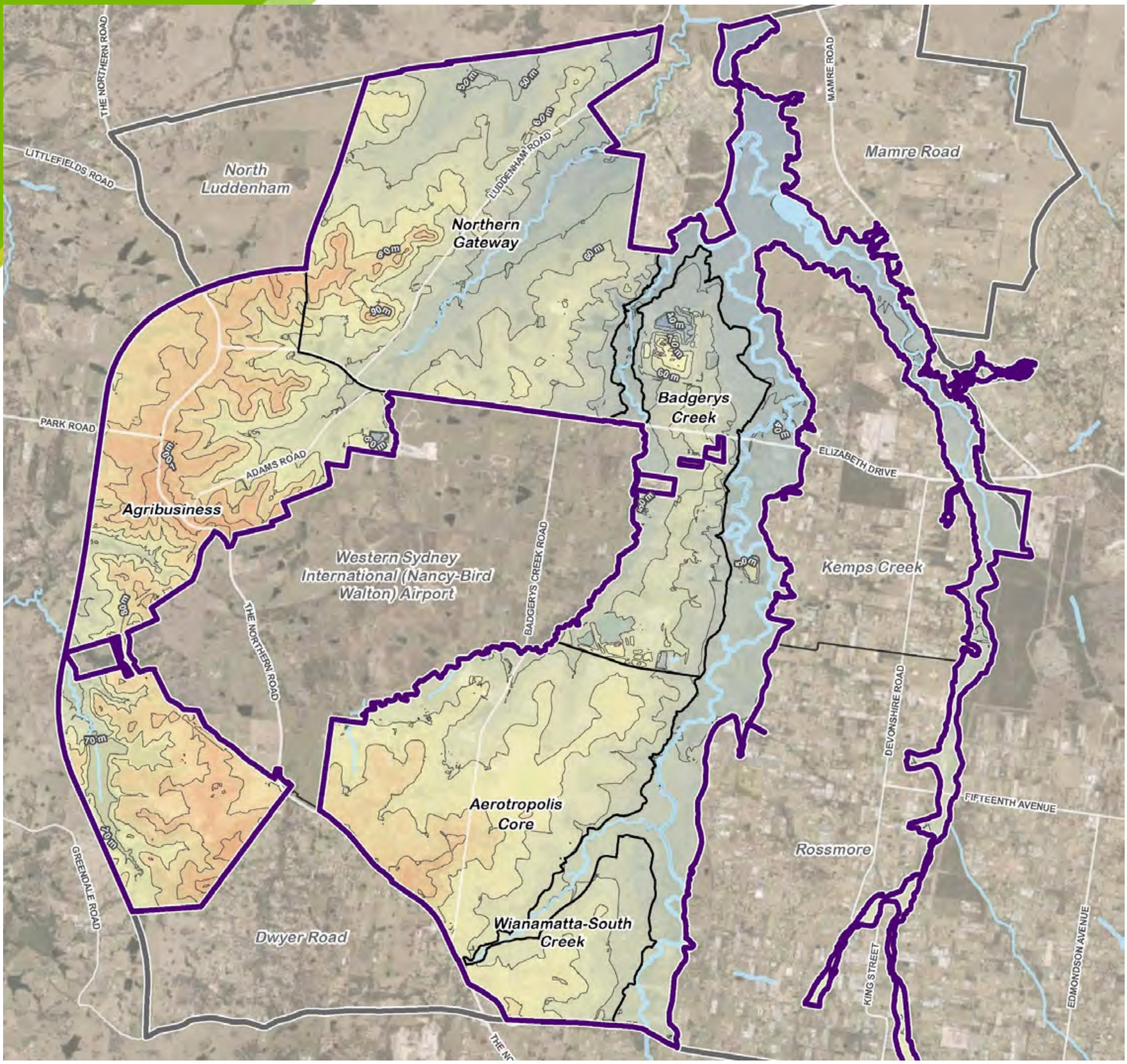


Draft Western Sydney Aerotropolis Constraints and Land Capability Assessment – Stage 1 Report

Client: Western Sydney Planning Partnership (WSPP)

Date: October 2020

aurecon
Bringing ideas to life

Executive Summary

This Stage 1 report has been prepared to consolidate the various studies used as input to the overarching Land Capability Assessment of the proposed Western Sydney Aerotropolis (WSA). The works will be used to inform decision making around initial Aerotropolis precinct planning, specifically relating to managing and enhancing the local environment and the Western Parkland City vision as described in the WSAP (2020).

The objectives of the project included:

- Identify and document existing soil and water conditions and land capability with respect to future urban development and precinct planning at a broad scale utilising several scenarios
- Identify constraints and opportunities specifically for groundwater, salinity, contamination and land capability to assess against scenarios for precinct planning
- Satisfy duty of care to future landowners and land managers by considering constraints and opportunities presented for precinct planning
- Ensure precinct planning advice adequately addresses NSW Government Policy requirements for land capability at the precinct planning level
- Prepare a report detailing the findings of the land capability assessment, which will support a future Local Environmental Plan or Development Control Plan for specific agreed urban development and precinct planning.

The Western Sydney Region is planned to undergo substantial transformation and growth over the coming decades. At this scale, the sustainability and success of the WSA can only occur through integrated land use and natural resource planning. Western Sydney Planning Partnership (WSPP), with key partners and stakeholders, has worked to develop the urban and transport vision and plans for the initial WSA precincts. These plans talk to the importance of delivering a high quality, liveable, resilient and sustainable city.

The key to activating the vibrancy, liveability and economy of the Western Sydney Region are the precincts that immediately surround the Western Sydney Airport. These precincts are the focus of this report and include the following initial precinct groupings:

- Aerotropolis Core
- Badgerys Creek and adjoining areas of Wianamatta-South Creek
- Northern Gateway
- Agribusiness

The Northern Gateway precinct covers an area of approximately 1,616 ha and is located within the current Liverpool LGA. The precinct is bisected from South-West to North-East by Cosgrove Creek.

The Agribusiness precinct is located west of the Western Sydney International Airport site and covers an area of approximately 1,560 ha. The precinct is characterised by a large network of interlinked drainage paths and creeks, the most prominent of which is Duncans Creek flowing from south to north along the western boundary of the precinct. The upper reaches of Cosgrove Creek drain the Northern section of the precinct.

Badgerys Creek is the smallest of the four urban precincts included in the current study covering an area of approximately 634 ha. The precinct is located east of the Western Sydney International Airport site.

The Aerotropolis Core is the southernmost precinct, spanning an area of approximately 1,382 Ha. The site is bounded by the Western Sydney International Airport and Badgerys Creek precinct to the north and the Wianamatta-South Creek precinct to the east.

Wianamatta-South Creek precinct borders the three major river systems comprising the South Creek catchment (South Creek, Kemps Creek and Badgerys Creek), covering an area of approximately 1,330 Ha.

Agricultural land capability

Constraints within the WSA for agricultural land use are generally moderate to high with localised areas of very high constraint around waterways. The results reflect a combination of constraint factors identified which have been weighted according to relative importance on agricultural activities.

The results from this assessment are in broad agreement with existing studies and should be used as a complementary mapping product, as the outputs incorporate landscape and soil property factors that have been previously unaccounted for in assessing land capability for agricultural development, along with local scale limitations derived from various restrictive land facets (e.g. wetlands, transport corridors, flood zones), and a weighted scale for constraints analyses.

The mapping products are limited by the relative scales of information used to assess the constraints, however local scale field investigations have been used to valid some of the baseline data, with results showing broad agreement with the input maps.

The specific constraints are presented as individual maps throughout this assessment. The specific constraints may be considered independently and cumulatively in better understand land capability within the WSA precincts. For example, areas of moderate soil fertility may also coincide with areas of high overall constraint due to the interplay of other factors such as slope, soil physical properties, and salinity risk.

The specific constraints associated with agricultural land use within the WSA have been discussed as part of this assessment. These constraints may be overcome through appropriate land management practices.

Urban land capability

Constraints within the WSA for urban land use are generally moderate with areas of high constraint around waterways and within steeply sloping areas of the Agribusiness precinct. The results reflect a combination of constraint factors identified which have been weighted according to relative importance on urban development and land use.

The results from this assessment are in broad agreement with existing studies and should can used as a complementary mapping product as the outputs incorporate landscape and soil property factors that have been previously unaccounted for in assessing land capability for urban development, along with local scale limitations derived from various restrictive land facets (e.g. wetlands, transport corridors, flood zones), and a weighted scale for constraints analyses.

The mapping products are limited by the relative scales of information used to assess the constraints, however local scale field investigations have been used to valid some of the baseline data, with results showing broad agreement with the input maps.

The specific constraints are presented as individual maps throughout this assessment. The specific constraints may be considered independently and cumulatively in better understand land capability within the WSA precincts. For example, areas of moderate soil fertility may also coincide with areas of high overall constraint due to the interplay of other factors such as slope, soil physical properties, and salinity risk.

The specific constraints associated with urban land use within the WSA have been discussed as part of this assessment. These constraints may be overcome through appropriate land development and management practices.

A series of baseline summary management measures that can be used to manage land capability aspects in the WSA precincts has been presented in this report.

A series of management measures for salinity and precinct planning are presented. Recommendations are made for appropriate management actions in specific elements of the landscape in each HGL.

Contamination risks and constraints have been assessed and mapped with future contamination site investigation recommendations provided.

Contents

Appendices

Figures

Tables

1 Introduction

1.1 Purpose of report

This Stage 1 report has been prepared to consolidate the various studies used as input to the overarching Land Capability Assessment of the proposed Western Sydney Aerotropolis (WSA). The works will be used to inform decision making around initial Aerotropolis precinct planning, specifically relating to managing and enhancing the local environment and the Western Parkland City vision as described in the WSAP (2020).

The objectives of the project include:

- Identify and document existing soil and water conditions and land capability with respect to future urban development and precinct planning at a broad scale utilising several scenarios
- Identify constraints and opportunities specifically for groundwater, salinity, contamination and land capability to assess against scenarios for precinct planning
- Satisfy duty of care to future landowners and land managers by considering constraints and opportunities presented for precinct planning
- Identifying potential contamination constrained development sites and recommendations for further investigations, including a map of areas for further investigation
- Ensure precinct planning advice adequately addresses NSW Government Policy requirements for land capability at the precinct planning level
- Prepare a document detailing the findings of the land capability assessment, which will support a Local Environmental Plan or Development Control Plan for specific agreed urban development and precinct planning options.

1.2 Project overview

The Western Sydney Region is planned to undergo substantial transformation and growth over the coming decades. At this scale, the sustainability and success of the WSA can only occur through integrated land use and natural resource planning. Western Sydney Planning Partnership (WSPP), with key partners and stakeholders, has worked to develop the urban and transport vision and plans for the region. These plans talk to the importance of delivering a high quality, liveable, resilient and sustainable city.

The Western Sydney Aerotropolis Plan (WSAP) sets the planning framework for the WSA. This Plan draws on the collaborative work being undertaken across the three levels of government and responds to the submissions received on the Stage 1 LUIIP. The WSAP will set the vision for the Aerotropolis as Greater Sydney's next global gateway with new jobs and places to learn within a cool, green and connected Parkland City. As part of the project WSPP will develop a high-level Structure Plan and land use plan for all precincts to guide precinct planning and subsequent master planning.

With projections of more than a million residents and 200,000 workers in the new Western Parkland City, this growth presents an opportunity to make large-scale changes to the natural amenities, encouraging individual choices to support sustainable and liveable city growth. The key to activating the vibrancy, liveability and economy of the Western Sydney Region are the precincts that immediately surround the Western Sydney Airport. These precincts are the focus of this report and include the following initial precinct groupings:

- Aerotropolis Core, Badgerys Creek and adjoining areas of Wianamatta-South Creek
- Northern Gateway
- Agribusiness.

Business as Usual (BAU) development – sprawling suburbs, large homes, small lots, land clearing and levelling would generate stormwater discharges that could damage the South Creek channel, its banks and natural systems and wildlife in this catchment.

A BAU approach to urbanisation of the catchment could produce:

- Hot urban areas
- Poor protection of vulnerable groundwater resources
- Cumulative development contribution to sustained salinity risk via discharge resulting in physical damage to infrastructure and community assets
- Poor walkability and fewer opportunities for genuine social connection – air quality and noise impacts
- Poor tree canopy (less than the 40% target for Metropolitan Sydney)
- Poor sense of place and local identity
- Damage to water ways, intact vegetation and biodiversity and indigenous history and connection.

The Western Parkland City proposes a new model of urban development – urban typologies to support business technologies, and new approaches to stormwater and recycled water use to overcome evolving climate challenges. The soils of Western Sydney have long been viewed as a constraint. The land capability study is aimed at identifying land properties that need to be considered and potentially managed to ensure risks related to urban development, stormwater management practices and recycled water use are adequately mitigated in the landscape.

1.3 Study limitations

The scope of work encompasses several standalone studies which have subsequently been consolidated to inform constraints and opportunity assessment for precinct planning. The studies and information used for precinct planning have been derived from publicly available sources of data at a scale and resolution suitable to inform precinct planning where detailed site investigations have not been undertaken to date. Further land capability site investigations and sampling of soils and waters to assess land and water constraints and opportunities will be required in the future for master planning and development within the initial precincts.

2 Study area

2.1 Regional setting

The study area delineated for the current WSA Constraints and Land Capability Assessment focuses on the initial precinct groupings:

- Aerotropolis Core, Badgerys Creek and adjoining areas of Wianamatta-South Creek
- Northern Gateway
- Agribusiness.

These areas are indicated in Figure 2-1 in relation to the Greater Sydney Metropolitan Area. The Aerotropolis includes 10 precincts, however, will eventually cover a far wider area, however, for the purposes of this assessment this grouping of initial precincts will be called the 'initial Aerotropolis Precincts'.

East-west green links will connect the South Creek parklands to Kemps Creek and further east to the Western Sydney Parklands, offering recreational opportunities such as walking trails, picnic grounds, working farms, water sports and mountain biking tracks. A network of new roads and transport corridors will be developed as parkways to create vegetated corridors.

2.2 Initial precincts in the Aerotropolis

The current study focusses on the precincts directly bordering the Western Sydney International Airport site, these precincts are the focus of this report and are indicated in Figure 2-2.

2.2.1 Northern gateway

The Northern Gateway precinct covers an area of approximately 1,616 ha and is located within the current Liverpool LGA. The precinct is bisected from South-West to North-East by Cosgrove Creek. The primary through road currently, running mostly adjacent to the Creek, is Luddenham Road, however the future M12 Motorway will traverse the precinct from West to East and the North-South Rail line will cross it north to south.

The current typologies planned for the Northern Gateway is a mix between High Density Residential in the North-West, bounded by Business Park space to the east and strata industrial to the south as indicated in Figure 2-3. Note that this figure and future precinct planning directions are subject to change and amendment, inclusion of the figure is for information only as an example of broad scale precinct planning.

2.2.2 Agribusiness

The Agribusiness precinct is located west of the Western Sydney International Airport site and covers an area of approximately 1,572 ha. The precinct is characterised by a large network of interlinked drainage paths and creeks, the most prominent of which is Duncans Creek flowing from south to north along the western boundary of the precinct. The upper reaches of Cosgrove Creek drain the Northern section of the precinct.

The bulk of the precinct is zoned for small scale agricultural practices, with a portion in the north-east demarcated for future industrial development as indicated in Figure 2-3.

2.2.3 Badgerys creek

Badgerys Creek is the smallest of the four urban precincts included in the current study covering an area of approximately 612 ha. The precinct is located east of the Western Sydney International Airport site with parcels of land demarcated for airport infrastructure located crossing the centre of the precinct as shown in Figure 2-3.

Elizabeth Drive splits the precinct into north and south with the latest zoning indicating Industrial development north of Elizabeth Drive and Business Parks/Commercial developments south. The proposed M12 Motorway will bisect the precinct through its northern tip.

2.2.4 Aerotropolis core

The Aerotropolis Core is the southernmost precinct, spanning an area of approximately 1,382 Ha. The site is bounded by the Western Sydney International Airport and Badgerys Creek precinct to the north and the Wianamatta-South Creek precinct to the east.

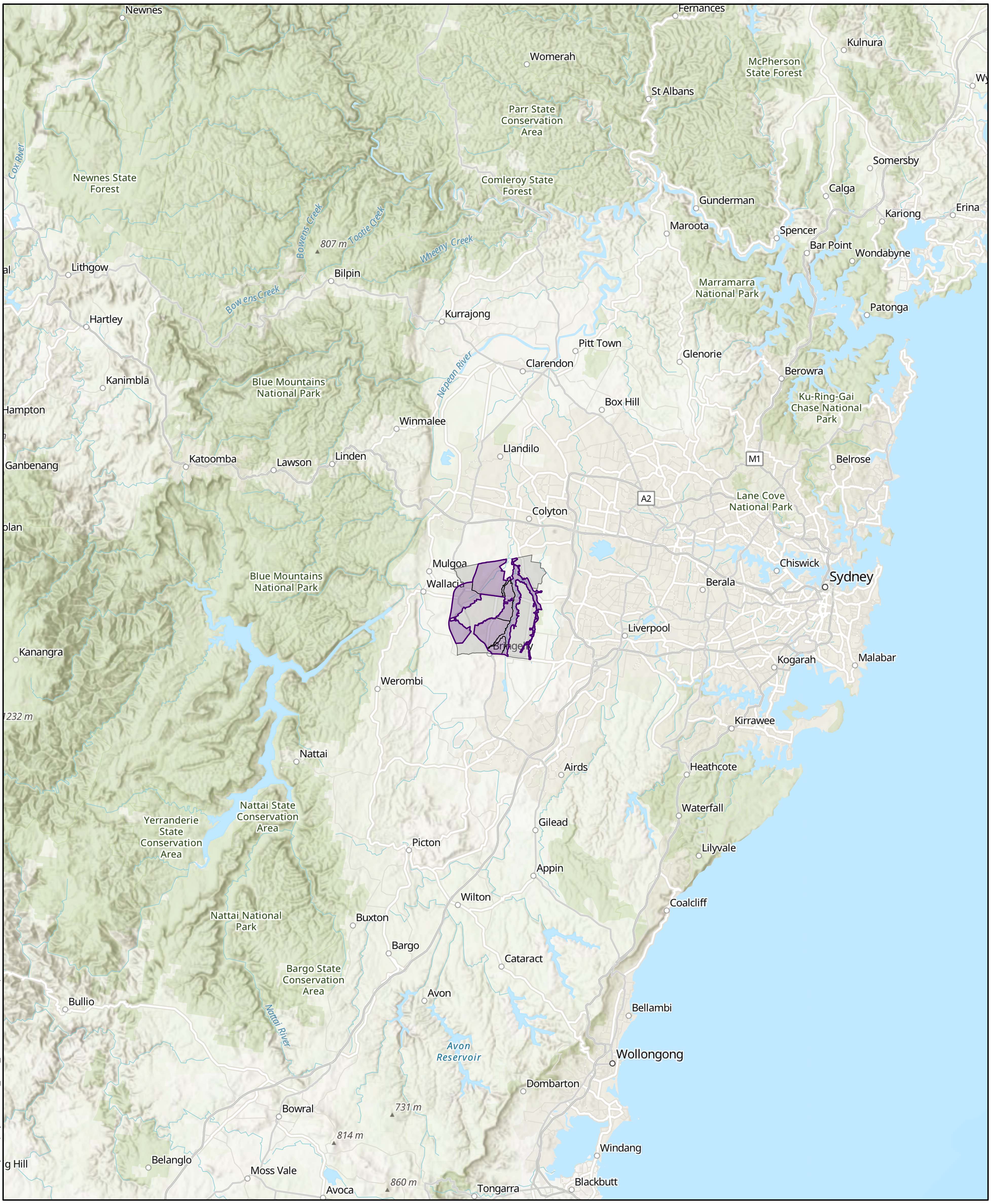
Currently the site is zoned for flexible employment adjacent to the Airport site, expanding into mixed flexible employment to the south as depicted in Figure 2-3. Note that this figure and future precinct planning directions are subject to change and amendment inclusion of the figure is for information only as an example of broad scale precinct planning. Land use is earmarked for several purposes ranging in advanced manufacturing to urban residential, with professional services, recreational space and trademark greenfield areas dissecting the urban typology. The North-South Rail Line (NSRL) is planned to connect the Aerotropolis core to the international airport northbound and South-West Rail Link Extension southbound.

2.2.5 Wianamatta-South creek

Wianamatta-South Creek precinct borders the three major river systems comprising the South Creek catchment (South Creek, Kemps Creek and Badgerys Creek), covering an area of approximately 1,392 Ha.

The precinct is devoted to environment and recreational zoning as illustrated in Figure 2-3. Key features may include water management facilities, greenspace, pedestrian and cycleway infrastructure, community and cultural centres and hospitality services.

aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\ArcPro\ArcPro.aprx\JOB No.\21-06-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area
Precinct boundary

Source: Aurecon, DPIE, NSW Spatial Services, ESRI

A3 scale: 1:500,000
0 10 20 km

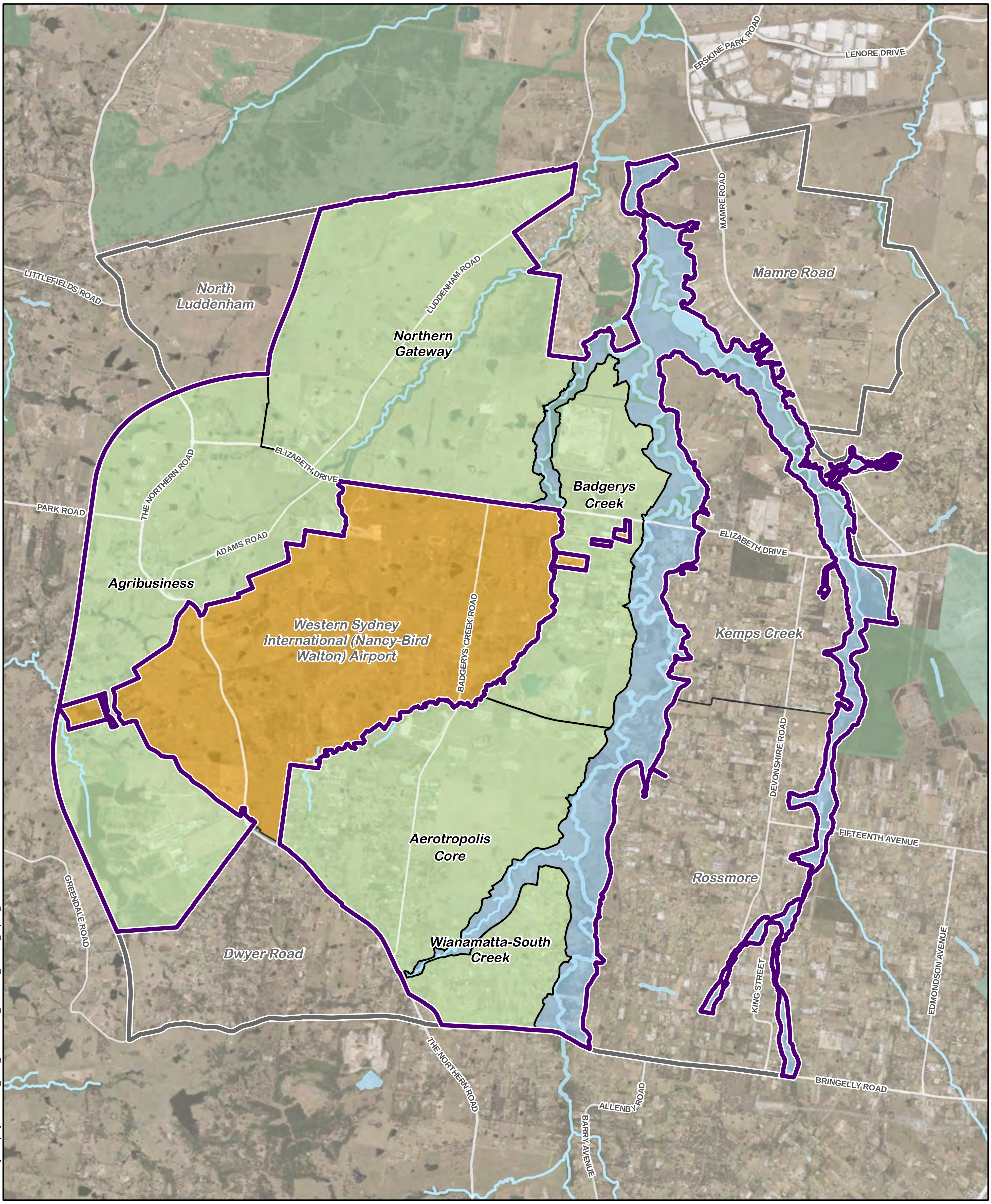
Date: 21/06/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Figure 2-1: Study Area – Regional Setting

aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Precinct_Layout_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

- Study area
- WSA Growth Area boundary
- Western Sydney International (Nancy-Bird Walton) Airport
- Initial Precincts
- Wianamatta-South Creek Precinct
- Low Priority Area

Base Data

- Watercourse
- National Parks & Reserves
- Western Sydney Parklands

Source: Aurecon, DPIE, NSW Spatial Services, ESRI

A3 scale: 1:55,000

0 1 2 km

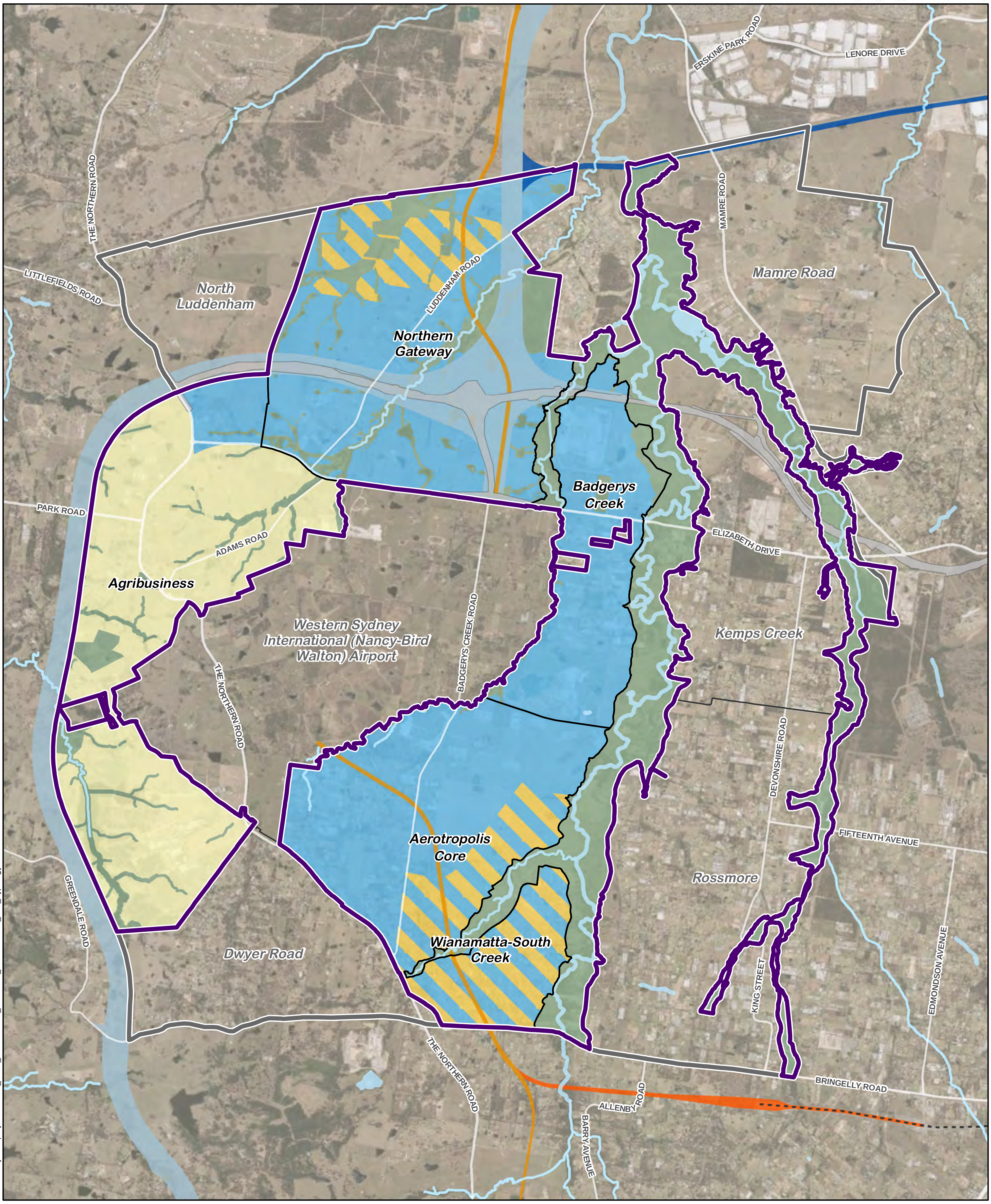
Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis Constraints and Land Capability Assessment

Figure 2-2: Study Area Precinct

aurecon



Study area
WSA Growth Area boundary
Precinct boundary

Base Data
Watercourse
Existing railway

Proposed Land Use
Agribusiness
Environment and Recreation
Flexible Employment
Mixed Flexible Employment & Urban Land

Future Transport Corridors
Outer Sydney Orbital
NSRL
South West Rail Link Extension
Western Sydney Freight Line
M12 Corridor

Source: Aurecon, DPIE, NSW Spatial Services, ESRI

A3 scale: 1:55,000
0 1 2 km

Date: 15/10/2020
Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis Constraints and Land Capability Assessment

Figure 2-3: Aerotropolis Precincts – Infrastructure and Typology

2.2.6 Precincts summary

Table 2-1 provides a summary of early typology vision and desirable land uses for the precincts.

Table 2-1 Precincts Summary

Precinct	Area (Ha)	Typology	Desirable land use*
Northern Gateway	1,616	Business Park High Density Residential Strata Industrial	High technology commercial enterprise/ industry, warehousing and logistics, education, offices, retail, residential, health services, entertainment, tourism facilities, cultural and creative industries, green public and private open spaces, recreation and visitor accommodation.
Agribusiness	1,560	Agriculture	Agribusiness, Agriculture, Intensive fresh and value-added food production, Food innovation technology and research, Food production and processing, Fresh food produce markets, Warehousing and logistics, High technology Industry, Ancillary rural residential, Complementary offices and retail, Education, Circular economy enabling infrastructure, Biosecurity enabling infrastructure, Integrated logistics hub.
Badgerys Creek	634	Commercial Industrial OR Enterprise	Defence and aerospace, advanced manufacturing activity, high technology industry, airport supporting development, local retail, Aerotropolis enabling industries, modernised resource recovery industries, light industrial, social infrastructure.
Aerotropolis Core	1,382	Business Park /Commercial Regional Parkland (Under Investigation)	Advanced manufacturing, defence and aerospace, research and development activity, high technology industry and infrastructure, education (including vocational and tertiary education); professional services, business incubator hubs, creative industries including 'popup installations' and festivals/events, commercial offices, food and beverage, indoor and outdoor recreation and sports facilities, medium to high density residential near the Metro station; retail, community; civic, entertainment, cultural facilities; green open and public space on public and private lands; public and private medical services, visitor accommodation.
Wianamatta-South Creek	1,330	Environment and Recreation	Water management, Open space, Recreation facilities, Pedestrian and cycle connectivity, Community and cultural facilities, environment protection, water management and restaurants or cafes.

*Western Sydney Aerotropolis Plan (WSPP, 2020)

2.3 Precincts drive through inspections

A series of photographs showing typical precinct landscapes and ground conditions is presented in **Appendix B** which was undertaken in July and September 2020. The photographs provide an understanding of current landscape conditions and typical land uses across the initial precincts and where required annotations on contamination risks. Due to site access constraints and social distancing requirements, no site inspections of specific allotments or industry was undertaken.

3 Background information and reports

Numerous studies have been conducted to develop an understanding of the Western Sydney landscape, current as well as historic. Many of these, and most relevant to the current Land Capability Assessment, have been focussed on supporting the proposed urban development within the current environment and landscape context.

The most relevant studies and their primary outcomes are discussed below. It should be noted that not all studies have been specifically endorsed by NSW Government and information within them has been used to fill data and information gaps for the project objectives.

3.1 Land capability assessment in Australia and New South Wales

*Land capability is the inherent physical capacity of the land to sustain a range of land uses and management practices in the long term without degradation to soil, land, air and water resources (*see Dent and Young 1981; Emery 1986; Sonter and Lawrie 2007) (OEH, 2012).

In Australia, land capability assessments are adopted differently in each state. The typical approaches are based on integration of empirical measurements, experience and intuitive judgements.

Land capability assessments are typically encompassed under a qualitative decision framework adopting broad descriptions of land capability or suitability class definitions. Evaluations are commonly based on limitations (constraints), utilising multiple constraints to provide an overall land classification.

This integrated semi-quantitative framework has been used and built upon for the purpose of this project in undertaking the assessment of land capability for the WSA, which can broadly be divided into areas of agricultural and urban land use.

3.1.1 Rural land capability mapping – Land and Soil Capability Scheme

NSW Office of Environment and Heritage (2012)

In New South Wales (NSW), two systems have typically been employed in undertaking assessments of the agricultural capability of landscapes: The rural land capability system – developed by the former NSW Soil Conservation Service (SCS) (Emery, 1985); and the agriculture suitability system developed by the NSW Department of Agriculture (Department of Agriculture, 1983). More recently the NSW Office of Environment and Heritage developed a mapping method and rule set which built on the rural capability and classification mapping by the former NSW SCS, but with more emphasis on a broader range of soil and landscape properties.

The current land and soil capability (LSC) mapping developed by the NSW OEH is based on an eight-class system of landscape limitations with values ranging between 1 (very slight to negligible limitations) and 8 (extreme limitations). The definitions for each LSC class are presented in Table 3-1.

Table 3-1 LSC Scheme Land and Soil Capability Classes and General Definitions (OEH, 2012)

LSC Class	General Definition
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation)	
1	Extremely high capability land: Land has no limitations. No special land management practices required. Land capable of all rural land uses and land management practices.
2	Very high capability land: Land has slight limitations. These can be managed by readily available, easily implemented management practices. Land is capable of most land uses and land management practices, including intensive cropping with cultivation.

LSC Class	General Definition
3	High capability land: Land has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation, using more intensive, readily available and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)	
4	Moderate capability land: Land has moderate to high limitations for high-impact land uses. Will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology.
5	Moderate–low capability land: Land has high limitations for high-impact land uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.
Land capable for a limited set of land uses (grazing, forestry and nature conservation, some horticulture)	
6	Low capability land: Land has very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation
Land generally incapable of agricultural land use (selective forestry and nature conservation)	
7	Very low capability land: Land has severe limitations that restrict most land uses and generally cannot be overcome. On-site and off-site impacts of land management practices can be extremely severe if limitations not managed. There should be minimal disturbance of native vegetation.
8	Extremely low capability land: Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation. There should be no disturbance of native vegetation.

The LSC assessment scheme concentrates on the assessment of the likely degradation hazards associated with implementing a broad agriculture land use on an area of land. The objective of the LSC assessment scheme is to prevent on-site and off-site environmental degradation. The scheme generally applies to low-intensity, dry-land agriculture, however it can identify some of the hazards that may influence more intense land uses. The LSC assessment scheme has the capacity to be applied at the paddock, farm, regional, and state scale and relies on general land, climate and soil information (OEH, 2012).

The LSC scheme defines LSC classes based on bio-physical land features which determine the on-site and off-site constraints and hazards associated with the land; including soil type, slope, landform position, acidity, salinity, drainage, rockiness (stoniness) and climate. The main hazards and limitations defined in the LSC scheme are:

- Water erosion (including sheet, rill, and gully erosion)
- Wind erosion
- Soil structure decline (sodicity)
- Soil acidification, salinity
- Waterlogging
- Stoniness and shallow soils
- Mass movement.

In the LSC scheme, classes are applied for these individual hazards with the overall LSC classification is based on the most limiting class (OEH, 2012).

The LSC class will give an indication of the land management practices that can be applied to a parcel of land without causing degradation of the land and soil on-site, and to the environment, ecosystems and infrastructure off-site (OEH, 2012).

A number of other landscape constraints not addressed in the LSC scheme include:

- Fertility: A function of nutrient content (major and trace elements), cation exchange capacity (CEC), leaching potential, soil chemistry, (including pH, phosphorous absorption capacity, presence of carbonates) (Sanchez, 2003)

- Slope: In conjunction with water erosion, directly affects land capability through its effect on trafficability
- Acid sulfate soil risk: Hazardous soils that generally occur in estuarine environments are a major constraint to land uses that involve excavation or disturbance of soils
- Land contamination: Chemical substances or wastes that are present in the soil at levels above what would be expected to naturally occur – directly affects land capability through its effect on soil quality and subsequent risks to human health / environment.
- Groundwater contamination: Chemical substances or wastes that are present in groundwater at levels above what would be expected to naturally occur– directly affects land capability through its effect on groundwater quality and subsequent risks to human health / environment
- Groundwater resource: Defined by both groundwater yield (extraction capacity) and overall quality (salinity and chemistry) – directly affects land capability through available resource for irrigation and other water resource requirements.
- Surface water resource (available flow and quality): defined by flows available for extraction and overall quality (salinity and chemistry) – directly affects land capability through available resource for irrigation and other water resource requirements
- Protected areas: Including protected wetlands, riparian corridors, conservation areas, national parks and reserves, and ecologically significant areas – excludes certain areas from consideration
- Easements and Transport Corridors: Including utilities easements, rail and road transport corridors– excludes certain areas from consideration.

It is important to recognise that the scheme provides guidance only on the physical capability of the land to support different agricultural land uses. It does not address ecological or socioeconomic issues that will influence the ultimate land-use decision over an area, such as environmental conservation areas, transport corridors.

3.1.2 Urban land capability mapping – NSW Soil Landscape Mapping

Bannerman and Hazelton (2011); Hazelton et al (2011)

An Urban Capability Scheme (UCS) for NSW was developed by the Soil Conservation Service (SCS) (Hannam and Hicks, 1980), independent of the rural land capability system. The scheme developed by the SCS comprised a qualitative assessment scheme, with overall land capability ratings based on single limiting factors.

The UCS scheme has been adopted further developed by the NSW Soil Landscape Mapping Series (Bannerman and Hazelton, 2011) The NSW Soil Landscape Mapping defines urban capability as: "*the ability of a parcel of land to support a certain intensity of urban development without serious erosion and sedimentation occurring during construction, as well as possible instability and drainage problems in the long term*".

The NSW Soil Landscape Mapping series identifies and maps major soil landscapes by qualities and constraints; integrating both landscape and soil limitations into single units with relatively uniform land management requirements.

The NSW Soil Landscape Mapping Reports (Bannerman and Hazelton, 2011) include a summary of general limitations associated with each soil landscape, including:

- Slope stability: Steep slopes, mass movement hazard, rockfall hazard
- Drainage: Flood hazard, waterlogging, permanently and seasonally high water tables
- Erosion: Water erosion hazard, wind erosion hazard, wave erosion hazard
- Soils: Shallow soil, non-cohesive soils, surface movement potential

The mapping reports also include a summary of physical and chemical soil limitations associated with each soil landscape, including:

- Physical limitations: Wet strength, shrink-swell potential, organic matter, stoniness
- Erosion: Sodicity, erodibility, hardsetting surfaces
- Permeability: High permeability, low permeability
- Toxicity: Acidity, alkalinity, salinity, aluminium toxicity
- Fertility: Fertility, available water capacity

The urban capability statements prepared as part of the NSW Soil Landscape Mapping account for the landscape limitations and are intended for regional (strategy) planning purposes; however, it is acknowledged that the information may be of sufficient detail for the planning of small scale, low value, low impact developments.

Under the NSW Soil Landscape Mapping scheme, urban capability classes are ranked and described as follows:

- Low (minor) limitations: represent areas with little or no physical limitations. Standard building designs may be used. These areas are generally classified as “high capability for urban development”.
- Moderate limitations: may influence design and impose certain management requirements on developments to ensure a stable land surface is maintained during and after development. These limitations can be overcome by careful design and adoption of site management techniques that ensure land surface stability. These areas are generally classified as “low to moderate capability for urban development”
- High (to severe) limitations: indicate areas with limitations that are difficult to overcome, requiring detailed site investigation and engineering design. Some areas may be so unsuitable for urban development that they are best left undisturbed. These are generally classified as “Not capable of urban development”.

Owing to the relative coarseness of the NSW Soil Landscape Mapping, further local data through semi-detailed investigations and/or detailed investigations are required to enable district, project, or local scale capability assessments for refinement of planning decisions.

3.1.3 Soil and land constraint assessment maps: Hawkesbury Nepean Catchment

Department of Environment Climate Change and Water (2010)

In 2010 the Department of Environment Climate Change and Water (DECCW) in NSW developed a series of land capability maps for the Hawkesbury-Nepean catchment using a soil and land constraint-based system integrated with geospatial information systems (GIS).

Data for the assessment was derived from available 1:100,000 soil landscape maps and reports, digital elevation models, acid sulfate soil risk mapping and erosion hazard modelling. The outputs from this assessment comprised a series of 25m x 25m digital raster maps with z values scaled according to overall level of constraint for each pixel (Scaled from 1 (low) to 15 (high).

A number of constraints-based mapping outputs were developed to broadly reflect a range of standard land uses zones that may be present within a local environment plan (LEP). The outputs included:

- Standard residential development (zones RU5, R1, R2)
- Medium density residential development (zones R2, R3, B1, B2, IN2, B4, IN4, SP3)
- High density residential development (zones R4)
- High density development (zones B5, B3, B7, IN1, IN3)
- Rural residential (zones R5, RU6)
- Agriculture – cropping / cultivation (Zone RU1)

- Agriculture – grazing (Zone RU1)
- Wastewater disposal – irrigation / trench absorption / pump out systems

The mapping products accounted for the relative impact of landscape and physical / chemical soil limitations on each standard development category.

The landscape constraints considered as part of the assessment included: steep slopes, water erosion hazard, flood hazard, acid sulfate soils, mass movement, wave attach, poor site drainage / waterlogging, general foundation hazard, shallow soils, and rock outcrop. Soil physical constraints included: Shrink-swell potential, low soil strength, low or high permeability, plant available water holding capacity, and stoniness. Soil chemical constraints included:

The mapping did not account for classification of areas under rural small holdings, forestry, infrastructure, rural landscapes, special activities, recreation, waterways, national parks or environmental conservation / management areas.

All data used to inform the assessment were derived from the NSW Soil Landscape Mapping sheets and reports (Hazelton et al., 2011); with the exception of topography, erosion hazard, acid sulfate soil risk and flooding, which were derived from other information sources.

3.1.4 Urban Salinity Management in the Western Sydney Aerotropolis Area (Derived from Western Sydney Hydrogeological Landscapes (2011)), Department of Planning, Industry and Environment, October 2020

This report was prepared to support planning processes for delivery of Stage 1 of the Western Sydney Aerotropolis. It focuses on management of urban salinity in the Western Sydney Hydrogeological Landscapes (HGL), where there is a high risk of salinity hazard impacts on both the built form (such as buildings and roads), and water dependent ecosystems that make up the blue-green grid.

3.1.5 Soil and Land Resource Mapping for the Western Sydney Aerotropolis Area (Derived from Soil and Land Resources of the Hawkesbury Nepean Catchment (2008)), Department of Planning, Industry and Environment, October 2020

This report was prepared to support planning processes for Stage 1 of the Western Sydney Aerotropolis. The report identifies soil and landscape constraints and qualities present in the Soil and Land Resources of the Hawkesbury Nepean Catchment (HNP) that occur in the Western Sydney Aerotropolis area and discusses differences between this latest soil landscape mapping and the earlier published *Soil Landscapes of the Penrith 1:100,000 sheet* product in 1990, which belonging to the Soil Landscape Series.

Given the Western Sydney Aerotropolis study area, the report focuses on constraints and qualities most relevant to the management of urban environments rather than requirements for extensive agriculture.

3.1.6 South Creek Land Capability Assessment for Irrigation Purposes

Aurecon (2019-2020)

The objective of the land capability assessment was to assess the physical capacity of the land to sustain a variety of land uses over the long term without compromising the integrity of the land across the South Creek Catchment area. Specifically, the potential impacts of recycled irrigation water from existing and planned Sydney Water wastewater facilities.

The project was delivered in two phases with the potential for a future monitoring program pending the outcomes of phase 1 and 2 as outlined below:

Phase 1 (2019)

Phase 1 consisted of a high-level preliminary desktop study with the primary objective of determining the suitability for recycled water irrigation in the South Creek catchment area. Parameters assessed included: land capability (using landscape and catchment data) for irrigation; current and future land zoning and typology; and infiltration-runoff modelling (MEDLI) to determine the potential volumetric irrigation capacity.

A key output from the phase one assessment was the development of a recycled water irrigation potential suitability map (shown in Figure 3-1), incorporating data from four relevant geographical datasets:

- The soil landscapes
- The hydrological groups of soils in NSW
- The hydrogeological landscapes, and
- Known and potential salinity occurrence areas and constraints.

The irrigation suitability within the WSA surrounding precinct study area show a dominance of "least suitable" and "less suitable" landscapes surrounding the Northern Gateway, Badgerys Creek, Aerotropolis Core and the Wianamatta-South Creek precincts. "More suitable" land was also characterised for majority of the Agribusiness precinct with minor portions of "less suitable" land to the north west and south west.

Phase 2 (2020)

The Phase 2 report was devised in response to the limitations and next steps characterised in the Phase 1 report. Focus was placed on ground-truthing the in-situ soil and groundwater conditions to support irrigation suitability and to also validate MEDLI modelling inputs.

Results from the Phase 2 assessment generally aligned with the Phase 1 irrigation suitability model outlined above. From all physical and chemical tests conducted, at least one irrigation suitability parameter was identified in each case as a potentially limiting factor in the implementation of sustainable irrigation practices. Interestingly, even the "more suitable" areas presented potentially limiting results. The suitability classes strongly align with salinity risks, with the "least suitable" classes exhibiting more exceedances in parameters such as saturated extract (EC_e) and Chloride concentrations. Limitations presented within the "more suitable" soil representative samples specifically related to acidity and structure (sodicity), which could lead to structural degradation, waterlogging and reduced optimum plant growth.

Overall conclusions indicated the data obtained through the Phase 2 field verification study has supported the findings of the Phase 1 desktop assessment and therefore, the identified risks remain valid and the implicit hazard level also amplified.

3.2 Vision for a green city

The Aerotropolis is in one of the warmest parts of Greater Sydney and heat can impact the health and lifestyle of residents and workers. The network of waterways offers the potential to create greater environmental, social and amenity benefits through strategies and solutions to mitigate urban heat.

- *Western Sydney Aerotropolis Plan* (WSPP, 2020)
- *Urban Cooling Review: South Creek* (Gallagher Studio and Studio Zanardo, 2020)

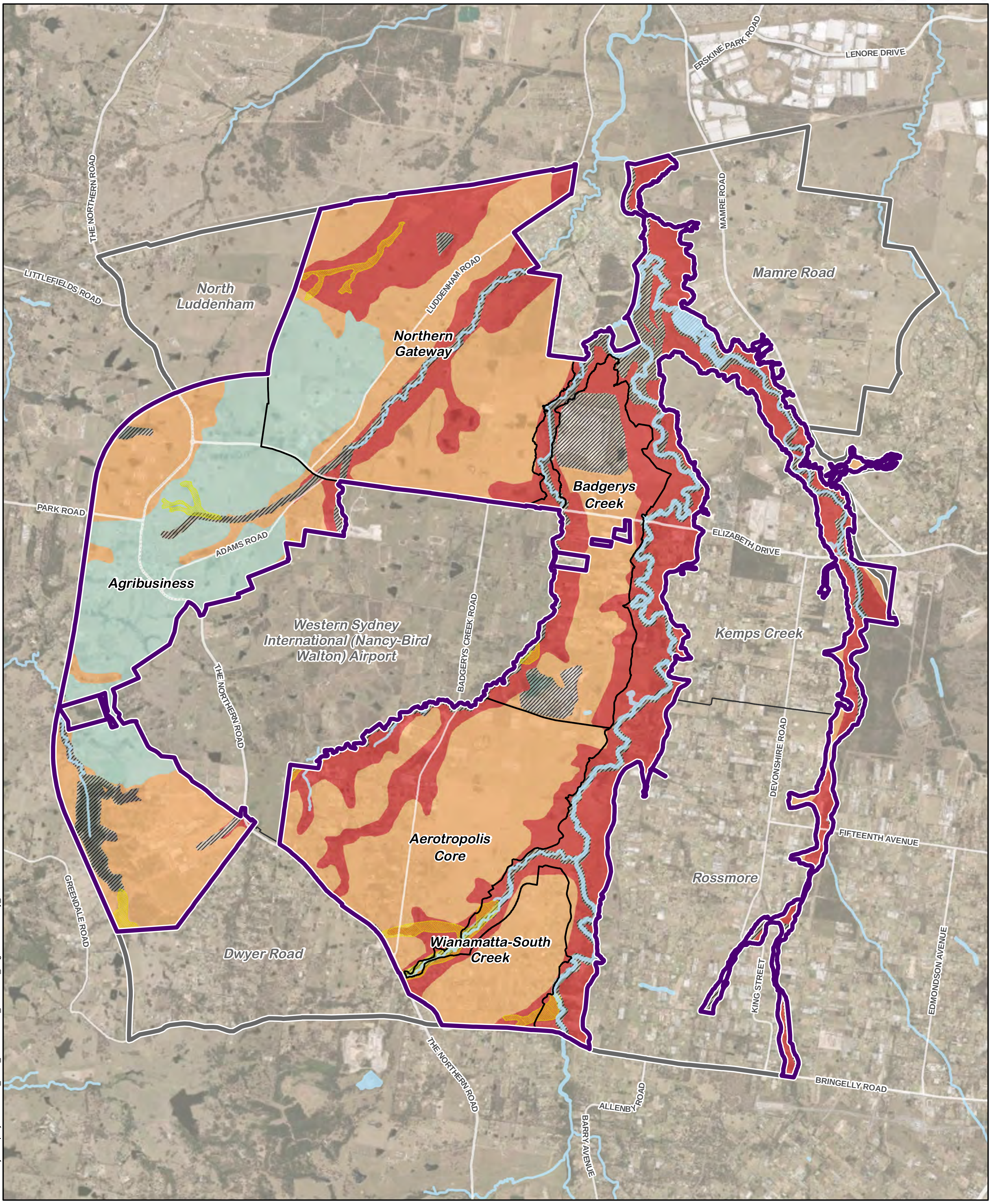
3.3 Environmental obstacles to manage

Western Sydney is known for its inherent salinity risks due to a combination of physical properties and more recent land management practices.

- *Management of Salinity: Urbanisation of South Creek Catchment* (DWC, 2020)
- *South Creek Land Capability Assessment for Irrigation Purposes* (Aurecon, 2019 & 2020)
- *South West Growth Centre and Western Sydney Employment Lands Salinity Study* (SMEC, 2015)
- *Guidelines for managing salinity in rural areas,* NSW Office of Environment and Heritage, Sydney, NSW (2015).

3.4 Historical land management in Western Sydney

Aboriginal peoples maintain a strong belief that if we care for Country, it will care for us. The Aerotropolis area is custodially cared for by three Aboriginal groups: the Darug, Dharawal and Gundungurra. Others, such as the Eora, Darkinjung, Wiradjuri and Yuin maintain trade or other obligatory care relationships with the area. The Deerubbin, Gandangara and Tharawal Local Aboriginal Land Councils also have local land holdings and responsibilities towards Aboriginal peoples living in the area. This significant connection to Country plays an important part in shaping this Plan (WSPP, 2020).



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSA_LCA_IrrigationSuitability_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

- Study area
- WSA Growth Area boundary
- Precinct boundary
- Watercourse
- Known salinity constraints
- Other constraints

Suitability Level

- Least Suitable
- Less Suitable
- More Suitable
- Most Suitable

Source: Aurecon, DPIE, NSW Spatial Services, ESRI

A3 scale: 1:55,000

0 1 2 km

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Figure 3-1: South Creek LCA – Irrigation Suitability Map (Aurecon, 2019)

3.5 Vision for a green city

3.5.1 Western Sydney Aerotropolis Plan

WSPP, 2020

The WSAP sets the planning framework for the WSA, with "an overarching objective to recognise country and provide opportunities to Connect with Country, Design for Country and Care for Country when planning for the Aerotropolis." Furthermore, the Aerotropolis will be designed via a "landscape-led approach, where Wianamatta–South Creek, large regional parks and an expansive network of green and blue corridors shape the city's structure and building." Such a framework speaks on the importance of assessing land capability through the initial planning and design phase of the Aerotropolis. Figure 3-2 illustrates the framework used to deliver the "Aerotropolis-shaping objective and principles".

The Plan was developed by the WSPP, a local government-led initiative that brings Blacktown, Blue Mountains, Camden, Campbelltown, Fairfield, Hawkesbury, Liverpool, Penrith and Wollondilly councils together with key State agencies. It builds on the Stage 1 Land Use and Infrastructure Implementation Plan (LUIIP) for the Aerotropolis, released in 2018.

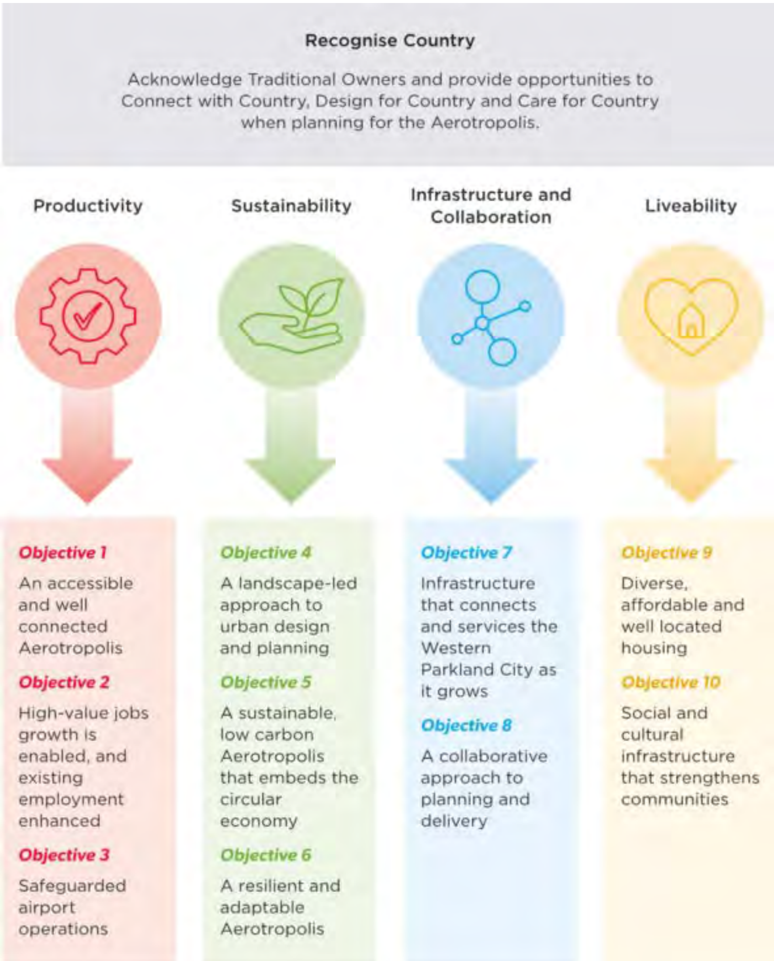


Figure 3-2 Aerotropolis shaping objectives and principles (WSPP, 2020)

The WSA comprises 10 precincts, five of which (Aerotropolis core, Agribusiness, Badgerys Creek, Northern Gateway and Wianamatta-South Creek) will be the focus within this Stage 1 land capability assessment as part of initial precinct planning.

In alignment with the overarching objective of connecting with country, the plan places a key focus on conserving and enriching the waterway health within the Wianamatta-South Creek Catchment utilising a risk-based approach to manage the cumulative effects of development, as defined in *Action 69* of the *Western City District Plan.*

Other key elements highlighted in the vision of the WSA plan include:

- Retaining water in the landscape
- Preserve, extend and restore the green
- Locate transit corridors within walking distance of landscape and amenity
- Orientate urban development towards landscape amenity, connected to transit corridors
- Adopt urban typologies.

High level land use, environmental asset and transport infrastructure plans were also designed as part of this report to facilitate a spatial representation of developmental vision within the initial Aerotropolis Precincts.

3.5.2 Urban Cooling Review: South Creek

Gallagher Studio and Studio Zanardo, 2020

Gallagher Studio and Studio Zanardo were engaged by Infrastructure NSW to develop a framework of principles/ controls to provide urban cooling in the Western Sydney Parkland. The study is based off a review of local and international research into urban cooling, in accordance with investigation of the catchments environmental and future climatic conditions. From this, a set of urban cooling principles/ controls for urban development (not yet market tested) in the catchment were established and applied to various development types including residential (low, medium, high), commercial, business parks, strata industrial and large format industrial. These controls were developed via an integrated approach to address a multitude of factors across residential, office, industrial and mixed-use development areas, with the intention of being used to inform the preparation of planning instruments.

The key elements mediums used to develop the urban cooling controls are listed below with an example of controls for each assessed area:

- **Deep soil areas:** has soft landscaped part of the site area used for growing trees, plants and grasses, that is not occupied by any structure above or below the surface of the ground including paving, services and car parking.

  E.g. Residential controls: 1) Minimum 50% of lot area for low/ medium density residential (4 storeys and less). 2) Minimum 55% of lot area for high density residential (5 storeys and above) 3) Consolidated rear deep soil landscape: i) Low & Medium Density residential (4 storeys and less): min. 20 metres building line to building line. ii) Residential (5 storeys and above): min. 24 metres building line to building line. 4) Deep soil: Min 6 metre dimension. Deep soil setback to street frontage: Min. 6 metre dimension. 5) Deep soil should be consolidated into front and rear setbacks. Buildings can be built to side boundaries to consolidate deep soil into front and rear setbacks.

- **Tree planting:** definition – minimum height of 15 metres at maturity.

  E.g. Office controls: 1) Lots are to provide a minimum number of trees. 1 tree per 300m2 or part thereof. 2) Additional tree planting required for on grade carparking open to the sky: 1 out of every 5 car spaces dedicated to tree planting (Refer to ***Parking*** *layout diagram below).*

- **Tree protection**

  E.g. Industrial controls: 1) Develop masterplan structure that retains existing trees. 2) Development must comply with Australian Standard Protection of Trees on Development Sites AS-4970-2009. 3) All new trees included in Tree Preservation orders.

- **Building controls**

  E.g. Residential controls: 1) Building depth: Max 18m building line to building line 2) Subject to Apartment Design Guide. 3) High Albedo / Light coloured roofs to all new buildings. 4) Primary communal open space on roof top. (5 storeys and above)

- **Parking**

  E.g. Office controls: 1) No on grade or basement carpark in deep soil area. 2) Additional tree planting required for on grade carparking open to the sky: 1 out of every 5 car spaces dedicated to tree planting oriented parallel to parking spaces to maximise shading. Permeable paving to all carparking bays. Refer to diagram. 3) Develop master plan structure that provides parking off site. 4) Tree canopy delivery is a priority in hardstand areas due to transpiration benefits. Prioritise car park trees with Leaf Area Index of 4 or above for carparks. Shade structures not an acceptable substitute for tree planting.

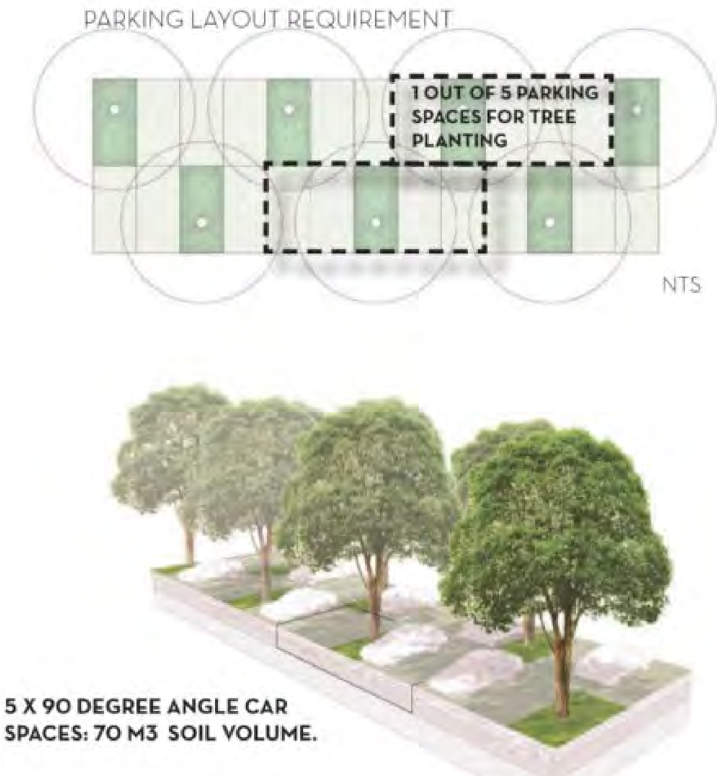


Figure 3-3 Parking layout requirements for tree planting

- **Pavements and surfacing**

  E.g. Industrial controls: 1) High albedo /light coloured pavements to all hardstand areas. 2) Design site stormwater runoff to drain to landscape areas. 3) Permeable paving to all carparking bays.

- **Soil**

  E.g. Mixed-Use controls: 1) Protect soil landscapes and maintain soil health to sustain environmental health, reduce salinity and deliver healthy tree canopy. 2) Develop masterplan structure that minimises excavation, cut and fill; 3) Minimise construction approaches that disturb B Horizon. 4) Minimise large scale irrigation to reduce salinity.

4 Baseline geospatial datasets

A number of baseline geospatial datasets have been used in the assessment of land capability for the WSA; these are summarised in Table 4-1. Table 4-2 presents the relative detail and associated objectives which can be achieved through varying scales of map resolution.

Table 4-1 Baseline geospatial datasets for land capability assessment of the Aerotropolis

Description	Format	Owner	Scale
Study Area			
Study area boundaries	Shapefile	DPIE	NA
Precinct boundaries and land use classifications	Shapefile	PPO	NA
Transport Infrastructure			
Road corridor from digital cadastre	Shapefile	DFSI	NA
Current Roads Layout	Shapefile	TfNSW	NA
State Environmental Planning Policy – Major Infrastructure Corridors	Shapefile	DPIE	NA
Indicative Road Network (Arterial) - Key Network Upgrades	Shapefile	TfNSW	NA
Proposed M12 construction corridor as per WSAP / EIS	Shapefile	TfNSW	NA
Outer Orbital	Shapefile	TfNSW	NA
Railway corridors	Shapefile	DPIE	NA
Metro Greater West proposed North South Rail Corridor	Shapefile	Metro	NA
Proposed South West Rail Link	Shapefile	TfNSW	NA
Proposed Western Sydney Freight Line	Shapefile	TfNSW	NA
Proposed East-West Rail link and stabling	Shapefile	Metro	NA
Hydrology and Flooding			
Surface Water Catchment Boundaries	Shapefile	DPIE	1:50,000
Combined flood models for 1 in 100 year	Geodatabase	PPO	-
Combined flood data PMF	Shapefile	PPO	-
Watercourses from the digital topographic set	Shapefile	DPIE	1:20,000
Water bodies / features cadastre as polygons	Shapefile	DFSI	1:20,000
Australian Hydrological Geospatial Fabric (Geofabric)	Geodatabase	BoM	1:20,000
National Parks and Conservation / Protected Areas			
Cumberland Plains Conservation Plan areas	Shapefile	DPIE	1:20,000
Veg protection under the 2006 Growth centres program	Shapefile	PPO	1:20,000
SEPP Sydney Region Growth Centres 2006 Riparian Protection RPN	Shapefile	DPIE	1:20,000
Local Environment Plan – Environmental Conservation Zones	Shapefile	Council	1:20,000
Local Environment Plan – National Parks and Nature Reserves	Shapefile	Council	1:20,000
Local Environment Plan – Environmental Management	Shapefile	Council	1:20,000
Local Environment Plan – Environmental Living	Shapefile	Council	1:20,000
Western Sydney Parklands footprint	Shapefile	WSP	1:20,000
National Parks and Reserves	Shapefile	DPIE	1:250,000
Ramsar Wetlands	Shapefile	OEH	1:100,000
State Environmental Planning Policy – Koala Habitat Protection	Shapefile	DPIE	-
Environmental Planning Instrument – Critical Habitat	Shapefile	DPIE	-
Environmental Planning Instrument – Environmentally Sensitive Land	Shapefile	DPIE	-
Environmental Planning Instrument – Native Vegetation Protection	Shapefile	DPIE	-

Description	Format	Owner	Scale
Environmental Planning Instrument – Riparian Lands	Shapefile	DPIE	-
Environmental Planning Instrument – Wetlands Protection	Shapefile	DPIE	-
Environmental Planning Instrument – Heritage	Shapefile	DPIE	1:25,000
Topography and Elevation			
Digital Elevation Model at 1m from LiDAR	ascii	PPO	1:1
1m Contours processed from 1m DEM	Shapefile	PPO	1:1
Geology and Soils			
Penrith 1:100,000 mapping geological layers	Shapefile	DPIE	1:100,000
Soil Landscapes of the Penrith 1:100,000 Sheet	Shapefile	DPIE	1:100,000
Acid Sulfate Soils Risk NSW	Shapefile	DPIE	1: 25,000
Estimated Inherent Soil Fertility of NSW	Shapefile	DPIE	1:100,000
Hydrologic Groups of Soils in NSW	Shapefile	DPIE	1:100,000
Land and Soil Capability Mapping for NSW	Shapefile	DPIE	1:100,000
Digital soil maps for key soil properties over NSW	Raster	DPIE	1:100,000
Salinity Potential of Western Sydney	Shapefile	DPIE	1:100,000
Groundwater			
Western Sydney Hydrogeological Landscapes 1st Ed.	Shapefile	DPIE	1:100,000
Environmental Planning Instrument - Groundwater Vulnerability	Shapefile	DPIE	1:100,000
Registered Groundwater Bores and Works	Shapefile	BoM	1:1
Contamination			
Contaminated sites notified to the NSW Environmental Protection Authority	Text	NSW EPA	1:1

Table 4-2 Land resource map scales and objectives (adapted from McKenzie et al., 2008)

Scale	Detail	Objectives
1:5,000	Very high	Site planning, precision farming
1:10,000	High	Urban land, small paddocks
1:25,000	Moderately high (detailed)	Field level planning
1:50,000	Medium (semi-detailed)	District level planning
1:100,000	Low (semi-detailed)	Regional land inventory, district level planning, extensive land use
1:250,000	Very low (reconnaissance)	National land inventory
1:500,000	Extremely low (exploratory)	General information

As shown by Table 4-1 and Table 4-2, a range of mapping products and spatial scales are available to inform the land capability assessment.

Factors influencing the overall confidence of the assessment will be limited by the relative spatial resolution of the datasets. Confidence limitations are discussed further in Section 6. This assessment will build on regional scale mapping with field level mapping products, (including Local environmental plans and environmental planning instruments) to derive an enhanced product to inform baseline precinct scale land use planning.

5 Assessment methodology

5.1 Agricultural land use

Aurecon has leveraged upon and utilised the existing LSC mapping in undertaking the assessment of land capability for agricultural land use within the WSA.

The methodology has utilised the existing OEH LSC mapping dataset as a base map for further constraints analysis, using a combination of additional regional scale mapping and field level planning data to provide a refined assessment. This approach is consistent previous studies (DECCW, 2010) and is generally considered good practice for refining broadscale urban planning data to district and field planning requirements.

Specifically, the refined land capability assessment for agricultural land use within the WSA builds on land capability from existing OEH LSC mapping by considering:

a) Areas where agricultural land use may not be considered based on local restrictions (e.g. wetlands, protected areas, riparian corridors, transport corridors etc)

b) Additional factors that contribute to general constraints for land capability based on open-source data and additional information made available as part of the assessment process, which are not considered or not suitably refined as part of the LSC mapping scheme (i.e. slope, soil fertility, irrigation rating, groundwater quality, groundwater yield, groundwater levels, and surface water quality); and

c) Additional factors that contribute to hazard based constraints based on open-source data and additional information made available as part of the assessment process, adding to and improving on resolution of the LSC mapping scheme (i.e. salinity potential, salinity hazard, erosion hazard, sodicity, and acid sulfate soils)

For the purpose of this assessment overall land capability will be considered as a combination of general constraints (reflecting land capability) and hazardous constraints (reflecting potential impacts from land use activities). General constraints and hazardous constraints have been modelled and mapped separately to provide a better understanding of landscape limitations and potential impacts related to agricultural land use, with a final mapping product incorporating both general and hazardous constraints.

For the purpose of classifying land capability, Aurecon has adopted semi-quantitative pair-wise comparison based analytical hierarchy process (AHP) commonly used in modelling exercises which require multiple component analysis (MCA) (Jankowski, 1995; Estoque, 2012). The AHP framework provides an approach for prioritising inputs that exert a greater control on the outcomes of decisions and has been frequently employed in land capability assessments (Xiang and Whitley, 1994; Rahdari et al., 2018).

The AHP prioritises factors by assigning relative numerical weights (reflecting the importance of the factor on the outcome) through pairwise comparison matrices, which are commonly evaluated based on empirical data and/or user experience.

Figure 5-1 and Figure 5-2 present the adopted AHP processes for evaluation land capability and hazardous constraints against agricultural land use. The information sources, factors, factor weights and criteria scores used as part of the AHP for general constraints are summarised in Table 5-1, with hazardous constraints summarised in

Table 5-2. Hazardous factors have been applied equal rating as they are considered equally important in risk assessment.

Existing land capability assessment maps have been given an automatic Rank of 1 and weight of 0.5, so that that additional factors cannot reduce or increase the overall land capability classification further than one constraint class.

A number of factors soil and landscape limiting factors have not been assessed as part of the scope as they are either covered by baseline capability maps at the available scale or are not present within the study area (e.g. acid sulfate soils).

Table 5-1 General Constraints Analysis for Agricultural Land Capability Assessment

Source	Factor	Rank	Weight	Constraint Rating and Score		
				Low (0.1)	Medium (0.5)	High (1)
NSW Land and Soil Capability Maps	Rural Capability Mapping	1	0.5	Classes 1-3	Classes 4-5	Classes 6-8
Digital Elevation Model	Slope	2	0.13	<8	8-20	>20
Hydrologic Groups of Soils in NSW	Soil Permeability	3	0.1	A	BC	D
NSW Soil Fertility Mapping	Soil Fertility	4	0.08	Moderately High and High	Moderate	Moderately Low and Low
NSW Hydrogeological Landscapes / BoM Records	Groundwater Yield	5	0.07	-	Mount Vernon, Shale Plains, Upper South Creek	Mulgoa, Greendale
NSW Hydrogeological Landscapes / BoM Records	Groundwater Quality	6	0.05	Mount Vernon	Mulgoa, Greendale	Shale Plains, Upper South Creek
NSW Hydrogeological Landscapes / WaterNSW	Water Quality	7	0.04	-	Mulgoa, Greendale	Shale Plains, Upper South Creek
NSW Hydrogeological Landscapes / BoM Records	Groundwater Levels	8	0.03	-	Mulgoa, Greendale, Mount Vernon, Shale Plains, Upper South Creek	-

Table 5-2 Hazardous Constraints Analysis for Agricultural Land Capability Assessment

Source	Factor	Rank and Weight	Constraint Rating and Score		
			Low (0.1)	Medium (0.5)	High (1)
NSW Hydrogeological Landscapes	Salinity Hazard	Rank: 1 Weight: 0.25	-	Mount Vernon, Mulgoa	Greendale, Shale Plains, Upper South Creek
2002 Soils Western Sydney Salinity Potential	Soils Western Sydney Salinity Potential		High	Moderate	Water
Modelled Hillslope Erosion over New South Wales (K Factors)	Erosion Hazard		<0.01-0.029	0.03-0.059	0.06->0.08
Digital soil maps for key soil properties over NSW	Exchangeable Sodium (%)		0-4	>4-10	>10

Figure 5-1: General Constraints Analysis for Agricultural Land Capability Assessment

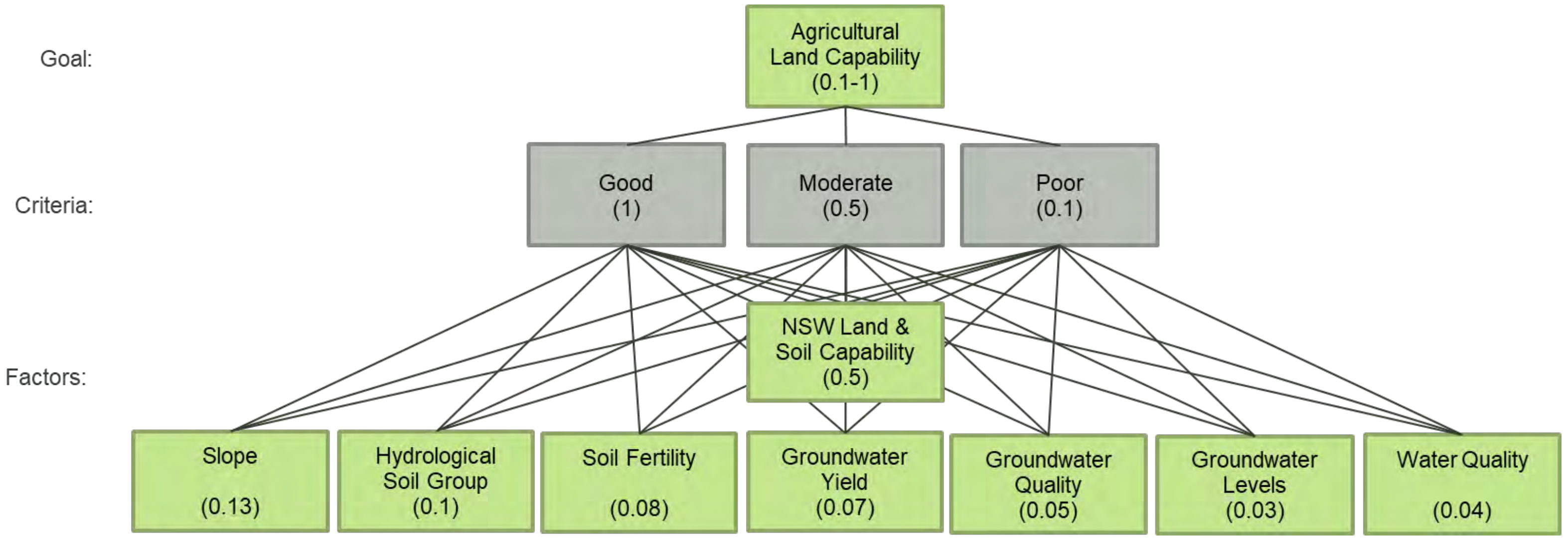
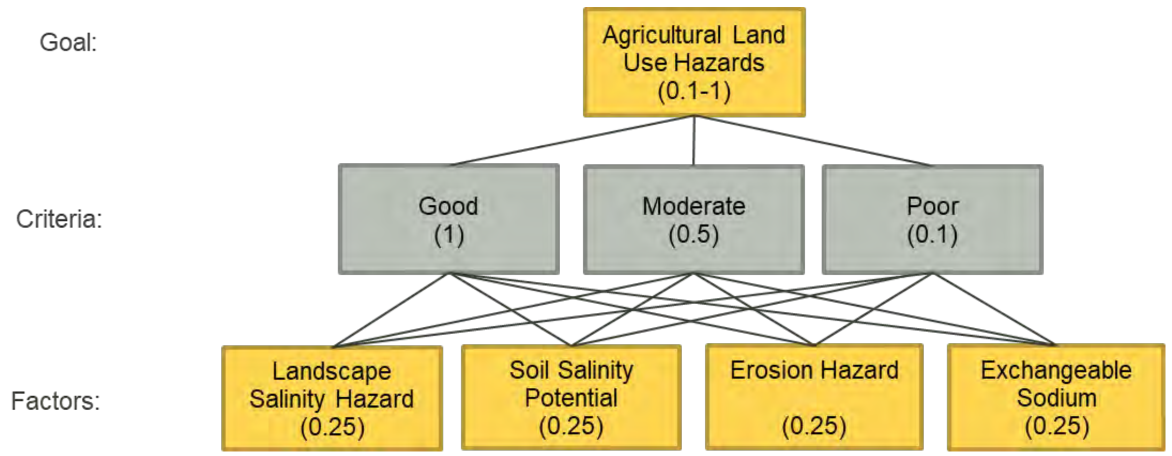


Figure 5-2: Hazardous Constraints Analysis for Agricultural Land Capability Assessment



5.2 Urban land use

Aurecon has leveraged upon and utilised the existing Soil Landscape Mapping (Bannerman and Hazelton, 2011) in undertaking the assessment of urban land capability for the WSA. The methodology has utilised the existing NSW Soil Landscape Mapping as a base map for further constraints analysis, using a combination of additional regional scale mapping and field level planning data to provide a refined assessment. This approach is consistent previous studies (DECCW, 2010) and is generally considered good practice for refining broadscale urban planning data to district and field planning requirements.

