APPENDIX K – SURFACE WATER ASSESSMENT

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Luddenham Advanced Resource Recovery CentrŜ

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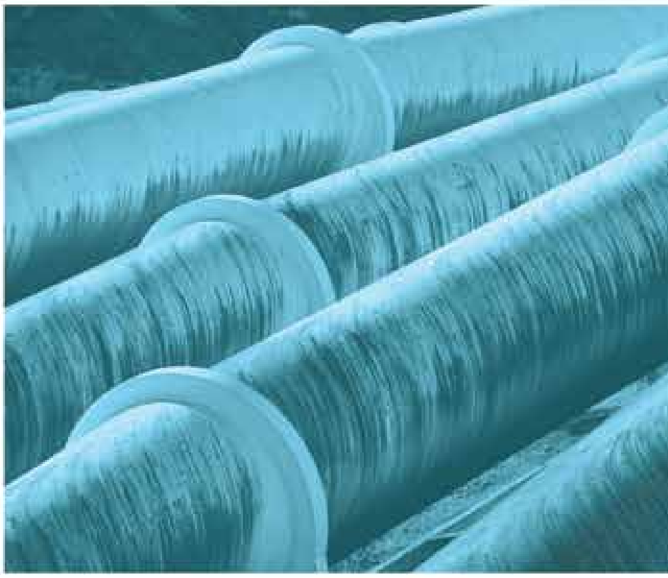
Prepared for Coombes Property Group & KLF Holdings Pty Ltd
July 2020

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Luddenham Advanced Resource Recovery Centre

Surface Water Assessment

Report Number

J190749 RP#23

Client

Coombes Property Group and KLF Holdings Pty Ltd

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Executive Summary

ES1 Introduction

Coombes Property Group (CPG) in partnership with KLF Holdings Pty Ltd (KLF) are seeking development consent for the construction and operation of an advanced resource recovery centre (ARRC) at 275 Adams Road, Luddenham NSW. The ARRC would predominantly accept construction and demolition waste, with some commercial and industrial waste. Waste will be processed (including sorting, screening, crushing, blending and shredding) on site with the aim of recovering up to 90% of the waste received.

There is an existing clay/shale quarry on the site that is currently inactive. CPG and KLF have commenced the application process to modify the quarry's development consent to allow reactivate quarrying operations. It is proposed to develop the ARRC in an area to the north of the existing quarry void. The ARRC will operate independently of the quarry operations. The ARRC and the quarry would share the same access road to Adams Road.

This surface water assessment has been prepared to support the environmental impact statement for the development of the ARRC.

ES2 Existing environment

The site is adjacent to the future Western Sydney Airport. Construction of the airport (including road infrastructure upgrades) has commenced. Commonwealth-owned land which will form part of the airport bounds the eastern and southern boundaries of the site.

The site is located within the Oaky Creek catchment. Oaky Creek forms the eastern boundary of the site and has a total catchment area of approximately 382 hectares (ha). The creek rises approximately 2 kilometres (km) south of the site and flows generally in a northerly direction. The creek continues downstream of the site for approximately 0.9 km before joining Cosgroves Creek.

The flow regimes of Oaky Creek and downstream watercourses have been extensively modified by land clearing, agriculture, extractive activities and urban and industrial development in the catchment, including the current Western Sydney Airport development.

ES3 Proposed water management

The key objectives of the proposed water management system are:

- minimise rainfall contact with waste material;
- separate stormwater runoff from water that may have contacted waste materials;
- minimise the use of potable water from the public supply by using non-potable water where it is acceptable and available;
- provide water quality controls to enable water reuse;
- minimise water discharges from the site; and
- minimise risks to the downstream receiving environment from discharges.

The key water management strategy adopted across the ARRC site is containment and management of water that has potentially been in contact with waste material ('dirty water'), with reuse where feasible. The key features of the proposed water management system include:

- all acceptance, processing, storage and dispatch of waste and recycled product will be carried out within an enclosed warehouse;
- internal pit and pipe network to convey stormwater to an onsite detention storage;
- capture of dirty water recycled from site activities in the warehouse within a leachate tank;
- treatment of dirty water within a water treatment plant;
- reuse of treated water and harvested stormwater to supply site activities; and
- discharge of excess stormwater from the onsite detention storage to Oaky Creek.

All dirty water captured from the warehouse will be treated by the water treatment plant, with all treated water reused for site activities. No untreated dirty water or treated dirty water is proposed to be discharged to the onsite detention storage or to Oaky Creek.

ES4 Flood risk

The ARRC facility is expected to remain above the limit of flooding along Oaky Creek for all events including the probable maximum flood (PMF) event for the Stage 1 development conditions of Western Sydney Airport, with the exception of the onsite detention storage, which is expected to be inundated by the fringe of the PMF event. The site is not expected to increase flood levels in Oaky Creek.

ES5 Residual impacts

The onsite detention storage will receive stormwater runoff from the warehouse roof, site offices, roads, carparks and landscaped areas. Reuse of harvested stormwater will reduce the volume and frequency of discharges. The storage will function to attenuate stormwater flows from the site as well as providing water quality treatment through sedimentation. Discharges are predicted to occur from the onsite detention storage into Oaky Creek. Scour protection and energy dissipation will be constructed at the discharge location and at the confluence with Oaky Creek to reduce erosion potential associated with the increased flow rates from the immediate site.

Water quality controls are expected to prevent any material change or degradation of the water quality of Oaky Creek due to discharges of excess stormwater. It is not proposed to discharge untreated dirty water or treated dirty water to the onsite detention storage or to Oaky Creek.

The site is not expected to change existing flood conditions for all storm events up to and including the PMF event.

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1 Introduction

1.1 Overview

CFT No 13 Pty Ltd, a member of Coombes Property Group (CPG), has recently acquired the property at 275 Adams Road, Luddenham New South Wales (NSW) (Lot 3 in DP 623799, 'the subject property') within the Liverpool City Council municipality. The subject property is host to an existing shale/clay quarry (the quarry site).

CPG owns, develops, and manages a national portfolio of office, retail, entertainment, land, and other assets. The company's business model is to retain long-term ownership and control of all its assets. CPG has the following staged vision to the long-term development of the subject property:

- Stage 1 Quarry Reactivation: **Solving a problem**. CPG intends to responsibly avoid the sterilisation of the remaining natural resource by completing the extraction of shale which is important to the local construction industry as raw material used by brick manufacturers in Western Sydney. Following the completion of approved extraction activities, the void will be prepared for rehabilitation.

- Stage 2 Advanced Resource Recovery Centre and Quarry Rehabilitation: **A smart way to fill the void**: CPG in partnership with KLF Holdings Pty Ltd (KLF) and in collaboration between the circular economy industry and the material science research sector, intends to establish a technology-led approach to resource recovery, management, and reuse of Western Sydney's construction waste, and repurposing those materials that cannot be recovered for use to rehabilitate the void. This will provide a sustainable and economically viable method of rehabilitating the void for development.

- Stage 3 High Value Employment Generating Development: **Transform the land to deliver high value agribusiness jobs**. CPG intends to develop the rehabilitated quarry site into a sustainable and high-tech agribusiness hub supporting food production, processing, freight transport, warehousing, and distribution, whilst continuing to invest in the resource recovery research and development initiatives. This will deliver the vision of a technology-led agribusiness precinct as part of the Aerotropolis that balances its valuable assets including proximity to the future Western Sydney Airport (WSA) and Outer Sydney Orbital.

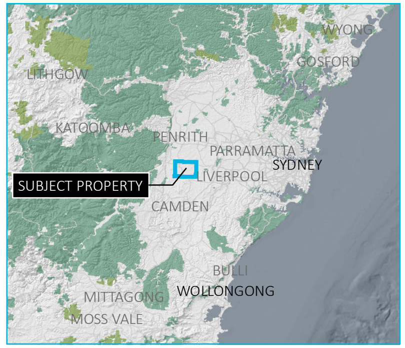
This report relates to a new development application for the development and operation of an Advanced Resource Recovery Centre (ARRC) relating to the delivery of Stage 2 above.

KLF is an Australian-owned and operated waste management company that operates two strategically located resource recovery and recycling facilities in Sydney; one at Camellia and another at Asquith. KLF has 20 years' experience in the waste recycling and resource recovery industry. KLF facilities are licensed by the NSW Environment Protection Authority (EPA) and have full International Organisation for Standardisation accreditation.

1.2 The subject property

There is an existing clay and shale quarry on the subject property approved under Development Consent DA-315-7-2003, as modified. The quarry is currently inactive. CPG and KLF (the 'applicants') have commenced the application process to modify the quarry's consent to allow quarry operations to recommence, with the primary intention of changing the approved access to the subject property to allow quarry operations (Modification 5, also referred to as MOD 5).

It is proposed to develop the ARRC within the same lot to the north of the existing quarry void. The ARRC site is shown in Figure 1.1.



KEY

- Subject property
- ARRC site
- Western Sydney Airport
- Major road
- Minor road
- Vehicular track
- Watercourse/drainage line
- NPWS reserve (see inset)
- State forest (see inset)

Source: EMM (2020); DFSI (2017); Nearmap (2020)

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Regional context

Luddenham Advanced Resource Recovery Centre
Surface Water Assessment
Figure 1.1

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The project is integral in achieving the intended future commercial/industrial land use for the subject property as the project provides a commercially viable means to infill the quarry void (subject to separate development consent). This will support the WSA and ongoing development of the Western Sydney Aerotropolis.

A new State significant development (SSD) consent under Division 4.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) is required to establish the ARRC. On 24 April 2020, the Department of Planning, Industry and Environment (DPIE) issued Secretary's Environmental Assessment Requirements (SEARs) for the environmental impact statement (EIS) for the project. The SSD consent application number is SSD-10446.

This report has been prepared by EMM Consulting Pty Limited (EMM) on behalf of the applicants.

1.3 Project overview

The key components of the ARRC project are as follows:

- construction and operation of an advanced construction and demolition resource recovery centre;
- all acceptance, processing, storage and dispatch of waste and recycled product will be carried out within an enclosed warehouse;
- accepting and processing up to 600,000 tonnes per annum (tpa) of waste for recycling;
- dispatch of up to approximately 540,000 tpa of recycled product;
- dispatch of approximately 60,000–120,000 tpa of non-recyclable residues either to an offsite licensed waste facility or to the adjacent quarry void (following approval of quarry rehabilitation activities);
- upgrade of the access road from the subject property to Adams Road;
- use of the access road; and
- ARRC operations up to 24 hours a day, 7 days per week.

The ARRC will accept general solid waste comprising building and demolition waste as well as selected commercial and industrial waste. No special, liquid, hazardous, restricted solid water, putrescible solid waste, or odorous waste, that could potentially pose a risk to the adjacent WSA, currently under construction, will be accepted at the ARRC.

The vast majority of materials accepted will be recovered, the remaining minor amount (10–20%) of non-recyclable residues will be disposed of at an offsite licensed landfill or to the quarry void on the site as part of rehabilitating the void.

The proposed project layout is shown in Figure 1.2.

1.4 Report objectives

This surface water assessment has been prepared to support the EIS for the ARRC. It characterises the existing environment, as relevant to surface water, based on a combination of desktop-based assessments and field investigations. It documents the ways in which issues relating to surface water have been considered in the design of the ARRC. This surface water assessment provides commitments to ongoing management and mitigation measures to minimise impacts to surface water and assesses unavoidable residual impacts.

The specific objectives of this surface water assessment are to:

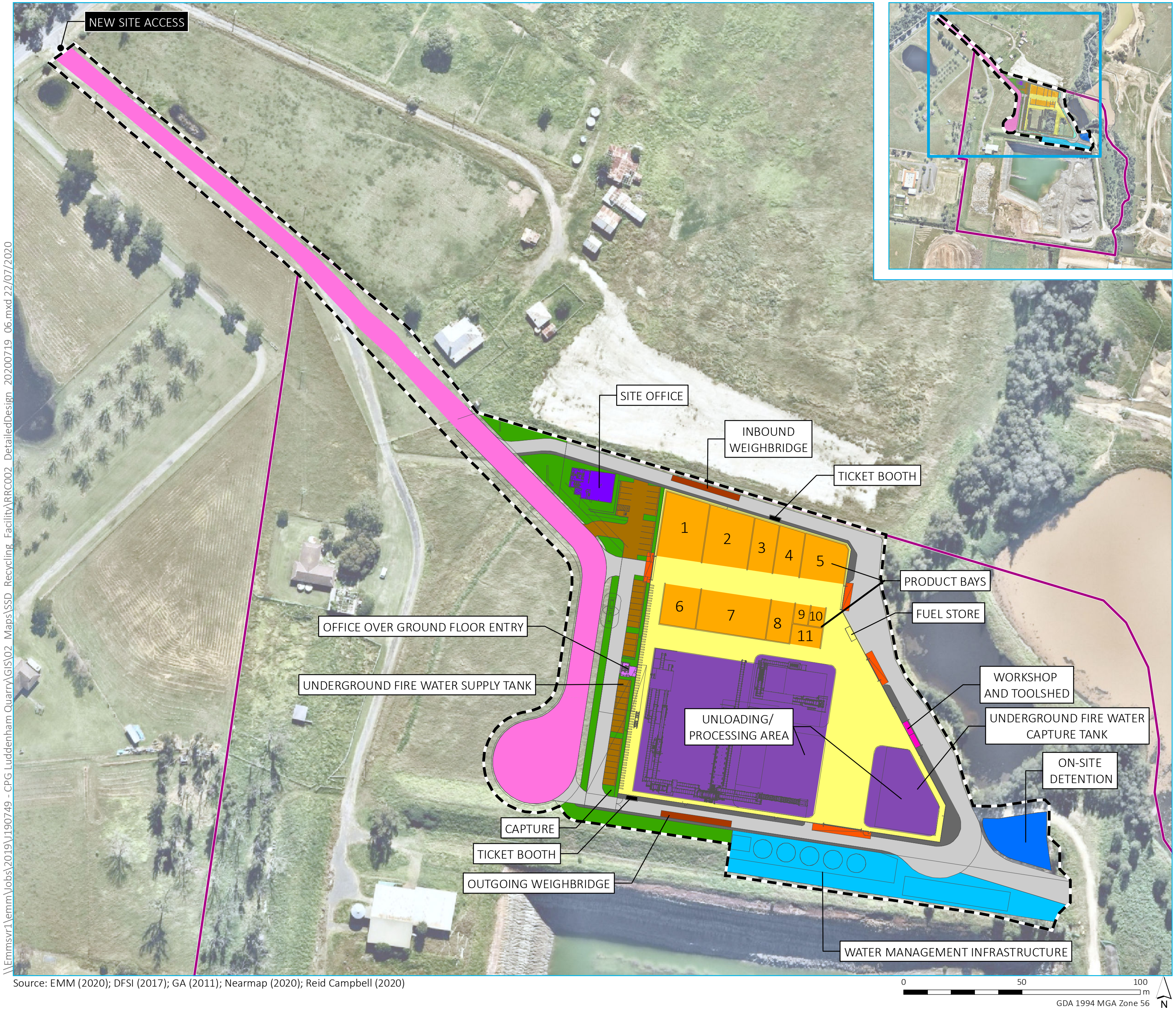
- describe and characterise the existing surface water environment;

- detail the proposed surface water management system at the site;
- identify and assess impacts to surface water during operation of the ARRC; and
- develop management and mitigation measures to minimise the impacts to surface water resources associated with the construction and operation of the ARRC.

1.5 Report structure

An overview of the structure of the surface water assessment is provided below:

- **Executive summary** provides a brief overview of the ARRC and the key findings of the assessment.
- **Chapter 1** introduces the key elements of the project and outlines the objectives of the assessment.
- **Chapter 2** describes the assessment requirements and provides an overview of relevant industry and government guidelines.
- **Chapter 3** provides a characterisation of the existing environment at the ARRC site.
- **Chapter 4** describes the proposed water management system.
- **Chapter 5** provides an assessment of flooding at the ARRC site.
- **Chapter 6** provides the results of site water balance modelling.
- **Chapter 7** assesses the residual impacts on surface water resources.
- **Chapter 8** details proposed monitoring, inspection and maintenance arrangements.
- **Chapter 9** addresses water licensing requirements.
- **Chapter 10** provides a summary of the key findings of the assessment.



Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020); Reid Campbell (2020)

KEY
- Subject property
- ARRC site
- Indicative detailed layout

Proposed element
- Awning
- Carpark
- Hardstand
- ARRC access road
- Kerb/pedestrian area
- Landscaping
- Office over ground floor
- On-site detention
- ARRC warehouse
- Product bay
- Site office
- Ticketbooth
- Tool shed, workshop
- Unloading/processing
- Water management infrastructure, including treatment plant and storage
- Weighbridge

Product bays
1. Concrete/ rubble masonry
2. Clean timber
3. Rigid plastics
4. Paper/cardboard/film
5. Stumps/asphalt/metal
6. Heavy residual
7. Fines screened
8. Soil audit
9. Ferrous
10. Non-ferrous
11. Non-recyclables

Project overview

Luddenham Advanced Resource Recovery Centre
Surface Water Assessment
Figure 1.2

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2 Assessment framework

2.1 Relevant legislation

2.1.1 *Environmental Planning and Assessment Act 1979*

The EP&A Act defines the statutory framework for planning approval and environmental assessment in NSW. This surface water assessment has been prepared in accordance with the SEARs and relevant government assessment requirements, issued on 24 April 2020. Table 2.1 provides the matters relevant to the surface water assessment and where the requirements have been addressed.

Table 2.1 Relevant assessment requirements

Assessment requirement	Where addressed
An assessment of potential impacts to soil and water resources, topography, hydrology, groundwater, drainage lines, watercourses and riparian lands on or nearby to the site, including mapping and description of existing background conditions and cumulative impacts and measures proposed to reduce and mitigate impacts.	Chapter 3 Chapter 7 *Land, Soil and Erosion Assessment Report* (EMM 2020)
A detailed site water balance including identification of water requirements for the life of the project, measures that would be implemented to ensure an adequate and secure water supply is available for the development and a detailed description of the measures to minimise water use at the site.	Chapter 6
Characterisation of water quality at the point of discharge to surface and/or groundwater against relevant water quality criteria (including details of the contaminants of concern that may leach from the waste into the wastewater and proposed mitigation measures to manage any impacts to receiving waters and monitoring activities and methodologies.	Section 3.6 Chapter 4 Section 7.2
Details of stormwater/wastewater management system including the capacity of onsite detention system(s), onsite sewage management and measures to treat, reuse or dispose of water.	Chapter 4
Description of the measures used to minimise water use.	Chapter 4
Detailed flooding assessment.	Chapter 5

2.1.2 *Protection of the Environment Operations Act 1997*

The NSW *Protection of the Environment Operations Act 1997* (POEO Act) is administered by the EPA, which is the primary environmental regulator for NSW. Under the POEO Act, an environment protection licence (EPL) is required for 'scheduled activities', generally activities with potentially significant environmental impacts. Licence conditions may relate to pollution prevention and monitoring and can control the air, noise, water and waste impacts of an activity.

The proposed activities at the ARRC are listed under Schedule 1 of the POEO Act as resource recovery, waste processing (non-thermal treatment) and waste storage. A new EPL under the POEO Act will be required for the operation of the ARRC.

2.1.3 *Water Management Act 2000*

The NSW *Water Management Act 2000* (WM Act) is based on the principles of ecologically sustainable development and the need to share and manage water resources for future generations. The WM Act recognises that water management decisions must consider economic, environmental, social, cultural and heritage factors. It recognises that sustainable and efficient use of water delivers economic and social benefits to the state of NSW. The WM Act provides for water sharing between different water users, including environmental, basic landholder rights and licence holders. The licensing provisions of the WM Act apply to those areas where a water sharing plan (WSP) has commenced.

WSPs are statutory documents that apply to one or more water sources. They define the rules for sharing and managing water resources within water source areas. WSPs describe the basis for water sharing and document the water available and how it is shared between environmental, extractive and other uses. The WSPs outline the water available for extractive uses within different categories, such as local water utilities, domestic and stock, basic landholder rights, irrigation and industrial uses.

The WSPs relevant to the site are:

- *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011* – the Upper South Creek Management Zone within the Hawkesbury and Lower Nepean Rivers Water Source applies to the surface water in the vicinity of the site; and
- *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* – the Sydney Basin Central Groundwater Source applies to groundwater in the vicinity of the site.

A 40-metre (m) buffer zone along the eastern boundary of Oaky Creek will be maintained. No works are proposed within the buffer, which forms the waterfront land of the creek, as part of the ARRC.

2.2 Local planning instruments

The Liverpool Local Environment Plan 2008 and Development Control Plan 2008 (DCP) guide planning decisions through zoning and development controls, which include considerations for development on flood prone land. The DCP also provides design guidance for stormwater management and erosion and sediment control.

These local planning instruments have been considered in the preparation of this surface water assessment.

2.3 Relevant guidelines

2.3.1 Australian Rainfall and Runoff

Australian Rainfall and Runoff (ARR) (Ball et al. 2019) is a national guideline document, data and software suite that can be used for the estimation of flood characteristics in Australia. It is widely accepted as a design guideline for all flood and stormwater-related investigation and design in Australia.

2.3.2 NSW Floodplain Development Manual

The NSW *Floodplain Development Manual* (DIPNR 2005) describes flood-prone land policy which has the primary objective of reducing the impact of flooding and flood liability on individual owners and occupiers of flood-prone property and to reduce private and public losses resulting from floods. At the same time, the policy recognises the benefits from occupation and development of flood-prone land.

2.3.3 NSW Floodplain Risk Management Guidelines

A number of guidelines have been developed to complement the NSW *Floodplain Development Manual* (DIPNR 2005). The following documents have also been considered as part of this assessment:

- *Floodplain Risk Management Guideline – Practical Considerations of Climate Change* (DECC 2007a), which provides advice on considering climate change impacts in managing flood risk; and
- *Floodplain Risk Management Guide – Incorporating 2016 Australian Rainfall and Runoff in Studies* (OEH 2019), which provides additional guidance for the application of ARR (2016 version) in NSW catchments.

2.3.4 Erosion and sediment control guidelines

Managing Urban Stormwater: Soils and Construction – Volume 1 (Landcom 2004) outlines the basic principles for the design, construction and implementation of sediment and erosion control measures to improve stormwater management and mitigate the impacts of land disturbance activities on soils and receiving waters.

2.3.5 NSW water quality and river flow objectives

The *NSW Water Quality and River Flow Objectives* (DECCW 2006) provides agreed environmental values and long-term targets for water quality and river flow in each catchment in NSW. The objectives are intended to be considered in assessing and managing the potential impacts of activities associated with waterways.

Water quality objectives have been agreed for fresh and estuarine surface waters and are consistent with the national framework for assessing water quality provided in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018). River flow objectives are the agreed high-level goals for surface water flow management that identify the key elements of the flow regime that protect river health and water quality for ecosystems and human uses.

The site is located within the Hawkesbury-Nepean catchment. Although there are no specified objectives for this catchment, the typical water quality and river flow objectives for uncontrolled streams in other catchments in NSW are provided in Table 2.2 for reference.

Table 2.2 Water quality and river flow objectives

Environmental value	Objective	Application to proposed modification
Water quality objectives		
Aquatic ecosystems	Maintaining or improving the ecological condition of water bodies and their riparian zones over the long term.	There are aquatic ecosystems downstream of the site within Oaky Creek. The protection of aquatic ecosystems is the primary water quality objective to be met.
Visual amenity	Aesthetic qualities of waters.	There are no public views or access to Oaky Creek adjacent to the site or immediate downstream areas.
Secondary contact recreation	Maintaining or improving water quality for activities such as boating or wading, where there is a low probability of water being swallowed.	There is no public access to Oaky Creek adjacent to the site or immediate downstream areas.

Table 2.2 Water quality and river flow objectives

Environmental value	Objective	Application to proposed modification
Primary contact recreation	Maintaining or improving water quality for activities such as swimming in which there is a high probability of water being swallowed.	There is no public access to Oaky Creek adjacent to the site or immediate downstream areas.
Livestock water supply	Protecting water quality to maximise the production of healthy livestock.	Some downstream users may extract water from Oaky Creek or downstream watercourses for agricultural purposes.
Irrigation water supply	Protecting the quality of waters applied to crops or pasture.	Some downstream users may extract water from Oaky Creek or downstream watercourses for agricultural purposes.
Homestead water supply	Protecting water quality for domestic use in homesteads, including drinking, cooking and bathing.	It is unlikely that any downstream users extract from Oaky Creek or downstream watercourses for homestead water supply.
Drinking water at point of supply – disinfection only	These objectives apply to all current and future licensed offtake points for town water supply and to specific sections of rivers that contribute to drinking water storages or immediately upstream of town water supply offtake points. The objectives also apply to sub-catchments or groundwater used for town water supplies.	Town water supply in the region is provided by Sydney Water. The site is not located within Sydney's drinking water catchment. Oaky Creek drains to the Hawkesbury-Nepean system downstream of Warragamba Dam. No water is extracted from downstream of the site for town water supply.
Drinking water at point of supply – clarification and disinfection		
Drinking water at point of supply – groundwater		
Aquatic foods (cooked)	Refers to protecting water quality so that it is suitable for the production of aquatic foods for human consumption and aquaculture activities.	Recreational fishers may use Oaky Creek or downstream watercourses. However, the trigger values for aquatic foods apply to aquaculture not recreational fishing. The required level of protection will be provided by meeting the objective for aquatic ecosystems.
River flow objectives		
Protect pools in dry times	Protect natural water levels in pools of creeks and rivers and wetlands during periods of no flows.	The flow regimes of Oaky Creek and downstream watercourses have been extensively modified by land clearing, agriculture, extractive activities and urban and industrial development in the catchment, including the current WSA development.
Protect natural low flows	Share low flows between the environment and water users and fully protect very low flows.	
Protect important rises in water levels	Protect or restore a proportion of moderate flows and high flows.	
Maintain wetland and floodplain inundation	Maintain or restore the natural inundation patterns and distribution of floodwater supporting natural wetland and floodplain ecosystems.	
Maintain natural flow variability	Maintain or mimic natural flow variability in all streams.	
Manage groundwater for ecosystems	Maintain groundwater within natural levels and variability, critical to surface flows and ecosystems.	

Table 2.2 Water quality and river flow objectives

Environmental value	Objective	Application to proposed modification
Minimise effects of weirs and other structures	Minimise the impact of instream structures.	No instream structures are proposed.

2.3.6 Australian and New Zealand guidelines for fresh and marine water quality

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018) provides guidance on monitoring, assessing and managing ambient water quality in a wide range of water resource types and according to specified environmental values, such as aquatic ecosystems, primary industries, recreation and drinking water. The guidelines provide a framework for:

- establishing water quality objectives;
- assessing and managing water quality for environmental values; and
- establishing protection levels, water quality indicators and trigger values.

Environmental values associated with the waterways and water sources surrounding the site include primary industry, aquatic ecosystems, recreational users, irrigation and stock watering. Water quality monitoring results have been compared to default guideline values (DGVs) recommended by ANZG (2018) for the protection of aquatic ecosystems. Oaky Creek is considered to be a 'slightly to moderately disturbed' system, due to the impact of disturbance in the catchment associated with past and ongoing agriculture and urban development, including the current development of WSA. The creek is also classified as a 'lowland river' as the elevation of the site is less than 150 m.

DGVs provided by ANZG (2018) for toxicants (including metals) are usually derived from ecotoxicity testing using a species sensitivity distribution of chronic toxicity data. The reliability of the DGVs is classified as very high, high, moderate, low, very low or unknown. Classification is primarily based on the number and type (chronic, acute or a mix of both) of data used to derive the guideline value, as well as the fit of the statistical model (species sensitivity distribution) to the data.

DGVs are provided by ANZG (2018) for 99%, 95%, 90% and 80% species protection. For most toxicants, the level of species protection assigned for slightly to moderately disturbed systems is the 95% species protection DGV. For parameters that potentially bioaccumulate, DGVs for 99% species protection are recommended by ANZG (2018) for slightly to moderately disturbed systems.

DGVs for slightly to moderately disturbed ecosystems recommended by ANZG (2018) are presented in Table 2.3. DGVs for physical and chemical stressors and nutrients provided by ANZECC (2000) have been used as these parameters have not yet been updated by ANZG (2018). DGVs for metals are based on the 95% species protection value recommended for slightly to moderately disturbed systems, unless otherwise noted.

Table 2.3 Default guideline values for the assessment of water quality

Parameter	Units	DGV	Additional information
Physical and chemical stressors			
Electrical conductivity	µS/cm	125–2,200	DGV for lowland river in south-east Australia (Table 3.3.3; ANZECC 2000)
pH	pH units	6.5–8.5	DGV for lowland river in south-east Australia (Table 3.3.2; ANZECC 2000)
Nutrients			
Reactive phosphorus	mg/L	0.02	DGV for lowland river in south-east Australia (Table 3.3.2; ANZECC 2000)
Total phosphorus	mg/L	0.05	DGV for lowland river in south-east Australia (Table 3.3.2; ANZECC 2000)
Dissolved metals			
Arsenic	mg/L	0.013	Moderate reliability DGV for As(V)
Cadmium	mg/L	0.0002	Very high reliability DGV
Chromium	mg/L	0.001	Very high reliability DGV for Cr(VI)
Copper	mg/L	0.0014	High reliability DGV
Lead	mg/L	0.0034	Moderate reliability DGV
Mercury	mg/L	0.00006	Moderate reliability DGV for 99% species protection level recommended for slightly to moderately disturbed systems due to the potential for bioaccumulation
Nickel	mg/L	0.011	Low reliability DGV
Zinc	mg/L	0.008	Very high reliability DGV

2.3.7 Bunding and spill management guidelines

The following NSW Government guidelines detail best practice storage, handling and spill management procedures for liquid chemicals:

- *Liquid Chemical Storage, Handling and Spill Management: Review of Best Practice Regulation* (DEC 2005); and
- *Storing and Handling Liquids: Environmental Protection: Participant's Manual* (DECC 2007b).

2.4 Relevant studies

2.4.1 Updated South Creek Flood Study

The *Updated South Creek Flood Study* (WorleyParsons 2015) was prepared for Penrith, Liverpool, Fairfield and Blacktown City Councils and is used to inform floodplain management within the South Creek catchment. The flood study involved the development of hydrologic and hydraulic models to define flood behaviour of South Creek and its tributaries.

Although the ARRC site is located within the South Creek catchment, the flood study did not model the site in sufficient detail for the purposes of this assessment. In addition, the upstream portions of the Oaky Creek catchment are currently undergoing earthworks related to the construction of the WSA, changing the local hydrology in this area.

2.4.2 Western Sydney Airport assessments

As part of the EIS for the WSA, which is adjacent to the site, assessment of the impacts on surface water hydrology, flooding and geomorphology were undertaken in the *Western Sydney Airport: Surface Water Hydrology and Geomorphology* assessment (GHD 2016). Relevant outcomes from this study have been included in this assessment where appropriate (refer Chapter 5).

3 Existing environment

3.1 Land use

The subject property is located at 275 Adams Road, Luddenham NSW and is legally described as Lot 3, DP 623799. The subject property is approximately 19 hectares (ha), with the ARRC site taking up approximately 3 ha within the northern portion of the subject property.

The subject property is adjacent to the future WSA. Construction of the airport (including road infrastructure upgrades) has commenced. Commonwealth-owned land which will form part of the airport is adjacent to the eastern and southern boundaries of the subject property.

Other surrounding land uses include:

- agricultural – grazing and intensive agriculture (eg poultry);
- rural residences – the closest occupied residence is approximately 70 m north of the site access road; and
- Hubertus Country Club and pistol range – immediately west of the site.

3.2 Topography

The subject property is generally flat with the exception of the quarry void. The property slopes gently from the south-west to the north-east flat (approximately 60 to 75 m Australian Height Datum (m AHD)). There is an approximately 10 m fall across the 500 m distance between the western and eastern boundaries of the subject property.

3.3 Climate

Patched point climate data was obtained from the Scientific Information for Land Owners (SILO) database hosted by the Science Division of the Queensland Government's Department of Environment and Science. SILO patched point data consist of interpolated estimates based on historically observed data from Bureau of Meteorology (BOM) weather stations. For this assessment, SILO data was obtained for the Badgerys Creek McMasters F.Stn station (BOM station number 67068), which is located 1 km north-east of the site.

Table 3.1 presents key information and statistical data from the historical SILO patched point data between 1889 and 2019. Figure 3.1 presents the average daily rainfall and evaporation rates determined from the SILO data.

