REPORT

EVOLUTION MINING LIMITED
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Mount Rawdon Operation

Tailings Storage Facility
Cover System Modelling

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1 INTRODUCTION

1.1 Mount Rawdon Operation

Mount Rawdon Operation (MRO) is an open cut gold mine, located approximately 80 kilometres (km) southwest of Bundaberg in South East Queensland. It is owned and operated by Evolution Mining Limited (Evolution) via its subsidiary Mt Rawdon Operations Pty Ltd.

ATC Williams Pty Ltd (ATCW) has been engaged by Evolution to develop field-scale cover system trials to support closure and rehabilitation of the Tailings Storage Facility (TSF); herein referred to the trials. It is understood that the TSF will be rehabilitated to a Post Mining Land Use (PMLU) of Open Woodland.

1.2 Scope

To inform cover system configurations included as part of the trials, ATCW has undertaken one-dimensional cover system modelling in SEEP/W. Modelling has been used to determined indicative performance of proposed cover systems based on the material investigation undertaken by ATCW **[1]**. This report has been prepared to detail the updated cover system model inputs, assumptions and results of the cover system modelling to support the development of the trials.

2 BACKGROUND

2.1 Conceptual Cover System Design

Investigations into potential cover system options for the TSF have been ongoing since 2007 with the most recent conceptual cover system design completed by ATCW in 2023 **[2] [3] [4] [5]**. In 2023, ATCW developed four conceptual cover system options **[5]**. A store and release cover was identified as the preferred cover system option (Cover D). The Forward Management Plan developed as part of **[5]**, recommended that variations of the store and release cover (i.e., Cover D) should be trialled to verify the cover system modelling and assess vegetation establishment prior to the full scale construction of the cover system on the TSF. A modified version of the store and release cover system was also selected to promote rainfall shedding (i.e., Modified Cover D).

In addition to the store and release cover, a modified version of the default cover system described by the Department of Environment, Science and Innovation (DESI) for a high risk TSF **[6]**, has been included, comprising a single layer capillary break (Cover A). DESI considers any structure that contains Potentially Acid Forming (PAF) material as a high risk structure when preparing the estimated rehabilitation cost. Cover A has been included as a means to demonstrate comparable performance with the store and release cover system (Cover D).

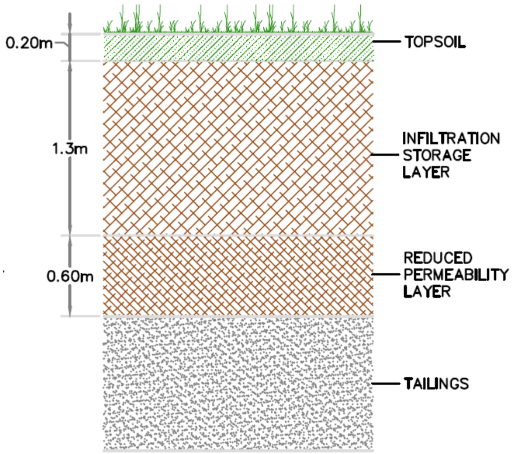
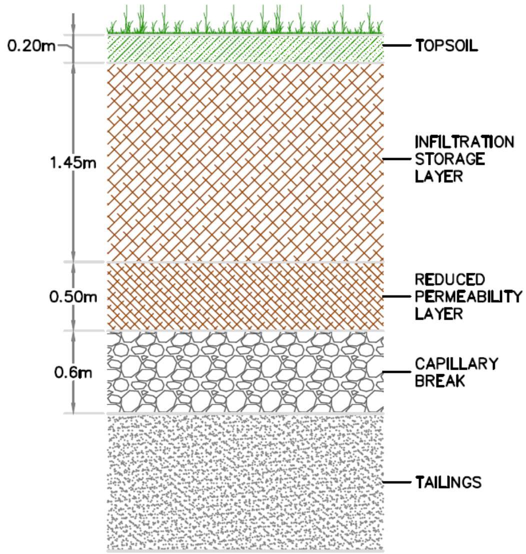
Cover systems which have been modelled and are proposed to be included as part of the trials are shown in **DIAGRAM 1** and summarised as follows:

Cover D:	Store and release cover system that allows sufficient rainfall to infiltration into the cover system profile (i.e., into both topsoil and Infiltration Storage Layer (ISL)) to support vegetation and incorporates a Reduced Permeability Layer (RPL) to minimise Net Percolation into the underlying tailings and PAF waste rock;
Modified Cover D:	Modified version of Cover D designed to promote runoff by reducing the permeability of the ISL;
Cover A:	Store and release cover system that comprises topsoil, ISL, RPL and incorporates a Capillary Break (CB) Layer.

DIAGRAM 1: ADAPTED CONCEPTUAL COVER SYSTEM DESIGNS

<table>
<tr><th>COVER D & MODIFIED COVER D</th><th>COVER A</th></tr>
<tr>
<td>Store and Release & Shedding Cover System

0.2 m Topsoil
1.3 m Infiltration Storage Layer (ISL).
Cover D: nominally compacted to 85% maximum dry density (MDD)
Modified Cover D: compacted to >90% MDD
0.6 m Reduced Permeability Layer
</td>
<td>Store and Release Cover System with a Capillary Break

0.2 m Topsoil
1.45 m Infiltration Storage Layer (ISL) compacted to 85% MDD
0.5 m Reduced Permeability Layer (RPL)
0.6 m CB Layer
</td>
</tr>
<tr>
<td>
</td>
<td>
</td>
</tr>
</table>

The function of each of the layers in the cover systems is described in **TABLE 1**.

TABLE 1: FUNCTION OF COVER LAYERS

Layer	Abbreviation	Function
Topsoil		Microbiologically active layer to provide nutrients to support vegetation growth
Infiltration Storage Layer	ISL	Store moisture to support vegetation growth and limit downward movement of moisture (negative flux). Rainfall is stored within the cover system and gradually released back to the atmosphere through evaporation and transpiration (Actual Evapotranspiration (AET)). Increased compaction of the infiltration storage layer, as proposed in modified Cover D, will promote increased runoff due to lower permeability compared with the overlying topsoil.
Reduced Permeability Layer	RPL	Provide a barrier beneath the ISL to reduce percolation into the underlying tailings material and PAF waste rock when the overlying storage capacity is exceeded.
Capillary Break Layer	CB	Disrupt the upward and downward movement of water (and hence salt) through capillary action by providing a change in pore size distribution.

2.2 Performance Criteria

Adopted performance criteria for the cover system are described in **[7]**. Of these performance criteria, aspects relevant to cover system modelling and trials are outlined in **TABLE 2**.

TABLE 2: COVER SYSTEM PERFORMANCE CRITERIA

OBJECTIVE	PERFORMANCE CRITERIA
Limit Net Percolation	Net Percolation into the TSF should be less than a nominal 10% of the total rainfall depth
	The number of days with Net Percolation exceeding a nominal 10 mm/day at the interface between the cover system and tailings should be less than 10 days per year
Limit Capillary Rise	No capillary rise of salts within the ISL root zone that may affect plant growth
Sustain Vegetation	Establish >30% vegetation cover.
	Sufficient Plant Available Water Capacity (PAWC) to sustain target vegetation

2.3 Material Characterisation

In April 2024, ATCW and Evolution undertook material investigation, comprised of testing pitting, sampling and laboratory testing program. The program aimed to supplement previous site investigations and identify the availability and suitability of borrow material for use in the cover system. Details of the material investigation are outlined in **[1]**.

Based on the current **[1]** and previous investigations **[8]**, surficial material at site generally comprises topsoil/alluvium, residual soils, extremely weathered rock (XW material) and weathered rock. A description of these materials and proposed function in the cover system is summarised as follows:

Topsoil: Topsoil/Alluvium, encountered at surface, generally to a depth of 0.25 m. To be used as the topsoil of the cover system to support vegetation.

Subsoil/Residual Soil: Clayey layer encountered beneath the topsoil in most locations and above the weathered rock and is derived from the underlying rock. To be used as the RPL due to the higher clay content and very low permeability when compacted.

XW Material/Weathered Rock: Material below surface soils, comprising extremely weathered (XW) and weathered rock with variable gravel and clay content related to the level of weathering. This material would be used for the ISL.

Materials which are required as part of the trial, but not sampled in the material investigation **[1]**, include the following:

Capillary Break: Clean (no fines) gravel aggregate, with a nominal grain size range of 5 mm to 20 mm, to be imported from a licenced quarry or manufactured on site by crushing and screening NAF rock.

It is understood that the proposed Mount Rawdon Pumped Hydro Project has the potential to generate substantial volumes of NAF waste rock that may be used for the rehabilitation of the TSF. NAF waste rock resources generated as a result of the pit cut back (subject to a block model) could be used as a trafficable layer for the construction of the cover system. A model scenario included the addition of 1 m of NAF waste rock as a trafficable layer to compare its impact on cover system performance.

3 MODEL DEVELOPMENT

3.1 General

Modelling was undertaken with SEEP/W, a finite element package software used for numerical modelling of saturated and unsaturated flow within soils **[9]**. Modelling was undertaken using a one-dimensional column through the proposed cover system profile and extending 5 m into the tailings profile.

3.2 Model Limitations

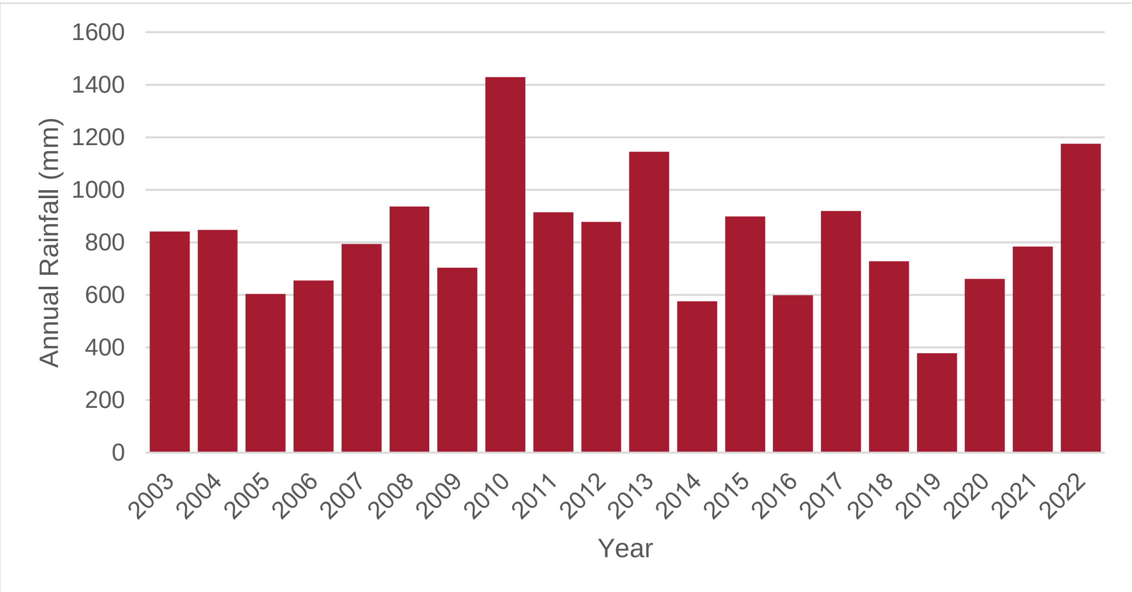
The cover system model has been developed using empirical formulas and material parameters obtained in laboratory testing, i.e. it has not been calibrated against field data. An uncalibrated model can have an error margin up to an order of magnitude due to the variability between laboratory and longer-term field obtained values. The primary function of the current, uncalibrated cover system model is to compare cover system options and configurations. It is not intended to definitively assess the performance of each cover system.

Undertaking a desktop assessment utilising laboratory test results of soils in a model is a standard approach to understand the relative performance of the cover system. Calibration of the model is then undertaken using data collected as part of the trials to improve model prediction over the longer term, rather than just the shorter term monitored during the trial. This may then result in further optimisation of the cover profile for final rehabilitation.

3.3 Climate Data

Climate data from 2003 until 2022 were sourced from Queensland Government Scientific Information for Land Owners (SILO) for the site location **[10]**. BoM station 39070 MT PERRY THE PINES is the closest recording station, and is located about 15 km north west of the MRO site. A daily time-step over a model duration of 20 years was adopted. This year range covers decadal changes including extended periods of hotter, wetter, cooler and drier weather. Annual rainfall for the period of January 2003 to December 2022 is depicted in **GRAPH 1** below.

GRAPH 1: ANNUAL RAINFALL



Other climatic data required for the model, adopted from the SILO Data Drill are summarised as follows:

- Humidity (daily maximum and minimums),
- Radiation (total daily), and

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- Temperature (daily maximum and minimums).

3.4 Model Scenarios

Scenarios modelled are summarised in **TABLE 3**. As discussed in **SECTION 2.1**, the preferred cover system comprises a store and release cover system (Cover D), with the single layer capillary break also included as the baseline for comparing performance objectives (Cover A).

Of the store and release and capillary break type cover systems, a range of configurations have been modelled with varying material thickness and material characteristics to assess various cover profiles and account for potential variation in material parameters. With respect to material parameters the following aspects were modified:

Saturated Hydraulic Conductivity:	The "modified" cover system (Model ID 3, 4, 9, 10) comprises reduced permeability of the ISL cover system to promote runoff.
Soil Water Characteristic Curves:	A range of SWCCs were generated from laboratory testing. To capture variance in the behaviour of soils under matric suction, the curves with the maximum and minimum saturated moisture content were adopted as the upper bound and lower bound soil water characteristic curves for each scenario.

Sensitivity analysis undertaken on material thickness comprised Model ID 7 to 16. These cover systems were initial runs to optimise cover thickness. Model results for these sensitivity runs are not discussed in detail but are included for completeness.

3.5 Geometry

The SEEP/W model comprises a one-dimensional column, comprised of 5 m of tailings overlain by the cover system. While the depth of tailings exceeds 5 m, climatic forcing is generally limited to the top few metres of the modelled profile. This assumption was checked during modelling to ensure that movement of water was not observed at the tailings depths greater than 5 m. It was noted that negligible movement of water was estimated by the model within the tailings. Therefore, modelling increased tailings depths would have no material impact on the outcome of the model.

3.6 Boundary Conditions

Model boundary conditions are outlined as follows:

Climatic Conditions:	Applied to the surface of the cover system as detailed in **SECTION 3.3**.
Initial Gradient (Free Drainage):	Applied at the base of the model to allow seepage from the model. Seepage rates are calculated assuming the downward flux is equal to the hydraulic conductivity at that point.
Vegetation:	Applied assuming woodland community, which is discussed further in **SECTION 3.8**.

Initial moisture content and pore water pressures were defined as an initial water head located 0.5 m below the tailings surface and running all models for 1,000 days to reach a point of equilibrium throughout the modelled profile. The initial 1,000 days are not presented, recognising these results are influenced by the initial water head input by the model user.

TABLE 3: COVER SYSTEMS MODELLED

<table>
<tr><th>ID</th><th>COVER SYSTEM</th><th>SWCC</th><th>VEGETATION</th><th>CONFIGURATION (SURFACE TO TAILINGS)</th><th>DESCRIPTION</th></tr>
<tr><td>1</td><td>Cover D</td><td>Lower Bound</td><td>None</td><td rowspan="2">• 0.20 m Topsoil
• 1.30 m ISL
• 0.60 m RPL</td><td rowspan="6">Initial runs of Cover D, Modified Cover D and Cover A using the upper and lower bound SWCC</td></tr>
<tr><td>2</td><td>Cover D</td><td>Upper Bound</td><td>None</td></tr>
<tr><td>3</td><td>Modified Cover D</td><td>Lower Bound</td><td>None</td><td rowspan="2">• 0.20 m Topsoil
• 1.30 m ISL
• 0.60 m RPL</td></tr>
<tr><td>4</td><td>Modified Cover D</td><td>Upper Bound</td><td>None</td></tr>
<tr><td>5</td><td>Cover A</td><td>Lower Bound</td><td>None</td><td rowspan="2">• 0.20 m Topsoil
• 1.45 m ISL
• 0.50 m RPL
• 0.60 m CB</td></tr>
<tr><td>6</td><td>Cover A</td><td>Upper Bound</td><td>None</td></tr>
<tr><td>7</td><td>Optimised Cover D</td><td>Lower Bound</td><td>None</td><td rowspan="2">• 0.20 m Topsoil
• 1.30 m ISL
• 0.40 m RPL</td><td rowspan="6">Initial runs of the Model ID 1 to 6 with reduced cover thickness based on predicted cover system performance</td></tr>
<tr><td>8</td><td>Optimised Cover D</td><td>Upper Bound</td><td>None</td></tr>
<tr><td>9</td><td>Optimised Modified Cover D</td><td>Lower Bound</td><td>None</td><td rowspan="2">• 0.20 m Topsoil
• 1.30 m ISL
• 0.40 m RPL</td></tr>
<tr><td>10</td><td>Optimised Modified Cover D</td><td>Upper Bound</td><td>None</td></tr>
<tr><td>11</td><td>Optimised Cover A</td><td>Lower Bound</td><td>None</td><td rowspan="2">• 0.20 m Topsoil
• 1.30 m ISL
• 0.40 m RPL
• 0.60 m CB</td></tr>
<tr><td>12</td><td>Optimised Cover A</td><td>Upper Bound</td><td>None</td></tr>
<tr><td>13</td><td>Cover D +1 m NAF</td><td>Lower Bound</td><td>None</td><td rowspan="2">• 0.20 m Topsoil
• 1.30 m ISL
• 0.60 m RPL
• 1.00 m NAF Waste Rock</td><td rowspan="2">Additional model run, adopting Cover D with 1m NAF rocky layer (refer SECTION 2.3)</td></tr>
<tr><td>14</td><td>Cover D +1 m NAF</td><td>Upper Bound</td><td>None</td></tr>
<tr><td>15</td><td>Cover D +Vegetation</td><td>Lower Bound</td><td>Vegetation</td><td rowspan="2">• 0.20 m Topsoil
• 1.30 m ISL
• 0.60 m RPL</td><td rowspan="2">Preferred cover system (Cover D) with vegetation</td></tr>
<tr><td>16</td><td>Cover D +Vegetation</td><td>Upper Bound</td><td>Vegetation</td></tr>
</table>

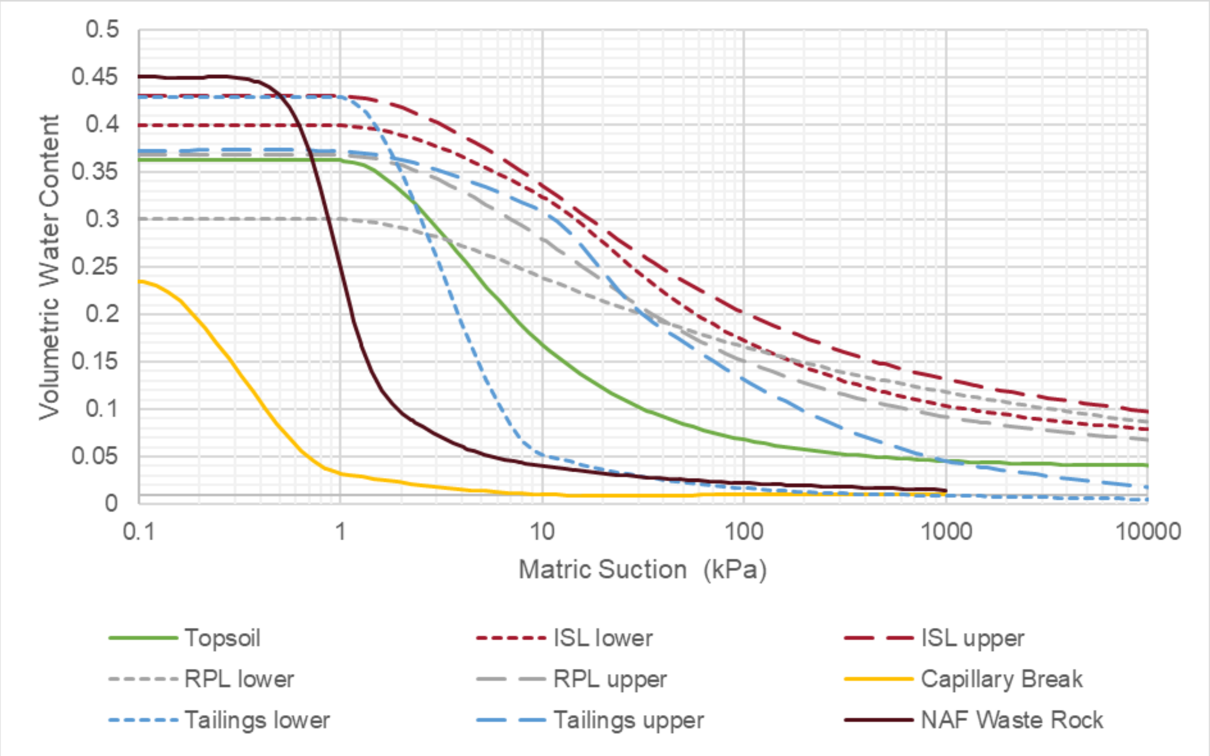
3.7 Material Properties

3.7.1 Soil Water Characteristic Curves

During laboratory testing **[1]**, it was noted that the moisture content measured at lower suctions for the ISL, RPL and Topsoil did not conform to typical traces for SWCCs. Extremely high Volumetric Moisture Contents (VWC) above lower suctions above field capacity (FC, nominally 10 kPa suction) were reported (FC > 44% VMC) for most samples, except Sample 6, 7 and 10; typical FC for sandy loam and sandy clay loams is around 30% VMC **[11]**. Some of the VWC were greater than the calculated soil porosity. This phenomenon can occur when swelling occurs during laboratory analysis which would not occur when the soil is confined with in the profile or when the soil particles are more porous than typically reported (as confirmed by the low particle density **[1]**), which is typically observed with volcanic soil.

The laboratory values were compared with predictions from RETC software **[12]** based on Particle Size Distribution and Dry Density (assumed 85% Maximum Dry Density) to assess departure from expected SWCCs and potentially provide more realistic estimates. For most samples, the laboratory and estimated SWCC were similar at the dry end but only a few were similar at the wet end. As a result, the estimated SWCCs values were adopted in the SEEP/W. Default SWCC's from SEEP/W for a poorly graded gravel were adopted for the CB Layer. Adopted SWCC's are shown in **GRAPH 2**.

GRAPH 2: ADOPTED SOIL WATER CHARACTERISTIC CURVES



3.7.2 Hydraulic Conductivity

The hydraulic conductivity curves were estimated using SEEP/W's inbuilt Fredlund-Xing-Huang model (**GRAPH 3**). The model inputs are the SWCCs (**SECTION 3.7.1**) and saturated hydraulic conductivity (**TABLE 4**), which were estimated using RETC software **[12]**, as described in **SECTION 3.7.1**.