To provide a consistent approach with agricultural land capability assessment, overall urban land capability will be considered as a combination of general (physical) constraints (reflecting land capability for urban development) and hazardous constraints (reflecting potential impacts from urban development).

Specifically, the refined land capability assessment for urban land use within the WSA builds on land capability from existing Soil Landscape Mapping, in a similar approach to agricultural land use by considering:

a) Areas where urban land use may not be considered based on local restrictions (e.g. wetlands, protected areas, riparian corridors, transport corridors etc)

b) Additional factors that contribute to general constraints for land capability based on open-source data and additional information made available as part of the assessment process, which are not considered or not suitably refined as part of the Soil Landscape mapping scheme (i.e. slope, groundwater levels, permeability); and

c) Additional factors that contribute to hazard based constraints based on open-source data and additional information made available as part of the assessment process, adding to and improving on resolution of the Soil Landscape mapping scheme (i.e. salinity potential, salinity hazard, erosion hazard, sodicity and acid sulfate soils)

In consistency with the approach for agricultural land use (Section 5.1), Aurecon has adopted the analytical hierarchy process to develop output mapping products for urban land use.

These two components have been modelled and mapped separately using the analytical hierarchy process (Section 4.1.1 – Aurecon methodology) to provide a better understanding of landscape limitations and potential impacts related to urban land use.

Figure 5-3 and Figure 5-4 present the adopted AHP processes for evaluation land capability and hazardous constraints against urban land use. The information sources, factors, factor weights and criteria scores used as part of the AHP for general constraints are summarised in Table 5-3, with hazardous constraints summarised in Table 5-4.

Hazardous factors have been applied equal rating as they are considered equally important in risk assessment. Existing land capability assessment maps have been given an automatic Rank of 1 and weight of 0.5, so that that additional factors cannot reduce or increase the overall land capability classification further than one constraint class.

A number of factors soil and landscape limiting factors have not been assessed as part of the scope as they are either covered by baseline capability maps at the available scale or are not present within the study area (e.g. acid sulfate soils).

Table 5-3 **General Constraints Analysis for Urban Land Capability Assessment**

Source	Factor	Rank	Weight	Constraint Rating and Score		
				Low (0.1)	Medium (0.5)	High (1)
NSW Soil Landscape Mapping	Urban Capability	1	0.5	Blacktown	Berkshire Park, Luddenham	South Creek, Disturbed Terrain
Digital Elevation Model	Slope	2	0.2	<8	8-15	>15
NSW Soil Landscape Mapping	Soil Wet Strength	3	0.1	Berkshire Park	South Creek	Luddenham, Blacktown, Disturbed Terrain
NSW Soil Landscape Mapping	Soil Shrink-Swell	4	0.1	Berkshire Park	South Creek, Blacktown	Luddenham, Disturbed Terrain
NSW Hydrogeological Landscapes	Groundwater Levels	5	0.06	-	Shale Plains, Upper South Creek, Mulgoa, Greendale, Mount Vernon	-
NSW Hydrologic Soil Groups	Soil Permeability	6	0.04	A, B	C	D

Table 5-4 **Hazardous Constraints Analysis for Urban Land Capability Assessment**

Source	Factor	Rank and Weight	Constraint Rating and Score		
			Low (0.1)	Medium (0.5)	High (1)
NSW Hydrogeological Landscapes	Salinity Hazard	Rank: 1 Weight: 0.25	-	Mount Vernon, Mulgoa	Greendale, Shale Plains, Upper South Creek
2002 Soils Western Sydney Salinity Potential	Soils Western Sydney Salinity Potential		Water	Moderate	High
Modelled Hillslope Erosion over New South Wales (K Factors)	Erosion Hazard		<0.01-0.029	0.03-0.059	0.06->0.08
Digital soil maps for key soil properties over NSW	Exchangeable Sodium (%)		0-4	>4-8	>8

Figure 5-3: **General Constraints Analysis for Urban Land Capability Assessment**

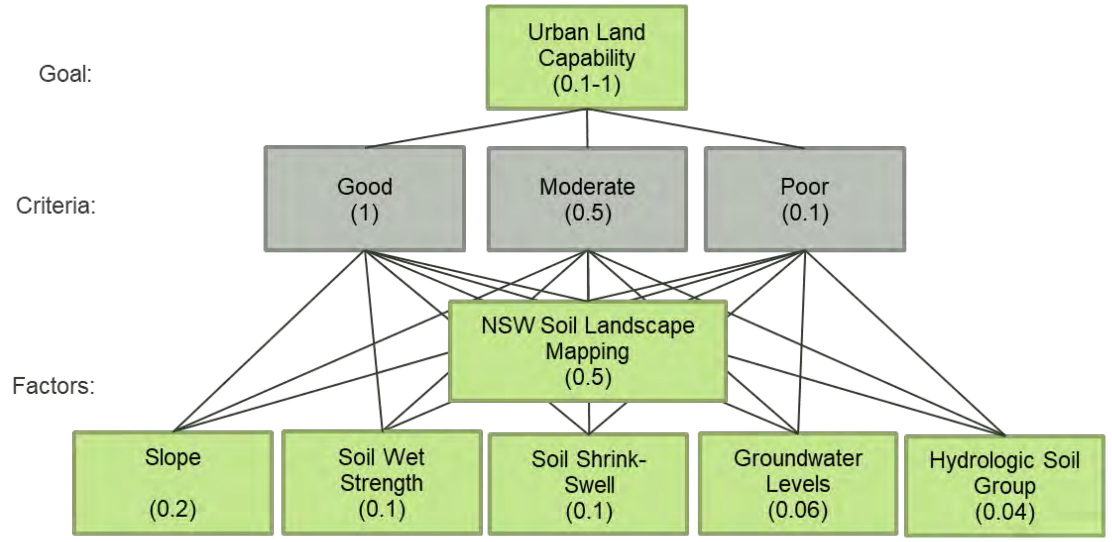
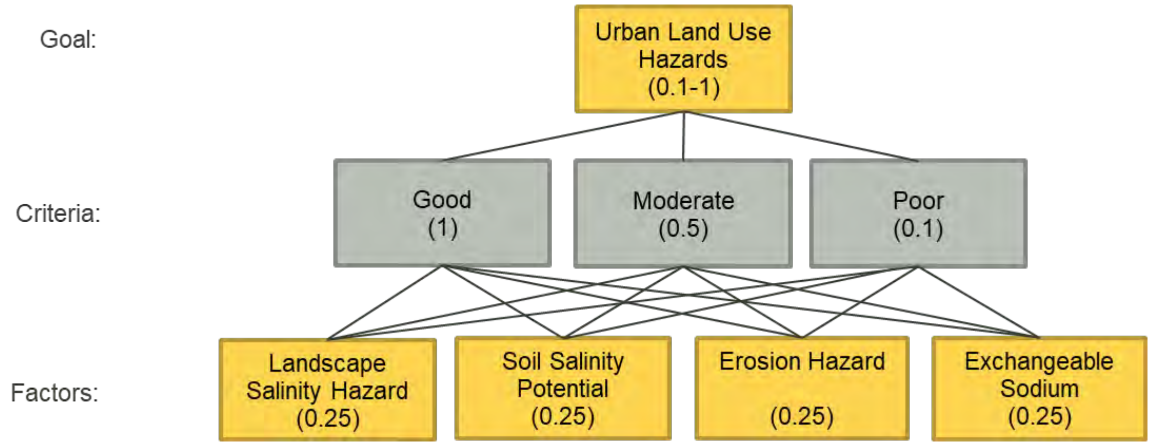


Figure 5-4: **Hazardous Constraints Analysis for Urban Land Capability Assessment**



5.3 Presentation of results

The results from this assessment are presented a series of hard copy and digital derivative land capability maps for the land uses that have been considered. The maps have been prepared on a 1 m by 1 m basis with constraint scores associated with each cell and key data on constraint factors and scores presented for each pixel.

Table 5-5 and Table 5-6 present rank and scoring benchmarks for the map products including general land capability and hazardous constraints. Mapping products are presented in Section 9.

Table 5-5 Rank and scoring for general constraints and land capability ratings

Rank	Score Interval	Constraint Rating
1	0.8 – 1.0	Very high constraint
2	0.6 – 0.8	High constraint
3	0.4 – 0.6	Moderate constraint
4	0.2 – 0.4	Low constraint
5	0.01 – 0.2	Very low constraint

Table 5-6 Rank and scoring for general constraints and land capability ratings

Rank	Score Interval	Constraint Rating
1	0.8 – 1.0	Very high hazard
2	0.6 – 0.8	High hazard
3	0.4 – 0.6	Moderate hazard
4	0.2 – 0.4	Low hazard
5	0.01 – 0.2	Very low hazard

The overall constraint rating for the WSA is based on the average value of both the general constraints and hazardous constraints. The overall constraint ratings are presented in Section 9.

6 Environmental conditions

6.1 Climate

6.1.1 Overview

The South Creek Catchment in which the Aerotropolis is located is considered to be one of the hottest and driest areas of the Greater Sydney Metropolitan Region. Local climate and weather conditions

The Department of Science, Information Technology and Innovation (DSITI) provides an enhanced climate database SILO (Scientific Information for Landowners) that holds Australian climate data from 1889. The interpolated climate data is stored on a regular 0.05° latitude x 0.05° longitude grid, which is approximately 5 km x 5 km. This database was used to obtain long-term geo-statistically determined climate records at six locations within the study area, including two weather observation stations, for the period 1 January 1900 to 15 June 2020 (119 years) shown in Figure 6-1.

Figure 6-1 to Figure 6-4 present graphical summaries of historical annual rainfall depths (Figure 6-1); monthly rainfall statistics (as box and whisker plots) (Figure 6-2); annual pan evaporation depths (Figure 6-3); and monthly evaporation and evapotranspiration statistics (as box and whisker plots) (Figure 6-4).

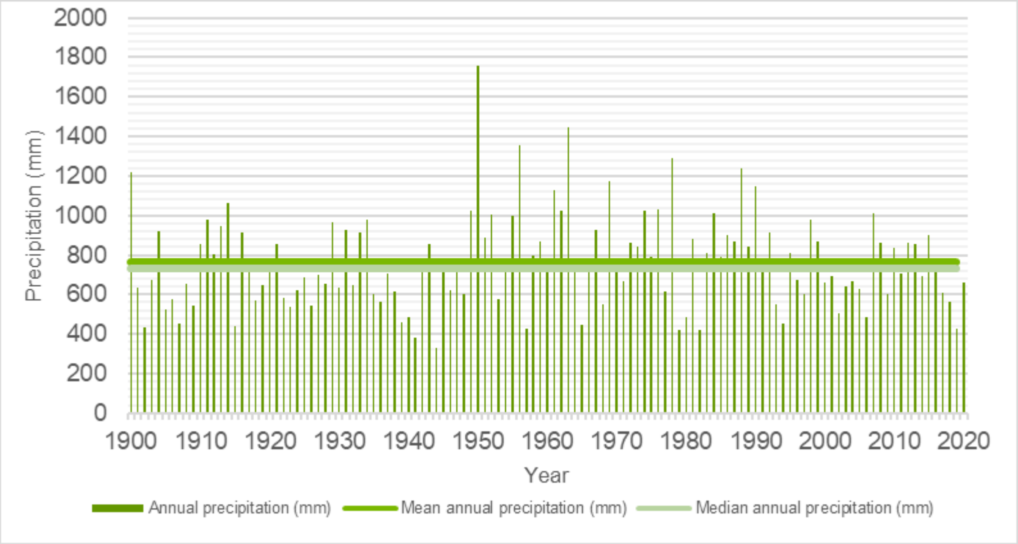


Figure 6-1 Historical annual precipitation (SILO climate data 1900 to 2020)

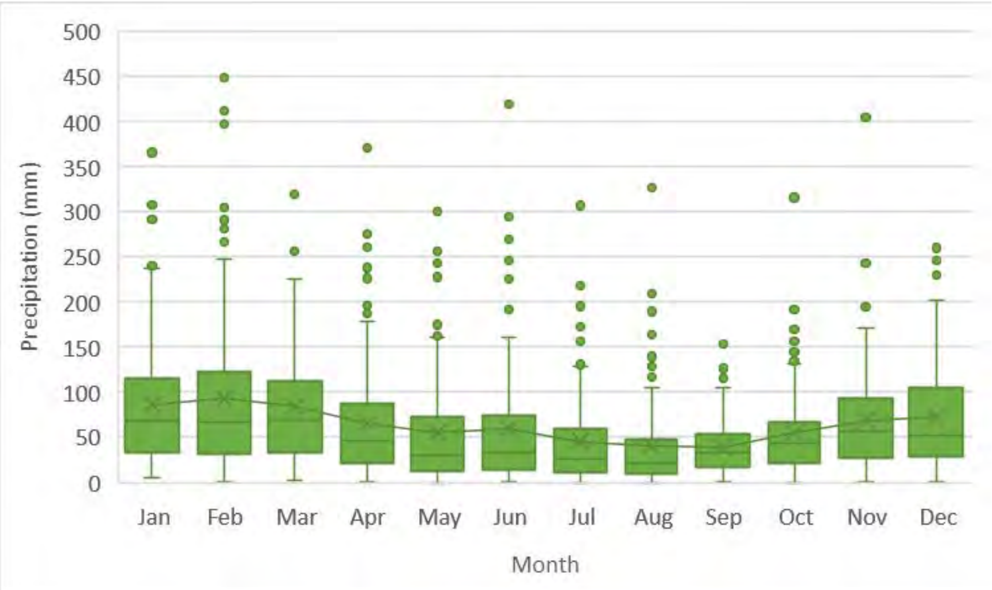


Figure 6-2 Monthly Precipitation – Box and Whisker Plot (SILO climate data 1900 to 2020)

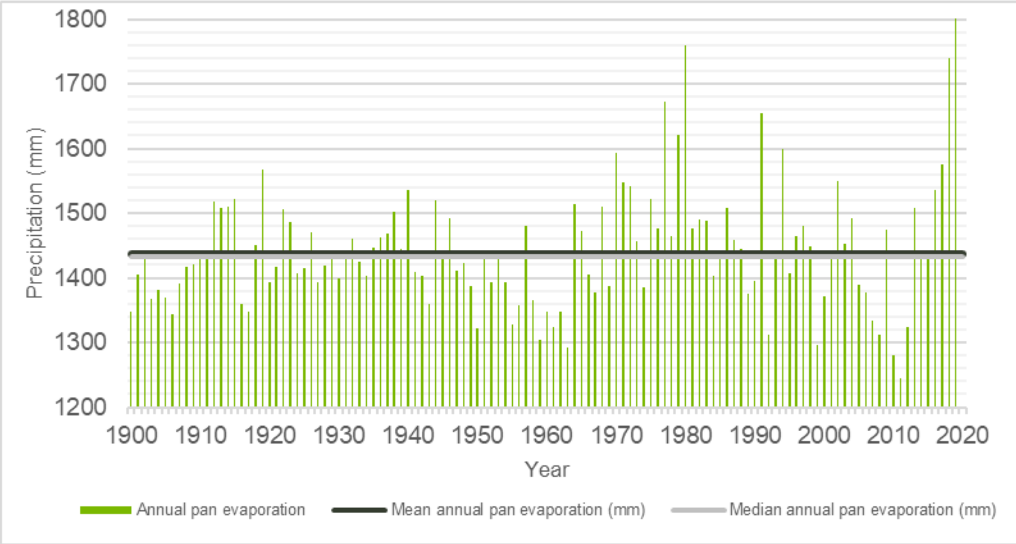


Figure 6-3 **Historical annual pan evaporation, and median annual evaporation / evapotranspiration comparisons (SILO climate data 1900 to 2020)**

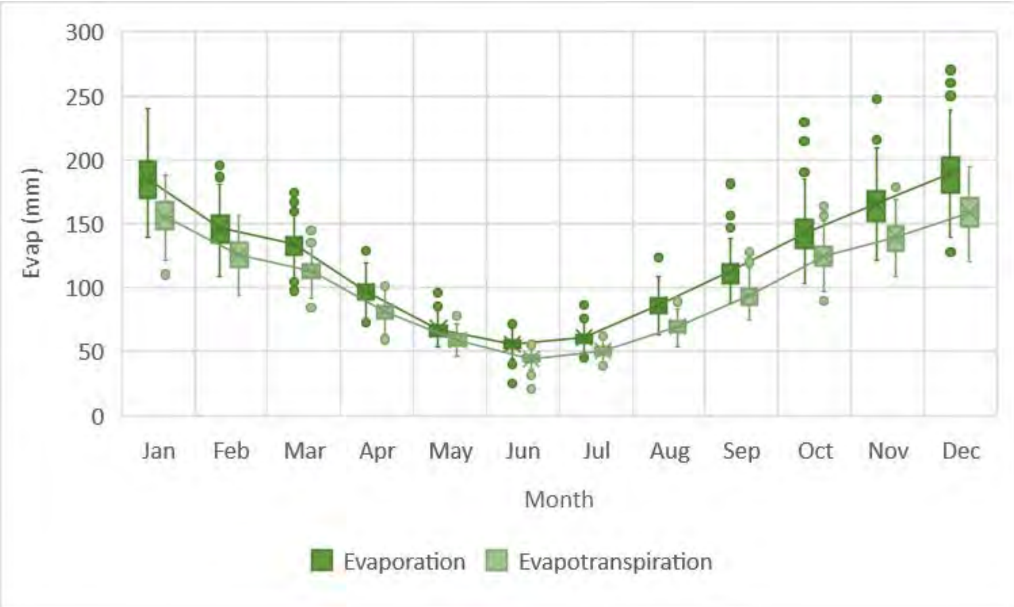
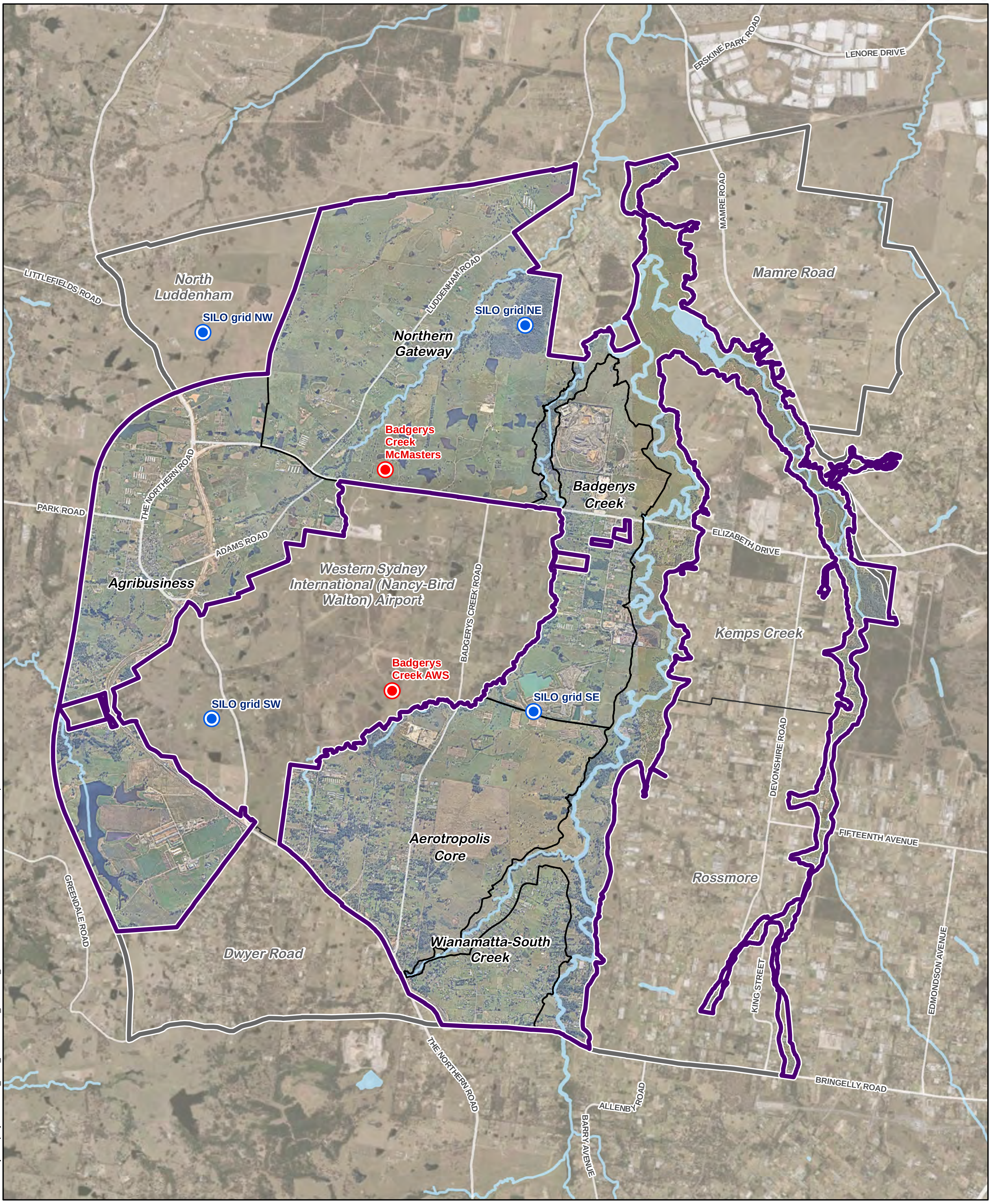


Figure 6-4 **Monthly Pan Evaporation and Evapotranspiration – Box and Whisker Plot (SILO climate data 1900 to 2020)**



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_WeatherStations.mxd\JOB No.\15-10-20\Liam.Stephen\Rev 0

Study area
WSA Growth Area boundary
Precinct boundary
BoM weather station
SILO grid point

Base Data

Watercourse

Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:55,000

0 1 2 km

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Figure 6-5: BoM weather stations and SILO grid points utilised for the collation of climate data

Table 6-1 provides summary annual rainfall and evaporation statistics generated for the site over the 119-year period.

Table 6-2 summarises the average monthly rainfall and evapotranspiration rates, along with upper (95 percentile) and lower (5 percentile) ranges.

Table 6-1 Average precipitation, evaporation and evapotranspiration statistics (SILO climate data 1900 to 2019)

Statistic	Annual Precipitation (mm)	Annual Pan Evaporation (mm)	FAO-56 Potential Evapotranspiration (mm)
Mean	763	1437	1216
Minimum	330 (1944)	1245 (2011)	1085 (1974)
Median	739	1433	1209
Maximum	1756 (1950)	1874 (1980)	1352 (1919)

Table 6-2 Mean precipitation and evaporation statistics (SILO climate data 1900 to 2019)

Statistic	Mean Precipitation (mm)	95%ile Precipitation (mm)	5%ile Precipitation (mm)	Mean ET (mm)	95%ile ET (mm)	5%ile ET (mm)
January	86.8	228.6	14.4	155.3	179.3	127.5
February	90.3	267.0	6.0	125.7	146.1	103.1
March	84.7	204.5	11.5	113.2	133.0	97.9
April	65.4	197.0	8.1	81.3	93.9	69.9
May	55.2	175.8	4.9	59.1	68.2	52.0
June	60.1	196.8	1.7	44.5	51.6	37.6
July	45.3	157.8	1.2	50.5	58.0	43.5
August	40.3	140.0	1.1	69.4	80.0	59.7
September	39.1	98.3	1.6	93.7	109.7	80.5
October	55.0	156.6	4.5	124.5	144.3	103.6
November	69.1	165.5	6.4	139.8	164.7	118.8
December	72.4	198.8	7.3	158.8	181.6	131.3

The results from analysis of climate and weather data show that seasonal variations are present in both precipitation (rainfall) and evaporation / evapotranspiration rates. This includes higher than average rainfall rates between the months of October and March, and lower than average rainfall rates between March and September; and similarly, higher than average evapotranspiration rates between October and March and lower than average evapotranspiration rates between April and September.

Significant outlier events can occur resulting in wetter than average conditions or drier than average conditions. Significantly wetter months may reflect significant storm events / higher than average daily rainfall, or dry conditions.

The average, minimum, and maximum annual evapotranspiration exceeds the annual rainfall equivalent with a calculated aridity index (P/PET) of 0.62 (UNEP, 1992), indicating a dry sub-humid climate.

Monthly median rainfall, evapotranspiration and aridity indices are shown in Figure 6-6. The graph shows aridity indices ranging from a low 0.4 in September / October (corresponding to the months of low to average rainfall and rising evapotranspiration) to a high of 1.3 in June (corresponding to the month with lowest median evapotranspiration). This range is representative of an annual fluctuation between semi-arid and humid conditions.

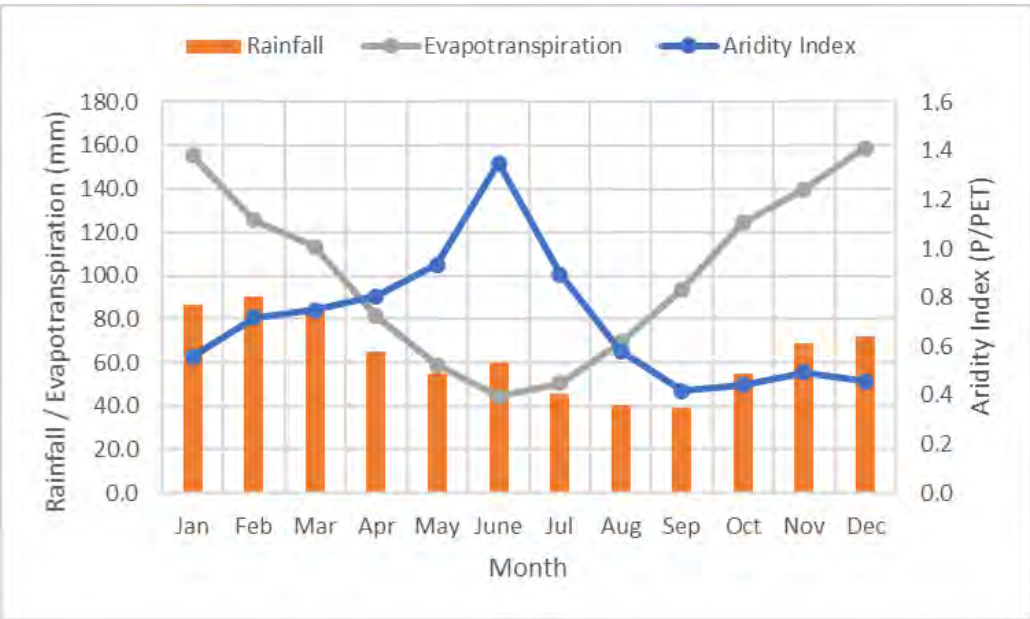


Figure 6-6 **Long-term mean monthly rainfall, evapotranspiration and aridity index**

6.2 Local topography

Topography of the five key initial Aerotropolis Precincts being assessed as part of this study is annotated in Figure 6-7**.**

The South Creek Catchment in which the Aerotropolis sites is generally described as a landscape of low undulating hills, gently sloping plains and ponded drainage lines (Bannerman and Hazelton, 2011), a classification which is consistent with standardised classification of landscapes in Australia (CSIRO, 2009). Local scale analysis of topographic contour lines indicates several distinct topographic landscape divisions that are broadly reflective of the WSA Growth Area boundaries.

The Aerotropolis Core precinct is characterised by a gently sloping landscape (2-10 %) waning from a topographic high in the south of the precinct boundary (c. 95m AHD) towards a topographic low in the north of the precinct boundary (c. 58 m AHD). Moderate slopes are present along the eastern and western boundaries of the Aerotropolis Core, reflecting spurs and creeks which slope towards Badgerys Creek in the west and South Creek in the east.

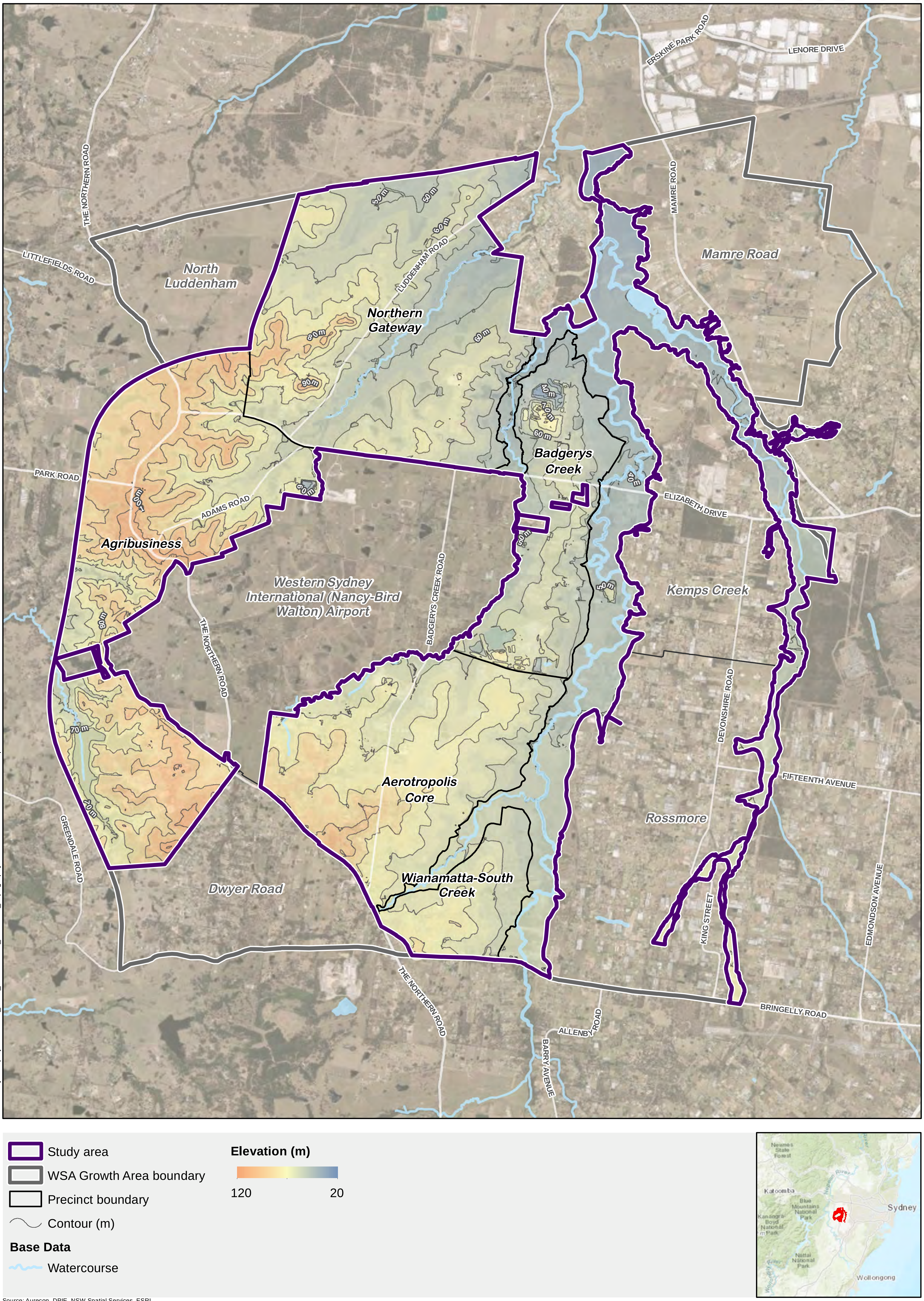
Badgerys Creek precinct is characterised by low, elongate, north-south aligned crest with open depressions to the east and west reflecting the drainage lines of South Creek and Badgerys Creek respectively. The landscape slopes east and west into the open depressions at a gentle gradient (1-10%). Elevations within the Badgerys Creek precinct typically range between 74 m AHD in the southernmost portion to 41 m AHD near the confluence of Badgerys Creek and South Creek at the northernmost portion of the precinct.

The Northern Gateway precinct is characterised by a central, low, open depression (c. 45 m AHD), which forms the drainage line for Cosgroves Creek and is oriented along a north-east to south-west axis, with a shallow gradient (2-5 %). The depression is flanked to the west by a moderate to steep sloped areas of spurs and ridges (10-30 %), which forms a local topographic high (c.95m AHD), and to the east by a moderately sloped elongate crest (5-15 %) which forms a raised area of land (c. 70 m AHD) between Cosgroves Creek and Badgerys Creek. A lowland (floodplain) area is present at the northern boundary of the Northern Gateway precinct, corresponding with a widening of the open depression that forms the drainage line for Cosgroves Creek.

The Agribusiness precinct is located within an area of raised terrain (c. 85-100 m AHD), which forms a local ridgeline and catchment boundary separating the South Creek Catchment and the Nepean River Catchment. The area around Luddenham in the northern portion of the precinct, forms a local plateau with undulating but generally shallow slopes (<10 %). Steeper slopes are present in the north-east and south-west portions of the precinct associated with local spurs shallow incised valleys forming the headwaters of Cosgroves Creek (South Creek Catchment) and Duncans Creek (Nepean River Catchment); at these locations' slopes are generally steeper (10-30 %).

The Wianamatta – South Creek precinct is located within open depressions that form the drainage lines and floodplains / riparian corridors of Badgerys Creek, South Creek, and Kemps Creek. Elevations within the open depressions that characterise this precinct are typically low (c. 30-45 m AHD) and flat. There is a gentle gradient from south to north (<5 %) reflective of creek profiles.

The assessment of constraints associated with topography that have been modelled as part of this study area presented in Section 7, along with other constraining factors.



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Topography.mxd|JOB No.|15-10-20|Liam.Stephen|Rev 0

Source: Aurecon, DPIE, NSW Spatial Services, ESRI

A3 scale: 1:55,000

0 1 2 km

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Figure 6-7: Topography

6.3 Soil landscapes

Soil landscape maps and reports have been prepared by the NSW Office of Environment and Heritage (Bannerman and Hazelton, 2011; Hazelton et al., (2011)) to inform planning authorities and the general public about the nature and limitations of soils in NSW.

The soil landscapes identified within the study area (derived from Soil Landscapes of the Penrith 1:100,000 Sheet (Hazelton et al., (2011)**)** are summarised in Table 6-3 and presented in Figure 6-8**.**

As shown by Table 6-3 and Figure 6-8 The soil landscapes present in the study area include Berkshire Park, Blacktown, Luddenham, South Creek and areas of disturbed terrain associated with anthropogenic (human) activities.

Table 6-3 Soil landscapes within study area

Soil type	Landscape Process and Soil Description	Relevant Precincts
Berkshire Park (bp)	**Alluvial**: Alluvial soils consisting of heavy clays and clayey sands, often mottled. Large boulders occur in sand/clay matrix. Occur on dissected, gently undulating low rises on Tertiary river terraces. Soils generally have increasing clay content with depth although erosion and deposition cycles may have caused the occasional reversal of this trend. Bp1: Dark brown sandy loam (A horizon) Bp2: Brown apedal sandy clay loam (A horizon) BP3: Brown sandy clay with up to 20% ironstone nodules (B horizon) BP4: High chroma (bright coloured) clay with up to 90% stones (B horizon)	Badgerys Creek
Blacktown (bt)	**Residual:** Shallow to moderately deep (>100 cm) hard setting mottled texture contrast soils. Brown loam over mottled brown light clay to grey plastic heavy clay. Bt1: Friable brownish black loam (A horizon) Bt2: Hardsetting brown clay loam (A2 horizon) Bt3: Strongly pedal, mottled brown light clay (B horizon) Bt4: Light grey plastic mottled clay (B3 / C horizon)	Agribusiness, Aerotropolis Core, Northern Gateway, Badgerys Creek
Luddenham (lu)	**Erosional:** Brown loam to clay loam over light to medium clay. Slopes 5-20%. Shallow on crests (<100 cm) to moderately deep (<150 cm) on lower slopes and drainage lines. Lu1: Friable dark brown loam (A1 horizon) Lu2: Hardsetting brown clay loam (A2 horizon) Lu3: Whole coloured, strongly pedal clay (B horizon) Lu4: Mottled grey plastic clay (deep subsoil) Lu5: Apedal brown sandy clay (B horizon)	Agribusiness, Northern Gateway
South Creek (sc)	**Alluvial:** Very deep layered sediments over bedrock or relict soils. Brown sandy loam to clay loam over brown light to medium clay. Typically present along major drainage lines. Sc1: Brown apedal single-grained loam (A horizon) Sc2: Dull brown clay loam (A Horizon) Sc3: Bright brown clay (B Horizon)	Wianamatta-South Creek, Berkshire Park, Northern Gateway, Aerotropolis Core, Agribusiness, Badgerys Creek
Disturbed Terrain	**Disturbed:** The original soil has been removed, greatly disturbed or buried. Landfill includes soil, rock, building and waste material	Wianamatta-South Creek

The Blacktown landscape is the most common landscape across the study area, accounting for the majority of available land within the Agribusiness, Aerotropolis, Northern Gateway and Badgerys Creek precincts. The South Creek landscape is the primary landscape associated with the Wianamatta-South Creek Precinct and intersects portions of other precincts along drainage lines. The Luddenham landscape is present across the Agribusiness and Northern Gateway precincts. The Berkshire Park landscape is present only as a minor area in Badgerys Creek; while disturbed terrain is also a minor area within the Wianamatta-South Creek Precinct.

In general, the soil landscapes within the study area typically comprise sandy loams and loams overlying or interbedded with sandy clays and clays. As such, soils in general have an increasing clay content with depth.

Overall confidence in the characteristics of soils and landscapes expressed by the NSW Soil Landscapes Mapping within the study area is limited by the relative coarseness in the scale of available mapping (i.e. 1:100,000 scale). This mapping should be considered an initial classification for further local scale investigations; or may be updated once more detailed mapping becomes available.

The assessment of constraints associated with soil landscapes that have been modelled as part of this study area presented in Section 7, along with other constraining factors.

6.3.1 Soil and land resources within the Aerotropolis

Additional soil landscape mapping was provided by DPIE (DPIE EES 2020) that provides a greater resolution of soil landscape facets and linework as presented in Figure 6-8a. Soil and land resource reports for each soil landscape have been provided in Appendix G along with a summary of soil and land constraints for soil landscapes in the Aerotropolis area (referring to Figure 6-8a).

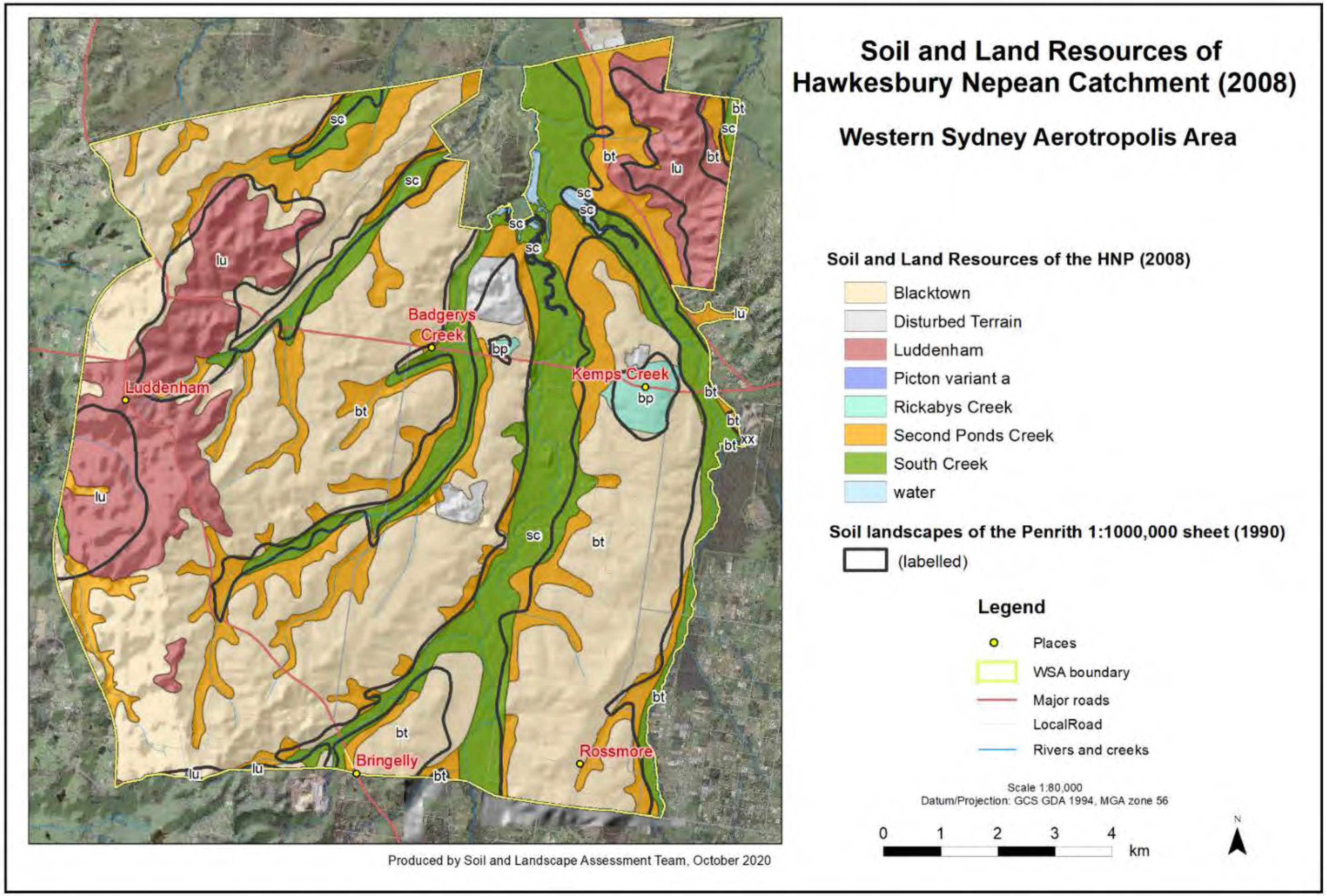
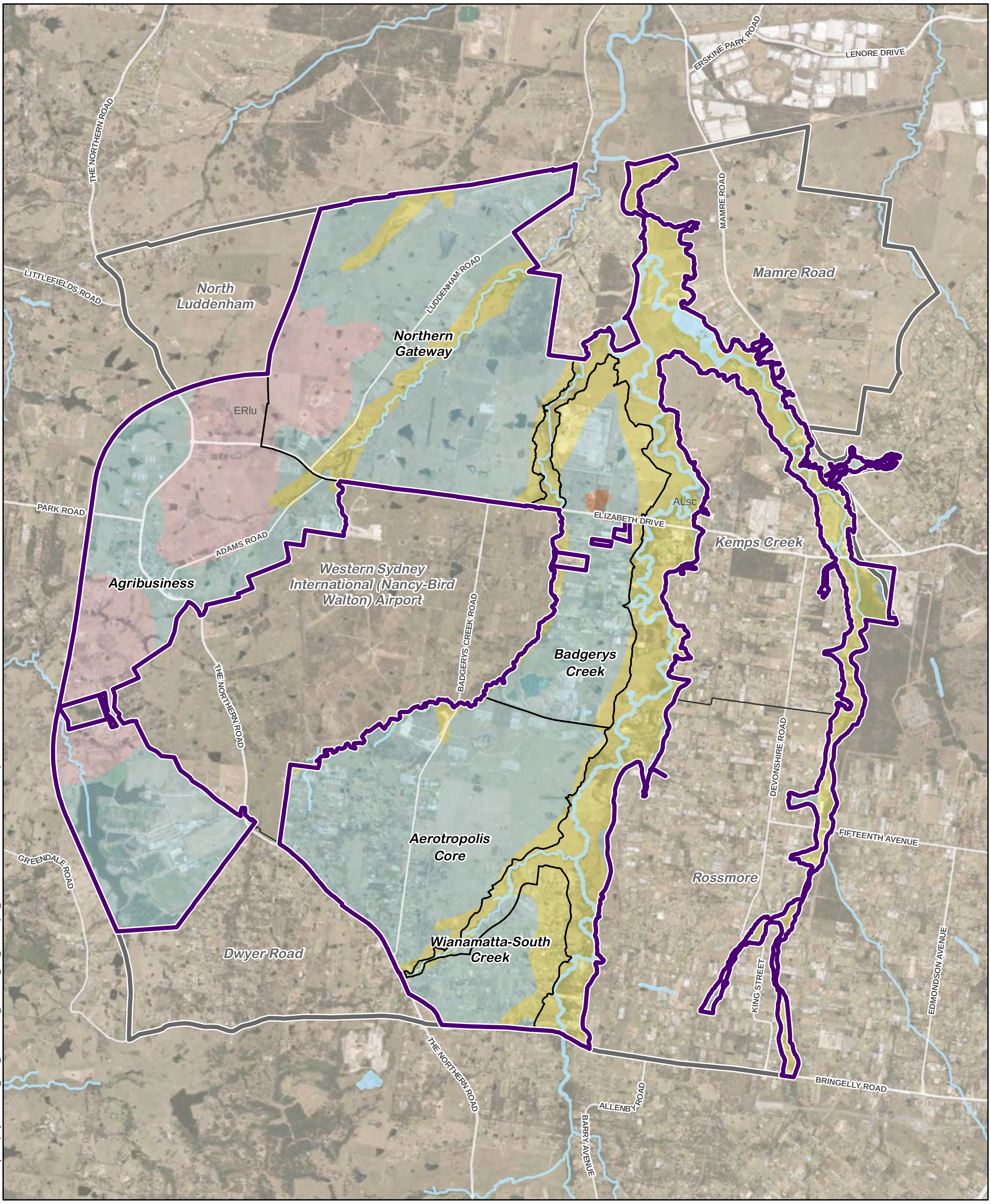


Figure 6-8a **Soil and Land Resources of Hawkesbury Nepean Catchment in the Aerotropolis Area (DPIE EES 2020).**

aurecon



- Study area
- WSA Growth Area boundary
- Precinct boundary

Base Data

- Watercourse

Soil Landscape (1:100k)

- ALbp Berkshire Park
- ERlu Luddenham
- REbt Blacktown
- ALsc South Creek
- DTxx Disturbed Terrain

Source: Aurecon, DPIE, NSW Spatial Services, ESRI

A3 scale: 1:55,000

0 1 2 km

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Figure 6-8: NSW Soil Landscapes

6.4 Soil physical properties

6.4.1 Wet strength

Soil wet strength describes the ability of a soil to support loads and resist deformation when wet. Low wet bearing strength soils typically include highly plastic clay-rich soils, poorly graded sands and silts, and organic soils (DECCW, 2010). Low wet strength soils have a tendency to be sticky and have poor trafficability ratings.

Under the Unified Soil Classification System (USCS) the following classes of soils may present limitations for stable building foundations (Finlayson, 1982):

- Peat and other highly organic soils (Pt)
- Organic clays of medium to high plasticity (OH)
- Inorganic clays of high plasticity (CH)
- Inorganic silts, elastic silts (MH)
- Inorganic silts and very fine sands, silty or clayey fine sands with slight plasticity (ML)
- Inorganic clays of low to medium plasticity (CL)

USCS ratings for soil wet strength are provided for landscapes in the NSW Soil Landscape Mapping Reports (Bannerman and Hazelton, 2011) alongside other physical soil limitations.

For the purpose of this assessment, soil wet strength characteristics have been derived from the Soil Landscapes of the Penrith 1:100,000 mapping reports. Table 6-4 summarises the soil landscapes and associated wet strengths of soil landscapes for the study area as shown in Figure 6-8.

Both the Blacktown landscape and Luddenham landscapes are regarded as having a low wet strength in their lower (B and C) soil horizons (Bannerman and Hazelton, 2011).

The Wianamatta-South Creek precinct is occupied primarily by the South Creek Landscape, which is not generally affected by low wet strength soils based on the NSW Soil Landscape mapping reports (Bannerman and Hazelton, 2011). The Berkshire Park landscape is present only as a small area within the Badgerys Creek precinct and is not affected by low wet soil strength.

Table 6-4 Wet Strength Classifications for Soil Landscape Classes

Soil Landscape	Low Wet Strength Prevalence	Relevant Precincts
Blacktown	W	Agribusiness, Aerotropolis Core, Northern Gateway, Badgerys Creek, South Creek
Berkshire Park	-	Badgerys Creek
Luddenham	W	Agribusiness, Northern Gateway
South Creek	-	Wianamatta – South Creek, Northern Gateway, Agribusiness, Badgerys Creek, Aerotropolis Core
Disturbed Terrain	ND	Wianamatta – South Creek (minor)
W = General Occurrence L = Localised Occurrence - = No occurrence		

Overall confidence in the wet strength characteristics of soils within the study area are limited by the relative coarseness in the scale of available mapping (i.e. 1:100,000 scale). This mapping should be considered an initial classification for further local scale investigations; or may be updated once more detailed mapping becomes available.

The assessment of constraints associated with soil wet strength and modelled as part of this study area presented in Section 7, along with other constraining factors.

6.4.2 Soil shrink-swell

Shrink-swell potential relates to a soils potential to change in volume as moisture content changes. It is primarily dependent on the content of certain clays that are subject to swelling behaviour.

Table 6-5 summarises the soil landscapes and associated shrink-swell potential of soil landscapes for the study area as shown in Figure 6-8.

Table 6-5 Shrink-Swell Potential for Soil Landscape Classes

Soil Landscape	Shrink-Swell Prevalence	Relevant Precincts
Blacktown	L	Agribusiness, Aerotropolis Core, Northern Gateway, Badgerys Creek, South Creek
Berkshire Park	-	Badgerys Creek
Luddenham	L	Agribusiness, Northern Gateway
South Creek	L	Wianamatta – South Creek, Northern Gateway, Agribusiness, Badgerys Creek, Aerotropolis Core
Disturbed Terrain	ND	Wianamatta – South Creek (minor)
W = General Occurrence L = Localised Occurrence - = No occurrence		

Overall confidence in the shrink-swell characteristics of soils within the study area are limited by the relative coarseness in the scale of available mapping (i.e. 1:100,000 scale). This mapping should be considered an initial classification for further local scale investigations; or may be updated once more detailed mapping becomes available.

The assessment of constraints associated with soil shrink swell that have been modelled as part of this study area presented in Section 7, along with other constraining factors.

6.4.3 Soil permeability

Hydrologic soil groups are mapped for all soils in NSW. The maps utilise Great Soil Group (GSG) classifications to assign relevant Hydrologic Soil Group classifications. Hydrologic soil groups can provide information about the relative permeability and waterlogging potential of soils (in combination with climate and position in landscape).

Hydrologic soil groups are determined by the lowest saturated hydraulic conductivity of a layer within a soil (i.e. the least transmissive layer). They are often used to determine runoff potential under similar storm and cover conditions, with each soil group being assigned both an infiltration rate and runoff potential. Hydrologic soil groups are divided into four categories. In NSW the four groups are defined as follows:

- Group A – Soils with high infiltration rates (>75 mm/hr), even when thoroughly wetted and consisting primarily of deep, well to excessively-drained sands or gravels. These soils high rate of water transmission. Typically comprise sandy soils.
- Group B – Soils with moderate infiltration (37.5-75 mm/hr) rates when thoroughly wetted and consisting primarily of moderately deep to deep, moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission. Typically comprise silty soils.
- Group C - Soils having slow infiltration rates (12.5-37.5 mm/hr) when thoroughly wetted and consisting primarily of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission. Typically comprise clayey soils.
- Group D - Soils having very slow infiltration rates (0-12.5 mm/hr) when thoroughly wetted and consisting primarily of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission. Typically comprise clayey soils.

It should be noted that classifications of HSG, permeability and waterlogging susceptibility can often be complicated by the presence of duplex soils which may exhibit more than one HSG classification. The presence of duplex soils can often lead to waterlogging, especially shallow duplexes on gentle slopes, changes of slope, or level areas / valley floors.

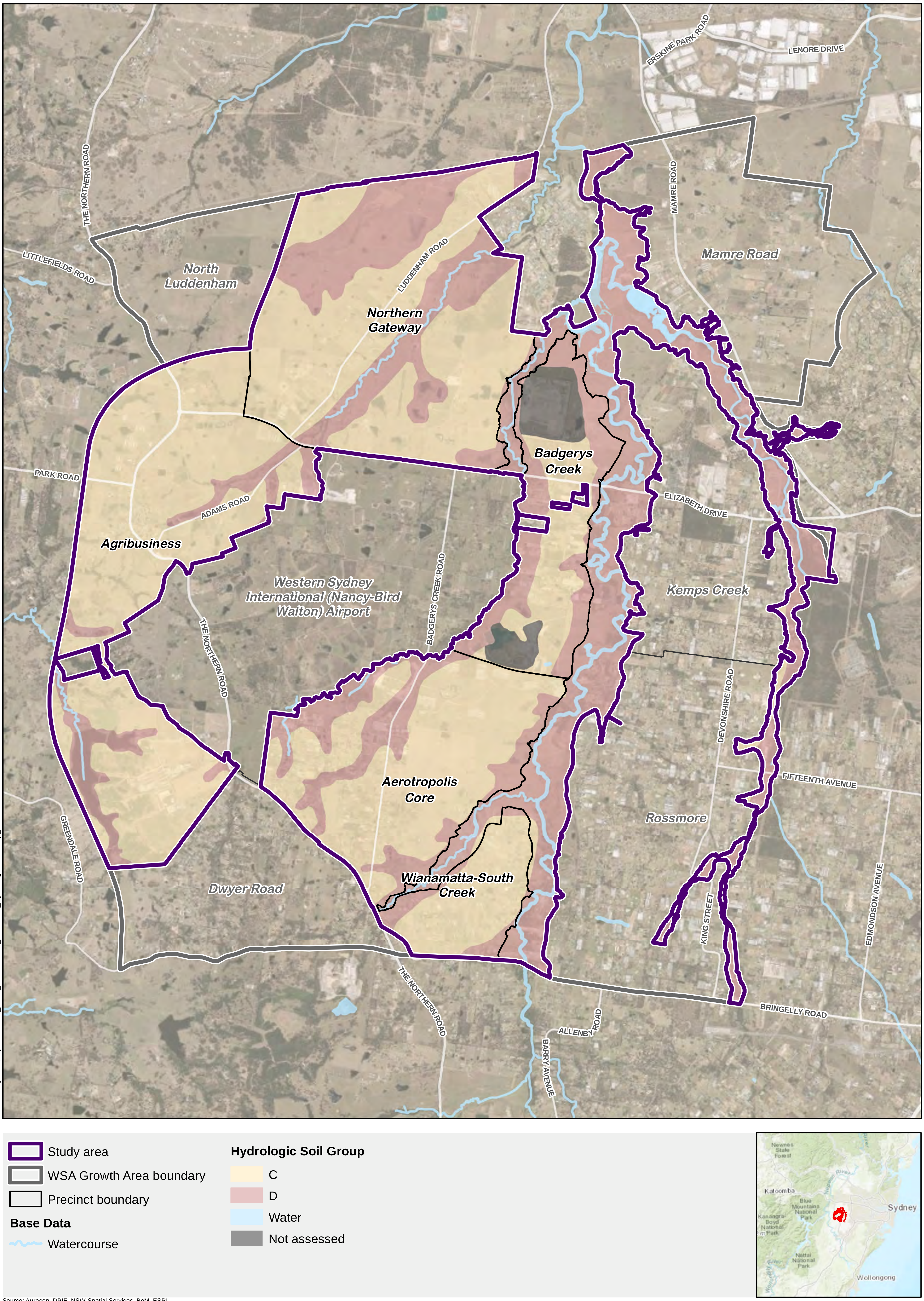
The Hydrologic Soil Groups present within the WSA study area with shown in Figure 6-9 and summarised in Table 6-6.

Table 6-6 Hydrologic Soil Groups within the WSA

HSG	Relevant Precincts
C	Agribusiness, Northern Gateway, Aerotropolis Core, Badgerys Creek
D	Agribusiness, Northern Gateway, Aerotropolis Core, Badgerys Creek, Wianamatta-South Creek

Review of Figure 6-9 shows that Group C soils are typically present within and alongside drainage lines of second order (Strahler) or greater, and generally associated with alluvial type soils (e.g. South Creek soil landscape). Group D soils are typically present away from drainage lines over areas typically associated with the Blacktown and Luddenham soil landscapes.

The assessment of constraints associated with soil permeability that have been modelled as part of this study area presented in Section 7, along with other constraining factors.



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_HydrologicSoilGroup_rev2.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Source: Aurecon, DPIE, NSW Spatial Services, BoM, ESRI

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Figure 6-9: Hydrologic Soil Groups within the WSA

6.5 Soil chemical properties

6.5.1 Sodicity

Sodicity, often expressed as exchangeable sodium percentage (ESP) measures the proportion of cation exchange sites occupied by sodium in clay particles. The presence of excessive amounts of exchangeable sodium can cause dispersion of soil aggregates into individual soil particles (deflocculation), leading to degradation of soil structure, and erosion. For this reason, sodic soils are often synonymous with dispersive clays.

Soils are considered sodic when the ESP is greater than 6, and highly sodic when the ESP is greater than 15. Table 6-7 presents the relationship between exchangeable sodium percentage and soil sodicity classifications.

Table 6-7 Relationship between exchangeable sodium percentage and sodicity

Rating	Exchangeable Sodium Percentage	
	Northcote & Skene (1972)	OEH (2012)
Non-sodic	<6	<5
Slightly sodic	6-10	5-8
moderately sodic	10-15	>8
Highly sodic	>15	>15

Figure 6-10 presents the sodicity classes (as ESP ranges) across the WSA derived from NSW Digital Soil Maps for Key Soil Properties (OEH, 2017) mapping product for soils up to 30 cm below ground level. The results show that all soils within the study area are generally non-sodic to slightly sodic (i.e. <6).

Dispersive clays have not been definitively associated with any specific geologic origin, but most have been found as alluvial clays in the form of slope wash, lake bed deposits, loess deposits, and flood plain deposits. In some areas, claystone and shales laid down as marine deposits have the same pore water salts as dispersive clay, and their residual soils are dispersive (Knodel, 1991).

It should be noted that dispersivity issues associated with sodic soils are generally reflective of interactions with non-saline water. In slightly saline or saline water sodic soils swell, but generally don't disperse due to reduced osmotic gradient within clay platelets (DPIW, 2009).

A relevant land capability desktop study and supporting field investigation conducted by Aurecon in 2019 and 2020 respectively, identified and assessed salinity risk within the South Creek catchment, inclusive of the current study area. This study has been used to provide an initial validation of the available sodicity mapping.

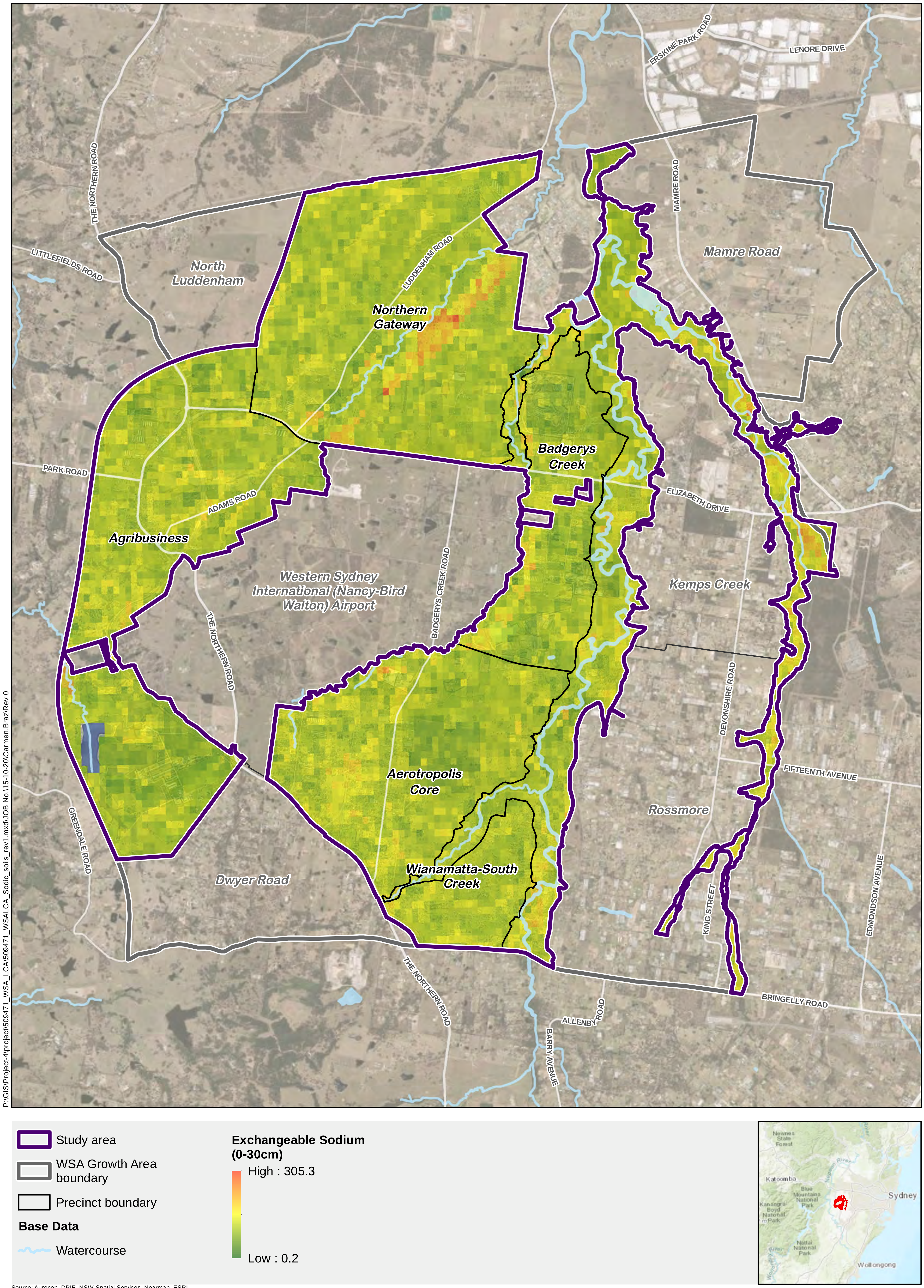
The locations of previous soil investigations into sodicity by Aurecon are presented in Figure 6-12 as they are contiguous with salinity mapping sites. Table 6-9 presents a summary of laboratory testing results for soil salinity from the locations identified in Figure 6-12.

Table 6-8 Summary of local soil sodicity testing results - WSA

Depth Range (m)	Minimum value (µs/m)	Maximum value (µs/m)	Average value (µs/m)
0-0.1	0.6	6.4	3.3
0.1-0.2	1.9	17.4	6.9
0.2-0.3	0.7	13.3	6.4
0.5-0.6	1.4	25.8	11.0
0.8-0.9	3.1	37.1	15.8

The results show that soils within the study area are generally non-sodic to slightly sodic, up to a depth of 0.5m below ground level. Between 0.5m and 0.6m conditions become moderately sodic before giving way to high sodic (>15) conditions. The findings for shallow soils (<30cm) are generally consistent with the available mapping presented in Figure 6-10.

The assessment of constraints associated with soil sodicity that have been modelled as part of this study area presented in Section 7, along with other constraining factors.



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Figure 6-10: Mapped soil sodicity

6.5.2 Salinity

Salinity is an inherent part of Australian landscape; however, human-induced process have notably disturbed the balance of salts through the alteration of hydrological and hydrogeological processes (IPWEA, 2002).

Salinity issues including the dryland and urban salinity that are present in South Creek catchment have been recognised as significant and worsening problems across much of Australia.

Soil salinity data collated in 2002 as part of a Department of Infrastructure, Planning and Natural Resources study was reviewed to obtain an understanding of areas known to be affected by salinity and those at risk of becoming salinized.

Figure 6-11 illustrates such areas relevant to the study boundary, indicating the majority of the study area is characterised as having a moderate salinity potential. Limited areas of known salinity and high salinity potential are also present; however, these are localised to low-lying gullies and foot slopes along creek lines.

Areas of known salinity may be defined as those areas where there is a known occurrence of saline soil, or where air photo interpretation and field observations have confirmed more than one of the following:

- Scalding
- Salt efflorescence
- Vegetation dieback
- Salt tolerant plant species
- Waterlogging

Areas of high salinity potential are defined as those places where soil, geology, topography and groundwater conditions predispose a site to salinity. These conditions are similar to those occurring in areas of known salinity. These areas are most common in lower slopes and drainage systems where water accumulation is high (i.e. high relative wetness index).

Areas of moderate salinity cover the remainder of the map wherever Wianamatta Group shales (Ashfield or Bringelly shales) and tertiary alluvial terraces are found. Scattered areas of scalding and salinity indicator plants have been noted but no concentrations have been mapped. Saline areas that have not yet been identified may occur in this zone. Saline areas may also occur in this zone if new risk factors arise.

Areas in which salinity processes do not operate or are of minor significance. Soils are rapidly drained and underlying strata (Hawkesbury / Narrabeen Sandstones) are highly permeable, resulting in continual flushing and removal of salts in the landscape. No salinity has been reported in these areas, nor is expected to occur.

The movement of salt within the landscape via the hydrological cycle is not represented as a function of salinity potential mapping. As such, salinity movement risks are identified through hydrogeological landscape mapping reports.

A relevant land capability desktop study and supporting field investigation conducted by Aurecon in 2019 and 2020 respectively, identified and assessed salinity risk within the South Creek catchment, inclusive of the current study area. This study has been used to provide an initial validation of the available salinity potential mapping.

The locations of previous soil investigations into land salinity by Aurecon are presented in Figure 6-12. Table 6-9 presents a summary of laboratory testing results for soil salinity from the locations identified in Figure 6-12.

Table 6-9 Summary of local soil salinity testing results - WSA

Depth range (m)	Minimum value (µs/m)	Maximum value (µs/m)	Average value (µs/m)
0-0.1	550	2,310	1090
0.1-0.2	400	2,300	864
0.2-0.3	300	2,360	470
0.5-0.6	200	3,990	1,350
0.8-0.9	200	13,300	3,810

Results were screened against soil salinity class guidelines (see Table 6-10) adopted from the Department of Primary Industries and Regional Development (DPIRD), Western Australia (2019) Measuring soil salinity to qualify the degree of salinity at a local level and aid in the validation of salinity hazard mapping annotated in Figure 6-12.

Table 6-10 Adopted soil salinity classes

Soil Salinity Classification in ECe (Calculated)	
ECe range (uS/cm)	**Salinity Class**
<2000	Non-saline
2000-4000	Slightly saline
4000-8000	Moderately saline
8000-16000	Highly saline
16000-32000	Severely saline
>32000	Extremely saline

Inferred salinity results indicate that near surface soils (0-0.6 m bgl) occur as predominantly ‘non-saline’, with the exception of one ‘slightly saline’ sample collected in the north-west section of the Northern Gateway precinct. Deeper subsoils (0.6-0.9 m bgl) presented ‘non-saline’ to ‘highly saline’ conditions. The findings are considered to be generally reflective of available soil salinity mapping.

The assessment of constraints associated with soil salinity that have been modelled as part of this study area presented in Section 7, along with other constraining factors.

6.5.3 Overarching principles for urban salinity management

Where salinity is likely to occur in areas of urban development, the following overarching principles should apply:

- Land managers should clearly demonstrate what measures will be employed to ensure the salinity hazard does not increase (both on site and on adjoining land) as a result of a development.
- Identify and manage sensitive soils (e.g. sodic soils, reactive soils, type of salts, salt loads).
- Consider the impacts that changing recharge and water quality regimes will have on groundwater and other water dependent ecosystems.
- New houses, buildings or infrastructure (including roads, pathways and retaining walls) in current or potentially salt affected areas may need to be built to withstand the effects of salinity (including the establishment of good drainage prior to construction).
- Drainage pits and some WSUD actions are not appropriate for high salt store or sensitive landscape positions.
- Leaky pipes in older delivery and stormwater systems will impact on the water balance and salt movement within a catchment and must be considered as part of the overall salinity management strategy.
- Employ deficit irrigation principles to prevent over-irrigation of sports grounds, golf courses, parks, private gardens and lawns, and limit the application of extra salt through water recycling programs or irrigation of saline groundwater.
- Implement a monitoring program (where deemed necessary) including a clear identification of responsibilities.

DPIE (DPIE EES 2020) have produced Figure 6-11a outlining WSA HGL extent which provides greater resolution on HGL extents and therefore salinity hazard classes for the WSA. Appendix C provides a summary of urban salinity hazard, management constraints and opportunities for HGLs in the Aerotropolis area.

In summary the salinity hazard classes for each HGL within the WSA are:

- Shale Plains HGL overall salinity hazard:
  - Very High. (noted to be outside of proposed developable areas in draft precinct plans and within the Wianamatta South-Creek Precinct).
- Upper South Creek HGL overall salinity hazard:
  - Very High. This covers the majority of the WSA initial precincts including Badgerys Creek, Aerotropolis Core, Northern Gateway and Wianamatta South-Creek.
- Mount Vernon HGL overall salinity hazard:
  - Moderate. (noted to be outside of the initial precincts assessed in this report, Mamre Road Precinct).
- Mulgoa HGL overall salinity hazard:
  - Moderate. Covers the western portion of the Northern Gateway Precinct and parts of the Agribusiness Precinct.
- Greendale HGL overall salinity hazard:
  - High. Covers part of the Agribusiness Precinct only.

