KCGM

KALGOORLIE CONSOLIDATED GOLD MINES PTY LTD

KALTAILS SEEPAGE AND GROUNDWATER MANAGEMENT PLAN

JUNE 2020

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1. INTRODUCTION

Kalgoorlie Consolidated Gold Mines Pty Ltd (KCGM) operates the Fimiston Open Pit, Mt Charlotte Underground Mine and the Fimiston and Gidji Processing Plants on behalf of joint venture owners; Northern Star Resources Ltd and Saracen Mineral Holdings Limited.

The Fimiston Operations and Mt Charlotte Underground Mine are located adjacent to the City of Kalgoorlie-Boulder approximately 600 km east of Perth, Western Australia, whilst the Gidji Processing Plant is located approximately 17 km north of Kalgoorlie-Boulder.

Gold ore from KCGM's mining operations is processed at the Fimiston Processing Plant, which is located on the eastern side of the Fimiston Open Pit. Tailings produced from the Fimiston Processing Plant are deposited into three operational Tailings Storage Facilities (TSFs); the Fimiston I, Fimiston II and Kaltails TSFs.

In accordance with conditions of Prescribed Premises Licence L6420/1988/14 (the Licence) issued to KCGM for the Fimiston Operations, KCGM has developed and implemented a Seepage and Groundwater Management Plan (SGMP) for each of the Fimiston (FSGMP) and Kaltails (KSGMP) TSFs. These plans incorporate practices to manage and control groundwater levels around the TSFs, to prevent impact to vegetation as a consequence of rising groundwater levels, due to seepage from the TSFs. If groundwater is not appropriately managed it could rise into the root zone causing detrimental impacts to the surrounding vegetation as a result of water logging.

The beneficial use of the groundwater in the Goldfields region is recognised by the Department of Water and Environmental Regulation (DWER) as being for the purpose of mining related activities including mineral processing; as defined in the Goldfields Groundwater Area Management Plan (Water Authority, 1994). Based on this, potential impacts on groundwater usage are not considered to be significant.

The KSGMP is intended to be a live document which will evolve from the experience gained during operations, routine performance review and feedback from regulators and other stakeholders. This KSGMP represents KCGM's strategy for the TSF incorporating requirements of the Licence. It also provides additional contextual information with regards to the target setting philosophy for the TSF.

2. BACKGROUND

The Kaltails TSF was formerly part of the Kalgoorlie Tailings Retreatment Project, a joint venture project between Normandy Australia Ltd and the Western Australian Mint. It was in operation during the period 1988 through to 1999. A rise in groundwater levels early in the life of this project caused detrimental impacts to the vegetation to the south of the TSF. A loss of vegetation was evident peripheral to the TSF and from the timber reserve further to the south. Seepage management activities implemented at the TSF in 1992 subsequently controlled the rising groundwater levels.

Prior to recommissioning the Kaltails TSF in 2011, KCGM carried out extensive groundwater modelling and studies to ensure that the TSF could be operated without further impact to vegetation in the surrounding area. It was identified that due to the natural land surface elevations around the Kaltails TSF that the aquifer is shallower (i.e. closer to the surface) than at the Fimiston TSFs. The shallow water table is expected to pre-date all influences from mining activities.

Potential impacts to the surrounding vegetation were considered manageable through implementation of a Seepage and Groundwater Management Plan specific to the Kaltails TSF, which incorporated the existing practices used to control seepage and groundwater at the Fimiston TSFs (e.g. seepage recovery bores). This was supported by the Environmental Protection Authority (EPA) who noted in Bulletin 1273 (December, 2007) that: *"With appropriate management from recommissioning, seepage from the historic Kaltails tailings dam is unlikely to cause any further environmental impact."*

The KSGMP was initially developed in November 2009. Implementation of the KSGMP included the refurbishment and re-equipping of production bores and monitoring bores installed around the Kaltails TSF, installation and operation of new groundwater production bores and seepage interception trenches, and the installation of additional groundwater monitoring bores located around the TSF and within the surrounding catchment. Many of these works were undertaken prior to re-commissioning the TSF, and collectively these facilities are referred to as the Kaltails TSF Borefield. Figure 1 shows the location of the facilities associated with the Kaltails TSF Borefield.

The KSGMP previously included the monitoring of vegetation health around the Kaltails TSF. This component was removed from the KSGMP in 2016 following removal of vegetation monitoring conditions from the Licence. It was deemed that over 10 years of photographic monitoring had shown there was no affect to vegetation health and that the depth to groundwater limits imposed by the Licence are sufficient to prevent groundwater levels rising into the root zone and causing detrimental impacts to the surrounding vegetation.

