Bayswater Water and Other Associated Operational Works Project

Appendix E – Water Balance Modelling Report

Bayswater Water and Other Associated Works Project

AGL Macquarie

Water Balance Modelling Report

IA215400 R002 | 02

22 November 2019

AGL Bayswater

Document history and status

Revision	Date	Description	By	Review	Approved
00	31/10/2019	Draft Report for Client Review	Pride Mangeya	Greg Sheppard	Kirsty Farmer
01	15/11/2019	Final Report	Pride Mangeya	Greg Sheppard	Kirsty Farmer
02	22/11/2019	Final report – minor updates	Pride Mangeya	Greg Sheppard	Kirsty Farmer

Bayswater Water and Other Associated Works

Project No:	IA215400
Document Title:	Water Balance Modelling Report
Document No.:	IA215400 R002
Revision:	02
Date:	22 November 2019
Client Name:	AGL Macquarie
Client No:	AGL Bayswater
Project Manager:	Kirsty Farmer
Author:	Pride Mangeya
File Name:	\\Jacobs.com\ANZ\IE\Projects\04_Eastern\IA215400\21 Deliverables\02 Water Balance Report\IA215400 AGL Bayswater Water Balance Report_Final_Rev02.docx

Jacobs Group (Australia) Pty Limited
ABN 37 001 024 095
Level 7, 177 Pacific Highway
North Sydney NSW 2060 Australia
PO Box 632 North Sydney
NSW 2059 Australia
T +61 2 9928 2100
F +61 2 9928 2444
www.jacobs.com

Contents

1. Introduction

AGL Macquarie own and operate the Bayswater Power Station (**Bayswater**), located approximately 16 km south-east of Muswellbrook, NSW. Bayswater was commissioned in 1985 to utility standards of the time and has a current technical life up to 2035. Prior to its retirement, water and wastewater infrastructure and site improvements are required to ensure its continued operational and environmental performance.

The proposed Water and Other Associated Operational Works (**WOAOW**) project (the **Project**) at Bayswater would ensure the continued safe, efficient and reliable operation of the Power Station until its retirement. This project provides the opportunity for improvements based on post-construction advances in water and wastewater management.

Jacobs, on behalf of AGL Macquarie has been commissioned to prepare an Environmental Impact Statement (**EIS**) for the assessment of infrastructure and water upgrade works, in accordance with Division 4.7 of the *Environmental Planning and Assessment Act* 1979 (NSW).

The Secretary Environmental Assessment Requirements (**SEARs**) for the Project were issued on 30 November 2018. This report addresses the following comment by the Department of Planning, Industry and Environment (**DPIE**) on the SEARs contained in a letter dated 3 December 2018:

" …. the following requirements of the proposal are required:

- *A detailed and consolidated site water balance."*

2. Project Summary

Bayswater was commissioned in 1985 and has a current technical life up to 2035. AGL Macquarie's asset management strategy has identified that the ageing water and wastewater infrastructure assets on site require upgrade and/or replacement to ensure the continued and efficient operation of Bayswater until its planned retirement. Further, since Bayswater was initially commissioned, there have been advances in water and wastewater management. AGL Macquarie have identified enhancement and upgrades to existing infrastructure that will result in improved environmental outcomes.

In addition, based on current emplacement and beneficial reuse of ash rates, the existing Bayswater Ash Dam (**BWAD**) is forecast to reach capacity within two years. To enable the ongoing operation of Bayswater, it is critical to augment the existing BWAD to provide additional emplacement capacity for fly ash and bottom ash from Bayswater. Further details of each Project element are provided below. The location of the Project is shown in Figure 2.1.

2.1 Site overview

Bayswater is located on the New England Highway, approximately 6 kilometres west of the locality of Liddell and approximately 15 kilometres south east of the township of Muswellbrook in the Upper Hunter Valley of New South Wales. Bayswater lies within the Local Government Areas of Muswellbrook and Singleton.

Bayswater's operational area occupies approximately 300 hectares (**Ha**). The Project is predominately located on land owned by AGL Macquarie, although some Project infrastructure also crosses road reserves owned by Roads and Maritime Services, Singleton Council, and small area/s of Crown land.

Data sources

Jacobs 2019,
AGL 2019,
NSW Spatial Services 2019

GDA94 MGA56

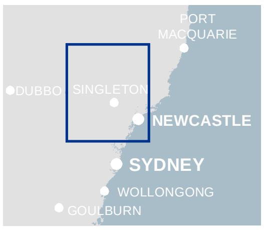


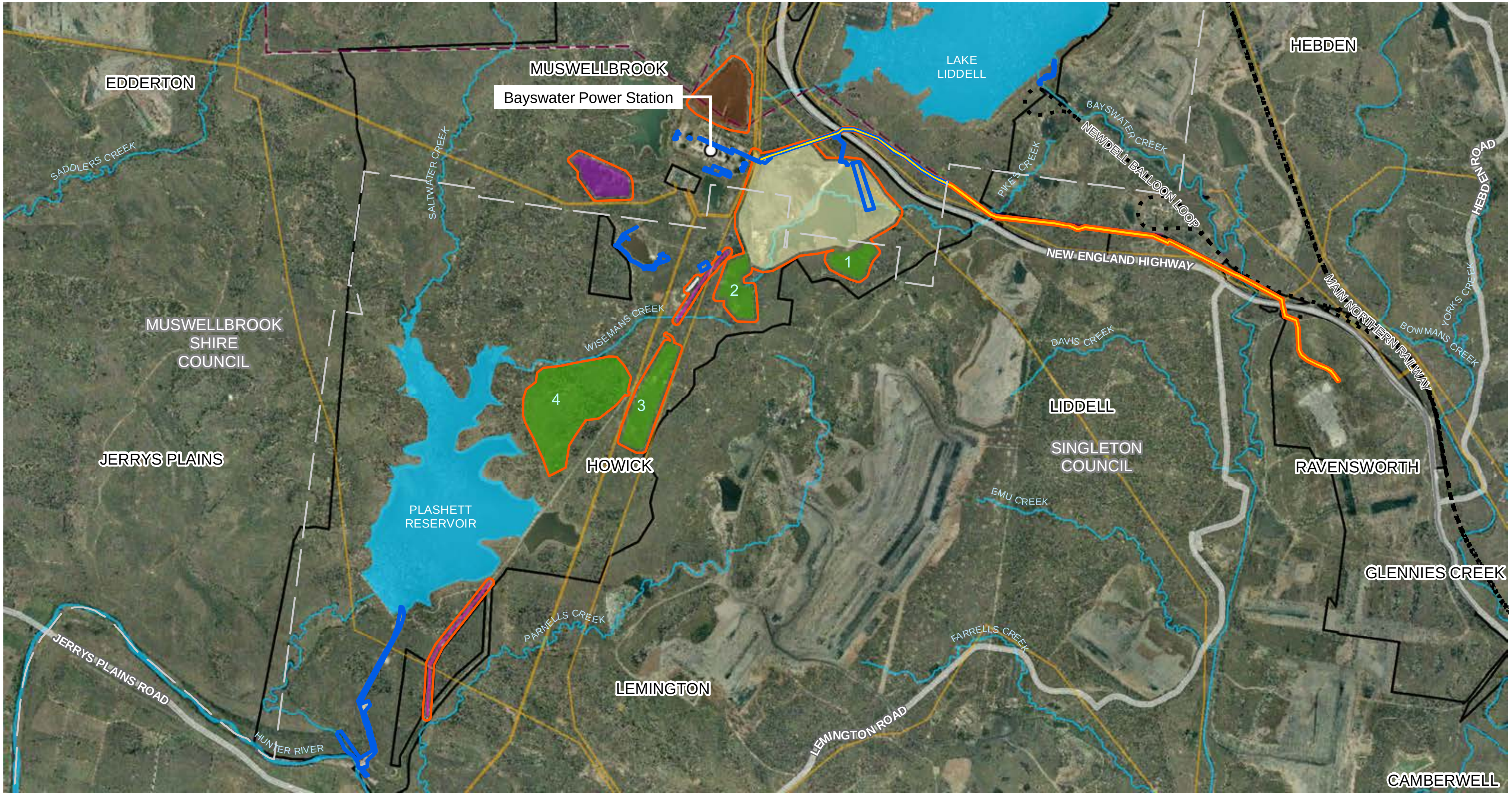
Figure 2 - 1 Project location

2.2 Project overview

The Project will include the following elements:

- Augmentation of the existing BWAD to provide additional ash storage capacity (**Ash Dam augmentation**);
- Improvements to water management structures and systems to ensure continued collection and reuse of process water and return waters from the BWAD (**Ash Dam augmentation**);
- Improvements to the management of water and waste materials within the coal handling plant sediment basin and associated drainage system (**Coal handling plant upgrades**);
- Increasing coal ash recycling activities to produce up to 1,000,000 tonnes per annum of ash derived product material and reuse of coal ash (**Ash harvesting**);
- Upgrades to existing fly ash harvesting infrastructure including the installation of weighbridges, construction of a new 240 tonne silo, tanker wash facility and additional truck parking (**Ash harvesting**);
- Construction and operation of a new coal ash pipeline to Ravensworth Void No. 3 for ash emplacement (**Ravensworth ash line)**;
- Construction and operation of a salt cake landfill facility to dispose of salt cake waste from the approved salt caking plant to be constructed at the Bayswater water treatment plant (**Salt cake landfill**);
- Construction and operation of a borrow pit(s) on AGL Macquarie land to facilitate the improvements proposed for the Project and other works on AGL Macquarie land (**Borrow Pits 1 to 4**); and
- Ancillary infrastructure works including repositioning of underground pipelines to above ground, replacement or upgrading of ageing pipelines, vegetation clearing associated with maintaining existing infrastructure, including along pipeline/transmission corridors and drainage canals as well as necessary for the construction of feedlines as required (**HP Pipe clearing, and LSP Pipe clearing**).

The location of each of these Project elements is shown in Figure 2.2



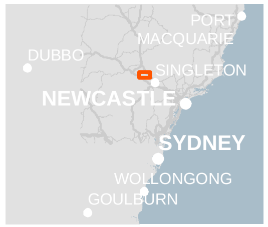
Study area
Local Government Area boundary
Footprints of approvals to be surrendered
AGL owned land
Railway
Electricity transmission line
Coal supply conveyor

Project elements:

Ash Dam Augmentation, Ash Harvesting and Water Management Works
Ravensworth Ash Line
Coal Handling Plant Water and Wastewater Infrastructure Upgrades
HP Pipe Clearing
LSP Sludge Line Clearing
Clay Borrow Pits
Salt Cake Landfill

0 2 4 km

1:78,000 at A4



Data sources
Jacobs 2019
AGL 2019
NSW Spatial Services 2019

GDA94 MGA56

Figure 2 - 2 AGL Site Plan and Project Elements

Date: 21/05/2020 Path: J:\IE\Projects\04_Eastern\IA215400\22_Spatial\GIS\Directory\Templates\Figures\WOAOW_EIS\IA215400_GIS_EIS_F002_r1v1_AGLSitePlanAndProjectElements.mxd
Created by : XX | QA by : XX

2.2.1 Ash Dam augmentation and Water Management Improvement Works

The BWAD forms part of the ash disposal system for Bayswater. The projected total annual ash production rate for Bayswater is currently just over two million tonnes. The BWAD initially received both flyash and bottom ash from Bayswater, but currently receives (mostly) bottom ash, as the majority of flyash is deposited at Ravensworth.

The existing BWAD is located southeast of Bayswater and comprises of 39 m high zoned earthfill embankment with a six-metre-wide crest. The main embankment of the BWAD is located on the eastern boundary of the BWAD, and the saddle dam extends westwards.

Based on projected disposal rates, the existing BWAD is forecast to reach capacity within two years.

The augmented BWAD would provide storage for an additional 12.5 million m^3 of fly ash and bottom ash. The augmentation would increase the size of the existing BWAD footprint by approximately 167,000 m^2. The site of the proposed BWAD is located to the east of Bayswater, on disturbed land. The proposed action would consist of:

- Construction of an 11.5 meter-high levee embankment on the western perimeter;
- Raising of the northern saddle dam by between 11.5 meters (to a rendered level (RL) of 184.5 meters at the western end) and 1.5 meters (to RL 174m at the eastern end)
- Construction of a concrete parapet wall along the main embankment crest to increase flood attenuation within the dam;
- Construction of two new southern saddle dams to prevent ash from spilling out of low points in a ridgeline to the south which forms the current southern BWAD edge;
- Extensions to the ash dispersion and water supply and management systems;
- Installation of BWAD divider walls allowing ash discharge to be undertaken in alternating cells and deployment of dust suppression (water sprays or polymers) to prevent dust events where necessary in accordance with existing dust management processes;
- Upgrade to ancillary infrastructure associated with ash disposal such as pumps, pipelines and power supply infrastructure;
- Water management improvement works associated with the main and saddle dam walls including diversion of clean runoff around the site and installation of new, and upgraded, seepage capture and return infrastructure; and
- Relocation/replacement of existing pipelines to current standards where necessary.

Construction of the augmented BWAD would require around approximately 1,000,000 m^3 of suitable earthfill material for the construction of the embankments. Materials required would be sourced from the proposed borrow pits described below.

The continued operation of the BWAD would remain unchanged with the exception of the introduction of additional piping to convey ash to the different discharge cells.

2.2.2 Coal handling plant water and wastewater infrastructure upgrades

Coal handling plant (**CHP**) water and wastewater infrastructure upgrades are proposed as part of an Environmental Improvement Program at Bayswater to improve the quality of discharges from the sediment basin and associated systems into Tinkers Creek (AECOM, 2017).

The CHP sediment basin currently overflows daily to Tinkers Creek. Additional water and wastewater management infrastructure works would include:

- Construction of clean water diversions to reduce stormwater inflows to the CHP sediment basin;

- Reuse of water within the coal plant water system where possible for operational purposes which could include water treatment; and
- Changes to the water management structures, including the enlargement/reconfiguration of the CHP sediment basin to allow for a larger volume of water to be stored with increased detention time and improved settlement of coal fines to better enable the treatment of water.

The proposed designs for enlarging/reconfiguring the CHP sediment basin were not available at the time of undertaking the water balance assessment. Therefore, the following conservative assumptions have been made for the purposes of this water balance assessment:

- The proposed upgrades do not include increasing the CHP sediment basin storage volume; and
- The volume and frequency of overflows to Tinkers Creek would not change due to the proposed upgrades.

2.2.3 Ash harvesting

AGL Macquarie currently recycles up to 170,000 tonnes of coal ash per annum from Bayswater including bottom ash from the BWAD. The proposed action would increase the scale of current coal ash recycling activities to enable the beneficial reuse of up to 1,000,000 tonnes per annum of ash during periods of peak demand. It is currently envisaged that average production values would reach around 600,000 tonnes per annum. The increased scale of ash recycling would reduce the volume of ash requiring deposition on site.

2.2.4 Ravensworth ash line

An additional 10 kilometre pipeline is proposed for the transfer and disposal of ash from the Ravensworth Fly Ash Plant (Bayswater) to Ravensworth Void No. 3. The majority of this pipeline would be installed above ground, with sections of trenching or underboring proposed to be installed below ground at New England Highway, roadways, Pikes Creek, Liddell Station Road and various other existing infrastructure corridors. Where the pipeline crosses Bayswater Creek and Chilcotts Creek, the pipeline would be raised above ground. The new pipeline would connect to the existing recently extended ash pipeline which runs from Ravensworth Void 3 to Void 5.

2.2.5 Salt cake landfill

Naturally occurring salts within the cooling water supply are currently removed by the Bayswater water treatment plant, stored in a brine concentrator decant basin and Lake Liddell prior to discharge to the Hunter River via Bayswater Creek, under the Hunter River Salinity Trading Scheme (HRSTS). A salt caking plant has been separately approved and will be constructed as part of the water treatment plant upgrade (Project approval 06_0047, as modified) as an alternative salt management solution. The existing approval has a deferred commencement condition which requires the establishment of a salt cake disposal solution prior to the operation of the salt caking plant.

To address this deferred commencement condition, the Project would include construction and operation of a salt cake landfill facility on site to store the salt cake produced from the approved caking plant. The landfill facility would include approximately 10 cells which would be constructed progressively. The facility would be designed to accommodate up to 50,000 tonnes of salt cake per year, with approximately 600,000 tonnes of salt cake being deposited over the operational life.

