30 November 2017

Director General
Department Administering the Environmental Protection Act 1986
Department of Water and Environmental Regulation
Locked Bag 33, Cloisters Square
PERTH WA 6805

Dear Sir/Madam,


Northern Star Resources Limited proposes to extend the existing above ground Tailings Storage Facility, known as TSF1, at its Kanowna Belle Gold Mine operations by constructing two new cells of similar size north of the existing cells. The proposed new TSF, known as TSF2, will provide additional life-of-mine tailings storage for ongoing operations and development of Northern Star’s Kalgoorlie Operations.

The following documents have been submitted to assist with the assessment of this Licence Amendment application:

1) Completed DWER Application Form: Works Approval / Licence Amendment
2) Licence Amendment Supporting Document for the KB TSF2 Project, and accompanying Appendices (on CD, via mail):
   - **APPENDIX C.** Flood Modelling for Kanowna Belle Mine: Preliminary High-Level Assessment, Eco Logical Australia, September 2017.

If you have any queries, please contact Yvonne Hynes – Senior Environmental Advisor, on vyhynes@nsrtd.com or phone (08) 9080 6103.

Yours sincerely,

Jim Coxon
General Manager
Kalgoorlie Operations
Northern Star Resources Ltd
LICENCE AMENDMENT
SUPPORTING DOCUMENT –
Kanowna Belle Tailings Storage
Facility 2 (TSF2)

KANOWNA BELLE GOLD MINE
L5029/1992/11

Prepared By:
Northern Star Resources Limited
Kalgoorlie Operations - Environment Department
November 2017
TABLE OF CONTENTS

1. INTRODUCTION ........................................................................................................ 4
   1.1 Background and Context ................................................................................. 4
   1.2 Project Objectives .......................................................................................... 4
   1.3 Applicant ......................................................................................................... 5
   1.4 Relevant Approvals ....................................................................................... 6
   1.5 Prescribed Premises ...................................................................................... 6
   1.6 Siting and Location ...................................................................................... 7
   1.7 Maps for Proposed Premises ....................................................................... 7

2. PROPOSED ACTIVITIES .......................................................................................... 10
   2.1 Operational and Design Details .................................................................. 10
      2.1.1 Construction Method ............................................................................. 12
      2.1.2 Embankment Design and Storage ......................................................... 12
      2.1.3 Tailings Deposition – Spigotting ........................................................... 13
      2.1.4 Return Water System ......................................................................... 13
      2.1.5 Design Floods – Freeboard .................................................................. 14
      2.1.6 Seepage Analysis .................................................................................. 15
      2.1.7 Seepage Management ............................................................................ 15
   2.2 Ancillary Infrastructure / Facilities ................................................................. 16
      2.2.1 Vibrating Wire Piezometers ................................................................ 16
      2.2.2 Tailings and Return Water Lines ........................................................... 16
      2.2.3 Return Water Pond Facility .................................................................. 16
      2.2.4 Powerline Corridor .............................................................................. 17
      2.2.5 Topsoil Stockpiles ................................................................................ 17
   2.3 Groundwater Monitoring Regime ................................................................... 19
      2.3.1 Bore Decommissioning ........................................................................ 19
      2.3.2 New Monitoring Bores ......................................................................... 21
      2.3.3 Existing Monitoring Bores to be Re-instated ........................................ 23
      2.3.4 Proposed Groundwater Monitoring Network ...................................... 23
      2.4 Inspections and Maintenance .................................................................... 25

3. ENVIRONMENTAL RISKS AND MANAGEMENT ............................................... 26
   3.1 Risk Assessment ............................................................................................ 26
   3.2 Groundwater .................................................................................................. 31
   3.3 Surface Water .................................................................................................. 33
   3.4 Flora, Fauna and Ecosystems ....................................................................... 35
3.5 Land Clearing......................................................................................................................... 35
3.6 Topsoil and Soil Profiles.......................................................................................................... 36
3.7 Atmospheric Pollution and Noise .......................................................................................... 37
3.7.1 Dust.................................................................................................................................. 37
3.7.2 Noise................................................................................................................................. 37
3.8 Waste Management.................................................................................................................. 37
3.9 Hazardous Materials............................................................................................................... 37
3.10 Social Environment............................................................................................................... 38
3.10.1 Aboriginal Heritage........................................................................................................... 38
3.10.2 European Heritage............................................................................................................ 38
3.10.3 Pastoral Leases.................................................................................................................. 38
4. APPENDICES ......................................................................................................................... 39

LIST OF TABLES
Table 1. Summary of KB TSF2 Key Characteristics .................................................................. 5
Table 2. Tenement Holders for the Project Area .......................................................................... 5
Table 3. Relevant Approvals for the KB TSF2 Project................................................................. 6
Table 4. Areas and Storage Capacities for TSF2 ....................................................................... 12
Table 5. Freeboard criteria ........................................................................................................... 14
Table 6. Results of Seepage Analyses ......................................................................................... 15
Table 7. Proposed New Monitoring Bores ................................................................................... 21
Table 8. Existing Monitoring Bores to be Re-instated ................................................................. 23
Table 9. Northern Star Resources, Risk Assessment Matrix & Definitions .................................. 27
Table 10. KB TSF2 Project – Risk Assessment ......................................................................... 28

LIST OF FIGURES
Figure 1. Regional Site Location Map ......................................................................................... 8
Figure 2. Overview Site Layout of the Project (Coffey, 2017) .................................................... 9
Figure 3. Proposed KB TSF2 Design of Starter Embankment (Coffey, 2017) ......................... 11
Figure 4. KB TSF2 Stage-Storage Capacity .............................................................................. 13
Figure 5. Freeboard nomenclature from DMIRS ...................................................................... 14
Figure 6. KB TSF2 – General Site Plan ..................................................................................... 18
Figure 7. Proposed Bores to be Decommissioned ...................................................................... 20
Figure 8. Proposed New Monitoring Bore Locations................................................................. 22
Figure 9. Proposed Groundwater Monitoring Network .......................................................... 24
Figure 10. Schematic cross section through TSF2 .................................................................... 31
Figure 11. Proposed Drainage Channel against aerial imagery and DEM (ELA, 2017) ............ 34
LIST OF APPENDICES


1. INTRODUCTION

1.1 Background and Context

The Kanowna Belle Gold Mine, owned and operated by Northern Star Resources Ltd (Northern Star), is located approximately 18km north-east of the City of Kalgoorlie-Boulder in Western Australia. Mining activities at Kanowna Belle (KB) commenced in 1993 with an open pit mine, followed by the development of underground operations starting in 1995.

Existing infrastructure at KB includes four Tailings Storage Facilities (TSFs) – Kanowna Belle TSF (TSF1), Waldon In-pit TSF (WPTSF), Red Hill In-pit TSF (RHTSF) and Calcine TSF (inactive). A processing plant, open pits, waste rock landforms, maintenance workshops, paste plant, mine surface dams, process water collection ponds and associated water recovery infrastructure and service facilities.

Due to a reducing surface area and increasing rate-of-rise on the existing TSF1, as well as depletion of in-pit tailings storage (WPTSF), it is planned to construct TSF2 to facilitate future management of tailings storage at Kanowna Belle. The proposed TSF2 will be located directly north of TSF1 on Tenement M27/92, and comprise of two square cells each approximately 750m x 650m in plan footprint area.

1.2 Project Objectives

The primary objective of this Project is to provide life-of-mine (LOM) tailings storage capacity through the extension of the existing above ground Tailings Storage Facility (TSF1), at Northern Star’s Kanowna Belle Gold Mine. The new above ground TSF, known as TSF2, will consist of two cells of similar size to the existing TSF and would share a boundary wall (abut the northern embankment wall of TSF1).

The location of TSF2 was selected based upon suitability of foundation conditions, proximity to mine infrastructure, tenement ownership and successful sterilisation. Northern Star conducted a sterilisation campaign that did not confirm any anomalous continuous mineralized structure in bedrock below the supergene enrichment at the proposed TSF2 area.

The proposed TSF2 will provide additional tailings storage capacity of approximately 20 million tonnes. This will allow for a further 10 years of storage capacity, based on the proposed throughput of 2Mtpa from the processing plant, and a tailings dry density of 1.5 tonnes/m$^3$.

