SARAJI EAST MINING LEASE PROJECT

Environmental Impact Statement

Appendix E-4

Subsidence Ponding Assessment

BHP Mitsubishi Alliance

ENGENY

BMA

Subsidence Ponding Assessment

Saraji East Mining Lease Project

M11000_542-REP-001

4 MAY 2023

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1.0. INTRODUCTION

This report has been prepared as part of the Supplementary Environmental Impact Statement (SEIS) for the Saraji East Mining Lease Project (the Project), a new underground mine on Mining Lease Application (MLA) 70383 which is proposed by BM Alliance Coal Operations Pty Ltd (BMA) on behalf of the Central Queensland Coal Associates (CQCA) Joint Venture.

As the underground mine is developed, the surface of the earth above the mine will subside. A physical effect of subsidence is the formation of ponding areas. Ponding areas are subsided areas that have potential to pond water.

The purpose of this report is to:

- Identify where ponding areas might form as a result of underground longwall mining (refer to Section 2.0).
- Determine the likely depth, surface area, volume, catchment area and overflow direction of each of the ponding areas (refer to Section 2.0).
- Describe the development and present the results of the GoldSim water balance model which was built to examine how the ponding areas (individually and as a collective) conservatively behave in regard to their ability to store water (refer to Section 3.0).

2.0. POTENTIAL FUTURE PONDING AREAS

2.1. Location

Topographical survey (LiDAR) of the Project area, the optimised mine plan and the predicted subsidence modelling (Minserve, 2022) has been used to identify potential future ponding areas within the Project area.

A total of 36 ponding areas have been identified, including three ponding areas within Hughes Creek.

The ponding areas will develop gradually over the life-of-mine. Two thirds (23) of the ponding areas will develop during the first decade of mining (Figure 2.1), while the remaining third (13) will develop during the second decade of mining (Figure 2.2).

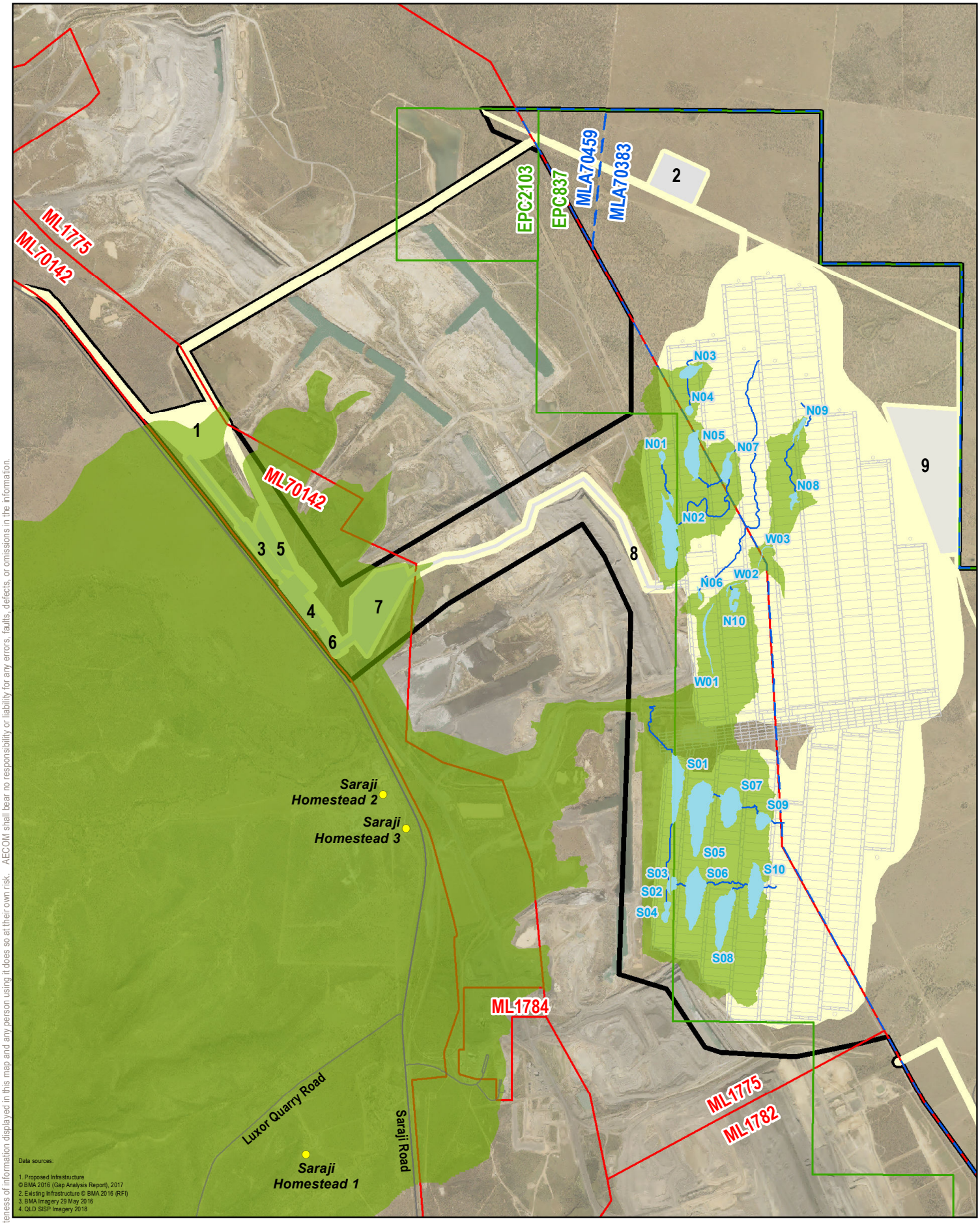
2.2. Catchment Areas and Overflow Directions

Topographical survey (LiDAR) of the Project area, the mine plan and the predicted subsidence modelling (Minserve, 2022) have also been used to determine catchment areas, and overflow points and directions for the each of the ponding areas.

The catchment areas for the ponding areas will develop over the life-of-mine. Figure 2.1 shows the catchment areas after the first decade of mining while Figure 2.2 shows the catchment areas after the second decade of mining. In both instances the catchment areas range in size from 3.1 ha (S03) to 17,348.8 ha (W01). However, the total catchment area reporting to the ponding areas after the first decade of mining is 18,211.7 ha while the total catchment reporting to the ponding areas after the second decade of mining is 18,581.5 ha (an increase of 369.8 ha).

Most of the ponding areas, but particularly the ponding areas to the south of Hughes Creek, overflow into one another along existing drainage channels. Ultimately, the ponds overflow into Plum Tree Creek, Hughes Creek and One Mile Creek.

The dominant land use type within the catchment areas for the purpose of the modelling is 'natural' (as opposed to 'disturbed') (Figure 2.3).



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LEGEND

- Project Site
- Project Footprint
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Surface Infrastructure
- Public Road
- Homestead
- Pond Overflow Destinations Year 10
- Pond Areas Year 10
- Pond Catchment Areas Year 10

Surface Infrastructure

1 Rail Loading Balloon Loop
2 Process Water Dam
3 Product Stockpiles
4 CHPP
5 Raw Water Dam
6 ROM Pad
7 Future MIA
8 Conveyor
9 Construction Accommodation Village

N

Figure 2.1
Potential Future Ponding Areas and their Catchments After 10 Years of Mining

Subsidence Management Plan
Saraji East Mining Lease Project

0 0.35 0.7 1.4
Kilometres

Scale: 1:59,840 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

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DATE: 20/07/2023 VERSION: 2

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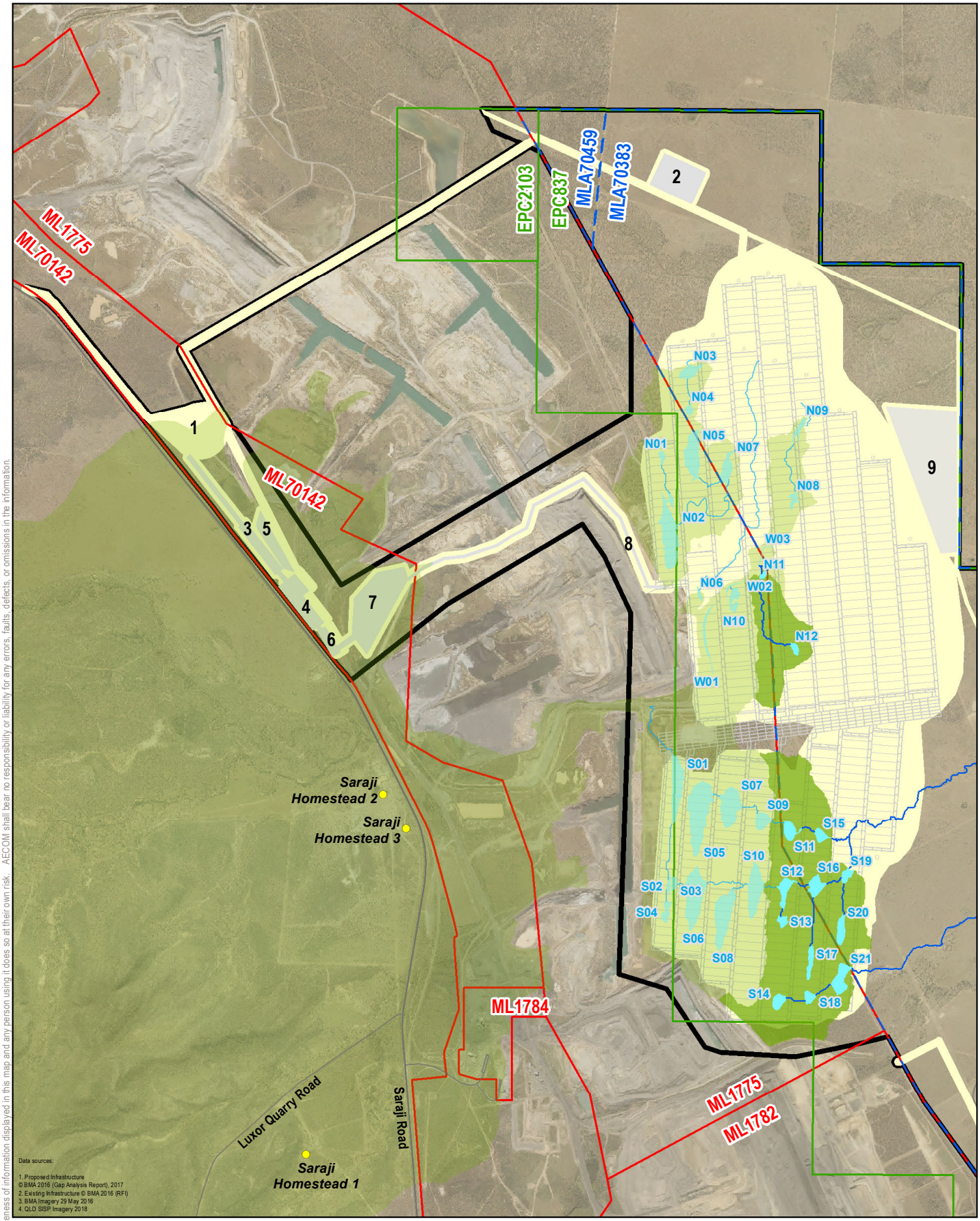

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Surface Infrastructure

1 Rail Loading Balloon Loop
2 Process Water Dam
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7 Future MIA
8 Conveyor
9 Construction Accommodation Village

N

Figure 2.2
Potential Future Ponding Areas and their Catchments After 20 Years of Mining

