18 Surface water and groundwater

The airport site contains about 64 kilometres of mapped watercourses and drainage lines (notably Badgerys Creek, Cosgroves Creek, Oaky Creek and Duncans Creek) and overlies the Bringelly Shale aquifer as well as unconfined areas of alluvial groundwater. Water quality sampling indicates that existing water quality is relatively degraded, with high levels of phosphorous and nitrogen in surface water that is attributable to land uses at the airport site and within the broader catchment.

Site preparation and construction of the Stage 1 development would transform approximately 60 per cent of the airport site from a rolling grassy and vegetated landscape to essentially a built environment with some landscaping. These changes would alter the catchment areas within the airport site and the permeability of the ground surface, which would in turn alter the duration, volume and velocity of surface water flow.

An estimated 1.36 megalitres (ML) of water would be required per day for site preparation works for the proposed airport including potable water for drinking and ablutions plus raw water for soil conditioning and dust suppression. For the purposes of this EIS it has been assumed that the necessary 8,600 litres (0.0086 ML) of potable water required per day would be sourced from existing assets operated by Sydney Water with the remaining water requirement supplied through stormwater runoff captured in the water management system or existing farm dams. It may be necessary to utilise other surface water sources or groundwater. Any such use would be subject to a separate assessment.

The design of the Stage 1 development includes a water management system to control the flow of surface water and improve the quality of water prior to its release back into the environment. This system comprises a series of channels and basins to collect and treat flows prior to release to receiving waters. The assessment indicates that this system would be generally effective at mitigating flooding and water quality impacts.

Because water quality at the airport site is already degraded and does not meet existing water quality criteria, it is unlikely the proposed airport will be able to achieve water quality criteria outlined in the Airports (Environment Protection) Regulations 1997 (AEPR). To take into account these existing conditions, local standards for water quality will be developed under Part 5 of the AEPR, with due consideration to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC Guidelines).

The ongoing development of local standards will be based on the results of continued baseline water quality monitoring, derived from a minimum of 24 months of data collected prior to the commencement of Main Construction Works. Water quality during the Stage 1 development was found to meet interim site-specific water quality criteria at all modelled locations. The interim water quality criteria were developed on the basis of 9 months of water quality monitoring.

The excavation and increase in impervious surfaces due to the development of the airport site would alter groundwater levels and recharge conditions. Impacts on groundwater receptors, including impacts on dependent vegetation or watercourses, are unlikely to be significant given the existing low hydraulic conductivity of the Bringelly Shale aquifer. Registered bores near the airport site are understood to target the Hawkesbury Sandstone aquifer, which is significantly deeper than the Bringelly Shale aquifer and not considered connected. As such, impacts on groundwater users are not expected.

The identified impacts would likely be further reduced during detailed design of the water management system. Baseline and ongoing monitoring of surface water and groundwater would be undertaken to characterise any residual impacts and prompt corrective action where necessary.

18.1 Introduction

This chapter provides an analysis of the surface water and groundwater systems potentially affected by the development of the proposed airport. It draws on technical assessments of surface water hydrology and geomorphology (see Appendix L1 (Volume 4)), surface water quality (see Appendix L2 (Volume 4)) and groundwater (see Appendix L3 (Volume 4)). The assessment describes the existing surface and groundwater resources at the airport site, considers potential impacts during construction and operation of the proposed airport and proposes measures to mitigate and manage these impacts.

18.2 Methodology

A range of qualitative and quantitative assessment approaches were adopted to consider the impact of the proposed airport on surface and groundwater resources at the airport site.

Field surveys were undertaken to provide an overview of the existing surface water features at the site, determine the physical stability of watercourses, identify hydraulic structures (such as bridges and culverts) and describe existing water quality. Predictive models were used to consider the impact of the change in landform characteristics at the airport site on runoff volumes and the subsequent impacts upon stream flow, flooding, groundwater recharge and water quality. Identification of the potential impacts on the environmental values and beneficial uses of surface and groundwater resources were identified, and mitigation and management measures were proposed to minimise the extent of potential impacts. The assessment included an analysis of the potential for climate change to exacerbate the environmental impacts arising from the proposed airport, including the susceptibility of the airport site to flooding.

18.2.1 Baseline data

Existing surface water and groundwater resources were described with reference to:

- desktop information including:
  - aerial imagery (AusImage 2014);
  - topography data (NSW LPI 2014);
  - watercourse data (NSW LPI 2012); and
  - climatology data (BoM 2015a).
- prior reporting including:
  - 1997-99 EIS (PPK 1997);
  - South Creek Flood Study (Worley Parsons 2015); and
  - surface water quality data in the Environmental Field Survey of Commonwealth Land at Badgerys Creek (SMEC 2014).
- site assessments for the EIS including:
  - contamination investigations (GHD 2015; GHD 2016);
  - geotechnical investigations (Coffey & Partners 1991); and
  - water quality monitoring (GHD 2015-2016).

18.2.2 Predictive modelling and analysis

Hydrologic and hydraulic models were developed to simulate runoff and streamflow associated with storms of varying severity. These storms are categorised in terms of the average recurrence interval (ARI), or average length of time between successive storms, and include the one year ARI, two year ARI, five year ARI, 20 year ARI and 100 year ARI events. The largest expected flood over any duration was also modelled based on estimates of maximum rainfall. The results of the hydrologic and hydraulic models were analysed to identify changes in the volume and velocity of surface water. Water quality models were developed to assess the quality of surface water leaving the airport site. Models used as part of the assessment included:

- hydrology models (RAFTS);
- hydraulics models (DRAINS and MIKE 21); and
- water quality models (MUSIC).

All models included representations of the water management system incorporated into the indicative design of the proposed airport. The water management system includes a series of grassed swales to convey run-off from the developed areas within the airport site to a series of bio-retention and detention basins as shown in Figure 18–1.

Each basin includes provision for water quality treatment by a bio-retention system and a flood detention basin to control the volume of discharges from the site. Stormwater will typically flow to the bio-retention treatment system located in the forebay of each basin for treatment prior to release to receiving waters. The minimum bio-retention area required to provide water quality treatment at each basin is shown in Table 18–1. It is noted that the civil design for each of the bio-retention basins has additional buffer areas set aside, to enable a greater treatment area to be provided as required based upon ongoing water quality monitoring.

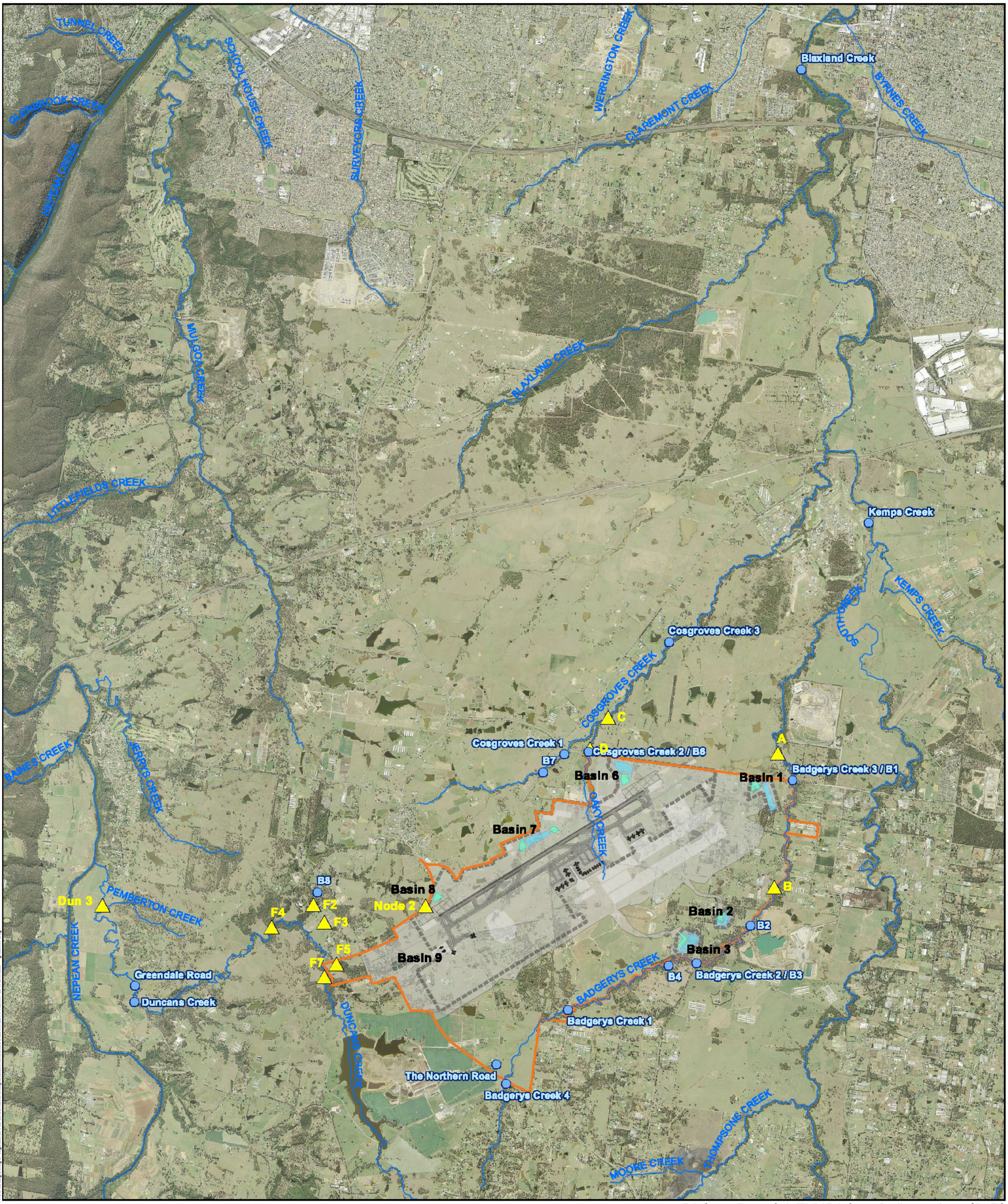
Higher flows during heavy rainfall will be diverted into the flood detention basins to provide storage and controlled release to the receiving waters. The detention basins have been designed to allow stormwater to be released in a way that mimics the natural flows as closely as possible over a range of storm durations and magnitudes.

The water management system has been designed to contain flows up to the 100 year ARI event without uncontrolled discharges occurring. The capacities of the basins to store surface water flows are presented in Table 18–1, excluding Basin 4 and 5 which would be integrated into the water management system for the long term development (see Chapter 36 (Volume 3)). The results of models were analysed to identify impacts on waterways, people and property.

Table 18–1 Stage 1 development basin sizing

Basin	Minimum Bio-retention Area (ha)	Flood detention volume (kl)	Discharge
Basin 1	0.6	125,000	Badgerys Creek
Basin 2	0.22	39,000	Badgerys Creek
Basin 3	0.6	100,000	Badgerys Creek
Basin 6	1.0	101,000	Oaky Creek
Basin 7	0.5	117,000	Oaky Creek (via tributary)
Basin 8	0.2	59,000	Duncans Creek (via tributary)
Basin 9	0.15	NA	Duncans Creek

Note: Basin 4 and Basin 5 would be integrated into the long term development (see Chapter 36 (Volume 3)) and so have not been included in the assessment of the Stage 1 development. Basin 9 is included in the Stage 1 development but is a relatively small bio-retention basin with no detention basin component.



