34 Surface water and groundwater

34.1 Introduction

This chapter provides an analysis of the surface water and groundwater resources affected by the indicative long term development of the proposed airport. It draws on technical assessments of surface water hydrology and geomorphology (Appendix L1 (Volume 4)), surface water quality (Appendix L2 (Volume 4)) and groundwater (Appendix L3 (Volume 4)). The assessment contained in this chapter builds on the assessment of impacts associated with the Stage 1 development (see Chapter 18 (Volume 2a)).

34.2 Methodology

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

Predictive models were used to consider the impact of the change in landform characteristics on runoff volumes and the subsequent impacts on stream flow, flooding, groundwater recharge and water quality. Potential impacts on the environmental values and beneficial uses of surface and groundwater resources were identified, and options for future management practices were considered as part of the assessment.

Full assessment methodologies are described in the respective technical papers presented in Appendix L (Volume 4). A summary of the regulatory and policy settings relevant to the management of water resources at the airport site is presented in Chapter 18 (Volume 2a).

The hydrologic, hydraulic and water quality models used in the assessment include representations of the water management system incorporated into the concept design of the indicative long term development. This water management system would comprise a series of grassed swales to convey runoff from the developed areas within the airport site, and a series of bio-retention and flood detention basins to manage flow quality and quantity prior to discharge to the receiving waters. Low flows are diverted and treated in the bio-retention system, while the higher flows are designed to bypass the bio-retention system and discharge directly into the flood detention basins. The flood detention basins then provide controlled release to the receiving waters in a way that mimics the natural flows as closely as possible over a range of storm durations and magnitudes.

The water management system would be largely constructed during the Stage 1 development and would be expanded to cater for the long term development. Notably, this would include the addition of Basin 4 and 5 on the southern side of the airport site in the Badgerys Creek catchment and an increase in the capacity of the bio-retention system as shown on Figure 34–1.

The results of the models were analysed to identify impacts on waterways, people and property and thereby assess the effectiveness of the water management system. The water management system has been designed to contain flows up to the 100 year average recurrence interval (ARI) event.

The capacities of the basins to treat and store surface water flows are presented in Table 34–1.

Table 34–1 Bio-retention and detention basin volumes (long term development)

Basin	Bio-retention (ha)	Flood detention (kl)	Discharge
Basin 1	1.8	125.000	Badgerys Creek
Basin 2	0.55	39,000	Badgerys Creek
Basin 3	0.6	100,000	Badgerys Creek
Basin 4	1.1	82,000	Badgerys Creek
Basin 5	0.5	65,000	Badgerys Creek
Basin 6	1.1	101,000	Oaky Creek
Basin 7	1.0	117,000	Oaky Creek (via tributary)
Basin 8	0.4	59,000	Duncans Creek (via tributary)
Basin 9	0.15	-Na	Duncans Creek