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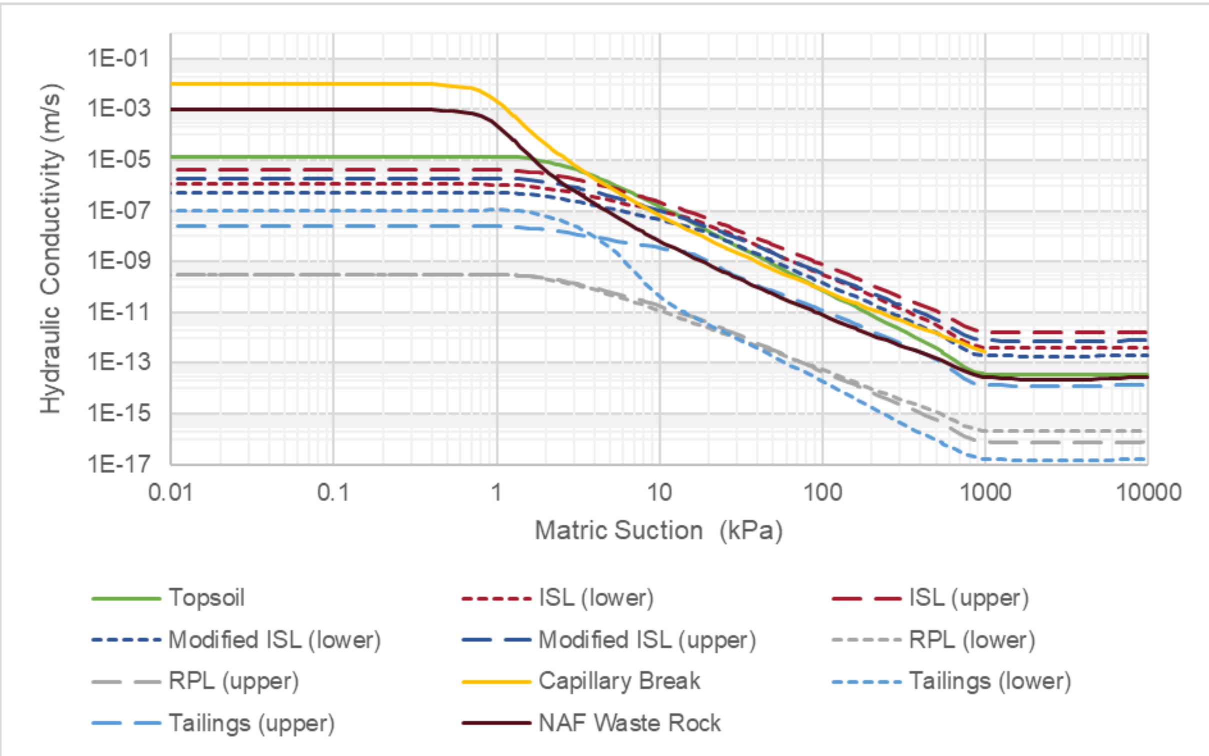
TABLE 4: ADOPTED SATURATED HYDRAULIC CONDUCTIVITY

LAYER	SWCC	SAMPLE ID	SATURATED HYDRAULIC CONDUCTIVITY (m/s)
Topsoil	Topsoil	Sample 1	1.33×10^{-5}
ISL	Lower Bound	Sample 9	1.11×10^{-6}
ISL	Upper Bound	Sample 10	4.02×10^{-6}
Modified ISL	Lower Bound	Sample 9	5.21×10^{-7}
Modified ISL	Upper Bound	Sample 10	1.87×10^{-6}
RPL	Lower Bound	Sample 4	3.00×10^{-10}
RPL	Upper Bound	Sample 3	3.00×10^{-10}
Tailings	Lower Bound	Tailings Coarse	1.06×10^{-7}
Tailings	Upper Bound	Tailings Fine	2.6×10^{-8}

GRAPH 3: PERMEABILITY CURVES



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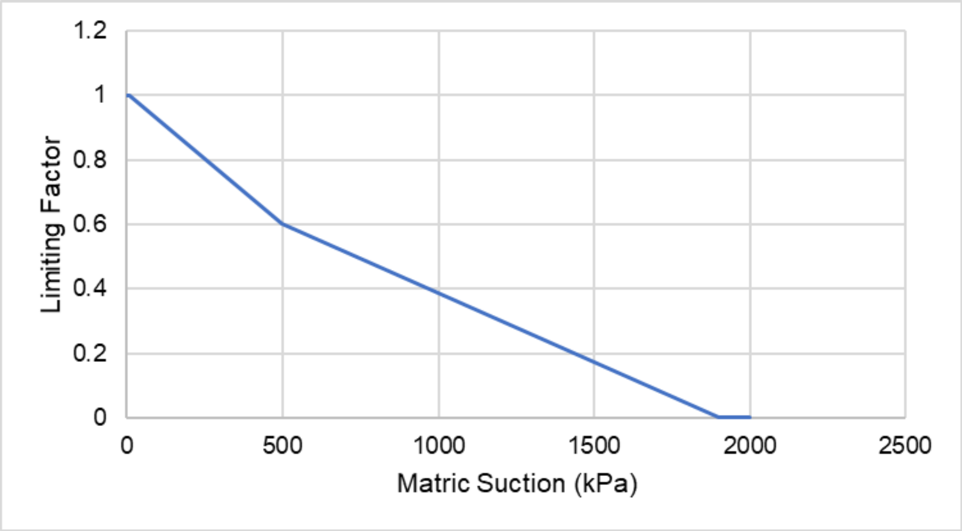
3.8 Vegetation

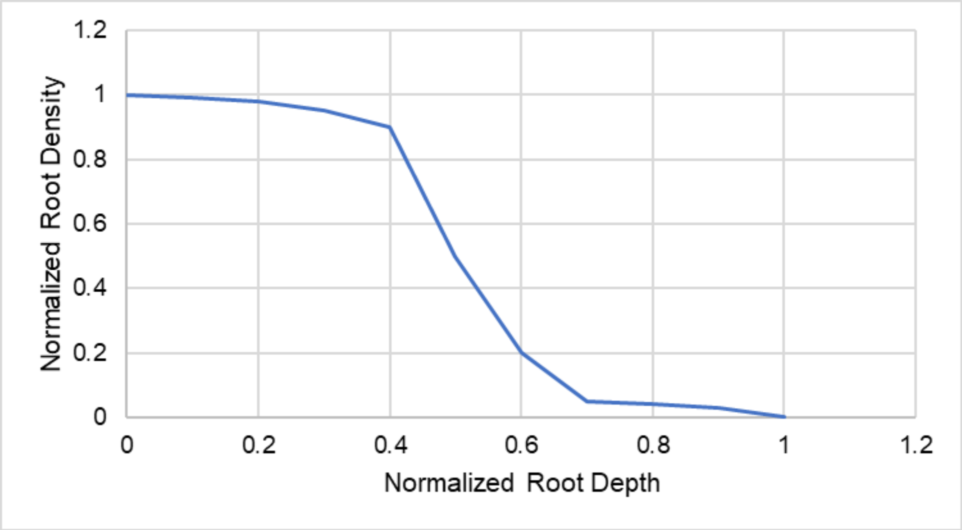
Vegetation inputs to SEEP/W comprise leaf area index, plant moisture limiting function, normalised root density and cover soil fraction. Vegetation parameters are highly variable depending on species and environmental factors such as rainfall. For the purposes of the model, a constant leaf area index of 2.5 and cover soil fraction of 0.85 were adopted, meaning the vegetation remains constant over the duration of the modelling and does not vary seasonally or annually. Plant moisture limiting function, root density and cover soil fraction functions are shown in **GRAPH 4** to **GRAPH 6**.

While vegetation will play a critical role with respect to medium to longer-term performance of the cover system, it is expected that plant function will increase over the first 3-5 years of the trials while plants establish. Additionally, further studies are being undertaken to confirm species, density, etc. for input to the model. To provide a conservative estimate of initial performance, vegetation was not modelled on all cover systems; however, a single scenario (Model ID 15 and 16) is included for comparison. This conservative approach allows improved confidence that the cover system will meet the performance criteria even in the extreme scenario that vegetation fails in the future.

GRAPH 4: PLANT MOISTURE LIMITING FUNCTION



GRAPH 5: NORMALISED ROOT DENSITY



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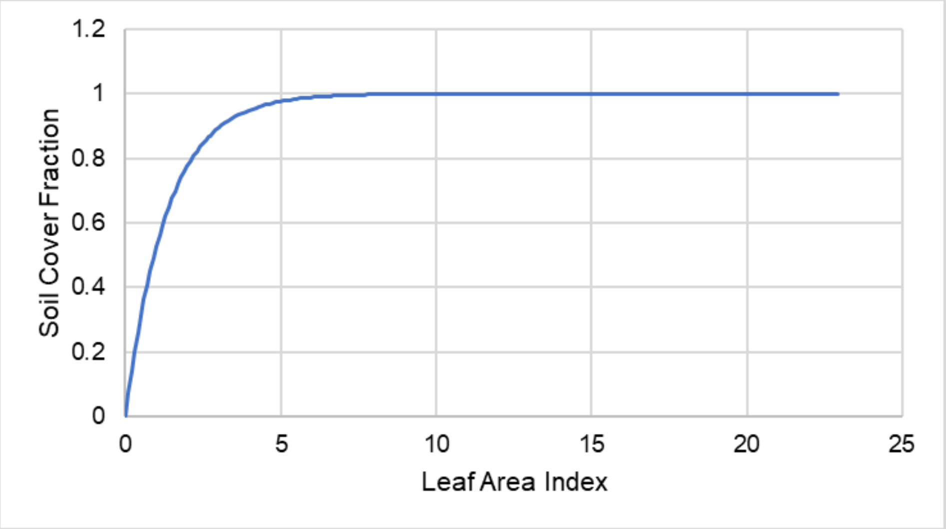
GRAPH 6: SOIL COVER FRACTION



4 RESULTS AND DISCUSSION

4.1 Overview and Terminology

The performance of each cover system has been assessed against the closure criteria discussed in **SECTION 2.2**. The terminology used is summarised as follows:

<u>Water Balance</u>

The water balance shows the balance of moisture within the modelled profile. Results which form part of the water balance are:

Rainfall:	Rainfall depth occurring for the modelled period.
Runoff:	Rainfall runoff that does not infiltrate into the cover system that reports as surface water runoff off the TSF. It is noted that as the model is one-dimensional, no run on is considered, with rainfall reporting as runoff leaving the model domain.
Evaporation:	Evaporation loss from the cover profile.
Flux:	Moisture flux gives an indication of the direction and rate of movement of moisture within and through the cover system profile. Negative flux rates indicate downward movement of moisture (e.g. rainfall infiltrating into the soil or percolation out of the soil and into the tailings) whilst positive flux rates are upward (e.g. evaporation or evapotranspiration to the atmosphere or capillary rise).
Net Percolation:	The volume of water moving out of the cover system profile and into the underlying tailings.

<u>Volumetric Water Content and Degree of Saturation</u>

The volumetric water content (VWC) is calculated on a daily basis to account for the redistribution of the net infiltration through the soil profile which can then potentially enter the underlying tailings. The PAWC is typically calculated as the difference between field capacity (nominally 33 kPa) and permanent wilting point (nominally 1,500 kPa). If drier than the wilting point, the matric suction no longer allows for uptake of moisture by plants.

Degree of Saturation provides the same chart to the VWC with the difference of the Y axis displaying the ratio of saturation from the residual moisture content (0.05 to 0.2) to saturated (1) (refer **GRAPH 7**).

4.2 Water Balance/Predicted Cover System Performance

Graphs depicting the cumulative water balance for the 20 year modelled duration are provided in **APPENDIX A**. A summary of the water balance is provided in **TABLE 5**. Model results indicate runoff accounts for less than 10% of the rainfall volume on an average annual basis, though it is noted that the simplification used by one-dimensional water balance models does not allow for accurate runoff prediction. The remaining rainfall initially infiltrates into upper layers of the cover system and is subsequently lost through evaporation, which typically represents more than 94% of the rainfall volume. Importantly, net percolation met the performance criteria for all model scenarios, limiting the net percolation into the underlying tailings material.

The performance of each cover system is similar, with all cover systems achieving performance objectives described in **SECTION 2.2**. The similarity between cover system performance is a result of the moisture remaining predominantly in the ISL and hence the CB does not impact the results. Also, the rainfall rate appears to remain below the hydraulic conductivity of the optimised modified Cover D ISL and hence does not result in significantly more runoff the optimised Cover D.

TABLE 5: AVERAGE ANNUAL WATER BALANCE

Model ID	Scenario		Average Annual Water Balance			
			Rainfall (mm/yr)	Runoff (mm/yr and % of Rainfall)	Evaporation (mm/yr and % of Rainfall)	NP (% of Rainfall)
7	Optimised Cover D	Upper	823.5	29 (3%)	809 (98%)	(<1%)
8		Lower	823.5	70 (9%)	803 (97%)	(<1%)
9	Optimised Modified Cover D	Upper	823.5	40 (5%)	800 (97%)	(<1%)
10		Lower	823.5	90 (11%)	774 (94%)	(<1%)
11	Optimised Cover A	Upper	823.5	34 (4%)	807.5 (98%)	(<1%)
12		Lower	823.5	42.5 (5%)	807.5 (98%)	(<1%)

It is highlighted that the sum of the losses (rainfall, evaporation and net percolation) are greater than 100% of the rainfall depth over the modelled period. The cause of additional losses is as follows:

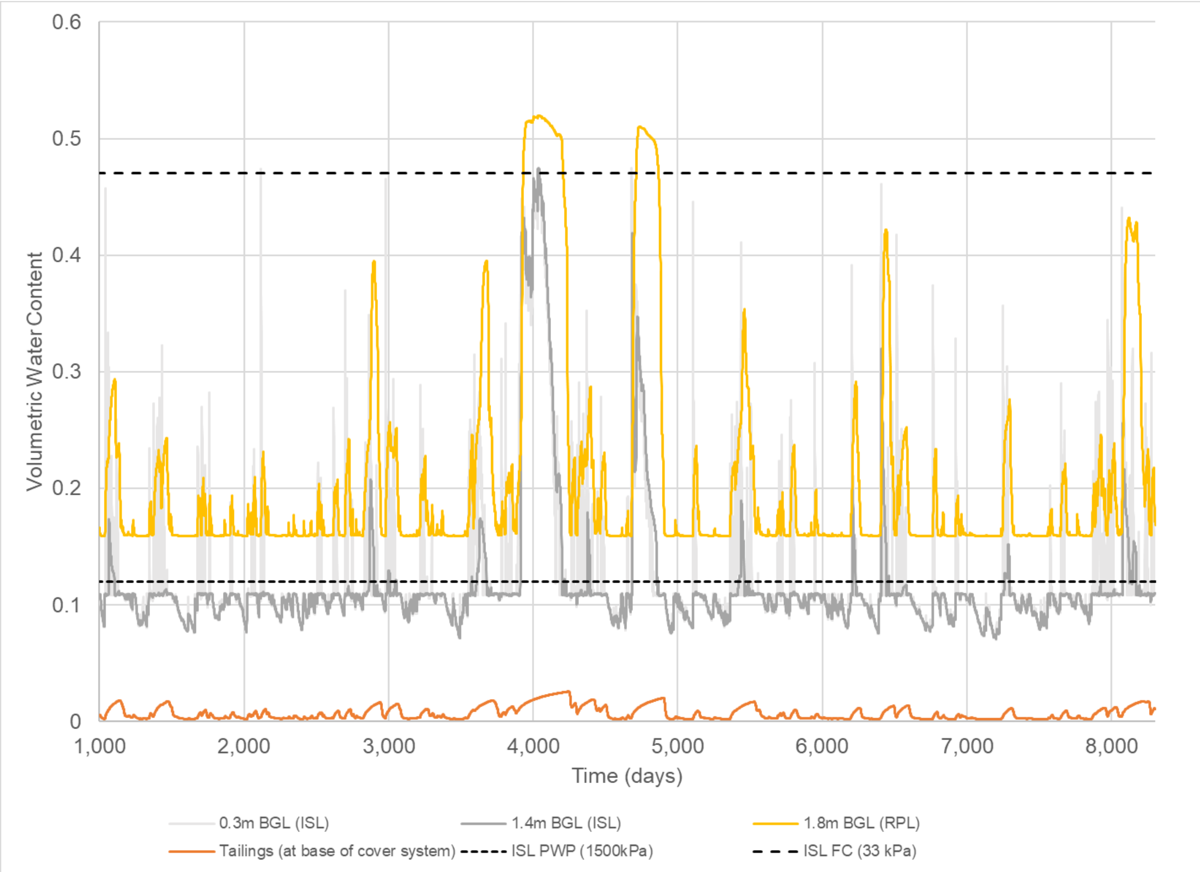
- Loss of initial moisture in cover system.
- Variability between the starting and ending water balance conditions, i.e. 2002 was a wetter than average year.
- Model error/mass balance error. Notwithstanding, the error in the model is not sufficient to materially impact the outcomes of the model.

4.3 Volumetric Water Content and Degree of Saturation

Saturation in the topsoil and upper layers of the ISL is highly variable, with increased water saturation after rainfall events, followed by periods of drying due to evaporation. At greater depths within in the ISL, increases in VWC are observed only following large rainfall events, indicating a significant rainfall depth if required for infiltration deep into the cover system profile.

An example chart (optimised Cover D – Upper) is provided in **GRAPH 7**, depicting range of VWC within the cover system as a response to rainfall events, and relatively static VWC in the tailings, indicating rainfall infiltrating the cover system does not reach the tailings. Similar plots for remaining cover systems are provided in **APPENDIX B**.

GRAPH 7: MODELLED ISL VWC – OPTIMISED COVER D UPPER BOUND



A significant difference in the RPL VWC is observed between the upper bound and lower bound SWCCs. For the lower bound SWCCs, the RPL generally remains at low VWC. With the exception of consistently large rainfall events in December 2010 (equivalent to day 3,912 in the graphs) where increased saturation is observed throughout the cover system layers. For the upper bound SWCCs, fluctuation in the saturation is observed, indicating moisture flux into the RPL may occur, however for all model runs, results indicate this movement of water does not transfer to the tailings, indicating variance in material properties (within the range modelled) would not impact the performance of the cover system.

Saturation of the tailings remains constantly low throughout the model duration, recognising NP (refer **SECTION 4.2**) is ≈0 and negligible flux reports through the cover system profile into the tailings.

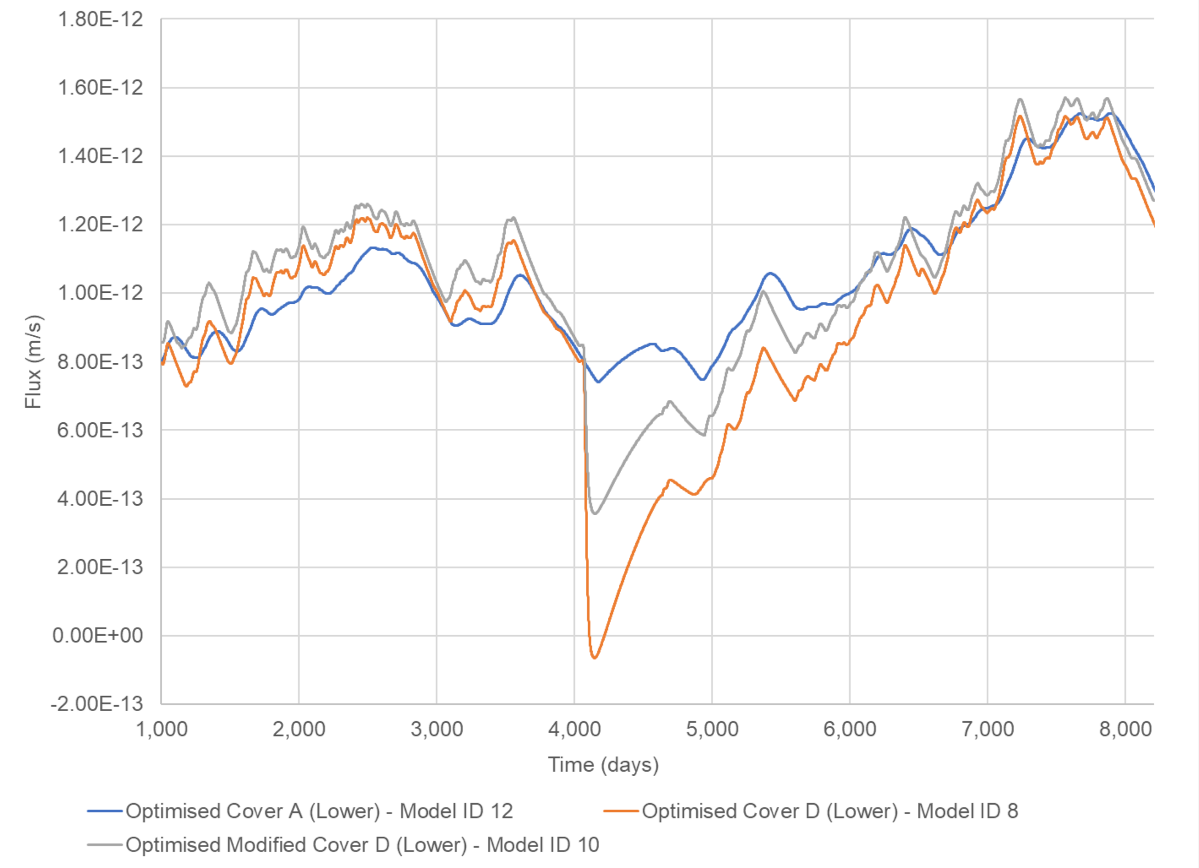
Overall, there is a net deficit of rainfall which will require plants to have drought tolerance to be able to survive during the dry season and lower rainfall years. The use of endemic native species will improve the potential for successful vegetation survival and establishment.

4.4 Flux

For all cover systems, flux near the surface (0.3 metres below ground level (m BGL)) is highly variable and controlled by climatic conditions. Negative flux rates (indicating infiltration) are observed following rainfall events, followed by periods of positive flux rates caused by evaporation. Similar patterns are observed at greater depths within the ISL at lower rates, with both positive and negative flux observed as a response to rainfall and subsequent evaporation.

Flux rates in the tailings, 0.2 m below the interface of the cover system and the tailings are close to zero, with an average rate in the order of 1×10^{-12} m/s, i.e. slightly positive (**GRAPH 8**). This equates to approximately to 0.03 mm/year and 0.7 mm for the 20-year modelled duration, indicating minimal moisture is moving across the cover system and tailings interface. At this low rate, it is not expected that salts are likely to move into the profile and affect plant growth. The combination of the depth of the cover layer and the use of endemic vegetation will potentially further reduce any potential risk. It is important to note that the difference between the model scenarios is insignificant with respect to model performance, with a constant rate of $1x10^{-12}$ m/s representing <1 mm over a 20 year period.

GRAPH 8: MODELLED FLUX – TOP OF TAILINGS (0.2M BELOW COVER/TAILINGS INTERFACE)



5 CONCLUSIONS

Key conclusions from model outcomes are summarised as follows:

- The store and release cover system (optimised Cover D) is likely to achieve similar performance compared to the optimised Cover A, indicating a CB is not required as NP and capillary rise are both negligible.
- Model results indicate that all water, which infiltrates the soil water boundary is lost through evaporation with zero NP for all modelled scenarios. Intuitively, zero NP seems unlikely. Notwithstanding, with a saturated conductivity of 1×10^{-10} m/s, the RPL is acting as an impermeable barrier. The saturated hydraulic conductivity in the model was based on laboratory testing, however, may vary in practice, through influences such as
  - Compaction achieved;
  - Defects in construction (thinner layers, poor quality assurance/quality control on material characterisation, etc.);
  - Cracking and desiccation;
  - Vegetation rooting depth; and
  - Bioturbation.

  Trials are therefore critical to confirm the realistic permeability of the RPL and any impact to performance over time.

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- Performance of the cover system will be impacted by the density of soils achieved during construction. Higher permeability in the ISL would lead to greater saturation of the RPL. Within the range of permeabilities modelled (which will be determined by the density/compaction), infiltration is limited to the layers of the cover system and wetting of the tailings layers is not observed.
- Soil properties are variable which is likely to impact the performance of the cover system. Variation in the SWCCs was observed to greatly impact flux rates and saturation within the soil profile. Notwithstanding, while increased saturation in the cover system was observed, model results indicated that infiltration is generally limited to the cover system and does not transfer to the tailings.
- As noted in **SECTION 3.2**, currently the cover system models are based on laboratory data and empirical formulas and hence results are considered to be precise and hence are suitable for comparing scenarios. The accuracy of prediction of an uncalibrate4d water balance model is typically estimated at around an order of magnitude. Data generated during the trials will be used to calibrate the model, to ensure that model results reflect conditions observed in the field and can then be used to more accurately predict the longer-term performance of the cover system and refine the cover system design.

6 RECOMMENDATIONS

The water balance modelling suggested that the scenarios are likely to perform similarly; however, the assumptions used to generate runoff are general and may underestimate the runoff generated from the covers. Consequently, although little difference was predicted between the optimised Cover D and optimised modified Cover D, this may be greater in the field. Further, the potential impact of vegetation on the cover performance was not predicted well by the model and hence field data collection will be imperative. As a result, it is recommended that the field trials include:

- Optimised Cover D;
- Optimised Modified Cover D; and
- Optimised Cover A.

During construction, the compaction achieved for the RPL and modified ISL will need to be measured to understand the practical compaction achievable over the soft underlying tailings.

Once the trials are established, weather data (rainfall, temperature, humidity as a minimum), runoff and soil erosion rates, soil moisture and vegetation parameters (leaf area index, coverage), will need to be collected to ensure the model can be calibrated. Leaf area index will require field measurement at different times during the year.

After 2 years, 5 years and at completion (nominally 10 years), it is recommended that test pits are excavated into the covers to allow observation and quantification of root distribution and measurement of *in situ* hydraulic conductivity and collection of undisturbed cores to measure dry density and soil water retention.