LEGEND

- Airport site
- Water quality sampling sites
- Watercourses
- Hydrology assessment reporting locations
- Detention Basin
- Bioretention Basin
- Stage 1 development area

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

0 0.5 1 2
Kilometres

Figure 18-1 - Surface water management system and sample sites

It is recognised that receiving water quality is influenced by the surrounding land-use and antecedent rainfall and run-off conditions occurring throughout the year. Water quality monitoring provides a snapshot of the quality of receiving water at the time of the sampling event and therefore does not capture the full range of run-off conditions experienced at the airport site.

Predictive modelling was therefore undertaken to estimate pollutant loads in the catchment under existing baseline conditions and calibrated with the available water quality monitoring results. The MUSIC model was chosen as it has the ability to estimate the quantity and quality of surface water generated at a site under a range of rainfall and catchment configurations. It can therefore provide a direct comparison between the baseline catchment conditions and the proposed development scenarios.

The water quality assessment was calibrated with water quality monitoring data collected in and around the airport site for the EIS and prior assessments. Historical water quality monitoring data available for the airport site and downstream areas includes data from the 1997-1999 EIS and the SMEC Environmental Field Survey of Commonwealth Land at Badgerys Creek. Water quality monitoring for the EIS has been ongoing since the completion of the draft EIS and will continue through construction and operation of the proposed airport.

The MUSIC model was initially set up to represent the existing airport catchment comprising a total of 39 individual subcatchments which were delineated using one m contours generated for the site. Two additional external catchments were modelled to represent the area downstream of Elizabeth Drive down to the confluence of South Creek with Blaxland Creek in order to assess the impacts on downstream water quality at a more regional scale.

Each individual subcatchment was broken down into five land use types to represent the existing land uses at the airport site and pollution parameters assigned based upon modelling guidelines and statistical analysis from extensive research undertaken at locations throughout Australia. The existing baseline model was then simulated for the full range of rainfall data and calibrated using the recent monitoring data. An iterative approach was taken to achieve modelled results similar to the monitoring data. Full details of the MUSIC modelling approach are provided in Appendix L2 (Volume 4).

18.3 Regulatory and policy setting

The Stage 1 development would be developed in accordance with the Airport Plan under the provisions of the *Airports Act 1996* (Airports Act) and associated regulations including the Airports (Environment Protection) Regulations 1997 (AEPR).

The Commonwealth and NSW legislative and policy settings and guidelines concerned with water resources – even where not directly applicable to the proposed airport – have been considered as part of the assessment process.

18.3.1 Legislation

18.3.1.1 Airport Act 1996

Environmental management at the airport site would be undertaken in accordance with Part 6 of the Airports Act and the AEPR, following the grant of an airport lease to an Airport Lessee Company (ALC). The Airports Act specifies offences relating to environmental harm, environmental management standards, and monitoring and incident response requirements, including in relation to water pollution. Standards in relation to water pollution include water quality criteria such as oxygen content, pH, salinity and turbidity.

Part 4 of the AEPR requires an ALC to take all reasonable and practicable measures to avoid polluting water. Part 6 of the AEPR requires an ALC to monitor pollution levels, including laboratory analysis accredited by the National Associated of Testing Authorities. In the period prior to granting an airport lease, any construction activities on the airport site would be conducted in accordance with the Airport Plan and have regard to the requirements of the AEPR.

Schedule 2 of AEPR sets out acceptable limits for water pollution (see Table 18–2 for an excerpt of key parameters). It is noted that these regulations are about five times more stringent than the current *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ 2000) (ANZECC guidelines) for total phosphorus and total nitrogen. It is understood that the limits within the AEPR are currently under review. A recent discussion paper recommended that these limits be updated to align with the current ANZECC guidelines (Department of Infrastructure and Transport 2013).

Table 18–2 Key water quality parameters under the AEPR

Parameter	Accepted limit
Total Phosphorous	< 0.01 mg/L
Total nitrogen (TN)	< 0.1 mg/L
Dissolved oxygen (DO)	80% of average level for a normal 24 hr period or < 6 mg/L
Total suspended solids (TSS)	Change not more than 10% from seasonal mean
Turbidity	Reduction of 10% clarity in the euphotic zone from the seasonal mean
pH	6.5 – 9.0
Salinity	> 1000 mg/L or an increase of > 5%

Note: The full list of water quality parameters and acceptable limits can be found in Schedule 2 of the AEPR

To allow for climatic, topographic and other site-specific considerations, Part 5 of the AEPR allows for the development of local standards for water quality. Local standards may be proposed by an ALC and approved by the Infrastructure Minister following a period of consultation with relevant authorities, stakeholders and the broader public. In particular, Regulation 5.02 (1) of the AEPR states that a substitute standard (local standard) may be proposed where it is considered that a limit of contamination specified in the AEPR is inappropriate.

However, the AEPR does not provide any technical guidance on how a local standard should be derived. The approach for the development of site specific trigger levels in accordance with the ANZECC (2000) Guidelines has therefore been adopted to develop interim site-specific water quality criteria as part of this assessment as described in Section 18.4.5.2. The interim criteria presented in this EIS are based upon nine months of monitoring data currently available.

It is expected that the interim site-specific water quality criteria would be reviewed following the completion of 24 months of water sampling. At that stage formal approval of the criteria would be sought in accordance with Part 5 of the AEPR.

18.3.1.2 Water Management Act 2000

The *Water Management Act 2000* (NSW) (Water Management Act) is administered by the NSW Department of Primary Industries and is intended to ensure that water resources are conserved and properly managed for sustainable use benefitting both present and future generations. The Water Management Act is also intended to provide a formal means for the protection and enhancement of the environmental qualities of waterways and their in-stream uses, and to provide for protection of catchment conditions. The Water Management Act will have limited direct applicability to the proposed airport as a result of the Airports Act and the AEPR. However, the intent and objectives have been considered as part of this assessment.

Water sharing plans have been developed under the Water Management Act for all water sources within NSW. The water sharing plans are developed with the aims of:

- clarifying the rights of the environment, landholders, town water suppliers and other licensed users;
- defining the long term average annual extraction limit for water sources;
- setting rules to manage impacts of extraction; and
- facilitating the trading of water between users.

Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources

The Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources commenced in 2011 and covers 87 management zones that are grouped into six water sources. The airport site is situated in the Hawkesbury and Lower Nepean Rivers source or catchment.

The Hawkesbury and Lower Nepean Rivers catchment is separated into numerous management areas, which include the Upper and Lower South Creek Management Zones and the Mid Nepean River Catchment Management Zone. Badgerys Creek, Oaky Creek and Cosgroves Creek are interpreted to be within the Upper South Creek Management Zone, and Duncans Creek is interpreted to be within the Wallacia Weir Management Zone (one of the Mid Nepean River Catchment Management Zones). The water sharing plan background document (NOW 2011) suggests that the South Creek region has high economic significance and depends on extraction for irrigation, town and industrial water supply.

Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources

The Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources covers 13 groundwater sources on the east coast of NSW. The airport is located within the Sydney Basin Central Porous Rock groundwater source area. The porous rock aquifer is referenced in the plan as sedimentary sandstone and siltstone formations with intervening coal seams.

The background document for the water sharing plan (NOW 2011) lists the Sydney Basin Central porous rock aquifer as having low to moderate contact with surface water with generally long travel times (years to decades). The allocated volumes of 2,592 ML/year versus a long term average annual extraction limit of 45,915 ML/year suggests that there is a significant amount of groundwater in the aquifer that has not been released for use.

18.3.1.3 Protection of the Environment Operations Act 1997

The objectives of the *Protection of the Environment and Operations Act 1997* (NSW) include the protection, restoration and enhancement of the quality of the environment, in recognition of the need to maintain ecological sustainable development including specific references to the protection of water quality. This assessment has taken into account the intent and objectives of that legislation.

18.3.2 Policies and guidelines

18.3.2.1 National Water Quality Management Strategy

The National Water Quality Management Strategy aims to protect Australian water resources by improving water quality while supporting the businesses, industry, environment and communities that depend on water for their continued development. The strategy consists of three major elements: policy, process and guidelines.

The main policy objective of the strategy is to achieve sustainable use of water resources by protecting and enhancing their quality, while maintaining economic and social development. The process strives to form a nationally consistent approach to water quality management through the development of high-status national guidelines. The guidelines provide the point of reference when issues are being determined on a case-by-case basis. These include guidance on regulatory and market-based approaches to managing water quality as well as regional water quality criteria.

The policy and principles document states that the generally accepted mechanism for establishing in-stream or aquifer water quality requirements is a two-step process which involves establishing a set of environmental values and establishing scientifically based water quality criteria corresponding to each value.

Criteria have been developed to characterise water quality relative to these environmental criteria and are outlined in the ANZECC guidelines and the Australian Drinking Water Guidelines (NHMRC 2011) and are discussed further below. The criteria specified in these documents have been used as the basis for the current environmental values in this assessment for the treatment requirements for discharge to receiving water environments.

18.3.2.2 NSW Water Quality Objectives

The NSW Water Quality Objectives (1999) are environmental values and long term goals endorsed by the NSW Government and the community for NSW's surface waters. They set out community values and uses for waterways and a range of water quality indicators to assist in establishing whether their current conditions support those values and uses.

The NSW Water Quality Objectives are generally consistent with the National Water Quality Management Strategy. The NSW Water Quality Objectives provide the environmental values for NSW waters, while the ANZECC guidelines provide the technical guidance in assessing the water quality needed to protect those values. Endorsed environmental values for the Hawkesbury-Nepean catchment include:

- aquatic ecosystem protection;
- recreational water use;
- raw drinking water; and
- irrigation and general use.

18.3.2.3 Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The national guidelines on water quality benchmarks within the ANZECC guidelines are applicable to the Stage 1 development and provide default trigger values of various analytes for comparison with sampled values.

The core concept of the guidelines relates to managing water quality for environmental values. For each environmental value, the guidelines identify particular water quality characteristics or 'indicators' that are used to assess whether the condition of the water supports that value.

The environmental values, expressed as water quality objectives, provide goals to assist in the selection of the most appropriate management options within a catchment. The guiding principles include the identification and protection of the environment values of a waterway. Where targets are not achieved for environmental values, activities in the catchment should be geared toward improving these values.

The guidelines also advocate an 'issues-based' approach to assessing ambient water quality, rather than the application of rigid numerical criteria without an appreciation of the context. This means that the guidelines focus on:

- the environmental values we are seeking to achieve or maintain;
- the outcomes being sought; and
- the ecological and environmental processes that drive any water quality problem.

It should also be noted that the environmental values and respective numerical indicator values apply to ambient background water quality and are not intended to be applied directly to stormwater discharges.

The ANZECC guidelines, containing the default trigger values for physical and chemical stressors applicable to the airport site and adopted in this assessment, are shown in Table 18–3. It is noted that these default trigger values are guideline values or water quality objectives only, and are not compliance standards or discharge criteria.