At current tailings production rates, the proposed TSF2 will be required for use by Quarter 1 2019. This will be preceded by a construction period of approximately 6 months to build the starter embankment, establish water management systems, tailings discharge / return water pipelines, installation of new monitoring bores and associated infrastructure.

Northern Star engaged Coffey Mining Pty Ltd (Coffey) to carry out a geotechnical investigation and develop a detailed design report for the proposed KB TSF2. A copy of the ‘Kanowna Belle Gold Mine: Tailings Storage Facility No. 2 – Design Report’ prepared by Coffey, has been provided in Appendix A.
A summary of the Project’s key characteristics has been provided in Table 1.

Table 1. Summary of KB TSF2 Key Characteristics

<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tailings storage capacity</td>
<td>20Mt</td>
</tr>
<tr>
<td>Tailings deposition rate</td>
<td>~2Mtpa</td>
</tr>
<tr>
<td>Operating life</td>
<td>~10 years</td>
</tr>
<tr>
<td>Tailings specifications</td>
<td>Slurry density: 43% solids</td>
</tr>
<tr>
<td></td>
<td>Dry density: 1.45 t/m³</td>
</tr>
<tr>
<td>Starter embankment RL</td>
<td>355m AHD</td>
</tr>
<tr>
<td>Final embankment RL</td>
<td>370m AHD</td>
</tr>
<tr>
<td>No. of embankment raises</td>
<td>Six (at ~2.5m lifts)</td>
</tr>
<tr>
<td>Freeboard criteria</td>
<td>Operational Freeboard = 0.3m</td>
</tr>
<tr>
<td></td>
<td>Beach Freeboard = 0.2m</td>
</tr>
<tr>
<td></td>
<td>Total Freeboard = 0.5m</td>
</tr>
<tr>
<td>Hazard / consequence rating</td>
<td>Medium, Category 1 *</td>
</tr>
<tr>
<td></td>
<td>Significant **</td>
</tr>
<tr>
<td>Start of decommissioning works</td>
<td>May/June 2018 (anticipated)</td>
</tr>
<tr>
<td>Start of construction works</td>
<td>August/September 2018 (anticipated)</td>
</tr>
<tr>
<td>Start of tailings deposition</td>
<td>March/April 2019 (anticipated)</td>
</tr>
</tbody>
</table>

* based on ‘Code of practice: tailings storage facilities in Western Australia’, DMP (now DMIRS), 2013.

1.3 Applicant

The Project proponent is Northern Star Resources Limited (Northern Star), on behalf of Northern Star (Kanowna) Pty Limited, a wholly owned subsidiary of Northern Star.

A summary of the tenement holders for tenements associated with this Licence Amendment application is provided in Table 2.

Table 2. Tenement Holders for the Project Area

<table>
<thead>
<tr>
<th>Tenement</th>
<th>Holder</th>
<th>Expiry Date</th>
<th>Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M27/92</td>
<td>Northern Star (Kanowna) Pty Limited</td>
<td>13/03/2030</td>
<td>972.65</td>
</tr>
<tr>
<td>M27/123</td>
<td>Northern Star (Kanowna) Pty Limited</td>
<td>09/10/2031</td>
<td>994.40</td>
</tr>
<tr>
<td>M27/103</td>
<td>Northern Star (Kanowna) Pty Limited</td>
<td>11/01/2031</td>
<td>944.25</td>
</tr>
<tr>
<td>M27/37</td>
<td>Northern Star (Kanowna) Pty Limited</td>
<td>15/03/2029</td>
<td>585.85</td>
</tr>
</tbody>
</table>
1.4 Relevant Approvals

A summary of the relevant approvals for this Project are provided in Table 3.

Table 3. Relevant Approvals for the KB TSF2 Project

<table>
<thead>
<tr>
<th>Agency</th>
<th>Approval</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department of Water and Environmental Regulation (DWER)</td>
<td>Licence Amendment</td>
<td>This document satisfies this requirement, and has been submitted to the DWER for approval prior to commencement.</td>
</tr>
<tr>
<td>Department of Mines, Industry Regulation and Safety (DMIRS)</td>
<td>Mining Proposal</td>
<td>Mining Proposal approval required for alteration of operations. To be submitted to DMIRS for approval prior to commencement.</td>
</tr>
<tr>
<td>Department of Mines, Industry Regulation and Safety (DMIRS) – Native Vegetation Branch</td>
<td>Clearing Permit</td>
<td>Clearing Permit required. Application submitted to DMIRS on 16 October 2017 (as the delegated authority for administering applications to clear native vegetation for activities regulated under the Mining Act 1978); CPS 7808/1 was advertised on 30 October 2017 and is pending approval.</td>
</tr>
<tr>
<td>Department of Water and Environmental Regulation (DWER)</td>
<td>Groundwater Abstraction</td>
<td>Covered by existing groundwater licence GWL 62498(6). GWL allows up to 3,030,000kL of groundwater to be abstracted per annum for the purposes of dewatering for mining, mineral ore processing, dust suppression for earthworks and construction and recovery of water for environmental uses. The current Groundwater Operating Strategy will be updated to reflect the change in operations, and submitted to DWER for endorsement.</td>
</tr>
<tr>
<td>Department of Mines, Industry Regulation and Safety (DMIRS)</td>
<td>Dangerous Goods Site Licence</td>
<td>Covered by DG5012576. The current Kanowna Belle DG Site Licence will be amended to cover the location of the new cyanide destruction plant, as necessary.</td>
</tr>
</tbody>
</table>

1.5 Prescribed Premises

Northern Star’s Kanowna Belle Gold Mine currently operates under DWER Operating Licence L5029/1992/11. The Licence allows for the following approved prescribed premises activities:

- Category 5 – Processing or beneficiation of metallic or non-metallic ore;
- Category 6 – Mine dewatering;
- Category 44 – Metal smelting or refining; and
A licence amendment application was recently submitted (26 September 2017) requesting an increase to the approved premises production or design capacity of Category 5, from 2Mtpa to 2.5Mtpa. The amendment application is currently being assessed and pending approval.

1.6 Siting and Location

The Project area is located at the Kanowna Belle Gold Mine site, approximately 18km north-east of the City of Kalgoorlie-Boulder in the Goldfields region of Western Australia, as shown in Figure 1.

There are no identified sensitive receptors or high value ecosystems within or in close proximity to the Project area. The Gidji Lake is located approximately 15km to the east of the proposed TSF2, and the nearest residential premises are the Aboriginal Ninga Mia Community and the City of Kalgoorlie-Boulder, both located approximately 18km south-west from the Project area.

The proposed TSF2 is located on Mining Lease M27/92 and is centred at Australia Map Grid (AMG) Zone 51 coordinates 362,760m East and 6,615,370m North.

1.7 Maps for Proposed Premises

A map showing an overview of the Kanowna Belle Gold Mine operations and an outline of the proposed site layout of TSF2 is provided in Figure 2.

A map showing the general arrangement / site plan of the proposed activities associated with this Project can be found in Section 4.0, Figure 8.
Figure 1. Regional Site Location Map
Figure 2. Overview Site Layout of the Project (Coffey, 2017)
2. PROPOSED ACTIVITIES

Northern Star’s Kanowna Belle operations currently has approval to deposit mine tailings in above ground tailings dams (TSF1 and Calcine TSF, historical), and disused open cut voids (Red Hill In-pit TSF and Waldon In-pit TSF). In order to provide tailings storage capacity for the current life of mine, Northern Star is proposing to expand TSF1 by constructing two new cells to the north of the existing cells. The new TSF will be of similar size and be known as TSF2.

2.1 Operational and Design Details

The following sections summarises the key operational and design considerations for the proposed TSF2 and has been extracted from the ‘Tailings Storage Facility No. 2 - Design Report, September 2017’ prepared by Coffey. A copy of the report has been provided in Appendix A.