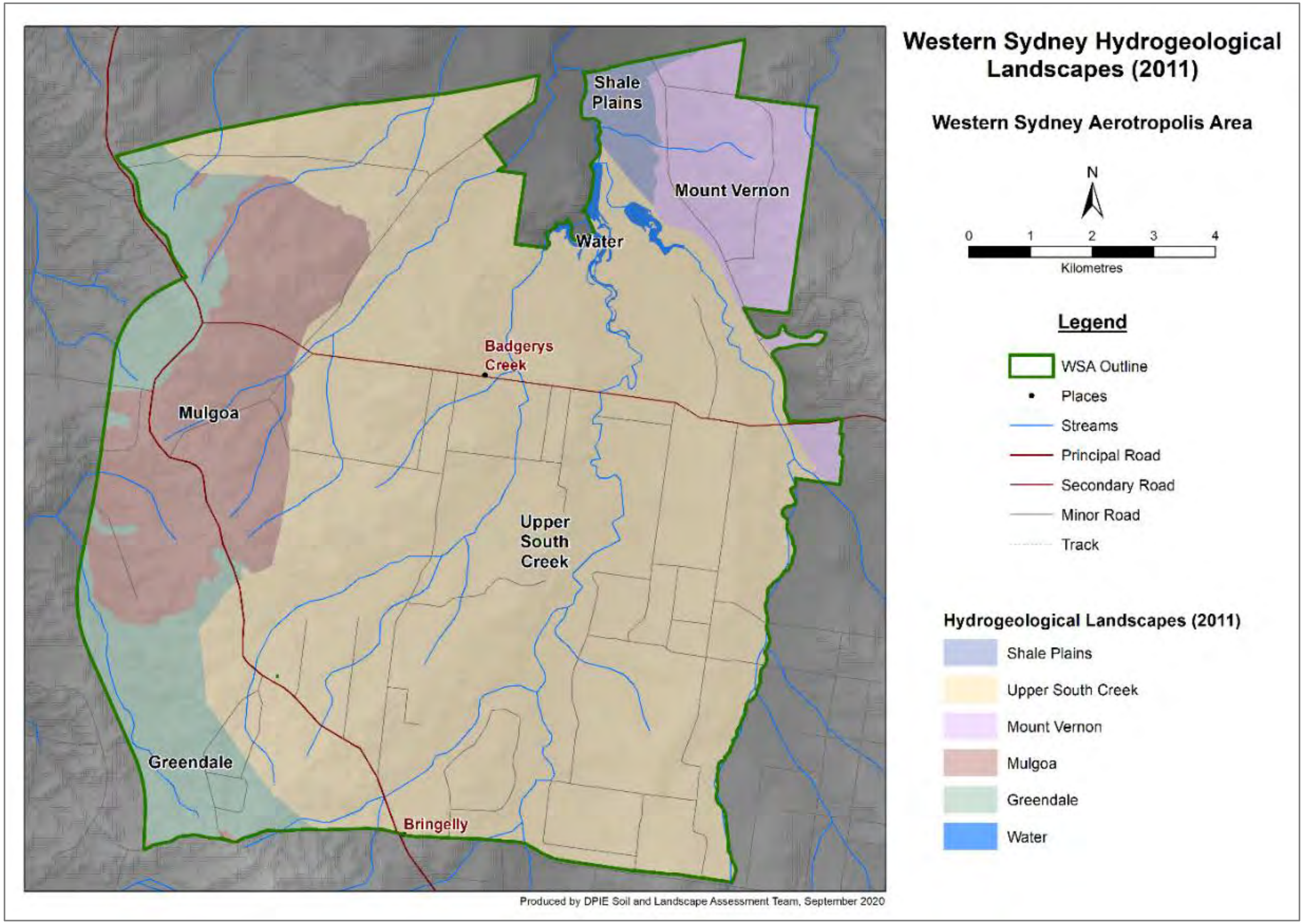
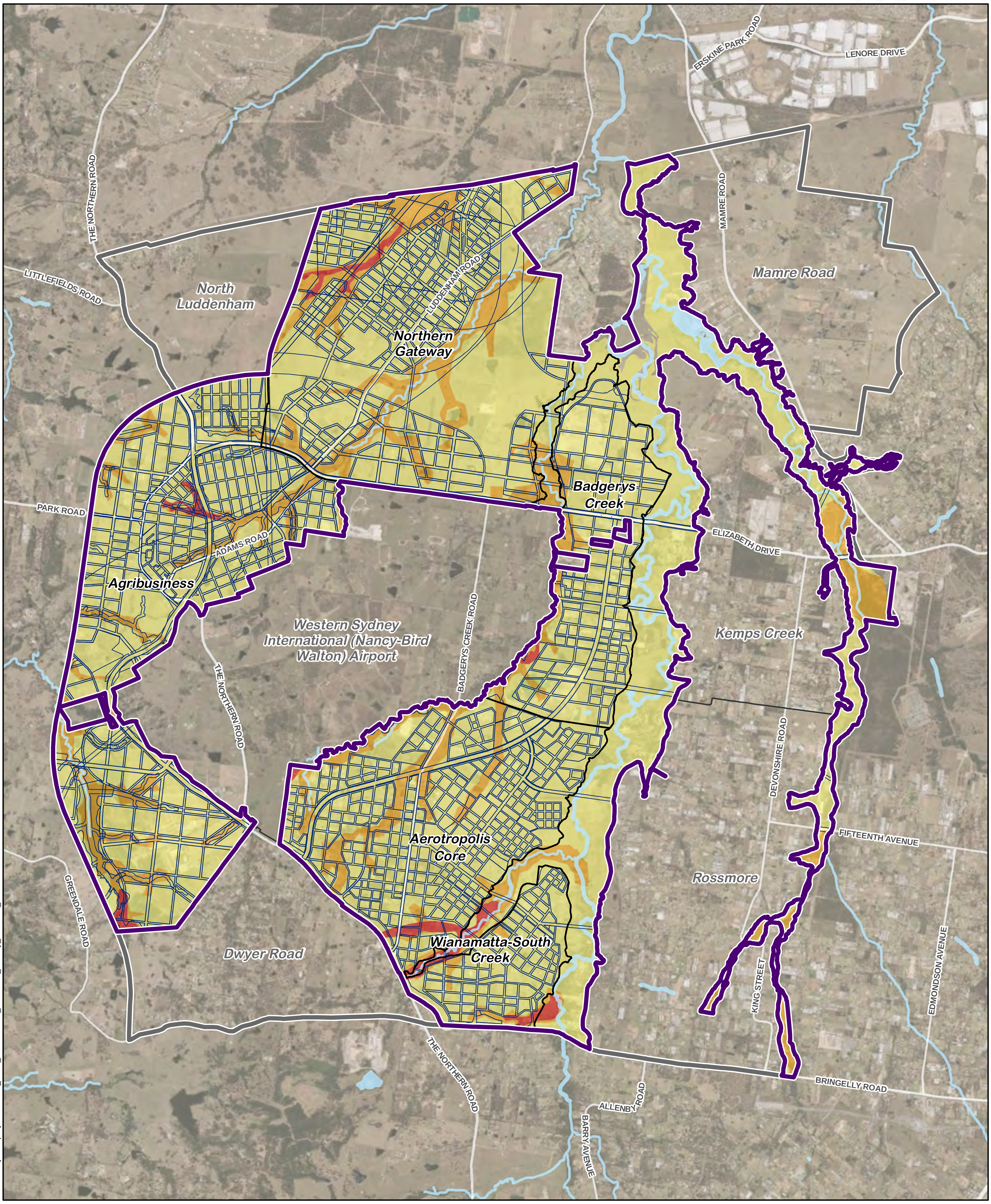


Figure 6-11a Western Sydney HGL extent in the Aerotropolis area (DPIE EES 2020)

aurecon



- Study area
- WSA Growth Area boundary
- Precinct boundary
- Precinct plans

Base Data

- Watercourse

Salinity Potential

- Known Salinity
- High
- Moderate

Source: Aurecon, DPIE, NSW Spatial Services, OEH, ESRI

A3 scale: 1:55,000

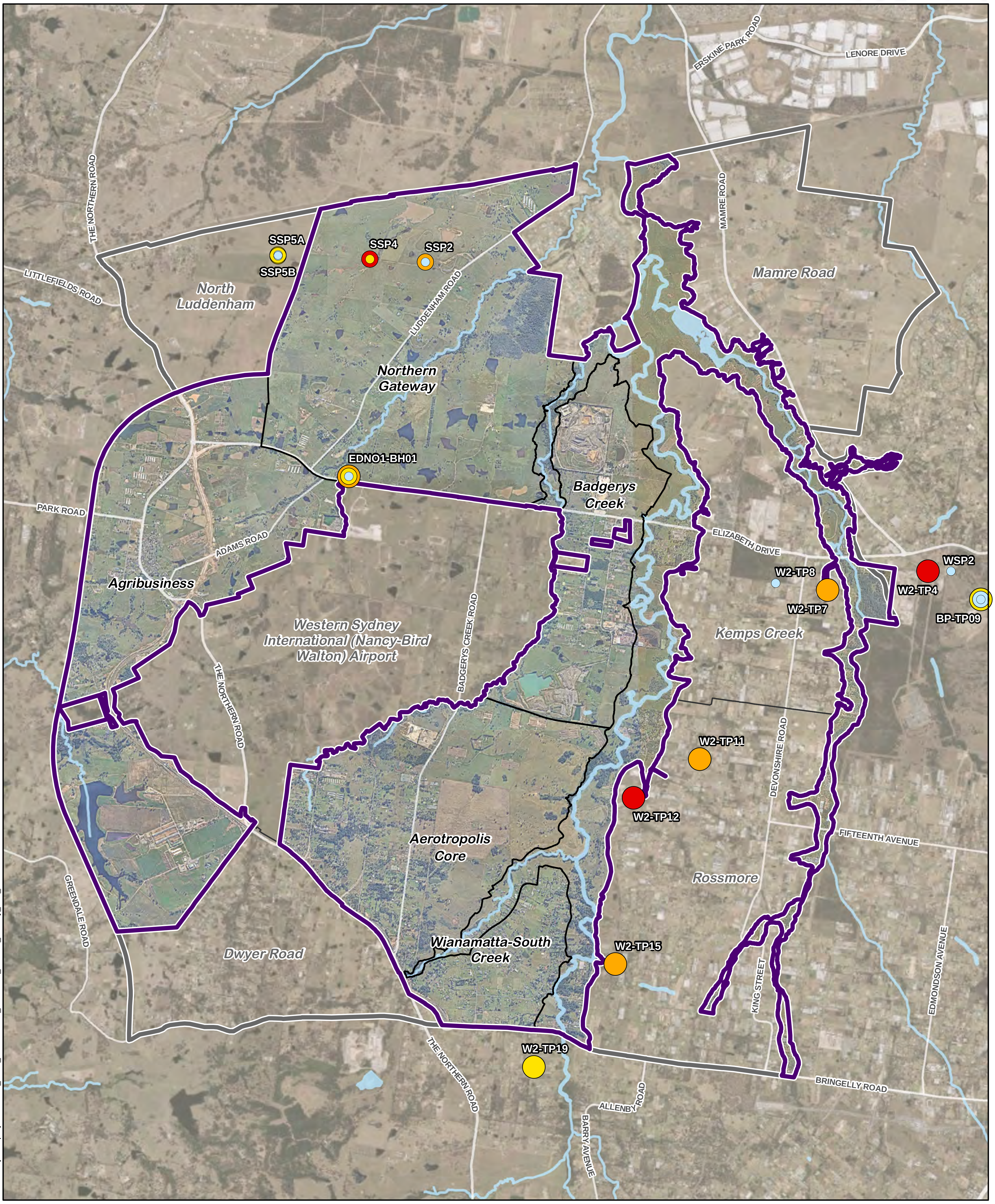
0 1 2 km

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis Constraints and Land Capability Assessment

Figure 6-11: Salinity potential risk mapping



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSA_LCA_Historic_Salinity_Soil_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

- Study area
- WSA Growth Area boundary
- Precinct boundary

Base Data

- Watercourse

Screened Interval Depth (m)

- 0-0.6
- 0.6-1.1
- >1.1

Salinity Class

- Highly saline
- Moderately saline
- Slightly saline
- Non-saline

Source: Aurecon, DPIE, NSW Spatial Services, Sydney Water, GHD, Jacobs, Nearmap, ESRI

A3 scale: 1:55,000

0 1 2 km

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Figure 6-12: Historical soil salinity data

6.6 Soil fertility

Soil fertility refers to the capacity of the soil to provide adequate supplies of nutrients in proper balance for the growth of specified plants, when growth factors such as light, moisture and temperature are favourable (DEC, 2004). Soil fertility is of upmost importance, providing an essential nutritional service to ensure maximum growth of plants (Kissel, 2019). As such, soil fertility is an important factor in land use planning.

Figure 6-13 presents the soil fertility classes that have been mapped within the WSA by the Office of Environment and Heritage (OEH, 2017). The classes are based on Estimated Inherent Soil Fertility of NSW (OEH, 2017), which describes soil fertility in NSW according to a five-class system that is derived from the Inherent soil fertility classes of Australian Great Soil Groups (Charman, 1978). The five classes are:

- Low (1)
- Moderately low (2)
- Moderate (3)
- Moderately high (4)
- High (5)

Table 6-11 presents a summary of the soil fertility classes and relevant precincts within the WSA.

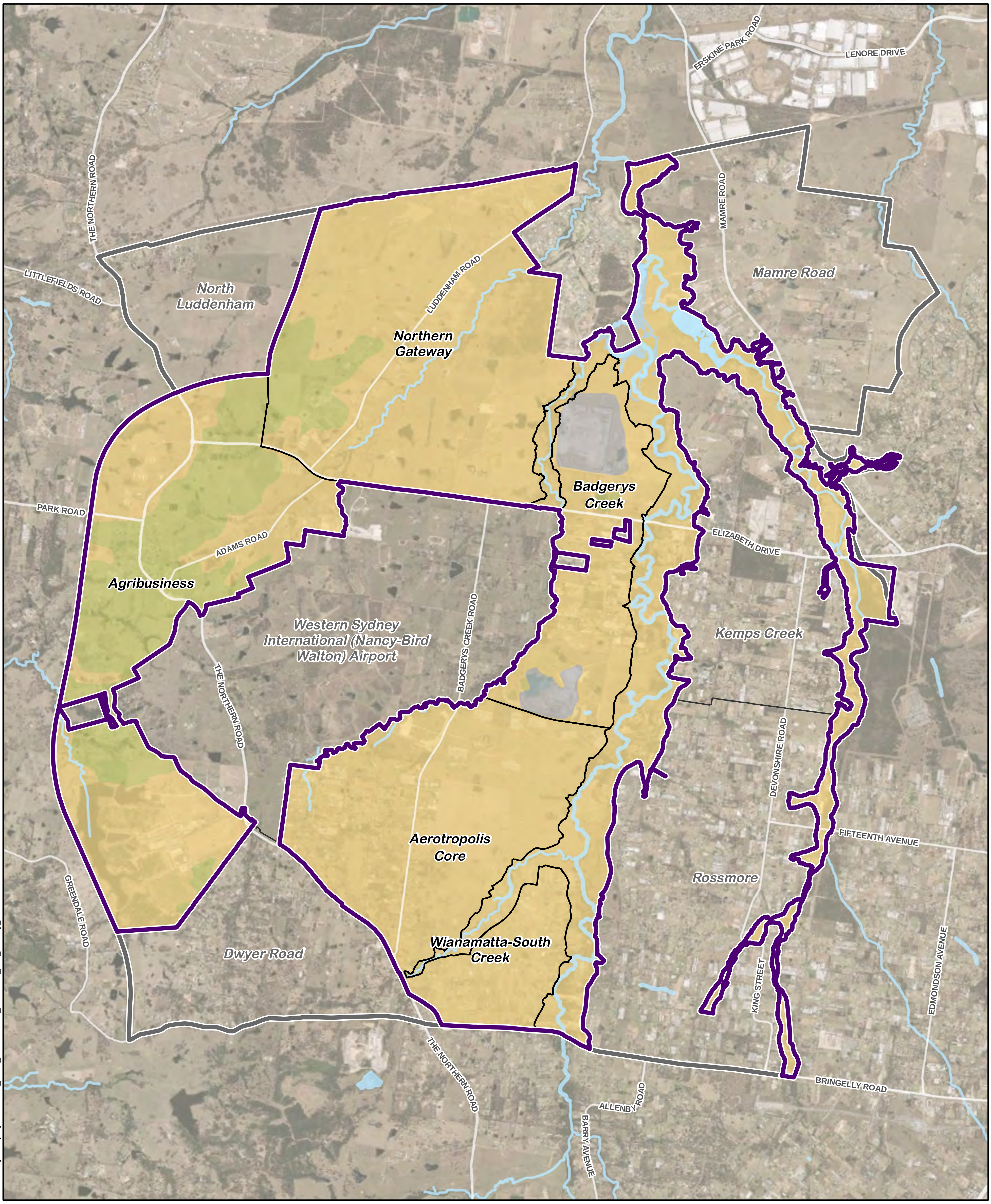
Table 6-11 Soil fertility classes within the Aerotropolis

Soil Class	Relevant Precincts
Class 2 (Moderately Low Fertility)	Agribusiness, Aerotropolis Core, Northern Gateway, Badgerys Creek, Wianamatta - South Creek
Class 3 (Moderate Fertility)	Agribusiness, Badgerys Creek (minor)
Not Assessed	Badgerys Creek

Review of Figure 6-13 and Table 6-11 shows that Class 2 (moderately low) fertility land is present in all precincts within the study area. Class 3 (moderate) fertility land is present over a large area of the Agribusiness precinct, and as a minor area within Badgerys Creek.

The assessment of constraints associated with soil fertility that have been modelled as part of this study area presented in Section 7, along with other constraining factors.

aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Soil_Fertility_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area boundary
Precinct boundary

Base Data

Watercourse

Estimated Soil Fertility

Moderately low
Moderate
Water
Not assessed

Source: Aurecon, DPIE, NSW Spatial Services, ESRI

A3 scale: 1:55,000

0 1 2 km

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis Constraints and Land Capability Assessment

Figure 6-13: Soil fertility

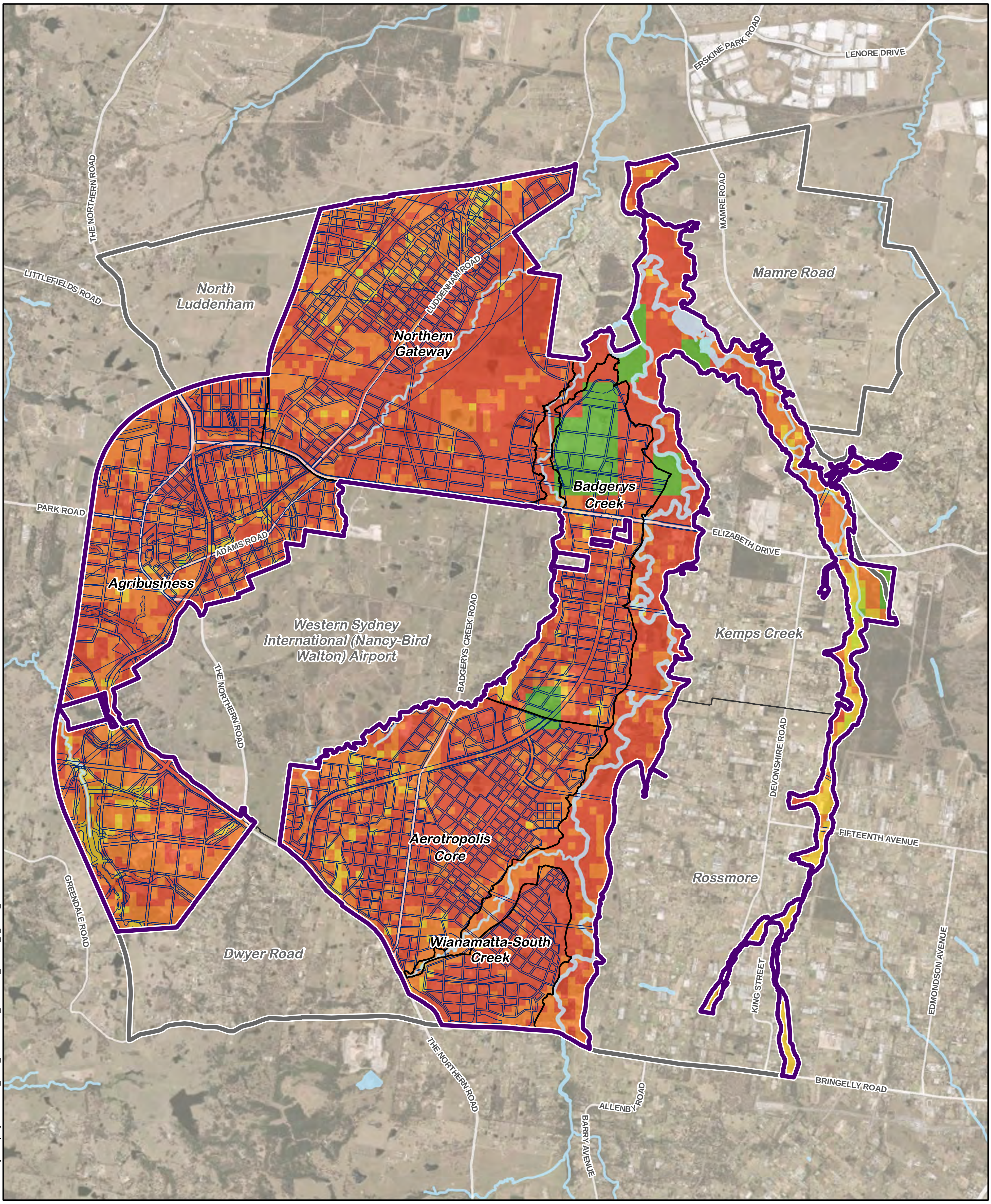
6.7 Soil erosion

Soil erosion is a major form of land degradation in NSW landscapes. The K-Factor is an index which quantifies the relative susceptibility of soil to sheet and rill erosion. K values for soils depend on a number of factors, including soil texture, soil structure, permeability, organic matter content and land use. Soil erosion hazard is an important component in land use planning as it can affect the condition of soils, stability of structures and impacts on the natural environment.

Figure 6-14 presents the soil K-Factor classes that have been mapped within the WSA by the Department of Planning, Industry and Environment NSW (DPIE, 2018). The K-Factor values may range from between <0.01 and >0.08.

The assessment of constraints associated with soil fertility that have been modelled as part of this study area presented in Section 7, along with other constraining factors.

aurecon



Study area

WSA Growth Area boundary

Precinct boundary

Precinct plans

Base Data

Watercourse

Modelled Hillslope Erosion (K-Factor)

0.01

0.01 - 0.05

0.05 - 0.055

0.055 - 0.06

0.06 - 0.065

0.065 - 0.07

Source: Aurecon, DPIE, NSW Spatial Services, ESRI

A3 scale: 1:55,000

0 1 2 km

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Soil Erosion (K-Factor)

6.8 Acid sulfate soils

Acid Sulfate Soils (ASS) refer to soils containing sulfides. When the sulfides contained in ASS are exposed to oxygen, such as from groundwater drawdown and/or excavation, sulfuric acid can be generated, which may result in a number of detrimental effects on groundwater dependant ecosystems, underground structures and receiving water bodies, including:

- Sulfuric acid causing leaching/mobilisation of metals from otherwise stable soil matrices, increasing the concentration of heavy metals in the groundwater to potentially toxic levels
- Reduced durability of underground structures, such as steel and concrete, through corrosion
- Degradation of soil quality in affected areas, preventing vegetation growth

Acid sulfate rock (ASR) can also occur within some geological units such as marine sedimentary units, coal measures and igneous rock with sulfide and pyrite mineralisation. All ASR contains appreciable iron sulfide that when disturbed and specifically crushed, present a risk of environmental and durability impacts for road structures when in contact with water and atmospheric oxygen. ASR presents a risk for fresh rock when excavated and not weathered rock that has been exposed to weathering process and leaching of pyrite over time.

A search of the Department of Planning and Environment ASS risk map indicates there is no mapped presence of ASS within the Aerotropolis precincts.

6.9 Hydrogeology and groundwater

6.9.1 Hydrogeological landscapes (landscape salinity)

Groundwater associated salinity (commonly known as seepage salinity) is the visual scalding of soil surfaces with a rising saline water table. Groundwater associated salinity occurs in discharge areas of the landscape as water exits from groundwater to the surface, bringing dissolved salts with it (Rengasamy, 2006).

The Hydrogeological Landscape (HGL) framework builds upon the groundwater flow system framework (Coram 1998; Walker et al 2003), primarily to assist in the management of groundwater salinity.

The HGL framework encompasses all forms of water flow within an HGL unit, including surface water, interflow and groundwater. HGL units integrate information on lithology, bedrock structure, regolith, soils, landforms and climate (rainfall, seasonality, evaporation).

Hydrogeological-Landscape frameworks and mapping products are compiled over a range of spatial scales ranging from local landscape features to regional systems spanning hundreds of kilometres. At the broadest scale major bedrock types, structural and architectural elements (such as geological units and stratification), landform and climatic characteristics are used. Local scale features may include regolith / soil type and thickness, morphology, and lithostructures); which assert local controls on water movement, storage and hydrological processes that can affect farm-scale management strategies.

The methodology used to arrive at an HGL landscape involves a structured comparison of salinity characteristics. These included water pathways through the landscape; salt stores; relative mobility of salt within the landscape; salinization processes, and salt signature within streams. These processes are integrated with landscape spatial variability to produce an overall salinity hazard assessment for any given area (Moore et al 2018).

Figure 6-15 presents the HGLs mapped for the WSA. The mapped units and relevant precincts are summarised in Table 6-12 and include Upper South Creek, Mount Vernon, Mulgoa, Greendale, and Shale Plains.

Table 6-12 Hydrogeological Landscapes in the WSA

HGL Name	Lithologies	Aquifer Type	Relevant Precincts
Upper South Creek	Recent alluvium – fine-grained sand, silt and clay. Bringelly Shale (Wianamatta Group).	Unconfined in unconsolidated alluvial sediments. Unconfined to semi-confined in fractured rock along structures. Local perching above clay-rich layers (seasonal).	Aerotropolis Core, Agribusiness, Badgerys Creek, Northern Gateway, Wianamatta – South Creek
Mount Vernon			Wianamatta – South Creek
Greendale			Aerotropolis
Shale Plains			Upper South Creek
Mulgoa	Bringelly Shale (Wianamatta Group). Ashfield Shale (Wianamatta Group). Unconsolidated colluvial and alluvial gravels, sands and silts deposited on lower slopes and along streams.	Unconfined to semi-confined in unconsolidated and cemented alluvial sediments. Unconfined to semi-confined in fractured rock along structures.	Aerotropolis, Northern Gateway

Review of Table 6-12 and Figure 6-15 shows that:

- The Upper South Creek landscape: Occupies the majority of the WSA study area, including all of Wianamatta-South Creek, Aerotropolis Core, and Badgerys Creek, along with a large proportion of the Northern Gateway and a small area within the Agribusiness precinct.
- The Mulgoa landscape occupies a large area within the southern portion of the Northern Gateway and large areas within the Agribusiness precinct.
- The Greendale landscape is exclusive to the Agribusiness district (generally in the northern and southern portions).
- The Mount Vernon and Shale Plains landscapes are present as a small, elongate areas along the easternmost boundary of the South Creek precinct.
- Typical aquifers within the HGLs present in the study area are unconfined unconsolidated aquifers in alluvial sediments; and unconfined to semi-confined aquifers in fractured rock. Local perched layers are also present in the Upper South Creek, Mount Vernon, Greendale, and Shale Plains landscapes.

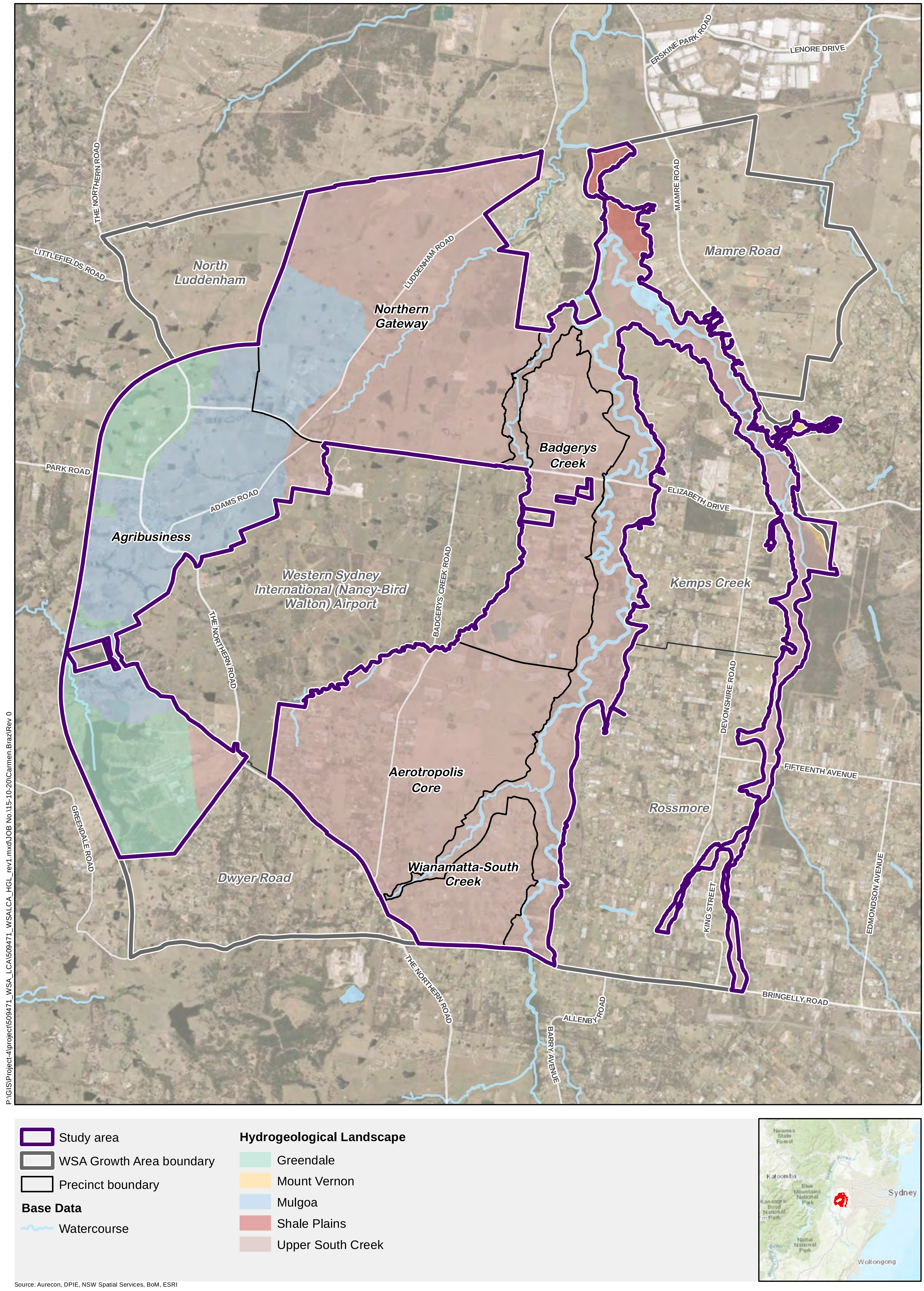
On the HGL derivative maps and associated tables, colours are used to define ranges for various attributes that contribute to the overall salinity hazard; including land salinity, salt export, water quality impact, salt availability, salt store, likelihood of salinity occurrence, potential impact of salinity and sodicity hazard. The overall salinity hazard for a landscape (rated from very low to very high) is based on the combination of these factors.

Salinity attributes for the HGLs identified in Figure 6-15 are summarised in Table 6-13. Figure 6-16 presents the equivalent overall salinity hazard ratings for the landscapes presented in Figure 6-15 and summarised in Table 6-13. It should be noted that the salinity ratings from the HGL reports are reflective of land-based salinity hazards and a separate assessment is required with respect to overall groundwater quality.

Table 6-13 Salinity impacts for each HGL relevant to the study area (DPIE 2011)

HGL Name	Land Salinity Impacts	Salt Export Impacts	Water EC Impacts	Salt Store	Salt Availability	Impact	Likelihood	Overall Salinity Hazard
Upper South Creek	High	High	High	High	Moderate	Severe	High	Very High
Mount Vernon	Moderate	Moderate	High	Moderate	Low	Significant	Moderate	Moderate
Mulgoa	Moderate	Moderate	Moderate	High	Moderate	Significant	Moderate	Moderate
Greendale	Moderate	Low	Moderate	Moderate	Moderate	Significant	High	High
Shale Plains	High	High	High	High	High	Severe	High	Very High

As shown in Table 6-13 the overall salinity hazards for landscapes within the WSA range from moderate to very high. Salinity is discussed further as groundwater salinity in Section 6.9.4.



Source: Aurecon, DPIE, NSW Spatial Services, BoM, ESRI

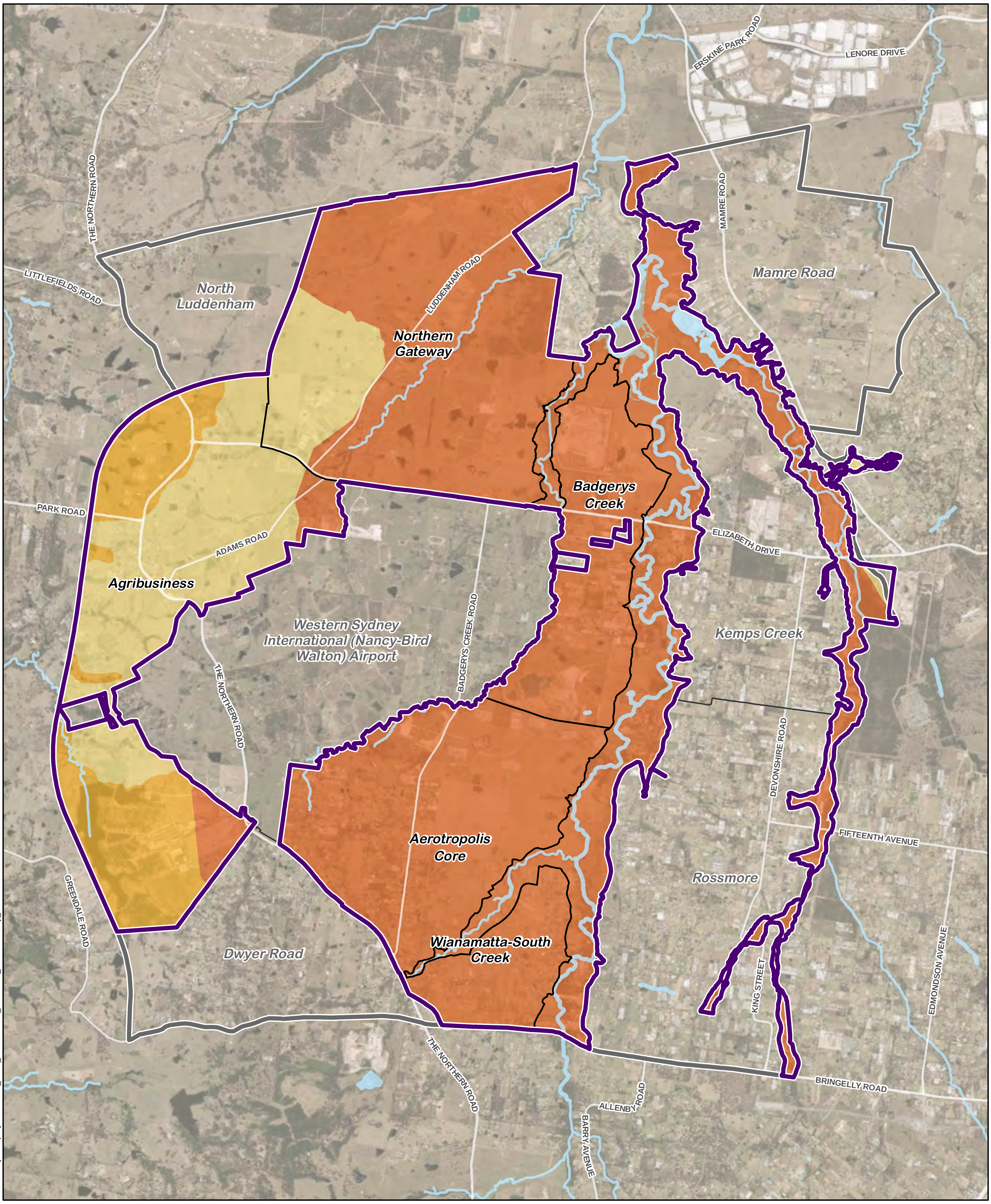
A3 scale: 1:55,000

0 1 2 km

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Figure 6-15: Hydrogeological Landscapes of Western Sydney



Study area

WSA Growth Area boundary

Precinct boundary

Base Data

Watercourse

Overall Salinity Hazard

Very High

High

Moderate

Source: Aurecon, DPIE, NSW Spatial Services, BoM, ESRI

A3 scale: 1:55,000

0 1 2 km

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis Constraints and Land Capability Assessment

Figure 6-16: Overall salinity hazard

6.9.2 Depth to groundwater

The depth to groundwater is a measure of the depth from the land surface to the water saturated zone in the underlying soil and rock. The depth to groundwater, also referred to as the depth to water table, is important in the assessment of land capability for a number of reasons, including identifying risks such as risks from groundwater flooding or dryland salinity; identifying resource, such as availability and ease of access of groundwater as a water resource; and identifying vulnerability to pollution or contamination.

The depth to water table is reported for each hydrogeological landscape present within the WSA study area. A review of the HGL reports has identified that the depth to water table in all HGLs are classified as 'intermediate', with ranges typically between 2m and 8m below ground level.

Aurecon has undertaken local scale investigation of groundwater levels using available data from previous studies. The investigation has included compiling and summarising groundwater levels from a network of monitoring wells installed throughout the study area. The monitoring network is presented in Figure 6-17 alongside groundwater elevation contours derived through interpolation.

Table 6-14 presents a summary of the hydrostratigraphic units, monitoring well target depths and recorded groundwater levels (as metres below ground level (mbgl)) within the local monitoring network.

Table 6-14 Summary of local hydrostratigraphic units and monitoring well records

Target Material	Target depth range (mbgl)	Groundwater Depth range (mbgl)
Alluvial	4.5 - 6.0	0.7 - 4.8
Regolith	4.5 - 18.5	0.5 – 5.7
Bringelly Shale	4.5 - 45.0	1.4 - 10.8

The following conclusions can be drawn from examination of Figure 6-17 and Table 6-14:

- The local groundwater monitoring wells are targeted within alluvial, regolith and upper layers of the local Bringelly Shale. They are typically screened between 4.5m and 45.0m below ground level, with an average depth of 15mbgl.
- The majority of local monitoring wells are screened at depths consistent with local scale groundwater flow systems.
- Groundwater flow is towards the north-east and generally consistent with overall topography, which is a key control on local scale groundwater flow systems.

The results of the local groundwater investigations validate the general groundwater levels reported by the NSW Hydrogeological Landscape (HGL) mapping reports.

6.9.3 Aquifer yield (specific storage)

Specific storage is a measure of the capacity of a saturated material to drain by gravity. Specifically, it is a measure of volume of water released from storage from a unit volume of aquifer per unit decline in hydraulic head. For unconfined aquifers, specific storage is expressed as specific yield, whereas for confined aquifers it is expressed as storativity.

Table 6-15 presents the estimates of specific yield that are reported for each hydrogeological landscape present within the WSA study area.

Table 6-15 Wet Specific yield estimates within the WSA

HGL Name	Specific Yield	Range	Relevant Precincts
Upper South Creek	Moderate	5-15%	Aerotropolis Core, Agribusiness, Badgerys Creek, Northern Gateway, Wianamatta – South Creek
Mount Vernon	Moderate	5-15%	Wianamatta – South Creek
Mulgoa	Low to Moderate	<5-15%	Aerotropolis, Northern Gateway
Greendale	Low to Moderate	<5-15%	Aerotropolis
Shale Plains	Moderate	5-15%	Upper South Creek

No data is currently available to validate estimates of specific yield from the NSW HGL reports; however, literature-based values on specific yield estimates for soil materials may be used as a preliminary verification. Brassington (2017) summarises typical ranges of specific yield for geological materials. The ranges presented by Brassington (2017) are consistent with the geological materials (fine sands, silts, clays, shale) present in the WSA study area and consistent with the specific yield estimates for the HGLs.

6.9.4 Groundwater quality

Groundwater quality, expressed as groundwater salinity, describes the electrical conductivity of groundwater. The salinity of groundwater can be classified into a number of suitability / status-based categories; these categories are presented in Table 6-16.

Table 6-16 Groundwater Salinity Classes (Rhoades et al., 1992; Stanton et al., 2017)

Category	Salinity Range (mg/L)	Suitability
Fresh	<500	Drinking and all irrigation
Slightly Saline	500-2,500	Crop irrigation and livestock use
Moderately Saline	2,500-10,000	Livestock
Very Saline	10,000-35,000	Very saline groundwater, limited use for certain livestock
Brine	>35,000	Seawater; some mining and industrial uses exist

Within the WSA a two-aquifer system is believed to exist with respect to groundwater quality (IAH, 2009); namely an upper/ regolith aquifer that is relatively fresh and pervious, but limited in depth and extent, and a lower shale bedrock aquifer, which is distinctly saline. These two aquifers are generally poorly interconnected by narrow fracture networks. This conceptual model is believed to be reflective of why streams within the WSA can run fresh in shale areas despite most of the deeper waters being saline. It also explains increases in salinity of surface waters during drought conditions, or in certain reaches of creeks.

Groundwater quality (as groundwater salinity) is reported for each hydrogeological landscape present within the WSA study area. Table 6-17 presents estimates of groundwater salinity within the WSA from the HGL reports.

Table 6-17 Groundwater salinity estimates within the WSA

HGL Name	Classification	Salinity Range (mg/L)	Relevant Precincts
Upper South Creek	Moderately saline to very saline.	>3,000	Aerotropolis Core, Agribusiness, Badgerys Creek, Northern Gateway, Wianamatta – South Creek
Shale Plains	Moderately saline to very saline.	>3,000	Upper South Creek
Mount Vernon	Slightly saline	500-1,000	Wianamatta – South Creek
Mulgoa, Greendale	Slightly saline to moderately saline. More saline in deeper aquifers	1,000-3,000	Aerotropolis, Northern Gateway

Aurecon has undertaken limited verification of groundwater salinity for each HGL through local data obtained from recent field investigations and relevant reports within the study area. Results from the limited datasets indicate salinity in shallow groundwater wells (<12m) ranges from approximately 2,200mg/L to 22,400mg/L with an average of 11,000mg/L across the study area. Deeper wells (>12m) record groundwater salinity ranges from approximately 2,100mg/L to 18,500mg/L with an average of 11,200 mg/L.

The results from recent monitoring, presented as salinity vs depth in Figure 6-17a show no direct correlation between salinity and depth of groundwater within the WSA; however, the variation in salinity is noted to decrease with depth. The decrease in variation is interpreted to reflect the effect of local landscape salt stores and the relative locations of monitoring wells within the landscape, with higher salinity values likely reflecting local groundwater discharge sites near salt stores.

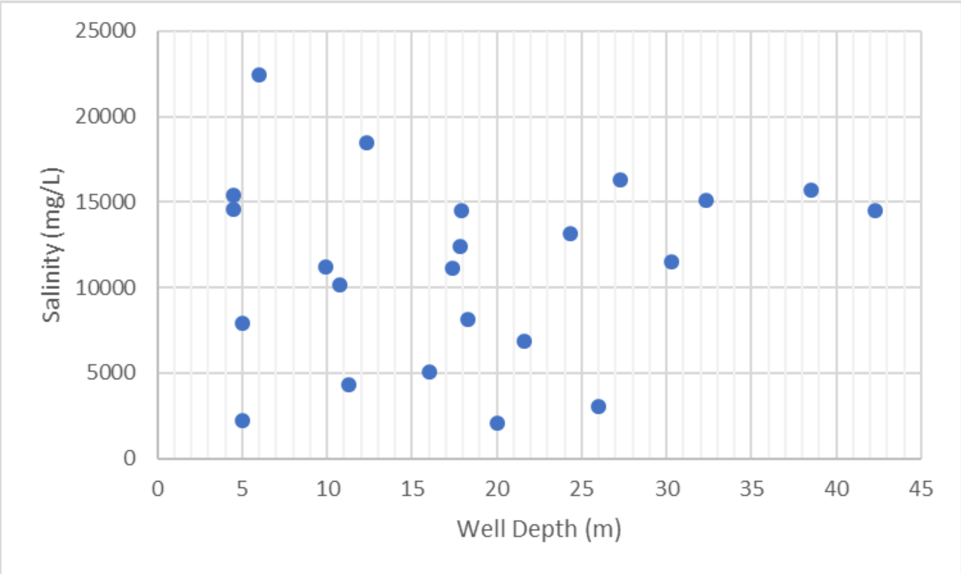
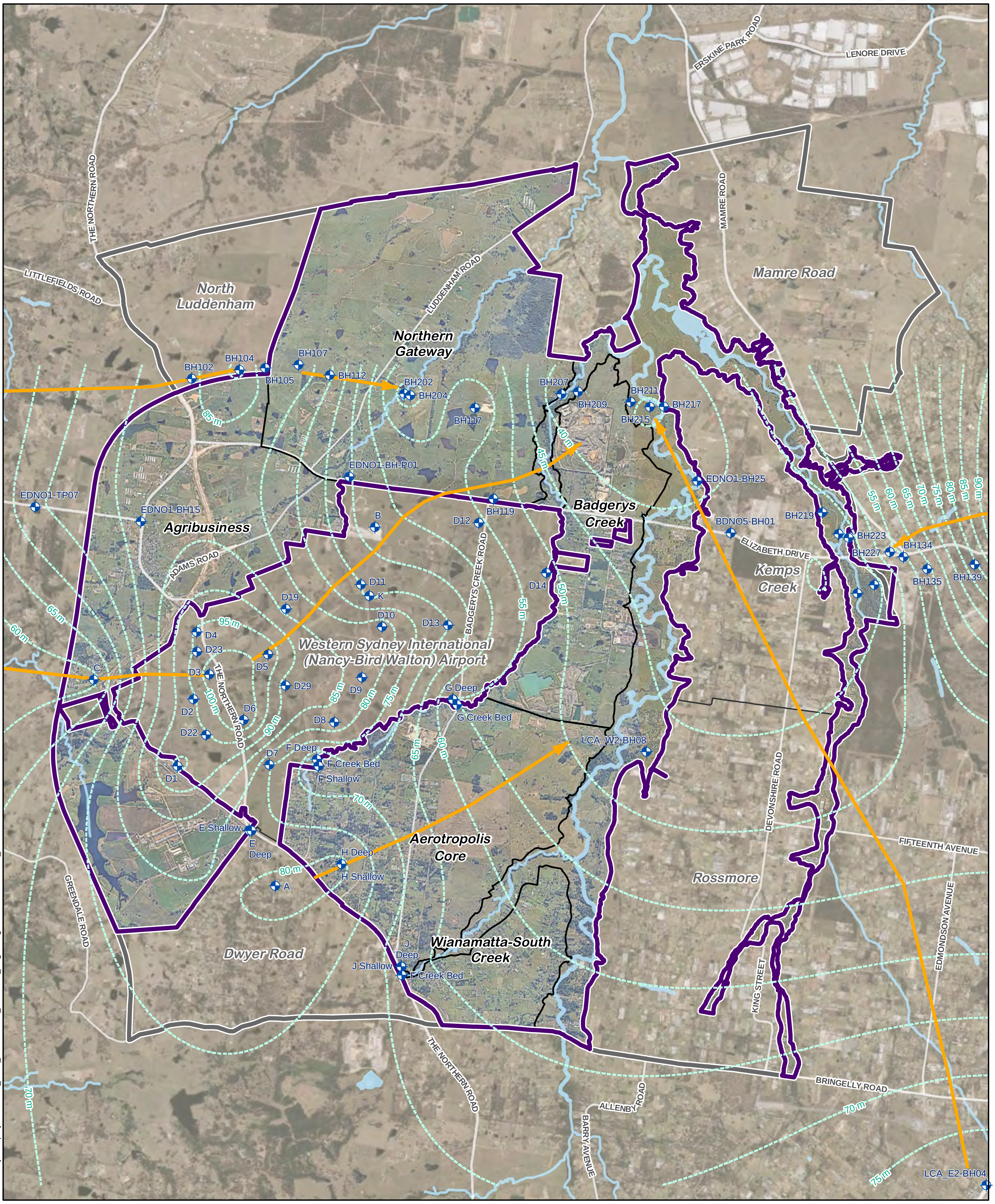


Figure 6-17a Groundwater salinity (mg/L) vs well depth in WSA

Overall, the results from groundwater monitoring are considered to be reflective of classifications provided by the HGL reports as generally moderately to very saline conditions.



Study area

WSA Growth Area boundary

Precinct boundary

Base Data

Watercourse

Groundwater monitoring well

Groundwater elevation contour (mAHD)

Regional flow direction

Source: Aurecon, DPIE, NSW Spatial Services, BoM, ESRI

A3 scale: 1:55,000

0 1 2 km

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Figure 6-17: Groundwater elevation contours and regional/intermediate flow directions

6.10 Surface water quality

This section describes the existing water quality for the seven (7) main creeks that intersect the study area, namely: Oaky Creek; Cosgrove Creek; Badgerys Creek; Duncans Creek; South Creek, Kemps Creek and Thompsons Creek.

Water quality data is available for the aforementioned creeks from existing sources and previous technical studies conducted within the area. Existing data includes the M12 Motorway EIS (Jacobs 2019), the Western Sydney Airport EIS Appendix L1 and L2 (GHD 2016), the Badgerys Creek Environmental Survey (SMEC 2014) and the Second Sydney Airport EIS (PPK 1997). The HGL mapping products are also a principal source of information on ambient surface water quality (as salinity), which are used as a base layer as part of this land capability assessment.

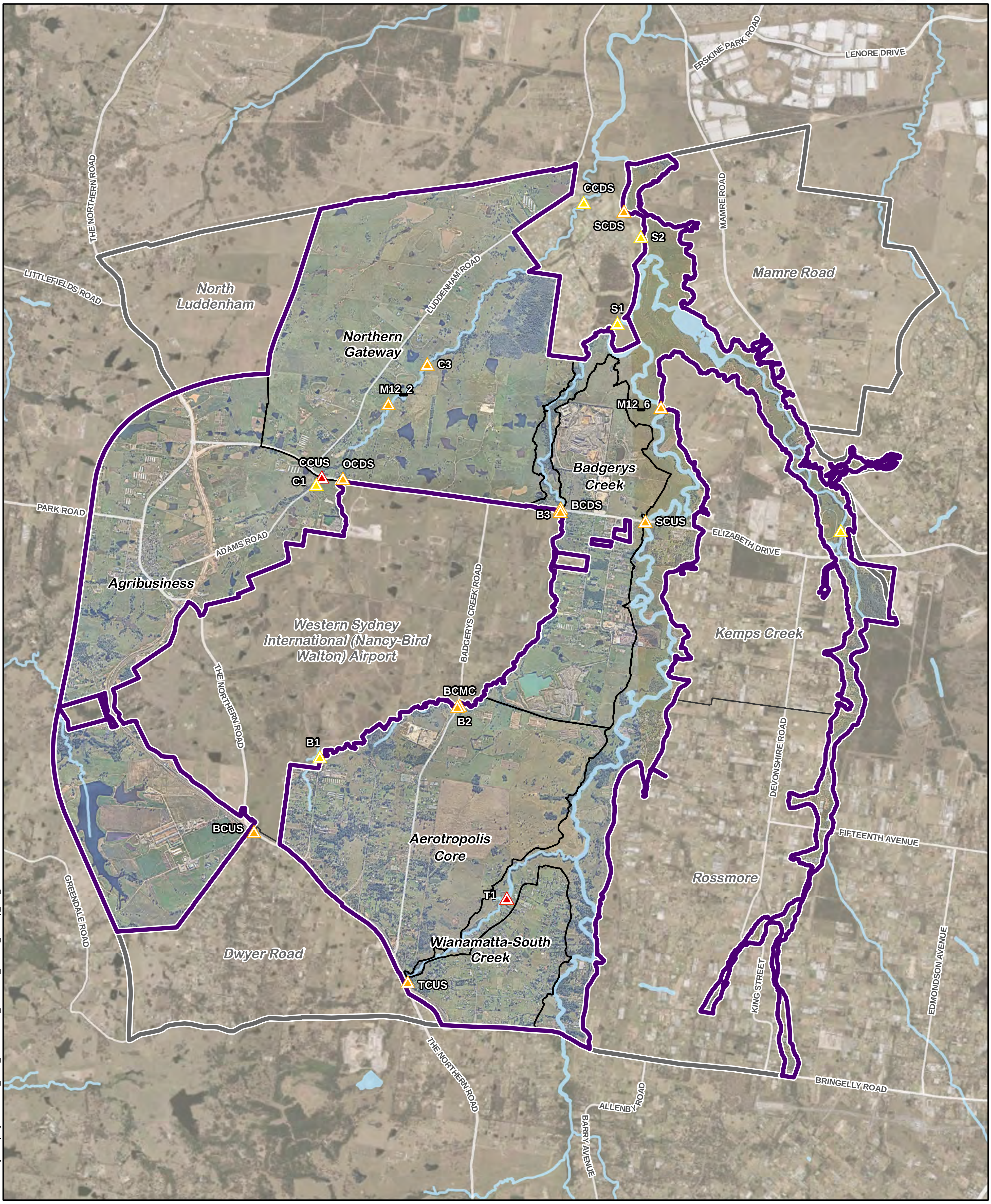
Table 6-18 presents the HGL classifications for surface water salinity within the WSA alongside results from available monitoring data. HGL classifications indicate that Upper South Creek, Shale Plains and Mount Vernon are all classified as high class for surface water salinity (880mg/L to 2,640 mg/L). Available monitoring data is in agreement with these classifications with ranges between 600 mg/L and 2,760 mg/L. Overall the surface waters within the WSA may be classified as slightly to moderately saline.

Table 6-18 Surface water salinity within the WSA

HGL Name	HGL Class	HGL Salinity (mg/L)	Measured Salinity (mg/L)		Relevant Precincts
		Range	Average	Range	
Upper South Creek	High	Baseflow: 880 – 2,640 Overall: 275 - 850	1,500	600 – 2,760	Aerotropolis Core, Agribusiness, Badgerys Creek, Northern Gateway, Wianamatta – South Creek
Shale Plains	High	Overall: 880 – 2,640	No Data	No Data	Upper South Creek
Mount Vernon	High	Overall: 1,050 – 2,150			Wianamatta – South Creek
Mulgoa	Moderate	No Data			Aerotropolis, Northern Gateway
Greendale	Moderate	Overall: 110 - 990			Aerotropolis

It is important to recognise that in-stream salinity within the WSA is largely controlled by local climate and weather conditions. The results from recent monitoring are in general agreement with the salinity ranges expressed in the HGL reports, supporting the landscape classification. Areas of no data are present within the study area, which is considered to be an existing gap for further investigation.

aurecon



Study area
WSA Growth Area boundary
Precinct boundary

Base Data

Watercourse

Salinity Class

Highly saline
Moderately saline
Slightly saline
Non-saline

Source: Aurecon, DPIE, NSW Spatial Services, Sydney Water, GHD, Jacobs, Nearmap, ESRI

A3 scale: 1:55,000

0 1 2 km

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis Constraints and Land Capability Assessment

Figure 6-18: Historical surface water salinity data

7 Constraints assessment

7.1 Climate

7.1.1 Agricultural and urban land use constraints

Dry sub-humid environments alongside arid, and semi-arid environments are typically at greater risk of environmental degradation than more humid environments. Desertification is a risk factor that may be driven by climatic variations and human activities. Anthropogenic (human) induced drivers of land degradation in sub-humid and arid environments are typically associated with unsustainable land management practices, including mono-functional land use.

The vulnerability to desertification of land is determined by climate, relief, the state of soil and natural vegetation, along with current and future land use activities. Climate conditions (rainfall, solar radiation and wind) all affect the physical and mechanical erosion phenomena, and chemical and biological degradation rates.

In dry sub-humid zones, the state of soil including texture, structure, chemical and biological status, along with land use activities, exert a more significant effect than climate on the overall desertification risk. It is widely acknowledged that human activities are commonly the primary factors driving desertification of vulnerable land globally (FAO, 2003).

Summarily, the local climate conditions may place constraints on land use activities within the Aerotropolis due to the increased vulnerability to land degradation through human activities; including depletion of soil nutrients, salinisation, soil erosion, agrochemical pollution, and vegetation degradation. Activities that may degrade the landscape should be carefully managed with consideration to the constraints that arise from local climate conditions and climate change, which is discussed further in the following section.

Climate has not been included as part of the decision framework for land capability assessment on urban and agricultural land capability in the study area due to the complex and transient nature of climate conditions, and complexity of interactions on the physical environment.

7.2 Topography

7.2.1 Overview

Topographic controls on land capability are primarily attributed to slope. Land use activities become increasingly difficult as slope increases, particularly above moderately inclined levels (>20%) (DECCW, 2010). Steeper slopes are also associated with greater potentials for erosion (due to increased rainfall-runoff velocities and wind erosion potentials), mass movement (gravitational forces on soil particles).

7.2.2 Agricultural land use constraints

In general consistency with the land and soil capability scheme approach (OEH, 2012), Aurecon has adopted a constraint rating system for agricultural land use, which divides slope as a percentage into three categories: Low constraint (<8%), moderate constraint (8-20%), and high constraint (>20%) (Table 5-1). These categories broadly reflect the classes adopted by the LSC assessment scheme.

7.2.3 Urban land use constraints

Constraints on urban development as a result of slope may vary in accordance with the scale of the development and the geotechnical controls that are utilised to ensure safe design. Previous work by the Department of Environment Climate change and Water (DECCW, 2010) identified 5 constraint classes for slope based on a standard residential development. Under the DECCW (2010) classification, slopes less than 8% were categorised as low constraint, slopes between 8% and 15% were categorised as moderate constraint, whilst slopes greater than 15% were categorised as high constraint. This categorisation is also generally consistent with Landslide Risk Management Concepts and Guidelines (AGS, 2007); and generally consistent with the land capability ratings for building foundations presented in Guidelines for Land Capability Assessment in Victoria (Rowe et al., 1981).

Table 7-1 presents a summary of typical slope constraints on urban development categories. Table 5-1 presents the criteria adopted by Aurecon for classifying urban land use constraints based on topography, which divides slope (as a percentage) into three categories: low constraint (<8), moderate constraint (8-15), and high constraint (>15). This is considered representative of low-density housing to small scale industrial, along with carparks, roads and urban infrastructure; however large-scale industrial is not considered.

Table 7-1 General Land Slope Constraints on Urban Development Categories

Average Site Slope	Development Category and Constraint Rating			
	Large Scale Industrial	Small Scale Industrial	Moderate Density Housing	Low Density Housing
1-5	Very low to Moderate	Very Low to Low	Very Low to Low	Very Low to Low
5-8	Moderate to High	Low	Low	Low
8-15	High to Very High	Moderate	Moderate	Moderate
15-25	Very High	High	High	Moderate-High
>25	Very High	Very High	Very High	High to Very High

A Digital Elevation Model with 1 m resolution has been used to identify slope classes for the purpose of land capability assessment of the Aerotropolis; this is considered suitable in providing the accuracy required for the project scale assessment outcomes.

7.3 Soil landscapes

7.3.1 Overview

NSW Soil Landscapes

Two soil landscape mapping products have formed the baseline data for the land capability assessment undertaken as part of this assessment. They include the NSW Soil and Landscape mapping (Bannerman and Hazelton, 2011, Hazelton et al., 2011), and the Land and Soil Capability (LSC) mapping (OEH, 2017). The NSW Soil and Landscape mapping has been used to inform baseline landscape capability with respect to urban development, while the LSC mapping has been used to inform baseline landscape capability with respect to rural (agricultural) development.

The NSW Soil Landscape Mapping Reports (Bannerman and Hazelton, 2011) include a summary of general limitations associated with each soil landscape; which are based on broad physical factors including slope stability, drainage, erosion, and soils, which may restrict urban or rural development.

The NSW soil landscape mapping reports have been used to derived baseline urban capability classifications for the purpose of this assessment. The mapping is used as a base layer for further refinement using additional regional and local scale mapping products.

NSW Land and soil capability mapping

The current land and soil capability (LSC) mapping developed by the NSW OEH (OEH, 2017) is based on an eight-class system of landscape limitations with values ranging between 1 (very slight to negligible limitations) and 8 (extreme limitations) (OEH, 2012).

The LSC scheme defines LSC classes based on bio-physical land features which determine the on-site and off-site constraints and hazards associated with the land; including soil type, slope, landform position, acidity, salinity, drainage, rockiness (stoniness) and climate.

The main hazards and limitations defined in the LSC scheme are: Water erosion (including sheet, rill, and gully erosion), wind erosion, soil structure decline (sodicity) soil acidification, salinity, waterlogging, stoniness and shallow soils, and mass movement. LSC classes are applied for these individual hazards with the overall LSC classification is based on the most limiting class (OEH, 2012).

The land and soil capability classes within the study area (derived from the Land and Soil Capability Mapping for NSW, (OEH, 2017)) are summarised in Table 7-2 and presented in Figure 7-1.

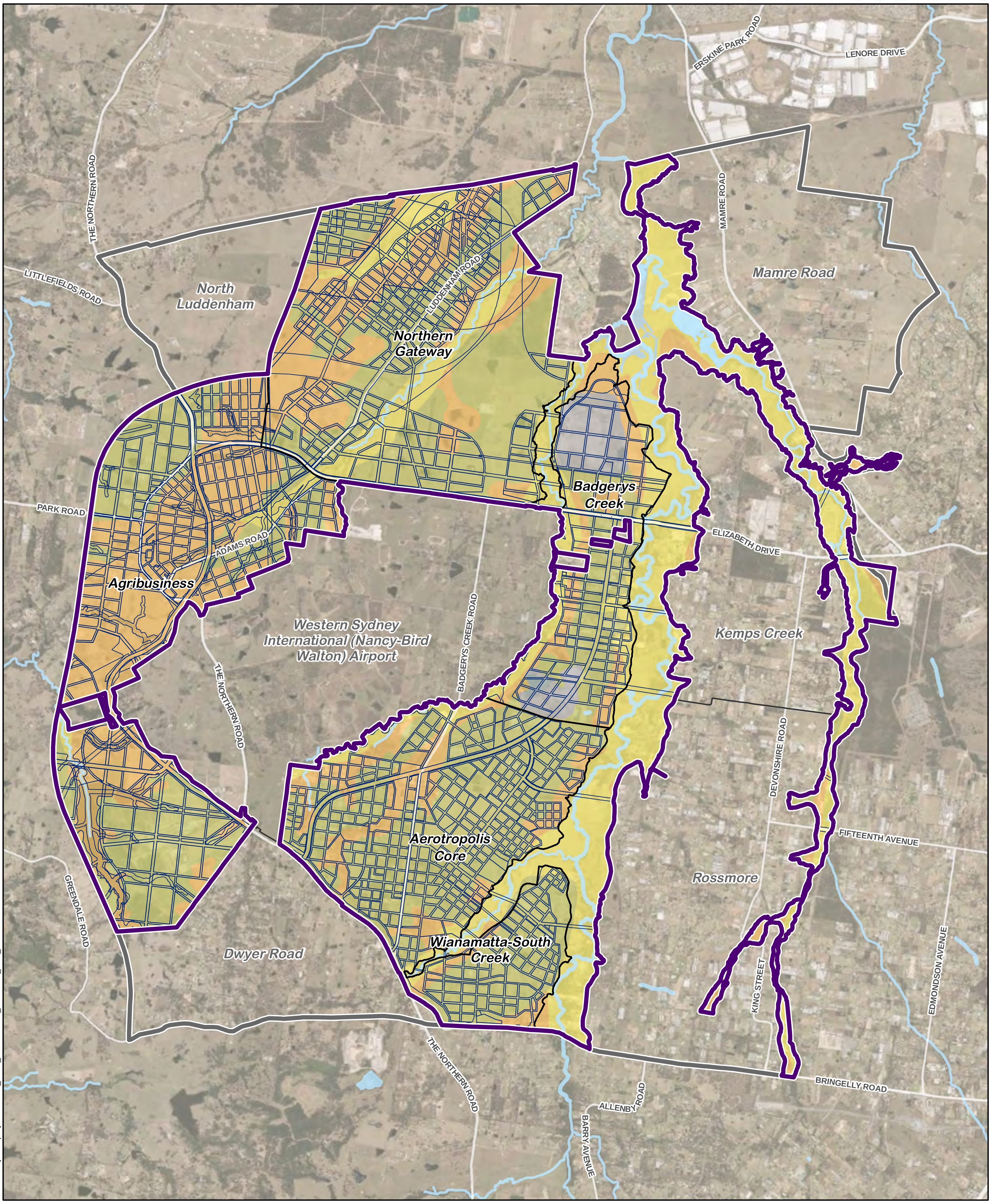
Table 7-2 LSC Scheme Land and Soil Capability Classes within study area

LSC Class	General Definition	Relevant Precincts
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)		
4	Moderate capability land: Land has moderate to high limitations for high-impact land uses. Will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology.	Agribusiness, Northern Gateway, Aerotropolis Core, Badgerys Creek
5	Moderate–low capability land: Land has high limitations for high-impact land uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.	Northern Gateway, Aerotropolis Core, Badgerys Creek, South Creek
Land capable for a limited set of land uses (grazing, forestry and nature conservation, some horticulture)		
6	Low capability land: Land has very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation	Agribusiness, Northern Gateway, Aerotropolis Core, Badgerys Creek, South Creek

Overall confidence in the agricultural land capability of soils within the study area are limited by the relative coarseness in the scale of available mapping (i.e. 1:100,000 scale). This mapping should be considered an initial classification for further local scale investigations; or may be updated once more detailed mapping becomes available.

The NSW Land and Soil Capability mapping reports have been used to derived baseline urban capability classifications for the purpose of this assessment. The mapping is used as a base layer for further refinement using additional regional and local scale mapping products.

aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSA_LCA_LSC_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area boundary
Precinct boundary
Precinct plans

Base Data

Watercourse

Land and Soil Capability

4 Moderate to severe limitations
5 Severe limitations
6 Very severe limitations
Disturbed Terrain
Water

Source: Aurecon, DPIE, NSW Spatial Services, ESRI

A3 scale: 1:55,000

0 1 2 km

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Figure 7-1: NSW Land and Soil Capability

7.3.2 Agricultural land use constraints

The land capability classes identified within the study area include moderate to low capability land for agricultural land-use. The most common and widespread LSC class is Class 4 (moderate capability land), which is present as large areas throughout Aerotropolis Core, Northern Gateway, Agribusiness, and Badgerys Creek.

The classifications presented in Table 7-2 indicate that:

- Class 4 and Class 6 land occupies the majority of the Agribusiness precinct, with a small elongated area of Class 5 either side of Cosgroves Creek.
- Class 4 land is present throughout most of the Aerotropolis Core, with smaller areas of Class 6 and Class 5 associated with local drainage lines.
- Class 4, Class 5, Class 6 and areas of unusable land are present within both Northern Gateway and Badgerys Creek, with Class 5 and Class 6 areas typically associated with drainage lines.
- South Creek is predominantly occupied by Class 5 land associated with the waterways, with smaller areas of Class 6 land along the boundaries of the precinct.

Overall, the study area can be described as moderate to low capability land for agricultural land use, based on the LSC assessment scheme.

Aurecon has adopted the LSC scheme classifications for the purpose of land capability assessment within the Aerotropolis (WSA). The LSC scheme classifications have been adapted and included as a principal component in the land capability assessment for the Aerotropolis alongside other contributing factors.

The overall land capability methodology adopted by Aurecon is adopted to account for the classifications presented in the LSC scheme, and further refine the classifications through additional factor analysis. As such the existing agricultural capability classifications have been given an automatic Rank of 1 and weight of 0.5, so that that additional factors cannot reduce or increase the overall land capability classification further than one constraint class.

Other landscape and soil limitations contributing to the overall agricultural land capability (e.g. permeability, fertility, salinity) are described separately through more focused mapping products.

7.3.3 Urban land use constraints

Urban Capability classifications are available for each soil landscape identified in the NSW Soil Landscape Mapping sheets (Hazelton et al., 2011) through the accompanying soil landscape mapping report (Bannerman and Hazelton, 2011).

The urban capability classifications are based on the severity of limitations that are likely to affect urban land use, are generally representative of broad landscape limitations, and are intended for regional planning scale exercises only. It is acknowledged that additional factors such as slope angle and specific soil conditions are required to enable project or local scale planning advice.

Table 7-3 presents the general urban capability for soil landscape classes for each soil landscape within the study area (Bannerman and Hazelton, 2011).

Table 7-3 General Urban Capability for Soil Landscape Classes

Soil Landscape	High Capability for Urban Development	Low to Moderate Capability for Urban Development	Not Capable for Urban Development
Blacktown	W	-	-
Berkshire Park	W	-	L
Luddenham	-	W	-
South Creek	-	-	W
Disturbed Terrain	ND	ND	ND
W = General Occurrence	L = Localised Occurrence		

The classifications presented in Table 7-3 indicate that:

- The Blacktown landscape has a high capability for urban development. This landscape is the primary landscape throughout the study area, including the Agribusiness, Aerotropolis Core, Northern Gateway, Badgerys Creek; with small isolated areas within the Wianamatta-South Creek Precinct.
- The Berkshire Park landscape generally has a high urban capability with localised areas not suitable for urban development. This landscape is present as a minor area within Badgerys Creek.
- The Luddenham landscape has a generally low to moderate capability for urban development. This landscape is present within the Agribusiness and Northern Gateway precincts.
- South Creek is generally considered not suitable for urban development. This landscape is present throughout the Wianamatta-South Creek precinct and small areas of other precincts.

Aurecon has adopted the urban capability classifications derived for the NSW Soil Landscape Mapping scheme (Bannerman and Hazelton, 2011) for the purpose of land capability assessment. The urban capability classifications presented in Table 7-3 have been adapted and included as a principal component in the Aerotropolis land capability assessment, alongside other contributing factors (identified in Table 5-1).

The overall land capability methodology adopted by Aurecon is adopted to account for the classifications presented in the NSW Soil Landscape Mapping scheme, and further refine the classifications through additional factor analysis. As such the existing urban capability classifications have been given an automatic Rank of 1 and weight of 0.5, so that that additional factors cannot reduce or increase the overall land capability classification further than one constraint class.

7.4 Soil physical properties

7.4.1 Soil wet strength

Agricultural land use constraints

Soil wet strength has not been considered as part of the constraint's assessment on agricultural land capability, as this is not typically identified as a constraining factor for agricultural land use (DECCW, 2010).

Urban land use constraints

Soils with low wet strength are generally considered unsuitable for building foundations and often make site access difficult during construction (Bannerman and Hazelton, 2011). Low wet strength soils often suffer severe structural damage if mechanically disturbed when wet.

Soils with low soil wet strength within the study area include the Blacktown and Luddenham landscapes, which occupy most of precincts within the WSA, except for the Wianamatta-South Creek precinct.

Table 5-3 presents the criteria adopted by Aurecon for classifying urban land use constraints based on soil wet strength. Under the adopted methodology the Blacktown and Luddenham landscapes are assigned a high constraint rating for urban development, along with disturbed terrain.

7.4.2 Soil shrink-swell

Agricultural land use constraints

Soil shrink-swell has not been considered as part of the constraint's assessment on agricultural land capability, as this is not typically identified as a constraining factor for agricultural land use (DECCW, 2010).

Urban land use constraints

The repeated expansion and contraction of shrink-swell affected soils can lead to serious damage to building foundations, transport infrastructure (roads and railways) underground infrastructure (including pipes and drains), dams, and other structures. Appropriate design and mitigating measures must be implemented to manage issues associated with shrink-swell soils (DECCW, 2010).

Construction on soils with a high shrink-swell potential requires special techniques such as laying a deeper than usual road paving or using a concrete slab rather than strip footings for dwelling foundations.

Soils with high shrink-swell potential within the study area include localised areas within the Blacktown, Luddenham, and South Creek landscapes, which occupy most of precincts within the WSA.

Table 5-3 presents the criteria adopted by Aurecon for classifying urban land use constraints based on soil wet strength. Under the adopted methodology the Luddenham landscape and disturbed terrain are assigned a high constraint rating for urban development.

7.4.3 Soil Permeability

Agricultural land use constraints

Soil permeability exerts and important control on agricultural land use planning. Low permeability, poorly draining soils are generally considered unsuitable for irrigation agriculture. On sloping land, lateral flow may occur above an impervious layer thereby draining the water away from the site, but on relatively flat areas such soils can become waterlogged and inhibit plant growth or become too boggy for the use of agricultural machinery. Conversely, soils that drain too rapidly may leach nutrients from the soil, requiring active land management to keep soils fertile.

Soil irrigation limitations developed by the Department of Environment Climate Change and Water (DECCW) identify three categories of soil limitation based on the average saturated hydraulic conductivity of soil. These are presented in

Table 7-4 Soil saturated hydraulic conductivity ranges and limitations

Limitation Class	Hydraulic Conductivity (mm/hr)	Typical Soil	Equivalent Hydrologic Soil Group
Nil or Slight Limitation	20-80	Sands to sandy loams; loamy silts and silts	A, B
Moderate Limitation	5-20 / >80	Sandy clay loam	C
Severe Limitation	<5	Clay loams to clay	D

Special works or higher levels of management may be necessary to overcome poor site drainage, and this will add to the cost of development and production.

Table 5-1 presents the criteria adopted by Aurecon for classifying agricultural land use constraints based on soil permeability (derived through the HSG classifications). As shown by Figure 6-9 and Table 6-6, the hydrologic groups present within the WSA include Group C and Group D soils. These are typically poorly draining soils and as such will present limitations to agricultural land development within the WSA.

Urban land use constraints

Soil permeability is also an important consideration on urban land use planning. Low permeability, poorly draining soils can increase to flooding in urban areas, damage to roads and buildings (consolidation), and increased stresses / requirements for stormwater infrastructure.

The permeability of soils has a decisive effect on the stability of foundations, seepage loss through embankments of reservoirs, drainage of subgrades, excavation of open cuts in water bearing sand, and rate of flow of water into wells. In particular, low permeability soils are often the cause of geotechnical and drainage issues.

Special works or higher levels of management may be necessary to overcome poor site drainage, and this will add to the cost of development and production.

Table 5-3 presents the criteria adopted by Aurecon for classifying urban land use constraints based on soil permeability (derived through the HSG classifications). As shown by Figure 6-9 and Table 6-6, the hydrologic groups present within the WSA include Group C and Group D soils. These are typically poorly draining soils and as such will present limitations to urban land development within the WSA.

7.5 Soil chemical properties

7.5.1 Sodicity

Agricultural land use constraints

The major issues arising from high sodium levels (relative to the other exchangeable cations) is on the physical properties of soil and effects on plant growth.

With respect to physical properties, high sodicity can affect soils in a number of ways, including:

- Breakdown of soil structure
- Increased potential for erosive soil loss during intense rainfall or irrigation cycles
- Development of soil crusts
- Setting of soils into large blocks on drying

Sodic soils can also reduce the agricultural capability of soils in a number of ways, including:

- Reducing root penetration and seedling emergence
- Reducing infiltration rates and plant available water capacity
- Increasing waterlogging and runoff potential
- Increasing difficulty of cultivation due to lack of soil structure
- Accumulation of salt (salinity) in the root zone, causing toxicity to plants and leading to dieback

An ESP of six has been considered to be the lower limit of the amount of sodium required to produce a detrimental effect on the growth of most crop plants (Northcote and Skene, 1972).

Table 7-5 presents the typical ranges of ESP based on constraints for effluent type irrigation systems (DEC 2004). The constraint values are representative of relative risks from structural degradation and waterlogging.

Table 7-5 Sodicity Constraints for irrigation by effluent (DEC 2004)

Constraint Rating	Exchangeable Sodium Percentage
Limited	0-5
Moderate	5-10
Significant	>10

Table 5-1 presents the criteria adopted by Aurecon for classifying agricultural land use constraints based on soil sodicity.

It should be noted that dispersivity issues associated with sodic soils are generally reflective of interactions with non-saline water. In slightly saline or saline water sodic soils swell, but generally don't disperse due to reduced osmotic gradient within clay platelets (DPIW, 2009). As such, freshwater irrigation may result in significant soil dispersion and erosion issues within sodic landscapes.

Productivity problems caused by sodicity, and appropriate management strategies to overcome such problems, are discussed in detail by Ford et al. (1993) for dryland agriculture and by Rengasamy and Olsson (1993) for irrigated agriculture. In general, sodic soils can be improved by addition of calcium and/or organic matter, and by reducing mechanic soil disturbance.

The erosion of sodic soils can also detrimentally impact on receiving waters, causing sedimentation and degradation / loss of habitat within riparian zones and riverine contamination.

Urban land use constraints

The major issues arising from high sodium levels in soil on urban land use is on the physical properties of soil, specifically the breakdown of soil structure and dispersivity.

Sodic soils are commonly synonymous with dispersive clay soils in geotechnical terms and can cause serious engineering problems if not identified and appropriately managed.

Most studies have shown that failure of structures built on or with dispersive clay soils occurred on first wetting, resulting in cracking by shrinkage, differential settlement, or construction deficiencies.

Erosion of dispersive (sodic) soils can undermine roads, buildings, and drains causing significant damage or failure to infrastructure. Erosion may be concentrated within and along pipes, cables and urban drainage lines and culverts, concentrating flows and causing significant environmental damage. Dispersive soils can also result in dam failure and flooding as a result of embankment failures.

Table 5-3 presents the criteria adopted by Aurecon for classifying urban land use constraints based on soil sodicity.

7.5.2 Salinity

Three major types of salinity exist within the environment, these include groundwater associated salinity, non-groundwater associated salinity, and irrigation induced salinity.

This section deals with agricultural and urban land use constraints associated with non-groundwater associated salinity and irrigation induced salinity constraints (i.e. salts within soils and introduced to shallow soils through irrigation).

increase in occurrence of soil salinity within the WSA may generally be prescribed to:

- Decreases in deep rooted vegetation (see groundwater associated salinity)
- Over-irrigation of crops, improved pastures and private gardens and lawns
- Alteration of natural drainage patterns by the construction of houses, railways, channels, etc
- Creation of wet zones of waterlogged soils by impeded drainage
- Leakage of standing water bodies, pools, lakes and service pipes
- Exposure of susceptible soils
- Irrigation of sports grounds, golf courses, and gardens

Agricultural land use constraints

The threshold value above which deleterious effects occur from soil salinity can vary depending on a number of factors including plant type, soil-water regime and climatic condition (Rengasamy, 2006). Saline soils can inhibit plant growth through osmotic effects, limiting the ability of the plant to uptake water, and through nutritional imbalances.

Plants have differing tolerances to saline conditions, but levels above 8 dS/m restrict all but salt tolerant plants and above 16 dS/m even salt tolerant plants suffer (Charman and Wooldridge 2007). Moderate salinity levels retard the growth of sensitive plants and reduce yield, while high salt levels may kill plants and lead to soil structural degradation

Salinity is also a major land degradation problem in NSW. Mobilisation of salts can have the effect of:

- Saline outbreaks and scalding on the ground surface
- Increased salinity concentration in streams
- Increased salt loads leaving the catchment and being transported downstream.

Many salt affected landscapes are also waterlogged where salts are leached from soils to form sodic horizons (Rengasamy, 2006). The development of sodic soils from agricultural practices can further exacerbate soil salinity, leading to accumulation of salt in subsoils.

Table 5-1 presents the criteria adopted by Aurecon for classifying agricultural land use constraints based on soil salinity (derived through the Soil Salinity Potential Risk Mapping for Western Sydney). As shown by Figure 6-11 the salinity potential within the WSA is generally moderate, with limited areas of high and very high along drainage lines.

Urban land use constraints

Urban salinity is a combination of dryland and irrigation salinity processes, alongside the hydrogeological effects of cutting, filling and the construction of subsurface, typically impermeable infrastructure (Rae 2007, NSW DPI 2009b). Salinization within the surface and subsurface soil layers can have a profound impact on both soil structure, and the durability of urban developments (SMEC, 2015).

Salinization can also have a significant and costly impact on urban developments through predominantly erosional and corrosive processes. The impacts of salinity in an urban context are summarised below (IPWEA, 2002):

- Infrastructure damage (e.g. building foundation damage, roadway breakup and corrosion of pipes and underground services)
- Declining water quality – impacting town water supplies, resulting in increased treatment and infrastructure costs
- Adverse impacts on ecosystems, particular cumulative affects downstream
- Declining landscape amenity through decreased vegetative cover and salt accumulation on surface soils
- Reduced water uses for industrial purposes
- Increasing water hardness
- Social and economic disruption and cost

Table 5-3 presents the criteria adopted by Aurecon for classifying urban land use constraints based on soil salinity (derived through the Soil Salinity Potential Risk Mapping for Western Sydney). As shown by Figure 6-11 the salinity potential within the WSA is generally moderate, with limited areas of high and very high along drainage lines.

