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Environmental Impact Statement – Chapter 17: Non-Aboriginal heritage

Warragamba Dam Raising

Reference No. 30012078
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17 Non-Aboriginal heritage

This chapter provides an assessment of non-Aboriginal heritage impacts during construction and operation of the Warragamba Dam Raising. The relevant Secretary's Environmental Assessment Requirements (SEARs) are shown in Table 17-1.

Table 17-1. Secretary's Environmental Assessment Requirements: Non-Aboriginal heritage

Desired performance outcomes	Secretary's Environmental Assessment Requirements [1]	Where addressed
10. Heritage Desired performance outcomes: The design, construction and operation of the project facilitates, to the greatest extent possible, the long-term protection, conservation and management of the heritage significance of items of environmental heritage objects and places. The design, construction and operation of the project avoids or minimises impacts, to the greatest extent possible, on the heritage significance of environmental heritage, objects and places.	1. The Proponent must identify and assess any direct and/or indirect impacts (including cumulative impacts) to the heritage significance of: (c) environmental heritage, as defined under the *Heritage Act 1977*	Section 17.2.3 Section 17.3 Section 17.4
	(d) items listed on the National and World Heritage lists. Investigations including surveys and identification of cultural heritage values should be conducted in consultation with OEH regional officers.	Section 17.2.3 Section 17.4 Section 17.5
	2. Where impacts to State or locally significant heritage items are identified, the assessment must: (a) include a statement of heritage impact for all heritage items (including significance assessment)	Section 17.4 Section 17.5
	(b) consider impacts to the item of significance caused by, but not limited to, vibration, demolition, archaeological disturbance, altered historical arrangements and access, visual amenity, landscape and vistas, curtilage, subsidence and architectural noise treatment (as relevant)	Section 17.4 Section 17.5 Chapter 19
	(c) outline measures to avoid and minimise those impacts in accordance with the current guidelines	Section 17.6
	(d) be undertaken by a suitably qualified heritage consultant(s) (note: where archaeological excavations are proposed, the relevant consultant must meet the NSW Heritage Council's Excavation Director criteria).	Section 17.1
	5. Any objects recorded as part of the assessment must be documented and notified to OEH.	Section 17.1 Section 17.6
	6. Where land is declared wilderness under the *Wilderness Act 1987* or on the World Heritage List as part of the Greater Blue Mountains World Heritage Area (GBMWHA)	Section 17.4.1 Chapter 12 Chapter 20

Desired performance outcomes	Secretary's Environmental Assessment Requirements [1]	Where addressed
	and lands declared as Wild Rivers under the NPW Act the Proponent: (a) must define the area and extent of impact on such lands	
	(b) provide evidence that the proposal is consistent with the *Wilderness Act 1987* and the management principles for wilderness areas	Chapter 12 Chapter 20
	(c) assess impacts on land to be included on the National Heritage List.	Section 17.3.3.2 Section 17.5.2.1

1. This chapter specifically addresses SEAR 10 in addition to those general requirements of the SEARs applicable to all chapters and as identified as such in Chapter 1 (Section 1.5, Table 1-1).

The non-Aboriginal heritage assessment is supported by detailed investigations, which have been documented in the Non-Aboriginal heritage impact assessment (Artefact Heritage 2019, Appendix I).

The proposed management and mitigation measures in this Chapter are collated in Chapter 29 (EIS synthesis, Project justification and conclusion).

17.1 Project overview

17.1.1 Project description

Warragamba Dam Raising is a project to provide flood mitigation to reduce the significant existing risk to life and property in the Hawkesbury-Nepean Valley downstream of the dam. This would be achieved through raising the level of the central spillway crest by around 12 metres and the auxiliary spillway crest by around 14 metres above the existing full supply level (FSL) for temporary storage of inflows. The spillway crest levels and outlets control the extent and duration of the temporary upstream inundation. There would be no change to the existing maximum volume of water stored for water supply.

Peer reviewed climate change research found that by 2090 it is likely an additional three metres of spillway height would be required to provide similar flood mitigation outcomes as the current flood mitigation proposal. Raising the dam side walls and roadway by an additional three metres may not be feasible in the future, both in terms of engineering constraints and cost. The current design includes raising the dam side walls and roadway by 17 metres now to enable adaptation to projected climate change. Any consideration of raising spillway heights is unlikely before the mid to late 21st century and would be subject to a separate planning approval process.

The Project would include the following main activities and elements:

- demolition or removal of parts of the existing Warragamba Dam, including the existing drum and radial gates,
- thickening and raising of the dam abutments
- thickening and raising of the central spillway
- new gates or slots to control discharge of water from the FMZ
- modifications to the auxiliary spillway
- operation of the dam for flood mitigation
- environmental flow infrastructure.

Construction is anticipated to be completed within four to five years

The Project would delay downstream flooding, which would reduce current downstream flood peaks and increase the time taken for downstream water levels to recede. The dam would be subject to the following operational regimes, depending on the water level.

17.1.1.1 Normal operations

Current operations would apply when the reservoir level is at or lower than the FSL.

17.1.1.2 Flood operations

Flood operations would apply when the water level is higher than the FSL. The FMZ would have sufficient storage to accommodate up to a 1 in 40 chance in a year flood. For larger floods the FMZ would be filled and uncontrolled discharge would occur over the central spillway, and potentially, auxiliary spillway of the dam. Operational objectives are to:

- maintain the structural integrity of the dam
- minimise risk to life
- minimise downstream impact of flooding to properties
- minimise environmental impact
- minimise social impact.

17.1.2 Project location and study area

The study area is shown on Figure 17-1. Warragamba Dam is located approximately 65 kilometres west of Sydney in a narrow gorge on the lower section of the Warragamba River, 3.3 kilometres before it joins the Nepean River. The township of Warragamba is located approximately one kilometre east of the dam wall. The upstream environment includes the reservoir formed by Warragamba Dam (Lake Burragorang) and its tributaries. The upstream study area is approximately 5,280 hectares in extent, broadly equating to the area between the existing FSL and the Project probable maximum (PMF) flood level. The downstream environment includes a short section of the Warragamba River, the Hawkesbury-Nepean River and its floodplain, and some of the tributaries of the Hawkesbury-Nepean River (such as South Creek) that experience backwater flooding affects.

The study area includes the construction impact area as well as downstream and upstream operational impact areas. The Project would result in an increase in the upstream PMF and a decrease in the downstream PMF. The study area for the non-Aboriginal heritage assessment is summarised as follows:

- **Construction zone:** Construction footprint of the Project including Warragamba Dam elements and facilities, immediate surrounds, and construction compounds.
- **Upstream:** Upstream operational impacts of the Project include the Project probable maximum flood (PMF) area of the Lake Burragorang catchment and tributaries that flow into Lake Burragorang.
- **Downstream:** The downstream operational impacts of the Project include the existing PMF area of the Warragamba River, the Hawkesbury-Nepean River and its floodplain, and some of the tributaries of the Hawkesbury-Nepean (note that the Project PMF would be less than the existing PMF)

17.2 Assessment methodology

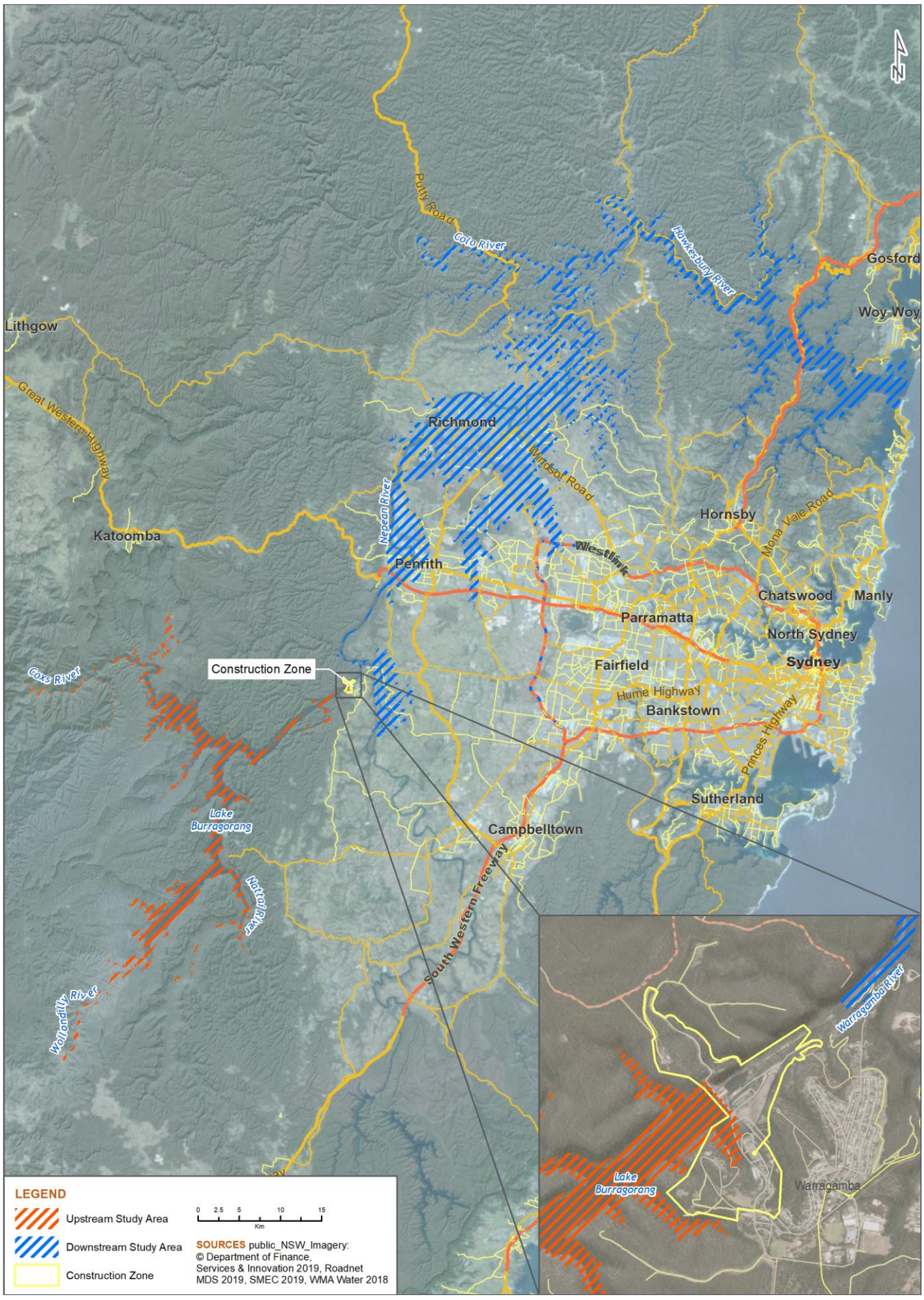
17.2.1 Study approach

The non-Aboriginal heritage impact assessment for the Project identifies non-Aboriginal heritage values within the Project footprint, assesses the potential impacts of the Project on these values and identifies appropriate management measures to minimise these impacts. The assessment was conducted by qualified specialist heritage consultants – Artefact Heritage.

The Office of Environment and Heritage (OEH) (now the Department of Premier and Cabinet (DCP)) was consulted regarding the non-Aboriginal assessment methodology. The methodology for this assessment included:

- desktop review of statutory heritage lists including the:
  - State Heritage Register (SHR)
  - Heritage schedules on Local Environmental Plans (LEPs)
  - Section 170 Heritage and Conservation Registers (S170 Registers)
  - World Heritage List (WHL)
  - National Heritage List (NHL)
  - Commonwealth Heritage List (CHL).
- review of previous heritage reports and management and reference documents, which informed the preparation of detailed land use histories to identify potential heritage sites and historical archaeological resources
- field surveys to inspect listed heritage items and heritage conservation areas (HCAs)

Figure 17-1. Study area



- field surveys of the construction area to inspect potential archaeological sites and to identify potential heritage items where subsurface impacts are anticipated
- desktop historical research to inform the impact assessment, including review of relevant conservation management plans (CMPs) and other plans of management
- assessment of potential heritage impacts from construction and operation of the Project
- recommendation of appropriate environmental management measures to avoid, mitigate and/or manage potential impacts on relevant non-Aboriginal heritage values.

The environmental impact assessment of World Heritage Areas is provided in Chapter 12 (Matters of national environmental significance - biodiversity) and Appendix J (World heritage assessment report).

Due to the large study area and generally minor impacts only items listed on statutory registers are included in the assessment, with the exception of Jooriland homestead. Items of potential heritage significance listed on non-statutory registers including the Register of the National Estate, National Trust Register and the RAIA Register of Twentieth Century Buildings have not been included in the assessment. Consultation with these institutions would be undertaken once stakeholders have matched areas of impacts to items on their respective databases.

A detailed assessment of non-Aboriginal archaeology was undertaken within the construction zone, the only portion of the study area where subsurface impacts are proposed. Due to the extent and large scale of the study area and generally minor impacts, the downstream and upstream zones have been subject to a high-level archaeological assessment and assessment of listed archaeological sites (see Appendix I - Non-Aboriginal heritage assessment report). Study limitations were:

- no Aboriginal heritage values were assessed – Aboriginal heritage and archaeological values and potential impacts are assessed in the Aboriginal Cultural Heritage Assessment Report
- no sub-surface investigations were undertaken. The assessment of archaeological potential is based on knowledge of similar sites and site formation processes, the historical background and predicted robustness of potential archaeological remains
- as excavation works associated with the project are confined to the construction zone only, detailed non-Aboriginal archaeological assessment focused on this zone. It has been assumed that potential impact to archaeological sites within the downstream Flood Mitigation Zone would be associated with increased periods of inundation, which would have minimal impact on subsurface archaeological remains. A high level archaeological assessment and consideration of listed archaeological items was therefore assumed to be appropriate
- this assessment relies on publicly available digital mapping data. No additional mapping has been carried out to map the curtilage of items that do not have publicly available digital mapping data (i.e. items on Section 170 Heritage and Conservation Registers)
- no identification or assessment of unlisted items of potential heritage significance not included on statutory registers or lists was undertaken due to the extensive potential study area created by predicted inundation data. The identification of unlisted heritage items was therefore beyond the scope of this assessment. The area downstream of the construction study area may therefore contain unlisted items with the potential to reach the local or state significance threshold
- no new archival investigations were undertaken
- no community consultation was undertaken. Social and associative significance assessments for heritage listed items and potential archaeological resources were based predominantly on existing studies and data included on the State Heritage Inventory (SHI) for individual items.

17.2.2 Legislation and policy framework

The methodology for the non-Aboriginal heritage assessment applies the NSW heritage criteria set out in *Assessing Heritage Significance, a NSW Heritage Manual update* (NSW Heritage Office 2001). The assessment has been undertaken in accordance with the requirements of the *Heritage Act 1977* (NSW), including identification of potential impacts on items of heritage value, heritage conservation areas (HCAs), built heritage landscapes and archaeology.

Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), heritage places are protected through their inscription on the World Heritage List (WHL), Commonwealth Heritage List (CHL) or the National Heritage List (NHL).

The protected matters search tool (PMST) identified the following potential for impacts to heritage matters of national environmental significance (MNES):

- upstream
  - one world heritage property
  - one national heritage place
- downstream
  - three world heritage properties
  - two national heritage places.

The proposed action was referred (EPBC Act referral 201717940) to the DoEE under the EPBC Act and was deemed a controlled action due to potentially significant impacts to world heritage properties and national heritage places (as well as listed threatened species and communities).

Of the world heritage properties and national heritage places identified in the PMST search, only the Greater Blue Mountains World Heritage Area (GBMWHA) was considered relevant. The GBMWHA is discussed in Chapter 12 (Matters of national environmental significance – biodiversity), Appendix J (World Heritage assessment report) and Chapter 20 (Protected and sensitive lands).

Identification and assessment of other places listed on the WHL, CHL and NHL is included in Appendix I (Non-Aboriginal heritage assessment report) and summarised in this chapter.

Relevant local environmental plans (which include heritage registers) are:

- Blacktown Local Environmental Plan 2015 (Blacktown LEP 2015) (Blue Mountains LEP 2015)
- Blue Mountains Local Environmental Plan 2015 (Blue Mountains LEP 2015)
- Camden Local Environmental Plan 2010 (Camden LEP 2010)
- Hawkesbury Local Environmental Plan 2012 (Hawkesbury LEP 2012)
- Hornsby Local Environmental Plan 2013 (Hornsby LEP 2013)
- Liverpool Local Environmental Plan 2008 (Liverpool LEP 2008)
- Oberon Local Environmental Plan 2013 (Oberon LEP 2013)
- Penrith Local Environmental Plan 2010 (Penrith LEP 2010)
- The Hills Local Environmental Plan 2012 (The Hills LEP 2012)
- Wollondilly Local Environmental Plan 2011 (Wollondilly LEP 2011)

The following relevant legislation and guidelines have also been considered:

- *Environmental Planning and Assessment Act* 1979 (NSW) (EP&A Act)
- State Environment Planning Policy (Infrastructure) 2007 (ISEPP)
- *NSW Heritage Manual* (NSW Heritage Office 1996)
- Matters of National Environmental Significance – Significant impact guidelines 1.1 (Department of the Environment (DoE) 2013)
- *The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance, 2013* (the Burra Charter) (Australia International Council on Monuments and Sites (ICOMOS) 2013).

17.2.3 Previous reports

A review of archaeological and historical reports relevant to the Project was completed and included the following:

- *Greater Blue Mountains World Heritage Area Strategic Plan* (Department of Environment and Climate Change (DECC) 2009)
- The Greater Blue Mountains World Heritage Area Nomination (National Parks and Wildlife Service (NPWS) 1998)
- Conservation Management Plan: Warragamba Supply Scheme DRAFT 7 (Graham Brooks & Associates Pty Ltd 2010)
- *Special Areas Strategic Plan of Management 2015* (WaterNSW & Office of Environment and Heritage (OEH) 2015)
- Australian Convict Sites Strategic Management Framework (Commonwealth of Australia 2018)

- The Old Great North Road Cultural Landscape, Dharug National Park, Conservation Management Plan (Griffin NRM Pty Ltd 2005)
- *Australian Convict Sites World Heritage Nomination* (Department of Environment, Water, Heritage and the Arts (DEWHA) 2008)
- Australian Convict Sites Nomination (Commonwealth of Australia 2008).

The environmental impact assessment of world heritage items is provided in Chapter 12 (Matters of national environmental significance - biodiversity) and Appendix J (World Heritage assessment report).

17.2.4 Existing environment and field survey

The determination of 'potential for heritage items'/'heritage potential' is done partly through assessment of historic and current land use, and disturbance to identify areas where artefacts may occur due to historic use, or 'not occur' because of historic or contemporary disturbance.

The assessment methodology includes reviewing and assessing available information and undertaking field inspections. This included reviewing the historic context of the study area and identification of heritage items and areas with potential for non-aboriginal heritage.

Site inspections of listed heritage items within the upstream and construction areas were undertaken on 17 November 2017, 8 March 2018, and 7 June 2018.

The Project would reduce the extent of the existing downstream PMF and potential impacts to non-Aboriginal items are expected to be generally minor. On this basis listed heritage items located downstream of the Project were not inspected. This is further addressed in Operational impacts (Section 17.5.2) and environmental management measures (Section 17.6).

Results of the site inspection are included under the heading for each listed item.

17.2.5 Assessment of built heritage significance

An assessment of built heritage significance was carried out for each listed heritage item or potential heritage item identified within the upstream study area. This included heritage items and HCAs that may be subject to demolition, visual, setting, vibration and/or settlement impacts from the Project.

The statements of significance for the assessed built heritage items have been drawn from the relevant state and local statutory heritage registers. Additional information on significance, including heritage curtilages, has been drawn from conservation reports, such as conservation management plans (CMPs), conservation plans and heritage impact statements, where available. This is discussed in Appendix I (Non-Aboriginal heritage assessment).

17.2.6 Archaeological assessment

The assessment of historical archaeological potential focused on the proposed construction zone. The assessment was based on consideration of the physical evidence observed during the field surveys, identified areas of previous disturbance, historical information about the development and occupation of the study area and previous archaeological assessments and investigations.

17.2.7 Approach to the assessment of potential impacts

Potential impacts on identified heritage items within the study area have been assessed for Project construction and operations. State and locally listed heritage items have been assessed using the legislation and guidelines listed above (Section 17.2).

World Heritage and national heritage places within the study area have been assessed for potential impacts using the criteria in the Matters of National Environmental Significance Significant Impact Assessment Guidelines (refer Chapter 12). A separate assessment has been prepared to address potential impacts to the World and National Listed Greater Blue Mountains Area including the NHL nominated Great Blue Mountains Area – Additional Values (refer Chapter 20).

The impact assessment for the operational downstream study area focussed on listed heritage items within the downstream areas that would be inundated by discharges from the Project flood mitigation zone (FMZ), where heritage items may experience flood events for an extended period. Listed heritage items outside of these areas would potentially experience a positive impact due to the reduced extent, duration and depth of flooding (compared to if the dam wall is not raised).

The heritage impact assessment is based on the types of impacts outlined in Table 17-2. Identification of the magnitude of the impact type is based on terminology contained in the *Guidance on Heritage Impact Assessments for Cultural World Heritage Properties* (ICOMOS 2011), as shown in Table 17-3.

Table 17-2. Heritage impact types

Impact Type	Definition
Direct	Impacts resulting from works located within the curtilage boundaries of the heritage item.
Potential direct	Impacts resulting from increased noise, vibrations and construction works located outside the curtilage boundaries of the heritage item.
Indirect	Impact to views, vistas and setting of the heritage item resulting from proposed works outside the curtilage boundaries of the heritage item.
Archaeological	Impacts to potential archaeological remains located within the curtilage boundaries of the heritage item.

Table 17-3. Magnitude of heritage impact terminology

Magnitude	Definition
High	Actions that would have a long-term and substantial impact on the significance of a heritage item. Actions that would remove key historic building elements, key historic landscape features, or significant archaeological materials, thereby resulting in a change of historic character, or altering of a historical resource. These actions cannot be fully mitigated.
Moderate	This would include actions involving the modification of a heritage, including altering the setting of a heritage item or landscape, partially removing archaeological resources, or the alteration of significant elements of fabric from historic structures. The impacts arising from such actions may be able to be partially mitigated.
Low	Actions that would results in the slight alteration of heritage buildings, archaeological resources, or the setting of an historical item. The impacts arising from such actions can usually be mitigated.
Neutral	Actions that would have no heritage impact.
Positive	Actions that would have no heritage impact and may result in positive outcomes.

17.3 Existing environment

17.3.1 Introduction

This section provides an overview of the Non-Aboriginal history and environmental context of the study area. This encompasses the history of Western Sydney and the Hawkesbury, an overview of Sydney's water supplies, development of Warragamba Dam and history of the conservation of the world and national heritage items within the study area.

Aboriginal history and context are discussed in Chapter 18 (Aboriginal cultural heritage).