The facility will be located approximately 1.4km north-west of the Kanowna Belle Processing Plant, and directly north of the existing KB TSF1. TSF2 will be a two-celled paddock-type facility constructed using upstream methods and will occupy an approximate footprint area of 100ha. Tailings slurry will be discharged sub-aerially around the perimeter of TSF2. Decant water will be recycled back to the processing plant via a central decant structure located in each cell, which will report to a lined return water pond on the northern side of the TSF. Seepage will be captured from the base of Cell 1 (Western cell) and Cell 2 (Eastern cell) via underdrainage and report to a seepage collection sump also located on the northern side of the facility.

The location, design and operation of TSF2 are aimed to:

- Reduce upfront capital costs and minimise overall construction cost (i.e. staged construction);
- Minimise daily inputs required for tailings storage operation and management;
- Maximise the tailings density and storage capacity by rotating the deposition points;
- Provide adequate tailings and stormwater storage capacity;
- Maximise return water (surface water and underdrainage water) to the plant; and
- Minimise environmental impacts (i.e. reduce seepage water losses).

The proposed general arrangement (starter embankment design plan) for KB TSF2 is shown in Figure 3.
Figure 3. Proposed KB TSF2 Design of Starter Embankment (Coffey, 2017)
2.1.1 Construction Method

The proposed TSF2 will be constructed in six lifts of approximately 2.5m each, using upstream construction methods to raise the perimeter embankments.

The starter embankment will be constructed using the uppermost surface clayey material from within the footprint area of TSF2. An underdrainage pipeline network will be installed on top of the compacted clay to collect water that has seeped through the tailings towards the ground surface. Future raises of the embankments will utilise compacted dried tailings and/or nearby mine waste rock material as appropriate.

The decant structure and decant causeway will also be raised at each stage to the embankment crest levels. The decant causeway will be constructed using moisture conditioned, traffic compacted clayey materials from the base of TSF2 footprint area. The decant structure will comprise of a concrete base and standard precast slotted concrete pipes surrounded by selected clean rock fill.

The perimeter embankment and decant causeway crests will be sheeted with a nominal 100 mm thickness of wearing course material (e.g. gravel) sourced from a designated location. Placed material that fail to meet the minimum test requirements of compaction and moisture content is to be reworked (moisture added or re-compacted) to meet the specified requirements.

A Scope of Works and Technical Specification document, covering the construction of the TSF2 starter embankments, key-in of TSF2 embankments to the northern wall of TSF1, decant piping network, decant structure, underdrainage and associated infrastructure, has been developed and included as an appendix to the design report (Appendix A).

2.1.2 Embankment Design and Storage

The embankments have design slopes of 1:2.75 (V:H) downstream and 1:2 (V:H) upstream. The dividing embankment accessway has design slopes of 1:1.5 (V:H) downstream and 1:1.5 (V:H) upstream. Table 4 provides a summary of areas and storage capacities for TSF2.

<table>
<thead>
<tr>
<th>Stage</th>
<th>RL</th>
<th>Combined Surface Area</th>
<th>Embankment / Raising Height</th>
<th>Layer Storage Volume</th>
<th>Combined Storage Volume</th>
<th>Storage Life</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[m AHD]</td>
<td>[m²]</td>
<td>[m]</td>
<td>[m³]</td>
<td>[m³]</td>
<td>[tons]</td>
</tr>
<tr>
<td>Starter</td>
<td>355.0</td>
<td>921,756</td>
<td>Varies</td>
<td>2,363,725</td>
<td>2,363,725</td>
<td>3,427,401</td>
</tr>
<tr>
<td>1</td>
<td>357.5</td>
<td>918,231</td>
<td>2.5</td>
<td>2,299,822</td>
<td>4,683,707</td>
<td>6,762,376</td>
</tr>
<tr>
<td>2</td>
<td>360.0</td>
<td>912,253</td>
<td>2.5</td>
<td>2,288,101</td>
<td>6,951,808</td>
<td>10,080,122</td>
</tr>
<tr>
<td>3</td>
<td>362.5</td>
<td>887,821</td>
<td>2.5</td>
<td>2,250,023</td>
<td>9,201,832</td>
<td>13,342,656</td>
</tr>
<tr>
<td>4</td>
<td>365.0</td>
<td>876,858</td>
<td>2.5</td>
<td>2,205,835</td>
<td>11,407,668</td>
<td>16,541,118</td>
</tr>
<tr>
<td>5</td>
<td>367.5</td>
<td>866,398</td>
<td>2.5</td>
<td>2,179,057</td>
<td>13,586,723</td>
<td>19,700,749</td>
</tr>
<tr>
<td>6</td>
<td>370.0</td>
<td>863,769</td>
<td>2.5</td>
<td>2,162,708</td>
<td>15,749,431</td>
<td>22,836,675</td>
</tr>
</tbody>
</table>

Table 4. Areas and Storage Capacities for TSF2
Due to the sloping nature of the ground the starter embankment height will vary. The height of the starter embankment will vary from 4m to 6m and have a crest at RL355m. The other stages will all be 2.5m embankment raises, taking the final height of the perimeter embankment to RL370m.

The rate-of-rise of the tailings surface is dependent on the size of the surface area of the tailings and supernatant pond. In the early stages when the area is small the rate-of-rise will be relatively fast. TSF2 will have a tailings storage capacity of approximately 2,370,000m$^3$ with a crest RL of 355m at starter embankment level. The total estimated storage at RL370m will be approximately 15,800,000m$^3$. A stage-storage capacity chart is included as Figure 4.

![Figure 4. KB TSF2 Stage-Storage Capacity](image)

### 2.1.3 Tailings Deposition – Spigotting

Tailings will be delivered to TSF2 via a contained (bunded) tailings delivery pipeline. A tailings distribution pipeline will be located around the full perimeter embankment, with regularly spaced valved (or similar) spigot off-takes. Tailings will be deposited sub-aerially and at low velocity via the multi point spigots located at nominal 20m intervals along the TSF2 perimeter.

Placement of tailings from spigot locations will be manipulated to control deposition beaching and maintain the position of the supernatant water pond central to the decant structures.

### 2.1.4 Return Water System

Water liberated from the tailings slurry (surface water) will be recovered from both decants at TSF2 Cells 1 and 2 via pumps and pipelines (total length approximately 1.5km) leading to a return water pond north of TSF2.
The return water pond will be constructed at the lowest point along the TSF2 northern embankment. The pond will be square (approximately 50m x 50m), lined with HDPE and approximately 2.8m deep. The return water facility will be fenced off and include the infrastructure required for operating the facility such as the pumping station and hydrogen peroxide dosing unit for cyanide destruction (similar setup as the existing return water facility north of TSF1).

Any seepage water collected from the existing TSF1 recovery bores will also be pumped back to the new return water pond. Recovered water collected will be returned to the processing plant for reuse. The pump at the return water pond will be operated automatically.

2.1.5 Design Floods – Freeboard

TSF2 has been designed such that a 1 in 100-year ARI, 72-hour duration storm rainfall event of 178mm, can be temporarily stored on top of the facility above the normal operating decant pool level. The design assumes that correct operational controls are adhered to, and that water is continually removed from the facility such that the minimum freeboard allowance is maintained. Freeboard requirements have been assessed in accordance with DMIRS (2015) guidelines. Figure 5 shows freeboard nomenclature obtained from DMIRS.

![Freeboard nomenclature from DMIRS](image)

Figure 5. Freeboard nomenclature from DMIRS

A minimum operational freeboard (vertical height between the tailings beach and embankment crest) of 300mm is recommended along with a minimum beach freeboard (vertical height between the 100-year ARI water level and top of tailings beach) of 200mm. The design freeboard criteria for TSF2 are summarised in Table 7.

Table 5. Freeboard criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Operational Freeboard</th>
<th>Beach Freeboard</th>
<th>1 in 100 year 72-hr event</th>
<th>Total Freeboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMIRS</td>
<td>0.3m</td>
<td>0.2m</td>
<td>0.178m</td>
<td>0.5m</td>
</tr>
</tbody>
</table>
2.1.6 Seepage Analysis

The maximum expected seepage for the final embankments through the 5,600m length of the perimeter embankment of TSF2 is expected to range between 120m³/day and 405m³/day, i.e. representing between 1.7% and 5.6% of the slurry water inflow (assuming to be approximately 7,200m³/day).