Construction and operation of the salt cake landfill would be in accordance with *NSW EPA Environmental Guidelines for solid waste landfills (Second Edition, 2016)* and would include appropriate leachate barrier systems and capping to prevent contamination of the surface and groundwater during operation.

2.2.6 Borrow pits

Four borrow pit sites are proposed to provide virgin excavated material for use in construction and subsequent remediation of the proposed action.

Additional geotechnical investigations are currently ongoing. The results of these investigations would inform the design and ultimate depths of the proposed borrow pits. The final design of the borrow pits will include clean water diversions. Excavation within the borrow pits would not intercept the groundwater table, and no dewatering works would be required.

It is expected that material from these borrow pit sites would be used primarily for the BWAD augmentation works and the salt cake landfill but also used on other projects as required and where appropriate.

2.2.7 Ancillary works

Routine clearing of vegetation along the alignments of the LSP Sludge Line and HP Pipeline would be undertaken to provide ongoing access for maintenance and management within the disturbance footprint.

3. Site Description

3.1 Topography and Drainage

The site is characterised by low hills with elevations ranging from 130 to 220m. In the vicinity of Bayswater, there are two water bodies; Lake Liddell to the north east and Plashett Reservoir to the south west, both with an elevation of approximately 130m AHD. Bayswater lies on top of a small hill (approximately 210m AHD) sloping towards the water body with a 3% slope to the north towards Lake Liddell and a 2% slope south towards Plashett Reservoir. To the west, a steep hill drains towards Saltwater Creek which flows west out of the study area and then south into the reservoir. A low ridge runs along the eastern boundary of the study area.

Within the vicinity of the Project, there are a number of hydrological features (Figure 2.2), including:

- Tinkers Creek, running along the western boundary of the proposal area and draining to Lake Liddell;
- Lake Liddell located to the north east of Bayswater;
- Plashett Reservoir located about 300m to the west of the proposed borrow pits (Borrow Pit 4);
- Saltwater Creek located to the west of Bayswater Power Station, which drains to Plashett Reservoir. A tributary of the Saltwater Creek, referred to in this report as the Noname Creek, is located to the south of the proposed salt cake landfill facility location;
- Wisemans Creek, which runs from east to west across Bayswater, before discharging to Plashett Reservoir;
- Pikes Creek, located to the north of the proposal area, intersecting with the existing BWAD and running parallel to the proposed Ravensworth Ash Line; and
- Bayswater Creek, draining from Lake Liddell before ultimately discharging to Hunter River.

3.2 Surface Water Catchment Areas

Figure 3.1 shows the surface water catchment areas that have been identified within the Bayswater operations boundary. The surface water catchment areas are named after the main water course or major infrastructure feature occurring within the catchment. The surface water catchments are briefly described below:

- **Noname Catchment**: The catchment drains to a tributary of Saltwater Creek (Figure 3.1), referred to in this report as the Noname Creek. The Salt Cake Landfill facility will be constructed within this catchment. Noname catchment has an area of approximately 285 Ha;
- **Pikes Creek Tributary**: The catchment drains to a tributary of Pikes Creek that is located to the south east of the BWAD. The catchment area would capture all the potential surface water runoff generated from the proposed Borrow Pit 1 and partially capture runoff from Borrow Pit 2. Pikes Creek Tributary catchment has an area of approximately 200 Ha;
- **Ash Dam Catchment**: The ash dam surface water catchment consists of the land surface area that drains to the ash dam. A small part of the proposed Borrow Pit 2 falls within this catchment on the south eastern boundary on top of the hill. The augmented ash dam catchment has an area of approximately 232 Ha;
- **Ash Dam Pond 1 Catchment**: This catchment comprises the surface water catchment area for ash dam seepage collection pond 1. The catchment is dominated by the main ash dam wall. Ash Dam Pond 1 Catchment has an area of approximately 6.6 Ha;

- **Ash Dam Seepage Pond 2**: The catchment area drains to the ash dam seepage collection 2, which is located downstream of ash dam seepage collection pond 1. Ash Dam Seepage Pond 2 has a catchment area of approximately 29 Ha;

- **Brine Holding Pond Catchment**: This is the surface water catchment area that drains to the Brine Holding Pond. The catchment has an area of approximately 35 Ha;

- **Cooling Water Make-up Dam Catchment**: This is the catchment area draining to the Cooling Water Make-up Dam. The catchment has an area of approximately 32.5 Ha;

- **CHP Sediment Basin Catchment**: This is the catchment area draining to the CHP sediment basin and includes the Coal Handling Plant area. The catchment has an area of approximately 161.2 Ha. A high proportion of the catchment area is occupied by impervious landcover in the form of building and infrastructure;

- **Middle Plashett Catchment**: This refers to a sub-catchment area of the Plashett Reservoir Catchment (Figure 3.1). Borrow Pits 3, 4 and a portion of Burrow Pit 2 are located within the Middle Plashett Catchment. Middle Plashett Catchment has an area of approximately 664 Ha; and

- **Brine Decant Pond Catchment**: This catchment area drains to the Brine Decant Pond and has an area of approximately 38 Ha.

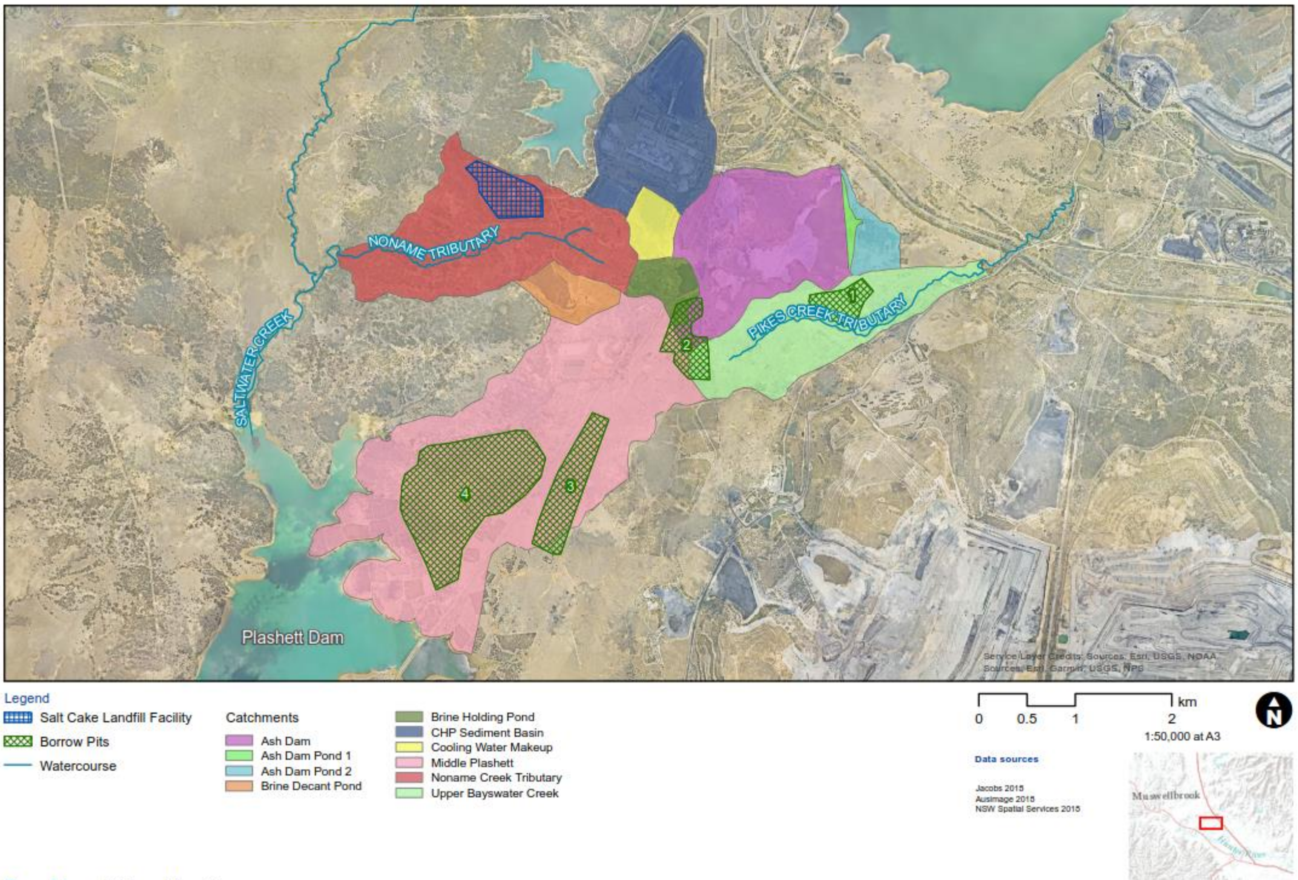


Figure 3.1: Surface water catchment areas.

3.3 Climate

3.3.1 Rainfall

Daily rainfall data from the AGL Liddell rain gauge, located on site is available from 2005 to 2018. Long-term rainfall data is available from Australian Government Bureau of Meteorology (**BoM**) Doyles Creek (Wood Park, Station Number 061130) rainfall station, located approximately 10 km to the south west of the site. Rainfall data is available from 1920 to present with a data gap between 1963 to 1971. The data was downloaded from Scientific Information for Land Owners (**SILO**) database and the missing data has been automatically interpolated.

The average long-term annual rainfall for the AGL Liddell rain gauge of 699mm is comparable to the Doyles Creek mean annual rainfall of 641mm. The monthly average rainfall between the two stations is comparable where rainfall is greater in the summer months from November to February.

Table 3.1: Mean rainfall summary for AGL and Doyles Creek stations

Station	Mean monthly rainfall total (mm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Doyles Creek (1)	74	77	56	45	38	51	41	36	42	54	63	63
AGL (2)	61	78	89	45	46	78	27	37	43	44	91	61

Notes. (1) Mean for data from 1920 to 2019.
(2) Mean for data from 2005 to 2018.

3.3.2 Evaporation

Class A pan evaporation for the Doyles Creek station (Wood Park, Station Number 061130) indicates that the long-term average Class A pan evaporation for the period from 1920 to present is approximately 1,510 mm/year. Table 3.2 presents mean daily Class A pan evaporation for each month, based on SILO data for the Doyles Creek station.

Table 3.2: Mean daily Class A pan evaporation at Doyles Creek Station

Average daily pan evaporation (mm/day)											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
6.60	5.71	4.59	3.35	2.20	1.64	1.89	2.66	3.77	4.86	5.84	6.69

Table 3.3 presents FAO56 potential evapotranspiration data for Doyles Creek station obtained from the SILO database.FAO potential evapotranspiration is calculated using the FAO Penman-Monteith method (http://www.fao.org/3/X0490E/X0490E00.htm).

Table 3.3 Estimated FAO56 evapotranspiration for Doyles Creek Station

Average daily FAO56 evapotranspiration (mm/day)											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.34	4.69	3.83	2.78	1.90	1.42	1.58	2.16	3.07	4.08	4.89	5.42

Areal actual evapotranspiration (**AAET**) is normally used to represent evaporation from soils. AAET is the average of the evapotranspiration that actually takes place under prevailing soil moisture conditions.

AAET data for the site was estimated from data available on the BoM website (http://www.bom.gov.au/jsp/ncc/climate_averages/evapotranspiration/index.jsp).

The BoM website has national coverage Geographic Information System (GIS) layers for long-term average monthly AAET data from 1961. Average daily AAET rates calculated from the monthly data obtained from BoM maps is provided in Table 3.4

Table 3.4: Estimated areal actual evapotranspiration for the site

Areal actual evapotranspiration for the site (mm/day)											
Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2.97	2.36	2.19	1.3	1	0.9	0.81	0.87	1.37	1.97	2.5	2.45

4. Scope Limitations and Exclusions

For the purposes of this water balance assessment, the following elements of the Project have not been considered further, as they would not result in any modification or changes to the containment performance or water and waste water process within Bayswater:

- HP Pipe clearing, and LSP Pipe clearing;
- Ravensworth ash line; and
- Ash harvesting.

AGL has indicated that changes to the water management structures are likely to include the enlargement/reconfiguration of the CHP sediment basin to allow for a larger volume of water to be stored/reused. However, the proposed designs for enlarging/reconfiguring the CHP sediment basin were not available at the time of undertaking the water balance assessment. Therefore, the following conservative assumptions have been made for the purposes of this water balance assessment:

- The proposed upgrades do not include increasing the CHP sediment basin storage volume; and
- The volume and frequency of overflows to Tinkers Creek would not change due to the proposed upgrades.

The study does not include assessment of the Freshwater Dam for the following reasons:

- None of the infrastructure upgrades are expected to result in process water discharges to the Freshwater Dam. There is a topographic groundwater and surface water divide between the proposed salt cake landfill facility and the Freshwater Dam. Therefore, it is highly unlikely that leachate or potential overflows from the salt cake landfill facility will discharge to the Fresh Water Dam; and
- The functions of the Freshwater Dam summarised in Table 5.1 will not be affected by the proposed WOAOW.

The scope of the study extends to large scale factors contributing to uncontrolled discharge from the Bayswater Ash Dam and the CHP sediment basin. Therefore, no rigorous calibration of the water balance model was undertaken to estimate the rainfall runoff coefficients applied to the model. The rainfall runoff coefficients applied to the water balance model were based mainly on values to previous model for surface areas considered to have similar runoff characteristics. The water balance model would require further calibration prior to it to being used for assessing reliability of the water supply

The study does not include investigations at process level, nor does it consider the reliability of the water supply from the Hunter River or the Plashett Reservoir.

5. Water Management System

5.1 Existing Water Management Systems

The Bayswater operations consist of key storages and processes summarised in Table 5.1. The following sections describe the water management systems that are likely to be affected by the proposed WOAOW project.

Table 5.1: Summary of storages (Source AECOM, 2016).

Storage	Key Processes
Bayswater Ash Dam	Receives coal ash slurry from Bayswater Power Station and water treatment plant effluents
Bayswater Ash Dam Seepage Collection Pond 1	Collects seepage from the Bayswater Ash Dam.
Bayswater Ash Dam Seepage Collection Pond 2	Collects seepage from Bayswater Ash Dam that is not collected in Seepage Pond 1.
Brine Concentrator holding pond	Stores reject waste streams from the Reverse Osmosis and Acid Regeneration processes of the Bayswater Water Treatment Plant
Cooling water make-up pond	Balancing storage from the Hunter Water Supply or Lake Liddell for site operations. Supplies water to the Bayswater cooling system.
Coal Handling Plant sediment basin	Water storage for process water discharges from the coal handling plant and process waste water from the Bayswater contaminated Water System (Oily water separator).
Lake Liddell	Water Supply Receives blowdown from Bayswater Power Station Cooling water from Liddell Power Station. Catchment runoff.
Plashett Reservoir	Water Supply
Freshwater Dam	Balancing storage from the lime softening plant. Supplies water to both the Liddell and Bayswater demineralisers for use in site processes.
Return water tanks	Balancing storages between Lake Liddell and the Bayswater Power Station
Treated effluent holding pond	Collects water from the Bayswater Power Station contaminated area via the oily water separator.
Contaminated water ponds	Collects process water from operational use of a number of plants including clarifier water, demineralisation effluents, oil contaminated wash down from within the station, plant drainage and runoff from dirty areas.
Oily water separator pond	Collects waste water from the oil water separator plant

5.1.1 Ash Dam Water Management System

The BWAD receives ash slurry from the ash plant. Table 5.2 shows the projected daily water volume in the ash slurry pumped from the ash plant to the BWAD.

Table 5.2: Water volume in ash slurry (Source: AECOM, 2016)

Year	Daily Water Volume in ash slurry to Ash Dam (m^3)
2014-2015	7,950
2015-2016	7,913
2016-2017	7,924
2017-2018	8,242
2018-2019	8,232
2019-2020	8,272
2020-2021	8,280
2021-2022	8,110
2022-2023	8,214

Water also enters the BWAD from a range of processes and sources. A summary of the inflows and outflows to and from the BWAD is provided in Table 5.3 and the schematic in Appendix A. The BWAD Water Management consists of three storages namely the BWAD; BWAD Seepage Collection Pond 1, and BWAD Seepage Collection Pond 2 (Appendix A). Table 5.3 also provides a summary of information on the volumes and surface areas for the storages. The Brine Holding Pond is included in the BWAD Water Management System because it overflows to the BWAD.