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APPENDICES

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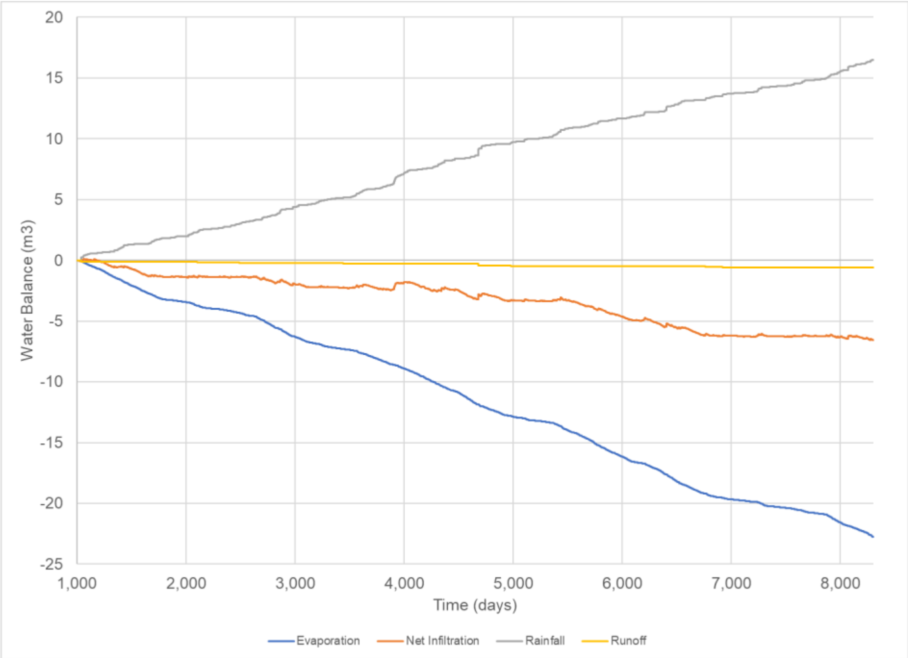
APPENDIX A – COVER SYSTEM MODELLING RESULTS

CHART 1: CUMULATIVE WATER BALANCE – COVER A (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



(B)

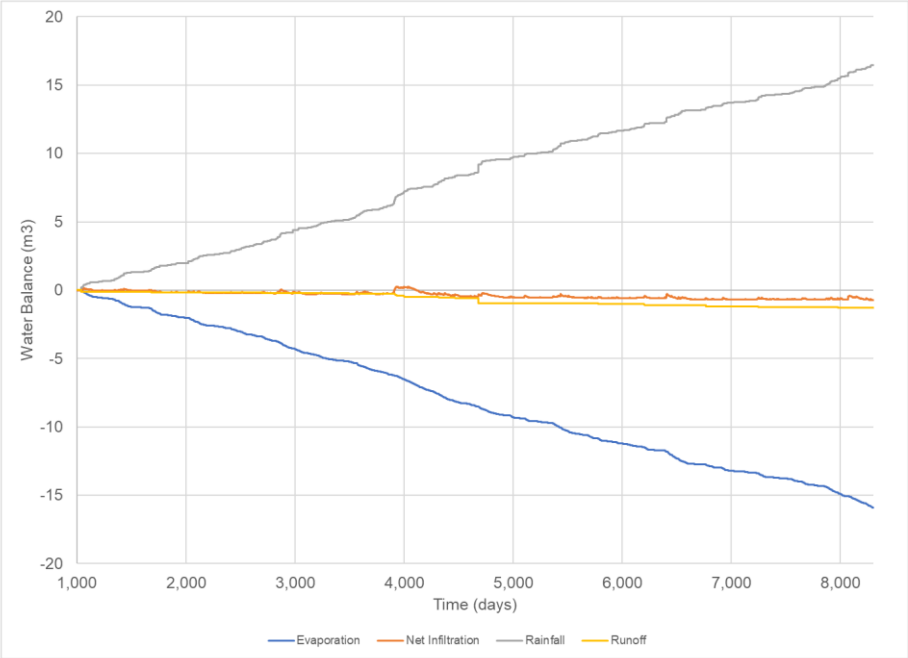
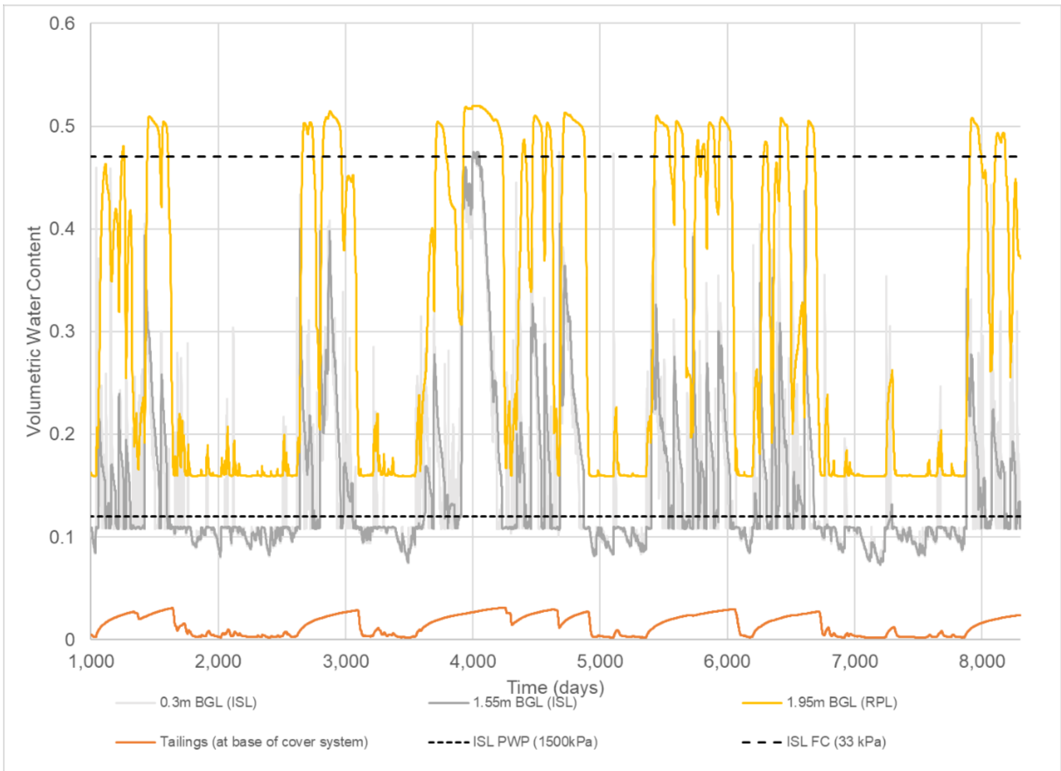


CHART 2: VWC – COVER A (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



(B)

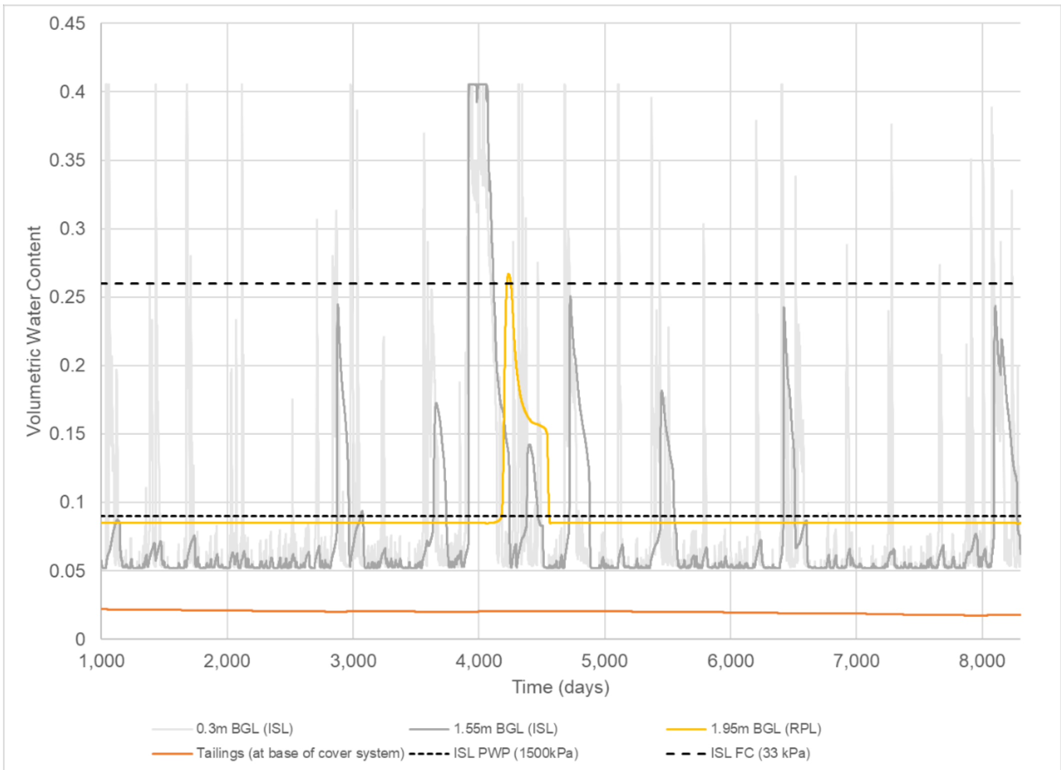


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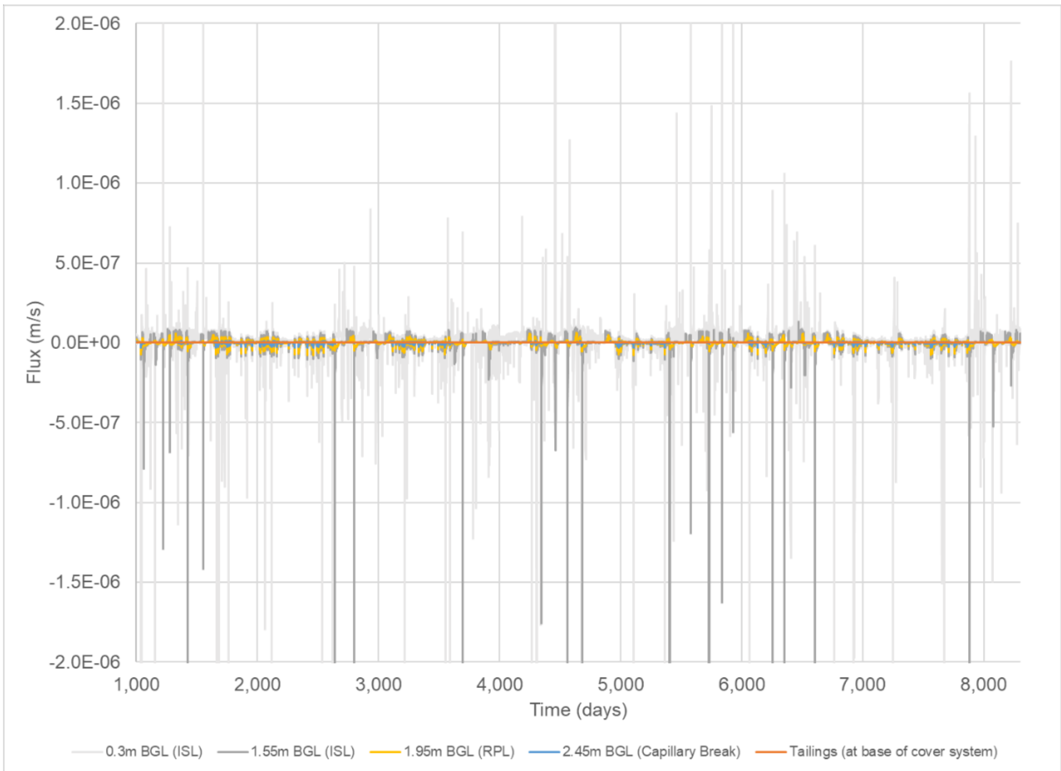
CHART 3: FLUX – COVER A (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



(B)

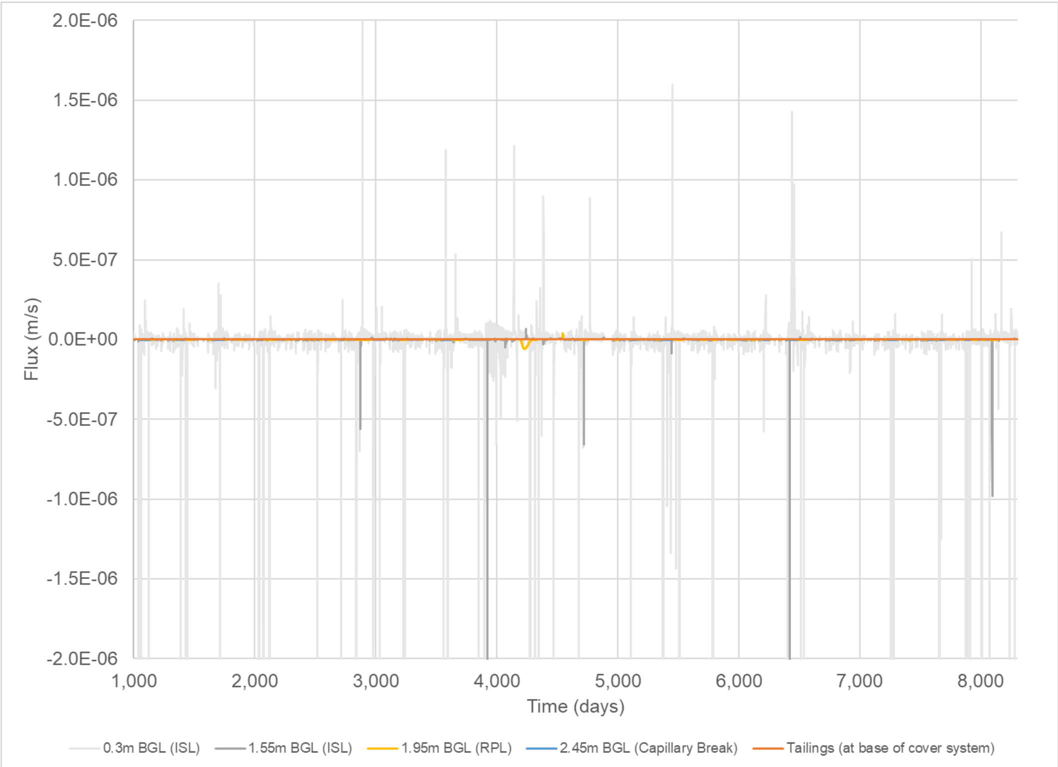
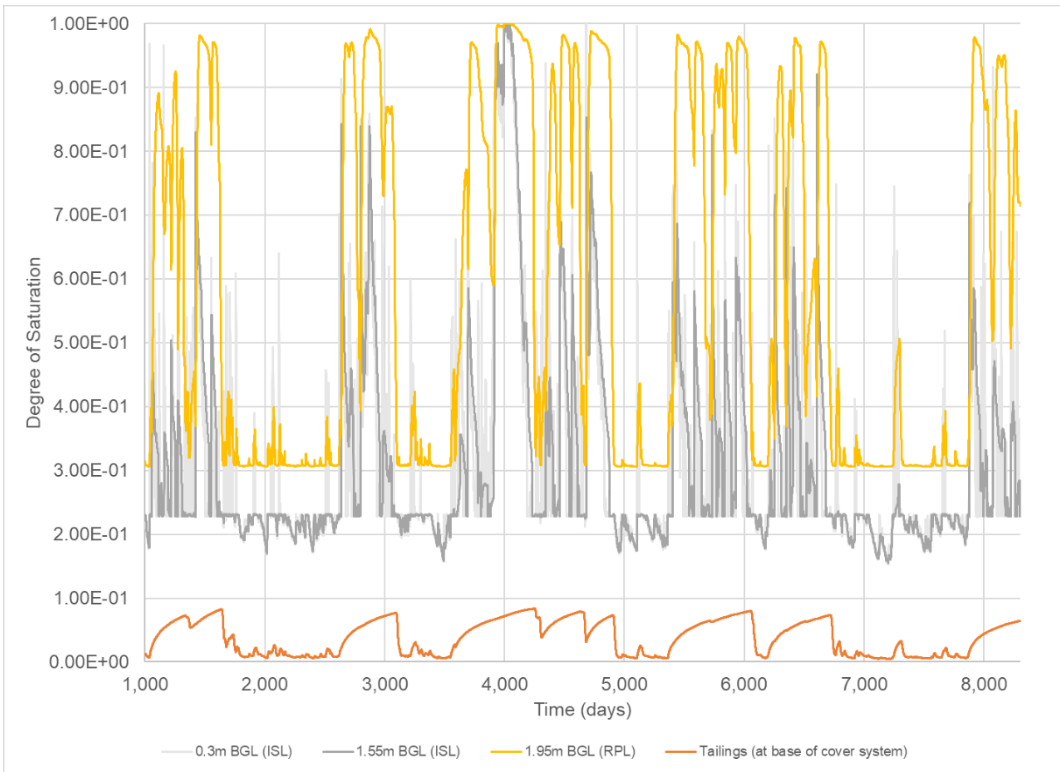


CHART 4: DEGREE OF SATURATION – COVER A (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



(B)

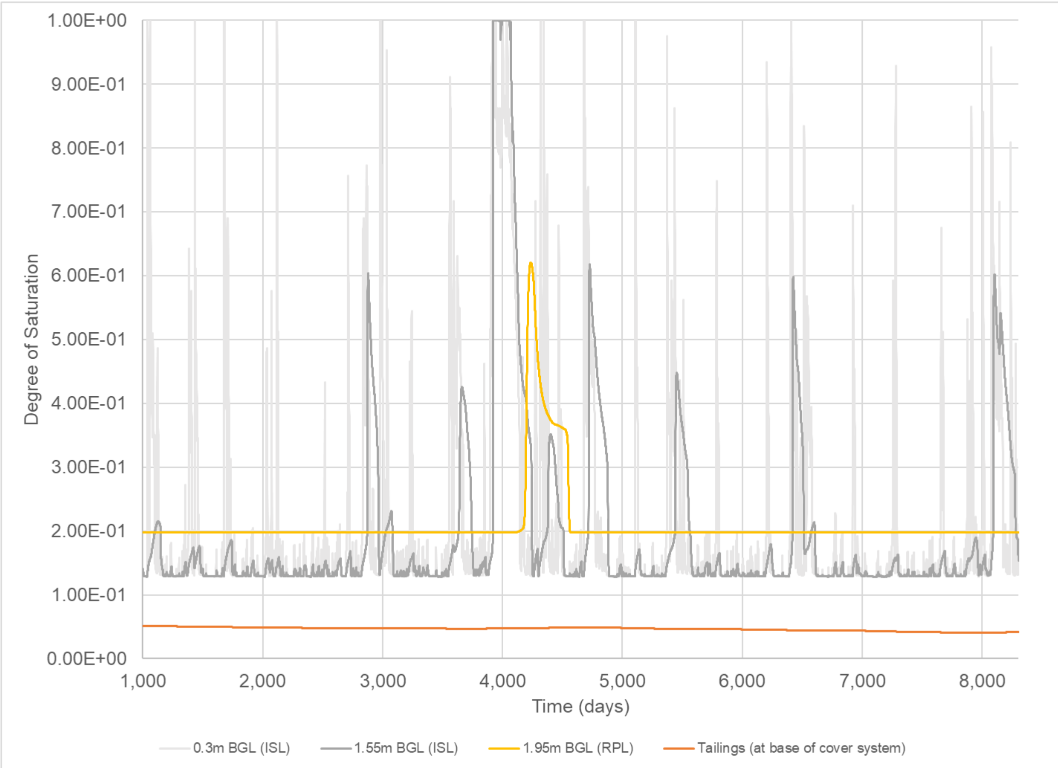
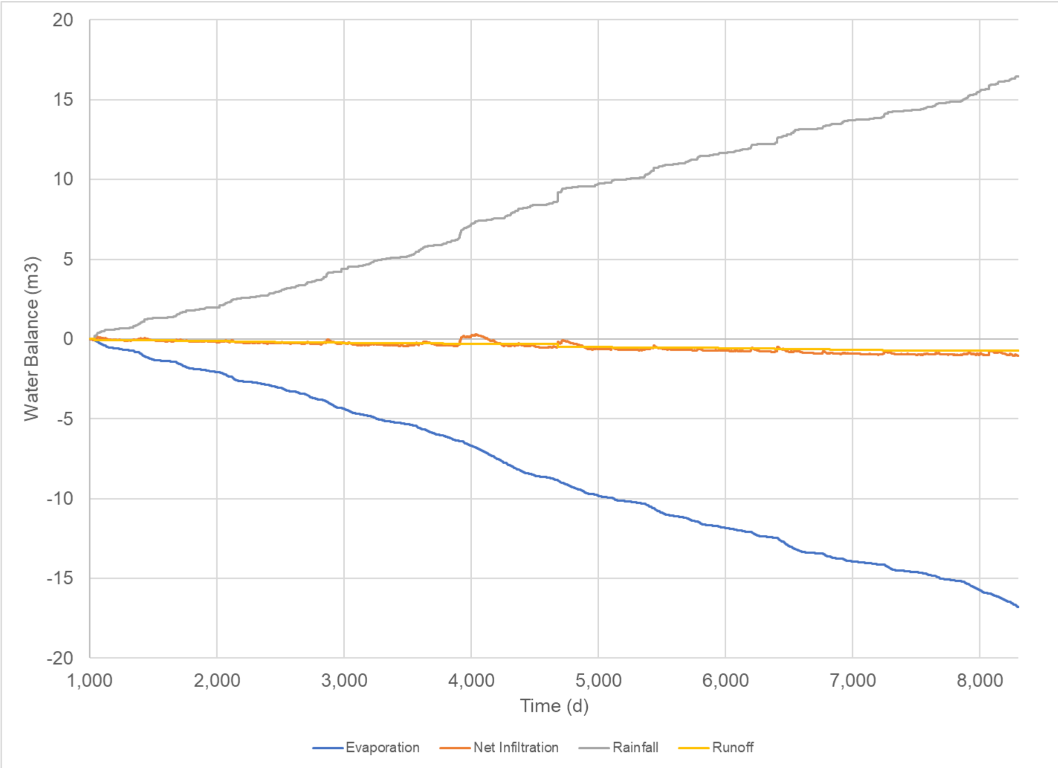


CHART 5: CUMULATIVE WATER BALANCE – COVER D (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



(B)

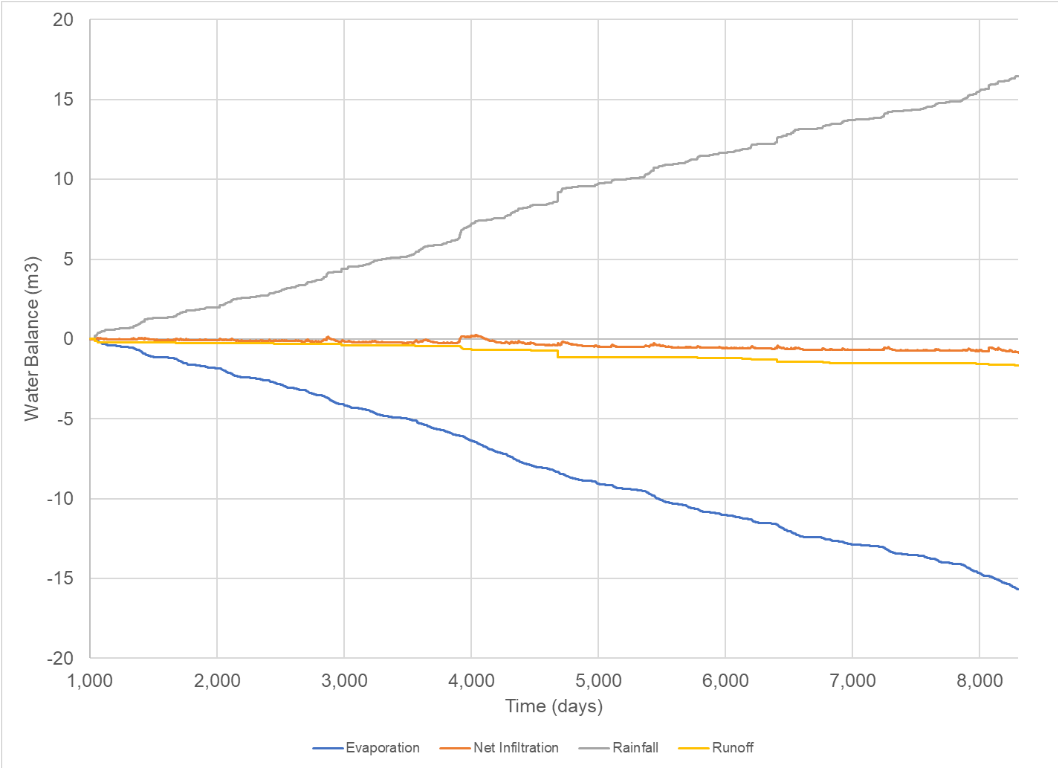
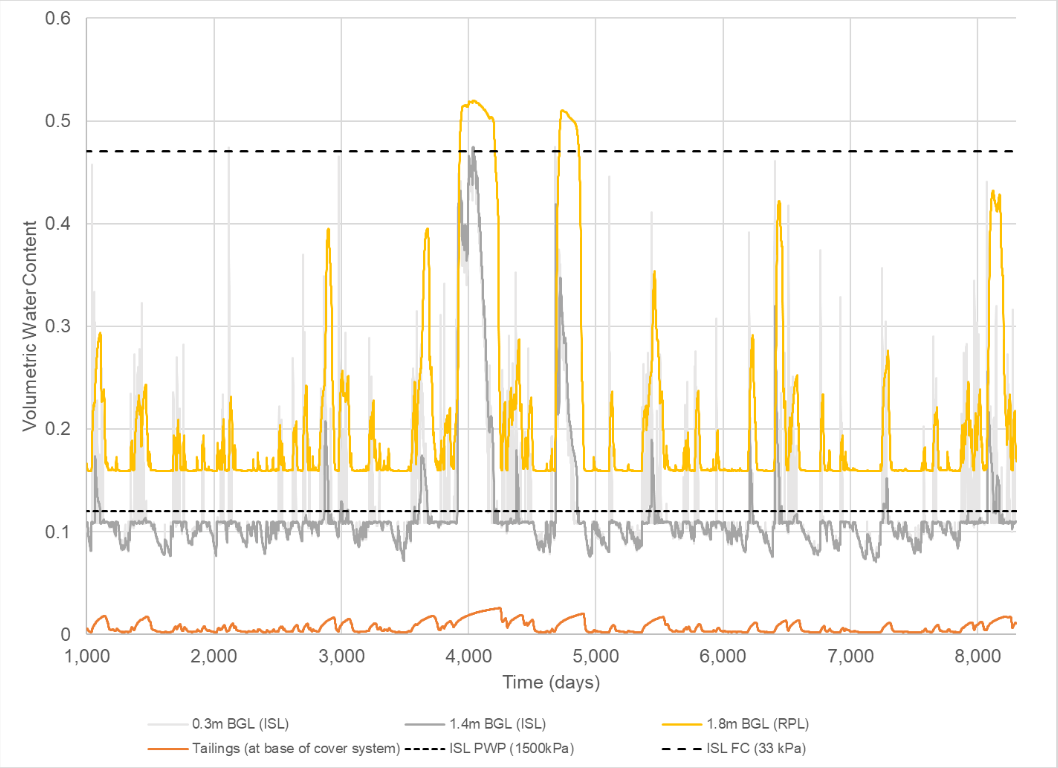


CHART 6: VWC – COVER D (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



(B)

