of impacted ecosystems - Decommissioning of impacted supply bores and re-instatement in suitable location	2	- All imported hazardous materials are to be stored and used in in accordance with relevant standards and removed from site on completion of mining - At the completion of operations, all stored hazardous materials and infrastructure within the MIA and CHPP, that have the potential to release contaminants to groundwater, will be removed from site - Contaminated land investigation to be undertaken at the completion of operations to identify contamination that has the potential to cause impacts to groundwater - Implementation of remediation and/or management plans as required to reduce potential groundwater impact risks - Mine affected water dams to be decommissioned (including investigation for potential contamination and groundwater impacts). - Groundwater monitoring to be undertaken in accordance with EA/PRCP conditions - Residual void catchments to be designed and created to establish sinks that provide for the collection of seepage from former operational areas, tailing storage facilities and spoil dumps - Appropriate management, placement, and monitoring of waste (spoil, tailings, rejects) during operations - Landforms constructed to minimise the potential for flooding of the residual voids - Modelling of groundwater and fate and transport to understand the impacts associated with landforms/activities	With all controls in place, including ongoing monitoring and maintenance, failure to attain a stable condition for land described as the post-mining land use is highly unlikely due to alternation of hydrogeological conditions	Highly Unlikely	0.03	0.9
Stable condition for land described as a post-mining land use (cattle grazing, grassland, woodland habitat, watercourse) is not achieved	PMLU 3	Alteration of surface water systems	1. Release of contaminants to surface water resources 2. Changes to alignments and ecosystems of drainage lines and creek 3. Changes to hydraulic flows 4. Changes to flood patterns/distribution 5. Alteration of surface water infiltration rates 6. Surface water flows over unvegetated/disturbed soils where revegetation has not re-established 7. Overland discharges from neighbouring landforms and rehabilitated areas 8. Creeks and drainage lines not attaining successful rehabilitated state	- Surface water chemistry altered rendering it not suitable for PMLU - AMD, NDM, SD reporting to surface water - Degradation of ecosystems and land uses connected to surface water flows and floodplains on and down gradient of the mine - Sedimentation of downstream surface water drainage lines resulting in changes to their hydraulic properties and impacting ecosystems - Surface water quality not supporting the establishment/maintenance of Environmental Values and Water Quality Objectives for the basins in which the mine is located - Accelerated erosion rates from surface water flows in disturbed areas and degraded ecosystems - Reduction in rehabilitation success rates due to reduced surface water quality - Alteration of soil properties associated with contaminants carried by surface waters, including erodibility and geotechnical qualities	3	- Surface water monitoring data to be collected in accordance with the EA. If impacts are identified, further investigations will be undertaken to determine appropriate remedial measures - Any loss of hazardous contaminants that cause contaminated land/environmental harm will be reported and investigated/remediated as appropriate - Remedial works will be undertaken where releases from site result in impacts to surface waters, which may include alteration of the landforms, implementation of a Site Management Plan, implementation of additional controls/measures that reduce the potential for surface water impacts and/or re-establishment of impacted ecosystems where appropriate - Rehabilitated landforms that do not attain a stable state to be repaired and revegetated	2	- All imported hazardous materials to be stored and used in accordance with relevant standards and removed from site on completion of operations - Mine affected water dams to be decommissioned and areas rehabilitated - Surface water monitoring to be undertaken in accordance with EA conditions - Monitoring of surrounding ecosystems will be undertaken in accordance with EA conditions - A contaminated land investigation will be undertaken at the completion of operations and remediation works undertaken as appropriate - Rehabilitation of disturbed areas will be undertaken as soon as possible after land becomes available - Rehabilitation and monitoring of disturbed reaches of creeks undertaken - Appropriate management, placement, and monitoring of waste (spoil, tailings, rejects) during operations - Landforms constructed to minimise the potential for flooding of the residual voids	With all controls in place, including ongoing monitoring and maintenance, failure to attain a stable condition for land described as the post-mining land use is unlikely due to alternation of surface water conditions	Unlikely	0.1	3