Table 18–3 ANZECC Guidelines Default Trigger Values for Slightly Disturbed Ecosystems in NSW Lowland Rivers

Parameter	Default Trigger Value for Lowland Rivers
Chlorophyll a Chl a (mg/L)	0.005
Total phosphorus TP (mg/L)	0.05
Filterable reactive phosphate FRP (mg/L)	0.02
Total nitrogen TN (mg/L)	0.5
Oxides of nitrogen NO_x (mg/L)	0.04
Ammonium NH4+ (mg/L)	0.02
Dissolved oxygen DO	85-110 %
pH	6.5 – 8
Salinity (µS/cm)	125-2200
Turbidity (NTU)	6 – 50

Source: ANZECC Guidelines (2000)

Default trigger values are generally adopted in the absence of available data, however the intent of the ANZECC guidelines is that the relative health and assimilative capacity of the actual receiving waters be taken into account. The ANZECC Guidelines state that site specific water quality values are therefore preferred and should be established and adopted where possible. This ensures that the trigger levels applied are not excessively and unnecessarily onerous. This is particularly the case for waterways that are already degraded, such as the airport site and South Creek catchments.

According to ANZECC Guidelines, site specific trigger levels should be based on a minimum of two years of contiguous monthly data at the site, with the trigger levels computed as the 80th percentile values. Interim site-specific water quality criteria for the Stage 1 development have been developed based upon nine months of available monitoring data.

18.3.2.4 Australian Drinking Water Guidelines

The Australian Drinking Water Guidelines (NHMRC 2011) provide a framework for the management of drinking water supplies to achieve a safe and appropriate point of supply. The guidelines provide a base standard for aesthetic and health water quality levels. These values apply in this assessment to the suitability of the groundwater for potable use.

18.3.2.5 State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011

The State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011 includes provisions requiring development within Sydney drinking water catchments to demonstrate a neutral or beneficial effect on water quality. As the airport site is not within a Sydney drinking water catchment, the policy does not directly apply to the Stage 1 development. Neutral or beneficial effect has nonetheless been considered in the process of describing the potential impacts of the Stage 1 development with reference to existing water quality.

18.3.2.6 New South Wales Flood Plain Development Manual

The New South Wales Floodplain Development Manual (Department of Infrastructure, Planning and Natural Resources 2005) concerns the management of flood-prone land within NSW. It provides guidelines in relation to flood management, including any development that has the potential to influence flooding, particularly in relation to increasing the flood risk to people and infrastructure.

18.3.2.7 Greater Sydney Local Land Service Transition Catchment Action Plan

Catchment action plans are 10-year plans to guide the management of water, land and vegetation by state government and local communities. The main waterways at the airport site (Badgerys Creek, Oaky Creek, Cosgroves Creek and Duncans Creek) fall within the Hawkesbury-Nepean catchment, which is managed under the Greater Sydney Local Land Service Transition Catchment Action Plan (NSW Catchment Management Authority 2014).

The action plan is relevant to any influence the proposed airport may have on the downstream catchments in relation to surface water and aquatic ecology. Relevant strategies within the action plan include development of a more water sensitive catchment, promoting resilience through climate change adaptation and a number of strategies relating to protecting aquatic ecosystems.

18.3.2.8 Lower Hawkesbury-Nepean River Nutrient Management Strategy

The Lower Hawkesbury-Nepean River Nutrient Management Strategy (OEH 2010a) has been developed with the aim of reducing nutrient loads from existing sources and limiting the growth in nutrient loads from changing land uses. The strategy includes development of a catchment-wide framework to coordinate and guide action on managing nutrients in the lower Hawkesbury-Nepean. The sources of nutrients identified as a priority are: urban stormwater, agricultural practices, onsite sewage management systems, sewage treatment systems and overflows, and degraded land and riparian vegetation.

18.3.2.9 Managing Urban Stormwater: Soils and Construction

Managing Urban Stormwater: Soils and Construction (Landcom 2004), also known as ‘the Blue Book’, provides guidance on stormwater management with a focus on control of erosion and sedimentation during construction. The guidance contained in the Blue Book has been considered in the commitments to mitigation and management measures during construction.

18.3.2.10 Water Sensitive Urban Design: Technical Guidelines for Western Sydney

Water Sensitive Urban Design: Technical Guidelines for Western Sydney (Upper Parramatta River Catchment Trust 2004) provides guidance on stormwater management with a focus on urban land uses. The technical guidelines include recommendations for onsite treatment measures to mitigate and limit the potential adverse effects on downstream receiving waterways. The guidelines also specify percentage reduction targets of 45 per cent for total phosphorus and total nitrogen and 85 per cent for suspended solids. The technical guidelines have been considered in the assessment of potential impacts and commitment to mitigation and management measures.

18.3.2.11 *Aquifer Interference Policy*

The purpose of the Aquifer Interference Policy is to explain the role and requirements of the responsible NSW Minister in administering the water licensing and assessment processes for aquifer interference activities under the Water Management Act. The aquifer interference assessment framework is a supporting tool to assess proposed activities against the Aquifer Interference Policy.

The proposed Stage 1 development includes the excavation of an underground cavity to provide for basement levels for the major terminal buildings. These works may constitute aquifer interference activities and as such the Aquifer Interference Policy has been considered as part of the assessment of these works.

18.3.2.12 *NSW State Groundwater Policy Framework Document*

The objective of the NSW State Groundwater Policy Framework Document (Department of Land and Water Conservation 1997) is to manage the State's groundwater resources so that they can sustain environmental, social and economic uses for the people of NSW. The NSW groundwater policy contains provisions regarding the protection of groundwater dependent ecosystems in addition to groundwater quantity and quality.

18.4 Existing environment

18.4.1 Climate and rainfall

The airport site hosts an automatic weather station operated by the Bureau of Meteorology. The weather station has recorded rainfall data at the airport site since 1998. Average annual rainfall at the airport site is 676.4 mm. Monthly rainfall and evaporation data are shown in Table 18–4.

Table 18–4 Average monthly rainfall at the airport site

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean monthly rainfall (mm)[a]	77.4	108.0	77.3	43.2	40.1	52.1	23.0	35.9	33.9	52.7	74.5	63.6
Highest monthly rainfall (mm)[a]	192.2	342.4	198.0	129.4	155.6	220.0	71.6	231.0	82.2	182.2	173.2	131.2
Lowest monthly rainfall (mm)[a]	13.6	13.4	21.4	1.8	1.8	2.0	2.8	1.0	6.4	0.4	8.4	14.2
Highest daily rainfall (mm)[a]	138.0	106.8	67.8	82.4	54.0	63.8	28.4	70.0	50.8	63.0	63.0	65.0
Evaporation (mm)[b]	172.7	128.4	115.9	75.6	50.2	38.4	38.4	55.5	75	120	145.5	154.1

[a] Data from Bureau of Meteorology automatic weather station.
[b] Data from Bureau of Meteorology Parramatta weather station, as the nearest representative location with available evaporation data.

18.4.2 Catchments

The airport site lies in the east of the Hawkesbury-Nepean catchment, which covers an area of 21,400 square kilometres. The Hawkesbury-Nepean catchment is characterised by meandering watercourses and is highly disturbed by clearing and urbanisation. All of the airport site subcatchments drain to the Hawkesbury Nepean system downstream of Lake Burragorang.

Subcatchments at the airport site are shown in Figure 18–2. The majority of the airport site drains to South Creek, which then flows to the Hawkesbury River. South Creek has a subcatchment area of 414 square kilometres with headwaters located near Narellan to the south of the airport site. The south-western corner of the airport site drains to Duncans Creek, which then flows to the Nepean River. Land uses within the airport site are predominantly agricultural (85 per cent), with smaller areas of rural residential (10 per cent), forest (four per cent) and horticulture (one per cent).

Water drawn from the catchment is used for irrigation for lucerne, fodder, pasture, turf, vegetables, orchards, cereals, flowers and stock watering purposes. Recreational facilities such as golf courses and sporting fields also draw water for irrigation, and the downstream estuarine reaches of the Hawkesbury River support fishing, prawning and oyster industries and recreational boating. It is noted that the airport site is not located within Sydney's drinking water catchment area.

18.4.3 Watercourses

The airport site contains around 64 kilometres of watercourses and drainage lines as shown in Figure 18–2. The major watercourses include Badgerys Creek, Oaky Creek and Cosgroves Creek in the South Creek catchment and Duncans Creek which is a tributary of the Nepean River. Clearing, agriculture and the construction of in-stream dams have affected the physical stability of many watercourses at the airport site. Bank erosion and head cut are evident at Badgerys Creek and Cosgroves Creek, despite these watercourses also having well vegetated riparian zones.

Badgerys Creek has its headwaters in the vicinity of Findley Road, Bringelly, approximately two kilometres south of the airport site. It flows in a north to north-east direction and forms the south-eastern boundary of the airport site as far as Elizabeth Drive. Badgerys Creek continues downstream for a further four kilometres until its confluence with South Creek. Land use within the Badgerys Creek catchment consists of agricultural, landfill, as well as residential uses. Ecologically sensitive riparian vegetation is also located along sections of Badgerys Creek.

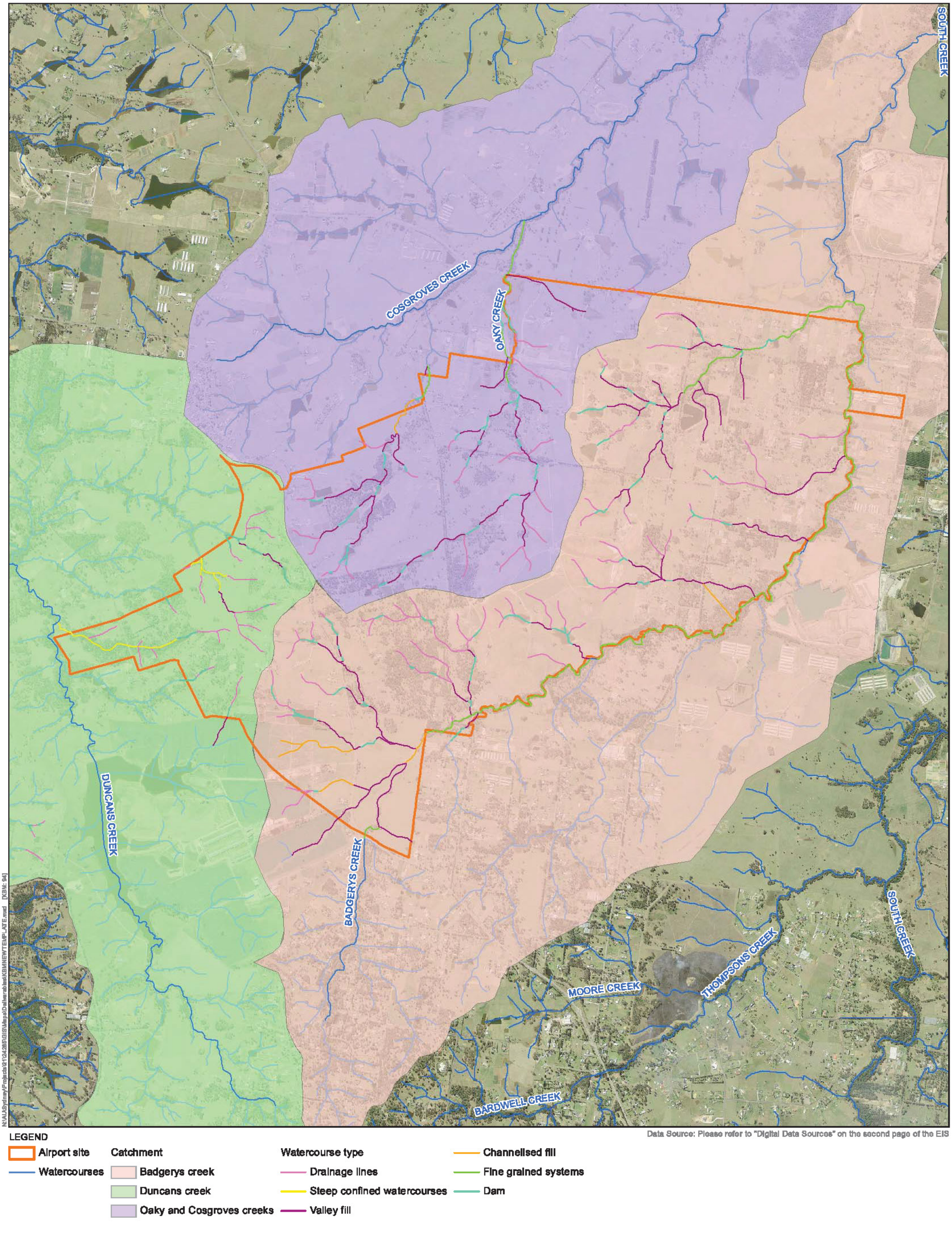


Figure 18-2 - Sub-catchments and watercourses at the airport site

18.4.4 Flooding

Existing surface water flows at the airport site during one year ARI and 100 year ARI storms were simulated in hydrologic and hydraulic models. In the one year ARI event, flooding is mostly confined to main watercourse channels and dams, while considerable overbank flooding is expected in a 100 year ARI event, as shown in Figure 18–3 and Figure 18–4.

