

Repurposing of the Genex Kidston mine site in Queensland, Australia

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Abstract

The Genex Kidston mine site is among the best examples in Australia of repurposing post-closure. The paper presents the rehabilitation history of the Kidston mine site as it approached closure in 2001, and the performance of the rehabilitation over the last 20 to 25 years. The rehabilitation strategy adopted by Kidston for their surface waste rock dump was to selectively place the mineralised material within a 50 to 60 m wide side encapsulation of fresh barren waste rock, and to construct an innovative store and release cover comprising oxide waste over the top of the dump revegetated with native trees, shrubs, and grasses. The dump rehabilitation aims were to prevent the exposure of the mineralised waste rock to rainfall infiltration incident on the free-draining fresh barren rock angle of repose slopes, and for the top cover to minimise the net percolation of incident rainfall into any underlying mineralised waste rock, which it has been demonstrated to achieve. For the surface tailings storage facility, the upper exposed layer of tailings oxidised and the oxidation products were largely leached by rainfall infiltration, resulting in a slightly alkaline pH, and rendering the tailings surface suited to direct revegetation with the addition of fertiliser and initial irrigation. The tailings also have a relatively low permeability. Both the low permeability of the tailings and the revegetation with native trees, shrubs and grasses serve to limit the net percolation of rainfall. Genex Power Limited purchased the Kidston mine site in 2016 with the aim of converting it to a Renewable Energy/Battery Hub, including a Solar Farm, on the surface tailings storage facility, and constructing a Pumped Storage Hydro Project, taking advantage of the two open pits. These facilities are described in the paper, which also provide the opportunity for the long-term management of the former mine site.

Keywords: *post-closure repurposing, rehabilitation, slope treatment, tailings storage facility, waste rock dump*

1 Introduction

Both mine operators and regulators often focus on the cost of mine site rehabilitation, essentially assuming that the rehabilitated mine site will be unproductive post-closure (Williams 2019). In fact, all activities on a mine site involve a cost, which must be allowed for in the assessment of the value of the commodity produced. The initial focus is on attempting to recover rehabilitation costs, which leads to the removal of infrastructure with some scrap value, such as electricity transmission lines and building materials. There is a need for a change in the narrative surrounding mine site rehabilitation to refocus on post-mining 'value' rather than 'cost', as is illustrated in Table 1. The Kidston Gold Mines site is located 270 km northwest of Townsville in North Queensland. Open pit mining extended from 1984 to 2001, and rehabilitation was implemented from 1995 to 2001. Kidston Gold Mines were operated with closure in mind and rehabilitation was leading edge at the time. Genex Power Limited purchased the Kidston mine site in 2016 with the aim of converting it to a Renewable Energy/Battery Hub, taking advantage of the mined landforms present. These included the flat top of the surface tailings storage facility, well suited to the development of a Solar Farm, and the two pits being used to construct a Pumped Storage Hydro Project. The operating and rehabilitation strategies employed at Kidston are described, together with the performance of the rehabilitation over the last 20 to 25 years, and the repurposing of the site by Genex as a Renewable Energy/Battery Hub.

Table 1 Conventional 'cost' versus alternative 'value-added' approaches to mine site rehabilitation

| Conventional cost-based rehabilitation | Alternative value-added rehabilitation |
|---|---|
| Production rules | Post-closure 'value' is identified up front |
| Rehabilitation is seen by operator and regulator as a 'cost' | Examples include: |
| Operator discounts cost over time, discouraging rehabilitation | <ul style="list-style-type: none"> • Renewable energy (NIMBY) – solar, wind and pumped storage, delivered to grid via mine transmission lines, if possible • Agriculture and/or fishery using water dams • Tourism and heritage (older the better) |
| Infrastructure such as power lines are stripped and sold for small gain | |
| Rehabilitation is limited to 'smoothing' and 'greening' | 'Value' sets rehabilitation budget |
| Post-closure land use and function are limited | Potential wins for operator, future land user and government |

2 Kidston mine site

The Kidston Gold Mines site is located 270 km northwest of Townsville in North Queensland.

2.1 Site overview

As shown in Figure 1, Kidston mined Wisers Hill Pit to 240 m depth (52 ha footprint), followed by Eldridge Pit to 270 m depth (54 ha footprint). The waste rock and tailings generated from Wisers Hill Pit were placed in a surface waste rock dump (WRD) surrounding the Wisers Hill Pit and a large surface tailings storage facility (TSF), respectively. The surface WRD has a typical height of about 36 m constructed in a single lift, with a total area of 337 ha. The surface WRD sits on Wisers Hill, which has a very low permeability, limiting rainfall and seepage infiltration. The surface TSF has a maximum embankment height of about 32 m, an average tailings depth of about 15 m, and an area of 310 ha in a total catchment of 414 ha. All of the waste rock and tailings generated from Eldridge Pit were backfilled into the completed Wisers Hill Pit, the waste rock end-dumped from the northwest crest of the pit (upper right in Figure 1), and the tailings thickened and gravity fed down the opposite southern crest of the pit. Figure 2 shows an aerial view of the Kidston Genex site, with the Solar Farm on the surface TSF to the top left, and the two partially flooded open pits that will be converted into a Pumped Storage Hydro Project; the backfilled Wisers Hill Pit in the centre, surrounded by the WRD, and Eldridge Pit to the lower left of Figure 2.

2.2 Climatic setting

The Kidston mine site experiences a subtropical hot and humid wet season (December to March) and long cooler dry season (April to November; Bureau of Meteorology, <http://www.bom.gov.au/>). Since 1902, there has been a rising trend in annual rainfall, from a low of about 620 mm in 1940 to over 800 mm in 2020. The historical mean annual rainfall is 656 mm, and the range is from 126 mm in 1926 to 1,588 mm in 1974 (20 to 240% of the average). Since the rehabilitation and closure of Kidston mine, the mean annual rainfall has been 795 mm, with a range from 539 mm in 2002 to 1,572 mm in 2009 (68 to 198% of the average). The average number of days of rain per year is 68 days, or only 19% of the year. The site climate is strongly net evaporative on average. The 2010/2011 wet season (1,572 mm of rain fell in 2010) swamped the WRD and TSF seepage collection ponds and pump-back to the pits, requiring major work to increase the storage capacity of the seepage collection ponds and the scale of the pump-back system.