The seepage flow determinations from the analyses for both starter and final embankments are summarised in Table 6.

Table 6. Results of Seepage Analyses

<table>
<thead>
<tr>
<th>Case</th>
<th>Seepage Flow (m³/day/m of embankment)</th>
<th>Approximate Embankment Length (m)</th>
<th>Estimated Seepage (m³/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starter embankment (Crest RL355m)</td>
<td>2.14×10⁻²</td>
<td>5600</td>
<td>120</td>
</tr>
<tr>
<td>Final embankment (Crest RL370m)</td>
<td>7.23×10⁻²</td>
<td>5600</td>
<td>405</td>
</tr>
</tbody>
</table>

Refer to Section 5 of the design report (Appendix A) for further details on the modelling and assessments of the TSF in relation to:

- 5.1. Water Balance analysis;
- 5.2. Seepage analysis;
- 5.3. Liquefaction assessment;
- 5.4. Stability analyses;
- 5.5. Deformation analysis; and
- 5.6. Dam Break Analysis.

2.1.7 Seepage Management

The seepage management controls adopted for this Project, based on the operational design parameters, geotechnical investigation and hydrogeological assessment, comprise of:

- A downstream seepage interception trench (toe drain) will be excavated along the perimeter of the facility to capture near surface seepage. The trench will be constructed such that water flow accumulates in the underdrainage and toe drain sumps located along the northern side of TSF2;
- A cut off trench will be excavated along the centreline of the embankment to a nominated target depth where competent low permeability material, suitable for the foundation, is encountered. The trench will be backfilled in layers to form the required embankment profile and to reduce seepage beneath the embankment;
- An underdrainage system comprising a finger drain network at the base of both cells to assist with recovery of water from consolidation of tailings and to reduce seepage losses. The total length of the underdrainage lines within TSF2 is approximately 6.3km and is aimed at collecting water beneath the tailings impoundment for both TSF2 Cells 1 and Cell 2. The underdrainage system will discharge any collected water into the water return pond located to the immediate north of TSF2; and
- Appropriate TSF operating practices including maximising water return from the facility and optimising the slurry density of the deposited tailings.

Other measures, including seepage recovery bores (in addition to the existing network of bores south of TSF1) have been considered for this Project. Additional seepage recovery bores may be installed later if required, as discussed in Section 3.2 of this document.

2.2 Ancillary Infrastructure / Facilities

As shown in Figure 6, additional infrastructure / facilities associated with the development and operation of TSF2 will be required. This includes but is not limited to: access roadways, pipeline and powerline corridors, return water pond, topsoil stockpile areas, and monitoring systems including new groundwater bores to replace those currently within the footprint of the proposed KB TSF2, and vibrating wire piezometers.

2.2.1 Vibrating Wire Piezometers

The TSF2 design comprises 8 arrays (3 at each array) of vibrating wire piezometers (VWPs) in order to monitor the phreatic surface within the perimeter embankment and the tailings materials near the embankment.

The VWPs will be located around the perimeter embankments of both Cells 1 and 2 (Figure 3). The VWPs at each array will comprise two VWPs located on each side of the starter embankment and one VWP located within the embankment. The wires for the VWPs will be located within a conduit installed in a shallow trench and run under the embankment to a terminal box located adjacent to the downstream monitoring bores.

2.2.2 Tailings and Return Water Lines

The tailings and return water pipelines connecting the process plant to the TSF2 and return water pond, will be buried or located inside bunded open trenches to contain any spillage of materials. The pipeline route from the process plant will continue via the existing pipeline corridor of TSF1 that currently runs within the toe drain/trench on the eastern perimeter of the facility.

In the event of pipeline failure, there will be an automated shutdown, as a result of telemetry and fitted leak detection system. The leak detection system, coupled with regular visual inspections of the pipeline corridors, will provide early detection of a pipeline failure and allow a prompt response. The affected pipeline will remain shut down until repaired and spilled materials disposed, as appropriate.

2.2.3 Return Water Pond Facility

The existing return water pond at TSF1, including the cyanide destruction plant, will need to be decommissioned and relocated. The new facility will be placed in a similar position, between the two cells to the north of the proposed TSF2 (Figure 3). The pond will be square (50m x 50m), lined with HDPE and approximately 2.8m deep.
The cyanide destruction plant will be installed to reduce the level of residual Cyanide in the decant return water pond prior to the water being transferred to the process plant for re-use. The facility will be designed in accordance with relevant Australian Standards.

### 2.2.4 Powerline Corridor

The current powerline servicing the existing TSF1 will need to be decommissioned and relocated. The proposed powerline for TSF2 will tee off from the existing powerline corridor that runs along the borefields access road. The estimated length of the proposed new powerline corridor is less than 1km.

### 2.2.5 Topsoil Stockpiles

Additional areas will require grubbing / clearing of vegetative material only to provide adequate locations for the stockpiling of topsoil.

The topsoil or growth medium stockpiles will be created from stripping undertaken prior to the construction of TSF2, and will later be re-used in the rehabilitation of the facility. Topsoil will be stripped to a nominal depth of 150mm and stockpiled separately in designated areas to a maximum height of 2.5m.

Refer to Section 3.6 for further information on topsoil management.
Figure 6. KB TSF2 – General Site Plan
2.3 Groundwater Monitoring Regime

2.3.1 Bore Decommissioning

A groundwater bore network and seepage recovery system is installed around the existing TSF1 in order to monitor and control seepage. The current network consists of 15 groundwater monitoring bores, 14 seepage recovery bores and a seepage interception trench around the facility. Some of the existing monitoring and seepage bores, as well as several (100+) historic exploration bores, lie within the proposed TSF2 footprint area.

Prior to commencing civil construction work for the new facility, bores located within the footprint will be decommissioned, backfilled, grouted or plugged as appropriate. Decommissioning of bores should therefore seek to re-seal the potential flow pathways between ground surface and the shallow aquifer units, and from the shallow aquifer into the fresh bedrock.

The existing TSF1 bores that will require decommissioning are shown in Figure 7, and include:

- 3x monitoring bores: GWMB3, GWMB4 and GWMB5 (currently on the KB Licence and will require subsequent removal from the Licence);
- 7x monitoring bores: M1, M2, M3, M4, M5, TD5 and TD6; and
- 7x seepage management bores: N1, N2, N3, N4, N5, N6 and N7.

Although the locations of the 17 monitoring and seepage bores that require decommissioning are well known, it is unlikely that all historic exploration bores will be found and sealed (however the majority of collars have been located).

Further details on the proposed bore decommissioning works are provided as Appendix B1 the ‘Kanowna Belle TSF Expansion – Groundwater Review’ prepared by AGE (Appendix B).
Figure 7. Proposed Bore Decommissioning

Legend
- Proposed Bore Decommissioning
- KB TSF2 Plan Footprint
- NSR Managed Tenements

KB TSF2
Proposed Bore Decommissioning

Coordinate System: GDA 1994 MGA Zone 51
Author: M. Reesell
2.3.2 **New Monitoring Bores**

To compensate for the closure of the bores, approximately 15 new monitoring bores will be installed around the new facility. Baseline data will be obtained from the new bores once drilled and prior to commencing tailings deposition into TSF2. The suggested/approximate locations of the additional bores are provided in Table 7, and shown in Figure 8.

Further details on the proposed new bore installation works are provided as Appendix B2 in the ‘Kanowna Belle TSF Expansion – Groundwater Review’ prepared by AGE (Appendix B).