The floodplain is more extensive on the western bank of Badgerys Creek than on the eastern bank due to the wider and flatter floodplain at the airport site. A number of the flood-affected rural residential lots outside the airport site are located in Bringelly in the area bounded by the airport site, The Northern Road and Badgerys Creek Road. Based on the available imagery, while a number of lots experience some inundation in a 100 year ARI event, most existing dwellings in this area remain outside the flood extent.

A number of dwellings are also located within or close to the flood extent on Badgerys Creek upstream of the airport site. Two dwellings close to the flood extent were also identified downstream of the airport site on Cosgroves Creek.

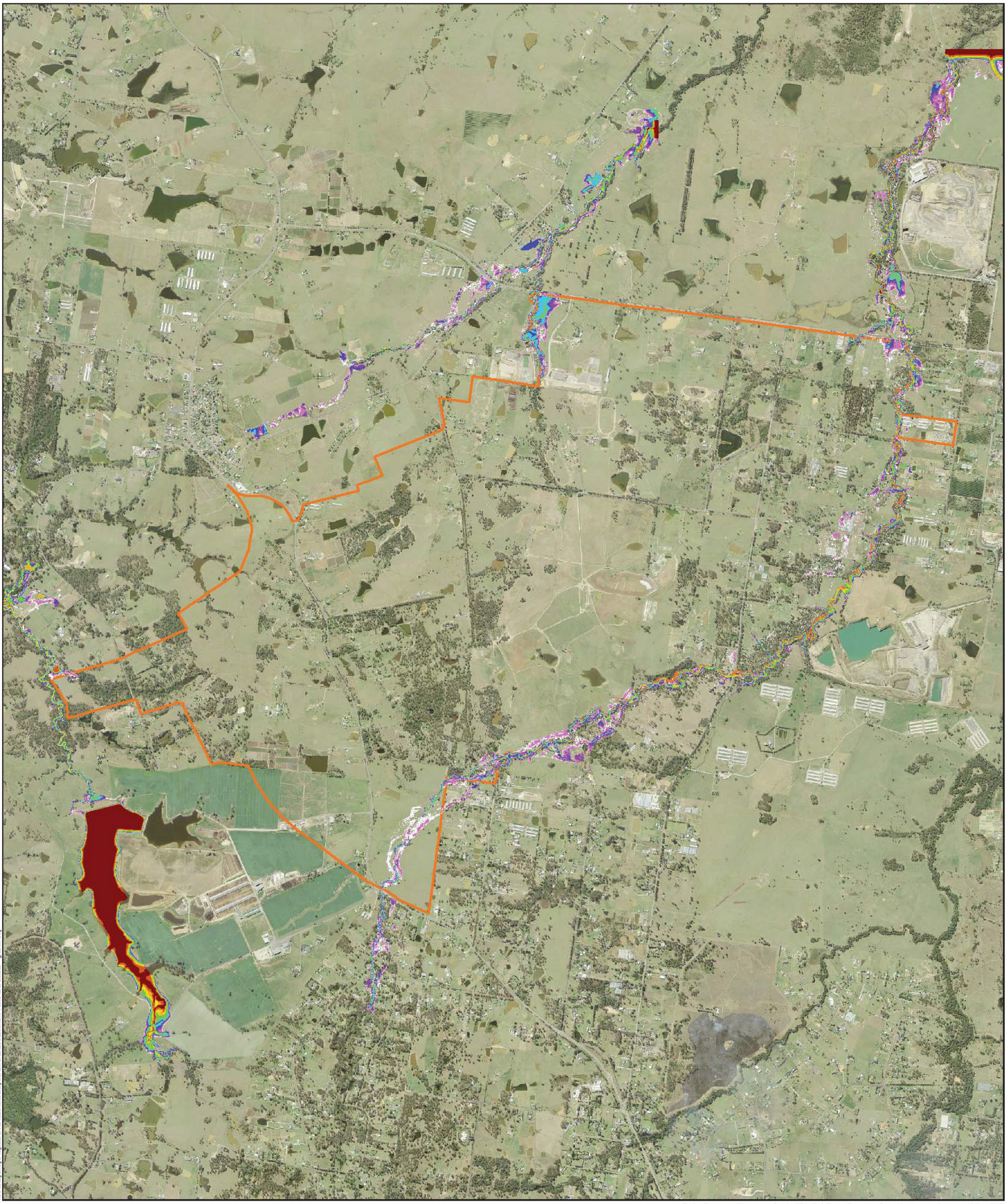
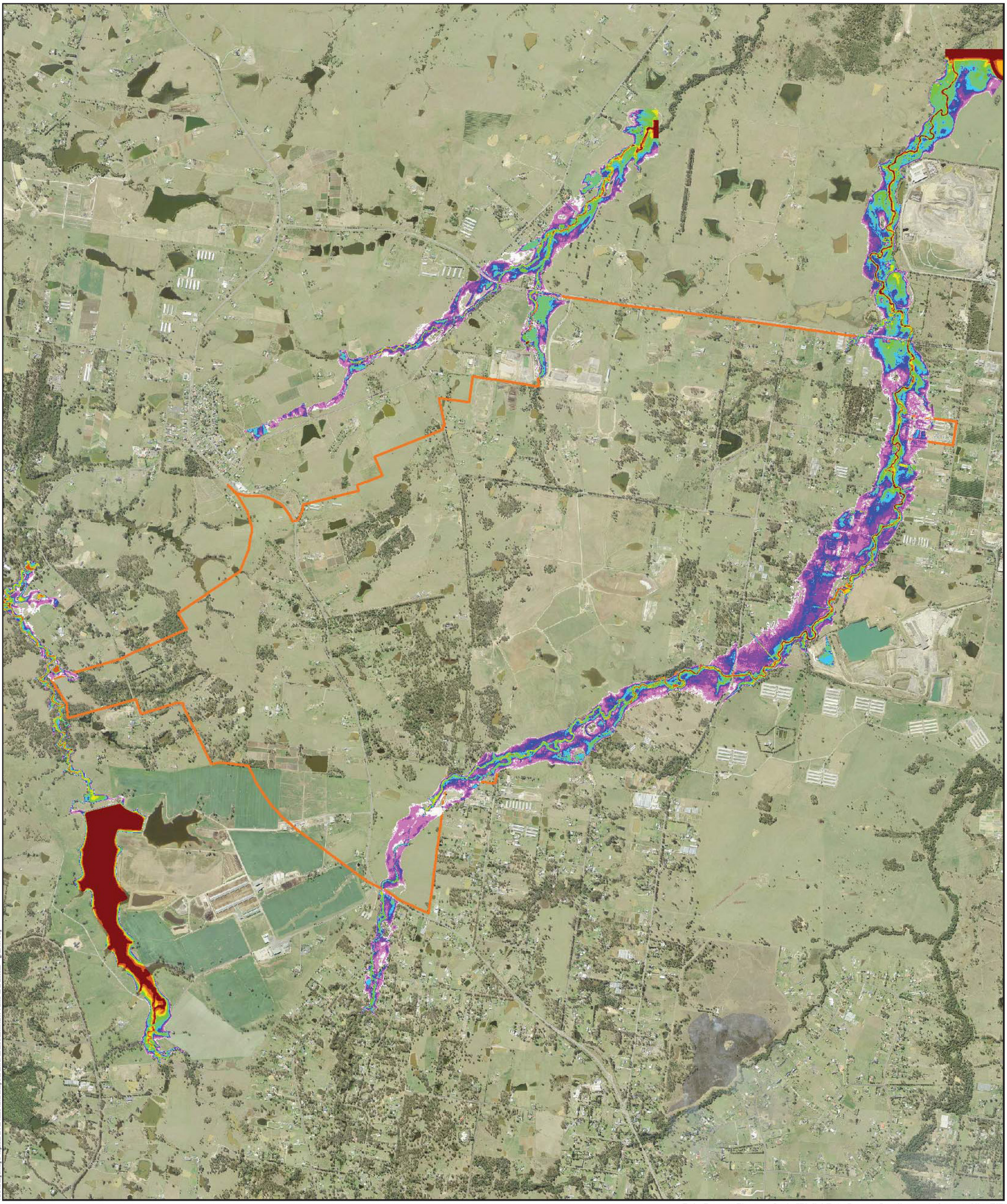


Figure 18-3 - Flood depth at the airport site during the 1 year ARI storm



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

Airport site

Flood depth (m)

- 0.1 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 2.5
- 2.5 - 3
- 3 - 4
- >4

0 0.25 0.5 1

Kilometres

Figure 18-4 - Flood depth at the airport site during the 100 year ARI storm

18.4.5 Surface water quality

18.4.5.1 Overview of existing water quality

The results of surface water quality sampling undertaken for the EIS are presented in Table 18–5. The results indicate that the water quality is generally poor and that the nutrient loads are generally well above both the AEPR accepted limits and the default values in the ANZECC guidelines. Turbidity and total suspended solids were found to be within acceptable levels, while dissolved oxygen levels were found to be relatively low. The data also indicate that conductivity levels were high, and above those for typical lowland rivers. Some exceedances of chromium, copper and zinc were also detected. These results are generally consistent with prior sampling (PPK 1997; SMEC 2014), which can be attributed to the minimal change to existing land use between the periods of sampling.

Water quality modelling of existing surface water quality was undertaken at upstream, downstream and major outflow locations in and around the airport site and calibrated using the existing surface water sampling results. The surface water quality modelling predicted that surface water runoff from the airport site contributes 230,440 kilograms of suspended solids, 376 kilograms of phosphorous and 3,404 kilograms of nitrogen to downstream waterways on average each year. The model results are consistent with surface water quality sampling at the airport site and prior data (PPK 1997; SMEC 2014).

Overall, the results indicate that both the airport site and downstream catchments are fairly degraded, particularly in terms of nutrients. The existing water quality does not typically satisfy the AEPR limits or default ANZECC guideline criteria for the protection of aquatic ecosystems, primary and secondary contact recreation, as well as irrigation water use for food and non-food crops.