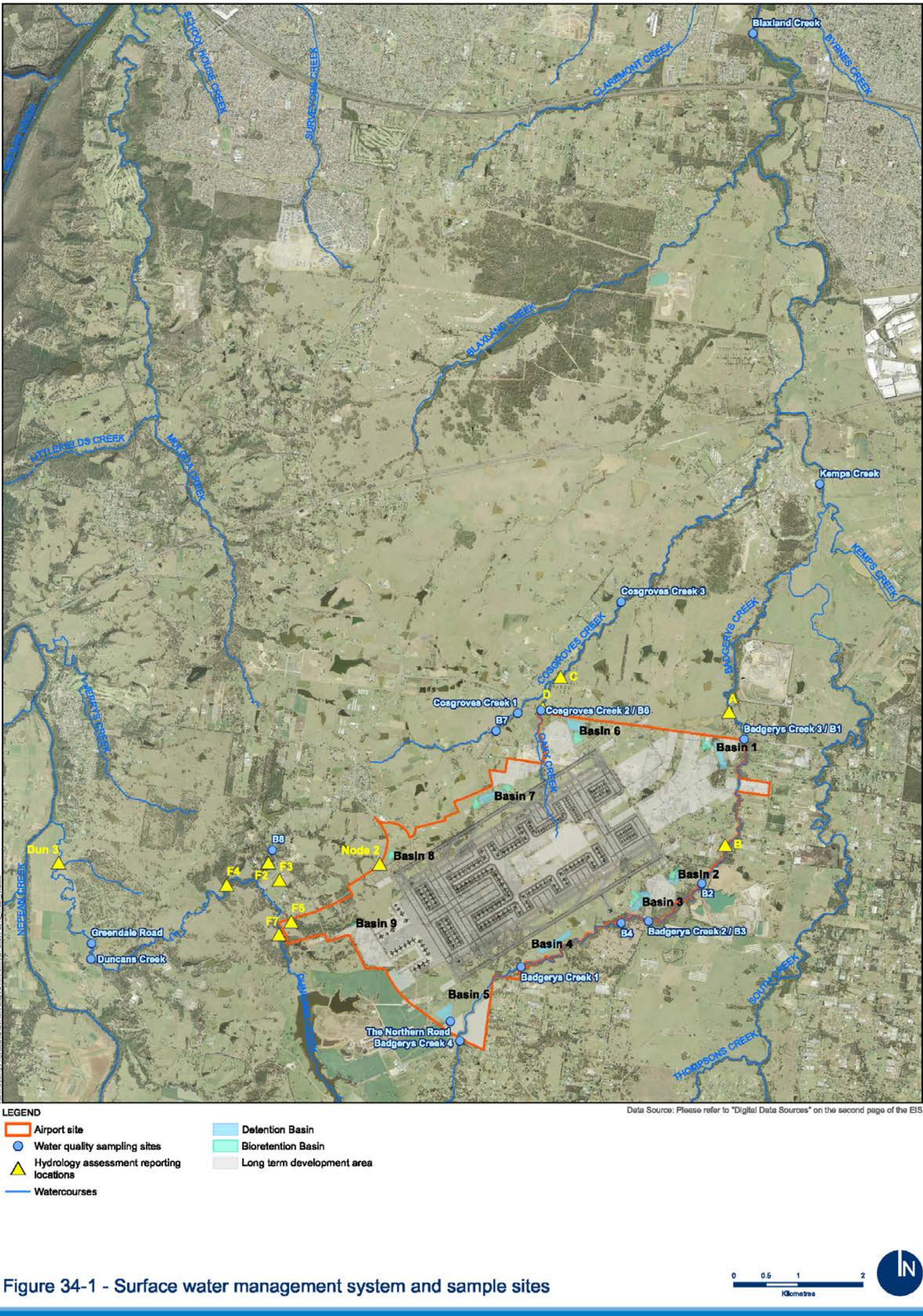

Figure 34-1 - Surface water management system and sample sites

34.3 Existing environment

The airport site lies in the north-east of the Hawkesbury-Nepean catchment and contains 64 kilometres of watercourses. The main watercourses at the airport site are Badgerys Creek, Cosgroves Creek and Duncans Creek. Other tributaries include Oaky Creek and a number of unnamed drainage lines and depressions. Clearing, agriculture and the construction of in-stream dams have affected the physical stability of the creeks and drainage channels, with bank erosion evident on the major watercourses despite having well vegetated riparian zones.

Existing surface water flows at the airport site during one 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 out-of-bank flooding is expected in a 100 year ARI event.

Water quality modelling simulations at locations in and around the airport site indicate that water quality is relatively degraded, with high nutrient levels that are attributable to existing land uses at the airport site and broader catchment. These results are consistent with surface water quality sampling at the airport site and prior data (PPK 1997; SMEC 2014).

Groundwater at the airport site is generally of 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.

The varying respective depths of each aquifer and their limited hydraulic conductivity mean there is low potential for connectivity between groundwater aquifers or surface water interaction.

Groundwater bores in the vicinity of the airport site are understood to target the Hawkesbury Sandstone aquifer. This aquifer is significantly deeper than the other aquifers at the airport site.

A more detailed description of the existing environment of the airport site and surrounding area with regard to surface water and groundwater is presented in Chapter 18 (Volume 2a).