Table 3.1 Key climate statistics

Key annual statistic	Units	Rainfall	Evaporation
Average	mm/year	756	1,470
Minimum	mm/year	330	1,169
5th percentile	mm/year	424	1,340
10th percentile	mm/year	477	1,400
Median	mm/year	737	1,472
90th percentile	mm/year	1,044	1,522

Table 3.1 Key climate statistics

Key annual statistic	Units	Rainfall	Evaporation
95th percentile	mm/year	1,164	1,581
Maximum	mm/year	1,695	1,746

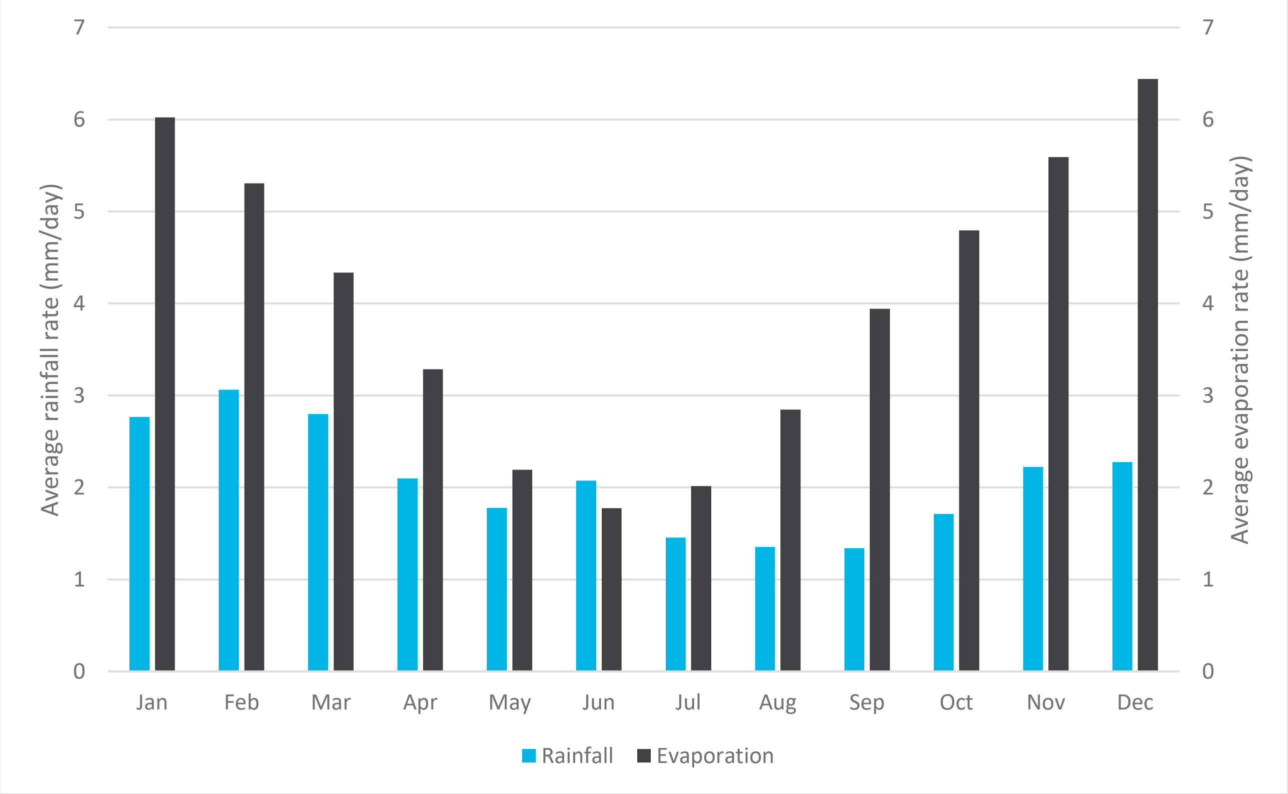

Figure 3.1 Average daily rainfall and evaporation rates

3.4 Geology

The Luddenham area lies within the central part of the Sydney Basin, which is comprised of several sedimentary strata including the thick coal seams in the greater region and extensive and continuous Hawkesbury Sandstone. These sandy sediments and the regional depression of the basin allowed the formation of shaly and silty strata (Wianamatta group) which includes the Ashfield and Bringelly Shales that are several hundred metres thick and form the bulk of the mineral resource at the quarry.

3.5 Hydrology

The site is located within the Oaky Creek catchment. Oaky Creek forms the eastern boundary of subject property and has a total catchment area of approximately 382 ha. The creek rises approximately 2 km south of the site and flows generally in a northerly direction. The creek continues downstream of the site for approximately 0.9 km before joining Cosgroves Creek. Downstream of the confluence with Oaky Creek, Cosgroves Creek flows for approximately 7 km before its confluence with South Creek, which ultimately contributes to the Hawkesbury River and Broken Bay. The total catchment area of Cosgroves Creek at the confluence with South Creek is approximately 2,163 ha. Watercourses and associated stream orders in the vicinity of the ARRC site are presented in Figure 3.2.

KEY

- Subject property
- ARRC site
- Western Sydney Airport
- Major road
- Minor road
- Vehicular track

Strahler stream order

- 1st order
- 2nd order
- 3rd order
- 4th order

Source: EMM (2020); DFSI (2017); GA (2011); ASGC (2006); Nearmap (2020)

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Watercourses

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Figure 3.2

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3.6 Water quality

3.6.1 Sampling program

Water quality monitoring associated with quarrying activities has historically been undertaken at locations upstream and downstream of the ARRC site, as shown in Figure 3.3. Sampling results are available between 2010 and 2017, during the previous operation of the quarry.

3.6.2 Monitoring results

A summary of median water quality results is presented in Table 3.2. All monitoring data is presented in Appendix A. Where an analytical result was below the detection limit, then the numerical value of half the detection limit was used in the analysis, unless otherwise specified. Results that exceed the relevant DGV (refer Table 2.3) are highlighted in bold.

A limited number of monitoring results were available for the majority of parameters, with limited information on the environmental conditions or context at the time of sampling such as methodology and flow within Oaky Creek. Whilst the extent of the water quality data available is insufficient to enable specific conclusions to be formed, it is considered to provide a reasonable indication of ambient water quality during quarrying operations on site.

Key results are summarised as follows:

- Salinity (as indicated by electrical conductivity) was elevated for Oaky Creek upstream of the ARRC site compared to the DGVs. This is typical for inland watercourses in NSW that have catchments dominated by agricultural land uses.
- pH within Oaky Creek, both upstream and downstream of the ARRC site, was within the DGV range.
- Total suspended solids (TSS) were generally reported to be low (typically below 50 milligrams per litre (mg/L)), however elevated concentrations were recorded following significant rainfall events, particularly at the Oaky Creek upstream site.
- Nutrient levels were generally low, with the exception of phosphorus concentrations at the Oaky Creek upstream site that exceeded the DGVs.
- Metals were generally found to be below DGVs, with slight exceedances of the relevant DGV for dissolved iron at the Oaky Creek upstream site.

Source: EMM (2020); DFSI (2017); GA (2011); ASGC (2006); Nearmap (2020)

KEY

- Subject property
- ARRC site
- Cadastral boundary
- Watercourse
- Water quality monitoring location

Water quality monitoring locations

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Figure 3.3

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Table 3.2 Summary of surface water quality monitoring results

Parameter	Units	Upstream		Downstream	
		Count	Median	Count	Median
Physical and chemical stressors					
Dissolved oxygen	mg/L	1	3.9	1	6.8
Electrical conductivity	µS/cm	1	**11,000**	2	1,870
pH	pH units	26	7.0	26	6.9
Total dissolved solids	mg/L	1	6,720	1	1,420
TSS	mg/L	26	37	26	14
Major ions					
Calcium	mg/L	1	53	1	36
Chloride	mg/L	1	3,500	1	670
Magnesium	mg/L	1	280	1	69
Potassium	mg/L	1	16	1	14
Sodium	mg/L	1	2,600	1	480
Sulfate	mg/L	1	130	1	83
Total alkalinity	mg/L	1	440	1	130
Nutrients					
Nitrate	mg/L	1	<0.005	1	<0.005
Nitrite	mg/L	1	<0.005	1	<0.005
Total Kjeldahl nitrogen	mg/L	1	3.7	1	0.6
Reactive phosphorus	mg/L	1	**0.174**	1	0.02
Total phosphorus	mg/L	1	**0.4**	1	<0.05
Dissolved metals					
Arsenic	mg/L	1	0.002	1	<0.001
Cadmium	mg/L	1	<0.0001	1	<0.0001

Table 3.2 Summary of surface water quality monitoring results

Parameter	Units	Upstream		Downstream	
		Count	Median	Count	Median
Chromium	mg/L	1	0.001	1	<0.001
Copper	mg/L	1	<0.001	1	<0.001
Iron	mg/L	1	**2.2**	1	0.2
Lead	mg/L	1	<0.001	1	<0.001
Mercury	mg/L	1	<0.00005	1	<0.00005
Nickel	mg/L	1	0.002	1	0.002
Zinc	mg/L	1	0.002	1	0.002
Total metals					
Iron	mg/L	1	5	1	0.6
Other parameters					
Biochemical oxygen demand	mg/L	25	5	25	2
Oil and grease	mg/L	25	2.5	25	2.5

Notes: mg/L milligrams per litre
µs/cm microsiemens per centimetre

4 Water management

4.1 Water management during construction

Construction of the proposed ARRC will be undertaken over an 18-month period. Erosion and sediment control plans will be prepared as part of the detailed design documentation. The erosion and sediment control plans will be prepared in accordance with the methods recommended by Landcom (2004). Further details of the proposed erosion and sediment controls during construction of the ARRC are provided in the *Land, Soil and Erosion Assessment Report* (EMM 2020).

4.2 Water management strategy

The water management objectives, and the approaches that have been applied to establish the proposed operational water management systems, are summarised in Table 4.1.

Table 4.1 Water management objectives and approach

Water management objectives		Approach
1	Minimise rainfall contact with waste material.	• Incoming and processed waste will be stored, processed and handled under cover.
2	Maximise the separation of stormwater runoff and water that has potentially come into contact with waste material.	• Stormwater runoff will be separated from water that may have contacted waste material (‘dirty water’), with dirty water directed into the internal dirty water management system.
3	Reduce infiltration to underlying soils and groundwater system.	• All storage, equipment areas, processing and handling areas will be sealed, except for the landscaped areas. • All surface water storages will be clay lined.
4	Minimise the use of potable water from the public supply for purposes where non-potable water is acceptable and available.	• Treated water and harvested stormwater will be used preferentially to supply site activities over potable water.
5	Provide water quality controls to enable reuse and reduce risks to downstream receiving environment.	• A water treatment plant will be installed to treat dirty water from site activities. • The onsite detention storage will allow the settling of suspended settlement and reduction of nutrient loads. • Chemical and hydrocarbon products will be stored in bunded areas in accordance with relevant Australian Standard AS1940:2004.
6	Minimise the risk of discharges from the site.	• No discharge of untreated dirty water or treated water off site. • Harvested stormwater captured in the onsite detention storage will be used to supply site activities.

4.3 Proposed water management system

The proposed water management system for the ARRC site is presented in Figure 4.1. Broadly, the water management system will be separated into two major water management areas. Each water management area is targeted towards managing the key risks associated with planned site activities in each area, which are categorised as follows:

- the warehouse area, which contains all site activities where waste material is stockpiled, processed and handled and water has the potential to come into contact with waste material; and
- the stormwater management area, which comprises the balance of the site area and all other site activities, including runoff from the warehouse roof.

The key water management strategy adopted across the ARRC site is containment and management of dirty water that has potentially been in contact with waste material, with reuse where feasible. The key features of the proposed water management system include:

- all acceptance, processing, storage and dispatch of waste and recycled product will be carried out within an enclosed warehouse;
- internal pit and pipe network to convey stormwater to an onsite detention storage;
- capture of dirty water recycled from site activities in the warehouse within a leachate tank;
- treatment of dirty water within a water treatment plant;
- reuse of treated water and harvested stormwater to supply site activities; and
- discharge of excess stormwater from the onsite detention storage to Oaky Creek.

4.3.1 Rainwater tanks

Stormwater runoff from a portion of the warehouse roof will be directed to rainwater tanks which will be used to supply water for toilets and irrigation of the landscaped areas of the site. The rainwater tanks will be topped up as required with treated water from the reuse water tanks (refer Section 4.3.3).

4.3.2 Stormwater management

An internal pit and pipe network will be utilised to convey stormwater runoff from the warehouse roof, site offices, roads, carparks and landscaped areas to the onsite detention storage (refer Appendix B for stormwater catchment plan). Inlet pits will be fitted with a gross pollutant trap to capture gross pollutants and coarse sediment prior to runoff entering the pipe network. The onsite detention storage enables suspended solids to settle out of the water column and also allows stormwater to be used to supplement the supply of water for site activities in the warehouse.

Overflows from the onsite detention storage will discharge to Oaky Creek. The storage outlet will include scour protection and suitable energy dissipation measures will be constructed at the point of confluence with Oaky Creek. This will reduce erosion potential associated with concentrated discharges and increased runoff rates.

Stormwater runoff from approximately 100 m of the access road will be directed via kerb and guttering to an existing table drain on Adams Road and will ultimately discharge to the Liverpool City Council stormwater network. Stormwater runoff from the remaining access road will be captured by the internal stormwater network described above.

4.3.3 Water treatment plant

A water treatment plant is proposed to be installed to treat dirty water from site activities within the warehouse. Where practical, any water available to be recovered from site activities within the warehouse will be reticulated to a leachate tank. Dirty water stored within the leachate tank will then be directed to the water treatment plant for treatment.

The treatment process proposed for the water treatment plant includes:

- Clarification – the clarifier will combine the solids settling function of a lamella clarifier with chemical dosing to remove suspended particles. A coagulant/flocculant and pH adjustment will be used to enhance settling of sediments and reduce concentrations of suspended particles.
- Break point chlorination – chlorine will be dosed into the post-clarified water to treat nutrients.
- Filtration (media) – removal of fine particulates and some competing ions.

Treatment requirements will be confirmed through testing. Sludge produced through pre-treatment clarification process will be contained and disposed of at an offsite licensed waste facility.

Treated water will be stored within reuse water tanks and will be used to supply site activities within the warehouse.

Periodic maintenance of the water treatment plant is expected to be required for up to 12 hours per week and include:

- refilling of chemicals;
- inspection of the treatment system;
- de-sludge clarifiers and tanks; and
- monitor and test outflow.

4.3.4 Warehouse

Water will be supplied to the following activities within the warehouse:

- sprinklers located at the entry and exit points of the warehouse;
- vehicle and plant washdown;
- dust suppression of waste and product stockpiles; and
- soil washing process.

The misters will be supplied by potable water due to human health risks. Water for washdown, dust suppression and soil washing activities will be obtained from the following sources (in order of supply):

- treated water from the reuse water tanks;
- harvested stormwater from the onsite detention storage; and
- potable water supply.

4.4 Potable water and wastewater

Potable water for the offices, amenities and misters located at the entry and exit points of the warehouse will be sourced from the Sydney Water potable water supply network. Prior to the site being connected to mains water, potable water will be supplied by tanker and stored within a 100-kilolitre (kL) tank, which is expected to be refilled up to once per week. Potable water will also be used for washdown, dust suppression and soil washing activities when demand exceeds the supply from the reuse water tanks and onsite detention storage.

Prior to a connection to Sydney Water's reticulated wastewater system, wastewater generated by onsite amenities will be discharged to a septic holding tank, which will be pumped out by an approved licensed contractor when required.

4.5 Chemical and hydrocarbon storage

Fuel and any hazardous chemicals will be stored in bunded facilities in accordance with NSW government guidelines (refer Section 2.3.7) and Australian Standard AS1940:2004.

