Alcoa
Wagerup ROWS Pond Project WG 0159

ROWS Pond Capacity

Problem Definition

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Executive Summary

During the RSA 9 Project (WG 0159) FEL2.2 it was identified that with expansion of the residue area current ROWS Pond capacity will not meet the required design criteria when RSA 9 is constructed, which is forecast to be in mid 2013, or for RSAs beyond this date. The ROWS Pond Project, a result of identifying this problem, is currently in problem definition phase and will culminate in agreement of the Design Criteria to be progressed into Solution Analysis.

Alcoa has a water balance for the contaminated water streams on-site. Hatch has modified the balance to calculate monthly operating storage volumes so the wet season ROWS Pond volume peaks can be identified. In addition, Monte Carlo analysis of rainfall has been incorporated to forecast rainfall when simulating future storage volume requirements.

This model has allowed for the analysis of various scenarios with four scenarios selected for analysis;

1. Overflowed volume if a 1% wet year occurs
2. Overflowed volume if a 1% wet year occurs, followed by an average year
3. Overflowed volume if a 1% wet year occurs, followed by one year of Monte Carlo forecast rainfall data
4. Overflowed volume projected from Monte Carlo forecast rainfall data from 2011 until 2022.

All scenarios analysed indicate that current ROWS Pond capacity is insufficient for future requirements, with the size of the capacity deficit dependent on the level of acceptable risk and period length analysed. The deficit increases with time due to the expected residue area expansion, which results in a greater amount of run-off collected per unit of rainfall (mm).

Traditionally Alcoa has used the 1%wet year as the basis for ROWS Pond capacity design, which results in a capacity deficit ranging from 400 ML in 2014 to 1,000 ML in 2020, with the deficit increasing due to the anticipated growth of the residue area.

Modelling indicates that there will be an accumulation of volume in the ROWS Pond following an average rainfall year (860mm/yr) unless activities outside normal operations occur to remove the volume stored in the ROWS Pond. This is reflected in the Scenario two results, whereby the ROWS Pond continues to overflow in the year following a 1% wet year if an average rainfall year is experienced, and operations are unable to remove ROWS water outside of the modelled activities.

Scenario three also indicates continued ROWS Pond overflows in the year following a 1% wet year using rainfall forecast by the Monte Carlo simulation, with the level of acceptable risk influencing the magnitude of overflowed volume.

Scenario four doesn't force a 1% wet year, forecasting rainfall for the entire period instead and produces the most conservative short-term overflow result. If a 1% level of risk is assumed, then the deficit in ROWS capacity until July 2016 is 287 ML. The deficit in ROWS capacity increases rapidly however to almost 3,000ML in July 2020.

1 Background

The Wagerup ROWS Pond is designed to store low TA run-off water collected from the residue area. The water collected in the ROWS pond supplies the high TA water circuit during the dry season when evaporation exceeds rainfall resulting in the high TA water circuit balance becoming net negative.

During the RSA 9 Project (WG 0159) FEL2.2 it was identified that with expansion of the residue area to include RSA 7N and 8, the current ROWS pond has insufficient capacity to store a 1% wet year. Current ROWS Pond capacity will not meet the required design criteria when RSA 9 is constructed, which is forecast to be in mid 2013, or for RSAs beyond this date. The ROWS Pond Project, a result of identifying this problem, is currently in problem definition phase and will culminate in agreement of the Design Criteria to be progressed into Solution Analysis.

2 Introduction

Alcoa has a water balance for the contaminated water streams on-site. The current refinery operating practice is to transfer from the ROWS pond to the Cooling Pond in summer. This is intended to maintain the Cooling Pond at a constant level. In the balance, the steady state discrepancy between water inputs and outputs is calculated and the annual discrepancy stored as either volume accumulation or consumption in the ROWS Pond. The operating practice to is reduce the ROWS pond to minimum level by May each year (400 ML), however the calculated annual stored volumes using the accumulation/consumption method correlate well with historical data on an annual basis.

