DISCHARGE WATER MANAGEMENT STRATEGY

Macquarie Coal Preparation Plant

Prepared for: Oceanic Coal Australia Limited

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with the Client. Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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DOCUMENT CONTROL

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1 Introduction

1.1 Background and Scope

SLR Consulting (SLR) was engaged by Oceanic Coal Australia Limited (OCAL) to undertake an investigation to address the Environment Protection Licence (EPL) 1360 notice of variation which requires a Discharge Water Management Study (DWMS) for the Macquarie Coal Preparation Plant (MCPP). This report specifically aims to address the requirements of condition U1.2 which states:

'The licensee is to undertake, complete and report on a study of mine closure water management that:

1. Details a plan showing all clean and dirty water catchments, all temporary and permanent water management structures and all discharge points;

2. Provides predictions for discharge volumes from Discharge Point 1 over time;

3. Provides predictions for discharge quality associated with Discharge Point 1 over time;

4. Assesses the predicted discharge volumes and quality (including salinity, pH, TSS and metals) against the existing concentration limits of the licence, the ANZECC Guidelines and the NSW Water Quality Objectives/NSW Marine Water Quality Objectives applicable to the receiving environment; and

5. Examines all practicable measures to minimise discharge volumes and manage discharge quality to achieve the relevant objectives and prevent pollution of the receiving environment upon mine closure.'

SLR inspected the MCCP site on 9th October 2018 to ground truth the catchments and arrangement of dams, and to identify any site-specific constraints and/or opportunities.

The DWMS has been undertaken in accordance with the key principles outlined within the following guidelines:

- Australian Rainfall and Runoff 2016 (ARR);
- The 'Blue Book' (Managing Urban Stormwater: Soils and Construction Vol. 1, 4th edition and Vol. 2E Mines and Quarries (Landcom, 2004 and DECC, 2008));
- NSW Water Quality and Marine Water Quality Objectives;
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018); and
- Glencore standards where they were deemed to be more conservative than the other best practice guidelines.

The DWMS does not consider any hydraulic constraints to discharge from the MCCP associated with high water levels from flooding on Cockle Creek.

1.2 Regional Hydrology

The MCPP is located in the Cockle Creek catchment area (located on the eastern foot slopes of the Sugarloaf Range). The Cockle Creek catchment area is approximately 10,600 ha and ultimately discharges into the northern end of Lake Macquarie at Boolaroo. The stream is tidal downstream of the weir located near Northville (James Street Weir). It is fed by a number of tributaries including Burkes, Flaggy, Cocked Hat, Brush, Winding and Argenton Creeks. The floodplain of Cockle Creek and its tributaries extends through the suburbs of Barnsley, Boolaroo, Edgeworth and Glendale, downstream to the northern end of Lake Macquarie near Speers Point. The susceptibility of the floodplain areas of all of these tributaries to flooding is well recognised.

2 MCPP Discharge Criteria

2.1 EPL 1360

EPL 1360 has one Licensed Discharge Point (LDP 1) at the MCPP. LDP 1 is located upslope of Cockle Creek at the northern end of the site. Monitoring criteria for surface water are only relevant to water actually discharging from the MCPP. LDP 1 within EPL 1360 includes a number of water quality and quantity discharge limits including:

- pH = 6.5-9.0;
- TSS = 50 mg/L; and
- Daily volume = 6000 kL/day.

The TSS concentration limit stipulated by EPL 1360 for LDP 1 is deemed not to apply when the discharge:

- Occurs solely as a result of rainfall measured at the premises which exceeds 51 mm over any consecutive five day period; and
- Continues for a period of not more than five (5) days from the last day of the five day consecutive rainfall period.

2.2 NSW Water Quality and Marine Water Quality Objectives

2.2.1 Lake Macquarie and Tuggerah Lakes Water Quality and River Flow Objectives

The NSW Water Quality Objectives (WQO) are the agreed environmental values and long-term goals for NSW's surface waters. They set out:

- the community's values and uses for our rivers, creeks, estuaries and lakes (i.e. healthy aquatic life, water suitable for recreational activities like swimming and boating, and drinking water); and
- a range of water quality indicators to help us assess whether the current condition of our waterways supports those values and uses.

The objectives are consistent with the agreed national framework for assessing water quality set out in the ANZECC 2000 Guidelines. These guidelines provide an agreed framework to assess water quality in terms of whether the water is suitable for a range of environmental values (including human uses). The Water Quality Objectives provide environmental values for NSW waters and the ANZECC 2000 Guidelines provide the technical guidance to assess the water quality needed to protect those values.

Cockle Creek is located within the 'Lake Macquarie and Tuggerah Lakes' region of the WQOs and is classed under 'Waterways affected by urban development'. The WQO's applicable to this region were considered during the preparation of this DWMS and include:

- Maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term;
- Aesthetic qualities of waters;
- Maintaining or improving water quality for activities such as boating and wading, where there is a low probability of water being swallowed;
- Maintain or restore the natural inundation patterns and distribution of floodwaters supporting natural wetland and floodplain ecosystems;
- Mimic the natural frequency, duration and seasonal nature of drying periods in naturally temporary waterways;
- Maintain or mimic natural flow variability in all streams;
- Maintain rates of rise and fall of river heights within natural bounds; and
- Minimise the impact of instream structures.

2.2.2 Marine Water Quality Objectives for NSW Ocean Waters

The introduction of the Marine Water Quality Objectives (MWQOs) is part of the NSW Government's program to set water quality objectives for all its major waterways.

In 1999, water quality objectives for NSW rivers and estuaries were introduced in 31 catchments. To complement these, the Government has developed a set of Marine Water Quality Objectives for NSW ocean waters - a key initiative under the Government's Coastal Protection Package announced in June 2001.

The aim of the Marine Water Quality Objectives is to simplify and streamline the consideration of water quality in coastal planning and management. This will ensure that the values and uses that the community places on ocean waters are recognised and protected, now and into the future.

The Marine Water Quality Objectives are intended for communities, local councils, Catchment Management Authorities and state agencies to use in catchment management and land use planning activities.

The Site is located within the Lake Macquarie LGA. As such, the Hunter and Central Coast MWQO's are applicable to the site and include:

- To maintain or improve the ecological condition of ocean waters;
- To maintain or improve ocean water quality so that it is suitable for activities such as swimming and other direct water contact sports;
- To maintain or improve ocean water quality so it is suitable for activities such as boating and fishing where there is less bodily contact with the waters;
- To maintain or improve ocean water quality so that it looks clean and is free of surface films and debris; and
- To maintain or improve ocean water quality for the production of aquatic foods for human consumption (whether derived from aquaculture or recreational, commercial or indigenous fishing).

The MWQO's were considered during the preparation of this DWMS.

2.3 ANZG 2018 Guidelines

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG) 2018 guidelines superseded the ANZECC 2000 guidelines in August 2018. They establish water quality trigger values for aquatic ecosystems and detail water quality trigger values for slightly to moderately disturbed systems. The ANZG guidelines acknowledge that, in some instances, the prescribed trigger values for water quality may be well below existing levels occurring within receiving water bodies and the need for site-specific background levels needs to be considered. The use of ambient background water quality data to establish site-specific guidelines for assessment of discharge waters is undertaken in such cases.

The ANZGT guidelines are presented as an online platform, to improve usability and facilitate updates as new information becomes available. Default trigger values for the Lake Macquarie region had not been developed during the preparation of this DWMS. As such, the default trigger values documented in the ANZECC 2000 guidelines were still considered to be applicable for the purposes of this DWMS.

3 MCPP Water Management System

3.1 Site Staging

Three water management stages have been assessed as part of this DWMS investigation to allow an assessment of both current and potential future water quality and discharge volumes. These stages are as follows:

- Stage 1 – Existing Water Management;
- Stage 2 – Future Water Management; and
- Stage 3 – Long term Water Management.

These stages are described in the sections below.

3.2 Stage 1 – Existing Water Management

Surface water at the MCPP is managed in accordance with the MCPP Water Management Plan, the MCPP Erosion and Sediment Management Plan and the OCAL Mine Closure Plan. Surface water runoff at MCPP generally drains to the east and is captured / contained in the MCPP water management system. The principal water use at MCPP has historically been process water for the treatment of raw coal however, this is no longer the case as the site is in the process of closing.

Clean water runoff is diverted around the site (where possible) to minimise the contamination of clean water by site activities and minimise the inflow of clean water runoff into disturbed areas. Runoff from disturbed areas is conveyed using catch drains to on-site sediment dams for treatment and reuse on-site or discharge off site via LDP 1. A catchment plan of the Stage 1 water management system, including dams, water conveyance structures, dam sub-catchment boundaries and the specific land types, is shown in **Figure 1**.

The MCPP site is segregated into a number of sub-catchments, each with its own storage for the collection of runoff. Five sub-catchments on site have been identified, as shown in **Figure 1** and include:

- Tailings Storage Facility (TSF);

- REA Dam;
- Catch Dam 1;
- Rail Loop; and
- Pond 3 (includes LDP 1).

The Pond 3 sub-catchment includes a number of dams including Pond 1, Pond 2, and Catch Dam 2. Water from the REA Dam, Catch Dam 1 and the Maturation Pond 4 are all pumped to this dam once the water level reaches a certain level.

With the exception of Maturation Pond 4, all of the maturation ponds are currently being filled in as part of the site closure works. As such, these dams were assumed to be filled in during Stage 1 with sediment laden runoff from these disturbed areas reporting to Maturation Pond 4.

At present, the Tailings Storage Facility (TSF) has not been capped and is operating as a dam, with all rainfall landing in, and runoff reporting to, this large water storage contained within the TSF. The OCAL Mine Closure Plan prepared by SLR in 2016 indicated that this dam would not overflow during extreme storm events so no overflows have been assumed from this structure in Stage 1 of this DWMS.

The external slopes of the TSF have at present not been rehabilitated, with many areas having carboniferous materials at the surface. Runoff from the northern slopes of the TSF report to the REA Dam, which is operated as a sediment dam, with water following storm events being pumped across to Catch Dam 1.

3.3 Stage 2 – Future Water Management

The Stage 2 water management system is intended to represent the near future scenario at the MCPP (i.e. 5-10 years from now). It will be the same as Stage 1 except for the following differences:

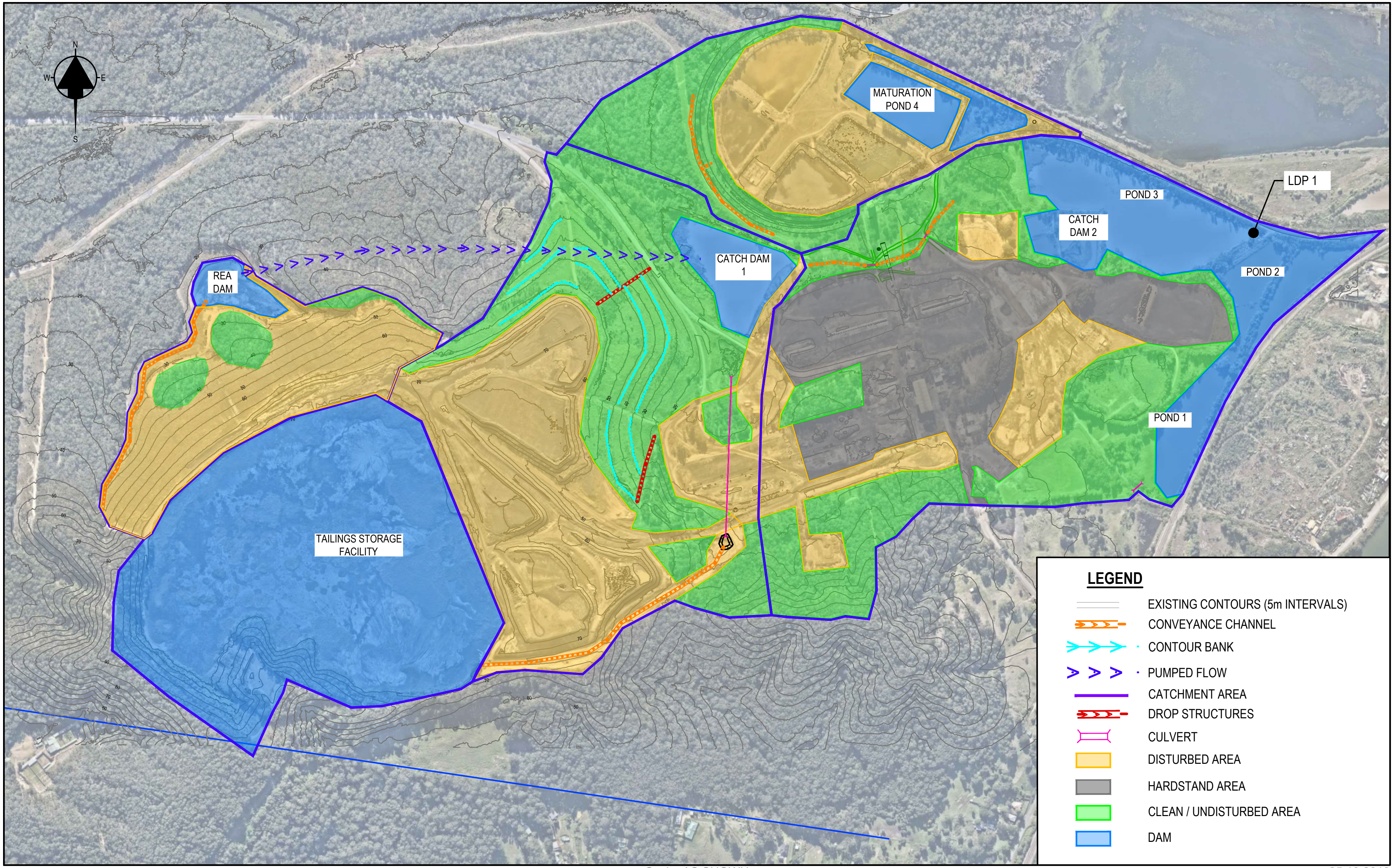
- Stabilisation works (including disturbances) on the northern face of the TSF will have occurred with additional water conveyance structures constructed. The REA Dam will be allowed to overflow and report to the environment via watercourses which flow northwards (Pumping from the REA Dam to Catch Dam 1 will cease);
- Stabilisation works on the eastern slopes of the TSF will have occurred;
- The top surface of the TSF will be capped and regarded to a free drainaing surface. Runoff from this area will overflow into a channel that reportsto Catch Dam 1; and,
- Several other existing disturbance areas located around the previous mine infrastructure area will have been rehabilitated.

