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Sampling, Analysis and Quality Plan

Warragamba Dam Wall Raising – proposed construction

Client Reference No. 30013187
Prepared for: WaterNSW
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Abbreviation and Acronyms

Abbreviation / Acronym	Description
ACM	Asbestos containing material
AEC	Area of environmental concern
AF	Asbestos Fines
AHD	Australian Height Datum
ASS	Acid Sulfate Soils
BTEX	Benzene, toluene, ethylbenzene and xylenes
CEC	Cation Exchange Capacity
CEMP	Construction Environmental Management Plan
CSM	Conceptual Site Model
CoPC	Contaminants of Potential Concern
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DDT	Dichlorodiphenyltrichloroethane
DSI	Detailed Site Investigation
DQO	Data Quality Objectives
EC	Electrical conductivity
EIL	Ecological Investigation Level
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
ESL	Ecological Screening Level
FA	Fibrous Asbestos
GDE	Groundwater dependant ecosystem
HIL	Health Investigation Level
HSL	Health Screening Level
LNAPL	Light non-aqueous phase liquid
m	Metres
m bgl	Metres below ground level
NATA	National Association of Testing Authorities
NEPC	National Environment Protection Council
NEPM	National Environment Protection (Assessment of Site Contamination) Measure (ASC NEPM)
NSW	New South Wales
OCP	Organochlorine pesticides
OPP	Organophosphorus pesticides
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated biphenyls
PSI	Preliminary Site Investigation

Abbreviation / Acronym	Description
PID	Photoionization detector
POEO Act	Protection of the Environment Operations Act
QA/QC	Quality Assurance/Quality Control
RAP	Remediation Action Plan
SAQP	Sampling, Analysis and Quality Plan
SWMS	Safe Working Method Statement
TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total Petroleum Hydrocarbons
TRH	Total Recoverable Hydrocarbons
WA DoH	Western Australia Department of Health

1. Introduction

1.1 General

In 2017, SMEC Australia Pty Ltd (SMEC) was engaged by WaterNSW to prepare an Environmental Impact Statement (EIS) in relation to the proposed raising of Warragamba Dam. Chapter 22 (Soils) of the EIS included a preliminary contaminated land desktop assessment which provided a broad assessment of the upstream probable maximum flood (PMF) area, the downstream PMF and the proposed construction areas adjacent to the Warragamba Dam. This preliminary contamination assessment comprised publicly available information and did not include any quantitative analysis based on sampling and laboratory analysis.

Following the public exhibition of the EIS in late 2021, the Department of Planning and Environment (DPE) provided WaterNSW with the submissions made to the EIS with regard to the proposal. Submissions were received from several NSW agencies including the Environment Protection Authority (EPA). The EPA submission provided advice on a range of matters including comments and recommendations relating to the preliminary contaminated land assessment in Chapter 22 of the EIS.

The EPA submission recommended that appropriate contaminated site investigations, carried out by appropriately qualified contaminated land consultants, should be completed covering the areas likely to be disturbed as part of the development to determine what remedial and management measures are required. The EPA advice stated, 'the investigations should assess all relevant media and justify if the proponent believes that groundwater testing is not necessary. Works should also consider whether asbestos is present in any building materials prior to the demolition works. The letter also advised that a NSW EPA-accredited Site Auditor was recommended to be engaged for the entire project footprint and throughout the duration of the works to ensure that any work required in relation to contamination is appropriately managed, including any unexpected contamination finds, so that there is confidence that the site will be suitable for the proposed use. The letter recommended that the following documents be prepared:

1. A Sampling, Analysis and Quality Plan (SAQP)
2. A Detailed Site Investigation (DSI)
3. Interim audit advice from a NSW EPA accredited Site Auditor

In May 2022, WaterNSW engaged SMEC to carry out a Preliminary Site Investigation (PSI). A draft PSI report, titled *'Preliminary Site Investigation, Warragamba Dam Wall Raising – proposed construction disturbance areas (SMEC, 2022)*' was submitted to WaterNSW for review and comment on 03 June 2022. The PSI included a review of historical information and site observations for Site 1 to Site 5 (refer to Figure 1, Appendix A) which lead to the identification of eight potential areas of environmental concern (AEC). The PSI recommended that a Detailed Site Investigation (DSI) was required to assess the sites with respect to contamination, fill data gaps, develop the Conceptual Site Model (CSM) and assess the need for remediation/management with respect to the proposed use of the sites during construction. This SAQP has been prepared for the DSI and should be read in conjunction with the PSI.

WaterNSW also engaged Andrew Kohlrusch (EPA accredited site auditor).

1.2 Objectives

The objectives of this SAQP were to provide the context, justification and details of the selected sampling and analysis approach for the proposed DSI.

The objectives of the DSI are to:

- Assess the potential for contamination to be present at the defined Sites from past or present activities within the depth of likely construction disturbance as specified by WaterNSW (refer to Section 2.2)
- Assess if contamination potentially poses a risk to human health or the environment under the proposed use during construction and post construction
- Provide recommendations on the need for further investigations and/or management based on the findings
- Provide preliminary data to inform waste disposal in relation to soil waste classification.

1.3 Scope of work

The scope of this SAQP has been prepared with reference to the policy, standards and guidelines outlined in Section 1.4. The SAQP includes:

- A summary of the PSI
- Preliminary conceptual site model
- Establishing data quality objectives and data quality indicators
- Assessment methodology (sample media, locations and rationale)
- Assessment criteria
- Quality assurance and quality control plan.