Subsidence Management Plan
Saraji East Mining Lease Project

0 0.35 0.7 1.4
Kilometres

Scale: 1:59,840 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

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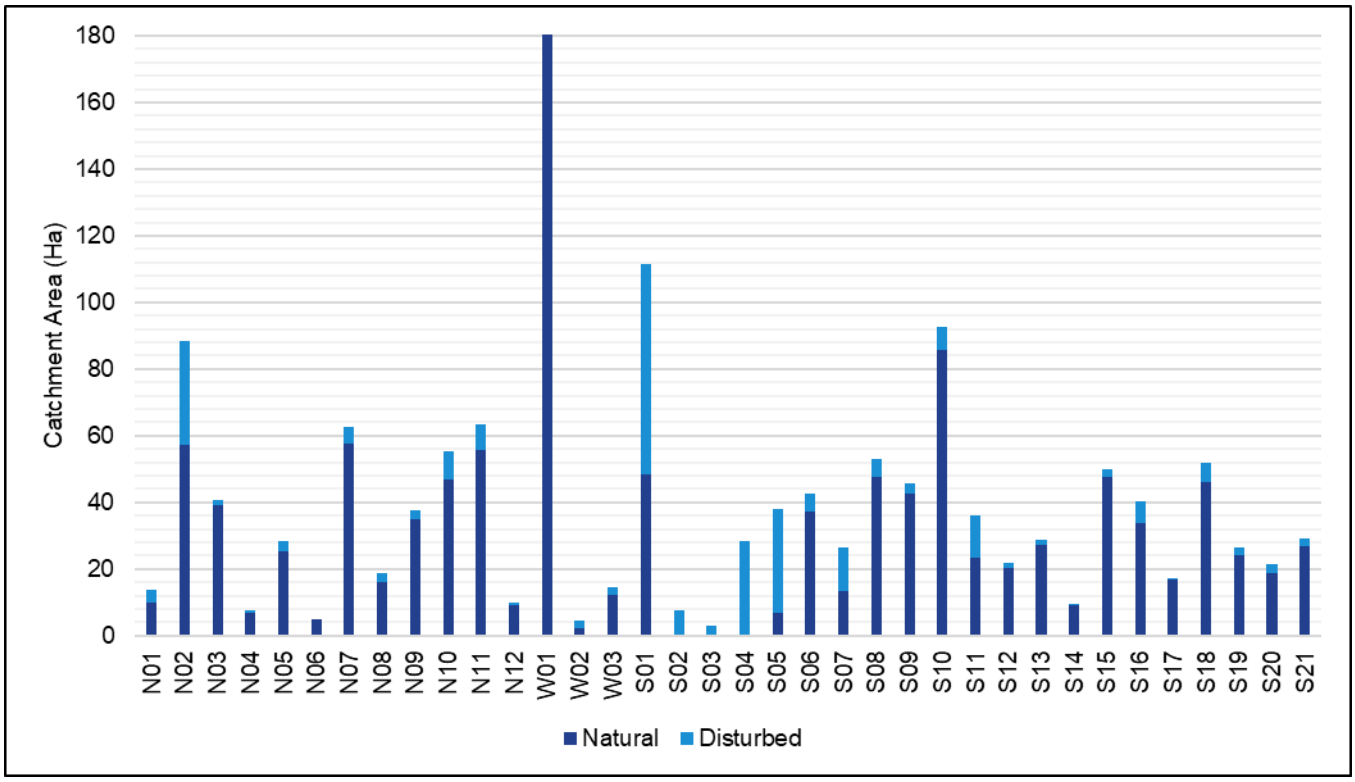

Figure 2.3: Graph of Catchment Areas for Ponding Areas After 20 Years of Mining

2.3. Depth, Surface Area and Volume

12D modelling software was used to determine depth-area-volume relationships for each of the potential future ponding areas (i.e. the subsided areas that have potential to pond water) within the Project area. The ponding areas are predicted to have:

- Maximum depths ranging from 0.3 m (N08) to 2.9 m (S05) (Figure 2.4).
- Maximum volumes ranging from 1.0 ML (N08) to 176.4 ML (S05) (Figure 2.5).
- A total cumulative maximum volume of 951.5 ML.
- Maximum surface areas ranging from 0.4 (W02) ha to 16.9 ha (S05) (Figure 2.6).
- A total cumulative maximum surface area of 138.7 ha.

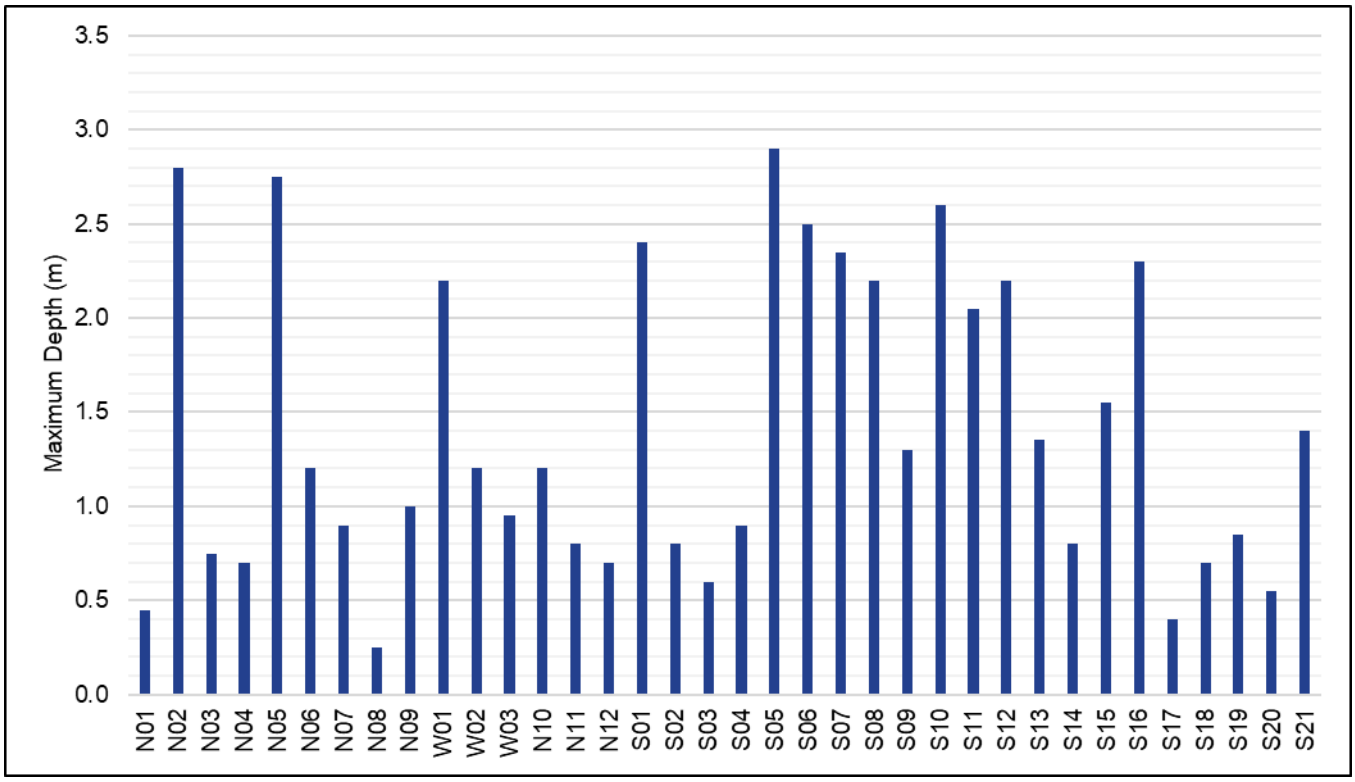

Figure 2.4: Maximum Depths of Ponding Areas

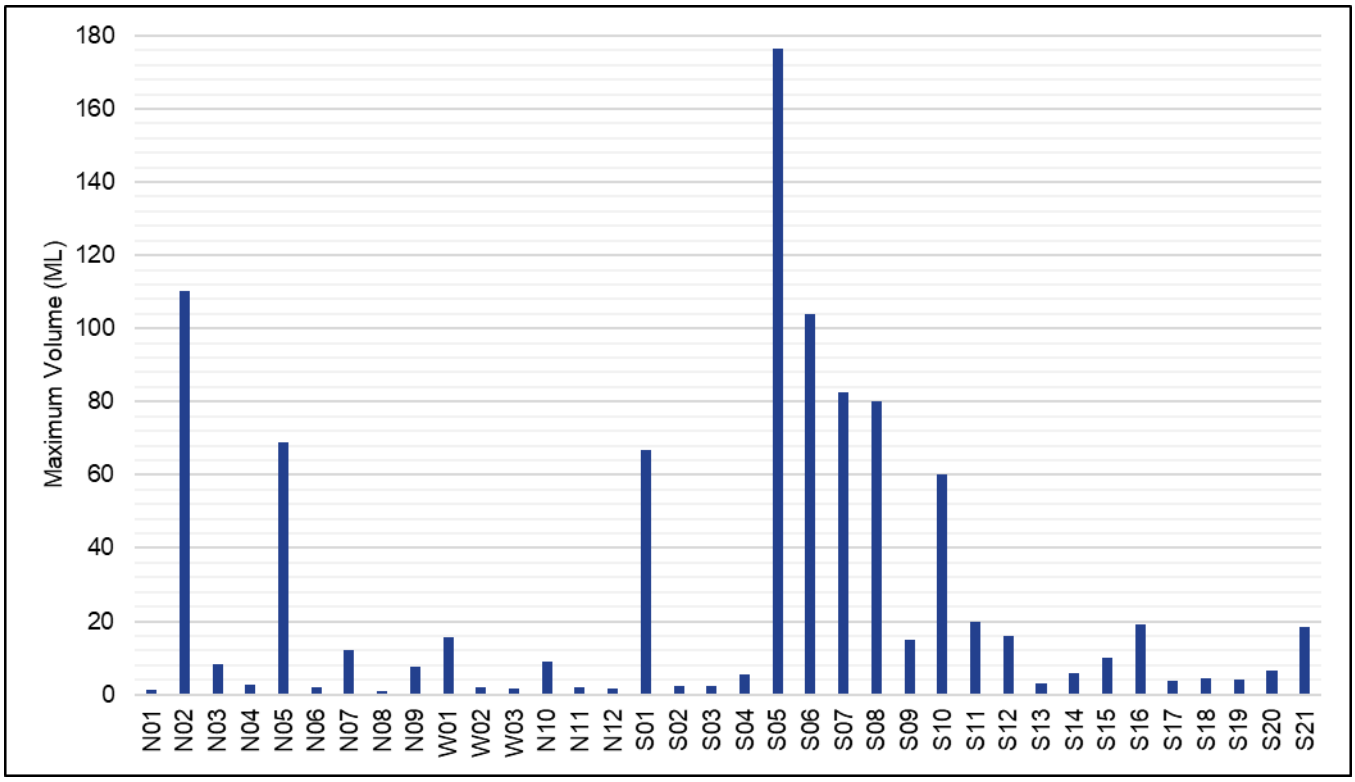

Figure 2.5: Maximum Volumes of Ponding Areas

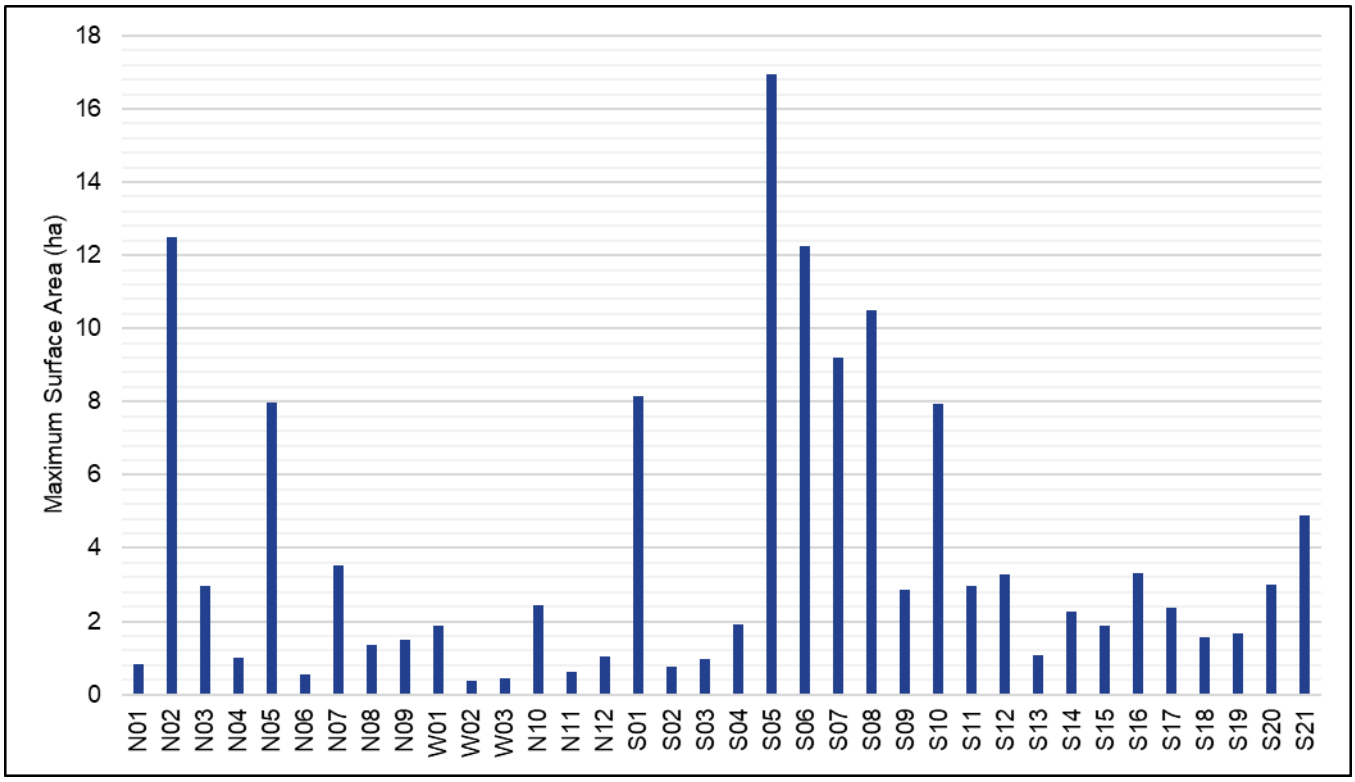

Figure 2.6: Maximum Surface Areas of Ponding Areas

3.0. WATER BALANCE MODELLING OF POTENTIAL FUTURE PONDING AREAS

3.1. Overview

A dynamic water balance model has been developed using GoldSim to simulate the daily quantity and salinity (i.e. Electrical Conductivity) of water flowing into, stored within and overflowing from the ponding areas. GoldSim is a Monte Carlo based software package that is commonly used in the mining industry for water balance modelling. The following sections describe the water balance model inputs, set up, assumptions, limitations and results.