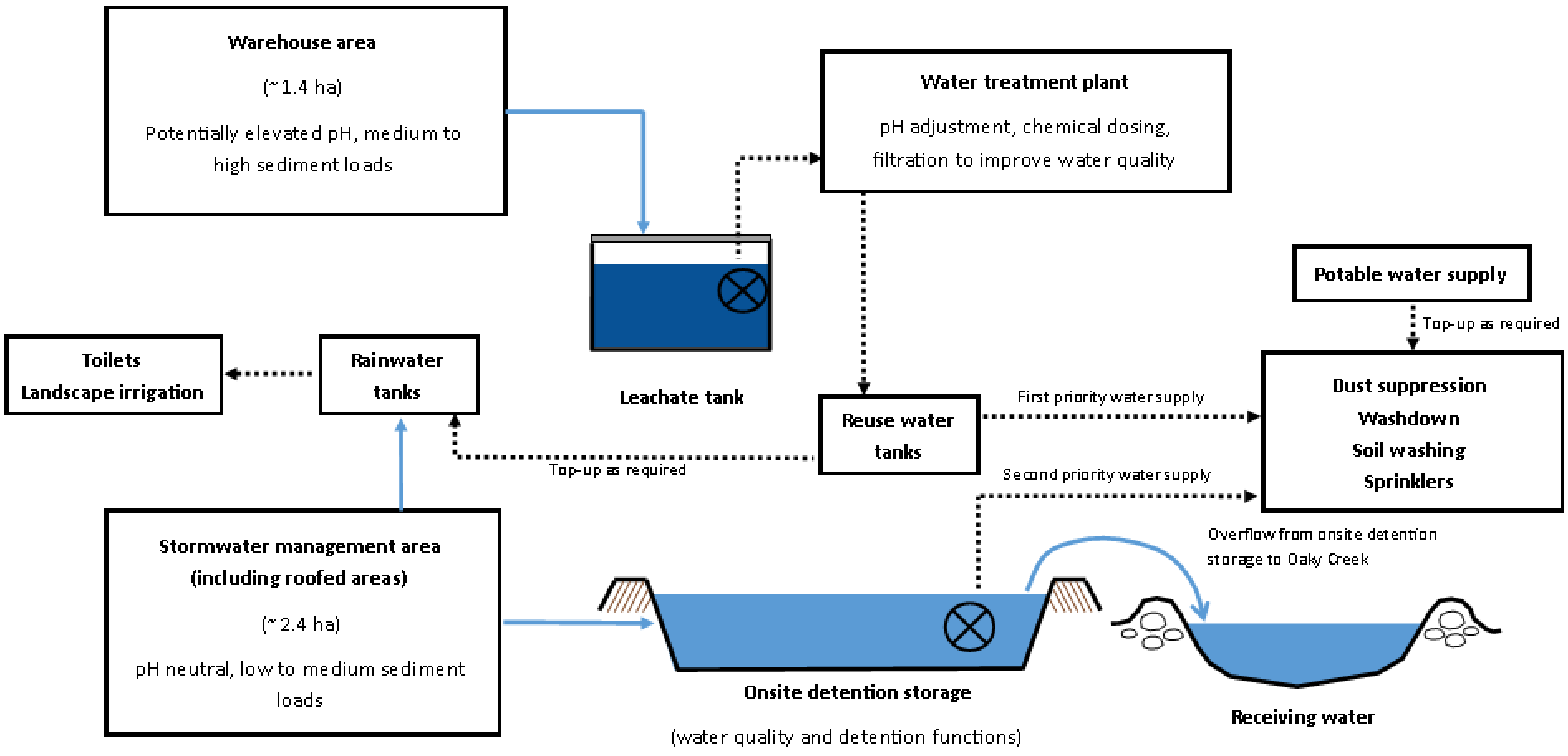


Figure 4.1 Water management system layout

5 Flood assessment

5.1 Overview

5.1.1 Previous studies

As part of the EIS for the WSA, assessment of the impacts on surface water hydrology, flooding and geomorphology (GHD 2016) was undertaken. A flood model was prepared using MIKE21 software, informed by DRAINS and XPRAFTS hydrology models.

5.1.2 Approach

For this assessment, a two-dimensional hydraulic model was developed to confirm the results presented by GHD (2016) and provide detailed flood mapping. Hydrology results of the WSA flooding assessment have been utilised to inform the hydraulic model.

The WSA development is currently underway and details of key hydrologic features such as the proposed earthworks and water management systems outflow designs were not available for this assessment. Hydrologic modelling undertaken as part of the WSA development EIS in 2016, included consideration of these key hydrologic characteristics (GHD 2016).

As such, it is considered appropriate to use hydrologic modelling results produced by GHD (2016) for the WSA development EIS to estimate flood flows through Oaky Creek.

5.2 Proposed assessment conditions

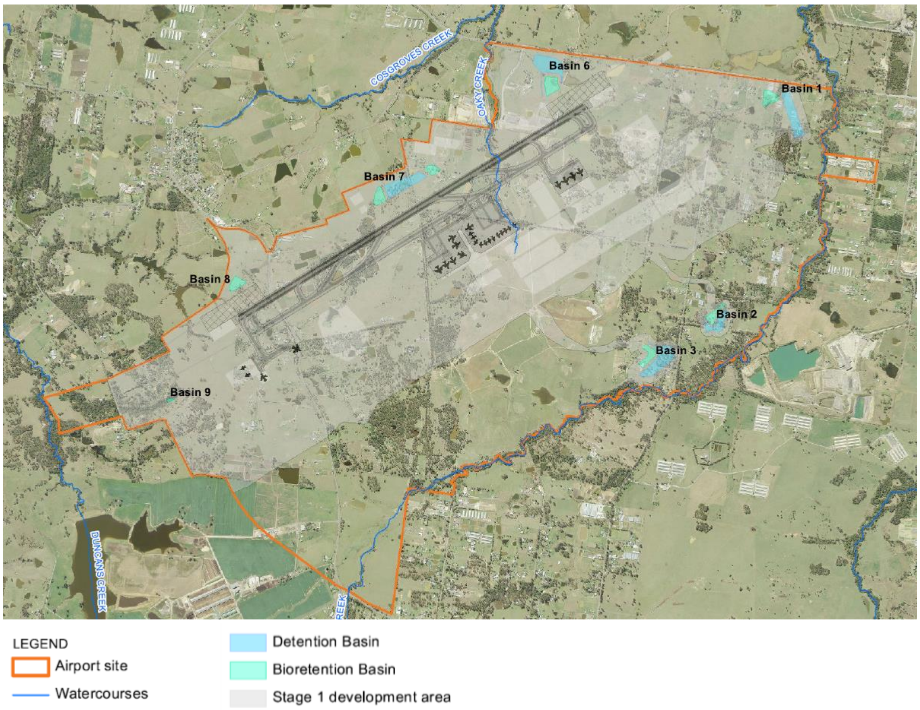
5.2.1 Western Sydney Airport

The WSA development is broken into two stages, the Stage 1 development and the long-term development. Construction of the Stage 1 development commenced in late 2018, involving significant earthworks to level the central and northern portions of the airport site (known as the construction impact zone) for the runway and related Stage 1 infrastructure. The construction impact zone is situated across the Oaky Creek headwaters, south of the subject property (refer to Figure 5.1).

5.2.2 Hydrological conditions

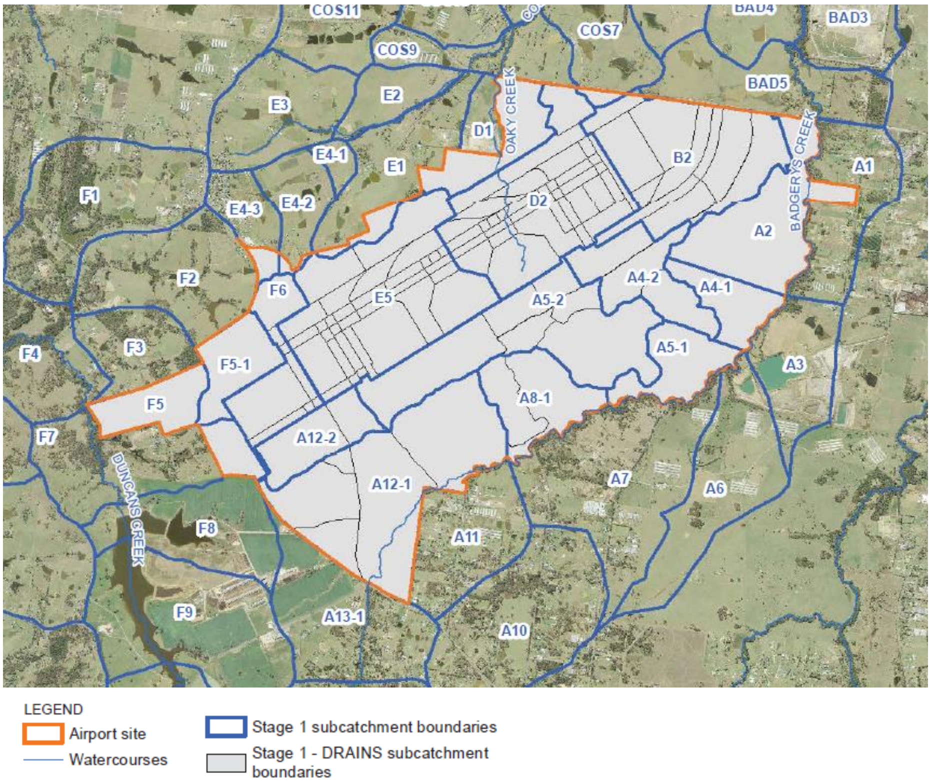
As mentioned above, the WSA development involves significant earthworks within the Oaky Creek catchment upstream of the ARRC site. To provide a level surface for the runway and associated infrastructure, areas of the Oaky Creek headwaters are being regraded to drain away from the site, in a north-east direction to Basin 6 and to the south-east to Basin 3 (refer Figure 5.1). The catchment area draining to Oaky Creek upstream of the site will be reduced by 75 ha as a result of the WSA development. Figure 5.2 shows the proposed catchment boundaries that will result from the current earthworks.

Long-term development works are not expected to cause changes to the Oaky Creek catchment hydrology beyond those assessed for Stage 1 (GHD 2016) and therefore Stage 1 flooding conditions are taken to be applicable to the ARRC site in the long-term.



Source: GHD (2016)

Figure 5.1 Western Sydney Airport - Stage 1 development



Source: GHD (2016)

Figure 5.2 Western Sydney Airport - Stage 1 catchment boundaries

5.3 Modelling methodology

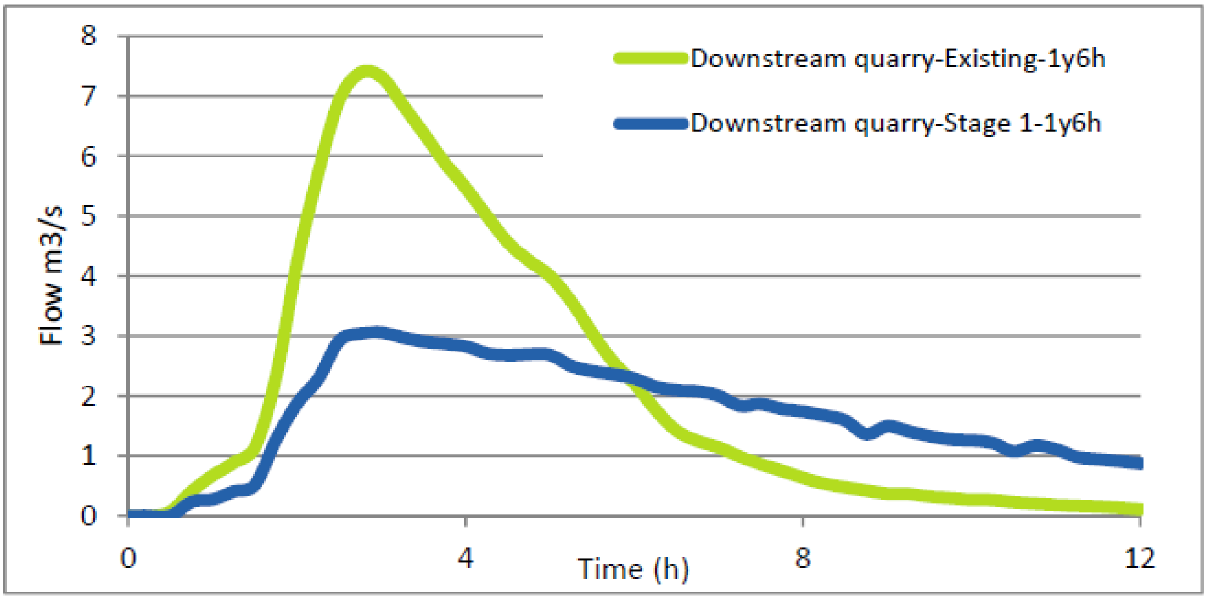
5.3.1 Hydrology

Hydrology results from GHD (2016) were adopted for use in this assessment for reasons outlined in Section 5.1.2.

i Adopted hydrographs

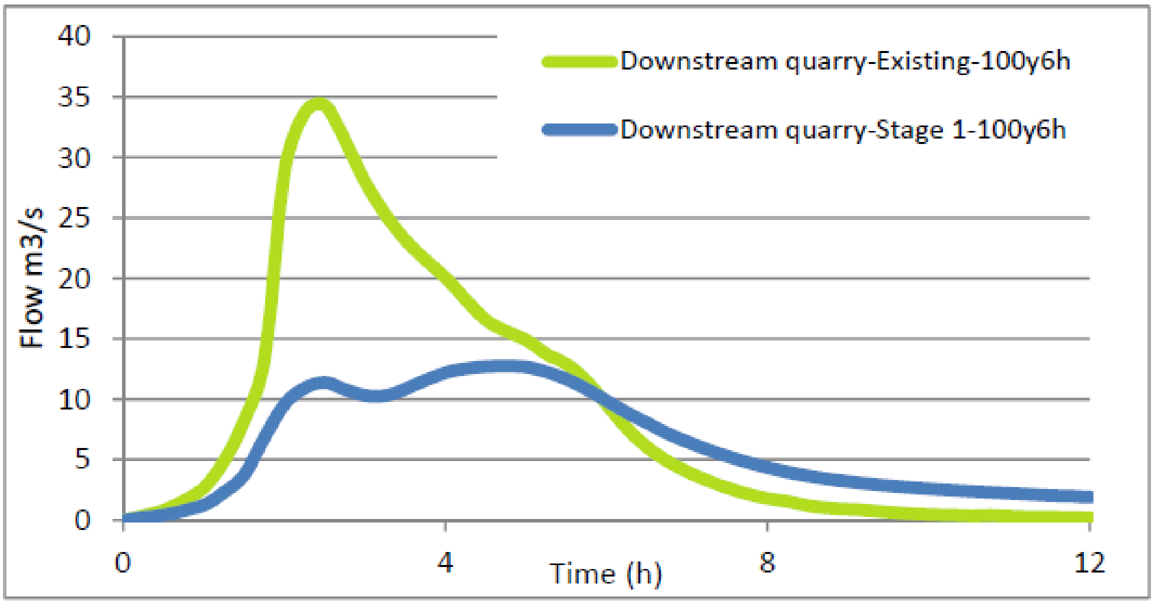
An increase in impervious catchment associated with the airport runway will be offset by the significant catchment area reductions to Oaky Creek upstream of the subject property. Figure 5.3 and Figure 5.4 present the changes in flow as a result of Stage 1 of the airport development. It is expected that Stage 1 will reduce pre-development peak flows at the quarry site by approximately 4.5 cubic metres per second (m^3/s) during a one-year average recurrence interval (ARI) event and 22 m^3/s during a 100-year ARI event.

The 100-year ARI peak flow at the quarry site is expected to be approximately 13 m^3/s for the Stage 1 airport development. The probable maximum flood (PMF) event was also simulated for the WSA EIS, where the PMF peak flow is expected to be approximately 40 m^3/s adjacent the site and approximately 200 m^3/s downstream of the site at Elizabeth Drive.



Source: GHD (2016)

Figure 5.3 Comparison of existing and Stage 1 flows for Oaky Creek (one-year average recurrence interval event)



Source: GHD (2016)

Figure 5.4 Comparison of existing and Stage 1 flows for Oaky Creek (100-year average recurrence interval event)

ii ARR2019 comparison

The GHD (2016) hydrologic modelling was developed in accordance with 1987 ARR guidelines (Pilgrim 1987). Since this time, these guidelines have been updated, with current recommended approach to flooding in Australian documented in the 2019 ARR guidelines (Ball et al. 2019).

Updates to ARR 1987 includes consideration of additional rainfall data in the development of design rainfall depths and temporal burst patterns.

A comparison between intensity-frequency-duration curves for the ARRC site under ARR 1987 and 2019 methods shows a slight reduction in the revised rainfall intensity for the critical duration flood event (6 hour) through Oaky Creek (Figure 5.5).

Effects of temporal burst patterns to storms are expected to be dampened as stormwater moves through the upstream water management system at the WSA development site, with the flood flow regime instead controlled by detention basin overflows. Differences in flood flow rates due to storm burst temporal patterns between ARR 1987 and 2019 are therefore expected to be negligible.

Application of ARR 1987 methods is therefore conservative in this application and the GHD (2016) hydrologic modelling results are considered appropriate for application to the ARRC site, particularly given the limited availability of the WSA water management system details for this assessment.