**Table 7. Proposed New Monitoring Bores**

<table>
<thead>
<tr>
<th>Bore ID (New)</th>
<th>Easting</th>
<th>Northing</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>GWMB12</td>
<td>362,054</td>
<td>6,615,268</td>
<td>West of TSF2 – confirm shallow geology, long term data collection for water level and water quality</td>
</tr>
<tr>
<td>GWMB13</td>
<td>362,054</td>
<td>6,615,505</td>
<td>West of TSF2 – confirm shallow geology, long term data collection for water level and water quality</td>
</tr>
<tr>
<td>GWMB14</td>
<td>362,303</td>
<td>6,615,787</td>
<td>North of TSF2 – confirm shallow geology, long term data collection for water level and water quality</td>
</tr>
<tr>
<td>GWMB15</td>
<td>362,513</td>
<td>6,615,787</td>
<td>North of TSF2 – confirm shallow geology, long term data collection for water level and water quality</td>
</tr>
<tr>
<td>GWMB16</td>
<td>362,932</td>
<td>6,615,787</td>
<td>North of TSF2 – confirm shallow geology, long term data collection for water level and water quality</td>
</tr>
<tr>
<td>GWMB17</td>
<td>363,141</td>
<td>6,615,787</td>
<td>North of TSF2 – confirm shallow geology, long term data collection for water level and water quality</td>
</tr>
<tr>
<td>GWMB18</td>
<td>363,391</td>
<td>6,615,504</td>
<td>East of TSF2 – confirm shallow geology, long term data collection for water level and water quality</td>
</tr>
<tr>
<td>GWMB19</td>
<td>363,391</td>
<td>6,615,268</td>
<td>East of TSF2 – confirm shallow geology, long term data collection for water level and water quality</td>
</tr>
<tr>
<td>GWMB20</td>
<td>363,119</td>
<td>6,616,005</td>
<td>North of TSF2 – in potential higher permeability palaeochannel materials. Will need to confirm location with site geologists</td>
</tr>
<tr>
<td>GWMB21</td>
<td>361,925</td>
<td>6,615,740</td>
<td>West of TSF2 – confirm shallow geology, long term data collection for water level and water quality</td>
</tr>
<tr>
<td>GWMB22</td>
<td>362,366</td>
<td>6,616,101</td>
<td>Shallow monitoring bore adjacent to TD7 – monitor for potential seepage in shallow higher permeability materials, screened ~6-9 mBGL</td>
</tr>
<tr>
<td>GWMB23</td>
<td>361,928</td>
<td>6,615,350</td>
<td>Shallow monitoring bore adjacent to TD8 – monitor for potential seepage in shallow higher permeability materials, screened ~6-9 mBGL</td>
</tr>
<tr>
<td>GWMB24</td>
<td>363,537</td>
<td>6,614,670</td>
<td>East of TSF1 – confirm shallow geology, long term data collection for water level and water quality</td>
</tr>
<tr>
<td>GWMB25</td>
<td>361,882</td>
<td>6,614,780</td>
<td>West of TSF1 – confirm shallow geology, long term data collection for water level and water quality</td>
</tr>
<tr>
<td>GWMB26</td>
<td>362,390</td>
<td>6,613,915</td>
<td>South of TSF1 – confirm shallow geology, long term data collection for water level and water quality. Clarify the hydraulic gradients present to the south of TSF1, and assist with quantifying the rate of infiltration occurring in this area, where surface ponding is known to occur.</td>
</tr>
</tbody>
</table>
Figure 8. Proposed New Monitoring Bore Locations
### 2.3.3 Existing Monitoring Bores to be Re-instated

To complete the monitoring array, it is planned for some historically drilled bores to the north and east of the new facility to be re-instated / rehabilitated and form part of the extensive groundwater monitoring network. These additional bores are listed in **Table 8**, and shown in **Figure 9**.

**Table 8. Existing Monitoring Bores to be Re-instated**

<table>
<thead>
<tr>
<th>Bore ID</th>
<th>Easting</th>
<th>Northing</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>TD1</td>
<td>362,184</td>
<td>6,615,905</td>
<td>North of TSF2 – some bore rehabilitation required to gain access through rust on cover</td>
</tr>
<tr>
<td>TD2</td>
<td>362,337</td>
<td>6,615,864</td>
<td>North of TSF2 – maintain and monitor</td>
</tr>
<tr>
<td>TD3</td>
<td>362,599</td>
<td>6,615,870</td>
<td>North of TSF2 – maintain and monitor</td>
</tr>
<tr>
<td>TD4</td>
<td>362,750</td>
<td>6,615,870</td>
<td>North of TSF2 – maintain and monitor</td>
</tr>
<tr>
<td>TD7</td>
<td>362,346</td>
<td>6,616,098</td>
<td>Further north of TSF2 – maintain and monitor</td>
</tr>
<tr>
<td>TD8</td>
<td>361,933</td>
<td>6,615,338</td>
<td>West of TSF2 – maintain and monitor</td>
</tr>
<tr>
<td>KWB79</td>
<td>361,971</td>
<td>6,615,850</td>
<td>North-west corner of TSF2 – maintain and monitor</td>
</tr>
</tbody>
</table>

### 2.3.4 Proposed Groundwater Monitoring Network

A map showing the proposed comprehensive groundwater monitoring network to satisfy the ongoing compliance monitoring and management requirements of TSF2 and the existing TSF1, has been provided in **Figure 9**.
Figure 9. Proposed Groundwater Monitoring Network
2.4 Inspections and Maintenance

Routine inspections are to be undertaken by an operator or shift supervisor, in accordance with the site's existing DWER Operating Licence and other regulatory approvals. The date of each inspection is to be entered into a log book and signed by the person allocated to undertake the inspection on that shift to ensure the requirement has been met. Existing pro-formas utilised for the existing TSF’s will be revised for use at KB TSF2.

Routine inspections and monitoring will cover:

- The pipelines (tailings delivery line and return water line) to and from the TSF;
- Leak detection system;
- Pumps and valves;
- Tailings discharge point;
- The decant pump;
- Location and size of the supernatant water pond;
- Seepage from the facility as indicated by monitoring bores;
- The general integrity of the crest and pit walls; and
- Any changes to existing cracking or seepage.
3. ENVIRONMENTAL RISKS AND MANAGEMENT

Due to the location of proposed infrastructure within an existing mining and operational footprint and historically disturbed area, many of the management measures to eliminate or mitigate environmental impacts have been detailed in previously submitted approval documents.

An assessment of the potential environmental impacts/risks and proposed management measures associated with the construction and operation of the proposed KB TSF2 has been undertaken and is detailed in the sections below.

3.1 Risk Assessment

A risk assessment, based on Northern Star’s Corporate risk matrix (Table 9), has been conducted to clearly identify and assess the key risks and control measures with developing the KB TSF2.

The risk assessment (Table 10) considers details contained within the design report prepared by Coffey, and the groundwater review prepared by AGE, and the surface water / flood modelling assessment prepared by Eco Logical, amongst other considerations of potential risks and controls associated with the Project.
Table 9. Northern Star Resources, Risk Assessment Matrix & Definitions

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>CONSEQUENCE</th>
<th>Insignificant</th>
<th>Minor</th>
<th>Moderate</th>
<th>Major</th>
<th>Catastrophic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almost Certain - Expected occurrences - once per week</td>
<td>A</td>
<td>5A</td>
<td>4A</td>
<td>3A</td>
<td>2A</td>
<td>1A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Likely - Probable occurrences - once per month</td>
<td>B</td>
<td>5B</td>
<td>4B</td>
<td>3B</td>
<td>2B</td>
<td>1B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td></td>
<td>High</td>
</tr>
<tr>
<td>Possible - Possible occurrences - once per year</td>
<td>C</td>
<td>5C</td>
<td>4C</td>
<td>3C</td>
<td>2C</td>
<td>1C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td></td>
<td>High</td>
</tr>
<tr>
<td>Unlikely - Unlikely to occur - once every 5-10 years</td>
<td>D</td>
<td>5D</td>
<td>4D</td>
<td>3D</td>
<td>2D</td>
<td>1D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Rare - May occur in exceptional circumstances - &gt;10 years</td>
<td>E</td>
<td>5E</td>
<td>4E</td>
<td>3E</td>
<td>2E</td>
<td>1E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>High risks are generally considered unacceptable. Risk and the implementation of mitigation strategies to be actively pursued. Notification to, and approval to conduct or continue activity required from, Executive Management prior to commencement or continuation when first identified or assessed as high risk. A Risk Owner to be appointed to ensure mitigation strategies are pursued and progress reported at least quarterly to the Chief Financial Officer.</td>
</tr>
<tr>
<td>Medium</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Medium risks, where appropriate, further risk mitigation strategies should be considered and applied as practicable. A Risk Owner should be appointed to manage this risk and ensure that all aspects relating to the risk and its mitigation are managed.</td>
</tr>
<tr>
<td>Low</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Low risks, where appropriate, further risk mitigation strategies should be considered as part of the process of continuous improvement. A Risk Owner should be appointed to manage this risk and ensure that all aspects relating to the risk and its mitigation are managed.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Control Effectiveness</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Inadequate</td>
<td>Risk management strategies or the control environment is considered insufficient or inadequate in mitigating the risk or no system or processes exists to manage the risk. Immediate action should be undertaken to improve risk mitigation.</td>
</tr>
<tr>
<td>Requires Improvement</td>
<td>Some strategies and controls are in place, but they are not operating sufficiently to mitigate the risk within business tolerance. Further risk mitigation strategies should be considered.</td>
</tr>
<tr>
<td>Adequate</td>
<td>Risk management strategies or controls in place are considered sufficient to mitigate the risk within business tolerance.</td>
</tr>
</tbody>
</table>
Table 10. KB TSF2 Project – Risk Assessment