Calibration of the water balance model carried out by Jacobs (Section 6.3) indicates that the BWAD seepage loss rate is between 105 and 110 L/s. Most of the seepage from the BWAD discharges towards Pikes Gully, where some of the seepage is initially captured by Seepage Collection Pond 1. AECOM (2016) indicate that seepage from the BWAD also discharges beneath the Saddle Dam to Lake Liddell (via Chilcotts Creek). The seepage rate through the Saddle Dam is estimated to be approximately 35 L/min (0.58 L/s) in summer and 96 L/min (1.6 L/s) in winter (AECOM 2016).

A significant proportion of the BWAD seepage that discharges towards Pikes Gully bypasses Seepage Collection Pond 1. Some of the seepage that bypasses Seepage Pond 1 is intercepted by Seepage Collection Pond 2. The BWAD seepage that is not intercepted by the two collection ponds ultimately discharges to Pikes Creek (Appendix A).

Information obtained from AGL Macquarie (AGL Macquarie, January 2018) indicates that pumping rates from Seepage Collection Pond 1 and Pond 2 to the BWAD are normally between 12 and 23 L/s. The note further indicates that AGL Macquarie were considering upgrading the pumps to achieve pumping rates of 26 L/s at each pond. The upgrade of the pumps is included in the scope of the WOAOW project.

Figure 5.1 presents the daily pumping duration for pumping from Seepage Collection Pond 1 to the BWAD. The average pumping duration is approximately 3 hours per day.

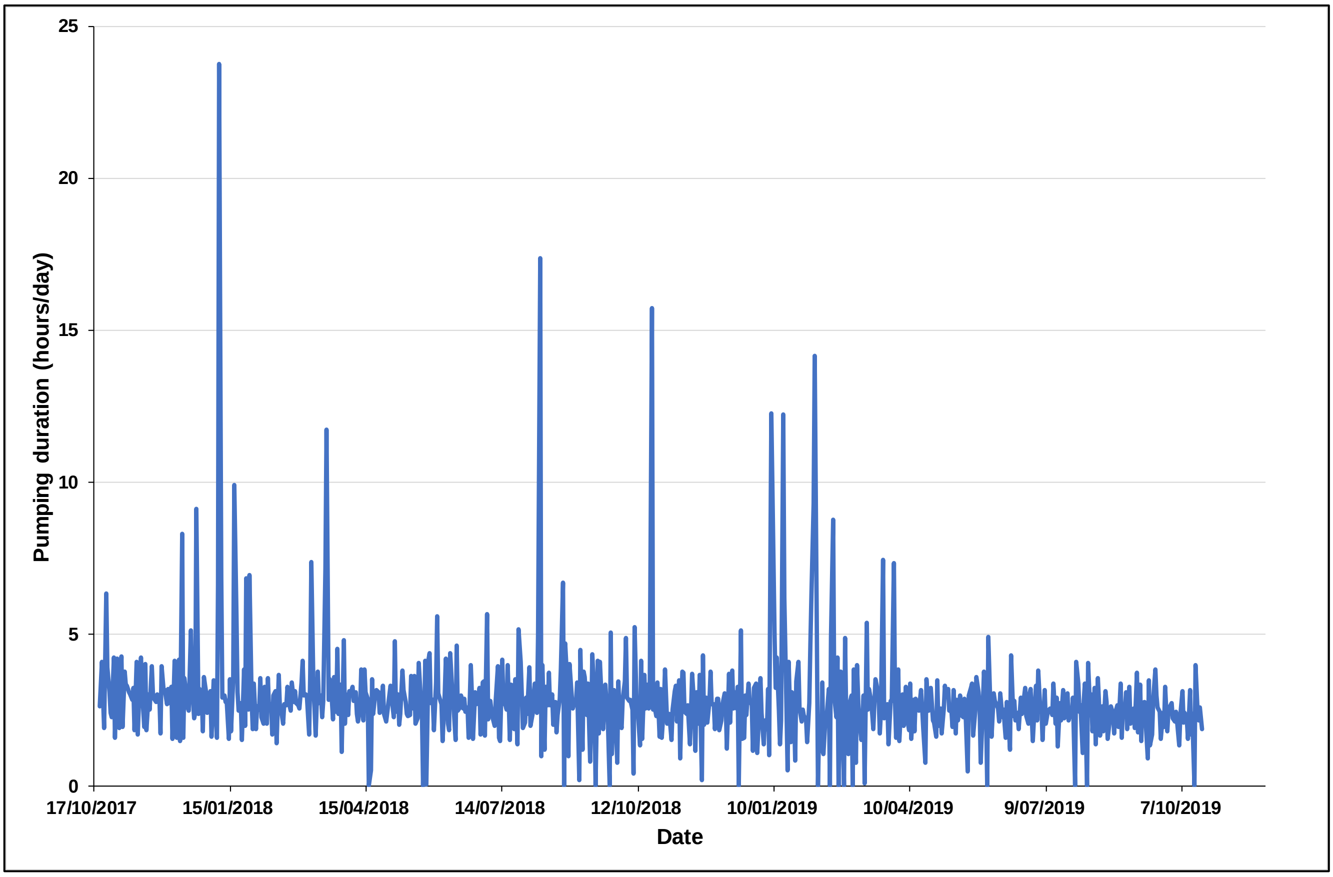


Figure 5.1: Daily pumping duration - Seepage Collection Pond 1 to Ash Dam.

Dam Embankments

The main dam embankment comprises a 39 m high zoned earth-fill embankment with a 6 m wide crest at RL 174 m. The main embankment of the BWAD is located on the eastern boundary, and the saddle dam extends westwards. A vertical chimney filter is provided 1.5 m downstream from the dam centreline and connects to a comprehensive array of horizontal finger drains in the foundation beneath the downstream embankment fill. These horizontal finger drains discharge into concrete toe drains, which flow to the seepage collection pond at the toe.

The Saddle Dam in the north western corner of the storage has a maximum height of 15 m and its design is similar to the main dam. It has a 6 m wide crest at RL 172.8 m and is 780 m long.

Emergency Spillway

The dam flood spillway consists of an open unlined channel excavated through a saddle near the left abutment of the main dam. A 6 m wide concrete sill, with an invert level at RL 172.0 m, is located at the upstream end of the channel. The approach channel upstream of the sill is lined with rip rap over a distance of 5 m. The spillway eventually discharges into Chilcotts Creek, and overflows eventually end up in Lake Liddell.

The NSW Dam Safety Committee (**DSC**) requires that the BWAD must have sufficient spillway capacity to safely discharge the 1 in 100,000 AEP flood event, without overtopping of any of the external embankments. This will need to be maintained at all times.

- A secondary environmental requirement set by the DSC for tailings dams, is that the dam needs to be capable of detaining the flood surcharge up to the 1 in 10-year, 72-hour storm. For storm events higher than the 1 in 10-year, 72-hour event, discharge via the spillway is allowed under the Bayswater EPL 779 for events greater than the 1 in 10-year, 72-hour storm.

BWAD Water Drainage

Discharge from the dam was originally via four submerged outlet towers which are connected by an outlet pipe situated upstream of the main embankment. The lower two towers (1 and 2) were constructed as part of the Stage 1 works and the upper two towers (3 and 4) as part of the Stage 2 works. The first three towers have been progressively blocked off as the ash deposits in the dam have encroached on the outlet pipe. Discharge from the dam is currently through tower 4.

Slurry water drains to the lower points of the BWAD and is either lost through evaporation and seepage or is drawn from the BWAD via outlet tower located towards the right abutment of the main embankment (Figure 5-2). Water from the tower is transferred via return water pipelines around the northern perimeter to the return water tanks, located at the western ridgeline for reuse. The return water pipelines are connected to the return water pumps in the pumping station at the toe of the main embankment.

A 300 m long Glass Reinforced Plastic (GRP) outlet pipeline joins the outlet towers to the valve pit downstream of the dam. The pipeline is encased in reinforced concrete within the foundation beneath the dam embankment. A 900 mm butterfly valve acts as a guard valve on the pipeline, which connects to the return water pumps in the pumping station at the toe of the dam.

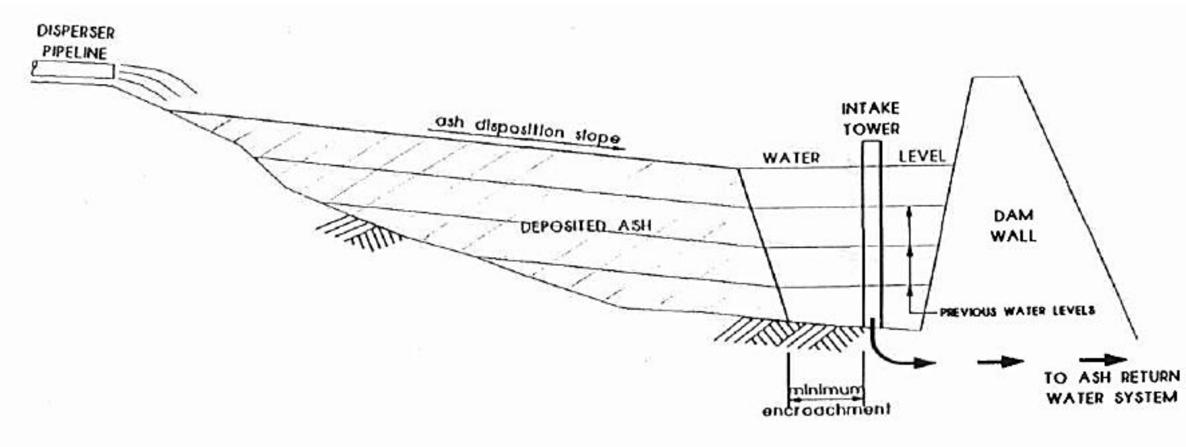


Figure 5-2 AGL Macquarie Site Plan and proposed works

Table 5.3: Summary of inflows and outflows to water storages

Storage	FSL [(1)] Elevation (mRL)	FSL Volume (ML)	Area at FSL (Ha)	Catchment Area (Ha)	Inflows	Outflows
Bayswater Ash Dam	171	2,163	39.28	232	• Direct rainfall • Rainfall runoff • Ash Plant Slurry water • Demineralisation Effluent • Boiler and Mills Cleanout • Ash Dam Seepage Pond return • Treated Sewage Effluent	• Seepage • Overflow via spillway • Evaporation
Bayswater Ash Dam Seepage Collection Pond 1	131	1.2	0.04	6.6	• Direct rainfall • Rainfall runoff • Groundwater • Ash Dam seepage	• Ash Dam (via pump)
Bayswater Ash Dam Seepage Collection Pond 2	131	1.2	0.04	29.27	• Direct rainfall • Rainfall runoff • Ash Dam seepage	• Ash Dam (via pump)
CHP Basin	161	47 [(2)]	1.45	161.2	• Direct rainfall • Rainfall runoff • Groundwater • Process water • Launder Flows • Firewater	• Overflows to Tinkers Creek • Evaporation
Cooling Water Make-Up Dam	190	360	9.5	30.56	• Direct rainfall • Rainfall runoff • Groundwater • Lake Liddell • Plashett Dam or Hunter River	• Bayswater Cooling Towers • Washdown water • Overflow to CHP Basin • Evaporation
Brine Holding Pond	184	480	5.8	33.16	• Direct rainfall • Rainfall runoff • Reverse Osmosis Waste	• Overflow to Ash Dam • Seepage • Evaporation

Note. [(1)] FSL = Full supply Level

[(2)] AGL has indicated that the maximum water storage in the CHP Basin has been reduced by approximately 20% to 37.6 ML due to coal fines build-up.

5.1.2 Coal Handling Plant Water Management System

Overview

The CHP water management system is summarised in Figure 5.3 and the flowchart in Appendix A. The main water storage in the CHP water management system is the CHP sediment basin. A summary of the inflows and outflows to the CHP sediment basin is provided Table 5.3.

Coal Handling Plant Sediment Basin

The maximum design storage capacity of the CHP sediment basin is approximately 47 ML and the maximum surface area is approximately 14,500 m^2. The 2017 report by AECOM indicated that, the maximum storage capacity and surface area had reduced to approximately 6.5 ML and 8,700 m^2 respectively due to accumulation of coal fines in the sediment pond.

In 2017, AGL carried out dredging works in the CHP sediment basin to remove coal fines. Coal fines have been building up in the sediment basin since the dredging in 2017. AGL personnel have provided information that coal fines currently occupy 20% of the CHP sediment basin volume (AGL Macquarie 2019).

The CHP sediment basin currently overflows daily to Tinkers Creek.

Process Water

Process water constitutes flows from the operational use of the plant, including clarifier water, demineralisation effluents, and oil contaminated wash down from within the station, plant drainage, and run off from dirty areas via gravity drainage lines. This contaminated water is collected in a number of pump stations within the station area and is pumped to the process water pond, whereby it is processed, through an oil-water separator and then discharged into the open drainage system around the eastern side of the CHP area stockpile area (Figure 5.3). The process water discharges to the CHP sediment dam.

Weekly monitoring data provided by AGL Macquarie indicates that the process water discharge rate for the period between January 2016 and September 2019 is approximately 9.8 ML/week (1.4 ML/day).

Launder Flow

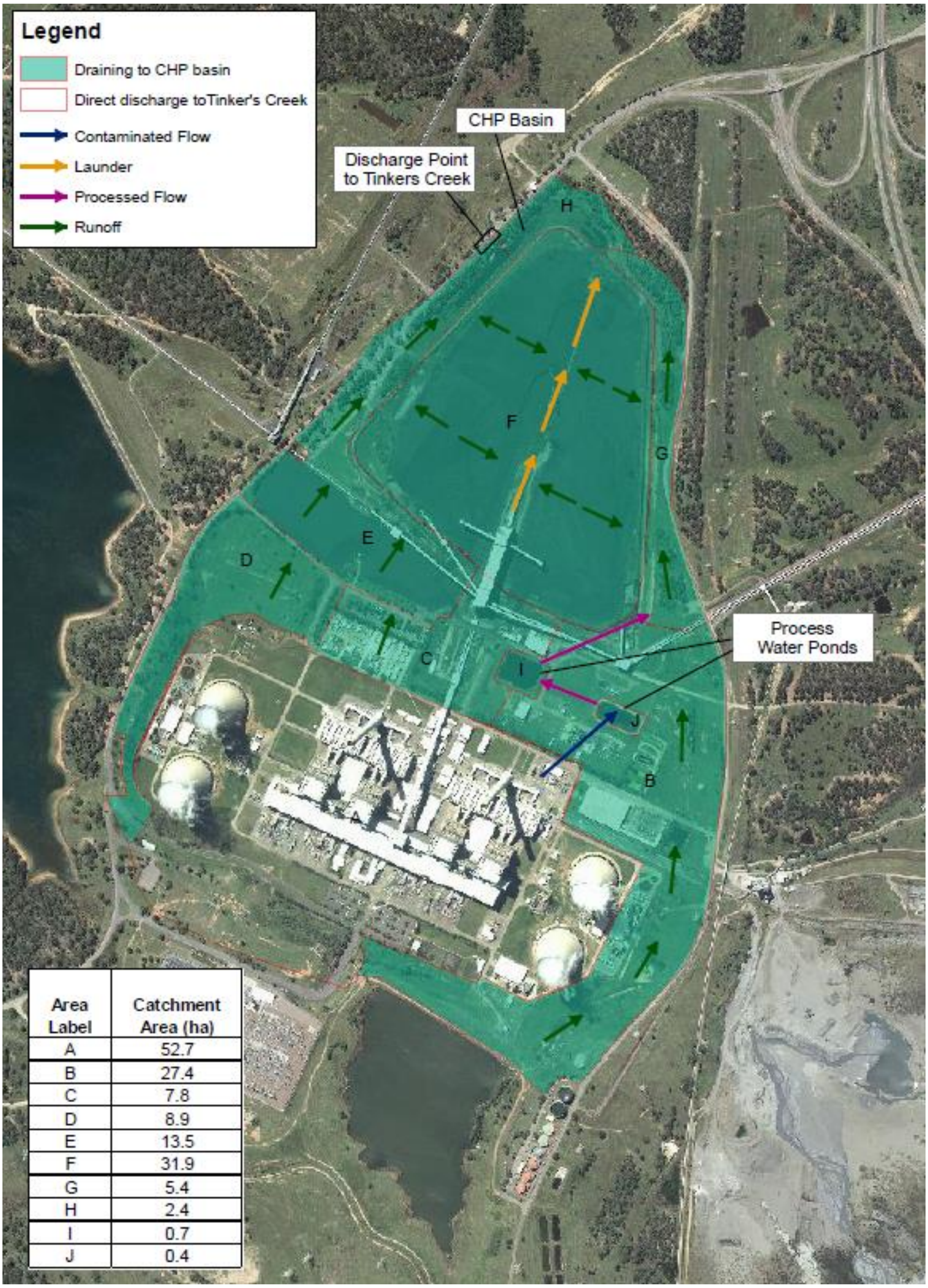
Launder flow is water used to cool the coal and conveyors to ensure the conveyors operate at a safe temperature level. AGL Macquarie personnel indicated that the launder flow rates can vary significantly. Launder flow rates reported in AECOM (2017) are presented in Table 5.4.