A catchment plan of the Stage 2 water management system, including dams, water conveyance structures, dam sub-catchment boundaries and the specific land types, is shown in **Figure 2**.

3.4 Stage 3 – Long Term Water Management

The Stage 3 water management system is intended to represent the long term future scenario at the MCPP (i.e. >10 years from now). Stage 3 includes future site redevelopment consistent with the OCAL mine closure plan, which includes areas of industrial land-use within the MCPP catchment. The exact final land-use of the site is unclear, however this DWMS has assumed that all disturbance areas will have been successfully rehabilitated and therefore no active management (i.e. dewatering or desilting) of the dams will be undertaken. If there is a regulated activity that requires an additional environmental licence then it is assumed that additional water quality controls would be implemented at that location.

This stage will include the same sub-catchment areas as Stage 2 except it is assumed that the site has been fully rehabilitated and no disturbance areas will be present. A catchment plan of the Stage 1 water management system, including dams, water conveyance structures, dam sub-catchment boundaries and the specific land types, is shown in **Figure 3**.



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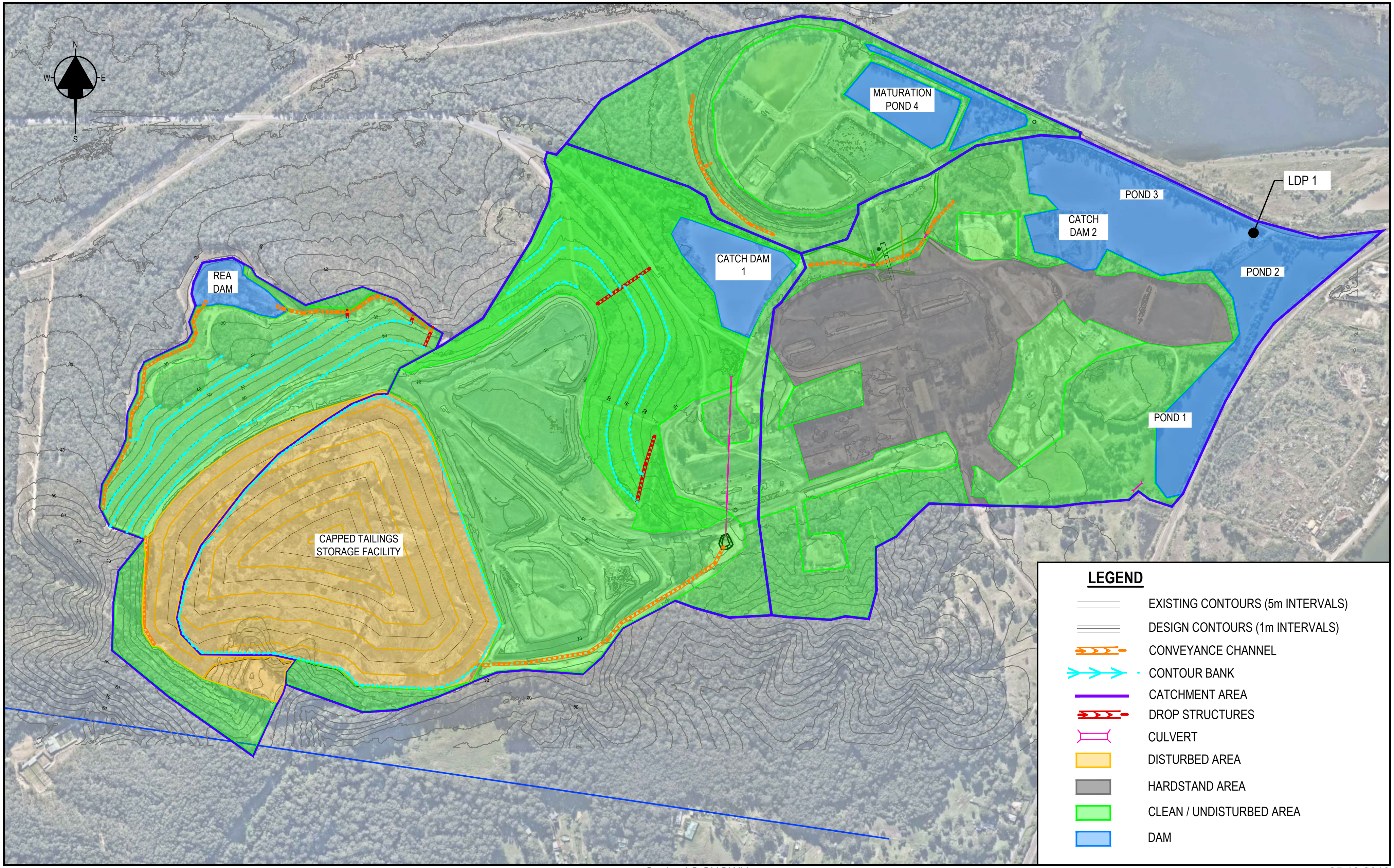
STAGE 1
EXISTING WATER MANAGEMENT SYSTEM

FIGURE 1



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STAGE 2
FUTURE WATER MANAGEMENT SYSTEM

FIGURE 2

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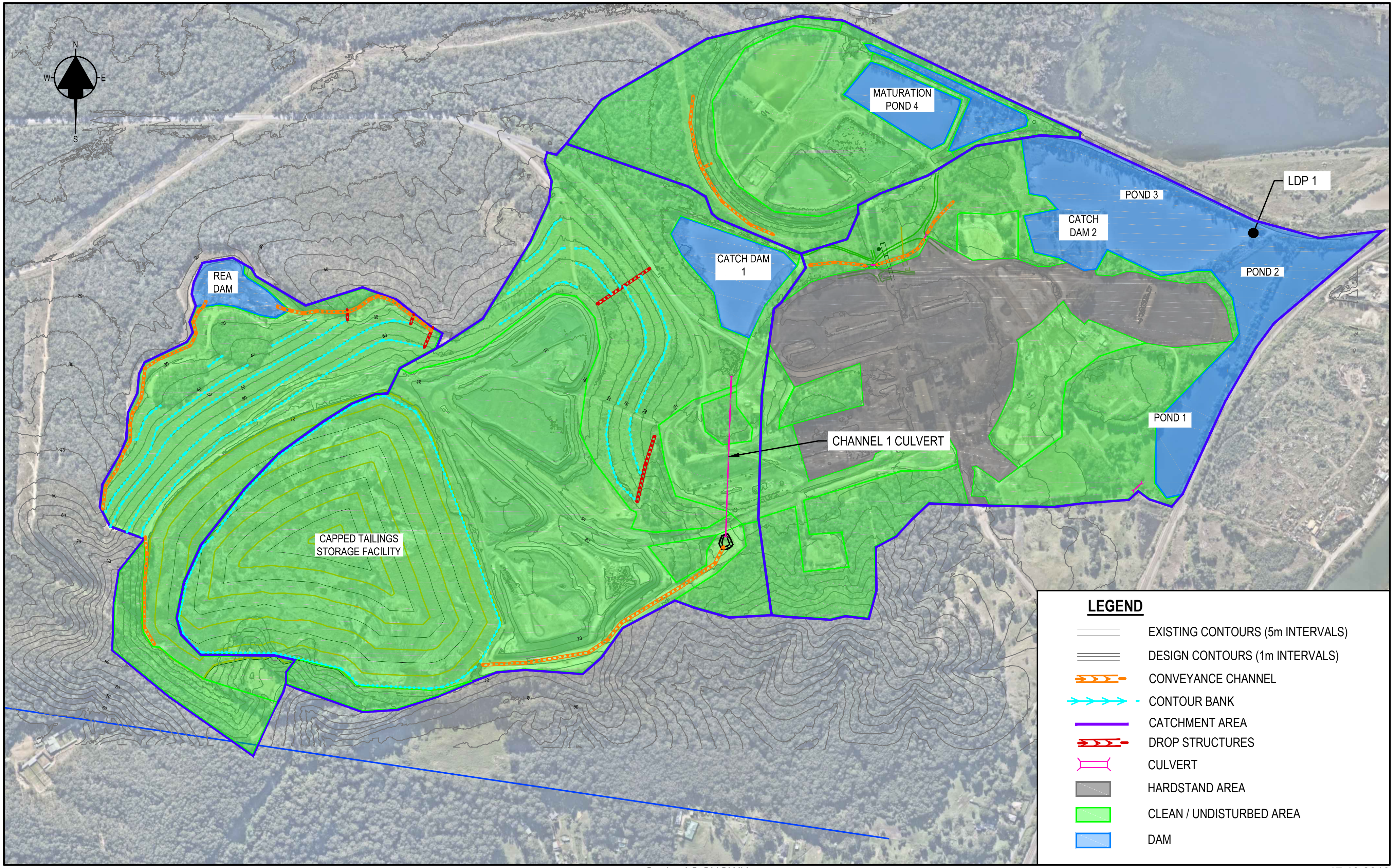

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STAGE 3
LONG TERM WATER MANAGEMENT SYSTEM

FIGURE 3

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4 Dam Sizing Assessment

An assessment of the capacity of the dams to retain runoff from each of the MCPP stages was undertaken as part of this DWMS. The required storage capacity of the sediment dams was calculated in accordance with the requirements of EPL 1360 and the Blue Book with the following design criteria and assumptions:

- The sediment dams were assessed against the EPL 1360 rainfall depth of 51mm. This rainfall event roughly equates to a 5 day, 90th percentile design storm (rainfall depth of 51.8mm as documented for Newcastle) which is also in accordance with Table 6.1 of the Blue Book for expected disturbance durations greater than 3 years and a standard receiving environment;
- Sediment dams were type F or type D based on the typical soil types within the area;
- A 'Disturbed' runoff coefficient of 0.74 was utilised in accordance with Table F2 of the Blue Book for the design rainfall depth;
- 'Clean' water runoff coefficient of 0.2 was utilised from undisturbed and rehabilitated areas; and
- The sediment storage zone was based on a management period of 12 months (i.e. the dams would be desilted annually). The sediment storage zone was calculated based on it being 50% of the settling zone storage in accordance with the Blue Book.
- Pond 3 includes the storage capacity and catchment areas of Pond 3, Pond 2 and Catch Dam 2 and assessed as a single dam system as it is understood that water can be pumped around these dams as required.

The storage capacity required within each of the proposed dam systems is detailed within **Table 1**. Calculations presented are those for the stage which represents the worst case at each dam. These results indicate that the existing dam capacity at the MCPP is sufficient to manage sediment laden runoff in accordance with the Blue Book and EPL 1360.

Table 1 MCPP Dam Capacity Assessment Results

Dam	Critical Stage	Catchment Area (ha)	Settling Zone Volume Required (ML)	Sediment Zone Volume Required (ML)	Total Dam Volume Required (ML)	Existing Dam Volume (ML)	Sufficient Capacity in Dam
REA Dam	Stage 1	15.63	5.60	2.80	8.40	33.0	Yes
Catch Dam 1 #1	Stage 1	48.81	13.32	6.66	19.99	65.0	Yes
Maturation Pond 4 #1	Stage 1	22.60	6.84	3.42	10.26	33.0	Yes
Pond 3	Stage 1	63.44	22.78	11.39	34.16	69.0 #2	Yes

#1 – This dam will be pumped and will overflow into Pond 3.
#2 – Includes Pond 1, Pond 2 and Catch Dam 2

5 Discharge Volume Assessment

5.1 General

Hydrological modelling was undertaken for the three MCPP scenario's detailed in **Section 3** in order to estimate the annual flow volumes that will pass through LDP 1 over time. GoldSim Version 11.1.4 was used to undertake a daily time step for these site scenario's. The GoldSim software is graphical, object-oriented system simulation software for completing either static or dynamic systems and is a widely accepted tool to undertake site water balances within the mining industry.

5.2 GoldSim Methodology/Assumptions

5.2.1 Rainfall

The Lake Macquarie region has a borderline oceanic/humid subtropical climate like much of central and northern NSW. Summers tend to be warm and winters are generally mild. Precipitation is heaviest in late autumn and early winter. A review of the Bureau of Meteorology (BOM) website indicated that there were no weather stations located in the immediate vicinity of the Site apart from the OCAL site's own weather station. This weather station, whilst useful for reviewing data from recent rainfall events, is limited by the amount of years where rainfall data was collected.

However, there are numerous stations in the general area of the site. All of these weather stations contain similar average annual rainfall statistics. The closest of these weather stations is the Edgeworth WWTP station (station number 61393) which includes rainfall data dating back to 1990. Rainfall statistics for the region from the Edgeworth Wastewater Treatment Plant (WWTP) station include:

- Minimum annual rainfall – 763mm in 1993;
- Average annual rainfall – 1138mm;
- Median annual rainfall – 1076mm; and
- Maximum annual rainfall – 1771mm in 1990.

Daily rainfall data from this weather station was used in the water balance from the period from 1st January 1990 to 31st December 2017. Only data from complete years was used for the purposes of the annual statistical analysis.

5.2.2 Evaporation

Evaporation data was obtained from the BOM's station at Williamtown RAAF (station number 61078), approximately 38km north-east of the MCPP. This was the closest meteorological weather station to the site with over 40 years of evaporation information. Evaporation data was adjusted to reflect changes in evaporation at site dams compared to measured pan evaporation at the weather station, by multiplying the average monthly evaporation rates by a pan coefficient of 0.7.

Figure 4 provides a representation of the adjusted average daily evaporation (for each month) at this weather station. This data was used to simulate evaporation from the MCPP dams within the water balance.