The implementation of the Stage 1 development would transform the northern portion of the airport site from a rolling grassy and vegetated landscape to an essentially built environment. These changes would alter the catchment areas within the airport site and the permeability of the ground surface, which in turn would alter the duration, volume and velocity of surface water flows. The baseline environmental conditions for the long term development would therefore be representative of already modified environmental conditions.

34.4 Assessment of impacts during operation

34.4.1 Watercourses and flooding

The long term development would modify the topography and permeability of catchment areas within the airport site. These changes would affect site run-off and receiving water flow patterns and increase the potential for flooding. The long term development would also involve the removal of watercourses. The total length of watercourses that would be removed is approximately 20 kilometres, the majority being minor drainage lines and valley fills with less defined channels. Badgerys Creek would be preserved within the environmental conservation zone along the south-eastern boundary of the airport site.

The concept design of the long term development includes expanding the water management system with the addition of two detention basins to control the flow of surface water (see Table 34–1). The assessment considers the effectiveness of this system in avoiding potential impacts on waterways, people and property.

A summary of changes to catchment areas as a result of the long term development is provided in Table 34–2. The long term changes to catchment areas and impervious surfaces are based on comparison with existing conditions, and incorporate the persistent effects of the Stage 1 development and the progressive implementation of the long term development.

Table 34–2 Catchment area comparison (long term development)

Location	Catchment area (existing) (ha)	Catchment area (long term) (ha)	Impervious area (existing) (%)	Impervious area (long term) (%)
Badgerys Creek at Elizabeth Drive	2,361	2,332 ↑	12	↑30
Oaky Creek at Elizabeth Drive	361	270 ↓	10	↑47
Cosgroves Creek at Elizabeth Drive	550	647 ↑	14	↑39
Badgerys Creek at South Creek	2,799	2,775 ↑	12	↑28
Cosgroves Creek at South Creek	2,165	2,179 ↓	14	↑25
Duncans Creek at Nepean River	2,379	2,380 ↓	14	↑15

The long term development would result in substantial increases in impervious areas as well as modification to sub-catchment flows within the airport site. An increase in sub-catchment area or impervious surfaces would typically increase runoff volumes and the timing of peak flows.

The proposed water management system has been designed to mitigate the increased runoff associated with the altered catchment conditions at the airport site. As a result, modelling of stream flows indicates that duration, volume and velocity of surface water flows in watercourses would generally be similar or reduced when compared to existing flow conditions.

Hydrology and flooding in and around the airport site during the one year ARI and 100 year ARI storms was simulated using hydrologic and hydraulic models. Peak flow rates for the critical duration storm event for the long term development at a range of reporting locations are summarised in Table 34–3 and compared to the equivalent storm event for the existing catchment. The results demonstrate the basins are generally effective in restricting the peak flows to the equivalent of, or less than, existing flows.

Flood extents and depths for a one year ARI and 100 year ARI storm event show minimal change from the existing catchment characteristics for the equivalent storm duration. No changes to flood levels are expected to affect dwellings or other infrastructure surrounding the airport site.

Localised changes in flow duration, volume and velocity would also be expected at locations where basins release surface water. These basin outlets would be designed to avoid the associated potential impacts of localised scour and erosion.

Table 34–3 Peaks flows at the airport site (long term development)

Location	1 year ARI peak flows (m^3/s)		100 year ARI peak flows (m^3/s)	
	Existing	Long term	Existing	Long term
Location A	27.1	28.9	136.6	136.7
Location B	25.7	26.2	120.7	118.8
Location C	21.7	15.8	114.5	76
Location D	7.4	3.0	34.3	12.5
Location F2	5.8	4.1	22.5	20.0
Location F3	2.6	2.4	10.4	9.5
Location F4	2.8	2.8	14.3	14.3
Location F5	2.1	2.7	7.9	11.7
Location F7	3.8	4.6	17.4	19.5
Node 2	2.9	0.9	12.2	4.3
Dun3	8.8	8.8	35.9	35.9

Peak flows have been determined for the critical duration storm event for the long term development. Peak flows of the equivalent storm event have then been modelled for the existing catchment.