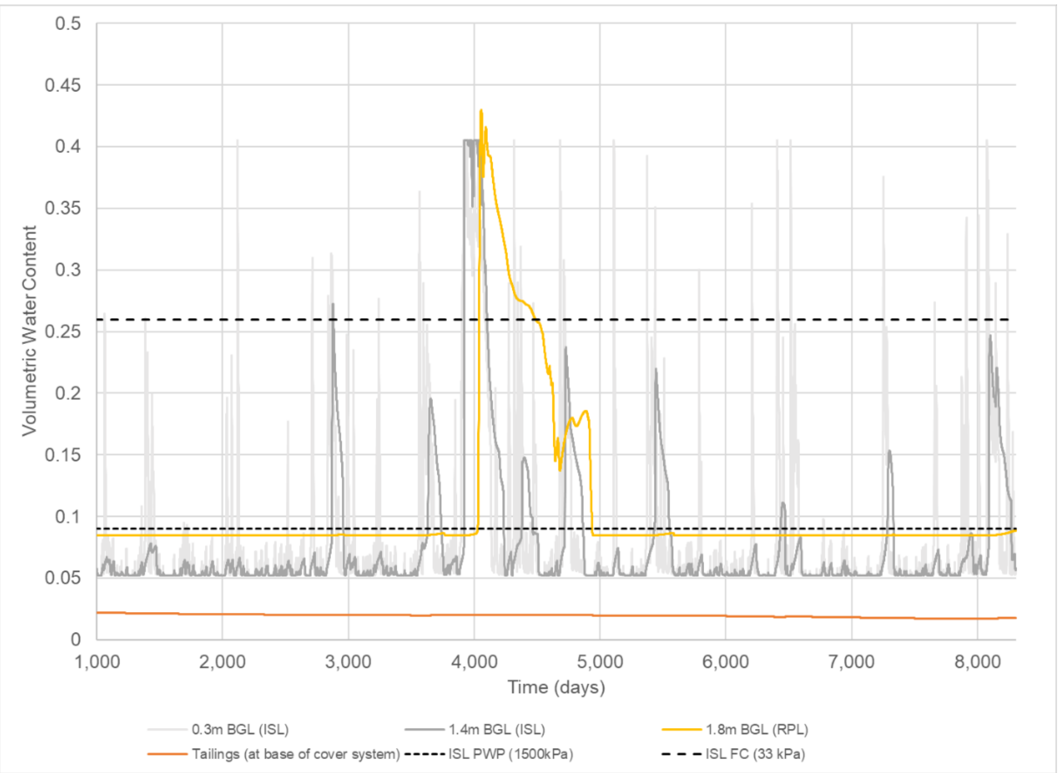
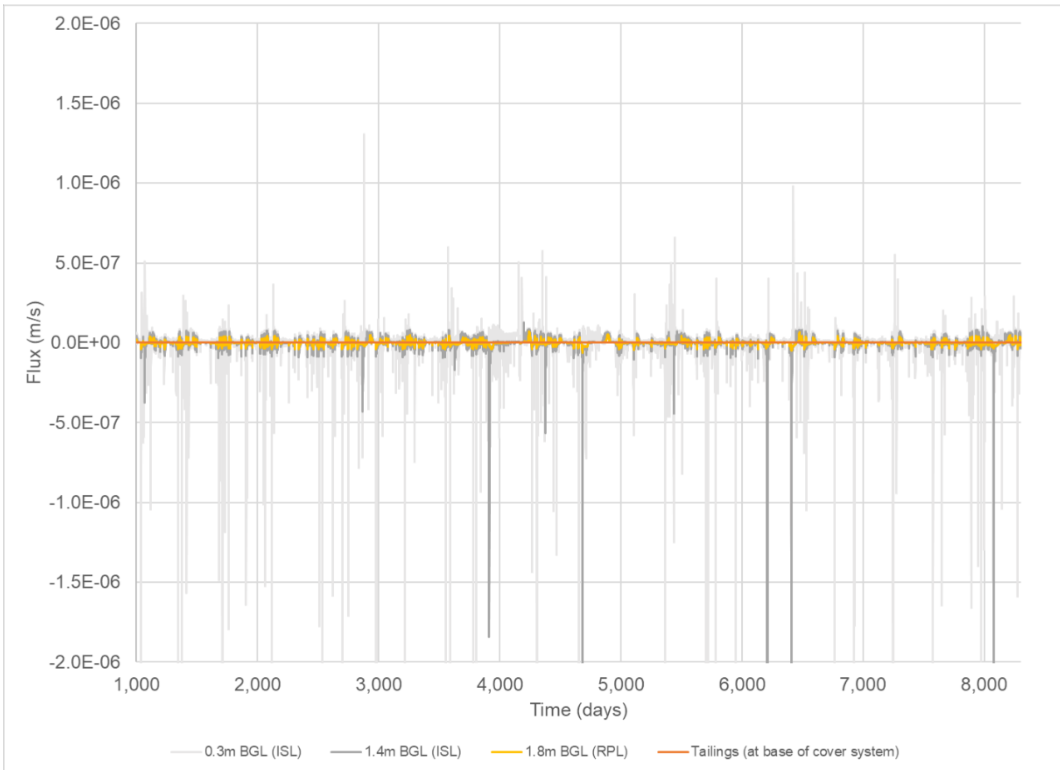


CHART 7: FLUX – COVER D (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



(B)

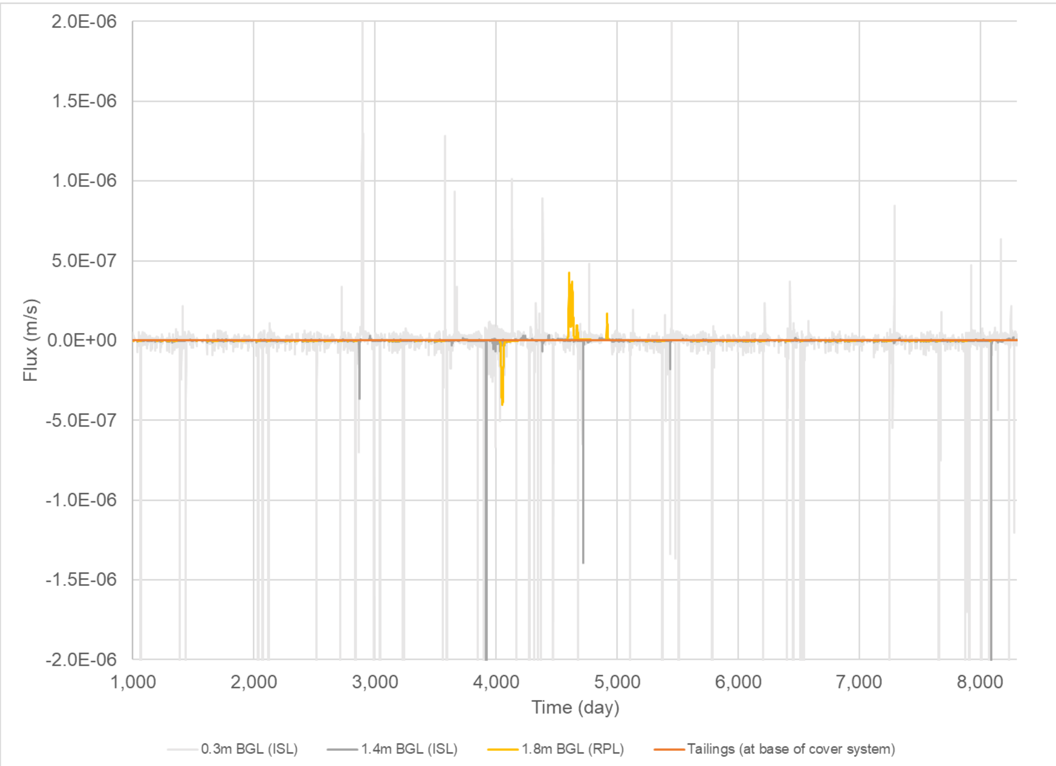
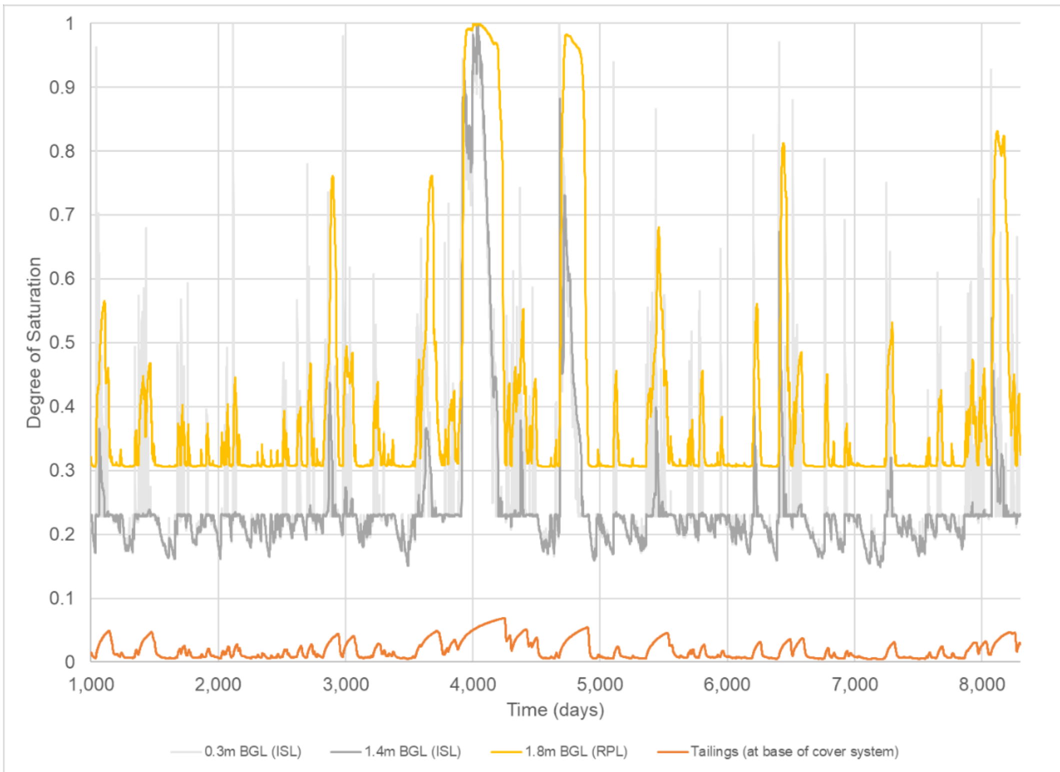


CHART 8: DEGREE OF SATURATION – COVER D (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



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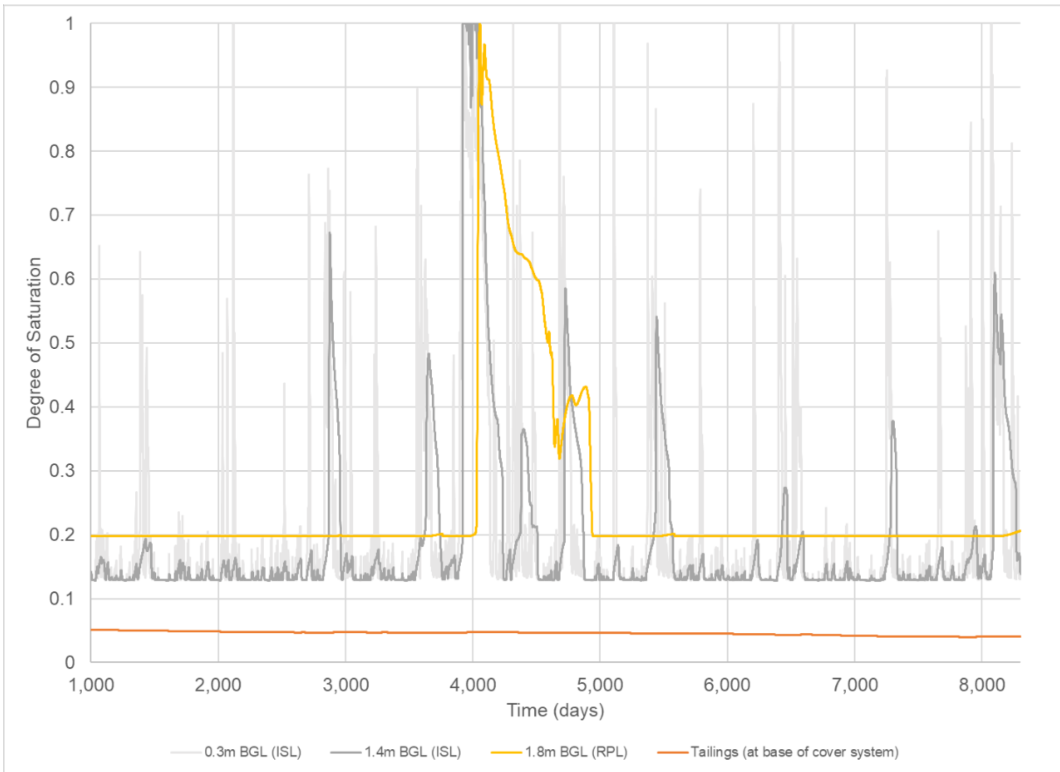
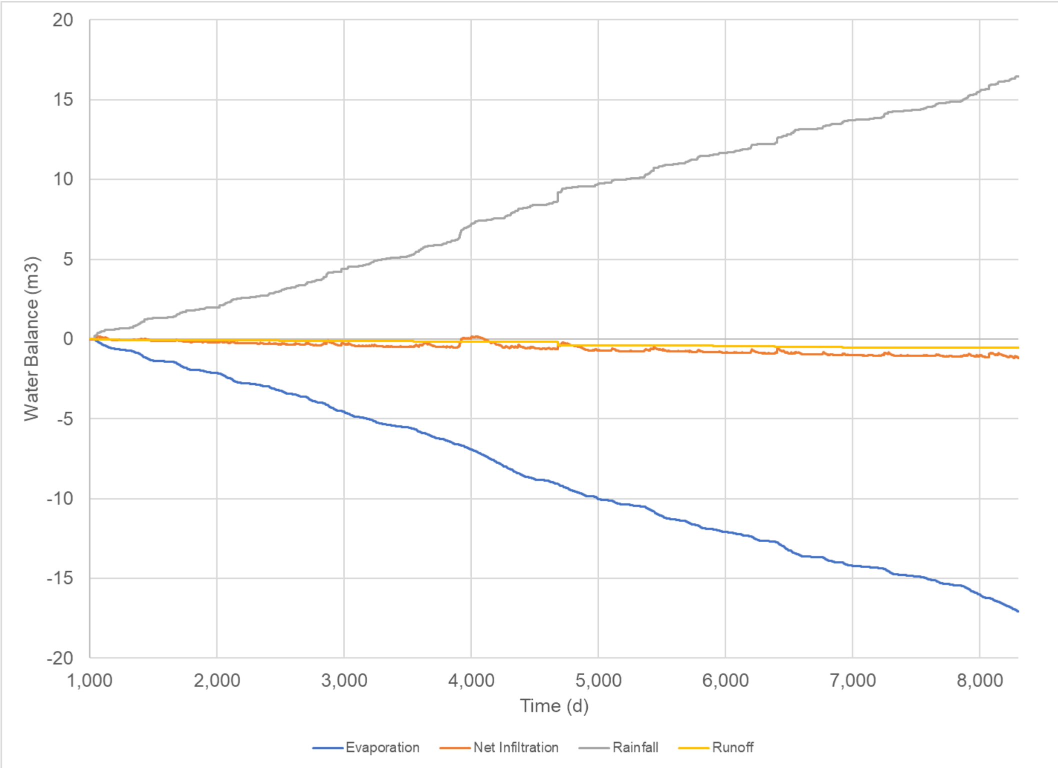


CHART 9: CUMULATIVE WATER BALANCE – MODIFED COVER D (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



(B)

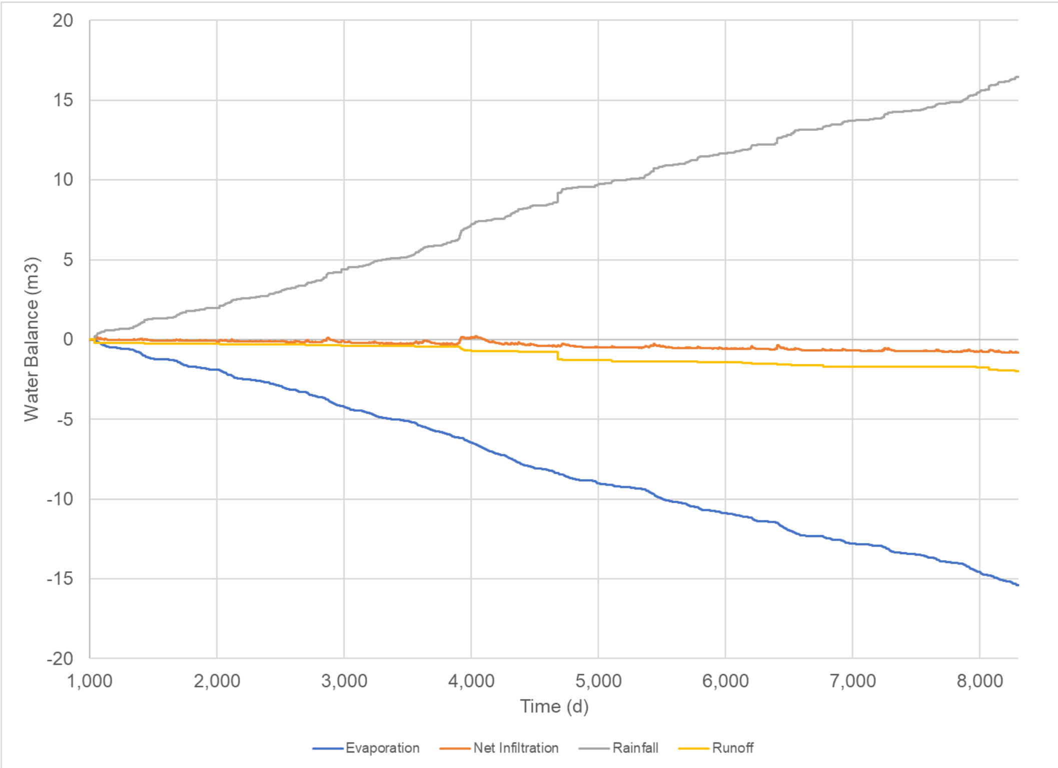
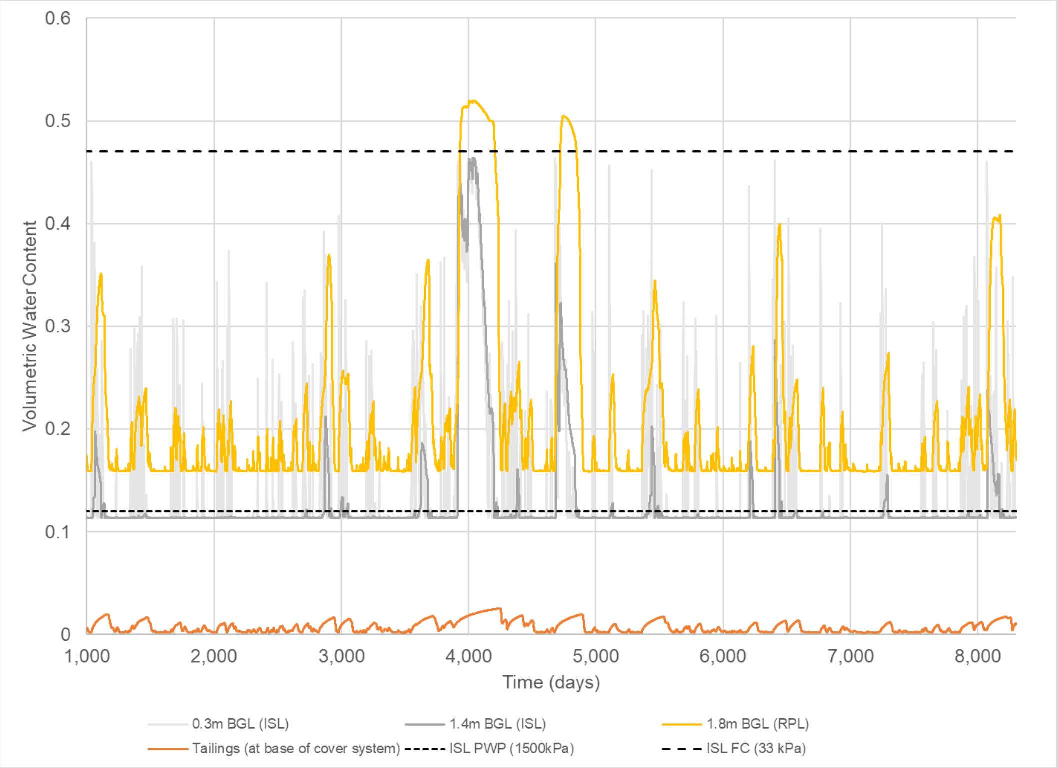


CHART 10: VWC – MODIFED COVER D (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



(B)

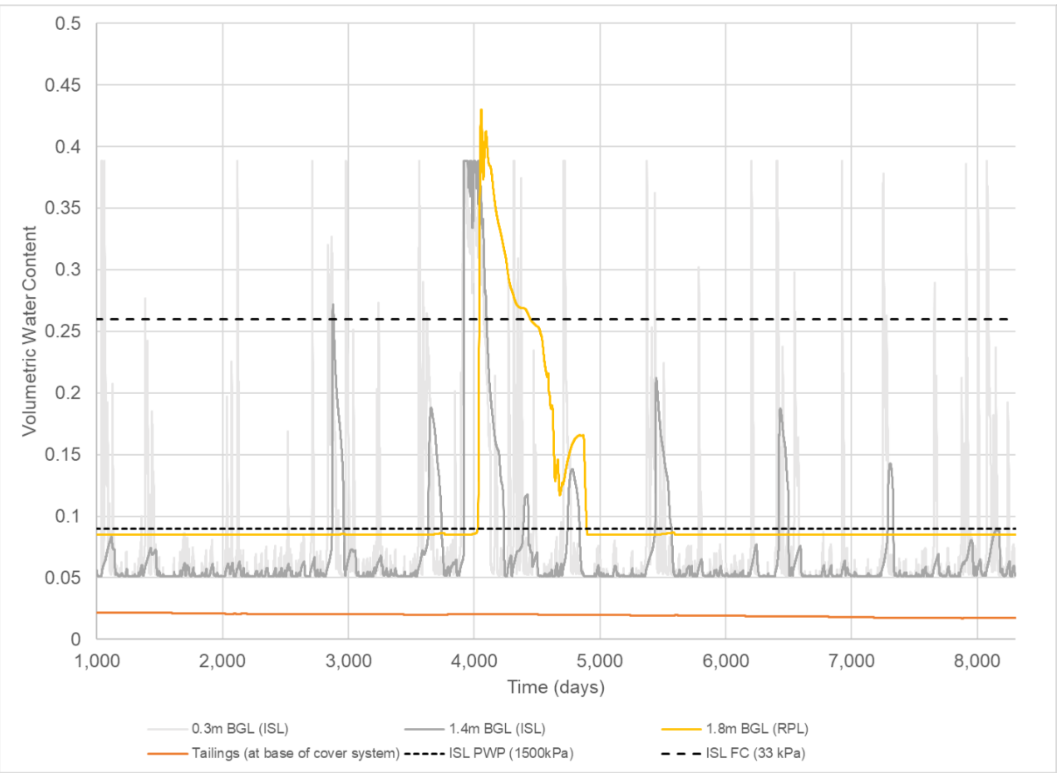
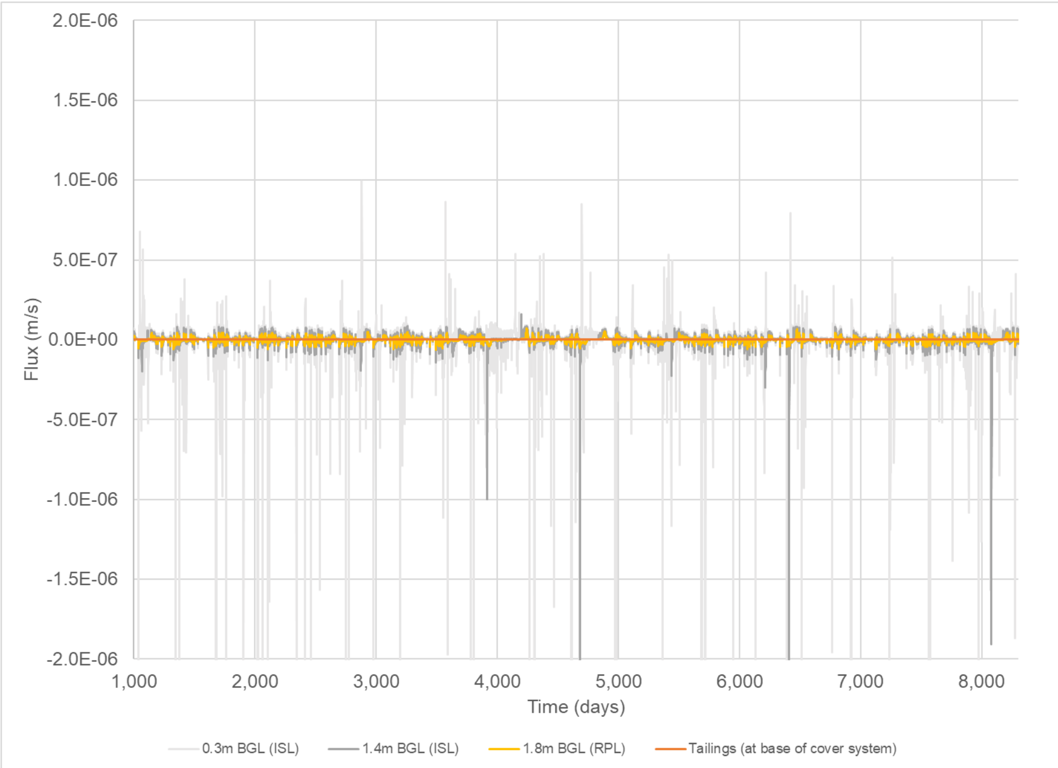


CHART 11: FLUX – MODIFIED COVER D (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



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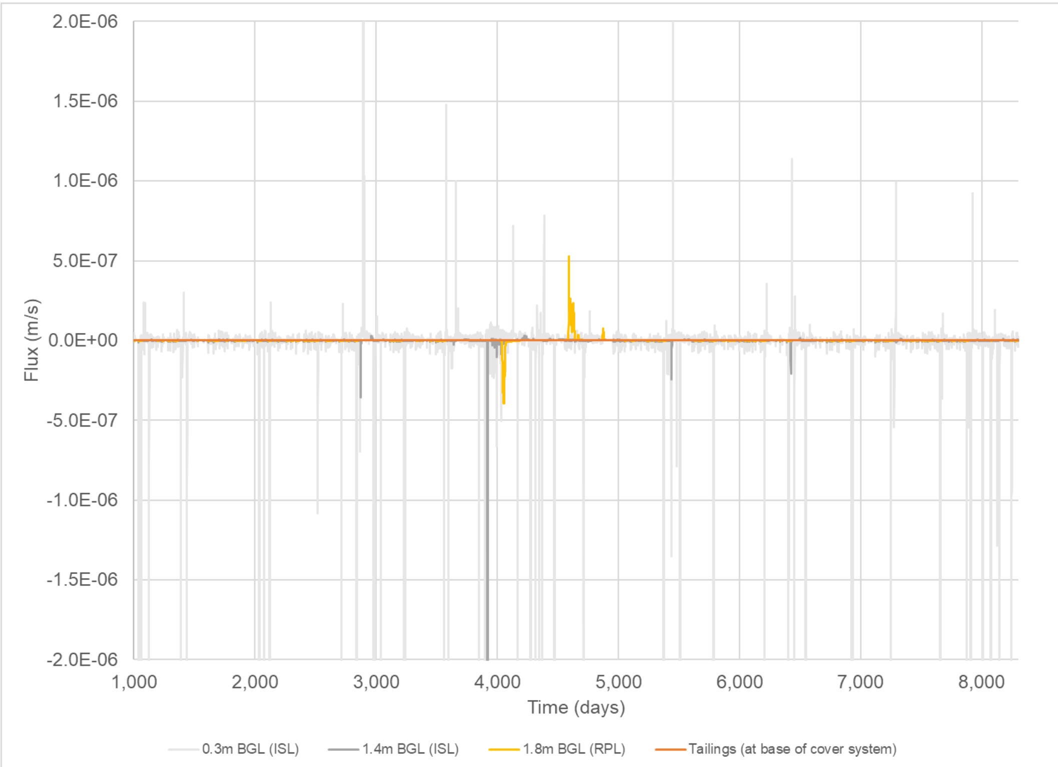
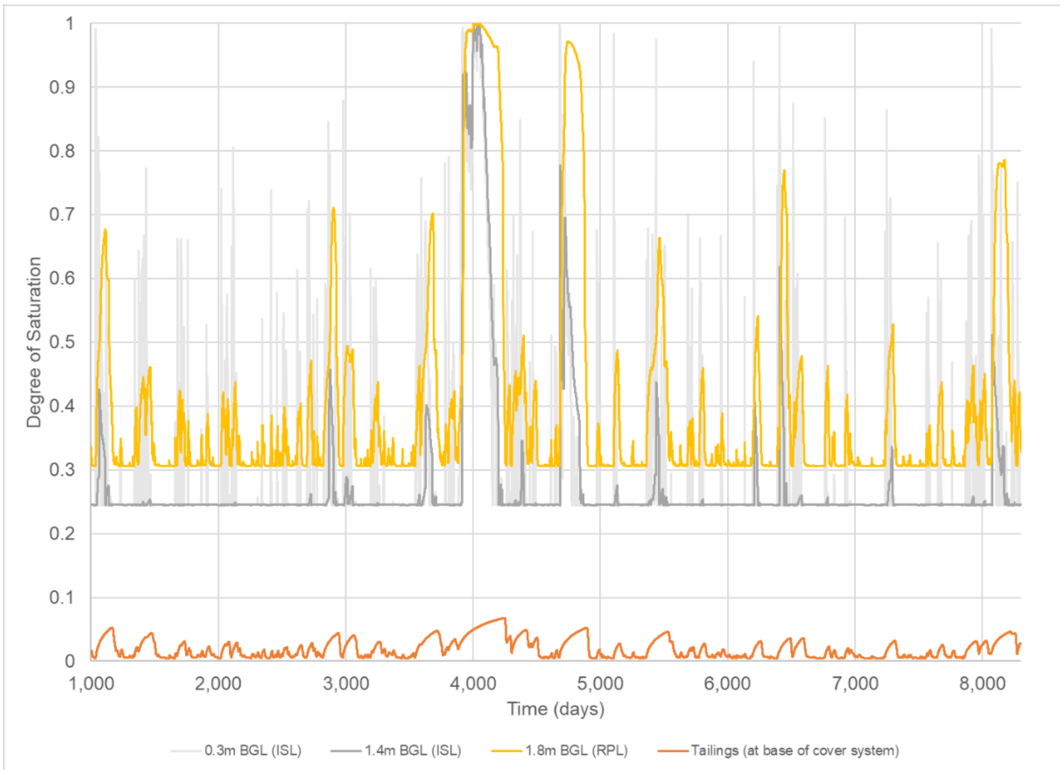