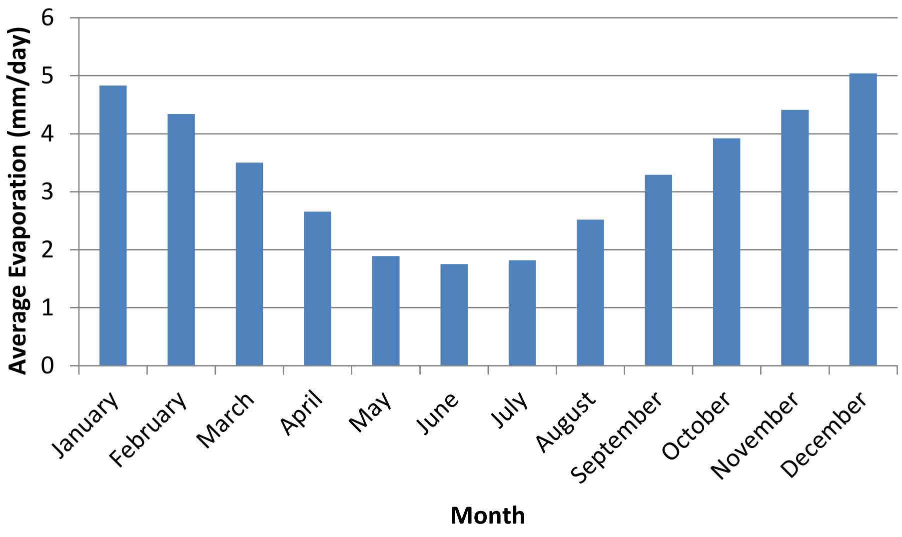


Figure 4 Average Adjusted Daily Evaporation Rates

5.2.3 Runoff Simulations

The Australian Water Balance Model (AWBM) was used to simulate runoff from rainfall on the various MCPP stages. The AWBM is a nationally-recognised catchment water balance model that can relate runoff to rainfall with daily data. The AWBM tracks changes in soil moisture storage, allowing a calculation of rainfall losses that account for antecedent rainfall, and generates daily runoff volumes for water balance modelling. Modelling was undertaken for various sub-catchment types including hardstand, disturbed and clean (undisturbed/rehabilitated).

AWBM parameters were selected based a combination of a literature review, calculations, previous operational water balances undertaken at the site and SLR's recommended values based on previous experience. These parameters were judged to be adequate for the purposes of this site water balance investigation and were adopted for the GoldSim modelling. The parameters used for different catchment surfaces are shown in **Table 2** below.

Table 2 MCPP Water Balance AWBM Parameters

Parameter	Clean / Rehabilitated	Hardstand	Disturbed
C1 (mm)	22.4	2.0	10
C2 (mm)	48.2	0.0	30
C3 (mm)	77.0	0.0	60
A1	0.134	1.0	0.134
A2	0.433	0	0.433
A3	0.433	0	0.433
BFI	0.25	0	0.1
K_{base}	0.813	0.96	0.95
K_{surf}	0.5	0.1	0.2

5.2.4 GoldSim Parameters and Assumptions

The following parameters and assumptions were incorporated in the GoldSim model:

- Daily time steps over a simulation length of 28 years were used for the analysis – daily rainfall data was the shortest period available for recorded data;
- Runoff from catchments was represented by the Australian Water Balance Model (AWBM) methodology, as described in Section 5.2.3;
- Pond 3 was simulated as a dam system including Pond 1, Pond 2 and Catch Dam 2;
- The REA Dam, Catch Dam 1 and Maturation Pond 4 were dewatered to Pond 3 in Stages 1 and 2 once the available volume in the dams reduced the capacity of the dams to less than the Settling Storage Volume estimated for each of these dams in Section 4. This dewatering was assumed to occur at a rate of 2ML/day. No active water management was undertaken in Stage 3 as the site was assumed to be rehabilitated (i.e. not requiring actively managed sediment dams);
- Catch Dam 1 and Maturation Pond 4 overflow into Pond 3. Overflows from the REA Dam will flow offsite and to the north;
- Water used for dust suppression was obtained from Pond 3 in Stages 1 and 2 at a rate of 0.08ML/day in accordance with the estimated use from previous water balances undertaken at the site. No dust suppression was undertaken in Stage 3 as the site was assumed to be rehabilitated (i.e. not requiring actively managed sediment dams);
- When available, water was released from Pond 3 at a rate of 6ML/day in accordance with the LDP 1 limits stipulated by EPL 1360;
- No allowance was made for leakage from the dams. This is a conservative assumption and was therefore considered to be acceptable for the purposes of the conceptual water balance investigation;
- It was assumed that no groundwater enters the MCPP dams; and
- It was assumed that the dams were half full at the start of the GoldSim simulation.

5.3 LDP 1 Flow Estimation Results

The estimated discharges and releases of water through LDP 1, as estimated by the GoldSim modelling for each of the proposed stages, are provided in **Table 3**. Overflows from the REA Dam were also estimated as this would occur to the north of the MCPP and not through LDP 1. The water levels within the MCPP dam systems during each of the staging scenarios are provided in **Appendix A** along with the predicted overflow volumes. Although historical rainfall data has been used during this assessment the results are intended to be used as a prediction of future flows.

Table 3 Estimated LDP 1 Flow Volumes and REA Overflow Volumes

Stage	Discharge Location	Discharge Type	Annual Min Volume (ML)	Annual Max Volume (ML)	Annual Average Volume (ML)
Stage 1 - Existing Water Management	LDP1	Offsite Release	225	901	559
		Overflow	0	552	105
		Total (Release and Overflow)	225	1453	664
	REA Dam	Overflow	0	39	7
Stage 2 - Future Water Management	LDP1	Offsite Release	221	892	560
		Overflow	0	681	129
		Total (Release and Overflow)	221	1573	689
	REA Dam	Overflow	0	89	83
Stage 3 - Long Term Water Management	LDP1	Offsite Release	0	0	0
		Overflow	54	1342	468
		Total (Release and Overflow)	54	1342	468
	REA Dam	Overflow	13	219	83

It can be seen from **Table 3** that the estimated annual water volumes being released/discharged via LDP 1 during stages 1, 2 and 3 are 664ML, 689ML and 468ML respectively. Runoff volumes are expected to increase once the TSF is capped and runoff is allowed to flow to Catch Dam 1 before flowing into Pond 3 and ultimately through LDP 1 (Stage 2). Runoff volumes are expected to then decrease once the site has been fully rehabilitated and no active management of runoff is undertaken (including regular release of water through LDP 1).

Overflow water volumes from the REA Dam are expected to increase from Stage 1 to Stage 2. Although the disturbed areas will be rehabilitated, the catchment area will be increased to include part of catchment currently reporting to the TSF, and since no active water management is undertaken (i.e. water is no longer pumped to Catch Dam 1). Overflows from the REA Dam are expected to have acceptable water quality once the catchment is fully rehabilitated.

5.4 Sensitivity Analysis

Detailed calibration of the site water balance could not be undertaken as the hydrological processes at the MCPP (including obtaining water from the Edgeworth WWTP) have changed in recent years and therefore the results cannot be compared to historical discharge volumes. The LDP 1 discharge volumes estimated for the current Stage 1 scenario are within the range of recent historical discharges from the site.

A sensitivity analysis was undertaken to assess the impact of runoff uncertainty within the GoldSim model, as this was considered to be the main source of uncertainty to the results. This sensitivity analysis assessed the impact of increasing and decreasing the runoff by 30% on the annual average water volumes released and discharged via LDP 1. The results of this sensitivity analysis are provided in **Table 4**.

Although a specific climate change assessment was not included in the scope of works of this DWMS investigation the results of the sensitivity analysis can be used to make some assessment of the possible impacts of climate change during the later scenario's (i.e. Stages 2 and 3).

Table 4 Estimated LDP 1 Flow Volumes and REA Overflow Volumes

Stage	Runoff Reduced by 30%	Annual Average LDP1 Volume (ML)	Runoff Increased by 30%
Stage 1 - Existing Water Management	455	664	873
Stage 2 - Future Water Management	472	689	907
Stage 3 - Long Term Water Management	261	468	679

6 Discharge Water Quality Assessment

6.1 Cockle Creek Water Quality

Upstream and downstream monitoring data within Cockle Creek from 2015 to August 2018 was assessed to assist with developing site specific trigger values and to assess the runoff water quality of the MCPP in the wider context of the catchment receiving waters. This monitoring data included TSS, pH and conductivity as well as both dissolved and total metals.

The upstream and downstream monitoring points are located approximately 50m upstream and 50m downstream of the discharge location into Cockle Creek. These locations are shown in Figure 5 of the surface water assessment report prepared for OCAL Mine Closure Plan.

A statistical summary of the upstream and downstream water quality monitoring is provided in **Table 5**.

Table 5 Cockle Creek Water Quality Monitoring Statistics

	Cockle Creek Upstream				Cockle Creek Downstream			
Parameter	**Min**	**Max**	**Mean**	**80th %ile**	**Min**	**Max**	**Mean**	**80th %ile**
Total Suspended Solids (mg/L)	4.0	402.0	22.3	22.2	5.0	459.0	24.0	22.8
pH	6.7	8.3	7.8	7.5 (20th) 8.0 (80th)	6.6	9.0	7.8	7.5 (20th) 8.1 (80th)
Conductivity (µS/cm)	277.0	57600.0	35203.3	50400.0	275.0	57500.0	35309.3	50560.0

	Cockle Creek Upstream				Cockle Creek Downstream			
Parameter	Min	Max	Mean	80th %ile	Min	Max	Mean	80th %ile
Al (dissolved) (µg/l)	30.0	990.0	215.8	294.0	20.0	600.0	203.3	284.0
Al (total) (µg/l)	2.0	5830.0	1450.2	1868.0	0.0	4280.0	1562.5	2508.0
As (dissolved) (µg/l)	1.0	10.0	3.2	2.8	1.0	10.0	3.8	6.4
As (total) (µg/l)	0.0	10.0	3.5	3.0	0.0	10.0	3.8	4.6
Be (dissolved) (µg/l)	1.0	10.0	2.5	1.0	1.0	10.0	2.5	1.0
Be (total) (µg/l)	0.0	10.0	2.4	1.0	0.0	10.0	2.4	1.0
Cd (dissolved) (µg/l)	0.0	2.6	0.6	1.1	0.0	3.0	0.7	0.9
Cd (total) (µg/l)	0.0	1.2	0.4	0.8	0.0	3.0	0.6	0.7
Cr (dissolved) (µg/l)	1.0	10.0	2.5	1.0	1.0	10.0	2.5	1.0
Cr (total) (µg/l)	0.0	10.0	2.8	3.0	0.0	10.0	2.7	2.8
Co (dissolved) (µg/l)	1.0	10.0	2.6	1.0	1.0	10.0	2.6	1.0
Co (total) (µg/l)	1.0	10.0	2.6	1.0	1.0	10.0	2.6	1.0
Cu (dissolved) (µg/l)	1.0	10.0	3.6	3.8	1.0	10.0	3.6	3.8
Cu (total) (µg/l)	0.0	27.0	6.7	6.0	0.0	10.0	4.8	5.8
Fe (dissolved) (mg/l)	0.1	0.8	0.4	0.5	0.1	0.7	0.3	0.5
Pb (dissolved) (µg/l)	1.0	43.0	7.0	9.8	1.0	10.0	3.3	6.8
Pb (total) (µg/l)	0.0	10.0	5.1	9.2	0.0	10.0	6.1	8.8

	Cockle Creek Upstream				Cockle Creek Downstream			
Parameter	Min	Max	Mean	80th %ile	Min	Max	Mean	80th %ile
Hg (dissolved) (µg/l)	0.0	0.1	0.1	0.1	0.0	0.1	0.1	0.1
Hg (total) (µg/l)	0.0	0.1	0.1	0.1	0.0	0.1	0.1	0.1
Mo (dissolved) (µg/l)	1.0	10.0	3.1	4.6	1.0	32.0	5.3	8.4
Mo (total) (µg/l)	0.0	10.0	2.9	2.8	0.0	10.0	3.0	3.0
Ni (dissolved) (µg/l)	1.0	10.0	2.7	2.0	1.0	31.0	5.3	8.4
Ni (total) (µg/l)	0.0	10.0	2.9	2.0	0.0	10.0	3.1	2.8
Se (dissolved) (µg/l)	1.0	100.0	24.3	10.0	1.0	100.0	24.3	10.0
Se (total) (µg/l)	0.0	100.0	24.2	10.0	0.0	100.0	24.2	10.0
Ag (dissolved) (µg/l)	1.0	10.0	2.8	4.2	1.0	10.0	2.8	4.2
Ag (total) (µg/l)	0.0	10.0	2.4	1.0	0.0	10.0	2.4	1.0
V (dissolved) (µg/l)	5.0	100.0	24.6	10.0	5.0	100.0	24.6	10.0
V (total) (µg/l)	0.0	100.0	24.2	10.0	0.0	100.0	24.2	10.0
Zn (dissolved) (µg/l)	5.0	90.0	47.1	51.6	11.0	98.0	53.2	78.8
Zn (total) (µg/l)	0.0	80.0	56.6	73.2	0.0	175.0	68.9	77.6

The results of the Cockle Creek water quality monitoring indicate that the water quality of the creek is similar to what would be expected for a creek located in a moderately disturbed catchment. Statistically significant increases of aluminium, arsenic, molybdenum, nickel and zinc were observed in the downstream monitoring point compared to the upstream monitoring point.

It is noted that due to small diurnal tides in Lake Macquarie, it may be possible during dry weather for water in Cockle Creek to move upstream. However, it is considered unlikely that discharges from LDP1 would reach the upstream monitoring location under normal tidal fluctuations.

Trigger values for assessing water quality runoff from the MCPP site would include a combination of the upstream 80th percentile Cockle Creek values (in accordance with the ANZG 2018 guidelines) and the LDP 1 concentration limit values detailed in Section 2.1.

6.2 Existing Water Quality

MCPP water quality monitoring data from 2015 to August 2018 was analysed to assist with the characterisation of the existing site runoff water quality. This water quality data includes discharge water quality data at LDP 1 and water quality data obtained from within the REA Dam, Maturation Pond 1 and Maturation Pond 5.