Stable condition for land described as a post-mining land use (cattle grazing, grassland, woodland habitat, watercourse) is not achieved	PMLU 4	Watercourse diversion not achieving closure objectives	1. Hydrologic characteristics of surface water and groundwater systems not representative of natural reaches 2. Hydraulic characteristics not representative of natural reaches 3. Geomorphic instability (bank erosion) 4. Seepage to/from residual voids impacting on stability 5. Sediment transport regime is not in equilibrium with and/or representative of the natural reaches 6. Poor riparian vegetation diversity and cover 7. High percentage of weeds/ invasive species 8. Poor water quality from runoff from surrounding landforms and rehabilitated areas 9. Failure of landforms impacting the performance of the diversion	- Sediment regime impacts within diversion and downstream reaches resulting in changes to hydraulic properties - Surface water chemistry altered rendering it not suitable for PMLU - Degradation of downstream ecosystems and land uses connected to surface water flows and floodplains - Surface water quality not supporting the establishment/maintenance of Environmental Values and Water Quality Objectives for the basins in which the mine is located - accelerated rates of erosion and instability within diversion embankments and surrounding the diversion causing landform instability, damage to rehabilitation areas and alteration of diversion hydraulics - Changes to environmental flows and flood regimes impacting on surrounding land users and environmental receptors	4	- Surface water monitoring data to be collected. If impacts are identified, further investigations will be undertaken to determine appropriate remedial measures - Rehabilitated landforms that do not attain a stable state to be investigated, repaired, revegetated and/or redesigned	2	- Creek diversion monitoring to relevant IDC standard and maintenance during the operational phase - Diversion remediation designs in accordance with the DNRME 2019 hydraulic design criteria for permanent diversions - Growth media and spoil assessment to determine ameliorant and fertiliser requirements - Revegetation species aligned to growth media, landforms and PMLU - Mine infrastructure that interacts with the creek diversions during operations will be removed prior to closure (e.g. culverts) - Rehabilitation of surrounding landforms	With all controls in place, including ongoing monitoring and maintenance, inability of watercourses to meet closure objectives is unlikely as realignment of the watercourses is proposed	Unlikely	0.1	3
Stable condition for land described as a post-mining land use (cattle grazing, grassland, woodland habitat, watercourse) is not achieved	PMLU 5	Contaminated land impacting on environmental receptors, rehabilitation and attainment of PMLUs	1. Discharges and accumulation of hazardous contaminants (including emerging contaminants) from operational activities 2. Licensed activities such as disposal of tailing, rejects, general and other wastes	- Contaminants present within soil or water that present an unacceptable risk to the receiving environment or PMLU - Alteration of soil chemistry that impacts on structural characteristics - Contaminants reducing the soil suitability for rehabilitation species	4	- Investigate and remediate contamination incidents - Implement a Site Management Plan to manage impacts, where required - Removal of primary or secondary sources - Restrict site usage - Undertake ongoing monitoring to manage contaminated land risks	3	- Cleaning up of spills upon identification - Remediation or management of residual risk - Contaminated land investigation to be undertaken during operations and at closure and areas of contamination remediated and/or managed as appropriate - Ongoing surface water and groundwater monitoring providing an earlier indication of contamination - Management of operational activities to limit any potential contamination	The contaminated land investigation and remediation/management works will aim to render the site suitable for the intended PMLUs and reduce the potential for any environmental harm. With operational sources of hazardous materials removed from site, tailings facilities covered and contained, the likelihood of contaminated land impacts preventing attainment of closure criteria is possible	Possible	0.3	30

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Stable condition for land described as a post-mining land use (cattle grazing, grassland, woodland habitat, watercourse) is not achieved	PMLU 6	Flooding influences on rehabilitation and final landforms	1. Water inundation of landforms 2. Saturation of materials within landforms 3. Velocities of floodwaters on rehabilitated landforms 4. Inaccurate modelling	- Reduction in geotechnical stability of landforms causing failure of the landforms - Erosion of landforms due to increased velocities of flood waters - Activation of dispersive materials resulting in accelerated erosion and sedimentation - Mobilisation of any contaminants contained within the landforms and impacts to downstream water and groundwater quality - Alteration of terrestrial ecology through introduction of weeds, sedimentation, or damage to rehabilitation species not able to withstand flooding - Introduction