Hatch has modified the balance to calculate monthly operating storage volumes so the wet season ROWS Pond volume peaks can be identified. In addition, Monte Carlo analysis of rainfall has been incorporated to forecast rainfall when simulating future storage volume requirements. The Monte Carlo model forecasts future rainfall data, using a Gamma distribution probability density function derived from historical rainfall data and stores the outputs for Monte Carlo analysis.

The modelling has been done allowing for future residue expansion milestones, and the projection of future storage volume allows Alcoa stakeholders to specify the Design Criteria for the Project in full knowledge of the constraints under which the design is valid.

3 Basis for Projecting Future Volumes

3.1 Operating Basis

Current ROWS capacity is 4,000 ML whilst the minimum operating volume allowable is 400 ML. Hence the current ROWS pond provides up to 3,600 ML of surge capacity.

No change was made to the existing basis used in the water balance model, and so discrepancies between the water inputs and outputs were stored as either volume accumulation or consumption in the ROWS pond.

A ROWS pond starting operating volume of 400 ML for the start of May 2011 was used.. The model contains historical rainfall data up to mid 2010, and when reviewed in line with the current dry year, achieving the minimum level prior to winter 2011 is reasonable.

3.2 Forecasting Basis

All modelling has been performed allowing for:

- An alumina production rate creep of 50tpd stepped annually, with a base production of 7,000tpd in 2010.
- Condensate evaporative losses in the cooling towers at a rate of 0.22kL/tonne of alumina production.
- Annual pump-up from the detention ponds to the upper/lower dam of 300 ML total across August and September if rainfall for the previous 12 months is < 900mm.
- RSA 9 is modelled to be online in July 2013.
- RSA 10 is modelled to be 43ha and online in July 2016.
- RSA 11 is modelled to be 43ha and online in July 2019.
- Additional RSA construction beyond 2019 has not been considered.

3.3 Weather Basis

Provide sufficient water storage for a 1% wet year (1400mm of cumulated rainfall within twelve consecutive months).

Contain the run-off collected from an average rainfall year in the year following a 1% wet year. An average rainfall year is equivalent to 860mm/year.

Extenuating factors such as a 1% 72hr storm event contributing to the 1% wet year have not been considered.

4 Capacity Projections

4.1 Scenarios Modelled

Alcoa has historically determined run-off storage capacity requirements by applying a 1% wet year. The model uses differing run-off co-efficients between active storage areas, remediated areas and water bodies. No change was made to any parameters relating to these factors when modelling.

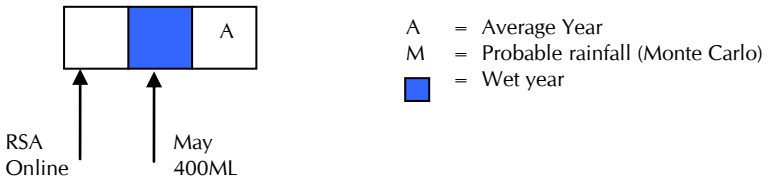
Modelling results for the capacity required at the conclusion of each incremental expansions of the residue area between 2010 and 2022 are shown in Table 4-1. Four capacity scenarios have been modelled:

Scenario 1

Current ROWS Pond level at 400ML for the start of May in the year following the construction of a new RSA, whereby a 1% wet year is endured. This scenario indicates the minimum overflow volume / additional ROWS capacity required in order to contain a 1% wet year.