<table>
<thead>
<tr>
<th>Risk or Unwanted Event</th>
<th>Hazards</th>
<th>Factors Contributing to Unwanted Event</th>
<th>Inherent Risk (no controls)</th>
<th>Control Measures</th>
<th>Residual Risk (with current controls)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Clearing: Impact to threatened flora and fauna communities; Land degradation; Damage to pastoral infrastructure; Impact to cultural heritage areas;</td>
<td>C 1 H</td>
<td>Adequate design - Geotechnical investigation of project site, design &amp; construction standards, engineering specs, controlled construction (e.g. embankment compaction and testing, rock armouring); Surface water / flood modelling of project site and associated catchments; Flow diversion to protect long-term integrity of TSF landform (i.e. extension of western diversion drain); Groundwater assessment and modelling review for project area; Operate TSF as per design and detailed in the Operating Manual; Implement pre-incident / emergency response plans for tailings spills etc; Solar drying - reduces the risk of saturated tailings; Embankment piezometer monitoring programme (i.e. installation of vibrating wire piezometers); Implement comprehensive groundwater monitoring programme; Annual third-party geotechnical audit / review; Construction sign-off by Engineer of Record and Project Manager; Comply with site procedures / management plans / operating manual; Hazard / Incident reporting; Adequate training and awareness (e.g. personnel are aware of obligations both internal and external, such as clearing permit &amp; Licence conditions); Final disturbance and “as built” to be surveyed and reported within annual MRF submissions; Ensure all relevant project personnel understand the construction plans / scope of work.</td>
<td>D 4 L A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TSF embankment rupture - possible supernatant &amp; tailings release; Non-compliance with regulations; Possible prosecution &amp; fines; Potential loss of tenement (regulator may issue forfeiture); Loss of stakeholder confidence (regulators, pastoralists, community); Increased closure costs; Likely to pay compensation (e.g. Mining Act); Major seismic event (earthquake); Embankment settlement - possible release due to liquefaction; Poor consolidation of embankments (erosion potential); Location not suitable.</td>
<td>C 1 H</td>
<td>Adequate design - Geotechnical investigation of project site, design &amp; construction standards, engineering specs, controlled construction (e.g. embankment compaction and testing, rock armouring); Surface water / flood modelling of project site and associated catchments; Flow diversion to protect long-term integrity of TSF landform (i.e. extension of western diversion drain); Groundwater assessment and modelling review for project area; Operate TSF as per design and detailed in the Operating Manual; Implement pre-incident / emergency response plans for tailings spills etc; Solar drying - reduces the risk of saturated tailings; Embankment piezometer monitoring programme (i.e. installation of vibrating wire piezometers); Implement comprehensive groundwater monitoring programme; Annual third-party geotechnical audit / review; Construction sign-off by Engineer of Record and Project Manager; Comply with site procedures / management plans / operating manual; Hazard / Incident reporting; Adequate training and awareness (e.g. personnel are aware of obligations both internal and external, such as clearing permit &amp; Licence conditions); Final disturbance and “as built” to be surveyed and reported within annual MRF submissions; Ensure all relevant project personnel understand the construction plans / scope of work.</td>
<td>D 4 L A</td>
</tr>
<tr>
<td>Risk or Unwanted Event</td>
<td>Hazards</td>
<td>Factors Contributing to Unwanted Event</td>
<td>Inherent Risk (no controls)</td>
<td>Control Measures</td>
<td>Residual Risk (with current controls)</td>
</tr>
<tr>
<td>------------------------</td>
<td>---------</td>
<td>---------------------------------------</td>
<td>----------------------------</td>
<td>-------------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td><strong>Seepage: Impact on soil / vegetation / water</strong></td>
<td>Seepage of mine impacted water (tailing &amp; superannulated liquor) into local groundwater; Non-compliance with regulations; Possible prosecution &amp; fines; Potential loss of tenement (regulator may issue forfeiture); Loss of stakeholder confidence (regulators, pastoralist, community); Increased closure costs; Unable to pay compensation (e.g. Mining Act).</td>
<td>Rising groundwater levels as a result of tailings deposition and water mounding; Inadequate seepage recovery system (bores, trenches, collection points); Lack of or poor monitoring programme (bores surrounding toe and regional embankment piezometers); Poor TSF pond management (e.g. operating at excessive pond volumes); Poor tailings deposition management (e.g. cyclic deposition inadequate, beaches not sloped resulting in poor return water/pond recovery); Incorrectly decommissioned exploration, monitoring and seepage management bores within TSF2 footprint; Ground surface becomes boggy and TSF cannot be inspected or maintained.</td>
<td>A 3 H</td>
<td>Detailed groundwater assessment and modeling review; Local groundwater is hypersaline - only beneficial use is for mining purposes; Thick saprolite layers will isolate any deeper aquifers from being impacted by shallow seepage; Fresh bedrock is expected to be of a low permeability which will limit seepage rates; Construct &amp; operate TSF in a manner which reduces seepage to the subsurface – i.e., low permeability base, underdrainage collection system, maintain a low decant level, aim to reduce cracking of TSF solids to limit rapid/increased surface infiltration potential; Correctly decommission exploration, monitoring and seepage management bores within TSF2 footprint and nearby surroundings to limit enhanced infiltration to underlying strata; Existing ground is relatively tight (potentially high permeability near surface strata are underlain by extensive deep rich sediments which will limit vertical movement of seepage); Infrastructure and facility inspections - 12 monthly visual inspections and records maintained; Conduct bathymetric surveys regularly; maintain water balance tracking / records as per Operating Manual; Install and maintain seepage recovery bores, if required; Implement comprehensive groundwater monitoring programme; Adequate deing and construction standards, engineering specs; Comply with site procedures / management plans / operating manual; Hazard / Incident reporting.</td>
<td>B 4 M</td>
</tr>
<tr>
<td><strong>Bevated Dust Generation: Impact on soil / vegetation / water</strong></td>
<td>Reduced visibility; Dust covered vegetation; Transport of mine impacted material off-site (tailing dust); Impact to local air quality; Loss of stakeholder confidence (regulators, pastoralist, community); Reduction or contamination of topsoil stocks (increased closure costs, insufficient stocks to meet rehab requirements).</td>
<td>Insufficient dust supression (transport corridors, construction areas, materials stockpile areas); Incorrect water used for dust supression (i.e. hypersaline groundwater); Working / transporting dry materials; High wind events; Poor tailings deposition management (e.g. cyclic deposition inadequate - cracking in beach surface, uneven beach formation); Large unstable stockpiles of topsoil.</td>
<td>A 4 M</td>
<td>Construction materials transported at optimal moisture content, with minimal dust generation potential; Controlled placement of tailings via multi-slipgooting to ensure surface remains damp and aids development of a salt crust; Topsoil removal to cease on high wind days; Topsoil stockpiles constructed to best practice design (e.g. ≤2.5m in height); Dust supression on topsoil stockpiles (fresh water) used as required; Supervision by Project Manager and relevant site personnel; Ensure all relevant project personnel understand the construction plans / scope of work; Appropriate capping and rehabilitation when decommissioned; Comply with site procedures / management plans / operating manual; Hazard / Incident Reporting.</td>
<td>D 4 L</td>
</tr>
<tr>
<td>Risk or Unwanted Event</td>
<td>Hazards</td>
<td>Factors Contributing to Unwanted Event</td>
<td>Inherent Risk (no controls)</td>
<td>Control Measures</td>
<td>Residual Risk (with current controls)</td>
</tr>
<tr>
<td>------------------------</td>
<td>---------</td>
<td>-------------------------------------</td>
<td>---------------------------</td>
<td>----------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td><strong>Overtopping - Hydraulic:</strong> Impact or contamination to land / soil / vegetation / water</td>
<td>Tailing / supernatant spillage from transfer infrastructure</td>
<td>Decant water pond is kept to a minimum; Operational freeboard is kept to &gt;300mm to allow for Average Recurrence Interval (ARI) 72-hr 1:100 year event; Multi-spatting and cyclic deposition to form sloped beaches; Regular checks for signs of erosion especially after heavy rainfall events to compliment regular 12hrly visual inspections; Crest slope upwards to shed water out of the TSF; Stormwater runoff generated outside the facility shall be diverted away from the facility such that it does not run against or pool within the vicinity of embankments; Embankment downstream slopes covered with rock armour to protect from erosion.</td>
<td>B</td>
<td>Octave design and construction standards / engineering specs (certified welds etc.); Undertake testing and commissioning process; Secondary containment (pipeline bunding / sumps / catch pits); DCS / control system automated detection - flow differentials and alarms, pressure alarm for block detection, low flow alarm; level sensors; Preventative maintenance by qualified tradespeople; Infrastructure / facility inspections - 12hrly visual inspections and records maintained; Training and awareness (e.g. personnel are aware of obligations both internal and external, such as tenement / licence conditions); Ensure all relevant project personnel understand the construction plans / scope of work; Comply with site procedures / management plans / operating manual; Hazard / incident reporting.</td>
<td>A</td>
</tr>
<tr>
<td><strong>Tailings &amp; Supernatant Liquor Spills:</strong> Impact or contamination to land / soil / vegetation / water</td>
<td>Tailing / supernatant spillage from transfer infrastructure</td>
<td>Inadequate design; Incompatible materials / fittings / valves; Overpressurisation - incorrect fittings / reductions; Failure of secondary containment; Failure of leak detection systems and automatic shutdown of pumps; Failure to follow SOPs and carry out quality inspections.</td>
<td>C</td>
<td>Decant pond management (increased size of decant pond); Poor embankment design (lack of armouring to reduce erosion).</td>
<td>L</td>
</tr>
</tbody>
</table>