7.6 Soil fertility

7.6.1 Agricultural land use constraints

Soils with low chemical fertility are a constraint to agricultural land uses. These soils have low levels of nutrients required for plant growth, (such as P, N, K, Ca, Mg and a range of trace elements), low organic matter content, and a limited ability to retain nutrients as indicated by a low cation exchange capacity (CEC) (DECCW, 2010).

Soils with poor chemical fertility usually require the application of chemical fertilisers, seasoned manure or compost to obtain permanent plant cover. Some soils, (such as those with high aluminium or iron oxide content that lock up phosphate) do not respond well to normal applications of fertiliser. (Bannerman and Hazelton, 2011).

Table 5-1 presents the criteria adopted by Aurecon for classifying agricultural land use constraints based on soil fertility. Under the adopted methodology Class 5 and Class 4 lands are assigned a low constraint rating, Class 3 land is assigned a moderate constraint rating, and Class 1 and Class 2 lands are assigned a high constraint rating. Via this methodology, the areas within precincts identified as Class 2 fertility in Table 6-11 will be classified under a high constraint rating, while Class 3 areas will be classified as a moderate constraint rating.

7.6.2 Urban land use constraints

Soil fertility has not been considered as part of the constraint's assessment on urban land capability, as this is not typically identified as a constraining factor for urban land use (DECCW, 2010). Areas of planned urban land use, which have inherent low soil fertility may be managed through importing of topsoil, and / or application of chemical / biological fertilisers for private gardens and public open space.

7.7 Hydrogeological landscapes (groundwater associated salinity)

The dynamics of groundwater processes are important in considering landscape salinity. High water tables and the process of capillary rise and evaporation lead to salts concentrating in the surface layers of the soil. High levels of salt can be expressed at discharge sites in the landscape, even though the background levels of salt in groundwater and soils can be quite low. The levels of salt expressed in the surface of soils at discharge sites can also vary dramatically over time with seasonal and longer term climatic influencing the flushing or concentrations of salt.

The methodology used to arrive at an HGL landscape involves a structured comparison of salinity characteristics. These included water pathways through the landscape; salt stores; relative mobility of salt within the landscape; salinization processes, and salt signature within streams. These processes are integrated with landscape spatial variability to produce an overall salinity hazard assessment for any given area (Moore et al 2018).

On the HGL derivative maps and associated tables, colours are used to define ranges for various attributes that contribute to the overall salinity hazard; including land salinity, salt export, water quality impact, salt availability, salt store, likelihood of salinity occurrence, potential impact of salinity and sodicity hazard. The overall salinity hazard for a landscape (rated from very low to very high) is based on the combination of these factors.

Each HGL identified through the HGL mapping scheme include strategies to manage landscape salinity. Management strategies include general landscape strategies, urban management strategies and rural management strategies. Within the WSA the following general management strategies apply:

- Intercept the shallow lateral flow and shallow groundwater: Upper South Creek, Shale Plains, Greendale
- Discharge rehabilitation and management: All landscapes
- Buffer the salt store – keep it dry and still: All landscapes
- Dry out the landscape with diffuse actions: All landscapes
- Increase agricultural production to dry out the landscape and reduce recharge: Mulgoa
- Stop discrete landscape discharge: Mount Vernon

7.7.1 The agricultural land use constraints

Clearance of native vegetation and planting of shallow rooted crops can lead to increases in salts concentrated at shallow depths due to reductions in deep percolation and reductions in deep soil transpiration processes.

Introduction of pastures and annual crops may lead to reduced evapotranspiration rates within the landscape, causing a rise in saline groundwater and development of shallow saline groundwater tables and resulting in landscape degradation.

Irrigation practices can introduce salinity to soils due to insufficient leaching or poor-quality irrigation water. In many irrigation regions, rising saline groundwater can interact with irrigated areas to create compound problems within root zones.

Table 5-1 presents the criteria adopted by Aurecon for classifying agricultural land use constraints based on landscape salinity (derived through HGL mapping). The Greendale, Shale Plains, Upper South Creek landscapes have been classified as high constraint for agricultural land use due to their very high to high ratings of salinity hazard. The Mulgoa and Mount Vernon landscapes have been classified as moderate constraint due to their moderate salinity hazard rating.

7.7.2 Urban land use constraints

Groundwater associated salinity can result in damage to urban buildings and infrastructure through rising damp, crumbling and deterioration of roads and pavements, fretting of bricks and mortar, and scalding of green areas in cricket grounds and golf clubs.

Urban activities can exacerbate impacts and environmental risks from saline landscapes by reducing permeability of soils through construction activities, removal of vegetation and loss of deep drainage, and increasing recharge from leaking pipes, resulting in rising groundwater tables and discharge of saline groundwater. The discharge of saline groundwater as a result of urban development can cause significant financial impacts through effects to both the natural and built environment.

Table 5-3 presents the criteria adopted by Aurecon for classifying urban land use constraints based on landscape salinity (derived through HGL mapping). The Greendale, Shale Plains, Upper South Creek landscapes have been classified as high constraint for agricultural land use due to their very high to high ratings of salinity hazard. The Mulgoa and Mount Vernon landscapes have been classified as moderate constraint due to their moderate salinity hazard rating.

7.8 Groundwater levels

7.8.1 Agricultural land use constraints

Agricultural land use activities are commonly dependent on and affected by groundwater levels. The management of groundwater levels for agricultural activities is essential in ensuring there is an adequate water supply to maintain the health of pasture and crops.

Agricultural land use can lead to both increases and decreases in groundwater levels depending on the nature of groundwater management and land use activity. Deep and intensive land drainage and over extraction of groundwater can lead to a decline in groundwater levels, whilst over-irrigation and removal of deep-rooted vegetation can lead to a rise in groundwater levels.

The deleterious effects of changes in groundwater levels are varied. Rising groundwater levels may often be associated with the salinization and waterlogging of soils, resulting in negative effects on plant growth. Rising groundwater levels can also cause local flooding, saline scalding, and discharge of highly saline flows into freshwater creeks. Conversely, decreasing groundwater levels can lead to desiccation of the land, discharge of acidic leachate from oxidation of acid sulfate soils, and loss of baseflow into receiving waterways, resulting in loss of aquatic habitats (including groundwater dependent ecosystems).

Table 5-1 presents the criteria adopted by Aurecon for classifying agricultural land use constraints based on groundwater levels within the WSA (derived through HGL mapping and verified through local investigations). All landscapes within the WSA are classified as moderate constraint, with groundwater levels typically between 2m and 8m below ground level.

7.8.2 Urban land use constraints

A critical assessment of groundwater levels is an important process in urban land use planning from district down to local subdivision planning. Groundwater levels within an area can pose a risk to the proposed urban design and appropriate management strategies are often required to mitigate risks.

At the district scale, the groundwater must be assessed based on seasonal and long-term predevelopment observations. Post development changes must then be modelled to account for changes in hydrology, transpiration, topography, and recharge.

At the local planning scale groundwater is typically managed through installation of drainage systems to control groundwater rise beneath urban areas, often requiring a combination of permeable soils and open channel drainage with invert levels set at discharge control levels referred to as controlled groundwater levels (CGLs).

Urban development is commonly associated with increases in groundwater levels as a result of reduced transpiration, leaking water supply and sewage infrastructure, along with importation of water from outside the catchment to meet water supply demands (Wakode et al., 2018).

Where groundwater is shallow, urban development may result in increased risks from flooding, salinization, contamination, stability of structures and viability of production wells.

Shallow groundwater tables also require significant dewatering measures to enable construction, increasing costs of urban development significantly. Dewatering can lead to oxidation of acid sulfate soils (where present), which produce acid leachate which can cause significant damage to buildings and the environment.

Within the WSA rising groundwater levels associated with urban development may cause significant salinity impacts to sensitive receiving environments and groundwater dependent ecosystems.

Table 5-3 presents the criteria adopted by Aurecon for classifying urban land use constraints based on groundwater levels within the WSA (derived through HGL mapping and verified through local investigations). All landscapes within the WSA are classified as moderate constraint, with groundwater levels typically between 2m and 8m below ground level.

7.9 Aquifer yield

Specific storage is a measure of the capacity of a saturated material to drain by gravity. Specifically, it is a measure of volume of water released from storage from a unit volume of aquifer per unit decline in hydraulic head. For unconfined aquifers, specific storage is expressed as specific yield, whereas for confined aquifers it is expressed as storativity.

Aquifer yield may be defined by the specific storage as a relative measure of both “safe yield” for agriculture, and dewatering requirements for urban development. Aquifers with a low storage coefficient yield relatively small volumes of groundwater per unit volume of aquifer, whereas aquifers with high storage coefficients will yield significant volumes of water per unit volume of aquifer.

7.9.1 Agricultural land use constraints

When determining how much water can safely be withdrawn from an aquifer system for agriculture, the concept of “safe yield” is often used. This term is synonymous with the balance between annual withdrawals and rates of recharge, with balance between the two intrinsically linked with the specific storage of aquifers.

Overdrawing from aquifers and installation of deep drainage systems can result in a decline in groundwater levels, which can reduce the overall yield of an aquifer as a result of consolidation causing loss of intergranular porosity and storage. Conversely, over irrigation or removal of deep-rooted vegetation can result in rising groundwater. Rates of rising and falling groundwater are intrinsically linked to the storage coefficient of aquifers.

Aquifers with low storage coefficients are generally less viable sources for extraction for the purpose of agriculture, particularly intensive irrigation-based practices, as they do not yield viable water resources.

Table 5-1 presents the criteria adopted by Aurecon for classifying agricultural land use constraints based on storage coefficients of aquifers within the WSA (derived through HGL mapping and verified through local investigations). All landscapes within the WSA are classified as moderate constraint, with groundwater levels typically between 2 m and 8 m below ground level.

7.10 Groundwater quality

The dominant geological formation of the Cumberland Plain Basin and the South Creek catchment is the Triassic Wianamatta Group, which is comprised mainly of shales. The groundwater resources of South Creek form part of the Hawkesbury-Nepean Alluvium aquifer, which has been identified as being at medium risk of devaluation of the beneficial uses through over-exploitation or contamination (DLWC 1998).

7.10.1 Agricultural land use constraints

A historical study conducted on the Wianamatta shale waters in 1942 concluded that the salt content of the Triassic Wianmatta Group was so high that the waters were of limited use for stock and quite useless for irrigation purposes (CRC, 2007). In a more recently published geological study of the area Jones and Clark (1991) reported that although there are not many groundwater bores in the Wianamatta Group, most of them yielded water that was saline and also hard. The salts were reported as connate in nature, and characteristic of the shales associated with the geological formation that was formed under brackish to marine conditions (CRC, 2007).

As groundwater is commonly used for irrigation and stock purposes in agricultural land use, it is an important consideration in land use planning. Groundwater salinity may affect the viability of crops due to salt tolerance, and the availability of water as a resource for livestock.

The groundwater quality, expressed as salinity, has been assessed through the HGL mapping reports and recent local scale investigations. The results have found generally moderately saline to very saline conditions in groundwater within the WSA.

Table 5-1 presents the criteria adopted by Aurecon for classifying agricultural land use constraints based on groundwater quality within the WSA (derived through HGL mapping and verified through local investigations).

7.11 Surface water quality

In 2007, the annual water use in agriculture in South Creek catchment was estimated to be around 18,000 ML with more than 50% of this being potable imported water and other sources including farm dams, surface water, and groundwater extractions (CRC, 2007).

7.11.1 Agricultural land use constraints

As surface water is commonly used for irrigation and stock purposes in agricultural land use, it is an important consideration in land use planning. Surface salinity may affect the viability of crops due to salt tolerance, and the availability of water as a resource for livestock.

The surface water quality, expressed as salinity, has been assessed through the HGL mapping reports and recent local scale investigations. The results have found generally slightly to moderately saline conditions in surface waters within the WSA.

Table 5-1 presents the criteria adopted by Aurecon for classifying agricultural land use constraints based on surface water quality within the WSA (derived through HGL mapping and verified through local investigations).

8 Limiting factors on land use

8.1 Wetlands

Areas identified as wetlands by the NSW Wetlands mapping are identified in Figure 8-1. A number of wetland sites have been mapped, including local reservoirs and freshwater lakes. Areas comprising wetlands have been classified as restricted areas within the land capability mapping products developed as part of this assessment, as development of these areas may lead to significant impacts to environmental habitats.

8.2 Environmentally sensitive land

Areas of classified environmentally sensitive land are presented in Figure 8-2 along with areas of scenic protection and terrestrial biodiversity. Areas of environmentally sensitive land and terrestrial biodiversity have been classified as restricted areas within the land capability mapping products developed as part of this assessment, as development of these areas may lead to significant impacts to environmental habitats and biological diversity.

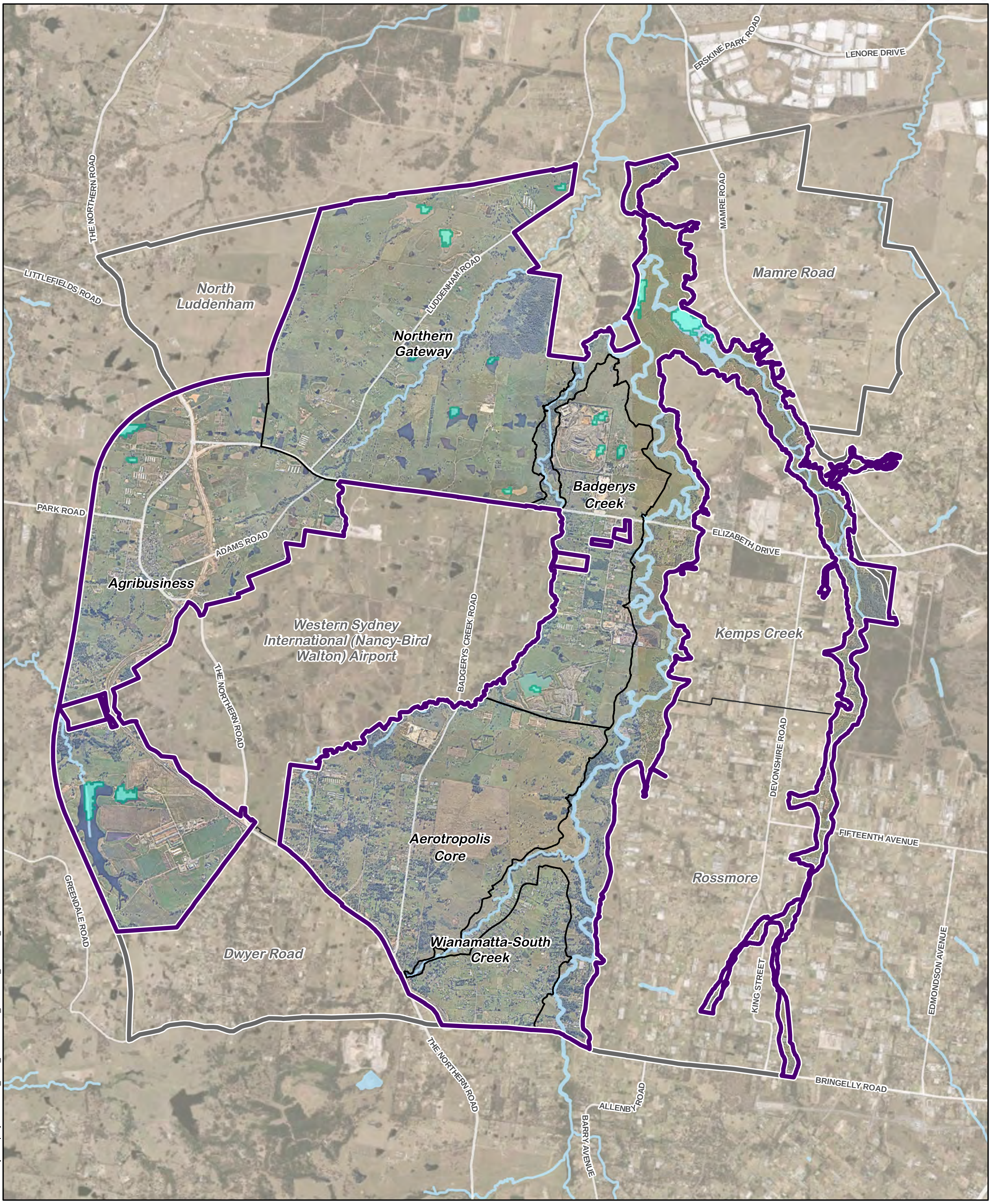
8.3 Flood prone land

Flood prone land, as identified by the 1 in 100-year flood event has been included as part of this assessment as a limiting factor on agricultural and urban land use due to the associated risks with developing within a flood zone. Figure 8-3 presents the 1 in 100-year flood extents within the WSA. These areas have been classified as restricted areas within the land capability mapping products developed as part of this assessment.

8.4 Major infrastructure corridors

Areas identified as major infrastructure corridors are identified in Figure 8-4. These areas have been classified as restricted areas within the land capability mapping products developed as part of this assessment.

aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Wetlands_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area boundary
Precinct boundary
NSW Wetlands

Base Data

Watercourse

Source: Aurecon, DPIE, NSW Spatial Services, OEH, Nearmap, ESRI

A3 scale: 1:55,000

0 1 2 km

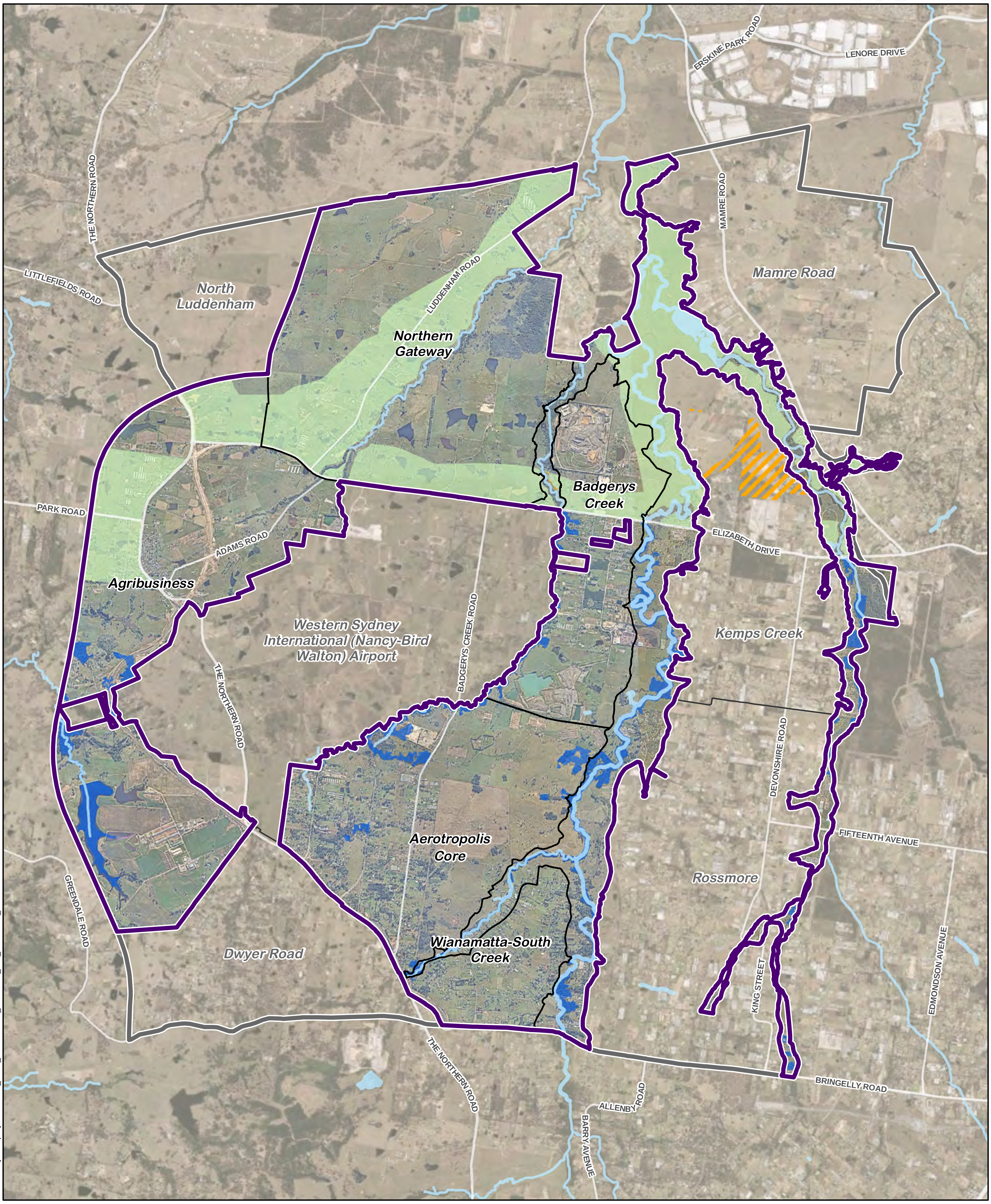
Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Figure 8-1: Wetlands

aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_EPI_Protection_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area boundary
Precinct boundary

Base Data

Watercourse

EPI Protection

Terrestrial Biodiversity
Scenic Protection Land
Environmentally Sensitive Land

Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:55,000

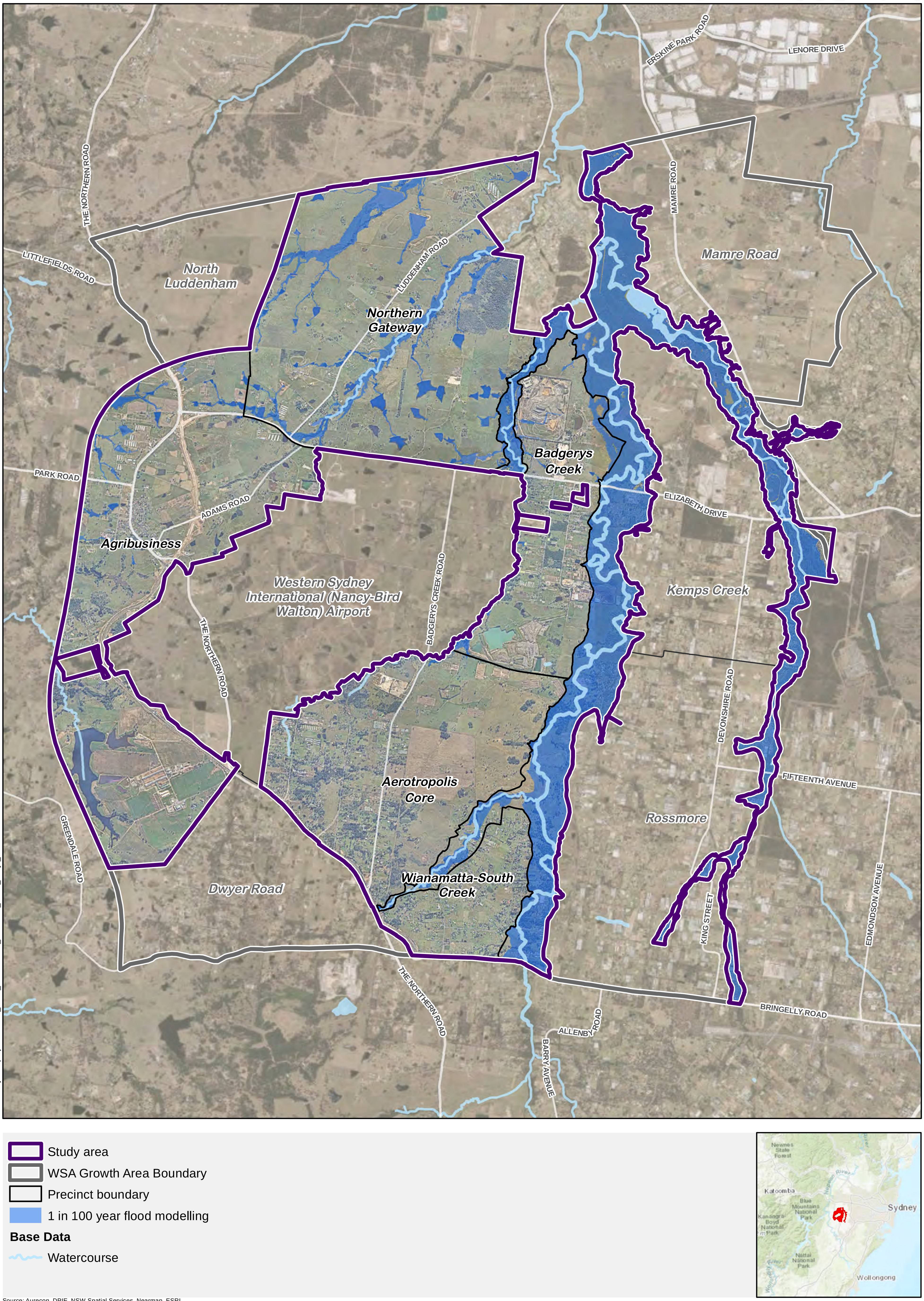
0 1 2 km

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Figure 8-2: EPI Protection



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Flood_100yr_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

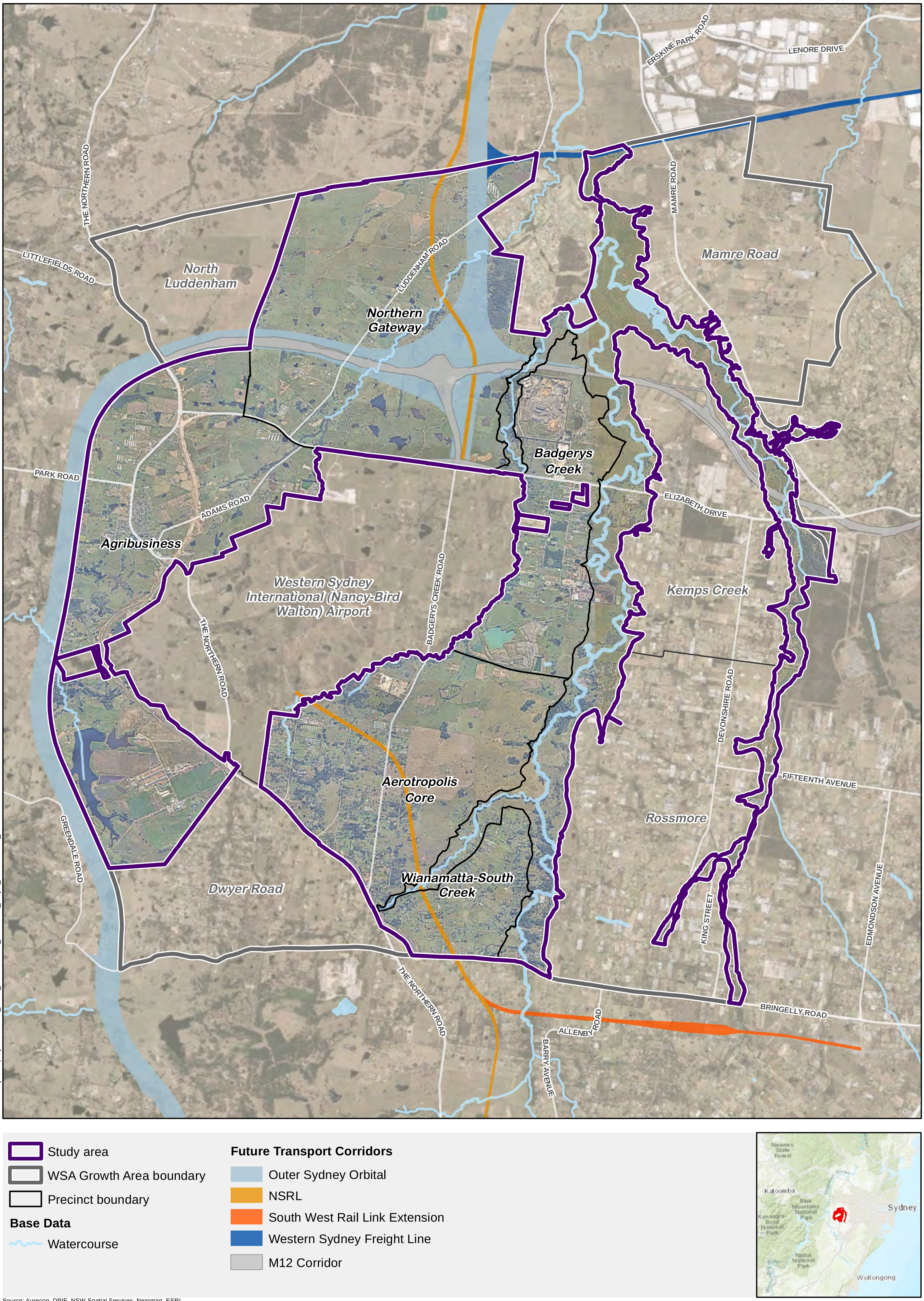
Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Figure 8-3: Flood prone land (1 in 100 yr)

aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Major_infrastructure_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:55,000

0 1 2 km

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Figure 8-4: Major infrastructure corridors

8.5 Contaminated land assessment

8.5.1 Overview

As part of the land and capability assessment of the WSA a baseline site contamination study which combines a review of desktop information with geospatial analytical techniques was undertaken to determine contamination risks with the WSA. These include review and geospatial analysis of selected historical aerial photographs looking at infilled farm dams, storage yards, former structures and significantly disturbed land, review of existing reports and data within WSA and review and collation of relevant desktop information that is publicly available. The following sections outline the contamination baseline assessment undertaken and findings.

The information obtained and reviewed has been used to identify areas within WSA which are likely to be constrained for future urban development from a contamination perspective. This does not preclude urban development but the constraints present (such as current or former land uses) may require remedial or mitigation measures much higher than surrounding developable lands.

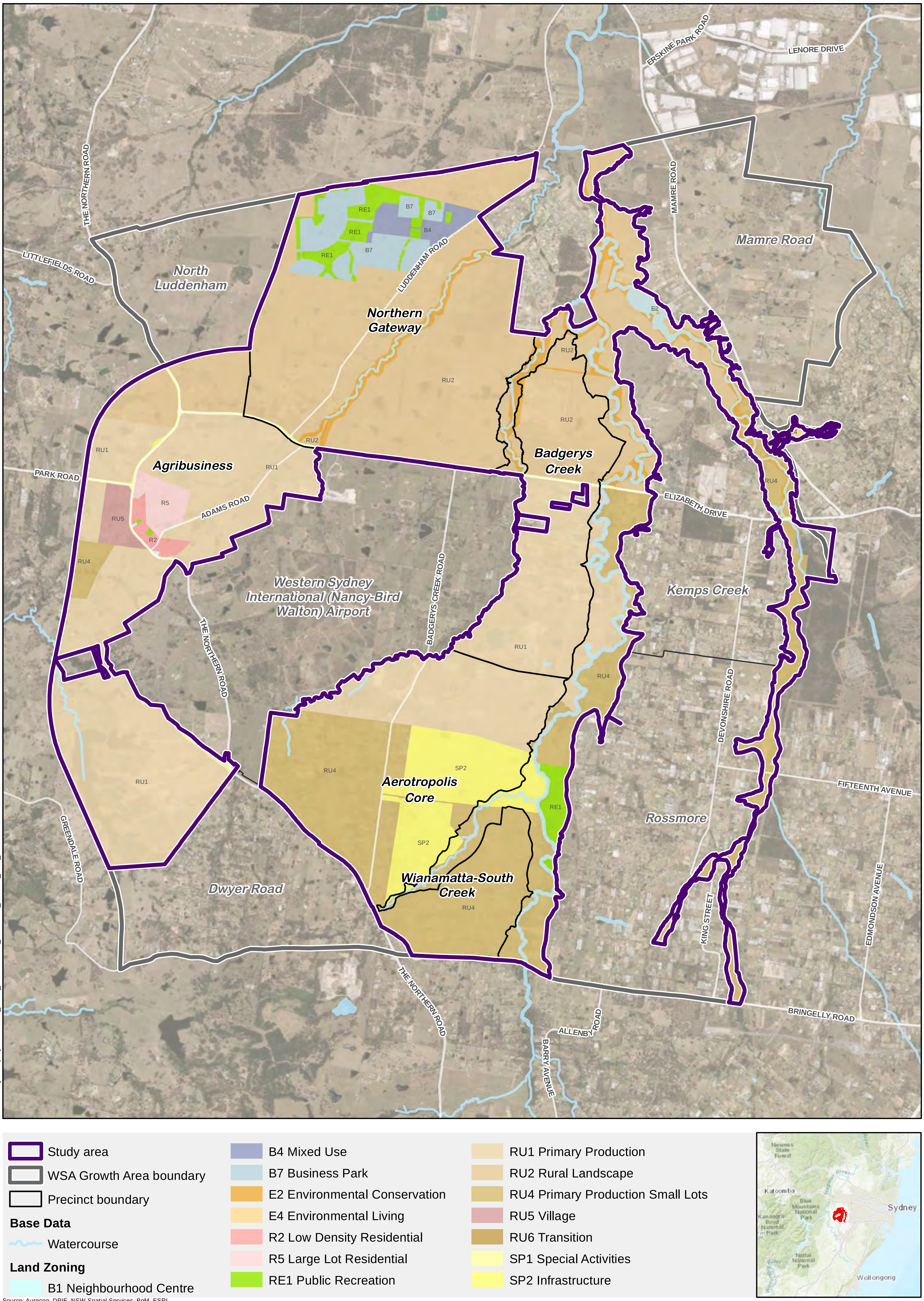
The review and interpretation of baseline information obtained has provided for the recommendation of further contaminated land investigations within WSA based on precinct planning inclusive of mapping areas that will require future site contamination investigations as the master planning or development application stage.

Former WSA land use zoning within the initial precincts is presented in Figure 8-5 which indicates that the majority of land within the initial precincts was formerly zoned RU1 to RU4 comprising rural activity. Exceptions include some residential zoning around Luddenham within the Agribusiness Precinct, Mixed Use and Business Park zoning in the northern portion of the Northern Gateway Precinct and SP2 infrastructure zoning within the Aerotropolis Core Precinct. It is noted that as of September 2020, the majority of the initial precincts are now zoned Enterprise, Mixed Use, Agribusiness and Environment & Recreation (SEPP WSA 2020).

8.5.2 Guidance documents

The baseline contamination assessment was undertaken in general accordance with the following guidance documents:

- National Environmental Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013)
- NSW EPA Guidelines for Consultants Reporting on Contaminated Land, 2020
- Guidelines made or endorsed by the NSW EPA.



Source: Aurecon, DPIE, NSW Spatial Services, BoM, ESRI

A3 scale: 1:55,000

0 1 2 km

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis Constraints and Land Capability Assessment

Figure 8-5: Former land zoning

P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSA_Current_LNZ_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

8.5.3 Historical aerial imagery review and APECs

Aurecon undertook a review of historical aerial photographs of the WSA precincts presented in **Appendix A**. Images were obtained using Nearmap aerial imagery and imagery from the Lands and Property Information Division of the Department of Finances and Services. Historical aerial imagery was obtained for the years 1947, 1965, 1986 and 2019-2020 with detailed review and recording of areas of potential environmental concern (APEC) for the following key contamination risks:

- Past building structures and disturbed land
- Filled or modified farm dams
- Current storage yards and disturbed land
- Other large site operations with a potential for contaminative activity based on size, industry and land use.

Summary assessment of APECs for the WSA precincts is provided in the following sections. Interpretation of historical land use as part of this review are summarised below in Table 8-1.

The maps presented in **Appendix A** can be used for future development planning and development control within the WSA precincts based on the requirements for undertaking more detailed contamination risk assessment during future master planning and development approval.

Table 8-1 Summary of historical aerial imagery

Year of image	Site land use observations	Surrounding land use observations
1947 (Black and White, DPIE)	▪ Land has been largely cleared for rural and agricultural use. ▪ Dams are present indicating livestock and animal farming. ▪ The eastern half of the WSA precincts (Aerotropolis Core and Badgerys Creek) remains underdeveloped	▪ Agricultural and primary production land use
1965 (Black and White, DPIE)	▪ More rural residencies appear across the WSA precincts, mainly focused on the western side ▪ Poultry farms appear in the Agribusiness and Aerotropolis Core precincts ▪ A significant number of farm dams are seen indicating livestock production increases, particularly in the Agribusiness Precinct ▪ More land has been cleared in the north east within Badgerys Creek Precinct	▪ Agricultural and primary production land use ▪ Further clearing of vegetation is visible
1986 (Colour, DPIE)	▪ Much more development has taken place throughout the WSA Precincts ▪ Three buildings on the west side of the Aerotropolis Core have been demolished ▪ Many more farm dams have been created suggesting more livestock production ▪ Five new poultry farms have been built in the Aerotropolis Core precinct and multiple in the north of the agribusiness precinct ▪ Two quarries are present in the Badgerys Creek Precinct ▪ Large agricultural patches have developed in the south of the Agribusiness Precinct ▪ Multiple green ponds suggesting algal bloom in several farm dams and water storages	▪ Agricultural and primary production land use ▪ Town centres have begun to expand through development
2020 (Colour, DPIE)	▪ Industrial areas have expanded in all WSA Precincts, most notably the Aerotropolis Core and Agribusiness Precinct ▪ Poultry farms in Badgerys Creek Precinct have been demolished ▪ Multiple dams have been filled in ▪ One new quarry is noted in the Badgerys Creek Precinct ▪ Large agricultural areas remain in all WSA Precincts	▪ Agricultural and primary production land use ▪ Town centres are established in Kemps Creek, Rossmore and Mulgoa

8.5.4 Previous reports and risk registers

Previous contamination or related reports were requested from WSPP. Additional relevant reports were also obtained from Aurecon's database, inclusive of relevant and available Sydney Water reports undertaken by Aurecon.

Detailed summaries of relevant reports which were provided to and summarised by Aurecon are outlined below.

Jacobs Group, 2019, M12 Motorway Environmental Impact Assessment

Jacobs was engaged by Roads and Maritime Services (RMS) (now part of Transport for NSW) to complete an Environmental Impact Statement for the proposed M12 Motorway which will connect Western Sydney Airport to Sydney's motorway network via the M7 and the Northern Road at Luddenham. Approximately one third of the proposed motorway runs through the WSA area (mostly Northern Gateway). Limited contamination investigations have been conducted in the M12 Motorway project footprint to characterise risk to sensitive receptors such as creeks, lakes and wetlands in the immediate vicinity.

Concentrations of PAH exceed adopted ecological screening levels at one location within the Badgerys Creek Precinct. Exceedances of methane and carbon dioxide gases were additionally noted within the Badgerys Creek Precinct. Heavy metals were noted to exceed adopted ecological guidelines, most notably cooper and zinc throughout multiple precincts.

Within the WSA Northern Gateway precinct, an area of known construction activities and stockpiles of building materials was marked as an area of interest or potential area of concern (PAOC). Contaminants of potential concern (COPC) noted in this area include heavy metals, BTEX, Asbestos, TRH, OCP, OPP, and PAH. Due to known contamination in this area it has been given a high-risk ranking. SUEZ Kemps Creek Resource Recovery Park, located in the Badgerys Creek precinct, has also been marked as a PAOC for this investigation and has been marked as medium risk. COPCs located in this area include TRH, BTEX, ammonia, PAH, Heavy Metals, OCP, OPP, PCB, Nutrients and asbestos.

The investigation noted multiple areas of uncontrolled filling throughout the proposed WSA area with the potential for these areas to be contaminated, including the presence of ACM. Asbestos is outlined as the greatest contamination and waste management risk within the M12 project footprint however none was found within the WSA area. Risk to nearby sensitive receptors is characterised as low due to the most common form of contamination, heavy metals in groundwater, concluded to be representative of background conditions.

Aurecon Arup Planning Partnership, 2020, Upper South Creek Infrastructure Pipeline Alignment Options – Preliminary Site Investigation

Sydney Water engaged Aurecon and Arup (Planning Partnership for Sydney Water) to complete a Preliminary Site Investigation (PSI) for proposed pipelines associated with new treatment facilities. Only limited and high-level information is provided in this review as the work is at concept staging. The two pipeline options may traverse the proposed WSA site with contamination investigations being completed for each option. Potential areas of concern (PAOC) include roads and associated emissions from vehicle exhaust, legacy PFAS impacts to surrounding environment, UXO impacted areas, incidental minor filling, herbicide/pesticide use and high salinity potential.

Based on the desktop review of information, findings from previous reports, historical aerial photograph review, site inspections and environmental constraints mapping the potential for widespread contamination within the proposed pipeline area is generally low. Areas noted as high contamination risk are noted throughout the two proposed pipelines however none fall within the WSA precincts.

Aurecon Arup Planning Partnership, 2019, Upper South Creek Infrastructure Options Assessment

Sydney Water engaged Aurecon and Arup (Planning Partnership for Sydney Water) to carry out a contamination PSI for proposed infrastructure within the Upper South Creek catchment, adjacent to the Wianamatta-South Creek Precinct of the WSA project. A desktop study was completed as part of this assessment to characterise the risk of contamination proposed to accommodate the infrastructure upgrade. Only limited and high-level information is provided in this review as the work is at concept staging.

The main contamination risk identified was historical uncontrolled filling of ground and the potential for large volumes of emplaced fill to contain asbestos and other hazardous wastes via former land uses and potential for illegal dumping.

Aurecon Arup Planning Partnership, 2020, Resilience Planning: Prospect South to Macarthur Infrastructure Preliminary Site Investigation

Sydney Water engaged Aurecon and Arup (Planning Partnership for Sydney Water) to complete a contamination PSI for proposed infrastructure upgrades. This investigation included two of the proposed precincts that make up the WSA, the Wianamatta-South Creek precinct and Aerotropolis Core. Potential area of concern (PAOC) noted in the two precincts include Brandown quarry/landfill and the SUEZ Kemp Creek Resource Recovery Park. Suspected illegal dumping, herbicides/ pesticides from agricultural use and uncontrolled filling has also been noted.

This project only marginally intersects with the WSA precinct boundaries and therefore the outcomes are limited in use. Only limited and high-level information is provided in this review as the work is at concept staging.

Aurecon Arup Planning Partnership, 2020, Resilience Planning: Prospect South to Macarthur Infrastructure, Detailed Site Investigation

Sydney Water engaged Aurecon and Arup (Planning Partnership for Sydney Water) to conduct a detailed site investigation (DSI), following on from the above PSI to assess the existing soil, surface and groundwater conditions within areas planned for infrastructure upgrades with a view to understanding potential hazards to human health during construction and potential impacts to sensitive ecological receptors. Only limited and high-level information is provided in this review as the work is at concept staging.

Based on site observations, samples collected, analytical results, comparison to adopted tier 1 screening criteria and findings of this investigation, hazards to human and ecological health within the study area from chemical contaminants in soil and water were considered to be low. Asbestos containing materials (ACM) was identified in several areas from historical illegal dumping. Minor concentrations of TRH and heavy metals were recorded throughout the WSA precincts within the project footprint assessed. The investigation found many of the pathways in the preliminary CSM that were considered plausible to be incomplete.

8.5.5 Regulatory database search

Contaminated sites notified to the NSW Environmental Protection Authority

Under Section 60 of the *Contaminated Land Management Act 1997* (CLM Act), a person whose activities has contaminated land, or a landowner whose land has been contaminated, is required to notify the EPA when they become aware of the contamination and if certain conditions are met.

If people have not been exposed to or are unlikely to be exposed to contaminants, if concentrations in groundwater or surface water are unlikely to remain at elevated concentrations, or if threshold criteria is not available for the contaminant in question, then reporting may not be required. Many contaminated sites remain unreported to NSW EPA.

A search of the NSW EPA public register was undertaken by Aurecon on 17 June 2020. Sites recorded within the study boundary are listed in Table 8-2 below and displayed in Figure 8-6.

Table 8-2 Summary of contaminated sites notified to the NSW EPA

Site ID / Address	Site Name	WSA Precinct	COPCs
3103 / Lot 4 The Northern Road Luddenham	Elura Liquid Waste Disposal Site	Agribusiness	Metals, Asbestos, Nutrients, hydrocarbons, ammonia, landfill gas, phenols
770 / 1163 Mamre Road, Kemps Creek	Caltex Branded Service Station	Wianamatta-South	TRH, BTEX, PAH, Metals, Solvents
897 / 3019-3035 The Northern Road, Luddenham	Caltex Branded Service Station	Agribusiness	TRH, BTEX, PAH, Metals, Solvents

Other potentially contaminating sites within or immediately adjacent to WSA precincts are summarised in Table 8-3.

Table 8-3 Summary of other identified potentially contaminating sites

Site Address	Site Name	WSA Precinct	COPCs
Lot 90 Elizabeth, Drive Kemps Creek	Brandown Quarry, Waste and Recycling Services	500m from Wianamatta-South Creek Precinct	Metals, Asbestos, Nutrients, hydrocarbons, ammonia, landfill gas, phenols
1725 Elizabeth Drive, Kemps Creek	SUEZ Kemps Creek Resource Recovery Park	Badgerys Creek	Metals, Asbestos, Nutrients, hydrocarbons, ammonia, landfill gas, phenols

NSW Government PFAS Investigation Program

The environmental and potential human health impacts from exposure to per-and poly-fluoroalkyl substances (PFAS) are of increasing concern worldwide. Environmental legislation in many jurisdictions includes obligations and duties to prevent environmental harm, nuisances and contamination. PFAS contamination can be environmentally significant due to its persistence and potential for bioaccumulation.

The PFAS National Environmental Management Plan (NEMP), Version 2.0, January 2020 was designed to regulate PFAS in the environment. The NSW EPA is currently undertaking a state-wide PFAS investigation program to identify the use and impacts of legacy PFAS.

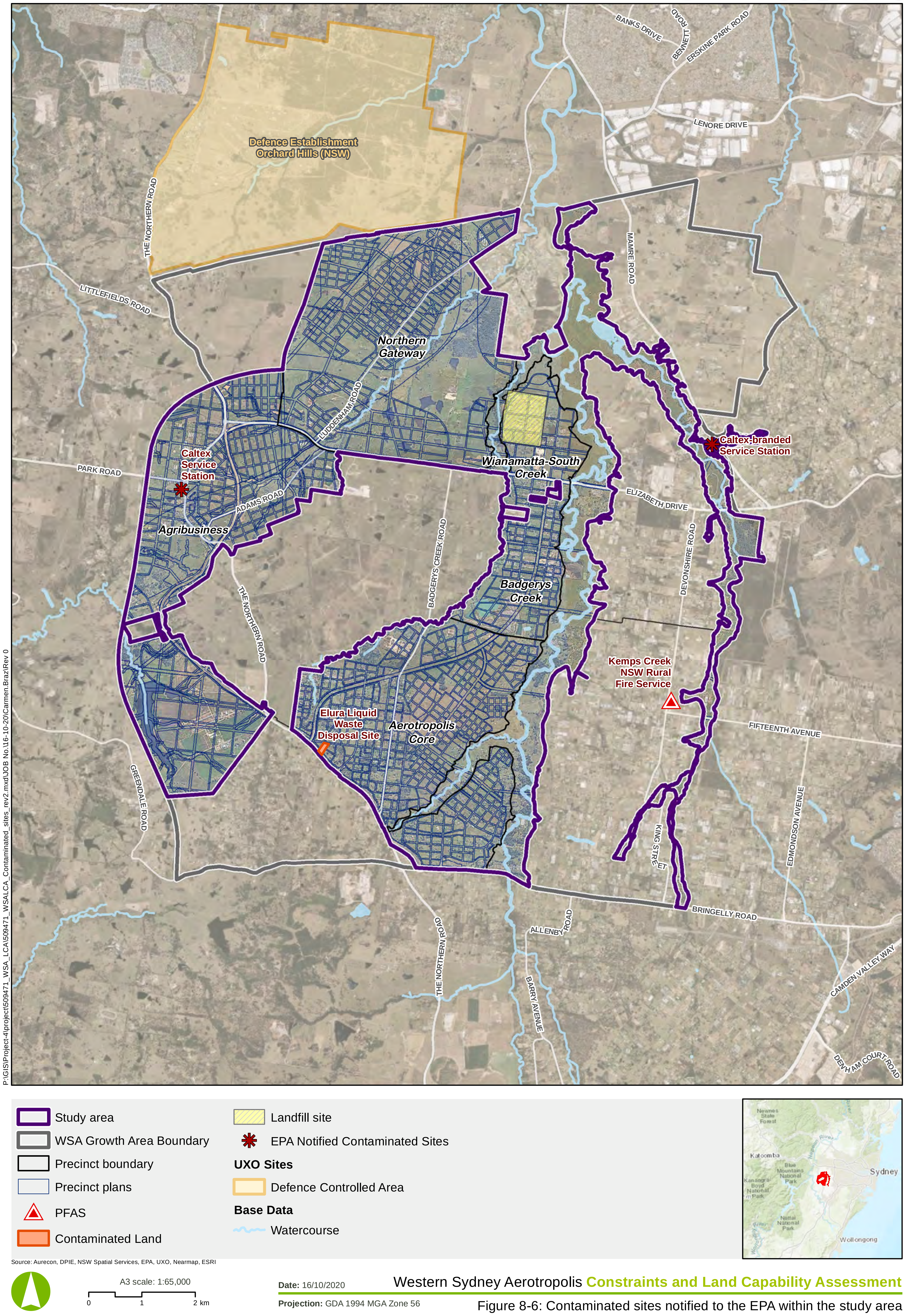
One PFAS investigation site was identified within a 10 km radius of the WSA precincts. The site is the Kemps Creek Rural Fire Service training site, located at 245 Devonshire Road, Kemps Creek. Figure 8-6 shows the location of the PFAS investigation site in relation to the WSA.

A detailed site investigation (DSI) for PFAS was completed in April 2018 which verified the presence of PFAS at and around the facility, and attempted to determine the extent of PFAS migration, and inform management actions for the site (NSW EPA, https://www.epa.nsw.gov.au/your-environment/contaminatedland/pfas-investigation-program/pfas-investigation-sites/kemps-creek-rfs-training-site). The EPA and NSW PFAS Taskforce has recommended that specific residents near the depot do not use surface water for drinking, cooking or watering produce. The training site is located within the Rossmore initial precinct (outside of the study area for this assessment).

Other potential local PFAS sources

Landfills due to the materials within have the potential to generate leachates with trace PFAS. The SUEZ Resource Recovery Park and Brandown Quarry both have the potential for PFAS to migrate off site into surrounding precincts if not contained by engineering controls such as leachate collections systems.

A small airfield, St Mary's / Kennets Airfield, is located in the north of the Northern Gateway precinct. PFAS is known to of been historically used at airfields in the form of aqueous film forming foam (AFFF). The risk is however considered to be low as PFAS was likely only used at larger commercial or defence airports for firefighting training and operational use.



Date: 16/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Figure 8-6: Contaminated sites notified to the EPA within the study area

Department of Defence Unexploded Ordinance risk mapping

Unexploded Ordinance (UXO) refers to ammunition which has been fired but has not functioned as designed and could be dangerous as they may easily become functioning with little handling. The Department of Defence maintains a record of sites confirmed as or suspected of being contaminated with UXO. This information is publicly available through their UXO risk mapping application (**http://www.defence.gov.au/UXO/Where/Default.asp**).

A search conducted on 17 June 2020 identified the Orchard Hills Defence Establishment boarders the Northern Gateway Precinct directly to the north. As no other areas of known UXO occur within the WSA the risk of encountering UXO and remnant contamination resides is considered to be low.

8.6 Areas of potential environmental concern (APECs)

A review of available site history information, public databases, previous reports and historical aerial photographs during the desktop review identified APECs and contaminants of potential concern (COPC) within each of the WSA precincts. These are summarised in Table 8-4.

Maps presented in **Appendix A** provide a detailed overview of discrete APECs and past building structures and disturbed land. Although these APECs have been recorded, they do not generally preclude the development of land and will require further site contamination investigations during master planning and development application. The further contamination investigations will determine as part of the planning and approvals process if the land is suitable or can be made suitable via remedial works or management for the proposed development.

Table 8-4 Potential areas of concern and contaminants of potential concern

WSA Precinct	Contamination hazard / potential area of concern	COPCs
Northern Gateway	▪ Construction activities and stockpiles of building materials ▪ Potential for legacy PFAS impacts at a small airfield (low risk) ▪ Historical uncontrolled filling and earthworks ▪ Historical and existing site structures containing hazardous materials such as asbestos and lead paint ▪ Herbicide/pesticide use within primary agricultural production areas ▪ Storage and maintenance of equipment and consumables including fuel, oil and chemicals in industrial areas	Metals, Asbestos, Nutrients, TRH, BTEX, PAH, phenols, pesticides (OCPs/OPPS), PFAS, Herbicides
Agribusiness	▪ Liquid waste and landfill depositional sites ▪ Service stations ▪ EPA notified contaminated sites ▪ Historical uncontrolled filling and earthworks ▪ Historical and existing site structures containing hazardous materials ▪ Herbicide/pesticide use within primary agricultural production areas ▪ Storage and maintenance of equipment and consumables including fuel, oil and chemicals in industrial areas	Metals, Asbestos, Nutrients, TRH, BTEX, PAH, ammonia, landfill gas, phenols, pesticides (OCPs/OPPS), Herbicides
Badgerys Creek	▪ Landfill materials, leachate and ground gases from nearby SUEZ Resource Recovery Park ▪ Historical uncontrolled filling and earthworks ▪ Historical and existing site structures containing hazardous materials ▪ Herbicide/pesticide use within primary agricultural production areas ▪ Storage and maintenance of equipment and consumables including fuel, oil and chemicals in industrial areas	Metals, Asbestos, Nutrients, TRH, BTEX, PAH, ammonia, landfill gas, phenols, pesticides (OCPs/OPPS), Herbicides

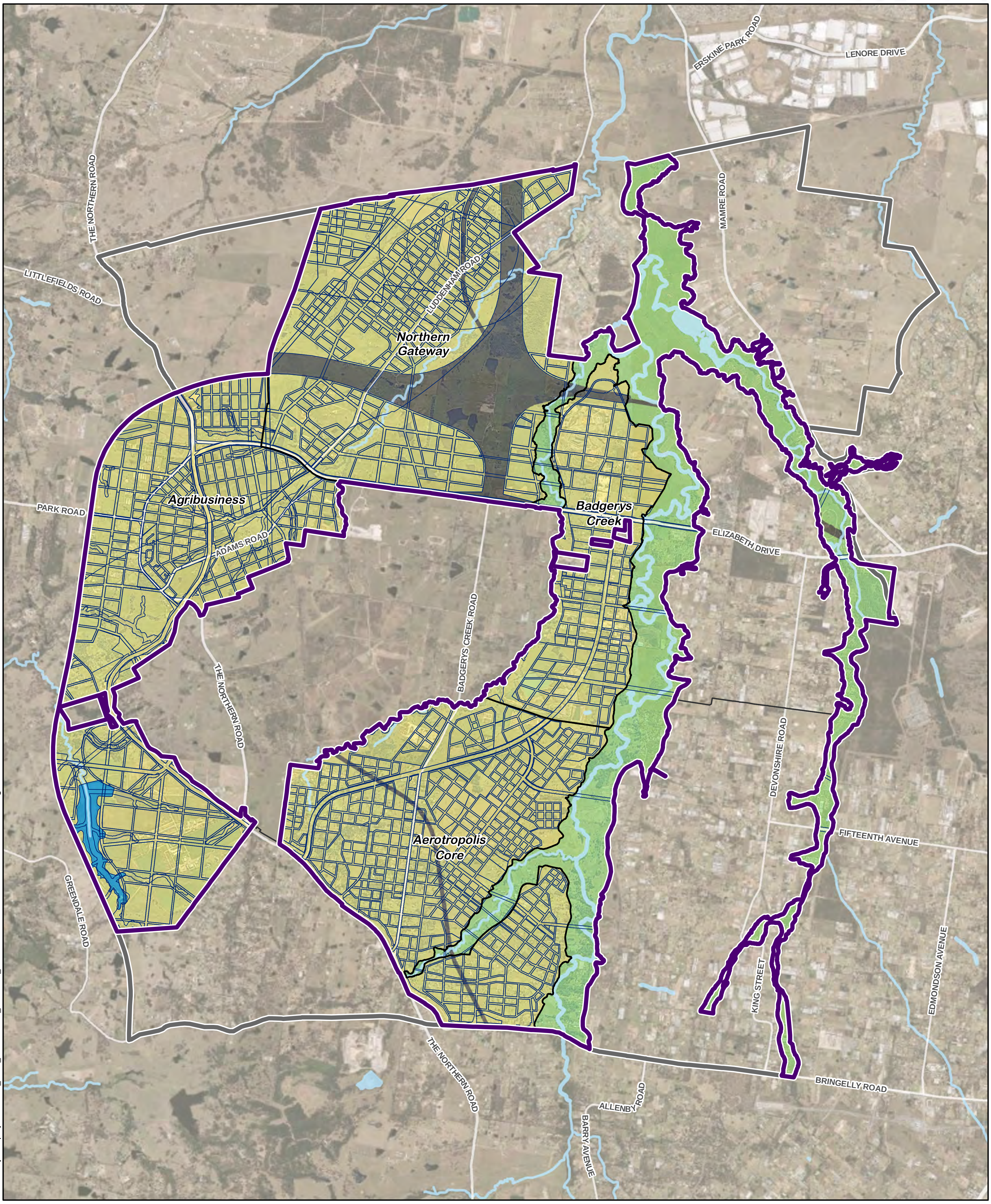
WSA Precinct	Contamination hazard / potential area of concern	COPCs
Aerotropolis Core	▪ Historical uncontrolled filling and earthworks ▪ Historical and existing site structures containing hazardous materials ▪ Herbicide/pesticide use within primary agricultural production areas ▪ Storage and maintenance of equipment and consumables including fuel, oil and chemicals in industrial areas	Metals, Asbestos, Nutrients, TRH, BTEX, PAH, phenols, pesticides (OCPs/OPPS), Herbicides
Wianamatta-South Creek	▪ Historical uncontrolled filling and earthworks ▪ Landfill materials, leachate and ground gases from nearby landfills ▪ Service stations ▪ Historical and existing site structures containing hazardous materials ▪ Herbicide/pesticide use within primary agricultural production areas ▪ Storage and maintenance of equipment and consumables including fuel, oil and chemicals in industrial areas	Metals, Asbestos, Nutrients, TRH, BTEX, PAH, ammonia, landfill gas, phenols, pesticides (OCPs/OPPS)

8.7 Recommended further contamination investigation priorities

Further contamination investigations across the WSA should be undertaken during master planning and development approval for proposed development. This would include undertaking a preliminary site investigation (PSI) and where required followed by a detailed site investigation (DSI) inclusive of intrusive site investigations, sampling and laboratory analysis and recommendation for land suitability for the proposed development or remedial or management actions to make the land suitable. This would be in accordance with the development control plan (DCP) at the time and any other NSW planning approvals such as SEPP 55 and requirements of the Contaminated Land Management Act 1997.

Figure 8-7 provides an overview of priority urban development future contamination investigation areas separated into precinct urban development (priority one), South Creek and riparian areas (priority two), future transport corridors and large water bodies.

aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Recommended further contamination site investigation areas.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area Boundary
Precinct boundary
Precinct plans
Base Data
Watercourse

Large water bodies not requiring contamination investigations (subject to master planning and future design review)
Recommended priority one future contaminated site investigation areas during master planning / DA stage
Recommended priority two future contaminated site investigation areas during master planning / DA stage
Future infrastructure corridors to be investigated for contamination as part of their planning approvals

Source: Aurecon, DPIE, NSW Spatial Services, EPA, UXO, Nearmap, ESRI

A3 scale: 1:55,000
0 1 2 km

Date: 15/10/2020
Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Figure 8-7: Recommended further contamination site investigation areas

8.8 Constrained development areas due to contamination risks

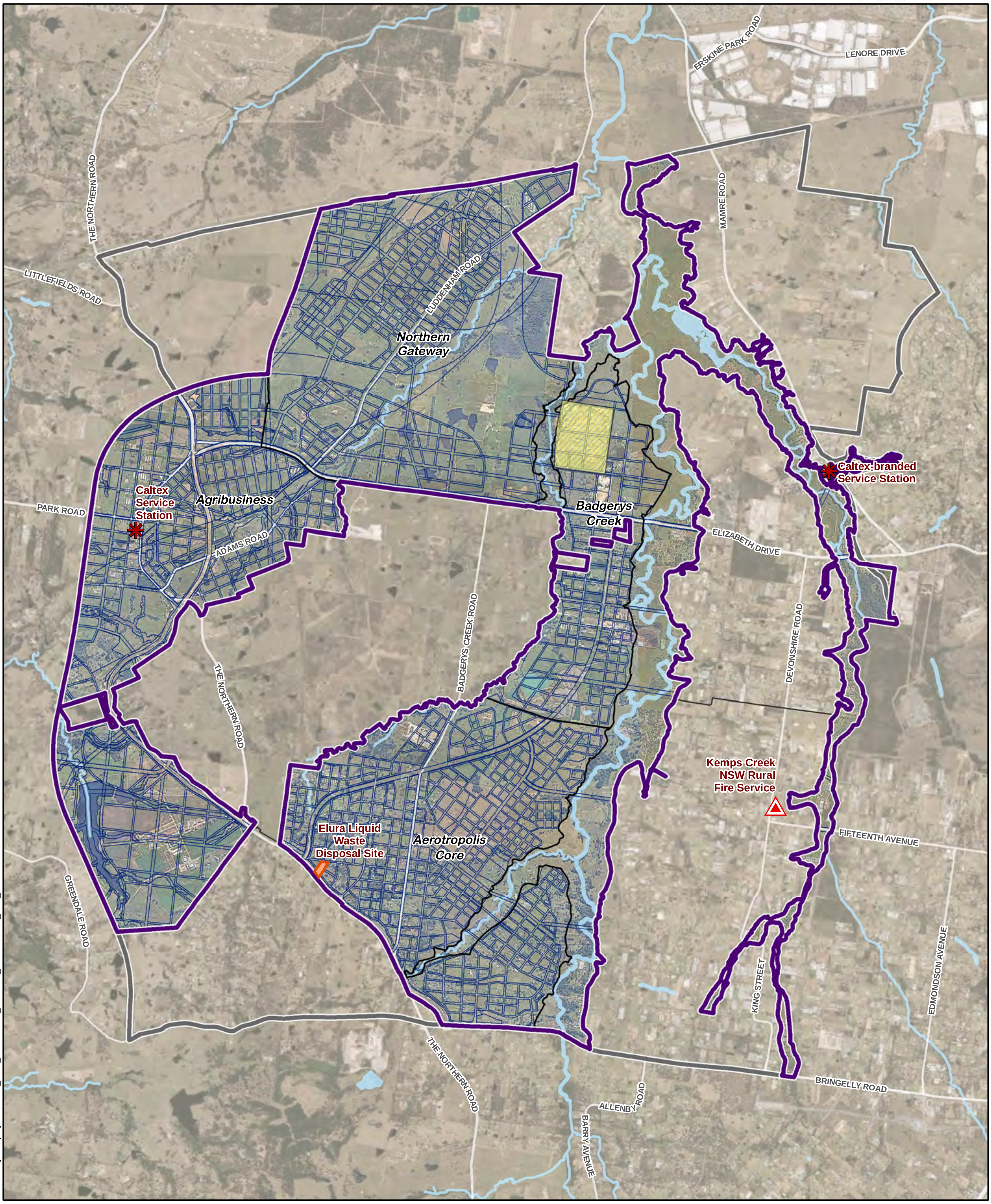
The information obtained and reviewed has been used to identify areas within WSA which are likely to be constrained for future urban development from a contamination perspective. A review of information indicates that some sites may have constraints that preclude urban development without significant remedial work and mitigation to make the land suitable for development. This list is indicative only and it should be noted that landfills, agricultural land uses, commercial farming and rural commercial land uses can and have been made suitable for urban development across Western Sydney through remedial actions, mitigation and appropriate planning.

The following sites are likely to have constraints associated with potential contamination relating various media such as soil, groundwater, surface water, landfill gas and vapour:

- **Aerotropolis Core and Badgerys Creek Precinct:**
  1. SUEZ Kemps Creek Resource Recovery Park, 1725 Elizabeth Drive, Kemps Creek
  2. Elura Liquid Waste Disposal Site, 3103 / Lot 4 The Northern Road Luddenham
  3. Australian Native Landscapes (ANL), 210 Martin Rd, Badgerys Creek NSW
  4. PGH Bricks Plant Badgerys Creek, 235 Martin Rd, Badgerys Creek NSW
- **Northern Gateway Precinct:**
  – No major constraints identified.
- **Agribusiness Precinct:**
  5. Caltex Branded Service Station, 897 / 3019-3035 The Northern Road, Luddenham
- **Wianamatta-South Creek Precinct:**
  6. Caltex Branded Service Station, 770 / 1163 Mamre Road, Kemps Creek
  7. Kemps Creek Rural Fire Service training site, 245 Devonshire Road, Kemps Creek

Figure 8-8 provides an overview of the sites listed above numbered from 1 to 7.

The list above does not consider discrete or incidental contamination risks such as smaller farm structures and small infilled ponds and areas across WSA which have been mapped and recorded in **Appendix A**. These smaller contamination risk areas should still be considered a constraint for developable lands however management and mitigation strategies are well known to minimise risk.



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Contaminated_sites_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

- Study area
- WSA Growth Area Boundary
- Precinct boundary
- Precinct plans
- Contaminated Land
- Landfill site
- EPA Notified Contaminated Sites

Base Data

- Watercourse

Potential for constraints on development and industry type:

1 - SUEZ Kemps Creek Resource Recovery Park (waste facility, various wastes)
2 - Elura Liquid Waste Disposal Site (liquid wastes)
3 - Australian Native Landscapes (ANL) (landscaping and building supplier)
4 - PGH Bricks Plant Badgerys Creek (Brick making industry)
5 - Caltex branded service station (petroleum storage and dispensing)
6 - Caltex branded service station (petroleum storage and dispensing)
7 - Kemps Creek NSW Rural Fire Service (Firefighting source, PFAS compounds)

Source: Aurecon, DPIE, NSW Spatial Services, EPA, UXO, Nearmap, ESRI

A3 scale: 1:55,000

0 1 2 km

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Figure 8-8: Constrained development areas due to contamination risks

8.9 Preliminary conceptual site model

Table 8-5 provides a list of the contamination APECs and links them with nearby receptors via potential pathways. This preliminary conceptual site model aims to derive high level contamination risks of each WSA precinct that should be considered in the future master planning and development applications.

Table 8-5 **Preliminary conceptual site model**

Precinct	Contamination Hazard/ Source	Potential Pathways	Potential receptors
Northern Gateway	▪ Construction activities and stockpiles of building materials ▪ Legacy PFAS impacts at a small airfield (low risk) ▪ Historical uncontrolled filling and earthworks ▪ Historical and existing site structures containing hazardous materials such as asbestos and lead paints ▪ Herbicide/pesticide use within primary agricultural production areas ▪ Storage and maintenance of equipment and consumables including fuel, oil and chemicals in industrial areas	▪ Dermal (direct contact), inhalation (dust vapour and odour) ingestion ▪ Direct contact of abstracted groundwater ▪ Stormwater/ wastewater inflows to excavations	▪ Construction and operations workers ▪ Genera public during construction ▪ Ecosystems within Cosgroves Creek ▪ Groundwater receptors ▪ Onsite remnant vegetation ▪ Ecological receptors
Agribusiness	▪ Liquid waste and landfill depositional sites ▪ Service stations ▪ EPA notified contaminated sites ▪ Historical uncontrolled filling and earthworks ▪ Historical and existing site structures containing hazardous materials ▪ Herbicide/pesticide use within primary agricultural production areas ▪ Storage and maintenance of equipment and consumables including fuel, oil and chemicals in industrial areas	▪ Dermal (direct contact), inhalation (dust vapour and odour) ingestion ▪ Direct contact of abstracted groundwater ▪ Stormwater/ wastewater inflows to excavations	▪ Construction and operations workers ▪ Genera public during construction ▪ Surface water receptors ▪ Groundwater receptors ▪ Onsite remnant vegetation ▪ Ecological receptors
Badgerys Creek	▪ Landfill materials, leachate and ground gases from nearby SUEZ Resource Recovery Park ▪ Historical uncontrolled filling and earthworks ▪ Historical and existing site structures containing hazardous materials ▪ Herbicide/pesticide use within primary agricultural production areas ▪ Storage and maintenance of equipment and consumables including fuel, oil and chemicals in industrial areas	▪ Dermal (direct contact), inhalation (dust vapour and odour) ingestion ▪ Direct contact of abstracted groundwater ▪ Stormwater/ wastewater inflows to excavations	▪ Construction and operations workers ▪ Genera Public during construction ▪ Ecosystems within Badgerys Creek ▪ Groundwater receptors ▪ Onsite remnant vegetation ▪ Ecological receptors
Aerotropolis Core	▪ Historical uncontrolled filling and earthworks ▪ Historical and existing site structures containing hazardous materials ▪ Herbicide/pesticide use within primary agricultural production areas ▪ Storage and maintenance of equipment and consumables including fuel, oil and chemicals in industrial areas	▪ Dermal (direct contact), inhalation (dust vapour and odour) ingestion ▪ Direct contact of abstracted groundwater ▪ Stormwater/ wastewater inflows to excavations	▪ Construction and operations workers ▪ Genera Public during construction ▪ Ecosystems within Badgerys Creek ▪ Groundwater receptors ▪ Onsite remnant vegetation ▪ Ecological receptors

Precinct	Contamination Hazard/ Source	Potential Pathways	Potential receptors
Wianamatta-South Creek	■ Historical uncontrolled filling and earthworks ■ Landfill materials, leachate and ground gases from nearby landfills ■ Service stations ■ Historical and existing site structures containing hazardous materials ■ Herbicide/pesticide use within primary agricultural production areas ■ Storage and maintenance of equipment and consumables including fuel, oil and chemicals in industrial areas	■ Dermal (direct contact), inhalation (dust vapour and odour) ingestion ■ Direct contact of abstracted groundwater ■ Stormwater/ wastewater inflows to excavations	■ Construction and operations workers ■ Genera Public during construction ■ Ecosystems within Wianamatta and South Creeks ■ Groundwater receptors ■ Onsite remnant vegetation

9 Assessment results

9.1 Agricultural land capability

Figure 9-1 to Figure 9-2 present output maps representing the general and hazardous land constraints for agricultural land use. Figure 9-3 presents the overall land constraint rating.

As illustrated by Figure 9-3, constraints within the WSA for agricultural land use are generally moderate to high with localised areas of very high constraint around waterways. The results reflect a combination of constraint factors identified in Table 5-1, which have been weighted according to relative importance on agricultural activities.

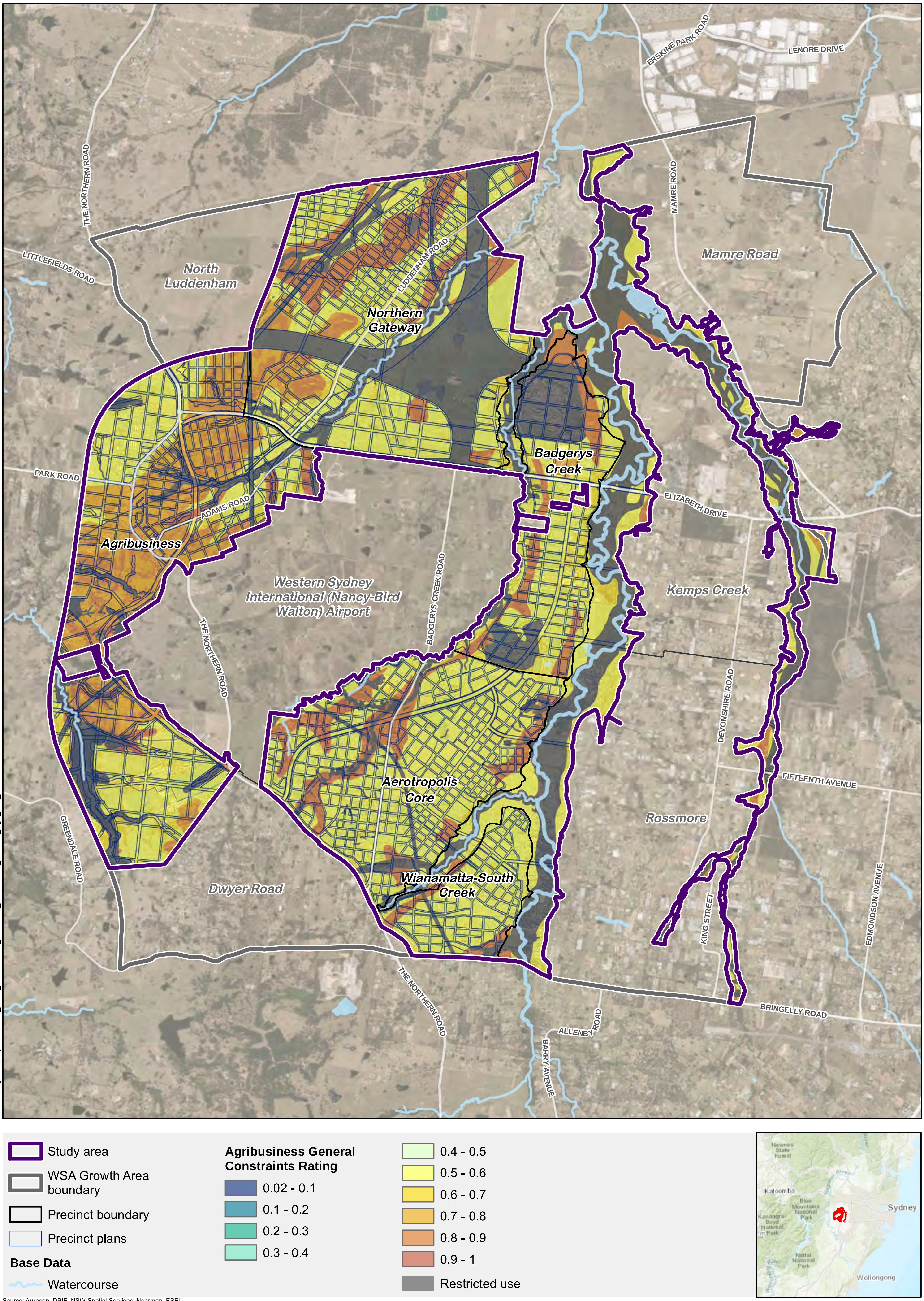
The results from this assessment are in broad agreement with existing studies and should can used as a complementary mapping product, as the outputs incorporate landscape and soil property factors that have been previously unaccounted for in assessing land capability for agricultural development, along with local scale limitations derived from various restrictive land facets (e.g. wetlands, transport corridors, flood zones), and a weighted scale for constraints analyses.

The mapping products are limited by the relative scales of information used to assess the constraints, however local scale field investigations have been used to valid some of the baseline data, with results showing broad agreement with the input maps.

The specific constraints are presented as individual maps throughout this assessment. The specific constraints may be considered independently and cumulatively in better understand land capability within the WSA. For example, areas of moderate soil fertility may also coincide with areas of high overall constraint due to the interplay of other factors such as slope, soil physical properties, and salinity risk.