3. OBJECTIVES AND TARGETS

The primary objective of the KSGMP is to prevent impact to vegetation as a consequence of rising groundwater levels due to seepage from the Kaltails TSF. Protection of vegetation requires the depth to groundwater to be maintained sufficiently deep so as not to impact on the soils from which plants source water (i.e. the root zone). Therefore, the management targets for the KSGMP are based on mitigation of seepage and maintaining depth to groundwater in the vicinity of the Kaltails TSF.

The management targets for the KSGMP are outlined in Table 1.

Table 1: KSGMP Management Targets

Item	Management Measure	Target
Depth to Groundwater in Monitoring Compliance Bores[1]	Maintain groundwater levels through seepage recovery (i.e. operation of the Kaltails TSF Borefield).	>4 mBGL in Zone A; and >1 mBGL in Zone B
TSF Supernatant Pool Size, under normal operation	Minimise the normal operating supernatant pool size on the Kaltails TSF through decant recovery.	<15% of the total surface area of the paddock in which deposition is occurring

[1] NB: A list of the Monitoring Compliance Bores is provided in the Licence.

4. SEEPAGE AND GROUNDWATER MANAGEMENT

To actively manage seepage and groundwater, KCGM has implemented the following controls:

- Recovering seepage by means of production bores and seepage interception trenches.
- Minimising the normal operating supernatant pool area on the Kaltails TSF.
- Monitoring groundwater levels in accordance with licence conditions.

4.1. Seepage Recovery

KCGM has established a network of seepage recovery bores and interception trenches around the perimeter of the Kaltails TSF. The majority of the production bores are located within 100 m of the Kaltails TSF. Figure 1 shows the location of the seepage recovery (production) bores and the interception trenches associated with the Kaltails TSF Borefield.

In 2009 and 2010, prior to recommissioning the Kaltails TSF, KCGM installed two seepage recovery trenches, 17 new production bores and 21 new monitoring bores, refurbished five of the original production bores and 23 of the original monitoring bores, converted six of the original production bores into monitoring bores, and decommissioned 43 of the original bores that were in poor condition and were no longer required by the project.

Twelve additional production bores were installed in April 2014. Initially these production bores were operated using portable generators until they were fully commissioned in 2015. And in March 2015, a further 10 production bores were installed and subsequently commissioned in 2016.

Two new production bores were commissioned in 2019, to replace a production bore which was decommissioned due to TSF remediation works.

In accordance with the *Rights in Water and* Irrigation Act 1915, KCGM has been issued a Licence to Take Water (GWL159860) for seepage recovery from the Kaltails TSF Borefield with an annual allowable groundwater abstraction volume of 4,000,000 kL.

Flow rates from Seepage Trench 1 have consistently been around 0.3 L/s, whilst flow rates from Seepage Trench 2 have been in the range of 3 to 5 L/s.

Annual groundwater abstraction from the production bores is highly variable, ranging from 1,131 kL at PB K31 to 109,887 kL at PB K01 (as recorded during 2018). This illustrates the heterogeneous nature of the ferricrete and alluvial sediment groundwater system, with bores intersecting a thicker and more transmissive portion of the ferricrete unit which generally provides the greatest flows.

Overall the average volume of groundwater produced by the Kaltails TSF Borefield since 2016 has been approximately 1,700,000 kL per annum. This is equivalent to 43% of the licensed allocation and an average flow rate of 54 L/s. This flow rate is deemed to be sufficient to manage seepage and maintain groundwater levels below the target depths.

All groundwater produced from the Kaltails TSF Borefield is saline. The Fimiston Processing Plant operated by KCGM has capacity to receive the total flow from the Kaltails TSF Borefield for use in ore processing.

4.2. TSF Supernatant Pool Size

The extent of the supernatant pool controls the portion of the tailings which remains permanently saturated, and therefore retains hydraulic connection from the pool at the surface of the facility to the potential seepage zone at the base of the facility. Generally, the larger the pool size, the larger the rate of seepage. This is confirmed by numerical modelling of seepage from the Fimiston I TSF which identified that allowing a supernatant pool equivalent to 20% of the paddock resulted in significantly shallower groundwater elevations around the facility compared to maintaining a pool area of 10% of the paddock (Golder, 2015).