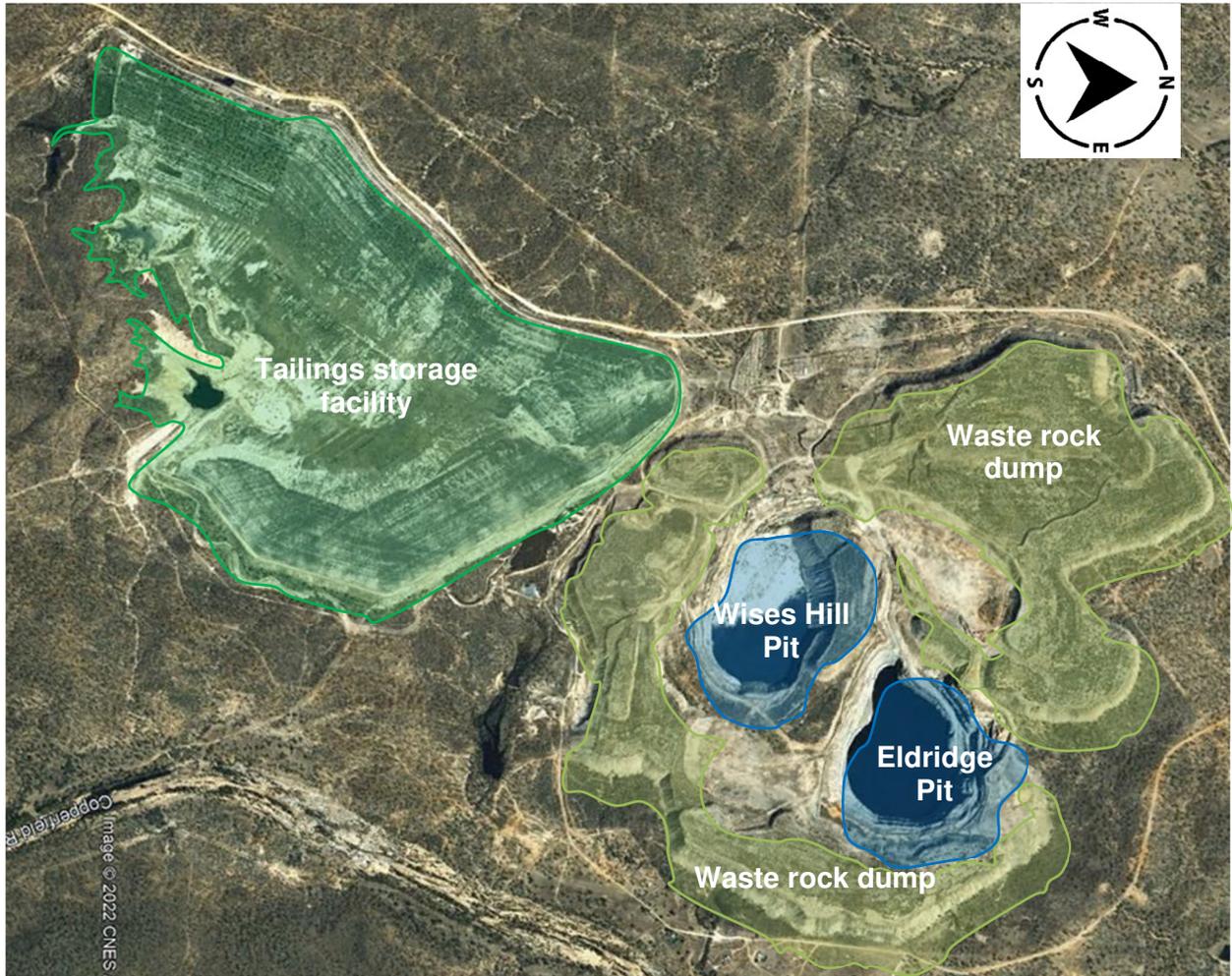


Figure 1 Google Earth image of Kidston mine site (December 2016)



Figure 2 Aerial view of Kidston Genex site

3 Rehabilitation of Kidston mine site

The current state of the open pits and the rehabilitation of the surface WRD and surface TSF at the Kidston mine site are described in the following sections.

3.1 State of open pits

Hydrogeological studies have demonstrated that the pits will remain groundwater sinks and the rock surrounding the pits is of very low permeability, as evidenced by the limited drawdown of the groundwater surrounding the pits during mining. The seepage from the surface WRD and surface TSF is collected in ponds and pumped to Eldridge Pit and has little impact on its volume or water quality.

Wises Pit water has a relatively high electrical conductivity (typically 6.6 dS/m), circum-neutral pH (typically about 8.1), is elevated in sulfate (typically 3,700 mg/L), and somewhat elevated in arsenic, cadmium, and nickel. Eldridge Pit water has a moderate electrical conductivity (typically 3.1 dS/m), circum-neutral pH (typically about 7.4), is moderately elevated in sulfate (typically 1,600 mg/L), and somewhat elevated in arsenic, cadmium, copper, manganese, and nickel.

3.2 Rehabilitation of surface waste rock dump

The Kidston waste rock comprised less than 20% mineralised (or potentially acid-forming) material with a typical sulfur content of 0.9%, typically 1.8 times its acid neutralisation capacity, making it potentially susceptible to acid generation in extreme wet seasons. The remainder of the Kidston waste rock comprised mostly fresh barren (non-acid forming [NAF]) rock, plus surficial NAF weathered rock or oxide waste. There was minimal topsoil, with the upper oxide layer serving as the natural growth medium. The oxide waste was highly erodible, particularly on slopes, even if they were flattened from their angle of repose.

The strategy adopted by Kidston for the construction of their surface WRD was to selectively place the mineralised waste rock within a 50 to 60 m wide side encapsulation of fresh barren rock, and to construct a cover comprising oxide waste over the top of the dump. The aims were to prevent the exposure of the mineralised material to rainfall infiltration incident on the free-draining fresh barren rock angle of repose slopes, and for the top cover to minimise the net percolation of incident rainfall into any underlying mineralised material.

The rehabilitation strategy developed for the surface WRD took into account the intense wet season and long dry season, the need to minimise the net percolation of rainfall into the encapsulated mineralised waste rock, and the erodibility of the oxide waste. A 'new' robust, non-shedding, erosion-resistant store and release cover system was developed for the top of the WRD, as later endorsed for the climatic setting of the site by the Global Acid Rock Drainage Guide (International Network for Acid Prevention 2009).

The principle behind the store and release cover system was to 'store' the wet season rainfall and 'release' the stored water through evapotranspiration during the long dry season, with the moisture state of the cover cycling seasonally between wet and dry, and no net wetting-up or drying-out of the cover over time. The success of a store and release cover is dependent on a low permeability layer at the base to 'hold up' rainfall infiltration in the upper growth medium, and revegetation with native trees, shrubs, and grasses to release it, with the sustainability of the revegetation in turn dependent on it. A natural analogue to the store and release cover system is a paleochannel, with water held up in the coarse-grained channel by a layer of low permeability sediment beneath it and sustaining vegetation along the channel.