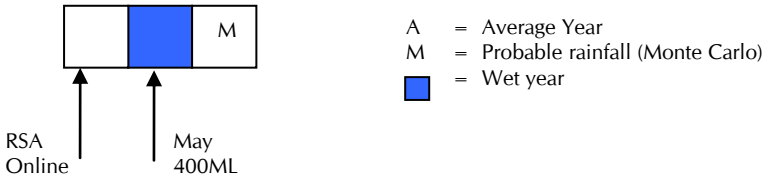
Scenario 2

Current ROWS Pond level at 400ML for the start of May in the year following the construction of a new RSA, whereby a 1% wet year is endured, followed by an average rainfall year. This scenario indicates the ROWS Pond volume the year after a 1% wet year has occurred, with modelled operations indicating whether additional volume has been accumulated or magnitude of ROWS capacity reclaimed following a 1% wet year.



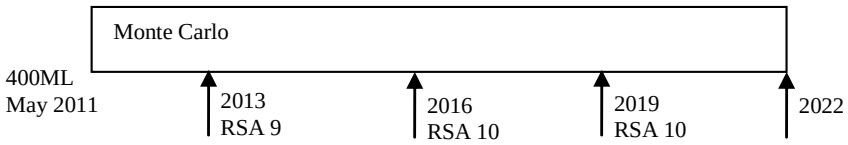
Scenario 3

Current ROWS Pond level at 400 ML for the start of May in the year following the construction of a new RSA, whereby a 1%wet year is endured, followed by rainfall forecast by the Monte Carlo analysis. Similar to Scenario two, except the rainfall year following a 1% wet year is independently forecast, based on historical data and probability.



Scenario 4

Current ROWS pond level at 400ML in May 2011. Storage capacity is on based on operating basis, forecast criteria and projected rainfall in each year from Monte Carlo analysis until 2022. This scenario indicates the required ROWS capacity using forecast rainfall for the entire analysis period.



4.2 Modelling Results

Where the Monte Carlo has been applied, both the 95th and 99th percentile overflow results are provided so the magnitude of the change with probability can be assessed.

Table 4-1: Scenario modelling results

	Scenario 1	Scenario 2	Scenario 3		Scenario 4	
	ROWS Pond Overflows	ROWS Pond Overflows	95th Percentile overflows	99th Percentile Overflows	95th Percentile overflows	99th Percentile Overflows
July 2013 - June 2016 (RSA 9 online)	420 ML	887 ML	1,329 ML	1,885 ML	No overflows	287 ML
July 2016 - June 2019 (RSA 10 online)	740 ML	1,462 ML	1,902 ML	2,539 ML	658 ML	1,601 ML
July 2019 - June 2022 (RSA 11 online)	1,061 ML	2,044 ML	2,305 ML	2,985 ML	1,733 ML	2,933 ML

The modelling results indicate that current ROWS Pond capacity will be insufficient to meet future needs, with the deficit of ROWS Pond capacity dependent on the required design life of the ROWS Pond and the method of analysis.

Traditionally Alcoa has used the 1% wet year as the basis for ROWS Pond capacity design, which results in a capacity deficit ranging from 400 ML in 2014 to 1,000 ML in 2020, with the deficit increasing due to the anticipated growth of the residue area which increases the run-off collected for storage.

Modelling indicates that there will be an accumulation of volume in the ROWS Pond following an average rainfall year (860mm/yr) unless activities outside normal operations occur to remove the volume stored in the ROWS Pond. This is reflected in the Scenario two results, whereby the ROWS Pond continues to overflow in the year following a 1% wet year if an average rainfall year is experienced, and operations are unable to remove ROWS water outside of the modelled activities.

Scenario three also indicates continued ROWS Pond overflows in the year following a 1% wet year using rainfall forecast by the Monte Carlo simulation, with the level of acceptable risk influencing the magnitude of overflowed volume.

Scenario four doesn't force a 1% wet year, forecasting rainfall for the entire period instead, and produces the most conservative short-term overflow result. In line with the 1% wet year basis, if a 1% level of risk is assumed, then the deficit in ROWS capacity until July 2016 is 287 ML. The deficit in ROWS capacity increases rapidly however to almost 3,000 ML by July 2022, peaking in September 2021.