Therefore, to mitigate the seepage rate, the size of the supernatant pool needs to be kept to a minimum. A target of the KSGMP is to maintain the supernatant pool size, under normal operating conditions, below a maximum of 15% of the total surface area of the paddock in which deposition is occurring on the Kaltails TSF. The total paddock surface area will be determined by survey upon the completion of each wall raise.

The size of the supernatant pool is monitored through a combination of daily visual inspections and fortnightly area surveys. To assist with maintaining the size of the supernatant pool below the 15% target, the rate of decant recovery is adjusted as required.

In the event that the size of the supernatant pool becomes greater than the target size (e.g. due to a high rainfall event), decant water from the TSFs will be used as a priority for mineral processing in preference to groundwater derived from remote saline water borefields (e.g. the Northern and Southern Borefields).

4.3. Depth to Groundwater

Protection of vegetation requires the depth to groundwater to be maintained so as not to impact on the soils from which plants source water (i.e. the root zone).

Studies referenced by the then Department of Agriculture and Food Western Australia determined that whilst native vegetation species may be relatively tolerant of high saline soils, many are poorly adapted to water logging.

A depth to groundwater target of 4 mBGL was self-set by KCGM in the 1990s with the aim of protecting vegetation in the area surrounding the Fimiston TSFs. However, there was no scientific data to support this target and there was uncertainty around the effectiveness of this target on long-term protection of vegetation. A tree root investigation undertaken by Botanica Consulting (2009) found that the majority of roots occur within the top 1 m of the soil profile.

Groundwater level targets for the Kaltails TSF Borefield have been developed based upon existing vegetation assemblages (particularly salinity tolerance and root depth) and current and historical groundwater levels in the area.

The Kaltails TSF is located on the edge of a floodway and there is a substantial fall in ground level elevation across the facility. These natural ground level elevation changes mean that the aquifer is significantly shallower (i.e. closer to the surface) in some areas. Depth to groundwater ranges from >15 mBGL to the northeast to <2 mBGL to the southwest.

The degree in variation in groundwater level across the Kaltails TSF warrants that different groundwater level targets be set for different zones. Two distinct zones (Zone A and Zone B) have been identified (Figure 1), with the boundaries separating these zones based on the type and quality of vegetation assemblages which are influenced by natural depth to groundwater contours (Figure 2).

Zone A is the larger zone and encompasses the majority of the area surrounding the Kaltails TSF. Vegetation surveys conducted during 2009 identified this area as mainly transitional Eucalyptus open woodland. The depth to groundwater target for Zone A is 4 mBGL. This is consistent with the depth to groundwater target for the Eastern Borefield which has been effective in protecting Eucalypt woodland vegetation in the vicinity of the Fimiston TSFs.

Zone B applies to the area to the southwest of the Kaltails TSF, and includes the area which was significantly impacted during the initial operation of the Kalgoorlie Tailings Retreatment Project. The depth to groundwater target for Zone B is 1 mBGL. To the southwest, toward Hannan Lake, the groundwater table naturally tends toward surface and so there must be some limit to which this target applies in this direction. The boundary of Zone B was aligned with General Purpose Lease G26/165 to the south and a pre-existing Prospecting Licence (P26/2373) to the west.

The depth to groundwater targets do not apply within the Operational Area of the Kaltails TSF, as it is recognised that groundwater level management is most difficult in the immediate proximity of the TSF with this area having the greatest potential to fluctuate. This fluctuation is due to operational changes in deposition of tailings within the facility and the size of the supernatant pool.

The Operational Area of the Kaltails TSF includes the footprint of the facility plus a halo around the perimeter, in which infrastructure associated with the operation of the facility is located. The halo is a maximum of 100 m wide or within the premises boundary. In the case of the Kaltails TSF this operational area equates to about 20% of the TSF footprint and is considered part of the facility. The size of the Operational Area halo is subject to annual review to ensure that it remains appropriate.

In accordance with Condition 3.3.1 of the Licence, depth to groundwater limits are applied to Compliance Monitoring Bores. Generally, these are monitoring bores located outside of the TSF Operational Area, however it does not apply to all monitoring bores located outside of the TSF Operational Area. A map of monitoring locations is provided in the Licence, which shows the location of the monitoring compliance bores.

4.4. Groundwater Quality

Groundwater in the vicinity of the Kaltails TSF is saline with total dissolved solids (TDS) concentrations varying from background levels of 40,000 mg/L to more than 100,000 mg/L. The quality of this groundwater is not suitable for potable or agricultural use (stock water and irrigation).

In accordance with Condition 3.3.1 of the Licence, KCGM is required to undertake monitoring of ambient groundwater quality.