The specific constraints associated with agricultural land use within the WSA have been discussed as part of this assessment. These constraints may be overcome through appropriate land management practices; however, it is beyond the scope of this assessment to present and discuss appropriate measures for agricultural land management.

aurecon



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:55,000

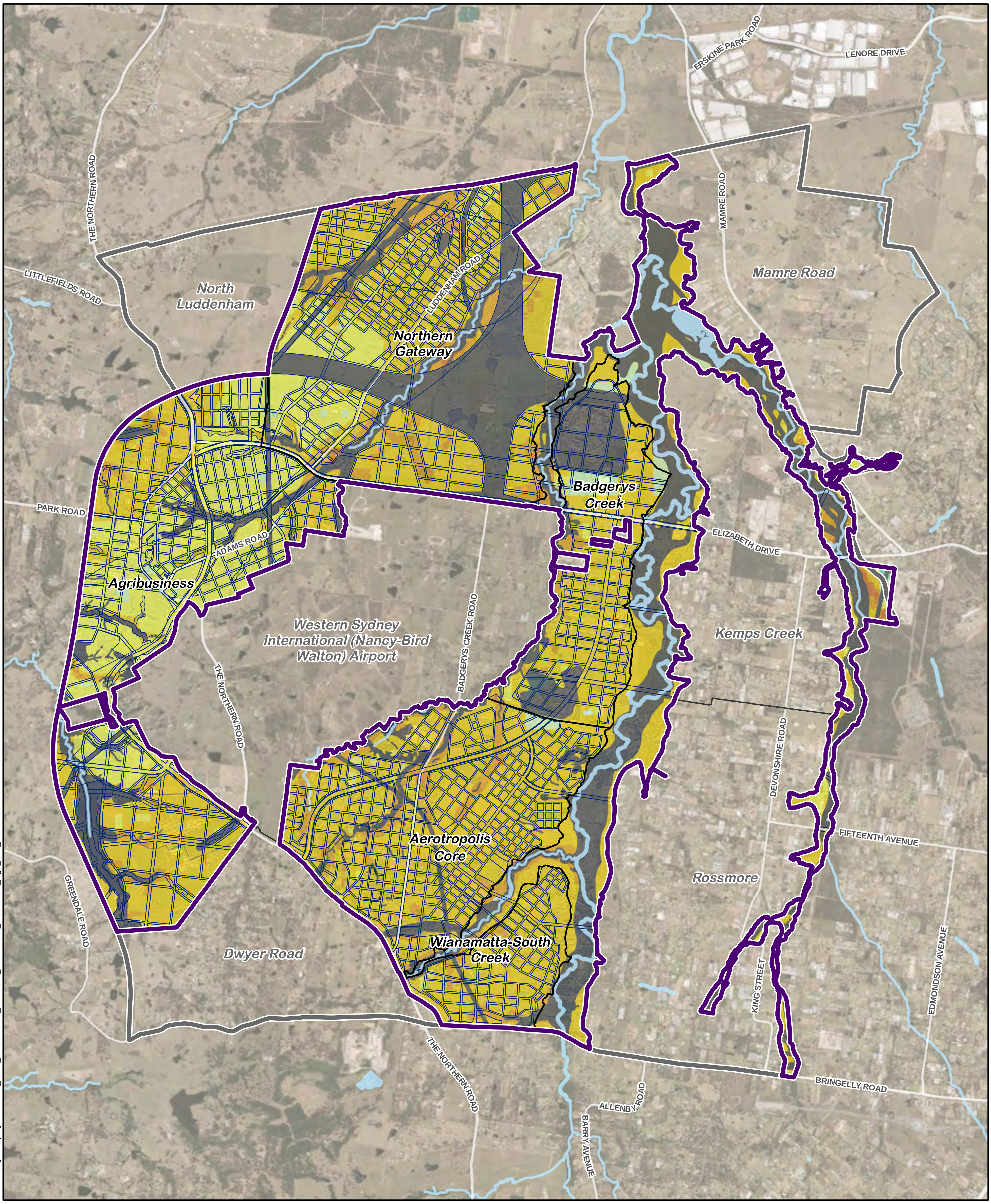
0 1 2 km

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis Constraints and Land Capability Assessment

Figure 9-1: General constraints – agriculture



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Constraints_Hazardous_Agri_ALL_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area

WSA Growth Area boundary

Precinct boundary

Precinct plans

Base Data

Watercourse

Hazard Constraints Rating

0.02 - 0.1

0.1 - 0.2

0.2 - 0.3

0.3 - 0.4

0.4 - 0.5

0.5 - 0.6

0.6 - 0.7

0.7 - 0.8

0.8 - 0.9

0.9 - 1

Restricted use

Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:55,000

0 1 2 km

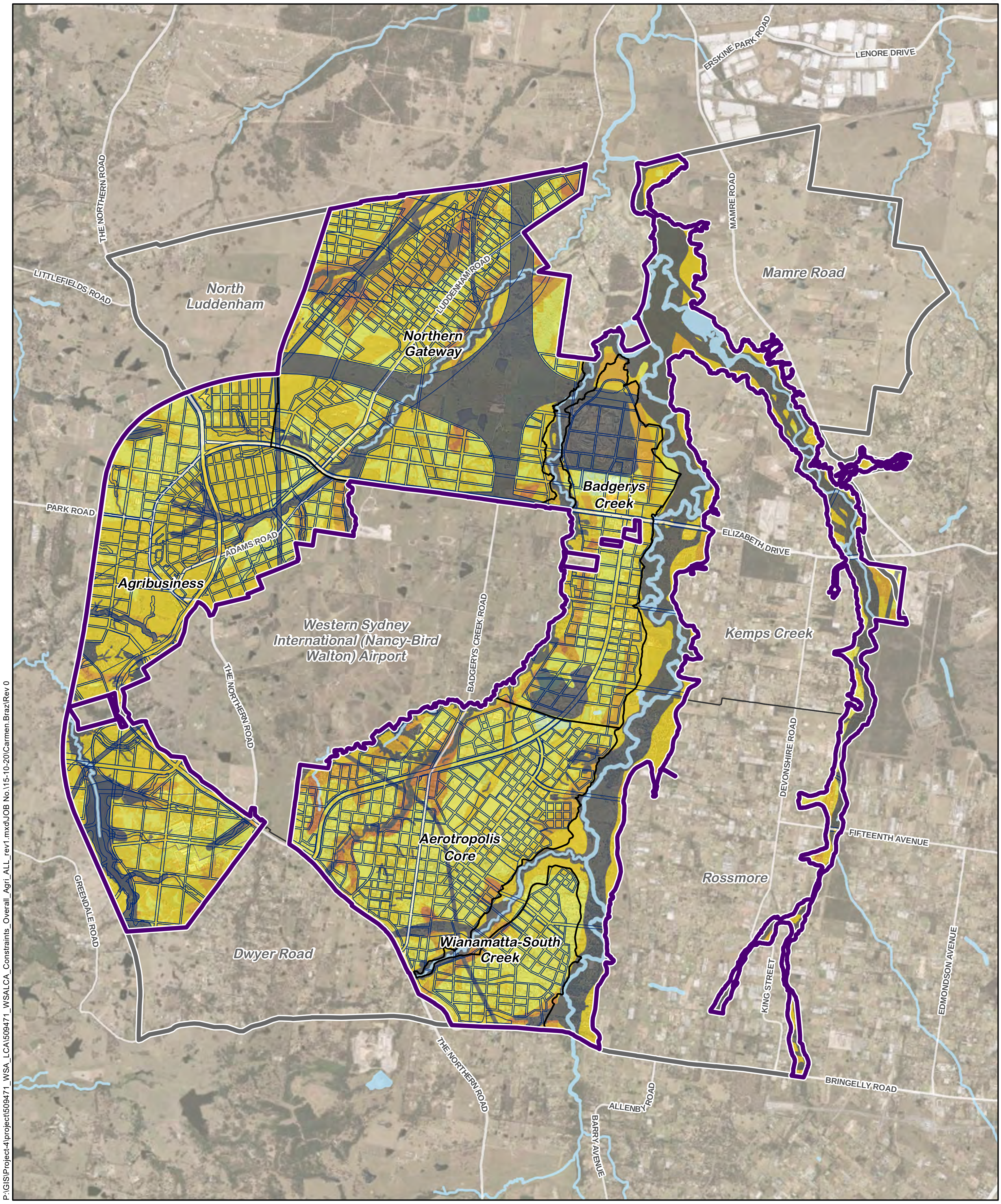
Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Figure 9-2: Hazardous constraints – agriculture

aurecon



Study area
WSA Growth Area boundary
Precinct boundary
Precinct plans

Base Data

Watercourse

Agribusiness Overall Constraints Rating

0.02 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.5
0.5 - 0.6
0.6 - 0.7
0.7 - 0.8
0.8 - 0.9
0.9 - 1
Restricted use

Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:55,000

0 1 2 km

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis Constraints and Land Capability Assessment

Figure 9-3: Overall constraints – agriculture

9.2 Urban land capability

Figure 9-4 and Figure 9-5 present output maps representing the general and hazardous land constraints for urban land use. Figure 9-6 presents the overall land constraint rating.

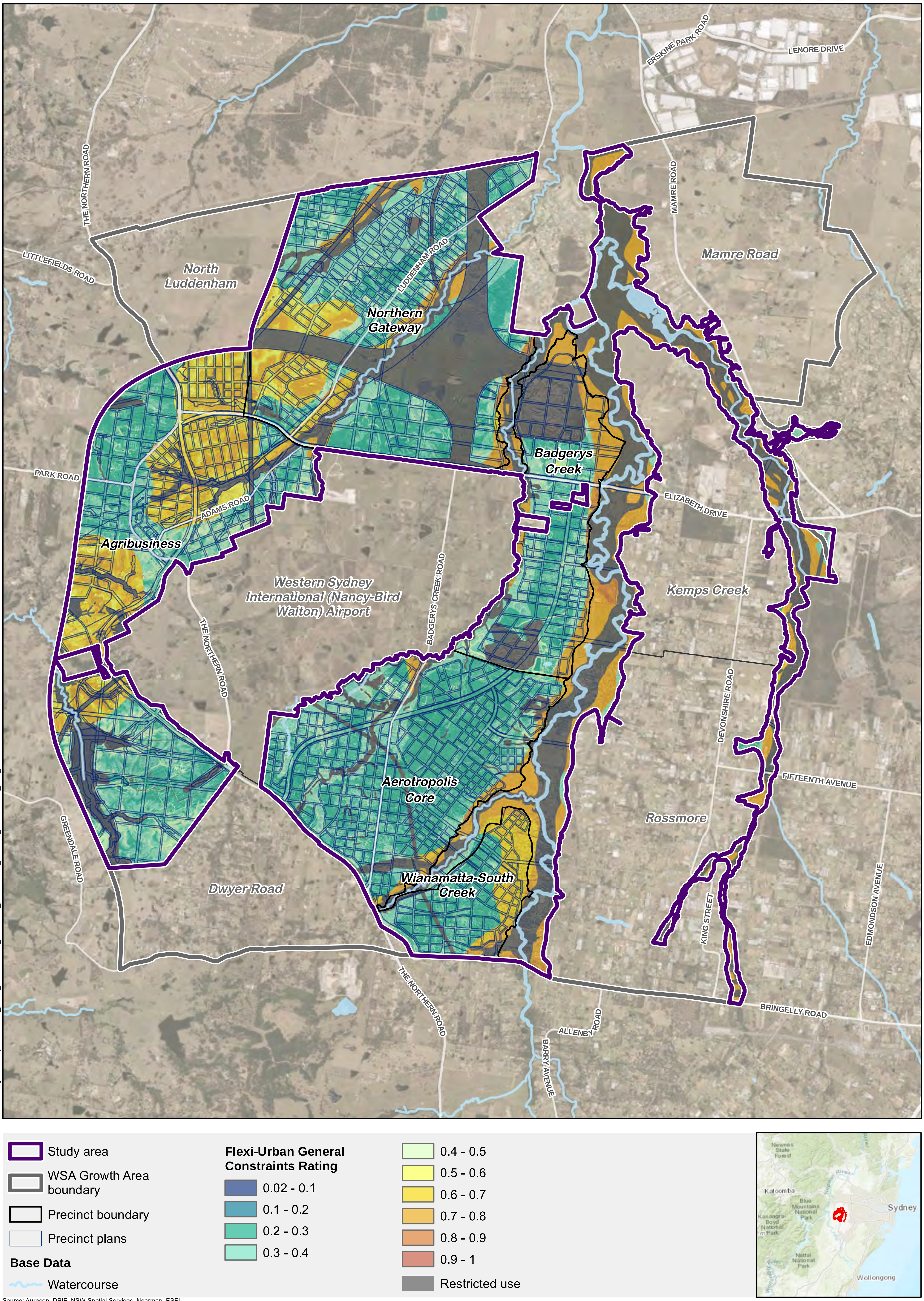
As illustrated by Figure 9-6, constraints within the WSA for urban land use are generally moderate with areas of high constraint around waterways and within steeply sloping areas of the Agribusiness precinct. The results reflect a combination of constraint factors identified in Table 5-5, which have been weighted according to relative importance on urban development and land use.

The results from this assessment are in broad agreement with existing studies and should can used as a complementary mapping product as the outputs incorporate landscape and soil property factors that have been previously unaccounted for in assessing land capability for urban development, along with local scale limitations derived from various restrictive land facets (e.g. wetlands, transport corridors, flood zones), and a weighted scale for constraints analyses.

The mapping products are limited by the relative scales of information used to assess the constraints, however local scale field investigations have been used to valid some of the baseline data, with results showing broad agreement with the input maps.

The specific constraints are presented as individual maps throughout this assessment. The specific constraints may be considered independently and cumulatively in better understand land capability within the WSA. For example, areas of moderate soil fertility may also coincide with areas of high overall constraint due to the interplay of other factors such as slope, soil physical properties, and salinity risk.

The specific constraints associated with urban land use within the WSA have been discussed as part of this assessment. These constraints may be overcome through appropriate land development and management practices; however, it is beyond the scope of this assessment to present and discuss appropriate measures for urban land management.



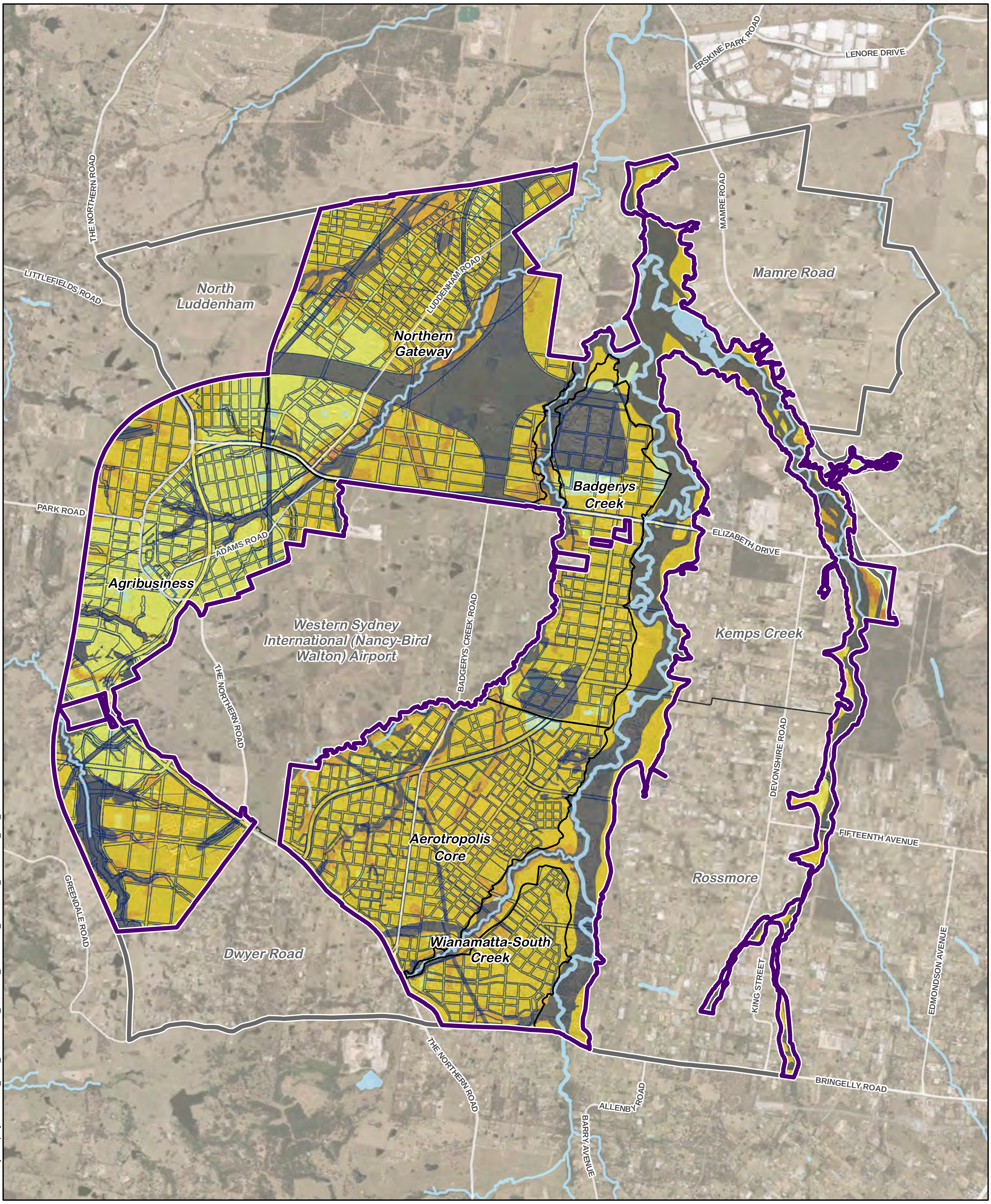
Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Figure 9-4:General constraints – urban land

aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Constraints_Hazardous_Flexi-Urban_ALL_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area boundary
Precinct boundary
Precinct plans

Base Data

Watercourse

Hazard Constraints Rating

0.02 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.5
0.5 - 0.6
0.6 - 0.7
0.7 - 0.8
0.8 - 0.9
0.9 - 1
Restricted use

Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:55,000

0 1 2 km

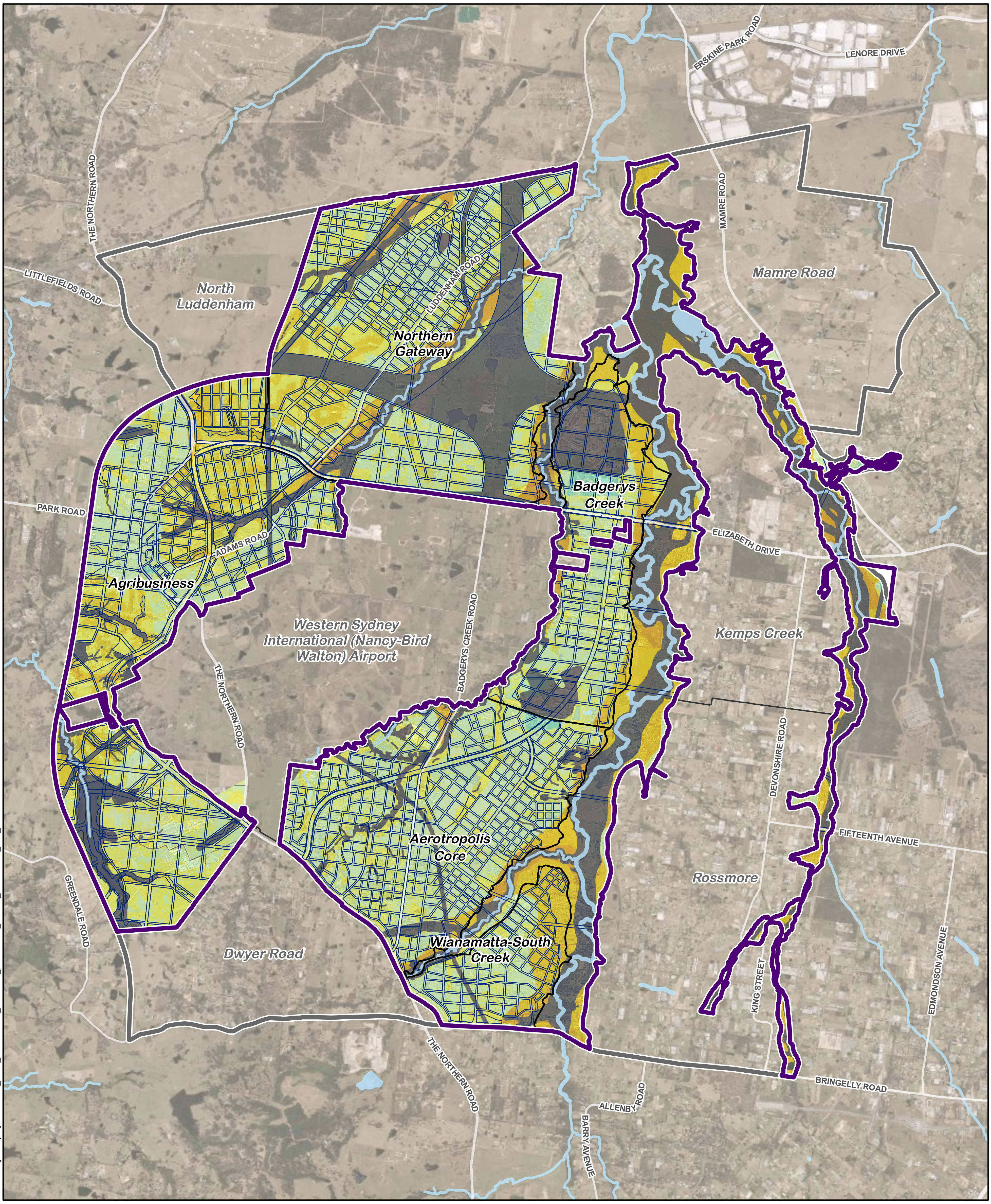
Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis Constraints and Land Capability Assessment

Figure 9-5: Hazardous constraints – urban land

aurecon



Study area

WSA Growth Area boundary

Precinct boundary

Precinct plans

Base Data

Watercourse

Flexi-Urban Overall Constraints Rating

0.02 - 0.1

0.1 - 0.2

0.2 - 0.3

0.3 - 0.4

0.4 - 0.5

0.5 - 0.6

0.6 - 0.7

0.7 - 0.8

0.8 - 0.9

0.9 - 1

Restricted use

Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:55,000

0 1 2 km

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Figure 9-6: Overall constraints – urban land

10 Climate change

10.1 Overview

Consideration of potential climate change is a crucial factor in assessing the future water resources, as it has the potential to influence the general environmental water balance as well as water quality, salinity and groundwater availability. The NSW Office of Environment and Heritage (OEH) has published several documents detailing the expected effects of climate change on water resources. Study results documented in a 2015 report, "*Climate change impacts on surface runoff and recharge to groundwater"* (OEH, 2015), have been used to assess expected local climatic changes.

The cumulative rainfall departure (CRD) method a concept sometimes utilized to evaluate short to long term temporal trends in rainfall. The method can be used to assess the prevalence and duration of below average (drying), or above average (wetting) rainfall conditions. A downward trend is used to indicate drying conditions, while an upward trend is considered representative of wetting conditions.

Figure 10-1 presents Annual and cumulative rainfall departure for the WSA for the period between 1900 and 2020. The graph shows both long- and short-term trends in rainfall conditions. Notably the long-term data shows a downward (drying) trend between 1900 and 1950, an upward (wetting) trend between 1948 and 1992; the current period (between 1992 and 2020) is characterised by an overall downward (drying) trend, with a stable period between 2006 and 2017. The period between 1996 and 2009 is coincident with the Australian Millennium Drought.

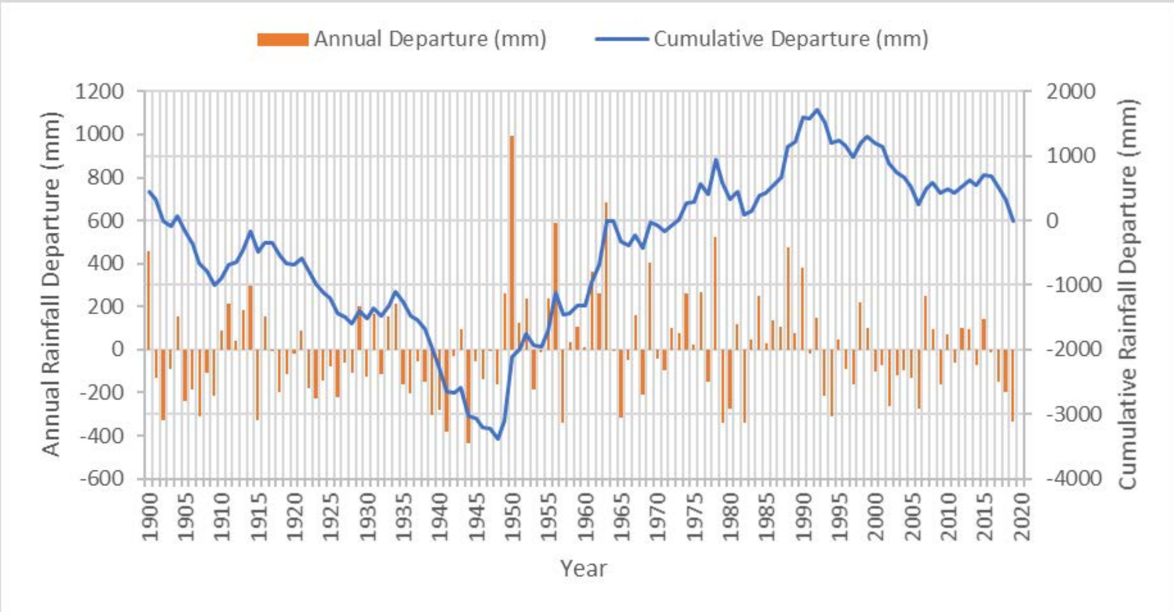


Figure 10-1 Annual and cumulative rainfall departure for the WSA (1900 – 2020)

Utilizing NARCliM (the NSW and ACT Regional Climate Modelling project), which is an ensemble of regional climate projections for south-east Australia, the study predicted near future (2020-2039) and far future (2060-2079) changes to rainfall, runoff and recharge to groundwater. Table 10-1 presents a summary of the statistical analysis for Metropolitan Sydney and the Hawkesbury catchment.

Table 10-1 Percent changes to multi-model mean annual rainfall, surface runoff and recharge

	Percentage change in near future (2020-2039)			Percent change in far future (2060-2079)		
State planning region	**Rainfall**	**Runoff**	**Recharge**	**Rainfall**	**Runoff**	**Recharge**
Metropolitan Sydney	0.4	4.0	-5.0	8.1	17.6	12.5
Hawkesbury Nepean Catchment	-0.1	0.9	-9.3	6.1	13.4	5.6

The study predicts that changes in near future (2020-2039) are likely to be characterised by a reduction in rainfall and groundwater recharge, and an increase in the surface runoff for the Hawkesbury-Nepean Catchment region, and reduction in recharge for the Metropolitan Sydney region. For the period between 2060-2079, the model predicts increase in all three parameters; rainfall, surface runoff and recharge to groundwater.

Modelled projections indicate with high confidence a future increase in the intensity of extreme rainfall events; however, the magnitude of the increases cannot be confidently projected. The publication does not provide details regarding changes to flood-producing rainfall events other than to confirm that changes to rainfall intensity are predicted.

The "*Practical Consideration of Climate Change"* (NSW Government Department of Environment and Climate Change, 2007) publication references climate change modelling carried out by the CSIRO in 2007 for the NSW Government to assess the impacts of climate change on rainfall intensities. The results showed a trend of increased rainfall intensities for the 40-year ARI one-day rainfall event across New South Wales. The projected changes in rainfall totals are indicated in Table 10-2.

Table 10-2 CSIRO indicative change in rainfall one-day total (CSIRO, 2007)

Location	40 Year 1-day rainfall total projected change 2030	40 Year 1-day rainfall total projected change 2070	Evaporation projection change 2030	Evaporation projected change 2070
Sydney Metropolitan	-3% to +12%	-7% to +10%	+1% to +8%	+2% to +24%
Hawkesbury Nepean	-3% to +12%	-7% to +10%	+1% to +8%	+2% to +24%
New South Wales Average	-2% to +15%	-1% to +15%	+1% to +12%	+3% to +38%

These expected rainfall and evaporation changes largely support the predictions presented in Table 10-1, as higher intensity storms will result in higher runoff volumes, whereas the increased evaporation rates will likely lead to reduced recharge, as suggested in the near future results.

Temperature projections for Eastern Australia indicate higher average temperatures for the near future (2030) with the daily average expected to rise between 0.5 and 1.4°C above the average value recorded between 1986 and 2005. By late in the century (2090), for a high emission scenario (RCP8.5) the projected range of warming is 2.8 to 5.0 °C. Under an intermediate scenario (RCP4.5) the projected warming is 1.3 to 2.6 °C. (OEH, 2014).

10.2 Climate change constraints on urban and agricultural land capability

Australia is one of the countries most affected by climate change, with agriculture representing one of the most exposed and vulnerable sectors (Campbell, 2008). Increasing demands on landscapes intensify the pressures on soil and water resources. Pressures on soil and water resources intensify further where climate change impacts result in declining land and water availability.

Global warming has been correlated with an increase in the frequency of extreme heat events and increased severity of drought conditions during periods of below average rainfall. As the climate warms, heavy rainfall is also expected to become more intense, contributing to increased risks of flash flooding. (CSIRO, 2018).

The NARCLiM modelling predictions indicate that changes to climate in the near future (2020-2039) are likely to result in reduced recharge to groundwater and increased runoff events, typically reflective of shorter duration, higher magnitude rainfall events.

The changes in climate predicted by the NARCLiM modelling will increase pressures on landscapes within the Aerotropolis. Impacts may include increased soil erosion rates, water scarcity, groundwater depletion, streamflow depletion, and vegetation loss, as a result of drought conditions and high magnitude rainfall events. Flood risk areas may also increase in response to higher magnitude rainfall events, further constraining areas of available land for safe development.

Adaptive and sustainable land management practices must be considered in order to respond to the greater vulnerability and constraints on land caused by climate change.

11 Summary baseline management measures

Table 11-1 provides a baseline summary of management measures that can be used to manage land capability aspects in the WSA. Further detail is provided in guidance documents listed in Section 12 of this report.

Table 11-1 Summary baseline management measures for land capability aspects

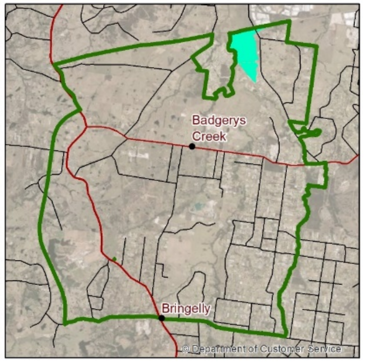
Constraint	Symptoms	Summary management actions
Soil Salinity	1. Stunted plant growth 2. Growth of salt tolerant species 3. Soil weathering and structural degradation	1. Scraping – remove salts that have accumulated on soil 2. Flushing – wash away salts by flushing water over the surface 3. Leaching – ponding freshwater to leach salts from soil 4. Select suitable irrigation measures to manage soil salinity 5. Select suitable irrigation water quality to manage soil salinity
Landscape Salinity (Groundwater Associated Salinity)	1. Waterlogging 2. Salt scalding (bare patches) on landscape 3. Growth of salt tolerant species 4. Unhealthy or dead trees 5. Damage to buildings, infrastructure and underground pipes 6. Reduced water quality in streams 7. Saline discharges	1. Buffer the salt store – keep it dry and still 2. Intercept shallow lateral flows and shallow groundwater 3. Stop discrete landscape recharge 4. Discharge rehabilitation and management 5. Increase agricultural production to dry out the landscape and reduce recharge 6. Dry out the landscape with diffuse actions over most of the landscape 7. Access and use groundwater to change water balance 8. Maximise recharge to dilute water tables with engineering actions 9. Minimise recharge with engineering actions 10. Maintain and maximize runoff 11. Manage and avoid acid sulfate soil
Soil Sodicity	1. Landscape erosion 2. Increased runoff 3. Waterlogging 4. Hardpans 5. Cracking and desiccation 6. Structural decline	1. Avoid disturbance and compaction 2. Alternative land use options 3. Planting tolerant species 4. Chemical amelioration 5. Deep ripping 6. Sand blocks and sand barriers 7. Topsoil / burial and revegetation 8. Increase organic matter 9. Deep ripping 10. Raised beds or deepened seedbeds 11. Improve drainage to reduce waterlogging
Soil Erosion	1. Loss of soil 2. Loss of land 3. Damage to infrastructure and buildings 4. Sedimentation of receiving environments 5. Mass movements	1. Use land according to capability 2. Cover soils to avoid soil loss 3. Control runoff to retard erosive forces 4. Utilise contouring to control energy gradients 5. Minimize soil disturbance 6. Restrict vehicle access to unpaved areas 7. Create sealed access where necessary with appropriate drainage 8. Consider planting deep-rooted vegetation
Water Quality (Surface Water and Groundwater)	1. Sedimentation of streams 2. Salinisation / pollution of groundwater 3. Salinisation / pollution of surface water 4. Loss of habitat within streams and riparian zones 5. Loss of groundwater / surface water resource potential	1. Minimize soil erosion 2. Identify and protect sensitive surface water and groundwater sources 3. Establish suitable land management practices 4. Establish Water Sensitive Urban Design measures to manage urban and agricultural water in the landscape.

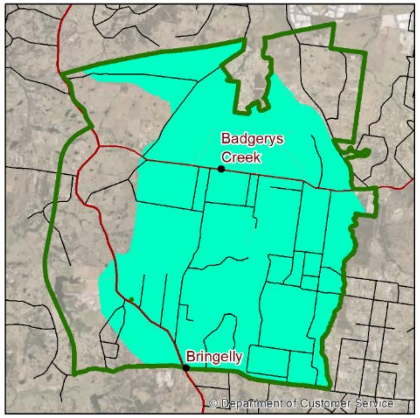
Constraint	Symptoms	Summary management actions
Groundwater Yield	1. Declining water tables 2. Reduced yield	1. Avoid over extraction of groundwater through allocation licences 2. Test permeability to establish safe sustainable yield

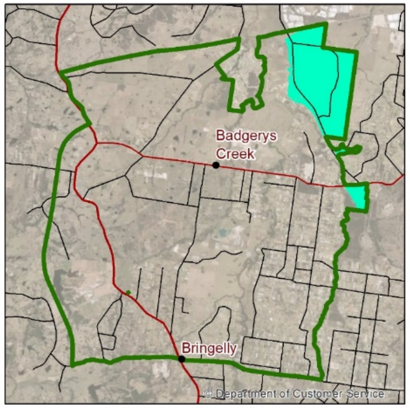
11.1 Specific salinity hazards, constraints and management strategies for precinct planning

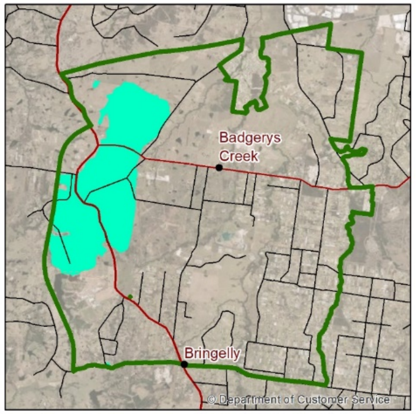
The following specific precinct planning strategies for salinity management are provided based on HGL, precinct, overall salinity hazard and management areas as outlined in Table 11-2. Detailed descriptions and further information is provided in Appendix D for each HGL, salinity risks and landscape type.

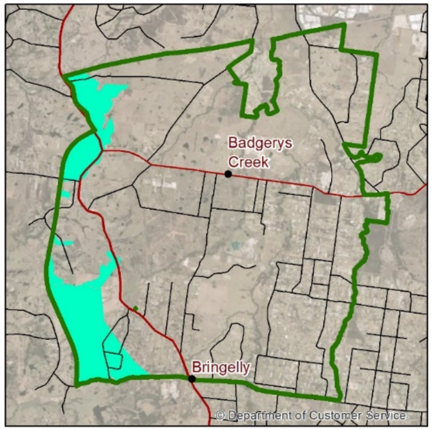
Table 11-2 Specific salinity hazards, constraints and management strategies

HGL	Precinct	Coverage	Overall salinity hazard	Specific land management constraints	Targeted urban management strategies (in priority order)
Shale Plains	Wianamatta South-Creek	Northern portion of Wianamatta South-Creek. Outside of proposed developable areas in draft precinct plans.  	Very High	▪ Urban development may increase the rate of accumulation of salt in upland depressions and on lower colluvial slopes, exacerbating land salinity in low lying areas which is already classed as high. ▪ Seasonal waterlogging. ▪ The flat constricted alluvial plain area is highly sensitive. Disturbance of the area is likely to significantly increase erosion and increase recharge which will mobilise salt to the adjacent stream. ▪ Plant species selection will require waterlogging tolerance.	1. **Urban Investigations (UI):** The landscape contains significant salinity, and geological situations that predispose salinity development. Assessment of the location, intensity and scale of salinity is needed. There are areas of sensitive sodic soils, particularly in drainage lines that need to be identified. 2. **Urban Planning (UP):** Planning of sub-division layout and design is required to manage salinity consequences. Development must not increase the salinity hazard of the natural and built environment. Layout and design should consider locations of roads, infrastructure and greenspace as well as building allotments, and water sensitive urban design. 3. **Urban Construction (UC):** Construction on saline land will require salt resistant/ resilient materials. The typical slope gradient of this HGL requires careful consideration of depth of cut and location of roads on hillslopes; and all infrastructure, including underground utilities. 4. **Urban Management (UM):** The input of water into the landscape (lawns, gardens, sporting fields) including the management of recycled water, requires careful management. 5. **Urban Vegetation (UV):** Maintain and enhance vegetation (including remnant vegetation) for the management of recharge, and as a buffer to excess water input. Waterwise gardening should be encouraged in residential areas. 6. **Riparian Management (RM):** Vegetation management in riparian areas will assist in minimising salt export to streams.

HGL	Precinct	Coverage	Overall salinity hazard	Specific land management constraints	Targeted urban management strategies (in priority order)
Upper South Creek	Badgerys Creek Aerotropolis Core Northern Gateway Wianamatta South-Creek	Covers the majority of the WSA initial precincts including Badgerys Creek, Aerotropolis Core, Northern Gateway and Wianamatta South-Creek 	Very High	▪ Urban development activities may increase the rate of accumulation of salt in upland depressions and on lower colluvial slopes, exacerbating land salinity in low lying areas which is already classed as high. ▪ Seasonal waterlogging. ▪ The flat constricted alluvial plain area is highly sensitive. Disturbance of the area is likely to significantly increase erosion and increase recharge which will mobilise salt to the adjacent stream. ▪ Plant species selection will require waterlogging tolerance.	1. **Urban Planning (UP):** Planning of sub-division layout and design is required to manage salinity consequences. Development must not increase the salinity hazard of the natural and built environment. Layout and design should consider locations of roads, infrastructure and greenspace as well as building allotments, and water sensitive urban design. 2. **Urban Investigations (UI):** The landscape contains significant salinity, and geological situations that predispose salinity development. Assessment of the location, intensity and scale of salinity is needed. There are areas of sensitive sodic soils, particularly in drainage lines that need to be identified. 3. **Urban Construction (UC):** Construction on saline land will require salt resistant/ resilient materials. The typical slope gradient of this HGL requires careful consideration of depth of cut and location of roads on hillslopes; and all infrastructure, including underground utilities. 4. **Urban Vegetation (UV):** Maintain and enhance vegetation (including remnant vegetation) for the management of recharge, and as a buffer to excess water input. Waterwise gardening should be encouraged in residential areas. 5. **Urban Management (UM):** The input of water into the landscape (lawns, gardens, sporting fields) including the management of recycled water requires careful management. 6. **Riparian Management (RM):** Vegetation management in riparian areas will assist in minimising salt export to streams.

HGL	Precinct	Coverage	Overall salinity hazard	Specific land management constraints	Targeted urban management strategies (in priority order)
Mount Vernon	Mamre Road (outside of initial precincts)	Outside of the initial precincts assessed in this report, Mamre Road Precinct.  	Moderate	■ Steep slopes may affect construction activities such as cut-and-fill and building of foundations. ■ In unsewered areas, on-site wastewater disposal leakages may interact with landscape salt store to increase salinity hazard. ■ Urban development activities may increase waterlogging and the rate of accumulation of salt on mid and lower slopes where salinity is already an issue.	1. **Urban Investigations (UI):** The landscape contains significant salinity, and geological situations that predispose salinity development. Assessment of the location, intensity and scale of salinity is needed. There are areas of sensitive sodic soils, particularly in drainage lines that need to be identified. 2. **Urban Planning (UP):** Planning of sub-division layout and design is required to manage salinity consequences. Development must not increase the salinity hazard of the natural and built environment. Layout and design should consider locations of roads, infrastructure and greenspace as well as building allotments, and water sensitive urban design. 3. **Urban Management (UM):** The input of water into the landscape (lawns, gardens, sporting fields) including the management of recycled water requires careful management. 4. **Urban Construction (UC):** Construction on saline land will require salt resistant/ resilient materials. The typical slope gradient of this HGL requires careful consideration of depth of cut and location of roads on hillslopes; and all infrastructure, including underground utilities. 5. **Urban Vegetation (UV):** Maintain and enhance vegetation (including remnant vegetation) for the management of recharge, and as a buffer to excess water input. Waterwise gardening should be encouraged in residential areas. 6. **Riparian Management (RM):** Vegetation management in riparian areas will assist in minimising salt export to streams.

HGL	Precinct	Coverage	Overall salinity hazard	Specific land management constraints	Targeted urban management strategies (in priority order)
Mulgoa	Northern Gateway	Covers the western portion of the Northern Gateway Precinct and parts of the Agribusiness Precinct  	Moderate	■ In unsewered areas, on-site wastewater disposal leakages may interact with landscape salt store to increase salinity hazard. ■ Steep slopes may affect construction activities such as cut-and-fill, building of foundations and retaining walls. Creation of barriers can increase localised accumulation of salt.	1. **Urban Planning (UP):** Planning of sub-division layout and design is required to manage salinity consequences. Development must not increase the salinity hazard of the natural and built environment. Layout and design should consider locations of roads, infrastructure and greenspace as well as building allotments, and water sensitive urban design. 2. **Urban Vegetation (UV):** Maintain and enhance vegetation (including remnant vegetation) for the management of recharge, and as a buffer to excess water input. Waterwise gardening should be encouraged in residential areas. 3. **Urban Investigations (UI):** The landscape contains significant salinity, and geological situations that predispose salinity development. Assessment of the location, intensity and scale of salinity is needed. There are areas of sensitive sodic soils, particularly in drainage lines that need to be identified. 4. **Urban Management (UM):** The input of water into the landscape (lawns, gardens, sporting fields) including the management of recycled water requires careful management. 5. **Riparian Management (RM):** Vegetation management in riparian areas will assist in minimising salt export to streams. 6. **Urban Construction (UC):** Construction on saline land will require salt resistant/ resilient materials. The typical slope gradient of this HGL requires careful consideration of depth of cut and location of roads on hillslopes; and all infrastructure, including underground utilities.
	Agribusiness		Moderate		

HGL	Precinct	Coverage	Overall salinity hazard	Specific land management constraints	Targeted urban management strategies (in priority order)
Greendale	Agribusiness	Covers part of the Agribusiness Precinct only 	High	■ Urban development activities may increase waterlogging and the rate of accumulation of salt on elevated upper and lower slopes where salinity is already an issue. ■ In unsewered areas, on-site wastewater disposal leakages may interact with landscape salt store to increase salinity hazard. ■ Seasonal waterlogging is an issue in upper landscape elements. ■ Urbanisation of areas currently under peri-urban land use will increase the recharge potential.	1. **Urban Planning (UP):** Planning of sub-division layout and design is required to manage salinity consequences. Development must not increase the salinity hazard of the natural and built environment. Layout and design should consider locations of roads, infrastructure and greenspace as well as building allotments, and water sensitive urban design. 2. **Urban Investigations (UI):** The landscape contains significant salinity, and geological situations that predispose salinity development. Assessment of the location, intensity and scale of salinity is needed. There are areas of sensitive sodic soils, particularly in drainage lines that need to be identified. 3. **Urban Construction (UC):** Construction on saline land will require salt resistant/ resilient materials. The typical slope gradient of this HGL requires careful consideration of depth of cut and location of roads on hillslopes; and all infrastructure, including underground utilities. 4. **Urban Management (UM):** The input of water into the landscape (lawns, gardens, sporting fields) including the management of recycled water requires careful management. 5. **Urban Vegetation (UV):** Maintain and enhance vegetation (including remnant vegetation) for the management of recharge, and as a buffer to excess water input. Waterwise gardening should be encouraged in residential areas. 6. **Riparian Management (RM):** Vegetation management in riparian areas will assist in minimising salt export to streams.

Adapted from NSW Department of Planning, Industry and Environment, Environment, Energy and Science Group, (in press) *Urban Salinity Management in the Western Sydney Aerotropolis Area (Derived from Western Sydney Hydrogeological Landscapes (2011)),* October 2020.

12 References

Aurecon 2019, South Creek Land Capability Assessment for Recycled Water Irrigation Potential Phase 1, Sydney Water Corporation

Aurecon 2020, South Creek Land Capability Assessment for Recycled Water Irrigation Potential Phase 2 – Field verification (DRAFT), Sydney Water Corporation

Australian Geomechanics Society (2007): Landslide Risk Management Concepts and Guidelines, Sub-committee on Landslide Risk Management, 2007.

Bannerman, S.M. and Hazelton, P.A. (2011): Soil Landscapes of the Penrith 1:100,000 Sheet interactive CDROM, NSW Office of Environment and Heritage, Sydney

Campbell A (2008) Managing Australia's Soils: A Policy Discussion Paper. Prepared for the National Committee on Soil and Terrain (NCST) through the Natural Resource Management Ministerial Council (NRMMC).

Charman, P.E.V. (1978): Soils of New South Wales - Their Characterisation, Classification and Conservation, Tech. Handbook No. 1, Soil Conservation Service of NSW, Sydney.

Charman, P.E.V. and Wooldridge, A.C., (2007): Soil chemical properties: Soil salinisation, in Soils: Their properties and management, 3rd edition, PEV Charman and BW Murphy (eds), Oxford University Press, Melbourne

Clark N.R. and Jones D.C., 1991, Penrith 1:100 000 Geological Sheet 9030, 1st edition. Geological Survey of New South Wales, Sydney.

Commonwealth Scientific and Industrial Research Organisation (2009): Australian Soil and Land Survey Field Handbook Third Edition, The National Committee on Soil and Terrain, CSIRO Publishing, 2009

Commonwealth Scientific and Industrial Research Organisation (2018): State of the Climate, Commonwealth of Australia, ISBN 978-1-925315-97-4, 2018.

Cooperative Research Centre for Irrigation Futures (CRC), (2007): Water Management in the South Creek Catchment - Current State, Issues and Challenges, Technical Report No.12/07, November 2007.

Department of Agriculture and Water Resources, Australian Government, 2019, Salinity and Water Quality, http://www.waterquality.gov.au/issues/salinity, Accessed 26/06/2020.

Department of Environment and Climate Change (DECC) 2008, Book 1 Dryland Salinity: The Basics, NSW Department of Planning, Industry and Environment

Department of Environment Climate Change and Water (2010): Soil and land constraint assessment for urban and regional planning, Department of Environment, Climate Change and Water NSW, Sydney.

Department of Infrastructure, Planning and Natural Resources (DIPNR) 2003, Salinity potential in Western Sydney 2002 (Map) and Guidelines to accompany Map of Salinity Potential in Western Sydney 2002 (Report)

Department of Infrastructure, Planning and Natural Resources (DIPNR) 2005, Landuse Planning and Urban Salinity – Local Government Salinity Initiative – Booklet No. 11

Department of Primary Industries and Regional Development (DPIRD), 2019, Assessing saline areas, Agriculture and Food, Government of Western Australia, <https://www.agric.wa.gov.au/dryland-salinity-site-assessment>

Department of Primary Industries and Water (2009): Dispersive Soils and their Management – Technical Reference Manual, April 2009.

Environmental Protection Authority (EPA) (2006b). Stormwater Trust Program. http://www.environment.nsw.gov.au/stormwater/usp/index.htm

Estoque, R.C. (2012): Analytic Hierarchy Process in Geospatial Analysis, Progress in Geospatial Analysis, DOI 10.1007/978-4-431-54000-7_11, 2012.

Finlayson, AA (1982): Terrain analysis, classification and an engineering geological assessment of the Sydney area, New South Wales, Technical paper No. 32, Division of Applied Geomechanics, CSIRO

Food and Agriculture Organization of the United Nations (2003): The State of Food and Agriculture, Water Policies and Agriculture, ISSN 0081-4539, No.26, August 1993.

Ford, G.W., Martin, J.J., Rengasamy, P., Boucher, S.C., Ellington, A., (1993): Soil Sodicity in Victoria, Australian Journal of Soil Research 31(6), January 1993.

GHD 2016, Western Sydney Airport Environmental Impact Statement – Appendix L2 Surface water quality, https://www.westernsydneyairport.gov.au/sites/default/files/WSA-EIS-Volume-4-Appendix-L2-Surface-water-quality.pdf

GHD.2016,.Western Sydney Airport Environmental Impact Statement – Appendix L1 Surface water hydrology and geomorphology, https://www.westernsydneyairport.gov.au/sites/default/files/WSA-EIS-Volume-4-Appendix-L1-Surface-water-hydrology-and-geomorphology.pdf

Haworth, R.J., (2003): The Shaping of Sydney by its Urban Geology. Quaternary International, 2003, 41-55.

Hazelton, P.A., Bannerman, S.M. and Tille, P.J. (2011b): Soil Landscapes of the Penrith 1:100,000 Sheet map, NSW Office of Environment and Heritage, Sydney

Institute of Public Works Engineering Australia (IPWEA) 2002, Local Government Salinity Management Handbook – A Resource Guide for the Public Works Professional

Jacobs Group Australia Pty Ltd (Jacobs) 2019, M12 Motorway Environmental Impact Statement, Roads and Maritime Services, <https://v2.communityanalytics.com.au/rms/m12/about-the-eis>

Jankowski P (1995): Integrating geographical information systems and multiple criteria decision-making methods. Int J Geogr Inform Syst 9:251–273.

Kissel D.E., 2019, Soil Fertility, Department of Agronomy, Kansas State University, Manhattan, Kansas.

Knodel, P.C., (1991): Characteristics and Problems of Dispersive Clay Soils, U.S. Department of the Interior, Bureau of Reclamation Denver Office, Research and Laboratory Services Division Materials Engineering Branch, October 1991.

McKenzie N, Isbell, R.F, Brown, K. and Jacquier, D. (2005): Major Soils Used for Agriculture in Australia. In: Soil Analysis an Interpretation Manual, Peverill, K.I., Sparrow, L.A. and Reuter, D.J. (Eds), CSIRO Publishing

McNally, G., 2009, Soil and groundwater salinity in the shales of western Sydney. In: Milne-Home WA (ed.) Groundwater in the Sydney Basin Symposium. International Association of Hydrogeologists NSW, 228–233.

Moore, C.L., Jenkins, B.R., Cowood, A.L., Nicholson, A., Muller, R., Wooldridge, A., Cook, W., Wilford, J.R., Littleboy, M., Winkler, M. and Harvey, K., (2018): Hydrogeological Landscapes framework: a biophysical approach to landscape characterisation and salinity hazard assessment. Soil Research, 56(1), pp.1-18

Moore, C.L., Jenkins, B.R., Cowood, A.L., Nicholson, A., Muller, R., Wooldridge, A., Cook, W., Wilford, J.R., Littleboy, M., Winkler, M. and Harvey, K., 2018. Hydrogeological Landscapes framework: a biophysical approach to landscape characterisation and salinity hazard assessment. Soil Research, 56(1), pp.1-18

Northcote, K.H. and Skene J.K.M., (1972): Australian soils with saline and sodic properties. CSIRO Soil Publication 27.

NRM North, 2009, Salinity Glove Box Guide, Tasmania, Northern Tasmanian Natural Resource Management Association Inc

NSW Department of Planning, Industry and Environment (NSW DPIE) 2019, Type of salinity and their prevention, https://www.environment.nsw.gov.au/topics/land-and-soil/soil-degradation/salinity/type-of-salinity-and-their-prevention, Accessed 26/06/2020

NSW Department of Planning, Industry and Environment, Environment, Energy and Science Group, (in press) Urban Salinity Management in the Western Sydney Aerotropolis Area (Derived from Western Sydney Hydrogeological Landscapes (2011)), October 2020

NSW Department of Planning, Industry and Environment, Environment, Energy and Science Group, (in press) Soil and Land Resource Mapping for the Western Sydney Aerotropolis Area (Derived from Soil and Land Resources of the Hawkesbury Nepean Catchment (2008)), October 2020

NSW DPI, 2005, Salinity Glove Box Guide for NSW Murray & Murrumbidgee compiled, NSW Department of Primary Industries

NSW DPI, 2009(a), Irrigation Salinity – Causes and Impacts, NSW Department of Industry & Investment, Sydney

NSW DPI, 2009(b), Urban Salinity – Causes and Impacts, NSW Department of Industry & Investment, Sydney

NSW DPI, 2009(c), Dryland Salinity – Causes and Impacts, NSW Department of Industry & Investment, Sydney

Office of Environment and Heritage (2012): The Land and Soil Capability Assessment Scheme, Second Approximation – A General Rural Land Evaluation System for New South Wales. NSW Office of Environment and Heritage, Sydney, October 2012.

Office of Environment and Heritage (2017): Estimated Inherent Soil Fertility of NSW, NSW Office of Environment and Heritage, Sydney.

PPK 1997, Geology, Soils and Water Technical Paper – Proposal for a Second Airport at Badgerys Creek or Holsworthy Military Area, PPK, Concord West

Proceedings of the International Association of Hydrogeologists, New South Wales Branch (2009): Groundwater in the Sydney Basin Symposium, Sydney, NSW, Australia, 4 – 5 August 2009.

Rae, Debbie J., 2007, Water Management in South Creek Catchment – Current state, issues and challenges. Technical Report No.12/07. Cooperative Research Centre for Irrigation Futures, Western Sydney

Rahdari, V., Soffianian, A. R., Pourmanafi, S., Ghaiumi, M. H., Mosadeghi, R., Amiri, F., (2018): multi-objective approach for land conservation capability evaluation using multi-criterion evaluation models, Applied Ecology and Environmental Research 16(2):1353-1367.

Rengasamy P Olsson KA (1993): Irrigation and sodicity. Australian Journal of Soil Research 31(6) 821 – 837.

Rhoades, J.D., Kandiah, A., and Mashali, A.M., (1992): The use of saline waters for crop production. Rome, Italy, Food and Agriculture Organization of the United Nations Irrigation and Drainage Paper 48.

Rowe, R.K., Howe, D.F., Alley, N. F. (1981): Guidelines for Land Capability Assessment in Victoria, Soil Conservation Authority, January 1981.

Sinclair, I., Docking, A., Jarecki, S., Parker, F., Saville, L., 2004, From the Outside Looking In. The future of Sydney's Rural Land, University of Western Sydney, Penrith.

Slinger, D. & Tenison, K., 2007, Salinity Glove Box Guide: NSW Murray & Murrumbidgee Catchments, NSW Department of Primary Industries.

SMEC 2014, Environmental Field Survey of Commonwealth Land at Badgerys Creek, SMEC, Sydney

SMEC, 2015, North West Growth Centre Salinity Study, NSW Department of Planning and Environment, Sydney.

Stanton, J.S., Anning, D.W., Brown, C.J., Moore, R.B., McGuire, V.L., Qi, S.L., Harris, A.C., Dennehy, K.F., McMahon, P.B., Degnan, J.R., and Böhlke, J.K., (2017): Brackish groundwater in the United States. U.S. Geological Survey Professional Paper 1833, 185 p.

United Nations Environment Programme (1992): World Atlas of Desertification, edited by N. Middleton and D. S. G. Thomas. Edward Arnold, ISBN 0 340 555 12 Vol. 2, London, 1992.

Victorian Resources Online (VRO) 2020, Porosity, Agriculture Victoria, http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/pages/soilhealth_soil_structure_porosity, Accessed 26/06/2020

Wakode, H.B., Baier, K., Jha, R., Azzam, R., (2018): Impact of Urbanization on Groundwater Recharge and Urban Water Balance for the City of Hyderabad India, International Soil and Water Conservation Research (6) 51-62.

Wooldridge, A, Nicholson, A, Muller R, Jenkins, B R Wilford, J and Winkler, M (2015) Guidelines for managing salinity in rural areas, NSW Office of Environment and Heritage, Sydney, NSW.

WSPP (2020) Western Sydney Aerotropolis Plan (Draft – for public comment), Western Sydney Planning Partnership, September 2020

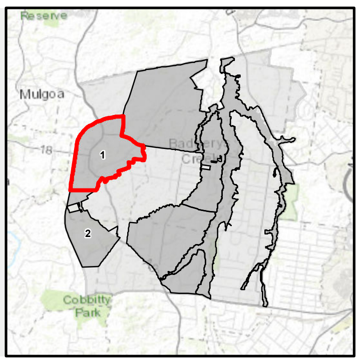
Xiang XN, Whitley D (1994): Weighting land suitability factors by the PLUS method. Environ Plann Des 21:273–304

Appendix A

Historical aerial imagery with Areas of Potential Environmental Concern (APECs)

aurecon

Study area
WSA Growth Area Boundary
Precinct boundary
Past structures and disturbed land (APEC)
Filled dams (APEC)



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:16,000
0 350 700 m

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

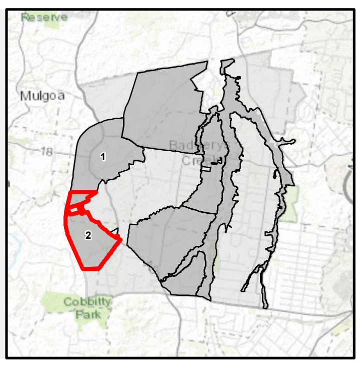
Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1947: Agribusiness Precinct

aurecon

P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Historical_Aerial_1947_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area Boundary
Precinct boundary
Past structures and disturbed land (APEC)
Filled dams (APEC)



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:14,000
0 300 600 m

Date: 15/10/2020
Projection: GDA 1994 MGA Zone 56

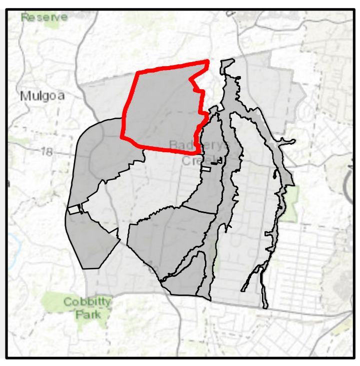
Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1947: Agribusiness Precinct

aurecon

P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSACA_Historical_Aerial_1947_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area Boundary
Precinct boundary
Past structures and disturbed land (APEC)
Filled dams (APEC)



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

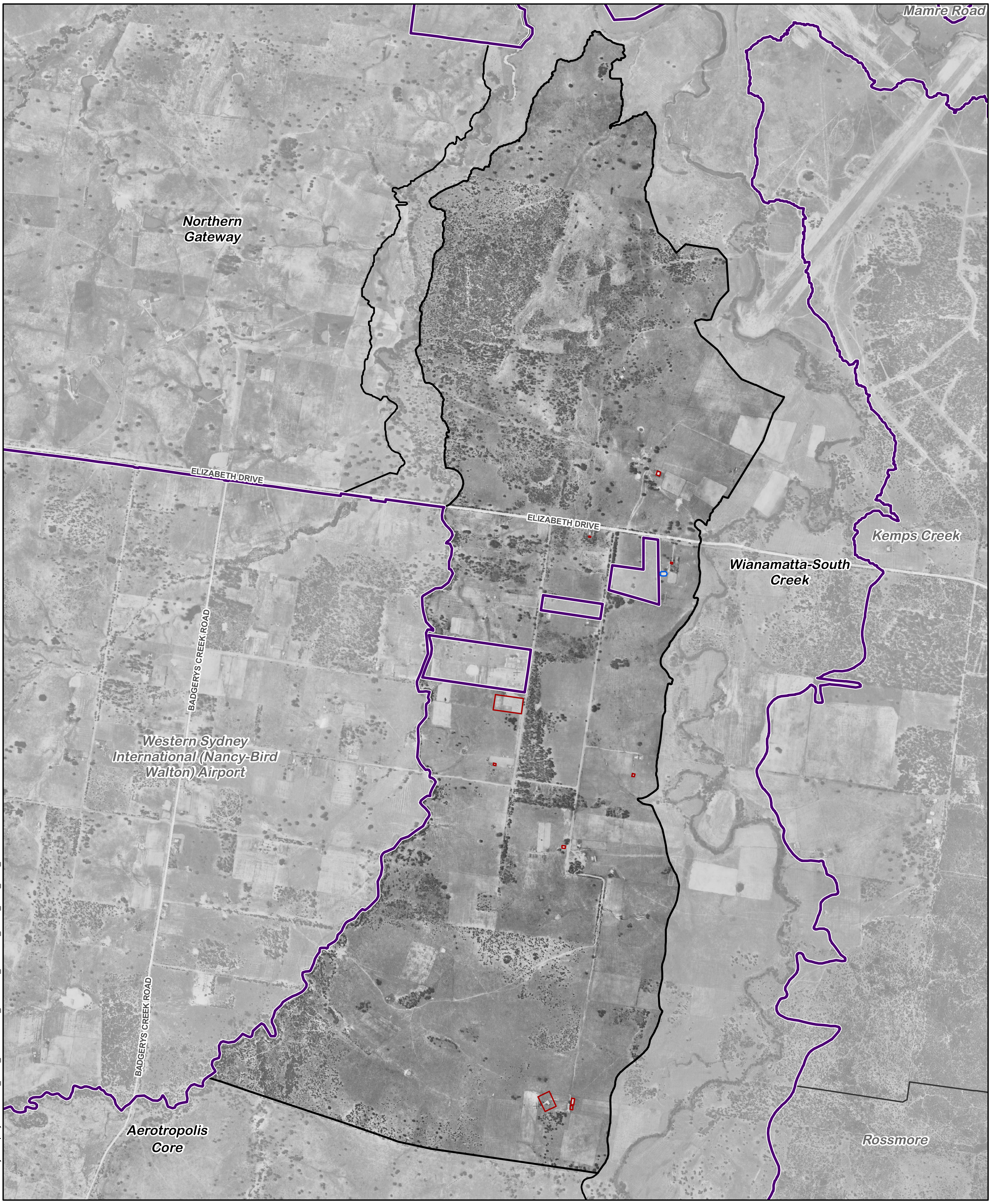
A3 scale: 1:18,000
0 390 780 m

Date: 15/10/2020
Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1947: Northern Gateway Precinct

aurecon



Study area
WSA Growth Area Boundary
Precinct boundary
Past structures and disturbed land (APEC)
Filled dams (APEC)

Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:18,000

0 390 780 m

Date: 15/10/2020

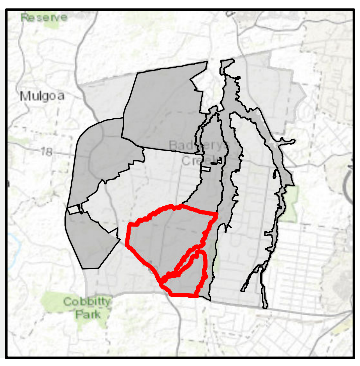
Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1947: Badgerys Creek Precinct

P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Historical_Aerial_1947_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area Boundary
Precinct boundary
Past structures and disturbed land (APEC)
Filled dams (APEC)



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:19,000

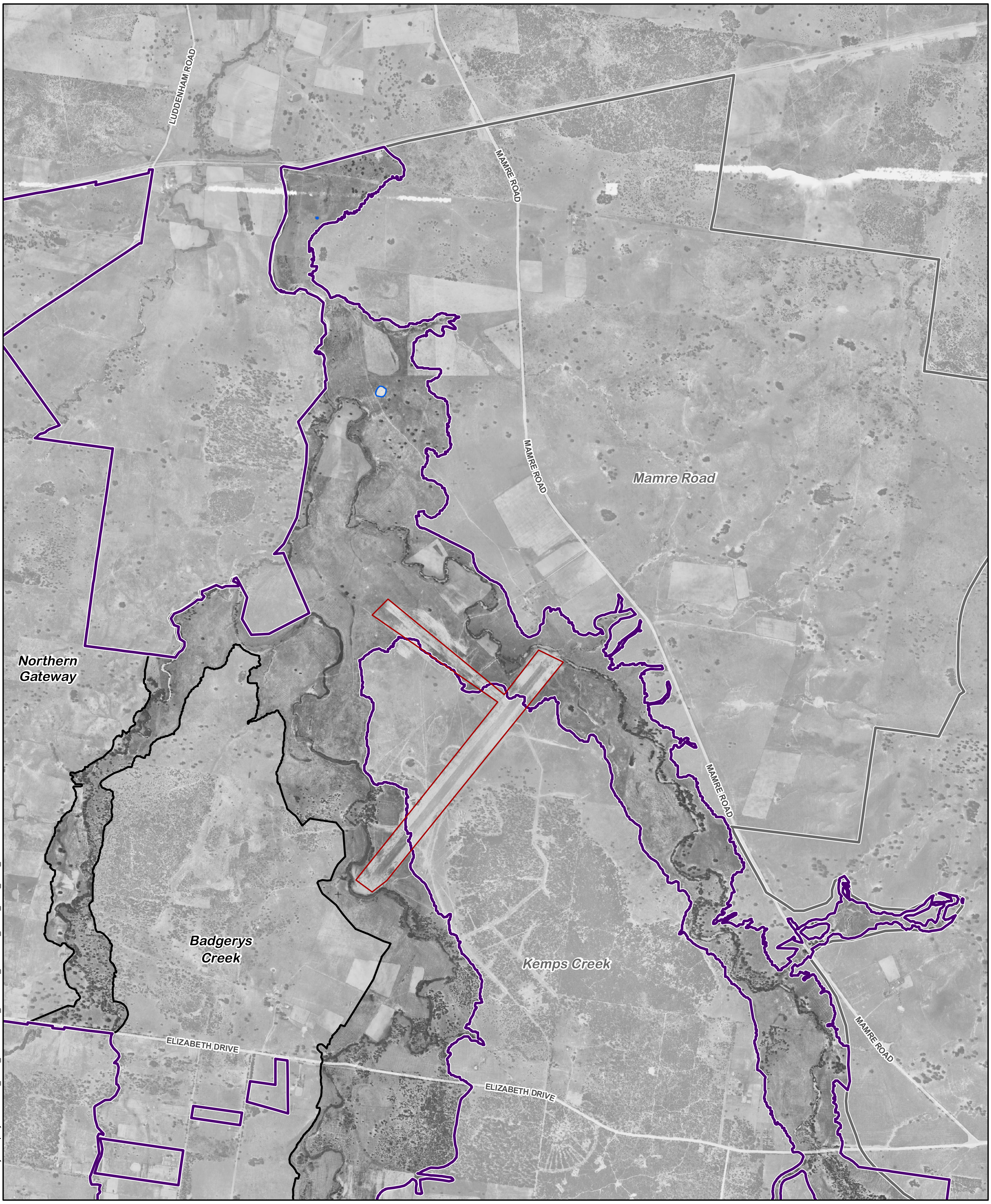
0 410 820 m

Date: 15/10/2020

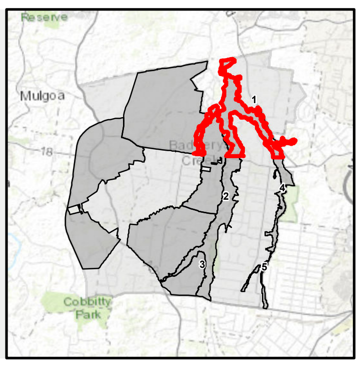
Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1947: Aerotropolis Core Precinct



Study area
Past structures and disturbed land (APEC)
WSA Growth Area Boundary
Filled dams (APEC)
Precinct boundary



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:22,000

0 480 960 m

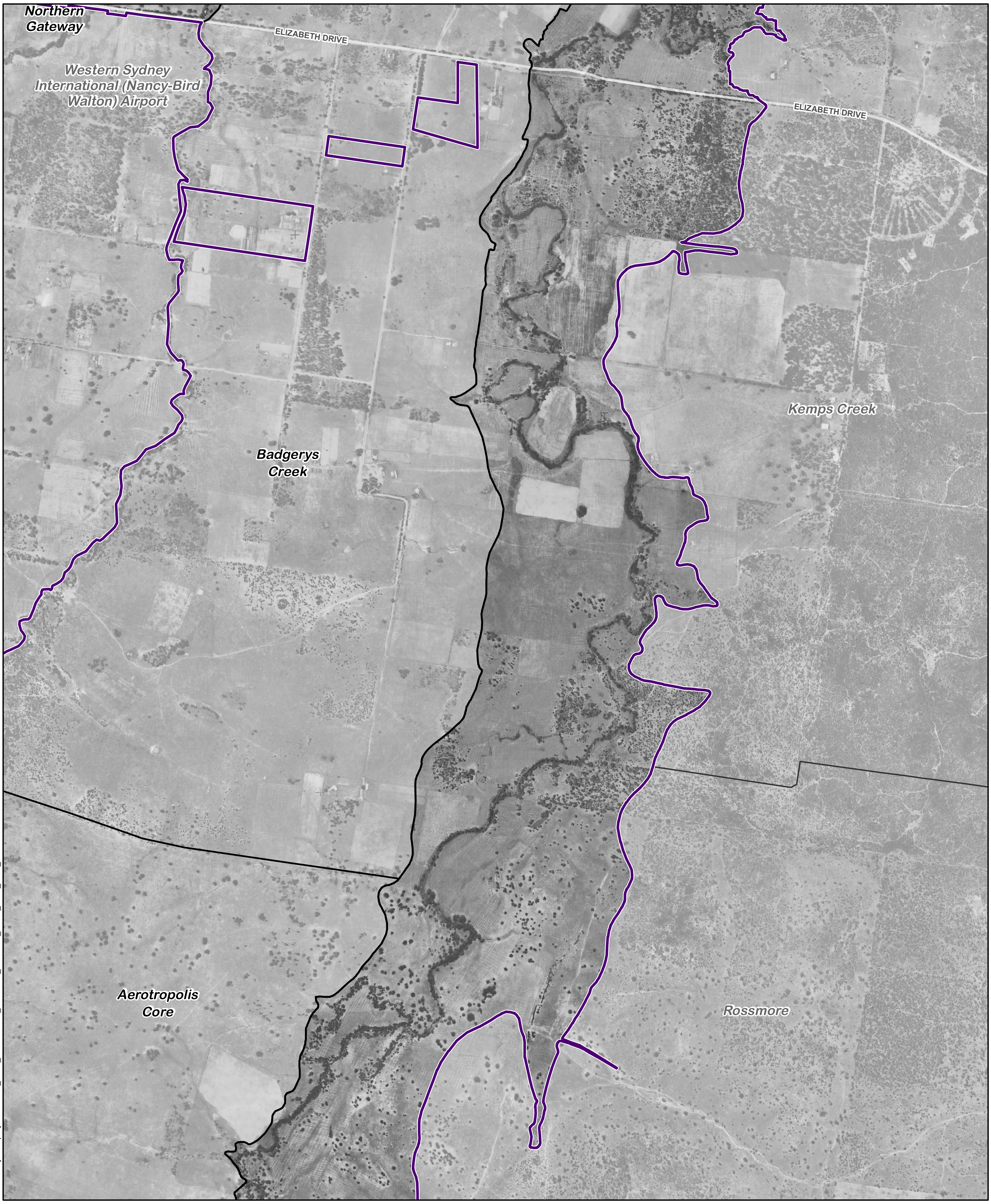
Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

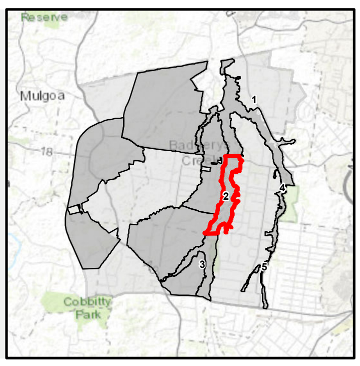
Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1947: Wianamatta-South Creek Precinct

aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Historical_Aerial_1947_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area Boundary
Precinct boundary
Past structures and disturbed land (APEC)
Filled dams (APEC)



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:14,000

0 300 600 m

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1947: Wianamatta-South Creek Precinct

Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:12,000

0 260 520 m

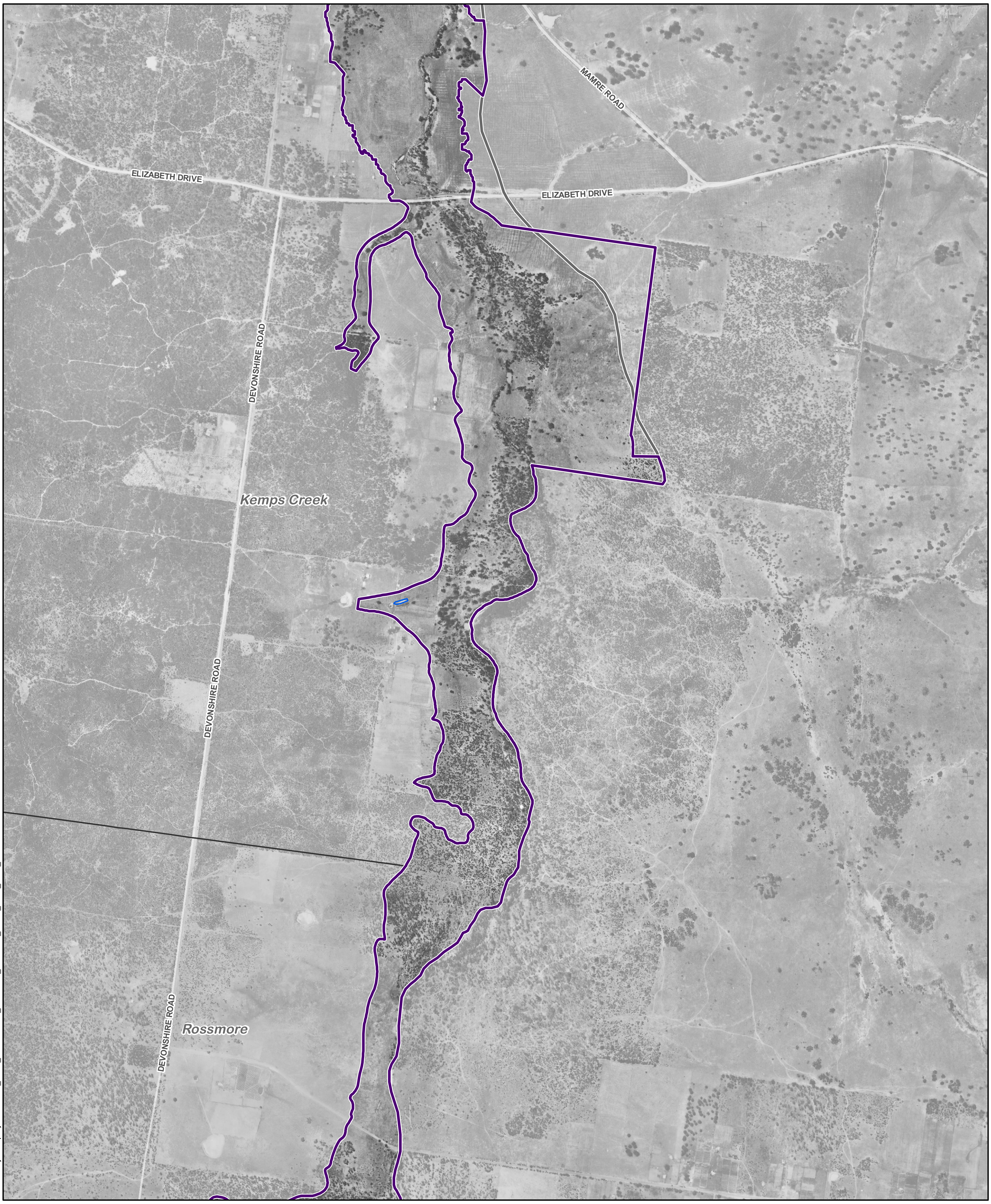
Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