Note that the water balance model described in the following sections is a separate model from the water balance model described in the Mine Water Balance Technical Report for the Project (AECOM, 2021). However, both of the models use some of the same input parameters (e.g. rainfall, evaporation and evapotranspiration, and Australian Water Balance Model (AWBM) parameters) for consistency.

3.2. Model Inputs

Key water balance model inputs and outputs are conceptualised in Figure 3.1 and include rainfall, evaporation, evapotranspiration, surface runoff, and seepage.

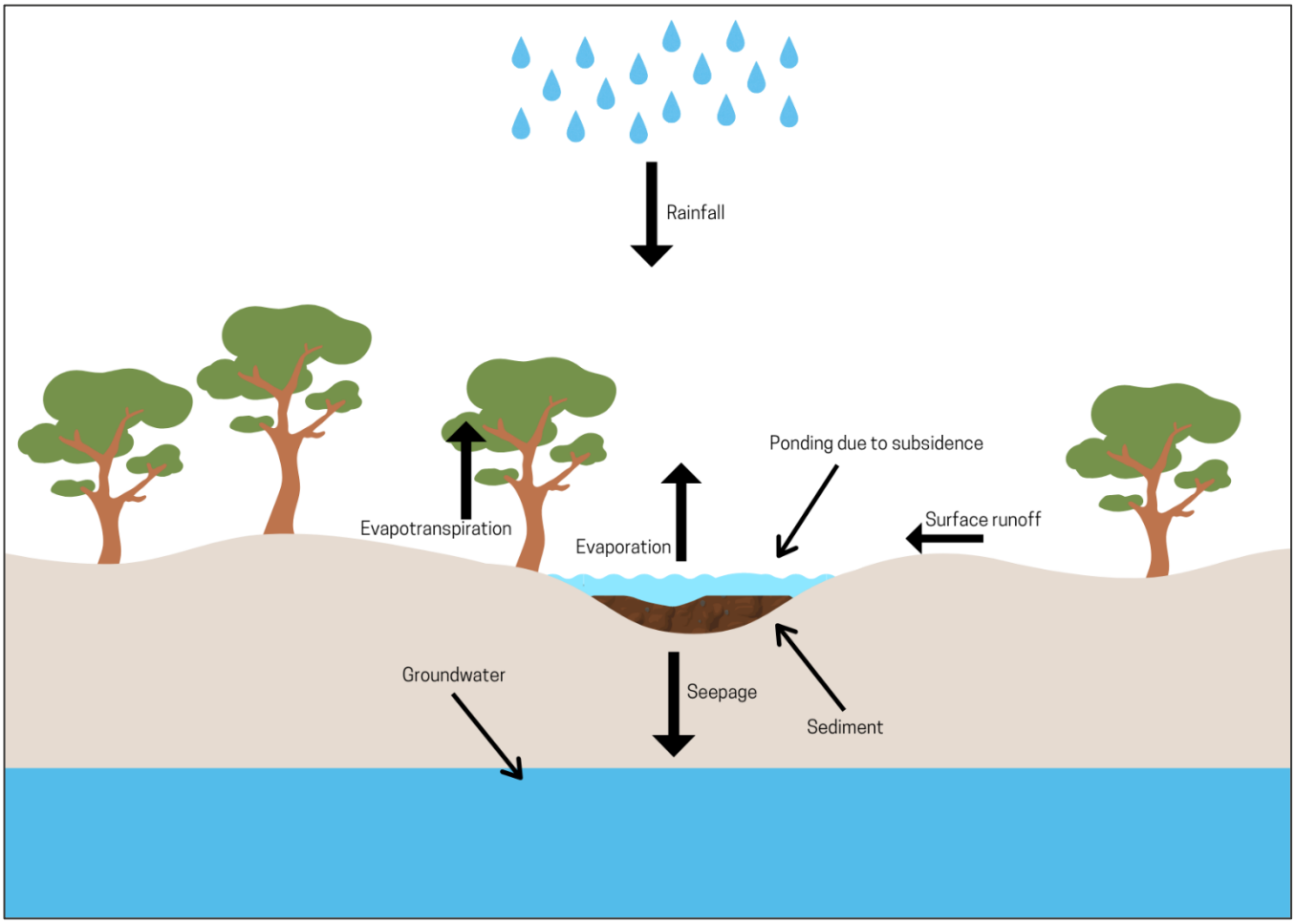

Figure 3.1: Conceptualisation of the Water Balance for a Ponding Area

3.2.1. Rainfall, Evaporation and Evapotranspiration

Rainfall and evaporation data for the water balance model has been obtained from the SILO database (Queensland Government, 2022), for the time period 1 January 1889 to 6 June 2022 (133 years) and for the coordinate (-22.35, 148.30) which is located within the Project area. The database commenced on 1 January 1998 and consists of gridded data that has been interpolated from Bureau of Meteorology weather stations.

Figure 3.2 is a summary of the 133 years' worth of rainfall data used in the water balance model. Mean annual rainfall is 580 mm/year, with approximately 60% of the mean annual rainfall (320 mm) occurring between December and March (inclusive).

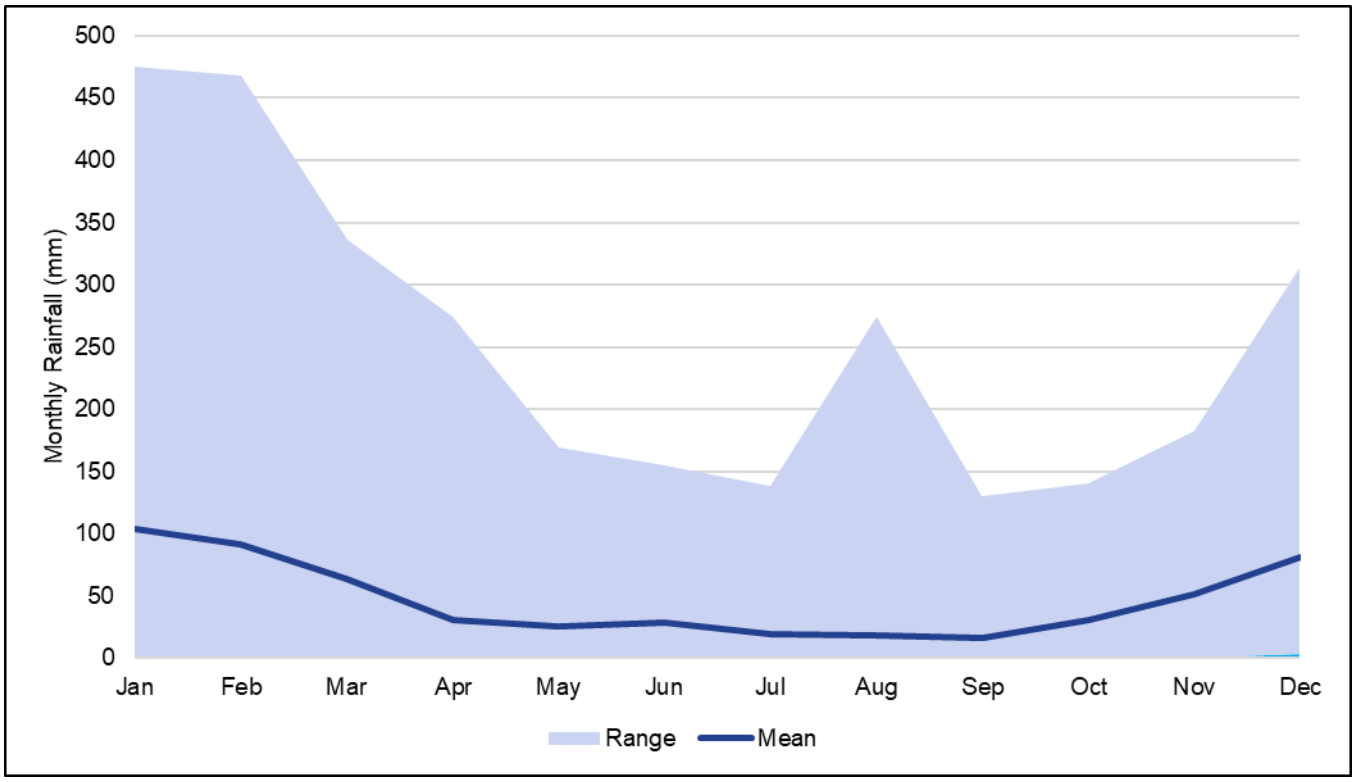

Figure 3.2: Monthly Rainfall (Sourced from SILO Data Drill for the Coordinate (-22.35, 148.30) Between 1889 and 2018)

Figure 3.3 is a summary of the 133 years' worth of evaporation data used in the water balance model. The evaporation data follows a similar trend to the rainfall data. Evaporation is highest between October and March (inclusive). Mean evaporation exceeds mean rainfall in every month of the year which is indicative of a strongly negative mean annual water balance.

For the purpose of the water balance model, evapotranspiration was assumed to be equal to 95% of evaporation.

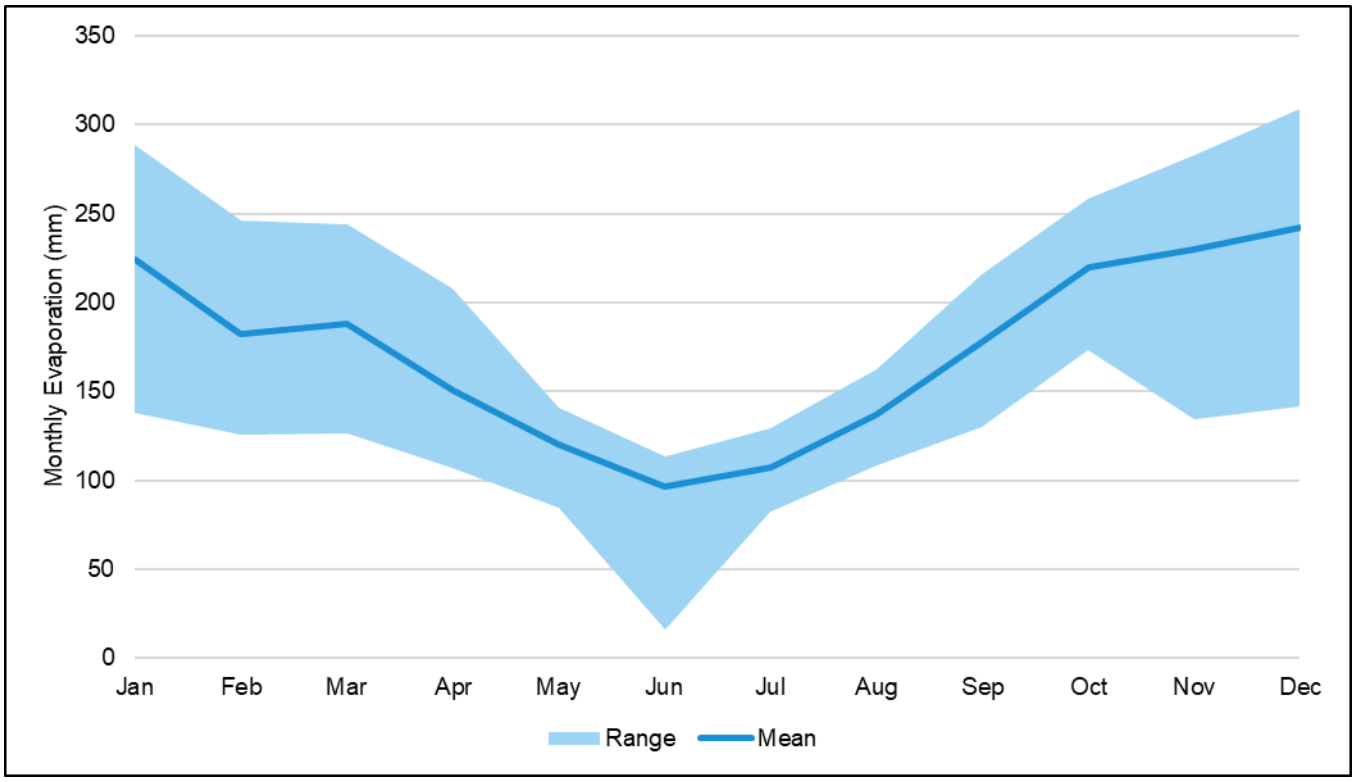

Figure 3.3: Monthly Rainfall Evaporation (SILO Data Drill for the Coordinate (-22.35, 148.30) Between 1970 and 2017)