CHART 12: DEGREE OF SATURATION – MODIFIED COVER D (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



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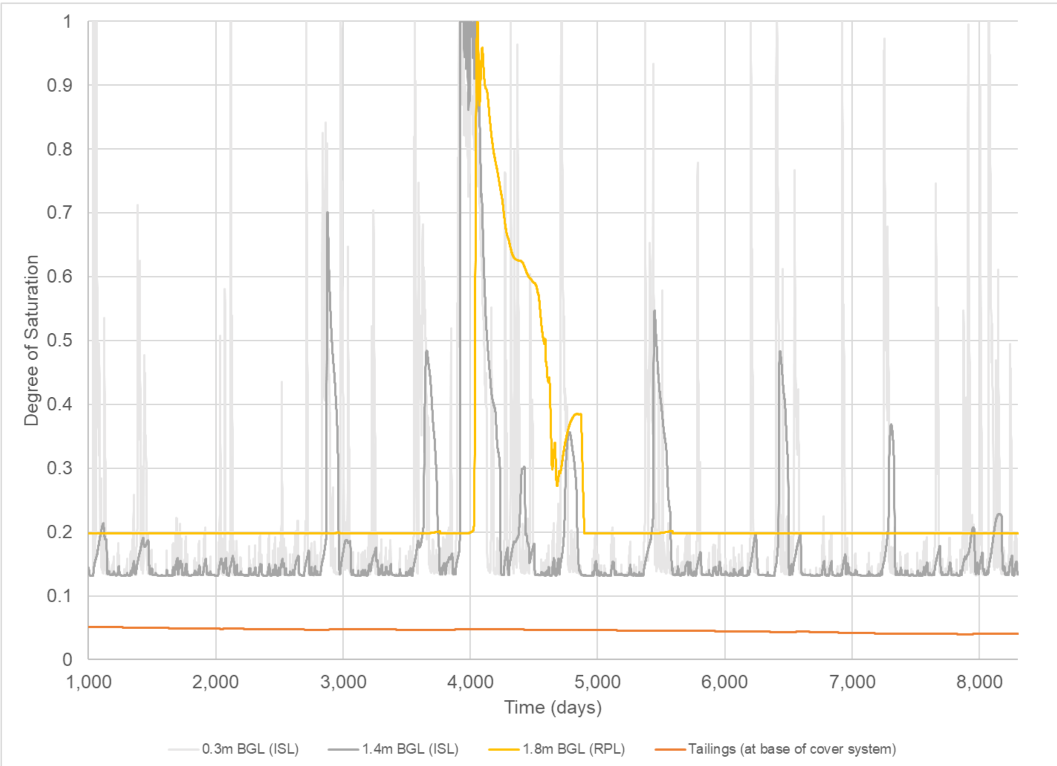
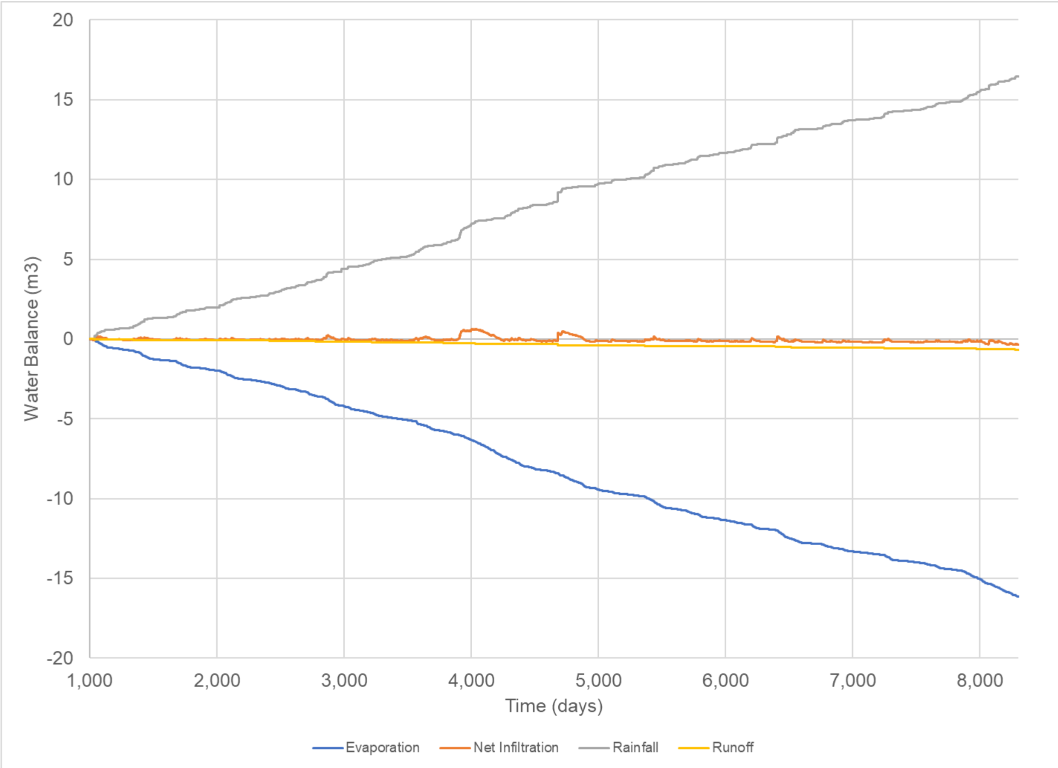


CHART 13: CUMULATIVE WATER BALANCE – OPTIMISED COVER A (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



(B)

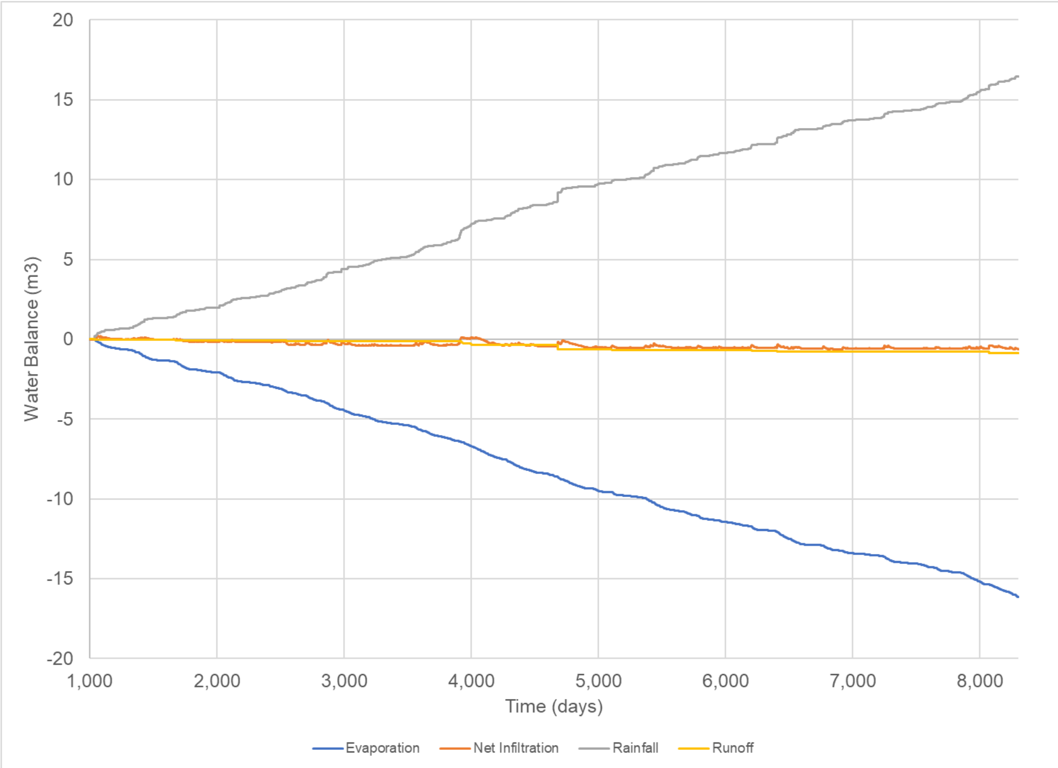
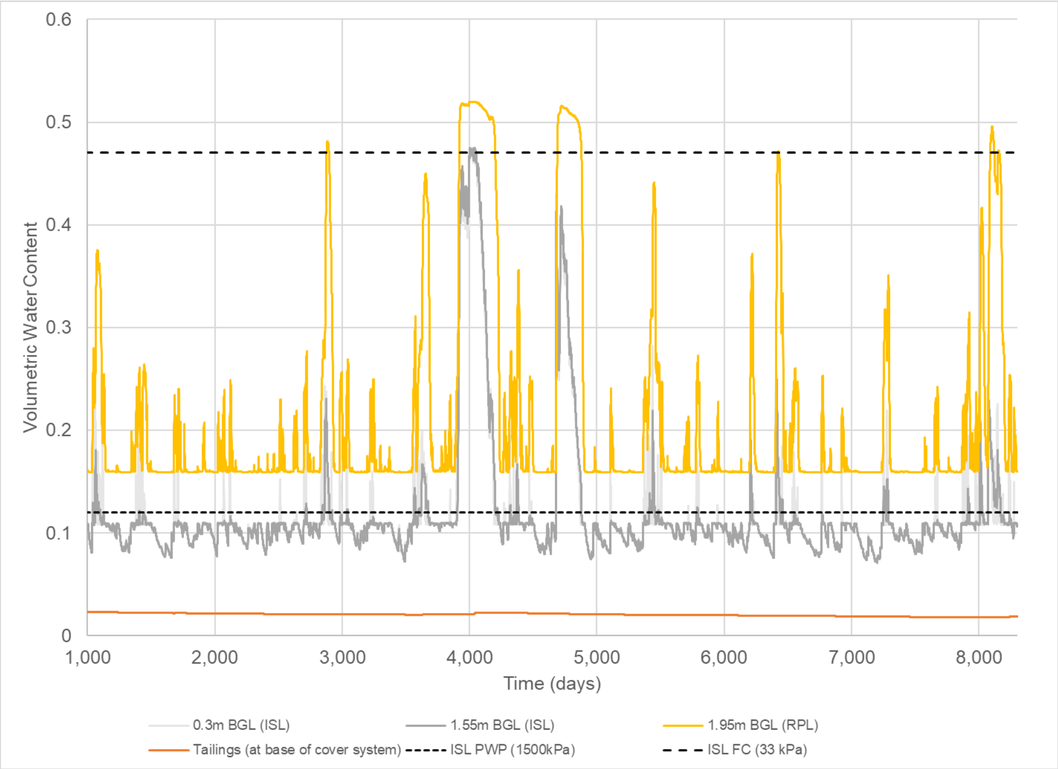


CHART 14: VWC – OPTIMISED COVER A (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



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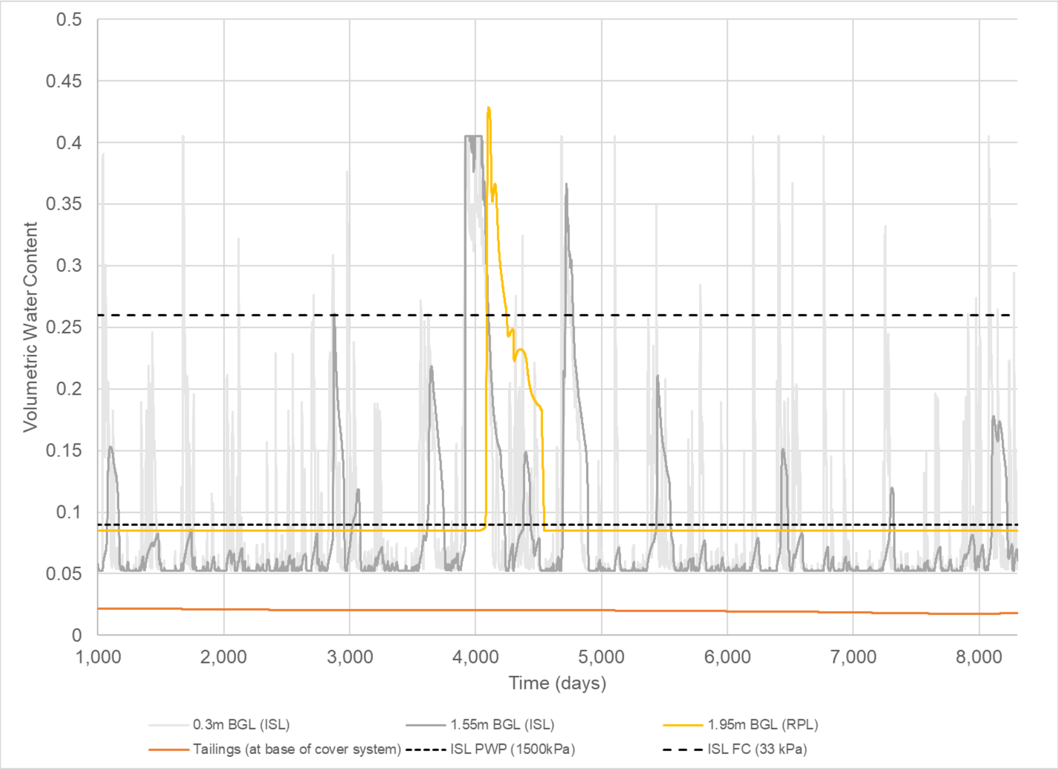
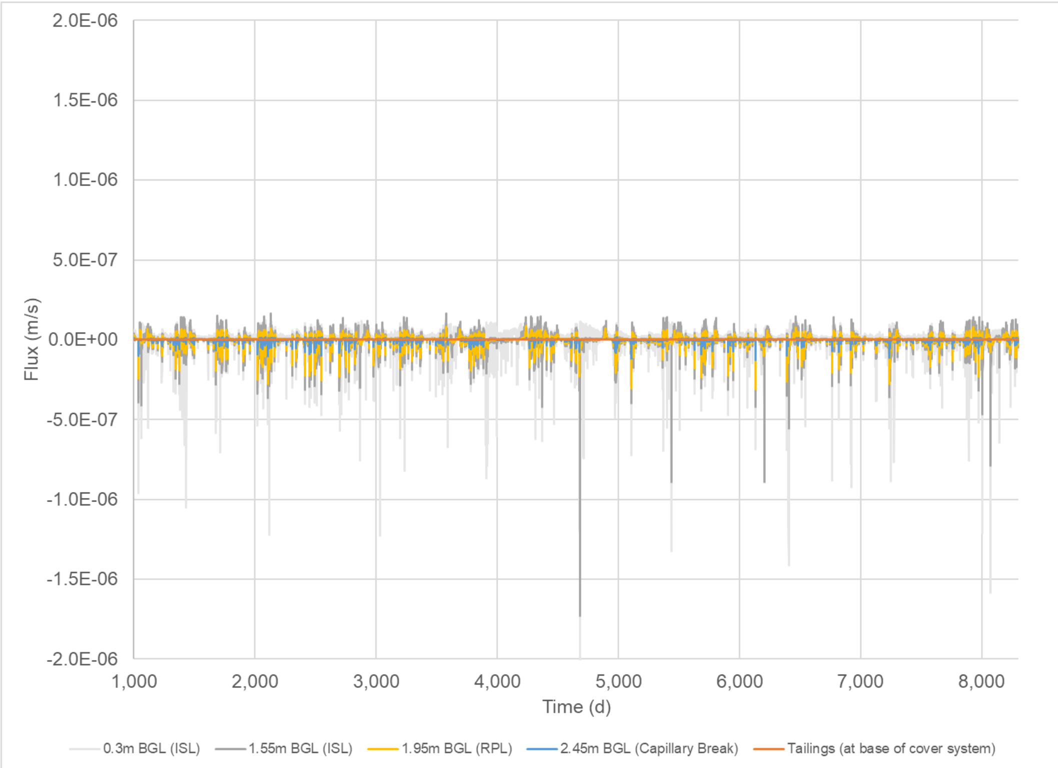


CHART 15: FLUX – OPTIMISED COVER A (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



(B)

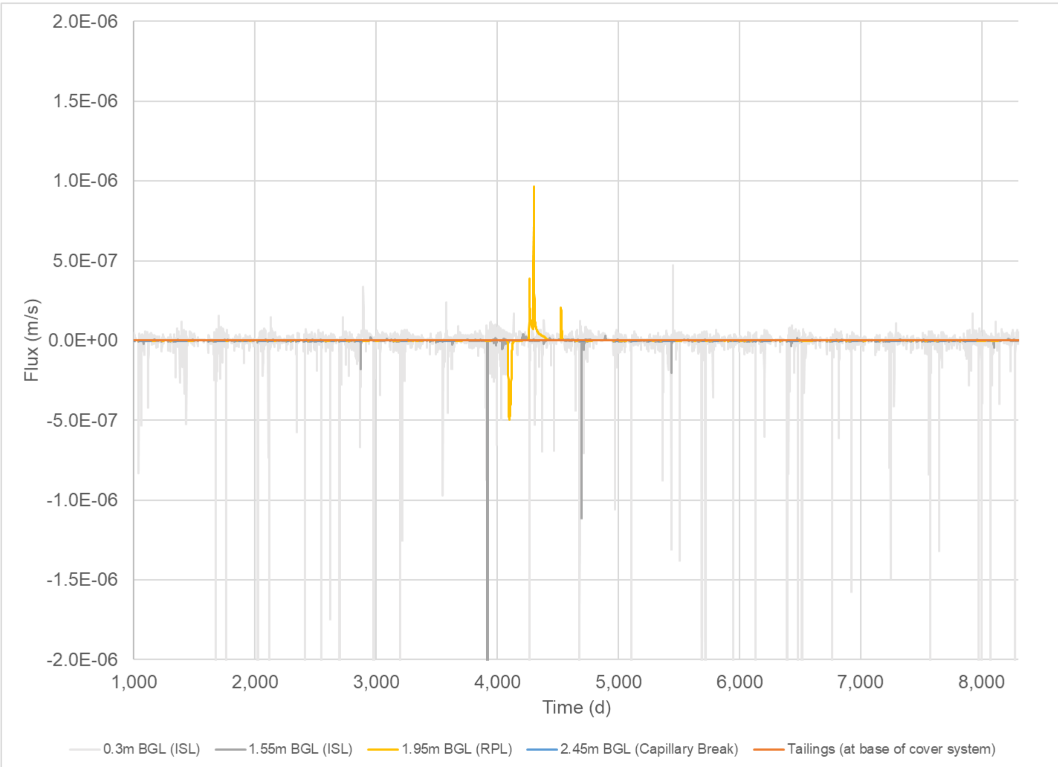
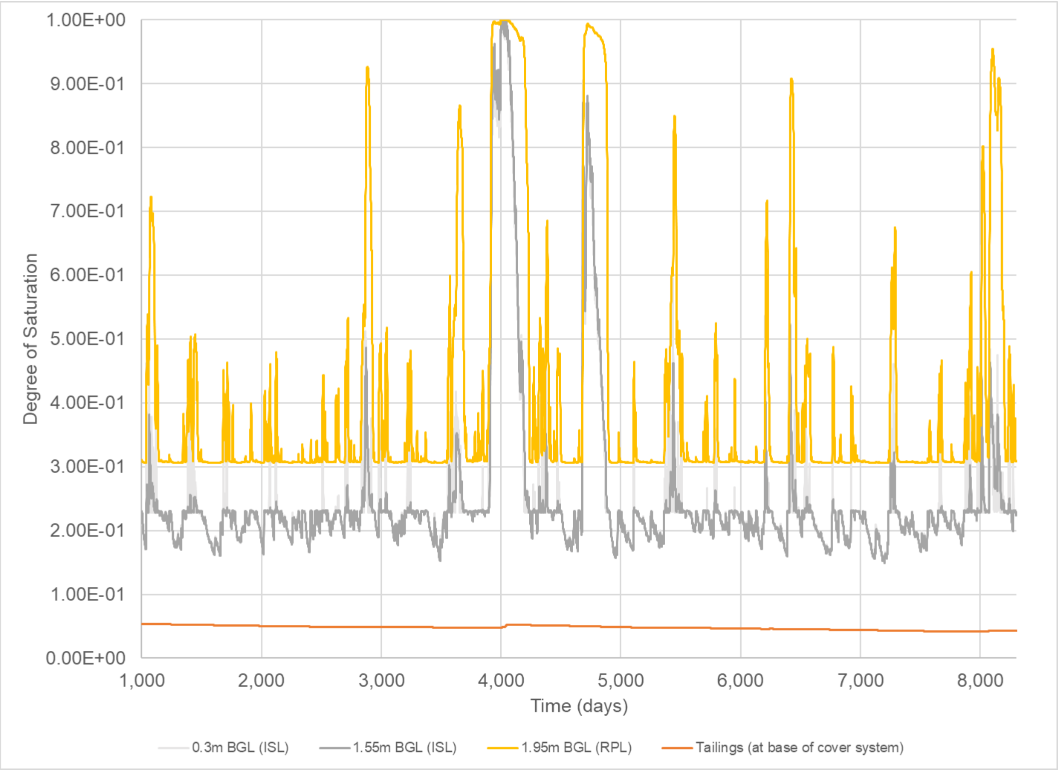


CHART 16: DEGREE OF SATURATION – OPTIMISED COVER A (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



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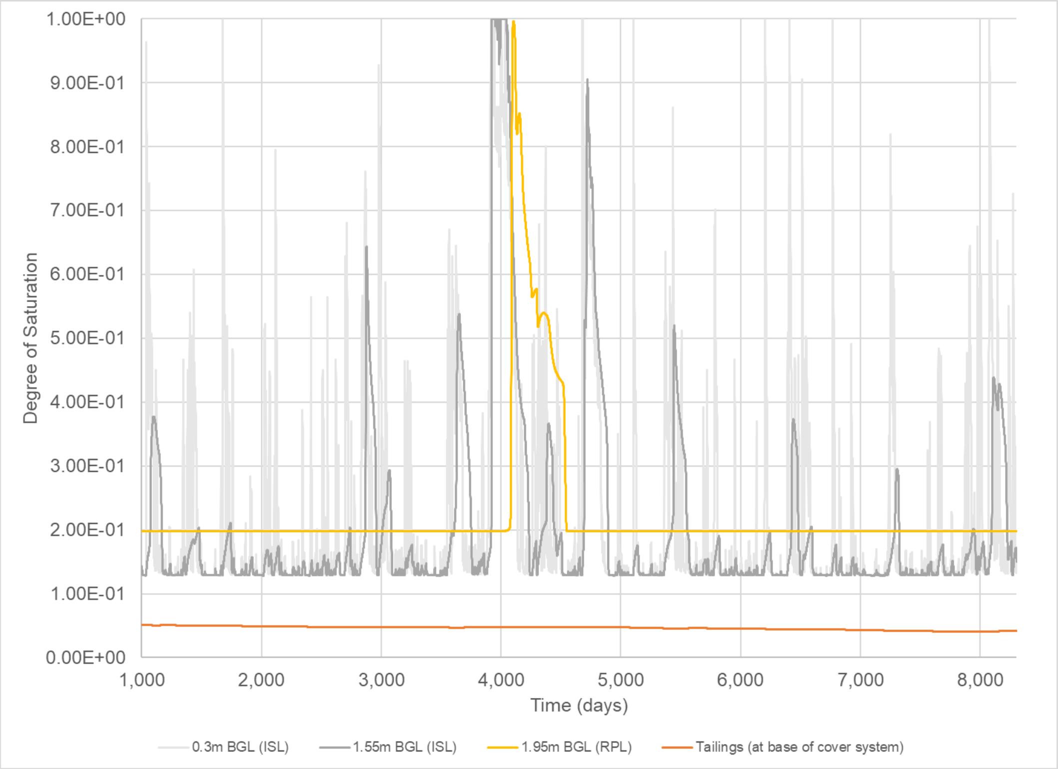
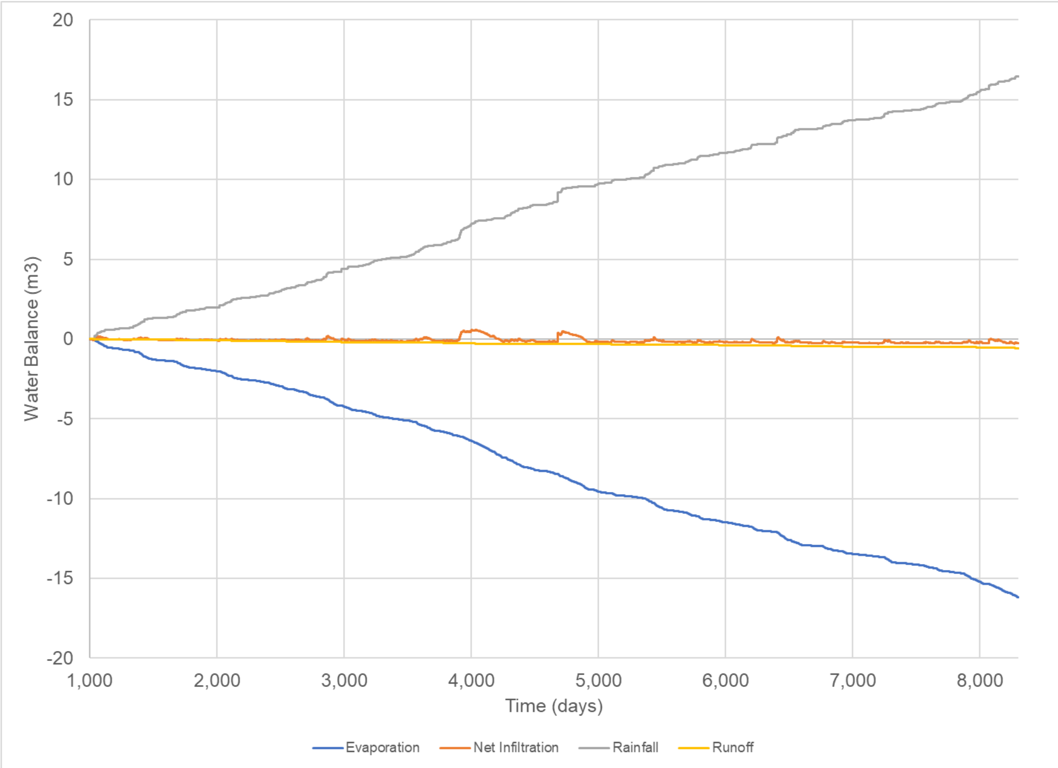