17.3.2 Historical overview

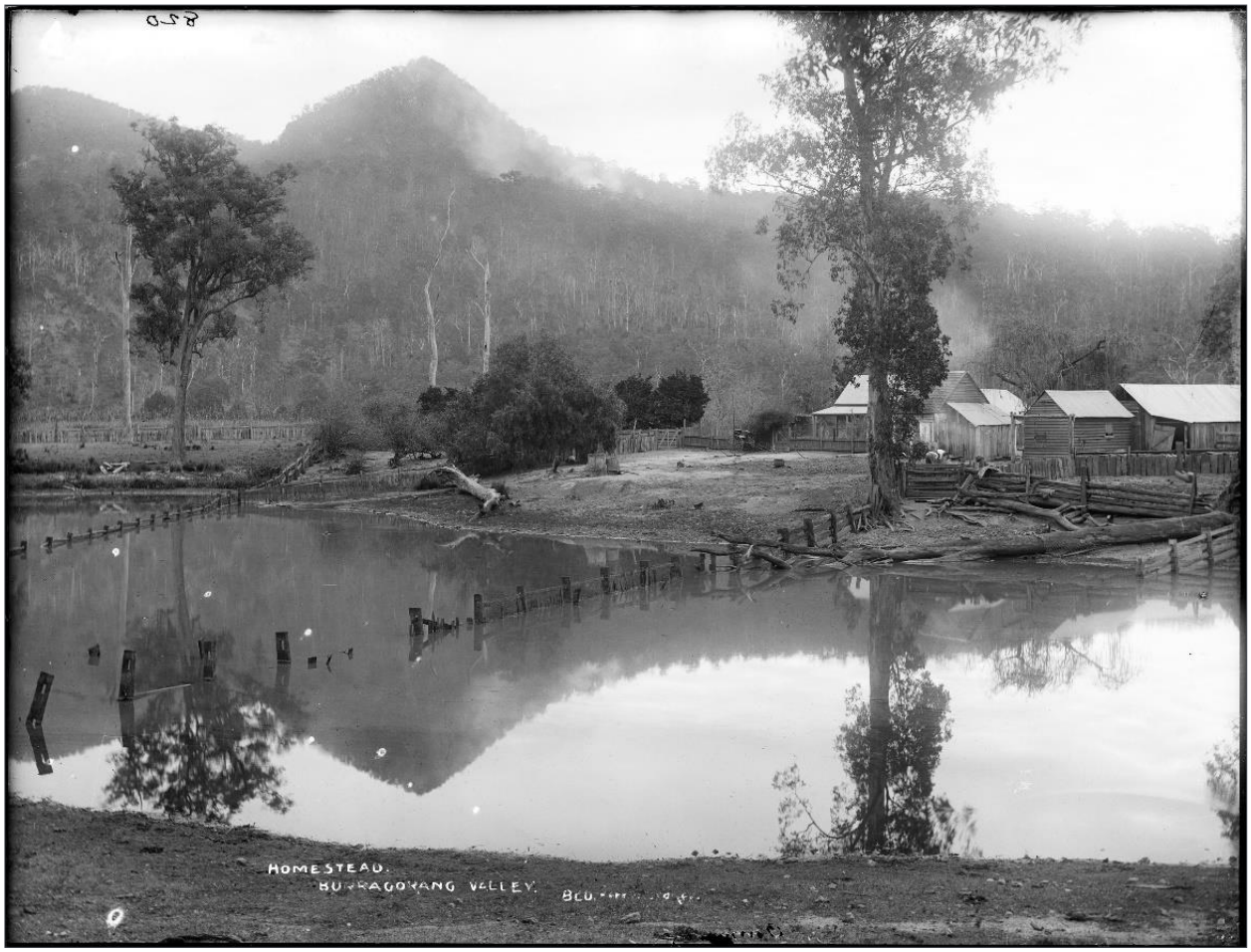
17.3.2.1 Early colonial history

Rural development and settlement within much of the study area was driven by the availability of fertile soil and accessible water sources such as creeks and river beds.

In May 1813, an exploratory expedition led by Gregory Blaxland, William Charles Wentworth, and William Lawson navigated a secure passage west across the Blue Mountains from Emu Plains. Although the expedition did not complete the crossing of the Great Dividing Range, access to the western pastoral lands had been established. During the early to mid-nineteenth century, areas surrounding the Blue Mountains were used by European immigrants for

mining (coal, lead and silver), farming, and recreational activities. Burragorang was established in 1827 as a mining town with houses, farms, churches and several guesthouses, as shown in Figure 17-2.

Figure 17-2. A homestead in the Burragorang Valley prior to flooding of the township to establish Warragamba Dam (circa 1884 - 1917)



Source: Museum of Applied Arts & Sciences. Object No. 85/1284-435

The importance of the Western Sydney agricultural region diminished with the development of a road link between Bathurst and Sydney, and the opening of agricultural land further west following the crossing of the Blue Mountains. Construction of a road to Parramatta from Sydney resulted in the character of the area changing due to attracting an influx of settlers. Drought in the 1870s was followed by wheat leaf rust, which resulted in a change of crop types so that by the 1890s the area was a major producer of citrus and dairy products. Quarrying and gravel and sand extraction in portions of the Cumberland Plain region has been conducted during the last decades of the nineteenth century and throughout the twentieth century.

17.3.2.2 Sydney's water supply

The early colony was serviced by spring water until the mid-1820s, which flowed into Sydney Cove and was known as the Tank Stream. From about 1827, a series of reservoirs were developed on the Lachlan Swamps as Sydney's second water supply, which are now part of the Centennial Park lakes system. The Lachlan Swamps continued to supply Sydney with water until about 1860 when it was replaced by the development of the Botany Swamps further to the south.

Residential and industrial growth in Sydney resulted in increasing water demand and consumption. By 1867, the Governor of NSW appointed a Special Commission to recommend a scheme that could supply a reliable and adequate water supply. The Upper Nepean Scheme was proposed, which was based on the provision of water from the Nepean River and its tributaries of the Avon, Cataract, and Cordeaux Rivers. It was built between 1879 and 1887 and commissioned in 1888. It involved the natural flow of waters without regulation in storage reservoirs by the

construction of weirs, tunnels and reservoirs. As part of the scheme, Prospect Reservoir was completed in 1888 (see Figure 17-3) as the first earth-fill embankment dam in Australia.

Figure 17-3. Historic photograph of Prospect Reservoir at the time of completion, 1888

Source: *Reproduced in Beasley (1988)*

For the remainder of the nineteenth century, Sydney's increasing water demand was met by increasing the capacity of existing supplies, while progressively developing the Botany water reserve and Prospect Reservoir. The construction of Cataract Dam in 1907 increased the potential of the Upper Nepean Scheme. In 1908, the Public Works Department suggested damming the Warragamba River for irrigation and water supply for a growing population.

17.3.2.3 Development of Warragamba Dam

The Public Works Department commenced planning for Warragamba Dam during the drought of 1915/16, however this was delayed due to the onset of World War One. In 1924, the responsibility for provision of water supplies for Sydney was transferred to the Metropolitan Water Sewerage and Drainage Board (MWS&DB). Despite the vital role of the Upper Nepean Scheme, the pressing need to supply adequate water supplies to the Sydney metropolitan area persisted.

The effects of the severe drought from 1934 to 1942 necessitated the commencement of the Warragamba supply system. In July 1938, the project to obtain water from Warragamba River was formally approved by the MWS&DB, with work to proceed in four stages:

Stage 1: *Construction of a 50-foot weir, pumping station and 48-inch diameter steel main to supply water to Prospect Reservoir*

Stage 1 of the Warragamba development involved construction of the Warragamba Emergency Supply Scheme, downstream of the current dam. A 50-foot high overshot weir was constructed, along with a pumping station and pipeline to deliver 40 million gallons per day to Prospect Reservoir. Twin 72-inch diameter steel pipes were laid through the weir, to service pumps supplying the 25-kilometre-long, 48-inch diameter cement lined steel pipeline to Prospect Reservoir. The pipeline also included a concrete arch bridge over Megarritys Creek, a dam of nine million gallons capacity to act as a balance reservoir on the line and to provide emergency supply, and a chlorination and alum plant for water treatment. The Warragamba Emergency Supply Scheme was completed within three years and

played a key part in avoiding the failure of Sydney's water supply. Upon its completion, efforts were diverted to completing the major dam and pipelines of the Warragamba development.

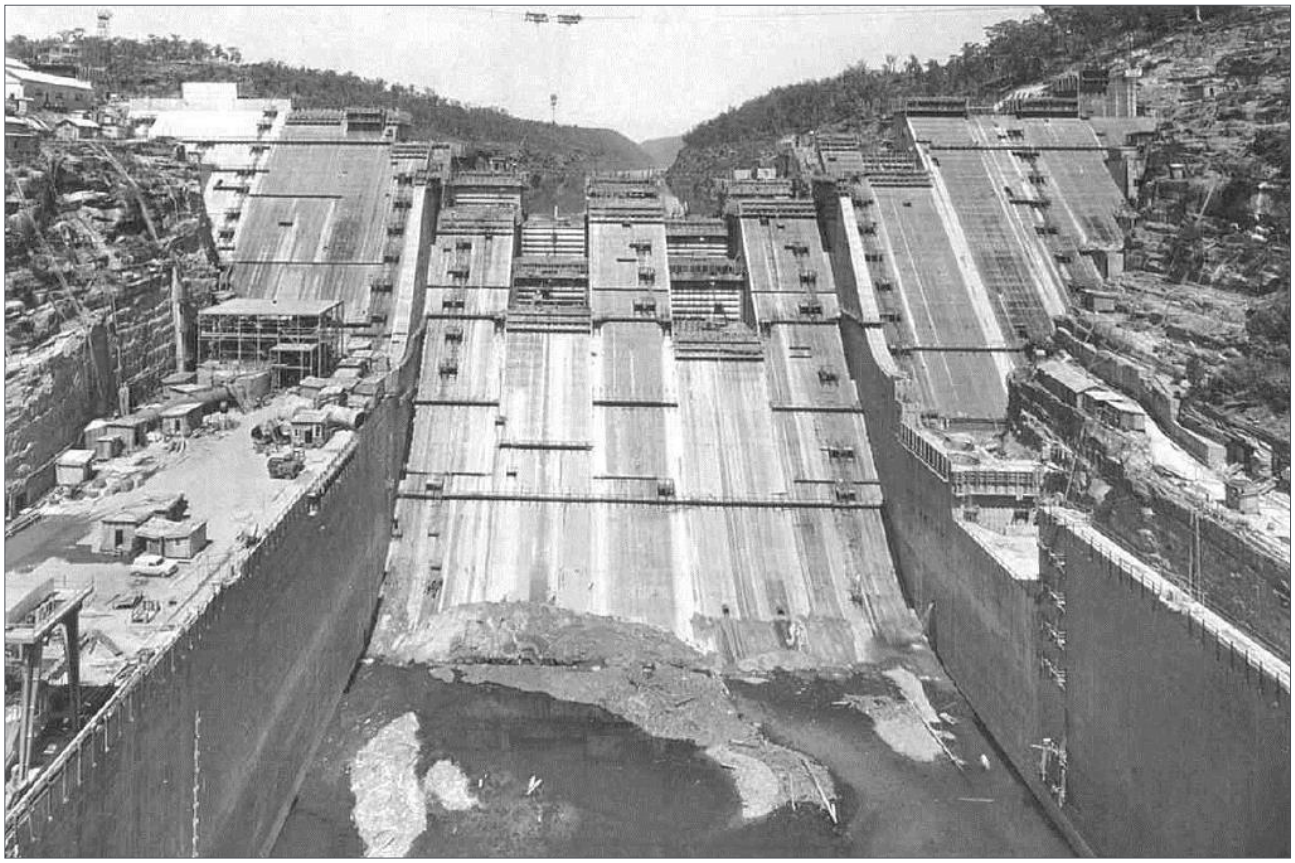
Stage 2: *Increase the capacity of the pumping station and size of the main to an 84-inch diameter pipe*

The second stage of the Warragamba development was the replacement of the temporary 48-inch diameter pipeline that had been constructed to take water from the weir associated with the Warragamba Emergency Supply Scheme to Prospect Reservoir, with an 84-inch diameter pipeline to provide more water to Prospect Reservoir.

Stage 3: *Construction of the main storage dam*

Stage 3 involved construction works for the dam, commencing in 1948. This included constructing coffer dams across the river upstream and downstream of the site, constructing 47 workers' cottages and employee barracks, reconstruction of access roads and excavation for equipment including the 10-ton cableway tower. Concreting works commenced in 1953. The Warragamba township was established during the dam construction. The dam was officially opened on 14 October 1960. Construction works on the dam wall are shown in Figure 17-4.

Figure 17-4. Historical photograph of works in progress at Warragamba Dam, 1958



Source: KW 581107 – 1, SWC/SCAHR&AF

Following the dam opening, completion of park, picnic and landscaped areas was undertaken to accommodate visitors and conducted tour groups of the dam. Heavy flood flows in November 1961 resulted in damage to the dam, particularly the rock abutments downstream of the dam, that necessitated a series of repairs.

Stage 4: *Amplification of the outlet system to Prospect Reservoir.*

Stage 4 occurred between 1965 and 1969 and involved construction of a second 23-kilometre pipeline to provide more water from Warragamba Dam to Prospect Reservoir.

Further works

Developments in rainfall and flood estimation during the early 1980s indicated that Warragamba Dam could experience floods much larger than previously estimated. In December 1985, the Warragamba Dam flood protection program was announced by the Government (Graham Brooks and Associates 2010:58-59).

With several model studies demonstrating the dam would fail after a 1 in 750-year flood event, a two-stage program was formulated. Between 1987 and 1990, the first stage involved the crest of the dam being raised by five metres to cater for a 1 in 1,500-year flood, and the dam wall itself was strengthened using post tensioned steel cables. The second stage involved the construction of an auxiliary spillway located on the eastern bank of the dam to divert excess flood waters around the dam and reduce the pressure on the wall (Graham Brooks and Associates 2010:59-60).

Further investigations into flooding and flood mitigation were undertaken and culminated in 1995 in a proposal to raise Warragamba Dam by 23 metres, primarily for dam safety but also to provide for flood mitigation. The 1995 proposal did not proceed.

In the late 1990s, major upgrades of Warragamba Dam were undertaken to prevent dam failure during extreme flooding events, to protect Sydney's water supply, and to prevent catastrophic downstream floods from dam failure. This resulted in the construction of the auxiliary spillway. However, these works only dealt with dam safety issues and did not address the major flood risks to the people and businesses in the Hawkesbury-Nepean Valley and the NSW economy.

Construction of the auxiliary spillway was undertaken between 1998 and 2002, which increased the dam's flood capacity to 75 percent of the PMF (estimated at that time). Preliminary site works commenced in 1998, and in 1999 construction of the large structure began. Works involved modification to the existing structure of the dam and surrounding area. Large amounts of rock and soil were removed from the site (effectively the western end of Haviland Park) and were relocated to the western bank to create the rehabilitated Left Bank Spoil embankment. Concurrently, a public platform and lookout overlooking the dam and spillway works site with access from Eighteenth Street, was constructed (Graham Brooks and Associates 2010:60). The construction of the auxiliary spillway resulted in the removal of a significant part of the Haviland Park's original area and exotic plantings, along with the loss of other features including a children's playground and picnic shelter located at the western end of the park.

Bushfires in December 2001 caused considerable damage to the area surrounding the dam and spillway construction site. Growth and plantings on the Left Bank Spoil embankment were affected, while archaeological sites and remains of elements relating to the Emergency Scheme, the former Community Relations building and works depot area and sheds, were lost. The fire also caused further damage to the deteriorating timber suspension bridge crossing the gorge (Graham Brooks and Associates 2010:60). Elements of Haviland Park were also impacted.

In 2008-2009, the Sydney Catchment Authority (SCA) constructed a new Warragamba Visitor and Operations Centre at the western end of Haviland Park, with views over the dam and auxiliary spillway. A new maintenance shed, and other auxiliary structures have also been built adjacent to the picnic areas. The former SCA Operations office, now the only extant building dating to the initial construction phase of the dam, has been adaptively reused as a Moveable Heritage store (Graham Brooks and Associates 2010:60).

17.3.3 Historical archaeological potential

The potential for the survival of archaeological remains is affected by activities that may have caused ground disturbance. This assessment is based on consideration of current ground conditions, and analysis of the historical development of the study area. Excavation works associated with the Project are confined to the construction area, which was the focus for archaeological investigations. Potential upstream and downstream impacts would be associated with increased periods of inundation.

The Warragamba Dam and surrounding landscape have undergone substantial modification through construction and upgrades. These works have disturbed evidence of the construction of the original Warragamba Emergency Supply Scheme and construction areas. The construction of the auxiliary spillway in the late 1990s removed the construction terraces that formerly held the ice making plant, concrete mixing plant, mechanical workshop and cement silos. Construction of the Warragamba Deep-Water Storage Access infrastructure in the early 2000s impacted on the site of the former chlorination plant, WPS009 and part of the former substation.

The primary phases of development in the area are summarised as:

- Phase 1 (c.1800 – c.1900): Early land grants and rural development
- Phase 2 (c.1900 – 1940): Urban expansion/Warragamba Dam.

17.3.3.1 Phase 1: Early land grants and rural development

Prior to the construction of Warragamba dam, there is nil to low potential that archaeological evidence of land clearance, and modification for agricultural or pasturing purposes would be located within the study area. Evidence

for these types of activities are typically ephemeral and are therefore likely to have been disturbed by ongoing modification of the landscape through construction. Archaeological remains may include the following:

- evidence of tree clearance (tree boles, etc.)
- evidence of cultivation (postholes, plough marks in subsoils, etc.)
- evidence of the formalisation of agricultural precinct boundaries, such as postholes associated with early fence lines.

17.3.3.2 Phase 2: Urban expansion/Warragamba Dam

The Conservation Management Plan (2010) (CMP) for the Warragamba Supply Scheme identified several locations with the potential to contain an archaeological resource (Graham Brooks & Associates 2010). The following potential archaeological resources are located within the construction footprint of the proposed works:

- the original construction township from the Warragamba Emergency Scheme and early years of site testing and establishment for Warragamba Dam – this was originally located on the ridge to the east of the river and is now mostly outside the ownership boundaries of the dam site
- evidence of the construction and operation of the Warragamba Emergency Scheme including the power station, chlorination and alum plant, batching plant and support sheds, which remains on the eastern bank of the river
- the single men's quarters and site of the wet canteen from the Warragamba Dam construction township on either side of the road to the Dam lookout
- staff barracks on the eastern side of the entrance road adjacent to Haviland Park
- junior staff quarters on the northern side of the road to the conference centre
- the aggregate bins, aerial ropeway and depot in the area now occupied by Haviland Park
- evidence of former roads and stores area to the east of the auxiliary spillway
- evidence associated with the 10-ton cableway in the terraced gardens
- evidence associated with the 18-ton cableway on the eastern side of the dam and the upper and lower tail tower foundations on the western side of the dam.

The study area has been assessed as having moderate to high potential to contain an archaeological resource associated with the Phase 2 development. The assessment of the significance of the potential archaeological resource against the NSW heritage assessment criteria in *Assessing Significance for Historical Archaeological Sites and 'Relics'* (Heritage Branch Department of Planning 2009) is provided in Appendix I (Non-Aboriginal Heritage Assessment). This resource, if found to be substantially intact, would reach the local significance threshold primarily for its historical, social and technological values.

17.3.4 Heritage items and conservation areas

A total of **988** existing listed heritage items were identified within the study area; however, in some instances a single place/item is represented on several statutory lists. The number of items under the listings includes:

- EPBC Act (11):
  - World Heritage List – 3
  - National Heritage List – 5
  - Commonwealth Heritage List – 3
- Heritage Act (184):
  - State Heritage List – 68
  - NSW Historic Shipwreck Database – 40
  - s170 Registers – 76
- Local Environment Plans – 793.

Heritage items listed on the CHL, NHL, SHR and s170 registers are summarised in Table 17-4 and shown on Figure 17-5 to Figure 17-10.

17.3.4.1 World Heritage List

Three world heritage listed places were identified within the study area including The Greater Blue Mountains Area and two Australian Convict Sites (Old Great North Road and Old Great North Road Buffer Zone).

The Greater Blue Mountains Area is discussed in Chapter 12 (Matters of national environmental significance - biodiversity), Appendix J (World heritage assessment report) and Chapter 20 (Protected and sensitive lands).

17.3.4.2 National Heritage List

There are five places within the study area on the National Heritage List (NHL), including three listed places and two nominated places. The study area is located partially within the curtilage of The Greater Blue Mountains Area (ID #105999) both upstream and downstream of the proposed construction zone. Other downstream listed places include the Old Great North Road and the Ku-ring-gai Chase National Park, Lion Island, Long Island and Spectacle Island Nature Reserves.

The two nominated places include The Greater Blue Mountains Area – Additional Values (ID #105696) and Great North Road, Wisemans Ferry to Bucketty (ID #106318). These have been assessed in accordance with the values provided in their nomination (until a decision is made on whether they are listed).

17.3.4.3 Commonwealth Heritage List

A search of the CHL identified three places listed, all within the downstream study area. This includes the North Base Trig Station, the Shale Woodland Llandilo and the RAAF Base Richmond.

17.3.4.4 State Heritage Register

A search of the SHR identified 68 places listed within the study area. There is one SHR item located within the construction zone, comprising Haviland Park (SHR No. 01375). The rest of the SHR items are located downstream.

As of 15 March 2019, there are no places within the study area that are subject to an Interim Heritage Order (IHO).

17.3.4.5 s170 heritage registers

A search of the s170 heritage registers identified 76 places listed within the study area. Of these, only the Warragamba Supply Scheme (#4580161) is located within the proposed construction zone of the study area.

Maps for s170 curtilages are not available for many items on the SHI database and the large number of items within the study area.

17.3.4.6 Jooriland Homestead

Jooriland Homestead is a former substantial sheep and grazing station located in the upper Wollondilly. The property was in use until the 1980s, with the homestead residence occupied into the 1960s. According to an article in The Land (Austin 2018), the site retains the original timber homestead, shearing shed, shearer's quarters, plunge dip and wool press. The property was obtained by the National Parks and Wildlife Service in 1993.

The Homestead is not listed on any statutory heritage register. To determine the heritage significance of this item a heritage assessment of the Jooriland Homestead should be undertaken by the asset owner. If the site is found to have significance at a local or state level, and therefore be eligible for listing on a statutory register the assessment would also provide recommendations around future management of the site.