Concentrations of pH, TDS, electrical conductivity and other trace elements may be useful indicators of seepage from the Kaltails TSF. However, groundwater quality is not considered relevant to achieving the objective of the KSGMP which can only be achieved through managing groundwater elevations.

The beneficial use of the groundwater in the Goldfields region is recognised by the Department of Water and Environmental Regulation (DWER) as being for the purpose of mining related activities including mineral processing; as defined in the Goldfields Groundwater Area Management Plan (Water Authority, 1994). Based on this, potential impacts on groundwater usage are not considered to be significant.

4.5. Pumping Capacity

In accordance with Condition 3.3.2 of the Licence, KCGM is required to take relevant management action (i.e. increase pumping capacity) in the case of an event as stipulated in Table 3.3.2.

Groundwater levels and trends in the Kaltails TSF Compliance Monitoring Bores are reviewed during the preparation of the Kaltails TSF Quarterly Groundwater Monitoring Report. Depending on groundwater levels and trends, a decision will be made as to whether an increase in groundwater pumping capacity is required. For example, short-term shallowing of groundwater levels in response to significant rainfall events do not necessarily trigger the requirement to increase pumping capacity, as some areas naturally recover quickly without the need for increased pumping.

The event criteria and required management actions associated with the Kaltails TSF are summarised below in **Error! Reference source not found.**.

Table 2: Management Actions for Groundwater Level and Quality Targets

Event		Management Action
Kaltails Zone A Compliance Monitoring Bores	Groundwater level <4 mBGL	Increase pumping capacity within 6 months
	Groundwater level >4 mBGL and <6 mBGL	Review the potential cause of the change in groundwater and increase pumping capacity within 9 months if cause is directly associated with seepage
Kaltails Zone B Compliance Monitoring Bores	Groundwater level <1 mBGL	Increase pumping capacity within 6 months
	Groundwater level >1 mBGL and <2 mBGL	Review the potential cause of the change in groundwater and increase pumping capacity within 9 months if cause is directly associated with seepage

An increase in pumping capacity can be achieved by:

- Maximising the use of near-by production bores;
- Upgrading existing infrastructure, such as pumps and pipelines; and/or
- Construction of new production bores and infrastructure.

The key steps/factors that determine the timeframe required for new bore installation are as follows:

- Expert consultation on water level trend – whether long/short term or event related (rainfall).
- Identification of bore locations.
- Licence application and approval to construct bores.
- Drilling contractor availability.

4.5.1 Construction and Decommissioning of Bores

New monitoring/production bores that are established within the Kaltails TSF Borefield will be constructed according to the requirements of the DWER and to relevant guidance contained in the following:

- National Minimum Bore Specification Committee - Minimum Construction Requirements for Water Bores in Australia (3rd edition, 2012).
- Department of Water (DoW), Water Quality Protection Guideline No 4 - Installation of Mine Site Groundwater Monitoring Bores.

If there is an inconsistency in construction standards, the requirements specified by the DWER will take precedence over those specified in the *Minimum Construction Requirements for Water Bores in Australia.*

The details of newly constructed production bores will be reported in accordance with the DWER requirements.

5. POST CLOSURE

Long-term management of ground and surface water systems affected by KCGM's mining operations has been identified as a key closure aspect within KCGM's Mine Closure Plan (MCP). It is envisioned that post closure criteria for groundwater levels surrounding the Kaltails TSF will be aligned with the objective of this KSGMP, which is to prevent impact to vegetation as a consequence of rising groundwater levels due to seepage from the Kaltails TSF.

The MCP has been developed and implemented in accordance with condition 11 of Ministerial Statement 782 and tenement conditions of associated Mining Leases. KCGM is required to review and resubmit the MCP every three years, and requires approval by both the Environmental Protection Authority (EPA) and the Department of Mines, Industry Regulation and Safety (DMIRS).

It is anticipated that once tailings deposition ceases at the Kaltails TSF, seepage from the facility will continue at reducing rates, and continued operation of the Kaltails TSF Borefield will be required to manage groundwater levels post closure. Pumping will be terminated once groundwater elevations reach agreed targets. The duration and rate of pumping will be a function of the residual seepage rates from the Kaltails TSF.

During development of the KSGMP a historical groundwater model was developed for the Kaltails TSF. This model indicates a pre-mining depth to groundwater ranging from approximately 17 mBGL on the northeast point of the facility to 4 mBGL on the southwest, where groundwater shallows to near surface as the floodway approaches Hannan Lake.