A summary of the LDP 1 water quality discharge statistics are provided in **Table 6** along with the calculated trigger values detailed in Section 6.1.

Table 6 LDP 1 Discharge Water Quality Monitoring Statistics

Parameter	Min	Max	Mean	80th %ile	Trigger Value
Total Suspended Solids (mg/L)	3.1	540.0	82.4	122.0	50.0
pH	6.9	9.0	8.3	8.0 (20th) 8.7 (80th)	7.5 (20th) 9.0 (80th)
Conductivity (µS/cm)	250.0	2400.0	1129.3	1588.0	50400.0
Al (dissolved) (µg/l)	10.0	700.0	179.2	224.0	294.0
Al (total) (µg/l)	160.0	14200.0	6655.8	10940.0	1868.0
As (dissolved) (µg/l)	1.0	2.0	1.3	2.0	2.8
As (total) (µg/l)	1.0	5.0	2.8	4.0	3.0
Be (dissolved) (µg/l)	1.0	1.0	1.0	1.0	1.0
Be (total) (µg/l)	1.0	1.0	1.0	1.0	1.0
Cd (dissolved) (µg/l)	0.1	0.2	0.1	0.1	1.1
Cd (total) (µg/l)	0.1	0.2	0.1	0.1	0.8
Cr (dissolved) (µg/l)	1.0	1.0	1.0	1.0	1.0

Parameter	Min	Max	Mean	80th %ile	Trigger Value
Cr (total) (µg/l)	1.0	4.0	2.3	3.0	3.0
Co (dissolved) (µg/l)	1.0	1.0	1.0	1.0	1.0
Co (total) (µg/l)	1.0	1.0	1.0	1.0	1.0
Cu (dissolved) (µg/l)	1.0	2.0	1.3	1.8	3.8
Cu (total) (µg/l)	1.0	9.0	5.3	8.0	6.0
Fe (dissolved) (mg/l)	0.1	0.4	0.1	0.2	0.5
Pb (dissolved) (µg/l)	1.0	1.0	1.0	1.0	9.8
Pb (total) (µg/l)	1.0	20.0	9.1	14.8	9.2
Hg (dissolved) (µg/l)	0.0	0.1	0.1	0.1	0.1
Hg (total) (µg/l)	0.0	0.1	0.1	0.1	0.1
Mo (dissolved) (µg/l)	1.0	5.0	2.7	5.0	4.6
Mo (total) (µg/l)	1.0	10.0	5.2	7.0	2.8
Ni (dissolved) (µg/l)	1.0	3.0	1.8	2.8	2.0
Ni (total) (µg/l)	2.0	5.0	3.9	4.8	2.0
Se (dissolved) (µg/l)	1.0	10.0	9.3	10.0	10.0
Se (total) (µg/l)	2.0	10.0	9.3	10.0	10.0
Ag (dissolved) (µg/l)	1.0	5.0	1.3	1.0	4.2
Ag (total) (µg/l)	1.0	5.0	1.3	1.0	1.0
V (dissolved) (µg/l)	5.0	10.0	9.6	10.0	10.0

Parameter	Min	Max	Mean	80th %ile	Trigger Value
V (total) (µg/l)	5.0	10.0	9.6	10.0	10.0
Zn (dissolved) (µg/l)	23.0	320.0	126.5	187.4	51.6
Zn (total) (µg/l)	214.0	1630.0	618.7	880.0	73.2
Oil and Grease (mg/L)	5.0	29.0	6.9	10.0	10

The water quality results presented in **Table 6** indicate that the TSS concentration often exceeds the LDP 1 discharge limit of 50mg/L. This, in part, may be due to the fact that OCAL often discharge when rainfall exceeds 51mm (or over 50mm as per previous licence condition), in accordance with EPL 1360, with reduced hydraulic residence time for settlement or treatment of suspended solids.

Table 6 also indicates that water quality discharged from LDP 1 is generally below the 80th percentile values for Cockle Creek (upstream). Some dissolved and total heavy metal exceedances of the 80th percentile values for Cockle Creek (upstream) have occurred in several heavy metals. These include molybdenum, nickel and zinc, whilst some exceedances of total concentrations are also noted in aluminium, arsenic, copper and lead. These heavy metal exceedances align with the statistically significant increases observed with the downstream Cockle Creek monitoring point compared to the upstream Cockle Creek monitoring point. It is noted that the majority of OCAL discharges occur during significant flow events (when the 5 day rainfall exceeds the 51mm specified within EPL1360).

Additional water quality data obtained from the REA Dam, Maturation Pond 1 and Maturation Pond 5 are provided in **Table 7** below. This data does not include information on heavy metal concentrations as this information was unavailable. As this water quality data does not pertain to water that is discharged from site it is not considered to be as applicable to this DWMS as the LDP 1 discharge data contained in **Table 6**.

Table 7 MCPP Dam Water Quality Monitoring Statistics

Dam	Parameter	Min	Max	Mean	80th %ile	EPL 1360 Limit
REA Dam	Total Suspended Solids (mg/L)	9.0	460.0	90.6	142.0	50.0
	pH	8.2	9.5	8.7	8.5 (20th) 8.9 (80th)	7.5 (20th) 9.0 (80th)
	Conductivity (µS/cm)	599.0	2420.0	1160.3	1380.0	NA
Maturation Pond 1	Total Suspended Solids (mg/L)	5.0	101.0	23.7	34.0	50.0

Dam	Parameter	Min	Max	Mean	80th %ile	EPL 1360 Limit
	pH	7.1	9.5	7.8	7.3 (20th) 8.3 (80th)	7.5 (20th) 9.0 (80th)
	Conductivity (µS/cm)	567.0	869.0	708.8	782.0	NA
Maturation Pond 5	Total Suspended Solids (mg/L)	7.0	342.0	91.2	167.0	50.0
	pH	5.3	10.1	8.5	8.2 (20th) 9.1 (80th)	7.5 (20th) 9.0 (80th)
	Conductivity (µS/cm)	416.0	2510.0	1187.4	1340.0	NA

6.3 Predicted Future Water Quality

The majority of the existing water quality data detailed in Section 6.2 was obtained when the MCPP was still operational. In particular it is noted that Spent Pickle Liquor was previously used on site as a water treatment until 2016.

Improvements in water quality are expected as closure works at site progress. Closure works which are likely to substantially improve the quality of water discharged from site include the following activities:

- Capping and vegetation of the TSF surface;
- Covering of carboniferous materials and rehabilitation of disturbed areas including the TSF external slopes, and areas around the previous mine infrastructure areas;
- Clean-up and rehabilitation of several previous maturation ponds. Sediments are being assessed for contaminants and remediated as required; and
- Progressive re-development opportunities within the previous mine infrastructure area noted as 'hardstand' on Figure 3.

7 Conclusions and Recommendations

Key findings of the DWMS include:

- Closure works at the MCPP have been considered at three key stages including the existing stage (Stage 1), a short-medium term stage (Stage 2) and a long term final land-use stage (Stage 3).
- Dams at the MCPP have adequate capacity to contain runoff in accordance with the EPL 1360 and Blue Book requirements for sediment dams.
- The estimated annual water volumes to be released/discharged via LDP 1 are 664ML, 689ML and 468ML during stages 1, 2 and 3 respectively. Runoff volumes are expected to increase once the TSF is capped and runoff is allowed to flow to Catch Dam 1 before flowing into Pond 3 and ultimately through LDP 1 (Stage 2). Runoff volumes are expected to decrease once the site has been rehabilitated and no active management of runoff is undertaken (including regular release of water through LDP 1).

- Overflow water volumes from the REA Dam are expected to increase from Stage 1 to Stage 2. Although the disturbed areas will be rehabilitated, the catchment area will be increased to include part of catchment currently reporting to the TSF, and since no active water management is undertaken (i.e. water is no longer pumped to Catch Dam 1). Overflows from the REA Dam are expected to have acceptable water quality once the catchment is fully rehabilitated.
- Water quality monitoring data indicates that the TSS concentration often exceeds the LDP 1 discharge limit of 50mg/L. This, in part, may be due to the fact that OCAL often discharge when rainfall exceeds 51mm, in accordance with EPL 1360, with reduced time for settlement or treatment of suspended solids.
- Water quality discharged from LDP 1 is generally below the 80th percentile values for Cockle Creek (upstream). Some dissolved and total heavy metal exceedances of the 80th percentile values for Cockle Creek (upstream) have occurred. These include molybdenum, nickel and zinc. Some exceedances of total concentrations are also noted in aluminium, arsenic, copper and lead. It is noted that the majority of OCAL discharges occur during significant flow events (when the 5 day rainfall exceeds the 51mm specified within EPL1360).
- Water management at the MCPP will generally align with the NSW Water Quality and Marine Water Quality Objectives. However, the discharge water quality will need to be monitored closely as the closure works progress, with improvement actions undertaken, if required based on future monitoring data in consultation with the EPA.
- Improvements in water quality are expected as closure works progress and the site is rehabilitated.

Recommendations for future water management at the MCPP include:

- Undertake ongoing monitoring of LDP 1 and the Cockle Creek monitoring points to identify the impact that the closure works are having on the quality of water discharged from the site;

  and
- The dams be desilted when the storage capacity is reduced by the ‘sediment storage zone’ volume. How often this occurs is subject to the amount of sediment being delivered into the dams.

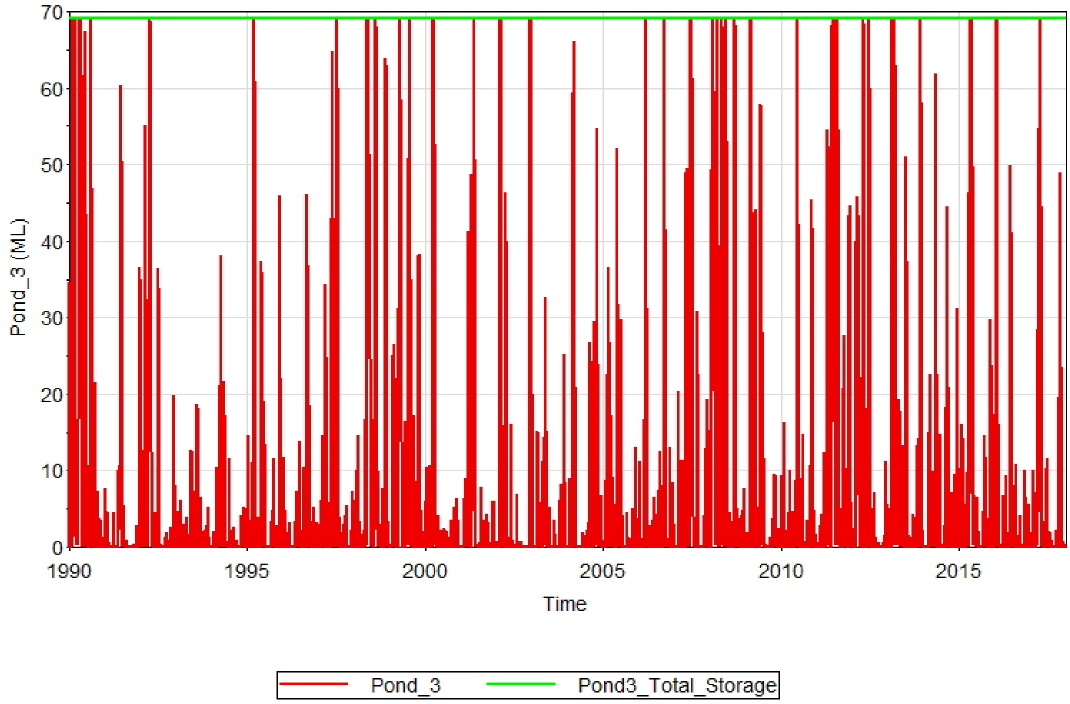
No specific immediate works or actions are recommended at the site as it is likely that the ongoing closure works will improve water quality over time. The mass loads of pollutants being discharged from the site are also anticipated to improve over time as the water volume reduces and the water quality improves.

Ongoing monitoring of water quality is recommended to confirm if proposed closure works are adequate to improve water quality to an acceptable level, or assess the need for any additional water quality improvement works.