Table 17-4. Historic heritage items within the study area

Item name	Address/suburb	Significance	Status	Register	Study area location
The Greater Blue Mountains Area	Great Western Hwy, Katoomba NSW	National	Listed	National Heritage List (ID 105999)	Upstream and Downstream
The Greater Blue Mountains Area Additional Values	Katoomba, NSW	National	Nominated	National Heritage List (ID 105696)	Upstream and Downstream
Great North Road, Wisemans Ferry to Bucketty	Wisemans Ferry to Bucketty, NSW	Commonwealth	Nominated	National Heritage List (ID 106318)	Downstream
Orchard Hills Cumberland Plain Woodland	The Northern Rd, Orchard Hills NSW	Commonwealth	Listed	Commonwealth Heritage List (ID 105317)	Downstream
North Base Trig Station	Dight St, Richmond RAAF Base NSW	Commonwealth	Listed	Commonwealth Heritage List (ID 105240)	Downstream
Shale Woodland Llandilo	Stony Creek Rd, Shanes Park NSW	Commonwealth	Listed	Commonwealth Heritage List (ID 105534)	Downstream
RAAF Base Richmond	McNamara Av, Richmond NSW	Commonwealth	Listed	Commonwealth Heritage List (ID 105653)	Downstream
Llandilo International Transmitting Station	Stoney Creek Rd, Shanes Park NSW	Commonwealth	Listed	Commonwealth Heritage List (ID 106101)	Downstream
Camden Post Office	135 Argyle St, Camden NSW	Commonwealth	Listed	Commonwealth Heritage List (ID 106176)	Downstream
Loder House	126 George Street Windsor	State	Listed	State Heritage Register (#00003) Department of Planning and Infrastructure S170 (#3490027)	Downstream
House and Outbuildings	5 Thompson Square Windsor	State	Listed	State Heritage Register (#00005)	Downstream
Toxana	157 Windsor Street Richmond	State	Listed	State Heritage Register (#00014)	Downstream
St. Matthew's Anglican Church, Rectory, Stables and Cemetery	Moses Street, Windsor	State	Listed	State Heritage Register (#00015)	Downstream

Item name	Address/suburb	Significance	Status	Register	Study area location
HMAS Parramatta shipwreck and memorials	Historic Shipwreck: Cascade Gully Memorials Parramatta and Sydney Parramatta	State	Listed	State Heritage Register (#01676)	Downstream
Peninsula House, Tebbutt's Observatory	Palmer Street, Windsor	State	Listed	State Heritage Register (#00028)	Downstream
Hobartville, including outbuildings	Richmond	State	Listed	State Heritage Register (#00035)	Downstream
Macquarie Arms Hotel	Thompson Square, Windsor	State	Listed	State Heritage Register (#00041)	Downstream
Mountain View	22 Inalls Lane Richmond	State	Listed	State Heritage Register (#00044)	Downstream
House	126 Windsor Street, Richmond	State	Listed	State Heritage Register (#00045)	Downstream
Torin Building	26 Coombes Drive, Penrith	State	Listed	State Heritage Register (#01796)	Downstream
Clear Oaks Moxey's Farm House	135 Francis Street Richmond	State	Listed	State Heritage Register (#00058)	Downstream
Glenmore	754-760 Mulgoa Road Mulgoa	State	Listed	State Heritage Register (#00074)	Downstream
Terrace Building	23-27 Johnston Street, Windsor	State	Listed	State Heritage Register (#00075)	Downstream
Cottage	29 North Street, Windsor	State	Listed	State Heritage Register (#00107)	Downstream
House	28 North Street, Windsor	State	Listed	State Heritage Register (#00108)	Downstream
House	35 North Street, Windsor	State	Listed	State Heritage Register (#00109)	Downstream
Houses	37-39 North Street Windsor	State	Listed	State Heritage Register (#00110)	Downstream
Hawkesbury River Rail Bridge and Long Island Group	Main Northern railway, Brooklyn	State	Listed	State Heritage Register (#01040)	Downstream
Thompson Square Conservation Area	Thompson Square, Windsor	State	Listed	State Heritage Register (#00126)	Downstream
Ebenezer Church (Uniting), Old Schoolhouse, Cemetery & Tree	Coromandel Road, Ebenezer	State	Listed	State Heritage Register (#00138)	Downstream
House	31-33 North Street, Windsor	State	Listed	State Heritage Register (#00142)	Downstream
House	25 North Street Windsor	State	Listed	State Heritage Register (#00150)	Downstream

Item name	Address/suburb	Significance	Status	Register	Study area location
Rev. Peter Turner Cottage and Well	350 George Street, Windsor	State	Listed	State Heritage Register (#00202)	Downstream
Hawkesbury River Railway Station Group	Main Northern Railway, Brooklyn	State	Listed	State Heritage Register (#01166)	Downstream
Peats Ferry Road Bridge over Hawkesbury River	Brooklyn	State	Listed	Roads and Maritime Services 4309666	Downstream
Mackenzie House	29 Fitzgerald Street Windsor	State	Listed	State Heritage Register (#00735)	Downstream
Mamre	Mamre Road, St. Marys	State	Listed	State Heritage Register (#00264) Department of Planning and Infrastructure S170 (#3490022)	Downstream
Macquarie Arms Inn (former)	104-106 Bathurst Street, Pitt Town	State	Listed	State Heritage Register (#00282)	Downstream
Upper Castlereagh Public School and residence	Castlereagh Road, Castlereagh	State	Listed	State Heritage Register (#00339)	Downstream
Victoria Bridge	Great Western Highway, Penrith	State	Listed	State Heritage Register (#01950)	Downstream
Glenleigh Estate	427 Mulgoa Road, Regentville	State	Listed	State Heritage Register (#00346)	Downstream
Rose Cottage	Rose Street, Wilberforce	State	Listed	State Heritage Register (#00358)	Downstream
Bird In The Hand Inn (former)	87 Eldon Street Pitt Town	State	Listed	State Heritage Register (#00373)	Downstream
Craithes House	34-40 Borec Road, Penrith	State	Listed	State Heritage Register (#00378)	Downstream
Lower Hawkesbury Wesleyan Chapel and site	Wisemans Ferry Road, Gunderman	State	Listed	State Heritage Register (#00576)	Downstream
Bowman House	368-370 Windsor Street Richmond	State	Listed	State Heritage Register (#00468)	Downstream
Stannix Park House, cattle tanks and site	Stannix Park Road, Wilberforce	State	Listed	State Heritage Register (#00598)	Downstream
Building	257-259 Windsor Street, Richmond	State	Listed	State Heritage Register (#00610)	Downstream
Natural Area	Rickards Avenue, Agnes Banks	State	Listed	State Heritage Register (#00649)	Downstream
Simmons Hardware Store	226 George Street Windsor	State	Listed	State Heritage Register (#00667)	Downstream
Clydesdale - Grand House, Barn & Cottage	1270 Richmond Road, Marsden Park	State	Listed	State Heritage Register (#00674)	Downstream

Item name	Address/suburb	Significance	Status	Register	Study area location
Seymours House	24 Bosworth Street, Richmond	State	Listed	State Heritage Register (#00681)	Downstream
Methodist Parsonage (former)	49 Macquarie Street, Windsor	State	Listed	State Heritage Register (#00735)	Downstream
Mackenzie House	29 Fitzgerald Street, Windsor	State	Listed	State Heritage Register (#00735)	Downstream
Uniting Church and Hall	29 Fitzgerald Street, Windsor	State	Listed	State Heritage Register (#00735)	Downstream
Claremont Cottage	Claremont Crescent, Windsor	State	Listed	State Heritage Register (#00738)	Downstream
Building, outbuildings, grounds, trees	49 - 51 Bosworth Street, Richmond	State	Listed	State Heritage Register (#00753)	Downstream
Windsor Court House	Court and Pitt Streets, Windsor	State	Listed	State Heritage Register (#00804) Attorney General's Department S170 (#3080018)	Downstream
Cattai Estate	Wisemans Ferry Road, Cattai	State	Listed	State Heritage Register (#00982)	Downstream
Stables at rear of Police Station	32-34 Bridge Street, Windsor	State	Listed	State Heritage Register (#01018)	Downstream
Emu Plains Railway Station Group	Main Western Railway, Emu Plains	State	Listed	State Heritage Register (#01136) RailCorp S170 (#4801017)	Downstream
Penrith Railway Station Group and Residence	Great Western Railway, Penrith	State	Listed	State Heritage Register (#01222) RailCorp S170 (#4801032)	Downstream
Richmond Railway Station Group	Blacktown-Richmond Railway, Richmond	State	Listed	State Heritage Register (#01236) RailCorp S170 (#4801005)	Downstream
Riverstone Railway Station Group and Residence	Riverstone Parade, Riverstone	State	Listed	State Heritage Register (#01237) RailCorp S170 (#4801009)	Downstream
Windsor Railway Station Group and Former Goods Yard	Blacktown-Richmond Railway, Windsor	State	Listed	State Heritage Register (#01287) RailCorp S170 (#4801003)	Downstream
Megarritys Bridge	Warragamba Dam, Warragamba	State	Listed	State Heritage Register (#01367)	Downstream
Warragamba Dam - Haviland Park	Warragamba Dam, Warragamba	State	Listed	State Heritage Register (#01375)	Within construction zone

Item name	Address/suburb	Significance	Status	Register	Study area location
Warragamba Emergency Scheme	Warragamba Dam, Warragamba	State	Listed	State Heritage Register (#01376)	Downstream
Rose Cottage and Early Slab Hut	Water Street, Werrington	State	Listed	State Heritage Register (#01392) Department of Planning and Infrastructure S170 (#3490017)	Downstream
Great Drain and two-house sites	Wisemans Ferry Road, Maroota South	State	Listed	State Heritage Register (#01402)	Downstream
Richmond Post Office	286 Windsor Street, Richmond	State	Listed	State Heritage Register (#01410)	Downstream
Australiana Pioneer Village	Rose Street, Wilberforce	State	Listed	State Heritage Register (#01683)	Downstream
Richmond Park	Bounded by East Market, Windsor and March Streets Richmond	State	Listed	State Heritage Register (#01808)	Downstream
Scheyville National Park	Scheyville Road, Scheyville	State	Listed	State Heritage Register (#01817)	Downstream
Yobarnie Keyline Farm	Grose Vale Road, Grose Vale	State	Listed	State Heritage Register (#01826)	Downstream
Emu Plains (Nepean River) Underbridge	Great Western Highway, Emu Plains	State	Listed	State Heritage Register (#01830) RailCorp S170 (#4801576)	Downstream
Emu Plains Correctional Centre	Emu Plains	State	Listed	Corrective Services NSW 3360092	Downstream
Emu Plains Correctional Centre – Manager of Industries Office	Emu Plains	State	Listed	Corrective Services NSW 3360093	Downstream
Government Cottage Archaeological Site	41 George Street, Windsor	State	Listed	State Heritage Register (#01843)	Downstream
McQuade Park	George Street, Windsor	State	Listed	State Heritage Register (#01851)	Downstream
Wilberforce Park	47 George Road, Wilberforce	State	Listed	State Heritage Register (#01868)	Downstream
Administration Building/Quadrangle Buildings and Garden	Richmond	State	Listed	University of Western Sydney S170 (#4730008)	Downstream
Blacksmith's Shop	Richmond	State	Listed	University of Western Sydney S170 (#4730004)	Downstream

Item name	Address/suburb	Significance	Status	Register	Study area location
Grandstand, Scoreboard and Oval	Richmond	State	Listed	University of Western Sydney S170 (#4730002)	Downstream
Owen Carter Memorial Chapel	Richmond	State	Listed	University of Western Sydney S170 (#4730007)	Downstream
River Farm	Richmond Lowlands	State	Listed	University of Western Sydney S170 (#4730011)	Downstream
Stable Square, Surrounding Lawns and Palm Trees	Richmond	State	Listed	University of Western Sydney S170 (#4730003)	Downstream
UWS Campus Planned Landscape	Richmond	State	Listed	University of Western Sydney S170 (#4730013)	Downstream
UWS Campus, Nature Reserve and Castlereagh Jewel Beetle Habitat and Movement	Richmond	State	Listed	University of Western Sydney S170 (#4730010)	Downstream
Wool Classing Building	Richmond	State	Listed	University of Western Sydney S170 (#4730005)	Downstream
Yarramundi House and Cottages	Richmond	State	Listed	University of Western Sydney S170 (#4730009)	Downstream
Richmond Courthouse and Police Station	Richmond	State	Listed	Attorney General's Department S170 (#3080112)	Downstream
Richmond Police Station and Court House	Richmond	State	Listed	NSW Police Service S170 (#4180148)	Downstream
Riverstone Police Station	Riverstone	State	Listed	NSW Police Service S170 (#4180152)	Downstream
Windsor Police Station	Windsor	State	Listed	NSW Police Service S170 (#4180149)	Downstream
Wisemans Ferry Police Station and Official Residence	Wisemans Ferry	State	Listed	NSW Police Service S170 (#4180150)	Downstream

Item name	Address/suburb	Significance	Status	Register	Study area location
Eastern Creek Bridge	Blacktown	State	Listed	Roads and Maritime Services S170 (#4309513)	Downstream
Northern Suburbs Ocean Outfall Sewer (NSOOS)	The Hills, Blacktown	State	Listed	Sydney Water S170 (#001303)	Downstream
Old Windsor Road and Windsor Road Heritage Precincts	Multiple	State	Listed	Roads and Maritime Services S170 (#4301011)	Downstream
Great North Road (retaining walls, culverts, road cutting)	1 km south of Wisemans Ferry	State	Listed	Roads and Maritime Services S170 (#4309678)	Downstream
Hawkesbury River Bridge, Richmond	North Richmond	State	Listed	Roads and Maritime Services S170 (#4309511)	Downstream
Hawkesbury River Bridge, Windsor	Windsor	State	Listed	Roads and Maritime Services S170 (#4309589)	Downstream
Peach Tree Creek Bridge	Penrith	State	Listed	Roads and Maritime Services S170 (#4309507)	Downstream
Sackville Ferry Crossing, Sackville	Sackville	State	Listed	Roads and Maritime Services S170 (#4311606)	Downstream
South Creek Bridge (Eastbound)	St Marys	State	Listed	Roads and Maritime Services S170 (#4309584)	Downstream
Victoria Bridge over Nepean River	Penrith	State	Listed	Roads and Maritime Services S170 (#4301653)	Downstream
Cottage	Llandilo	State	Listed	Department of Planning and Infrastructure S170 (#3490019)	Downstream
Four winds	Werrington	State	Listed	Department of Planning and Infrastructure S170 (#3490036)	Downstream
Margaret Farm and Barn	St Marys	State	Listed	Department of Planning and Infrastructure S170 (#3490031)	Downstream

Item name	Address/suburb	Significance	Status	Register	Study area location
Old Police Station	Emu Plains	State	Listed	Department of Planning and Infrastructure S170 (#3490018)	Downstream
Original building (Nepean Cottage Hospital)	Penrith	State	Listed	NSW Department of Health 3540104	Downstream
St Marys Railway Station Group	St Marys	State	Listed	RailCorp 4801036	Downstream
Torquay	Werrington	State	Listed	Department of Planning and Infrastructure S170 (#3490016)	Downstream
Wool Pack Inn (Ruin)	St Marys	State	Listed	Department of Planning and Infrastructure S170 (#3490032)	Downstream
Windsor Fire Station	Windsor	State	Listed	NSW Fire Brigades S170 (#4690108)	Downstream
1841 Tilley 5 inch Manual Fire Engine	Penrith	State	Listed	NSW Fire Brigades 4690173	Downstream
869 Shand Mason 7" Manual Fire Engine	Penrith	State	Listed	NSW Fire Brigades 4690169	Downstream
1891 Shand Mason Steamer Fire Engine	Penrith	State	Listed	NSW Fire Brigades 4690165	Downstream
1898 Shand Mason Curricle Ladders - Fire Engine	Penrith	State	Listed	NSW Fire Brigades 4690168	Downstream
1916 Garford Type 64 Chain Drive Fire Engine	Penrith	State	Listed	NSW Fire Brigades 4690171	Downstream
1929 Ahrens Fox PS2 Fire Engine	Penrith	State	Listed	NSW Fire Brigades 4690166	Downstream
1939 Dennis Big 6 Fire Engine	Penrith	State	Listed	NSW Fire Brigades 4690167	Downstream
1942 Ford 21W Fire Brigade Mobile Canteen	Penrith	State	Listed	NSW Fire Brigades 4690172	Downstream
1949 Dennis F1 Fire Engine (Scout Car)	Penrith	State	Listed	NSW Fire Brigades 4690176	Downstream
Commissioner's Uniform (NSW Fire Brigades) - Ian Mac Dougall	Penrith	State	Listed	NSW Fire Brigades 4690174	Downstream

Item name	Address/suburb	Significance	Status	Register	Study area location
Edward Smith Headquarters Switchboard - 1909	Penrith	State	Listed	NSW Fire Brigades 4690170	Downstream
NSW Fire Brigades Heritage Fleet	Emu Plains	State	Listed	RailCorp 4690177	Downstream
NSWFB 'No. 10' Vehicle Number Plates	Emu Plains	State	Listed	RailCorp 4690110	Downstream
Emu Plains (Lapstone Ck) Underbridge	Emu Plains	State	Listed	RailCorp S170 (#4803210)	Downstream
Emu Plains Railway Culvert	Emu Plains	State	Listed	RailCorp S170 (#4804417)	Downstream
Mulgrave Railway Residence	Mulgrave	State	Listed	RailCorp S170 (#4801027)	Downstream
Pitt Town Water Pumping Station (WP0064)	McGraths Hill	State	Listed	Sydney Water S170 (#4574706)	Downstream
Warragamba Sewage Treatment Plant	Warragamba	State	Listed	Sydney Water S170 (#4576020)	Downstream
Windsor (Elevated) Reservoir (WS 0140)	Windsor	State	Listed	Sydney Water S170 (#4575812)	Downstream
Windsor Water Pumping Station (WP00062)	Windsor	State	Listed	Sydney Water S170 (#4574708)	Downstream
Penrith Weir	Penrith	State	Listed	State Waters S170 (#4550169)	Downstream
State Records Movable Heritage – Furniture	Penrith	State	Listed	Department of Commerce S170 (#4270005)	Downstream
State Records Movable Heritage - Memorials	Penrith	State	Listed	Department of Commerce S170 (#4270006)	Downstream
Warragamba Supply Scheme	Warragamba	State	Listed	WaterNSW S170 (#4580161)	Within construction zone
Brooklyn (Long Island) Archaeological Site	Brooklyn	State	Listed	4803221	Downstream
Brooklyn Former Railway Platform (Long Island)	Long Island	State	Listed	RailCorp 4803221	Downstream

17.3.4.7 NSW Register of Shipwrecks

There are 40 items listed on the NSW Register of Shipwrecks that are potentially located within the study area, which include both air and sea craft. The follow entries were extracted from the NSW Register of Shipwrecks on 13 March 2019. At the time of this register search, the interactive map feature on the then OEH website for historic shipwrecks was not available. As such, identified maritime items that are potentially within the study area are based on an approximate manual search of the Nepean and Hawkesbury Rivers and tributaries, and the associated descriptions of items.

All the wrecks are located downstream of the proposed construction zone. Relics associated with each wreck are protected under the Heritage Act if they are more than 75 years old. These shipwrecks are shown in Table 17-5.

Table 17-5. Shipwrecks within the study area (downstream)

Shipwreck name	Location	Wrecked/ re-floated	Protection status
Aero Club Aircraft (#2671)	Nepean River (Hawkesbury) - Agnes Banks area	Unknown	Unknown
RAAF Aircraft (#2662)	Hawkesbury River - Windsor area	Salvaged	Unknown
RAAF Wapiti (#2661)	Hawkesbury River - Windsor area	Salvaged	Unknown
Windsor wharf (#2585)	The Terrace, Windsor	N/A	Heritage Act 1977
Government Wharf – Windsor (#2580)	The Terrace, Windsor	N/A	Heritage Act 1977
Narara (#2674)	Hawkesbury River - Sackville area	Re-floated	Heritage Act 1977
Isabel (#2659)	Hawkesbury - Leet's Vale area	Unknown	Heritage Act 1977
Gipsy Moth (#2668)	Hawkesbury River - Wiseman's Ferry area	Unknown	Heritage Act 1977
Adelaide	Broken Bay, off Hawkesbury River	Wrecked	Historic Shipwrecks Act 1976
Bella Coulter	Hawkesbury River mouth, Flint & Steel Point	Wrecked	Heritage Act 1977
Charlotte Fenwick	Hawkesbury River	Wrecked	Heritage Act 1977
Elizabeth	Hawkesbury River	Wrecked	Heritage Act 1977
Endeavour	Hawkesbury River	Wrecked	Heritage Act 1977
General Gordon	Hawkesbury River, Cowan Water, Waratah Bay	Wrecked	Heritage Act 1977
Happy Days	Hawkesbury River, Brooklyn, 'The Gunya'	Wrecked	Heritage Act 1977
Hawkesbury	Hawkesbury River	Wrecked	Heritage Act 1977
Hawkesbury	Hawkesbury River, Sackville Reach	Re-floated	Heritage Act 1977
Kellermont	Hawkesbury River, Flint & Steel Bay	Grounded	Historic Shipwrecks Act 1976
LHE	Hawkesbury River, Jerusalem Bay	Wrecked	Not protected
Marian	Hawkesbury River, Croppy Point	Wrecked	Heritage Act 1977
Minmi	Hawkesbury Bridge	Sank at mooring	Heritage Act 1977
Parramatta (1) Ex HMAS	Hawkesbury River	Foundered	Heritage Act 1977
Peggy	Hawkesbury River - Brooklyn	Wrecked	Heritage Act 1977

Shipwreck name	Location	Wrecked/ re-floated	Protection status
Phoenix	Hawkesbury River	Wrecked	Heritage Act 1977
Sally	Hawkesbury and Sydney	Wrecked	Historic Shipwrecks Act 1976
Speedwell	Ashore near Hawkesbury River	Wrecked	Historic Shipwrecks Act 1976
Surprise	Hawkesbury River near Brooklyn	Abandoned	Navigation Act 2012
Swan (1) Ex HMAS	Little Wobby, Hawkesbury River	Foundered	Heritage Act 1977
Unidentified - Hawkesbury River, Long Island	Long Island, Hawkesbury River	Wrecked	Unknown
Unidentified - Hawkesbury River, Mullet Creek, Wondabyne area - Boat	Hawkesbury River, Mullet Creek	Wrecked	Unknown
Unidentified Hawkesbury River - Spectacle Island Nature Reserve, near Mooney Mooney 1	Hawkesbury River, Spectacle Island, near Mooney Mooney	Wrecked	Unknown
Unidentified Hawkesbury River - Spectacle Island Nature Reserve, near Mooney Mooney 2	Hawkesbury River, Spectacle Island, near Mooney Mooney	Wrecked	Unknown
Unidentified Hawkesbury River - Spectacle Island Nature Reserve, near Mooney Mooney 3	Hawkesbury River, Spectacle Island, near Mooney Mooney	Wrecked	Unknown
Unidentified Hawkesbury River Windsor 1	Hawkesbury River north side of Windsor	Unknown	Not protected
William and Mary	On beach at mouth of Hawkesbury River	Refloated	Historic Shipwrecks Act 1976 and Heritage Act 1977
Willirie	Hawkesbury River	Unknown	Heritage Act 1977
Z Special Unit Camp X - Refuge Bay, Broken Bay	Hawkesbury River, Broken Bay, Refuge Bay	Unknown	Unknown
Unknown Wharf Waratah Bay Cowan Creek Hawkesbury	Waratah Bay, Cowan Creek, Hawkesbury River	N/A	Heritage Act 1977
Argument	Broken Bay, East and West Reef	Wrecked	Historic Shipwrecks Act 1976
Unidentified	Broken Bay, about 3 miles from North Head	Wrecked	Historic Shipwrecks Act 1976 and Heritage Act 1977

17.3.4.8 Local heritage items

The study area falls within the boundaries of the Blacktown, Central Coast, Hawkesbury, Hornsby, Pittwater, Gosford, Liverpool, Penrith, The Hills and Wollondilly LEPs. All these local government areas pre-date the most recent council mergers. The study area is also located within the boundaries of the Sydney Region Growth Centres SEPP (SRGC) 2006. LEP registers and the SRGC SEPP includes a list of places/sites of heritage significance.

There are 793 places listed on the LEPs and SEPP SRGC within the study, which are summarised in Table 17-6. The full list is provided in Appendix I (Non-Aboriginal heritage assessment) with some of these items being duplicates of heritage items/places listed on the state statutory registers. All items are located downstream of the dam wall except for the Warragamba Supply Scheme and Warragamba Emergency Scheme (LEP No. I270) (refer to Section 17.3.4.5), which is located within the construction zone.