34.4.2 Surface water quality

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 concentrations.

34.4.2.1 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. This approach is typically extremely difficult to achieve when modifying land use from a rural to an urbanised or developed catchment.

The volume of surface water flows leaving the airport site during the long term development would increase as a result of changes to sub-catchment areas and increases in impervious surfaces. This will result in an increase to the total pollutant loads released from the site largely as a function of the increased volumes of surface water run-off leaving the airport site.

Modelled pollutant loads downstream from the airport site are presented in Table 34–4, with the percentage change in these pollutant loads compared to existing conditions (pre-development) shown in brackets for comparison. Increases in phosphorous and nitrogen loads would be most pronounced at basin outlets where surface water flows leave the airport site. Relative increases in loads, as a proportion of existing conditions, would decrease progressively downstream of the airport site as surface water flows are received from the wider catchment.

Table 34–4 Annual flows and pollutant loads downstream from the airport site

Location	Flow (ML)	Average Annual Loads (kg/yr)			
		Suspended solids	Phosphorous	Nitrogen	Gross pollutants
Local impacts					
Basin 1 outlet (to Badgerys Creek)	1,300 (+157%)	69,600 (+21%)	269 (+161%)	1,750 (+91%)	3,990
Basin 2 outlet (to Badgerys Creek)	402 (+613%)	15,200 (+129%)	80.2 (+821%)	541 (+549%	617
Basin 3 outlet (to Badgerys Creek)	577 (+287%)	19,300 (-4%)	104 (+358%)	764 (+252%)	467
Basin 4 outlet (to Badgerys Creek)	1,090 (+1,299%)	38,100 (+756%)	199 (+499%)	1,440 (+393%)	345
Basin 5 outlet (to Badgerys Creek)	638 (+145%)	77,200 (+116%)	193 (+220%)	1,050 (+98%)	5,090
Basin 6 outlet (to Oaky/Cosgroves Creek)	1,030 (+177%)	50,700 (-3%)	209 (+175%)	1,370 (+100%)	2,520
Basin 7 outlet (to Cosgroves Creek)	1,050 (+514%)	40,800 (+35%)	191 (+380%)	1,400 (+254%)	789
Basin 8 outlet (to Duncans Creek)	313 (+161%)	16,000 (-2%)	63.2 (+170%)	419 (+98%)	0
Basin 9 outlet (to Duncans Creek)	182 (+238%)	8,970 (+25%)	46.1 (+434%)	289 (+281%)	539
Badgerys Creek 1	1,190 (+27%)	117,000 (+16%)	294 (+61%)	2,030 (+18%)	7,970
Badgerys Creek 2	2,840 (+78%)	224,000 (+24%)	605 (+84%)	4,480 (+46%)	9,210
Badgerys Creek 3	5,540 (+102%)	391,000 (+22%)	1,160 (+105%)	8,550 (+63%)	15,100
Regional impacts					
Cosgroves Creek 1	2,540 (+154%)	177,000 (+12%)	506 (+130%)	3,810 (+75%)	3,690
Cosgroves Creek 3	3,210 (+89%)	273,000 (+7%)	653 (+77%)	5,280 (+45%)	5,580
Duncans Creek	2,710 (+18%)	352,000 (+11%)	578 (+21%)	4,930 (+17%)	6,580

Location	Flow (ML)	Average Annual Loads (kg/yr)			
Kemps Creek	25,300 (+12%)	2,970,000 (+2%)	5,090 (+13%)	49,600 (+8%)	84,800
Blaxland Creek	36,300 (+13%)	3,980,000 (+3%)	6,940 (+14%)	66,800 (+8%)	127,000

34.4.2.2 Pollution retention targets

The efficacy of the water management system in reducing pollutant loads leaving the airport side was modelled and assessed in accordance with the *Water Sensitive Urban Design: Technical Guidelines for Western Sydney* (WSUD Guidelines).

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 as undertaken under the NORBE approach.