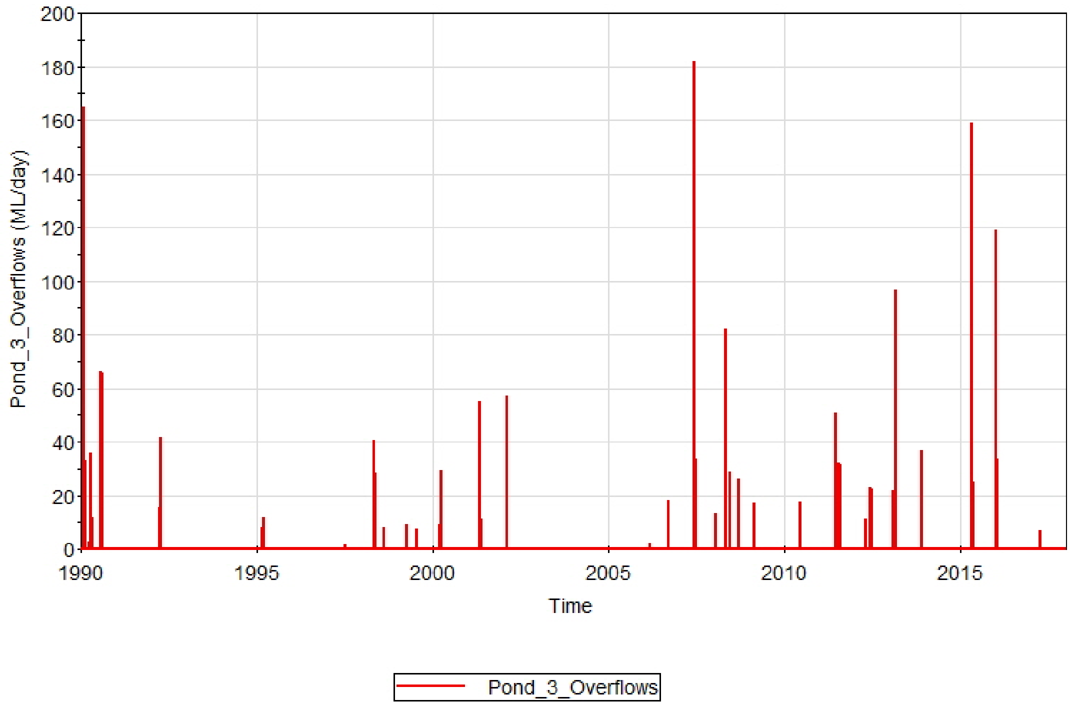
APPENDIX A

GoldSim Dam Levels and Overflow Rates

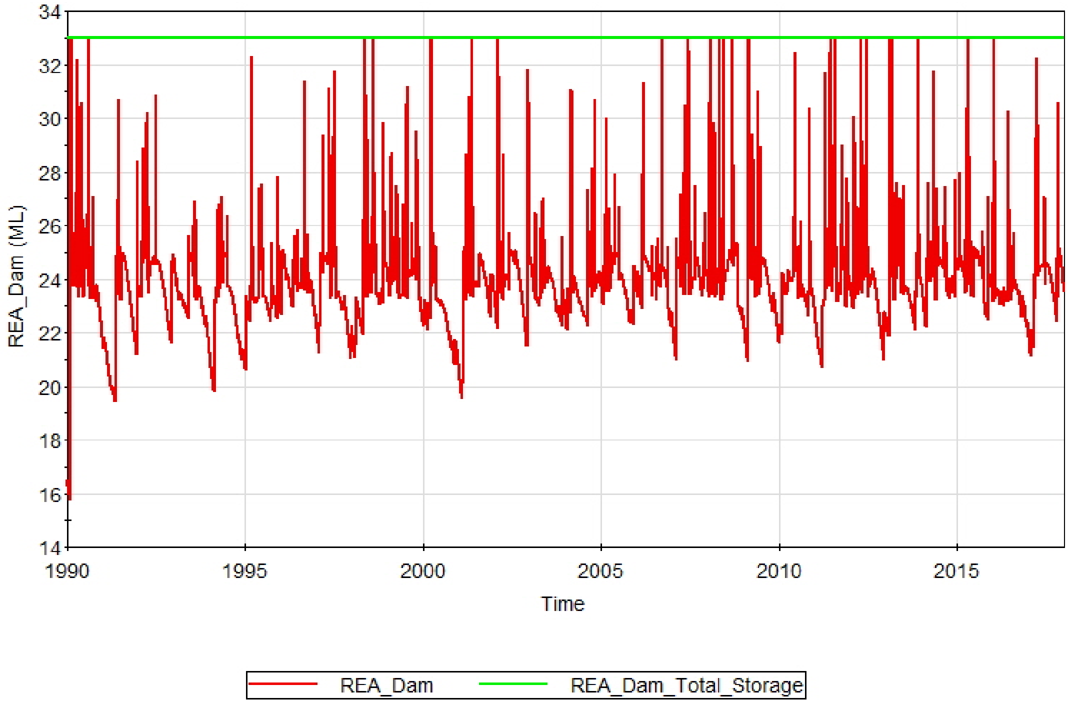
Stage 1 – Pond 3



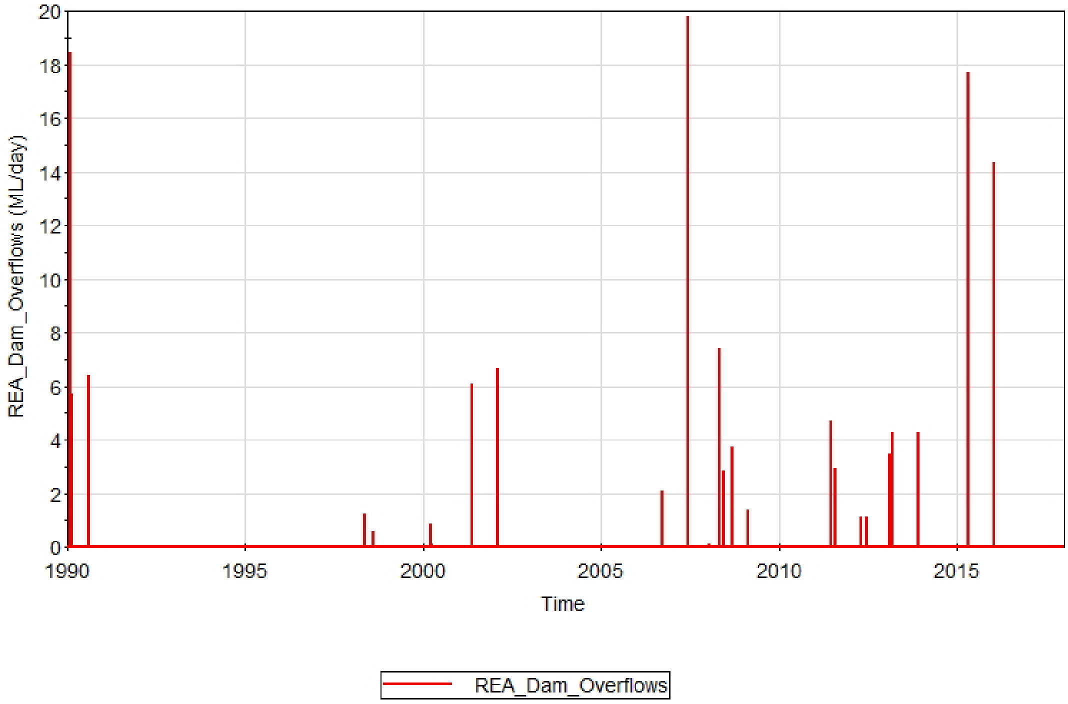
Stage 1 – Pond 3 Overflows



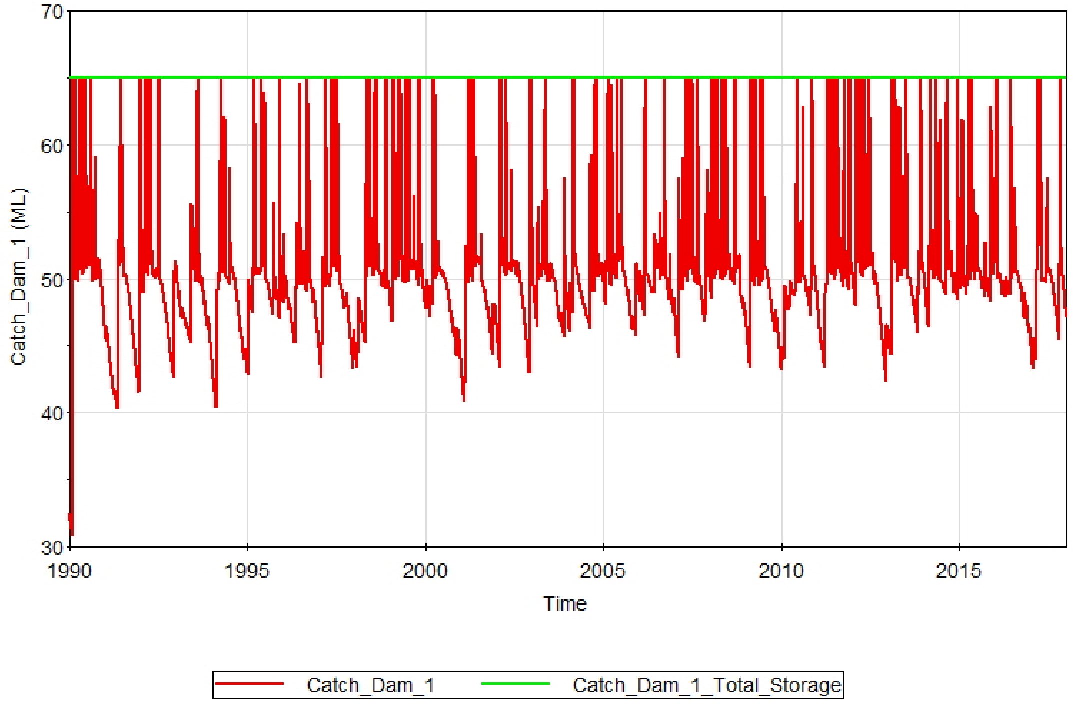
Stage 1 – REA Dam



Stage 1 – REA Dam Overflows



Stage 1 – Catch Dam 1



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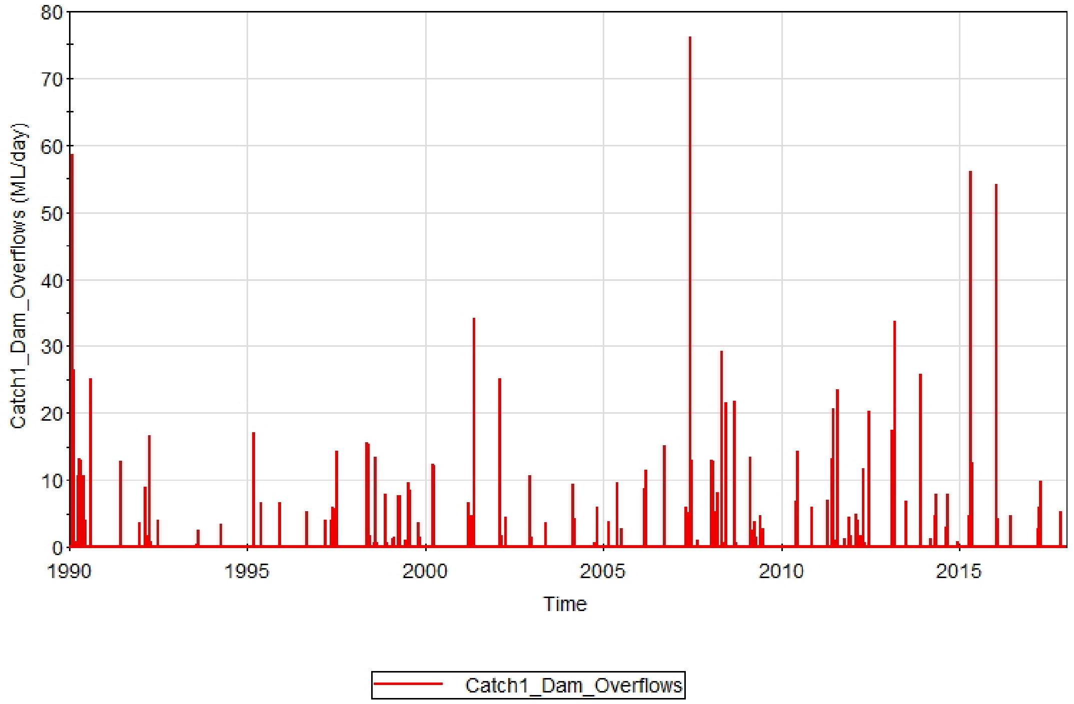
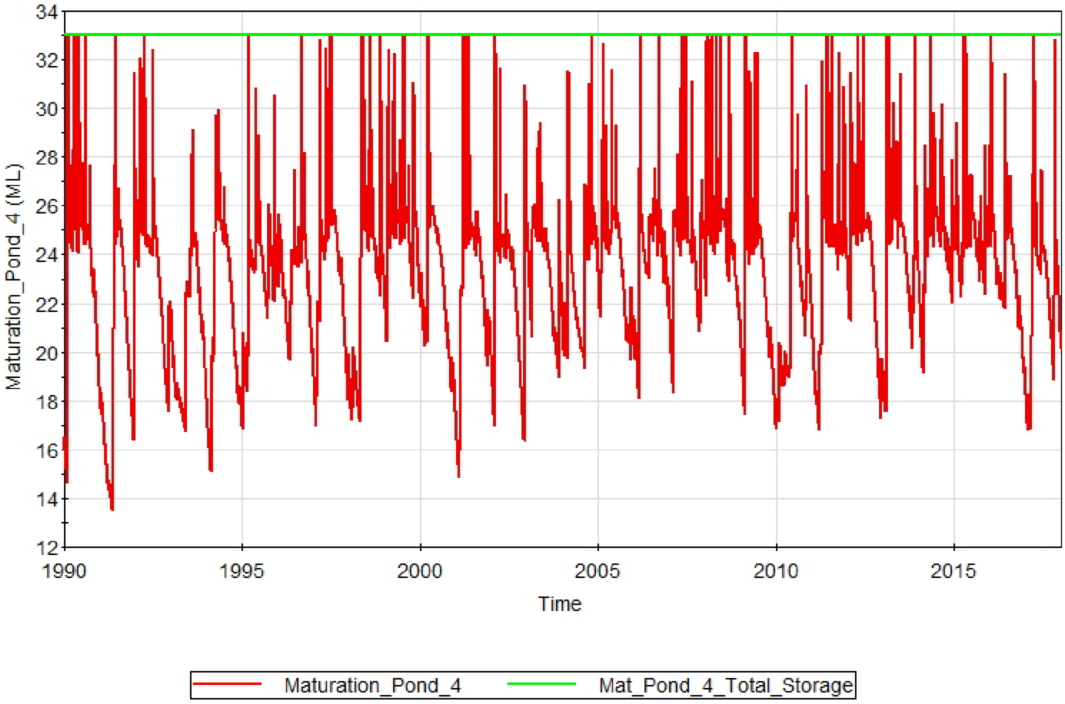
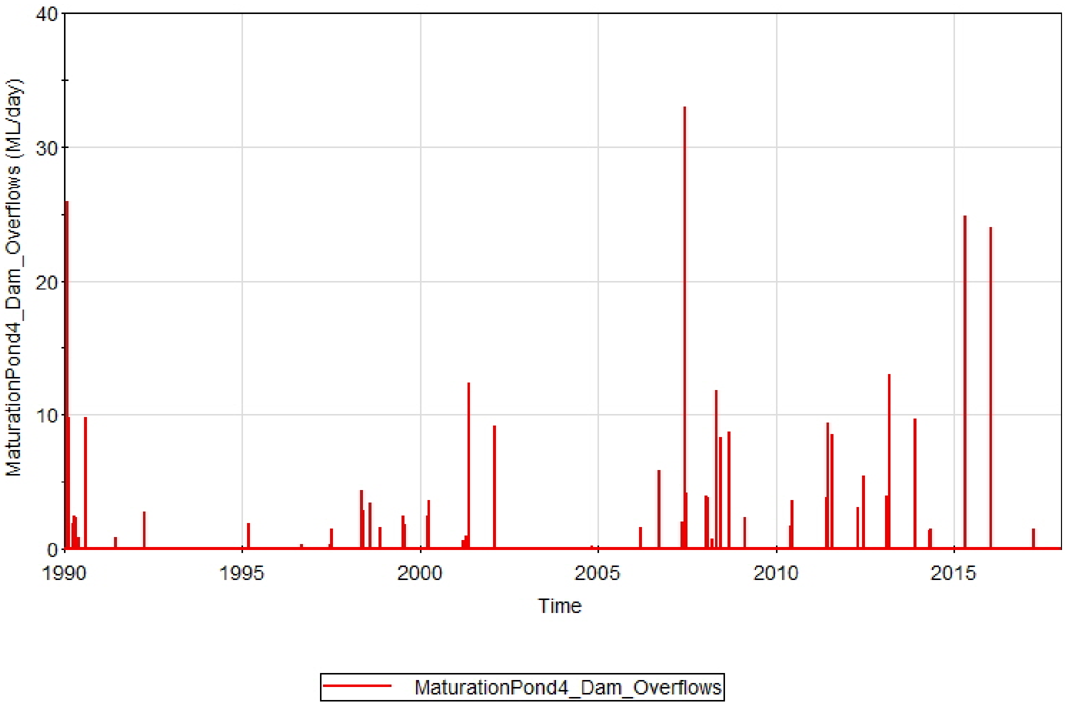