Bews et al. (1997) described the design and trialling of the store and release cover system for the top of the WRD, shown schematically in Figure 3. The adopted design was a 500 mm compacted layer of selected fine-grained, highly weathered oxide waste to hold up rainfall infiltration, overlain by a nominal 1.5 m thick, loose-dumped, mounded 'rocky soil mulch' layer of highly weathered oxide waste to serve as an evapotranspirative growth medium for trees, shrubs and grasses. The initial trial covers involved truck paddock-dumped rocky soil mulch, which was later smoothed by low-bearing pressure dozers to 'smear' potential seepage flow paths to the base of the rocky soil mulch layer, while still not shedding erosive rainfall.

Since the oxide waste was found to be highly erodible on slopes, the fresh barren waste rock side slopes of the WRD were left at their angle of repose and partially over-dumped with oxide waste to promote moisture retention and revegetation with native shrubs and grasses. The over-dumped oxide waste tended to ‘hang up’ on the upper angle of repose slope, and dumping was limited to avoid the run-out of oxide waste to the toe of the dump. The aim was to have the oxide waste wash into the fresh waste rock by incident rainfall. Revegetation was facilitated by aerial fertilising and seeding.

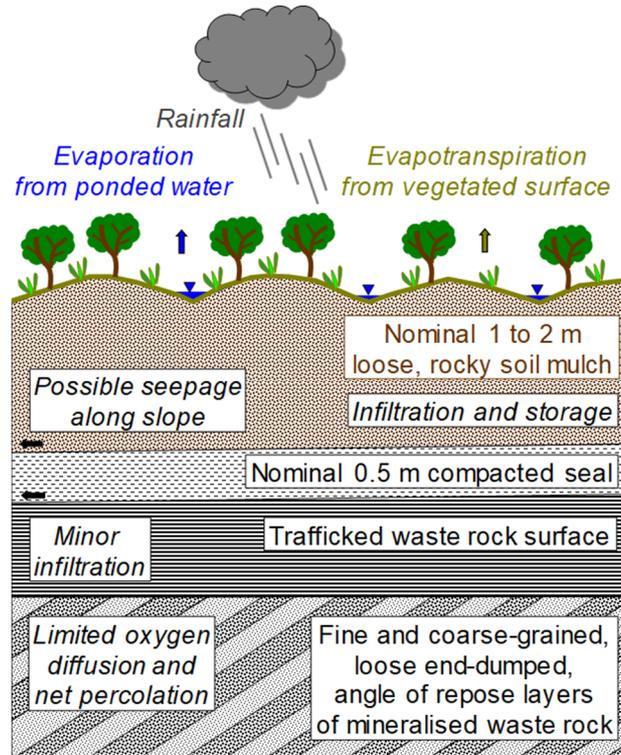


Figure 3 Schematic of store and release cover system developed for Kidston waste rock dump top

3.3 Rehabilitation of surface tailings storage facility

The Kidston tailings contained up to 1.5% sulfur, which was concentrated along tailings streams on the surface TSF during deposition, covering perhaps 10% of the tailings beach. The sulfur was largely neutralised by the alkaline process water (being a highly alkaline cyanide process), supplemented by the addition of lime along the final tailings streams to neutralise concentrated sulfur. The upper exposed layer of tailings oxidised and the oxidation products were largely leached by rainfall infiltration, resulting in a slightly alkaline pH, and rendering the tailings surface suited to direct revegetation with native trees, shrubs, and grasses, with the addition of fertiliser and initial irrigation. The native revegetation and desaturation of the tailings were expected to limit the net percolation of rainfall.

4 Performance of rehabilitated surface waste rock dump

The early and recent store and release cover performance of and seepage from the rehabilitated surface WRD at the Kidston mine site are described in the following sections.

4.1 Early monitoring of waste rock dump cover performance and seepage

During the first 6 years (Williams et al. 2003), the 23 ha instrumented store and release cover trial constructed at Kidston in late 1995 recorded an average net percolation of rainfall of 0.25%, with a maximum of 1.1%. The annual rainfall totals during this period were 524 mm, 623 mm, 475 mm, 522 mm, 713 mm, and 523 mm, which are generally well below the then long-term mean annual rainfall of 656 mm, which also impacted native revegetation.

The intermittent ponding of rainfall between the store and release cover mounds was observed following rainfall events during each wet season. The gravimetric moisture content of the rocky soil mulch layer cycled between a minimum of about 4% (about 20% saturated) at the end of each dry season and about 13% (about 70% saturated) during the wet season. The estimated (unsaturated) hydraulic conductivity of the surficial rocky soil mulch beneath ponded rainfall was about 15 mm/day (1.7×10^{-7} m/s), resulting in a wetting front that penetrated about 250 mm into the rocky soil mulch layer before the pond disappeared. Evaporation from the ponded rainfall averaged about 11 mm/day.

Water uptake by 2–3-year-old eucalypts ranged from 2 to 20 L/day/tree during the late dry season (October) to 10 to 30 L/day/tree during the wet season, making eucalypts the key to sustainable transpiration. Water uptake by 2–3-year-old acacias was 3 to 4 L/day/tree during October. Water uptake by grass cover was 2 to 4 mm/day. Overall, the water uptake by the native revegetation varied between about 2 mm/day in the dry season to 4 to 6 mm/day during the wet season, compared with an annual average daily rainfall of about 2 mm, demonstrating that the cover was generally net evapotranspirative.

Prior to the 23 ha store and release cover being constructed on part of the WRD, the seepage rate at the toe averaged 4 to 5 L/s. The cover reduced this by about 30%. Following the covering of the entire WRD, the seepage rate reduced to less than 1 L/s or less than 1.4% of annual rainfall incident on the top of the dump. This seepage included ongoing but diminishing drain down of the WRD, which had been wet-up by rainfall infiltration during its construction, with net percolation through the store and release cover estimated to be less than 1% of annual rainfall.

Williams et al. (2006) confirmed the findings reported in Williams et al. (2003) and reported reducing seepage flows and improving quality. V-notch weirs were installed on the main toe seeps from the WRD in October 2002 and measured a reduction in flows to about 0.6 L/s by August 2005. The 1990/1991 extreme wet season (1,269 mm of rainfall was recorded in 1991) initiated mild AMD, which resulted in the pH of the seepage dropping suddenly from about 7.5 to about 4.5, and the sudden increase in dissolved copper and zinc (Figure 4). However, copper and zinc concentrations in the seepage reduced dramatically following the completion of the covers on the WRD at the end of 2001.