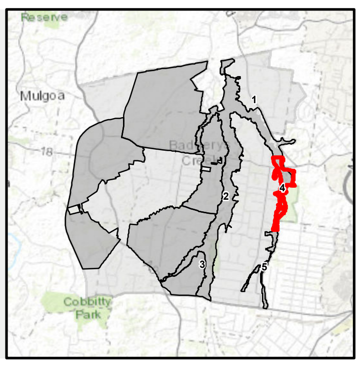
Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1947: Wianamatta-South Creek Precinct

aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Historical_Aerial_1947_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area Boundary
Precinct boundary
Past structures and disturbed land (APEC)
Filled dams (APEC)



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:13,000

0 280 560 m

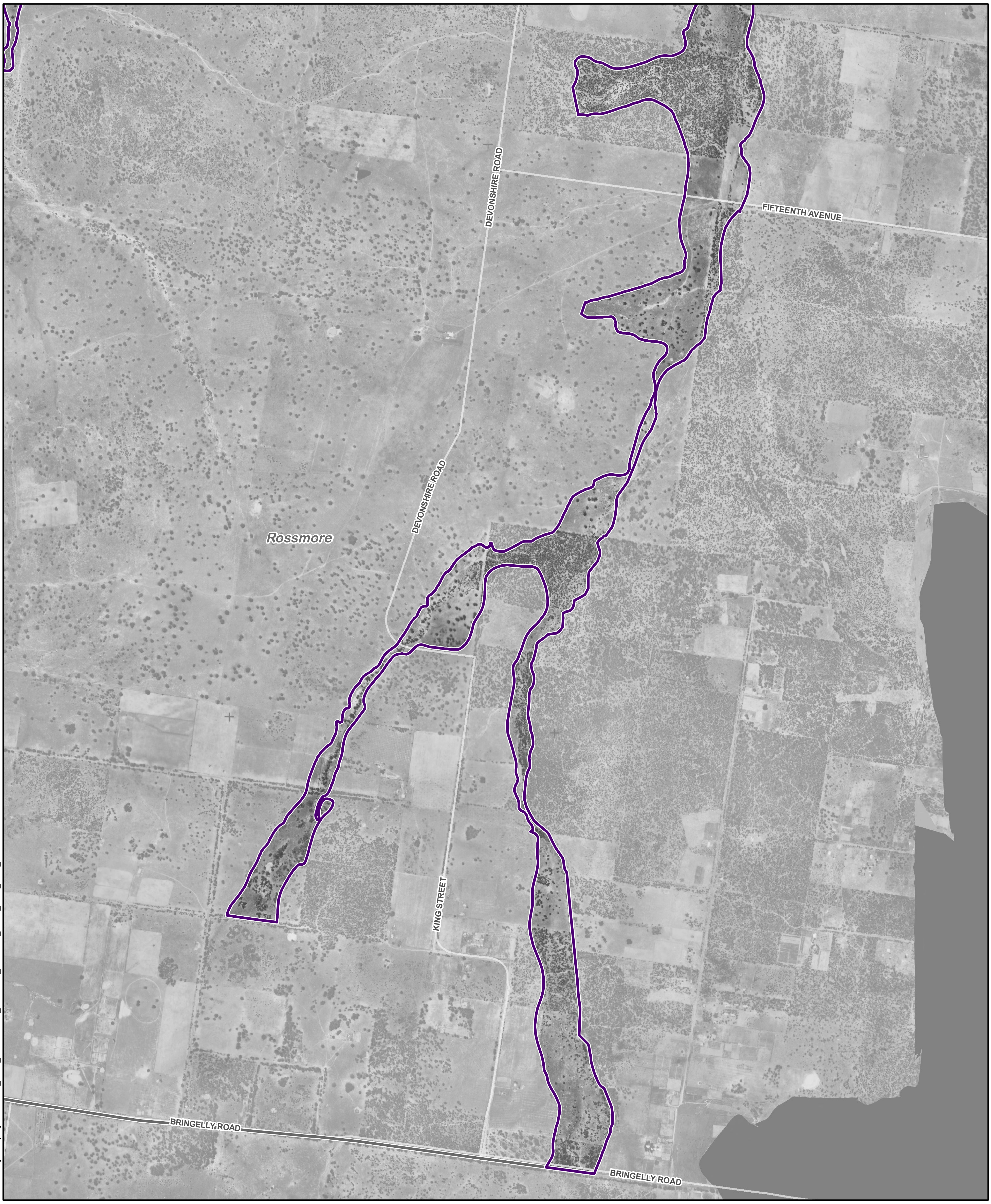
Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

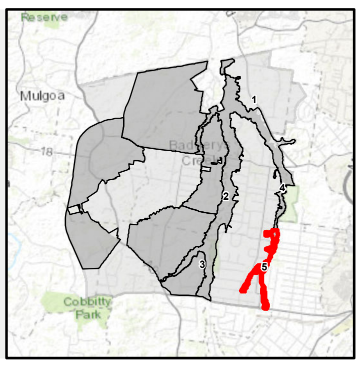
Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1947: Wianamatta-South Creek Precinct

aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Historical_Aerial_1947_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area Boundary
Precinct boundary
Past structures and disturbed land (APEC)
Filled dams (APEC)



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:14,000

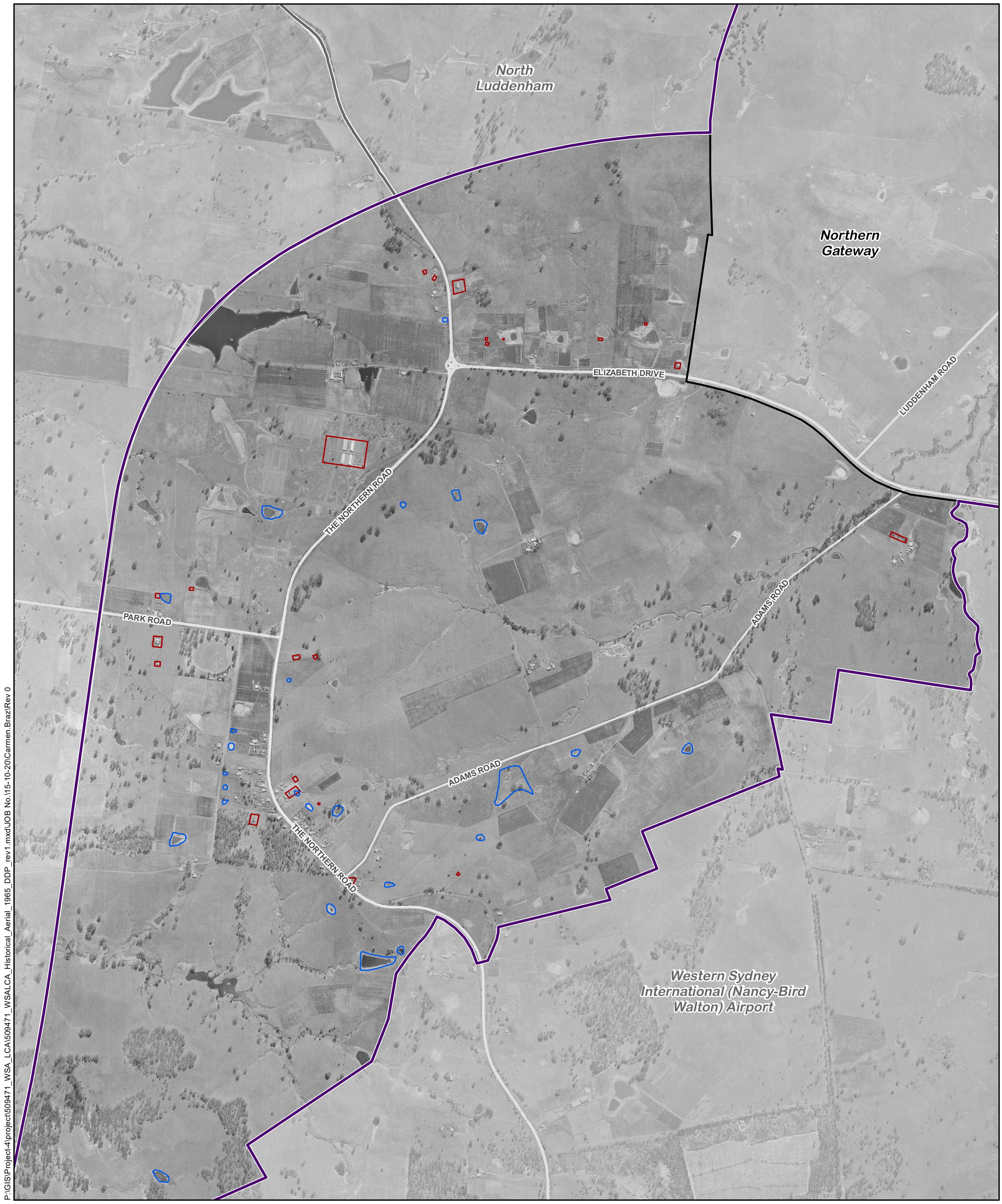
0 300 600 m

Date: 15/10/2020

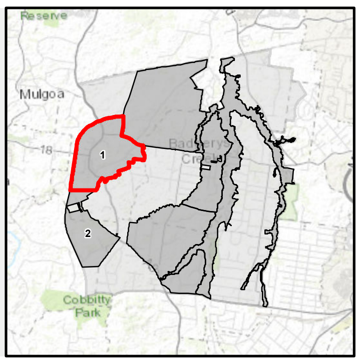
Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1947: Wianamatta-South Creek Precinct



Study area
WSA Growth Area Boundary
Precinct boundary
Past structures and disturbed land (APEC)
Filled dams (APEC)



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:16,000
0 350 700 m

Date: 15/10/2020
Projection: GDA 1994 MGA Zone 56

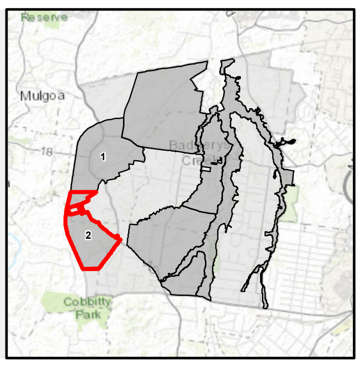
Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1965: Agribusiness Precinct

aurecon

P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Historical_Aerial_1965_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area Boundary
Precinct boundary
Past structures and disturbed land (APEC)
Filled dams (APEC)



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:14,000

0 300 600 m

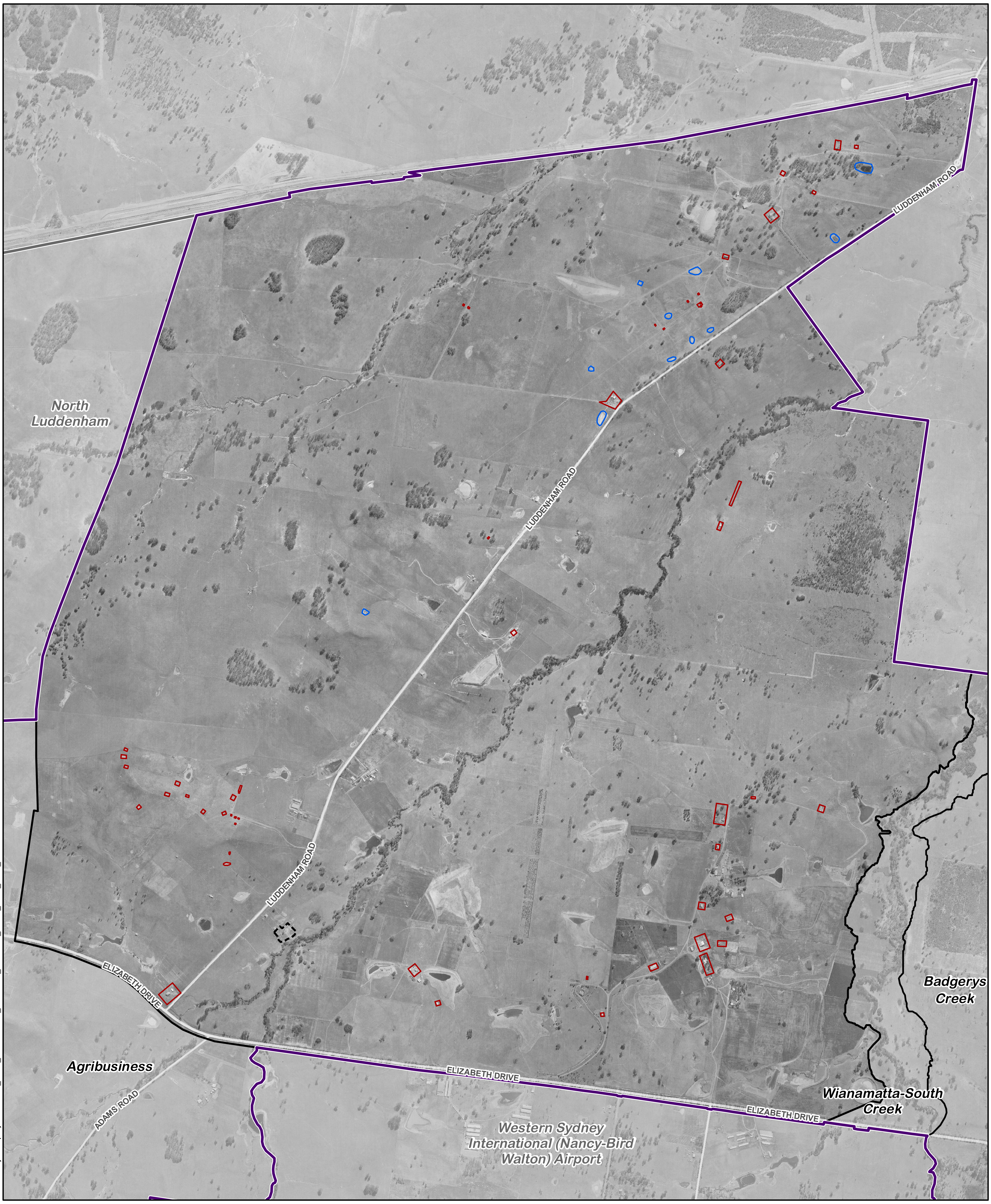
Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

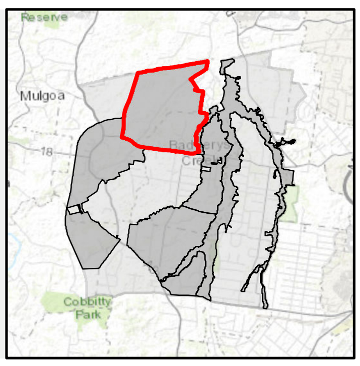
Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1965: Agribusiness Precinct

aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Historical_Aerial_1965_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area Boundary
Precinct boundary
Past structures and disturbed land (APEC)
Filled dams (APEC)
Current storage yards and disturbed land (APEC)



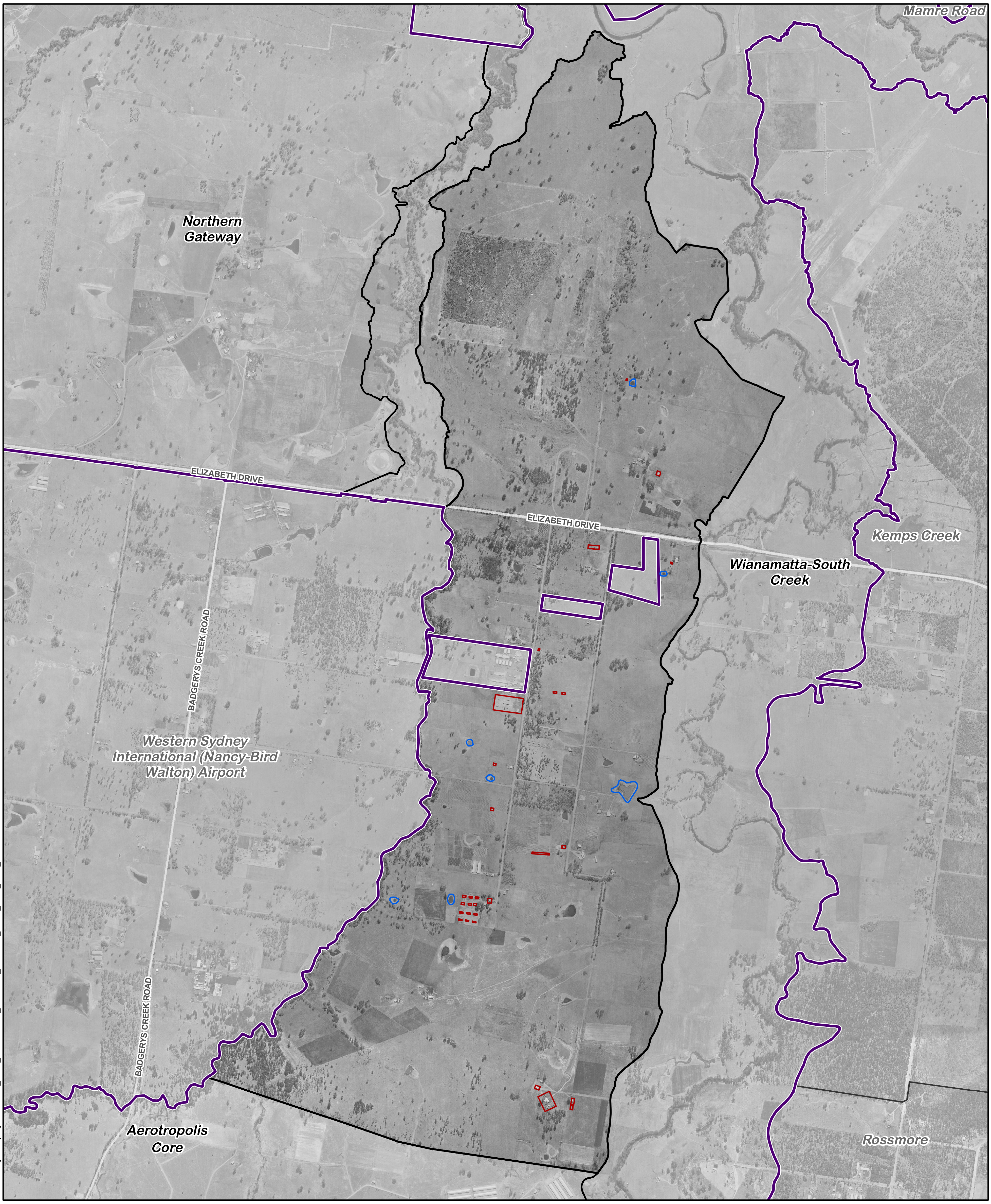
Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:18,000
0 390 780 m

Date: 15/10/2020
Projection: GDA 1994 MGA Zone 56

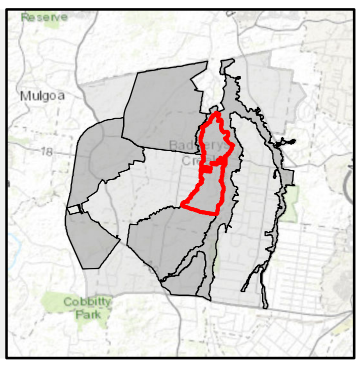
Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1965: Northern Gateway Precinct



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Historical_Aerial_1965_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area Boundary
Precinct boundary
Past structures and disturbed land (APEC)
Filled dams (APEC)



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

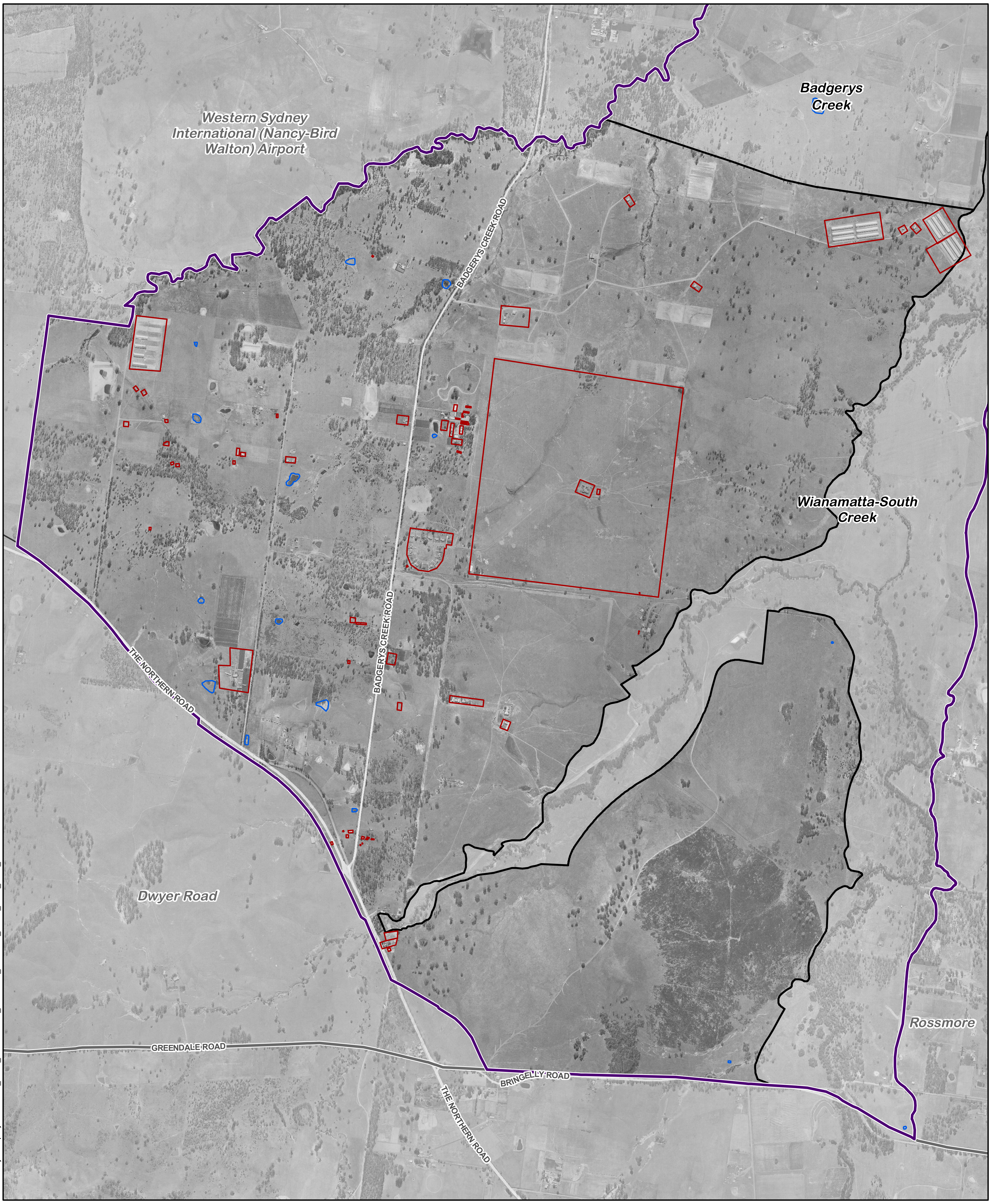
A3 scale: 1:18,000
0 390 780 m

Date: 15/10/2020
Projection: GDA 1994 MGA Zone 56

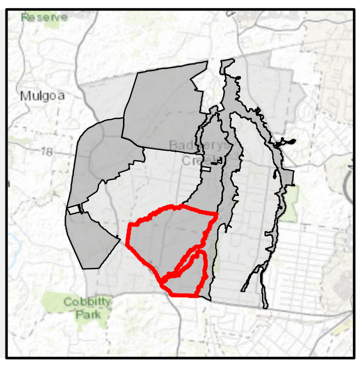
Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1965: Badgerys Creek Precinct

aurecon



Study area
WSA Growth Area Boundary
Precinct boundary
Past structures and disturbed land (APEC)
Filled dams (APEC)



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:19,000

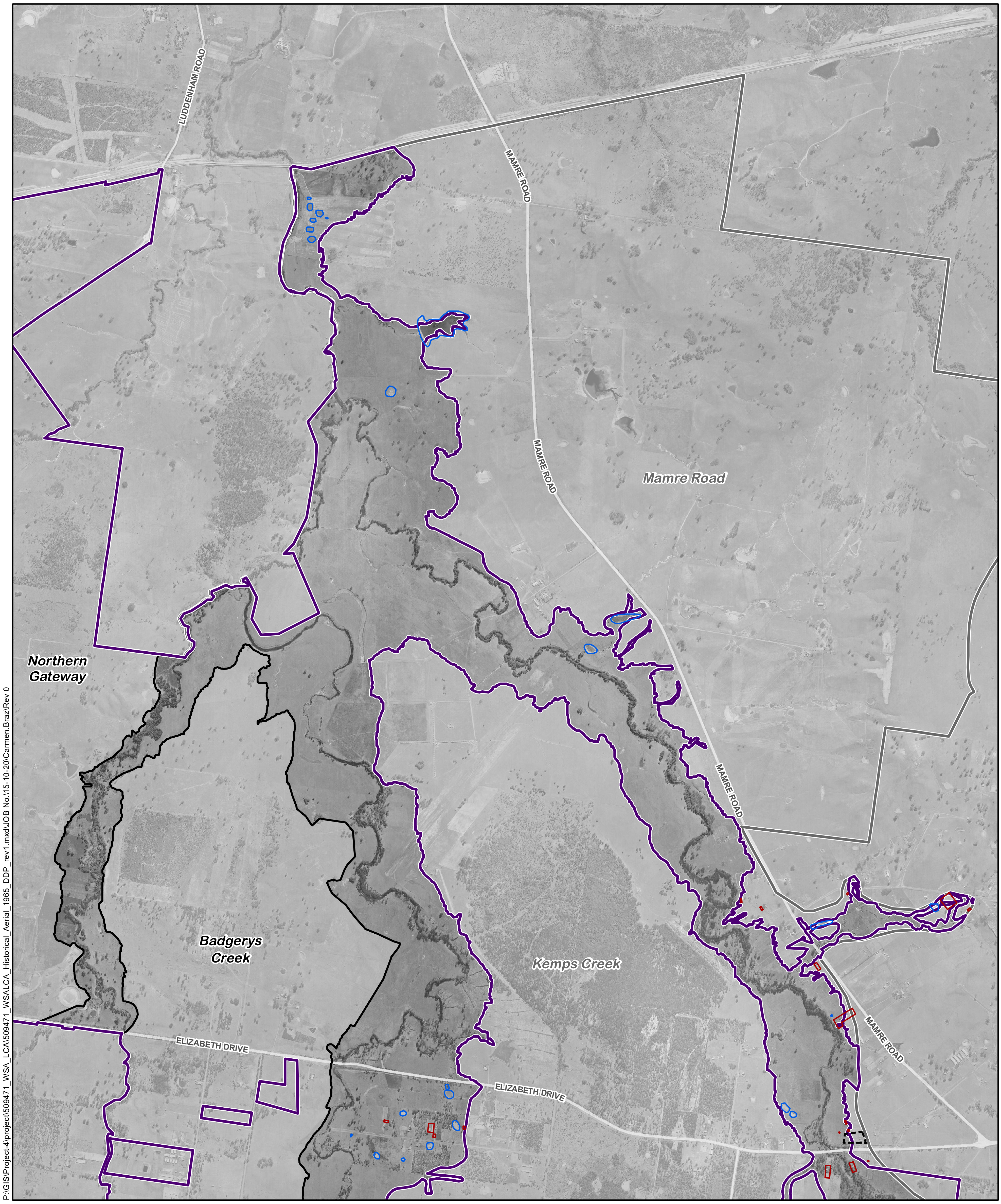
0 410 820 m

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1965: Aerotropolis Core Precinct



Study area
WSA Growth Area Boundary
Precinct boundary
Past structures and disturbed land (APEC)
Filled dams (APEC)
Current storage yards and disturbed land (APEC)

Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:22,000

0 480 960 m

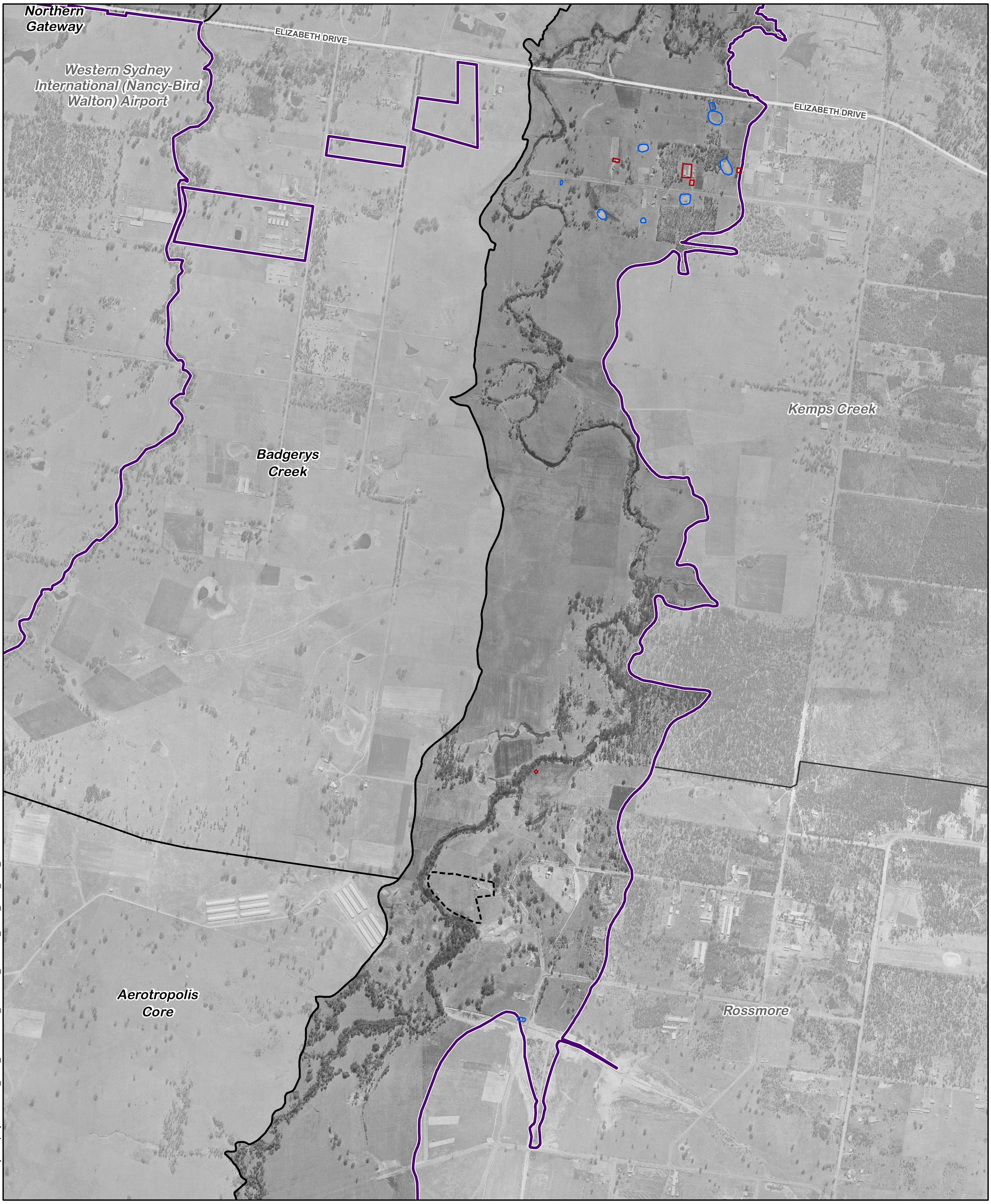
Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

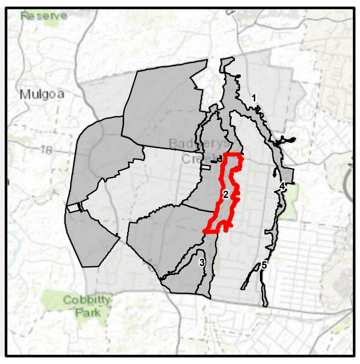
Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1965: Wianamatta-South Creek Precinct

aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Historical_Aerial_1965_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area Boundary
Precinct boundary
Past structures and disturbed land (APEC)
Filled dams (APEC)
Current storage yards and disturbed land (APEC)



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:14,000
0 300 600 m

Date: 15/10/2020
Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1965: Wianamatta-South Creek Precinct

Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:12,000

0 260 520 m

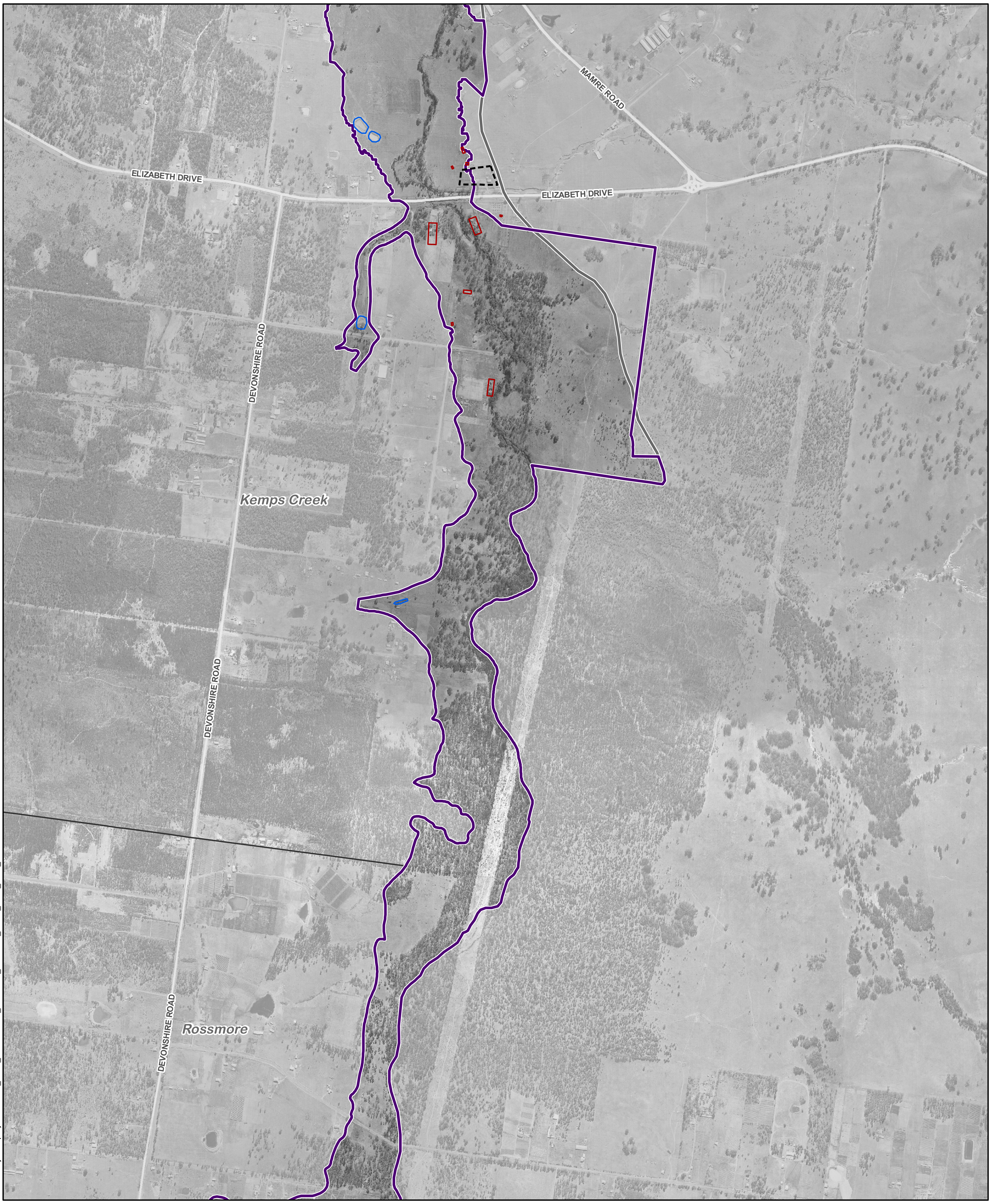
Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

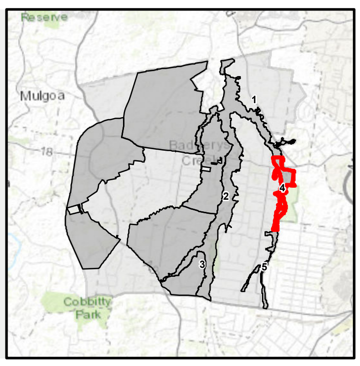
Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1965: Wianamatta-South Creek Precinct

aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSA_LCA_Historical_Aerial_1965_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

- Study area
- WSA Growth Area Boundary
- Precinct boundary
- Past structures and disturbed land (APEC)
- Filled dams (APEC)
- Current storage yards and disturbed land (APEC)



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:13,000

0 280 560 m

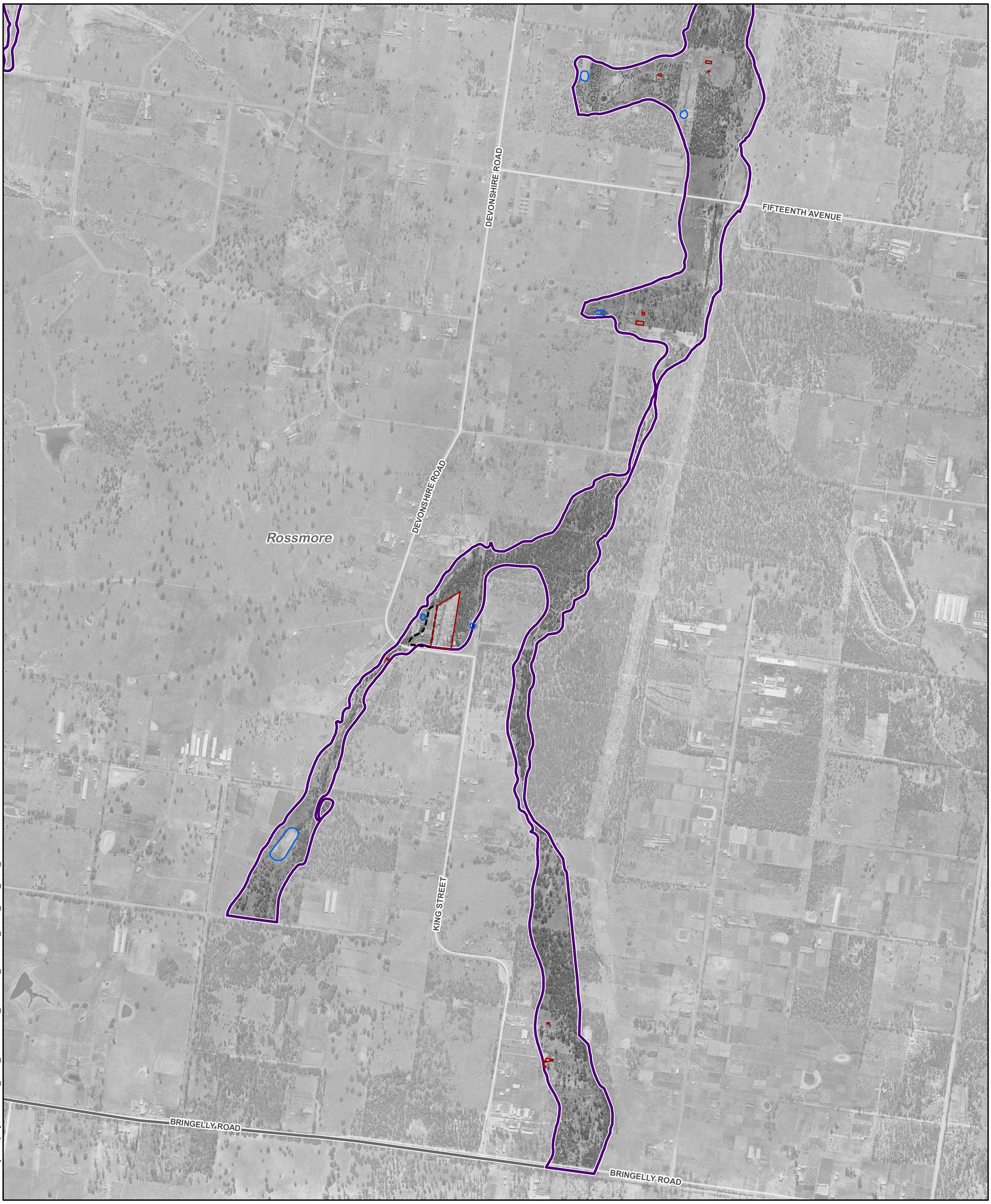
Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

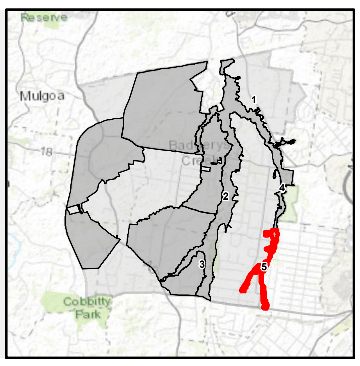
Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1965: Wianamatta-South Creek Precinct

aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSA_LCA_Historical_Aerial_1965_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area Boundary
Precinct boundary
Past structures and disturbed land (APEC)
Filled dams (APEC)
Current storage yards and disturbed land (APEC)



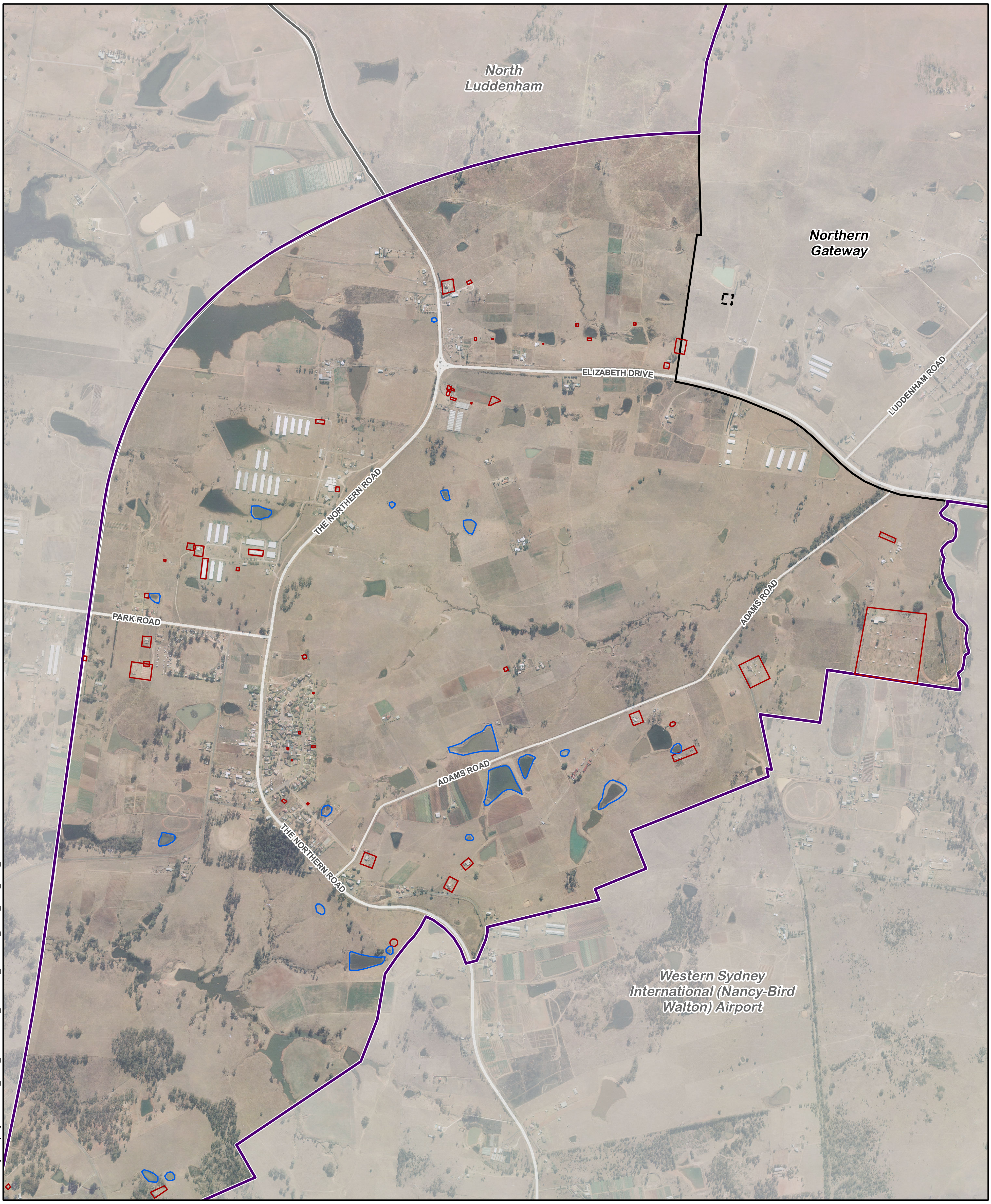
Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:14,000
0 300 600 m

Date: 15/10/2020
Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1965: Wianamatta-South Creek Precinct



Study area
WSA Growth Area Boundary
Precinct boundary
Past structures and disturbed land (APEC)
Filled dams (APEC)
Current storage yards and disturbed land (APEC)

Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

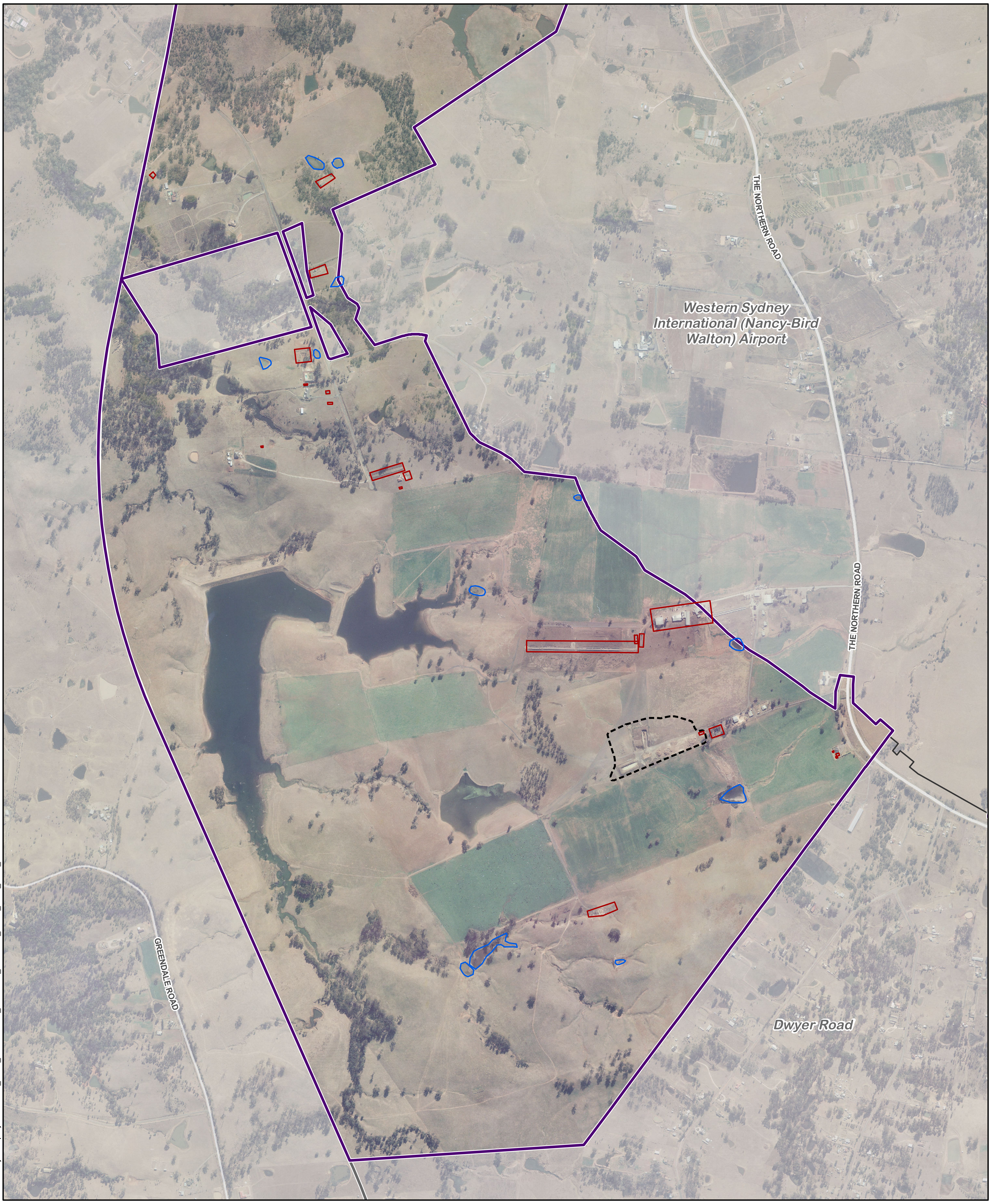
A3 scale: 1:16,000
0 350 700 m

Date: 15/10/2020
Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

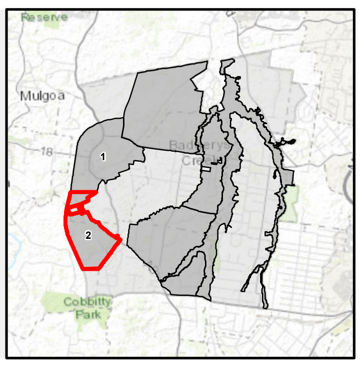
Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1986: Agribusiness Precinct

aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSA_LCA_Historical_Aerial_1986_DDP_rev1.mxd\JOB No.15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area Boundary
Precinct boundary
Past structures and disturbed land (APEC)
Filled dams (APEC)
Current storage yards and disturbed land (APEC)



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:14,000

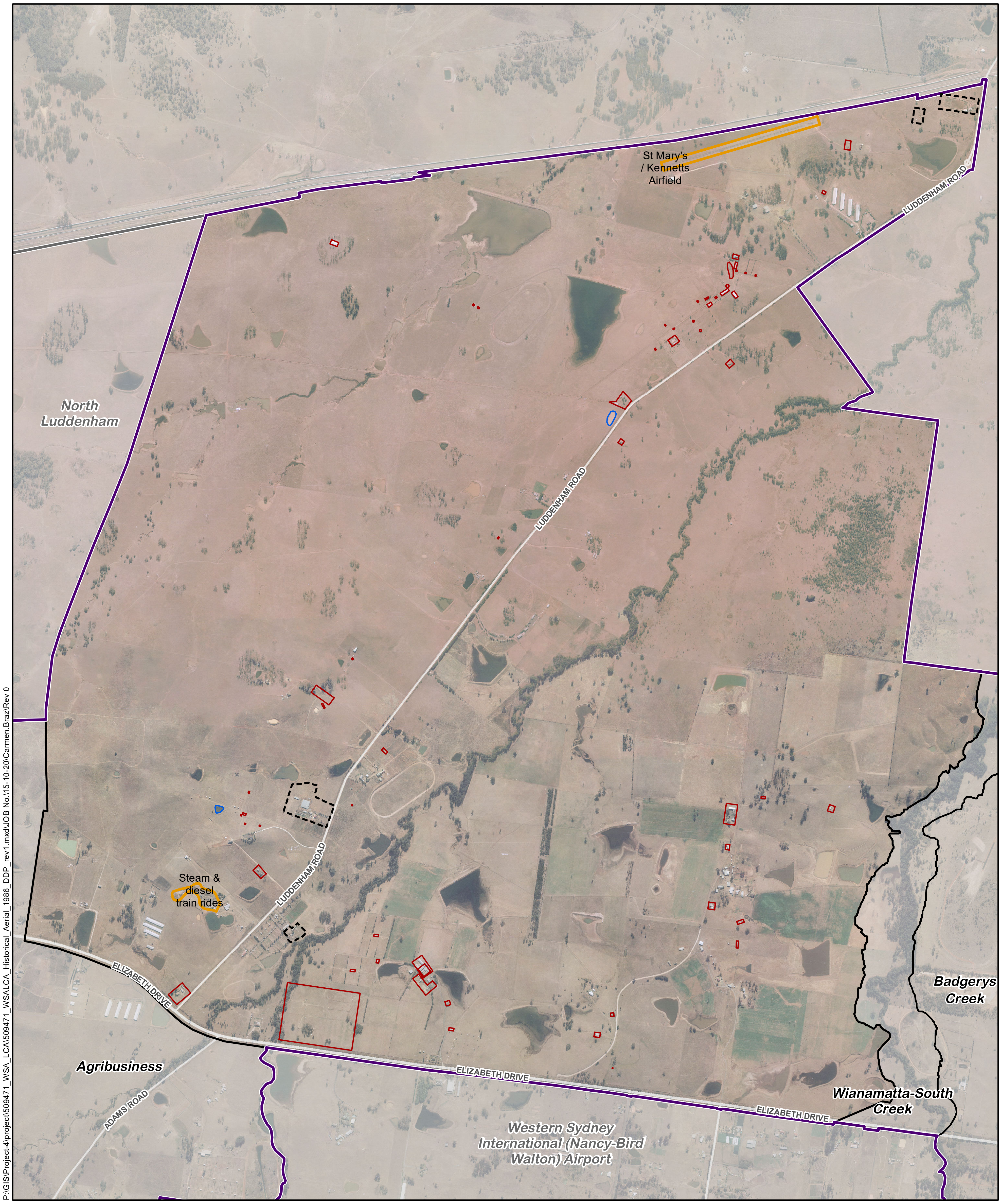
0 300 600 m

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1986: Agribusiness Precinct



Study area
WSA Growth Area Boundary
Precinct boundary
Past structures and disturbed land (APEC)
Filled dams (APEC)
Current storage yards and disturbed land (APEC)
Other large sites (APEC)

Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:18,000

0 390 780 m

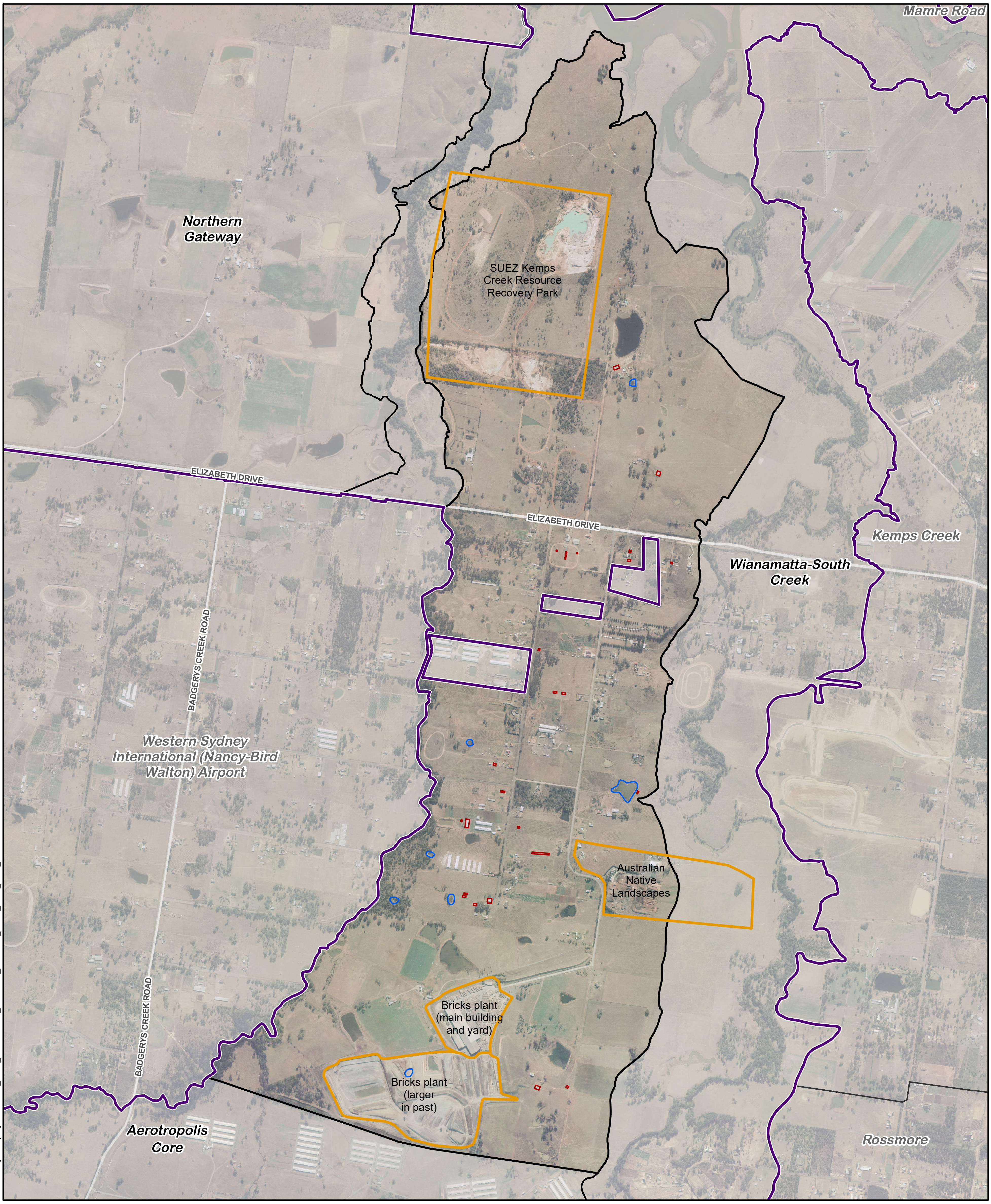
Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

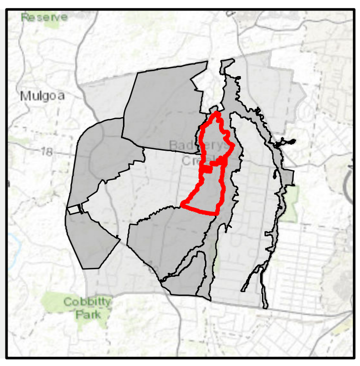
Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1986: Northern Gateway Precinct

aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSA_LCA_Historical_Aerial_1986_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

- Study area
- WSA Growth Area Boundary
- Precinct boundary
- Past structures and disturbed land (APEC)
- Filled dams (APEC)
- Other large sites (APEC)



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:18,000

0 390 780 m

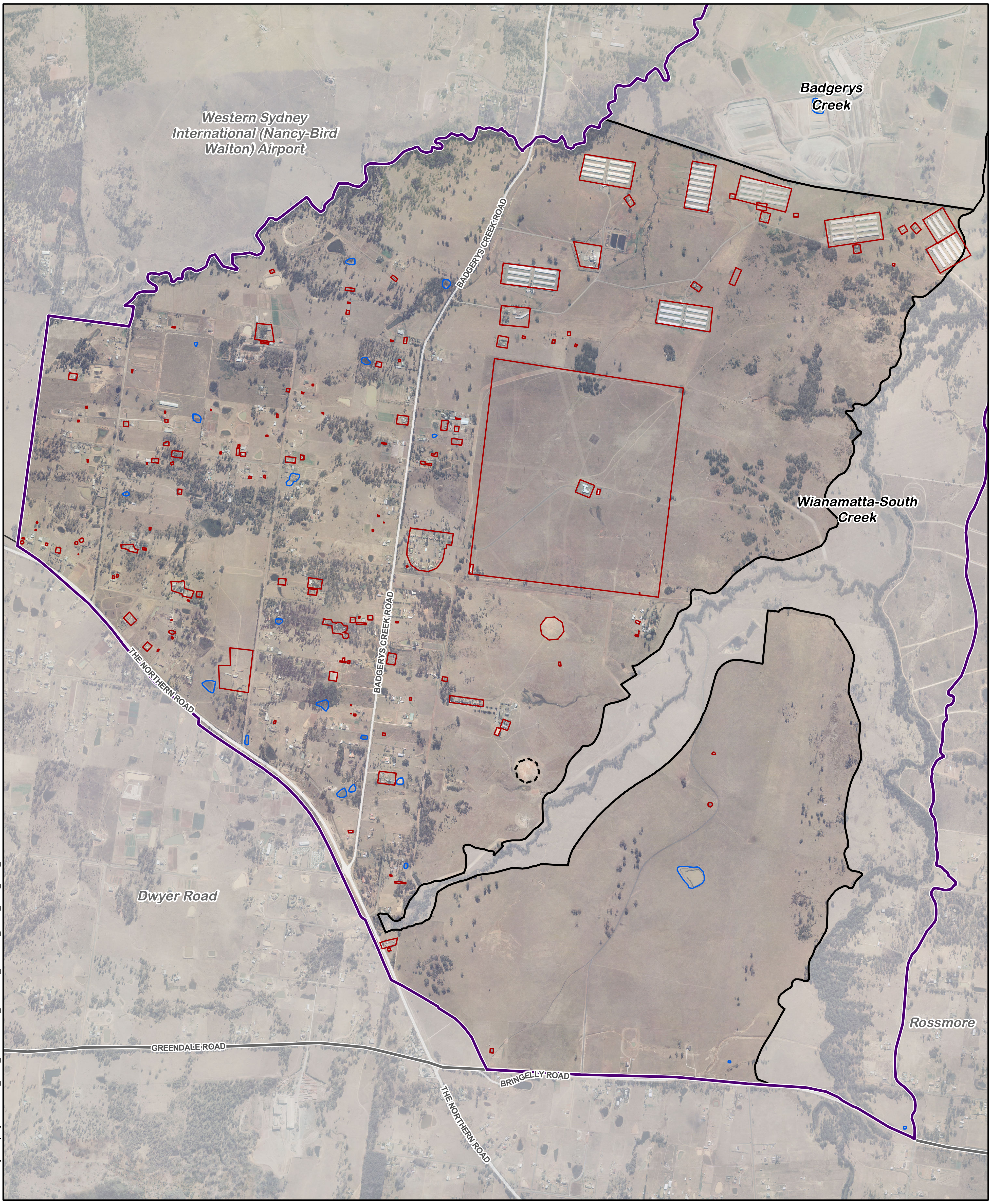
Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

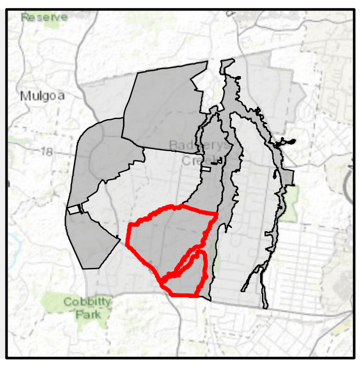
Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1986: Badgerys Creek Precinct

aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Historical_Aerial_1986_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area Boundary
Precinct boundary
Past structures and disturbed land (APEC)
Filled dams (APEC)
Current storage yards and disturbed land (APEC)



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:19,000

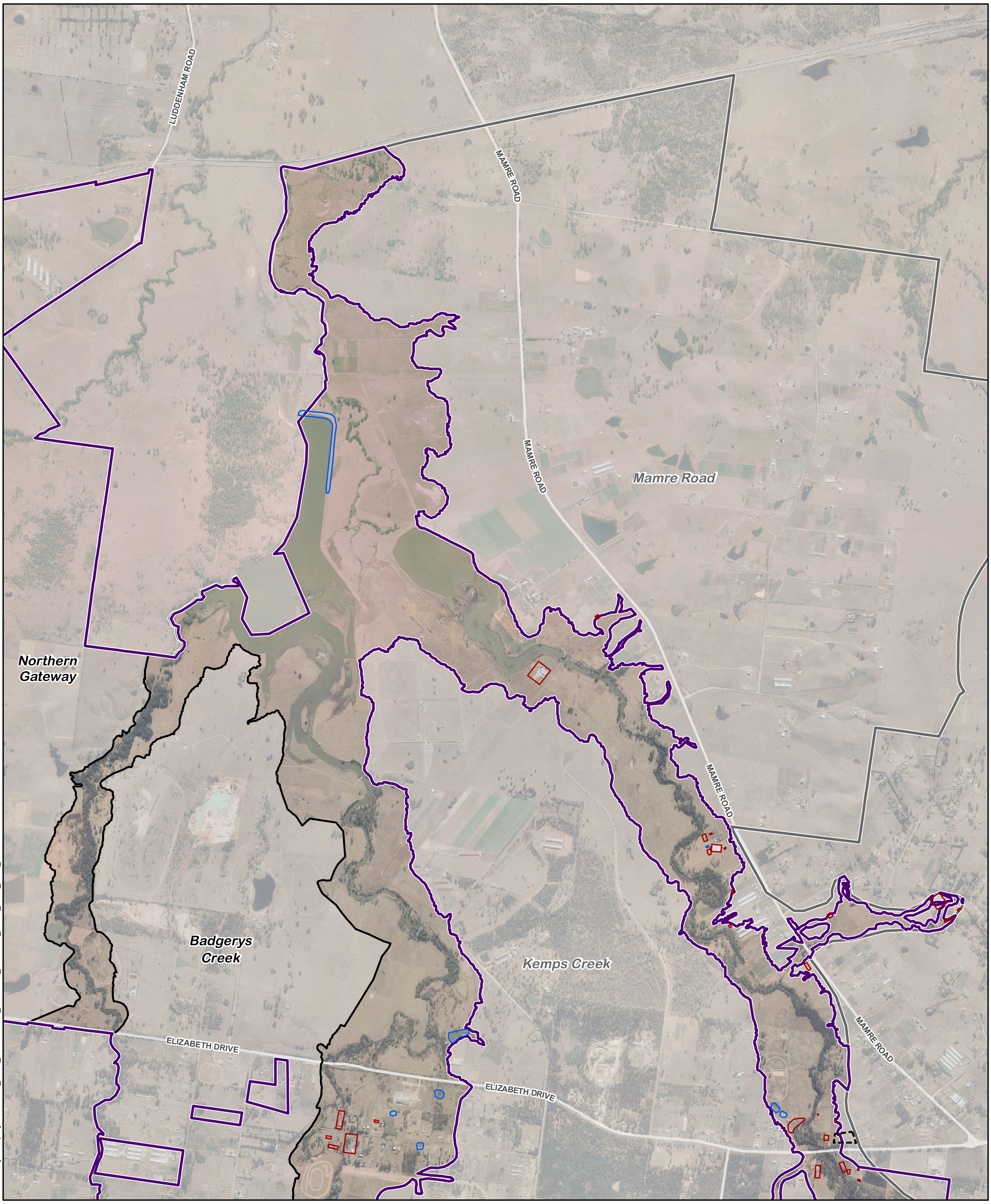
0 410 820 m

Date: 15/10/2020

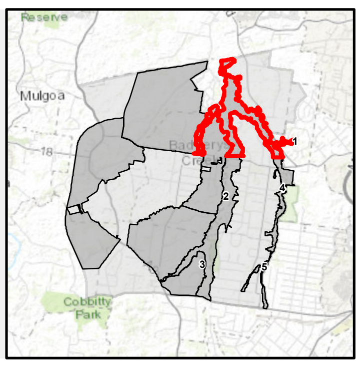
Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1986: Aerotropolis Core Precinct



Study area
WSA Growth Area Boundary
Precinct boundary
Past structures and disturbed land (APEC)
Filled dams (APEC)
Current storage yards and disturbed land (APEC)



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:22,000

0 480 960 m

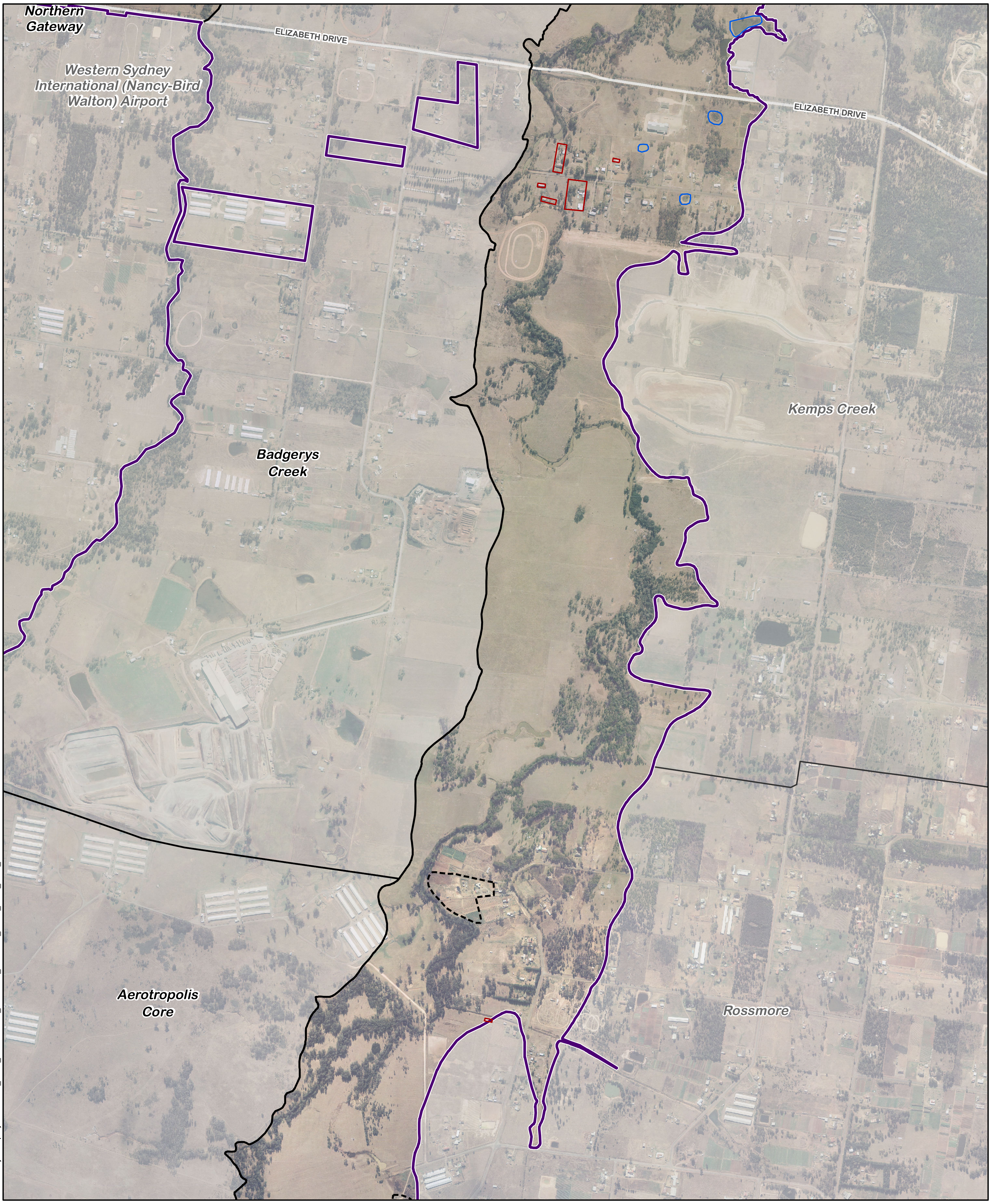
Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

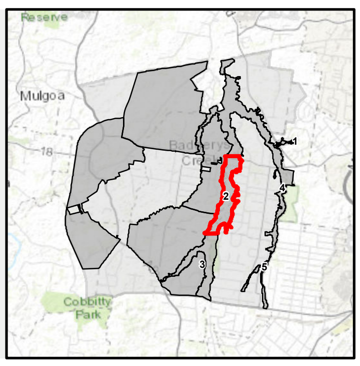
Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1986: Wianamatta-South Creek Precinct

aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSA_LCA_Historical_Aerial_1986_DDP_rev1.mxd\JOB No.15-10-20\Carmen.Braz\Rev 0

Study area	Past structures and disturbed land (APEC)
WSA Growth Area Boundary	Filled dams (APEC)
Precinct boundary	Current storage yards and disturbed land (APEC)



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:14,000

0 300 600 m

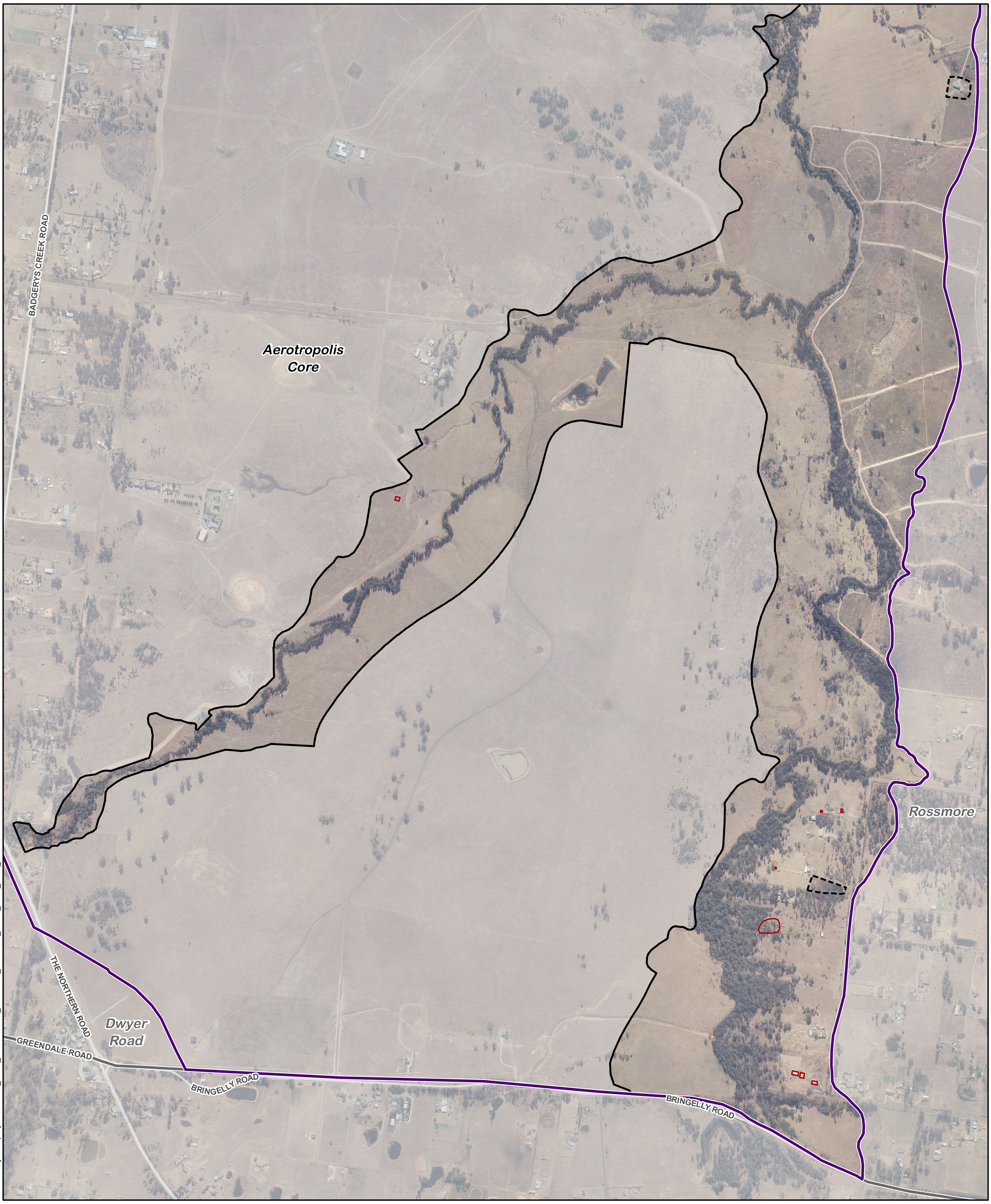
Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

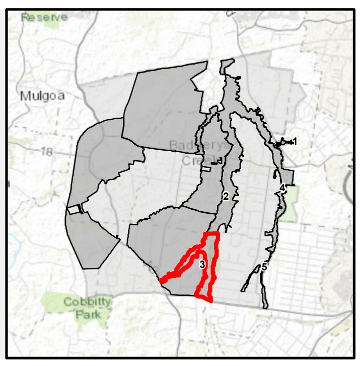
Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1986: Wianamatta-South Creek Precinct

aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSA_LCA_Historical_Aerial_1986_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