Table 5.4: Launder Flow Rates (Source: AECOM, 2017)

Flow	Water Discharge (ML/day)
Minimum	0.192
Maximum	0.327
Average	0.259

Firewater

AGL personnel reported a leak in the firewater system of 1 to 2 ML/day AECOM (2017). The leaking water from the firewater system discharged to the CHP sediment basin. AECOM (2017) applied a flow of 0.25 ML/day to represent the firewater system leak in the previous water balance model. AGL Macquarie personnel have indicated that firewater system leak has since been repaired.



Area Label	Catchment Area (ha)
A	52.7
B	27.4
C	7.8
D	8.9
E	13.5
F	31.9
G	5.4
H	2.4
I	0.7
J	0.4

Figure 5.3: Coal Handling Plant water management system (Source AECOM, 2017)

CHP Sediment Basin Overflows

The CHP sediment Basin overflows to Tinkers Creek. Xylem Analytics Australia (**Xylem**) was engaged by AGL Macquarie to install a flow monitor to provide telemetry flow data at the weir at the CHP sediment basin outlet. Flow monitoring was carried out from November 2016 to March 2017. The results of the flow monitoring are described in Appendix B.

5.1.3 Cooling Water Management System

Cooling water for the Bayswater cooling towers is sourced from the Cooling Water Make-up (**CWMU**) Dam. The water is treated through the de-salinisation plant before use. After passing through the plant condensers and other cooling systems, cooling water is treated through two Cooling Tower Water Treatment Plants (an alkalinity reduction plant and a reverse osmosis plant). The waste products from the water treatment plant are transferred to the Brine Concentrator Holding Pond for further water recovery and treatment. Three Brine concentrators (vapour recompression evaporators) have been installed to reclaim some of the waste water which is transferred to the station demineralisation plant for further treatment or transferred to the CWMU Dam.

A summary of inflows and outflows to the CWMU Dam is provided in Table 5.3. Transfer rates between the various components are provided in Appendix A. The Bayswater cooling towers water demand and the maximum washdown water demand are 90 ML/day and 15 ML/day respectively.

The CWMU Dam is a pumped storage that operates between 189.2 m RL and 189.7 mRL. When the Storage level drops to 189.2 m RL (270 ML), the pumps automatically cut in. Figure 5.4 presents the CWMU Dam water monitoring data from 1985. The monitoring data shows that since 1985, water levels in the CWMU have dropped below 189.0 m RL on only a few occasions. AGL Macquarie has indicated that water level below 189.0 m RL were recorded during periods when the pumps were undergoing maintenance service.

Lake Liddell is the primary water source for the CWMU and when Lake Liddell water is not available, water is sourced externally from either Plashett Dam or the Hunter River.

The transfer from Lake Liddell to the CWMU is generally between 40 to 50 ML/day. The maximum capacity for the transfer is approximately 100 ML/day.

External water supply to the CWMU from Plashett Dam or Hunter River occurs when water supply from Lake Liddell is not available. The combined licensed water take from Plashett Dam and Hunter River is 70 ML/day (810 L/s). The maximum pumping capacity for the water transfer from Plashett/Hunter River to the CWMU Dam is 540 L/s.

Overflows from the CWMU discharge to the CHP sediment basin. AGL Macquarie staff have indicated that no overflows from the CWMU Dam have occurred in the past.

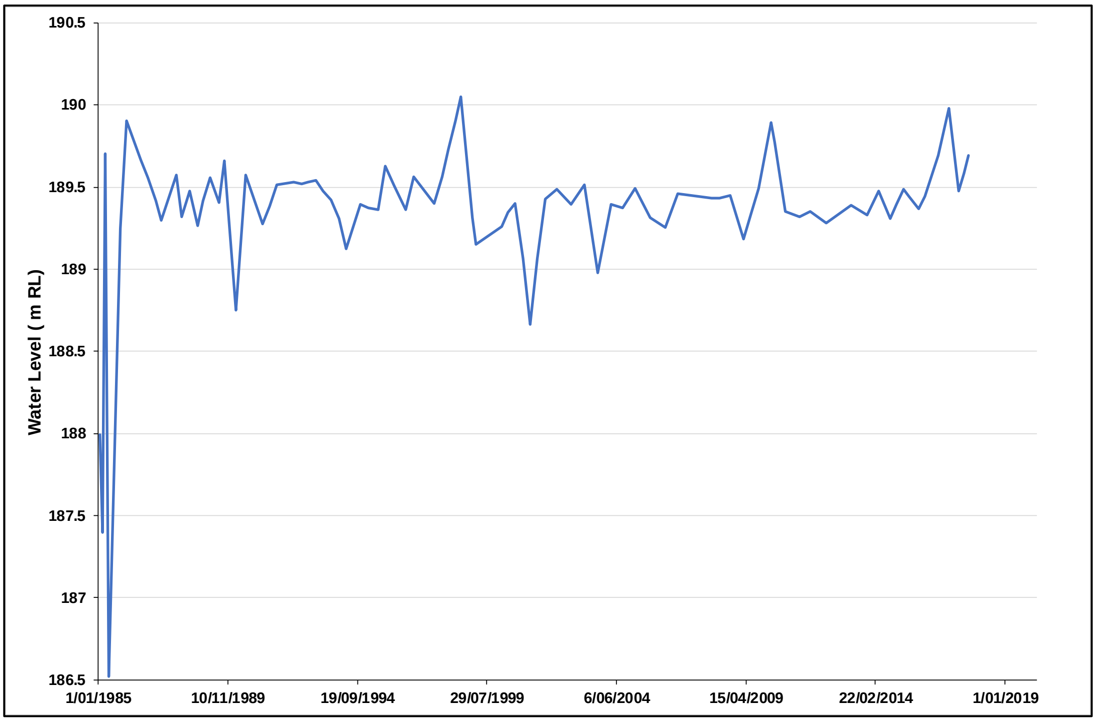


Figure 5.4: Cooling Water Make-up Dam water level monitoring data.

5.2 Proposed Water Management System

5.2.1 Salt Cake Landfill Facility Water Management

In accordance with the NSW EPA Environmental Guidelines for solid waste landfills (Second Edition, 2016) a leachate barrier system will be constructed in each salt cake landfill cell to contain leachate and prevent the contamination of surface water and groundwater over the life of the landfill. The proposed leachate barrier system WSP (2018) consists of the following elements from bottom to top:

- a compacted sub-base 200 mm thick to provide a firm, stable, smooth surface of high bearing strength on which to install the liner;
- a compacted clay liner at least 1,000 mm thick, with an in situ hydraulic conductivity of less than 1 x 10^{-9} m/s. As an alternative to compacted clay, a geosynthetic clay liner may be used, provided it is used in composite with an overlying geomembrane liner;
- a flexible membrane liner of high-density polyethylene at least 2mm thick;
- a protection or cushion geotextile to protect the flexible membrane liner from damage by construction equipment and overlying materials;
- a leachate collection layer comprising a 300mm thick gravel drainage layer including collection pipework which slopes to a sump or extraction point; and
- a separation geotextile comprising a non-woven geotextile fabric filter to reduce the ingress of fines from the overlying waste.

The concept design developed by WSP (2018) allows for a freeboard in the maximum salt cake storage in each cell equivalent to a 24 hour 1 in 25-year storm event as required by the EPA guidelines.

Each landfill cell would be constructed with a longitudinal fall on the base so that briny liquid (leachate) drains to a sump area. A portable pump would then be used to pump this liquid out of the sump via a leachate riser and the leachate will be transferred back to the Brine Concentrator Plant (**BCP**) and or Brine Holding Pond (**BHP**).

Given that the proposed surface area of cells is large enough to store in excess of three years of cake storage, the amount of rain / clean water reporting to the contaminated material would need to be minimised. This would be managed by constructing a temporary earth divider within the overall cell. The lowest part of the cell would have an area for the placement of cake storage with anything “upstream” separated off by an earthen divider (WSP 2018). This would limit the volume of water that would be mixed with the cake storage and hence need to be recycled back to the BCP and or BHP. As the volume of cake storage in the cell increases, the divider can be moved further upstream with the cell. Stormwater within the salt disposal cell would be transferred back to the BHP.

During operation of the salt cake landfill facility, the active cell would be covered on a daily basis with a suitable material to minimise dust and rainwater infiltration into the salt cake (and therefore the amount of leachate generated). Where no salt cake landfilling is undertaken for more than 90 days, an intermediate soil cover would be used. The daily and intermediate soil covers would be in accordance with *EPA Environmental Guidelines* (EPA, 2016).

As most of the proposed cells would be of turkey’s nest style construction, no natural stormwater runoff would enter these cells. In the case of the few cells where some sides are all in cut, diversion bunds will be constructed to prevent stormwater entering the cells.

The landfill cell design also includes groundwater underdrains to reduce the potential for partially saturated groundwater conditions (perched groundwater systems) developing beneath the landfill cells (WSP, 2018).

The final capping of each landfill cell would comprise of a compacted clay layer at least 600 mm thick to reduce rainfall infiltration and then a one meter thick revegetation layer comprising of clean soils, top soil and vegetation in accordance with the EPA guidelines (EPA, 2016).

5.2.2 Borrow Pit Water Management

The final design of the borrow pits will include clean water diversions. Excavation within the borrow pits would not intercept with groundwater table, and no groundwater dewatering works would be required.

It has been assumed that during construction, the borrow pits would be maintained to be free of surface water ponding, thereby enabling the extracted materials to be suitable for use as part of the Project. Further details on the proposed water management and drainage structures would be developed as part of the detailed design. The “dirty” water will be managed in accordance with the Blue book and water will be used for operational purposes such as dust management. Details of the “dirty” water management during construction will be provided in the Water Management Plan/CEMP that will be developed for the project.

It is assumed that the design of the borrow pits would have appropriate retention time or treatment such that any discharge meets the water quality objectives of the receiving water body during operation. AGL Macquarie has indicated that the final borrow pit landforms will be free-draining once stabilised to an acceptable level capable of meeting the water quality objectives of the receiving water body.

5.2.3 Ash Dam Augmentation Water Management

Table 5.5 summarises the proposed BWAD augmentation concept design developed by Aurecon (2019). The concept design includes the construction of a 0.5 m high concrete parapet wall along the main embankment crest to increase flood attenuation within the dam to meet dam safety committee requirements. This 0.5 m raise is only required to attenuate extreme floods for a short duration and therefore does not need to be fully watertight (Aurecon, 2019).

Table 5.5 shows that the decant pond operational target level will vary throughout the life of the dam. It is noted that the augmented ash dam could be delivered in three stages, as outlined below and in Aurecon (2019). However, for the purposes of the EIS, it has been assumed that the ash dam would be delivered to its fullest augmented capacity (ie up to Stage 3) in full. To meet the environmental freeboard requirements the following pond target levels are set for the ash dam:

- Stage 1 – RL 171.0 m
- Stage 2 – R 171.5 m
- Stage 3 – RL 172.0 m

Given the ash water is a closed recycled system, the pond level will naturally rise due to the impeding ash beach. However, to ensure that adequate environmental freeboard is maintained throughout the life of the dam, an operational target level should not be exceeded to avoid spills over the spillway. To achieve this water will need to be progressively removed from the ash cycle to manage this natural rise, despite an increasing operational pond level.

In order to reduce the discharge of water via the BWAD spillway, other means of removing water will need to be implemented. Options understood to be available may include:

- Using the transfer point at the return water tanks, water may be added to the flyash slurry that is destined for Ravensworth Void 5 (RWV5). Surplus BWAD water may be sent through this transfer out to RWV4 for use in the flyash cycle and/or discharged through LDP17 located in Void 4 (under the HRSTS); and
- Alternatively, excess water can also be sent to Liddell Main Cooling Water Dam.

Decant water is currently drawn from the BWAD using Intake Tower 4, located towards the right abutment of the main embankment. The tower was reported to be under water in March 2019 (Aurecon, 2019). The current proposal is augmentation of the return water intake, to prevent it becoming inundated by ash and allowing operation of a higher pond level. The current proposal is to attach a prefabricated stainless steel 'snorkel' to the opening of the existing intake, raising its minimum operating level to RL 171 m (Aurecon, 2019).

Table 5.5: Summary of Ash Dam augmentation concept design

Parameter	Stage 1	Stage 2	Stage 3
Western Wall crest elevation (mRL)	179.0	183.0	185.5
Saddle Wall crest elevation (mRL)	172.4 to 179	173.5 to 183	174 to 185.5
Southern saddle dam (mRL)	183(1)	n/a	177 (2)
Pond operational target level (mRL)	171.0	171.5	172.0
Pond Volume (ML)	3,325	744	65
Spillway invert (mRL)	172.0	172.5	173.7
Environmental freeboard (ML)	462	361	238
Main embankment crest (mRL)	174.0	174.0	174.5
Total Freeboard (m)	2.0	1.5	0.8

Notes (1) New saddle dam required to prevent ash from spilling out of low point along southern ridgeline.
(2) Construction of a second southern side saddle dam at an (averaged) crest RL of 177 m.

6. GoldSim Water Balance Modelling

6.1 Introduction

A GoldSim water balance model was developed and used to calculate the volume of water in storages at the end of each day by accounting for inflows and outflows. The GoldSim water balance model was developed based on the schematic presented in Appendix A.

6.2 Australian Water Balance Model

The GoldSim model developed by Jacobs uses the Australian Water Balance Model (**AWBM**) to calculate runoff from rainfall at daily time increments (Boughton, 1993).

6.2.1 AWBM Structure

The structure of the AWBM is shown in Figure 6.1. Boughton (2004) provides a detailed description of the AWBM. The AWBM consists of three partial areas (A1, A2 & A3) and associated surface stores (C1, C2 & C3). Simulated surface runoff occurs when the surface stores fill and overflow. At each time step, rainfall is added to each of the surface stores (C1, C2 & C3) and evapotranspiration is subtracted. If there is excess moisture (water) from any store, it becomes runoff and is divided between surface runoff and baseflow.

The baseflow index (**BFI**) is the fraction of total flow that appears as baseflow. Discharge from the baseflow store is calculated as BS * (1.0 - K_b) where BS is the amount of moisture in the baseflow store and K_b is the baseflow recession constant for the time step of the calculations.

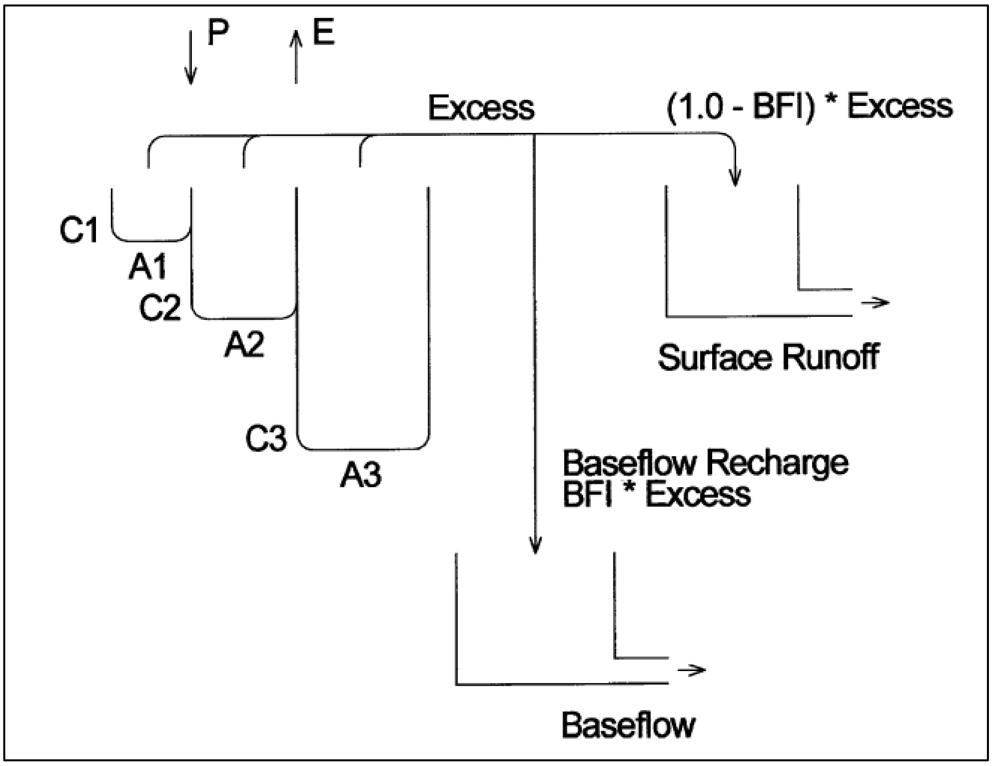


Figure 6.1: Structure of the Australian Water Balance Model.