3.2.2. Surface Runoff

The AWBM has been used to estimate surface runoff reporting to each of the ponding areas (Figure 3.4) in the water balance model. The AWBM represents the catchment of each ponding area as three surface stores. The water balance of each store is calculated at daily time steps, independent of the other stores. At each timestep, rainfall is added to the store while evapotranspiration is subtracted. If the value of water in the store exceeds the capacity of the store, the excess water becomes surface runoff. (If there is a base flow component to stream flow, which is considered not applicable to the ponding areas, part of this surface runoff is used to recharge the base flow store.).

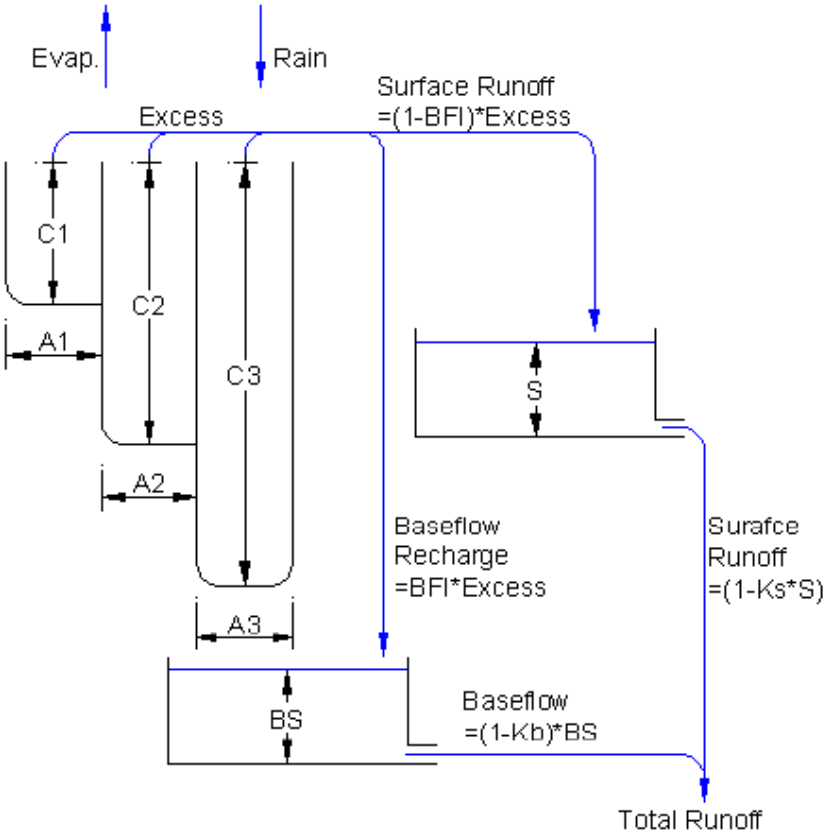

Figure 3.4: AWBM Schematic

The AWBM parameters that have been adopted for the water balance model are listed in Table 3.1. They are sourced from the existing BHP Saraji Mine GoldSim water balance model (BHP, 2022), which is considered representative for the Project area, and are specific to natural and disturbed land use types.

Table 3.1: Adopted AWBM Parameters

AWBM Parameter	Description	Land Use Type - Natural	Land Use Type – Disturbed
A1	Partial area	0.134	0.134
A2	Partial area	0.433	0.433
A3	Partial area	0.433	0.433
C1	Surface storage capacity	10mm	10mm
C2	Surface storage capacity	50mm	50mm
C3	Surface storage capacity	200mm	100mm
BFI	Base Flow Index	0.35	0.1

AWBM Parameter	Description	Land Use Type - Natural	Land Use Type – Disturbed
K_b	Base flow recession constant	0.7	0.7
K_s	Surface flow recession constant	0.1	0.1

3.2.3. Rainfall and Runoff Water Quality

The Total Dissolved Solids (TDS) concentrations for rainfall and surface runoff that have been adopted for the water balance model are listed in Table 3.2. They are sourced from the existing BHP Saraji Mine GoldSim water balance model (BHP, 2022). TDS is converted to Electrical Conductivity (EC) in the water balance model using a conversion factor of 0.67 TDS/EC (Australian Government National Health and Medical Research Council, 2011).

Table 3.2: Adopted Rainfall and Runoff Water Quality

Rainfall/Runoff	Adopted TDS (mg/L)	EC Equivalent (µS/cm)
Rainfall	30	45
Runoff – Natural Land Use Type	201	300
Runoff – Disturbed Land Use Type	335	500

3.2.4. Seepage

In the absence of any reliable estimates of the rate of seepage from the ponding areas into the surrounding soil, seepage has been assumed to be negligible (i.e. 0 mm/day) for the purpose of the water balance model. This means that the modelled volumes, overflow frequency and duration of inundation calculated by the model will be conservative (Refer to Section 3.3).

3.3. Model Set Up, Assumptions and Limitations

The GoldSim water balance model uses the rainfall, evaporation, evapotranspiration, surface runoff and seepage inputs described in Section 3.2, as well as the ponding area catchments, overflow directions and depth-area-volume relationships described in Section 1.0, to simulate the daily quantity and salinity (i.e. EC) of water flowing into, stored within and overflowing from the ponding areas.

The water balance model can be run for a maximum of 133 years which is the time period of the historical rainfall and evaporation data inputted into the model.

The following assumptions and limitations apply to the water balance model (in addition to any assumptions and limitations mentioned in Section 3.2):

- The water balance model is based on 133 years of historical rainfall and evaporation data from within the Project area which is assumed to be representative of future rainfall and evaporation rates within the Project area:
  - The water balance model does not consider climate change. Climate change has the potential to increase the severity of rainfall events and/or prolong the duration of dry periods. However it is considered unlikely that these increases will significantly change the risks associated with ponding (as discussed in the SMP) or the proposed controls.
  - Note that the water balance model described in the Mine Water Balance Technical Report for the Project (AECOM, 2021) does consider climate change. This report should be consulted for further information on potential climate change impacts on / as a result of the Project.

- The water balance model has been set to start running in October (i.e. just prior to the onset of the wet season).
- The initial volume of water stored in each of the ponding areas has been set to 0 ML.
- The water balance model does not account for flooding influences:
  - During flood events there may be the potential for land-based ponds (i.e. those not directly located within waterways) to receive inflows of flood waters from local waterways.
  - This would act to increase the volume and decrease the salinity of water stored within the land-based ponds. The modelling does not account for this increased flushing and is therefore conservative in the overflow and water quality results.
- The water balance model does not account for sediment infilling (i.e. accretion):
  - Over time the ponding areas will gradually fill with sediment settled out of the stored water.
  - This would act to decrease the storage volume of the ponding areas.
  - It is expected to take hundreds of years, if not more, for the land-based ponding areas to completely fill with sediment dependent on their volumes and catchments.
  - The waterway ponding areas however are expected to fill with sediment much faster than the land-based ponding areas (i.e. within the life of mine) due to the waterway ponding areas having a much larger upstream catchment area, and therefore the potential for larger and more frequent sediment loads to be transported into the waterway ponding areas. The modelling does not account for this infilling and is therefore conservative in the overflow, water quality and water take results.
- The existing mine or farm dams within the ponding area catchments are not fully represented in the model:
  - For example, the existing turkeys nest dam within the N02 catchment is not represented in the model.
  - Existing dams that are located within the ponding areas (e.g. the existing dams within the N05, N09, S05 and S07 ponding areas) are partially represented in the depth-area-volume relationships for these ponding areas. This is because the predicted subsidence modelling surface incorporates the water level/volume of the dams at the time the LiDAR was captured and does not represent maximum depths (i.e. empty) storages.

The water balance model has been based on the best available data, including site-specific AWBM parameters, and has been quality checked/reviewed by principal engineers. However, there are some limitations that can influence the accuracy of the results. As discussed in Section 3.2.4, seepage has been conservatively assumed as negligible until more data can be collected to verify seepage rates. This assumption may overestimate the modelled volumes and overflow frequencies of the ponds, and the model results are therefore considered conservative. This assumption can be refined through collection of water level information during operations to perform calibrations of the modelling and infer the influence of infiltration. It also supports the need for further case-by-case assessments of the ponds during operations using the refined model parameters.

3.4. Results

3.4.1. Typical Ponding Area Behaviour

Three ponding areas (N07, S19 and W03), were chosen to demonstrate the typical behaviour of the ponding areas. These ponding areas were chosen because:

- N07 – Land-based ponding area located to the north of Hughes Creek and receives overflows from multiple ponding areas.
- S05 – Land-based ponding area located to the south of Hughes Creek and has the largest maximum depth, volume and surface area of all of the ponding areas.
- S19 – Land-based ponding area located to the south of Hughes Creek and receives overflows from the highest number of ponding areas.
- W03 – Waterway ponding area that is furthest downstream on Hughes Creek and also receives overflows from multiple ponding areas.

Figure 3.5, Figure 3.6, Figure 3.7 and Figure 3.8 show how the volume and salinity (i.e. EC) of water stored in ponding areas N07, S05, S19 and W03 is expected to fluctuate over a 20 year period (7,305 days). This was done by running the model for the first 20 years of its maximum runtime of 133 years. The historical rainfall and evaporation data for this first 20 years includes a combination of wet and dry years, including consecutive wet/dry years.

Key observations based on the modelled scenarios for these ponds include:

- Over the 20 year period, the ponding areas repeatedly fill and empty.
- N07 contains water 70% of the time, S05 contains water 74% of the time, S19 contains water 56% of the time and W03 contains water 89% of the time. Durations and volumes of ponding are conservative due to the assumption of negligible seepage.
- N07 was modelled as overflowing 22 times, S05 does not overflow, W03 overflows 108 times and S19 overflows 28 times. Overflow frequencies are conservative due to the assumption of negligible seepage.
- There is a clear inverse relationship between volume and EC.
- In general, EC declines to relatively fresh levels (i.e. EC < 1,500 µS/cm, which is well below the level at which adverse effects on livestock (beef cattle) may occur) whenever the ponding areas experience a significant filling event (i.e. when the volume of stored water exceeds approximately 15% of the maximum volume).
- S05 does not experience significant filling events as frequently as S05, W03 and S19, most likely due to its large maximum volume and moderate external catchment area. Consequently, the EC of S05 is modelled as exceeding >10,000 µS/cm for the majority of the 20 year period.
- The EC of the land-based ponding areas trends upwards when there is consecutive years without significant filling events (i.e. dry years), indicative of evapo-concentration of salts within the ponding areas. 2 – 3 consecutive years with significant filling events (i.e. wet years) are required to return the EC to the levels experienced prior to the dry years.
- Generally the modelling indicates that the runoff into the ponds, overflows and flushing of salts is sufficient to avoid an accumulation of salts in the long term. However some ponds (e.g. S05) were modelled as maintaining high salinities for longer durations.