It should be noted that as a result of the permanent changes to the hydrological regime associated with the operation of the Kaltails TSF, groundwater elevations are unlikely to return to the estimated pre-mining elevations in all locations. Therefore, post closure criteria for groundwater levels will be determined on a facility and location specific basis, and will be finalised and incorporated into future versions of the MCP.

6. REVIEW

Review of the KSGMP will be undertaken as per the following:

- On advice from the DWER;
- Following a significant change in process or operational aspect; or
- Following recommendations made in the annual audit.

7. REPORTING

7.1. Quarterly Groundwater Monitoring Report

In accordance with Condition 4.2.2 of the Licence, KCGM shall submit a Quarterly Groundwater Monitoring Report to the DWER within 46 calendar days after the end of the reporting period.

Results of groundwater monitoring programme and commentary on performance against the KSGMP targets are provided within this report.

7.2. Annual Audit

In accordance with Condition 1.3.6 of the Licence, the KSGMP is required to be audited each year by a suitably qualified professional. The audit shall include but not be limited to:

- The licensee's progress towards existing targets and milestones;
- Whether the objectives in the KSGMP are being achieved and are still appropriate; and
- A statement of the independence of the auditor, including experiences and qualifications.

The reporting period for the annual audit is currently defined by KCGM to be 1 October to 30 September each year.

7.3. Annual Environment Report

In accordance with condition 4.2.1 of the Licence, KCGM shall include a copy of the Annual Audit Report of the KSGMP in the Annual Environment Report, which is submitted to the DWER by 31 March each year.

8. STAKEHOLDER CONSULTATION

The KSGMP was developed in accordance with Condition 2 of Works Approval W4613/2009/1 which required KCGM to submit a final version of the KSGMP to the then Department of Environment and Conservation for approval prior to recommissioning the Kaltails TSF. The KSGMP incorporated the seepage and groundwater management practices outlined in the FSGMP which was implemented in 2005 following comprehensive consultation with the then Department of Environment and the community of Kalgoorlie-Boulder.

Initially, in accordance with conditions of the Licence, the outcomes of the audit for the FSGMP were made available for public comment for a minimum period of 21 days. This condition was removed when the Licence was reissued 26 September 2008. In 2009, KCGM began consulting with the Community Reference Group (CRG) and obtaining feedback on the FSGMP annual audit to ensure the audit continued to undergo appropriate community consultation.

In keeping with the FSGMP, the requirement to consult annually with the CRG on the KSGMP draft audit report was incorporated into the KSGMP in 2012. Since then the feedback received from the CRG has been supportive of KCGM's management practices however has not resulted in any material changes to the KSGMP.

Consequently, KCGM has determined that presentation of the audit report findings to the CRG is no longer required. However, a copy of the audit report will be provided to the CRG members if requested.

9. GLOSSARY OF TERMS

Beneficial Use: The current or future uses of an identified resource. Beneficial Use is also referred to as the Environmental Value of a resource. Beneficial use designations provide objectives for the management, use and protection of the resource.

Bore: A narrow, normally vertical hole drilled in soil or rock to monitor or withdraw groundwater from an aquifer.

Borefield: A group of bores to monitor or withdraw groundwater.

Compliance Monitoring Bore: Monitoring bores which are located outside the TSF Operational Area as listed in the Licence.

CRG: Community Reference Group

DWER: Department of Water and Environmental Regulation.

FSGMP: Fimiston Seepage and Groundwater Management Plan.

Groundwater Level: The upper surface of groundwater, or the level below which an unconfined aquifer is permanently saturated with water, (also known as water-table, piezometric level).

Kaltails TSF Borefield: This is the bore network that is constructed around the Kaltails TSF and comprises all of the Production and Monitoring Bores and associated infrastructure. This is distinct from the Kaltails Borefield which is a saline water supply borefield located approximately 5 km further to the southeast.

KSGMP: Kaltails Seepage and Groundwater Management Plan.

mBGL: Is the groundwater level or depth below ground level in metres.

TSF Operational Area: The area of the Kaltails TSF that includes the immediate footprint of the facility plus a halo around the perimeter in which infrastructure associated with the operation of the facility is located. The halo is a maximum of 100m wide.

Seepage: Water infiltration into the soil beneath the TSF**.**

Supernatant Pool: This is the pool of water that forms on the surface of an active TSF paddock and comprises water that has bled to the surface from the tailings slurry as it settles. The water then flows to the low point on the TSF surface from where it is reclaimed for reuse in the Processing Plant.