The results presented in Table 34–5 show that the bio-retention basins proposed as part of the water management system effectively reduce pollutant loads. The drainage system would be refined during detailed design, with consideration given to enlarging the bio-retention basin areas to improve the efficacy in reducing pollutant loads. This will be particularly required for Basin 5 and 9 where the WSUD guidelines retention targets are not achieved.

Table 34–5 Pollutants retained by drainage system at airport site

Location	Suspended solids (%)	Phosphorous (%)	Nitrogen (%)
Guideline value	80	45	45
Basin 1 outlet (to Badgerys Creek)	79.3	58.2	45.4
Basin 2 outlet (to Badgerys Creek)	86.9	63.7	46.9
Basin 3 outlet (to Badgerys Creek)	87.1	63.4	46.4
Basin 4 outlet (to Badgerys Creek)	88.5	67.2	46.3
Basin 5 outlet (to Badgerys Creek)	56.3	42.4	31.9
Basin 6 outlet (to Oaky/Cosgroves Creek)	81.6	59.6	45.1
Basin 7 outlet (to Cosgroves Creek)	86.5	65.2	45.2
Basin 8 outlet (to Duncans Creek)	83.5	63.7	45.4
Basin 9 outlet (to Duncans Creek)	81.8	55.1	41.0

34.4.2.3 Pollutant concentrations

Pollutant concentrations are readily monitored and have a direct correlation with the relative health of waterways and ecosystems. Both the Airports (Environment Protection) Regulations 1997 (AEPR) and Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC) refer to pollutant concentrations in the setting of trigger levels and pollutant limits. To allow for climatic, topographic and other site-specific considerations, the AEPR and the ANZECC guidelines allow for the development of local standards or site specific trigger levels specific to the existing water quality and environmental values for the catchment as described in Chapter 18 (Volume 2a).

The predicted surface water quality discharges during the operation of the long term development were modelled at upstream, downstream and major outflow locations in and around the airport site. The results were compared with modelling of existing surface water quality discharges from the airport site to determine the impact of the long term development upon pollutant concentrations. The model results are summarised in Table 34–6 for comparison with ANZECC Guidelines default trigger levels for slightly disturbed ecosystems in lowland rivers, AEPR limits, and interim local site trigger levels 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 long term 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 trigger levels established for the airport catchment, the long term 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.

These results can be 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 development of 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 34–6 Surface water quality at the airport site and downstream

Location	Existing (mg/L)			Long term development (mg/L)		
	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	40	0.05	0.5	40	0.05	0.5
Interim local limits	23.2	0.92	6.2	23.2	0.92	6.2
Basin 1	22.1	0.14	1.54	↓13.0	↓0.11	↓0.88
Basin 2	22.1	0.09	1.25	↓13.3	↑0.11	↓0.91
Basin 3	21.9	0.09	1.26	↓10.6	↑0.11	↓0.84

Location	Existing (mg/L)			Long term development (mg/L)		
Basin 4	20.7	0.38	2.91	↓9.70	↓0.12	↓0.82
Basin 5	23.0	0.17	1.74	↓14.2	↓0.11	↓0.87
Basin 6	22.5	0.15	1.60	↓12.5	↓0.11	↓0.87
Basin 7	22.2	0.15	1.59	↓9.5	↓0.12	↓0.81
Basin 8	23.2	0.13	1.52	↓2.9	0.13	↓0.63
Basin 9	20.4	0.10	1.26	↓13.4	↑0.11	↓0.92
Badgerys Creek 1	21.5	0.14	1.48	↓15.0	↓0.12	↓0.98
Badgerys Creek 2	21.8	0.15	1.55	↓13.3	↓0.12	↓0.95
Badgerys Creek 3	21.9	0.15	1.55	↓13.3	↓0.12	↓0.95
Cosgroves Creek 1	22.7	0.15	1.61	↓12.5	↓0.12	↓0.94
Cosgroves Creek 3	22.5	0.15	1.58	↓12.8	↓0.12	↓0.95
Duncans Creek	22.1	0.14	1.54	↓14.8	↓0.12	↓1.04
Kemps Creek	21.0	0.13	1.45	↓13.9	↓0.12	↓1.01
Blaxland Creek	20.9	0.13	1.39	↓13.7	↓0.12	↓0.99

34.4.3 Reclaimed water irrigation

An estimated 15.4 ML of domestic wastewater per day would be generated during operation of the long term development. The wastewater may be treated and recycled through irrigation at the airport site, or transferred to an offsite sewage treatment system.