It should be noted that:

- Although the expected volume and EC of water stored in ponding area W03 has been presented over a 20 year period, the three waterway ponding areas (W01, W02 and W03) are not expected to be in-situ for this long. As stated in Section 3.3, over the life-of-mine the waterway ponding areas are expected to partially/completely infill with sediment.
- The "Livestock Drinking EC Limit" of 7,462 µS/cm shown in Figure 3.5, Figure 3.6, Figure 3.7 and Figure 3.8 is derived from the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000). It represents maximum concentration of EC in drinking water that beef cattle can adapt to without loss of production. According to the Guidelines, beef cattle have the ability to tolerate significantly higher concentrations of EC in drinking water (up to 14,925 µS/cm) for short periods of time if introduced gradually.

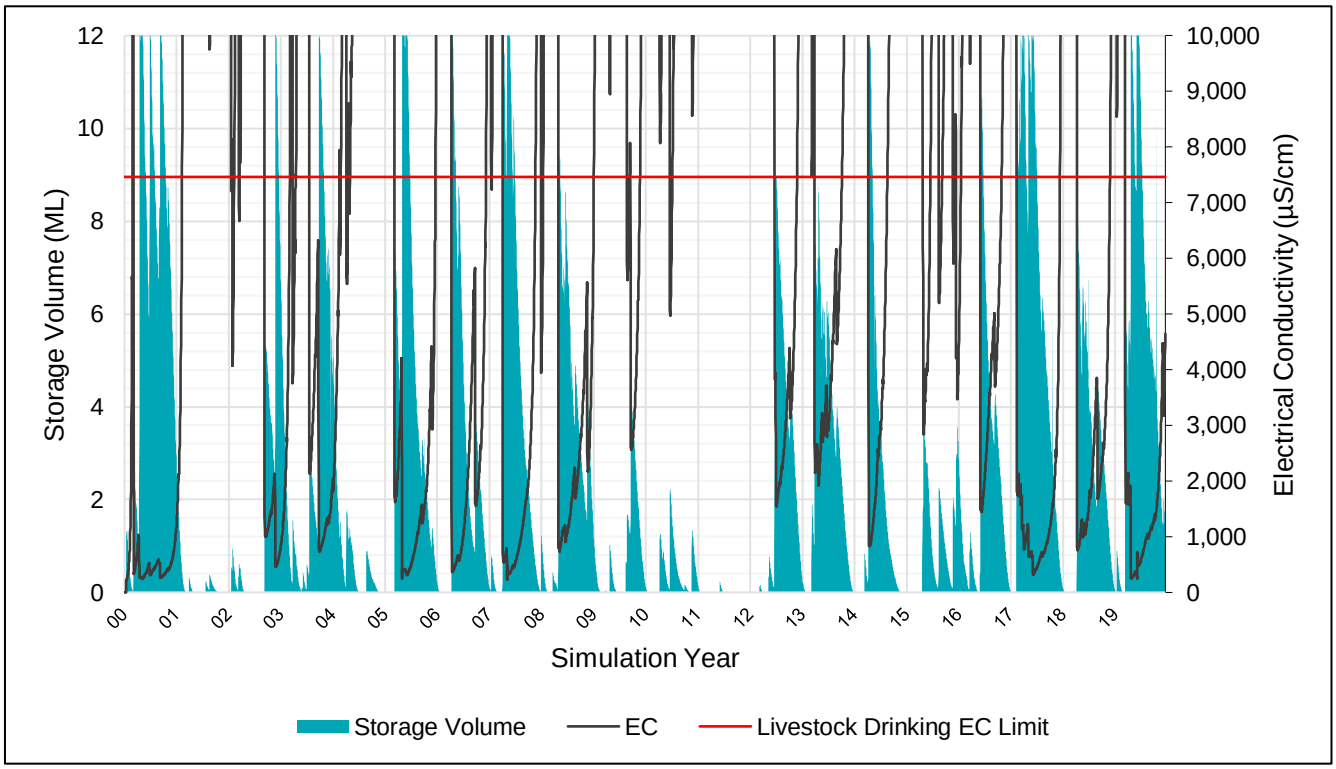

Figure 3.5: Relationship Between Storage Volume, EC and Time for Ponding Area N07 (Maximum Volume 12 ML)

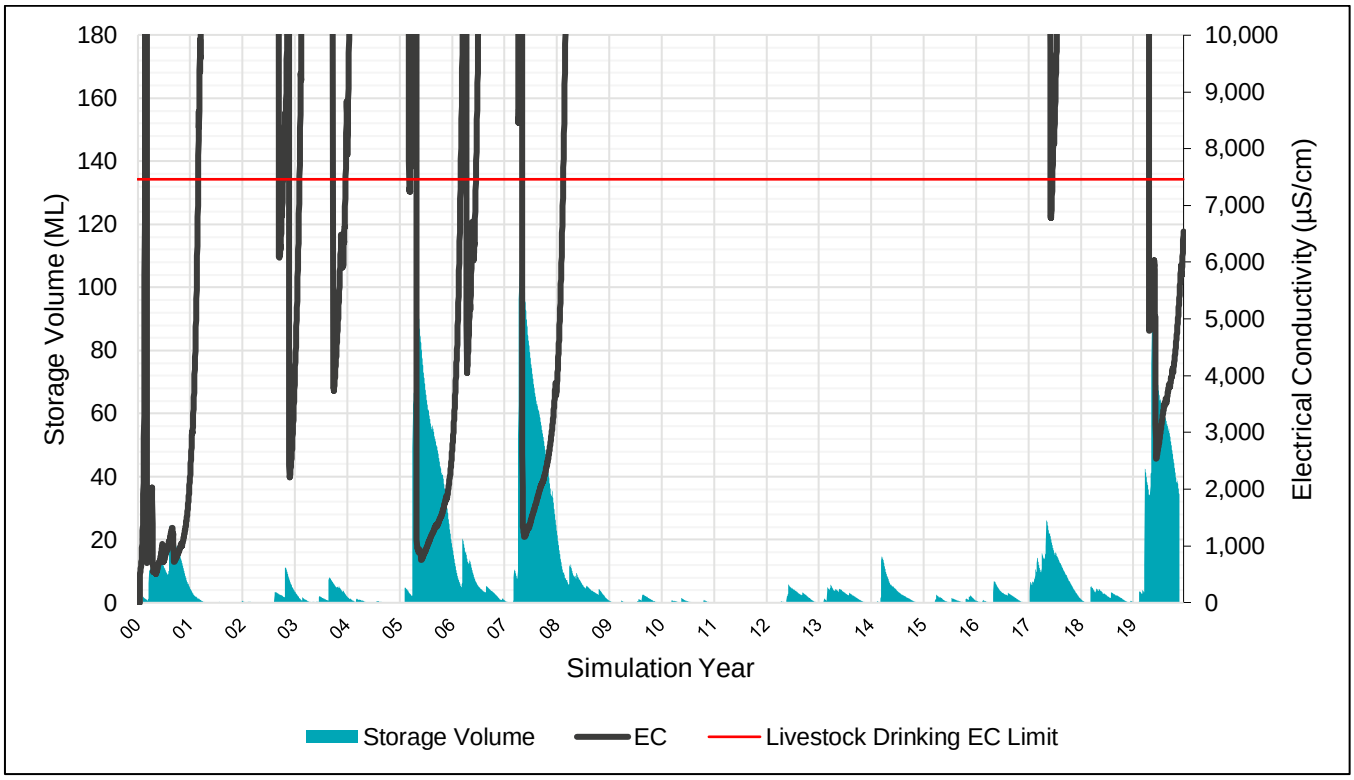

Figure 3.6: Relationship Between Storage Volume, EC and Time for Ponding Area S05 (Maximum Volume 176 ML)

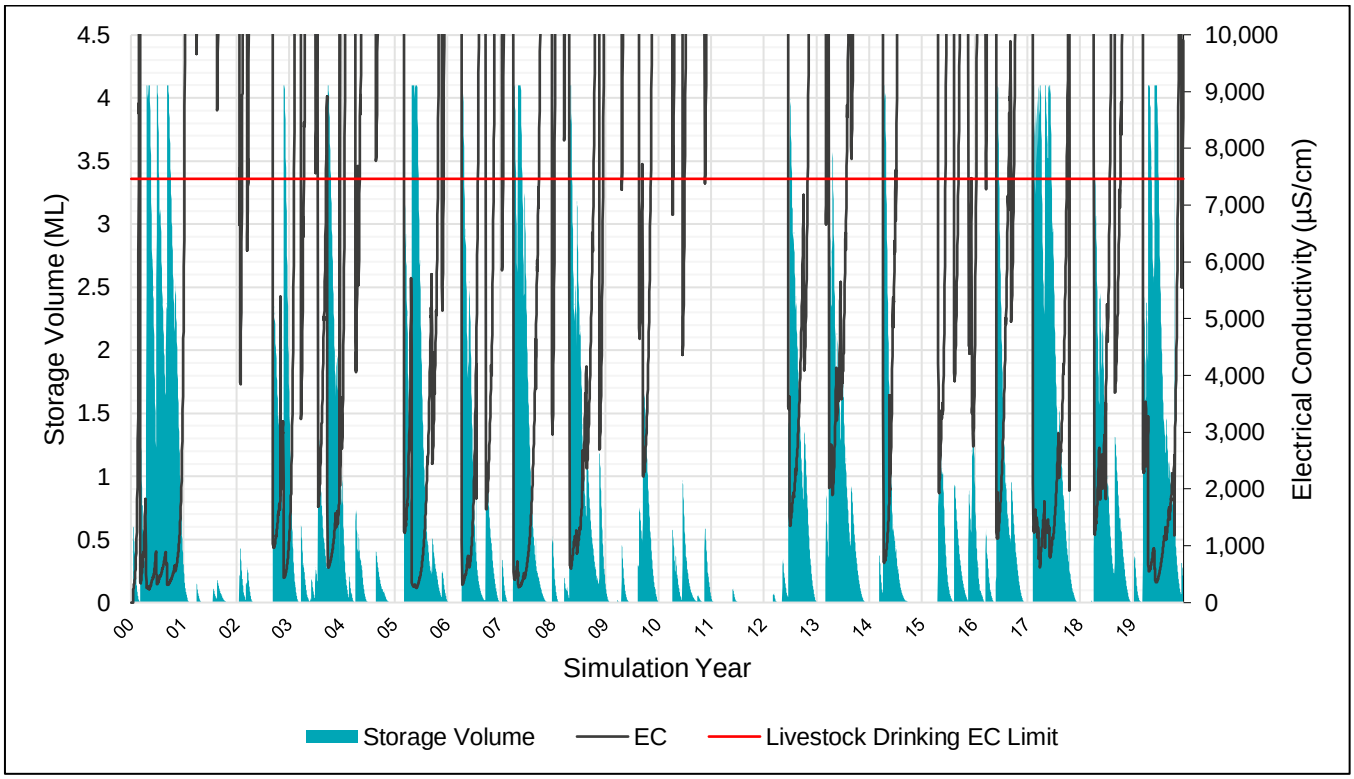

Figure 3.7: Relationship Between Storage Volume, EC and Time for Ponding Area S19 (Maximum Volume 4.1 ML)