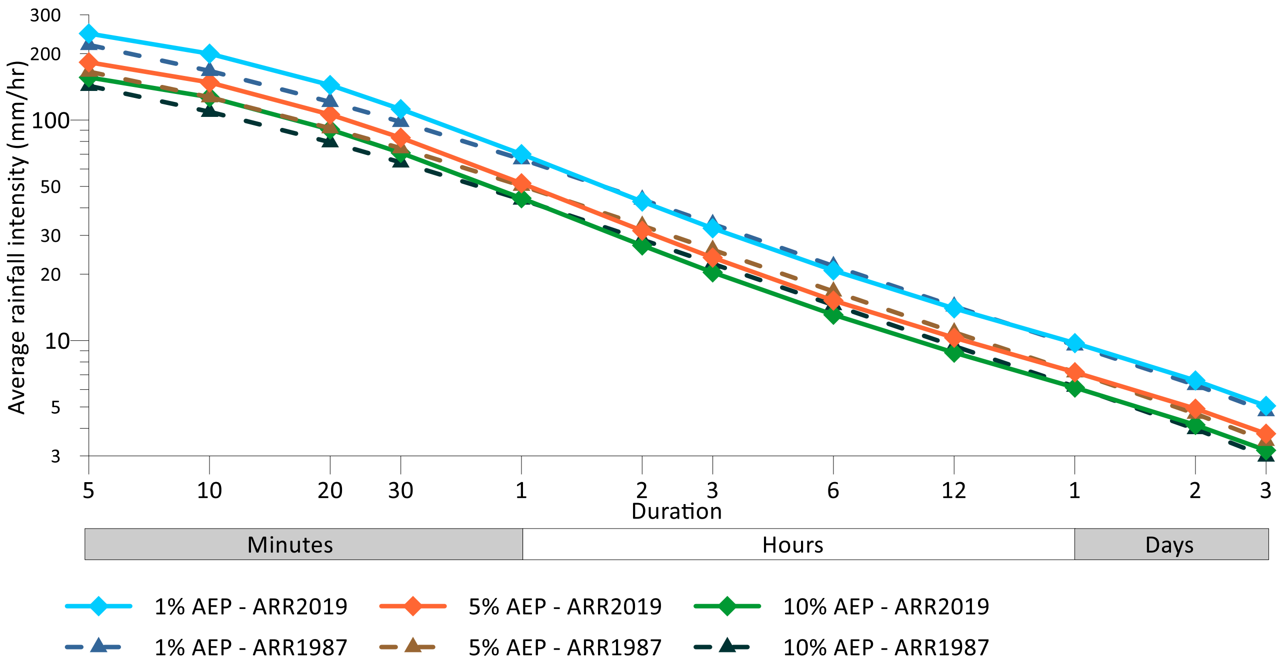


Figure 5.5 Intensity-frequency-duration charts for ARR1987 and ARR2019

5.3.2 Hydraulics

A two-dimensional TUFLOW hydraulic model (version 2020-01-AA) was developed to assess flood depths and extents through the ARRC site. The TUFLOW model was informed by a 1 m digital elevation model (DEM) sourced from the NSW Government Department of Finance, Services and Innovation – Spatial Services department based on light detection and ranging (LiDAR) survey collected in 2019.

i Model version

TUFLOW is a hydrodynamic model used for simulating one-dimensional and two-dimensional flows where the two-dimensional solution occurs over a regular grid of square elements. TUFLOW has been used in Australia by major consultancies and government departments to simulate flooding for a wide variety of rural and urban locations and is well known by the Australian hydrological profession as an appropriate tool for runoff simulation when appropriate site-specific parameters are used.

The high-performance computing (HPC) version of TUFLOW partitions two-dimensional grid solutions into compartments for parallel solving, using either multiple computer processing units (CPU) or graphic processing units (GPU). Parallel computations can reduce model runtimes, with GPU typically resulting in a faster solution than CPU. TUFLOW HPC (GPU) was used to model runoff within the hydraulic model domain (see below).

ii Model domain and grid size

The hydraulic model domain covers the Oaky Creek flood conveyance area, the ARRC site and the downstream confluence with Cosgroves Creek. The active model domain covers an area of 86 ha with a model grid size of 1.5 m x 1.5 m and is shown in Figure 5.7. This model grid size is of an appropriate resolution to model key hydraulic features adjacent the ARRC site such as bridges and channels.

Source: EMM (2020); DFSI (2017); GA (2011); ASGC (2006); Nearmap (2020)

0 100 200 m
GDA 1994 MGA Zone 56
N

KEY
- Subject property
- ARRC site
- Cadastral boundary
- Watercourse
- Upstream bridge
- Elizabeth Drive culvert

Model boundary
- HQ
- QT

Material type
- Grassed floodplain and quarry area
- Marsh
- Waterbody
- Thick vegetation (trees)

Two-dimensional modelling extent

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Figure 5.6

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iii Manning's roughness

Manning's roughness values were selected based on inspection of aerial imagery and from site observations. The upstream sections of Oaky Creek were observed to be densely vegetated, with fallen trees blocking the watercourse at various intervals, before widening into a reedy marshland at the online dammed storage.

The applied Manning's roughness values are presented in Table 5.1.

Table 5.1 Manning's roughness values

Land use[1]	Manning's value
Minimal vegetation (grassed)	0.04
Water management basins and dams	0.02
Thick vegetation (trees)	0.10
Vegetated channel	0.10
Marsh	0.07

Note: 1. Spatial variation of land use categories shown in Figure 5.6.

iv Boundary conditions

Hydrologic modelling results (GHD 2016) were applied to the model as inflow hydrographs (QT) at the model boundaries at Oaky Creek and Cosgroves Creek. A variable flow stage-discharge (HQ) boundary condition was applied to the downstream model boundary. The water surface slope at the downstream boundary was defined so that the stage-discharge relationship at the boundary was automatically generated by TUFLOW.

v Initial water levels

Initial water levels were defined for several existing waterbodies within the two-dimensional model domain, including the adjacent quarry water management dam and the Oaky Creek online storage dam.

Initial water levels were applied based on LiDAR data reflected from the dam water surfaces. Topographic data was manipulated in TUFLOW to lower existing dam elevations to an assumed depth of 0.5 m below initial water level.

vi Hydraulic features

Watercourse structures were identified at two locations along Oaky Creek, as shown in Figure 5.6. The arrangement and approximate dimensions of the structures were obtained during field survey. The details of the two watercourse structures are presented in Table 5.2.

Table 5.2 Adopted watercourse structure dimensions

Location	Type	Model application	Number of cells	Width (m)	Height (m)
Upstream bridge	Clear span bridge	Two-dimensional layered flow constriction layer	1	15.0[1]	Varied with terrain
Elizabeth Drive Culvert	Rectangular culvert	On-dimensional culvert element	2	2.6	2.0

Notes: 1. Width of bridge noted as span between abutments.

5.4 Hydraulic assessment

The ARRC facility is expected to remain above the limit of flooding along Oaky Creek for all events including the PMF for the Stage 1 development conditions of WSA, with the exception of the onsite detention storage, which is expected to be inundated by the fringe of the PMF event. The site is not expected to increase flood levels in Oaky Creek.

Figure 5.7 and Figure 5.8 present the modelled flood extents and depths for the 100 year ARI and PMF events respectively. Flood depths within Oaky Creek are estimated to be around 0.4 m to 0.8 m for a 100-year ARI event, with localised deeper sections up to 1.2 m. Flood depths are estimated to be around 1.2 m to 1.4 m for the PMF event with deeper sections up to 1.8 m.

It is noted that maximum flood depths presented in this assessment are generally higher than those presented in GHD (2016). This is expected to be due higher resolution of the model terrain utilised in this assessment compared to the broader catchment scale modelling completed for GHD (2016). Flood extents presented in both assessments are considered comparable.

Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020)

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100-year average recurrence interval flood depth

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Figure 5.7

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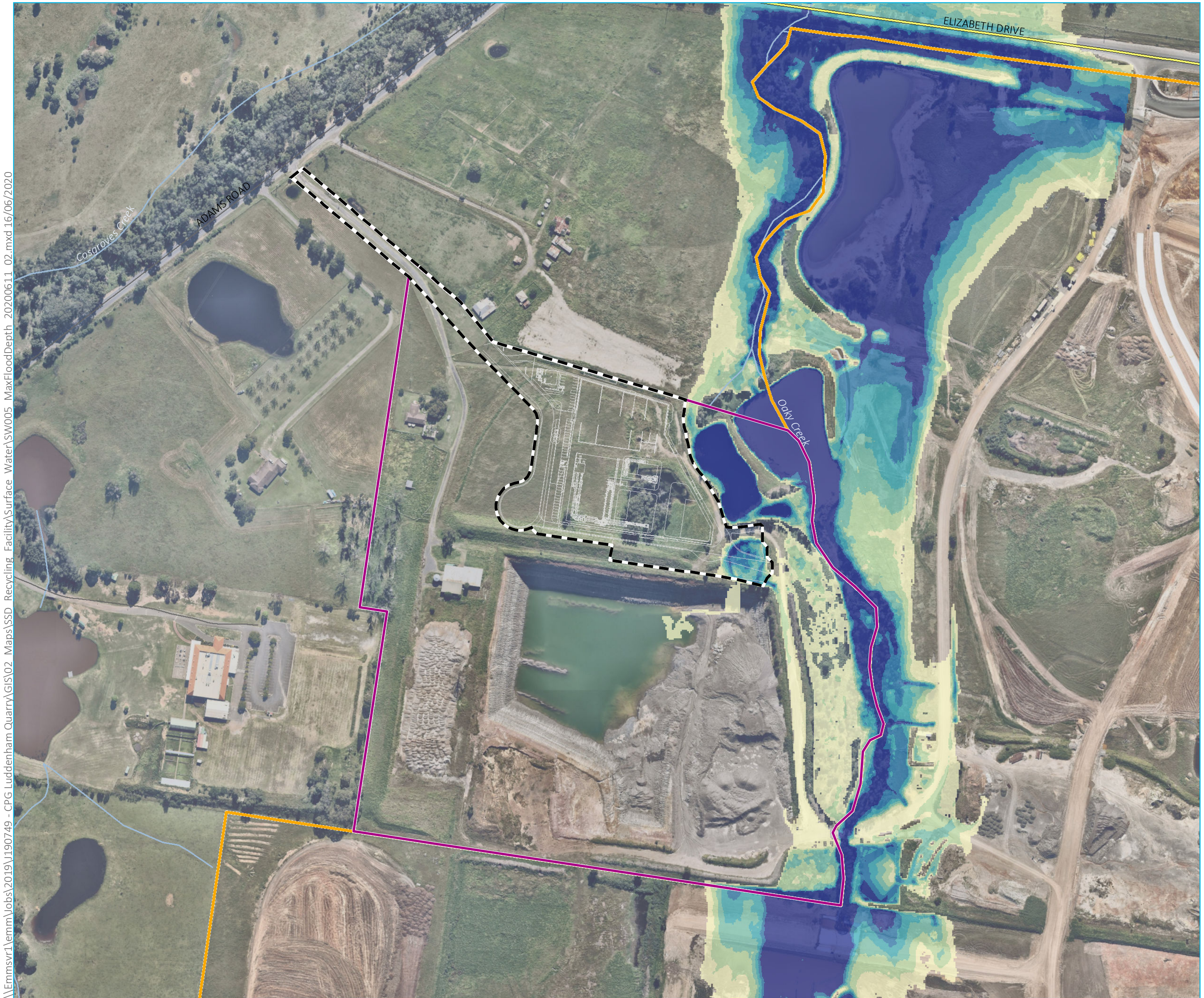

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Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020)

0 100 200 m
GDA 1994 MGA Zone 56
N

KEY
- Subject property
- ARRC site
- Western Sydney Airport
- Indicative detailed layout
- Major road
- Minor road

Peak flood depth (m)
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- > 1

Probable maximum flood depth

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Figure 5.8

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6 Site water balance

A water balance model was developed for the ARRC water management system. The objectives of the modelling were to estimate the volume of water that is captured by the water management system available for reuse and site discharge volumes.

6.1 Modelling methodology

The water balance model was developed in GoldSim version 12.1. The model applies a continuous simulation methodology that assesses the performance of the modelled water management system under a range of rainfall and evaporation sequences. The model was created by representing the water cycle as a series of elements, each containing pre-set rules and data, that were linked together to simulate the interaction of these elements.

6.2 Data

6.2.1 Climatic data

A 131-year simulation period was adopted for the water balance model using historical daily rainfall and evaporation data from the Badgerys Creek McMasters station (BOM station number 67068) between 1889 and 2019, as discussed in Section 3.3.

6.2.2 Stormwater runoff

Surface runoff was estimated using the Australian Water Balance Model (AWBM). The AWBM was developed by Boughton (2004) and is widely used across Australia to estimate runoff. The hydrological model calculates runoff and baseflow components from rainfall after allowing for relevant losses and storage. The AWBM was incorporated into the GoldSim water balance model for the site.

For each surface type present on site, the AWBM was parameterised to achieve long-term average volumetric runoff coefficients (Cv) based on typical values. The assumed catchment breakdown and Cv applied to each surface type is provided in Table 6.1.

Table 6.1 Catchment runoff parameters

Surface type	Management areas	Area (ha)	Cv
Impervious – high runoff potential	Roofs, sealed roads, hardstand areas	2.1	0.9
Vegetation – low runoff potential	Landscaped areas	0.3	0.4

6.2.3 Operational water demands

As discussed in Section 4.3.4, water will be required for misters, washdown, dust suppression and soil washing. Estimated water demands, source (in order of priority) and loss rates that were used in the water balance model are provided in Table 6.2. High and low water demand scenarios have been modelled, respectively representing site activities with and without the soil washing process.

Table 6.2 Operational water demands

Element	Demand	Supply (in order of priority)	Loss
Misters	2.6 ML/year	1. Potable water	100%
Washdown	3.0 ML/year	1. Reuse water tanks 2. Onsite detention storage 3. Potable water	25%
Dust suppression	1.6 ML/year	1. Reuse water tanks 2. Onsite detention storage 3. Potable water	75%
Soil washing	52.2 ML/year	1. Reuse water tanks 2. Onsite detention storage 3. Potable water	40%

Water demand for other site activities including amenities and landscape irrigation are considered negligible compared to the other demands of the site and therefore have not been included in the modelling.

6.2.4 Water management infrastructure

The proposed water management system infrastructure modelling assumptions are presented in Table 6.3. These features will be finalised during detailed design of the site; however, it is anticipated the model validity will not be significantly impacted by any minor changes.

Table 6.3 Water balance model assumptions

Model element	Assumption
Onsite detention storage	Capacity 500 kL
Leachate tank	Capacity 130 kL
Reuse water tanks	Capacity 100 kL
Water treatment plant	Maximum treatment rate 6 L/s

6.3 Modelling results

Two model scenarios were simulated to represent high water demand (with soil washing process) and low water demand (without soil washing process) within the warehouse.

6.3.1 High water demand modelling scenario

The distribution of water across the sire estimated by the water balance model for typical dry (10th percentile), median (50th percentile) and wet (90th percentile) rainfall years for the high water demand modelling scenario is presented in Figure 6.1, Figure 6.2 and Figure 6.3, respectively.

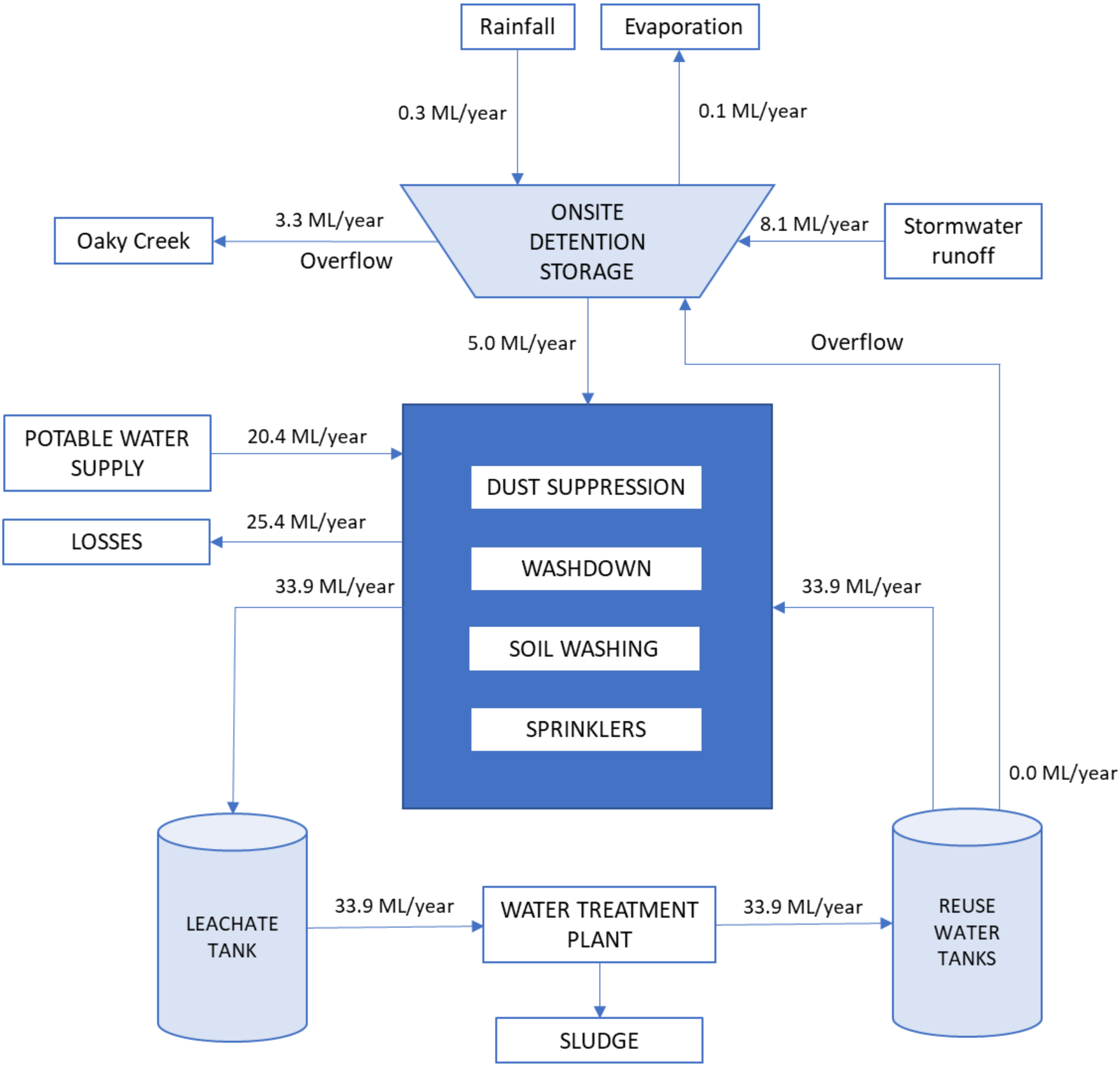

Figure 6.1 Water balance results – high water demand modelling scenario for typical dry rainfall year