Table 17-6. Place counts for LEP and SRGC schedules

Schedule	Number of places listed
Blacktown Local Environmental Plan 2015	28
Hawkesbury Local Environmental Plan 2012	469
Hornsby Local Environmental Plan 2013	54
Liverpool Local Environmental Plan 2008	6
Penrith Local Environmental Plan 2010	154
The Hills Local Environmental Plan 2012	43
Wollondilly Local Environmental Plan 2011	5
Gosford Local Environmental Plan 2014	25
Pittwater Local Environmental Plan 2014	2
State Environmental Planning Policy (Sydney Region Growth Centres) 2006	7
Total	793

Figure 17-5. Heritage items located upstream of the proposed construction zone – Part 1

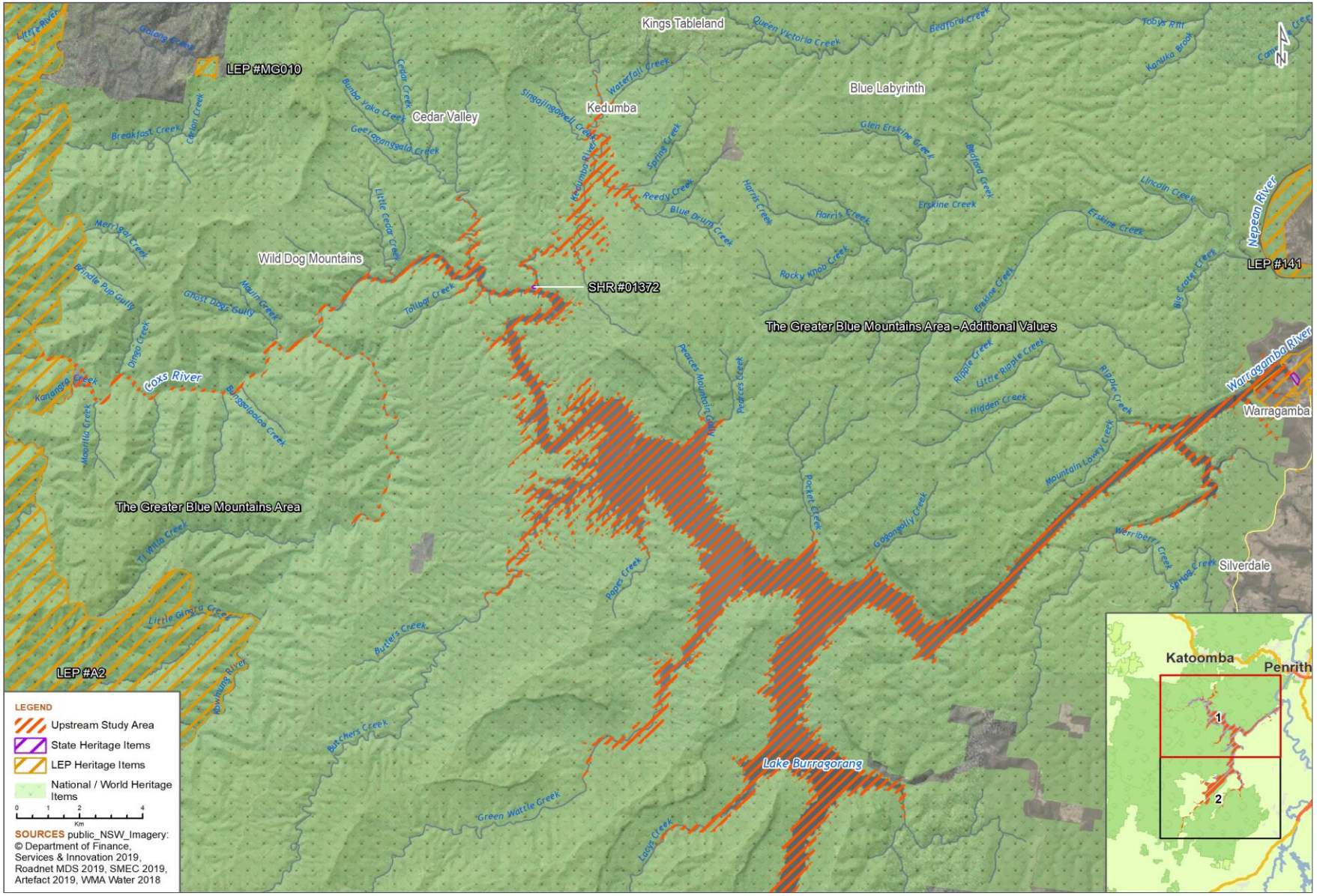


Figure 17-6. Heritage items located upstream of the proposed construction zone – Part 2

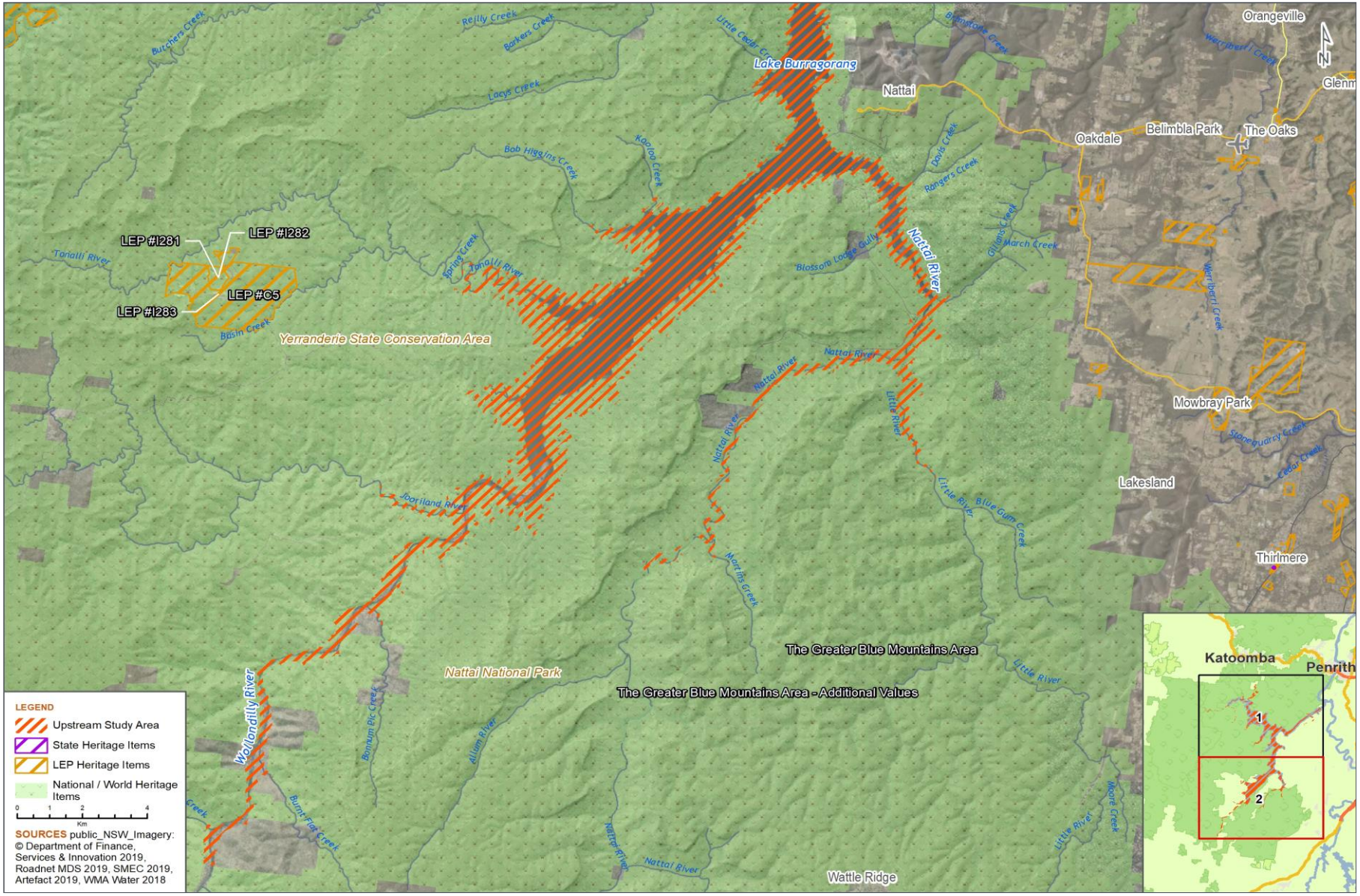


Figure 17-7. Heritage items located within or nearby the proposed construction zone

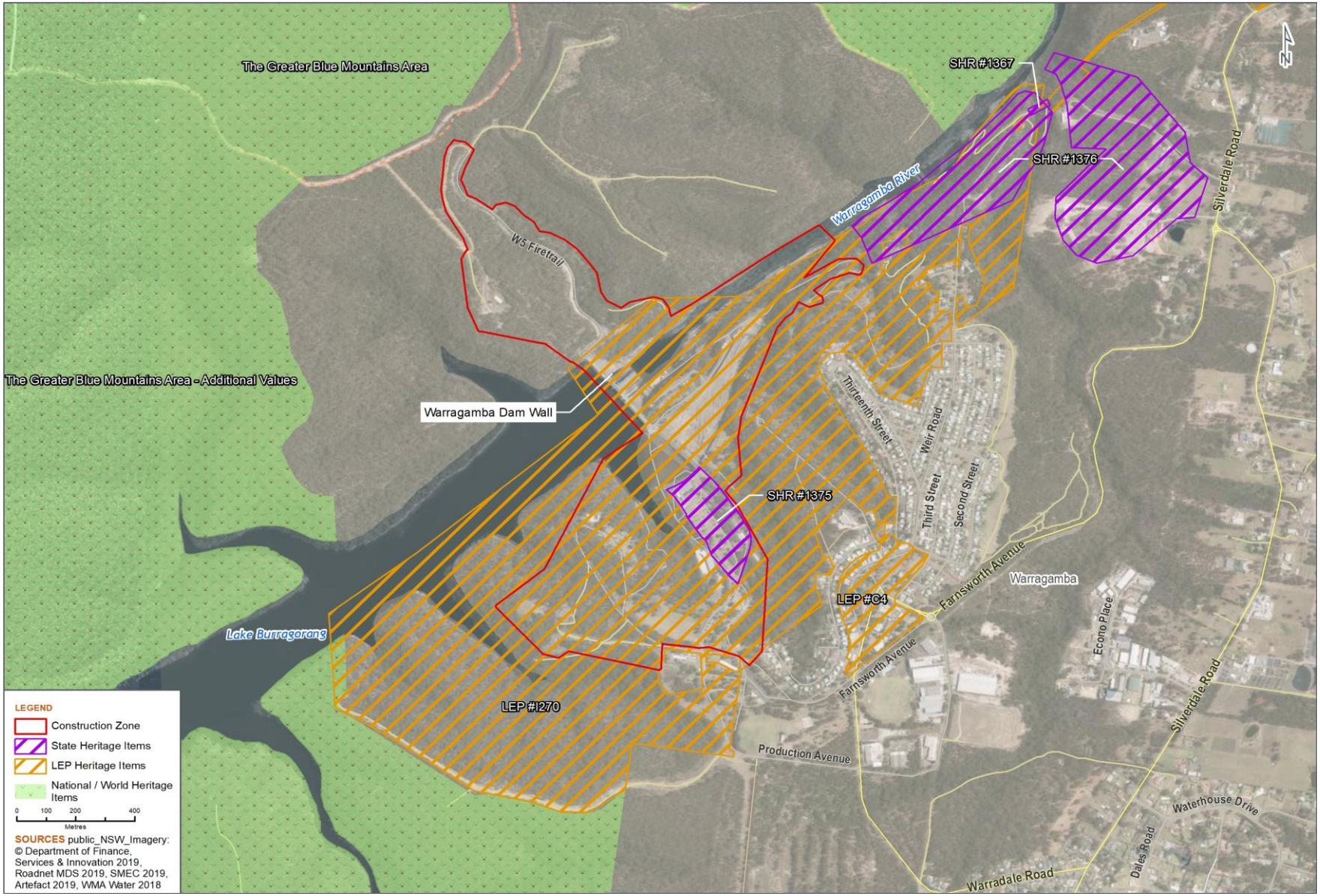


Figure 17-8. Heritage items located downstream of the proposed construction zone - Part 1

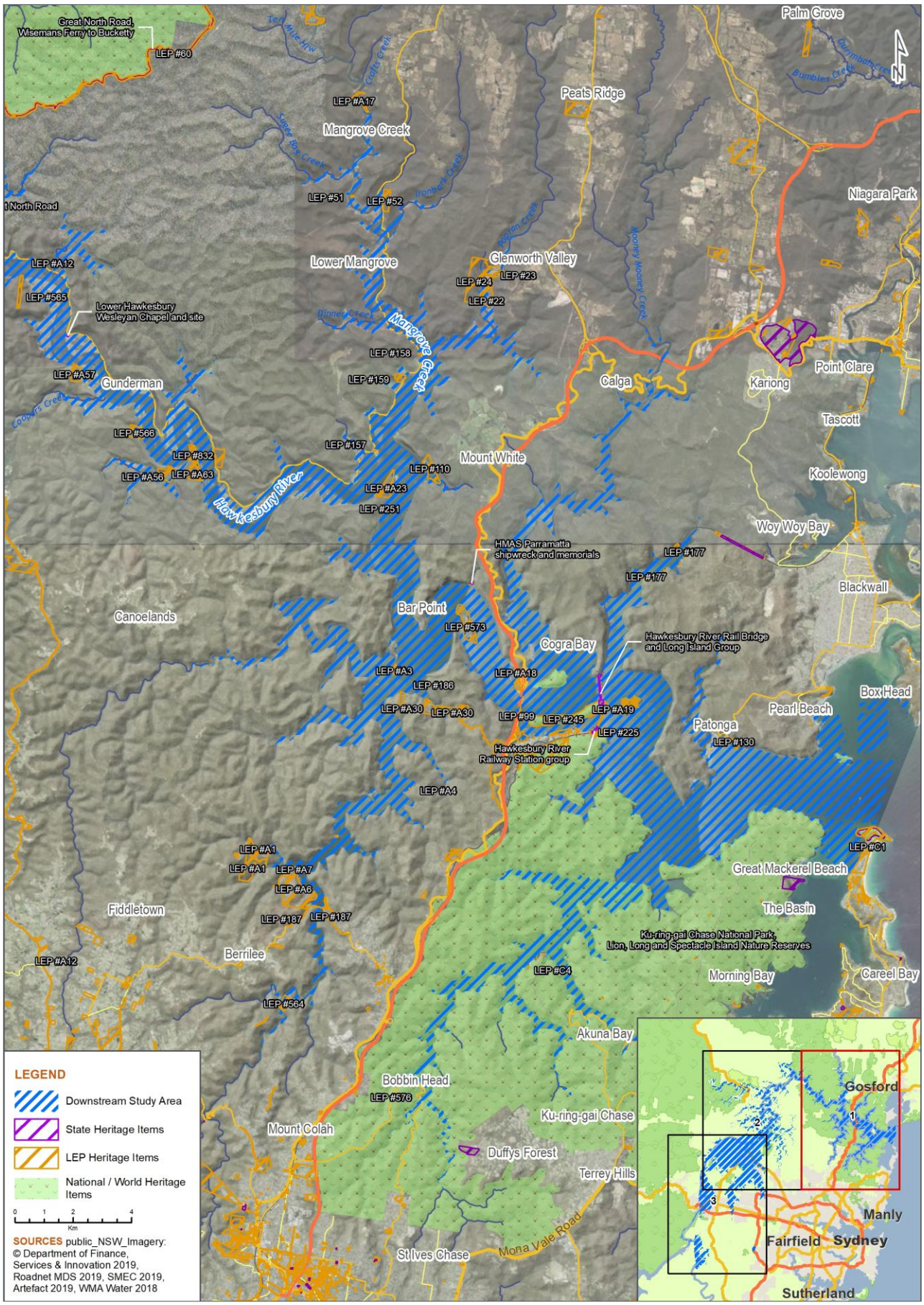


Figure 17-9. Heritage items located downstream of the proposed construction zone - Part 2

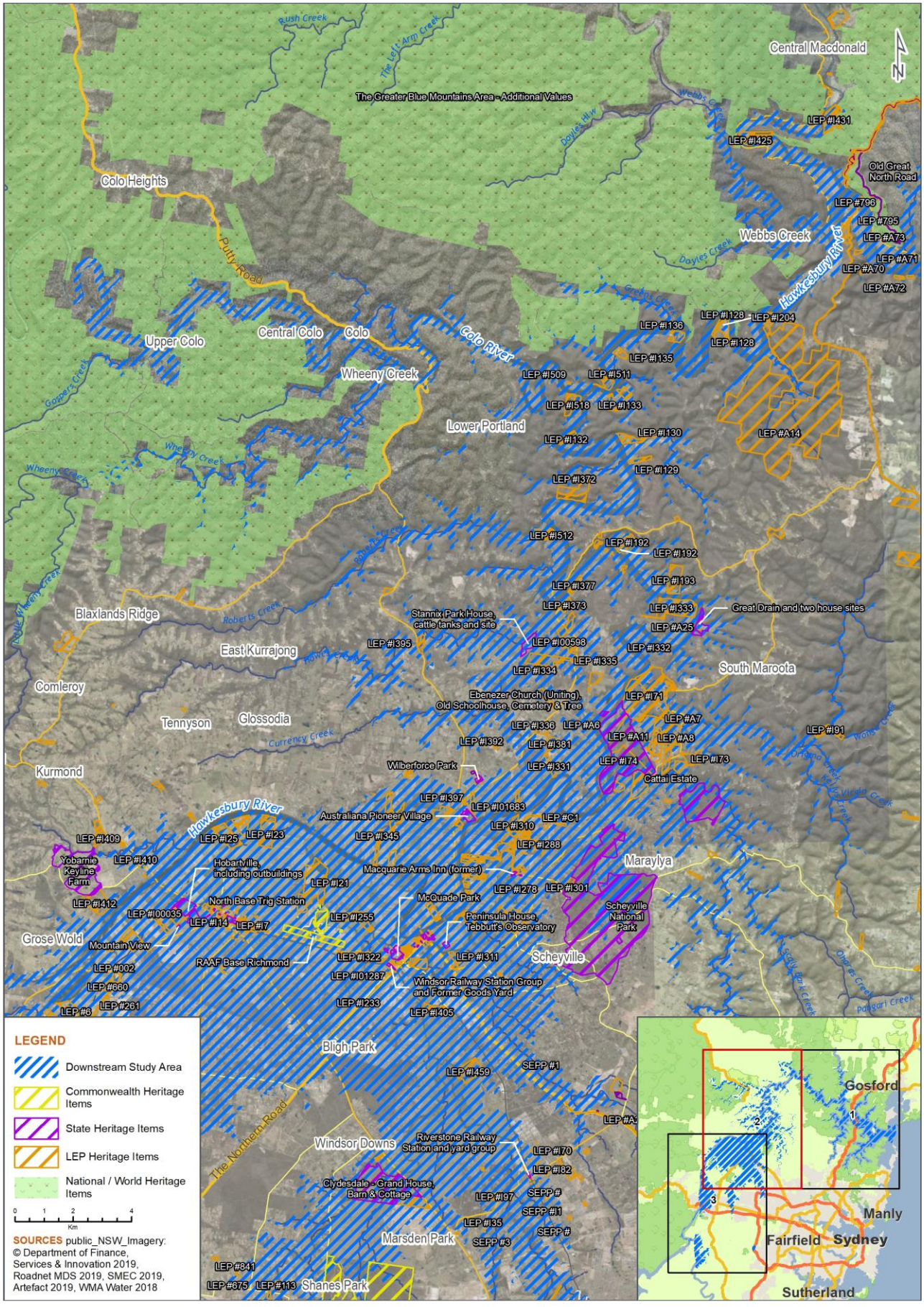
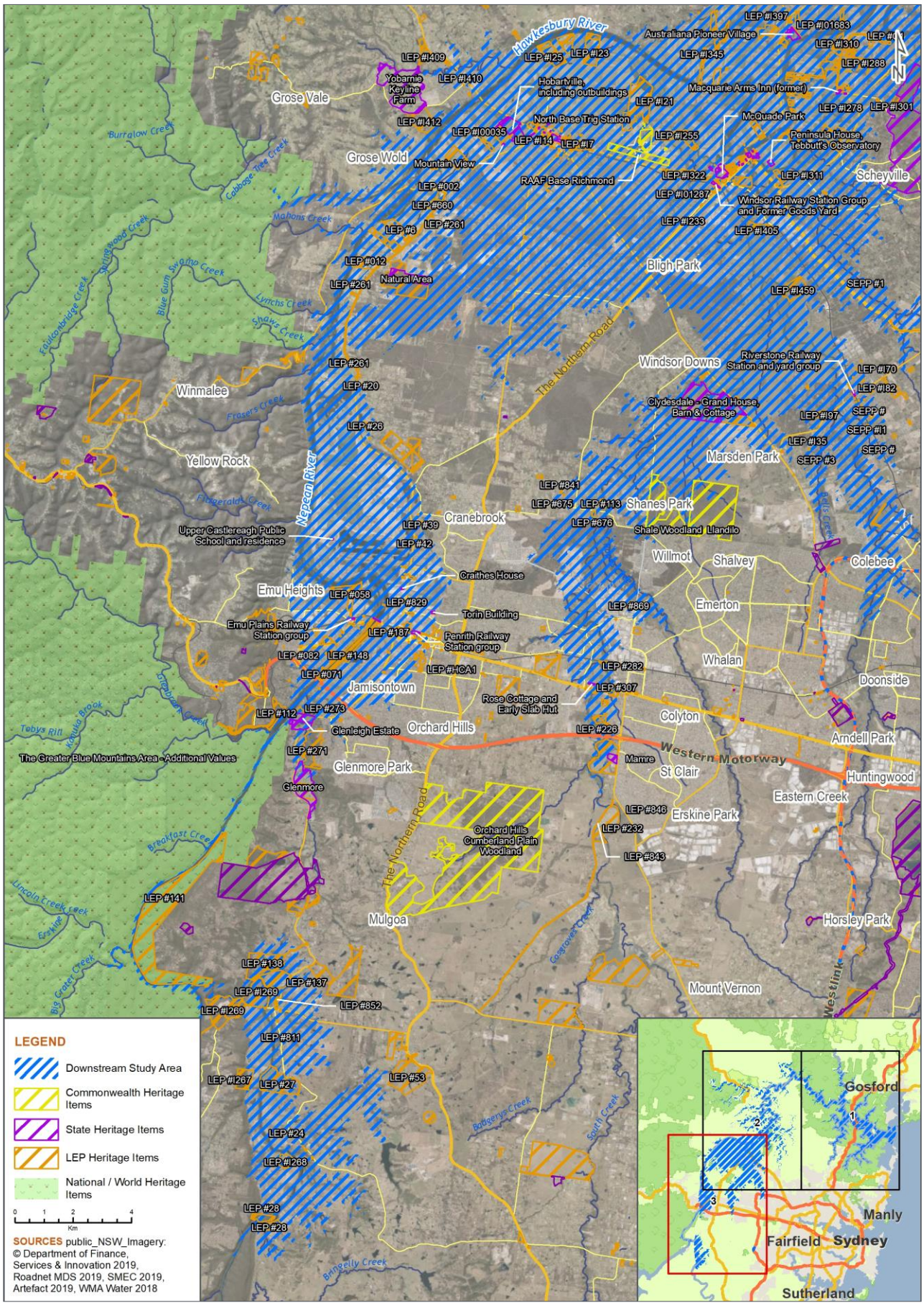


Figure 17-10. Heritage items located downstream of the proposed construction zone - Part 3



17.3.5 Site inspections

Site inspections were undertaken of the following:

- Warragamba Supply Scheme
- Warragamba Dam - Haviland Park
- Warragamba Emergency Supply Scheme
- Australian Convict Sites (Old Great North Road)
- Ku-ring-gai Chase National Park, Lion Island, Long Island and Spectacle Island Nature Reserves.

The heritage significance and any relevant further information revealed during the site surveys are discussed below.

17.3.5.1 Warragamba Supply Scheme (WaterNSW s170 No. 4580161, LEP No. I270)

The SHI database listing card for the Warragamba Supply Scheme does not provide a physical description of the item. The Warragamba Supply Scheme CMP 2010 identifies the item as comprising the following components and sub-components:

- Warragamba Dam: Main dam wall with a crest length of 351 metres and height 142 metres. The dam is a straight gravity wall and contains the following sub-components:
  - crest gantry crane
  - crest gates
  - dam outlets
  - internal inspection galleries, lift shafts, and access tunnels
  - 18-ton Cableway (upper tail tower).
  - Haviland Park
  - hydro-electric power station.
  - suspension bridge.
  - valve house.
  - picnic grounds.
  - dam models and existing visitor centre.
  - production office and other buildings within Haviland Park.
  - conference Centre
  - former construction township.
- Warragamba Emergency Scheme (see Section 17.2.4.2)
- Warragamba Prospect Pipelines 1 and 2.

The SHI database listing card for the Warragamba Supply Scheme heritage item provides the following statement of significance (OEH n.d.c):

> *The Warragamba Supply Scheme is the largest and most important of the water supply systems to provide a secure water supply to satisfy the demands of industrial, commercial and residential development of metropolitan Sydney. The dam, associated infrastructure and pipelines is one of the largest (possibly largest) of any type of dam in the world constructed specifically for an urban water supply.*
>
> *The Warragamba Dam foundation and wall drainage systems, and the post-war architectural expression of the crest, lift towers and Valve House collectively continue to be integral elements of an outstanding example of a high, straight concrete gravity wall, which at the time of construction was the highest concrete gravity dam in the world constructed on stone foundations.*
>
> *The scale of the use of mass concrete in the dam wall is unique in New South Wales. The design of the spillway incorporated in the wall and crest gates demonstrate a notable technological advancement and are possibly the only extant examples of their type in Australia.*
>
> *The means of construction and infrastructure established for the construction of the dam, involved innovative techniques that were used for the first time in Australia, such as the pre-stressed concrete frame of the ice making plant and the use of circulated chilled water to cool the concrete being placed. The techniques also incorporated*

equipment and fabric from previous Board works and brought together experience gained from these earlier works and overseas models.

The Dam contains in-situ items of post-war era water delivery technologies developed by the Water Board, such as lengths of pipes, emergency roller gate, trash racks and penstocks which in consideration of their scale and integrity are rare examples of their types. The welded mild steel delivery pipeline similarly represents a notable advance in construction technology for the period.

It contains items of machinery and structures which are significant due to their relationship and role they played during the construction period, and which continue to demonstrate the means of construction and operations such as the Upper Tail Tower and remains of the Warragamba Suspension Bridge.

The dam is a regional landmark that has engendered beautification works undertaken from early in the construction phase to post completion of the dam for the use of local and general visiting public.

The picnic areas in particular have strong associations with past management practices of the Water Board and Haviland Park in particular demonstrates the Board's recognition of the scale and importance of the dam and adoption of a more sophisticated approach to picnic area and park design and layout under the influence of specialist consultants such as Professor Spooner. The grounds of the dam are associated with the local and regional community of Sydney as a longstanding place of passive recreation.