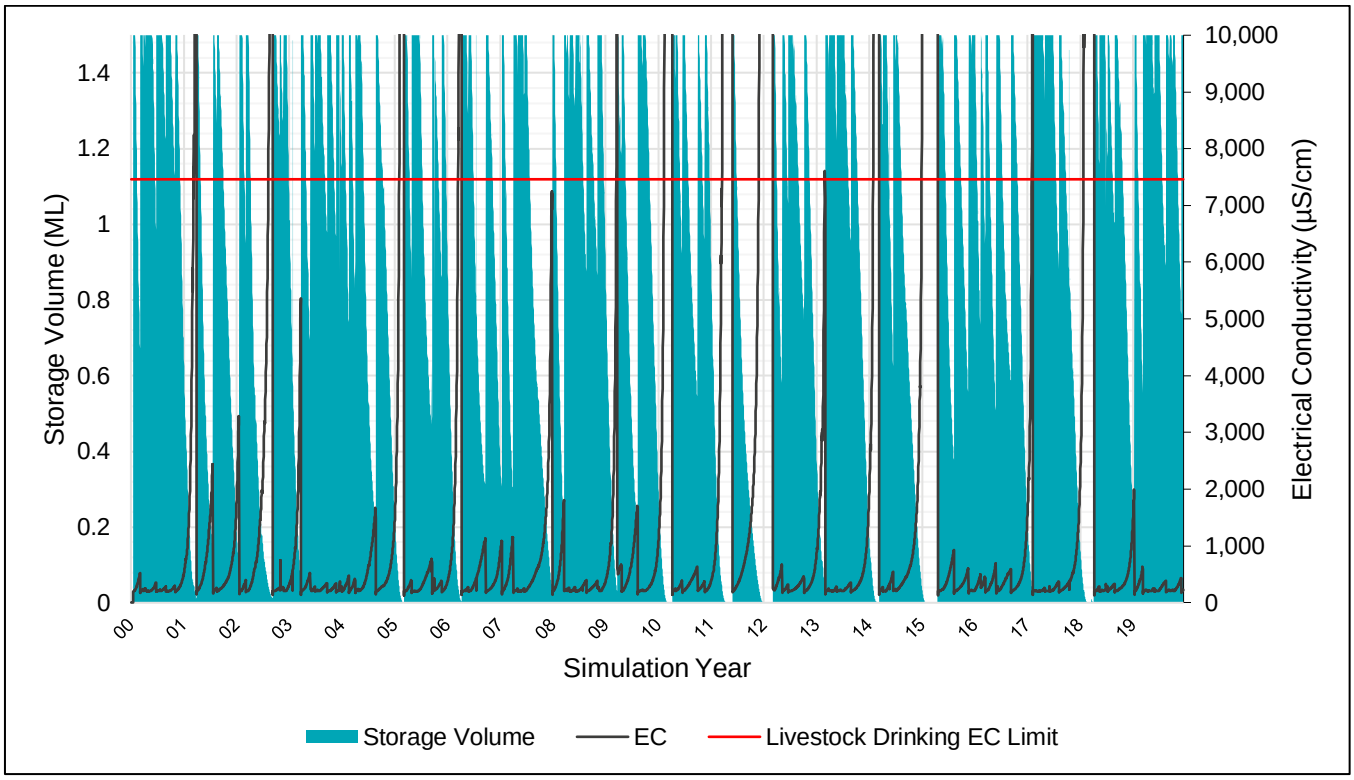

Figure 3.8: Relationship Between Storage Volume, EC and Time for Ponding Area W03 (Maximum Volume 1.5 ML)

3.4.2. Ponding Depth and Volume

To gain a deeper understanding of how the volume and depth of water stored in the ponding areas varies over time, the water balance model was run for the maximum runtime of 133 years and volume- and depth-duration curves were developed. These curves conservatively conceptualise how often each of the ponding areas exceed certain volumes and depths of stored water. The curves for the land-based ponding areas are presented separately to the curves for the waterway ponding areas because they exhibit different trends.

3.4.2.1. Land-Based Ponding Areas

Figure 3.9 is a plot of the depth-duration curves for the land-based ponding areas. The curves are not labelled as the intent of this plot is to illustrate the typical behaviour of the ponding areas as a collective. Key observations include:

- All of the ponding areas contain water more than 50% of the time. Durations and volumes are conservative due to the assumption of negligible seepage.
- On average, the shallower ponding areas (i.e. maximum depth < 1 m) are empty more frequently than the deeper ponding areas.

Figure 3.10 is a plot of the volume-duration curves for the land-based ponding areas. The volume-duration curves exhibit similar trends to the depth-duration curves.

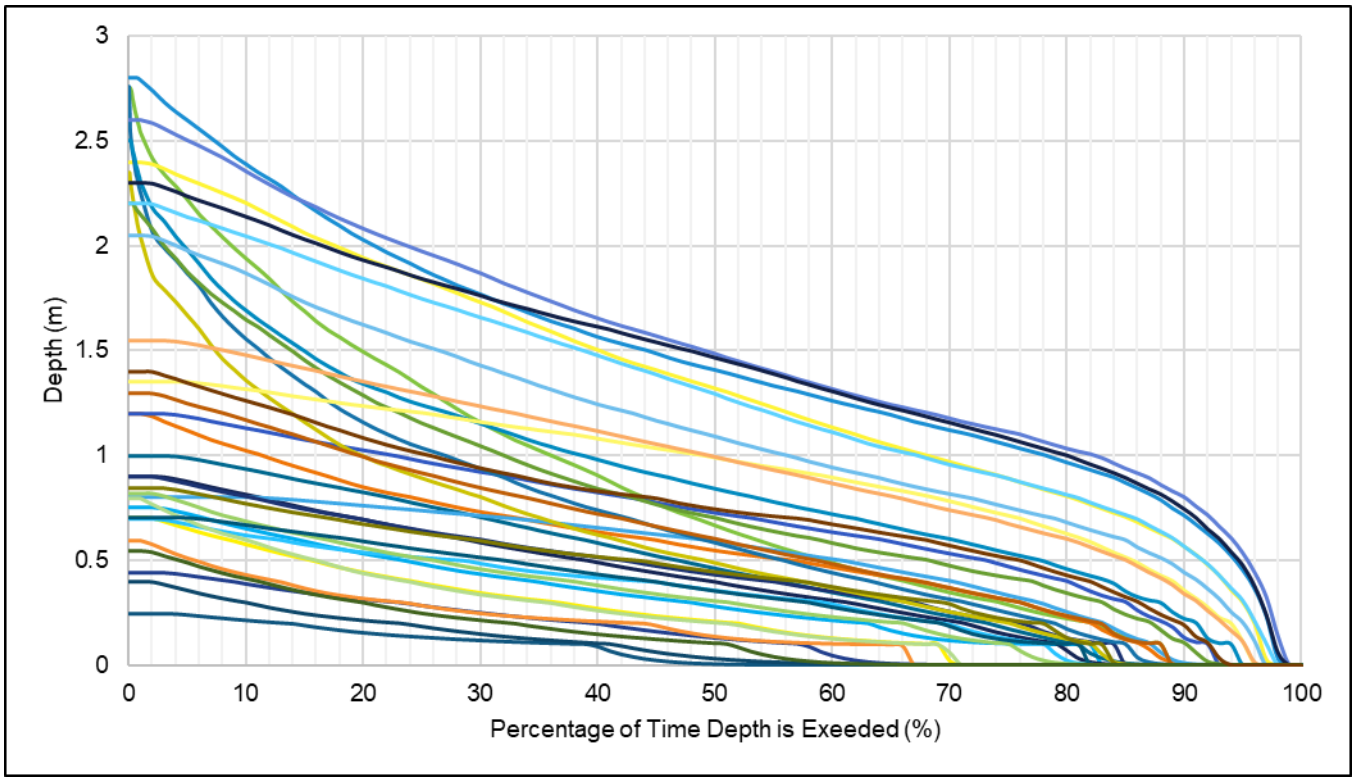

Figure 3.9: Depth-Duration Curve for Land-Based Ponding Areas

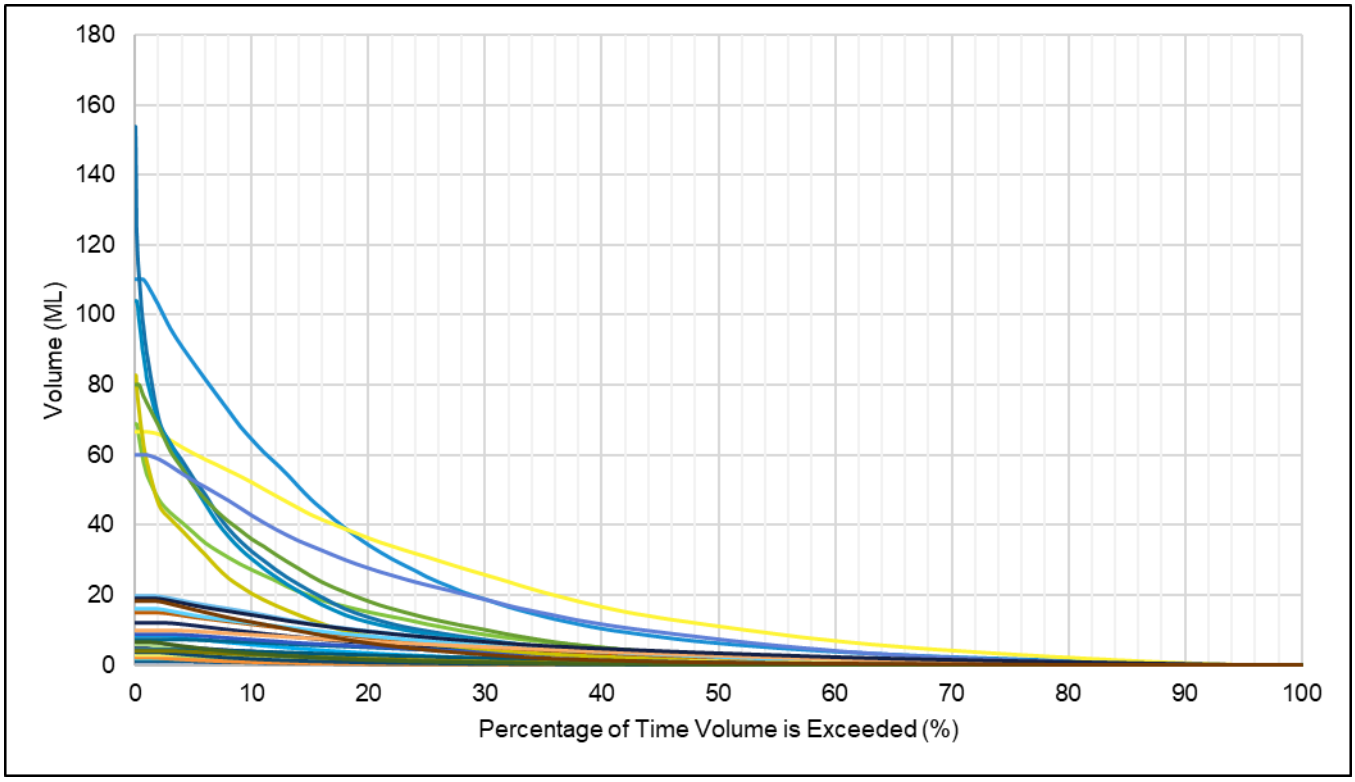

Figure 3.10: Volume-Duration Curve for Land-Based Ponding Areas

3.4.2.2. Waterway Ponding Areas

Figure 3.11 is a plot of the depth-duration curves for the waterway ponding areas. Key observations include:

- Compared to the land-based ponding areas the waterway ponding areas contain water much more frequently (i.e. >95% of the time).
- For the majority of the time, the depth of water stored in the waterway ponding areas is relatively high (i.e. >90% of the maximum depth).

Figure 3.12 is a plot of the volume-duration curves for the waterway ponding areas. The volume-duration curves exhibit similar trends to the depth-duration curves.