18.4.5.2 Local standards

As outlined in Section 18.3.1.1, to allow for climatic, topographic and other site-specific considerations, Part 5 of AEPR provides a process for the development of local standards for water quality. However, the AEPR does not provide any technical guidance on how such local standards should be derived. Under the ANZECC Guidelines, site specific trigger levels may be established by computing the 80th percentile values from a minimum of two years of contiguous monthly data. The ANZECC Guideline approach has been used for the development of interim site-specific water quality criteria for the purposes of this EIS. It is expected that the interim criteria will be updated following the completion of 24 months of water sampling and that formal approval would be sought for the local standards in accordance with Part 5 of the AEPR.

The results indicate that the water quality is generally poor and that the nutrient loads are generally well above both the AEPR accepted limits and the default values in the ANZECC guidelines.

The existing water quality in the subcatchment areas draining from the airport site is generally poor as a result of previous agricultural development and urbanisation, so the use of site specific data to develop interim criteria is more appropriate than the use of either the default trigger levels in the ANZECC Guidelines or the current AEPR limits. Monthly water quality monitoring commenced in November 2015 and nine months of monitoring data have been collected and analysed at the time of this report, as shown in Table 18–5. This comprises more than 80 samples collected at various locations around the airport site for each water quality parameter.

Table 18–5 Background surface water quality

Location	Dissolved oxygen (%)	Conductivity (µS/cm)	Turbidity (Nephelometric Turbidity Units)	Total suspended solids (mg/L)	Nitrogen (mg/L)	Phosphorous (mg/L)
AEPR Limits	80% of average or < 6 mg/L	6.5-9	Reduction of 10% clarity from seasonal mean	< 10% change from seasonal mean	0.1	0.01
ANZECC Guidelines	85-110	125-2,200	6-50	<40	0.5	0.05
Sampling results for March 2015						
Badgerys Creek 2	36	3,100	7.71	5	18.5	0.31
Badgerys Creek 3	8.6	3,050	13	5	2.3	1
Badgerys Creek 4	21.3	2,710	12	23	6.2	0.42
Cosgroves Creek 1	73.6	5,020	4.25	5	0.8	0.03
Cosgroves Creek 2	55.4	4,320	38.1	19	1.2	0.05
Duncans Creek	52.5	847	89.2	14	0.9	0.06
Sampling results for November 2015 to July 2016, averaged monthly data						
B1	44.4	1486	39.9	14.2	3.7	0.4
B2	45.7	1646	19.1	15.6	3.2	0.4
B3	57.1	6933	55.1	20.7	5.6	0.8
B4	45.8	1825	70.2	26.3	9.3	1.6
B6	54.5	2370	28.2	8.4	2.4	0.1
B7	41.2	770	31.9	8.8	1.1	0.1
B8	58.8	1502	20.3	11.7	1.1	0.1
Greendale Road	48.1	1534	33.6	10.5	1.1	0.1
The Northern Road	17.8	2736	251.2	80.1	36.3	5.9

The interim site-specific water quality criteria derived from the nine months of data, for total phosphorus, total nitrogen and suspended solids, are summarised in Table 18–7 and compared with AEPR limits and ANZECC default trigger levels.

It is recognised that, despite the number of existing samples, the period of sampling still falls short of the 24 months stipulated in ANZECC Guidelines. Nevertheless, these interim results are considered to be useful in providing an early indication of the likely range of results expected when the full 24 months of data becomes available.

In Table 18–6, it is noted that the interim site trigger levels for total phosphorus and total nitrogen concentrations are significantly elevated above both the ANZECC Guidelines default trigger levels and AEPR limits. For suspended solids, however, the interim site trigger level is less than that in ANZECC Guidelines and the NSW Blue Book for Soils and Construction.

Table 18–6 Interim site-specific water quality criteria

	Total suspended Solids (mg/L)	Total Phosphorus (mg/L)	Total Nitrogen (mg/L)
Interim water quality criteria[1]	23.2	0.92	6.2
ANZECC Guidelines Default Trigger Levels	40	0.05	0.5
`AEPR Limits	Change not more than 10% from seasonal mean	0.01	0.1

1) Based on monthly water quality monitoring data obtained at various locations around the airport site, consisting of more than 80 samples for each parameter.

18.4.6 Groundwater

Groundwater at the airport site is generally poor quality with limited beneficial use or environmental value. The aquifers at the airport site include:

- an unconfined aquifer in the shallow alluvium of the main watercourses at the airport site;
- an intermittent aquifer in weathered clays overlying the Bringelly Shale;
- a confined aquifer within the Bringelly Shale; and
- a confined aquifer within the Hawkesbury Sandstone.

Groundwater within the alluvium has been measured at depths between 0.7 and 4.7 metres. Within the Bringelly Shale, groundwater has been measured at depths between 3.0 and 11.7 metres, and at depths between 2.4 and 4 metres in the overlying weathered material (PPK 1997; Coffey & Partners 1991). Groundwater within the Hawkesbury Sandstone is significantly deeper because the aquifer is 100 metres below ground level. The variation in depths to groundwater indicates low potential for connectivity between groundwater aquifers.

The Bringelly Shale aquifers at the airport site are considered to have limited hydraulic conductivity. Vertical hydraulic conductivities are expected to be two to three orders of magnitude lower than horizontal hydraulic conductivities, indicating a strong downward head gradient, further limiting potential for connectivity with the underlying Hawkesbury Sandstone aquifer.

The weathered soils of the Bringelly Shale that occur over most of the airport site are anticipated to result in relatively low groundwater recharge with an average of 0.5 per cent of annual rainfall entering the groundwater system. Soil infiltration testing estimates maximum recharge rates of approximately 0.012 millimetres per day for the clayey shale soils, and 0.0057 millimetres per day for the alluvium, indicating very limited groundwater recharge conditions.

An idealised hydrogeological conceptual model for the airport site is shown on Figure 18–5, highlighting the interactions between groundwater and potential systems reliant on groundwater.

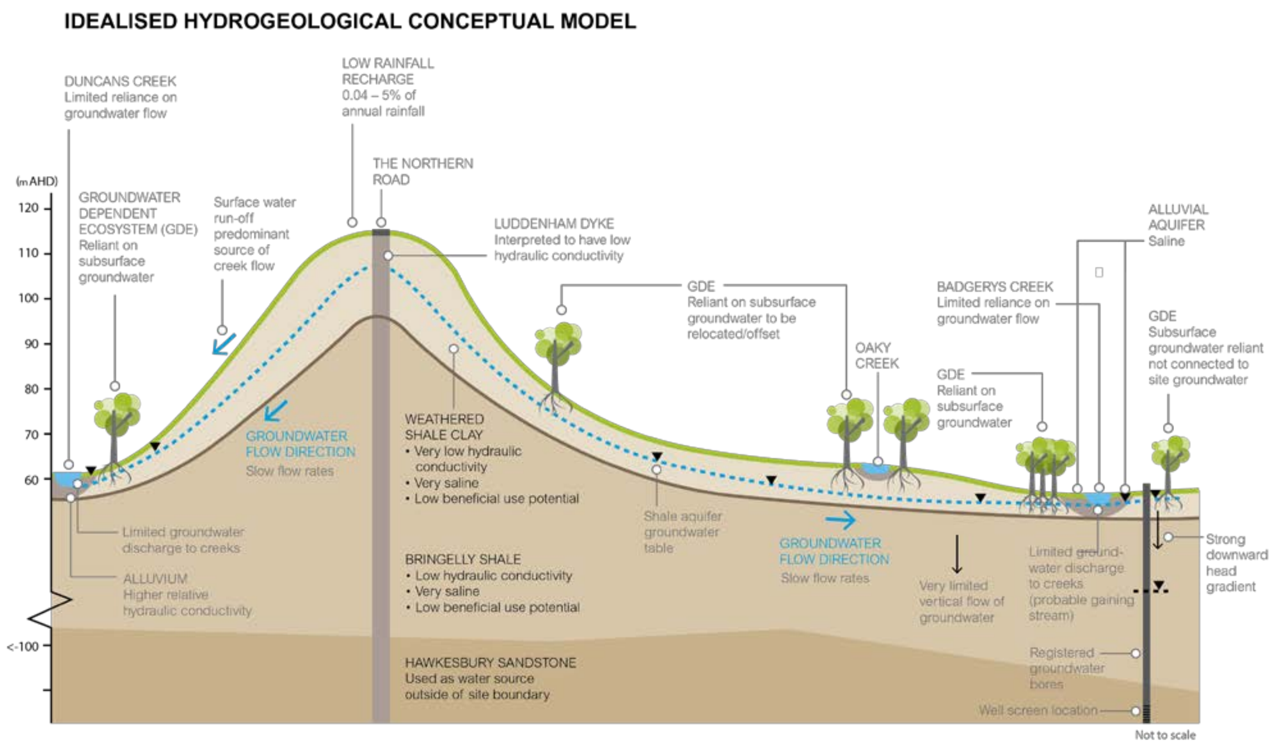


Figure 18–5 Conceptual hydrogeological model

Groundwater quality data indicates elevated concentrations of lead, zinc, copper, nitrogen and phosphorous above the values in the ANZECC freshwater guidelines. Nitrate and sulphate exceeded guideline values at some locations. Groundwater was found to be saline with an average electrical conductivity equalling 21,474 µS/cm and exceeding the 2,200 µS/cm guideline (PPK 1997), indicating a low beneficial reuse potential.

The airport site has been cleared extensively with the exception of stands of remnant and regrowth vegetation located predominantly along Badgerys Creek and the south-western portion of the airport site. This remaining vegetation generally comprises Cumberland Plain Woodland and River-flat Forest. These stands of vegetation broadly correlate with the areas identified as potentially groundwater dependent ecosystems; however, no watercourses in or adjoining the airport site are recorded as being groundwater dependent (BoM 2015a).

The shallower alluvial aquifer at the airport site is understood to discharge at Badgerys Creek, Cosgroves Creek and Duncans Creek. However, surface discharges from the Bringelly Shale aquifer and overlying weathered material are likely to be limited by low connectivity and hydraulic conductivity. Groundwater salinity is an order of magnitude higher on average than surface water salinity at the airport site, which is further evidence of the limited groundwater discharge.

A number of surface water farm dams are present across the site. These features are expected to have been developed initially to capture surface water runoff and are therefore primarily reliant on surface water inputs rather than groundwater. The low permeability clays in which these dams have been developed would limit the connection with surrounding groundwater.

A total of 42 groundwater bores are registered in the vicinity of the airport site. The groundwater bores are recorded as being constructed to significant depths and are understood to generally target the Hawkesbury Sandstone aquifer, which is known to be of higher beneficial use value. It is likely that the Hawkesbury Sandstone is preferentially targeted because of the relatively poor quality of Bringelly Shale groundwater.

18.5 Assessment of impacts during construction

Construction of the Stage 1 development would transform approximately 60 per cent of the airport site from a rolling grassy and vegetated landscape to an essentially built environment with some landscaping. These changes would alter the catchment areas within the airport site and the permeability of the ground surface, which in turn would alter the quality, duration, volume and velocity of surface water flows from the site.

The Stage 1 development would include a water management system to control the flow of surface water and improve the quality of water before it flows downstream (see Section 18.2.2). The assessment accounts for the effectiveness of this system in mitigating potential impacts to waterways, people and property.