A field survey of the Warragamba Supply Scheme encompassed accessible areas potentially impacted by the Project, comprising the main dam wall and its associated features, surrounding picnic grounds including Haviland Park (above) and the Terraced Garden (see Figure 17-11 to Figure 17-13).

Figure 17-11. View north-west to existing bridge on Production Avenue over auxiliary spillway and crest road on the dam wall

Figure 17-12. View north-west from terrace garden picnic area showing the dam wall, towers and downstream face

Figure 17-13. View down from Crest Road to the Valve House and attached annexe building located to the rear

17.3.5.2 Warragamba Emergency Supply Scheme (SHR No. 01376, LEP No. I270)

The SHR listing for the Warragamba Emergency Scheme heritage item provides the following description of the item (OEH n.d.b):

> *Construction site for the Warragamba Emergency Scheme was located on the east bank of the Warragamba River. Access to the site was along the road currently known as Weir Road. Major elements of the construction work still extant include the weir, a 10-cable cableway, shads, batching plants, roads, electrical substation, chlorination plant, maintenance staff accommodation, balance reservoir, Megarrity's bridge, water pumping station, tunnels, and associated pipelines.*

The SHR listing for the Warragamba Emergency Scheme provides the following statement of significance (OEH n.d.b):

> *The Emergency Scheme is representative of the collective engineering response to Sydney's critical water shortage during the Second World War period. It was the first stage in the storage and extraction of water from the Warragamba River, and was preliminary to the Warragamba Dam. All the components are excellent examples of the civil engineering skills of the times; the Balance Reservoir is particularly significant because it provides a stilling pool downstream of Warragamba Dam for the purpose of flood discharge; the group of five cottages associated with the construction of the dam are considered to be of high significance because they housed the operations staff between 1940 and 1959. These have since been incorporated into the Warragamba township, one of the largest townships in the Shire of Wollondilly.*

Site surveys were undertaken of key elements (see Figure 17-14 and Figure 17-15) of the Warragamba Emergency Supply Scheme.

Figure 17-14. View north-east from Weir Road towards Megarritys Bridge

Figure 17-15. View south-west along Weir Road towards pumping station

17.3.5.3 Warragamba Dam - Haviland Park (SHR No. 01375)

The SHR listing for the Warragamba Dam - Haviland Park heritage item provides the following description of the item (OEH n.d.a):

> *Warragamba Dam is in a narrow gorge within the Warragamba River, approximately 65 km west of Sydney and 15km south of Penrith. The south-eastern corner of the site connects to the Warragamba township established as part of the Warragamba Supply Scheme. The northern side of the dam is adjacent to the Blue Mountains National Park. East of the dam is a large Entry Precinct and Picnic Grounds, and Haviland Park is between this Precinct and the dam itself and spillways.*
>
> *Haviland Park is to the dam's east and covers 10 acres contains plantings and built features which are substantially intact from the time of establishment in the 1960s. There is remnant evidence of the construction apparatus, including rail tracks, building footings, concrete anchors, former aggregate conveyor tunnel, existing terraced road alignments, 19-ton cableway and associated machinery. The existing timber and fibro systems office (former engineers' office) and information centre (former staff mess) which constitute the only two remaining buildings from the original construction site.*
>
> *Haviland Park now comprises two open, relatively level grassed areas bounded by native and introduced trees and shrubs. The most prominent are two rows of sweet gums (*Liquidambar styraciflua*) planted during the 1960s. The areas are bounded by access roads with newly formed car parking areas and kerbs also provided. The precinct is the major open space recreation area of the dam but has been closed since 1997 due to construction works at the site. (Sydney Catchment Authority 2007, 1)*[1].

[1] The SHR listing description has not been updated and some information may be inaccurate. For example, the 'information centre' (former staff mess) was destroyed by fires in 2001.

The SHR listing for the Warragamba Dam - Haviland Park heritage item provides the following statement of significance (OEH n.d.a):

> *Haviland Park has a high level of state heritage significance for several reasons. It represents the pinnacle of quality visitor facilities provided by the Board at Dam sites. It contains numerous archaeological, architectural and engineering remnants from the dam's construction.*

A site survey was undertaken of Haviland Park. Many of the significant Haviland Park elements listed on the SHR are no longer extant due to the December 2001 bushfires. The only remaining significant elements comprise a remnant fountain base (see Figure 17-16), several mature plantings at the southern end of the site and sections of dry packed stone retaining wall. A former aggregate conveyor tunnel also remains within the site.

Figure 17-16. View south-east across Haviland Park towards remnant fountain base

17.3.5.4 Australian Convict Sites (Old Great North Road) (WHL Place ID 106209, NHL Place ID 106318)

A field survey was undertaken of a localised section of the Australian Convict Sites/Old Great North Road (see Figure 17-17). This survey encompassed accessible areas of the Old Great North Road that are within or near the study area.

The WHL entry for the Australian Convict Sites provides the following description of the item (United Nations Educational, Scientific and Cultural Organisation (UNESCO) n.d.a):

> *The property includes a selection of eleven penal sites, among the thousands established by the British Empire on Australian soil in the 18th and 19th centuries …The Australian Convict Sites presents the best surviving examples of large-scale convict transportation and the colonial expansion of European powers through the presence and labour of convicts.*

Following is the introduction to the statement of Outstanding Universal Value for the WHL entry for the Australian Convict Sites (DoEE n.d):

> *The property consists of 11 complementary sites. It constitutes an outstanding and large-scale example of the forced migration of convicts, who were condemned to transportation to distant colonies of the British Empire; the same method was also used by other colonial states.*

The NHL entry for the Old Great North Road provides the following description of the item (DoEE 2019b):

> *The convict built Great North Road runs in a generally northward direction from Sydney for some 250 kilometres to Jerry's Plains in the Hunter Valley…. The nominated place is the 7.5 kilometre portion of the Old Great North Road incorporating the 1.8 kilometre Devine's Hill section of road (built 1829-32) and the abandoned 5.2 kilometre*

Finch's Line (built 1828) which provide ascents from the Hawkesbury River on its northern side, opposite the town of Wisemans Ferry, to the sandstone plateau in an open forest setting plus the link road (0.5 km) joining them. The precinct lies within the Dharug National Park and the natural setting retains the qualities of the physical environment in which the convict road builders would have laboured. The scale and extensive nature of the road structures along this portion of the Old Great North Road represent the most advanced aspects of road engineering in the colony in the 1820s.

The setting of the Old Great North Road is important as it provides a sense of what nineteenth century travel was like. The scenic quality of the Old Great North Road landscape derives from the contrast between monumental stone remains and the seemingly undisturbed nature of the bush around them. Important views across undisturbed bushland are gained from the ridge top locations of the road, while the Finch's Line provides spectacular views over the Hawkesbury River and Wisemans Ferry.

The NHL entry for the Old Great North Road provides the following statement of significance (DoEE 2019b):

Finch's Line and the Devine's Hill ascent are important as a particularly challenging segment of the 250 km long Great North Road. The road, built with convict labour, was commenced in 1826 and completed in 1836. This segment of the Great North Road contains a rich array of features associated with convict road building, including traces of the first road, known as Finch's Line constructed in 1828, the later road re-alignment ascending Devine's Hill built between 1829-32, the archaeological remains of a convict stockade which housed convicts during the building of the road, the landscape setting of the roads including the massive retaining walls and buttresses on Devine's Hill, culverts and the landscape along the roads and between the routes.

Figure 17-17. View north to entrance of Australian Convict Site (Old Great North Road) from Settlers Road

17.3.5.5 Ku-ring-gai Chase National Park, Lion Island, Long Island and Spectacle Island Nature Reserves (NHL Place ID 105817)

The NHL entry for the Ku-ring-gai Chase National Park and Lion Island, Long Island and Spectacle Island Nature Reserves provides the following description of the item (DoEE 2019a):

Covering an area of 14,882 hectares, Ku-ring-gai Chase National Park is located on the dissected Hornsby Plateau near the centre of the sedimentary Sydney basin and demonstrates a range of landscapes, including drowned river valley estuaries, steep sandstone cliffs and plateaus (Thomas & Benson 1985). Lion Island, Long Island and Spectacle Island Nature Reserves are all located in the lower Hawkesbury River close to Ku-ring-gai Chase National Park.

Ku-ring-gai Chase National Park has been a conservation area since 1894. It is located within the Sydney metropolitan area, approximately 20 kilometres north of the centre of Sydney and receives over 2 million visitors a year. The National Park includes Barrenjoey Head, the site of an early customs house and a lighthouse complex with two cottages. Lion Island (8 hectares) is situated just inside the entrance to Broken Bay and is entirely included in the nature reserve. Long Island is situated near the town of Brooklyn. Most of the island (73 hectares) is included in the nature reserve while a small area at the eastern end of the island is managed by the State Rail Authority and includes a railway tunnel and several buildings. Spectacle Island (36 hectares) is situated near the junction of the Hawkesbury River and Mooney Mooney Creek and is entirely included in the nature reserve (NSW NPWS 2002).

Extensive evidence of Aboriginal use and occupation occurs in the place, with over 800 sites or locations with physical evidence of Aboriginal use recorded (NSW NPWS 2002, NSW NPWS 2006b). Shell middens along the foreshore are the most common type of evidence recorded. Other evidence includes rock engravings and paintings, grinding grooves, stone arrangements, burials and occupation sites. No systematic survey has been undertaken across the park, and it is likely that additional sites occur within the park.

The NHL entry for the Ku-ring-gai Chase National Park and Lion Island, Long Island and Spectacle Island Nature Reserves provides the following summary statement of significance (DoEE 2019a):

Ku-ring-gai Chase National Park and Long Island, Lion Island and Spectacle Island Nature Reserves contain an exceptional representation of the Sydney region biota, a region which is recognised as a nationally outstanding centre of biodiversity. The place contains a complex pattern of 24 plant communities, including heathland, woodland, open forest, swamps and warm temperate rainforest, with a high native plant species richness of over 1,000 species and an outstanding diversity of bird and other animal species. This diversity includes an outstanding representation of the species that are unique to the Sydney region, particularly those restricted to the Hawkesbury Sandstone landform. The place is an outstanding example of a centre of biodiversity.

17.3.6 Archaeological assessment

An assessment of the study area's potential to contain historical archaeological resources was conducted. 'Archaeological potential' refers to the likelihood that an area contains physical remains associated with an earlier phase of occupation, activity or development of that area. This is distinct from 'archaeological significance' and 'archaeological research potential'. These designations refer to the cultural value of potential archaeological remains and are the primary basis of the recommended management actions included in this document.

Excavation works associated with the Project would be confined to the construction area, which was the focus for archaeological investigations. Potential upstream and downstream impacts would be associated with increased periods of inundation, which would have minimal impact on subsurface archaeological remains.

The following two primary phases of development, and potential associated land uses, were used to assess the potential extent of archaeological evidence within the study area:

- phase 1 (c.1800 – c.1900): early land grants and rural development
- phase 2 (c.1900 - 1940): urban expansion/Warragamba dam.

An assessment of the archaeological potential associated with the above phases within the construction zone determined that it is unlikely that any archaeological evidence of Phase 1 remains, however there is a moderate to high potential that archaeological evidence associated with Phase 2 could be located within the construction zone. A summary of the assessment of potential is provided in Table 17-7 and shown in Figure 17-18.

The assessment of significance of Phase 2 was conducted in accordance with the criteria in the NSW Heritage Branch document *"Assessing Significance for Historical Archaeological sites and Relics"*. A summary of the significance assessment against the NSW Heritage Assessment criteria is included in Table 17-8.

Table 17-7. Summary of archaeological potential in the construction footprint

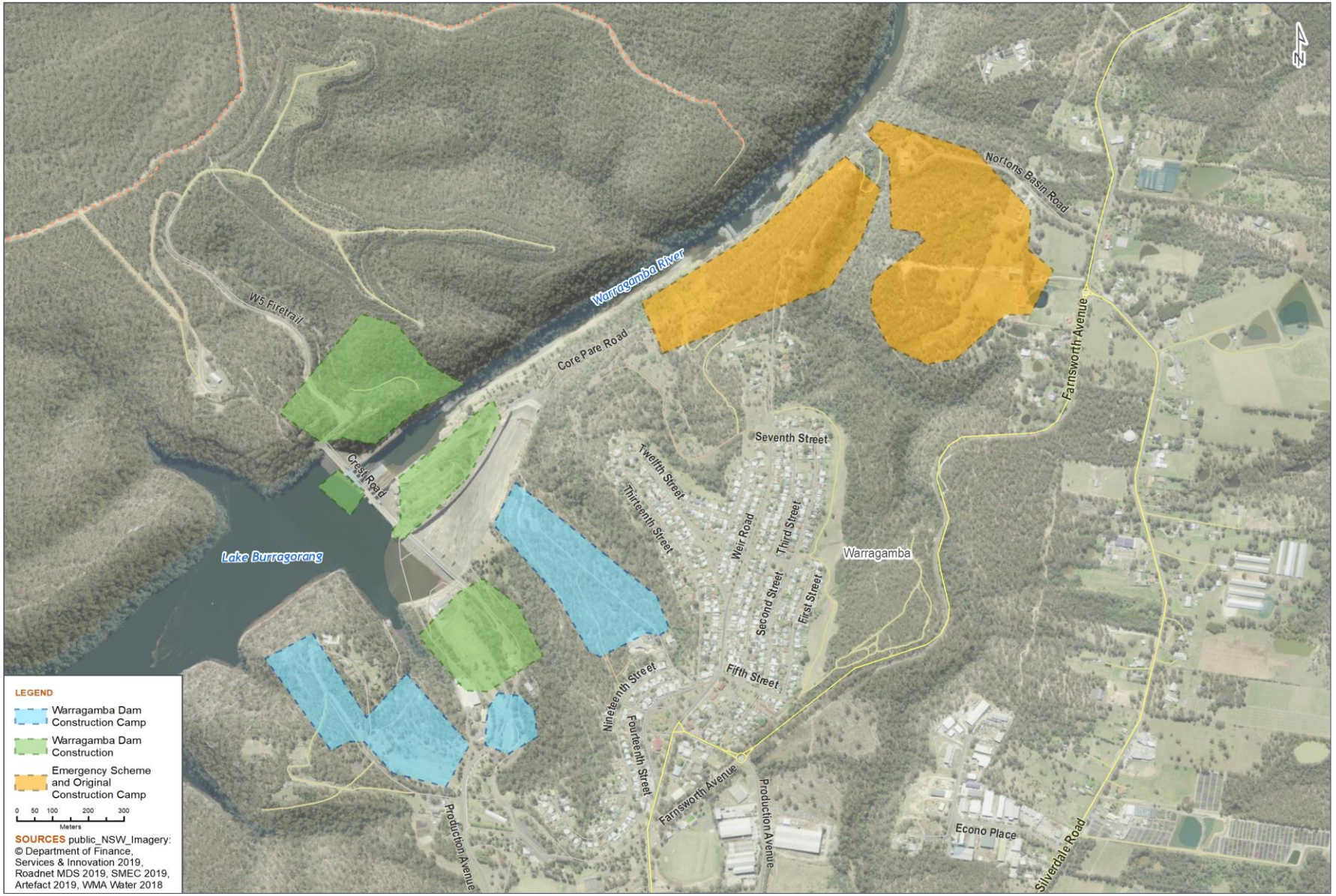
Phase	Potential archaeological remains	Level of disturbance	Archaeological potential
1: Early Land Grants	Evidence of land clearance, and modification for agricultural or pasturing purposes including tree boles, plough marks and fence lines.	High level of disturbance through 20th century construction activity.	Nil to Low
2: Warragamba Dam	Evidence of the original emergency scheme (power station, chlorination and alum plant, batching plant, and support sheds) and construction camp. Remains may include: ▪ building platforms, retaining walls, guttering and drainage, artefact deposits and possibly some building footings ▪ concrete slabs and plinths, disused services and pipelines, former roadways (some with bitumen or gravel surfaces), concrete pathways and steps, dry packed retaining walls, artefact deposits and evidence of rock cuttings.	Localised disturbance through demolition and later construction activities.	Moderate to High
	Remains of the Warragamba Dam construction camp including: ▪ evidence of the single men's barracks including footings, roads, paths, disused services, and artefact deposits ▪ evidence of former anchor tunnel, tail tower footings and pathways ▪ evidence of junior and senior staff barracks including footings, services, artefact deposits and landscaping features.	Localised disturbance through demolition and later construction activities.	Moderate to High
	Evidence of the construction of Warragamba Dam including: ▪ the carpenter's stores and Folly Creek suspension bridge including concrete slabs and footings, pits, services and the concrete slab and anchor tunnel for the suspension bridge ▪ former roads and road surfaces ▪ footings and disused services associated with the former offices ▪ evidence of the 18 and 10-ton cableways including concrete slab footings, tracks and buffer stops of the 18-tonne cableway travelling tail tower; footings of the former electricity sub-station; the west-bank block anchor for the Warragamba Gorge suspension bridge; and the slab footing of the former compressor house. ▪ the current terraced gardens contain the space formerly occupied by the travelling 10-ton cableway tower and its tracks and may also contain footing slabs from the former compressors, pumps and coolers ▪ evidence of the original upstream coffer dam.	Heavy localised impact through construction of the auxiliary spillway in the 1990s Construction of the Warragamba Deep-Water Storage Access Infrastructure in the early 2000s impacted on the site of the former chlorination plant and substation Construction of the Visitor Centre in 2008 impacted some of the archaeology associated with the McCann's Island aerial ropeway under Haviland Park	Moderate to High

Table 17-8. Assessment of significance against the NSW Heritage assessment criteria

Criteria	Discussion	Local	State
A – Historical Significance An item is important in the course or pattern of the local area's cultural or natural history.	The Warragamba Supply Scheme has played a fundamental role in providing water to metropolitan Sydney from 1940, through the Emergency Scheme at a time of great need and during protracted record drought and since with the construction of Warragamba Dam in ensuring security of water supply. The construction of the Emergency Scheme narrowly averted failure of the Sydney's water supply and was constructed in record time using nearly all the Boards available resources and manpower. The construction of the Warragamba Dam was the single factor that led to the settlement of the township of Warragamba. Archaeological evidence associated with the Emergency Scheme, construction of Warragamba Dam, and the individuals who were involved in the construction works, would contribute to our knowledge of the cultural history of the area. The potential archaeological resource within the study area, if found to be significantly intact and legible, may have significance at a local level.	✓	-
B – Associative Significance An item has strong or special associations with the life or works of a person, or group of persons, of importance in the local area's cultural or natural history.	The construction of the Warragamba Supply Scheme between the years 1937 and 1961, necessitated the employment of a large body of labourers and tradesmen who lived at the construction sites with their families. The number of employees at the Emergency Scheme was up to 2,000 and up to 1,700 for Warragamba Dam, numbers which represents a major influx to the population of the local area. The township that emerged during the construction of the Dam, and the workers and their descendants, continue to have strong associations with the site. The potential archaeological resource within the study area, if found to be significantly intact, may have significance at a local level.	✓	-
C – Aesthetic Significance An item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in the local area.	The potential archaeological remains within the study area have little potential for aesthetic significance. Although it is recognised that exposed in situ archaeological remains may have distinctive/attractive visual qualities and have visual characteristics with the ability to connect communities and individuals to the past through tangible remains, the potential archaeological remains at the study area are likely to be ephemeral. The potential archaeological resource does not meet the local significance threshold under this criterion.	-	-
D – Social Significance An item has strong or special association with a community or cultural group in the local area for social, cultural or spiritual reasons	Warragamba Dam is recognised and significant part of the historic built environment of the local area. The Dam and surrounding area have strong links and continued association with Warragamba township, with some of the residents having direct association with its construction and ongoing operations. Archaeological evidence associated with former workers and inhabitants of the construction camps and Warragamba township may have resonance with the descendants of these individuals. The potential archaeological resource may meet the local significance threshold under this criterion.	✓	-

Criteria	Discussion	Local	State
E – Research Potential An item has potential to yield information that will contribute to an understanding of the local area's cultural or natural history	Archaeological remains associated with the construction of the Supply Scheme between 1937 to 1961 have the potential to demonstrate aspects of its planning and construction. Remains may include remnant structures and/or modified landscapes associated with the provision of plant and equipment, employee accommodation and camp services, and routes of access for the supply of stores and materials. Remains may include: ▪ remnant road alignments - The principal means of access to the dam construction site for transporting men, equipment, stores, and materials ▪ remains of the Emergency Scheme camps and barracks ▪ remains of the substation and other infrastructure ▪ evidence of the travelling tail towers and cableway - Remnant features of this use include the broad, sweeping, cleared platform, upper tail tower and rails/tracks. ▪ Potential archaeological evidence contained within the subject site is likely to contribute to knowledge on several questions relevant to major or broader research questions relating to NSW history, such as: ▪ developing local, regional, and national economies – Environment; cultural landscape – Activities associated with the interactions between humans, human societies and the shaping of their physical surroundings. ▪ The potential archaeological resource within the study area, if found to be significantly intact and legible, may have significance at a local level.	✓	-
F – Rarity An item possesses uncommon, rare or endangered aspects of the local area's cultural or natural history	The study area has the potential to contain evidence of a significant 20th century engineering achievement, and the development of a landscape created for the specific purpose of managing the water supply of Sydney. Should an archaeological resource associated with this phase of development be present and intact, it would be relatively rare. The potential archaeological resource within the study area, if found to be significantly intact and legible, may have significance at a local level.	✓	-
G – Representative An item is important in demonstrating the principal characteristics of a class of NSW's cultural or natural places of cultural or natural environments (or the cultural or natural history of the local area).	The construction technologies used at Warragamba represent a culmination of the technology and experience associated with dams constructed in New South Wales through to this period. Key representative attributes include the use of rope and cableways, the building of camps and township to house labourers and tradesmen, building of cottages to house salaried staff, the construction of terraced platforms for plant and machinery, mechanisation of concrete production, the construction of purpose built road of access to transport men, supplies and materials to the site, the building of permanent infrastructure such as water supply and the use of electricity to power plant, equipment and township. The potential archaeological resource within the study area, if found to be significantly intact and legible, may have significance at a local level.	✓	-

Figure 17-18. Overview of location of potential archaeological resources (see Table 17-7 for discussion of archaeological potential)



17.3.6.1 Statement of archaeological significance

The assessment of archaeological potential found:

- the area was used as agricultural land prior to the construction of the Warragamba Emergency Scheme in the 1940s. It is unlikely that archaeological remains pre-dating early 20th century development has been retained
- the construction study area has moderate to high potential to contain an archaeological resource associated with the construction of the Warragamba Emergency Scheme, including earlier structures, evidence of former technologies, and the workers' construction camp and township. There is potential that archaeological remains associated with these developments are retained within the study area.

The assessment of significance of potential archaeological resources associated with the Warragamba Emergency Scheme, if found to be substantially intact, would reach the local significance threshold primarily for its historical, social, and technological values. Known or potential archaeological remains should be managed in accordance with their significance.

17.4 Assessment of potential construction impacts

A range of physical and visual impacts to the following heritage listed places/items would result from construction:

- Warragamba Dam - Haviland Park (SHR No. 01375)
- Warragamba Emergency Scheme (SHR No. 01376)
- Warragamba Supply Scheme (WaterNSW s170 No. 4580161).

The curtilages of listed heritage items within the construction zone are shown in Figure 17-19 and potential construction impacts discussed below.