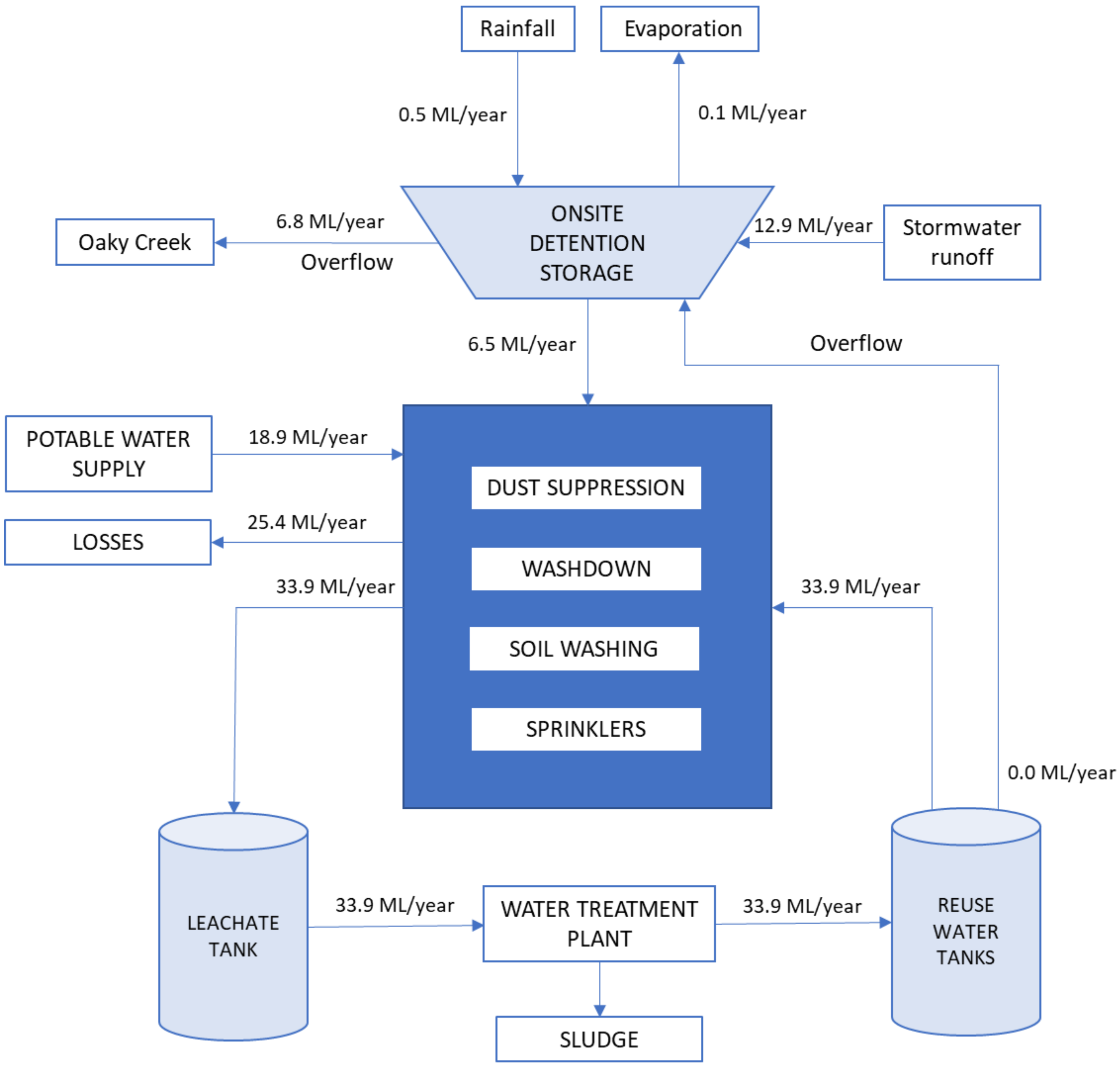

Figure 6.2 Water balance results – high water demand modelling scenario for typical median rainfall year

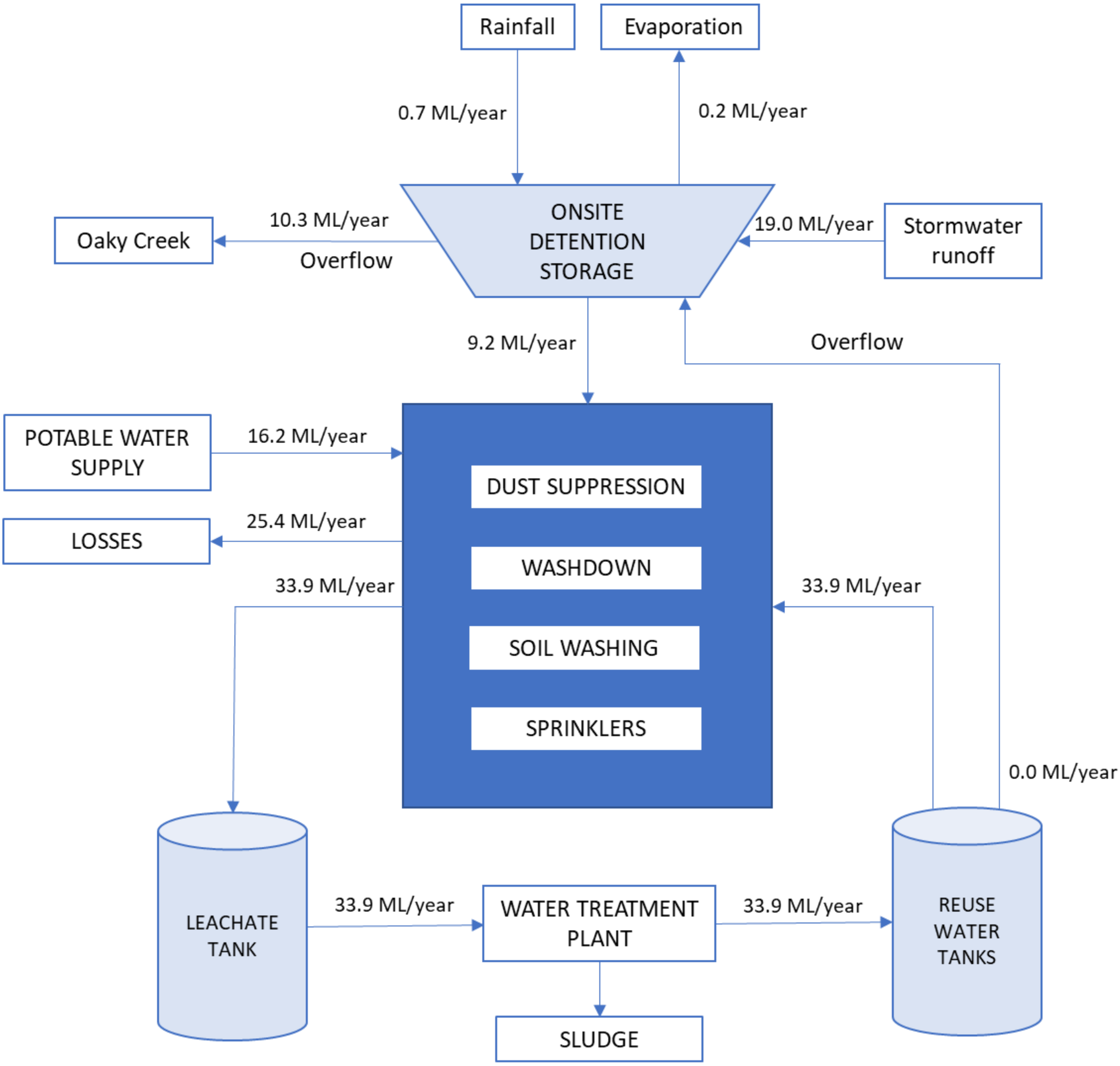

Figure 6.3 Water balance results – high water demand modelling scenario for typical wet rainfall year

An overview of the overall inputs and outputs for the proposed water management system for typical dry (10th percentile), median (50th percentile) and wet (90th percentile) rainfall years for the high water demand modelling scenarios is provided in Table 6.4.

Table 6.4 Summary of annual water balance results – high water demand modelling scenario

	Dry (10th percentile) rainfall year	Median (50th percentile) rainfall year	Wet (90th percentile) rainfall year
	ML/year	ML/year	ML/year
INPUTS			
Rainfall and runoff	8.4	13.4	19.7
Potable water supply	20.4	18.9	16.2
Total inputs	28.8	32.3	35.9
OUTPUTS			
Evaporation	0.1	0.1	0.2
Losses from site activities	25.4	25.4	25.4
Discharge to Oaky Creek	3.3	6.8	10.3
Total outputs	28.8	32.3	35.9

6.3.2 Low water demand modelling scenario

The distribution of water across the sire estimated by the water balance model for typical dry (10th percentile), median (50th percentile) and wet (90th percentile) rainfall years for the low water demand modelling scenario is presented in Figure 6.4, Figure 6.5 and Figure 6.6 respectively.

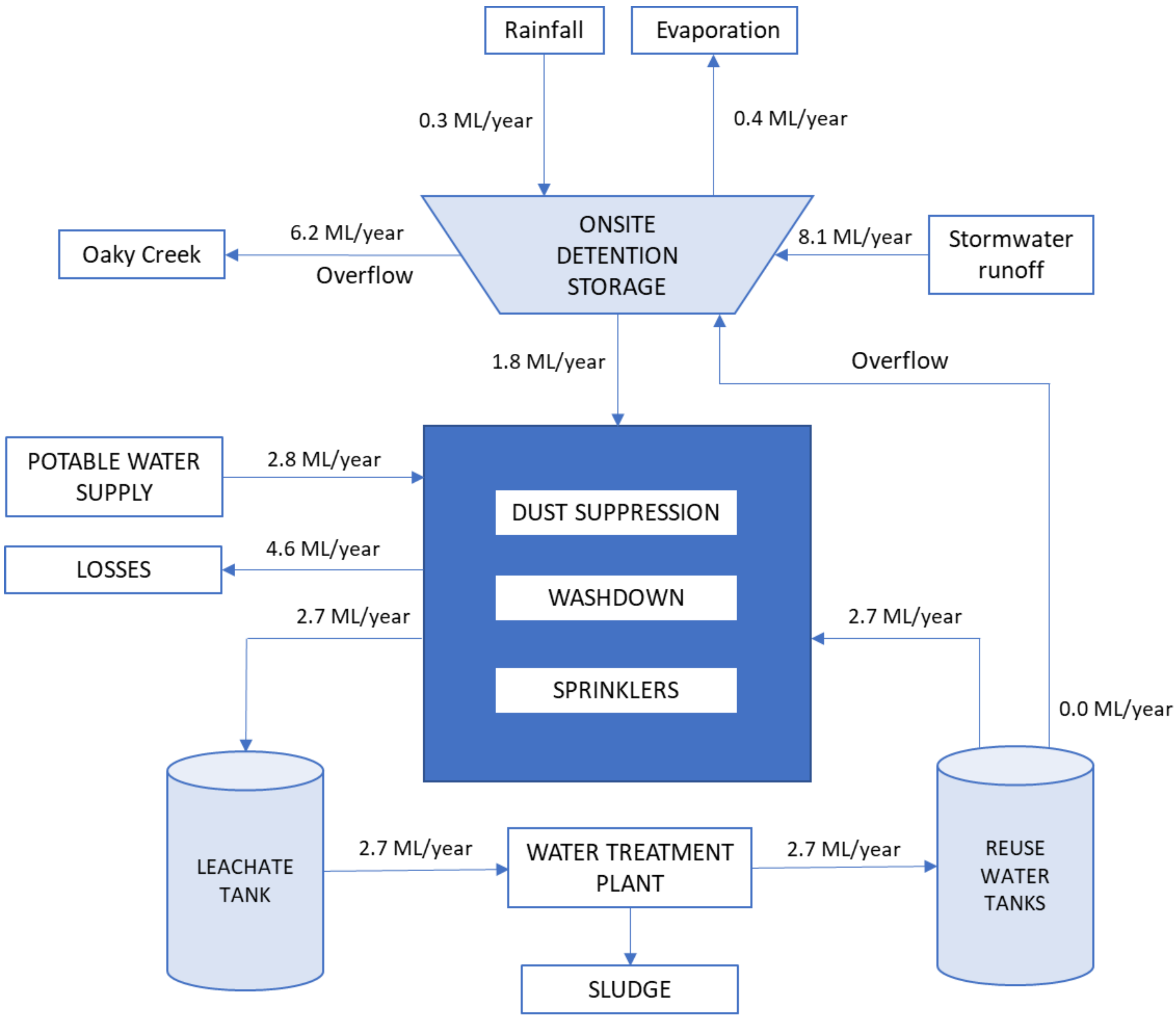

Figure 6.4 Water balance results – low water demand modelling scenario for typical dry rainfall year

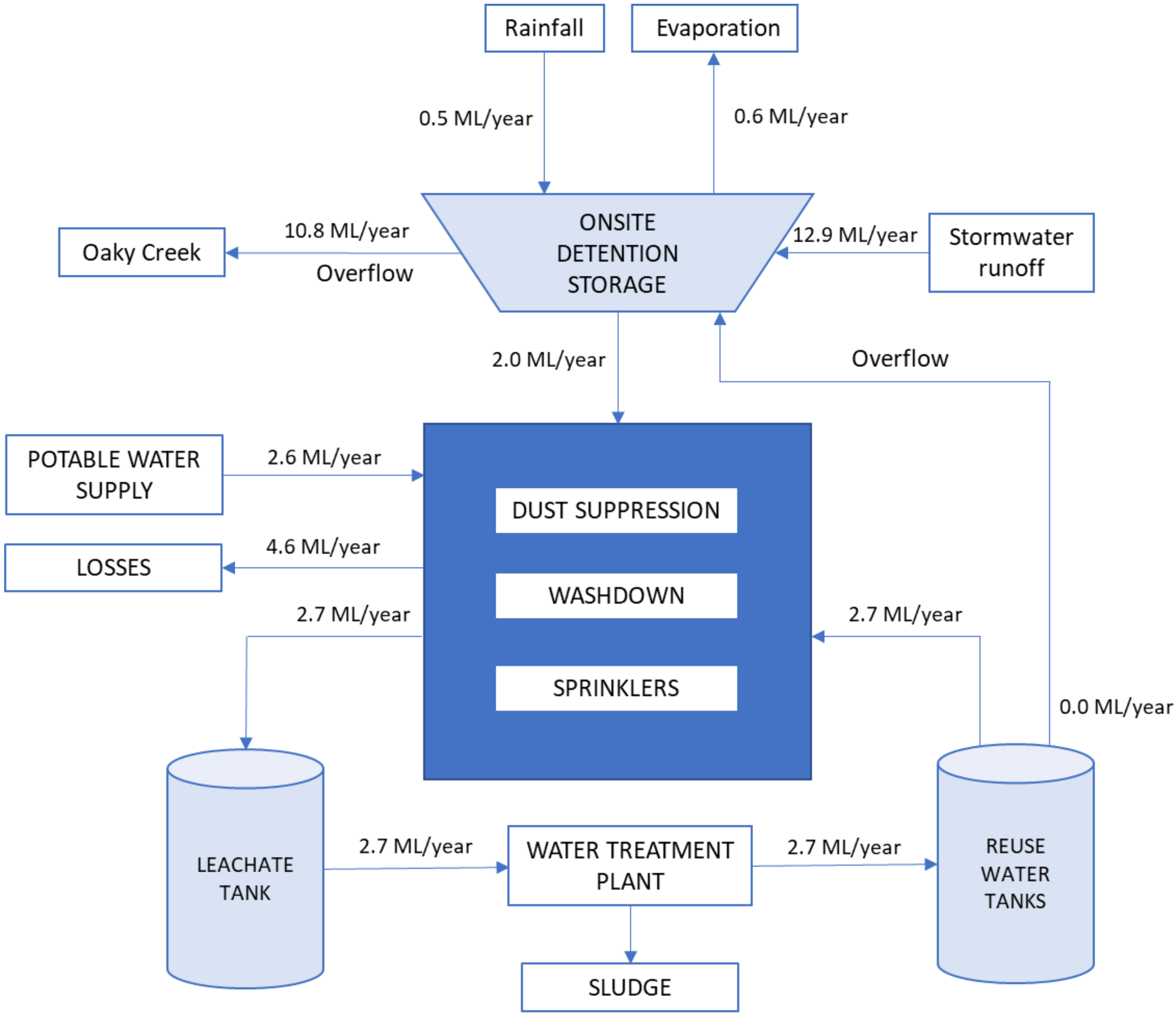

Figure 6.5 Water balance results – low water demand modelling scenario for typical median rainfall year