of weeds and impacts to rehabilitation vegetation establishment - Loss of flood waters/environmental flows to residual voids	3	- Assessment of landform failure and required rectification works upon safe access to site immediately after the flood event. Assessment to include identification of measures that would limit potential for ongoing impacts - Re-engineering of landforms to mitigate future failures followed by re-construction of landforms, and rehabilitation works - Assessment of downstream impacts and undertake remediation/rehabilitation as required to re-establish drainage line hydraulics and ecosystems in liaison with the administering authority - Monitoring of landform stability and rehabilitation success to be undertaken	1	- Removal of infrastructure from watercourses, decommissioning of dams and remediation of contaminated material where required - Design of landforms within flood extents that are stable and able to withstand flooding and water velocities - Establishment of vegetation suitable for the environment and reduces erosion risks	Preventative controls include returning rehabilitated landforms to a condition that is consistent with the pre-operational setting and will not include dams, voids or other structures that have a higher potential of failure during flood events. Therefore, the likelihood of the impacts associated with landform and rehabilitation failures due to flooding, is highly unlikely and not expected to occur within a 50 year period	Highly Unlikely	0.03	0.3
Stable condition for land described as a post-mining land use (cattle grazing, grassland, woodland habitat, watercourse) is not achieved	PMLU 7	Rehabilitated landforms result in alteration of flood hydrology upstream and downstream	1. Changes to drainage network hydraulics 2. Artificial landforms reducing or increasing flood extent and changing velocities/flows 3. Changes to vegetation cover and soil type which alter runoff and infiltration rates	- Increasing/decreasing of flood extents, frequency and severity - Degradation of ecosystems due to altered flows, flood extent, duration or frequency - Infrastructure damage - Health and safety risks to on-site and off-site land users associated with increased flood heights, velocities and frequency	2	- Due to the off-site nature of the impacts, which occur during significant flood events, available mitigating controls at the time of the impact are limited due to safety and accessibility restrictions. After flooding has receded, landform design and alteration could be undertaken to reduce possible future events	1	- Removal of infrastructure that would adversely interfere with stream hydraulics (culverts) and decommissioning of dams - Establishment of landforms that are stable and provide appropriate level of flood protection to the residual voids - Undertake monitoring and maintenance works where required to maintain landforms	With preventative controls implemented, identified impacts associated with alteration of flood hydrology are highly unlikely and not expected to occur within a 50 year period	Highly Unlikely	0.03	0.3
Stable condition for land described as a post-mining land use (cattle grazing, grassland, woodland habitat, watercourse) is not achieved	PMLU 8	Insufficient or inappropriate growth media and rock resources required for rehabilitation activities	1. Insufficient growth media and rock quantities of suitable quality 2. Unstable material (erosive, dispersive, saline materials) 3. Weed infestation (soil is already infested with weed seeds) 4. Insufficient placement depth and surface treatment 5. Incorrect soil and rock characterisation and amelioration 6. Inappropriate topsoil and rock stockpiling and management	- Erosion - Growth media loss - Topsoil deficit - Failure of vegetation (poor vegetation growth or incorrect vegetation affecting PMLU)	3	- Monitoring of rehabilitation success to confirm stability and identify requirements for rectification works - Repair erosion areas, retest growth media and revegetate	2	- Topsoil surveys and mapping - Review the topsoil, growth media and rock resource quantities periodically during operations to ensure sufficient volumes for the rehabilitation needs - Undertake rehabilitation planning and preparation in accordance with the requirements for growth media, rock, seed and management for the PMLU - Management of topsoil and rock stockpiles and application during rehabilitation. - Growth media assessment to determine use of ameliorant and fertiliser requirements - Amelioration and fertiliser applied as per assessment - Selective handling of materials for placement - Compliance to plan	With all controls in place, including ongoing monitoring and maintenance, insufficient or inappropriate growth media and rock for use on rehabilitation is unlikely	Unlikely	0.1	3