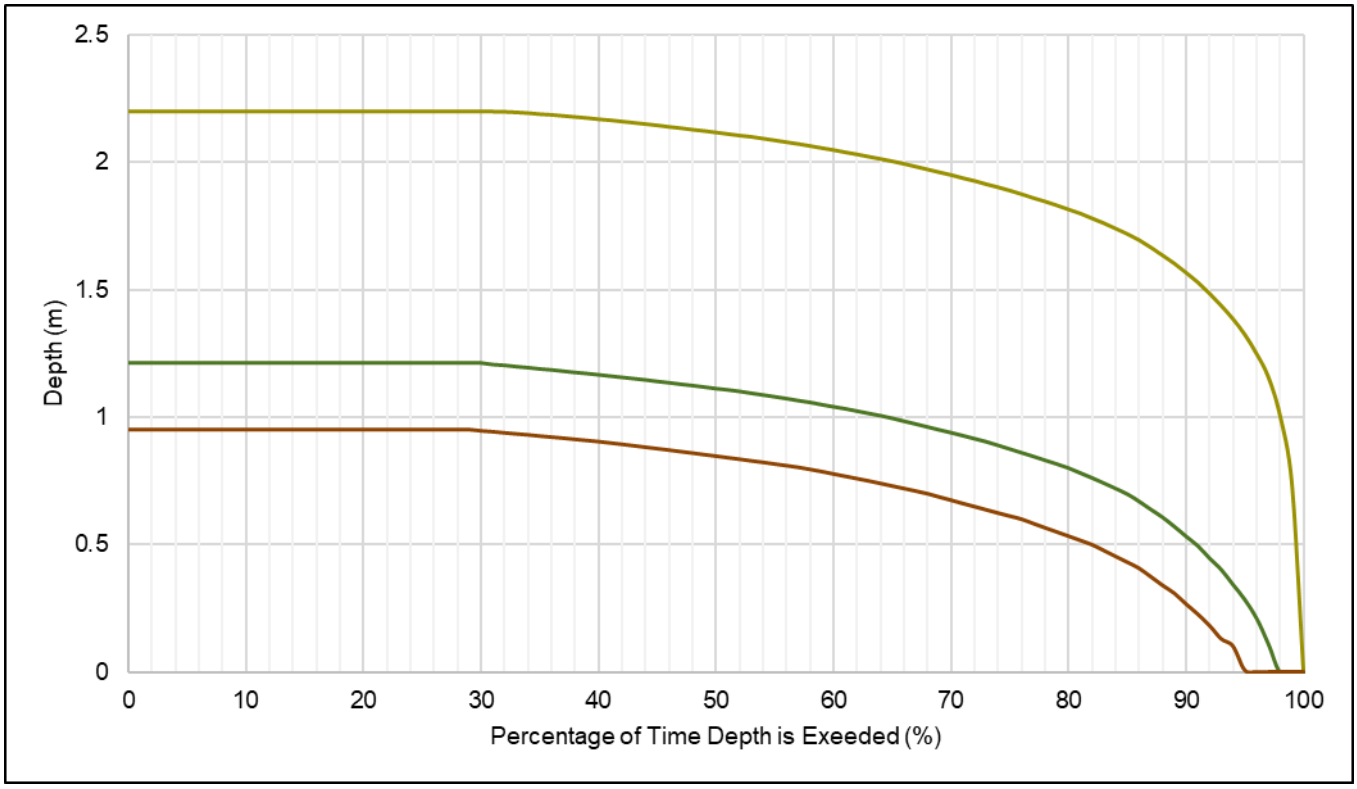

Figure 3.11: Depth-Duration Curve for Waterway Ponding Areas

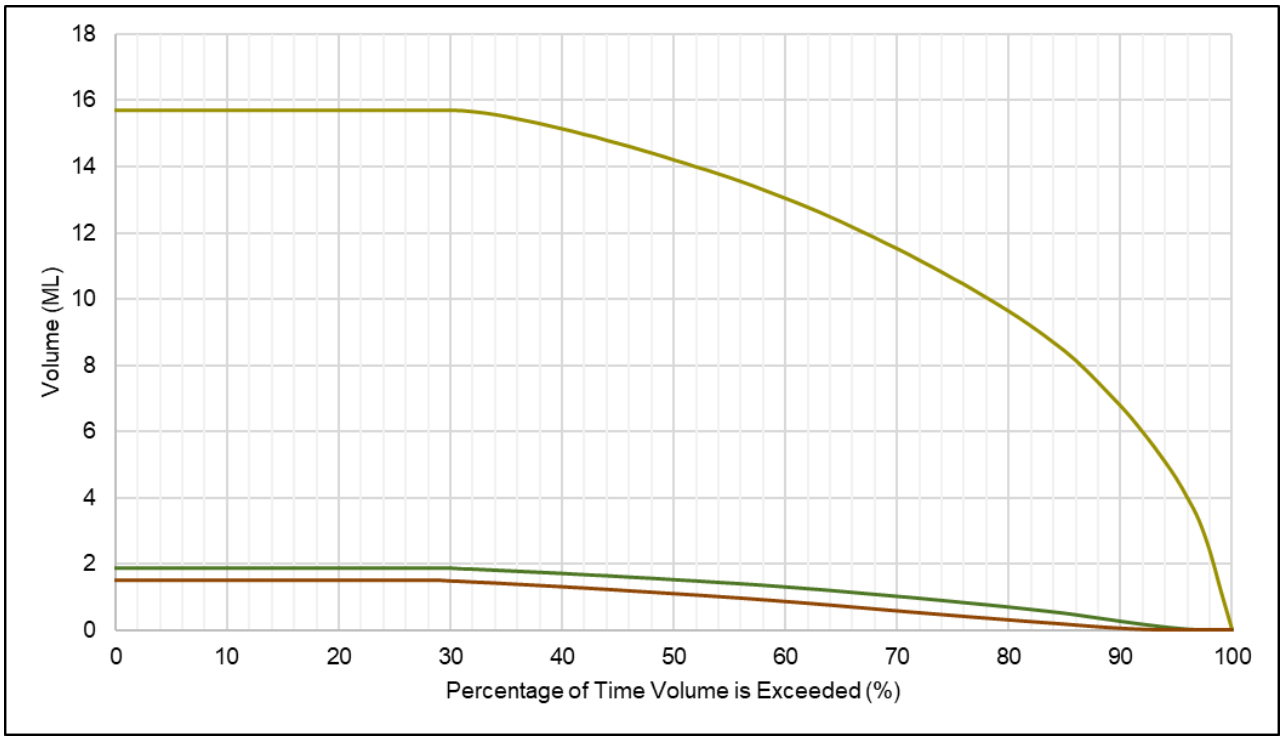

Figure 3.12: Volume-Duration Curve for Waterway Ponding Areas

3.4.3. Stored Water Quality

To gain a deeper understanding of how the salinity (i.e. EC) of water stored in the ponding areas varies over time, the water balance model was run for the maximum runtime of 133 years and EC-duration curves were developed. These curves conceptualise how often the stored water within each of the ponding areas exceeds certain EC levels.

The EC data that was used to develop the curves was filtered to exclude unrealistically high EC values (>50,000 µS/cm) which occur in the water balance model when there is an extremely small volume of water in the ponding areas.

The curves for the land-based ponding areas are presented separately to the curves for the waterway ponding areas because they exhibit different trends.

3.4.3.1. Land-Based Ponding Areas

Figure 3.13 is a plot of the depth-duration curves for the land-based ponding areas. The curves are not labelled as the intent of this plot is to illustrate the typical behaviour of the ponding areas as a collective. Key observations include:

- The EC of six of the ponding areas exceeds the adopted "Livestock Drinking EC Limit" of 7,462 µS/cm for >50% of the time.
- The EC of two of the ponding areas (S05 and S07) exceeds the adopted "Livestock Drinking EC Limit" of 7,462 µS/cm for >80% of the time.

As explained in Section 3.4.1, the adopted "Livestock Drinking EC Limit" of 7,462 µS/cm is derived from the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000). It represents maximum concentration of EC in drinking water that beef cattle can adapt to without loss of production. According to the Guidelines, beef cattle have the ability to tolerate significantly higher concentrations of EC in drinking water (up to 14,925 µS/cm) for short periods of time if introduced gradually.

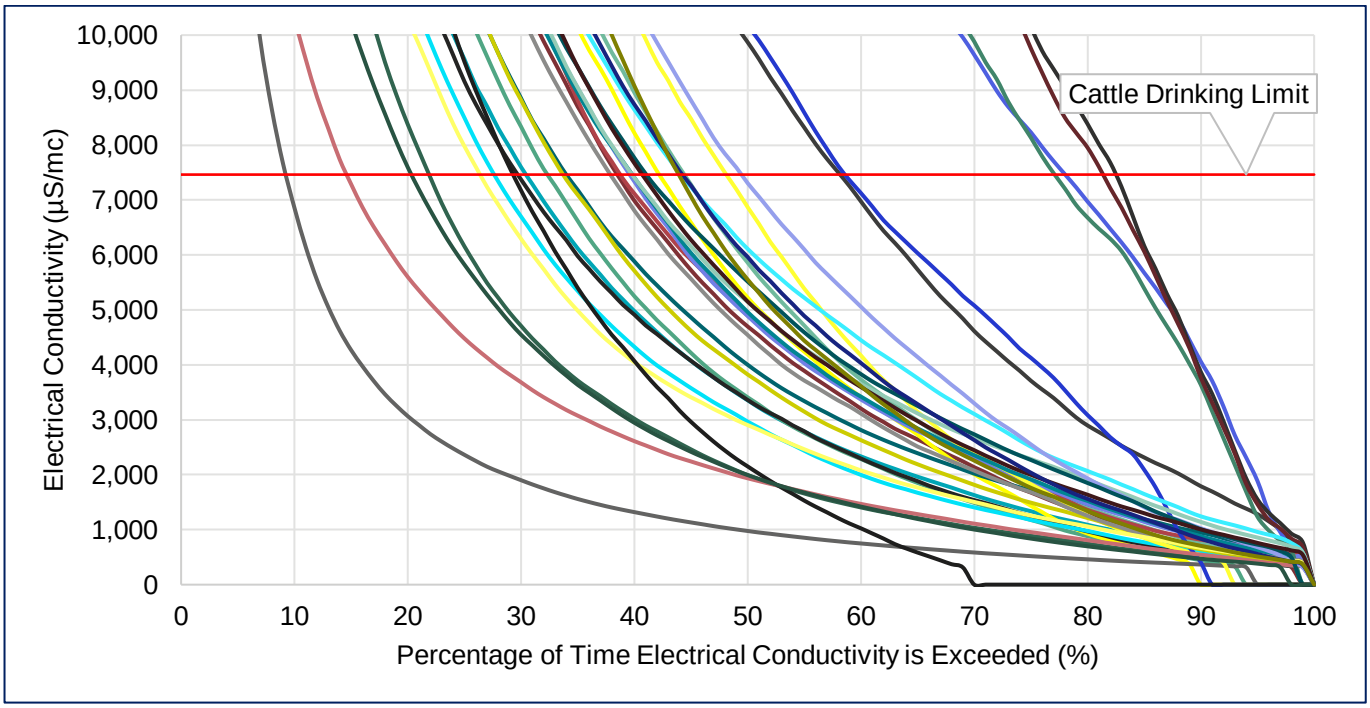

Figure 3.13: EC-Duration Curve for Land-Based Ponding Areas

3.4.3.2. Waterway Ponding Areas

Figure 3.14 is a plot of the EC-duration curves for the waterway ponding areas. Key observations include:

- Compared to the land-based ponding areas, the waterway ponding areas are modelled as much less saline.
- The EC of the waterway ponds is below the adopted "Livestock Drinking EC Limit" of 7,462 µS/cm (ANZECC, 2000) for >95% of the time. These ponds have relatively large maximum depths, volumes and surface areas (Figure 2.4, Figure 2.5 and Figure 2.6) and they are also not predicted to overflow very frequently (Section 3.4.4).

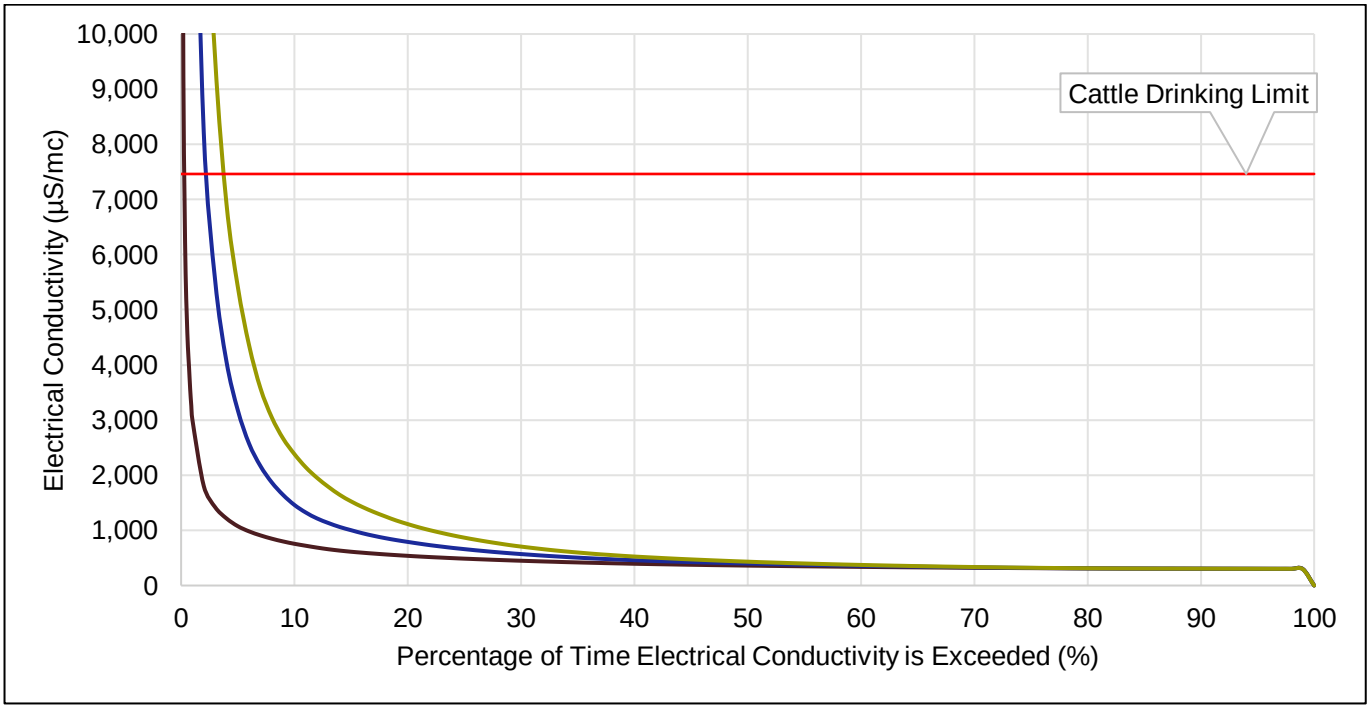

Figure 3.14: EC-Duration Curve for Waterway Ponding Areas

3.4.4. Overflow Probability

Figure 3.15 presents the annual overflow probability for each of the ponding areas. Key observations include:

- The three waterway ponding areas have the highest annual overflow probability at 99% (i.e. the water balance model was run for 133 years and the waterway ponds experienced at least one overflow event in 131 of the years).
- Ponding area S05, which is the largest of all the ponding areas in terms of depth, volume and surface area, has the lowest annual overflow probability at 0% (i.e. the water balance model was run for 133 years and ponding area S05 did not experience an overflow event in any of the years).
- Ponding areas N05, S06, S07 and S08 also have relatively low annual overflow probabilities at <10%.
- The low annual overflow probabilities of ponding areas N05, S05, S06 and S07 is most likely contributing to the relatively high EC concentrations that these ponding areas were modelled as having (Section 3.4.3.1).