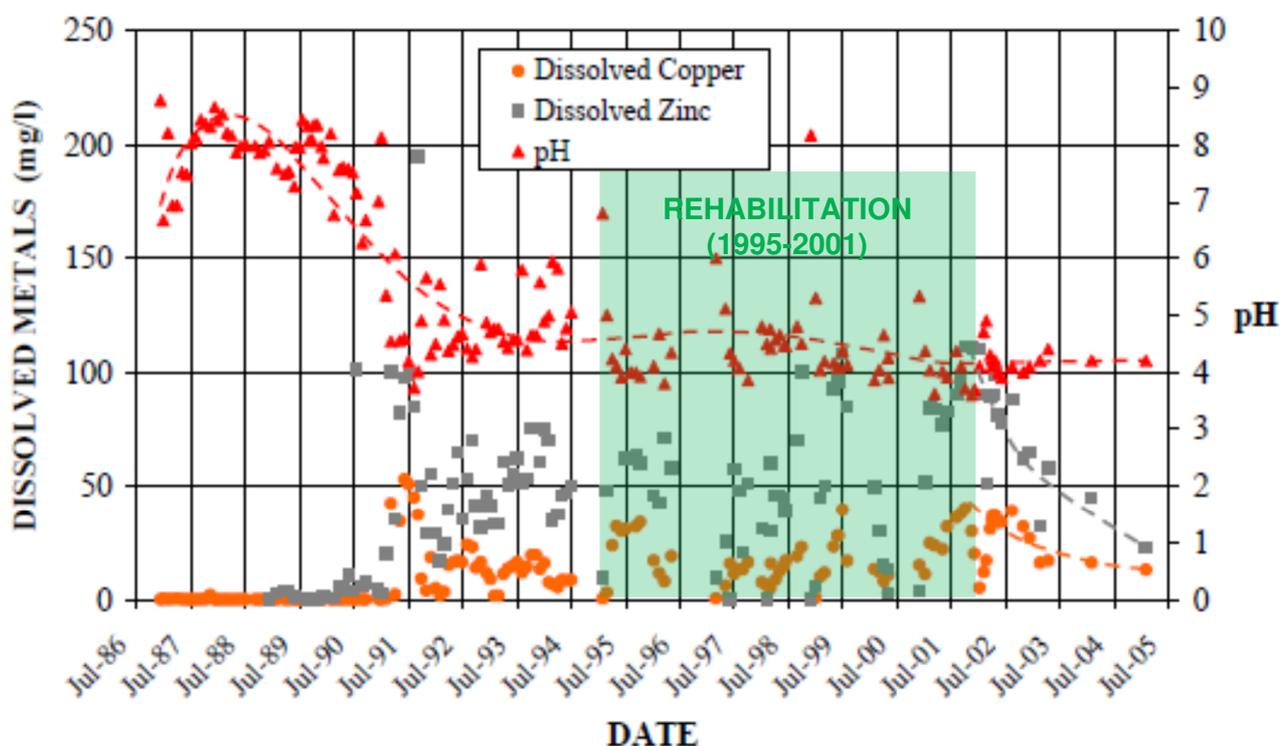


Figure 4 Improving seepage quality after completion of store and release covers

4.2 Recent monitoring of waste rock dump cover performance

Test pits were excavated and sampled through the 25-year-old store and release covers on the surface WRD in the dry season (August and November 2021), and further test pit investigations are planned to study the wetting-up of the covers. Test pits were excavated through the crests and troughs of the store and release cover mounds at three locations, covering the range of revegetation conditions across the WRD. The samples collected from the test pits were subjected to geotechnical and agronomic testing. The geotechnical testing included laboratory gravimetric moisture content testing by drying in a 105°C oven, and laboratory total suction (water potential) measurements using a WP4C Dew Point Hygrometer. The agronomic testing included field and laboratory pH measurements, laboratory electrical conductivity measurements, and laboratory exchangeable sodium percentage measurements.

Typical gravimetric moisture content profiles through the crest and trough of the store and release cover, sampled in August 2021, are shown in Figure 5, together with the inferred profile on materials with depth, which closely match the specified store and release cover design. The dashed red line is the average of all six test pits excavated in August 2021. The gravimetric moisture content at full saturation is estimated to be 15%, although this value will vary with the density of the cover material and would be expected to be lower in the compacted finer-grained sealing layer at the base of the cover. It is clear from Figure 5 that the periodic collection of rainfall in the trough results in an elevated moisture content at shallow depth, although this is not seen at depth. The compacted sealing layer is less than one-third saturated, as is the trafficked waste rock beneath the cover.

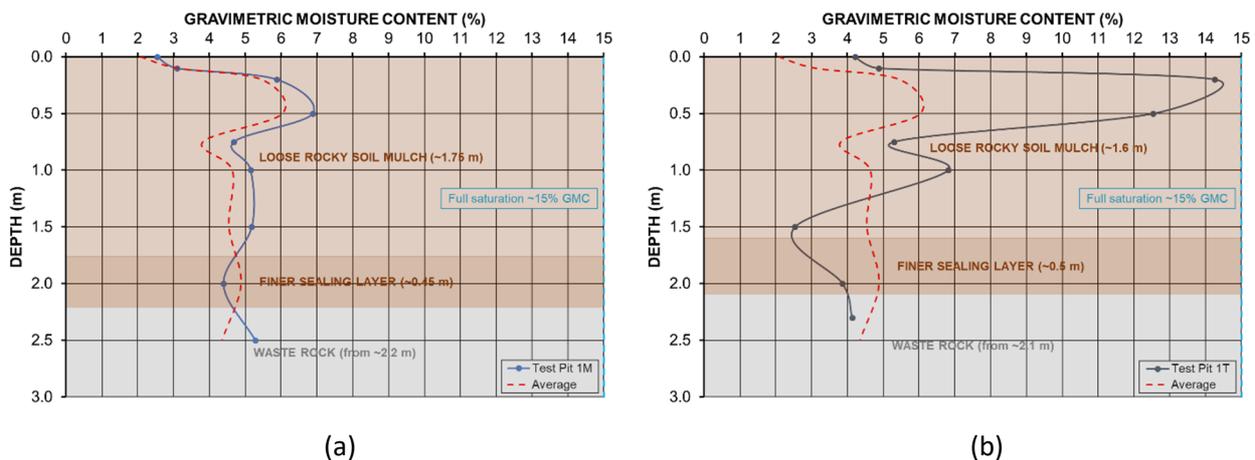


Figure 5 Typical gravimetric moisture content profiles through: (a) Crest and (b) Trough of store and release cover, sampled in August 2021

Typical total suction profiles through the crest and trough of the store and release cover, sampled in August 2021, are shown in Figure 6. The dashed red line is the average of all six test pits excavated in August 2021. The dashed light blue curve represents the worst possible case of a watertable perched at the top of the compacted sealing layer, giving zero suction at that elevation. It is clear from Figure 6 that the total suction, which is mainly matric suction because the electrical conductivity is low, is about three orders of magnitude lower than the worst ‘hydrostatic’ case, indicating that the cover is very strongly evapotranspirative.