18.5.1 Watercourses

The bulk earthworks programme proposed to be carried out for construction of the Stage 1 development would involve the removal of minor watercourses within the construction impact zone. The total length of watercourses that would be removed is 36.5 kilometres. The majority of these watercourses are minor drainage lines and valley fills with less defined channels.

Construction would also change the topography and permeability of subcatchment areas at the airport site. These changes would affect flows in receiving watercourses upstream and downstream of the airport site. The changes would occur progressively during construction and would be greatest at completion.

18.5.2 Flooding

The Stage 1 development would include substantial and large-scale earthworks which would modify drainage direction and overland flow paths, changing the nature of flooding on the airport site. As construction progresses and the impervious area expands, the volume of runoff from the airport site would also increase.

Without progressive introduction of formal drainage designed to cater to the new site conditions, there is potential for disruption to construction activities due to flooding and waterlogged soils, as well as the potential for downstream flooding. Detention basins have been incorporated into the indicative site design which would mitigate the increase in runoff, reducing offsite impacts of surface water flows. The detention basins would be established at the commencement of the construction programme. This would enable the management of stormwater releases throughout the remainder of the construction programme.

There is a high likelihood of large rainfall events during the construction of the Stage 1 development and throughout operation of the proposed airport. The operation of the water management system during such events is discussed in Section 18.6.2.

18.5.3 Surface water quality

Clearing and bulk earthworks would increase the surface area, and in some places the slope, of exposed soil surfaces at the airport site. These conditions would present a risk of erosion and associated surface water quality impacts. With regard to the main watercourses at the airport site, bulk earthworks would not occur within 90 metres of Badgerys Creek, 300 metres of Cosgroves Creek or 880 metres of Duncans Creek.

The design capacity and placement of detention basins would ensure that all drainage water from disturbed areas would be captured prior to discharge. The water management system would include the main detention basins (see Figure 18–1) supplemented by a series of interim sediment basins and control measures within the immediate work area. The water management system would have the effect of improving the quality of the surface water prior to release to receiving waters by allowing sediment to settle within the basins. The water management system, in combination with other standard construction erosion control measures, would readily mitigate the potential impacts of sedimentation. These and related measures are detailed in Section 18.7.

Construction of the proposed Stage 1 development would involve the use of a range of fuels and chemicals. These substances may be released to the environment in the event of a mishap during refuelling, maintenance or general storage and handling.

Releases would be avoided with the implementation of Australian Standards for the storage and handling of hazardous materials. In the unlikely event of a significant leak or spill of contaminants, remediation would be implemented as soon as practicable.

18.5.4 Groundwater

The proposed airport has the potential to affect groundwater conditions through three principal mechanisms involving groundwater recharge, groundwater drawdown and groundwater quality.

18.5.4.1 Groundwater recharge

Groundwater recharge, the process by which surface water infiltrates downward toward the water table, would be affected by compaction and the establishment of impermeable surfaces across the airport site during construction. Re-profiling of the land surface may lead to a temporary increase in rainfall recharge during bulk earthworks, as the fill is expected to have a higher overall permeability than the existing site conditions. However, as construction progresses, the proportion of paved surfaces would increase, which would reduce recharge to below existing conditions.

Overall, minimal change to local groundwater recharge would be expected as the existing shale derived clay soils have low permeability resulting in the majority of rainfall at the site being released as stormwater runoff rather than infiltrating to groundwater. It is not expected that a reduction in recharge would affect any sensitive ecological receptors or beneficial uses of the groundwater system.

18.5.4.2 Groundwater drawdown

Groundwater drawdown is anticipated as a result of airport site re-profiling and dewatering of excavation beneath the water table. Extensive re-profiling of the airport site would be undertaken to create a flatter surface for the development of the proposed runway and associated facilities. The re-profiling would result in a lowering of groundwater elevations in areas that currently have higher topographical elevation. It is also expected to result in reduced groundwater flow rates and hence reduced discharge to surrounding surface features. The peripheries of the re-profiled area would have exposed cuttings that would seep and reduce groundwater elevations in the elevated areas around the cuttings. The re-profiling would not result in dewatering of the groundwater system below the level of the surrounding creeks and there would be no potential for creeks to dry up due to this activity.

Establishment of basements in the terminal complex would likely intercept the underlying shale aquifers and require dewatering and management throughout construction. Due to low inherent hydraulic conductivities of the geology in these areas, it can be expected that seepage volumes would be relatively small.

As drawdown impacts are expected to be minor, a groundwater monitoring programme at potential sensitive receptors (riparian vegetation and creeks) is considered to be sufficient to identify the emergence of any impacts.

18.5.4.3 Groundwater quality

Potential groundwater quality risks include isolated spills and incidents occurring during construction, and diffuse impacts associated with general construction activities such as the use of machinery. Contaminants of primary concern are usually hydrocarbons; however, other chemicals such as herbicides, pesticides and fertiliser may also be used during construction. Impacts may result from the infiltration of pollutants through the ground surface or through dirty water retention facilities (such as temporary sediment basins) to the underlying groundwater systems.

Groundwater seepage into excavations for building basements would need to be managed by pumping seepage to stormwater management facilities or other suitable treatment systems. Chemicals of concern in groundwater seepage include total dissolved solids, metals, total nitrogen, phosphorus and sulphate. Minor small seepage from cuttings would also require appropriate management prior to discharge offsite.

Groundwater present in the shallow geology has been identified to have high salinity values. The excavation and use of this material for infilling could permit the release of additional salts into groundwater. This would only occur where increased recharge occurs to fill areas, and where a shallow groundwater table develops in the fill material.

As the underlying aquifer system is of low beneficial use, adverse impacts may potentially occur when affected groundwater migrates beneath areas of groundwater-reliant vegetation (located in creek riparian areas) or discharges into creeks. Groundwater flow velocities are expected to be slow, and as such the emergence of any impacts would also be slow. A groundwater monitoring approach is considered suitable to manage the identification of groundwater quality impacts.

18.5.5 Water use

Water would be utilised during construction for soil conditioning and dust suppression.

An estimated 1.36 ML of water would be required per day for site preparation works. For the purposes of this assessment it has been assumed that to meet this requirement 8,600 litres (0.0086 ML) of potable water would be required per day and would be supplied from existing assets operated by Sydney Water. The remaining water would be supplied through stormwater runoff captured in sediment dams or existing farm dams.

To meet water demand during construction it may be necessary to access water from other sources such as groundwater or surface water sources within the catchment. However, water extraction from such alternative sources would be subject to a separate assessment.

18.6 Assessment of impacts during operation

The Stage 1 development will result in modifications to topography and land use within the airport site. The catchment areas within the airport site and the permeability of the ground surface would be altered, which in turn alters the duration, volume and quality of stormwater run-off from the site.

The design of the Stage 1 development includes a water management system for the management of discharge from the site (see Section 18.2.2). The assessment accounts for the effectiveness of this system in mitigating potential impacts on waterways, people and property.

18.6.1 Watercourses

The alterations to the topography and permeability of the airport site made during construction would persist through operation of the Stage 1 development. During operation of the Stage 1 development flows in receiving watercourses upstream and downstream of the airport site would be affected, relative to existing conditions. Changes to flows in receiving watercourses have the potential to affect their physical conditions.

Hydrologic and hydraulic modelling, which incorporates the Stage 1 development landform and water management system, indicates that duration, volume and velocity of surface water flows in watercourses are similar or reduced when compared to existing flow conditions in all but a few cases. The Stage 1 development would therefore not significantly affect watercourse morphology.

Increased shear stress may occur in localised areas during the larger 100 year ARI flood events. These increases would potentially affect physical stability through bed or bank erosion in localised areas, but would not be significant in the context of these large flood events.

Increases in flood depth at Cosgroves Creek and Oaky Creek (see Section 18.6.2) have the potential to affect the physical stability of watercourses through bed or bank erosion. Localised increases are also expected to occur at basin outflows.

Other changes to surface water flows upstream and downstream of the airport site are not expected to affect the physical stability of watercourses.

Potential impacts would be mitigated through further refinement of the water management system, including the provision of erosion controls at basin outlets.

18.6.2 Flooding

The Stage 1 development would result in a modification to existing onsite flow paths and subcatchment boundaries, with resultant potential impacts on surface water flows and the receiving watercourses.

The Stage 1 development would result in a portion of the airport site that currently drains towards the Oaky Creek and Cosgroves Creek catchments to the north being diverted south towards Badgerys Creek, while a portion of the airport site that currently drains to Badgerys Creek would be diverted to Duncans and Oaky Creeks. The proposed airport would change surface run-off conditions in the catchments it intersects, which may also create minor incidental losses associated with evaporative changes.

A summary of changes to subcatchment areas within the airport site is provided in Table 18–7. A reduction in catchment area would generally result in reduced flows downstream; conversely, an increase in catchment area would increase flows downstream. An increase in impervious surfaces would also increase runoff and downstream flows.

Table 18–7 Changes in catchment area and impervious area at the airport site

Location	Catchment area (ha)		Impervious area (%)	
	Existing	Stage 1	Existing	Stage 1
Badgerys Creek at Elizabeth Drive	2,361	↓2,351	12	↑16
Oaky Creek at Elizabeth Drive	361	↓286	10	↑43
Cosgroves Creek at Elizabeth Drive	550	↑635	14	↑20
Badgerys Creek at South Creek	2,799	↓2,792	12	↑14
Cosgroves Creek at South Creek	2,165	↑2,183	14	↑20
Duncans Creek at Nepean River	2,379	↓2,357	14	↑15

↓/↑ denotes decrease/increase

Hydraulic and hydrologic modelling indicates that the volume, duration and velocity of surface water flows in water courses would be usually similar or reduced compared to existing conditions. Changes in volume, duration or intensity of flows would be variable depending on the storm event.

Table 18–8 shows the peak flow rates for the critical duration storm event for the Stage 1 development compared to the equivalent storm event for the existing catchment at the locations mapped in Figure 18–1. As shown, peak flows are usually similar or reduced with some localised increases at Duncans Creek near the airport site. These peak flows were determined for critical storm durations and as such are considered to encompass other, less severe impacts for other storm events.

The introduction of detention basins would also lead to decreases in flow depth at watercourses downstream of the airport site. Decreases were predicted in the order of 300 mm at Oaky Creek and 100 mm at Cosgroves Creek for the 1 year ARI event. Flow depths at Badgerys Creek would likewise decrease by up to 150 mm.

Localised increases were predicted of 250 mm at Oaky Creek upstream of Cosgroves Creek, minor increases of 25 mm at Cosgrove Creek upstream of the airport site and 90 mm at Badgerys Creek near The Northern Road. Flow depths during the larger 5 year and 100 year ARI events would similarly decrease downstream of the site, as with the 1 year ARI event. Increases in flow depth at Oaky Creek and Cosgroves Creek are not expected to affect dwellings. Increases in flow depth at Badgerys Creek are due to the realignment of The Northern Road and would be further assessed and mitigated through the assessment and design of that project. Changed flow depths at Duncans Creek would be within 50 mm in most cases and are not expected to affect dwellings. Mapping of all modelled floods is provided in the hydrology and geomorphology assessment in Appendix L1 (Volume 4).