CHART 17: CUMULATIVE WATER BALANCE – OPTIMISED COVER D (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



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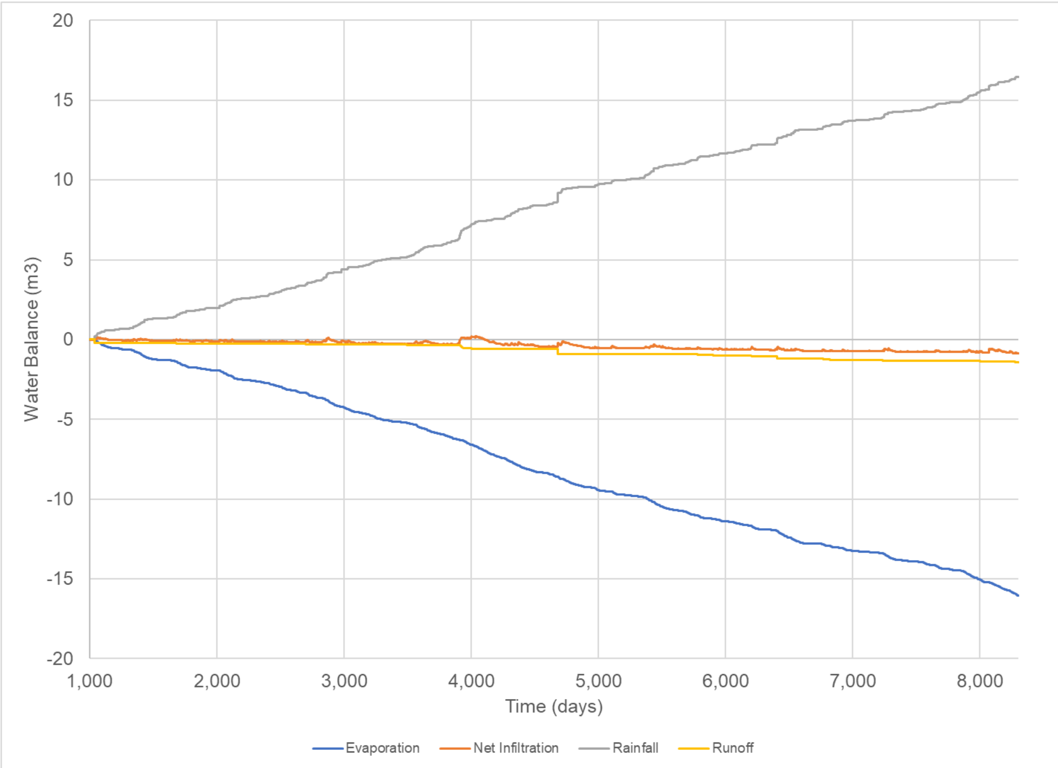
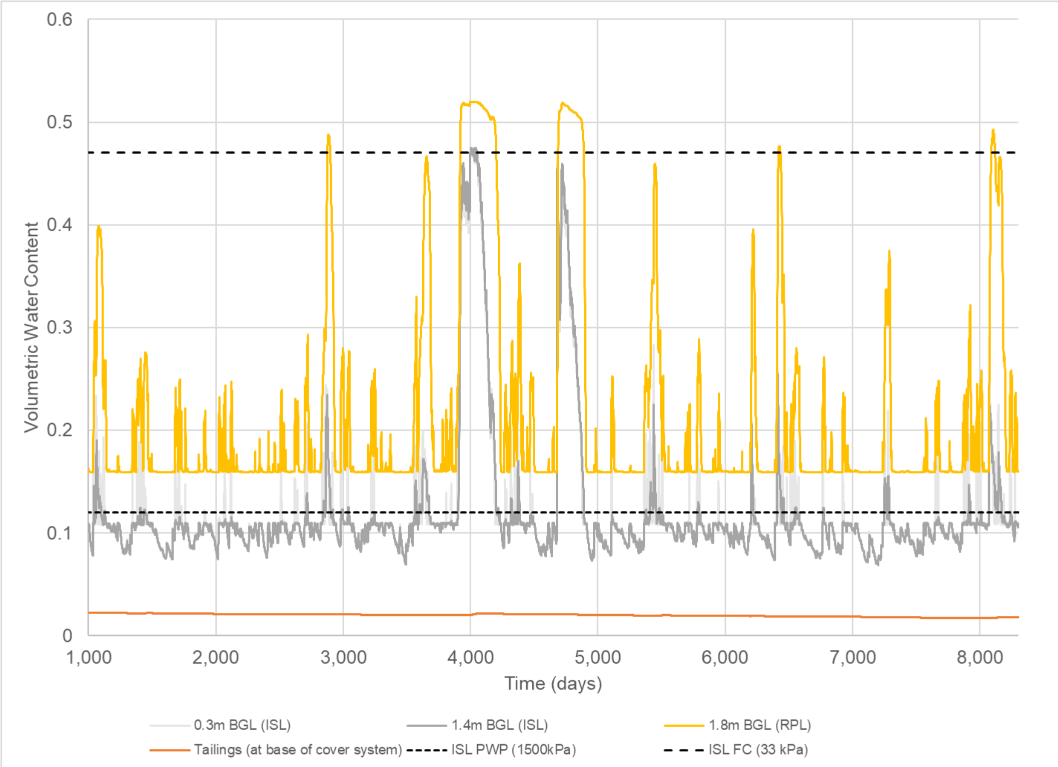


CHART 18: VWC – OPTIMISED COVER D (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



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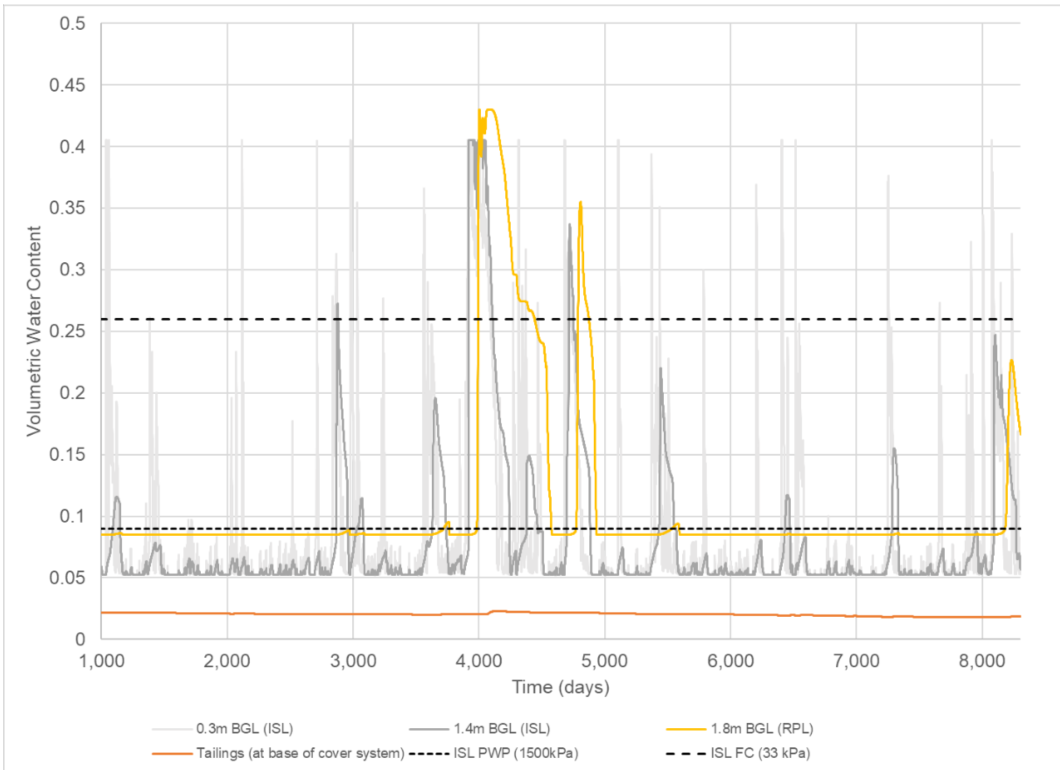
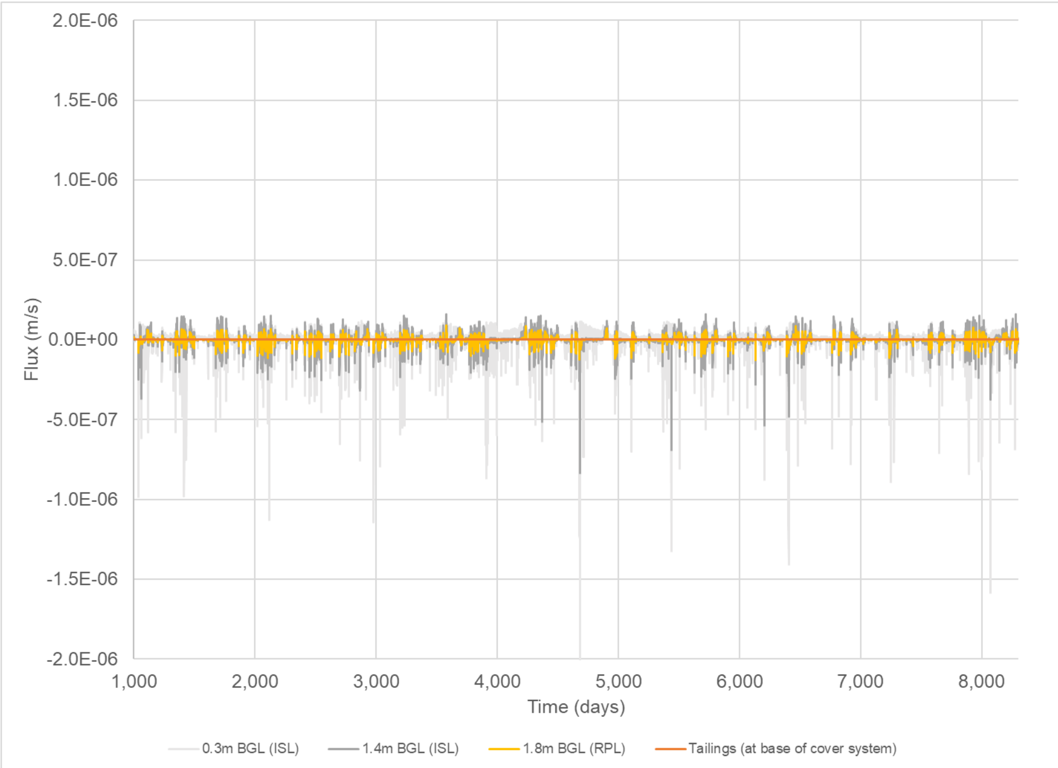


CHART 19: FLUX – OPTIMISED COVER D (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



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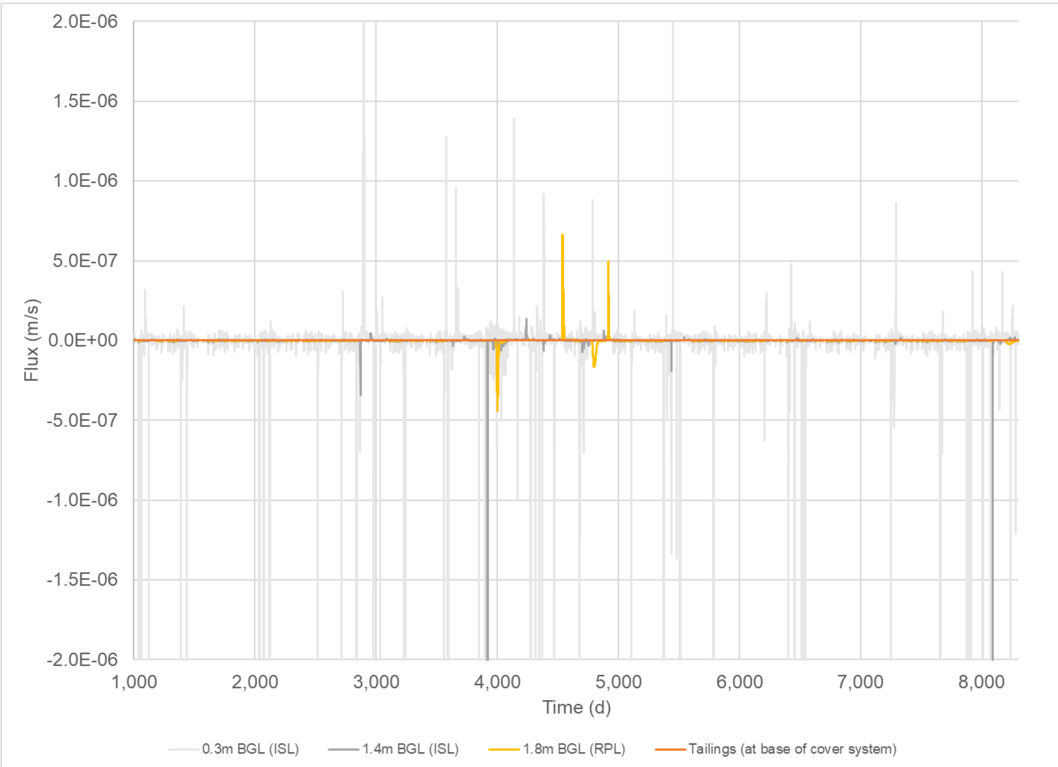

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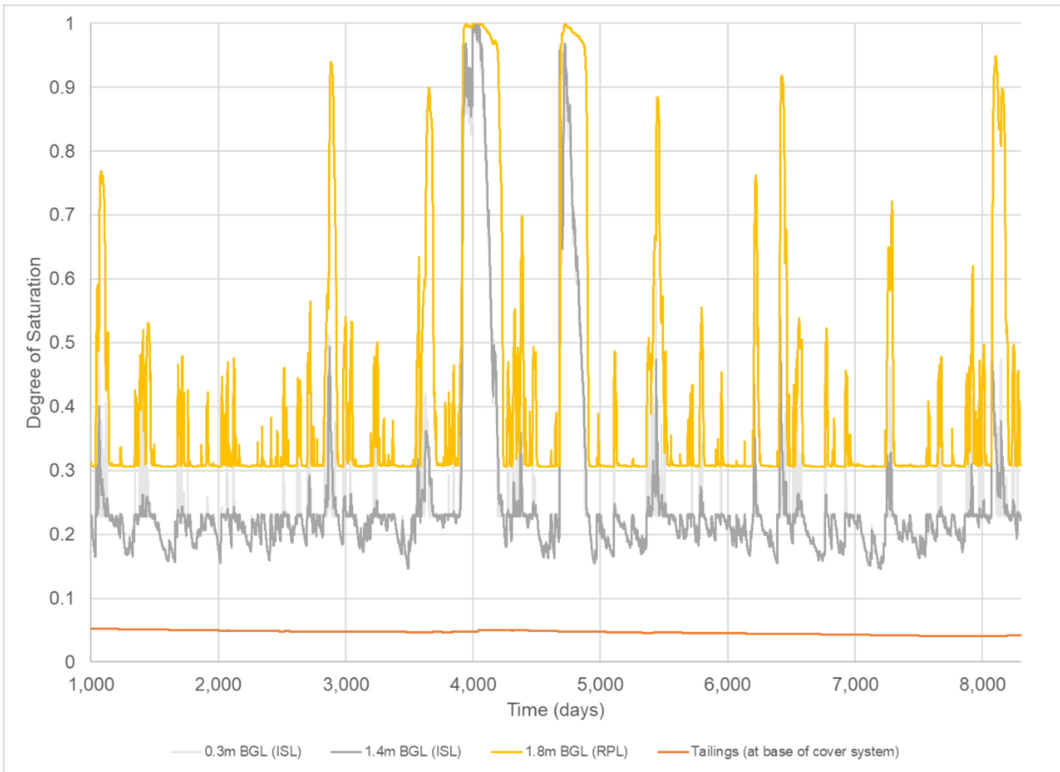
CHART 20: DEGREE OF SATURATION – OPTIMISED COVER D (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



(B)

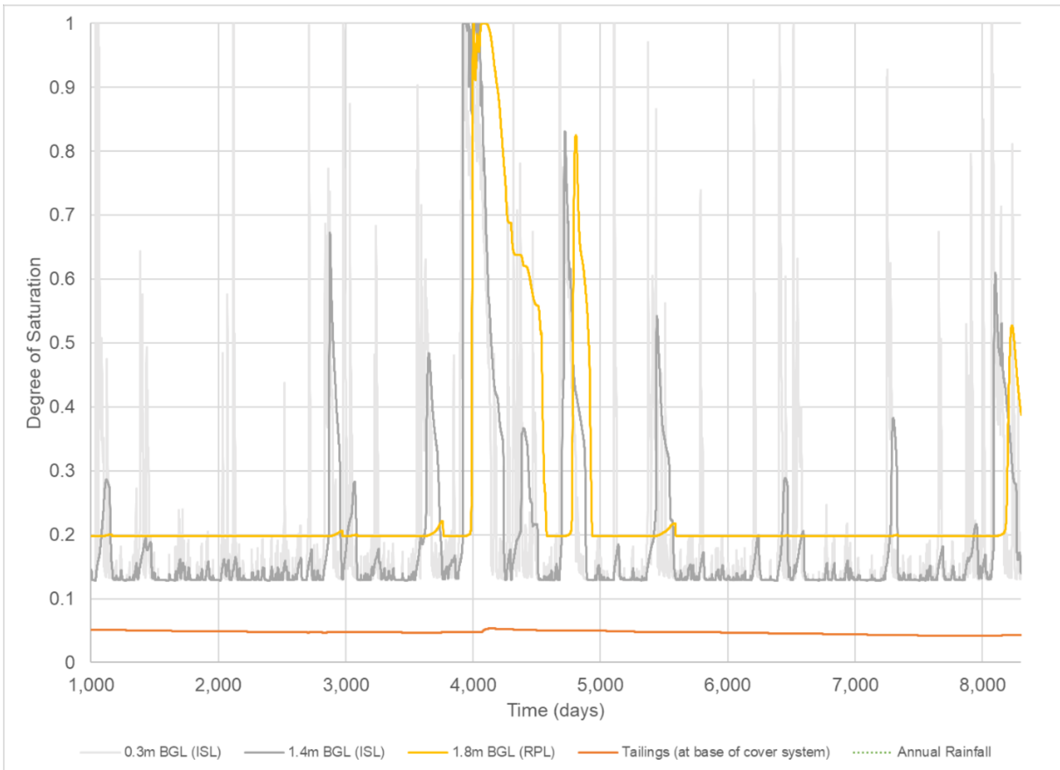
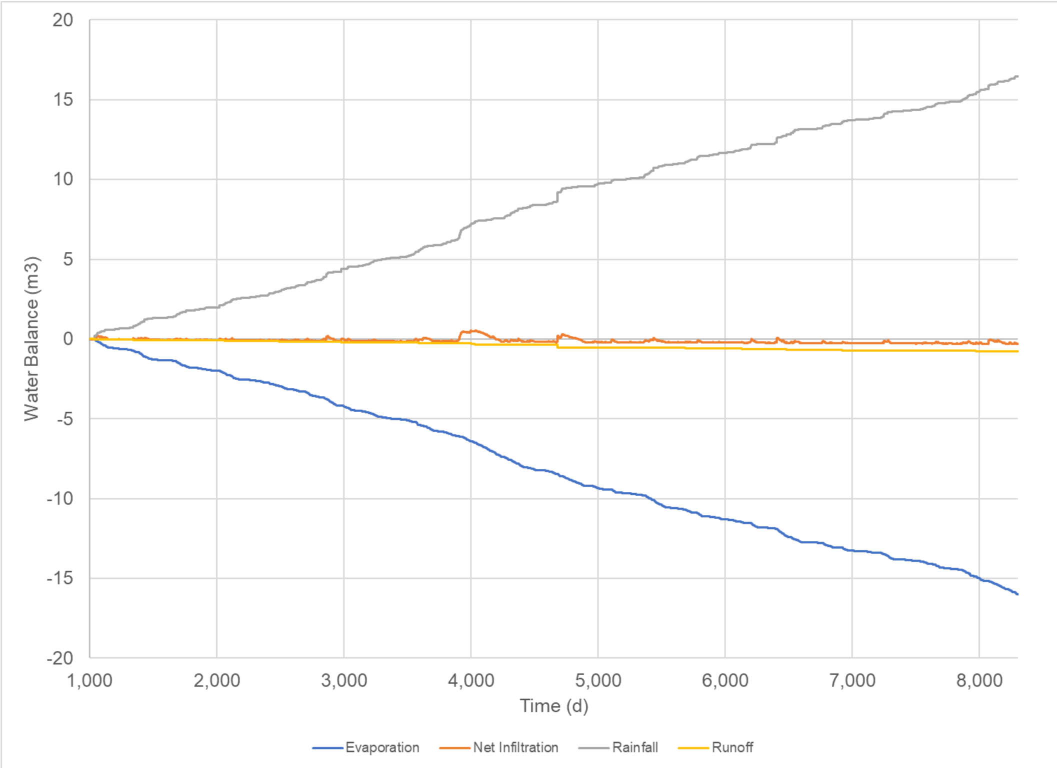


CHART 21: CUMULATIVE WATER BALANCE – OPTIMISED MODIFED COVER D (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



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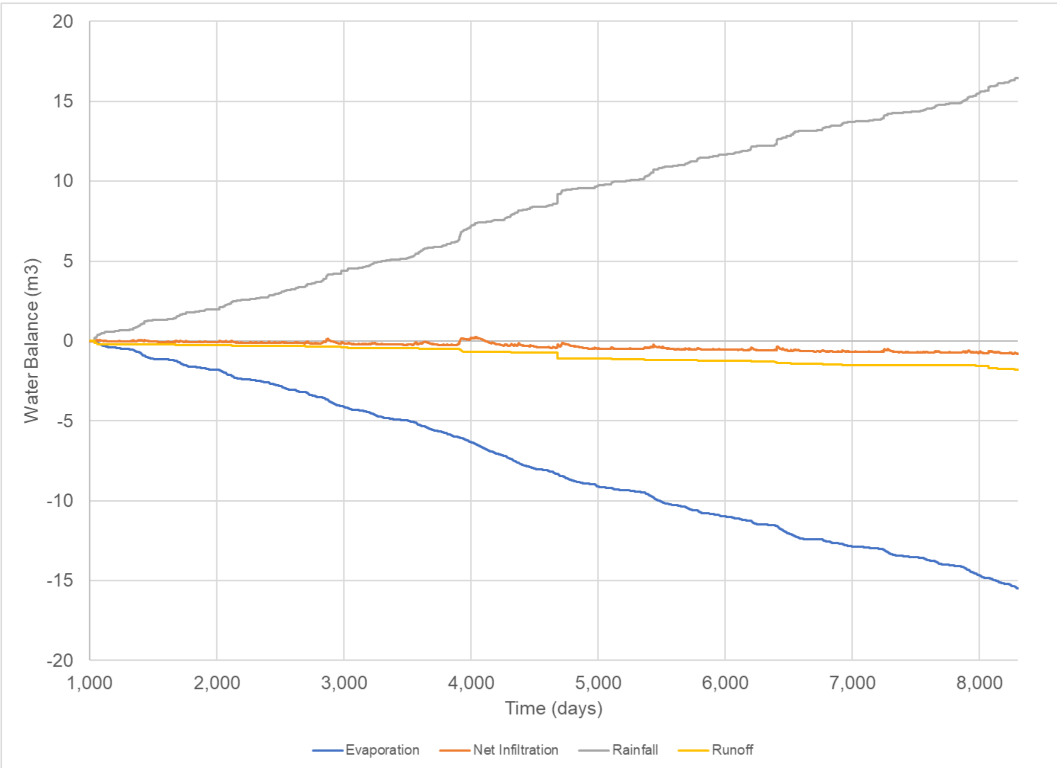
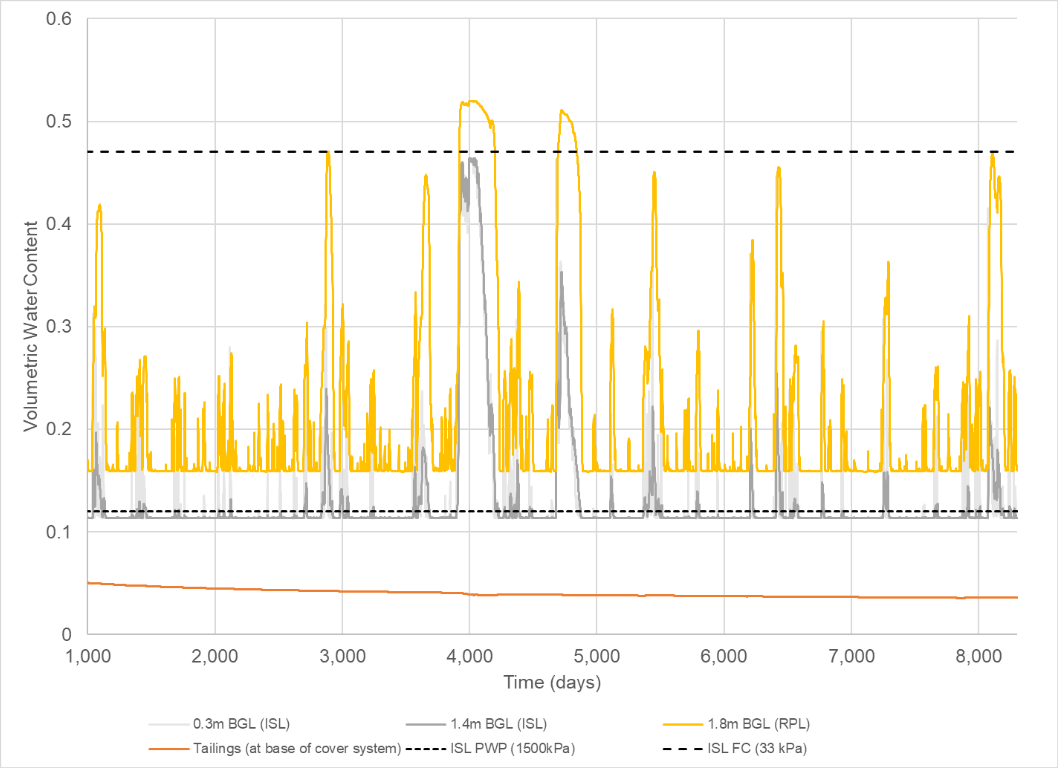