6.2.2 Catchment Area Surface Runoff Types

The surface water catchment areas shown in Figure 3.1 were sub-divided into various surface runoff types for the purposes of assigning appropriate AWBM runoff parameters. Catchment areas were sub-divided into the following surface runoff types:

- Natural/undisturbed;
- Roads/Hardstand;
- Stockpile;
- Borrow Pit;
- Salt-cake landfill; and
- Ash deposits.

The surface runoff type areas for each catchment were defined based on aerial imagery captured in January 2019 provided by AGL Macquarie. Table 6.1 provides a summary of the surface type areas assigned to each catchment under existing and future (proposed) conditions.

To apply the AWBM in a given catchment, the rainfall-runoff model input parameters described in Section 6.2.1 must be defined. The parameters are usually estimated as follows:

- For a catchment where streamflow gauging data is available, the AWBM parameters can be estimated by a process of calibration where recorded streamflows are compared with model calculated streamflows. However, there was no suitable streamflow gauging data available for the AGL Macquarie site catchments that could be used to calibrate the model; and
- Where sufficient water level monitoring data is available for water storages (pond and dams), the AWBM parameters for the pond/dam catchment areas can be estimated during calibration for pond/dam water levels. There was insufficient water level monitoring data for the ponds/dams to calibrate the model, except for the CHP Sediment Basin.

Given the general lack of suitable water level and streamflow monitoring data that could be used to calibrate the model for AWBM runoff parameters, the parameters for the AGL Bayswater site AWBM were assigned based on a previous water balance model developed for a site in the Hunter Valley with similar surface runoff types (WRM, 2015). Table 6.2 presents AWBM parameters assigned to the site AWBM. For the purposes of this assessment, the AWBM parameters assigned to the borrow pits and the salt-cake landfill facility were the same as parameters assigned to roads/hardstand areas in the WRM (2015) model. Ash deposits in the BWAD were assumed to have the same runoff characteristics as spoil.

Table 6.1: Catchment area surface types.

Catchment	Area (Ha)													
	Natural		Roads/Hardstand		Coal stockpile		Borrow Pit		Salt-cake landfill		Ash deposits		Ponded Water [1]	
	Existing	Future	Existing	Future	Existing	Future	Existing	Future	Existing	Future	Existing	Future	Existing	Future
Middle Plashett Reservoir	648.58	461.57	15.65	15.65	0	0	0	187.01	0	0	0	0	0	0
Noname Creek	277.24	249.48	7.7	7.7	0	0	0	0	0	27.76	0	0	0	0
Pikes Creek Tributary	199.86	166.42	0	0	0	0	0	33.44	0	0	0	0	0	0
CHP Sediment Basin	28.57	28.57	36.3	36.3	31.9	31.9	0	0	0	0	0	0	1.45	1.45
Ash Dam	88.68	80.76	2.25	2.25	0	0	0	7.92	0	0	102.79	102.79	39.28	15.88
Brine Holding Dam	26.46	22.96	0.9	0.9	0	0	0	3.5	0	0	0	0	5.8	5.8
Cooling Water Makeup	20.46	20.46	0.6	0.6	0	0	0	0	0	0	0	0	9.5	9.5
Ash Pond 1	0	0	6.47	6.47	0	0	0	0	0	0	0	0	0.13	0.13
Ash Pond 2	28.19	28.19	0.95	0.95	0	0	0	0	0	0	0	0	0.13	0.13

Notes. [1] Surface area at full capacity.

Table 6.2: Parameters assigned to AGL site AWBM (Source: WRM, 2015).

Parameter	Units	Natural	Ash deposits	Coal Stockpile	Roads/ Hardstand	Borrow Pit	Salt-cake landfill
A1	-	0.2	0.1	0.1	0.1	0.1	0.1
A2	-	0.2	0.3	0.9	0.9	0.9	0.9
A3	-	0.6	0.6	0.0	0.0	0.0	0.0
C1	mm	45	15	4	4	4	4
C2	mm	95	50	16	16	16	16
C3	mm	150	110	-	-	-	-
BFI	-	0.55	0.2	0	0	0	0
Kb	1/day	0.7	0	0	0	0	0

6.3 Model Calibration

6.3.1 Ash Dam Flow and Volume Calibration

A high-level model calibration was carried out to estimate the BWAD seepage loss rate based on observed BWAD water pond level data.

AGL Macquarie provided BWAD bathymetric data for the survey undertaken at the end of August 2019. Jacobs used the bathymetric data to develop relationships between BWAD pond water elevation, pond storage volume and pond area. Jacobs estimated the ponded water volume in the BWAD at the end of August 2019 to be approximately 1,100 ML.

During the calibration process, the BWAD seepage rate was adjusted in order to obtain a reasonably good match between simulated and observed pond water storage volumes for the period at the end of August 2019.

The following climatic input data was applied to the water balance model during the calibration:

- Rainfall data from the site rain-gauge;
- Class A Pan Evaporation from the Doyles Creek station (SILO Database) was used to represent evaporation from the CHP sediment basin surface area; and
- Areal actual evapotranspiration (AAET) data for the BoM website (Table 3.4) was used to represent evapotranspiration from soils in the model.

The water balance model was run for the period between 1 January 2018 and 31 August 2019 with varying BWAD seepage loss rates.

Table 6.3 shows that the best match between simulated and observed pond water storage volumes was obtained when the BWAD seepage rate applied to the model was between 105 and 110 L/s.

Table 6.3: Pond volumes simulated using varying Ash Dam seepage rates

Seepage rate applied to model (L/s)	Model simulated Ash Dam water pond volume (ML)
110	975
109	1,013
108	1,051
107	1,088
106	1,126
105	1,164

6.3.2 Coal Handling Plant Water Management System Flow Calibration

A high-level calibration of the GoldSim water balance model was carried out to select model flow inputs that result in a reasonably good match between simulated and observed CHP basin overflows. The CHP sediment basin discharges (overflows) to Tinkers Creek.

The observed (monitoring data) for CHP sediment basin overflows are summarised in Appendix B. The GoldSim model was calibrated using CHP sediment basin overflow monitoring data for the period from October 2016 to mid-January 2017. Flow monitoring for the period between mid-January to March 2017 was not used in the calibration because of the uncertainty in the data due to errors associated with placement of the silt boom (Appendix B).

The following model inputs were assigned to the model during the calibration:

- Rainfall data from the site rain-gauge;
- Class A Pan Evaporation from the Doyles Creek station (SILO Database) was used to represent evaporation from the CHP Basin surface area. A pan factor of 0.65 was applied to simulate evaporation from the CHP Basin surface;
- AAET data for the BoM website (Table 3.4) was used to represent evapotranspiration from soils in the model; and
- Process water flow monitoring data provided by AGL Macquarie which is summarised in Figure 6.2. The process water discharges to the CHP sediment basin. Process water constitutes flows from the operational use of the plant, including clarifier water, demineralisation effluents, and oil contaminated wash down from within the station, plant drainage, and run off from dirty areas.

The hydrograph in Figure 6.3 shows simulated and observed CHP sediment basin overflows for the calibrated model. The hydrograph shows a reasonably good match between simulated and observed flows, especially for the period between mid-November 2016 and mid-January 2017.

The GoldSim was able to replicate peak CHP basin overflow events associated with large rainfall events. Daily process water inflows (to the CHP basin) applied to the GoldSim model were calculated from weekly process water monitoring data provided by AGL Macquarie. Therefore, the model was not able to replicate the daily variation in CHP basin overflow associated with daily variation in process water inflows.

In summary, results of the calibration using CHP sediment basin overflow monitoring data indicates that the water balance model simulates CHP sediment overflows acceptably well.

The level of calibration shown in Figure 6.3 was achieved using model inputs presented in Table 6.4.

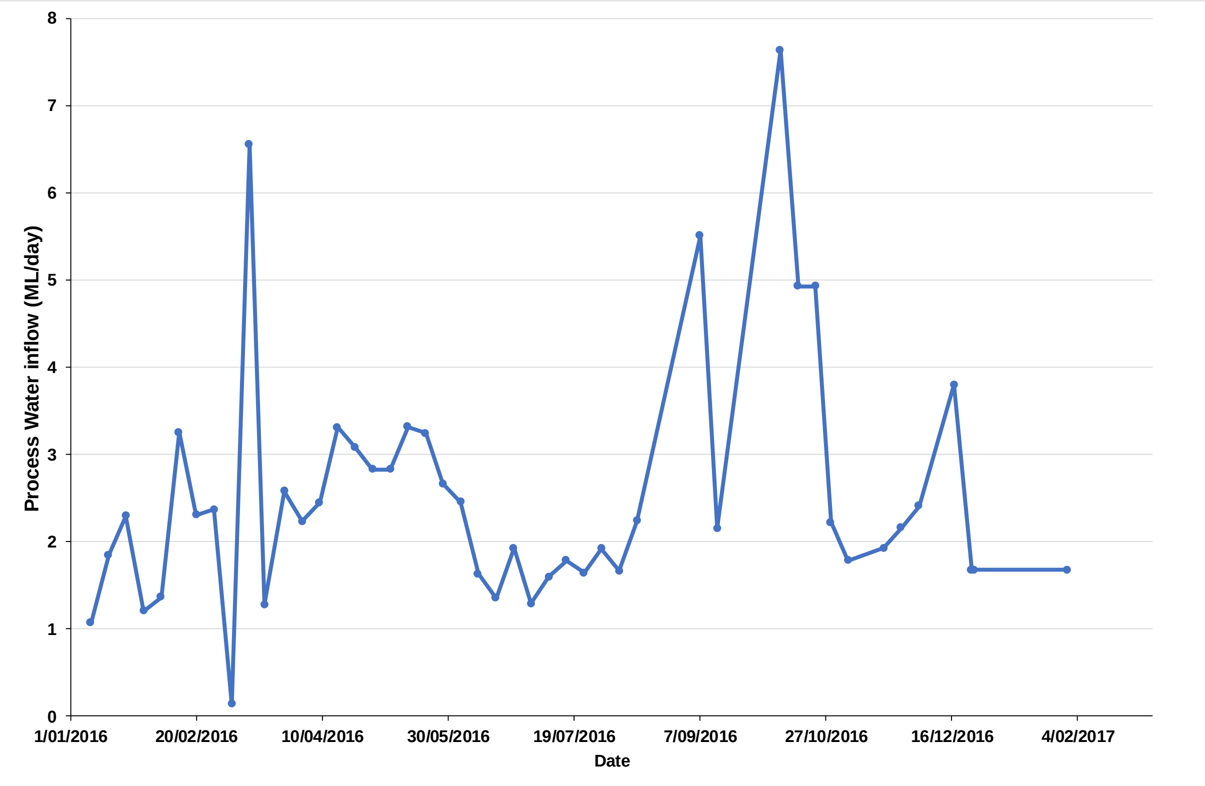


Figure 6.2: Process water flow monitoring data.

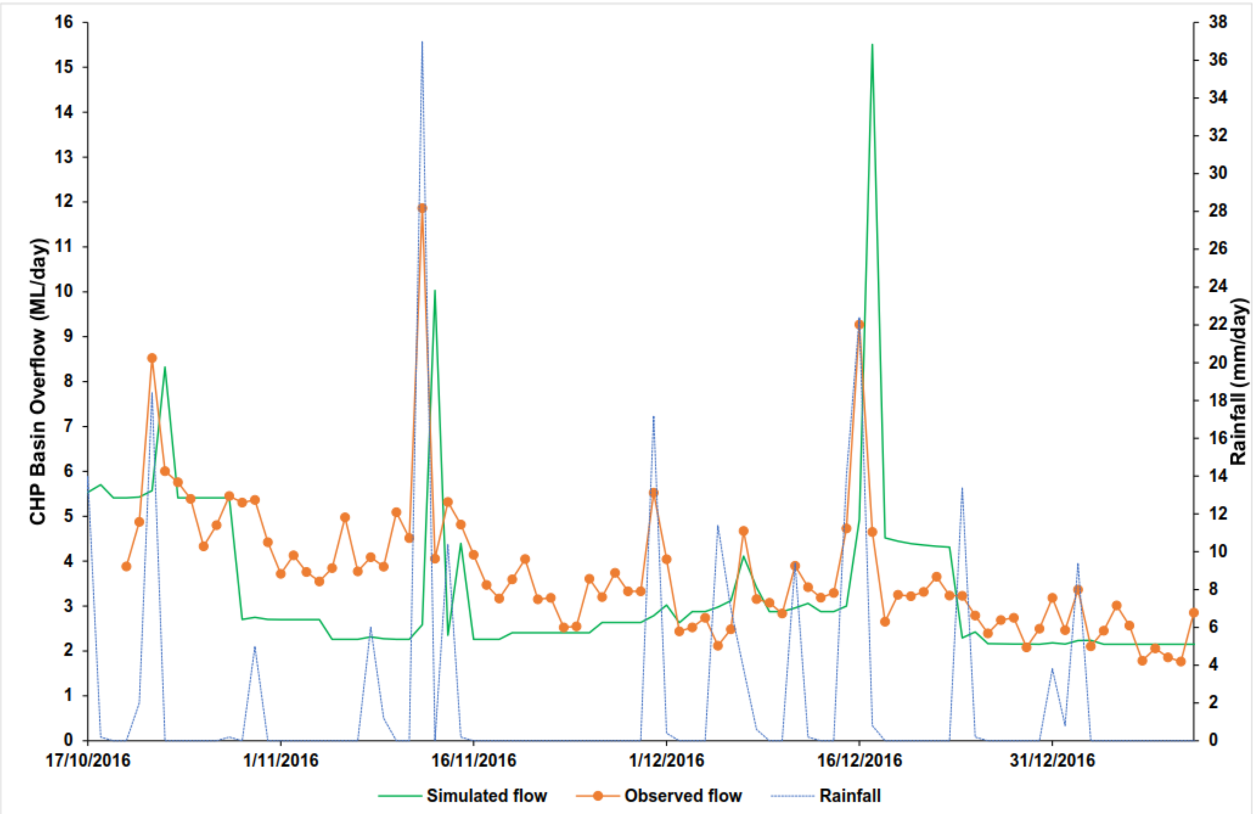


Figure 6.3: Simulated and observed overflows for the CHP basin.

Table 6.4: Model input parameter values assigned to calibrated model.

Model Input	Description	Calibrated Model Values
Launder Water	Inflow to CHP sediment basin (Section 0)	0.26 ML/day
Process water	Inflow to CHP sediment basin (Section 0)	Figure 6.2
Firewater	Inflow to CHP sediment basin (Section 0)	0.25 ML/day
AWBM coefficients	Rainfall runoff coefficients	Table 6.2
Climate	Rainfall, Class A Pan evaporation, Pan factor and AAET	Unchanged from initial values described above

6.4 Water Balance Modelling Assessment

The water balance model was used to predict storage volumes and flows for the water management systems under existing and post-upgrade conditions. The prediction period was for the period from January 2020 to December 2035, which covers the remaining operation period of Bayswater.

6.4.1 Monte Carlo Simulation

The Monte Carlo functionality within GoldSim was utilised to produce probabilistic model results, which quantify storage volumes and flows based on the foreseeable life of the operations over a range of climatic rainfall conditions. Monte Carlo simulation in GoldSim was used to translate (propagate) the uncertainty in rainfall into uncertainties in water balance model predictions. In the Monte Carlo simulation, the model was run 500 times for each day of the simulation period. Each of the 500 simulations is of equal probability and is referred to as a realisation of the water management system. For each realisation, single values for rainfall (from the 500 rainfall stochastic datasets) are randomly picked. Five hundred separate and independent results are generated, each representing a possible "future" for the water management system. The results of the 500 independent system realisations are assembled into probability distributions of possible outcomes (GoldSim Technology Group, 2018).