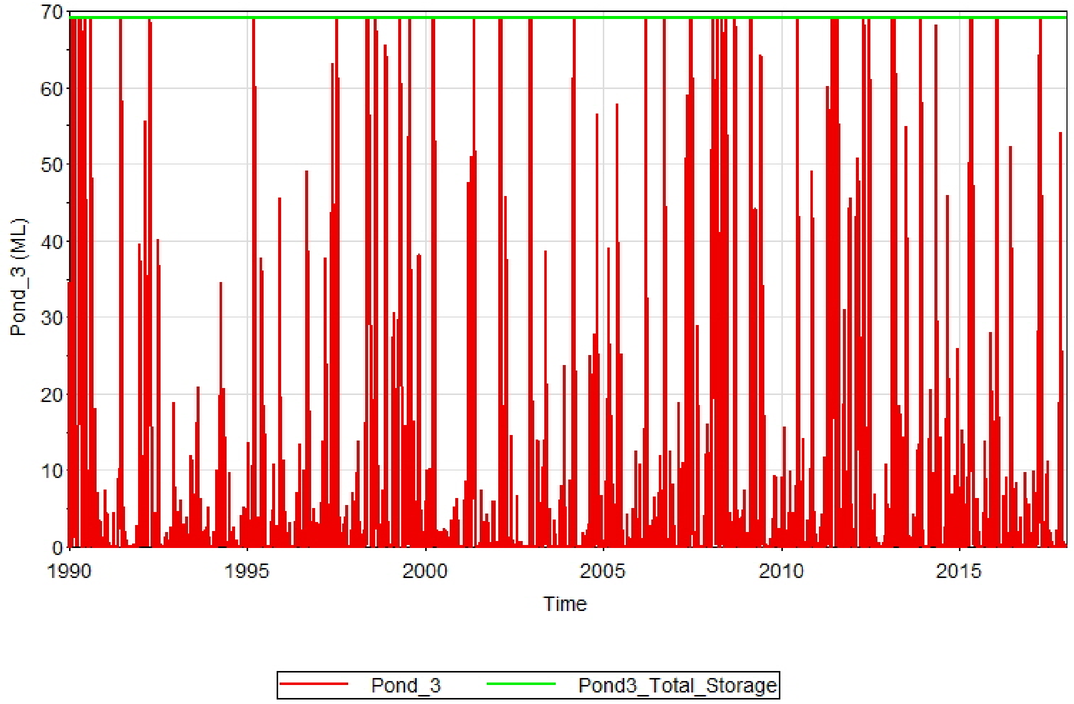
Stage 1 – Maturation Pond 4



Stage 1 – Maturation Pond 4 Overflows



Stage 2 – Pond 3



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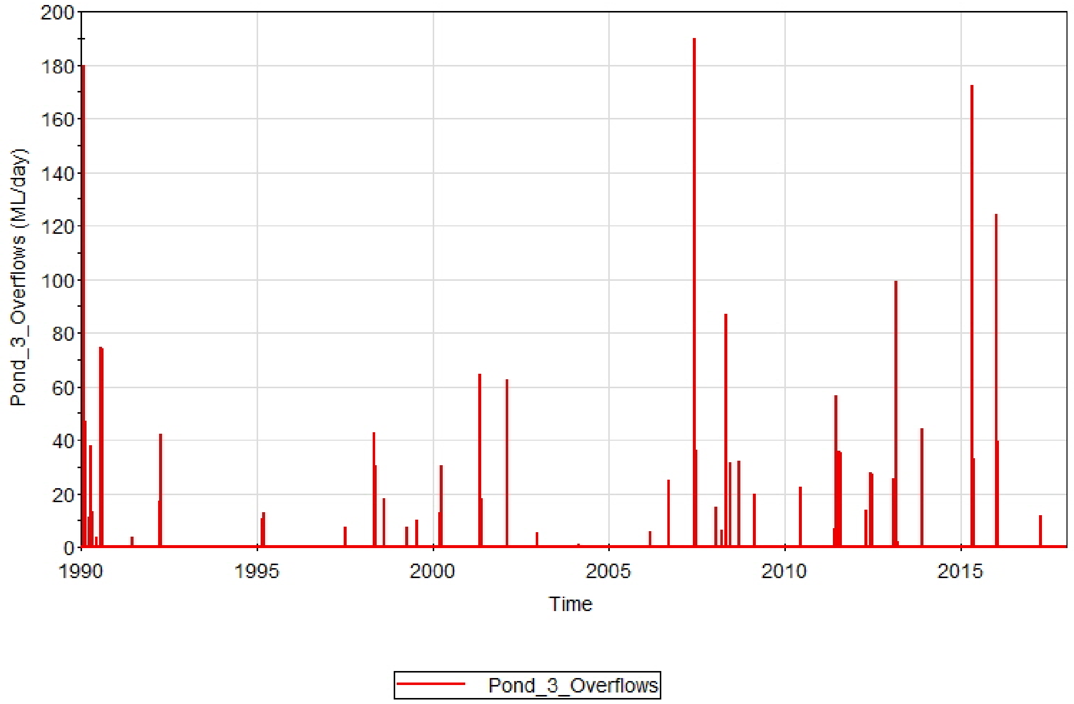
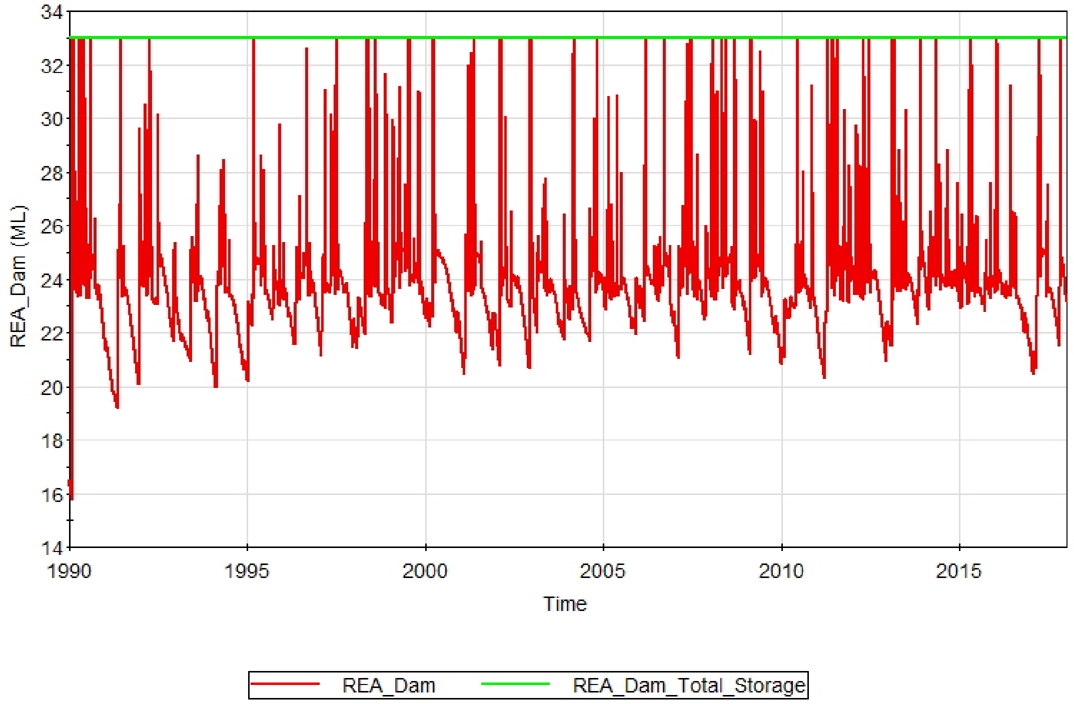
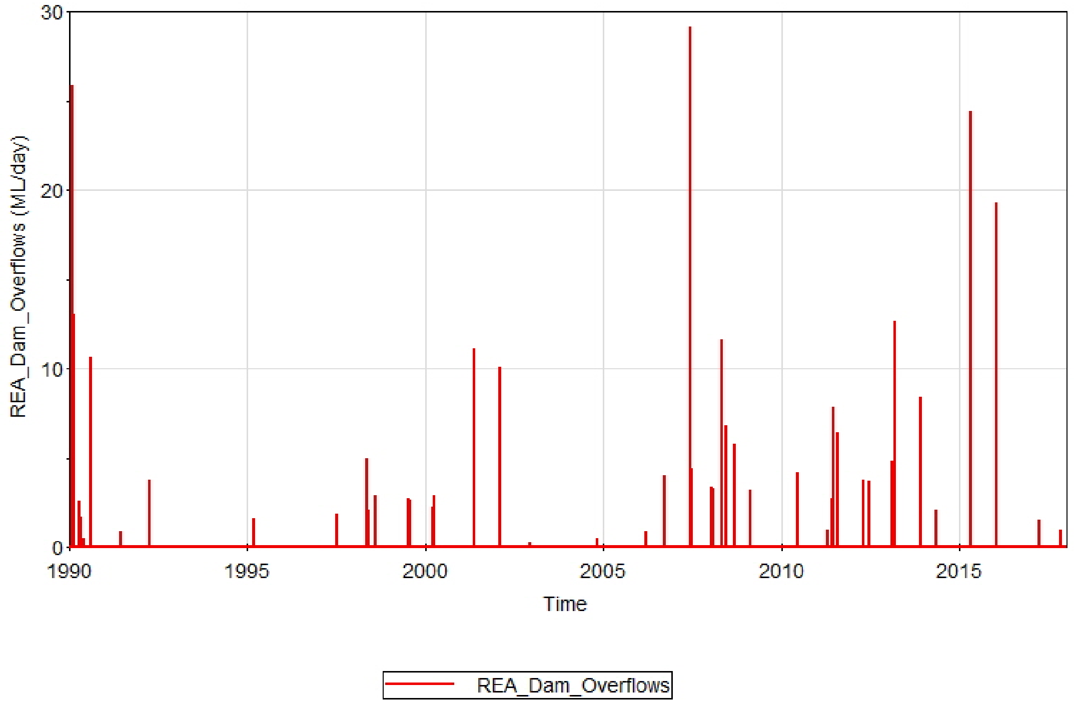