Stable condition for land described as a post-mining land use (cattle grazing, grassland, woodland habitat, watercourse) is not achieved	PMLU 9	Insufficient management of mineral waste	1. Poor material characterisation 2. Geochemistry not correctly defined for materials stored in permanent landforms (i.e. tailings, rejects, spoil) leading to an incorrect assessment of their potential for AMD and salinity generation and transport 3. Inappropriate placement of adverse material 4. Poor landform execution 5. Inappropriate mineral waste management strategy 6. Generation and release of AMD/SD/NMD from coal processing waste and / or coal during operation accumulating in groundwater, surface water, soils	- Release of contaminants to surface water and groundwater from rehabilitated landforms - Vegetation failure - Water cannot be used by end user (human and ecosystem)	4	- Monitoring of rehabilitation success to confirm stability and identify requirements for rectification works - Maintenance and rectification works undertaken - NUMAs are acting as sinks for groundwater therefore capturing potential AMD / salinity impacted seepage from TSF/spoil piles/reject stockpiles - Spoil materials have excess buffering capacity (i.e. acid neutralising capacity in excess of acid generating capacity)	1	- Material characterisation (outcomes stored in GeoBank) in line with BHP Materials Management Standard - Remove and/or cover undesirable materials - Ongoing sampling of tailings and rejects from processing plant - Ongoing sampling of overburden / Interburden - Appropriate material placement and selective handling during operations - Appropriate water quality monitoring for surface and groundwater to enable tracking of processes affecting water quality during operation and into closure - Undertaking appropriate fate and transport modelling during operations, pending of risk profile of landform	With all controls in place, including ongoing monitoring and maintenance, insufficient management of waste characterisation is unlikely	Unlikely	0.1	1
Stable condition for land described as a post-mining land use (cattle grazing, grassland, woodland habitat, watercourse) is not achieved	PMLU 10	Failure of, or inappropriate cover	1. Poor material characterisation 2. Geochemistry not correctly defined for materials stored in permanent landforms (i.e. tailings, rejects, spoil) leading to an incorrect assessment of their potential for AMD and salinity generation and transport 3. Erosional instability 4. Geotechnical instability 5. Insufficient materials to achieve cover 6. Unsuitable materials used for cover 7. Livestock impact stability of cover	- Release of contaminants to surface and/or groundwater from rehabilitated landforms. - Poor vegetation establishment - Erosion - Failure or collapse of structure, including cover	4	- Surface water and groundwater monitoring data to be collected in accordance with the EA. If impacts are identified, further investigations will be undertaken to determine appropriate remedial measures - Rehabilitation monitoring and identification of maintenance - Complete maintenance	2	- Material characterisation during operations - Ongoing sampling of tailings and rejects from processing plant - Tailings and rejects material appropriately disposed on-site - Tailings capped with at least 2m of competent benign spoil - Cover to be a free draining landform - Restrict livestock from areas with a cover	With all controls in place, including ongoing monitoring and maintenance, failure of cover is unlikely	Unlikely	0.1	3
Stable condition for land described as a post-mining land use (cattle grazing, grassland, woodland habitat, watercourse) is not achieved	PMLU 11	Inadequate and/or inappropriate revegetation	1. Unfavourable climatic conditions and/or weather events 2. Incorrect species mix 3. Poor seed quality 4. Weed contaminated seed 5. Poor quality growth media or seed bed preparation 6. Erosion 7. Land contaminants	- Exposed soils due to poor vegetation establishment and growth, resulting in enhanced erosion rates. - Increased weed establishment and growth. - Reduction in land capability of PMLU (woodland habitat and/or grazing) - Need for ongoing corrective action - soil sampling and analysis, amelioration and re-vegetation	3	- Monitoring of rehabilitation success to confirm stability and identify requirements for rectification works - Rectification works undertaken e.g. repair erosion areas, retest materials, review seed mix and revegetate	1	- Growth media and spoil assessment to determine ameliorant and fertiliser requirements - Management of seed selection, provenance and quality - Plant at optimal time of year - Revegetation species aligned to growth media, landforms and PMLU	With all controls in place, including revegetating with species aligned to growth media, landforms and PMLUs, as well as monitoring and maintenance activities, total failure of revegetation is unlikely	Unlikely	0.1	1
Stable condition for land described as a post-mining land use (cattle grazing, grassland, woodland habitat, watercourse) is not achieved	PMLU 12	Deterioration of built infrastructure conditions	1. Potential soil contamination around mine industrial areas 2. Insufficient maintenance of infrastructure	- Reduced soil fertility to support PMLU land capability - Potential contamination of surface water runoff affecting integrity of local catchments	3	- Undertake a preliminary contaminated land assessment prior to the completion of the approved activities, identify if any areas require a further Detailed Site Investigation and remediation plan developed if required - Conduct ongoing maintenance	1	- Clean up and remediate contamination during operational period - Undertake contaminated land assessment and remediation/management where required post mining	With all controls in place, including ongoing monitoring and maintenance, deterioration of built infrastructure is unlikely	Unlikely	0.1	1