6.4.2 Climate Data

The Stochastic Climate Library (**SCL**) version 2.2 (Srikanthan et al., 2006) was used for generating 500 daily stochastic rainfall datasets for the purposes of the water balance predictive modelling. At least 30 years of continuous daily rainfall data is required to generate rainfall data.

Given that only fourteen years of non-continuous rainfall data was available from the site rainfall station, rainfall data from the Doyles Creek (Wood Park, Station Number 061130) rainfall station was used to generate the stochastic rainfall data. Doyles Creek rainfall station, which is located approximately 10 km to the south west of the site, has daily rainfall data from 1920.

Evaporation applied in the model for water storages (ponds and dams) was estimated by multiplying Class A evaporation (Table 3.2) by a pan factor of 0.65.

AAET data for the BoM website (Table 3.4) was used to represent evapotranspiration from soils in the model.

6.4.3 Water Balance Modelling Global Settings

The 15-year model simulation period represents the approximate remaining operational period of Bayswater, assumed to be from January 2020 to December 2035. As described in Section 6.4.1 and 6.4.2, the model was run 500 times for each day of the simulation period to capture the variability in future rainfall. This report presents the following volume and flow modelling results:

- 5th percentile flow or volume (**Dry scenario**): The 5th percentile flow or volume is the amount which marks off the lowest 5 per cent of the flow or volume simulated for each day (i.e. 5% of the 500 flows or volumes simulated for each day do not exceed this amount);

- 95th percentile flow or volume (**Wet scenario**): For any simulated day, the 95th percentile amount represents the amount (flow or volume) which 95% of the 500 model realizations do not exceed. The 95th percentile amount is exceeded during extreme wet conditions; and

- Mean flow or volume (**Average rainfall scenario**). Represents the average simulated flow or volume on each day.

6.4.4 Ash Dam Water Management System Modelling

6.4.4.1 Methodology

The water balance model was used to calculate daily storage volumes and associated flows for the BWAD water management system.

Based on information provided by AGL Macquarie, it has been assumed that return water is pumped from the Seepage Collection Pond 1 to BWAD at a constant rate of 26 L/s for a duration of three hours per day (Section 5.1.1).

There is no information available on the duration of pumping from Seepage Collection Pond 1 to BWAD. For the purposes of this water balance assessment, it has been assumed that return water is also pumped from the Seepage Collection Pond 2 to BWAD at a constant rate of 26 L/s for a duration of three hours per day.

6.4.4.2 Results

Figure 6.4 shows the simulated BWAD pond water volume under existing conditions. The full supply volume (**FSV**) of the BWAD water storage pond for existing conditions applied to the model was 2,640 ML, based on the analysis of topographic survey data from August 2019 provided by AGL. The modelling on which the results presented in are based, assumes that the BWAD water storage pond FSV remains constant over the 15-year simulation period.

The average rainfall scenario modelling results for existing conditions presented in Figure 6.4 indicate that, over the 15-year simulation period, the BWAD water pond will not spill over the spillway (i.e. the pond water volume will not exceed the FSV of 2,640 ML. The wet scenario modelling results for existing conditions show the BWAD water storage pond spilling over the spillway for most of the period between 2023 and 2035.

Figure 6.5 shows the simulated BWAD pond water volume for the third stage of the proposed BWAD augmentation. The designs provided by Aurecon (2019) indicate that the FSV of the BWAD water storage pond for the third stage of augmentation is approximately 65 ML (Section 5.2.3). The modelling on which the results presented in Figure 6.5 are based assumes that the BWAD water storage pond FSV remains constant over the 15-year simulation period.

The average rainfall scenario modelling results for the third stage of the proposed BWAD augmentation presented in Figure 6.5 indicate that, over the 15-year simulation period, the BWAD water pond will not spill over the spillway (i.e. the pond water volume will not exceed the water pond maximum capacity of 65 ML. The wet scenario modelling results show the BWAD water storage pond spilling over the spillway for the entire 15-year simulation period.

In summary both Figure 6.4 and Figure 6.5 show that, for average rainfall conditions, the water balance model predicts no overflows from the BWAD for both existing and post- BWAD augmentation conditions. However, for extreme wet conditions, that are unlikely to be exceeded for 95% of the time (i.e. are likely to occur less than 5 % of the time), the water balance model predicts that overflow from the BWAD water storage pond may occur via the spillway.

Table 6.5 presents the average daily BWAD water balance for the 15-year period from January 2020 to December 2035. The table presents 5th Percentile (Dry Scenario), average scenario and 95th Percentile (Wet Scenario) volumes and flows for existing and post-augmentation conditions. Table 6.5 indicates that, by far, the largest water inflow component to the BWAD is from the ash slurry from the ash plant (average daily inflow = 8.216 ML/day).

Table 6.5 also indicates that, for both existing and post-augmentation conditions (with no mitigations), the daily seepage discharge to Pikes Creek ranges from approximately 8.7 ML to 9.2 ML.

Table 6.5 also indicates that modelled daily seepage flows from the BWAD bypassing the BWAD seepage collection system (Seepage Collection Pond 1 and Seepage Collection Pond 2) are similar for existing and post-BWAD augmentation conditions for varying rainfall scenarios. Table 6.5 indicates that the modelled seepage losses range from 8.7 ML/day to 9.2 ML/day. It is likely that a significant portion of the BWAD seepage flows bypassing the BWAD seepage collection system discharges to Pikes Creek.

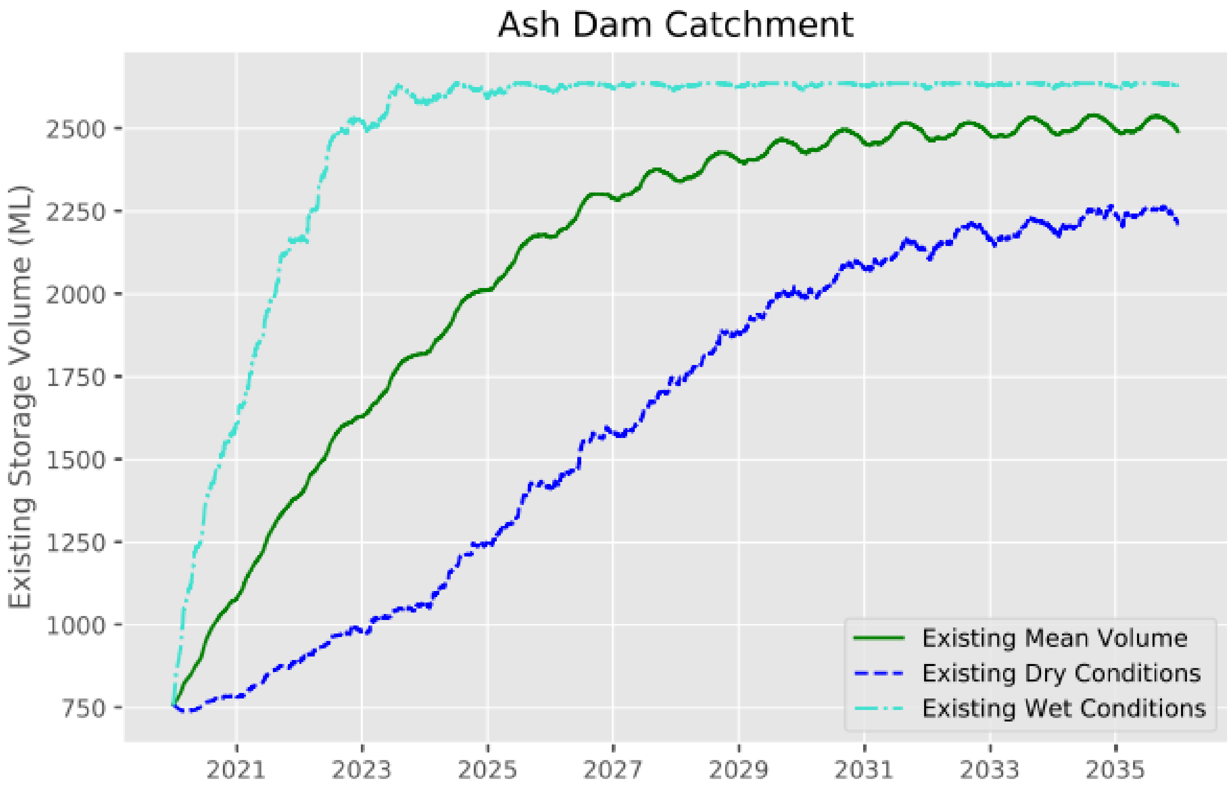


Figure 6.4: Simulated Ash Dam pond water volume for existing conditions.

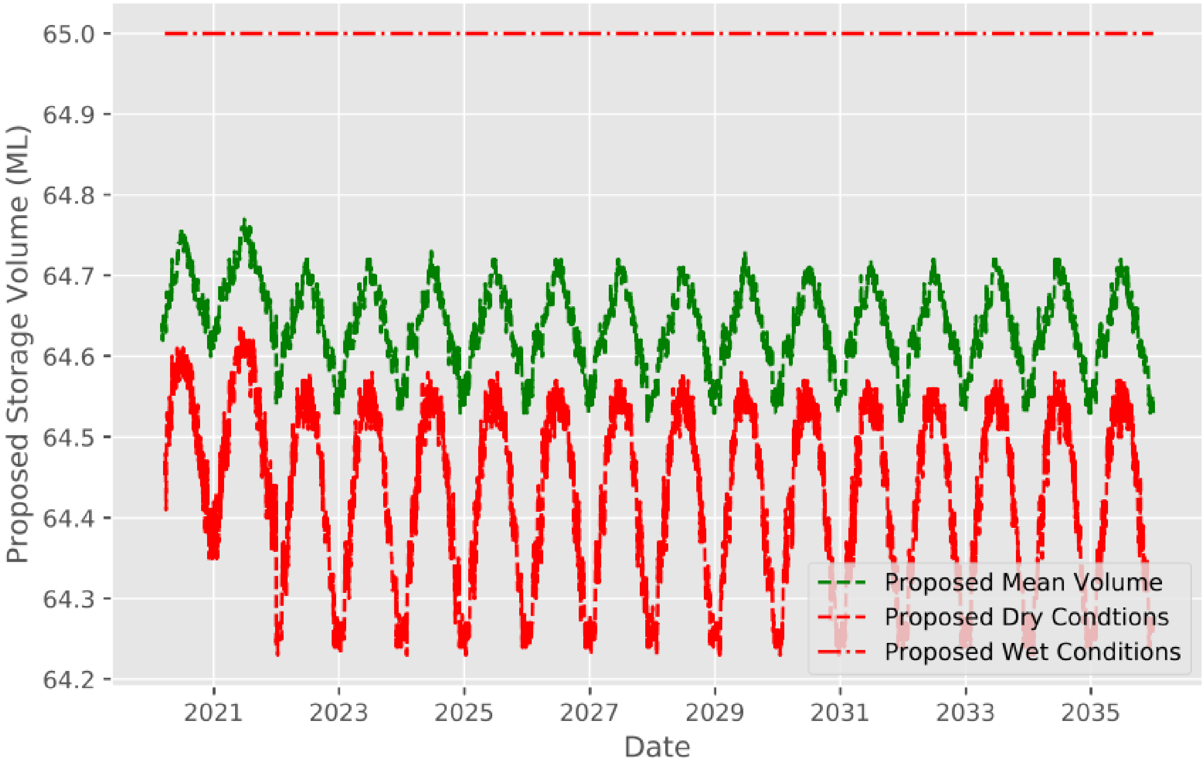


Figure 6.5: Simulated Ash Dam pond water volume for post-augmentation conditions.

Table 6.5: Ash Dam water balance summary.

	Dry Scenario (5th Percentile)		Average Scenario (Mean)		Wet Scenario (95th Percentile)	
	Existing	Proposed	Existing	Proposed	Existing	Proposed
ASH DAM WATER STORAGE VOLUME (ML)	1,626	65	2,109	65	2,487	65
INPUTS (ML/d)						
Rainfall	0.000	0.000	0.663	0.070	4.140	0.439
Runoff	0.000	0.000	0.822	0.822	2.183	2.183
Seepage Collection Pond 1	0.239	0.000	0.264	0.178	0.270	0.254
Seepage Collection Pond 2	0.239	0.000	0.264	0.178	0.270	0.254
Brine Holding Pond overflow	0.000	0.000	0.000	0.000	0.000	0.000
Boiler and Mills Cleanout	0.000	0.000	0.000	0.000	0.000	0.000
Demineralisation Effluent	0.787	0.787	0.787	0.787	0.787	0.787
Treated Sewage Effluent	0.000	0.000	0.000	0.000	0.000	0.000
Ash Plant	8.216	8.216	8.216	8.216	8.216	8.216
OUTPUTS (ML/d)						
Overflow	0.000	0.000	0.000	0.000	0.050	2.042
Evaporation	0.822	0.114	1.089	0.115	1.295	0.115
Seepage to Collection Ponds	0.478	0.000	0.528	0.356	0.540	0.508
Seepage to Lake Liddell	0.094	0.094	0.094	0.094	0.094	0.094
Seepage to Bayswater Creek	8.702	8.733	8.715	8.886	8.757	9.241

6.4.5 Coal Handling Plant Water Management System Modelling

6.4.5.1 Methodology

The water balance model was used to calculate daily storage volumes for the CHP sediment basin and associated flows. The following model inputs were applied to represent future process flows:

- Process Water: The average daily discharge flow from the contaminated water pond monitoring data for the period from 2016 to 2019;
- Launder flows: The model input value applied to the calibrated water balance model (Section 6.3.2); and
- Firewater leak: AGL personnel have indicated that firewater system leak has since been repaired. Therefore, a model input value of 0 ML/day was applied to the model to represent firewater leak inflows to the CHP basin.

6.4.5.2 Results

Table 6.6 presents the average daily CHP Basin water balance for the 15-year period from January 2020 to December 2035. The table presents 5th Percentile (Dry Scenario), average scenario and 95th Percentile (Wet Scenario) volumes and flows for existing and (post-upgrade) conditions. Model predicted volumes and flows for the existing and post-upgrade conditions are the same, given that the proposed upgrades are not expected to have a negligible impact on the water management system.

All the model scenarios presented in Table 6.6 indicate that the CHP sediment basin will continue to overflow daily to Tinkers Creek for both the existing and post-upgrade conditions. The daily overflow volume is expected to range from 1.6 to 4.2 ML/day with an average of 2.3 ML/day.

Process water inflows constitute approximately 60% of the inflows to the CHP Basin for average rainfall conditions.

Table 6.6: CHP Basin water balance summary

	Dry Scenario (5th Percentile)		Average Scenario (Mean)		Wet Scenario (95th Percentile)	
	Existing	Proposed	Existing	Proposed	Existing	Proposed
CHP SEDIMENT BASIN STORAGE VOLUME (ML)	37.6	37.6	37.6	37.6	37.6	37.6
INPUTS (ML/d)						
Rainfall	0.000	0.000	0.026	0.026	0.161	0.161
Runoff	0.000	0.000	0.628	0.628	2.552	2.552
Launder water	0.259	0.259	0.259	0.259	0.259	0.259
Process Water	1.400	1.400	1.400	1.400	1.400	1.400
Cooling Water Makeup Dam Overflow	0.000	0.000	0.000	0.000	0.000	0.000
OUTPUTS (ML/d)						
Evaporation	0.042	0.042	0.042	0.042	0.042	0.042
Overflow	1.617	1.617	2.271	2.271	4.246	4.246

6.4.6 Catchment Runoff Modelling

The location of the proposed borrow pits are shown in Figure 3.1. The proposed borrow pits locations are in the following catchments:

- Borrow Pit 3, Borrow Pit 4 and a small part of Borrow Pit 2 will be excavated in the Middle Plashett surface water catchment area;
- Borrow Pit 1 and a part of Borrow Pit 2 will be excavated in Pikes Creek Tributary catchment area; and
- Part of Borrow pit 2 will be excavated in the BWAD surface water catchment area.

It has been assumed that during construction, the borrow pits would be maintained to be free of surface water ponding, thereby enabling the extracted materials to be suitable for use as part of the Project. Further details on the proposed water management and drainage structures would be developed as part of the detailed design. The "dirty" water will be managed in accordance with the Blue book and water will be used for operational purposes such as dust management. Details of the "dirty" water management during construction will be provided in the Water Management Plan/CEMP that will be developed for the project.