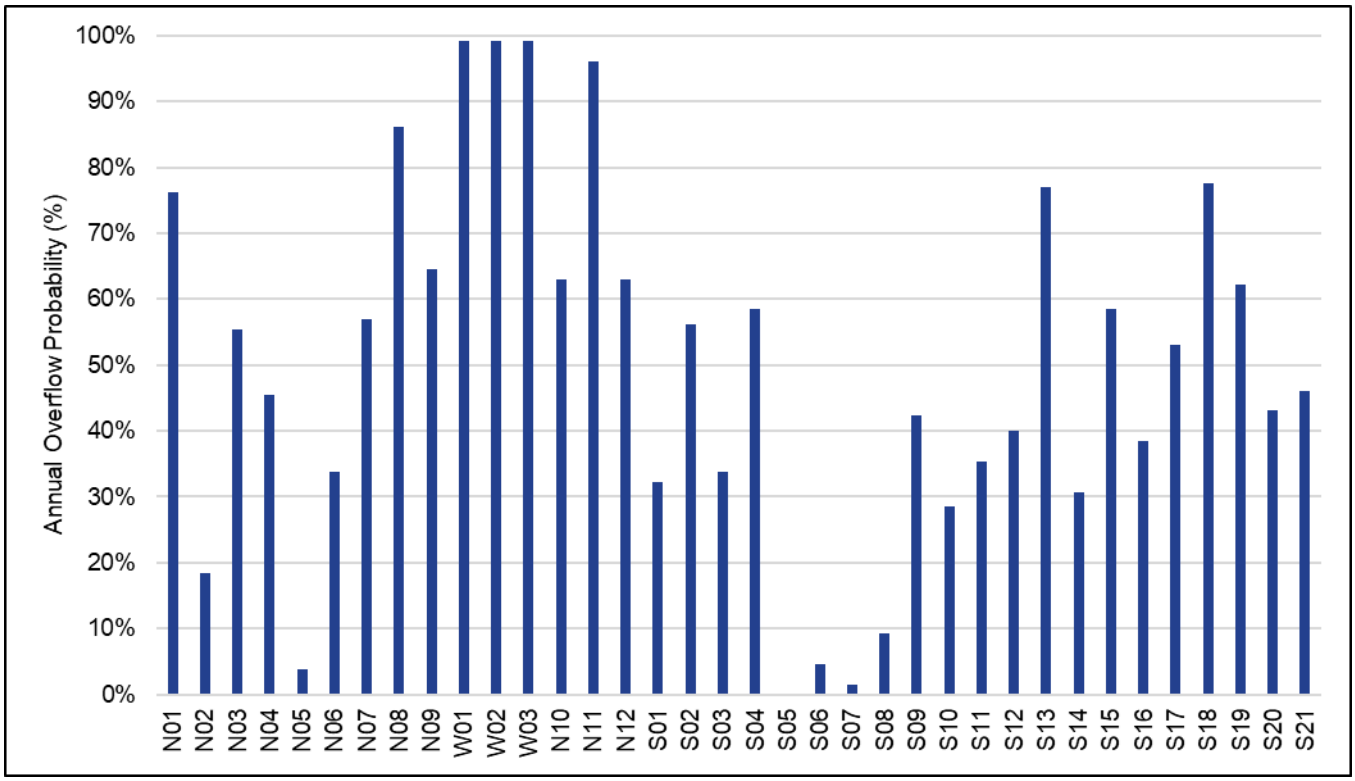

Figure 3.15: Annual Overflow Probability for each of the Ponding Areas

3.4.5. Volume of Surface Water Available to Downstream Users

The water balance model was run for the maximum runtime of 133 years and the results were used to calculate the annual (October to October) volume of surface water generated from within the ponding area catchments that is allowed to flow into Boomerang Creek, Hughes Creek and One Mile Creek (and therefore may be theoretically used by downstream users). This calculation was completed for three scenarios:

- Pre-mining of Project (i.e. existing):
  - Total catchment area of 18,581.5 ha, all reporting directly to Boomerang Creek, Hughes Creek and One Mile Creek.
  - No ponding areas.
- After 10 years of mining:
  - Total catchment area of 18,581.5 ha, 18,191.0 ha of which reports to ponding areas and 390.5 ha of which reports directly to Boomerang Creek, Hughes Creek and One Mile Creek.
  - 23 ponding areas are expected to develop by this time, including the three waterway ponds (Figure 2.1).

  - 7 ponding areas have the potential to overflow into Boomerang Creek, Hughes Creek or One Mile Creek.

- After 20 years of mining:
  - Total catchment area of 18,581.5 ha, all reporting to ponding areas.
  - All 36 ponding areas are expected to develop by this time (Figure 2.2).
  - 8 ponding areas have the potential to overflow into Boomerang Creek, Hughes Creek or One Mile Creek.

The results are presented in Table 3.3. Key observations include:

- The ponding areas are expected to reduce the annual volume of surface water generated from within the ponding area catchments that flows into Boomerang Creek, Hughes Creek and One Mile Creek.
- After 10 years of mining, the cumulative reduction volume is approximately 313 ML (50th percentile).
- After 20 years of mining, the cumulative reduction volume is slightly higher at approximately 445 ML (50th percentile).
- The waterway ponding areas have been included in the results for the 'after 20 years of mining' scenario. This is conservative because the three waterway ponding areas are not expected to be in-situ for this long. As stated in Section 3.3, over the life-of-mine the waterway ponding areas are expected to partially/completely infill with sediment, which would act to decrease the storage volume of the waterway ponding areas and allow more water to flow downstream, resulting in a smaller difference from the 'pre-mining' scenario.

Table 3.3: Annual Volume of Surface Water Generated Within Ponding Area Catchments Flowing Downstream

Percentile	Pre-Mining (ML)	After 10 Years (ML)	Difference from Pre-Mining (ML)	Difference from Pre-Mining (%)	After 20 Years (ML)	Difference from Pre-Mining (ML)	Difference from Pre-Mining (%)
95th Percentile	39,576.6	38,890.4	-686.2	-1.7%	38,749.9	-826.7	-2.1%
50th Percentile	6,711.5	6,399.4	-312.2	-4.7%	6,266.5	-445.0	-6.6%
5th Percentile	1,179.8	1,092.2	-87.6	-7.4%	1,065.15	-114.7	-10.8%

3.5. Discussion

3.5.1. Evapoconcentration of Salts in Water Stored Within the Ponding Areas

The water balance model results indicate that:

- Over time, the ponding areas will repeatedly fill (at times, to the point of overflowing) and empty in response to rainfall, surface runoff and evaporation/evapotranspiration.
- Evapoconcentration of salts in water stored within the ponding areas is likely to occur over the short-term (e.g. when there are consecutive dry years). Generally, however, the ponding areas will receive sufficient inflows of rainfall and runoff, and overflow frequently enough, to avoid accumulation of salts over the long term (20+ years).
- Although there is unlikely to be accumulation of salts over the long-term, some of the ponding areas may experience high EC levels for prolonged periods of time. The ponding areas that are most likely to experience high EC levels for prolonged periods of time are those that have relatively large volumes and small catchment areas relative to the maximum surface area of the ponding area, meaning that they will hardly ever overflow (which is important for flushing salts out of the ponding areas and keeping the water fresh). As shown in Table 3.4:
  - The EC of water stored within ponding areas N05, S05, S06 and S07 is predicted to exceed the adopted "Livestock Drinking EC Limit" of 7,462 µS/cm (ANZECC, 2000) up to 83% of the time. These ponding areas have an annual overflow probability (i.e. the probability

that the ponding area will overflow on at least one day per year) of less than 5%. Trigger Action Response Plan measures may need to be implemented in/around these ponding areas to prevent adverse impacts on stock (if they are to be used for stock watering).

– Conversely, the EC of water stored within ponding areas N11, S13 and S18 is predicted to exceed the adopted "Livestock Drinking EC Limit" up to only 21% of the time. These ponding areas have an annual overflow probability of more than 77%. These ponding areas would generally be suitable for stock watering.

Table 3.4: Comparison of select ponding areas in terms of volume, catchment area, surface area, percentage of time EC exceeds ANZECC stock drinking limit and annual overflow probability

Ponding Area	Maximum Volume (ML)	Catchment Area (ha)	Maximum Surface Area (ha)	Ratio of Catchment Area to Maximum Surface Area[1]	Percentage of time EC exceeds adopted "Livestock Drinking EC Limit" of 7,462 µS/cm[1]	Annual overflow probability (%)[2]
N05	69	28	8	4	79	4
S05	176	38	17	2	83	0
S06	104	43	12	4	78	5
S07	83	27	9	3	82	2
N11	2	63	1	63	10	96
S13	3	29	1	29	15	77
S18	5	52	2	23	21	78

[1] A higher ratio is indicative of a lower percentage of time that EC exceeds the adopted "Livestock Drinking EC Limit" limit and a higher annual overflow probability

[2] Based on 133 consecutive years' worth of water balance model results

– The waterway ponding areas (i.e. ponds W01, W02 and W03) experience the lowest EC levels (predicted to exceed the adopted "Livestock Drinking EC Limit" less than 5% of the time) and overflow the most frequently (annual overflow probability of more than 99%). Sediment will be deposited into the waterway ponding areas during filling events. Overtime, the waterway ponding areas will completely fill with sediment and the waterway bed will be returned to free-draining grade. Thus, any adverse impacts associated with the waterway ponding areas will be temporary in nature.

- Regardless of volume, catchment area or maximum surface area, any water that that overflows from the ponding areas will be relatively fresh (.e. EC <1,500 µS/cm). This suggests that overflows from the ponding areas are unlikely to impact on the water quality of downgradient waterways.

3.5.2. Reduction in the Volume of Water Available to Downstream Users

The results presented in Table 3.3, showed that:

- As expected, the ponding areas will reduce the annual volume of surface water generated from within the Project area that is allowed to flow into Boomerang Creek, Hughes Creek and One Mile Creek.
- The reduction ranges from approximately 4.7% (after 10 years of mining at 50th percentile rainfall conditions) to 6.6% (after 20 years of mining at 50th percentile rainfall conditions).

- Larger ponding areas that hardly ever overflow contribute the most to the reduction.

The reduction is unlikely to result in adverse impacts on downstream aquatic ecosystems, graziers, etc. due to the very small percentage of the Isaac River and Fitzroy River catchments that the Project area makes up (the Project area is situated in the Isaac River catchment which is a sub-catchment of the Fitzroy River catchment). As shown in Table 3.5, the combined catchment areas of Boomerang Creek, Hughes Creek and One Mile Creek make up approximately 1.1% of the Isaac River catchment and 0.2% of the Fitzroy Basin catchment.

Table 3.5: Comparison of catchment areas (DES, 2018)

	Fitzroy River	Isaac River	Boomerang Creek, Hughes Creek and One Mile Creek
Catchment area (ha)	14,266,000	2,236,000	24,800
Boomerang Creek, Hughes Creek and One Mile Creek catchment area as a percentage of the Fitzroy River / Isaac River catchment area	0.2%	1.1%	-

4.0. REFERENCES

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Queensland Government. (2022, July 10). *SILO - Australian climate data from 1889 to yesterday*. Retrieved from https://www.longpaddock.qld.gov.au/silo/

5.0. QUALIFICATIONS

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