The laboratory measured pH values were generally circum-neutral, with a range from 4.6 to 9.0 and an average value of 7.0 for samples from the six test pits excavated in August 2021. The laboratory measured saturated electrical conductivity values ranged from 0.23 to 1.40 dS/m, with an average value of 0.7 dS/m, all well under the plant threshold value of 4 dS/m. The laboratory measured exchangeable sodium percentage values ranged from 0.6 to 2.6%, with an average value of 1.0%, all well under the plant threshold value of 6%. As a result of the favourable pH and exchangeable sodium percentage values, no further agronomic testing was warranted.

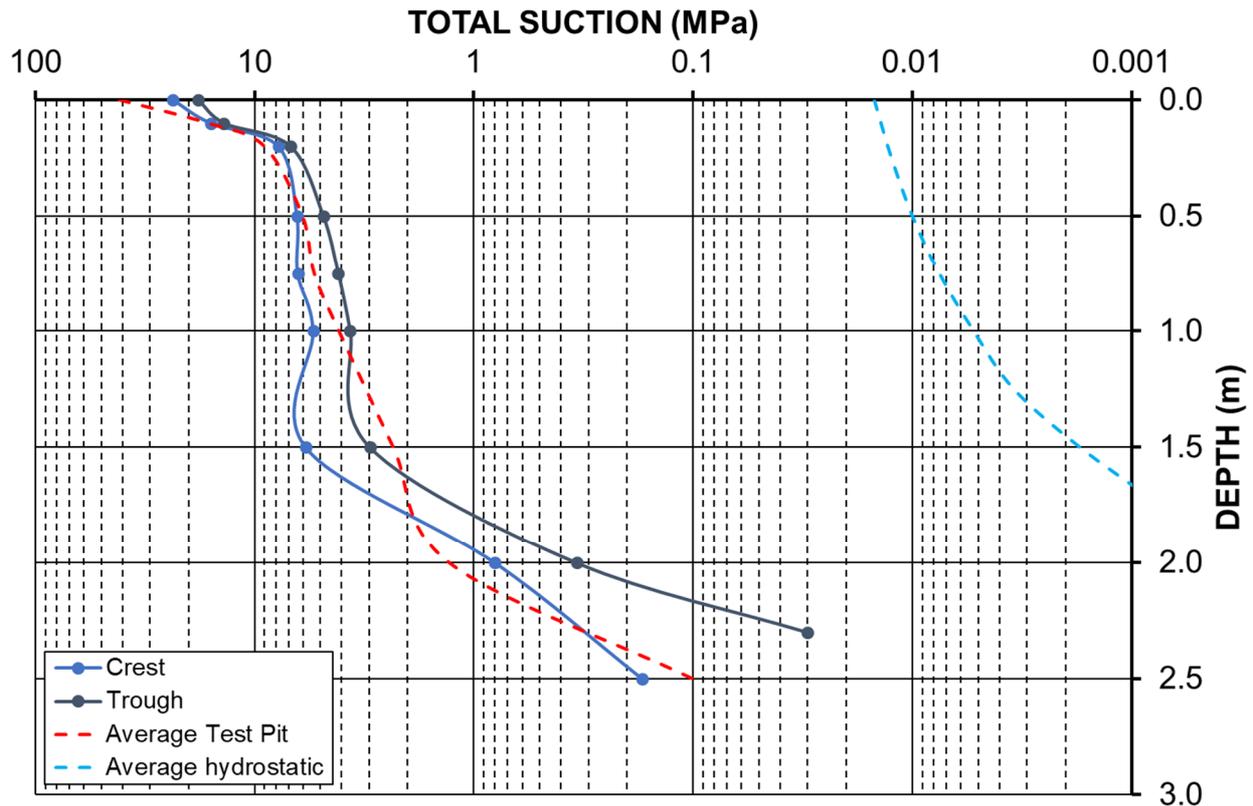


Figure 6 Typical total suction profiles through crest and trough of store and release cover, sampled in August 2021

It was concluded from the results of the testing of test pit samples recovered in August 2021 that the store and release cover and chemistry generally are not revegetation limiting. There was no evidence of salt or acidity uptake into the cover (in fact, the underlying trafficked waste rock was generally more alkaline). Revegetation is generally better on the crests of the store and release cover than in the troughs, likely due to wet season flooding. Moisture retention and revegetation are generally better where there is a compacted layer at depth to hold up rainfall infiltration, and the rocky soil mulch contains fines (not just sand-sized and coarser particles). Revegetation of the store and release cover appears to be a function of the effectiveness of the original seeding and hence nutrient cycling, and ponding in troughs is detrimental.

4.3 Monitoring of waste rock dump seepage

The pump-back of seepage from the surface WRD toe seepage collection ponds to the pits provides an indicator of seepage rates from the facility, and increases with rainfall, although it is somewhat lagged in time. Mean annual seepage from the WRD is estimated from pumping records to be 2.2% of mean annual rainfall incident on the dump (at 1.8 L/s), allowing for evaporation from the seepage collection ponds of 0.3%, and negating any seepage into the tight foundation. Of the total seepage, the uncovered side slopes account for an estimated 1.4% (assuming 50% rainfall infiltration), implying an estimated 0.8% net percolation through the store and release covers, which compares well with the best achievable using any cover system of the order of 1% of similar annual rainfall totals, increasing with increasing rainfall (Benson et al. 2002). The available pumping data from 2012 to 2020 allow the estimated seepage as a percentage of annual rainfall to be plotted versus annual rainfall as a percentage of the mean annual rainfall (Figure 7), which shows increasing percentage seepage with increasing rainfall, as was also found by Benson et al. (2002).