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NUMA causes environmental harm off tenure and is not safe and structurally stable	NUMA 1	Residual void walls do not achieve geotechnical stability	1. Geotechnical instability 2. Geochemical instability 3. Increase/decrease in predicted void water levels 4. Incorrect geotechnical assessment	- Failure of void walls leads to instability beyond NUMA extent	4	- Geotechnical monitoring - Identify requirements for rectification works	1	- Geotechnical assessment and final void wall design - Pit floor treatments as required during operations to improve low-wall stability - Geotechnical monitoring during operations. - Updated geotechnical assessment to be completed as mining approaches final limits and wall design and NUMA extent adjusted if required - NUMA extents designed to include the required factor of safety (FoS) limit - Bunding or equivalent landform, fencing and signage placed at FoS limit - Minimum distance of 50m between the residual void crest and the toe of the safety bund, where against a tenure boundary - Minimum 25m distance between the residual void low-wall crest within the NUMA and the safety bund or equivalent landform	With all controls in place, including ongoing monitoring and maintenance, wall failure beyond the NUMA limit is unlikely	Unlikely	0.1	1
NUMA causes environmental harm off tenure and is not safe and structurally stable	NUMA 2	Uncontrolled access to NUMA	1. Inappropriate design, management and construction of safety bund or equivalent landform 2. Inadequate/poorly maintained fencing and signage	- Unmanaged access to NUMA by people or livestock	4	- Compliance checks as part of monitoring	1	- Safety bund or equivalent landform, fencing and signage placed at FoS limit, where required. - Geotech modelling to determine FoS limit	With all controls in place, including ongoing monitoring and maintenance, failure of bunding, fencing and signage is unlikely	Unlikely	0.1	1
NUMA causes environmental harm off tenure and is not safe and structurally stable	NUMA 3	Uncontrolled flooding into residual voids	1. Flood mitigation is not installed or incorrect construction 2. Incorrect flood modelling	- Uncontrolled capture of flood waters - Altered/changed alignment of creeks and drainage lines - Removal of downstream environmental flows - Filling of residual void with water and interconnecting groundwater units - Geotechnical instability of residual void - Contamination of clean surface water flows, within residual void - Contamination of groundwater resources	4	- Uncontrolled capture of flood waters - Altered/changed alignment of creeks and drainage lines - Removal of downstream environmental flows - Filling of residual void with water and interconnecting groundwater units - Geotechnical instability of residual void - Contamination of clean surface water flows, within residual void - Contamination of groundwater resources	2	- Flood modelling including climate change scenarios - Void flood mitigation designed to 0.1% AEP flood event - Void flood mitigation (partial backfill and/or landforms) installed - Compliance to plan	With all controls in place, including ongoing monitoring and maintenance, uncontrolled flooding into voids is highly unlikely. Landform design includes partial backfill that provide protection for a 0.1% AEP event + climate change + 1m	Highly Unlikely	0.03	0.9
NUMA causes environmental harm off tenure and is not safe and structurally stable	NUMA 4	Water in the residual void causes environmental harm outside of the mining tenure	1. Groundwater outflow seepage not identified by groundwater modelling 2. Poor water quality 3. Overtopping or interconnection of the void lake with shallow groundwater water units	- Reduction in surface and/or groundwater quality down gradient of the site - Degradation of ecosystems interacting with impacted water - Changes to the chemistry of shallow groundwater units - Groundwater extraction/use off site impacted	4	- Rectification works on impacted ecosystems or bores - Installation of engineering controls to limit potential for ongoing impacts	3	- Up to date groundwater and void lake water balance modelling - Void flood mitigation to 0.1% AEP flood event - Void flood mitigation (partial backfill and/or landforms) installed - Containment of potential sediment as a result of erosion from the low-wall within the residual void - Landform design to enable establishment of collective groundwater sink within tenure boundary - Compliance to plan	With all controls in place, including ongoing monitoring and maintenance, any water in voids causing environmental harm outside of mining tenure is unlikely. Modelling indicates the voids will act as long-term sinks and water levels will remain below the original groundwater levels and the shallower geological units	Unlikely	0.1	10