- Study area
- WSA Growth Area Boundary
- Precinct boundary
- Past structures and disturbed land (APEC)
- Filled dams (APEC)
- Current storage yards and disturbed land (APEC)



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:12,000

0 260 520 m

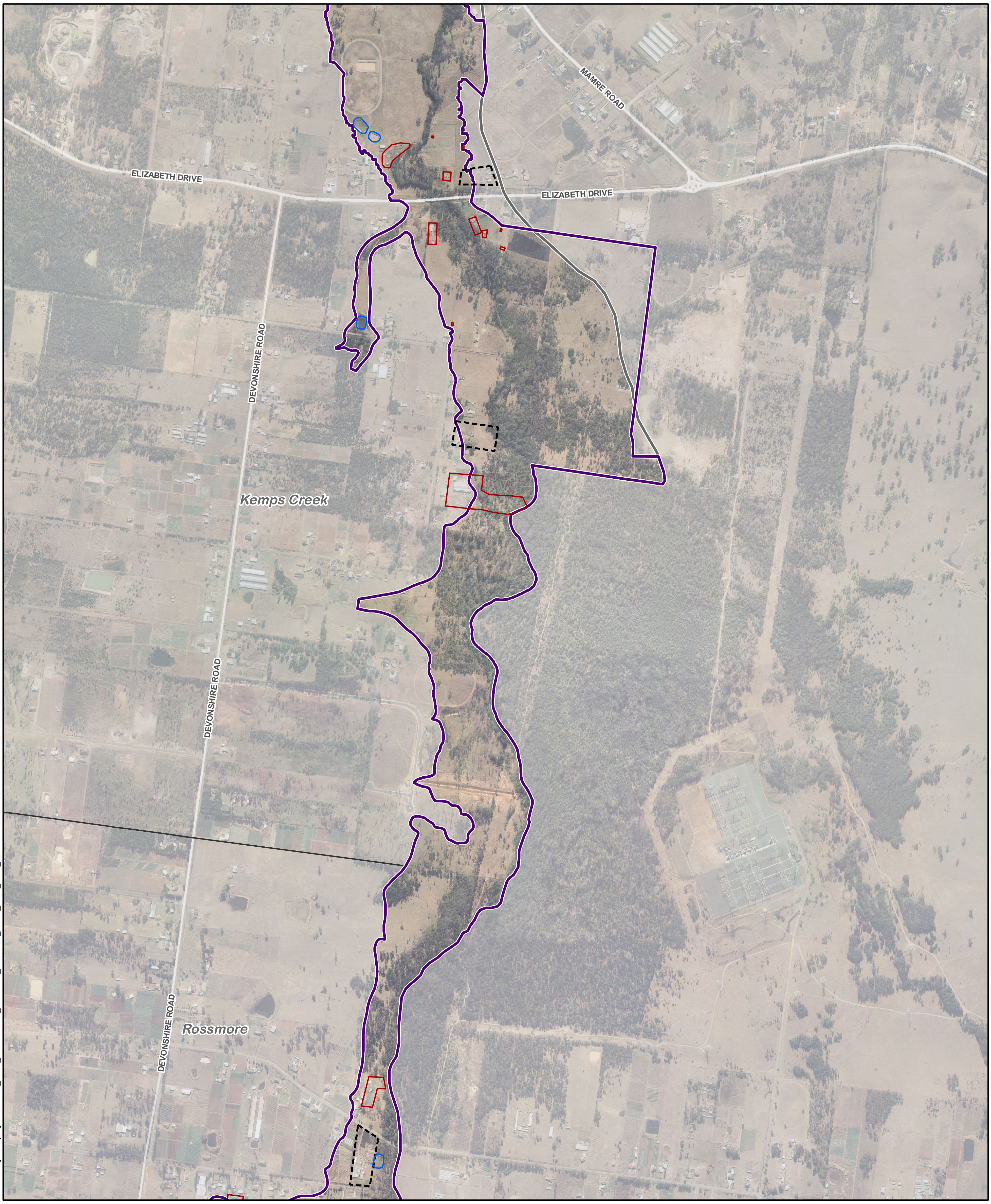
Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

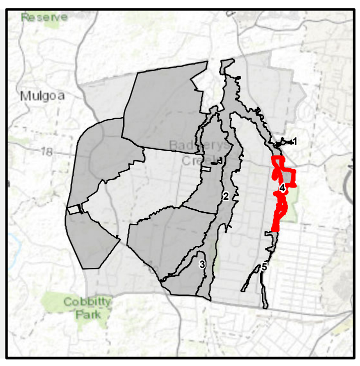
Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1986: Wianamatta-South Creek Precinct

P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Historical_Aerial_1986_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0



Study area
WSA Growth Area Boundary
Precinct boundary
Past structures and disturbed land (APEC)
Filled dams (APEC)
Current storage yards and disturbed land (APEC)



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:13,000

0 280 560 m

Date: 15/10/2020

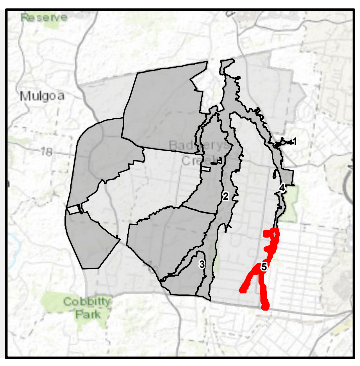
Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1986: Wianamatta-South Creek Precinct

P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Historical_Aerial_1986_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area Boundary
Precinct boundary
Past structures and disturbed land (APEC)
Filled dams (APEC)
Current storage yards and disturbed land (APEC)



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:14,000
0 300 600 m

Date: 15/10/2020
Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC) - 1986: Wianamatta-South Creek Precinct

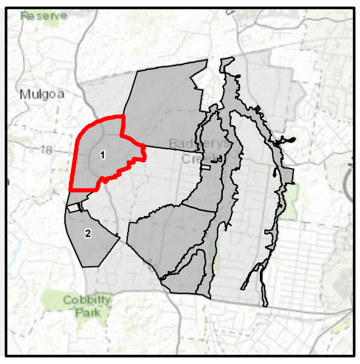
aurecon

P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Historical_Aerial_ALL_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

- Study area
- WSA Growth Area Boundary
- Precinct boundary
- Filled dams (APEC)
- Current storage yards and disturbed land (APEC)
- Other large sites (APEC)
- The Northern Road upgrade works

Past structures and disturbed land (last appearance date) (APEC)

- 1986
- 1970
- 1965
- 1947



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:16,000

0 350 700 m

Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC): Agribusiness Precinct

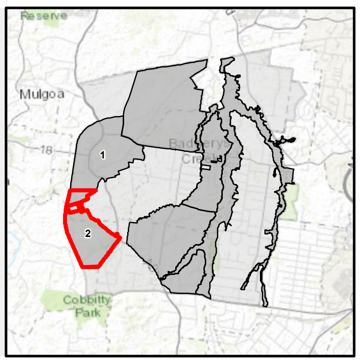
aurecon

P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Historical_Aerial_ALL_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area Boundary
Precinct boundary

Filled dams (APEC)
Current storage yards and disturbed land (APEC)
Other large sites (APEC)
The Northern Road upgrade works

Past structures and disturbed land (last appearance date) (APEC)
1986
1970
1965
1947



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

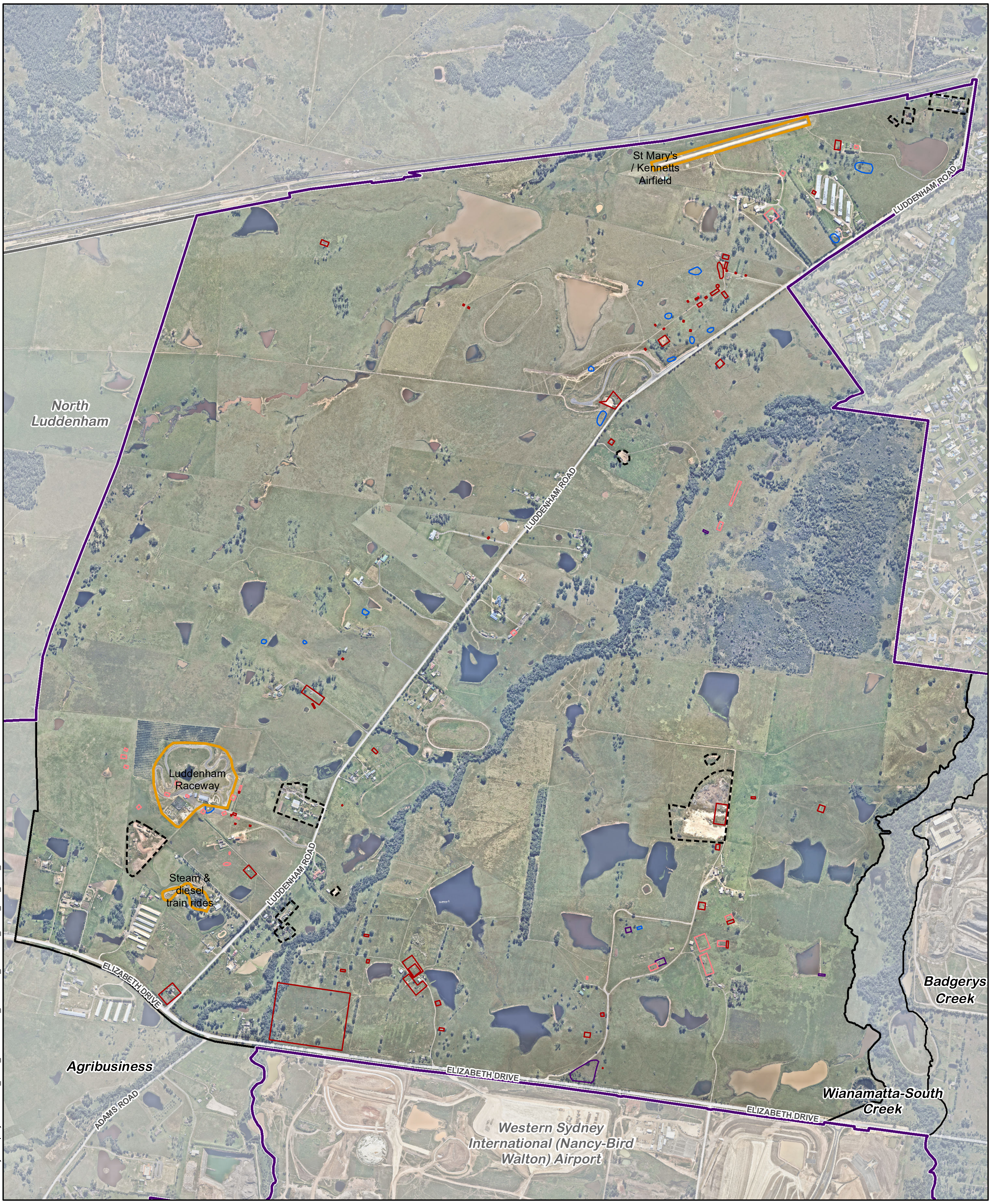
A3 scale: 1:14,000
0 300 600 m

Date: 15/10/2020
Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC): Agribusiness Precinct

aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Historical_Aerial_ALL_DDP_rev1.mxd\JOB No.15-10-20\Carmen.Braz\Rev 0

Study area

WSA Growth Area Boundary

Precinct boundary

Filled dams (APEC)

Current storage yards and disturbed land (APEC)

Other large sites (APEC)

The Northern Road upgrade works

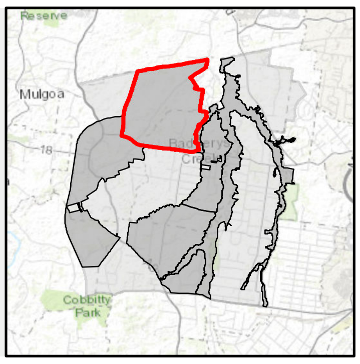
Past structures and disturbed land (last appearance date) (APEC)

1986

1970

1965

1947



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:18,000

0 390 780 m

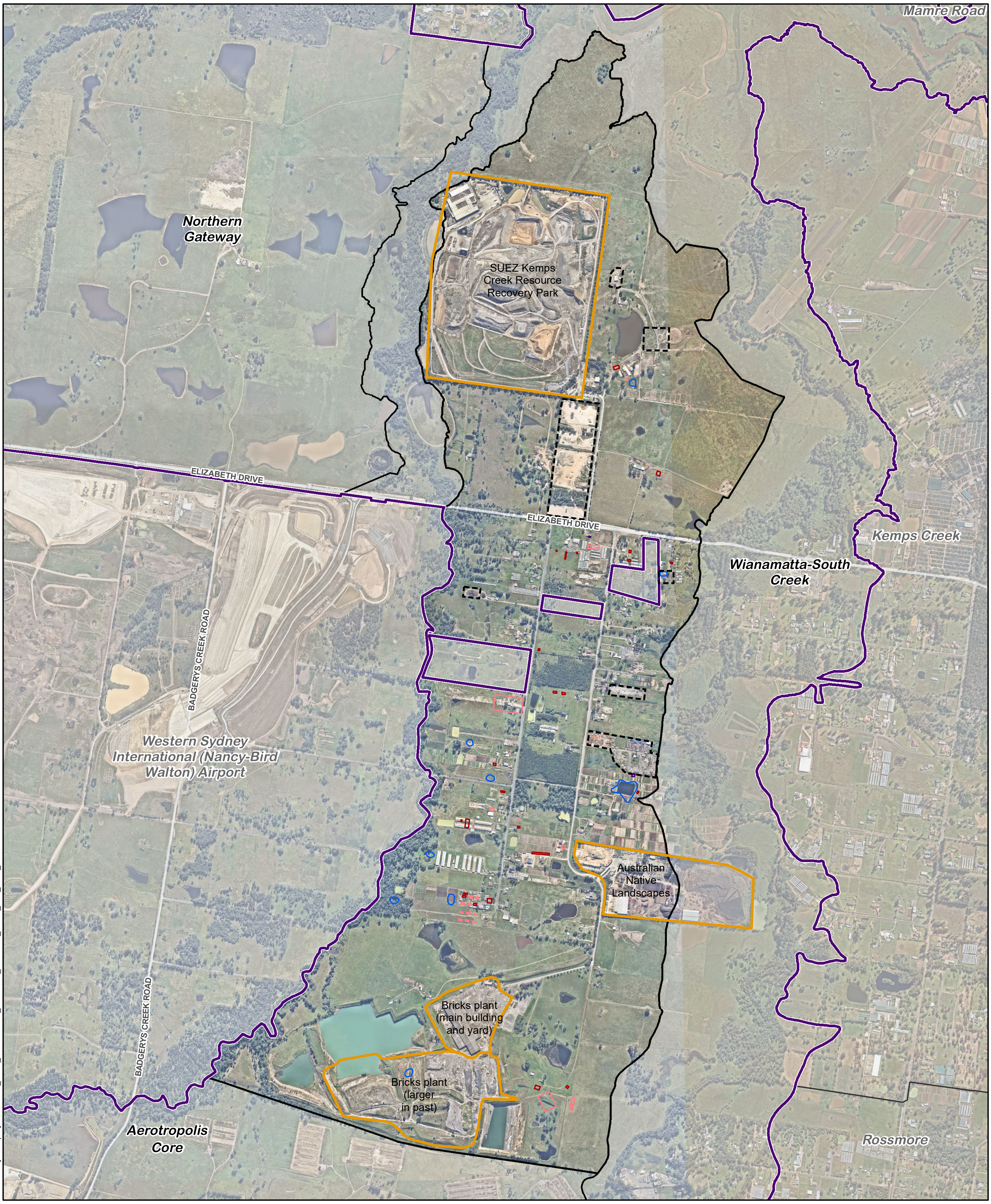
Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC): Northern Gateway Precinct

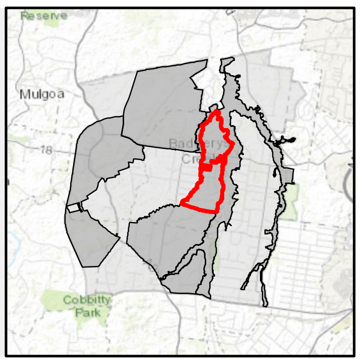
aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Historical_Aerial_ALL_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area Boundary
Precinct boundary
Filled dams (APEC)
Current storage yards and disturbed land (APEC)
Other large sites (APEC)
The Northern Road upgrade works

Past structures and disturbed land (last appearance date) (APEC)
1986
1970
1965
1947



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

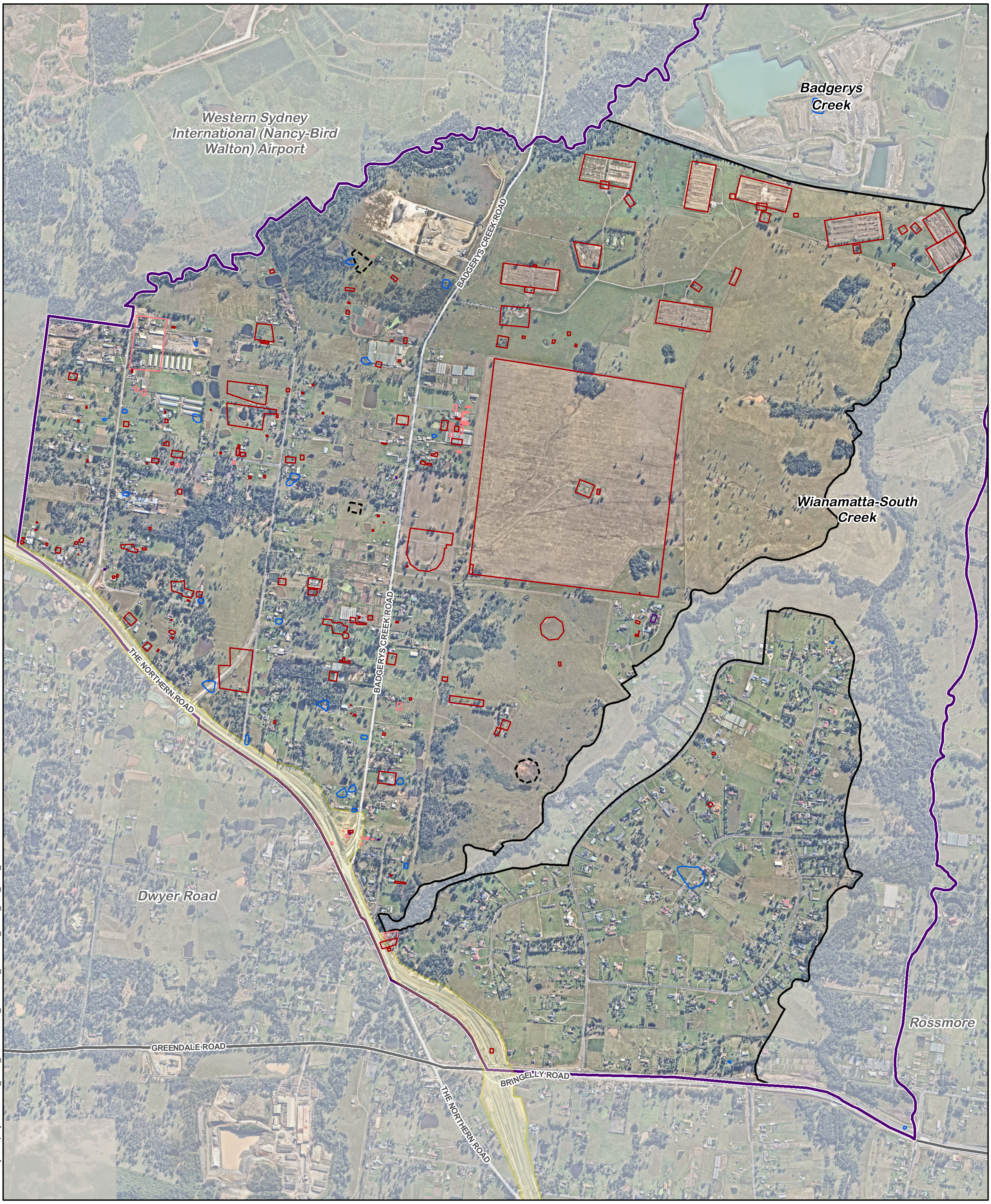
A3 scale: 1:18,000
0 390 780 m

Date: 15/10/2020
Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC): Badgerys Creek Precinct

aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Historical_Aerial_ALL_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area

WSA Growth Area Boundary

Precinct boundary

Filled dams (APEC)

Current storage yards and disturbed land (APEC)

Other large sites (APEC)

The Northern Road upgrade works

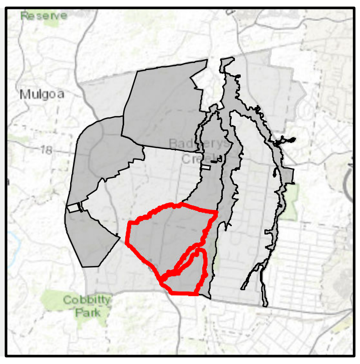
Past structures and disturbed land (last appearance date) (APEC)

1986

1970

1965

1947



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:19,000

0 410 820 m

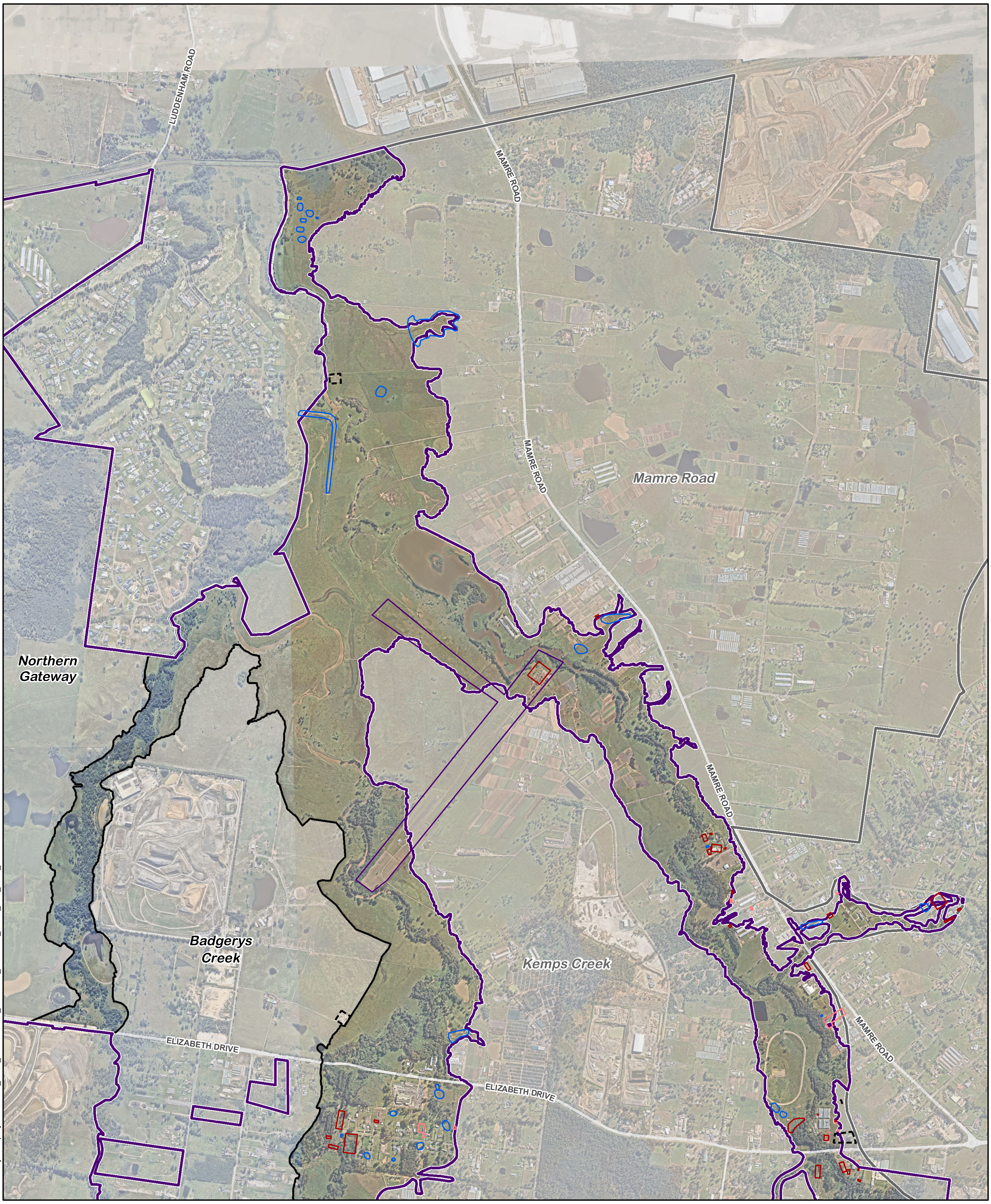
Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC): Aerotropolis Core Precinct

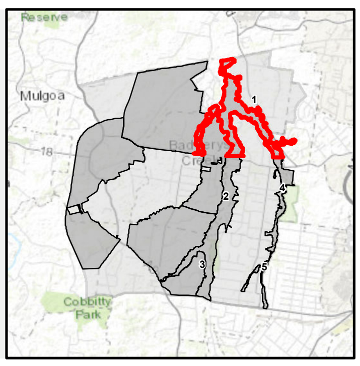
aurecon



Study area
WSA Growth Area Boundary
Precinct boundary
Filled dams (APEC)
Current storage yards and disturbed land (APEC)
Other large sites (APEC)
The Northern Road upgrade works

Past structures and disturbed land (last appearance date) (APEC)

1986
1970
1965
1947



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:22,000

0 480 960 m

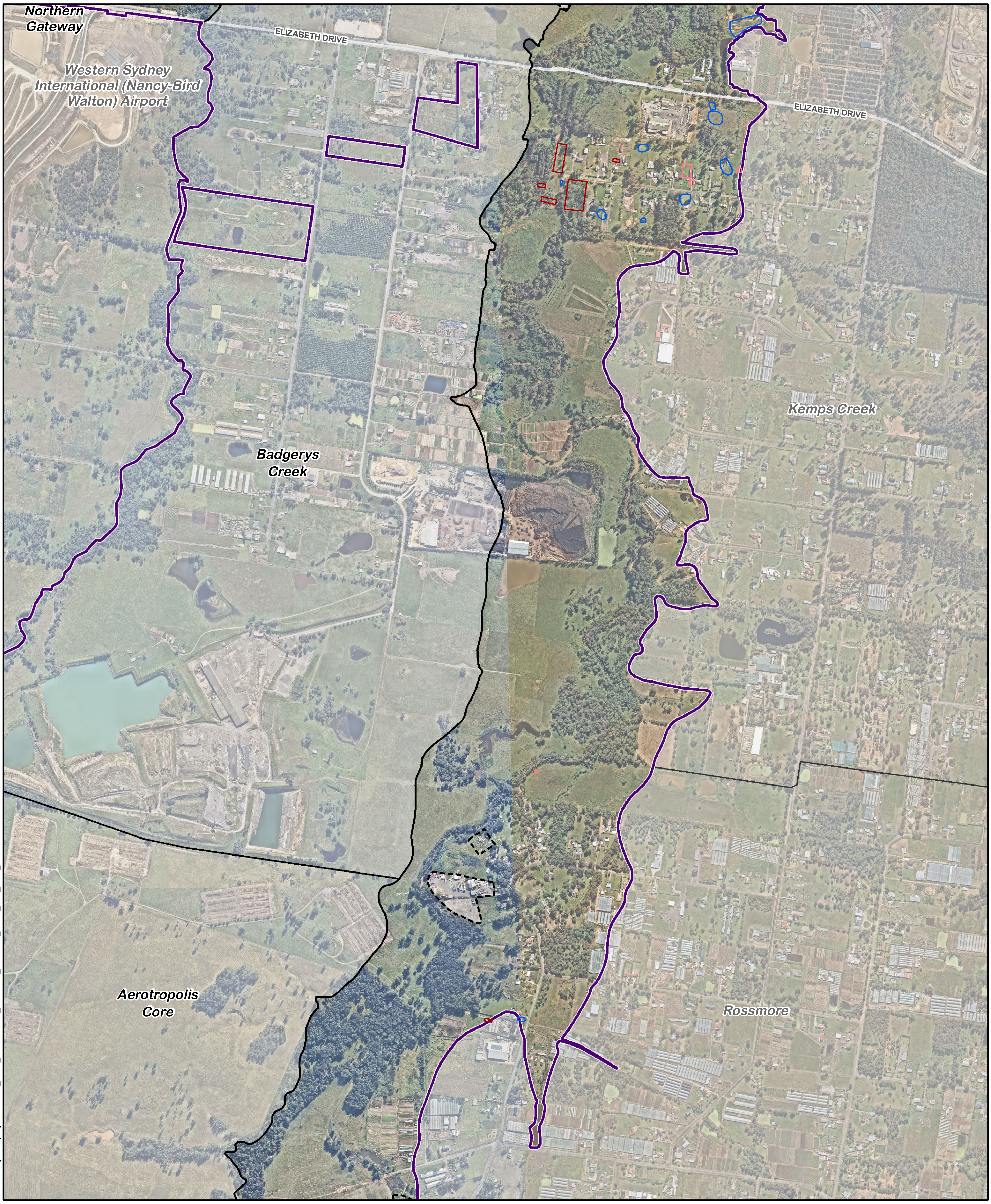
Date: 15/10/2020

Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC): Wianamatta-South Creek Precinct

aurecon

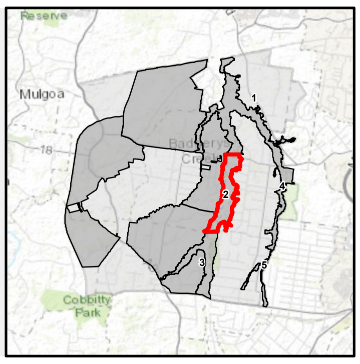


P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Historical_Aerial_ALL_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area Boundary
Precinct boundary

Filled dams (APEC)
Current storage yards and disturbed land (APEC)
Other large sites (APEC)
The Northern Road upgrade works

Past structures and disturbed land (last appearance date) (APEC)
1986
1970
1965
1947



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

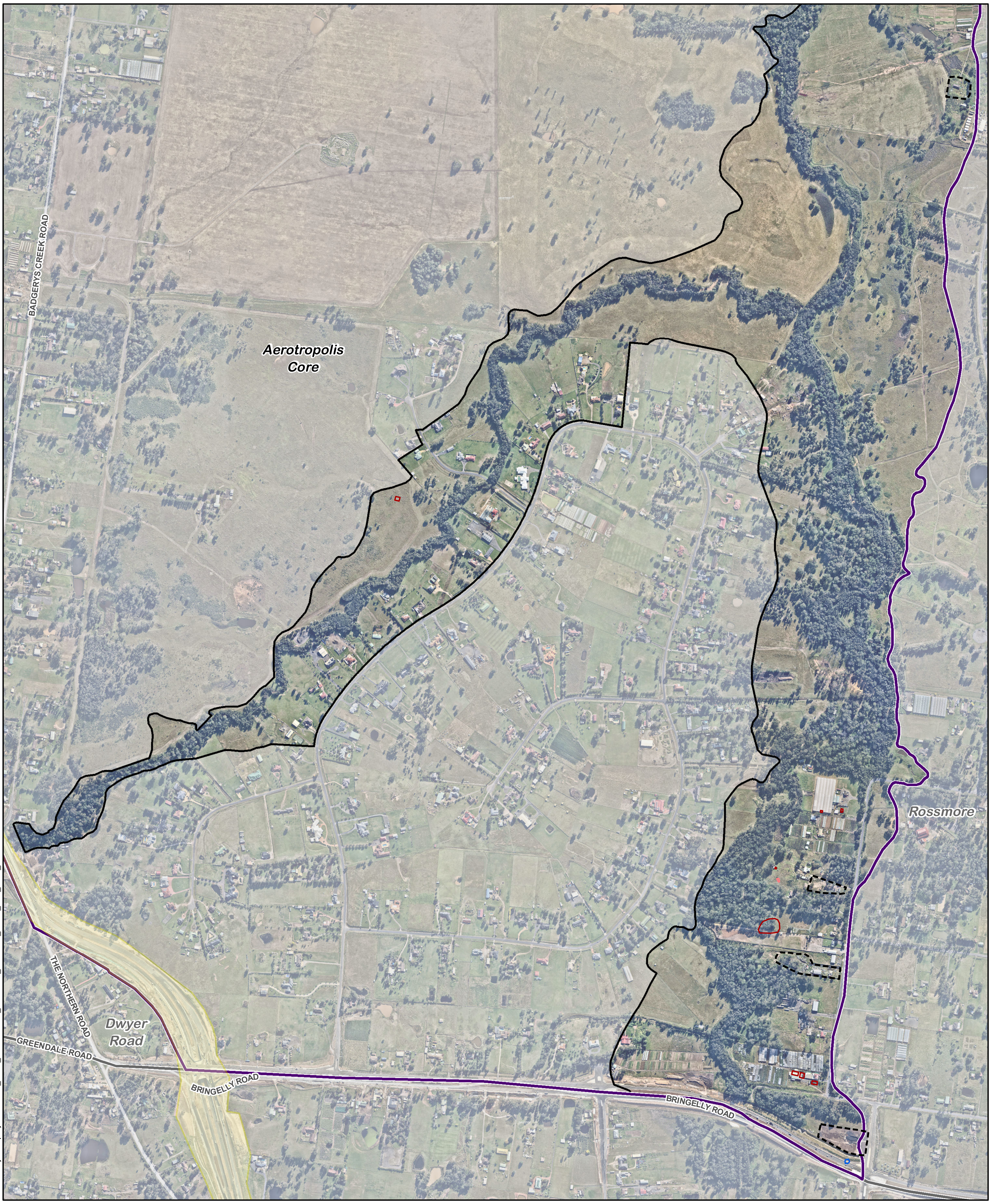
A3 scale: 1:14,000
0 300 600 m

Date: 15/10/2020
Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC): Wianamatta-South Creek Precinct

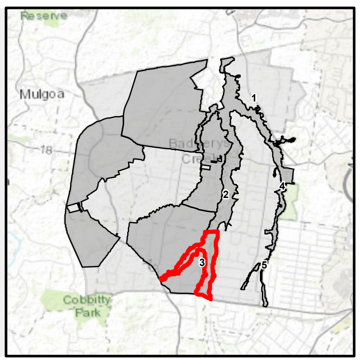
aurecon



P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Historical_Aerial_ALL_DDP_rev1.mxd\JOB No.15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area Boundary
Precinct boundary
Filled dams (APEC)
Current storage yards and disturbed land (APEC)
Other large sites (APEC)
The Northern Road upgrade works

Past structures and disturbed land (last appearance date) (APEC)
1986
1970
1965
1947



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

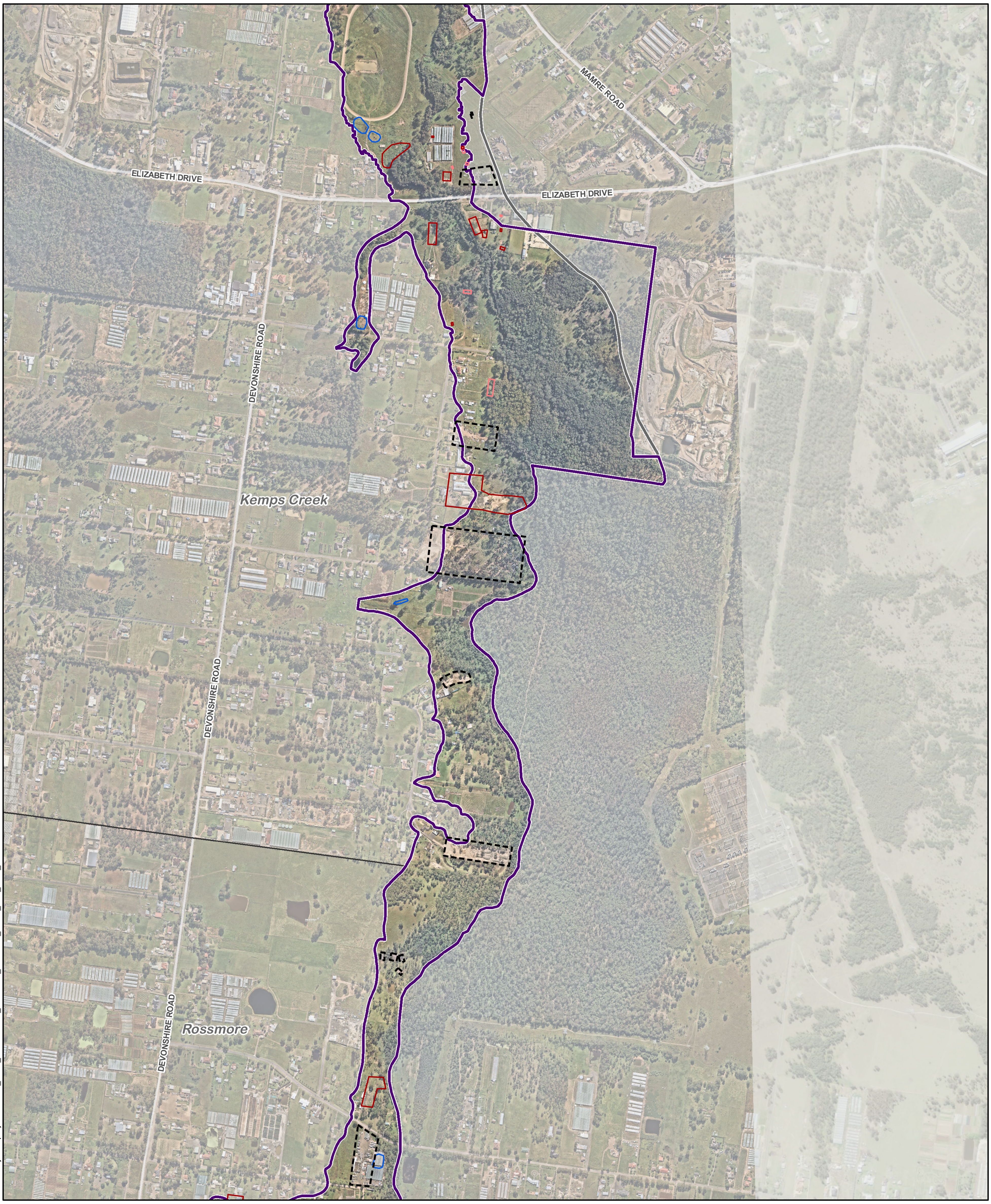
A3 scale: 1:12,000
0 260 520 m

Date: 15/10/2020
Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC): Wianamatta-South Creek Precinct

aurecon

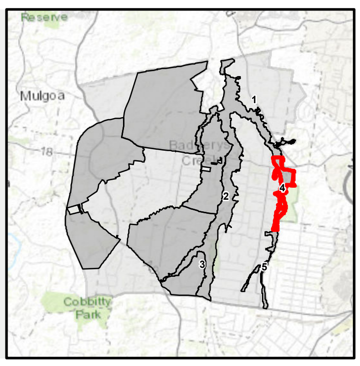


P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Historical_Aerial_ALL_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area Boundary
Precinct boundary

Filled dams (APEC)
Current storage yards and disturbed land (APEC)
Other large sites (APEC)
The Northern Road upgrade works

Past structures and disturbed land (last appearance date) (APEC)
1986
1970
1965
1947



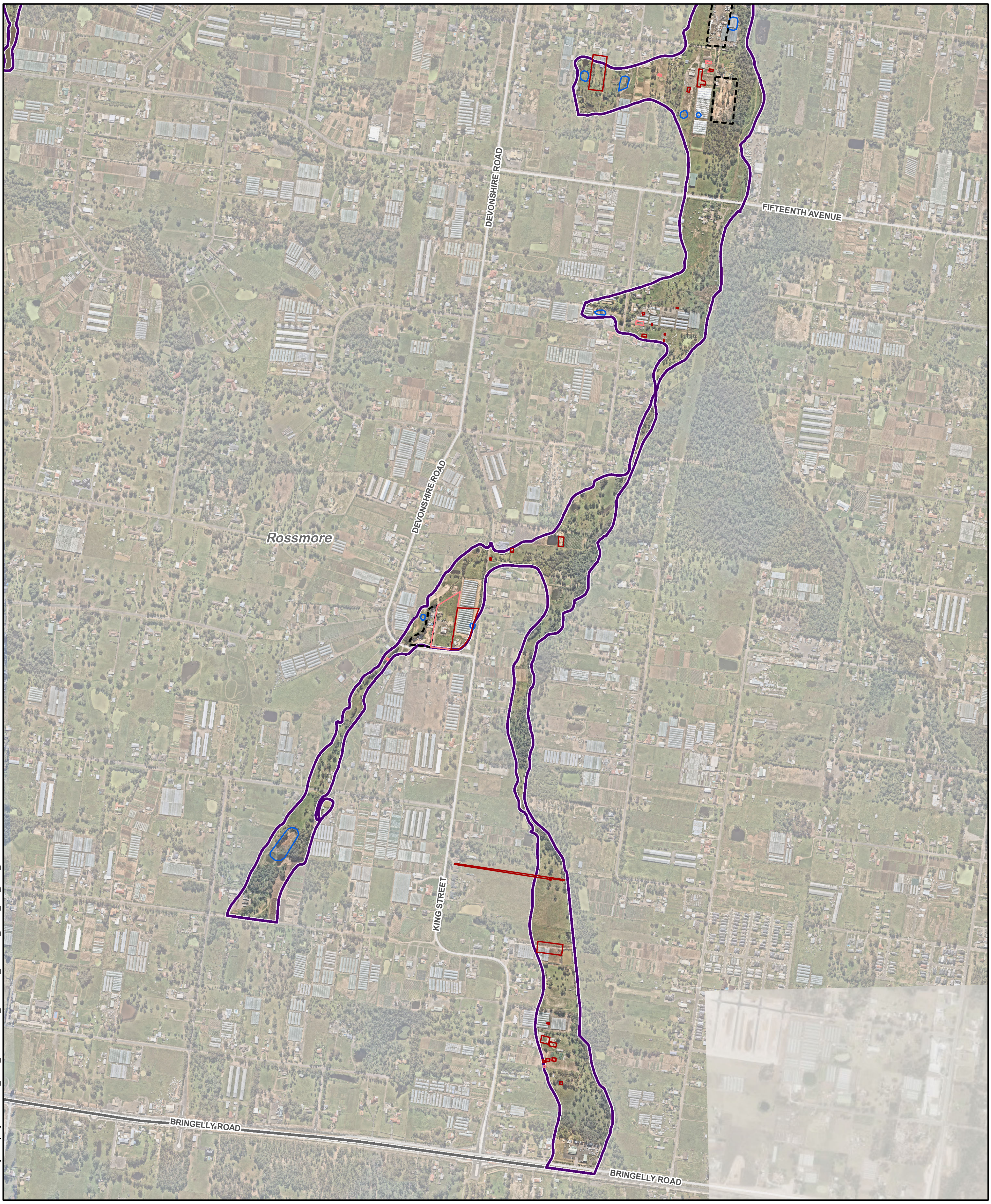
Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:13,000
0 280 560 m

Date: 15/10/2020
Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC): Wianamatta-South Creek Precinct

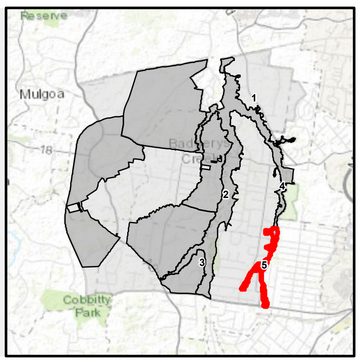


P:\GIS\Project-4\project\509471_WSA_LCA\509471_WSALCA_Historical_Aerial_ALL_DDP_rev1.mxd\JOB No.\15-10-20\Carmen.Braz\Rev 0

Study area
WSA Growth Area Boundary
Precinct boundary

Filled dams (APEC)
Current storage yards and disturbed land (APEC)
Other large sites (APEC)
The Northern Road upgrade works

Past structures and disturbed land (last appearance date) (APEC)
1986
1970
1965
1947



Source: Aurecon, DPIE, NSW Spatial Services, Nearmap, ESRI

A3 scale: 1:14,000
0 300 600 m

Date: 15/10/2020
Projection: GDA 1994 MGA Zone 56

Western Sydney Aerotropolis **Constraints and Land Capability Assessment**

Historical Aerials and Contamination Areas of Potential Environmental Concern (APEC): Wianamatta-South Creek Precinct

Appendix B
WSA precincts inspection and photo log

Client Name	Project Name	Project ID
Western Sydney Planning Partnership	Western Sydney Aerotropolis Constraints and Land Capability Assessment	509471

Photo No.	Date	
1	July 2020	
Description South Creek and banks within Wianamatta-South Creek northern section.		

Photo No.	Date	
2	July 2020	
Description South Creek and banks within Wianamatta-South Creek northern section.		

Client Name	Project Name	Project ID
Western Sydney Planning Partnership	Western Sydney Aerotropolis Constraints and Land Capability Assessment	509471

Photo No.	Date	
3	July 2020	
Description South Creek and banks within Wianamatta-South Creek northern section.		

Photo No.	Date	
4	September 2020	
Description Martin Road in Badgerys Creek Precinct. Typically rural zoned land with large lots and single dwellings.		

Client Name	Project Name	Project ID
Western Sydney Planning Partnership	Western Sydney Aerotropolis Constraints and Land Capability Assessment	509471

Photo No.	Date	
5	September 2020	
Description Typical rural landscape of Badgerys Creek Precinct.		

Photo No.	Date	
6	September 2020	
Description Typical agricultural landscape of Badgerys Creek Precinct.		

Client Name	Project Name	Project ID
Western Sydney Planning Partnership	Western Sydney Aerotropolis Constraints and Land Capability Assessment	509471

Photo No.	Date	
7	September 2020	
Description Typical rural landscape of Badgerys Creek Precinct.		

Photo No.	Date	
8	September 2020	
Description Some stockpiled soils and wastes within rural zoned lands in Badgerys Creek Precinct. Contamination risks and waste management.		

Client Name	Project Name	Project ID
Western Sydney Planning Partnership	Western Sydney Aerotropolis Constraints and Land Capability Assessment	509471

Photo No.	Date	
9	September 2020	
Description Some stockpiled soils and wastes within rural zoned lands in Badgerys Creek Precinct. Contamination risks and waste management.		

Photo No.	Date	
10	September 2020	
Description Typical rural landscape of Badgerys Creek Precinct.		

Client Name	Project Name	Project ID
Western Sydney Planning Partnership	Western Sydney Aerotropolis Constraints and Land Capability Assessment	509471

Photo No.	Date	
11	September 2020	
Description		
Warragamba Dam pipelines in the north of the Northern Gateway Precinct.		

Photo No.	Date	
12	September 2020	
Description		
Northern Gateway Precinct typical rural landscape along Luddenham Road.		

Client Name	Project Name	Project ID
Western Sydney Planning Partnership	Western Sydney Aerotropolis Constraints and Land Capability Assessment	509471

Photo No.	Date	
13	September 2020	
Description Northern Gateway Precinct typical rural landscape along Luddenham Road.		

Photo No.	Date	
14	September 2020	
Description Typical rural landscape along Adams Road in the Agribusiness Precinct.		

Client Name	Project Name	Project ID
Western Sydney Planning Partnership	Western Sydney Aerotropolis Constraints and Land Capability Assessment	509471

Photo No. 15	Date September 2020	
Description Typical agricultural landscape within the southern portion of the Agribusiness Precinct.		

Photo No. 16	Date September 2020	
Description Typical agricultural landscape within the southern portion of the Agribusiness Precinct.		

Client Name	Project Name	Project ID
Western Sydney Planning Partnership	Western Sydney Aerotropolis Constraints and Land Capability Assessment	509471

Photo No.	Date	
17	September 2020	
Description Typical rural landscape within the Aerotropolis Core Precinct along Kelvin Park Drive.		

Photo No.	Date	
18	September 2020	
Description Typical rural landscape within the Aerotropolis Core Precinct along Kelvin Park Drive.		

Client Name	Project Name	Project ID
Western Sydney Planning Partnership	Western Sydney Aerotropolis Constraints and Land Capability Assessment	509471

Photo No.	Date	
19	September 2020	
Description		
Typical rural landscape within the southern portion of the Aerotropolis Core.		

Photo No.	Date	
20	September 2020	
Description		
Typical rural landscape within the southern portion of the Aerotropolis Core.		

Appendix C

Summary of urban salinity hazard, management constraints and opportunities for HGLs in the Aerotropolis area (DPIE EES 2020).

HGL Name	Land Salinity Impacts	Salt Load Export Impacts	Water EC Impacts	Overall hazard	Urban Landscape Management Strategies	Targeted Urban Management Strategies	Management Constraints	Management Opportunities
Shale Plains	High	High	High	Very High	2,4,1,6	UI, UP, UC, UM, UV, RM	▪ Urban development may increase the rate of accumulation of salt in upland depressions and on lower colluvial slopes, exacerbating land salinity in low lying areas which is already classed as high. ▪ Seasonal waterlogging. ▪ The flat constricted alluvial plain area is highly sensitive. Disturbance of the area is likely to significantly increase erosion and increase recharge which will mobilise salt to the adjacent stream. ▪ Plant species selection will require waterlogging tolerance.	▪ Discharge management – deep rooted trees and shrubs are likely to be effective in this landscape if correct species are selected based on salinity tolerance. There is an abundance of shallow groundwater available. ▪ Deep rooted trees and shrubs to intercept shallow groundwater will provide salinity control at seasonal salt sites as well as points of constriction.
Upper South Creek	High	High	High	Very High	2,4,1,6	UP, UI, UC, UV, UM, RM	▪ Urban development activities may increase the rate of accumulation of salt in upland depressions and on lower colluvial slopes, exacerbating land salinity in low lying areas which is already classed as high. ▪ Seasonal waterlogging. ▪ The flat constricted alluvial plain area is highly sensitive. Disturbance of the area is likely to significantly increase erosion and increase recharge which will mobilise salt to the adjacent stream. ▪ Plant species selection will require waterlogging tolerance.	▪ Discharge management – deep rooted trees and shrubs are likely to be effective in this landscape if correct species are selected based on salinity tolerance. There is an abundance of shallow groundwater available. ▪ Deep-rooted trees and shrubs to intercept shallow groundwater will provide salinity control at seasonal salt sites as well as points of constriction.

HGL Name	Land Salinity Impacts	Salt Load Export Impacts	Water EC Impacts	Overall hazard	Urban Landscape Management Strategies	Targeted Urban Management Strategies	Management Constraints	Management Opportunities
Mount Vernon	Moderate	Moderate	High	Moderate	1,3,4,6	UI, UP, UM, UC, UV, RM	▪ Steep slopes may affect construction activities such as cut-and-fill and building of foundations. ▪ In unsewered areas, on-site wastewater disposal leakages may interact with landscape salt store to increase salinity hazard. ▪ Urban development activities may increase waterlogging and the rate of accumulation of salt on mid and lower slopes where salinity is already an issue.	▪ Local scale hydrological systems allow specific targeting of recharge with direct impact on discharge. Pre-planning at the local scale will reduce the impact on the built environment. ▪ Discharge management – deep rooted trees and shrubs are likely to be effective in this landscape if correct species are selected based on salinity tolerance. There is an abundance of shallow groundwater available in the lower landscape. ▪ Discharge management – integrated use of urban salinity management practices (salt resistant/resilient materials, water management) consistent with building codes would enable protection of infrastructure and dwellings in lower landscape.
Mulgoa	Moderate	Moderate	Moderate	Moderate	1,2,5,6	UP, UV, UI, UM, RM, UC (Specific urban management actions have not been specified for Mulgoa HGL)	▪ In unsewered areas, on-site wastewater disposal leakages may interact with landscape salt store to increase salinity hazard. ▪ Steep slopes may affect construction activities such as cut-and-fill, building of foundations and retaining walls. Creation of barriers can increase localised accumulation of salt.	▪ Salt sites are small and easily remedied. ▪ Remnant vegetation – trees and shrubs will assist controlling waterlogging and will assist salinity control at small salt sites in upper drainage lines.

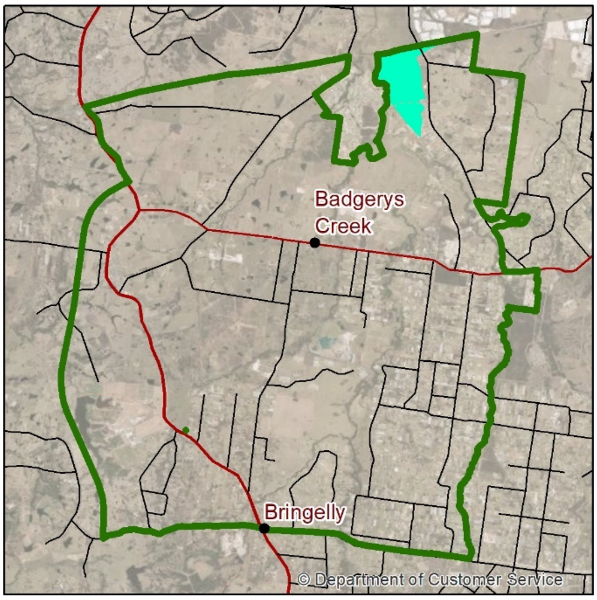
HGL Name	Land Salinity Impacts	Salt Load Export Impacts	Water EC Impacts	Overall hazard	Urban Landscape Management Strategies	Targeted Urban Management Strategies	Management Constraints	Management Opportunities
Greendale	Moderate	Low	Moderate	High	1,2,4,6	UP, UI, UC, UM, UV, RM	▪ Urban development activities may increase waterlogging and the rate of accumulation of salt on elevated upper and lower slopes where salinity is already an issue. ▪ In unsewered areas, on-site wastewater disposal leakages may interact with landscape salt store to increase salinity hazard. ▪ Seasonal waterlogging is an issue in upper landscape elements. ▪ Urbanisation of areas currently under peri-urban land use will increase the recharge potential.	▪ Isolated salt sites in upper landscape are of manageable size. ▪ Discharge management – deep rooted trees and shrubs are likely to be effective in this landscape if correct species are selected based on salinity tolerance. There is an abundance of shallow groundwater available. ▪ Discharge management – integrated use of urban salinity management practices (salt resistant/resilient materials, water management) consistent with building codes would enable protection of infrastructure and dwellings in lower landscape.

Source: *NSW Department of Planning, Industry and Environment, Environment, Energy and Science Group, (in press) Urban Salinity Management in the Western Sydney Aerotropolis Area (Derived from Western Sydney Hydrogeological Landscapes (2011)), October 2020*

Appendix D
HGL specific management (DPIE EES 2020)

Shale Plains HGL

Overall hazard	Very High
Likelihood	High
Overall Impact	Severe
Urban Landscape Management Strategies	2,4,1,6
Targeted Urban Management Strategies	UI, UP, UC, UM, UV, RM



Salinity expression

Land Salinity	Land salinity is high. Frequent small to moderate (0.1–1 ha) cyclic salt sites occur in this landscape within urban structures (e.g. sporting fields, developed parks, stormwater detention basins). Some larger sites also occur along drainage lines and colluvial slopes. There appears to be a combination of localised salt cycling and deeper groundwater rise contributing to the total salt affected land. The land surface salinity impact of this HGL is high.
Salt Load (export)	Salt load is high driven by salt wash off and groundwater discharge. Small to moderate but frequent widely distributed salt sites contribute high load during rain events whilst salty groundwater discharge maintains significant load in dry times.
Water EC (water quality)	Water EC high. Generally brackish water (1.6–4.8 dS/m). The water quality impact of this HGL is high.

Specific land management constraints

- Urban development may increase the rate of accumulation of salt in upland depressions and on lower colluvial slopes, exacerbating land salinity in low lying areas which is already classed as high.
- Seasonal waterlogging.
- The flat constricted alluvial plain area is highly sensitive. Disturbance of the area is likely to significantly increase erosion and increase recharge which will mobilise salt to the adjacent stream.
- Plant species selection will require waterlogging tolerance.

Specific land management opportunities

- Discharge management – deep rooted trees and shrubs are likely to be effective in this landscape if correct species are selected based on salinity tolerance. There is an abundance of shallow groundwater available.
- Deep rooted trees and shrubs to intercept shallow groundwater will provide salinity control at seasonal salt sites as well as points of constriction.

Strategies for urban salinity management

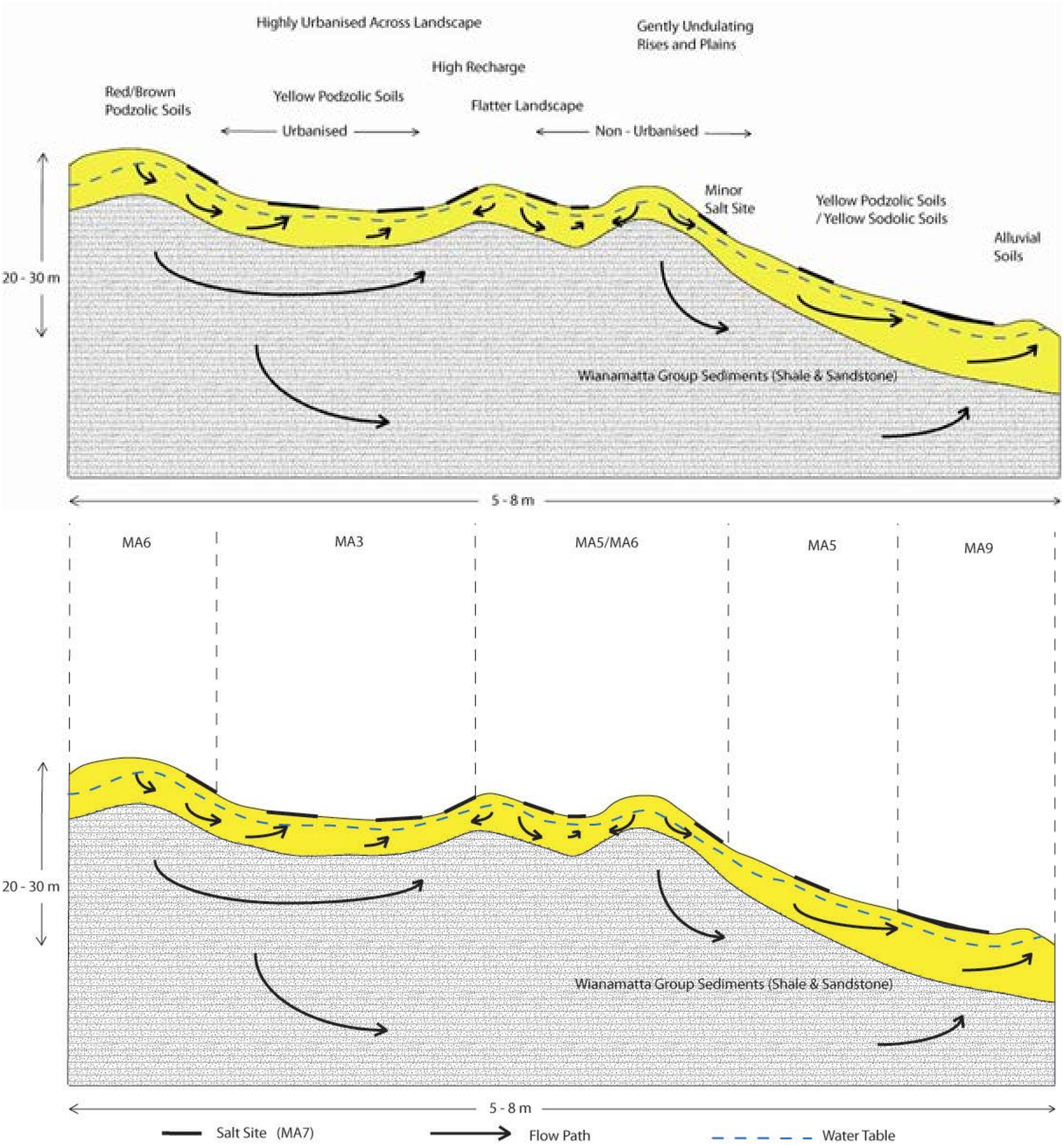
Urban landscape management strategies

- **Intercept the lateral flow and shallow groundwater (2):** This HGL can target shallow water tables that exist at the contact between underlying geology and around colluvial elements. Rows of deep- rooted trees (8–30 rows) and shrubs can be effective in interception of lateral flow. Rooting depth will intercept shallow groundwater.
- **Discharge rehabilitation (4):** The saline sites are numerous and vary in size. Discharge management will reduce salt discharge to streams when species salt tolerances are matched to salt site intensity.
- **Buffer the salt store (1):** There are discrete stores of salt in upper colluvial areas, which vegetation can buffer, limiting the salinity impact. They are generally in the upper erosional elements of the landscape associated with specific stratigraphy and comprise a significant percentage of this HGL.
- **Dry out the landscape with diffuse actions over most of the landscape (6):** Maximise plant growth and water use in order to use excess soil moisture and shallow groundwater. Healthy, actively growing vegetation will also act as a buffer to groundwater accessions in wet seasonal conditions.

Targeted urban management strategies (in priority order)

- **Urban Investigations (UI):** The landscape contains significant salinity, and geological situations that predispose salinity development. Assessment of the location, intensity and scale of salinity is needed. There are areas of sensitive sodic soils, particularly in drainage lines that need to be identified.
- **Urban Planning (UP):** Planning of sub-division layout and design is required to manage salinity consequences. Development must not increase the salinity hazard of the natural and built environment. Layout and design should consider locations of roads, infrastructure and greenspace as well as building allotments, and water sensitive urban design.
- **Urban Construction (UC):** Construction on saline land will require salt resistant/ resilient materials. The typical slope gradient of this HGL requires careful consideration of depth of cut and location of roads on hillslopes; and all infrastructure, including underground utilities.
- **Urban Management (UM):** The input of water into the landscape (lawns, gardens, sporting fields) including the management of recycled water, requires careful management.
- **Urban Vegetation (UV):** Maintain and enhance vegetation (including remnant vegetation) for the management of recharge, and as a buffer to excess water input. Waterwise gardening should be encouraged in residential areas.
- **Riparian Management (RM):** Vegetation management in riparian areas will assist in minimising salt export to streams.

Conceptual cross-section and management areas



High hazard land use

There are some activities that should be discouraged in this HGL as they will have negative impacts on salinity.

At Risk Management Areas	Action
MA3, MA5, MA6	• Avoid deep cut and exposure of susceptible soils during development when establishing infrastructure and dwellings.
MA3, MA5, MA6, MA9	• Avoid obstruction to surface and sub-surface drainage that will cause wet areas creating waterlogging and salt mobilisation

Management actions

Urban salinity management actions to consider for specific management areas in this landscape are as follows:

Management Areas	Action
MA6 (Rises)	**Urban Investigations** • Investigate concentration and composition of salts in the soil profile, groundwater and surface waters during initial site assessment to determine salinity hazard (UI1) **Urban Planning** • Prior to commencement of earthworks sodic/saline soils should be identified (UP1) **Urban Construction** • Minimise depth of cut and exposure of susceptible soils during development. Ensure fill material interface is not saline (UC1) **Urban Management** • Employ deficit irrigation principles to prevent over-irrigation of sports grounds, golf courses, parks, private gardens and lawn (UM2) **Urban Vegetation** • Retain or establish areas of deep-rooted salt tolerant indigenous vegetation to manage recharge or discharge site (UV1) • Locate strategic plantings of deep-rooted perennial vegetation to manage discharge areas (UV5)
MA3 (Upper slopes – colluvial)	**Urban Investigations** • Investigate concentration and composition of salts in the soil profile, groundwater and surface waters during initial site assessment to determine salinity hazard (UI1) • Identify and manage sodic soils (UI3) **Urban Planning** • Prior to commencement of earthworks sodic/saline soils should be identified (UP1) • Minimise use of infiltration and detention of stormwater in hazard areas; consider lining of detention systems to prevent infiltration. Reconsider WSUD implications in relation to salinity management and potential impact on nearby groundwater dependent ecosystems (GDEs) (UP2) • In areas where nearby GDEs are not reliant on recharge, maximise the size of impervious surfaces to prevent recharge of (perched) groundwater tables. Constructed pervious surfaces may need to be lined and drained to stormwater outlets. Consideration will need to be given to the offsite ecological impacts of diverting runoff (UP4) • Implementation of WSUD techniques considers the potential impact on the local salinity hazard. Revise principles of WSUD where salinity affects are an issue (UP5) **Urban Construction** • In areas where nearby GDEs are not reliant on recharge, deep drainage should be minimised by maximising surface water runoff (UC2) • Sub-surface drainage should be incorporated into all infrastructure including roads, pathways, behind cuts and retaining walls and other impervious areas to avoid waterlogging (UC3) • Establish good drainage prior to construction in shrink/swell soils (UC4) • Ensure road construction is suitable for conditions (UC5) • New houses, buildings or infrastructure (including roads, pathways and retaining walls) in current or potentially salt affected areas may need to be built to withstand the effects of salinity utilising industry accepted standards. In badly affected areas, consideration should be given to rehabilitating salt affected land, building above ground or consideration of open space options (UC6) • Consider the use of salt protected materials for services (e.g. salt resistant drainage pipes, casing of underground services) (UC7) **Urban Management**

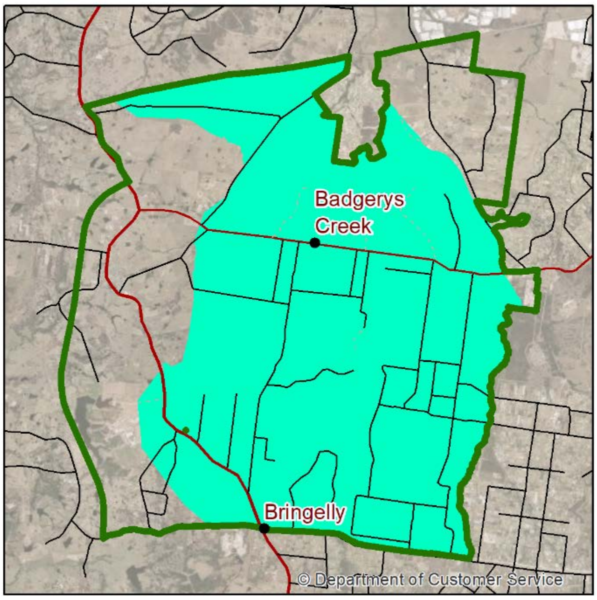
Management Areas	Action
	• Employ deficit irrigation principles to prevent over-irrigation of sports grounds, golf courses, parks, private gardens and lawns (UM2) **Urban Vegetation** • Promote the retention and establishment of deep-rooted vegetation that maximises water use in new urban development areas (UV2) • Locate strategic plantings of deep-rooted perennial vegetation to manage discharge areas (UV3) • Establish new vegetation using salt tolerant species (UV4)
MA5/MA6 (Rolling)	**Urban Investigations** • Investigate concentration and composition of salts in the soil profile, groundwater and surface waters during initial site assessment to determine salinity hazard (UI1) • Identify and manage sodic soils (UI3) **Urban Planning** • Prior to commencement of earthworks sodic/saline soils should be identified (UP1) • In areas where nearby GDEs are not reliant on recharge, maximise the size of impervious surfaces to prevent recharge of (perched) groundwater tables. Constructed pervious surfaces may need to be lined and drained to stormwater outlets. Consideration will need to be given to the offsite ecological impacts of diverting runoff (UP4) • Implementation of WSUD techniques considers the potential impact on the local salinity hazard. Revise principles of WSUD where salinity affects are an issue (UP5) **Urban Construction** • Sub-surface drainage should be incorporated into all infrastructure including roads, pathways, behind cuts and retaining walls and other impervious areas to avoid waterlogging (UC3) • Establish good drainage prior to construction in shrink/swell soils (UC4) • Ensure road construction is suitable for conditions (UC5) • New houses, buildings or infrastructure (including roads, pathways and retaining walls) in current or potentially salt affected areas may need to be built to withstand the effects of salinity utilising industry accepted standards. In badly affected areas, consideration should be given to rehabilitating salt affected land, building above ground or consideration of open space options (UC6) • Consider the use of salt protected materials for services (e.g. salt resistant drainage pipes, casing of underground services) (UC7) **Urban Management** • Employ deficit irrigation principles to prevent over-irrigation of sports grounds, golf courses, parks, private gardens and lawns (UM2) **Urban Vegetation** • Establish new vegetation using salt tolerant species (UV4)

Management Areas	Action
MA5 (Lower slopes – colluvial)	**Urban Investigations** • Investigate concentration and composition of salts in the soil profile, groundwater and surface waters during initial site assessment to determine salinity hazard (UI1) • Use geophysical techniques to define geological contact (EM survey) (UI2) **Urban Planning** • Prior to commencement of earthworks sodic/saline soils should be identified (UP1) • Implementation of WSUD techniques considers the potential impact on the local salinity hazard. Revise principles of WSUD where salinity affects are an issue (UP5) **Urban Construction** • Establish good drainage prior to construction in shrink/swell soils (UC4) • Ensure road construction is suitable for conditions (UC5) • Consider the use of salt protected materials for services (e.g. salt resistant drainage pipes, casing of underground services) (UC7) **Urban Management** • Employ deficit irrigation principles to prevent over-irrigation of sports grounds, golf courses, parks, private gardens and lawns (UM2) **Urban Vegetation** • Promote the retention and establishment of deep-rooted vegetation that maximises water use in new urban development areas (UV2) • Locate strategic plantings of deep-rooted perennial vegetation to manage discharge areas (UV3) • Establish new vegetation using salt tolerant species (UV4)
MA9 (Alluvial plain)	**Urban Investigations** • Investigate concentration and composition of salts in the soil profile, groundwater and surface waters during initial site assessment to determine salinity hazard (UI1) **Urban Planning** • Prior to commencement of earthworks sodic/saline soils should be identified (UP1) **Urban Construction** • Consider the use of salt protected materials for services (e.g. salt resistant drainage pipes, casing of underground services) (UC7) **Urban Management** • Minimise leakage of standing water bodies, pools, lakes, and service pipes (UM1) **Urban Vegetation** • Retain or establish areas of deep-rooted salt tolerant indigenous vegetation to manage recharge or discharge site (UV1) • Establish new vegetation using salt tolerant species (UV4) **Riparian Management** • Retain or re-establish areas of effectively vegetated riparian buffer zones to manage discharge areas (preferably salt tolerant indigenous vegetation) (RM1) • Maintain/re-establish effective vegetated riparian buffer zones (RM2)

Source: *NSW Department of Planning, Industry and Environment, Environment, Energy and Science Group, (in press) Urban Salinity Management in the Western Sydney Aerotropolis Area (Derived from Western Sydney Hydrogeological Landscapes (2011)), October 2020*

Upper South Creek HGL

Overall hazard	Very High
Likelihood	High
Overall Impact	Severe
Urban Landscape Management Strategies	2,4,1,6
Targeted Urban Management Strategies	UP, UI, UC, UV, UM, RM



Salinity expression

Land Salinity	Land salinity is high. Some moderate to large (1–10 ha) salt sites occur in this landscape. These sites mostly occur on footslopes at the contact between Second Ponds Creek Soil Landscape and South Creek Soil Landscape. The salt sites are on the colluvial footslopes (often associated with irrigation) and in the upper colluvial areas (Blacktown Soil Landscape).
Salt Load (export)	Salt export is high. High export driven by salt wash off and lateral throughflow and groundwater discharge into streams. Moderate to large salt sites contribute significant load.
Water EC (water quality)	Water EC is high. Ranges from 0.5–1.54 dS/m. Base flow EC generally brackish (1.6–4.8 dS/m)..

Specific land management constraints

- Urban development activities may increase the rate of accumulation of salt in upland depressions and on lower colluvial slopes, exacerbating land salinity in low lying areas which is already classed as high.
- Seasonal waterlogging.
- The flat constricted alluvial plain area is highly sensitive. Disturbance of the area is likely to significantly increase erosion and increase recharge which will mobilise salt to the adjacent stream.
- Plant species selection will require waterlogging tolerance.

Specific land management opportunities

- Discharge management – deep rooted trees and shrubs are likely to be highly in this landscape if correct species are selected based on salinity tolerance. There is an abundance of shallow groundwater available.
- Deep rooted trees and shrubs to intercept shallow groundwater will provide salinity control at seasonal salt sites as well as points of constriction.

Strategies for urban salinity management

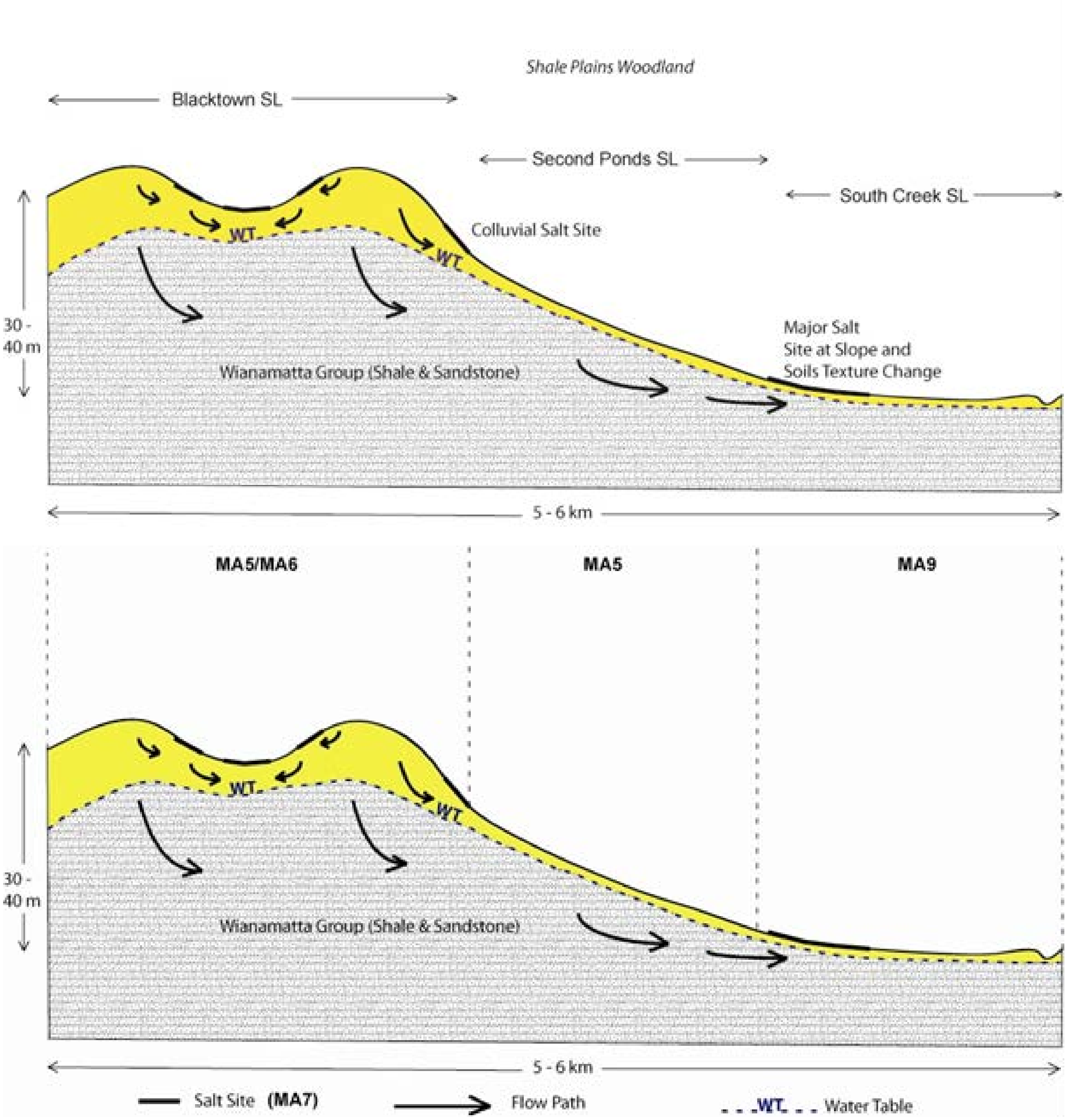
Urban landscape management strategies

- **Intercept the lateral flow and shallow groundwater (2):** This HGL can target shallow water tables that exist at the contact between underlying geology and colluvial slopes. Rows of deep rooted trees (8–30 rows) and shrubs can be effective in interception of lateral flow. Rooting depth will intercept shallow groundwater.
- **Discharge rehabilitation (4):** The saline sites are numerous and variable in size. Discharge management will reduce salt discharge to streams when species salt tolerances are matched to salt site intensity.
- **Buffer the salt store (1):** There are stores of salt in discrete upper and lower colluvial areas, which vegetation can buffer, limiting the salinity impact. They are generally in the upper erosional elements of the landscape associated with specific stratigraphy and comprise a significant percentage of this HGL.
- **Dry out the landscape with diffuse actions over most of the landscape (6):** Maximise plant growth and water use in order to use excess soil moisture and shallow groundwater. Healthy, actively growing vegetation will also act as a buffer to groundwater accessions in wet seasonal conditions.