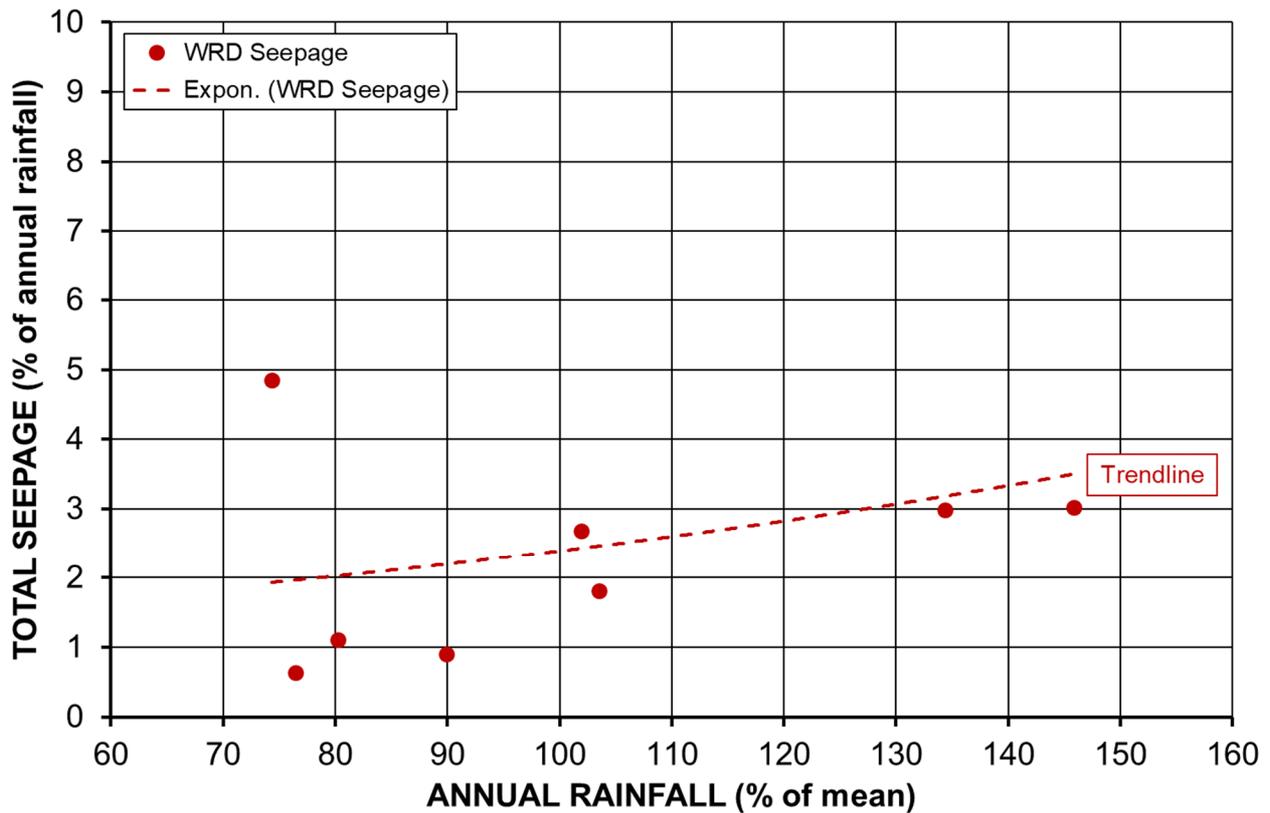


Figure 7 Total seepage versus annual rainfall for rehabilitated surface waste rock dump

While water quality in the seepage collection ponds at low points around the toe of the surface WRD remains acidic and has elevated dissolved copper and zinc, water quality downstream of the site is generally in compliance with regulatory limits. Wises Pit water has a relatively high electrical conductivity (typically 6.6 dS/m), circum-neutral pH (typically about 8.1), is elevated in sulfate (typically 3,700 mg/L), and somewhat elevated in arsenic, cadmium, and nickel. Eldridge Pit water has a moderate electrical conductivity (typically 3.1 dS/m), circum-neutral pH (typically about 7.4), is moderately elevated in sulfate (typically 1,600 mg/L), and somewhat elevated in arsenic, cadmium, copper, manganese, and nickel.

4.4 Long-term monitoring of waste rock dump revegetation

The development of mean total native revegetation cover on the top of the WRD during the 20-year period since the completion of rehabilitation at the end of 2001 is a high 82% (<https://vegmachine.net/>), as shown in Figure 8. Unremarkably, the percentage of green or living revegetation cover has fluctuated seasonally. Importantly, however, ‘bare ground’ has steadily declined to an average 13% over the past 5 years. Apart from high density, the revegetation also shows considerable diversity, with tree, shrub, and grass cover, as shown in Figure 9.

5 Performance of rehabilitated surface tailings storage facility

The pump-back of seepage from the surface TSF to the pits provides an indicator of seepage rates from the facility, and increases with rainfall, although it is somewhat lagged in time. Mean annual seepage from the TSF is estimated from pumping records to be 2.9% of rainfall incident on the total 414 ha catchment (at 3.0 L/s), allowing for evaporation from the seepage collection ponds of 0.3%, and negating any seepage into the tight foundation. For the 310 ha surface TSF footprint, a net percolation into the tailings of 2.2% is inferred, which is considerably higher than that inferred through the surface WRD store and release cover of 0.8% of incident rainfall. The available pumping data from 2012 to 2020 allow the estimated seepage as a

percentage of annual rainfall to be plotted versus annual rainfall as a percentage of the mean annual rainfall (Figure 10), which shows increasing percentage seepage with increasing rainfall.