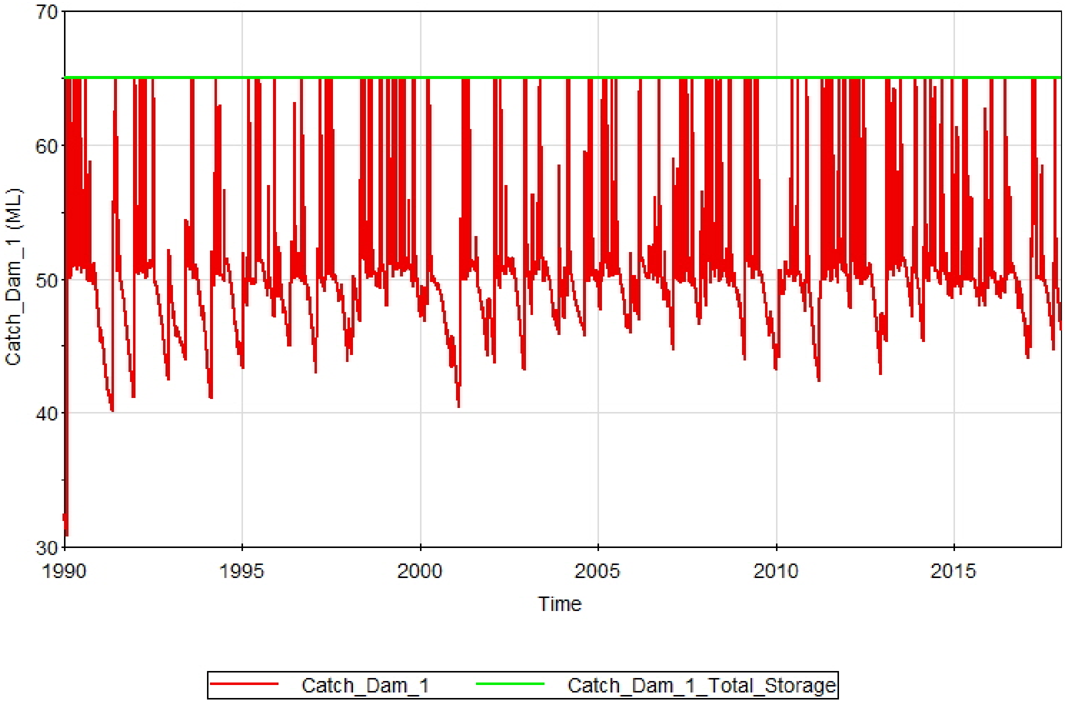
Stage 2 – REA Dam



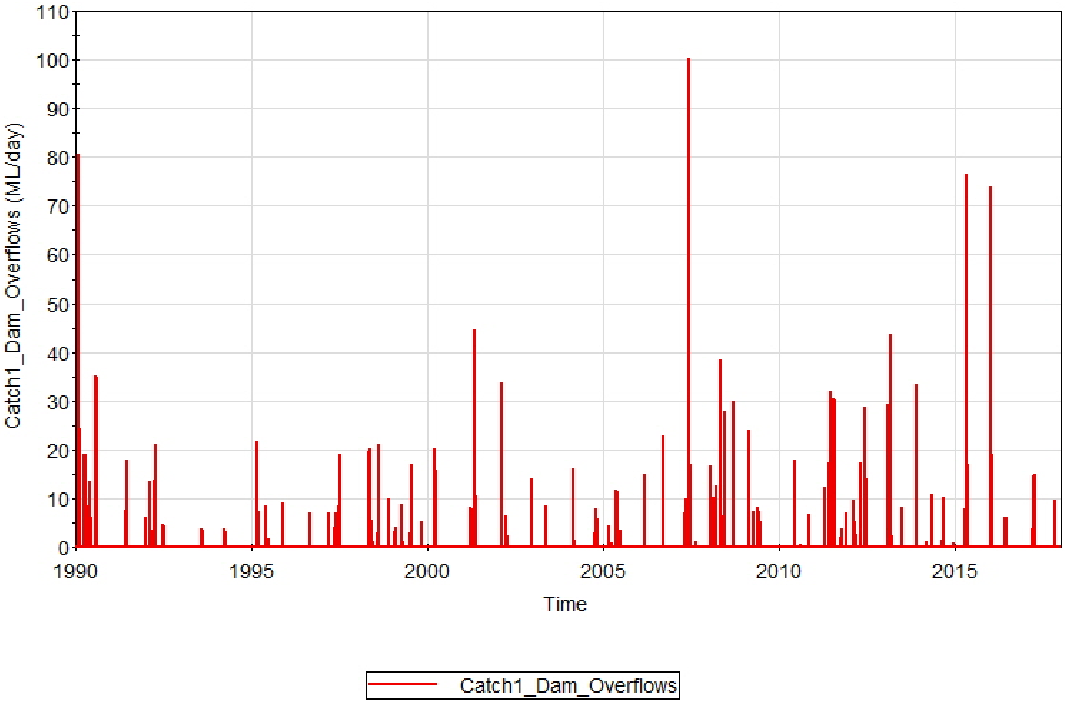
Stage 2 – REA Dam Overflows



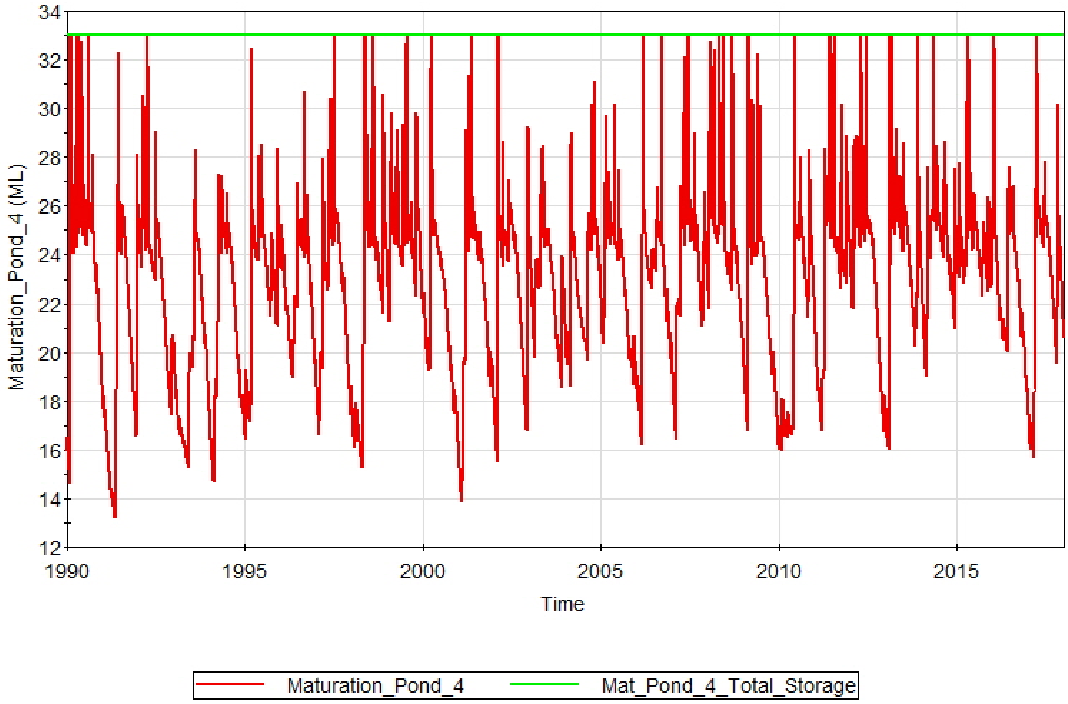
Stage 2 – Catch Dam 1



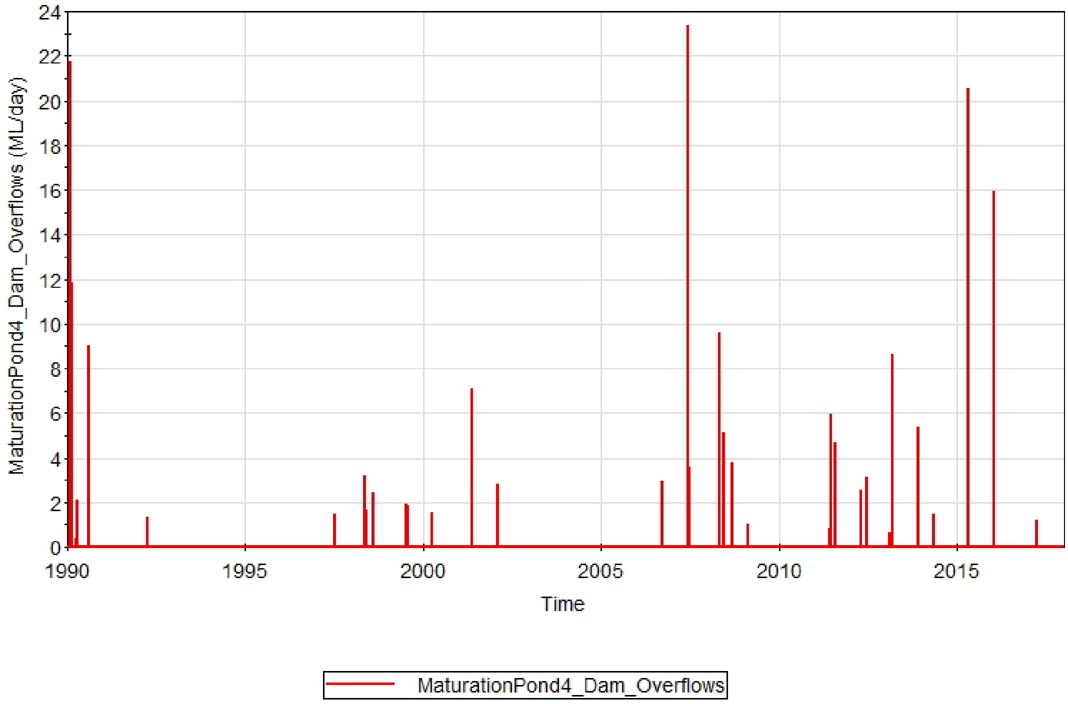
Stage 2 – Catch Dam 1 Overflows



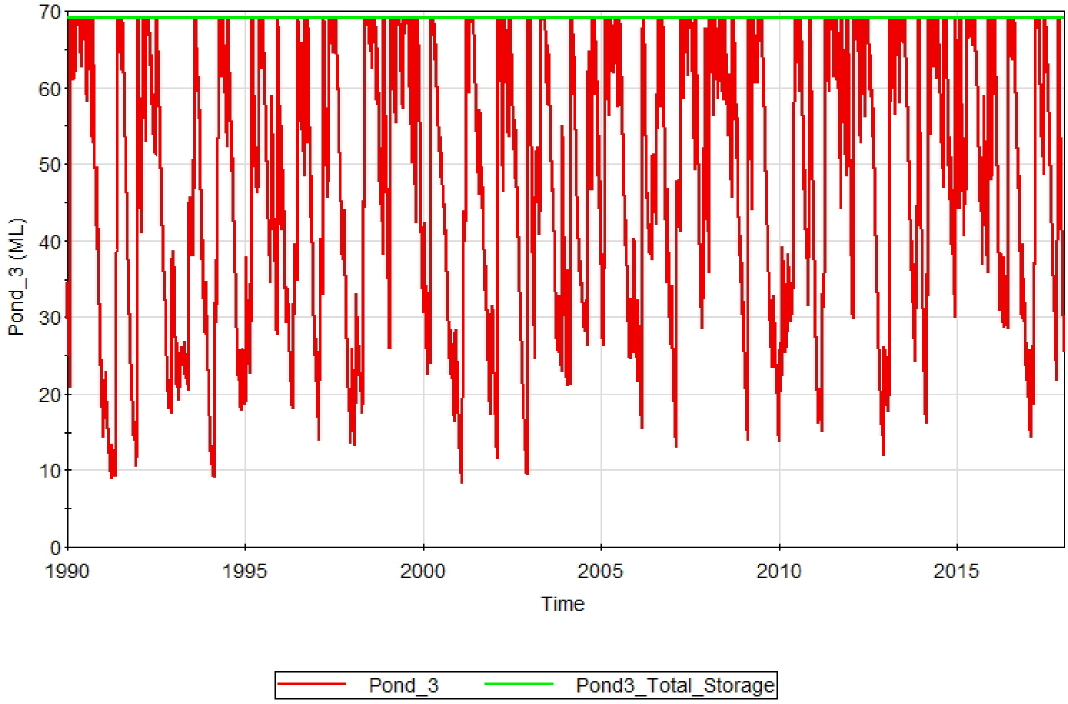
Stage 2 – Maturation Pond 4



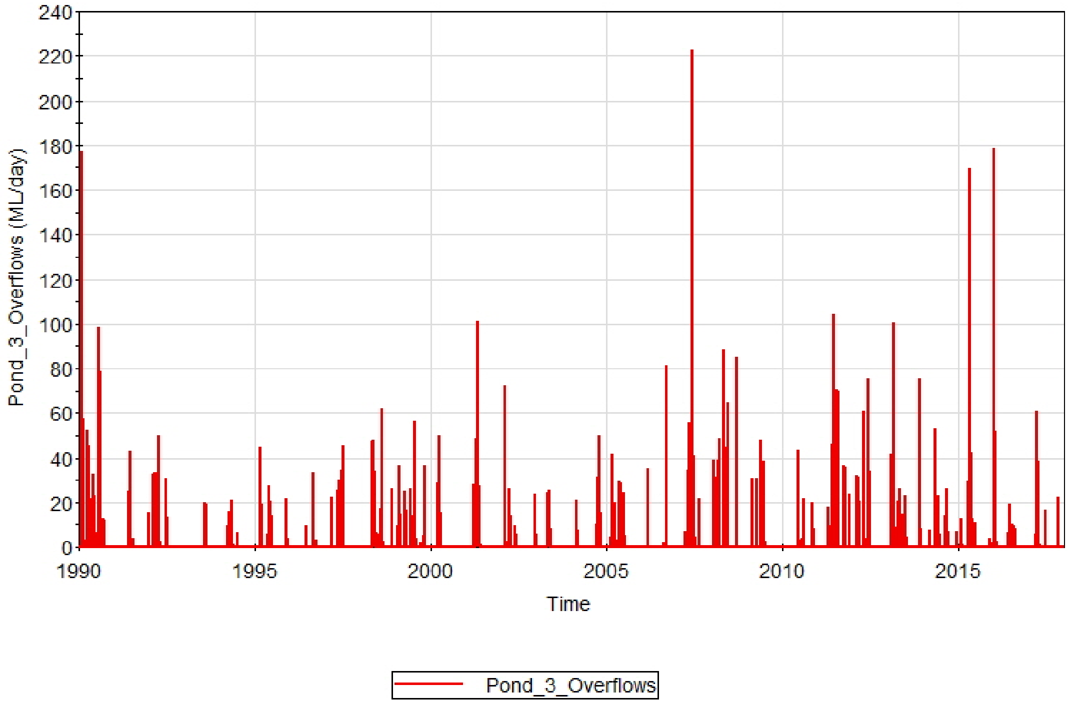
Stage 2 – Maturation Pond 4 Overflows



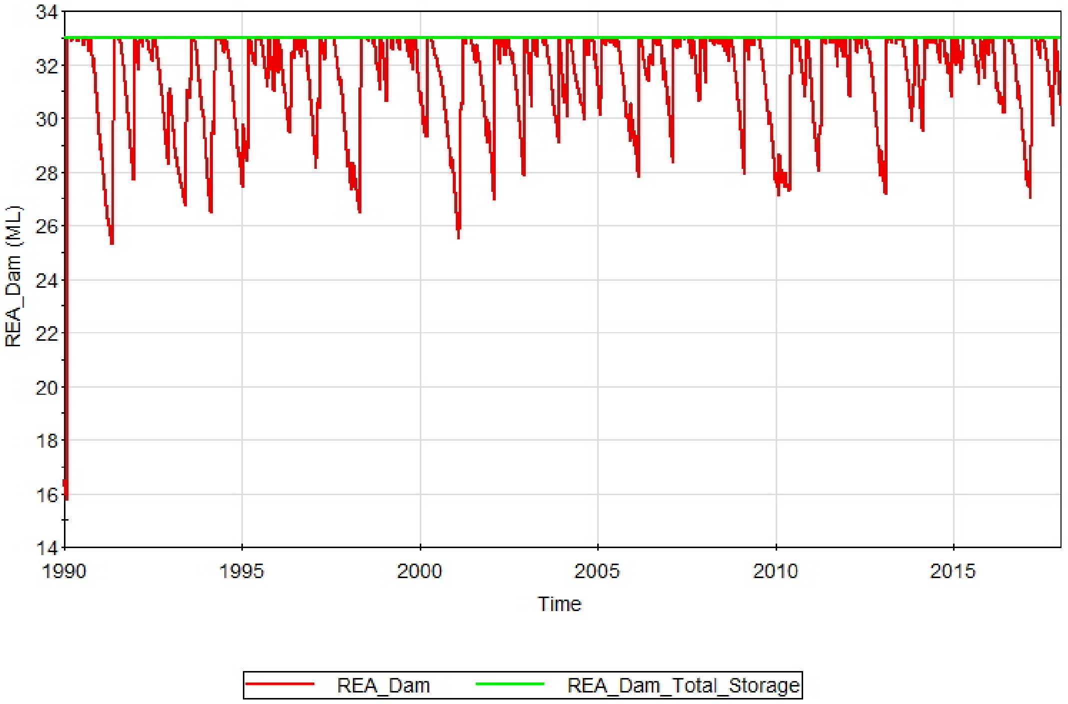
Stage 3 – Pond 3