Table 18–8 Modelled peak flows at the airport site for the Stage 1 development

Location	1 year ARI peak flows (m3/s)		100 year ARI peak flows (m3/s)	
	Existing	Stage 1	Existing	Stage 1
Location A	27.1	25.9	136.6	125.7
Location B	25.7	23.3	120.7	114.4
Location C	21.7	15.8	114.5	77.2
Location D	7.4	3.1	34.3	12.8
Location F2	5.8	4.0	22.5	19.1
Location F3	2.6	2.4	10.4	9.5
Location F4	2.8	2.8	14.3	14.3
Location F5	2.1	2.6	7.9	11.4
Location F7	3.8	3.9	17.4	18.1
Node 2	2.8	0.9	12.2	4.3
Dun3	8.8	8.8	35.9	35.9

Note: Peak flows have been determined for the critical duration storm event for the Stage 1 development. Peak flows of the equivalent storm event have then been modelled for the existing catchment.

18.6.3 Surface water quality

Surface water runoff generated during the operation of the Stage 1 development may be impacted by a range of pollutants such as suspended and dissolved solids, nutrients, gross pollutants, heavy metals, and total petroleum hydrocarbons (TPH).

Suspended solids and nutrients are generated, in differing quantities, under all types of rural and urban catchments, and may be the result of soil erosion, decaying vegetation and matter, and the use of fertilisers. Gross pollutants include anything larger than sediment, and may be organic or non-organic. They include rubbish, plastic, bottles, tyres, or larger items such as shopping trolleys. Heavy metals such as zinc, lead, chromium and copper are generally associated with aircraft and vehicle movement, as well as repair workshops and maintenance areas. The corrosion of galvanised materials, pipes, metal work, wear and tear of tyres, brakes, and the combustion of lubricating oils all have the potential to generate heavy metals. Total petroleum hydrocarbons in fuels stored, transferred or burnt may also find their way into the water management system and impact on the downstream waterways.

It is noted that heavy metal elements may also originate from natural soils in the area or from existing land uses. Recent water quality data obtained at the airport site watercourses indicate elevated levels for zinc, copper and chromium in addition to suspended solids and nutrients. Heavy metals contained in stormwater runoff are generally strongly bound to suspended solids and can be effectively filtered in grass swales and sediment basins.

Modelling the impact of surface water runoff pollutants on the receiving water environment has been undertaken for suspended solids, nutrients (phosphorous and nitrogen) and gross pollutants. The modelling has considered the effectiveness of the proposed water management system to meet the objectives for the receiving waters with respect to:

- average annual pollutant loads (kg/year);
- pollutant retention targets for urban development; and
- average pollutant load concentrations.

18.6.3.1 Average annual pollutant loads

In assessing the average annual loads, the post development levels are compared to those under existing conditions. This approach is similar to the NORBE (Neutral OR Beneficial Effect) approach to water quality management, which aims to manage the post development pollutant loads discharging from a site, such that the water quality is equal to or better than the pre-development or existing loads. The approach is typically extremely difficult to achieve when modifying land use from a rural to an urbanised or developed catchment.

The average annual pollutant loads resulting from the Stage 1 development are presented in Table 18–9 for suspended solids, total phosphorus, total nitrogen and gross pollutants. The percentage change in these pollutant loads compared to existing conditions (pre-development) is also shown in brackets for comparison. Local impacts relate to those immediately downstream of the airport site, while the regional impacts relate to those up to 16 km downstream of the airport site. The percentage change in loads for gross pollutants has not been calculated due to the fact that, in practice, gross pollutants are readily controlled through the use of gross pollutant traps and other standard stormwater devices.

Table 18–9 Modelled pollutant loads

Location	Flow (ML/year)	Average Annual Loads (kg/yr)			
		Suspend solids	Phosphorous	Nitrogen	Gross pollutants
Local Impacts					
Basin 1 Outlet (to Badgerys Creek)	555 (+10%)	18400 (-68%)	103 (+5%)	702 (-23%)	257
Basin 2 Outlet (to Badgerys Creek)	456 (+709%)	34400 (+418%)	142 (+1530%)	825 (+890%)	2430
Basin 3 Outlet (to Badgerys Creek)	410 (+175%)	20400 (+1%)	106 (+367%)	626 (+188%)	1360
Basin 4 Outlet (to Badgerys Creek)	130 (+67%)	15600 (+251%)	60.9 (+83%)	336 (+15%)	2310
Basin 5 Outlet (to Badgerys Creek)	529 (+103%)	67500 (+89%)	254 (+321%)	1340 (+153%)	9750
Basin 6 Outlet (to Oaky/ Cosgroves Creek)	899 (+142%)	44300 (-15%)	188 (+147%)	1200 (+75%)	2160
Basin 7 Outlet (to Cosgroves Creek)	573 (+235%)	20100 (-34%)	109 (+174%)	745 (+88%)	696
Basin 8 Outlet (to Duncans Creek)	169 (+41%)	6400 (-61%)	34.4 (+47%)	220 (+4%)	0
Basin 9 Outlet (to Duncans Creek)	172 (+219%)	8400 (+17%)	44.2 (+412%)	272 +258%)	539
B1 – Badgerys Creek 4	1080 (+15%)	110000 (+9%)	355 (+94%)	2330 (+35%)	12600
Badgerys Creek 2 / B2	1700 (+11%)	199000 (+11%)	523 (+59%)	3680 (+20%)	15800
Badgerys Creek 3 / B3	3620 (+32%)	337000 (+5%)	976 (+72%)	6830 (+30%)	20700
Regional Impacts					
Cosgroves Creek 1	1930 (+93%)	146000 (-8%)	404 (+84%)	3030 (+39%)	3250
Cosgroves Creek 3	2610 (+54%)	240000 (-6%)	549 (+49%)	4480 (+23%)	5130
Duncans Creek	2480 (+8%)	332000 (+5%)	507 (+6%)	4540 (+7%)	3190

Location	Flow (ML/year)	Average Annual Loads (kg/yr)			
		Suspend solids	Phosphorous	Nitrogen	Gross pollutants
Kemps Creek	23400 (+4%)	2770000 (-5%)	4900 (+8%)	47200 (+3%)	90400
Blaxland Creek	33800 (+6%)	3710000 (-4%)	6670 (+9%)	63800 (+4%)	132000

The Stage 1 development would result in increased loads of phosphorous and nitrogen, largely as a function of the increase in runoff volumes associated with the modified catchment areas and changes to land use. Relative increases in phosphorous and nitrogen loads attributed to the proposed airport would be most pronounced at basin outlets, where surface water flows leave the airport site, but would progressively decrease downstream of the airport site as receiving waterways receive flows from the wider catchment. The proposed water management system would be generally effective at reducing loads of suspended solids in surface water, compared to existing conditions.

18.6.3.2 Pollution retention targets

The WSUD Guidelines specify pollutant retention targets as a practical way of treating urban stormwater quality. These targets recognise that urban development will typically lead to an increase in pollutant loads in comparison to rural land uses. The focus is therefore on managing the pollutant loads to acceptable levels, rather than maintaining the existing load levels. The application of these guidelines is generally less stringent than the NORBE approach where the existing catchments are of a rural nature.

The bio-retention basins proposed as part of the water management system in the revised draft Airport Plan have been designed to achieve the WSUD Guidelines. It is also noted that the civil design for each of the bio-retention basins has additional buffer areas set aside to enable a greater treatment area to be provided as required. This approach provides flexibility to increase the level of treatment following the adoption of local standards and site specific water quality trigger levels developed following the completion of long term baseline monitoring in accordance with AEPR and the ANZECC guidelines.

The potential impacts of the proposed Stage 1 development, measured against the requirements of the WSUD Guidelines, are presented in Table 18–10. The targets are that 80 per cent of suspended solids, 45 per cent of total phosphorus, and 45 per cent of total nitrogen should be retained on the airport site. It is noted that in the use of the WSUD Guidelines for Western Sydney, the basin outlet flows are derived only from the proposed development areas and Basin 4 and Basin 5 will not be constructed during the Stage 1 development.

The nine basin outlets effectively represent the locations where the pollutant loads generated from the proposed airport would discharge into the downstream environment. The results show that, in terms of suspended solids, total phosphorus and total nitrogen, Basins 1, 3, 6, 7 and 8 satisfy the reduction target. Basins 2 and 9 do not completely satisfy the retention target and increasing the treatment area is recommended during the detailed design of these basins.

Table 18–10 Retention of pollutant loads

Location	Retention of pollutant loads (%)		
	Total suspended solids	Total phosphorous	Total nitrogen
Western Sydney Guidelines	80%	45%	45%
Basin 1 Outlet (to Badgerys Creek)	85.0	60.6	48.4
Basin 2 Outlet (to Badgerys Creek)	62.9	40.4	34.7
Basin 3 Outlet (to Badgerys Creek)	83.0	59.6	53.7
Basin 4 Outlet (to Badgerys Creek)	0.0	0.0	0.0
Basin 5 Outlet (to Badgerys Creek)	0.0	0.0	0.0
Basin 6 Outlet (to Oaky/ Cosgroves Creek)	82.6	61.3	45.1
Basin 7 Outlet (to Cosgroves Creek)	83.4	61.0	45.3
Basin 8 Outlet (to Duncans Creek)	83.4	60.1	45.4
Basin 9 Outlet (to Duncans Creek)	76.1	50.8	37.4

18.6.3.3 Pollutant concentrations

Pollutant concentrations are readily monitored and have a direct correlation with the relative health of waterways and ecosystems. Both AEPR and ANZECC Guidelines refer to concentrations in the setting of trigger levels and pollutant limits.

Existing surface water quality was modelled at upstream, downstream and major outflow locations in and around the airport site. This was done to allow a direct comparison with the predicted surface water quality during the Stage 1 development.

The model results are summarised in Table 18-10 for comparison with ANZECC Guidelines default trigger levels for slightly disturbed ecosystems in lowland rivers, AEPR limits, and interim site-specific water quality criteria established for the airport site catchment. The results show that pollutant concentrations would typically decrease at most downstream locations. Despite the water management system for the Stage 1 development leading to general improvements in pollutant concentrations locally and regionally, the improvements would not be sufficient to meet the AEPR limits or default values in the ANZECC guidelines. However, using the interim site-specific water quality criteria established for the airport catchment, the post-development water quality is found to satisfy the site specific water quality objectives for suspended solids, total phosphorus, and total nitrogen at all the locations.

The above outcomes are attributed to the degraded nature of the existing catchments which have not met ANZECC Guidelines default trigger levels for several years. Nevertheless, it is noted that the proposed airport does not preclude the opportunity to make further improvements in downstream water quality in South Creek in the future, to work towards satisfying the NSW Water Quality Objectives.