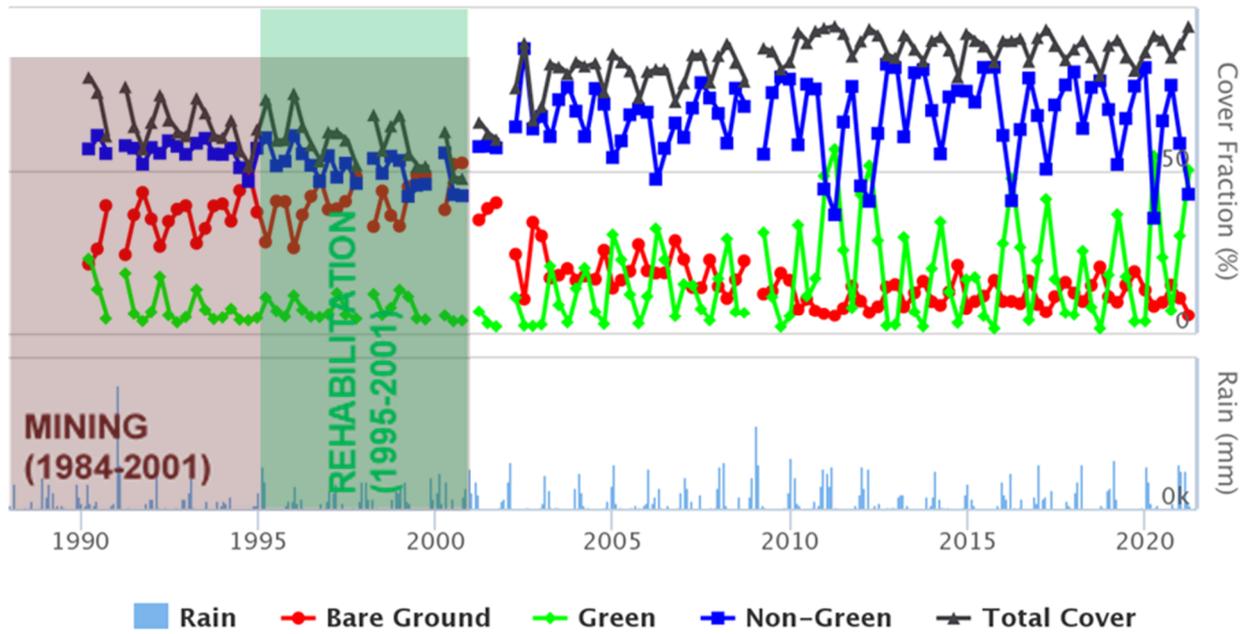


Figure 8 Development of total native revegetation cover on top of waste rock dump



Figure 9 Density and diversity of native revegetation cover on waste rock dump

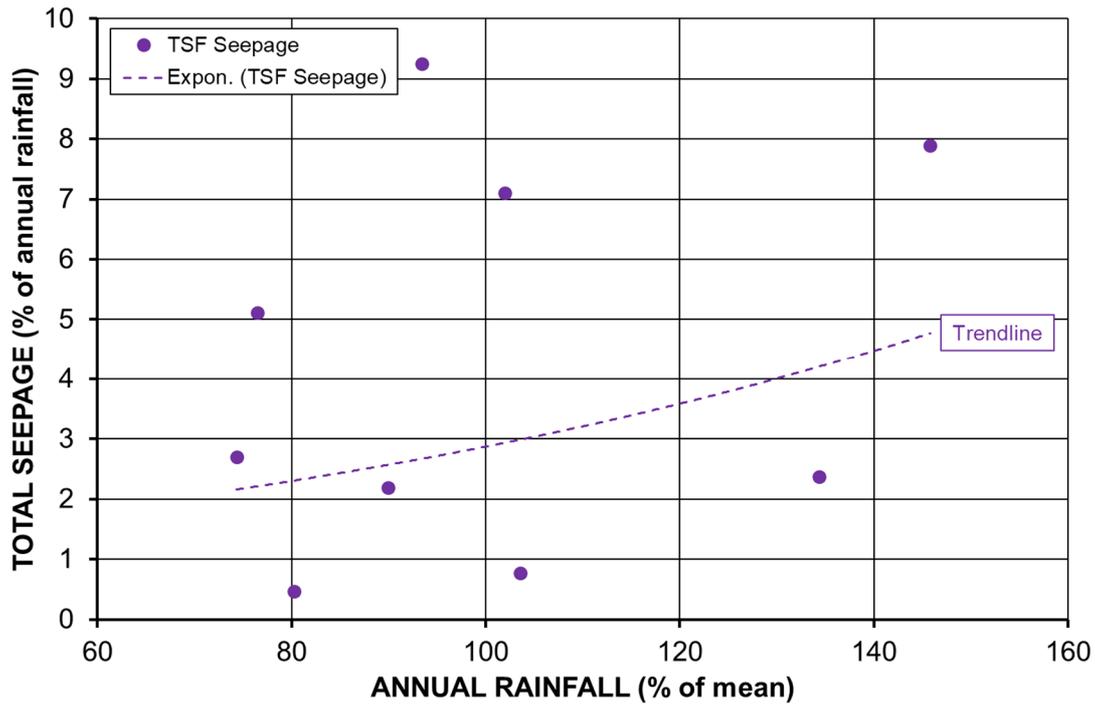


Figure 10 Total seepage versus annual rainfall for rehabilitated surface tailings storage facility

While water quality in the seepage collection ponds around the surface TSF remains acidic and has elevated dissolved copper and zinc, water quality downstream of the site is generally in compliance with regulatory limits.

Mulligan et al. (2006) reported on direct native revegetation trials on tailings from 1998, and monitoring of the direct native revegetation of the tailings from 2001 to 2005, which demonstrated progression towards a sustainable native plant community, achieving almost 70% revegetation cover and less than 15% bare ground. There was more diversity of shrubs and trees on the revegetated tailings than in the surrounding grazed land, which had been subjected to periodic burning to promote pasture grass, resulting in a dominance of ironbark trees (Figure 11).



Figure 11 (a) Native revegetation on tailings; (b) Natural regeneration

6 Genex renewable energy/battery hub

The construction by Genex in 2017 of the Solar Farm on the surface TSF took advantage of the favourable buy-in tariffs offered by the Queensland Government at the time (they have since been reduced, making

solar installation less economic). Genex is currently constructing a Pumped Storage Hydro Project, which is due to be in service by early 2025. The Solar Farm, Pumped Storage Hydro Project, and the sustainability of the Genex Renewable Energy/Battery Hub at Kidston are described in the following sections.

6.1 Solar Farm on surface tailings storage facility

The flat top of the surface TSF was well suited to the development of a Solar Farm. In late 2017, Genex completed the construction of a 50 MW (AC, 63 MW DC) Solar Farm at a total cost of \$124 million, over a large part of the near-flat Kidston surface TSF. The project required the removal of trees and shrubs, while the original seeding and planting of high proportions of introduced grasses and legumes persists beneath the rotating solar panels and is regularly slashed (Figure 12). The grasses and legumes control dust off the underlying tailings.

The Genex Solar Farm Project (<https://genexpower.com.au/50mw-kidston-solar-project/>) has 540,000 solar panels operating on a single-axis tracking system, with an anticipated project life of 30 years, and takes advantage of the highest solar radiation zone in Australia. It feeds power to the National Electricity Market via the existing Ergon Energy 132 kV transmission line that previously fed power to the Kidston mine. The project generates up to 145,000 MWh/year, powering up to 26,000 homes, and offsets up to 120,000 t of CO₂/year.