November 2017
3.2 Groundwater

Northern Star engaged Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) to review the hydrogeological conditions and undertake a groundwater impact assessment for the proposed facility. The Project area is generally described as having a naturally low pH, hypersaline groundwater and shallow water table. A schematic cross-section through TSF2 illustrated in the AGE review (Figure 10), indicates that the TSF2 footprint is generally underlain by alluvial/colluvial deposits [clay/silt sand], followed by palaeochannel deposits and saprolite clays (weathered bedrock). The depth to bedrock is anticipated to be greater than 80m below ground level.

![Figure 10. Schematic cross section through TSF2](image)

The hydrogeological review found that it appears unlikely that the development of TSF2 will cause extensive impacts to the surrounding groundwater environment. A summary of the potential impacts and management measures has been provided below.

A copy of the groundwater report ‘Kanowna Belle TSF Expansion – Groundwater Review, September 2017’ prepared by AGE can be found in Appendix B.
Potential Risks/Impacts
The key risks and potential impacts associated with decommissioning the northern groundwater monitoring and seepage management bores around TSF1, and construction and operation of TSF2, include:

- Contaminating local groundwater via the seepage of tailings, causing impacts to the surrounding environment;
- Migration of contaminated groundwater away from TSF2;
- Hypersaline groundwater rises into rooting zone, causing vegetation stress / death;
- Groundwater levels rise close to surface causing structural instability of the TSF’s; and
- Ground surface becomes boggy and TSF cannot be inspected or maintained.

Management Measures
The potential impacts associated with the Project are reduced by several inherent controls such as the location and geology of the site and lack of potential use for the local groundwater. Other mitigation measures involve more active controls such as regular groundwater monitoring to identify changes as early as possible.

Below is a summary of the inherent and active controls / management measures to be implemented:

- Identified shallow aquifer units are potentially isolated from ground surface by a low permeability clay layer;
- Thick saprolite layers will isolate any deeper aquifers from being impacted by shallow seepage;
- Fresh bedrock is expected to be of low permeability which will limit seepage rates;
- Potentially high permeability near surface strata are underlain by extensive clay rich sediments which will limit vertical movement of seepage;
- Groundwater is naturally of poor water quality (low pH, high TDS) and there are no local users who may be affected;
- Construct and operate TSF in a manner which reduces seepage to the subsurface – i.e. low permeability base, underdrainage pipeline network, maintain a low decant level / supernatant pond size, aim to reduce cracking of TSF solids to limit rapid surface infiltration potential;
- Monitor water levels and groundwater quality in the bores surrounding the TSF. If necessary, install additional seepage bores to control groundwater levels and limit the extent of seepage;
- Correctly decommission exploration, monitoring and seepage management bores within the planned TSF2 footprint and nearby surroundings to limit enhanced infiltration to underlying strata;
- Seepage from TSF1 has historically migrated into groundwater and has been managed with no significant impacts reported;
- Water levels around TSF1 are already within or the potential rooting zone with no observable impacts reported;
- Review active management of the TSF perimeter drains to reduce the potential surface water infiltration volume;
- Increase abstraction from southern seepage management bores to compensate for lack of abstraction from the north; and
- Leave current TSF1 seepage management system operational for as long as possible.
Contributions to groundwater through seepage from TSF2 is therefore expected to be minimal due to the management measures described above, and implementation of the proposed seepage control measures outlined in Section 2.1.7. Groundwater levels and water quality will continue to be managed through the existing seepage recovery system and proposed new groundwater monitoring network detailed in Section 2.3.

3.3 Surface Water

The Kanowna Belle mine site is characterised with 13 catchments feeding the artificial drains and 9 internal catchments within the current levee system. An extensive flood protection bund around is already exists to divert surface/flood waters around the Kanowna Belle mine site including the KB TSF1.

Northern Star engaged Eco Logical Australia (ELA) to assess peak flow volumes in the current drainage system and estimate potential flood levels across the mine site with a view to determining control features for the proposed TSF2.

A copy of the surface water report ‘Flood modelling for Kanowna Belle Mine: Preliminary High-Level Assessment, October 2017’ prepared by ELA can be found in Appendix C.

Potential Risks/Impacts

The construction and operation of the proposed TSF2 may result in:

- Increased sediment run-off from disturbed ground and from stockpiled materials associated with the Project;
- Impacts to vegetation communities, such as mulga, which are susceptible to changes in surface water flows; and
- Alteration of surface water quality due to uncontrolled release / leakage of tailings, or runoff from TSF external embankments.

Management Measures

Due to the short period of time during which surface water is present in the area and proposed management measures, the risk of impacts on surface water in the area is considered to be low. Additional management measures include:

- Western diversion drain to be extended approximately 250-300 metres north of the existing terminus (Figure 11);
- Compromised sections of the existing artificial drain structures should be repaired and re-formed to ensure the integrity of the existing drain network; and
- Existing culverts and other restrictions to the drain to be cleared of accumulated debris.

The extension of the western drain to beyond the northern boundary of the proposed TSF2, coupled with maintenance of the existing drainage structure will effectively isolate both the TSF and KB mine site from potential flooding conditions.
Figure 11. Proposed Drainage Channel against aerial imagery and DEM (ELA, 2017)
3.4 Flora, Fauna and Ecosystems

A Flora and Fauna Reconnaissance Survey covering the proposed Project area was conducted by Botanica Consulting in early September 2017. Previous flora and fauna surveys over the Project area and its surrounds have been commissioned in 2007 and in 2011, of which a detailed Level 2 survey was undertaken.

The area proposed for the KB TSF2 has been previously disturbed by pastoral and exploration activities. The land systems and associated vegetation and habitat complexes at the Project are well represented in the region. Clearing of vegetation in the area is unlikely to have a significant effect on nearby flora, fauna and ecosystems.