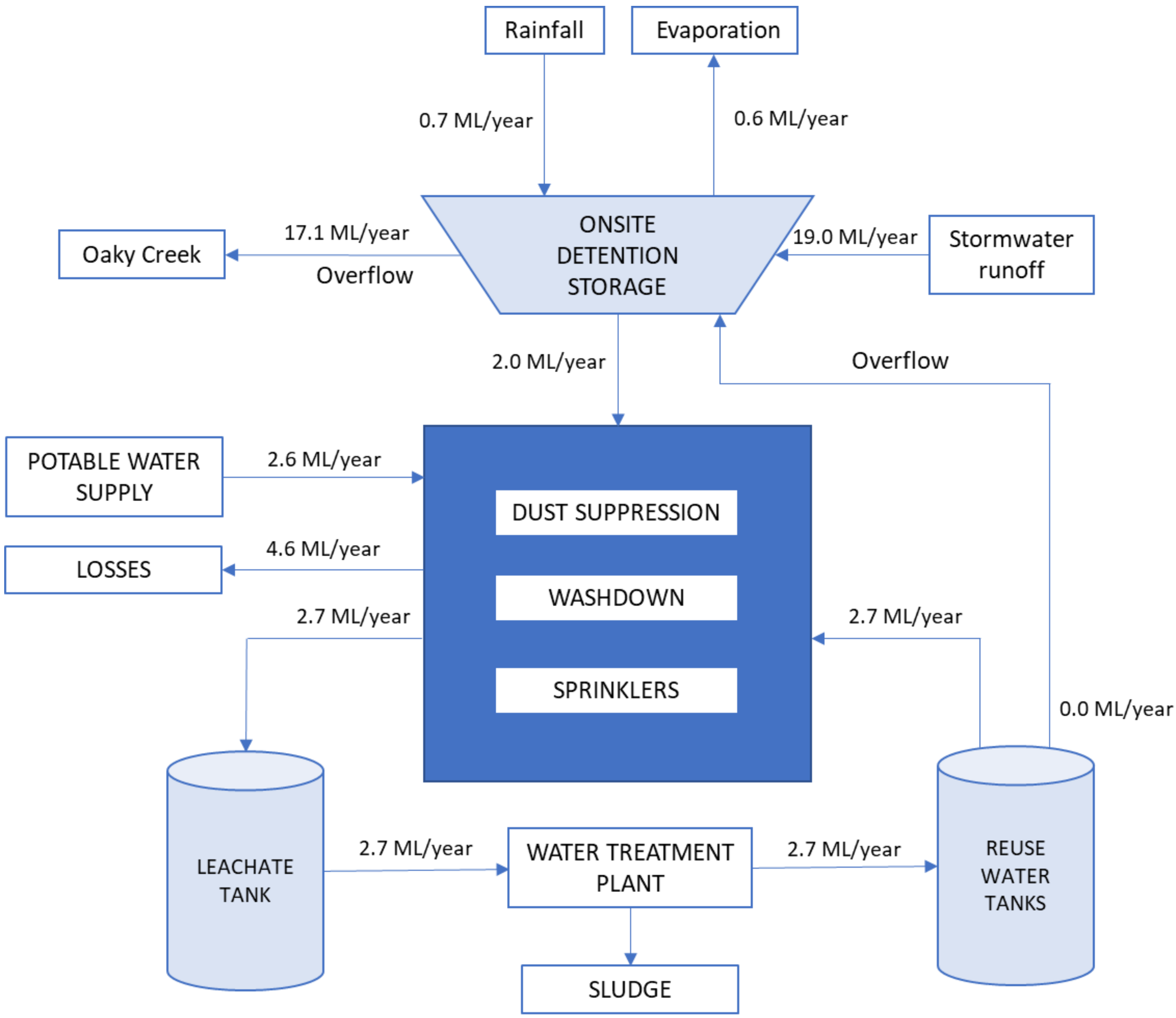

Figure 6.6 Water balance results – low water demand modelling scenario for typical wet rainfall year

An overview of the overall inputs and outputs for the proposed water management system for typical dry (10th percentile), median (50th percentile) and wet (90th percentile) rainfall years for the low water demand modelling scenarios is provided in Table 6.5.

Table 6.5 Summary of annual water balance results – low water demand modelling scenario

	Dry (10th percentile) rainfall year	Median (50th percentile) rainfall year	Wet (90th percentile) rainfall year
	ML/year	**ML/year**	**ML/year**
INPUTS			
Rainfall and runoff	8.4	13.4	19.7
Potable water supply	2.8	2.6	2.6
Total inputs	11.2	16.0	22.3
OUTPUTS			
Evaporation	0.4	0.6	0.6
Losses from site activities	4.6	4.6	4.6
Discharge to Oaky Creek	6.2	10.8	17.1
Total outputs	11.2	16.0	22.3

6.4 Discussion

The water balance results show that, for the high water demand scenario under typical median (50th percentile) rainfall conditions, approximately 50% of stormwater runoff from the site will be able to be harvested for reuse and approximately 57% of water supplied to the warehouse for site activities will be able to be treated and recycled. This will meet approximately 68% of the total demand for site activities.

For the low water demand scenario under typical median (50th percentile) rainfall conditions, approximately 15% stormwater runoff will be able to be harvested and reused and approximately 37% of water supplied to the warehouse will be able to be treated and recycled. This will meet approximately 64% of the total demand for site activities.

For above average rainfall conditions, it is expected that more stormwater would be available to be harvested for reuse (particularly for the high water demand scenario) and discharges to Oaky Creek from the onsite detention storage would increase.

For below average rainfall conditions, it is expected that less stormwater would be available for harvesting and reuse for both scenarios and discharges to Oaky Creek from the onsite detention storage would decrease.

For both high and low water demand scenarios and all modelled rainfall conditions, it was predicted that all dirty water captured from the warehouse would be treated by the water treatment plant, with all treated water reused for site activities, with no overflow from the reuse water tanks to the onsite detention storage. Therefore, it is not proposed to discharge any untreated dirty water or treated water to the onsite detention storage or to Oaky Creek.

The reuse of treated water recycled from the warehouse and harvested stormwater from the onsite detention storage to supply site activities minimises the demand from potable water supply and reduces the volume and frequency of discharges offsite to Oaky Creek.

Modelling and the interpretation of results is representative of annual rainfall conditions and typical responses of the proposed water management system. Intensity and duration of individual storm events will also affect how the proposed water management system will respond on an individual storm event basis.

7 Residual impacts

7.1 Water quantity

Development of the ARRC site will include bulk earthworks and changing pervious surfaces to hardstand. These works will reduce the permeability of the site, causing runoff to be conveyed more quickly and potentially increasing peak flow rates from the site. The onsite detention storage will function to attenuate stormwater flows from the site (as well as providing water quality treatment). Scour protection and energy dissipation will be constructed at the discharge location and at the confluence with Oaky Creek to reduce erosion potential associated with the increased flow rates from the immediate site.

7.2 Water quality

Water quality controls that will be applied to the site include:

- all acceptance, processing, storage and dispatch of waste and recycled product will be carried out within an enclosed warehouse;
- separating dirty water that has potentially come into contact with waste material from stormwater runoff from the warehouse roof, site offices, roads, carparks and landscaped areas;
- incoming and processed waste will be stored, processed and handled under cover;
- installing and operating a water treatment plant to treat dirty water, with treated water reused preferentially to supply site activities;
- installing a gross pollutant trap within inlet pits to capture gross pollutants and coarse sediment prior to stormwater runoff entering the pipe network; and
- enabling the settlement of suspended solids out of the water column within the onsite detention storage.

Discharges of stormwater are predicted to occur from the onsite detention storage into Oaky Creek. The storage will receive stormwater runoff from the warehouse roof, site offices, roads, carparks and landscaped areas. No untreated dirty water or treated water will be directed to the onsite detention storage or discharged to Oaky Creek (refer Section 6.3.2). Reuse of harvested stormwater will reduce the volume and frequency of discharges. Discharges will occur most frequently following periods of rainfall, at which time there is expected to be dilution by coincident flows in Oaky Creek.

Coarse and some fine suspended solids are expected to be removed in the onsite detention storage via sedimentation processes. Water quality monitoring will be undertaken within Oaky Creek, upstream and downstream of the site and within the onsite detention storage (discussed further in Chapter 8). The monitoring will be used to identify water quality impacts associated with discharges. If water quality impacts are identified, the following contingency measures are recommended to be implemented:

- implementing a first flush process to capture the initial runoff of a rainfall event from the warehouse roof, site offices, roads and carparks to entrain most of the potentially contaminating material which may be present and direct the runoff to the water treatment plant for treatment and reuse; and/or
- application of coagulating and/or flocculating agents to enhance sediment removal prior to discharge.

Sediment settling times are recommended to be analysed once the site is fully operational to determine the actual settling time of the onsite detention storage. Jar testing is recommended to determine appropriate coagulating and/or flocculating agent, if required, and the application rate for treatment. The application rate is required to be sufficiently high enough to remove suspended solids and allow discharge of water without polluting receiving waters with the coagulating/flocculating agent itself.

The requirement for additional stormwater treatment devices will be determined during the detailed design phase of the project and will be sized to meet Liverpool City Council pollution reduction targets. Given that discharges to Oaky Creek will be restricted to overflows of stormwater runoff from the onsite detention storage, with no discharge of untreated dirty water or treated water, the operation of the ARRC is expected to have negligible impact on the water quality of downstream receiving environments.

7.3 NSW water quality and river flow objectives

An assessment of the proposed water management system against the typical water quality and river flow objectives for uncontrolled streams in NSW is provided in Table 7.1.

Table 7.1 Assessment of water quality and river flow objectives

Environmental value	Objective	Application to proposed modification
Water quality objectives		
Aquatic ecosystems	Maintaining or improving the ecological condition of water bodies and their riparian zones over the long term.	No impacts to aquatic ecosystems are expected as the water quality of discharges is not expected to materially change or degrade the water quality of Oaky Creek.
Visual amenity	Aesthetic qualities of waters.	No impacts to the visual amenity of Oaky Creek is expected as the water quality of discharges is not expected to materially change or degrade the water quality of Oaky Creek. In particular, discharges are not expected to have elevated concentrations of oils, petrochemicals or floating debris or nuisance organisms such as algae.
Secondary contact recreation	Maintaining or improving water quality for activities such as boating or wading, where there is a low probability of water being swallowed.	No impacts to primary or secondary contact recreation activities are expected as the water quality of discharges is not expected to materially change or degrade the water quality of Oaky Creek. In particular, discharges are not expected to have elevated concentrations of faecal coliforms, enterococci or protozoans as there is no source of these pollutants within the water management system.
Primary contact recreation	Maintaining or improving water quality for activities such as swimming in which there is a high probability of water being swallowed.	
Livestock water supply	Protecting water quality to maximise the production of healthy livestock.	No impacts to downstream users for agricultural purposes are expected as the water quality of discharges is not expected to materially change or degrade the water quality of Oaky Creek.
Irrigation water supply	Protecting the quality of waters applied to crops or pasture.	
Homestead water supply	Protecting water quality for domestic use in homesteads, including drinking, cooking and bathing.	It is unlikely that downstream users extract water from Oaky Creek or downstream watercourses for homestead water supply. Therefore, impacts to homestead water supply have not been assessed.

Table 7.1 Assessment of water quality and river flow objectives

Environmental value	Objective	Application to proposed modification
Drinking water at point of supply – disinfection only Drinking water at point of supply – clarification and disinfection Drinking water at point of supply – groundwater	These objectives apply to all current and future licensed offtake points for town water supply and to specific sections of rivers that contribute to drinking water storages or immediately upstream of town water supply offtake points. The objectives also apply to sub-catchments or groundwater used for town water supplies.	Town water supply in the region is provided by Sydney Water. The site is not located within Sydney's drinking water catchment. Oaky Creek drains to the Hawkesbury-Nepean system downstream of Warragamba Dam. No water is extracted from downstream of the site for town water supply. Therefore, impacts to drinking water supply have not been assessed.
Aquatic foods (cooked)	Refers to protecting water quality so that it is suitable for the production of aquatic foods for human consumption and aquaculture activities.	Recreational fishers may use Oaky Creek and downstream watercourses. However, the trigger values for aquatic foods apply to aquaculture not recreational fishing. The required level of protection will be provided by meeting the objective for aquatic ecosystems.
River flow objectives		
Protect pools in dry times	Protect natural water levels in pools of creeks and rivers and wetlands during periods of no flows.	The flow regimes of Oaky Creek and downstream watercourses have been extensively modified by land clearing, agriculture, extractive activities and urban and industrial development in the catchment, including the current WSA development. No extraction of surface water from Oaky Creek is proposed as part of the ARRC development. Occasional discharges from the onsite detention storage to Oaky Creek will occur when the water stored on site exceeds the demand of site activities. The water balance model predicted a total discharge of up to 10.8 ML/year for the typical median (50th percentile) rainfall event (low water demand modelling scenario).
Protect natural low flows	Share low flows between the environment and water users and fully protect very low flows.	
Protect important rises in water levels	Protect or restore a proportion of moderate flows and high flows.	
Maintain wetland and floodplain inundation	Maintain or restore the natural inundation patterns and distribution of floodwater supporting natural wetland and floodplain ecosystems.	
Maintain natural flow variability	Maintain or mimic natural flow variability in all streams.	
Manage groundwater for ecosystems	Maintain groundwater within natural levels and variability, critical to surface flows and ecosystems.	
Minimise effects of weirs and other structures	Minimise the impact of instream structures.	No instream structures are proposed.

7.4 Flood impacts

The ARRC facility is expected to remain above the limit of flooding along Oaky Creek for all events including the PMF for the Stage 1 development conditions of WSA, with the exception of the onsite detention storage, which is expected to be inundated by the fringe of the PMF event. The site is not expected to impact flood levels in Oaky Creek.

8 Monitoring, inspection and maintenance programs

Following approval of the proposed ARRC, an operational environmental management plan would be developed for the ARRC in consultation with DPIE – Water and the EPA. The plan will address any specific development consent or licence conditions and is recommended to include:

- baseline monitoring data results;
- objectives and performance criteria including trigger levels for investigating any potentially adverse impacts associated with water management;
- details of the monitoring, inspection and maintenance programs;
- reporting procedures for the results of the monitoring program; and
- plans to respond to any exceedances of the performance criteria.

8.1 Monitoring program

The objective of the monitoring plan is to collect data to:

- assess the effectiveness of the water management system;
- identify and quantify water quality impacts to receiving waters; and
- assess compliance with any relevant development consent and licence conditions.

Surface water quality monitoring is recommended to be undertaken at the following locations:

- Oaky Creek upstream of the ARRC site;
- Oaky Creek downstream of the ARRC site;
- water stored within the onsite detention storage; and
- outflow of water treatment plant.

Monitoring of Oaky Creek upstream and downstream of the ARRC site will be undertaken in conjunction with the water quality monitoring program for the quarry.

An indicative analytical suite for the site is presented in Table 8.1. Physical and chemical stressors (with the exception of TSS) are recommended to be monitored in situ with a calibrated hand-held water quality meter. All other parameters are recommended to be analysed at a laboratory accredited by the National Association of Testing Authorities (NATA).