Table 18–11 Modelled surface water quality at the airport site

	Existing (mg/L)			Stage 1 development (mg/L)		
Location	Suspended solids	Phosphorous	Nitrogen	Suspended solids	Phosphorous	Nitrogen
AEPR Limits	< 10% change from Seasonal Mean	0.01	0.1	< 10% change from Seasonal Mean	0.01	0.1
ANZECC Guidelines	40	0.05	0.5	40	0.05	0.5
Interim water quality criteria	23.2	0.92	6.2	23.2	0.92	6.2
Basin 1	22.1	0.14	1.54	↓7.09	↓0.12	↓0.75
Basin 2	22.1	0.09	1.25	↓15.7	↑0.11	↓0.97
Basin 3	21.9	0.09	1.26	↓13.2	↑0.11	↓0.91
Basin 4	20.7	0.38	2.91	↑23.5	↓0.10	↓1.19
Basin 5	23.0	0.17	1.74	↑23.9	↓0.10	↓1.18
Basin 6	22.5	0.15	1.60	↓12.3	↓0.11	↓0.87
Basin 7	22.2	0.15	1.59	↓7.56	↓0.12	↓0.75
Basin 8	23.2	0.13	1.52	↓2.45	↓0.12	↓0.62
Basin 9	20.4	0.10	1.26	↓13.3	↑0.11	↓0.94
Badgerys Creek 1	21.5	0.14	1.48	↑23	↓0.11	↓1.20
Badgerys Creek 2	21.8	0.15	1.55	↑22.9	↓0.11	↓1.22
Badgerys Creek 3	21.9	0.15	1.55	↓15.1	↓0.12	↓1.00
Cosgroves Creek 1	22.7	0.15	1.61	↓11.0	↓0.12	↓0.88
Cosgroves Creek 3	22.5	0.15	1.58	↓11.4	↓0.12	↓0.91
Duncans Creek	22.1	0.14	1.54	↓14.9	↓0.12	↓1.03
Kemps Creek	21.0	0.13	1.45	↓15.2	↓0.12	↓1.04
Blaxland Creek	20.9	0.13	1.39	↓14.4	↓0.11	↓1.01

↓/↑ denotes decrease/increase

18.6.4 Reclaimed water irrigation

An estimated 2.5 ML of wastewater per day would be generated during operation of the Stage 1 development. The wastewater would be reticulated, treated and recycled (as grey water) or irrigated onsite. Treatment and irrigation methods would be determined in detailed design, but it is expected that wastewater would be treated with membrane biological reactor technology to produce high quality reclaimed water suitable for beneficial reuse or irrigation.

The key risks to surface water and groundwater associated with the irrigation of reclaimed water are runoff to surface water or infiltration to groundwater. These risks would be limited in the first instance as reclaimed water would be of relatively high quality and appropriate management practices would be adopted, such as balancing storages and proper irrigation scheduling to avoid excessive irrigation.

18.6.5 Groundwater

The potential groundwater impacts during operation of the Stage 1 development would likely encompass those previously discussed in Section 18.5.4, namely groundwater recharge, groundwater drawdown and groundwater quality. Impacts on groundwater recharge are not expected to be significant given the very limited groundwater recharge conditions at the airport site (see Section 18.4.6). Groundwater drawdown effects due to inflows would be limited following the initial effects of bulk earthworks and excavation. Significant groundwater inflows to underground infrastructure are not expected and would be controlled, if necessary, through the use of lining or other engineering controls.

The operation of the proposed airport would involve the use of a range of fuels and chemicals. These substances may be released to the environment in the event of a mishap during refuelling, maintenance or general storage and handling. Releases would be avoided with the implementation of Australian Standards for the storage and handling of hazardous materials. Remediation would be implemented as soon as practicable in the unlikely event of a significant leak or spill of contaminants.

18.7 Mitigation and management measures

Measures to manage potential impacts on surface water and groundwater during construction and operation are listed in Table 18–12.

A Soil and Water Construction Environmental Management Plan (CEMP) and Operational Environmental Management Plan (OEMP) will be prepared prior to Main Construction Works and operation of the Stage 1 development respectively. The plans will collate the mitigation and management measures discussed in this section and itemised in Table 18–12. These and other environmental management plans are discussed in further detail in Chapter 28 (Volume 2b).

Some of the main proposed measures include:

- refinement of the water management system to improve flood and water quality performance as far as practicable;
- regular inspection and maintenance of the water management system to ensure all components are functioning as designed;

- implementation of standards for storage and handling of fuels or chemicals with the potential to contaminate surface water or groundwater; and
- baseline and ongoing monitoring of surface water and groundwater, fulfilling the requirements of the AEPR.

The establishment of erosion controls in line with *Managing urban stormwater: soils and construction* (Landcom 2004) would be central to the management and mitigation of erosion and associated surface water quality impacts. These measures are discussed in Chapter 17.

The reclaimed water reuse scheme would be designed and operated in accordance with the risk framework and management principles contained in the *National Guidelines on Water Recycling* (Environment Protection and Heritage Council 2006) and the *Environmental guidelines: Use of effluent by irrigation* (DEC 2004d). This approach would avoid harm to surface water and groundwater. These measures are also discussed in Chapter 17.

Table 18–12 Mitigation and management measures

Issue	Measure	Timing
Surface water management system	As part of the detailed design process for the Stage 1 development, a surface water management system will be developed. Development of a surface water management system for the airport site may involve a progressive process of design and implementation covering both the construction and operational phases. This may include the implementation of temporary system elements specifically for the construction phase. The system will include: • a detailed design of basins and channels to capture the majority of runoff, including during construction; • refined drainage system design performance standards to optimise capacity and release timing, mimicking natural flows as far as practicable; • separate bio-retention basins to provide additional treatment for low flows and separation of these features from the drainage system to protect contained water during flood events; • pollutant traps to prevent debris and other coarse material entering the drainage system; • stabilisation structures at outlets to include rock check dams at regular intervals along channels and energy dissipaters at basin outlets; • capacity for containment of accidental leaks or spills in the drainage system at maintenance areas, fuel farms or other areas where fuels or chemicals are stored or handled in accordance with Australian standards; and • measures to address impacts on downstream and upstream uses, including sensitive environmental values.	Pre-construction Construction
Development of local standards	Local standards for water quality will be developed under the AEPR, with due consideration to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ 2000) and the results of baseline water quality monitoring which will take place for a minimum of 24 months prior to the commencement of Main Construction Works.	Pre-construction

<table>
<tr><th>Issue</th><th>Measure</th><th>Timing</th></tr>
<tr><td>Erosion and sedimentation</td><td>Impacts associated with erosion and sediment will be mitigated through:
installing a site drainage system prior to commencement of bulk earthworks;
minimising the surface area disturbed at any one time by, where practical, staging construction works and stabilising soils with vegetation or appropriate cover materials;
establishing erosion and sediment controls in accordance with the 'NSW OEH Blue Book – Managing urban stormwater: soils and construction';
providing intermediate sediment retention basins within the construction impact zone to provide additional treatment prior to completion of the airport's site drainage system. Specific erosion control measures would be developed for the management of highly erodible soils such as those anticipated in the Luddenham and South Creek soil landscapes;
mulching cleared vegetation for use in erosion control at construction sites;
covering and stabilising soil stockpiles with vegetation or mulch;
stockpiling topsoil at a maximum height of two metres, where practicable; and
distributing and seeding topsoil over landscaped areas at the completion of bulk earthworks.</td><td>Construction</td></tr>
<tr><td>Leaks or spills of fuel or other chemicals</td><td>To minimise the risk of leaks or spills the following mitigation measures will be put in place:
maintenance areas, fuel farms and other areas where fuels or chemicals are stored or handled would be bunded to contain any accidental spills or leaks;
fuel and other chemicals will be stored and handled in accordance with relevant Australian standards such as:
AS 1940-2004 The storage and handling of flammable and combustible liquids;
AS/NZS 4452:1997 The storage and handling of toxic substances;
AS/NZS 5026:2012 The storage and handling of Class 4 dangerous goods; and
AS/NZS 1547:2012 On-site domestic wastewater management; and
a protocol will be developed and implemented to respond to and remedy leaks or spills.</td><td>Construction
Operation</td></tr>
<tr><td>Surface and groundwater quality monitoring</td><td>The most suitable surface and groundwater locations will be determined in consultation with the NSW Environment Protection Authority and relevant local councils.
Regular site inspections will be carried out to monitor the effectiveness of the water management system and water management controls, recording inspection results, and making an inspection log available to the Department of Infrastructure and Regional Development.
The frequency of site inspections will be increased during and immediately after wet weather when there is a higher potential for the offsite transport of pollutants from the airport site.
Groundwater elevation monitoring will be conducted to detect potential impacts to base flow in the vicinity of potentially sensitive creeks and groundwater dependent vegetation. Monitoring will be undertaken quarterly through construction up to a minimum period of three years after the completion of the Stage 1 development and until any identified impacts stabilise. Monitoring will also be undertaken quarterly up to a minimum period of three years after commencement of operations or until any identified impacts stabilise.
Groundwater quality monitoring of alluvial and Bringelly shale aquifers will be conducted at major infrastructure, locations, down gradient from these locations and in the vicinity of groundwater dependent vegetation or water courses. Monitoring will initially be undertaken quarterly and adjusted as appropriate.
Monthly surface water quality monitoring will be conducted to monitor performance of the water management system. This monitoring will occur once the water management system is in place and take place at basin outflows and during selected upstream and downstream locations.</td><td>Construction
Operation</td></tr>
</table>

Issue	Measure	Timing
Groundwater inflows	To mitigate the impacts associated with groundwater inflows the following measures will be implemented: • groundwater inflows will be reused or released with appropriate treatment; • where groundwater is released to surface waters, treatment will be undertaken to bring water pollution below the accepted limits set out in the AEPR or any local standards; and • corrective measures will be developed and implemented to supplement groundwater supplies in the unlikely event of impacts to dependent vegetation or watercourses.	Construction Operation
Wastewater reuse	The treated water irrigation scheme will be designed and operated in accordance with the risk framework and management principles contained in the National Guidelines on Water Recycling (EPHC 2006) and Environmental guidelines: Use of effluent by irrigation (DEC 2004).	Operation
Review and refinement of water management system	In the event monitoring shows that water quality or hydrology criteria established for the airport site are not met, relevant aspects of the water management system will be reviewed and refined, as necessary, to ensure future compliance.	Operation

18.8 Conclusion

Construction of the Stage 1 development would transform approximately 60 per cent of the airport site from a rolling grassy and vegetated landscape to an essentially built environment with some landscaping. These changes would alter the catchment areas within the airport site and the permeability of the ground surface, which would in turn alter the duration, volume and velocity of surface water flow. The proposed bulk earthworks and excavations at the airport site are likely to receive some groundwater inflows.

Hydrologic and hydraulic modelling of the airport site during construction and operation indicates that there is a degree of variation in how the water management system responds to different storm events. The water management system as currently planned would be generally effective at mitigating watercourse and flooding impacts; however, refinement of the water management system would occur during detailed design of the proposed airport.

The refinement of the water management system would address some of the more substantial increases to flows at Oaky Creek, as well as the enhanced use of bio-retention basins and swales and other intermediate structures to further improve water quality outcomes.

Because water quality at the airport site is already degraded and does not meet existing water quality criteria, it is unlikely that the proposed airport will be able to achieve water quality criteria outlined in the AEPR. To take into account these existing conditions, local standards for water quality will be developed under Part 5 of the AEPR, with due consideration to the ANZECC Guidelines. The development of local standards will be based on the results of baseline water quality monitoring, derived from a minimum of 24 months of data collected prior to the commencement of Main Construction Works.

Water quality during the Stage 1 development was found to meet site-specific interim water quality criteria at all modelled locations. The interim water quality criteria were developed on the basis of 9 months of water quality monitoring.

Overall it is considered that the residual impacts to surface water and groundwater would be reasonable considering the scale and nature of the proposed airport development. Baseline and ongoing monitoring of surface water and groundwater would be undertaken to characterise any residual impacts and prompt corrective action where necessary.