Tailings Storage Facility (TSF): An engineered structure (holding area) that consists of embankments designed for storing tailings usually with a mechanism to recover water for re-use.


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Monitoring Bore
Production Bore
Toe Drain & Seepage Interception Trench
TSF Operational Area
ZONE A
ZONE B
KCGM
Figure 1
Kaltails TSF Borefield - Facilities
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1 Km
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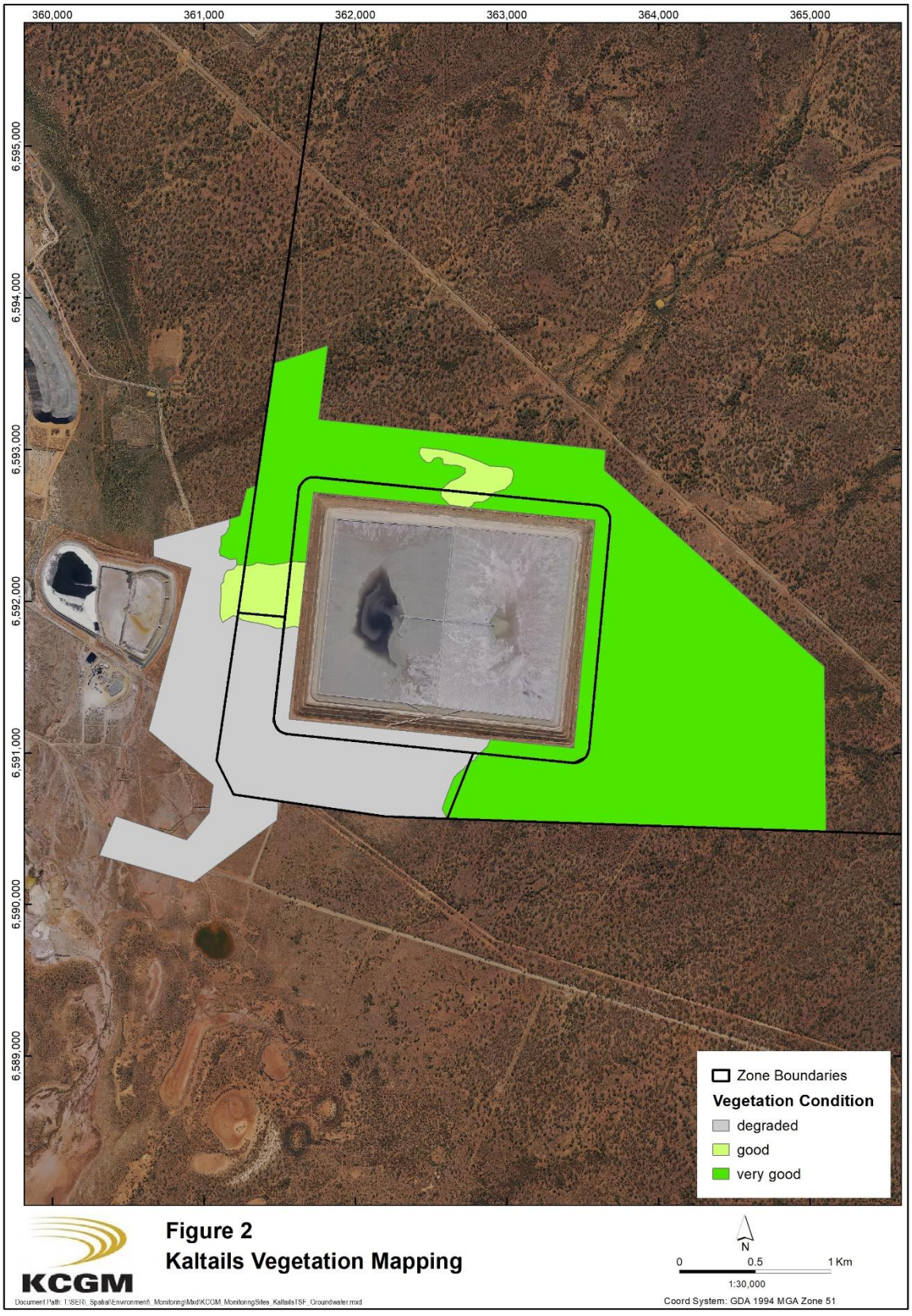
Coord System: GDA 1994 MGA Zone 51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Zone Boundaries
Vegetation Condition
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KCGM
Figure 2
Kaltails Vegetation Mapping
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Coord System: GDA 1994 MGA Zone 51