Figure 12 Genex Solar Farm on Kidston surface tailings storage facility. (a) Aerial view; (b) Rotating solar panels and underlying grass and legume cover

6.2 Pumped Storage Hydro Project under construction

The Genex Pumped Storage Hydro Project, utilising the two pits at Kidston, will be the first pumped hydro project in Australia for over 40 years, the first to be developed by the private sector, and the third largest electricity storage device in the country (<https://genexpower.com.au/250mw-kidston-pumped-storage-hydro-project/>; Figure 13). Construction of the project commenced in May 2021, will create up to 900 direct jobs, and is planned to be completed in late 2024 and commissioned in early 2025, for a total cost of \$777 million. The project will feed up to 250 MW into the approximately 7,000 MW Queensland sector of the National Electricity Market via a new transmission line. Over its 8-hour daily generation duration, it will have a storage capacity of 2,000 MWh. It will include two 125 MW reversible turbines in an underground cavern, with a start-up time of less than 30 s, driven by a head of 181 to 218 m from the upper reservoir above the turbines.

The Wises Pit footprint is being greatly enlarged by Genex to serve as the upper reservoir, with Eldridge Pit as the lower storage reservoir. The expansion of the upper reservoir is needed to maintain an adequate head above the turbines by limiting the drop in water level to less than 5 m during power generation. The sides of the expanded Wises Pit will be lined with a geomembrane to limit seepage, while the underlying natural ground and pit walls are tight and of very low permeability. The nearby Copperfield Dam, which previously delivered water the Kidston mine and continues to supply water for local cattle grazing, will provide up to 1 GL/year of

make-up water to replace that lost to evaporation from the enlarged upper reservoir. The below-ground infrastructure of Genex Pumped Storage Hydro Project at Kidston is shown in Figure 14 (AECOM 2018).



Figure 13 Plan view of Genex Pumped Storage Hydro Project at Kidston

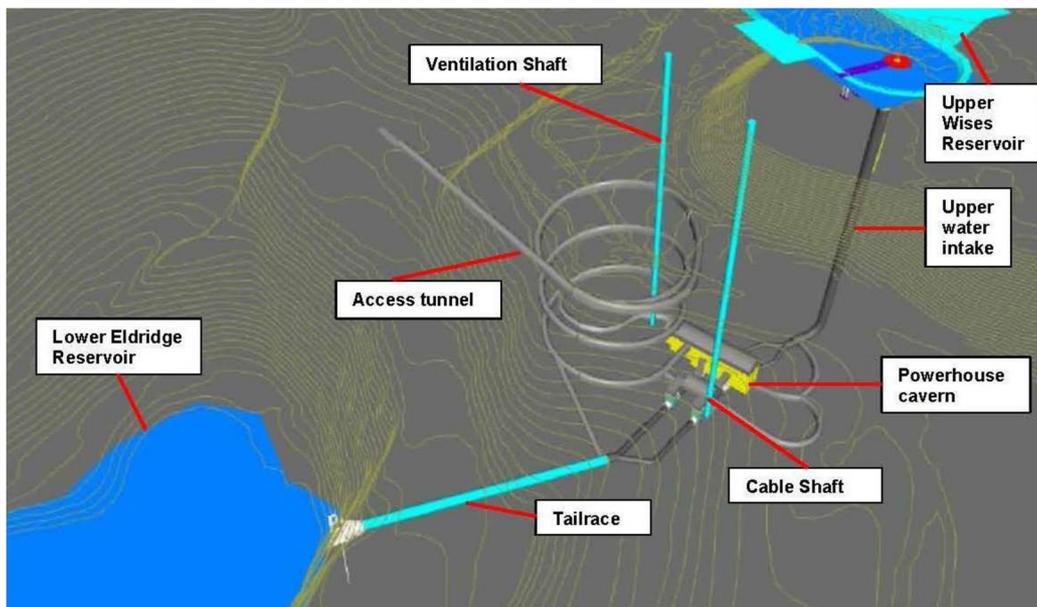


Figure 14 Below-ground infrastructure of Genex Pumped Storage Hydro Project at Kidston

Eldridge Pit will receive all TSF and waste rock seepage pump-back in the future, leading to a minor decline in its water quality. The water quality in Wises Pit is expected to improve with the operation of the Pumped Storage Hydro Project, due to initial mixing with the currently better-quality Eldridge Pit water, and ongoing dilution by freshwater from the Copperfield Dam.

6.3 Sustainability of Genex Renewable Energy/Battery Hub at Kidston

The Genex Solar Farm and Pumped Storage Hydro Project at Kidston have generated hundreds of construction jobs and have long projected lives of at least 30 years and 80 years, respectively. The Solar Farm and Pumped Storage Hydro Project, and other solar and wind-generating projects planned by Genex, will require monitoring and maintenance for many decades, offering employment opportunities and also

providing the capability and resources to maintain the post-mining landforms at the site. This will focus primarily on maintaining the seepage collection ponds and pump-back system to Eldridge Pit.

The repurposing of the Kidston site and its occupation by Genex ensures ongoing regional benefit, at the same time as ensuring the ongoing safe, stable, and non-polluting status of the mine waste facilities at the site.

7 Conclusion

The Genex Kidston mine site is among the best examples in Australia of repurposing post-closure. The rehabilitation history of the Kidston mine site and its performance over the last 20 to 25 years have been described. The rehabilitation strategy adopted by Kidston for their surface WRD involved a wide side encapsulation of fresh barren waste rock, which was over-dumped with oxide waste to promote native revegetation, and an innovative native revegetated store and release cover over the top of the dump. For the surface TSF, the upper exposed layer of tailings oxidised and the oxidation products were largely leached by rainfall infiltration, resulting in a slightly alkaline pH, and rendering the tailings surface suited to direct native revegetation with the addition of fertiliser and initial irrigation. The store and release cover on the top of the WRD has been successful in limiting net percolation of rainfall into the underlying waste rock to 0.8% of the mean annual rainfall and supports dense and diverse native revegetation. Revegetation on the top and sides of the WRD is sufficient to control erosion. The well-revegetated tailings limit net percolation of rainfall to 2.9% of the mean annual rainfall.

Genex Power Limited is converting the Kidston mine site into a Renewable Energy/Battery Hub, including a Solar Farm constructed on the surface TSF, and the construction of a Pumped Storage Hydro Project, taking advantage of the two open pits. These facilities also provide the opportunity for the long-term management of the former mine site.

Acknowledgement

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