It is assumed that the design of the borrow pits would have appropriate retention time or treatment such that any discharge meets the water quality objectives of the receiving water body during operation. AGL Macquarie has indicated that the final borrow pit landforms will be free-draining once stabilised to an acceptable level capable of meeting the water quality objectives of the receiving water body.

The water balance model was used to assess the potential increase in total surface water catchment runoff from the final free-draining borrow pit landforms.

6.4.6.1 Methodology

The water balance model was used to compare the simulated catchment runoff discharges for the following conditions:

- Existing scenario: This model scenario propagates existing conditions into the future without any change (i.e. No excavation of borrow pits). Therefore, the land surfaces in the proposed borrow pit areas would remain predominantly natural; and

- Post-development scenario: This worst-case model scenario assumes that the borrow pits will all be excavated at the same time. It is conservatively assumed that all the borrow pits will be excavated to maximum capacity at the start of the simulation period (January 2020). It is also assumed that the runoff characteristics of the borrow pit surfaces will be similar to road/hardstand surfaces (Table 6.2).

The assessment was based on a comparison of simulated daily catchment runoff volumes for average (mean) rainfall conditions.

6.4.6.2 Results

Figure 6.6 shows the modelled difference in daily runoff between the existing and post-development scenarios for the Middle Plashett Catchment. Modelled post-development daily stormwater runoff is higher than existing conditions runoff by up to 3.5 kL/day. The difference in simulated daily runoff between the two scenarios is less than 0.2% of the average simulated daily runoff for the catchment under existing conditions.

Figure 6.7 shows the modelled difference in daily runoff between the existing and post-development scenarios for the Pikes Creek Tributary Catchment. Modelled post-development daily stormwater runoff is higher than existing conditions by up to 0.6 kL/day. The difference in simulated daily runoff between the two scenarios is less than 0.15% of the average simulated daily runoff for the catchment under existing conditions.

For the BWAD surface water catchment, the impacts of the excavation of Borrow Pit 2 on the simulated daily runoff volume is minor to negligible due to the small area coverage of the borrow pit in the catchment.

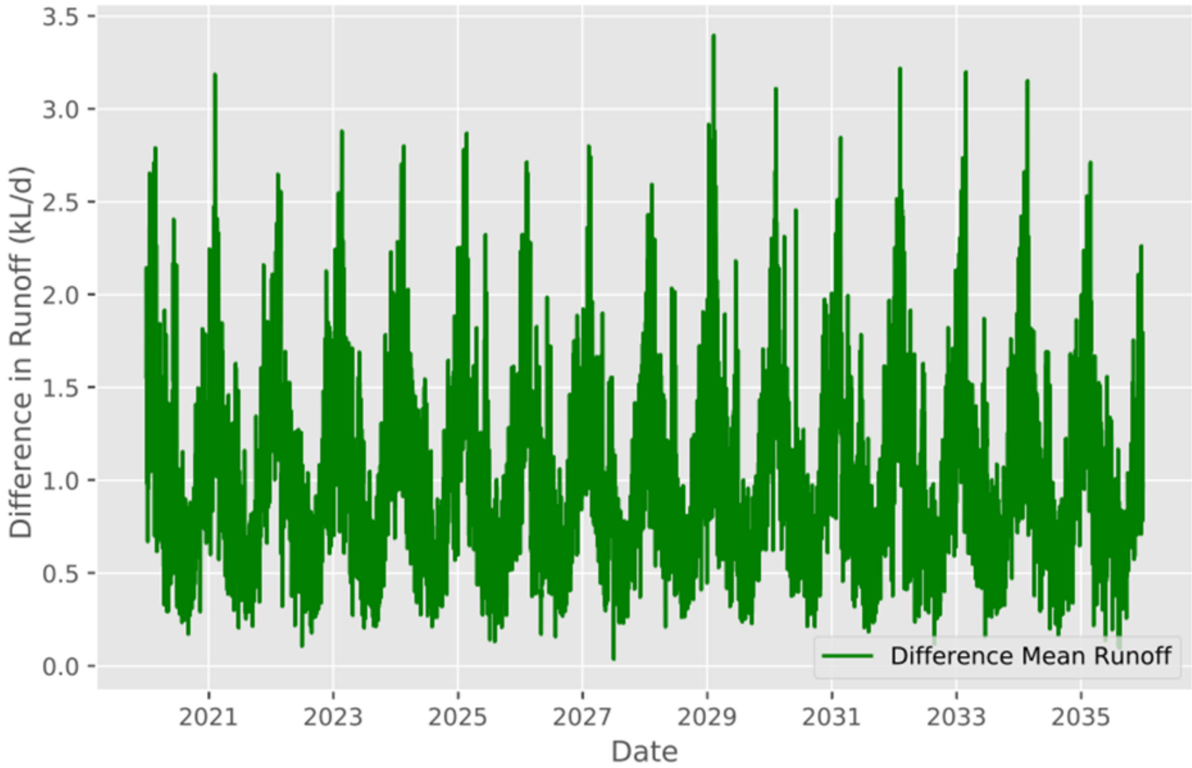


Figure 6.6: Difference in runoff between existing and post-development scenarios - Middle Plashett Catchment.

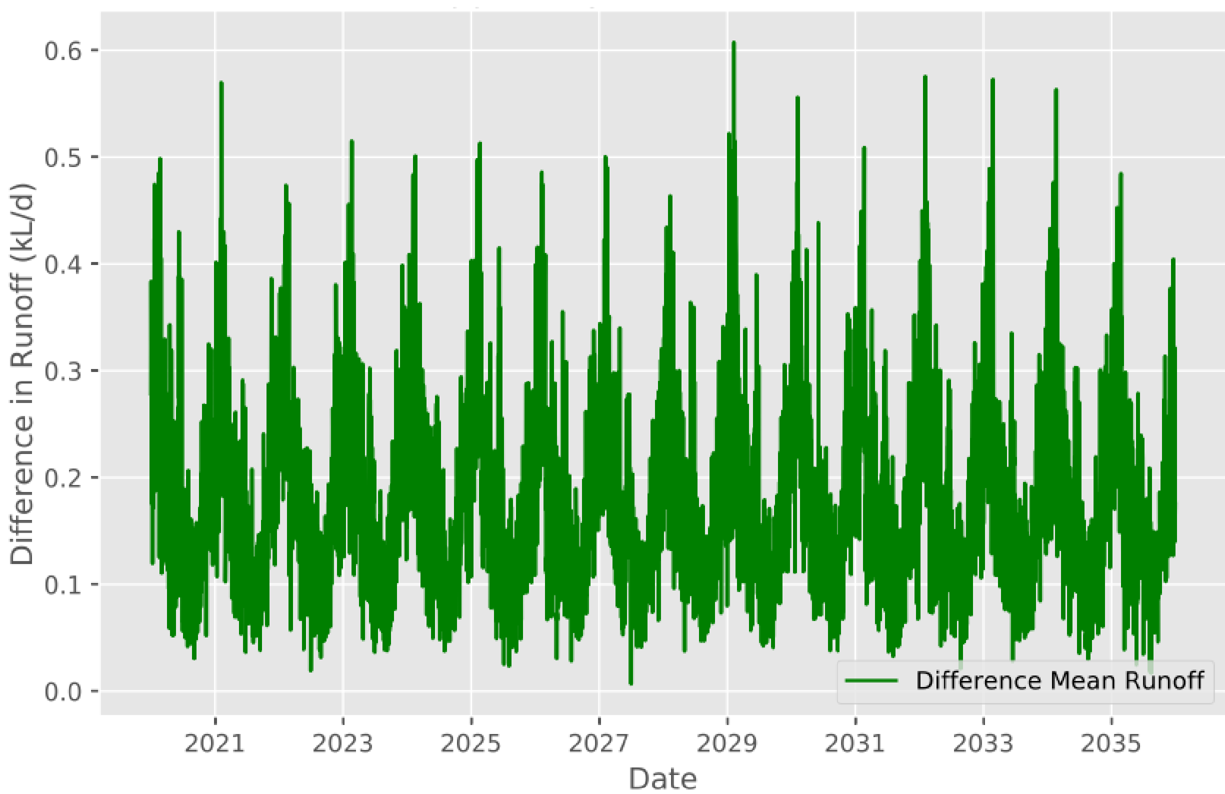


Figure 6.7: Difference in runoff between existing and post-development scenarios - Pikes Creek Tributary Catchment.

7. Surface Water Quantity Impact Assessment and Mitigation Measures

7.1.1 Ash Dam Water Management System Impacts

Potential overflows from the BWAD

Water balance modelling results for BWAD (Figure 6.4 and Figure 6.5) show that, for average rainfall conditions, the water balance model predicts no overflows from the BWAD for both existing and post- BWAD augmentation conditions. However, for extreme wet conditions, that are likely to occur less than 5% of the time, the water balance model predicts that overflows from the BWAD water storage pond may occur via the spillway.

A secondary environmental requirement set by the DSC that is applicable to the BWAD, is that the dam needs to be capable of detaining the flood surcharge up to the 1 in 10-year, 72-hour storm, without releasing any water over the spillway.

Whilst the Bayswater EPL allows for discharge from the BWAD spillway, as a mitigation measure to avoid spills over the BWAD spillway, AGL Macquarie has committed to ensuring that adequate environmental freeboard is maintained throughout the life of the dam by setting operational target levels for the BWAD. AGL Macquarie will ensure that the operational target levels are not exceeded to avoid spills over the spillway. To achieve these operational target levels, water will need to be progressively removed from the ash cycle to manage this natural rise (Aurecon, 2019). Other means of removing water will be implemented. Options understood to be available may include the following:

- Using the transfer point to send water directly to Void 4. Surplus BWAD water may be sent through this transfer out to Ravensworth Void 4 for eventual use in the flyash cycle and/or discharged from Void 4 under the HRSTS were appropriate; and
- Alternatively, excess water can be transferred to the BCP and treated for use in the cooling water system.

Given the proposed mitigation measures, the potential surface water impacts due to increasing volume and frequency of overflows from the BWAD due the proposed BWAD augmentation are likely to range from minor to negligible.

Potential seepage losses from BWAD

The water balance modelling results (Table 6.5) indicate that daily seepage flows from the BWAD bypassing the BWAD seepage collection system (Seepage Collection Pond 1 and Seepage Collection Pond 2) are similar for existing and post-BWAD augmentation conditions for varying rainfall scenarios. Table 6.5 indicates that the modelled seepage losses range from 8.7 ML/day to 9.2 ML/day. It is likely that a significant portion of the BWAD seepage flows bypassing the BWAD seepage collection system discharges to Bayswater Creek.

AGL has committed to upgrading the BWAD seepage collection system to maximise the volume of BWAD seepage loss flows that are captured by the seepage pond collection and pumped back to BWAD. The proposed upgrades to the seepage pond collection system and return water system include:

- Installing a seepage collection system below the saddle dam wall;
- Enlargement and deepening of the existing seepage collection ponds;
- Installation of larger capacity pumps to increase the maximum volume of seepage water that can be pumped back to the BWAD following large storm events; and
- Increasing the duration of pumping from the seepage collection ponds to the ash dam.

Therefore, the proposed upgrades to the seepage collection are expected to result in a reduction of the volume of the potentially impacted BWAD seepage that is discharged to the receiving environment. This is likely to have a positive impact on the water quality of Pikes Creek and other downstream receiving water bodies.

7.1.2 CHP Water Management System Impacts

The results of the predictive water balance modelling assessment indicate that the CHP sediment basin will continue to overflow daily to Tinkers Creek for both the existing and post-upgrade conditions. The water balance model predicts that daily overflow volume is expected to range from approximately 1.6 to 4.2 ML/day with an average of 2.3 ML/day over the next 15 years. The water balance assessment also indicates that process water inflows from the cooling towers constitute approximately 60% of the inflows to the CHP sediment basin for average rainfall conditions.

The aim of the proposed upgrades to the CHP water and wastewater infrastructure is to improve the water quality of the discharges to Tinkers Creek. However, the proposed changes are not expected to have a significant impact on the volume and frequency of water discharged from the CHP Basin to Tinkers Creek.

7.1.3 Borrow Pits Impacts

The water balance model was used to assess the potential increase in total surface water catchment runoff from the final free-draining borrow pit landforms.

The water balance modelling indicates that the likely impacts of the final free-draining borrow pit landforms on daily stormwater runoff volumes are minor to negligible (Section 6.4.6).

- For the Middle Plashett Catchment, modelled post-development daily stormwater runoff is higher than existing conditions runoff by up to 3.5 kL/day (less than 0.2% of the existing catchment runoff).
- For the Pikes Creek Tributary Catchment, modelled post-development daily stormwater runoff is higher than existing conditions runoff by up to 0.6 kL/day (less than 0.15% of the existing catchment runoff).
- For the BWAD surface water catchment, the impacts of the excavation of Borrow Pit 2 on the simulated daily runoff volume are likely to range from minor to negligible due to the small area coverage of the borrow pit in the catchment.

7.1.4 Salt Cake Landfill Facility Impacts

There is a potential for briny leachate to discharge from the active salt cake cell. However, the following proposed features of the salt cake landfill facility design will minimise the discharge of briny leachate from the salt cake landfill facility:

- A leachate barrier system will be installed to contain leachate;
- Each salt cake cell will be constructed with a longitudinal fall on the base so that contaminated (briny) liquid falls to a sump area. A portable pump will then be used to pump this liquid out of the sump via a leachate riser and transfer the brine back to the BCP or BHP;
- Only a single salt cake cell will be constructed at a time. Only when the previous cell is nearing its full storage capacity will the next cell need to be constructed, notionally over a 3 to 6 month period;
- During operation of the salt cake landfill facility, the active cell would be covered on a daily basis with a suitable material to minimise dust and rainwater infiltration into the salt cake (and therefore the amount of leachate generated). Where no salt cake landfilling is undertaken for more than 90 days, an intermediate soil cover would be used. The daily and intermediate soil covers would be in accordance with *EPA Environmental Guidelines* (EPA, 2016);

- A turkey's nest style construction is proposed to ensure that no natural stormwater runoff will enter these cells. In the case of the few cells where some sides are all in cut, diversion bunds will be constructed to prevent runoff into the cells;
- Establishment of clean water diversion drains; and.
- Final capping of the contaminated material will occur once each cell is filled to its designed volume.

The change in stormwater runoff discharge due to construction and operation of the salt cake landfill facility is likely to be minor to negligible due to the following mitigation measures:

- The active cell is likely to occupy approximately 10% of the total proposed salt cake landfill facility area at any time during the operation phase. Therefore, the impact of operating the active cell on the total stormwater runoff and peak flow within Noname surface water catchment is likely to be negligible;
- The final capped and rehabilitated surface of the salt cake landfill facility will be designed to ensure that the surface water runoff characteristics of the rehabilitated surface and the existing surface area are similar; and
- As indicated in Section 5.2.1, the active cell is likely to occupy approximately 10% of the total proposed salt cake facility area at any time during the operation phase. Therefore, the impact of operating the active cell on the total stormwater runoff and peak flow within Noname surface water catchment is likely to be negligible.

7.1.5 Cooling Water Management System Impacts

The cooling water management system will not be affected by the proposed water infrastructure projects at the Bayswater operations.

8. Summary and Conclusions

- The water balance model predicts no overflows via the spillway from the BWAD for both existing and post-BWAD augmentation conditions for average rainfall conditions (Figure 6.4 and Figure 6.5). However, for extreme wet conditions, that are likely to occur less than 5 % of the time, the water balance model predicts that overflow from the BWAD water storage pond may occur via the spillway.

- As a mitigation measure to avoid spills over the BWAD spillway, AGL Macquarie has committed to ensuring that adequate environmental freeboard is maintained throughout the life of the dam by setting operational target levels for the BWAD. AGL Macquarie will ensure that the operational target levels are not exceeded to avoid spills over the spillway for rainfall events up to the 1 in 10-year, 72-hour storm. To achieve these operational target levels, water will need to be progressively removed from the ash cycle to manage this natural rise. Given the proposed mitigation measures, the potential surface water impacts due to increasing volume and frequency of overflows from the BWAD due the proposed BWAD augmentation are likely to range from minor to negligible. Options understood to be available for progressively removing water from the ash cycle include the following:

  - Using the transfer point to send water directly to Void 4. Surplus BWAD water may be sent through this transfer out to Ravensworth Void 4 for eventual use in the flyash cycle and/or discharged from Void 4 under the HRSTS were appropriate; and

  - Alternatively, excess water can be transferred to the BCP and treated for use in the cooling water system.