Specific treatment and irrigation methods would be determined during detailed design. Wastewater treatment at the airport site would be expected to utilise membrane biological reactor technology, which produces high quality reclaimed water suitable for beneficial reuses including irrigation.

The key risks to surface water and groundwater associated with the irrigation of reclaimed water would be runoff to surface water, or infiltration to groundwater.

These risks would be limited as appropriate management practices would be adopted, such as balancing storages and appropriate scheduling to avoid excessive irrigation. In addition, the reclaimed water would be of relatively high quality and with appropriate management would be unlikely to negatively impact on surface water and groundwater.

34.4.4 Groundwater

The long term development would have the potential to affect groundwater conditions through changes to groundwater recharge, groundwater drawdown and impacts on groundwater quality.

Groundwater drawdown would be anticipated as a result of airport site re-profiling and dewatering of excavations beneath the water table. The re-profiling would result in a lowering of groundwater levels in areas that currently have higher topographical elevation, and is anticipated to result in a slight reduction in groundwater flow rates. 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 drying up of the creeks from this activity.

The peripheries of the re-profiled area and establishment of basement levels in terminal buildings would result in exposed cuttings that would seep and require dewatering and management. Seepage volumes would be relatively small as a result of the inherent low hydraulic conductivities in the local geology.

Overall there is anticipated to be minimal change to local groundwater recharge or drawdown associated with the long term development of the site. The minor modification to groundwater conditions is not anticipated to result in impacts on any sensitive ecological receptors or beneficial uses of the groundwater system.

Groundwater seepage into building basements would need to be managed by pumping any 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. Significant groundwater inflows to underground infrastructure would not be 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. In the unlikely event of a significant leak or spill of contaminants, remediation would be implemented as soon as practicable.

Groundwater bores in the vicinity of the airport site are understood to target the Hawkesbury Sandstone aquifer. Direct impacts on this aquifer are not predicted as a result of the construction of the proposed airport. As such, there are no impacts during the long term development predicted to groundwater bore users.

34.5 Considerations for future development stages

Measures to manage potential impacts on surface water and groundwater would be similar to those implemented for the Stage 1 development, being adjusted or expanded as necessary according to the detailed assessment which would be undertaken for the long term development. Some of the key proposed measures include:

- refinement of the surface water drainage system, including outlet structures, during detailed design to improve flood and water quality performance as far as practicable;
- implementation of erosion controls in line with industry practice at the time of construction;

- design and operation of the waste water treatment and reclaimed water reuse scheme in accordance with relevant guidelines at the time of operation, or transport of waste water offsite to the Sydney Water treatment system;
- regular inspection and maintenance of the surface water drainage 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.

Water quality matters associated with the proposed airport would also be regulated under the AEPR or equivalent regulations in place at the time.

34.6 Summary of findings

The long term development would transform the southern portion of the airport site from a rolling grassy and vegetated landscape to a built environment. These changes would alter the catchment areas within the airport site and the permeability of the ground surface, which in turn would alter the duration, volume and velocity of surface water flows. The long term development would generally represent a continuation of the impacts identified for the Stage 1 development.

Hydrologic and hydraulic modelling of the airport site during operation indicates that there is a degree of variation in how the drainage system would respond to different storm events. The drainage system would generally be effective at mitigating watercourse and flooding impacts. Refinement of the modelled water management system would occur during detailed design of the proposed airport development.

Minor alterations to local groundwater recharge and drawdown are anticipated to occur at the airport site, along with the need for minor dewatering as a result of the establishment of building basements. Changes to groundwater conditions at the airport site are anticipated to be minor and are not expected to impact sensitive ecological receptors or beneficial uses of the groundwater system.