17.4.1 Warragamba Dam - Haviland Park (SHR No. 01375)

17.4.1.1 Physical impact assessment

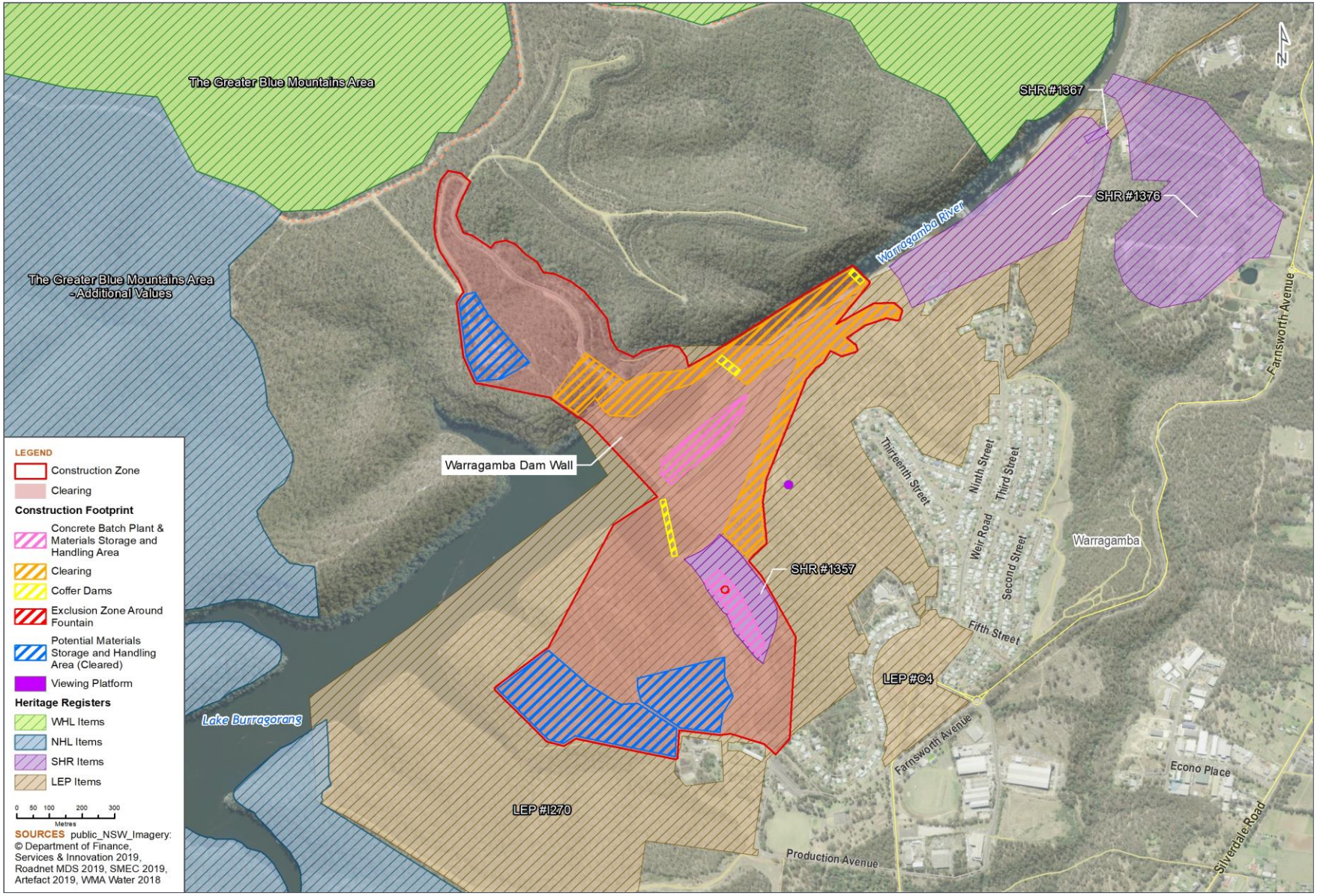
Haviland Park has been modified since it was originally built, due mainly to a bushfire in December 2001 and a major storm event in 2018 that uprooted many of the more recent plantings. This resulted in the loss of many of the remaining original elements within Haviland Park, including several buildings and original plantings throughout the site. The Operations and Visitor Information Centre and associated landscaping was constructed on the northern portion of the site in 2007.

The project would result in a range of direct (physical) and indirect (visual) impacts to the SHR listed Haviland Park, which is located within the Warragamba Supply Scheme and immediately east of the dam wall site. Covering an area of approximately 10 acres, the recreational space within Haviland Park contains rows of tree plantings, an original concrete fountain base (fountain no longer operable and upper section removed), remnant sections of the dry packed stone retaining wall that surrounded the site and facilities for public use, along with potential for historical archaeology relating to the area's former use as the construction site for the dam. Remnant construction evidence remains within Haviland Park, including existing terraced road alignments and associated machinery.

Construction of a new bridge over the auxiliary spillway and realignment of a section of Production Avenue within the heritage curtilage of Haviland Park would occur due to the proposed works. In addition, the proposed realignment of a section of Production Avenue would impact the section of Haviland Park modified by landscaping works carried out in 2007. While this portion of the SHR item does not contain any significant elements, the realignment works would result in modifications and reduction of the item's heritage curtilage in this locality.

It is also proposed to locate the laydown area/batching plant within Haviland Park, requiring excavation across the whole site and removal of all trees and vegetation within the item's heritage curtilage. While most of the plantings are recent following the construction of the auxiliary spillway, 2001 bushfires and storm event in 2018, several mature trees remain in the southern end of the park. This includes a series of paperbarks, which are described in the CMP 2010 as dating to the 1970s and having 'obscured in part the form of the space'. The removal of all plantings would result in a direct impact to the landscape quality and setting of the park. Retention and protection of the remnant concrete fountain base within the park is proposed and this would assist in maintaining the cultural landscape qualities of the park.

Figure 17-19. Heritage curtilages within the construction area



The Warragamba Supply Scheme CMP 2010 outlines the requirement for the preparation of an Archival Recording prior to any changes or works within the heritage curtilage of Warragamba Dam. This includes temporary changes to Haviland Park. Mitigation measures to carry out detailed archival recording as part of the Project are covered in Section 17-5. The Project would result in an overall temporary **high direct (physical) impact** to the SHR listed Haviland Park heritage item.

17.4.1.2 Visual impact assessment

The SHR listed Haviland Park would be visually impacted during construction by diminishing the landscape quality and setting of the park. Revegetation and landscaping works would mitigate visual impact to the cultural landscape of the park. The establishment of a batching plant and introduction of large machinery in Haviland Park during construction would obscure significant views from the approaches towards the dam along Farnsworth Avenue, although this visual impact would be temporary in nature. The Project would result in an overall **moderate indirect (visual) impact** to the SHR listed Haviland Park heritage item.

17.4.2 Warragamba emergency scheme (SHR No. 01376)

17.4.2.1 Physical impacts

The Warragamba Emergency Scheme is identified as a 'primary' element of significance in the Warragamba Supply Scheme CMP 2010. The Project would not involve any direct (physical) impacts to key components within the emergency scheme comprising the weir and later diversion tunnel, pumping station, Megarrity's Creek Bridge, former construction platform, balance reservoir or early dam model.

Indirect physical impacts are associated with flood events, which are not considered to result in any additional impact to the current flood conditions as the volume of water discharged into Warragamba River by the dam would not change. For most events, there would be a reduction in the peak flow discharged by the dam, which would lessen any risk of damage to the heritage item.

The Project would result in a **low direct (physical) impact** to the SHR listed Warragamba Emergency Scheme heritage item.

17.4.2.2 Visual impacts

Part of the heritage curtilage of the Warragamba Emergency Scheme would be visually impacted for the duration construction by diminishing the landscape setting of the item, which is identified as playing an important role in defining the landscape character and setting of the Warragamba Emergency Scheme. Revegetation and landscaping works following completion of the Project would mitigate associated visual impacts.

The Project would result in an overall **low indirect (visual) impact** to the SHR listed Warragamba Emergency Scheme heritage item.

17.4.3 Warragamba supply scheme (WaterNSW s170 No. 4580161)

17.4.3.1 Physical impacts

Individual components within the overall heritage item of the Warragamba Supply Scheme would be subjected to varying degrees of impact. The main heritage impacts are expected to be focused around the dam wall and its associated features including the crest crane, equipment and commemorative plaques and memorials, the Valve House, landscaped areas of Haviland Park (discussed previously) and the Terraced Garden to the east, and the 18-ton upper tail tower located on the western bank of the dam.

The Project would result in permanent physical changes to the dam wall and its current configuration and features, which would directly impact the original fabric of the dam wall itself. In addition, the drum and radial gates, associated mechanical and electrical infrastructure, and portions of the piers within the main spillway would be removed and replaced. The lift towers on both abutments would be raised by around 17 metres, and a 12–15 metre wide pathway would be built along the top of the abutments to connect with the approaches.

Significant features on the crest road including the crest crane and associated equipment, and several commemorative plaques/memorials are expected to be impacted as follows:

- removal of the crest crane, which is one of the original and practical features of the crest road. The blue-painted and track mounted structure has been retained historically for maintenance works along the crest and

gates and emergency operations. Removal of the crest crane would represent a direct physical impact to the heritage significance and intactness of the Warragamba Supply Scheme complex

- relocation of plaques and memorials on the crest roadway, including the rectangular polished terrazzo/concrete memorial with brass plaques commemorating the works and the significant persons involved. The memorial, which was unveiled at the opening ceremony of the dam in October 1960, was previously relocated during the construction of the auxiliary spillway. The relocation of memorials and plaques to new locations on the raised dam would not result in any additional impacts to the heritage significance of the Warragamba Supply Scheme complex
- eighteen (18) ton upper tail tower remaining on the western bank of the dam due to modifications to the left abutment access. The 18-ton upper tail tower demonstrates the original construction and operation processes of the dam. The Project has been developed to allow for the relocation of the 18-ton upper tail tower to a proposed new position along the crane rails on the terrace around 30 metres upstream, which would represent a positive heritage outcome
- site of the adjacent terraced gardens, which constituted part of Haviland Park prior to the construction of the auxiliary spillway, resulting from minor encroachments. This component, featuring ornamental gardens that reflect an ongoing evolution in garden design since the dam's construction, would be impacted by the proposed establishment of a laydown area/batch plant in this location which could result in the removal of vegetation and significant landscape elements, along with ground excavations, and direct impacts to significant fabric within the Warragamba Supply Scheme.

The Project would result in a **high direct (physical) impact** to the s170 Warragamba Supply Scheme heritage item.

17.4.3.2 Visual impacts

The increase in height and width of the dam wall would result in visual changes to the dam's profile and modifications to aspects that are evocative of the original design of the dam wall. It is noted the relative dimensions would be proportionately retained and the design would adopt a smooth profile, and that the dam wall has been previously raised and subject to change over time to maintain the item's ongoing role and significant use.

The demolition of elements near the dam wall, comprising of original machinery like the crest crane, would also result in permanent visual changes to these significant elements of the Warragamba Supply Scheme. The loss of these items would diminish the visual qualities and intactness of the dam site.

The Project would involve clearing of bushland and vegetation adjacent to the dam, which the CMP (2010) identified as playing an important role in defining the landscape character and setting of the Warragamba Supply Scheme. Clearing of vegetation, as such, would result in visual changes that would diminish the landscape setting of the dam, although it is noted that revegetation and landscaping works following completion of the Project would mitigate associated visual impacts.

The Project would result in an overall **moderate indirect (visual) impact** to the s170 Warragamba Supply Scheme heritage item.

17.5 Assessment of potential operational impacts

17.5.1 Upstream

Potential impacts of the Project to the significance and values of the Greater Blue Mountains Area have been separately assessed in Chapter 20 (Protected and sensitive land, including World Heritage Properties) and Appendix J (World heritage assessment report).

The Jooriland Homestead (unlisted potential heritage item) would be inundated under the existing PMF and the Project has potential to extend periods of temporary inundation during flood events. The homestead site is currently uninhabited, and the structures are not being maintained. It is therefore expected that the potential impact of an extended inundation period may result in additional deterioration of the homestead structures.

17.5.2 Downstream

The Hawkesbury-Nepean Valley can experience extensive flooding and many heritage items located within, or near the Hawkesbury-Nepean River or its tributaries may experience impacts from flooding. Flooding may cause direct or indirect impacts to heritage items depending on the depth of flooding, length of flooding and velocity of flood waters.

Within the operational downstream areas, the assessment of non-Aboriginal heritage impacts focused on listed heritage items located within the inundation area resulting from discharges from the FMZ. For downstream areas, there are two phases of the operation of the Project that may potentially result in impacts (including benefits) including:

- changes in peak flooding extents, depths, durations, and velocities
- changes in flooding extents, depths, durations, and velocities during discharges from the FMZ.

17.5.2.1 Operational impacts – peak flooding

To assess any changes in impacts from changes in peak flooding, heritage items were mapped and the flooding extents for both the existing and Project scenarios overlain for various flood events. The change in the number of heritage items impacted by flooding due to the Project were then identified, as shown in Table 17-9 (the reduction in number of heritage items impacted shown in red).

(Note that due to the unavailability of mapped Section 170 Heritage and Conservation Register curtilages on the SHI database, items on Section 170 Heritage and Conservation Registers have not been included in the table counts below, although many of these items are also covered by LEP or SHR listings).

Table 17-9. Summary of upstream and downstream listed heritage items currently impacted by flood events compared to number impacted due to the proposed works

Heritage list	1 in 5		1 in 10		1 in 20		1 in 100		PMF	
	Cur	Prop	Cur	Prop	Cur	Prop	Cur	Prop	Cur	Prop
World Heritage	2	2	2	2	2	2	3	3	3	3
National	4	4	4	4	4	4	4	4	5	5
Commonwealth	0	0	0	0	0	0	2	**0**	3	3
State Heritage Register	24	**16**	27	**19**	30	**23**	40	**29**	67	67
LEP	222	**192**	239	**207**	266	**228**	395	**270**	813	**793**

There would be a reduction in the number of Commonwealth, State and LEP listed heritage items that would experience flooding with the Project for all events. The reduction in the number of heritage items affected by ranged between about 10 and 30 percent of the total number of heritage items, depending upon the type of heritage item and size of event. The largest decrease was for the 1 in 100 chance in a year flood event. As well as a reduction in the number of heritage items directly impacted by flooding, heritage items that would continue to be impacted by flooding would generally experience:

- a shorter duration of flooding
- a reduction in the depth of flooding
- the same or lower flood water velocities.

Overall, the Project would result in a reduction of impacts to downstream heritage items due to a reduction in peak flooding impacts for most events.

17.5.2.2 Operational impacts – discharge from the flood mitigation zone

Listed heritage items that would be flooded for extended periods of time, generally between one to seven days longer than the current situation, were identified to determine operational impacts while the FMZ is being emptied. Listed heritage items that would potentially be impacted are:

- Three WHL (including two declared places and one buffer zone)
- Four NHL (including two listed places and two nominated places)
- 15 SHR
- 184 LEP
- One SEPP
- 17 s170.

These items are given in Appendix I (Non-Aboriginal heritage impact assessment, Table 7.6) and shown in Figure 17-20 to Figure 17-26, and discussed as follows.

Figure 17-20. WHL sites within inundation area resulting from FMZ discharge

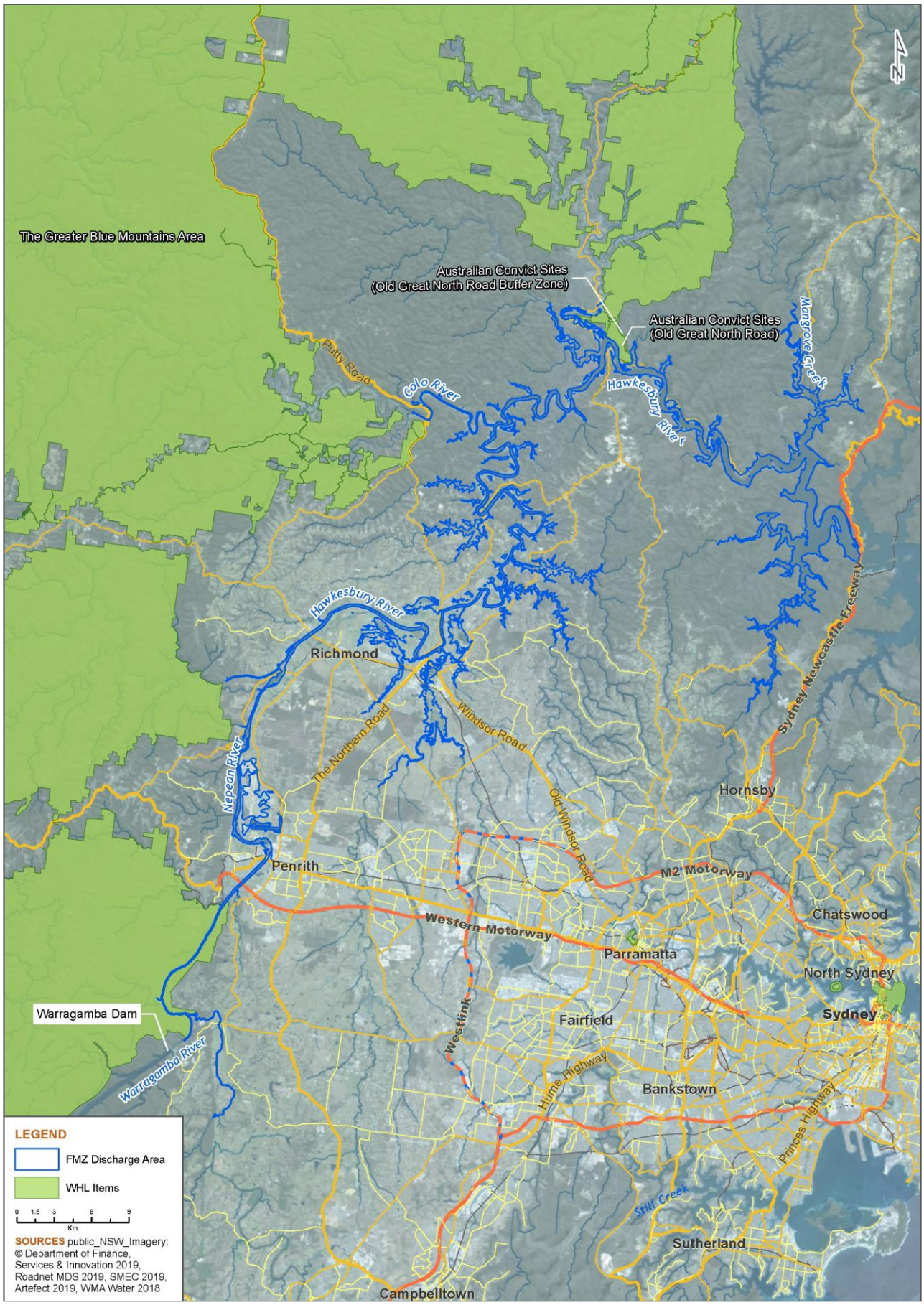


Figure 17-21. NHL sites within inundation area resulting from FMZ discharge

Figure 17-22. SHR items within inundation area resulting from FMZ discharge (Part 1)

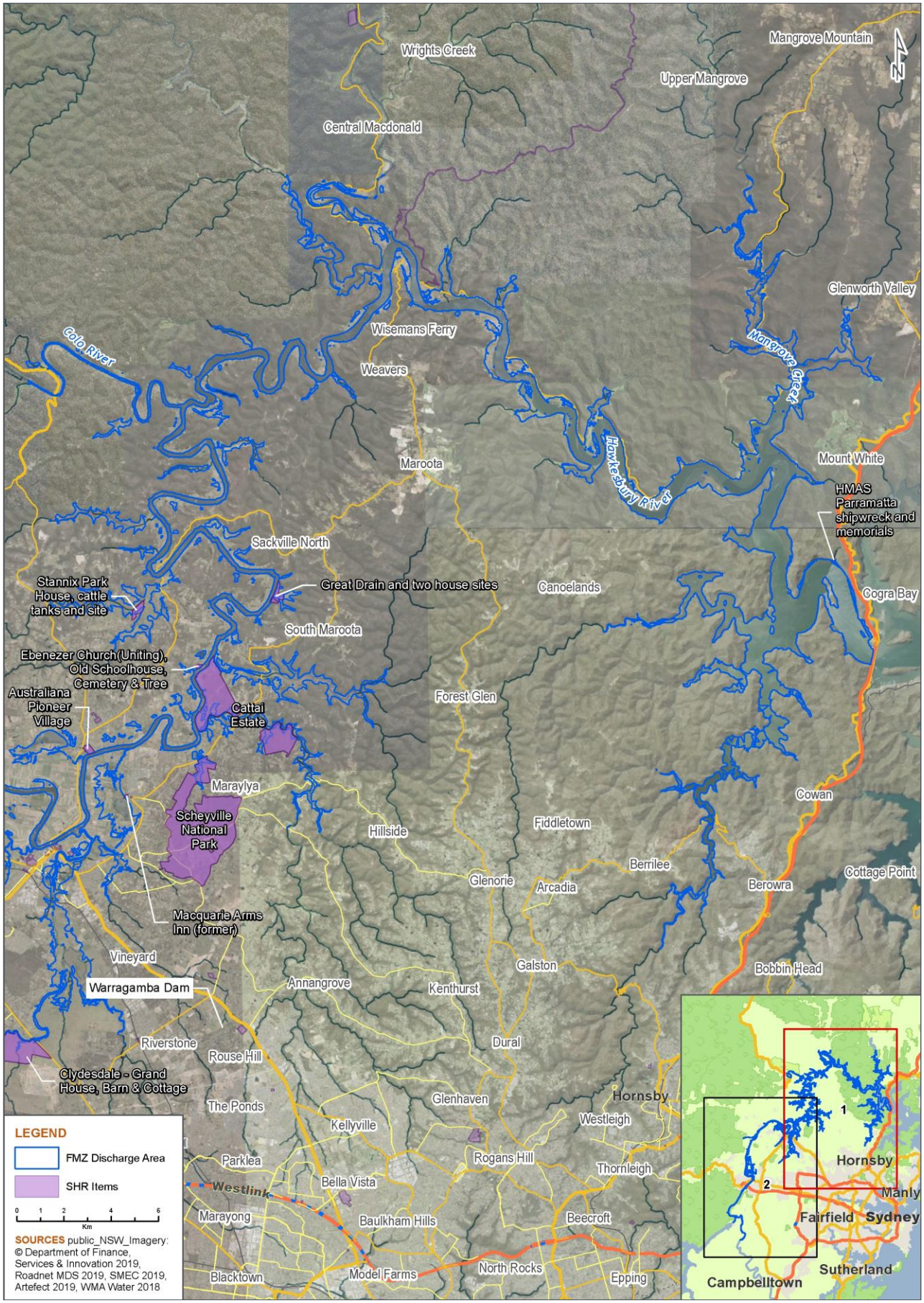


Figure 17-23. SHR items within inundation area resulting from FMZ discharge (Part 2)

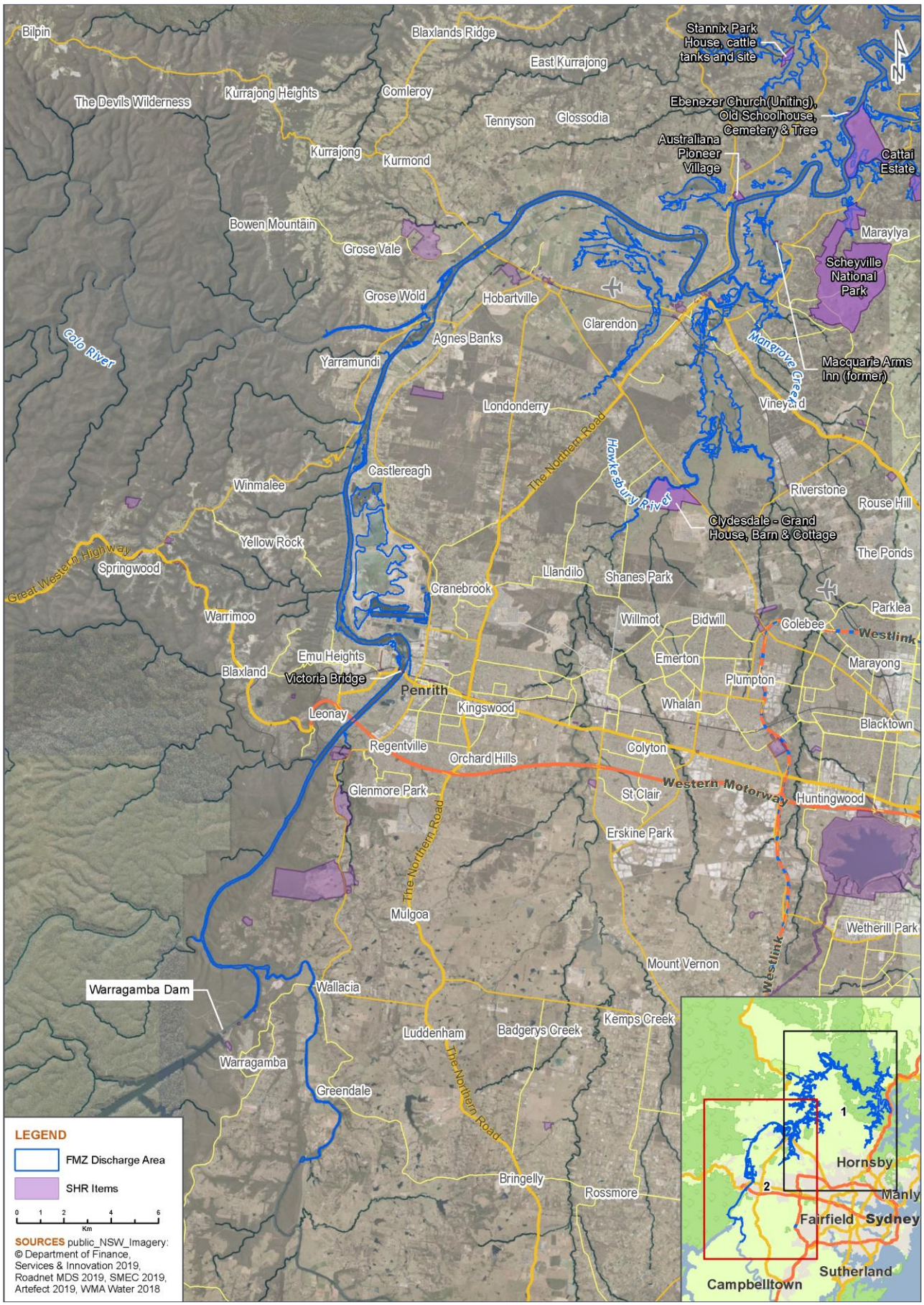


Figure 17-24. LEP listed heritage site within inundation area resulting from FMZ discharge (Part 1)