CHART 22: VWC – OPTIMISED MODIFED COVER D (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



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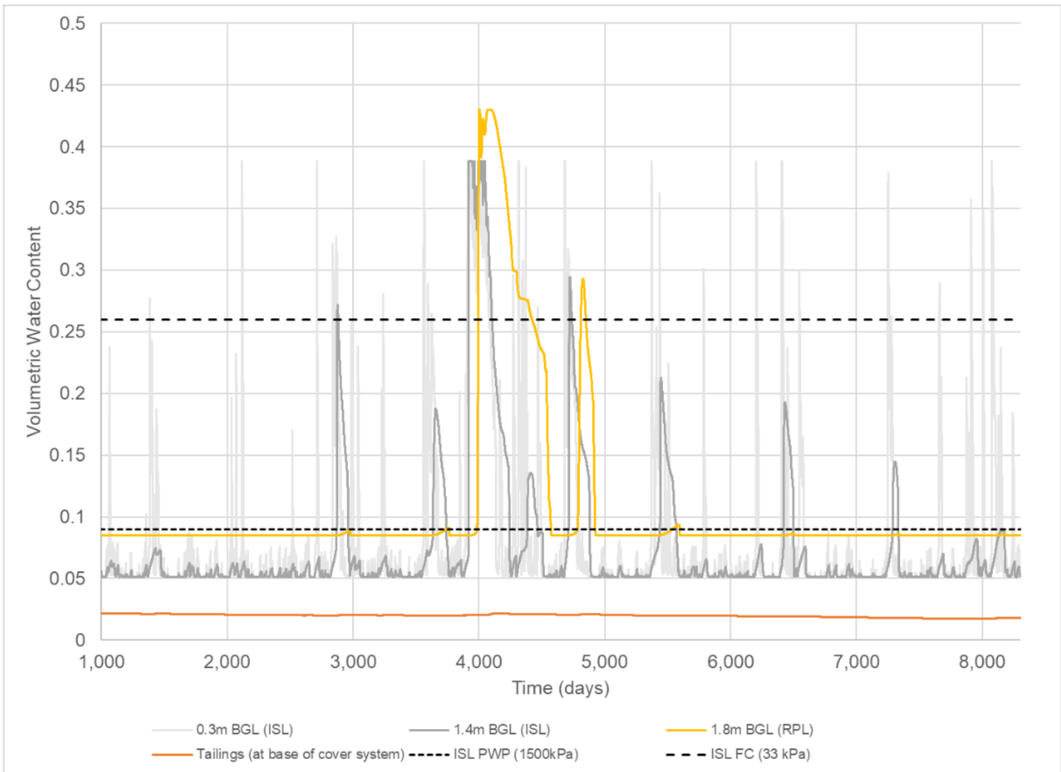

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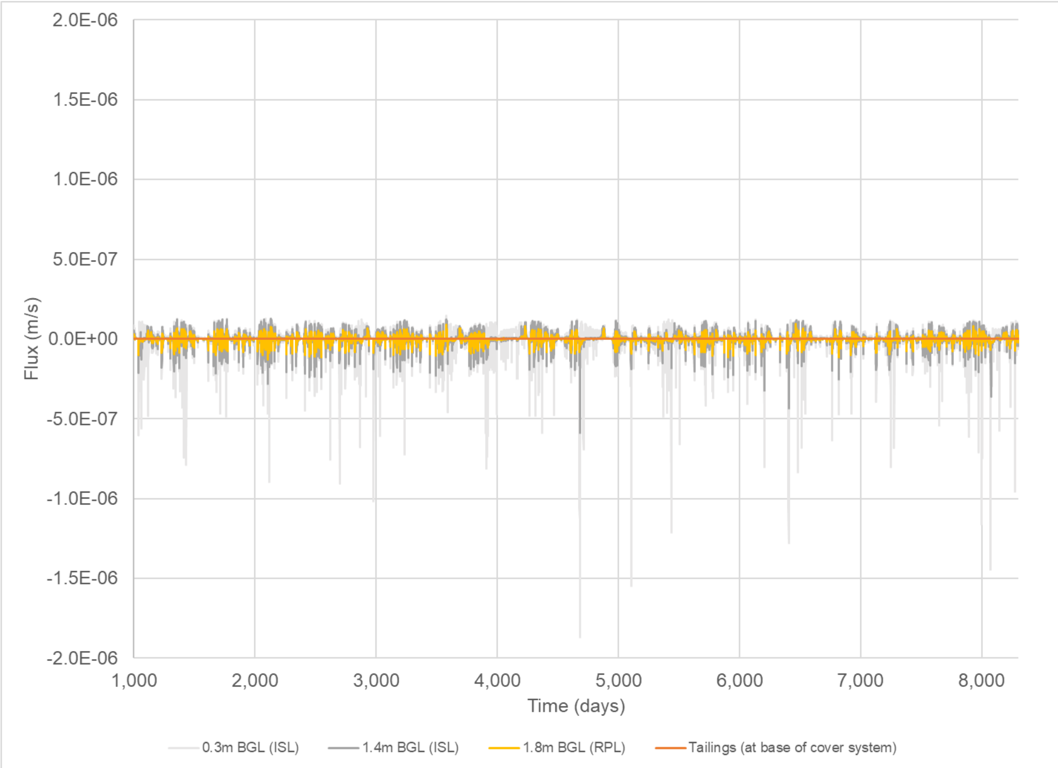
CHART 23: FLUX – OPTIMISED MODIFIED COVER D (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



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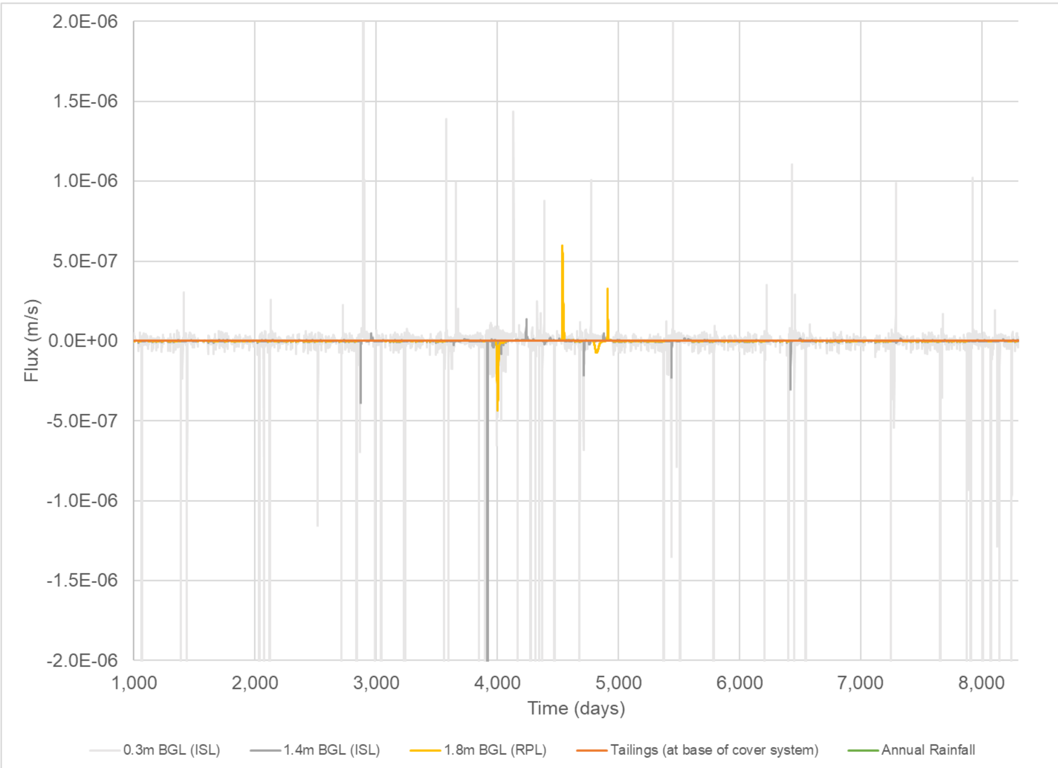
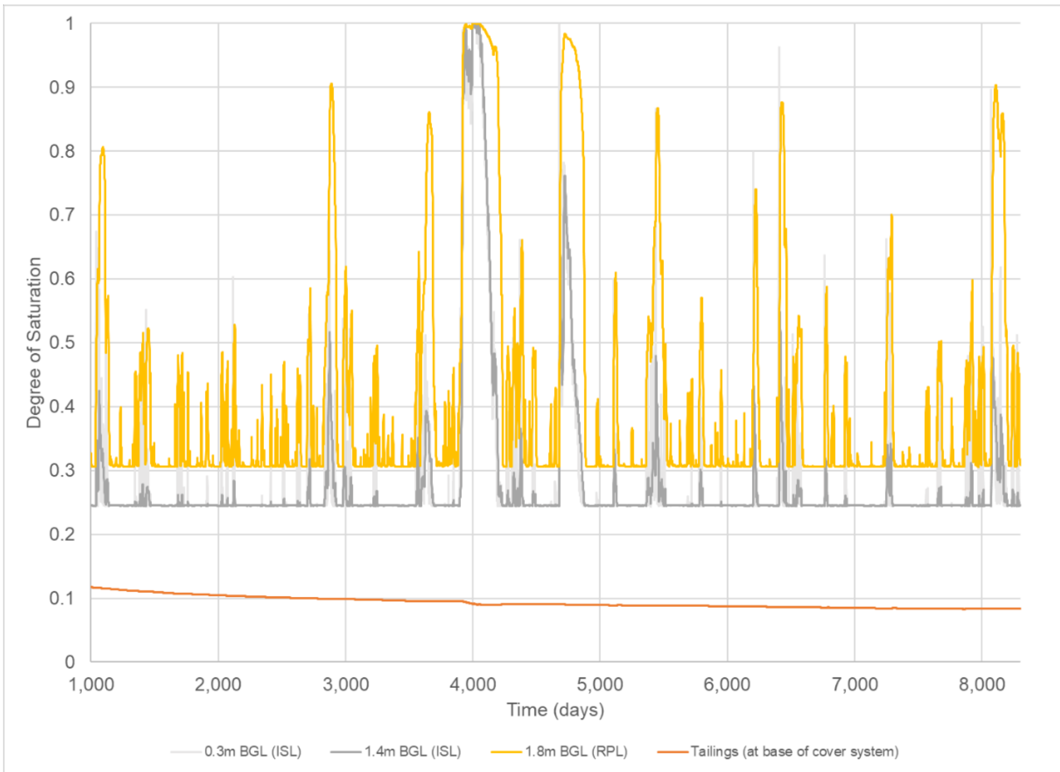


CHART 24: DEGREE OF SATURATION – OPTIMISED MODIFIED COVER D (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



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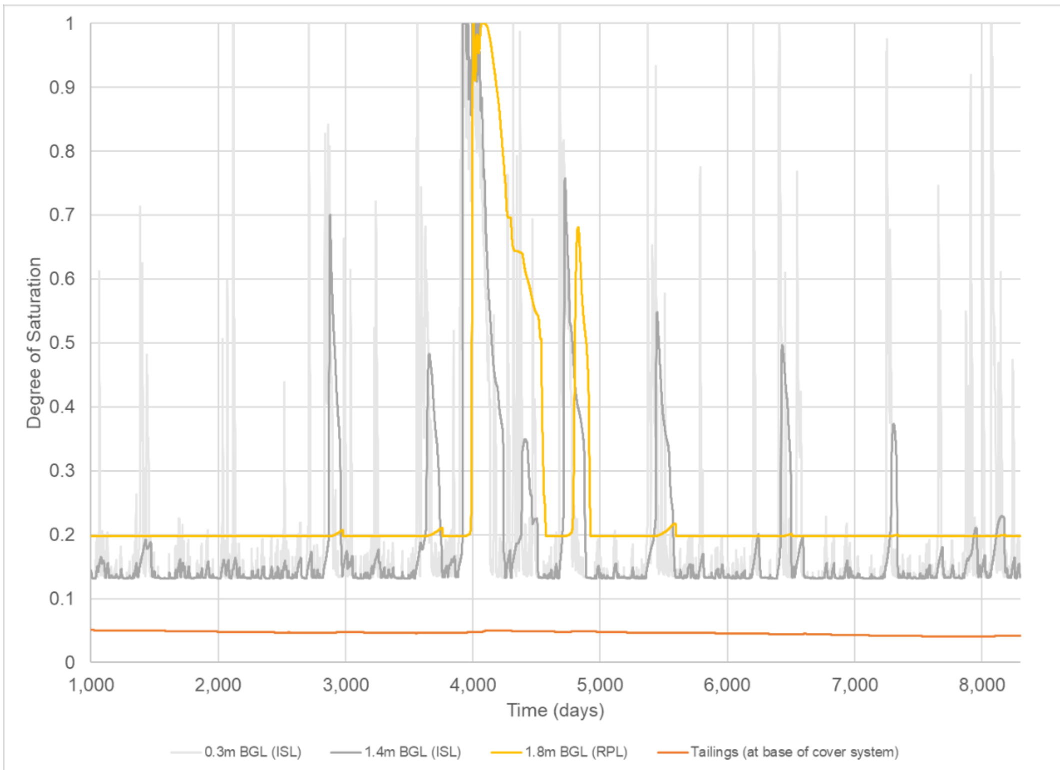
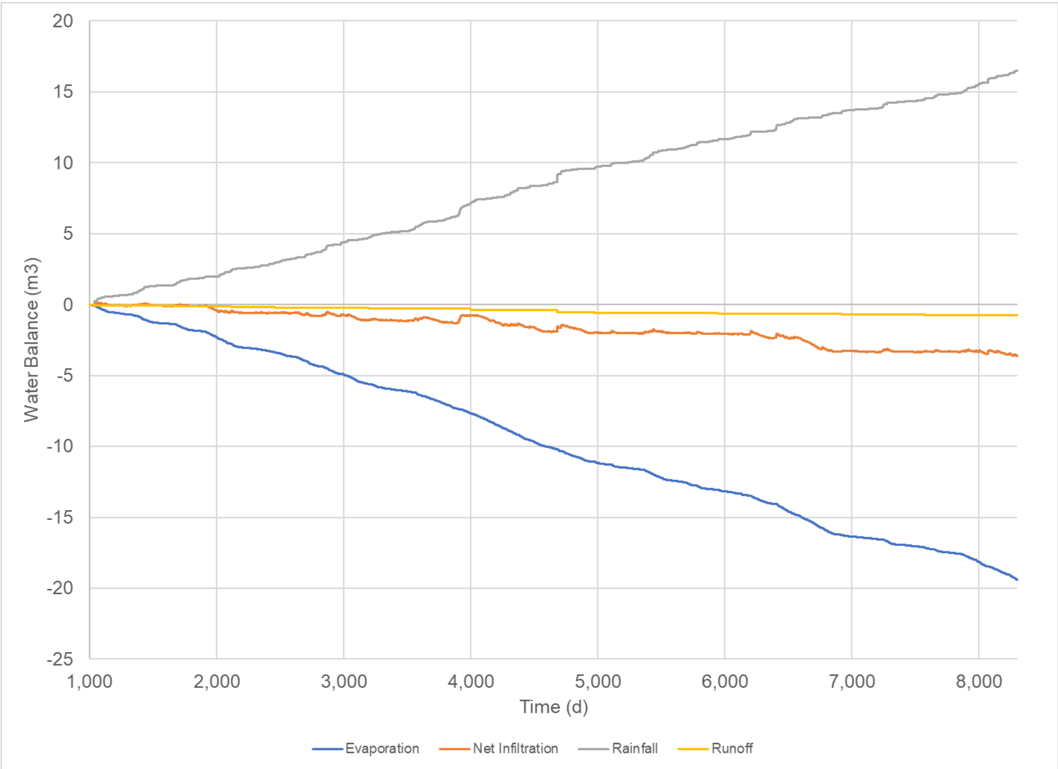
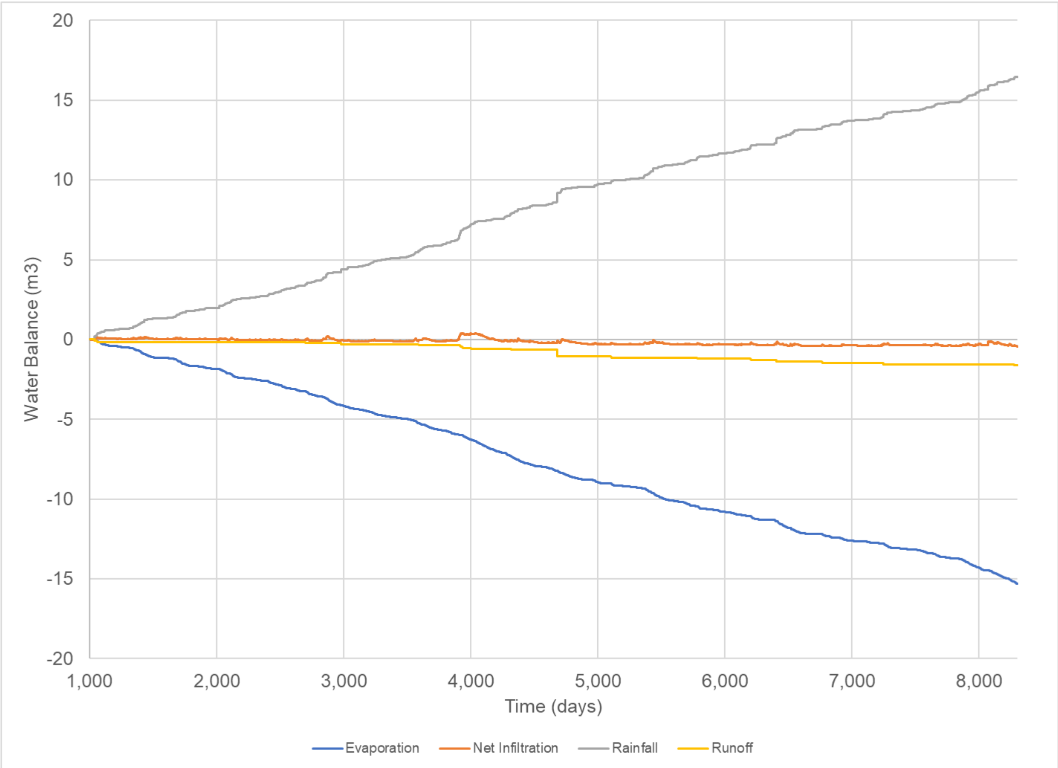


CHART 25: CUMULATIVE WATER BALANCE – COVER D +1M NAF WASTE ROCK (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



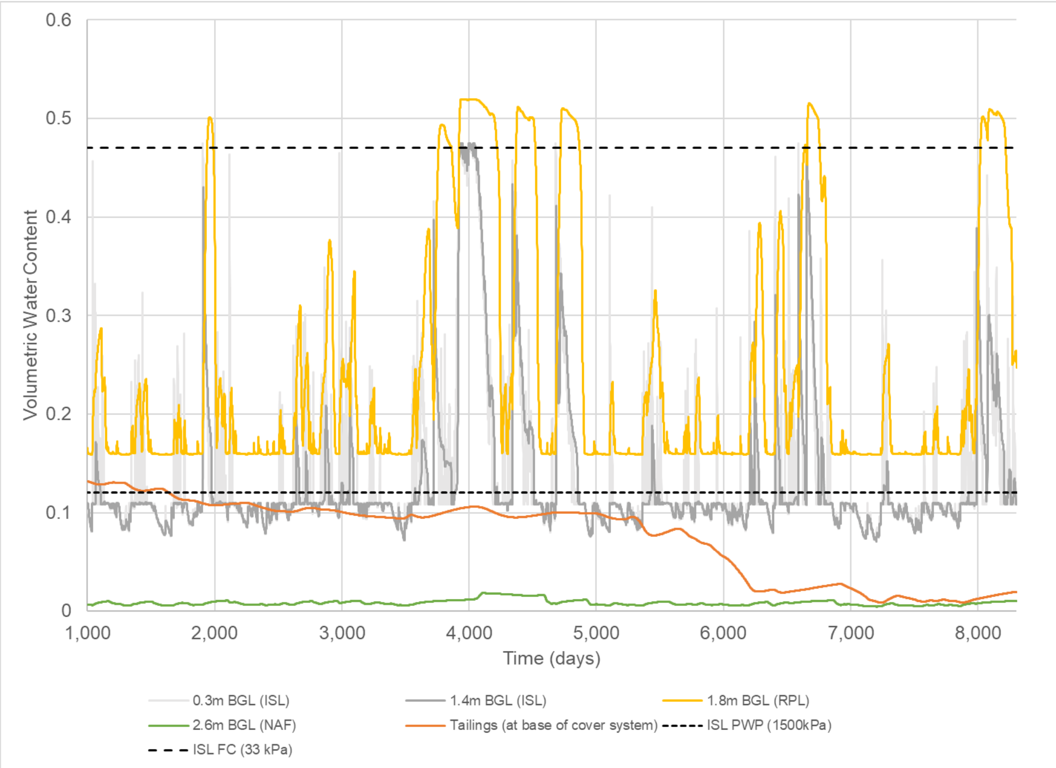
(B)



TAILINGS.WATER.WASTE.