- The water balance modelling results (Table 6.5) indicate that daily seepage flows from the BWAD bypassing the BWAD seepage collection system (Seepage Collection Pond 1 and Seepage Collection Pond 2) are similar for existing and post-BWAD augmentation conditions for varying rainfall scenarios. Table 6.5 indicates that the modelled seepage losses range from 8.7 ML/day to 9.2 ML/day. It is likely that a significant portion of the BWAD seepage flows bypassing the BWAD seepage collection system discharges to Pikes Creek.

- AGL Macquarie has committed to upgrading the BWAD seepage collection system to maximise the volume of BWAD seepage loss flows that are captured by the seepage pond collection and pumped back to BWAD. Therefore, the proposed upgrades to the seepage collection are expected to result in a reduction of the volume of the potentially impacted BWAD seepage that is discharged to the receiving environment. This is likely to have a positive impact on the water quality of Pikes Creek and other downstream receiving water bodies.

- The results of the predictive water balance modelling assessment indicate that the CHP sediment basin will continue to overflow daily to Tinkers Creek for both the existing and post-upgrade conditions. The water balance model predicts that daily overflow volume is expected to range from approximately 1.6 to 4.2 ML/day with an average of 2.3 ML/day over the next 15 years. The water balance assessment also indicates that process water inflows constitute approximately 60% of the inflows to the CHP sediment basin for average rainfall conditions. The aim of the proposed upgrades to the CHP water and wastewater infrastructure is to improve the water quality of the discharges to Tinkers Creek. However, the proposed changes are not expected to have a significant impact on the volume and frequency of water discharged from the CHP Basin to Tinkers Creek.

- The water balance modelling indicates that the likely impacts of the final free-draining borrow pit landforms on daily stormwater runoff volumes are minor to negligible.

- The following proposed features of the salt cake landfill facility design will minimise the discharge of briny leachate from the salt cake landfill facility (Section 7.1.4). The change in stormwater runoff discharge due to construction and operation of the salt cake landfill facility is likely to be minor to negligible due to the following mitigation measures:

  - The active cell is likely to occupy approximately 10% of the total proposed salt cake landfill facility area at any time during the operation phase. Therefore, the impact of operating the active cell on the total stormwater runoff and peak flow within Noname surface water catchment is likely to be negligible;

- The final capped and rehabilitated surface of the salt cake landfill facility will be designed to ensure that the surface water runoff characteristics of the rehabilitated surface and the existing surface area are similar; and
- As indicated in Section 5.2.1, the active cell is likely to occupy approximately 10% of the total proposed salt cake facility area at any time during the operation phase. Therefore, the impact of operating the active cell on the total stormwater runoff and peak flow within Noname surface water catchment is likely to be negligible.

- The cooling water management system will not be affected by the proposed water infrastructure projects at the Bayswater.

9. References

AECOM (2016). Water Balance Assessment, Bayswater and Liddell Ash Dams. Report prepared for AGL Macquarie Pty Ltd (Ref: 60338713, dated 28 June 2016) by AECOM Australia Pty Ltd, Newcastle NSW Australia.

AECOM (2017). Water Balance Assessment, Bayswater CHP Sediment Basin. Report prepared for AGL Macquarie Pty Ltd (Ref: 60519036, dated 29 June 2017) by AECOM Australia Pty Ltd, Newcastle NSW Australia.

Aurecon (2019). Bayswater Ash Dam Augmentation Design Report. Report prepared for AGL Macquarie by Aurecon Australasia Pty Ltd. March 2019.

Boughton, W.C., 1993. A hydrograph-based model for estimating the water yield of ungauged catchments. In: Proceedings of the 1993 Hydrology and Water Resources Conference, Institution of Engineers, Australia, National Conference Publication no. 93/14, pp. 317–324.

Boughton, W.C., 2004. The Australian water balance model. Environmental Modelling & Software 19 (2004) 943-956.

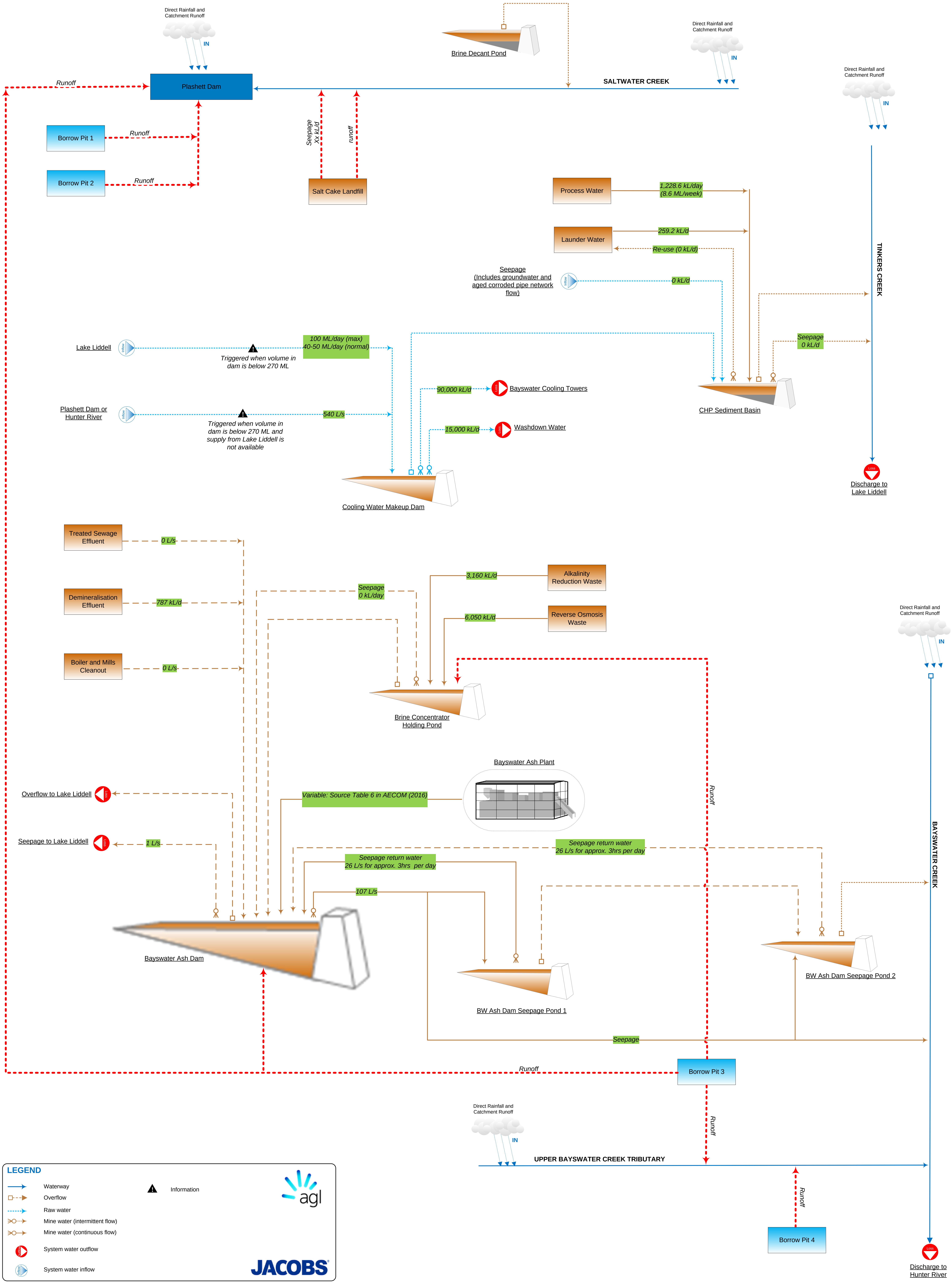
GoldSim Technology Group, 2018. User's Guide, GoldSim, Probabilistic Simulation Environment. Version 12.1 (June 2018). GoldSim Technology Group LLC.

Srikanthan et al., 2006. Stochastic climate library. CRC for Catchment Hydrology.

WRM (2015). Bylong Coal Project – Surface Water Flooding Impact Assessment. Report prepared for Hansen Bailey Pty Ltd by WRM Water & Environment Pty Ltd. 18 June 2015.

WSP (2018). AGL Macquarie – Revised Concept Design of landfill area at former contractor's compound following geotechnical investigations. Technical Memo prepared by Cesar Martinez (WSP) to Peter Wolfgang (AGL). 16 March 2018.

Appendix A. Water Management System Schematic



Project Number	IA215400	Revisions	A	19/06/2019	Issued for Comment	Approval		Signature	Date
Project Name	AGL Bayswater WWIP		B	25/10/2019	DRAFT REPORT		Drawn by	PM	25/10/2019
Document Name	AGL WBM Bayswater Schematic						Checked by	TW	25/10/2019

Appendix B. Monitoring data for CHP Basin overflows

Xylem Analytics Australia (Xylem) was engaged by AGL Macquarie to install a flow monitor to provide telemetry flow data at the weir of the CHP sediment basin outlet. Flow monitoring was carried out from November 2016 to March 2017.

AECOM (2017) reviewed the CHP sediment basin monitoring data and noted that there was a significant jump in the flow data for the period between January and March 2017 (Figure B1). Xylem carried out a site visit and observed that a silt boom had been placed across the causeway and was lying across the base of the downstream fence line. This was believed to have caused the inflated head measurement in the data file as the water had backed up in the pond.

Xylem estimated the likely influence of the silt boom ranged between 18 to 30cm dependant on the natural lift of the section of the silt boom and whether there was any overtopping during an event.

Based on the new silt boom placement a new rating curve was provided and applied with a truncation of the raw level data that takes into account the influence of a silt boom. The flow data was corrected by a 15 cm influence of the silt boom. The corrected flow data is presented in Figure B2.

The flows presented in Figure B1 and B2 represent instantaneous flows measured at five-minute intervals that have been converted from units of m^3/s to ML/day by multiplication with a factor of 24x60x60/1000. Therefore, the flows presented in Figure B1 and B2 overstate the average daily flows that would be calculated from the average of the instantaneous (five minute) flows over a 24hr period.

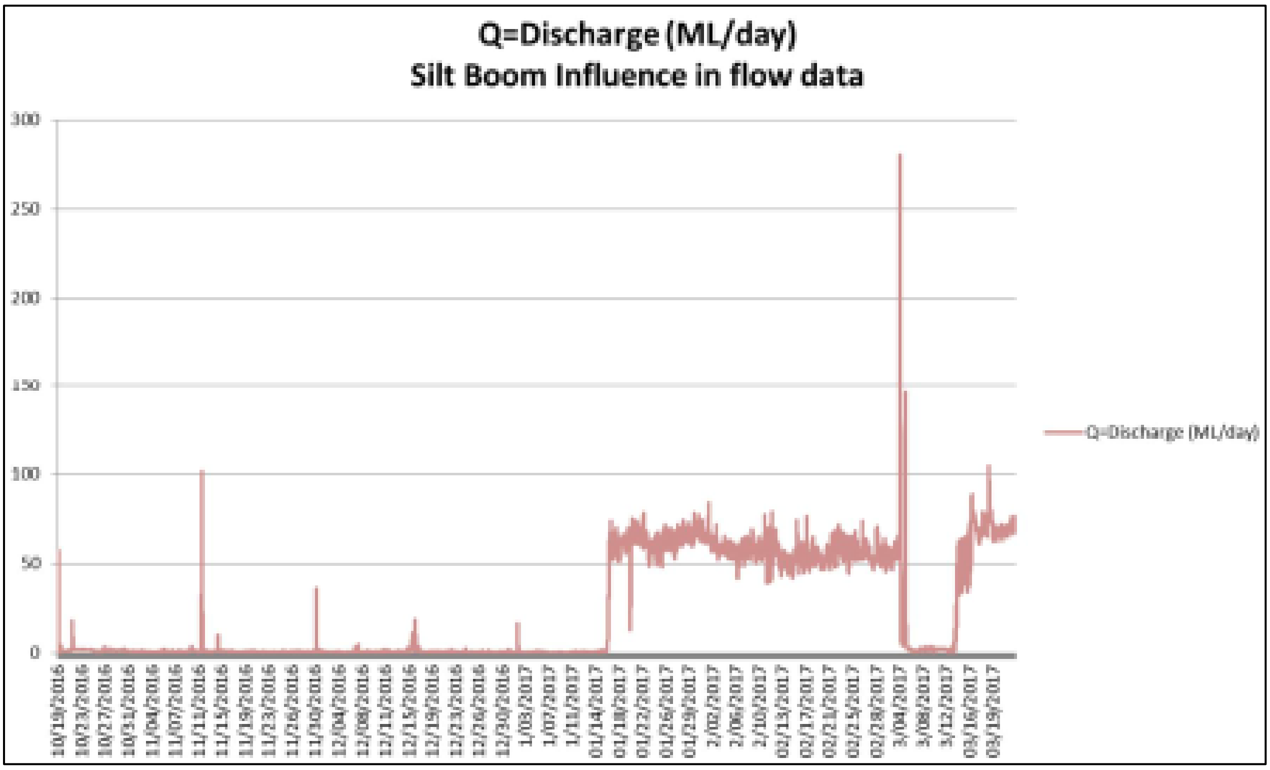


Figure B1. Uncorrected CHP sediment basin overflow monitoring data.

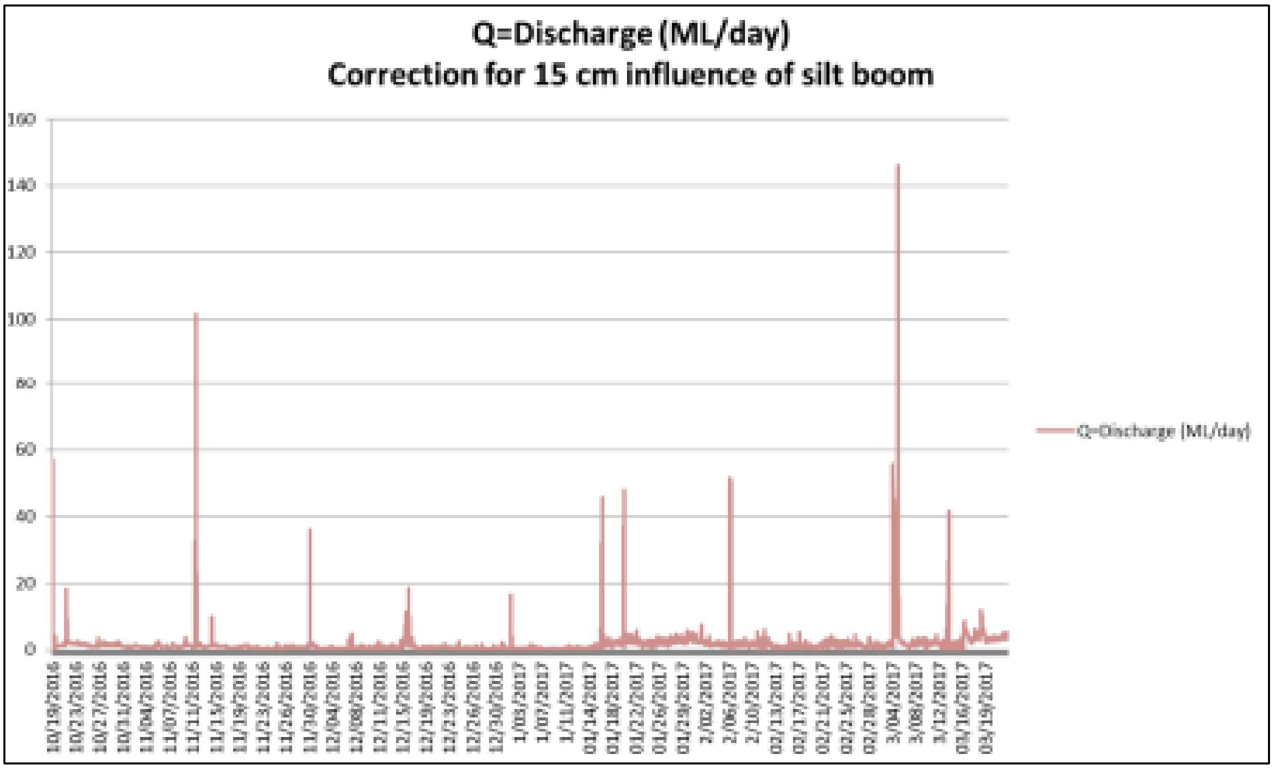


Figure B2. Corrected CHP sediment basin overflow monitoring data.