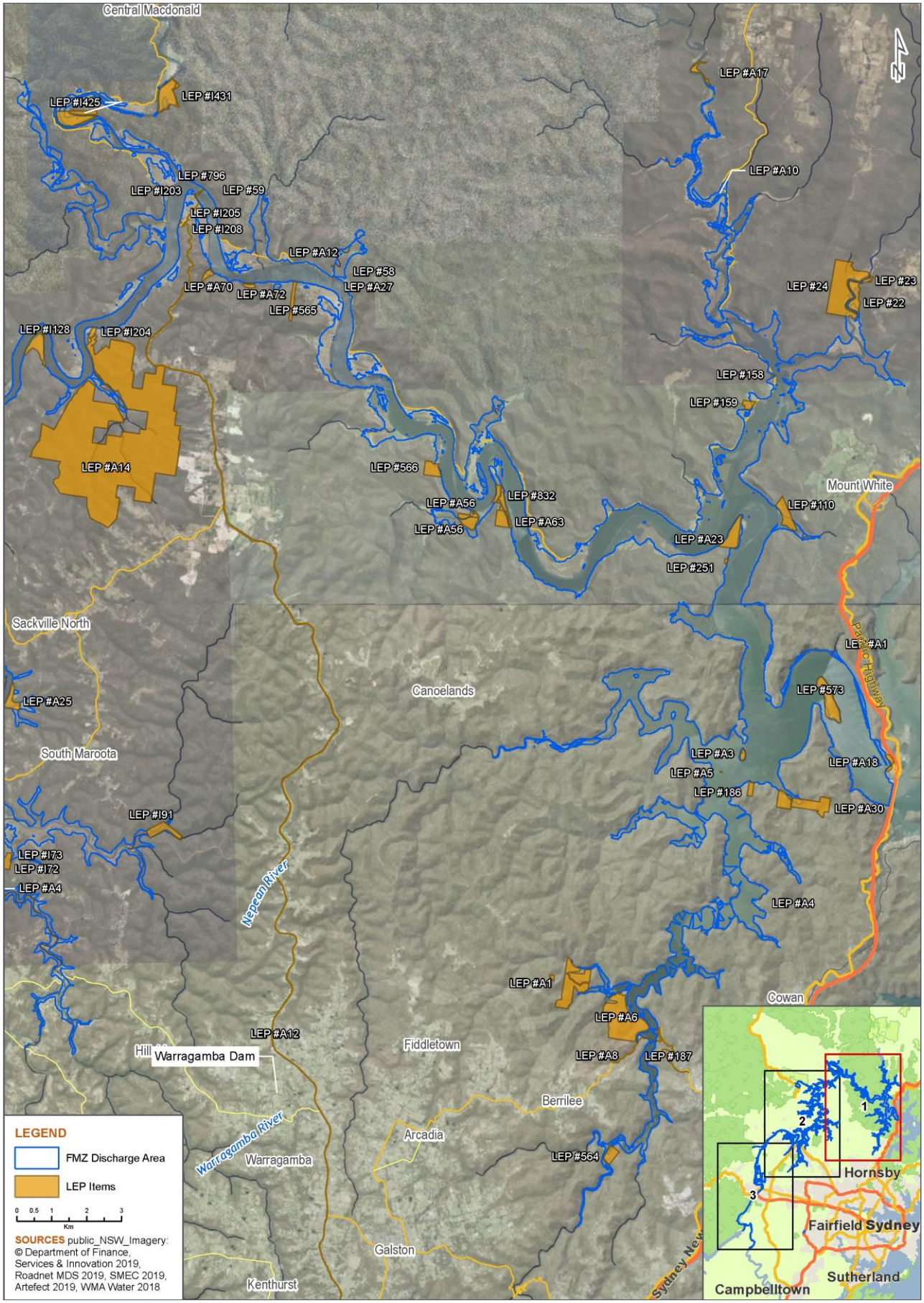


Figure 17-25. LEP listed heritage site within inundation area resulting from FMZ discharge (Part 2)

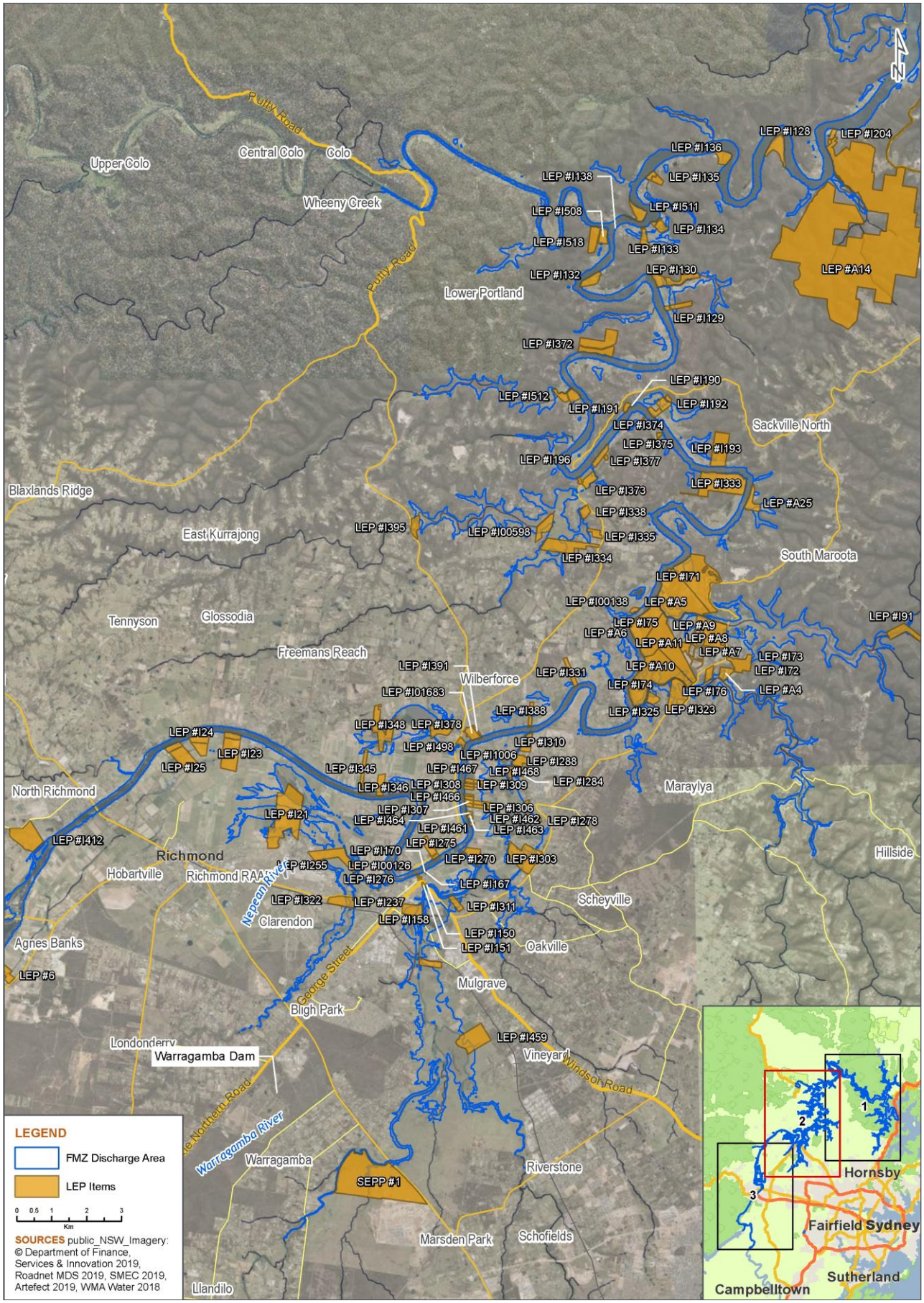
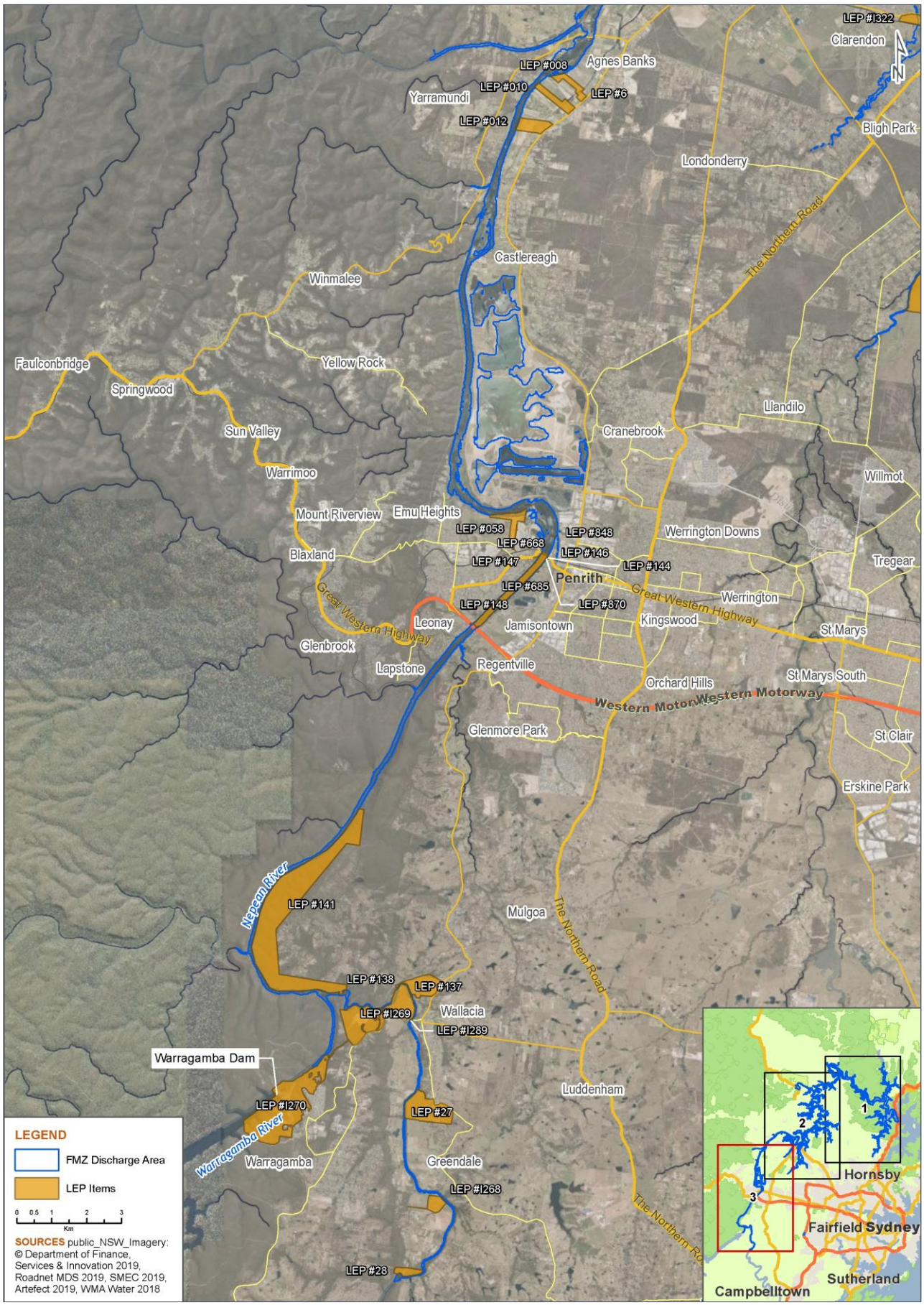


Figure 17-26. LEP listed heritage site within inundation area resulting from FMZ discharge (Part 3)



Built heritage items

The heritage items potentially impacted by downstream operational impacts encompass a range of built heritage items, including houses, cottages, churches, barns, huts, walls, bridges, wharves, homestead complexes, outbuildings, toll houses, headstones, graves, ruins, villages and conservation areas. These items are of varying material and construction typologies including timber, brick, stone, concrete, steel and iron. While some of these heritage items were constructed by and are associated with early European settlement, other items have been constructed more recently. It is also noted that many items would likely contain moveable heritage items.

While some historic structures are durable and relatively resistant to flooding, many are at risk from flood damage and inappropriate remedial works. Permeable materials like timber, lime mortars, plasters and soft bricks are at greater risk of impact. The level of impact on individual items would be dependent on several factors including the construction, permeability and materiality of the item, its structural and fabric condition, the nature of any moveable heritage items, and the depth and velocity of the low-level floodwaters resulting from discharges from the FMZ. It is noted that there would be reduced impacts from the reduction in peak flooding levels, durations and velocities.

The only built heritage items located within the area inundated by discharges from the FMZ are designed to cope with minor flooding and include:

- Rowing Course (LEP Item No.148) – while the rowing course would be unable to be used during the flood mitigation zone discharge, the course itself would not be affected by the flood mitigation zone discharge.
- Windsor Bridge (LEP Item No.I276) – The water level resulting from the flood mitigation zone discharge would be below the deck level of the bridge and the bridge would remain open. No impacts from the flood mitigation zone discharge would be expected.
- Cable Ferry (Wisemans Ferry) (LEP Item No. 796) – Wisemans Ferry is expected to remain open and would not be impacted by the discharge.

It is anticipated that impacts on built heritage items within the area inundated by discharges from the FMZ would be low (in comparison to existing flooding conditions). Impacts to built heritage items within the area inundated by discharges from the FMZ impacts will be managed in accordance with the measures identified in Section 17.6.

Archaeological items

Archaeological items potentially impacted by discharges from the FMZ include sites of former slab huts, cottages, homesteads, inns, boat sheds, churches and mills, drains and drainage trenches, horse works, ballast heaps, convict-built roads, fire trails, burial grounds, quarry sites and conservation areas. These items are of varying material and construction typologies including timber, brick, stone, concrete, steel, and iron. While some of these archaeological items were constructed by and are associated with early European settlement, other items are associated with more recent development. The level of impact on individual items would be dependent on several factors including the construction, permeability and materiality of the archaeological resource, its fabric condition, whether the archaeological resource is located beneath existing structures or otherwise on a vacant undeveloped site, and the depth and velocity of floodwaters within the area inundated by discharges from the FMZ.

For the majority of archaeological items within the area inundated by discharges from the FMZ, impacts would consist of minor flooding of low points (for example, waterways) within the curtilage of the heritage item, rather than direct flooding of the heritage item. Most heritage items near the river or tributaries have been located on the higher elevations of the specific lot to avoid the impacts of flooding. However, there may be some archaeological items in the lower areas of the terrain around waterways including drainage canals and remains of wharves.

Potential impacts would mainly involve longer inundations within existing flood events and associated flooding levels, and it is anticipated that impacts would be low in comparison to existing flooding conditions. Impacts to archaeological items within the area inundated by discharges from the FMZ will be managed in accordance with the measures identified in Section 17.6.

Landscape items

A range of landscape items are potentially within the area inundated by discharges from the FMZ, including nature reserves and bushland, significant trees, paddocks and pastures within farms and homestead complexes and natural features like the Nepean River, the Scheyville National Park and Kangaroo Point. These items are of varying typologies. While some of these heritage items are associated with the natural integrity and intactness of the item, others are associated with landscape features that have been created by human settlement. The level of impact on individual items would be dependent on several factors including the presence and amount of vegetation cover and/or trees

within the landscape element, and the depth and velocity of the floodwaters within the area inundated by discharges from the FMZ.

For landscape heritage items within the area inundated by discharges from the FMZ, impacts would consist of minor flooding of low points (for example, waterways) within the curtilage of the heritage item, rather than direct flooding of any built landscape heritage items. These areas are generally riparian or wetland/swamp areas and have adapted to inundation by flood waters.

As impacts would mainly involve longer inundations within existing flood events and associated flooding levels, it is anticipated that impacts would be low in comparison to existing flooding conditions. Impacts to landscape items within the area inundated by discharges from the FMZ will be managed in accordance with the measures identified in Section 17.6.

Maritime items and shipwrecks

The area impacted within the area inundated by discharges from the FMZ encompasses a range of maritime heritage items, including shipwrecks, sites and remains of wharves, piers and seawalls. These items are of ranging material and construction typologies including timber, brick, stone, concrete, steel and iron. While some of these heritage items were constructed by and are associated with early European settlement, other items are more recent. The level of impact on individual items would be dependent on several factors including the construction, permeability and materiality of the item, its structural and fabric condition, nature of the wreck, and the depth and velocity of the floodwaters within the area inundated by discharges from the FMZ.

As impacts would mainly involve longer inundations within existing flood events and associated flooding levels, it is anticipated that impacts would be low in comparison to existing flooding conditions. Impacts to maritime items within the area inundated by discharges from the FMZ will be managed in accordance with the measures identified in Section 17.6.

17.5.2.3 World Heritage or national heritage listings

Greater Blue Mountains Area (WHL Place ID 105127 and NHL Place ID 105999) and The Greater Blue Mountains Area - additional values (NHL Place ID 105696)

The Greater Blue Mountains Area and Greater Blue Mountains Area Additional Values includes WHL and NHL curtilage areas that would be impacted by flooding events downstream of the dam. The potential impacts to the significance and values of the Greater Blue Mountains Area are discussed in Chapter 12 (Matters of national environmental significance - biodiversity/world heritage) and Appendix J (World Heritage assessment report). In summary, the Project would result in:

- an increase in potential area of inundation of the Greater Blue Mountains World Heritage Area by about 0.06 percent for a 3-day PMF event and 0.04 percent for a 1 in 100 chance in a year flood. This temporary increase in inundation area is not considered to constitute a significant change. Inundation would only occur when the dam is above FSL and, when it does occur, would be temporary for up to two weeks. This is not likely to have a material impact on the World Heritage values of this area
- an Increase in potential area of inundation of the National Parks and Wildlife estates by 9.03 percent under a 3-day PMF event, and 7.36 percent under a 1 in 100 chance in a year flood. The largest increase in potential inundation is for the Yerranderie State Conservation Area (3.69 percent for 3-day PMF and 3.16 percent for a 1 in 100 chance in a year flood), which borders Lake Burragorang. Inundation would only occur when the dam in above FSL and would only be temporary for up to two weeks. This is not considered likely to have a material impact on the values of National Parks and Wildlife estates in this area

Australian convict sites (Old Great North Road) and buffer zone (WHL Place ID 106209)

a) Physical impact assessment

The potential impact of the Project to the WHL Australian Convict Sites (Old Great North Road) is not considered to be significant as the proposed PMF associated with the dam raising would only marginally encroach on the curtilage of the WHL item, the affected sections of which are not associated with significant elements or components, and instead comprise portions of the Hawkesbury-Nepean Rivers, Settlers Road, Wisemans Ferry Road and nearby private properties and farm land. A small portion of the item's Buffer Zone is within the area potentially impacted downstream. The Buffer Zone may therefore be affected by a variety of potential indirect impacts associated with low

level flood waters being present for an extended period. Potential impacts would be minimal in nature. The main area of the item's heritage curtilage would not be affected.

The Project would result in a **low direct (physical) impact** to the WHL Australian Convict Sites (Old Great North Road).

b) Visual impact assessment

It is not anticipated that the Project would result in any visual changes to the portions of the Australian Convict Sites (Old Great North Road) heritage curtilage and Buffer Zone that are within the study area. Potential indirect visual impact associated with discharges from the FMZ and the localised effect of retention of low level flood waters for an extended period would be low in nature.

The Project would result in a **neutral indirect (visual)** impact to the WHL Australian Convict Sites (Old Great North Road).

Great North Road, Wisemans Ferry to Bucketty (NHL Place ID 106318)

The assessed heritage impact on the values of the nominated Great North Road, Wisemans Ferry to Bucketty heritage item are covered above for its World Heritage listing (refer to Section 17.3.5.4). The Project would not result in any significant impact or benefit to the Great North Road, with both the existing and proposed Project PMF only encroaching upon a minor portion of the southern and eastern boundary of the item's curtilage. These low areas of impact are located a considerable distance from significant elements within the Great North Road. Overall, the proposed action would not result in any significant physical or visual impacts or benefits to the Great North Road, Wisemans Ferry to Bucketty NHL item.

Ku-ring-gai Chase National Park, Lion, Long and Spectacle Island Nature Reserves (NHL Place ID 105817)

a) Physical impact assessment

The Project would not impact on the Ku-ring-gai Chase National Park and Lion, Long and Spectacle Island Nature Reserves. These areas are located a considerable distance downstream from the dam and in an area where marine influences and local catchment inflows dominate. Therefore, none or low changes in flood levels or regimes are anticipated.

The Project would result in a **neutral (physical) impact** to the NHL Ku-ring-gai Chase National Park and Lion, Long and Spectacle Island Nature Reserves.

b) Visual impact assessment

The Project would not result in any visual changes to portions of the Ku-ring-gai Chase National Park and Lion, Long and Spectacle Island Nature Reserves. These areas are located a considerable distance downstream from the dam and in an area where marine influences and local catchment inflows dominate. Therefore, none or low changes in flood levels or regimes are anticipated. No impacts on visual amenity from the Project are predicted in these areas.

The Project would result in a **neutral (visual) impact** to the NHL Ku-ring-gai Chase National Park and Lion, Long and Spectacle Island Nature Reserves.

Assessment of significance

Under the EPBC Act, the *Matters of National Environmental Significance – Significant impact guidelines 1.1* (DoE 2013) pose a series of questions to assist in the clarification of whether an action should be referred to the Minister.

The answers to these questions, which have been considered regarding the potential impacts associated with the proposed action, are shown in Table 17-10.

Table 17-10. MNES nature of impact questions

Nature of MNES impact questions	Australian convict sites (Old Great North Road)	Ku-Ring-Gai Chase National Park, Lion, Long and Spectacle Island Nature Reserves
Are there any matters of national environmental significance located in the area of the proposed action (noting that 'the area of the proposed action' is broader than the immediate location where the action is undertaken; consider also whether there are any matters of national environmental significance adjacent to or up/ downstream from the immediate location that may potentially be impacted)?	Yes. The proposed action would occur in proximity to the Australian Convict Sites (Old Great North Road), involving parts of the curtilage closest to the Hawkesbury-Nepean. Only the Australian Convict Sites (Old Great North Road) Buffer Zone has the potential to be impacted by flooding.	Yes. The proposed action would occur in proximity to the Ku-ring-gai Chase National Park and Lion, Long and Spectacle Island Nature Reserves, involving parts of the curtilage closest to the Hawkesbury River and tributaries.
Considering the proposed action at its broadest scope (that is, considering all stages and components of the action, and all related activities and infrastructure), is there potential for impacts, including indirect impacts, on matters of national environmental significance?	No. No permanent impacts to World Heritage values associated with the Australian Convict Sites (Old Great North Road) are anticipated by the proposed action. Significant elements and components within the heritage item are located outside of the proposed PMF associated with the dam raising. There is potential for minor indirect impact associated with portions of the WHL Buffer Zone being within the area impacted by flooding downstream.	No. No impacts to National Heritage values associated with the Ku-ring-gai Chase National Park and Lion, Long and Spectacle Island Nature Reserves are anticipated by the proposed action.
Are there any proposed measures to avoid or reduce impacts on matters of national environmental significance (and if so, is the effectiveness of these measures certain enough to reduce the level of impact below the 'significant impact' threshold)?	No. The proposed action is unlikely to result in adverse impact to World (or National) heritage values associated with the Australian Convict Sites (Old Great North Road). This is due to the existing flood event conditions at the site location, and the location of significant elements of the item (comprising the Old Great North Road itself) that are located outside of the Project PMF. As there is not anticipated to be a significant impact to the heritage item, no specific measures have been recommended to reduce impact on the Old Great North Road component of the Australian Convict Sites World heritage item.	No. The proposed action is not considered to result in an impact to National Heritage values associated with the Ku-ring-gai Chase National Park and Lion, Long and Spectacle Island Nature Reserves that are more than minor in nature, due to the existing flood event conditions at the site location and the overall negligible flood level rise that would occur.