A copy of the ‘KB TSF / Mill Expansion Flora and Fauna Reconnaissance Survey, September 2017’ report prepared by Botanica Consulting has been provided in Appendix D.

Potential Risks/Impacts

The main potential impacts on flora and fauna from the proposed KB TSF2 are:

- Fauna attracted to the supernatant water ponding on the surface of the TSF, however fauna is not expected to use the pond as a water supply given the hypersaline nature of the groundwater and tailings;
- Fauna attracted to the TSF may become lodged in the wet tailings;
- Fauna may become trapped in the HPDE lined return water pond;
- Habitat loss and displacement through vegetation clearing;
- Flora and vegetation loss via rising groundwater (hypersaline) levels; and
- Flora and vegetation loss due to uncontrolled release / spill / leak from tailings pipeline.

Management Measures

To minimise potential impacts to flora and fauna, the following management measures will be implemented:

- Maintain a fence and gate around the return water pond / cyanide destruction facility;
- Appropriate egress points will be installed on the lined return water pond;
- Visual inspections including fauna activity, as part of routine inspections of the TSF;
- Seepage management via the underdrainage system, continued operation of the existing TSF1 seepage recovery bores, and seepage interception trench;
- Pipelines contained within earthen bunded corridors or buried where necessary; and
- Pipelines will be equipped with leak detection that will signal a line failure to operational personnel via the DCS at the process plant, and trigger automatic cut outs.

3.5 Land Clearing

Potential Risks/Impacts

The construction and operation of the proposed TSF2 will result in land clearing of approximately 100 ha for the TSF2 plan footprint. Additional clearing will be required for ancillary infrastructure including, but not limited to: powerline and pipeline corridors, return water/decant pond, diversion drain, access roadways, additional monitoring bores, relocation of pastoral fence line and topsoil stockpile storage areas.
Clearing will result in the loss of vegetation and soil disturbance. Other potential impacts include the loss of fauna habitats, generation of dust, introduction of weed species and surface water flows.

**Management Measures**

Any vegetation clearing and land disturbance will be undertaken to minimise fauna habitat loss, soil erosion and impacts to local groundwater and surface water systems. The following management measures will be implemented:

- Before disturbance commences, an internal process for ground disturbance approval (GDA) will be completed, and the areas to be cleared will be marked / delineated to prevent over clearing;
- To minimise the spread of weeds and soil pathogens, all machinery involved in land clearing activities will be cleaned and inspected prior to earthworks commencing within the Project area;
- Mature vegetation (trees / low lying scrub etc) will be pushed up and grubbed into separate stockpiles. Grubbing material will generally be located upslope of the topsoil stockpiles, to minimise water run-on to the topsoil stockpiles;
- Topsoil / growth medium will be stripped and stockpiled separately in designated areas, to a nominal depth of 150mm and maximum height of 2.5m;
- Clearing permit conditions will be adhered to (as noted in Section 1.4, clearing permit was submitted to DMIRS – Native Vegetation Branch and is pending approval).

### 3.6 Topsoil and Soil Profiles

#### Potential Risks/Impacts

Poor topsoil management has the potential to result in:

- Deterioration of topsoil quality through poor stockpile management (e.g. contamination by seepage, loss of seed viability, loss of structure through excessive handling etc);
- Contamination of topsoil with underlying subsoils through poor stripping management;
- Loss of topsoil through erosion of stockpiles via water and wind action; and
- Loss of topsoil through dust generation.

#### Management Measures

After the grubbing of vegetation, the following management measures will be implemented:

- Viable topsoil / growth medium will be stripped to a nominal depth of 150 mm and stockpiled in low profiles at a maximum height of 2.5m to retain seed viability;
- Topsoil and grubbing material will be stockpiled in designated areas to minimise interference to the flow of surface water;
- The topsoil stockpiles will be constructed in such a manner as to reduce the risk of erosion, increase drainage and promote revegetation; and
- Saline water will not be used for dust suppression on topsoil stockpiles to avoid contamination and loss of topsoil.
3.7 Atmospheric Pollution and Noise

3.7.1 Dust

Dust may be produced from the construction of the Project. Water carts will be used on access tracks/roads, as required, to manage dust emissions generated. The use of saline water for dust suppression will be controlled to avoid overspray which may affect surrounding vegetation.

During operation of the TSF, there is minimal potential for generation of dust as the tailings will remain damp and a crust of salt will develop on the surface as the tailings dries out between deposition cycles. There will also be minimal vehicle movement around the TSF, except during monitoring and maintenance.

There are no nearby residences and the only activities in the immediate area with the potential to be affected by dust are those operated by Northern Star.

3.7.2 Noise

Noise is expected to be generated during the construction of the proposed TSF2 and raising of the embankments through the use of earthmoving machinery. During operation, deposition of tailing will not have any noticeable noise emission associated with it apart from the operation of pumps and the use of vehicles to inspect the facility.

The nearest residential premises are the Ninga Mia Community and the City of Kalgoorlie-Boulder, located approximately 18km to the south-west of the Kanowna Belle operations.

Any noise emissions resulting from the activities of this Project will adhere to the Environmental Protection (Noise) Regulations 1997.

3.8 Waste Management

Waste materials generated during the construction and operation of the Project will be collected, transported, stored and disposed of in a manner which minimises environmental harm and in accordance with relevant Acts and Regulations.

General waste products will be taken to an approved landfill facility (i.e. Yari Road Landfill). Any hydrocarbon-contaminated materials, waste oil, coolants etc will be collected and removed off site by a licenced controlled waste carrier. All paper, cardboard, plastics and scrap metal produced on site will be recycled where possible.

3.9 Hazardous Materials

Northern Star currently has a Dangerous Goods Site Licence for the Kanowna Belle operations pursuant to the Dangerous Goods Safety Act 2004. This licence will be amended to include dangerous goods required by the cyanide destruction facility proposed for the TSF2.

The facility will be designed to minimise the potential impact of spills by the following measures:

- Construction on a bunded concrete slab;
- Construction of storage facility in accordance with relevant Australian standards; and
- Storage and handling in accordance with the requirements of the Dangerous Goods Safety (Storage and Handling of Non-Explosives) Regulations 2007.
3.10 Social Environment

3.10.1 Aboriginal Heritage

Previous ethnographic and archaeological surveys were conducted on the Kanowna tenements throughout the early to late 1990’s when the Kanowna Belle Gold Mine Project was first initiated. These surveys incorporated extensive involvement of many relevant local Aboriginal groups.

Surveys undertaken to date have not identified any registered Aboriginal heritage sites or sites of significance within or near the proposed TSF2. This would appear to be consistent with the locality of the Project area which displays mainly saline flats with no permanent fresh water.

Furthermore, a search on the Department of Planning, Lands and Heritage (DPLH) database - Aboriginal Heritage Inquiry System (AHIS), in October 2017 found no registered Aboriginal heritage sites on the affected tenements.

3.10.2 European Heritage

The Kanowna Belle project area has been associated with gold mining and exploration since the late 1800s. As such, there are many reserves around the Kanowna Belle Gold Mine associated with the old Kanowna townsite.

The proposed location of TSF2 does not occur on any of the reserves. The historic Kanowna townsite is located approximately 3 kilometres south-east of the Project area and will not be impacted.

3.10.3 Pastoral Leases

The Project area lies partially on the privately-owned Mt Vetters pastoral lease. Northern Star Resources has an access agreement with the Mt Vetters Pastoral Station Managers, J. & A. Stevens, and maintains regular contact and a positive relationship with the Stevens. Adequate and open consultation has been undertaken with the Pastoral Station Managers regarding the proposed activities.

Due to the high level of current and historic mining activity in and around the Project area, the proposed TSF2 is not expected to have any impact on pastoral activities.
4. APPENDICES

**APPENDIX A:** Kanowna Belle Gold Mine: Tailing Storage Facility 2 - Design Report, prepared by Coffey Mining Pty Ltd, September 2017.


**APPENDIX C:** Flood Modelling for Kanowna Belle Mine: Preliminary High-Level Assessment, prepared by Eco Logical Australia, September 2017.