Table 8.1 Recommended surface water quality monitoring program

Location	Category	Parameters	Analysis method	Frequency
Oaky Creek upstream Oaky Creek downstream Onsite detention storage	Physical and chemical stressors	Dissolved oxygen, electrical conductivity, pH, total dissolved solids, turbidity	In situ with a calibrated hand-held water quality meter	Quarterly or once during or after any discharge event
		TSS	Analysis undertaken at NATA accredited laboratory	
	Nutrients	Ammonia, nitrate, nitrite, total Kjeldahl nitrogen, total nitrogen, reactive phosphorus, total phosphorus	Analysis undertaken at NATA accredited laboratory	
	Dissolved metals	Aluminium, arsenic, boron, cadmium, chromium, copper, iron, lead, manganese, nickel, zinc	Analysis undertaken at NATA accredited laboratory	
	Other	Total hardness, oil and grease	Analysis undertaken at NATA accredited laboratory	
Water treatment plant outflow	Physical and chemical stressors	Electrical conductivity, pH, turbidity	In situ with a calibrated hand-held water quality meter	During periodic maintenance of water treatment plant
		TSS	Analysis undertaken at NATA accredited laboratory	
	Nutrients	Ammonia, nitrate, nitrite, total Kjeldahl nitrogen, total nitrogen, reactive phosphorus, total phosphorus	Analysis undertaken at NATA accredited laboratory	
	Other	Oil and grease	Analysis undertaken at NATA accredited laboratory	

All monitoring will be undertaken in accordance with *Approved Methods for Sampling and Analysis of Water Pollutants in New South Wales* (DEC 2004).

Reporting requirements for the surface water quality monitoring program, including appropriate assessment criteria and triggers for response and action, will be developed as part of the operational environmental management plan.

8.2 Inspection and maintenance program

Site inspections of the water management system will be undertaken informally on a regular basis and formally on a quarterly basis. The water management infrastructure will be visually inspected for capacity, structural integrity and effectiveness. Maintenance, such as the removal of excessive sediment accumulation or macrophyte growth from the onsite detention storage, will be implemented as required. Maintenance of the water treatment plant will be in accordance with the manufacturer's specifications.

9 Water licensing

Stormwater runoff captured by the onsite detention storage will be reused for operational activities or discharged to Oaky Creek. Water take from the storage is excluded works under Schedule 1, item 3 of the NSW Water Management (General) Regulation 2018 (dams solely for the capture, containment or recirculation of drainage). Dams used for the containment and reuse of catchment runoff consistent with industry best practice to prevent the contamination of a watercourse is also excluded from harvestable rights calculations. Accordingly, the ARRC is not expected to have any requirements for licensing of surface water take.

As the ARRC is an SSD, there is no requirement to obtain approvals, including water use, water management work or controlled activity approvals, in accordance with Section 4.41 of the EP&A Act.

10 Summary

10.1 Project context

CPG/KLF propose to construct and operate an ARRC on the northern portion of the subject property. The ARRC would predominantly accept construction and demolition waste, with some commercial and industrial waste. This surface water assessment forms part of the EIS that has been prepared for the proposed ARRC and addresses the SEARs that are relevant to surface water management.

10.2 Water management overview

The key water management strategy adopted across the ARRC site is containment and management of water that has potentially been in contact with waste material, with reuse where feasible. The key features of the proposed water management system include:

- all acceptance, processing, storage and dispatch of waste and recycled product will be carried out within an enclosed warehouse;
- internal pit and pipe network to convey stormwater to an onsite detention storage;
- capture of dirty water recycled from site activities in the warehouse within a leachate tank;
- treatment of dirty water within a water treatment plant;
- reuse of treated water and harvested stormwater to supply site activities; and
- discharge of excess stormwater from the onsite detention storage to Oaky Creek.

All dirty water captured from the warehouse will be treated by the water treatment plant, with all treated water reused for site activities. No untreated dirty water or treated dirty water is proposed to be discharged to the onsite detention storage or to Oaky Creek.

10.3 Expected outcomes

The proposed water management system is expected to achieve the following outcomes:

- reuse of treated water and harvested stormwater is predicted by the water balance model to provide at least 60% of the demand for site activities under typical median (50th percentile) rainfall conditions, reducing the demand from potable water supply and the volume and frequency of discharges offsite to Oaky Creek;
- water quality controls are expected to function to prevent any material change or degradation of the water quality of Oaky Creek due to discharges of excess stormwater;
- the ARRC is expected to remain above the limit of flooding along Oaky Creek, with the exception of the onsite detention storage which is expected to be inundated by the fringe of the PMF event; and
- the development of the site is not expected to increase flood levels in Oaky Creek.

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Abbreviations

AHD	Australian Height Datum
ARI	average recurrence interval
ARR	*Australian Rainfall and Runoff* guidelines
ARRC	advanced resource recovery centre
AWBM	Australian Water Balance Model
BOM	Bureau of Meteorology
CPG	Coombes Property Group
CPU	computer processing units
DCP	development control plan
DEM	digital elevation model
DGV	default guideline value
DPIE	Department of Planning, Industry and Environment
EIS	environmental impact statement
EMM	EMM Consulting Pty Ltd
EP&A Act	*Environmental Planning and Assessment Act*
EPA	Environment Protection Authority
EPL	environment protection licence
GPU	graphic processing units
HPC	high-performance computing
KLF	KLF Holdings Pty Ltd
LiDAR	light detection and ranging
NATA	National Association of Testing Authorities
NSW	New South Wales
PMF	probable maximum flood
POEO Act	*Protection of the Environment Operations Act 1997*
SEARs	Planning Secretary's environmental assessment requirements
SILO	Scientific Information for Land Owners
SSD	State significant development
tpa	tonnes per annum
TSS	total suspended solids
WM Act	*Water Management Act 2000*
WSA	Western Sydney Airport
WSP	water sharing plan


Appendix !

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Table A.1 Water quality results – Upstream monitoring site

Parameter	Units	19/08/2010	20/09/2010	21/10/2010	22/11/2010	20/01/2011	22/03/2011	20/06/2011	21/07/2011	23/08/2011	20/12/2011	19/01/2012	20/02/2012	21/03/2012	19/04/2012	18/02/2013	18/09/2013	18/11/2013	16/04/2014	18/08/2014	16/10/2014	19/05/2015	04/07/2016	06/10/2016	06/03/2017	04/04/2017	22/08/2017
Physical and chemical stressors																											
Dissolved oxygen	mg/L																										3.9
Electrical conductivity	µS/cm																										**11,000**
pH	pH units	7.3	7.1	7.2	6.5	7.1	6.6	6.7	6.6	6.9	7.1	7.2	6.9	7.3	7.0	6.5	7.5	**5.7**	6.8	6.7	7.0	6.8	6.9	7.3	7.1	7.2	7.6
Total dissolved solids	mg/L																										6,720
Total suspended solids	mg/L	13	143	31	30	9	280	165	280	329	55	104	39	12	29	46	21	43	61	627	230	35	3	13	11	7	17
Major ions																											
Calcium	mg/L																										53
Chloride	mg/L																										3,500
Magnesium	mg/L																										280
Potassium	mg/L																										16
Sodium	mg/L																										2,600
Sulfate	mg/L																										130
Total alkalinity	mg/L																										440
Nutrients																											
Nitrate	mg/L																										<0.005
Nitrite	mg/L																										<0.005
Total Kjeldahl nitrogen	mg/L																										3.7
Reactive phosphorus	mg/L																										**0.17**
Total phosphorus	mg/L																										**0.4**

Table A.1 Water quality results – Upstream monitoring site

Parameter	Units	19/08/2010	20/09/2010	21/10/2010	22/11/2010	20/01/2011	22/03/2011	20/06/2011	21/07/2011	23/08/2011	20/12/2011	19/01/2012	20/02/2012	21/03/2012	19/04/2012	18/02/2013	18/09/2013	18/11/2013	16/04/2014	18/08/2014	16/10/2014	19/05/2015	04/07/2016	06/10/2016	06/03/2017	04/04/2017	22/08/2017
Dissolved metals																											
Arsenic	mg/L																										0.002
Cadmium	mg/L																										<0.0001
Chromium	mg/L																										0.001
Copper	mg/L																										<0.001
Iron	mg/L																										**2.2**
Lead	mg/L																										<0.001
Mercury	mg/L																										<0.00005
Nickel	mg/L																										0.002
Zinc	mg/L																										0.002
Total metals																											
Iron	mg/L																										5
Other parameters																											
Biochemical oxygen demand	mg/L		17	14	13	7	86	1	4	4	5	3	5	8	8	2	7	39	7	2	2	2	<2	2	4	3	9
Oil and grease	mg/L		<5	<5	22	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	10	5	5	6	<5	<5	<5	<5	<5

Table A.2 Water quality results – Downstream monitoring site

Parameter	Units	19/08/2010	20/09/2010	21/10/2010	22/11/2010	20/01/2011	22/03/2011	21/07/2011	23/08/2011	20/12/2011	19/01/2012	20/02/2012	21/03/2012	19/04/2012	18/02/2013	18/09/2013	18/11/2013	16/04/2014	18/08/2014	16/10/2014	19/05/2015	17/11/2015	4/07/2016	6/10/2016	6/03/2017	4/04/2017	22/08/2017
Physical and chemical stressors																											
Dissolved oxygen	mg/L																										6.8
Electrical conductivity	µS/cm																					1,280					**2,460**
pH	pH units	6.9	6.6	6.8	6.9	7.2	7.3	6.8	6.6	7.1	6.9	6.9	7.3	7.0	6.6	7.0	6.9	6.8	7.0	7.0	7.1	7.4	6.9	7.1	6.8	7.3	6.9
Total dissolved solids	mg/L																										1,420
Total suspended solids	mg/L	28	68	14	6	69	9	4	31	34	6	57	14	64	14	12	8	3	48	41	6	7	2	7	15	17	<1
Major ions																											
Calcium	mg/L																										36
Chloride	mg/L																										670
Magnesium	mg/L																										69
Potassium	mg/L																										14
Sodium	mg/L																										480
Sulfate	mg/L																										83
Total alkalinity	mg/L																										130
Nutrients																											
Nitrate	mg/L																										<0.005
Nitrite	mg/L																										<0.005
Total Kjeldahl nitrogen	mg/L																										0.6
Reactive phosphorus	mg/L																										0.02
Total phosphorus	mg/L																										<0.05

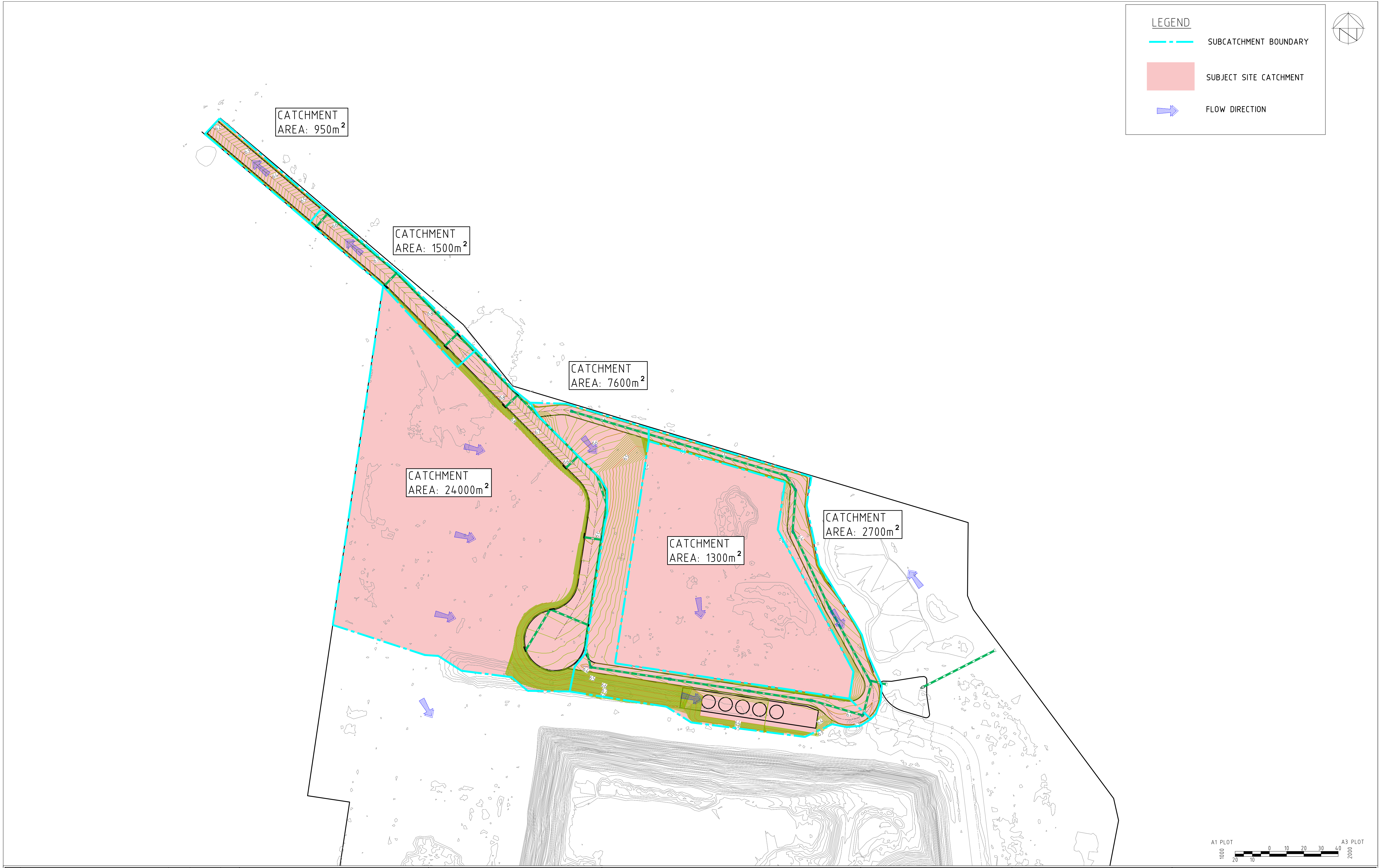
Table A.2 Water quality results – Downstream monitoring site

Parameter	Units	19/08/2010	20/09/2010	21/10/2010	22/11/2010	20/01/2011	22/03/2011	21/07/2011	23/08/2011	20/12/2011	19/01/2012	20/02/2012	21/03/2012	19/04/2012	18/02/2013	18/09/2013	18/11/2013	16/04/2014	18/08/2014	16/10/2014	19/05/2015	17/11/2015	4/07/2016	6/10/2016	6/03/2017	4/04/2017	22/08/2017
Dissolved metals																											
Arsenic	mg/L																										<0.001
Cadmium	mg/L																										<0.0001
Chromium	mg/L																										<0.001
Copper	mg/L																										<0.001
Iron	mg/L																										0.2
Lead	mg/L																										<0.001
Mercury	mg/L																										<0.00005
Nickel	mg/L																										0.002
Zinc	mg/L																										0.002
Total metals																											
Iron	mg/L																										0.6
Other parameters																											
Biochemical oxygen demand	mg/L		12	6	7	31	12	2	3	2	2	4	7	9	2	2	7	2	2	2	2	<2	<2	<2	2	5	<2
Oil and grease	mg/L		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	10	5	5	7	<5	<5	<5	<5	<5	<5


Appendix B

Stormwater catchment plan



No.	AMENDMENT	APPROVED	DATE	AMENDED BY
D	ISSUED FOR DA APPROVAL	MO	17.07.2020	EJ
C	ISSUED FOR DA APPROVAL	MO	17.06.2020	EJ
B	ISSUED FOR DA APPROVAL	MO	05.06.2020	EJ
A	ISSUED FOR DA APPROVAL	MO	05.06.2020	EJ

DEVELOPMENT TEAM

CLIENT

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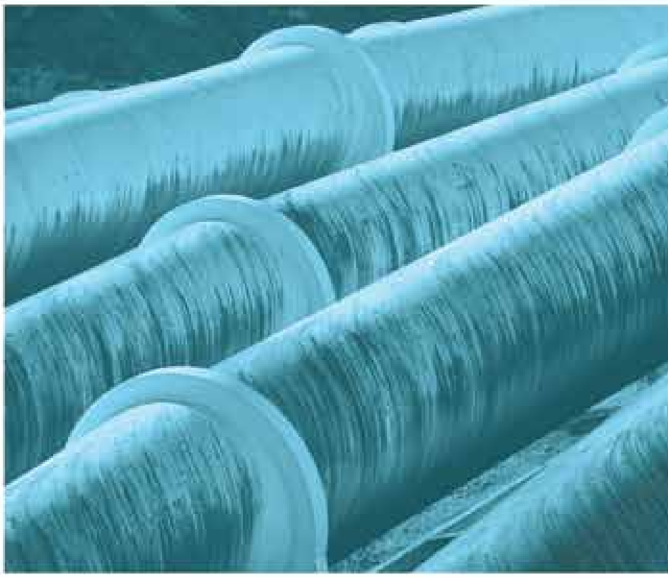
CHECKED MO DATE 05.06.2020
DESIGNED BY MO
DRAWN BY EJ
CAD FILE: S:\7472 Coombes 275 Adams Rd, Luddenham\Acad\Current Drawings\Civil\7472-SSDA-030.dwg
SCALE AS SHOWN
SHEET No.

PROJECT
275 ADAMS ROAD LUDDENHAM

DRAWING TITLE
STORMWATER CATCHMENT PLAN

PROJECT No. 7472-SSDA
DRAWING No. 030
AMDT D



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