Nature of MNES impact questions	Australian convict sites (Old Great North Road)	Ku-Ring-Gai Chase National Park, Lion, Long and Spectacle Island Nature Reserves
Are any impacts of the proposed action on matters of national environmental significance likely to be significant impacts (important, notable, or of consequence, having regard to their context or intensity)?	No. The proposed action is not expected to impact on matters of national environmental significance.	No. The proposed action is not expected to impact on matters of national environmental significance.

An assessment against the Significant Impact Criteria outlined in the *Matters of National Environmental Significance – Significant Impact Guidelines 1.1* (DoE 2013) has been conducted to assist in determining whether the impacts of the proposed action on any matter of national environmental significance are likely to be significant. This assessment is presented in Table 17-11.

Table 17-11. Assessment against Significant Impact Criteria

Significant impact criterion	Impact to Australian convict sites (Old Great North Road)	Ku-Ring-Gai Chase National Park, Lion, Long and Spectacle Island Nature Reserves
Permanently remove, destroy, damage or substantially alter the fabric of a World Heritage property	**No** – construction works associated with the project would not take place within the curtilage of the heritage item. The proposed action would not result in impact to the fabric of the Great North Road. The PMF encroaches only slightly on the curtilage of the heritage item in areas that do not contain significant elements or components.	**No** - construction works associated with the project would not take place within the curtilage of the heritage item. Negligible changes in flood levels within the heritage item have been predicated. The proposed action would not alter the heritage item.
Permanently remove, destroy, damage or substantially alter the fabric of a National Heritage Place in a manner which is inconsistent with relevant values	**No** – as above, significant fabric associated with the Great North Road heritage item are outside the PMF. The heritage values of the place would remain unaffected.	**No** – as above, the item is located a considerable distance downstream from the construction study area, negligible changes in flood levels are predicted with the park and nature reserves. Overall, the heritage values of the place would remain unaffected.
Extend, renovate, refurbish or substantially alter a World Heritage property or National Heritage Place in a manner which is inconsistent with relevant values	**No** – the proposed action would not alter fabric associated with the heritage item.	**No** – as above, the heritage values of the place would remain unaffected.
Permanently remove, destroy, damage or substantially disturb archaeological deposits or artefacts in a World Heritage property or National Heritage Place	**No** - as above, significant components of the Great North Road are outside the PMF. It is not anticipated that significant archaeological remains directly associated with the heritage item would be affected by the proposed action.	**No** – potential impact to the heritage item through flooding is considered to be negligible. It is not anticipated that significant archaeological remains associated with the heritage item would be affected by the proposed action.
Involve activities in a World Heritage property or National Heritage Place with substantial and/or long–term impacts on its values	**No** – the proposed action would not result in substantial or long-term impact to the heritage values of the heritage item.	**No** - the proposed action would not result in substantial or long-term impact to the heritage values of the heritage item.
Involve construction of buildings or other structures within, adjacent to, or within important sight lines of, a World Heritage property or National Heritage Place which are inconsistent with relevant values	**No** – the proposed action would not visually alter the heritage item.	**No** – the construction study area would not be visible from the heritage item and would not impact on significant sight lines or its setting.
Make notable changes to the layout, spaces, form or species composition in a garden, landscape or setting of a World Heritage property or National Heritage Place which are inconsistent with relevant values	**No** – construction works associated with the project would not take place within the curtilage of the heritage item. No change to the fabric of the item, or its setting, would occur because of the proposed action.	**No** - construction works associated with the project would not take place within the curtilage of the heritage item. No change to the fabric of the item, or its setting, would occur because of the proposed action.
Alter the setting of a World Heritage property or National Heritage Place in a manner that is inconsistent with relevant values	**No** - as above, significant fabric associated with the Great North Road heritage item are outside the PMF. The heritage values of the place would remain unaffected.	**No** – the item is located a considerable distance downstream from the construction study area and negligible changes in flood levels are predicted with the park and nature reserves. Overall, the setting of the heritage item would remain unaffected.

17.5.2.4 Summary of downstream impacts

Overall, the non-Aboriginal heritage assessment has identified that the anticipated downstream impacts of the Project would generally result in a reduction of the number of heritage items that would be flooded during the nominated flooding events, or otherwise a reduction in the depth and duration of flooding for other heritage items. However, it is noted that additional impacts would occur to heritage items within the area inundated by discharges from the FMZ, where low level flooding would be extended in duration. This includes a range of built heritage, landscape, archaeological and maritime items. Management measures associated with these impacts are included in Section 17.6.

17.5.3 NSW Register of shipwrecks

The level of impact on individual items would be dependent on several factors including the construction, permeability and materiality of the item, its structural and fabric condition, nature of the wreck, and the depth and velocity of floodwaters.

Despite the unknown condition of and generalised location of the wrecks and maritime items in the Nepean and Hawkesbury Rivers and associated tributaries, impacts would mainly involve longer inundations within existing flood events and associated flooding levels, therefore it is anticipated that impacts on maritime items and shipwrecks downstream would be low in comparison to existing flooding conditions. Impacts to maritime items downstream would be managed in accordance with the measures identified in Section 17.6.

17.5.4 Archaeological impact assessment

The Project construction site includes several activities with the potential to impact on archaeological remains, including vegetation clearance, demolition, levelling and construction works (see Figure 17-27).

The Project would result in impact to archaeological remains associated with the Warragamba Dam construction camp through vegetation removal and associated excavation works. These works are proposed for the eastern-most portion of the area identified as having archaeological potential, and it is not anticipated that the works would result in a substantial impact to potential remains.

The laydown area would require considerable ground disturbance through vegetation removal and levelling works and is therefore likely to result in a moderate to high impact to archaeological resources in this location.

Project works within areas identified as having potential to contain archaeological remains include:

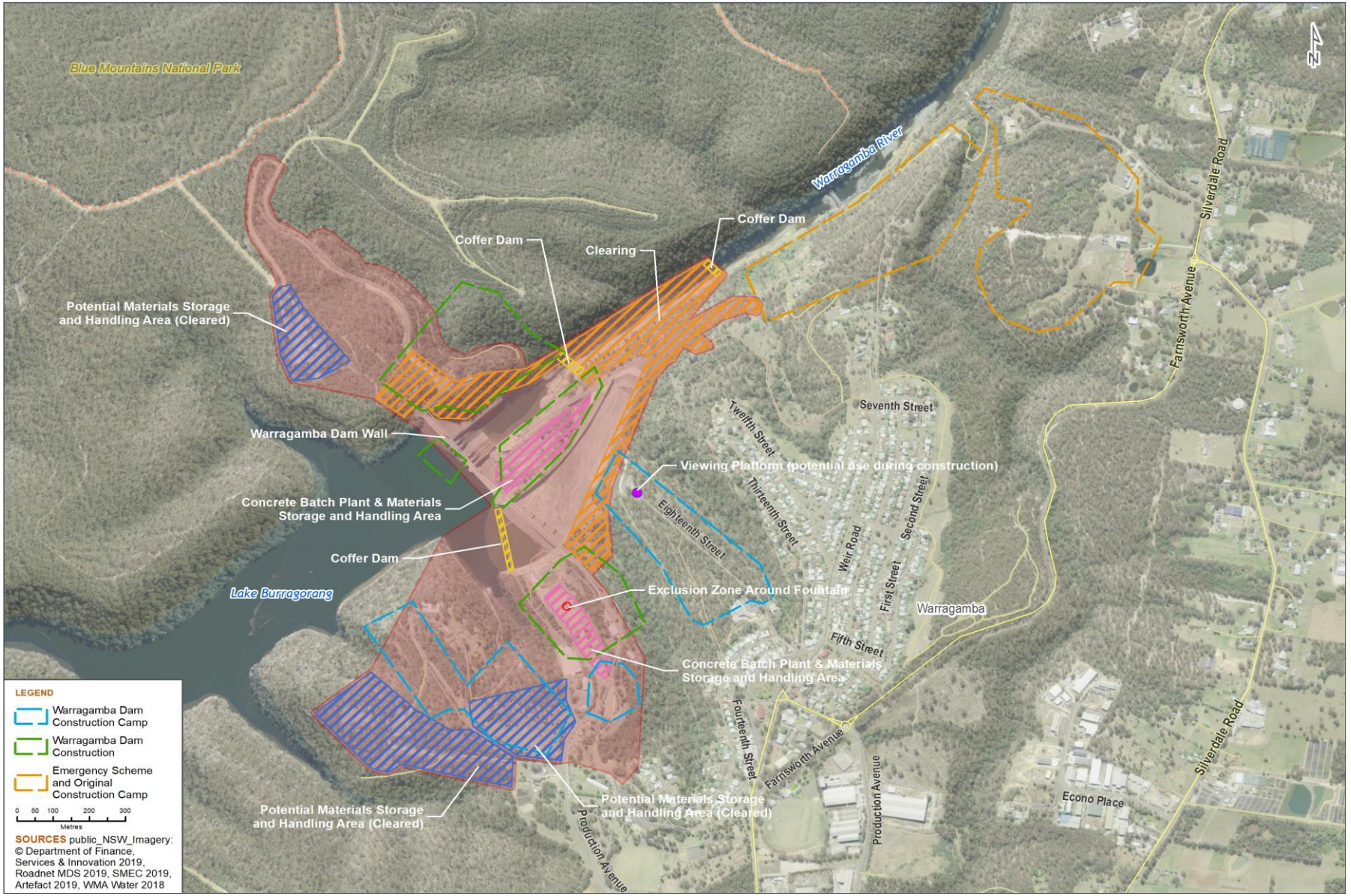
- the establishment of batch plant 1, including clearance and demolition of the existing office building to the rear of the valve house
- the establishment of batch plant 2 and laydown area
- vegetation clearance
- construction of the raised dam wall and spillway.

It is anticipated that construction works and vegetation removal near the dam would result in a **moderate to high impact** to archaeological remains.

Project works within areas identified as having potential to contain archaeological remains associated with the Emergency Scheme and Original Construction camp include the location of the laydown area in the easternmost portion.

The laydown area may potentially impact the location identified as having potential to contain archaeological remains associated with the Original Emergency Scheme construction camp. Archaeological remains associated with this historical phase, if intact, have the potential to retain considerable research potential, and would be considered rare in the regional context. If this area is to be used as a laydown site, impacts to archaeological artefacts may result from clearing and levelling works to facilitate establishment of construction site facilities.

Figure 17-27. Archaeological potential areas and construction area



17.5.5 Cumulative impacts

Downstream cumulative impacts to hundreds of items of local, State, National and World heritage significance would see positive benefits from the Project and flood mitigation measures in terms of a reduction or otherwise avoidance of inundation in nominated flooding events.

The cumulative impact of the Project around the dam itself within the construction zone has been assessed as resulting in **moderate to high direct (physical) and indirect (visual**) **impacts**, including to the State listed Haviland Park and s170 listed Warragamba Supply Scheme. The impacts outlined above, including those within the Project construction areas, are partially offset by the positive impacts downstream that reduces the number of listed heritage items affected by flooding events.

It is noted that additional indirect impacts would occur to listed heritage items within the area inundated by discharges from the FMZ where flooding events would be extended in duration. This includes a range of built heritage, landscape, archaeological and maritime items. The cumulative impact of these items being inundated for an extended period, although generally of a minor nature, would ultimately be dependent on the condition, construction and typology of each item, and managed in accordance with the measures identified in Section 17.5.

The Project would likely have a cumulative impact on the WHL and NHL Greater Blue Mountains Area relating to areas upstream of the dam wall that would be impacted by the retention of flood waters at an increased level in some areas. Potential impacts of the Project to the significance and values of the Greater Blue Mountains Area are addressed in Chapter 12 (Matters of national environmental significance - biodiversity/world heritage), Chapter 20 (Protected and sensitive lands) and Appendix J (World heritage assessment report).

17.6 Environmental management measures

Safeguards and management measures have been developed to avoid, minimise or manage potential impacts to non-Aboriginal heritage. These mitigation measures utilise the following guidelines:

- *NSW Heritage Manual* (NSW Heritage Office 1996)
- *Interpreting Heritage Places and Items Guidelines* (NSW Heritage Office 2005b)
- *Heritage Interpretation Policy* (NSW Heritage Office 2005a).

Relevant management and mitigation measures are shown in Table 17-12. These mitigation and management measures have been incorporated in the Environmental Management measures in Chapter 29 (EIS synthesis, Project justification and conclusion)

Table 17-12. Management measures

Impact	ID	Environment management measure	Timing	Responsible
Impacts on directly affected heritage items	NAH1	Where possible, consideration will be given to conserve and avoid impact to elements of primary significance and heritage items within the construction zone. Where impact and/or removal is unavoidable, the subsequent measures will be enacted. Photographic Archival Recording and reporting would be carried out in accordance with the NSW Heritage Office's *How to Prepare Archival Records of Heritage Items* (1998a), and *Photographic Recording of Heritage Items Using Film or Digital Capture* (2006). The record would be prepared by a suitably qualified heritage consultant using archival-quality material. Records for SHR listed items would be held at the NSW Heritage Council and State Library. Records for LEP-listed items would be held by the local Council and local library. A copy of the record would be held by the owner of the asset. Appropriate heritage interpretation would be incorporated into the design for the Project in accordance with the NSW Heritage Office's *NSW Heritage Manual* (1996), *Interpreting Heritage Places and Items Guidelines* (2005b), and *Heritage Interpretation Policy* (2005a).	Pre-construction	WaterNSW
	NAH2	A Heritage Interpretation Strategy for the Project will be incorporated into future designs and planning. Opportunities for interpretive displays in appropriate locations would be explored.	Design	WaterNSW WaterNSW
	NAH3	An appropriately qualified and experienced heritage architect will provide independent review periodically throughout detailed design.	Design	WaterNSW
	NAH4	The Project design will be sympathetic to impacted items (including retained significant elements) and surrounding heritage items by minimising impacts to sight lines, views and setting.	Design	WaterNSW
	NAH5	Except for heritage significant elements affected by the Project, direct impact on other heritage significant items elements will be avoided.	Design and Construction	WaterNSW Construction Contractor
	NAH6	Where heritage significant items or elements are to be retained within the construction zone, detailed design will consider appropriate adaptive reuse or interpretive use to be developed in consultation with a heritage architect.	Design and Construction	WaterNSW Construction Contractor
	NAH7	A moveable heritage item strategy (including a salvage strategy) will be prepared for the Warragamba Supply Scheme. The strategy will be prepared by a suitably qualified heritage consultant in consultation with WaterNSW and include a comprehensive record of significant elements to be impacted. This will include items, machinery and equipment, and commemorative plaques and memorials contained within curtilage of the Warragamba Dam site. The moveable heritage item strategy will form part of a broader interpretation strategy for the Warragamba Supply Scheme.	Pre-construction	WaterNSW Construction Contractor

Impact	ID	Environment management measure	Timing	Responsible
	NAH8	The fabric of primary and contributory significance of items proposed for removal will be identified and catalogued according to the significant fabric strategy prior to design development and will be re-used or salvaged where possible. Where not re-used within the design of the Project, the significant fabric strategy will indicate appropriate storage locations as well as appropriate off-site locations where the salvaged elements may be reused in the future. Where large elements are impacted a sample of fabric may be appropriate.	Pre-construction	WaterNSW Construction Contractor
	NAH9	Methodologies for the removal of existing structures and construction of new structures and infrastructure will be developed to minimise direct and visual impacts to other elements within the curtilages of the heritage items or to heritage items located near works.	Design and Construction	WaterNSW Construction Contractor
Impacts on heritage visual values	NAH10	Site remediation measures related to construction sites will be incorporated within the Urban Design and Landscape Plan. The objective of the remediation will be to minimise long-term impacts on the visual amenity of the items by recreating a sympathetic environment. A landscape scheme would be prepared for the SHR listed Haviland Park to re-instate planting and landscaping within and around the item's curtilage. The scheme will consider appropriate plantings. Any boundary wall treatment will be designed in consultation with a heritage architect.	Design and Construction	WaterNSW Construction Contractor
Impacts on archaeological resources	NAH11	An archaeological research design will be prepared and implemented to identify the need for archaeological testing or monitoring. Archaeological mitigation measures recommended in the archaeological research design will be carried out in accordance with Heritage Council guidelines, and where identified in the archaeological research design, would be supervised by a suitably qualified Excavation Director. An Unexpected Finds Policy will be implemented during the Project to manage and mitigate potential impacts to the potential archaeological resource.	Pre-construction	WaterNSW Construction Contractor
Impacts from ancillary works	NAH12	Ancillary works required by the Project related to batch plant, laydown areas, power supply, drainage facilities and any other works will be designed and constructed to minimise impacts on heritage items and areas of archaeological potential as much as feasible within the context of the Project.	Pre-construction	WaterNSW Construction Contractor
Impacts to Haviland Park	NAH13	Design and construction within the SHR curtilage of Haviland Park will consider the recommendations of the Warragamba Supply Scheme CMP 2010 (Graham Brookes and Associates 2010) and the significant fabric strategy.	Design and Construction	WaterNSW Construction Contractor
Impacts to the Warragamba Supply Scheme	NAH14	Design and construction within the s170 curtilage of the Warragamba Supply Scheme will consider the recommendations of the Warragamba Supply Scheme CMP 2010 (Graham Brooks & Associates 2010) and the significant fabric strategy.	Design and Construction	WaterNSW Construction Contractor

17.7 Risk analysis

An environmental risk analysis was carried out in accordance with the SEARs, using the methodology provided in Appendix C (Risk assessment procedure). A Project risk matrix was developed and risk ranking evaluated by considering:

- the likelihood (L) of an impact occurring
- the severity or consequence (C) of the impact in a biophysical and/or socio-economic context, with consideration of:
  - whether the impact will be in breach of regulatory or policy requirements
  - the sensitivity of receptors
  - duration of impact, that is, whether the impact is permanent or temporary
  - the areal extent of the impact and/or the magnitude of the impact on receptors.

The likelihood and consequence matrix is shown on Figure 17-28.

Once the consequence and likelihood of an impact are assessed, the risk matrix provides an associated ranking of risk significance: **Low**; **Medium**; **High** or **Extreme,** as shown in Table 17-13**.** The residual risk was determined after the application of proposed mitigation measures.

The risk analysis for potential flooding and hydrology impacts is provided in Table 17-14. This includes the residual risk of the potential impact after the implementation of mitigation measures.

Table 17-13. Risk ranking definitions

Risk definitions	
Extreme 21 – 25	Widespread and diverse primary and secondary impacts with significant long-term effects on the environment, livelihood and quality of life. Those affected will have irreparable impacts on livelihoods and quality of life.
High 15 – 20	Significant resources and/or Project modification would be required to manage potential environmental damage. These risks can be accommodated in a project of this size, however comprehensive and effective monitoring measures would need to be employed such that Project activities are halted and/or appropriately moderated. Those impacted may be able to adapt to change and regain their livelihoods and quality of life with a degree of difficulty.
Medium 9 – 14	Risk is tolerable if mitigation measures are in place, however management procedures will need to ensure necessary actions are quickly taken in response to perceived or actual environmental damage. Those impacted will be able to adapt to changes.
Low 1 – 8	On-going monitoring is required however resources allocation and responses would have low priority compared to higher ranked risks. Those impacted will be able to adapt to change with relative ease.

Figure 17-28. Risk matrix

		Consequence				
		Negligible	**Minor**	**Medium**	**Major**	**Extreme**
	LEGAL	No legal consequences	No legal consequences	Incident potentially causing breach of licence conditions	Breach of licence conditions	Breach of licence conditions resulting in shutdown of Project operations.
	SOCIO-ECONOMIC	Impacts that are practically indistinguishable from the social baseline, or consist of solely localised or temporary/short-term effects with no consequences on livelihoods and quality of life.	Short-term or temporary impacts with limited consequences on livelihoods and quality of life. Those affected will be able to adapt to the changes with relative ease and regain their pre-impact livelihoods and quality of life.	Primary and secondary impacts with moderate effects on livelihoods and quality of life. Will be able to adapt to the changes with some difficulty and regain their pre-impact livelihoods and quality of life.	Widespread and diverse primary and secondary impacts with significant long-term effects on livelihoods and quality of life. Those affected may be able to adapt to changes with a degree of difficulty and regain their pre-impact livelihoods and quality of life.	Widespread and diverse primary and secondary impacts with irreparable impacts on livelihoods and quality of life and no possibility to restore livelihoods.
	HEALTH	No health consequences	Accident or illness with little or no impact on ability to function. Medical treatment required is limited or unnecessary.	Accident or illness leading to mild to moderate functional impairment requiring medical treatment.	Accident or illness leading to permanent disability or requiring a high level of medical treatment or management.	Accident, serious illness or chronic exposure resulting in fatality.
	ENVIRONMENT	Localised (on-site), short-term impact on habitat, species or environmental media	Localised or widespread medium-term impact to habitat, species or environmental media	Localised degradation of sensitive habitat or widespread long-term impacts on habitat, species or environmental media. Possible contribution to cumulative impacts.	Widespread and long-term changes to sensitive habitat, species diversity or abundance or environmental media. Temporary loss of ecosystem function at landscape scale. Moderate contribution to cumulative impacts.	Loss of a nationally or internationally recognised threatened species or vegetation community. Permanent loss of ecosystem function on a landscape scale. Major contribution to cumulative effects
		A - negligible	**B** - minor	**C** - medium	**D** - major	**E** - extreme
Expected to occur during the Project or beyond the Project	**a** - expected	**13**	**14**	**20**	**24**	**25**
May occur during the Project or beyond the Project	**b** - may	**8**	**12**	**19**	**22**	**23**
Possible under exceptional circumstances	**c** - possible	**6**	**7**	**11**	**18**	**21**
Unlikely to occur during the Project	**d** - unlikely	**4**	**5**	**10**	**16**	**17**
Rare or previously unknown to occur	**e** - rare	**1**	**2**	**3**	**9**	**15**

Risk Definition (see Table 17-13)	**Low**	**Medium**	**High**	**Extreme**

Table 17-14. Non-Aboriginal heritage risk analysis

Heritage								
Key impacts	Risk before mitigation			Mitigation and management	Risk after mitigation			Residual risk
	L	C	R		L	C	R	
Construction								
Construction works may potentially impact on: ▪ heritage visual values ▪ archaeological resources ▪ ancillary works ▪ Haviland Park	a	C	20	NAH1, NAH2, NAH3, NAH4, NAH6, NAH7, NAH8, NAH9, NAH10, NAH11, NAH12, NAH13, NAH14	d	B	14	There would be significant benefits to downstream non-aboriginal heritage due to a reduction in downstream flood frequency and extents. However, unmitigated non-Aboriginal heritage risk is assessed as High due to: ▪ design and construction within the heritage curtilages will cause unavoidable impacts to heritage items ▪ discharge of the flood mitigation zone (FMZ) may impact heritage items downstream due to increased inundation periods. However, this is a relatively low risk as FMZ discharges would generally be contained within the existing river profile. Mitigation measures would substantially reduce potential non-Aboriginal heritage impacts to a Medium risk, however it is expected that impacts may be unavoidable, which may prompt further mitigation response should potential heritage items be uncovered during construction or identified within the extended FMZ discharge area.
Operation								
Project operations may potentially impact on some heritage items up to about seven days longer than the current situation. These include: ▪ three WHL (including two declared places and one buffer zone) ▪ four NHL (including two listed places and two nominated places) ▪ 15 SHR ▪ 184 LEP ▪ One SEPP ▪ 17 s170.	a	C	20	NAH14	a	B	14	

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