Targeted urban management strategies (in priority order)

- **Urban Planning (UP):** Planning of sub-division layout and design is required to manage salinity consequences. Development must not increase the salinity hazard of the natural and built environment. Layout and design should consider locations of roads, infrastructure and greenspace as well as building allotments, and water sensitive urban design.
- **Urban Investigations (UI):** The landscape contains significant salinity, and geological situations that predispose salinity development. Assessment of the location, intensity and scale of salinity is needed. There are areas of sensitive sodic soils, particularly in drainage lines that need to be identified.
- **Urban Construction (UC):** Construction on saline land will require salt resistant/ resilient materials. The typical slope gradient of this HGL requires careful consideration of depth of cut and location of roads on hillslopes; and all infrastructure, including underground utilities.
- **Urban Vegetation (UV):** Maintain and enhance vegetation (including remnant vegetation) for the management of recharge, and as a buffer to excess water input. Waterwise gardening should be encouraged in residential areas.
- **Urban Management (UM):** The input of water into the landscape (lawns, gardens, sporting fields) including the management of recycled water requires careful management.
- **Riparian Management (RM):** Vegetation management in riparian areas will assist in minimising salt export to streams.

Conceptual cross-section and management areas



High hazard land use

There are some activities that should be discouraged in this HGL as they will have negative impacts on salinity.

At Risk Management Areas	Action
MA5, MA5/MA6	• Avoid deep cut and exposure of susceptible soils during development when establishing infrastructure and dwellings.
MA5, MA5/MA6, MA9	• Avoid obstruction to surface and sub-surface drainage that will cause wet areas creating waterlogging and salt mobilisation. • Avoid activities that will increase recharge. • Natural and induced salinity risk area – extensive investigations and planning are required.

Management actions

Urban salinity management actions to consider for specific management areas in this landscape are as follows:

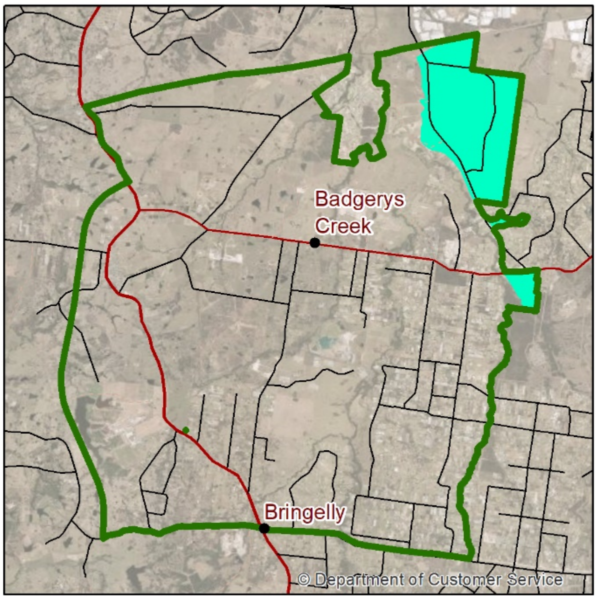
Management Areas	Action
MA5/MA6 (Rolling)	**Urban Planning** • Prior to commencement of earthworks sodic/saline soils should be identified (UP1) • In areas where nearby GDEs are not reliant on recharge, maximise the size of impervious surfaces to prevent recharge of (perched) groundwater tables. Constructed pervious surfaces may need to be lined and drained to stormwater outlets. Consideration will need to be given to the offsite ecological impacts of diverting runoff (UP4) • Implementation of WSUD techniques considers the potential impact on the local salinity hazard. Revise principles of WSUD where salinity affects are an issue (UP5) **Urban Investigations** • Investigate concentration and composition of salts in the soil profile, groundwater and surface waters during initial site assessment to determine salinity hazard (UI1) • Identify and manage sodic soils (UI3) **Urban Construction** • Minimise depth of cut and exposure of susceptible soils during development. Ensure fill material is not saline (UC1) • Sub-surface drainage should be incorporated into all infrastructure including roads, pathways, behind cuts and retaining walls and other impervious areas to avoid waterlogging (UC3) • Establish good drainage prior to construction in shrink/swell soils (UC4) • Ensure road construction is suitable for conditions (UC5) • New houses, buildings or infrastructure (including roads, pathways and retaining walls) in current or potentially salt affected areas may need to be built to withstand the effects of salinity utilising industry accepted standards. In badly affected areas, consideration should be given to rehabilitating salt affected land, building above ground or consideration of open space options (UC6) • Consider the use of salt protected materials for services (e.g. salt resistant drainage pipes, casing of underground services) (UC7) **Urban Vegetation** • Retain or establish areas of deep-rooted salt tolerant vegetation to manage recharge or discharge site (UV1) • Establish new vegetation using salt tolerant species (UV4) **Urban Management** • Employ deficit irrigation principles to prevent over-irrigation of sports grounds, golf courses, parks, private gardens and lawn (UM2)
MA5 (Lower slopes – colluvial)	**Urban Planning** • Prior to commencement of earthworks sodic/saline soils should be identified (UP1) • Minimise use of infiltration and detention of stormwater in hazard areas; consider lining of detention systems to prevent infiltration. Reconsider WSUD implications in relation to salinity management and potential impact on nearby groundwater dependent ecosystems (GDEs) (UP2) • Implementation of WSUD techniques consider the potential impact on the local salinity hazard. Revise principles of WSUD where salinity affects are an issue (UP5) **Urban Investigations** • Investigate concentration and composition of salts in the soil profile, groundwater and surface waters during initial site assessment to determine salinity hazard (UI1)

Management Areas	Action
	• Use geophysical techniques to define geological contact (EM survey) (UI2) **Urban Construction** • Establish good drainage prior to construction in shrink/swell soils (UC4) • Ensure road construction is suitable for conditions (UC5) • Consider the use of salt protected materials for services (e.g. salt resistant drainage pipes, casing of underground services) (UC7) **Urban Vegetation** • Promote the retention and establishment of deep-rooted vegetation that maximises water use in new urban development areas (UV2) • Locate strategic plantings of deep-rooted perennial vegetation to manage discharge areas (UV3) • Establish new vegetation using salt tolerant species (UV4) **Urban Management** • Employ deficit irrigation principles to prevent over-irrigation of sports grounds, golf courses, parks, private gardens and lawns (UM2)
MA9 (Alluvial plain)	**Urban Planning** • Prior to commencement of earthworks sodic/saline soils should be identified (UP1) • Minimise use of infiltration and detention of stormwater in hazard areas; consider lining of detention systems to prevent infiltration. Reconsider WSUD implications in relation to salinity management and potential impact on nearby groundwater dependent ecosystems (GDEs) (UP2) **Urban Investigations** • Investigate concentration and composition of salts in the soil profile, groundwater and surface waters during initial site assessment to determine salinity hazard (UI1) **Urban Construction** • Consider the use of salt protected materials for services (e.g. salt resistant drainage pipes, casing of underground services) (UC7) **Urban Vegetation** • Retain or establish areas of deep-rooted salt tolerant indigenous vegetation to manage recharge or discharge site (UV1) • Establish new vegetation using salt tolerant species (UV4) **Urban Management** • Minimise leakage of standing water bodies, pools, lakes and service pipes (UM1) **Riparian Management** • Retain or re-establish areas of effectively vegetated riparian buffer zones to manage discharge areas (preferably salt tolerant indigenous vegetation) (RM1) • Maintain/re-establish effective vegetated riparian buffer zones (RM2)

Source: *NSW Department of Planning, Industry and Environment, Environment, Energy and Science Group, (in press) Urban Salinity Management in the Western Sydney Aerotropolis Area (Derived from Western Sydney Hydrogeological Landscapes (2011)), October 2020*

Mount Vernon HGL

Overall hazard	Moderate
Likelihood	Moderate
Overall Impact	Significant
Urban Landscape Management Strategies	1,3,4,6
Targeted Urban Management Strategies	UI, UP, UM, UC, UV, RM



Salinity expression

Land Salinity	Land salinity is moderate. Numerous small salt outbreaks can occur in low lying lower slope and upper slope positions.
Salt Load (export)	Salt load is moderate. Salty groundwater discharges into streams from relatively small catchment area and flow volume. The salt export impact of this HGL is moderate.
Water EC (water quality)	Water EC is high. Low quality and generally brackish water ranging from 1.9–3.9 dS/m.

Specific land management constraints

- Steep slopes may affect construction activities such as cut-and-fill and building of foundations.
- In unsewered areas, on-site wastewater disposal leakages may interact with landscape salt store to increase salinity hazard.
- Urban development activities may increase waterlogging and the rate of accumulation of salt on mid and lower slopes where salinity is already an issue.

Specific land management opportunities

- Local scale hydrological systems allow specific targeting of recharge with direct result on discharge. Pre-planning at the local scale will reduce the impact on the built environment.
- Discharge management – deep rooted trees and shrubs are likely to be effective in this landscape if correct species are selected based on salinity tolerance. There is an abundance of shallow groundwater available in lower landscape.
- Discharge management – integrated use of urban salinity management practices (salt resistant/resilient materials, water management) consistent with building codes would enable protection of infrastructure and dwellings in lower landscape.

Strategies for urban salinity management

Urban landscape management strategies

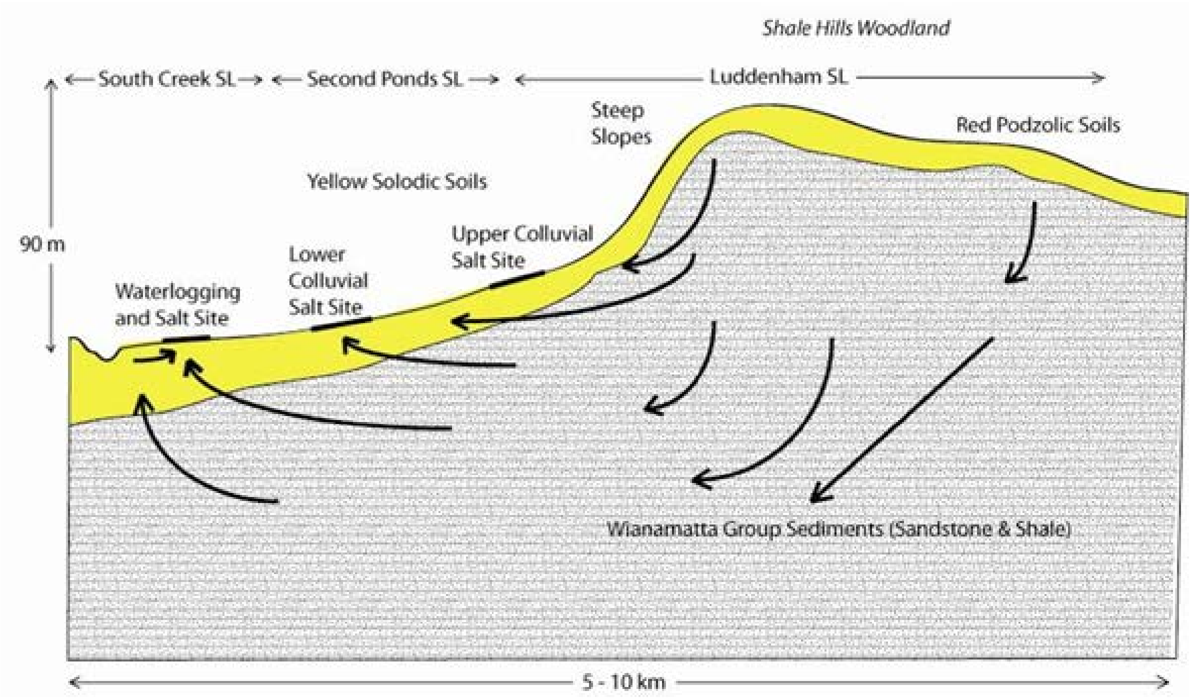
- **Buffer the salt store (1):** There are stores of salt in discrete upper and lower colluvial areas, which vegetation can buffer, limiting the salinity impact. They are generally in the upper erosional elements of the landscape associated with specific stratigraphy and comprise a significant percentage of this HGL.

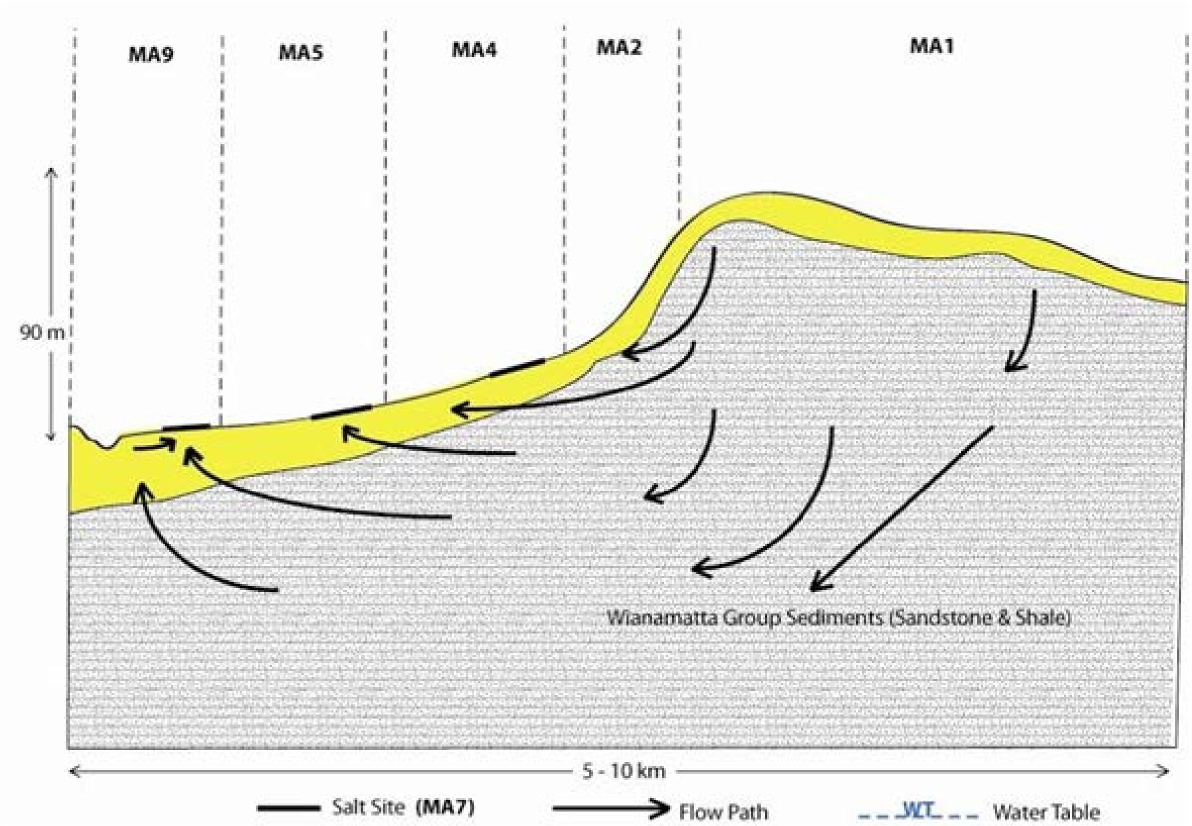
- **Stop discrete landscape recharge (3):** There are discrete elements of this landscape where specific recharge occurs.
- **Discharge rehabilitation (4):** The saline sites are small and numerous. Discharge management will reduce salt discharge to streams when species salt tolerances are matched to salt site intensity.
- **Dry out the landscape with diffuse actions over most of the landscape (6):** Maximise plant growth and water use in order to use excess soil moisture and shallow groundwater. Healthy, actively growing vegetation will also act as a buffer to groundwater accessions in wet seasonal conditions.

Targeted urban management strategies (in priority order)

- **Urban Investigations (UI):** The landscape contains significant salinity, and geological situations that predispose salinity development. Assessment of the location, intensity and scale of salinity is needed. There are areas of sensitive sodic soils, particularly in drainage lines that need to be identified.
- **Urban Planning (UP):** Planning of sub-division layout and design is required to manage salinity consequences. Development must not increase the salinity hazard of the natural and built environment. Layout and design should consider locations of roads, infrastructure and greenspace as well as building allotments, and water sensitive urban design.
- **Urban Management (UM):** The input of water into the landscape (lawns, gardens, sporting fields) including the management of recycled water requires careful management.
- **Urban Construction (UC):** Construction on saline land will require salt resistant/ resilient materials. The typical slope gradient of this HGL requires careful consideration of depth of cut and location of roads on hillslopes; and all infrastructure, including underground utilities.
- **Urban Vegetation (UV):** Maintain and enhance vegetation (including remnant vegetation) for the management of recharge, and as a buffer to excess water input. Waterwise gardening should be encouraged in residential areas.
- **Riparian Management (RM):** Vegetation management in riparian areas will assist in minimising salt export to streams.

Conceptual cross-section and management areas





High hazard land use

There are some activities that should be discouraged in this HGL as they will have negative impacts on salinity.

At Risk Management Areas	Action
MA4, MA5, MA9	• Correct selection of vegetation species is required to effectively reduce amount of shallow groundwater salinity reaching the surface.

At Risk Management Areas	Action
MA5, MA9	• Avoid recharge through over-irrigation and on-site wastewater disposal leakages. • Use salt protected materials for services (e.g. salt resistant drainage pipes, casing of underground services). • Avoid obstruction to surface and sub-surface drainage that will cause wet areas creating waterlogging and salt mobilisation.

Management actions

Urban salinity management actions to consider for specific management areas in this landscape are as follows:

Management Areas	Action
MA1 (Ridges)	**Urban Construction** • Minimise depth of cut and exposure of susceptible soils during development. Ensure fill material interface is not saline (UC1) • In areas where nearby GDEs are not reliant on recharge, deep drainage should be minimised by maximising surface water runoff (UC2) • Establish good drainage prior to construction in shrink/swell soils (UC4) **Urban Vegetation** • Promote the retention and establishment of deep-rooted vegetation that maximises water use in new urban development areas (UV2) • Develop native landscaping and “waterwise” gardens to reduce over-irrigation and water usage (UV3)
MA2 (Upper slopes – erosional)	**Urban Planning** • Implementation of WSUD techniques considers the potential impact on the local salinity hazard. Revise principles of WSUD where salinity affects are an issue (UP5) **Urban Management** • Employ deficit irrigation principles to prevent over-irrigation of sports grounds, golf courses, parks, private gardens and lawns (UM2) **Urban Construction** • Minimise depth of cut and exposure of susceptible soils during development. Ensure fill material interface is not saline (UC1) • Sub-surface drainage should be incorporated into all infrastructure including roads, pathways, behind cuts and retaining walls and other impervious areas to avoid waterlogging (UC3) • Ensure road construction is suitable for conditions (UC5) **Urban Vegetation** • Promote the retention and establishment of deep-rooted vegetation that maximises water use in new urban development areas (UV2)
MA4 (Midslopes - colluvial)	**Urban Investigations** • Investigate concentration and composition of salts in the soil profile, groundwater and surface waters during initial site assessment to determine salinity hazard (UI1) **Urban Planning** • Prior to commencement of earth works sodic/saline soils should be identified (UP1) • Minimise use of infiltration and detention of stormwater in hazard areas; consider lining of detention systems to prevent infiltration. Reconsider WSUD implications in relation to salinity management and potential impact on nearby groundwater dependent ecosystems (GDEs) (UP2) • Identification of discharge sites should influence the size of the area to be developed (UP3)

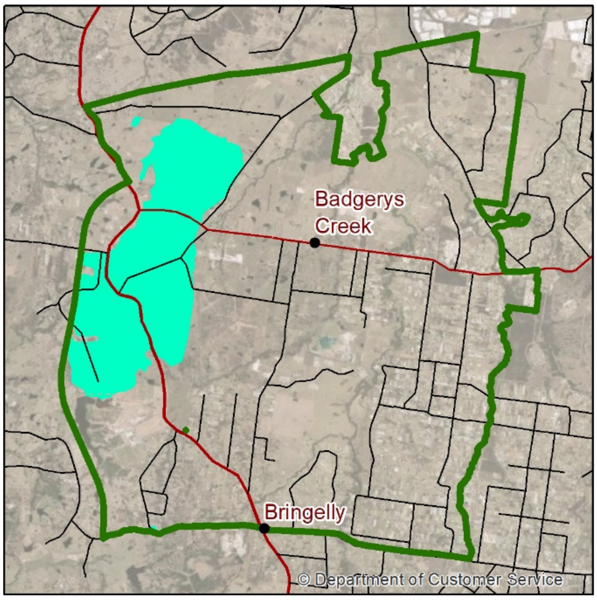
Management Areas	Action
	• Implementation of WSUD techniques considers the potential impact on the local salinity hazard. Revise principles of WSUD where salinity affects are an issue (UP5) **Urban Management** • Employ deficit irrigation principles to prevent over-irrigation of sports grounds, golf courses, parks, private gardens and lawns (UM2) **Urban Construction** • Minimise depth of cut and exposure of susceptible soils during development. Ensure fill material interface is not saline (UC1) • Sub-surface drainage should be incorporated into all infrastructure including roads, pathways, behind cuts and retaining walls and other impervious areas to avoid waterlogging (UC3) • Ensure road construction is suitable for conditions (UC5) • New houses, buildings or infrastructure (including roads, pathways and retaining walls) in current or potentially salt affected areas may need to be built to withstand the effects of salinity utilising industry accepted standards. In badly affected areas, consideration should be given to rehabilitating salt affected land, building above ground or consideration of open space options (UC6) • Minimise the alteration of natural drainage patterns through construction of houses, roads, railways, channels etc. (UC8) **Urban Vegetation** • Retain or establish areas of deep-rooted salt tolerant indigenous vegetation to manage recharge or discharge sites (UV1) • Promote the retention and establishment of deep-rooted vegetation that maximises water use in new urban development areas (UV2) • Develop native landscaping and "waterwise" gardens to reduce over-irrigation and water usage (UV3)
MA5 (Lower slopes – colluvial)	**Urban Investigations** • Investigate concentration and composition of salts in the soil profile, groundwater and surface waters during initial site assessment to determine salinity hazard (UI1) **Urban Planning** • Prior to commencement of earth works sodic/saline soils should be identified (UP1) • Minimise use of infiltration and detention of stormwater in hazard areas; consider lining of detention systems to prevent infiltration. Reconsider WSUD implications in relation to salinity management and potential impact on nearby groundwater dependent ecosystems (GDEs) (UP2) • Identification of discharge sites should influence the size of the area to be developed (UP3) • Implementation of WSUD techniques considers the potential impact on the local salinity hazard. Revise principles of WSUD where salinity affects are an issue (UP5) **Urban Management** • Minimise leakage of standing water bodies, pools, lakes and service pipes (UM1) • Employ deficit irrigation principles to prevent over-irrigation of sports grounds, golf courses, parks, private gardens and lawns (UM2) **Urban Construction** • In areas where nearby GDEs are not reliant on recharge, deep drainage should be minimised by maximising surface water runoff (UC2) • Sub-surface drainage should be incorporated into all infrastructure including roads, pathways, behind cuts and retaining walls and other impervious areas to avoid waterlogging (UC3) • Ensure road construction is suitable for conditions (UC5)

Management Areas	Action
	• New houses, buildings or infrastructure (including roads, pathways and retaining walls) in current or potentially salt affected areas may need to be built to withstand the effects of salinity utilising industry accepted standards. In badly affected areas, consideration should be given to rehabilitating salt affected land, building above ground or consideration of open space options (UC6) • Consider the use of salt protected materials for services (e.g. salt resistant drainage pipes, casing of underground services) (UC7) • Minimise the alteration of natural drainage patterns through construction of houses, roads, railways, channels etc (UC8) **Urban Vegetation** • Retain or establish areas of deep-rooted salt tolerant indigenous vegetation to manage recharge or discharge sites (UV1) • Promote the retention and establishment of deep-rooted vegetation that maximises water use in new urban development areas (UV2) • Develop native landscaping and "waterwise" gardens to reduce over-irrigation and water usage (UV3)
MA9 (Alluvial plain)	**Urban Construction** • Consider the use of salt protected materials for services (e.g. salt resistant drainage pipes, casing of underground services) (UC7) **Urban Vegetation** • Establish new vegetation using salt tolerant species (UV4) **Riparian Management** • Retain or re-establish areas of effectively vegetated riparian buffer zones to manage discharge areas (preferably salt tolerant indigenous vegetation) (RM1) • Maintain/re-establish effective vegetated riparian buffer zones (RM2)

Source: *NSW Department of Planning, Industry and Environment, Environment, Energy and Science Group, (in press) Urban Salinity Management in the Western Sydney Aerotropolis Area (Derived from Western Sydney Hydrogeological Landscapes (2011)), October 2020*

Mulgoa HGL

Overall hazard	Moderate
Likelihood	Moderate
Overall Impact	Significant
Urban Landscape Management Strategies	1,2,5,6
Targeted Urban Management Strategies	UP, UV, UI, UM, RM, UC



Salinity expression

Land Salinity	Land salinity is moderate. Frequent small salt sites in upper drainage lines. Minor salt salts do occur in the low-lying low slope areas.
Salt Load (export)	Salt export is moderate. Lateral throughflow and groundwater discharge into the Nepean River will contribute load, however the Nepean River will significantly dilute salt discharge emanating from this HGL.
Water EC (water quality)	Water EC is moderate. The internal drainage lines have moderate EC.

Specific land management constraints

- In unsewered areas, on-site wastewater disposal leakages may interact with landscape salt store to increase salinity hazard.
- Steep slopes may affect construction activities such as cut-and-fill, building of foundations and retaining walls. Creation of barriers can increase localised accumulation of salt.

Specific land management opportunities

- Salt sites are small and easily remedied.
- Remnant vegetation – trees and shrubs will assist controlling waterlogging and will assist salinity control at small salt sites in upper drainage lines.

Strategies for urban salinity management

Urban Landscape Management Strategies

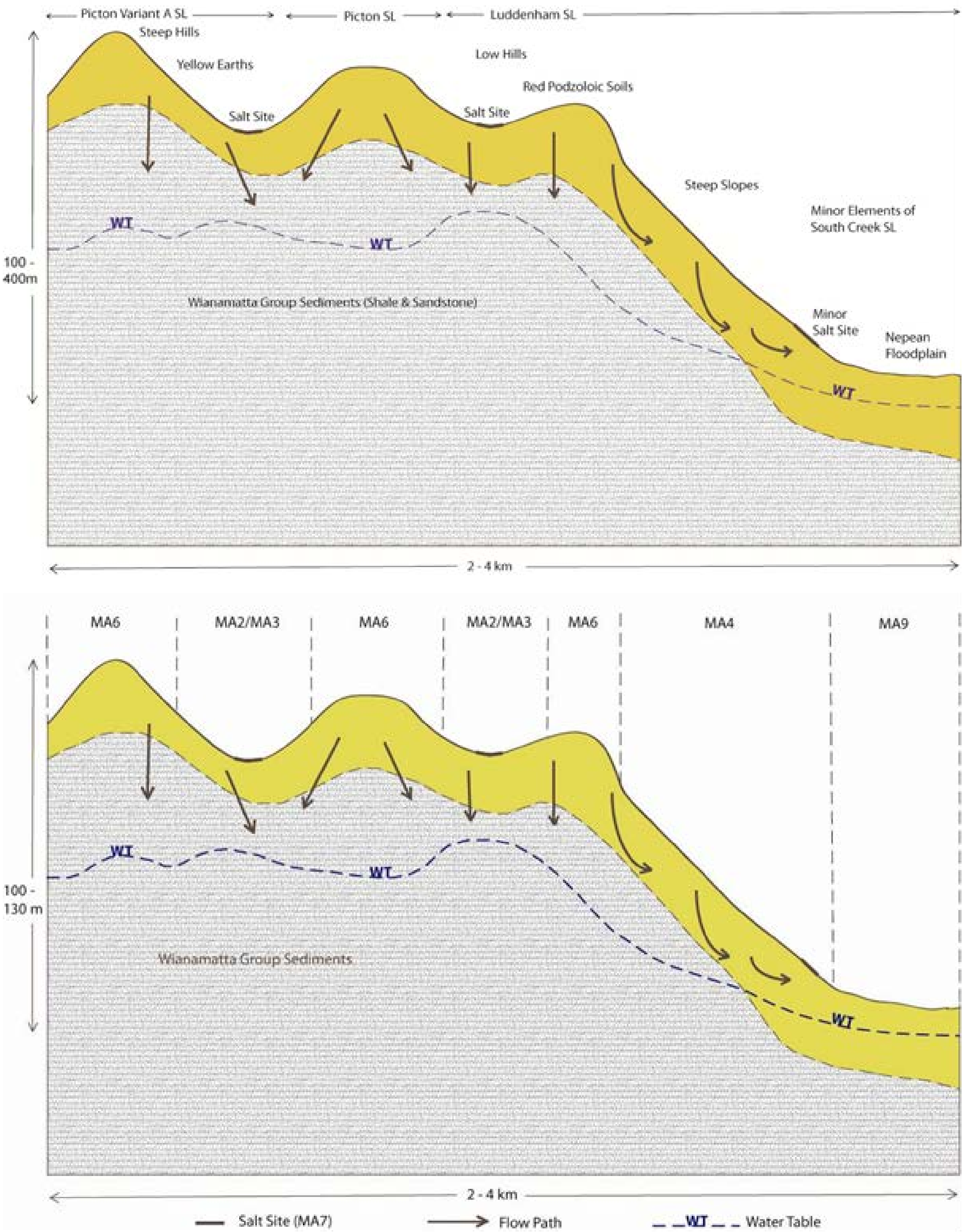
- **Buffer the salt store (1):** There are stores of salt in discrete upper and lower colluvial areas, which vegetation can buffer, limiting the salinity impact. They are generally in the upper erosional elements of the landscape associated with specific stratigraphy and comprise a significant percentage of this HGL.
- **Discharge rehabilitation (2):** The saline sites are small in size and numerous. Discharge management will reduce salt discharge to streams when species salt tolerances are matched to salt site intensity.

- **Increase agricultural production to dry out the landscape and reduce recharge (5):** The area is currently mostly in agricultural or horticultural usage. There are significant native and introduced pastures in the area.
- **Dry out the landscape with diffuse actions over most of the landscape (6):** Maximise plant growth and water use in order to use excess soil moisture and shallow groundwater. Healthy, actively growing vegetation will also act as a buffer to groundwater accessions in wet seasonal conditions.

Targeted Urban Management Strategies (in priority order)

- **Urban Planning (UP):** Planning of sub-division layout and design is required to manage salinity consequences. Development must not increase the salinity hazard of the natural and built environment. Layout and design should consider locations of roads, infrastructure and greenspace as well as building allotments, and water sensitive urban design.
- **Urban Vegetation (UV):** Maintain and enhance vegetation (including remnant vegetation) for the management of recharge, and as a buffer to excess water input. Waterwise gardening should be encouraged in residential areas.
- **Urban Investigations (UI):** The landscape contains significant salinity, and geological situations that predispose salinity development. Assessment of the location, intensity and scale of salinity is needed. There are areas of sensitive sodic soils, particularly in drainage lines that need to be identified.
- **Urban Management (UM):** The input of water into the landscape (lawns, gardens, sporting fields) including the management of recycled water requires careful management.
- **Riparian Management (RM):** Vegetation management in riparian areas will assist in minimising salt export to streams.
- **Urban Construction (UC):** Construction on saline land will require salt resistant/ resilient materials. The typical slope gradient of this HGL requires careful consideration of depth of cut and location of roads on hillslopes; and all infrastructure, including underground utilities.

Conceptual cross-section and management areas



High hazard land use

There are some management actions that should be discouraged in this HGL as they will have negative impacts on salinity.

At Risk Management Areas	Action
MA4, MA9	• Avoid obstruction to surface and sub-surface drainage that will cause wet areas creating waterlogging and salt mobilisation • Avoid recharge through over irrigation and on-site wastewater disposal leakages.

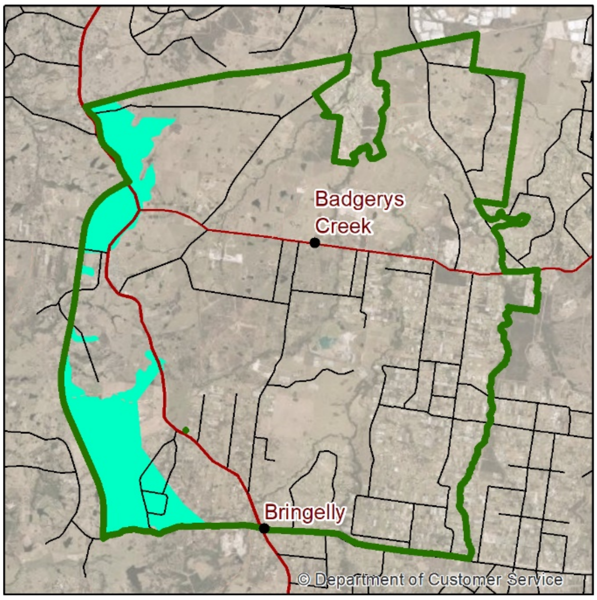
Management actions

Urbanisation was minimal in this HGL when the original Western Sydney HGL classification was undertaken. Hence specific urban salinity management actions were not derived for the HGL.

Source: *NSW Department of Planning, Industry and Environment, Environment, Energy and Science Group, (in press) Urban Salinity Management in the Western Sydney Aerotropolis Area (Derived from Western Sydney Hydrogeological Landscapes (2011)), October 2020*

Greendale HGL

Overall hazard	High
Likelihood	High
Overall Impact	Significant
Urban Landscape Management Strategies	1,2,4,6
Targeted Urban Management Strategies	UP, UI, UC, UM, UV, RM



Salinity expression

Land Salinity	Land salinity is moderate. Frequent small seasonal salt sites may occur on the elevated low rises and on ponded areas.
Salt Load (export)	Salt export is low. The lack of free-flowing drainage lines and associated higher recharge areas restricts salt export via surface water flows.
Water EC (water quality)	Water EC is moderate. Base flow and ponded water EC generally marginal (0.2–1.8 dS/m). Increased EC in ponds may occur during dry periods. The impact of salt on water quality is moderate (localised).

Specific land management constraints

- Urban development activities may increase waterlogging and the rate of accumulation of salt on elevated upper and lower slopes where salinity is already an issue.
- In unsewered areas, on-site wastewater disposal leakages may interact with landscape salt store to increase salinity hazard.
- Seasonal waterlogging is an issue in upper landscape elements.
- Urbanisation of areas currently under peri-urban land use will increase the recharge potential.

Specific land management opportunities

- Isolated salt sites in upper landscape are of manageable size.
- Discharge management – deep rooted trees and shrubs are likely to be effective in this landscape if correct species are selected based on salinity tolerance. There is an abundance of shallow groundwater available.
- Discharge management – integrated use of urban salinity management practices (salt resistant/resilient materials, water management) consistent with building codes would enable protection of infrastructure and dwellings in lower landscape.

Strategies for urban salinity management

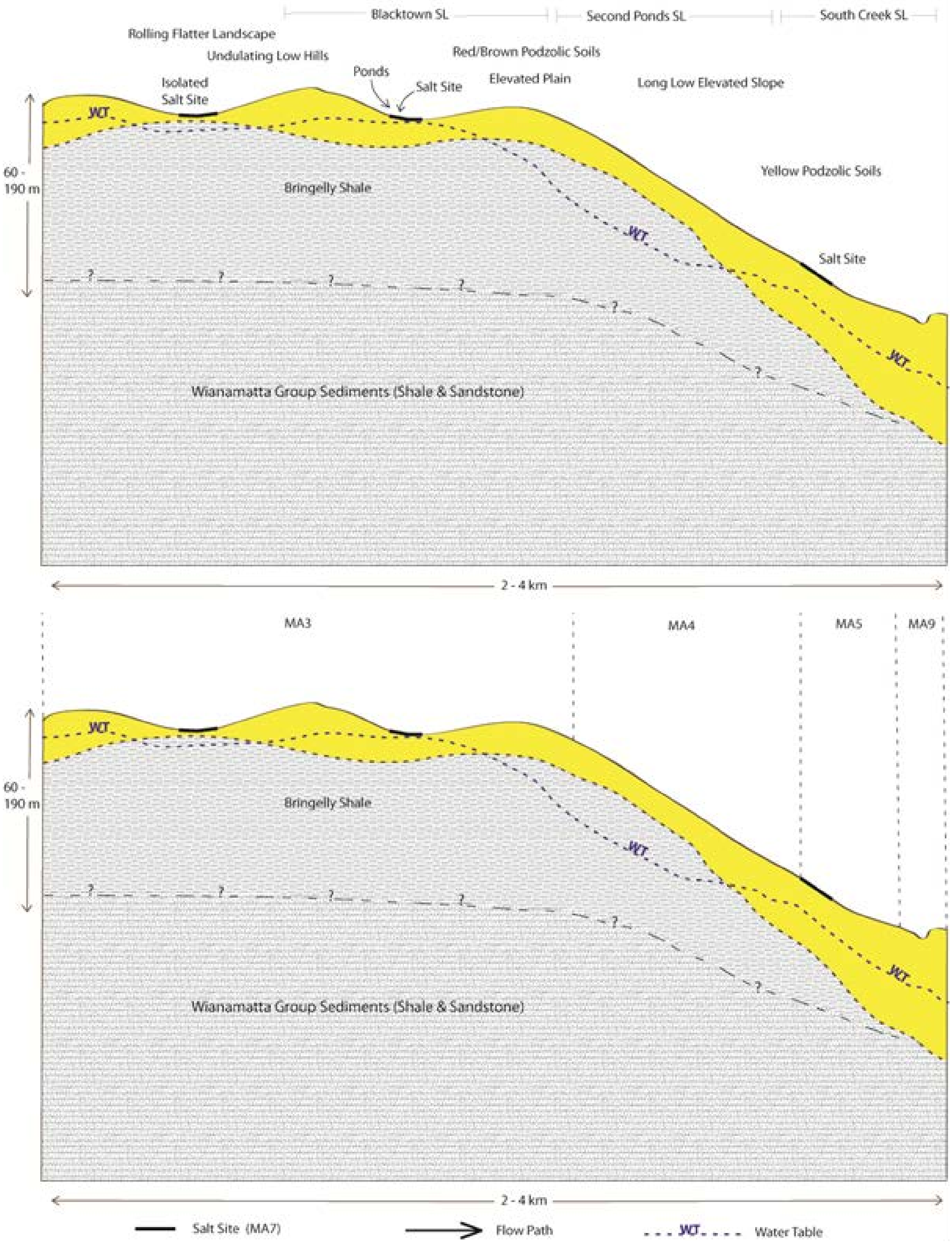
Urban landscape management strategies

- **Buffer the salt store (1):** There are stores of salt in discrete upper and lower colluvial areas, which vegetation can buffer, limiting the salinity impact. They are generally in the upper elements of the landscape controlled by regolith depth.
- **Intercept the lateral flow and shallow groundwater (2):** This HGL can target shallow water tables that exist at the upper and lower colluvial slope elements and where the regolith is shallow. Rows of deep rooted trees (8–30 rows) and shrubs can be effective in interception of lateral flow. Rooting depth will intercept shallow groundwater in the upper part of the landscape.
- **Discharge rehabilitation (4):** The saline sites are small and numerous. Discharge management will reduce salt discharge to streams when species salt tolerances are matched to salt site intensity.
- **Dry out the landscape with diffuse actions over most of the landscape (6):** Maximise plant growth and water use in order to use excess soil moisture and shallow groundwater. Healthy, actively growing vegetation will also act as a buffer to groundwater accessions in wet seasonal conditions.

Targeted urban management strategies (in priority order)

- **Urban Planning (UP):** Planning of sub-division layout and design is required to manage salinity consequences. Development must not increase the salinity hazard of the natural and built environment. Layout and design should consider locations of roads, infrastructure and greenspace as well as building allotments, and water sensitive urban design.
- **Urban Investigations (UI):** The landscape contains significant salinity, and geological situations that predispose salinity development. Assessment of the location, intensity and scale of salinity is needed. There are areas of sensitive sodic soils, particularly in drainage lines that need to be identified.
- **Urban Construction (UC):** Construction on saline land will require salt resistant/ resilient materials. The typical slope gradient of this HGL requires careful consideration of depth of cut and location of roads on hillslopes; and all infrastructure, including underground utilities.
- **Urban Management (UM):** The input of water into the landscape (lawns, gardens, sporting fields) including the management of recycled water requires careful management.
- **Urban Vegetation (UV):** Maintain and enhance vegetation (including remnant vegetation) for the management of recharge, and as a buffer to excess water input. Waterwise gardening should be encouraged in residential areas.
- **Riparian Management (RM):** Vegetation management in riparian areas will assist in minimising salt export to streams.

Conceptual cross-section and management areas



High hazard land use

There are some activities that should be discouraged in this HGL as they will have negative impacts on salinity.

At Risk Management Areas	Action
MA3, MA4, MA5, MA9	• Avoid recharge that leads to waterlogging through over-irrigation and on-site wastewater disposal leakages.

At Risk Management Areas	Action
	• Correct selection of vegetation species is required to effectively reduce amount of shallow groundwater salinity reaching the surface.
MA5, MA9	• Avoid recharge through over-irrigation and on-site wastewater disposal leakages. • Avoid obstruction to surface and sub-surface drainage that will cause wet areas creating waterlogging and salt mobilisation

Management actions

Urban salinity management actions to consider for specific management areas in this landscape are as follows:

Management Areas	Action
MA3 (Upper slopes – colluvial)	**Urban Planning** • Minimise use of infiltration and detention of stormwater in hazard areas; consider lining of detention systems to prevent infiltration. Reconsider WSUD implications in relation to salinity management and potential impact on nearby groundwater dependent ecosystems (GDEs) (UP2) • Identification of discharge sites should influence the size of the area to be developed (UP3) • Implementation of WSUD techniques considers the potential impact on the local salinity hazard. Revise principles of WSUD where salinity affects are an issue (UP5) **Urban Construction** • Minimise depth of cut and exposure of susceptible soils during development. Ensure fill material interface is not saline (UC1) • Sub-surface drainage should be incorporated into all infrastructure including roads, pathways, behind cuts and retaining walls and other impervious areas to avoid waterlogging (UC3) • Ensure road construction is suitable for conditions (UC5) **Urban Management** • Employ deficit irrigation principles to prevent over-irrigation of sports grounds, golf courses, parks, private gardens and lawn (UM2) **Urban Vegetation** • Promote the retention and establishment of deep-rooted vegetation that maximises water use in new urban development areas (UV2)
MA4 (Midslopes – colluvial)	**Urban Planning** • Minimise use of infiltration and detention of stormwater in hazard areas; consider lining of detention systems to prevent infiltration. Reconsider WSUD implications in relation to salinity management and potential impact on nearby groundwater dependent ecosystems (GDEs) (UP2) • Identification of discharge sites should influence the size of the area to be developed (UP3) • Implementation of WSUD techniques considers the potential impact on the local salinity hazard. Revise principles of WSUD where salinity affects are an issue (UP5) **Urban Investigations** • Investigate concentration and composition of salts in the soil profile, groundwater and surface waters during initial site assessment to determine salinity hazard (UI1) **Urban Construction** • Minimise depth of cut and exposure of susceptible soils during development. Ensure fill material interface is not saline (UC1)

Management Areas	Action
	• Sub-surface drainage should be incorporated into all infrastructure including roads, pathways, behind cuts and retaining walls and other impervious areas to avoid waterlogging (UC3) **Urban Management** • Employ deficit irrigation principles to prevent over-irrigation of sports grounds, golf courses, parks, private gardens and lawns (UM2) **Urban Vegetation** • Retain or establish areas of deep-rooted salt tolerant indigenous vegetation to manage recharge or discharge sites (UV1) • Promote the retention and establishment of deep-rooted vegetation that maximises water use in new urban development areas (UV2) • Develop native landscaping and “waterwise” gardens to reduce over-irrigation and water usage (UV3)
MA5 (Lower slopes – colluvial)	**Urban Planning** • Prior to commencement of earth works sodic/saline soils should be identified (UP1) • Minimise use of infiltration and detention of stormwater in hazard areas; consider lining of detention systems to prevent infiltration. Reconsider WSUD implications in relation to salinity management and potential impact on nearby groundwater dependent ecosystems (GDEs) (UP2) • Identification of discharge sites should influence the size of the area to be developed (UP3) • Implementation of WSUD techniques considers the potential impact on the local salinity hazard. Revise principles of WSUD where salinity affects are an issue (UP5) **Urban Investigations** • Investigate concentration and composition of salts in the soil profile, groundwater and surface waters during initial site assessment to determine salinity hazard (UI1) **Urban Construction** • In areas where nearby GDEs are not reliant on recharge, deep drainage should be minimised by maximising surface water runoff (UC2) • Sub-surface drainage should be incorporated into all infrastructure including roads, pathways, behind cuts and retaining walls and other impervious areas to avoid waterlogging (UC3) • Ensure road construction is suitable for conditions (UC5) • Consider the use of salt protected materials for services (e.g. salt resistant drainage pipes, casing of underground services) (UC7) • Minimise the alteration of natural drainage patterns through construction of houses, roads, railways, channels etc (UC8) **Urban Management** • Minimise leakage of standing water bodies, pools, lakes and service pipes (UM1) • Employ deficit irrigation principles to prevent over-irrigation of sports grounds, golf courses, parks, private gardens and lawns (UM2) • Manage plant growth to maximise water usage (UM3) **Urban Vegetation** • Retain or establish areas of deep-rooted salt tolerant indigenous vegetation to manage recharge or discharge sites (UV1) • Promote the retention and establishment of deep-rooted vegetation that maximises water use in new urban development areas (UV2) • Develop native landscaping and “waterwise” gardens to reduce over-irrigation and water usage (UV3)
MA9 (Alluvial plain)	**Urban Vegetation** • Establish new vegetation using salt tolerant species (UV4)

Management Areas	Action
	Riparian Management • Retain or re-establish areas of effectively vegetated riparian buffer zones to manage discharge areas (preferably salt tolerant indigenous vegetation) (RM1) • Maintain/re-establish effective vegetated riparian buffer zones (RM2)

Source: *NSW Department of Planning, Industry and Environment, Environment, Energy and Science Group, (in press) Urban Salinity Management in the Western Sydney Aerotropolis Area (Derived from Western Sydney Hydrogeological Landscapes (2011)), October 2020*

Appendix E
Urban Salinity Management (DPIE EES 2020)

Source: *NSW Department of Planning, Industry and Environment, Environment, Energy and Science Group, (in press) Urban Salinity Management in the Western Sydney Aerotropolis Area (Derived from Western Sydney Hydrogeological Landscapes (2011)), October 2020*

Targeted urban management strategies

These strategies are used to target activities in each HGL. They recognise the need for diffuse and specific activities within the landscape that are required to impact on salinity issues.

Targeted urban management strategies are grouped into six areas of activity:

- **Urban Investigations (UI)**: The landscape contains significant salinity, and geological situations that predispose it to salinity development. Assessment of the location, intensity and scale of salinity is needed. Identification of extreme salinity is needed.
- **Urban Planning (UP)**: Planning of sub-division layout and design is required to manage salinity consequences. Development should not increase the salinity hazard of the natural and built environment. Layout and design should consider locations of roads, infrastructure and greenspace as well as building allotments, and water sensitive urban design (WSUD).
- **Urban Construction (UC)**: Construction on saline land will require salt resistant/resilient materials. The salinities encountered in this HGL require careful consideration of construction method, depth of cut and location of roads, and all infrastructure including underground utilities.
- **Urban Management (UM)**: The input of water into the landscape (from lawns, gardens, sporting fields), including the management of recycled water, requires careful management.
- **Urban Vegetation (UV)**: Maintain and enhance vegetation (including remnant vegetation) for the management of recharge and as a buffer to excess water input. Water-wise gardening should be encouraged in residential areas.
- **Riparian Management (RM)**: Vegetation management in riparian areas will assist in minimising salt export to streams.

Urban management action priorities will vary in importance between HGLs in the Aerotropolis area as indicated in Table F1.

Table F1 Targeted urban management strategy group priorities for Western Sydney HGLs in the Aerotropolis area.

Urban HGLs	Targeted Urban Management Strategy Groups (in priority order)
Shale Plains HGL	UI, UP, UC, UM, UV, RM
Upper South Creek HGL	UP, UI, UC, UV, UM, RM
Mt Vernon HGL	UI, UP, UM, UC, UV, RM
Mulgoa HGL	UP, UV, UI, UM, RM, UC
Greendale HGL	UP, UI, UC, UM, UV, RM

Urban management actions

Specific urban management actions are assigned to appropriate management areas, ensuring that salinity management options used give optimal outcomes across the urban landscape.

The applicability of a management action may vary. Sometimes the action is very suitable for delivering a strategy but unsuited to deliver a different strategy. Similarly, a management action which is suitable for salinity management in one landscape may be unsuitable or ineffective in another. Combinations of urban management actions are tailored in accordance with the urban management strategy objectives.

The **key to urban salinity management using the HGL framework is to match the specific actions to the appropriate management area.** As an example, a key urban management action priority for slope areas and the alluvial plain of the Upper South Creek HGL is **Urban Planning (UP)**, specifically **UP1**. In this case, sodic/saline soils should be identified prior to starting earthworks.

The urban management actions of each targeted urban management strategy group are described in Table 5. This table presents all the management actions available. Not all will be suitable for every HGL in the Aerotropolis area. Sometimes a management action that is very suitable for delivering one strategy will be unsuitable for a different strategy. Similarly, a management action which is suitable for salinity management in one landscape may be unsuitable or ineffective in another. Combinations of management actions are tailored in accordance with management strategy objectives.

The appropriate urban management actions to apply to specific management areas in each HGL in the Aerotropolis area are described in Appendix D.

Table F2 Targeted urban management strategy groups and associated actions for Western Sydney HGLs in the Aerotropolis area.

Targeted Urban Management Strategy Group	Code	Management Action
Urban Planning	UP1	Prior to starting earthworks, sodic/saline soils should be identified
	UP2	Minimise use of infiltration and detention of stormwater in hazard areas; consider lining of detention systems to prevent infiltration. Reconsider WSUD implications in relation to salinity management and potential impact on nearby groundwater dependent ecosystems.
	UP3	Identification of discharge sites should influence the size of the area to be developed
	UP4	In areas where nearby groundwater dependent ecosystems are not reliant on recharge, maximise the size of impervious surfaces to prevent recharge of (perched) groundwater tables. Constructed pervious surfaces may need to be lined and drained to stormwater outlets. Consideration will need to be given to the offsite ecological impacts of diverting runoff.
	UP5	Implementation of WSUD techniques considers the potential impact on the local salinity hazard. Revise principles of WSUD where salinity effects are an issue
Urban Investigations	UI1	Investigate concentration and composition of salts in the soil profile, groundwater and surface waters during initial site assessment to determine salinity hazard
	UI2	Use geophysical techniques to define geological contacts (EM survey)
	UI3	Identify and manage sodic soils
Urban Vegetation	UV1	Retain or establish areas of deep-rooted salt tolerant indigenous vegetation to manage recharge or discharge site
	UV2	Promote the retention and establishment of deep-rooted vegetation that maximises water use in new urban development areas
	UV3	Develop native landscaping and water-wise gardens to reduce over-irrigation and water usage
	UV4	Establish new vegetation using salt tolerant species
	UV5	Locate strategic plantings of deep-rooted perennial vegetation to manage discharge areas
Urban Construction	UC1	Minimise depth of cut and exposure in susceptible soils during development. Ensure fill material interface is not saline
	UC2	In areas where nearby groundwater dependent ecosystems are not reliant on recharge, deep drainage should be minimised by maximising surface water runoff
	UC3	Sub-surface drainage should be incorporated into all infrastructure including roads, pathways, behind cuts and retaining walls and other impervious areas to avoid waterlogging

Targeted Urban Management Strategy Group	Code	Management Action
	UC4	Establish good drainage prior to construction in shrink/swell soils
	UC5	Ensure road construction is suitable for conditions
	UC6	New houses, buildings or infrastructure (including roads, pathways and retaining walls) in current or potentially salt affected areas may need to be built to withstand the effects of salinity utilising industry accepted standards. In badly affected areas, consideration should be given to rehabilitating salt affected land, building above ground or incorporating open space options
	UC7	Consider the use of salt protected materials for services (e.g. salt resistant drainage pipes, casing of underground services)
	UC8	Minimise the alteration of natural drainage patterns from construction of houses, roads, railways, channels etc
Urban Management	UM1	Minimise leakage of standing water bodies, pools, lakes and service pipes
	UM2	Employ deficit irrigation principles to prevent over-irrigation of sports grounds, golf courses, parks, private gardens and lawns
	UM3	Manage plant growth to maximise water usage.
Riparian Management	RM1	Retain or re-establish effectively vegetated riparian buffer zones to manage discharge areas (preferably with salt tolerant indigenous vegetation)
	RM2	Maintain/re-establish effective vegetated riparian buffer zones

High hazard land uses

High hazard land uses have a range of impacts that have a negative outcome in the landscape. Salinity processes will intensify, and salt mobilisation will be increased due to:

- lowered evapotranspiration/plant water use
- rising and high water tables
- changed water balance and surface water management requirements.

High hazard land uses range in their importance across different landscapes and across different management areas. They can have the following negative outcomes.

- lower plant water use leading to more recharge
- increased hydraulic head
- lower surface water runoff leading to less dilution flow in streams
- limited conditions for soil water storage
- limited conditions for plant water use
- damage to infrastructure
- adding salt to soil profile

Appendix F

Soil and land resource reports (DPIE EES 2020)

Table G1 Summary of soil and land constraints for soil landscapes in the Aerotropolis area (DPIE 2020).

Soil Landscape Name / (code)	Geomorphic process	Dominant soil regolith stability	Flood hazard	Foundation hazard	Gully erosion risk	High run-on	Mass movement hazard	Permanent waterlogging	Poor drainage	Seasonal waterlogging	Shallow soils	Subsoil sodicity	Urban capability (A-E)
Blacktown (bty)	Residual (Erosional)	R3	-	L	L	L	-	-	L	L	L	W	B
Luddenham (luz)	Erosional	R3	L	W	L	L	L	-	L	L	-	W	B
Picton variant a (pnza)	Colluvial	R3	-	W	L	L	W	-	L	L	L	W	D
Rickabys Creek (rcz)	Stagnant Alluvial	R3	L	W	-	L	L	L	W	L	L	W	B
South Creek (scy)	Alluvial	R4	W	-	L	W	-	L	W	L	-	W	D(E)
Seconds Pond Creek (spz)	Transferral	R4	L	W	W	W	-	L	W	W	-	W	D

W = Widespread occurrences, L = Localised occurrences, - = Not observed

Source: *NSW Department of Planning, Industry and Environment, Environment, Energy and Science Group, (in press) Soil and Land Resource Mapping for the Western Sydney Aerotropolis Area (Derived from Soil and Land Resources of the Hawkesbury Nepean Catchment (2008)), October 2020*

Blacktown

bty	Blacktown	Residual/Erosional

Summary

Landscape Low hills and rises on Wianamatta Group Shale (shale, sandstone-lithic and sandstone- quartz) in the Cumberland Plain, Hornsby Plateau and Picton Hills. Local relief 10-50 m; altitude 10-202 m; slopes 0-9%; rock outcrop nil. Extensively cleared woodland.

Soils Red Kurosols (Red and Brown Podzolic Soils) Red and Yellow Sodosols (Soloths) and Yellow Chromosols (Yellow Podzolic Soils). Red Chromosols, Red Dermosols and Red Ferrosols (Krasnozems) on iron-rich parent material.

Vegetation Extensively cleared. Two distinct vegetation units. Closer to the coast the vegetation is dominated by wet sclerophyll forest (tall open forest) with this grading into dry sclerophyll forest (open woodland) to the west as rainfall declines. The wet sclerophyll forest is dominated by *Eucalyptus saligna* and *E. pilularis*, with minor pockets of *E. sieberi*. The dry sclerophyll forest is dominated by Shale Plains Woodland (NPWS 2000) with minor occurrences of Shale Hills Woodland. Dominant species are *E. moluccana* and *E. tereticornis*. There is generally a smaller tree stratum, a shrub stratum and a ground cover stratum. Common tree species include *E. moluccana* (grey box), *E. tereticornis* (forest red gum), *E. crebra* (ironbark), *E. eugenioides* (thin-leaved stringybark), *E. baueriana* (blue box),*Corymbia maculata* (spotted gum), *Exocarpos cupressiformis* (native cherry), *Acacia parramattensis* spp*. parramattensis* (Sydney green wattle) and *Acacia decurrens* (black wattle). Shrubs are dominated by *Bursaria spinosa* (blackthorn). Ground strata includes *Dichondra repens* (kidney weed), *Aristida vagans* (wire grass), *Microlaena stipoides* var*. stipoides*, *Themeda australis* (kangaroo grass), *Brunoniella australis* (blue trumpet), *Desmodium varians* (slender tick-trefoil), *Opercularia diphylla* (common stinkweed), *Wahlenbergia gracilis* (Australian bluebell) and *Dichelachne micrantha* (short-haired plume grass).

Land use	Land use is diverse, and includes grazing pasture, vegetable/flower growing, rural residential, urban, industrial and orchards/cropping. There is increasing pressure for more urban development in this landscape.
Land degradation	Some saline scalds occur mainly at breaks in slope and in lower slope positions where drainage has been significantly altered. At many sites, the A1 horizon has been eroded (sheet erosion), leaving an organically influenced A2 horizon exposed as topsoil.

Land capability

Rural land capability	IV (II, VI)	**Urban Capability**	B (C)
Grazing limitation	low	**Urban limitation**	low to moderate
Cultivation limitation	low to moderate	**Soil regolith stability**	R3 (R1, R4)

Constraints

Steep slopes	not observed	**Mass movement hazard**	not observed
Seasonal waterlogging	localised	**Permanent waterlogging**	not observed
Flood hazard	not observed	**Foundation hazard**	localised
Salinity hazard	localised	**Low fertility**	localised

Erosion Hazard

Sheet	localised	**Gully**	localised
Streambank	not observed	**Wind**	not observed

Source: *NSW Department of Planning, Industry and Environment, Environment, Energy and Science Group, (in press) Soil and Land Resource Mapping for the Western Sydney Aerotropolis Area (Derived from Soil and Land Resources of the Hawkesbury Nepean Catchment (2008)), October 2020*

Luddenham

luz	Luddenham	Erosional

Summary

Landscape Hills and low hills on Wianamatta Group Bringelly Shale (shale, sandstone-lithic and siltstone/mudstone) in the Cumberland Plain and Blue Mountains Plateau. Local relief 30-100 m; altitude 10-404 m; slopes 5-20%; rock outcrop nil. Extensively cleared woodland.

Soils Red Kurosols and Chromosols (Red Podzolic Soils) on crests and slopes, Red Kandosols (Red Earths) on sandstone members, Brown Sodosols (Yellow Solodic Soils) on footslopes and lower slopes and Brown Dermosols on siltstone/mudstone members.

Vegetation Extensively cleared Grey Box Woodland dominated by *Eucalyptus moluccana* (grey box) and *E. tereticornis* (forest red gum), with some sites having *E. crebra* (narrow-leaved ironbark) as a co-dominant species. This landscape has a mixture of Shale Hills Woodland and Shale Plains Woodland (NPWS, 2000). Species include *E. moluccana* (grey box), *E. tereticornis* (forest red gum), *E. maculata* (spotted gum), *E. crebra* (narrow-leaved ironbark), *E. amplifolia* (cabbage gum) and *E. fibrosa* (broad-leaved ironbark). On creek lines *Casuarina glauca* (swamp oak) and *Melaleuca decora* were found. Shrubs include *Bursaria spinosa* (blackthorn), *Breynia oblongifolia* (coffee bush), *Allocasuarina torulosa* (forest oak), *Acacia implexa* (hickory wattle), *Dillwynia sieberi* and *Hardenbergia violacea* (purple coral pea).

Land use The landscape is dominated by improved pastures but there is significant urban and rural residential development. On the less steep slopes (<10%) there is vegetable and vine growing. There are also small areas of scrub or parkland.

Land degradation Moderate gully erosion on steep slopes. Sheet erosion is moderate, slopes are unstable and mass movement occurs. There are small patches of salt in low lying, lower slope positions.

Land capability

Rural land capability	IV (VI)	**Urban Capability**	B (C)
Grazing limitation	low to moderate	**Urban limitation**	moderate to high
Cultivation limitation	low to high	**Soil regolith stability**	R3 (R2)

Constraints

Steep slopes	localised	**Mass movement hazard**	localised
Seasonal waterlogging	localised	**Permanent waterlogging**	not observed
Flood hazard	localised	**Foundation hazard**	widespread
Salinity hazard	localised	**Low fertility**	localised

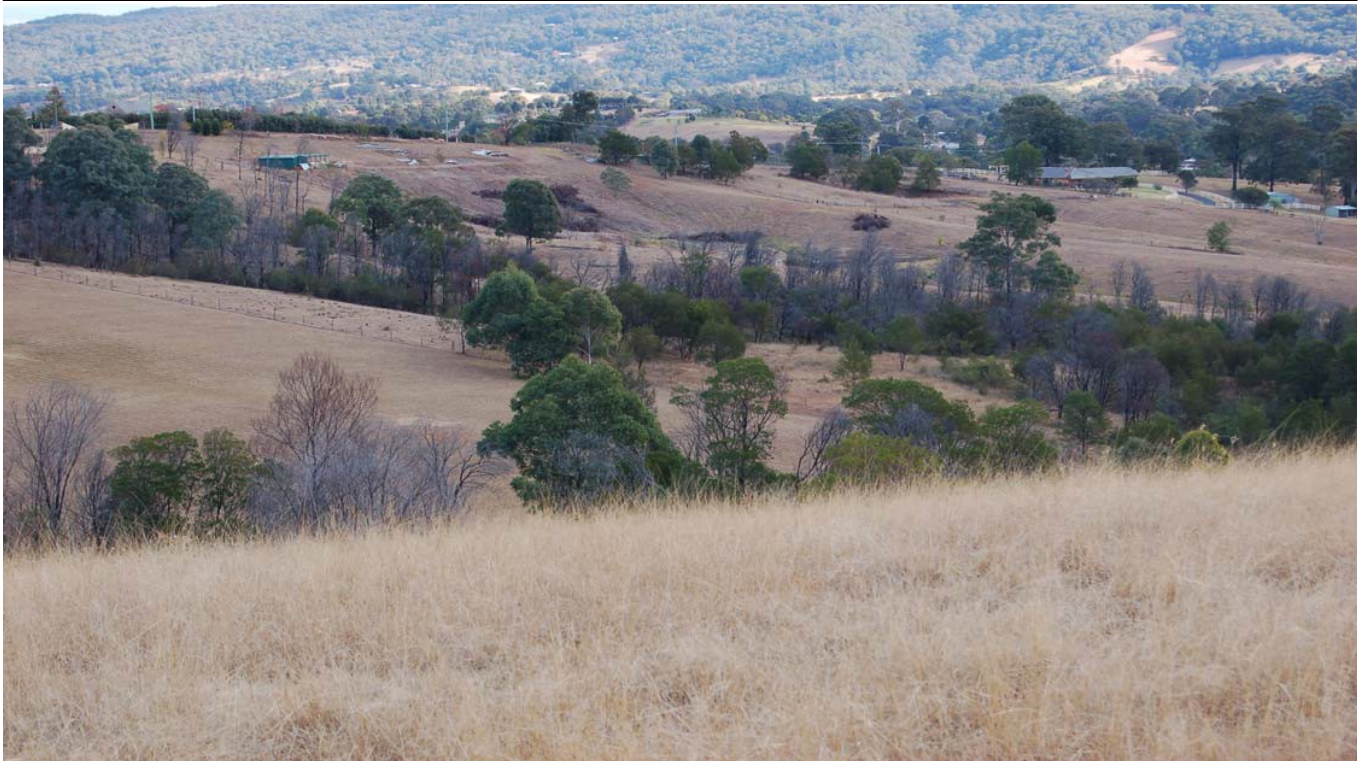
Erosion hazard

Sheet	widespread	**Gully**	localised
Streambank	not observed	**Wind**	not observed

Source: *NSW Department of Planning, Industry and Environment, Environment, Energy and Science Group, (in press) Soil and Land Resource Mapping for the Western Sydney Aerotropolis Area (Derived from Soil and Land Resources of the Hawkesbury Nepean Catchment (2008)), October 2020*

Picton variant a

pnza	Picton variant a	Colluvial



Summary

Landscape	Hills on Wianamatta Group Bringelly Shale (shale and sandstone-lithic) in the Cumberland Plain. Local relief 30-100 m; altitude 30-184 m; slopes 15-25%; rock outcrop nil. Partially cleared woodland.
Soils	Red, Brown and Yellow Kurosols and Chromosols (Red, Brown and Yellow Podzolic Soils)and Natric Kurosols and Sodosols (Soloths).
Vegetation	Partially cleared Grey Box Woodland. Dominated by *Eucalyptus moluccana* (grey box) and *E. tereticornis* (forest red gum), with some sites having *E. crebra* (narrow-leaved ironbark) as a co-dominant species. Other species include *E. amplifolia (cabbage gum) and E. fibrosa* (broad-leaved ironbark). On creek lines *Casuarina Glauca* (swamp oak) and *Melaleuca decora* are found. Shrubs include *Bursaria spinosa* (golden candlesticks), *Dillwynia juniperina* and *Hardenbergia violacea* (false sarsaparilla).
Land use	Mostly cleared for grazing on improved pastures, but some sites timber/scrub unused due to steepness of slope.
Land degradation	Minor sheet and rill erosion on tracks within timbered area. Severe gully erosion within drainage lines where landscape has been cleared and grazed heavily. Widespread slope instability and mass movement in the form of terracettes, slumps and creep flows

Land capability

Rural land capability	(VI (IV, V)	**Urban Capability**	D (E)
Grazing limitation	low to high	**Urban limitation**	high to extreme
Cultivation limitation	high to extreme	**Soil regolith stability**	R3 (R1)

Constraints

Steep slopes	widespread	**Mass movement hazard**	widespre
Seasonal waterlogging	localised	**Permanent waterlogging**	not
Flood hazard	not observed	**Foundation hazard**	widespre
Salinity hazard	localised	**Low fertility**	localised

Erosion hazard

Sheet	widespread	**Gully**	localised
Streambank	not observed	**Wind**	not observed

Source: *NSW Department of Planning, Industry and Environment, Environment, Energy and Science Group, (in press) Soil and Land Resource Mapping for the Western Sydney Aerotropolis Area (Derived from Soil and Land Resources of the Hawkesbury Nepean Catchment (2008)), October 2020*

Rickabys Creek

rcz	Rickabys Creek	Stagnant Alluvial

Summary

Landscape	Plain on Tertiary Alluvium Rickaby's Creek Gravel (alluvium, clay and gravel) in the Cumberland Plain, Blue Mountains Plateau and Wanganderry Tablelands. Local relief 10- 100 m; altitude 10-160 m; slopes 0-10%; rock outcrop nil. Partially cleared woodland.
Soils	Red and Grey Dermosols (Red Podzolic Soil) and Red Kurosols (Red Podzolic Soils).
Vegetation	Partially cleared Castlereagh Scribbly Gum Woodland and Shale/Gravel Transitional Forest (Benson & Keith, 1990). Common species include *Eucalyptus sclerophylla* (hardleaved scribbly gum), *Angophora bakeri* (narrow-leaved apple), *E. fibrosa* (broad-leaved ironbark), *E. moluccana* (coastal grey box), *E. amplifolia* (cabbage gum), *E. parramattensis* (Parramatta red gum), *E. euginioides* (thin-leaved stringybark), *E. punctata* (grey gum), *Casuarina glauca* (swamp oak), *Acacia parramattensis* (Parramatta wattle) and *E. tereticornis* (forest red gum).
Land use	Most of the landscape has been left unused around the Rickabys Creek area. There are minor areas of urban development and some grazing in the Mulgoa Road area. A small section is also within the Blue Mountains National Park.
Land degradation	There is moderate sheet erosion on the steep slopes of the Lapstone monocline and minor streambank erosion where it occurs along streams. There are also reworked, depositional materials on some lower slopes and on the Blue Mountains Plateau.

Land capability

Rural land capability	V (VI)	**Urban Capability**	B
Grazing limitation	moderate to high	**Urban limitation**	low to high
Cultivation limitation	high to very high	**Soil regolith stability**	R3

Constraints

Steep slopes	localised	**Mass movement hazard**	localised
Seasonal waterlogging	localised	**Permanent waterlogging**	localised
Flood hazard	localised	**Foundation hazard**	widespread
Salinity hazard	localised	**Low fertility**	localised

Erosion hazard

Sheet	widespread	**Gully**	not observed
Streambank	localised	**Wind**	not observed

Source: *NSW Department of Planning, Industry and Environment, Environment, Energy and Science Group, (in press) Soil and Land Resource Mapping for the Western Sydney Aerotropolis Area (Derived from Soil and Land Resources of the Hawkesbury Nepean Catchment (2008)), October 2020*

Second Ponds Creek

spz	**Second Ponds Creek**

Summary

Landscape	Footslopes and plains on Colluvium/Alluvium and Wianamatta Group Shale (shale and colluvium) in the Cumberland Plain. Local relief 5-30 m; altitude 10-112 m; slopes 0-3%; rock outcrop nil. Extensively cleared woodland.
Soils	Brown and Yellow Sodosols (Soloths), Brown and Yellow Chromosols and Kurosols (Yellow Podzolic Soils).
Vegetation	Described by NPWS (2000) as Shale Plains Woodland and Alluvial Woodland. The Shale Plains Woodland is dominated by *Eucalyptus tereticornis* (forest red gum) and *E. moluccana* (coastal grey box). The Alluvial Woodland contains *E. amplifolia* (cabbage gum), *Angophora floribunda* (rough-barked apple) and *E. tereticornis* (forest red gum). Other species observed include *E. crebra* (narrow-leaved ironbark), *E. eugenioides* (thin-leaved stringybark), *Corymbia maculata* (spotted gum), *Acacia parramattensis* (Parramatta wattle), *Acacia decurrens* (green wattle), *Exocarpos cupressiformis* (native cherry), *Casuarina glauca* (swamp oak) and *Melaleuca linariifolia* (flax-leaved paperbark).
Land use	Land use includes improved and native pastures, urban and rural residential development, and vegetable/flower growing.
Land degradation	Locally severe salt scalding and associated erosion on lower slope positions Localised gully erosion along drainage depressions.

Land capability

Rural land capability	VI	**Urban Capability**	D
low to moderate	**Urban limitation**	moderate – very high	
Cultivation limitation	low to high	**Soil regolith stability**	R3 (R2)

Constraints

Steep slopes	not observed	**Mass movement hazard**	not observed
Seasonal waterlogging	widespread	**Permanent waterlogging**	localised
Flood hazard	localised	**Foundation hazard**	widespread
Salinity hazard	widespread	**Low fertility**	widespread

Erosion hazard

Sheet	widespread	**Gully**	widespread
Streambank	not observed	**Wind**	not observed

Source: *NSW Department of Planning, Industry and Environment, Environment, Energy and Science Group, (in press) Soil and Land Resource Mapping for the Western Sydney Aerotropolis Area (Derived from Soil and Land Resources of the Hawkesbury Nepean Catchment (2008)), October 2020*

South Creek

scy	South Creek	Alluvial

Summary

Landscape Flood plain on Quaternary Alluvium (alluvium, shale, sand and silt) in the Cumberland Plain. Local relief 0-10 m; altitude 3-159 m; slopes 0-3%; rock outcrop nil. Extensively cleared open forest.

Soils Grey, Yellow and Brown Chromosols (Grey, Red, Brown Podzolic Soils), Black and Brown Dermosols (Prairie Soils) and Tenosols (Alluvial Soils).

Vegetation Original vegetation has been extensively cleared. Described by NPWS (2000) as Alluvial Woodland and River Flat forest. There is usually an upper tree stratum and a lower tree stratum and a sparse shrub stratum and dense ground cover. In the Wollongong map sheet area species observed include *Angophora subvelutina* (broad-leaved apple), *Eucalyptus amplifolia* (cabbage gum*), E. benthamii* (Camden white gum), *Casuarina glauca* (swamp oak), *Melaleuca* spp. (paperbarks), *Leptospermum* spp. (tea-trees). Grass and rush species include *Eleocharis sphacelata* (tall spike rush) and *Juncus usitatus* (juncus). Species observed in the Penrith area include *Eucalyptus amplifolia* (cabbage gum), *E. tereticornis* (forest red gum), *Angophora floribunda* (rough-barked apple), which dominate the upper stratum along with *E. moluccana* (coastal grey box), *A. subvelutina* (broad-leaved apple), *and E. eugenioides* (thin-leaved stringybark) also occurring. *Acacia parramattensis* subsp. *Parramattensis* (Parramatta wattle), *Casuarina glauca* (swamp oak) and *Melaleuca linariifolia* (flax-leaved paperbark) are found in the lower tree stratum. *Bursaria spinosa* (blackthorn) dominates the shrub stratum. *Rubus vulgaris* (blackberry) is a common exotic weed.

Land use Around Wollongong, mainly used for pasture (sheep, cattle and horse grazing). Some areas are cultivated. Around Penrith, mostly reserved for recreation and flood detention, with some minor grazing on improved pastures.

Land degradation	This landscape is highly modified due to urban and rural/urban development. It is an active fluvial area with many areas of fluvial erosion (including streambank erosion) and deposition. Post-settlement alluvium often overlies buried soil horizons. Subsoils are sometimes saline, and this is evident in surface scalds where water tables are close to the surface. These areas are prone to sheet and gully erosion.

Land capability

Rural land capability	IV (III)	**Urban Capability**	D (E)
Grazing limitation	low to moderate	**Urban limitation**	high to extreme
Cultivation limitation	low to high	**Soil regolith stability**	R4 (R3)

Constraints

Steep slopes	not observed	**Mass movement hazard**	not observed
Seasonal waterlogging	localised	**Permanent waterlogging**	localised
Flood hazard	widespread	**Foundation hazard**	localised
Salinity hazard	localised	**Low fertility**	localised

Erosion hazard

Sheet	localised	**Gully**	localised
Streambank	widespread	**Wind**	not observed

Source: *NSW Department of Planning, Industry and Environment, Environment, Energy and Science Group, (in press) Soil and Land Resource Mapping for the Western Sydney Aerotropolis Area (Derived from Soil and Land Resources of the Hawkesbury Nepean Catchment (2008)), October 2020*

Document prepared by

Aurecon Australasia Pty Ltd
ABN 54 005 139 873
Level 5, 116 Military Road
Neutral Bay NSW 2089
PO Box 538
Neutral Bay NSW 2089
Australia

T +61 2 9465 5599
F +61 2 9465 5598
E sydney@aurecongroup.com
W aurecongroup.com

aurecon

Bringing ideas to life