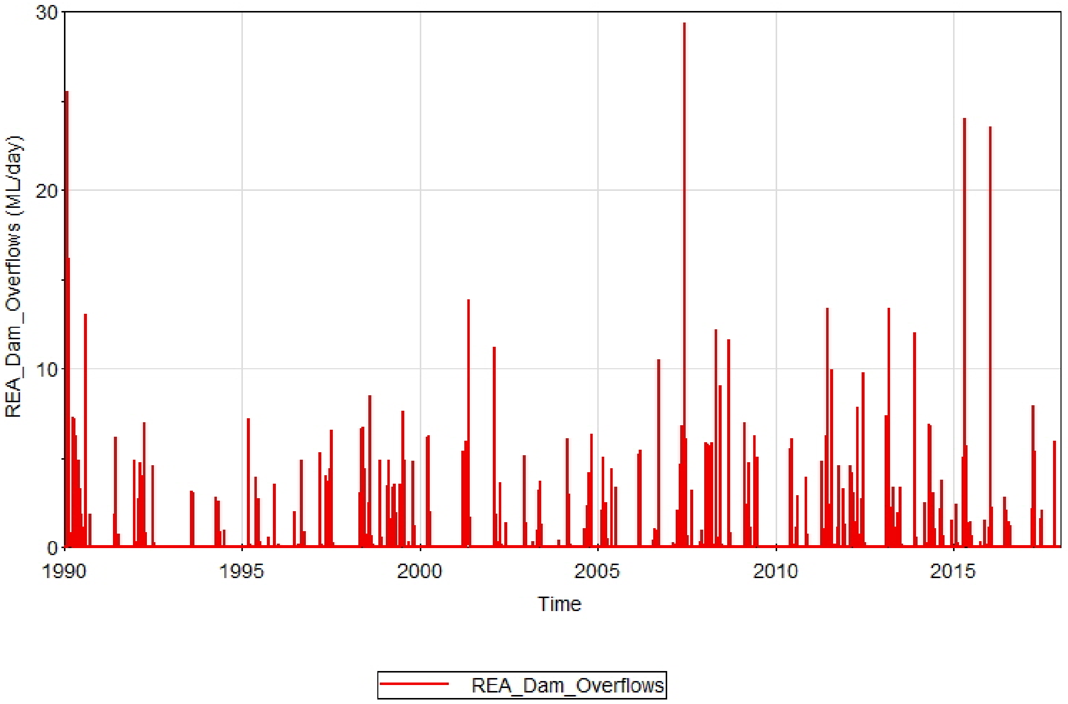
Stage 3 – Pond 3 Overflows



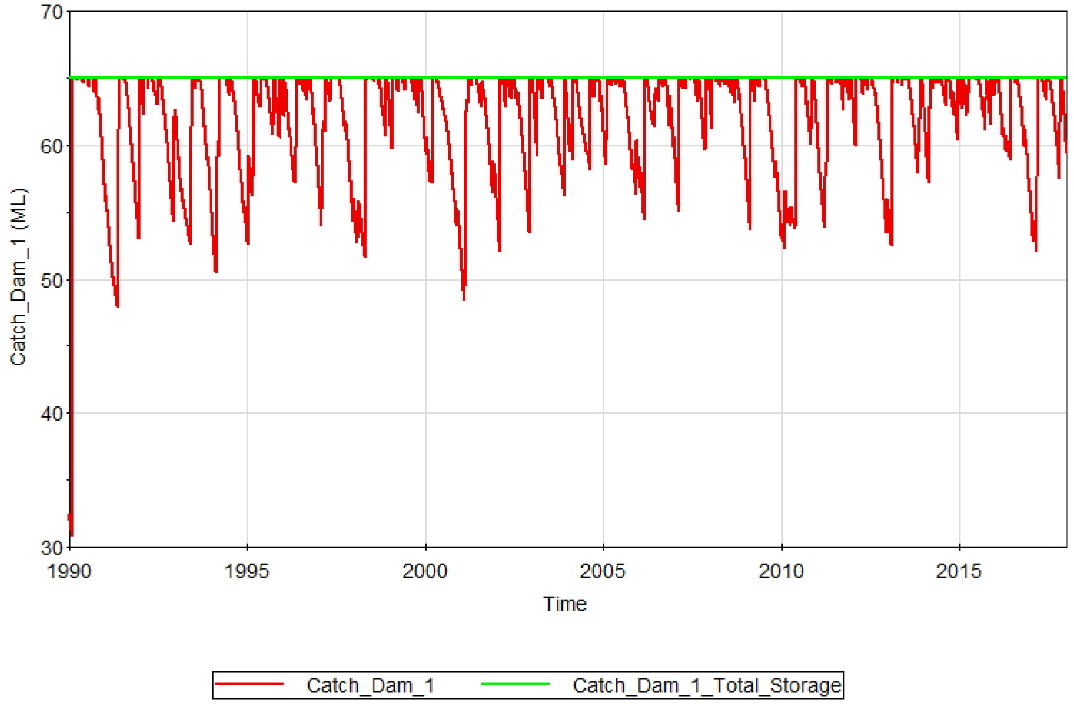
Stage 3 – REA Dam



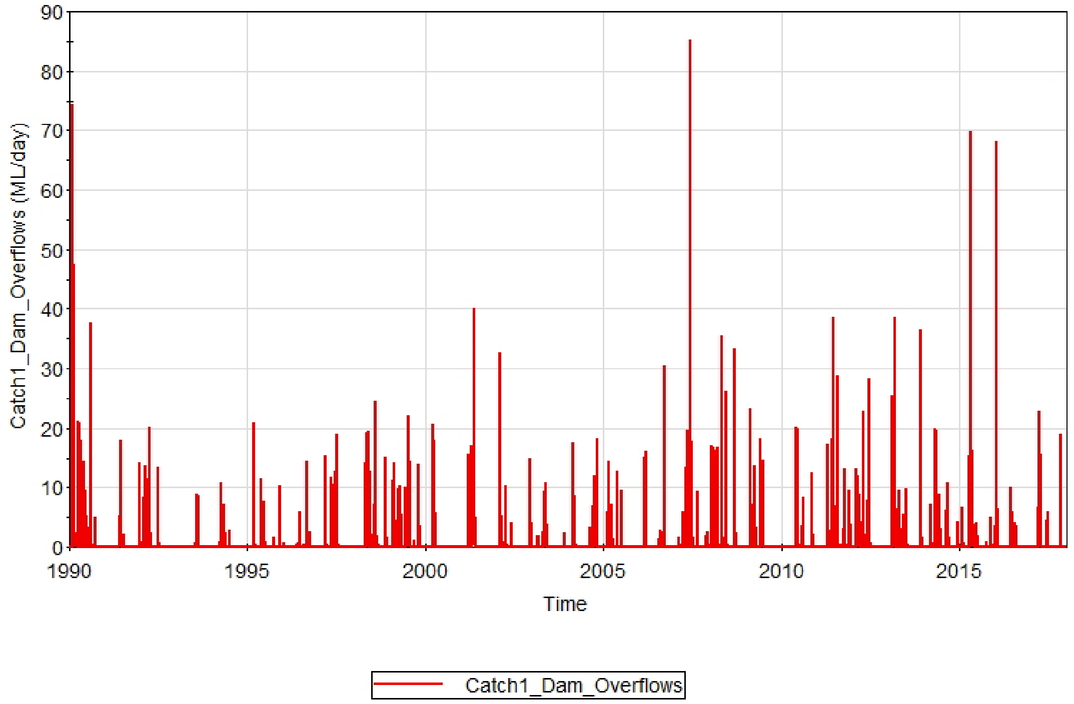
Stage 3 – REA Dam Overflows



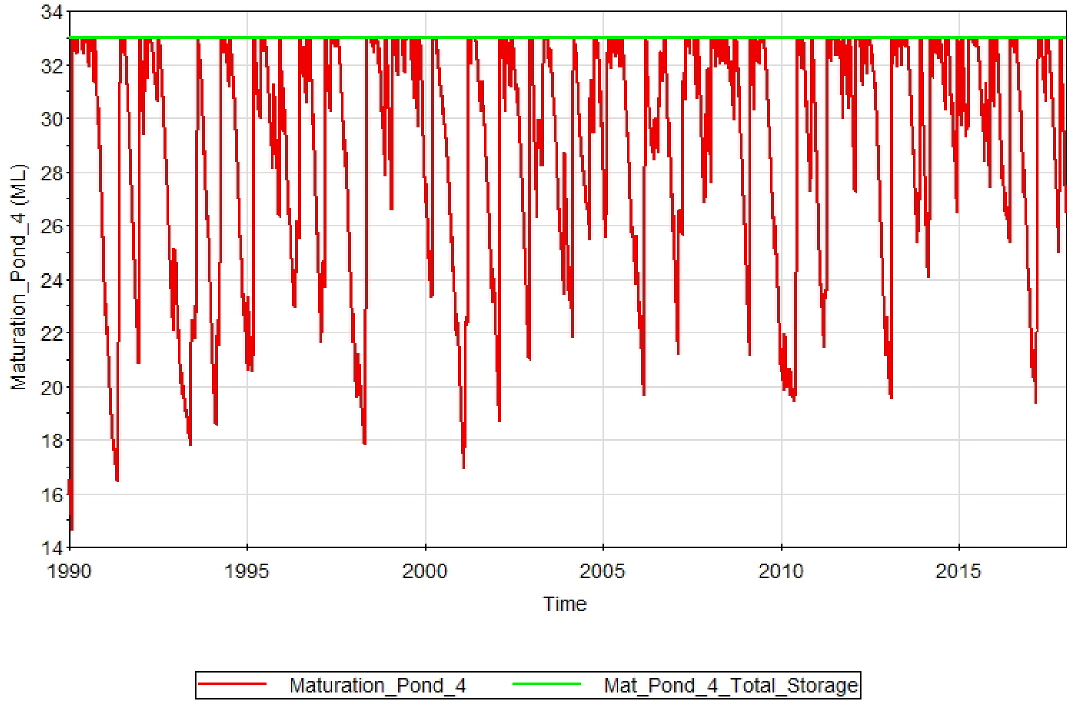
Stage 3 – Catch Dam 1



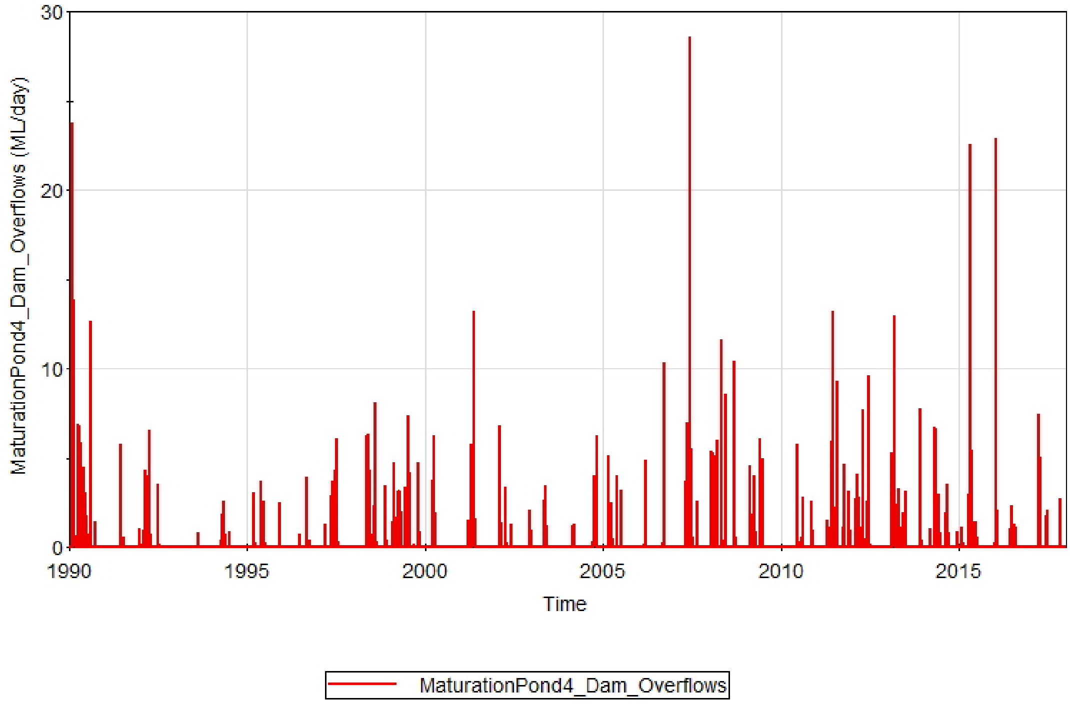
Stage 3 – Catch Dam 1 Overflows



Stage 3 – Maturation Pond 4



Stage 3 – Maturation Pond 4 Overflows



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