CHART 26: VWC – COVER D +1M NAF WASTE ROCK (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



(B)

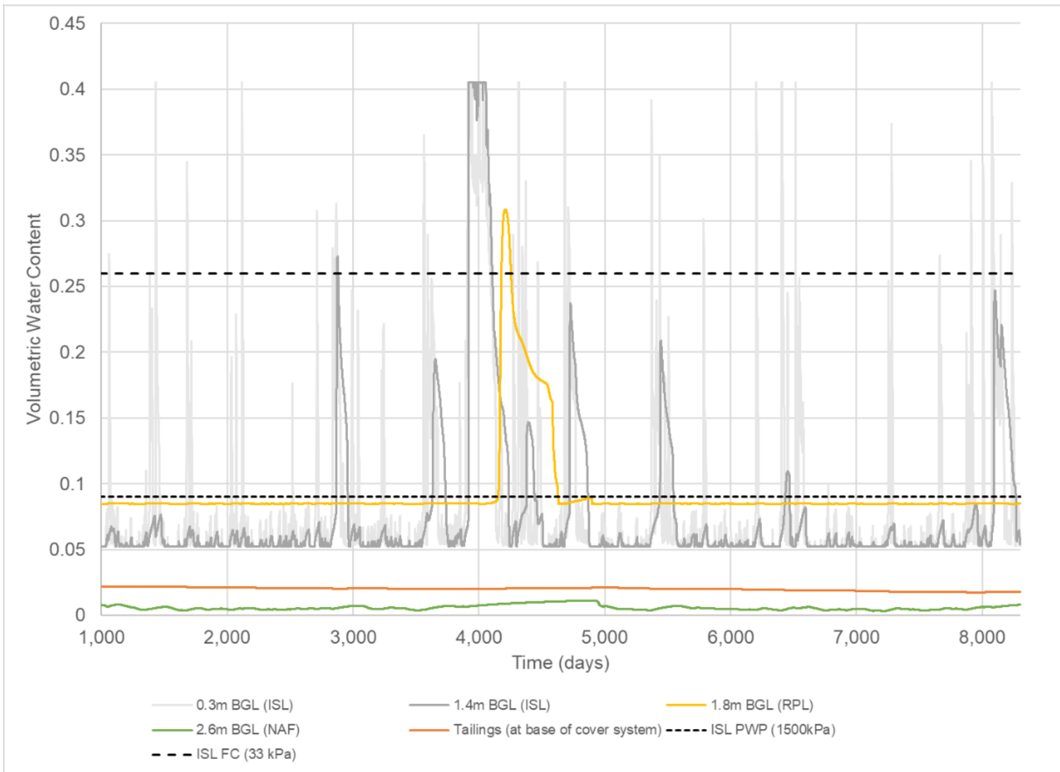
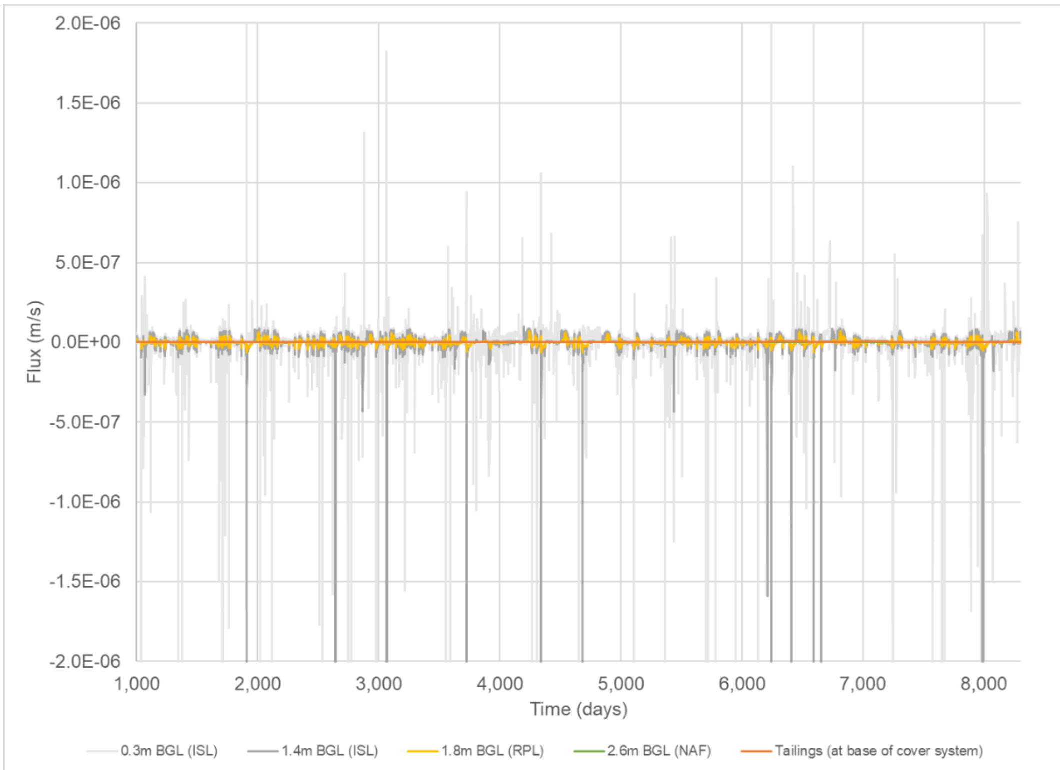


CHART 27: FLUX – COVER D +1M NAF WASTE ROCK (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



(B)

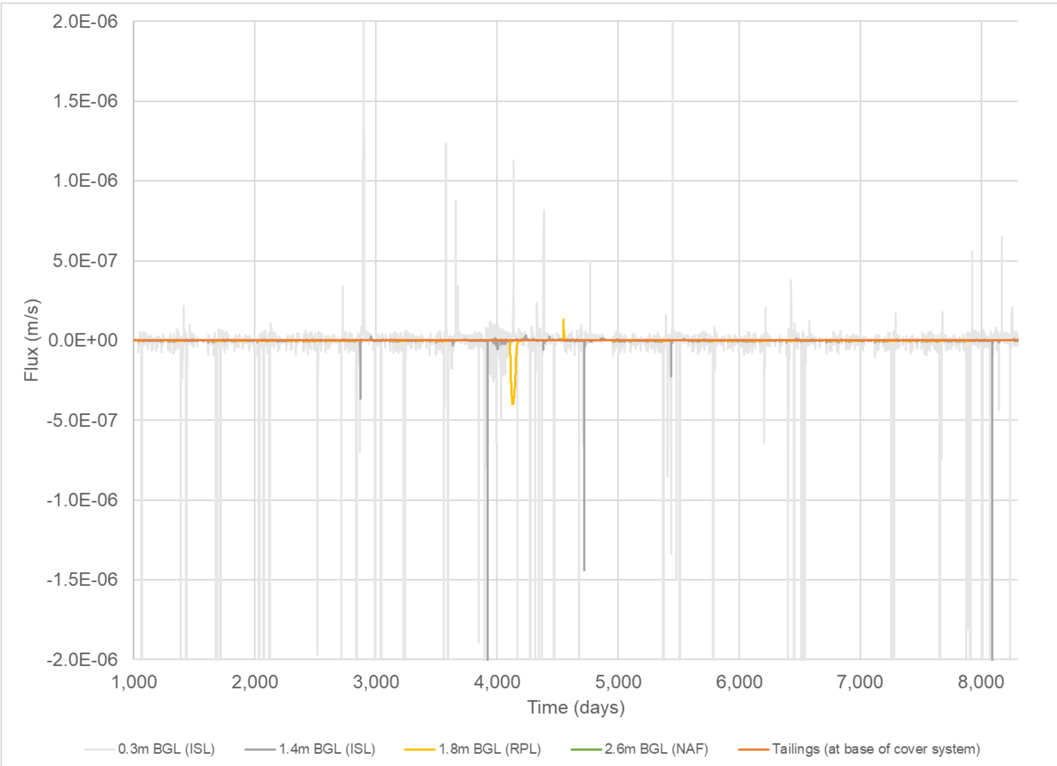
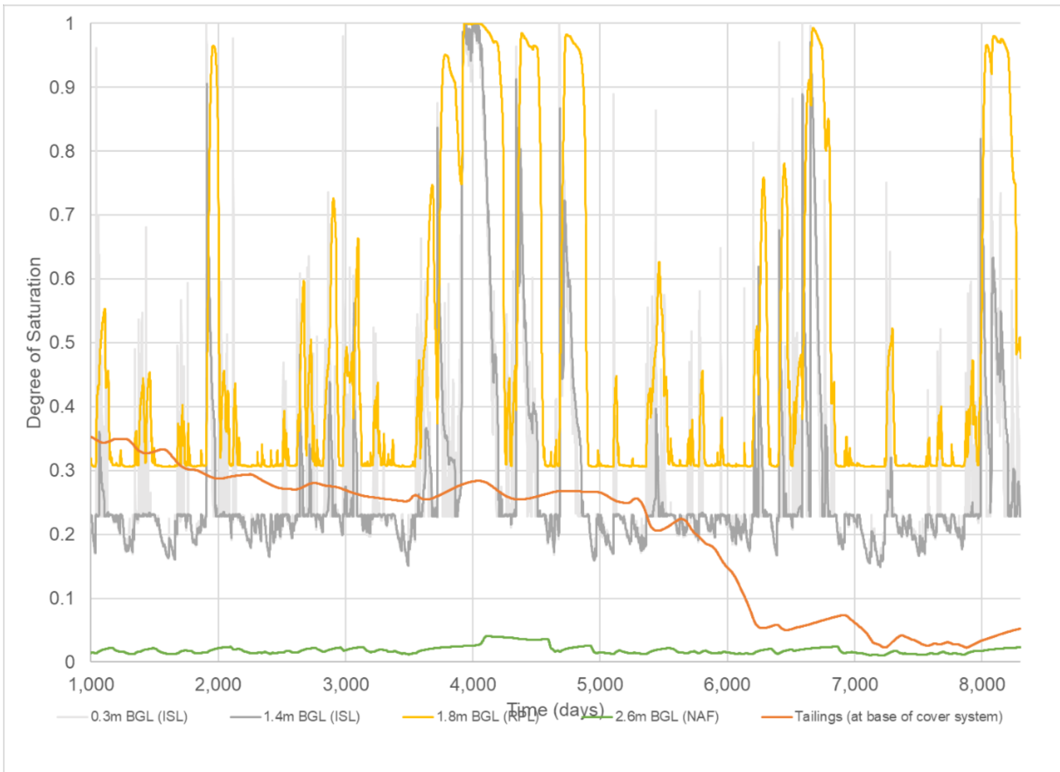


CHART 28: DEGREE OF SATURATION – COVER D +1M NAF WASTE ROCK (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



(B)

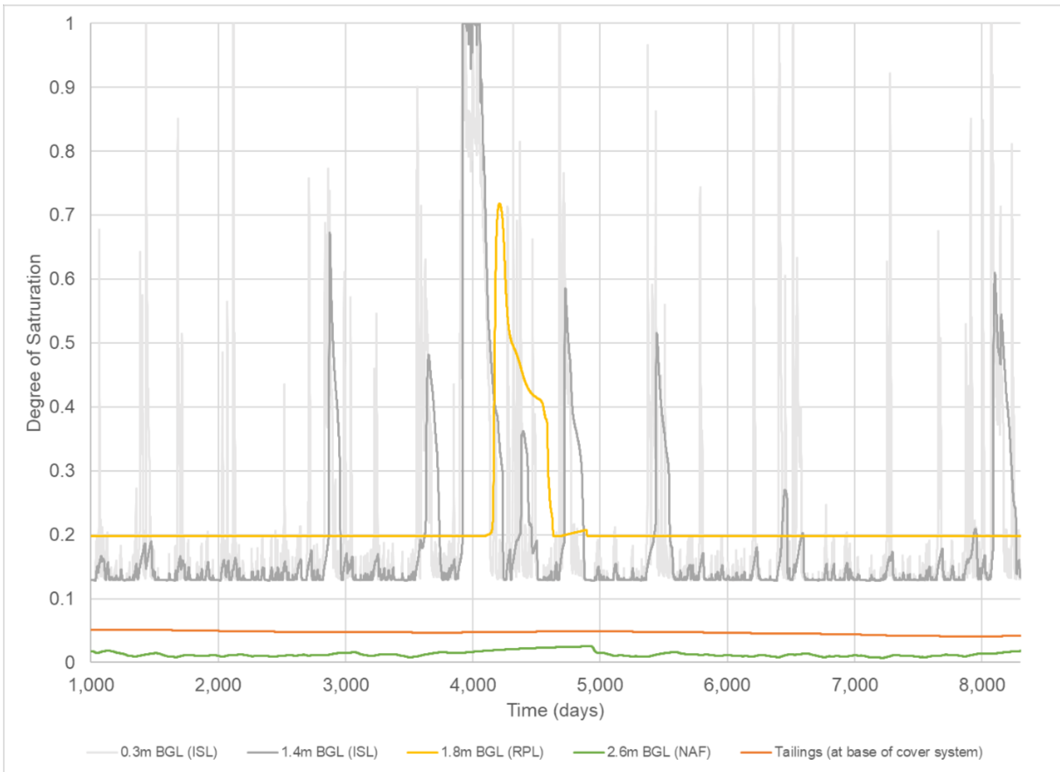
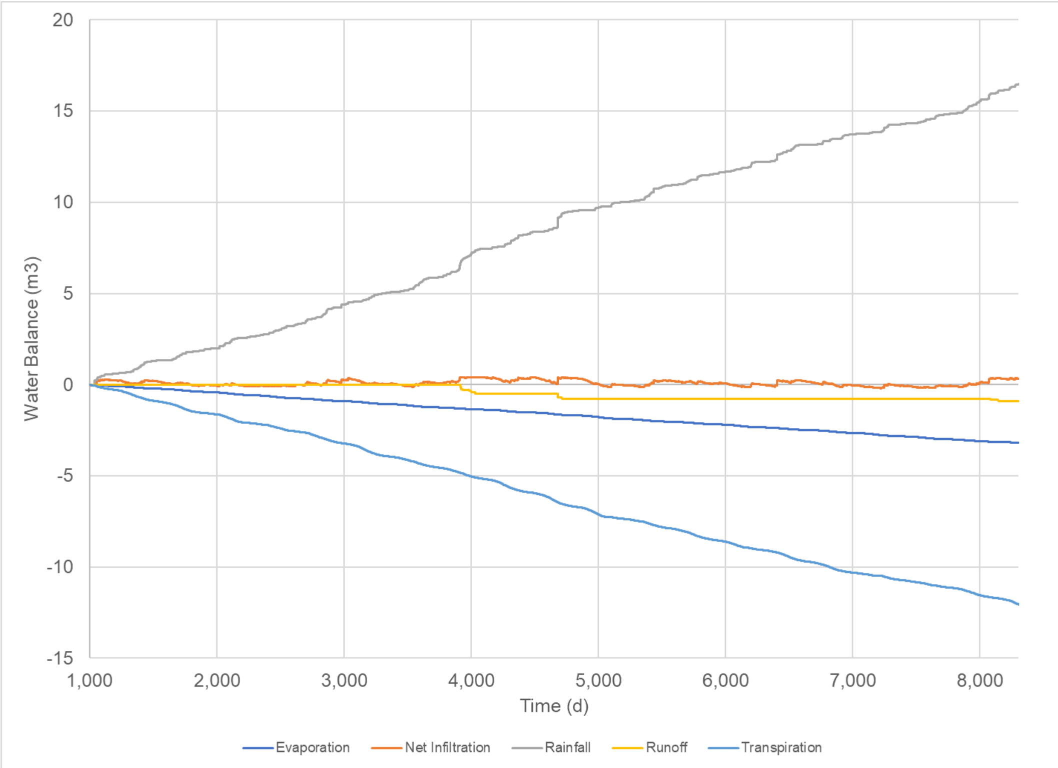


CHART 29: CUMULATIVE WATER BALANCE – COVER D +VEGETATION (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



(B)

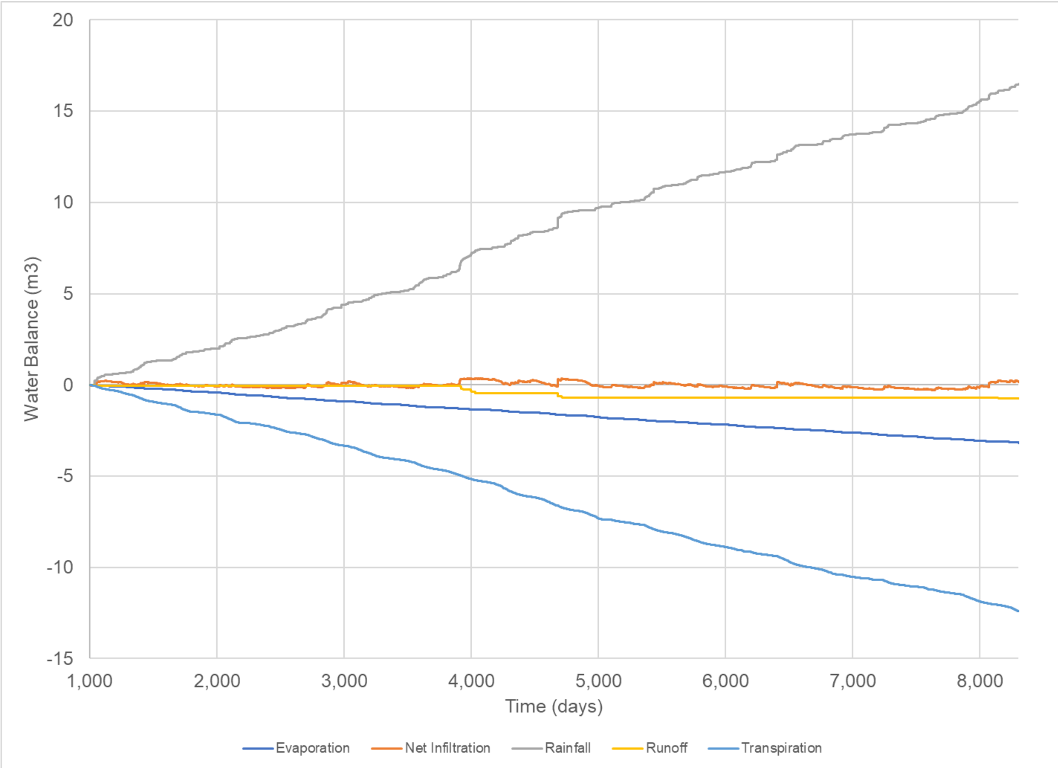
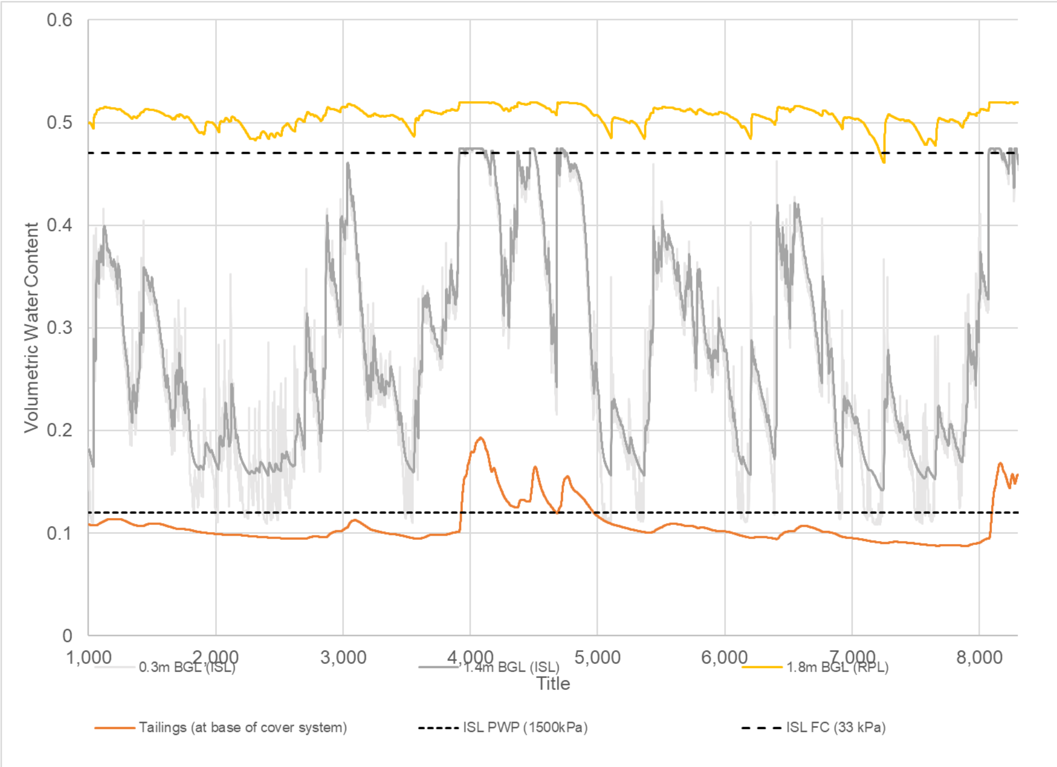


CHART 30: VWC – COVER D +VEGETATION (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

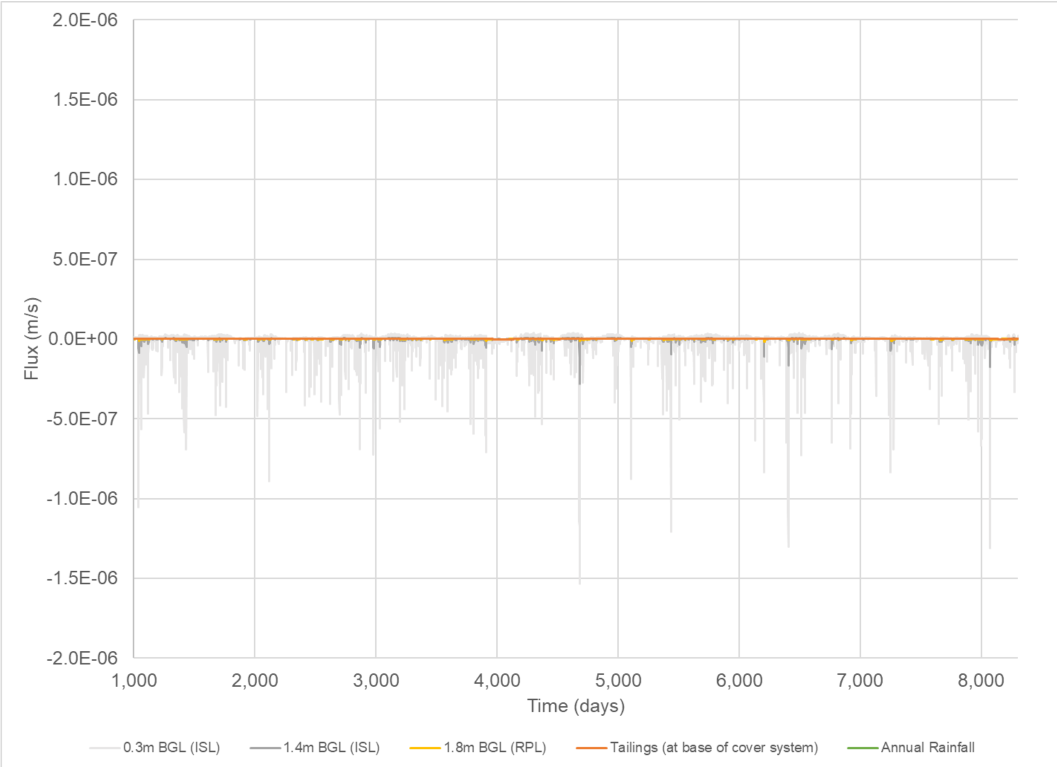
(A)



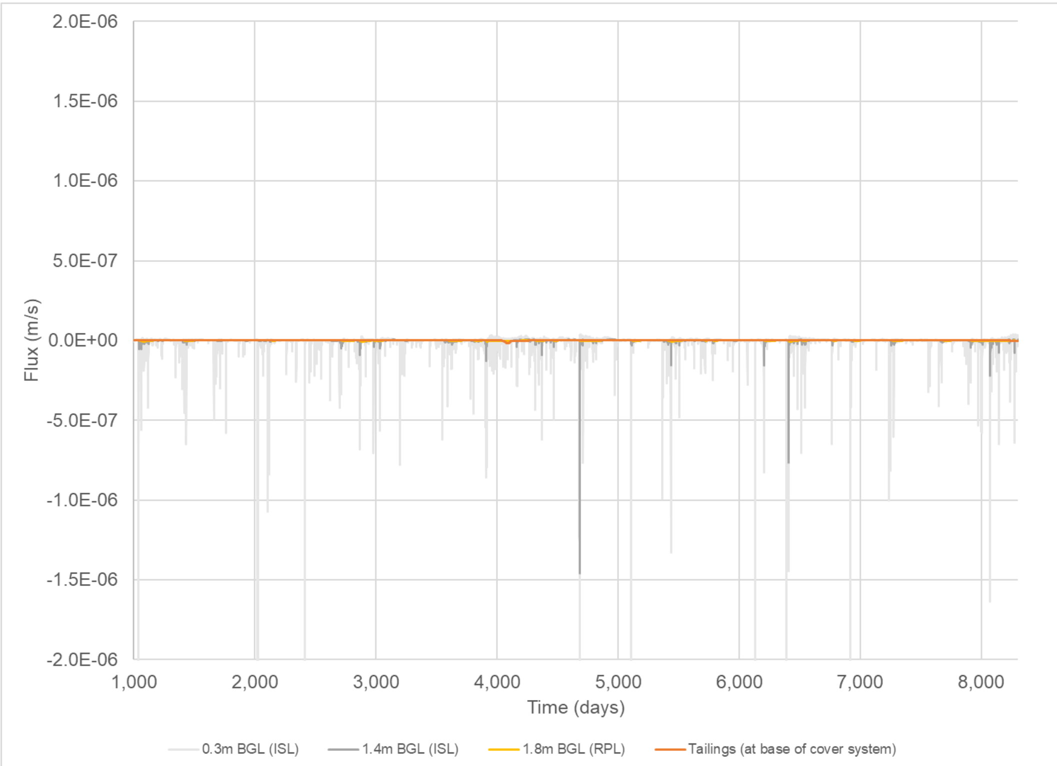
(B)

CHART 31: FLUX – COVER D +VEGETATION (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



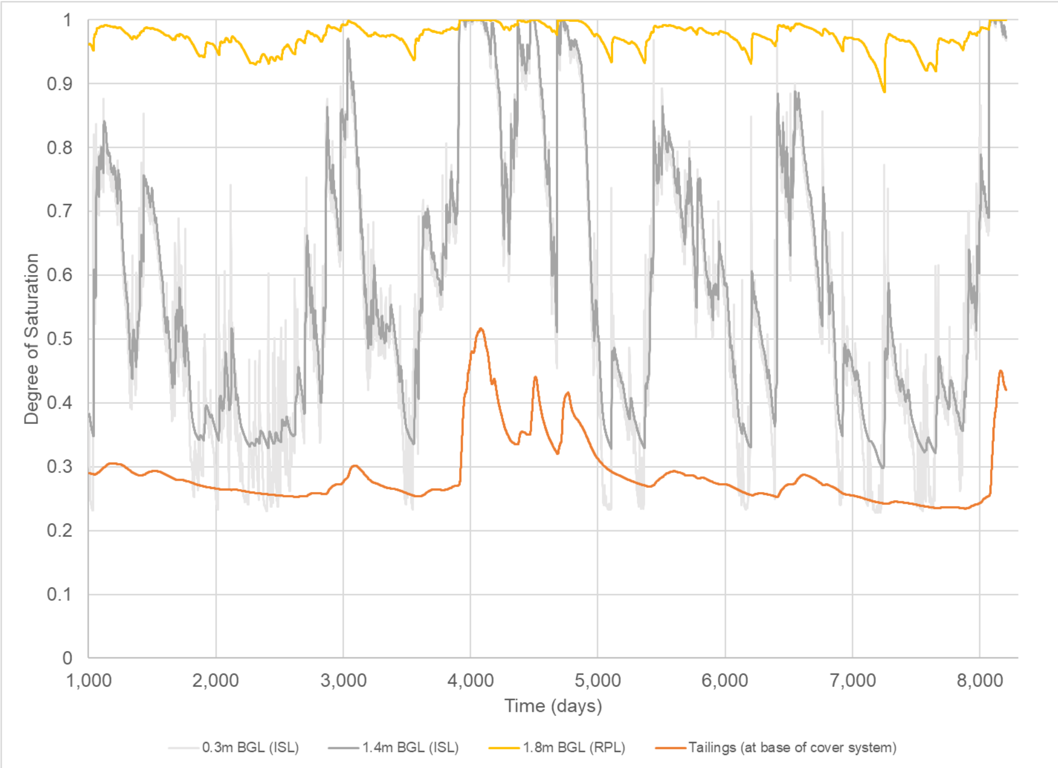
(B)



TAILINGS.WATER.WASTE.

CHART 32: DEGREE OF SATURATION – COVER D +VEGETATION (A) UPPER BOUND SWCC (B) LOWER BOUND SWCC

(A)



(B)