1.4 Published guidelines

This SAQP has been prepared with reference to the following applicable published guidelines:

- Australian Standard AS4482.1-2005 Guide the investigation and sampling of site with potentially contaminated soil Part 1: Non-volatile and semi-volatile compounds
- Government of Western Australia: Department of Health (2009), Guidelines of the Assessment, Remediation and Management of Asbestos Contaminated Sites in Western Australia
- NEPC, National Environment Protection (Assessment of Site Contamination) Measure 1999 (ASC NEPM)
- NSW EPA (1995), Sampling Design Guidelines
- NSW EPA (2014) Waste Classification Guidelines, Part 1: Classifying Waste
- NSW EPA (2020) Contaminated land guidelines: Consultants Reporting on Contaminated Land.

2. Site Description

The following sections are sourced from information presented in the PSI (SMEC, 2022).

2.1 Site location

For the purposes of this assessment, the proposed construction areas have been divided into five main Sites (the Sites). Each Site has been named based on its previous or proposed use, as follows:

- Site 1 – Former painters/grit blasting area
- Site 2 – Proposed vegetation clearance area
- Site 3 – Terraced gardens
- Site 4 – Haviland Park
- Site 5
  - 5a – Materials storage
  - Site 5b – Heliport/former housing.

The location of each Site relative to Warragamba Dam is shown in Figure 1, Appendix A. Additional focussed site details are presented in Figure 2-1 to 2-5, Appendix A.

A summary of site information for each of the Sites is presented below in Table 2-1 to Table 2-6 below:

Table 2-1 Site 1 Summary

Address	Located off W5 Erskine Range Trail, Blue Mountains National Park
Title Identifiers	Lot 1 DP87998
Area	Approximately 38,600m^2 (3.86ha)
Zoning	SP2 Infrastructure (Wollondilly Local Environmental Plan, 2011)
Current Land use	Parts of this area are used by WaterNSW for storage of some equipment related to the dam including a shed (mainly used for rock core storage) with the remainder comprising vacant bushland with some cleared areas. An asphalt surface loop road is located within the central portion of the Site.
Proposed land use	Materials storage and handling area for the proposed dam raising.
Surrounding land use	The Site is immediately surrounded on all sides by dense bushland. Several surfaced and un-surfaced tracks are located to the north and east.

Table 2-2 Site 2 Summary

Address	Includes bushland on both sides of Warragamba dam. The Warragamba River flows through this Site but is excluded.
Title Identifiers	Lot 1 DP87998, Lot 1124 DP1159978, Part of Lot 5 DP248989, Part of Lot 4 DP628780
Area	Approximately 206,400m^2 (20.64ha)
Zoning	SP2 Infrastructure (Wollondilly Local Environmental Plan, 2011)
Current Land use	The majority of this Site comprises bushland with steeply sloping valley sides. A section of asphalt surfaced access road and a former 'Tail Tower' (cable style crane used for original dam construction) are located within the north-western portion of this Site. An access road is also located within part of this Site to the east.
Proposed land use	Vegetation clearance area required for the proposed dam raising

Surrounding land use	Dense bushland is located immediately off-site to the north, south and east. Warragamba dam wall and Lake Burragorang are located off-site to the west. The Warragamba River flows west to east through the central portion of the Site.

Table 2-3 Site 3 Summary

Address	Located off Valve House Road, Warragamba, NSW
Title Identifiers	Part of Lot 1124 DP1159978
Area	Approximately 27, 420m^2 (2.742ha)
Zoning	SP2 Infrastructure (Wollondilly Local Environmental Plan, 2011)
Current Land use	Terraced area associated with the dam, predominantly comprising three levels. Each level is separated from the next by an exposed sandstone cliff face. The lower level comprises an asphalt paved access road with several small building structures (e.g. electrical transformer, electrical building, back-up generator building). The other two levels mostly comprise maintained lawns and gardens.
Proposed land use	Concrete batch plant and materials storage and handling area for the proposed dam raising
Surrounding land use	**North:** Former hydropower station, and Warragamba River located beyond **East:** Asphalt surfaced road and dense bush land **South:** Warragamba Dam emergency spillway **West:** Warragamba Dam wall with Lake Burragorang located beyond.

Table 2-4 Site 4 Summary

Address	Located between Farnsworth Avenue and Production Avenue, Warragamba, NSW
Title Identifiers	Part of Lot 1124 DP1159978
Area	Approximately 2444m^2 (2.444ha)
Zoning	SP2 Infrastructure (Wollondilly Local Environmental Plan, 2011)
Current Land use	Grassed parkland with scattered trees.
Proposed land use	Concrete batch plant and materials storage and handling area for the proposed dam raising
Surrounding land use	This Site is generally surrounded by an access road, bushland and ancillary infrastructure associated with Warragamba Dam. Workshop areas are located down slope, immediately off-site to the west. Several structures (including a residential dwelling and associated sheds are located immediately off-site to the east). The Warragamba Dam visitor centre is located immediately off-site to the north.

Table 2-5 Site 5a Summary

Address	Located in the vicinity of Twenty Fourth Street and Twenty Third Street, Warragamba, NSW
Title Identifiers	Part of Lot 1124/DP1159978
Area	Approximately 94,360m^2 (9.436ha)
Zoning	SP2 Infrastructure (Wollondilly Local Environmental Plan, 2011)
Current Land use	Predominantly bushland including several vehicle tracks and some cleared areas. A storage area for old equipment associated with the dam is located along the southern and northern edge of the main access road, the equipment generally comprises rusted steel/concrete items. A cleared area in the north-eastern portion of this Site contains a weather station and a small communications building and associated satellite tower. An area used for mulch storage by WaterNSW is located within the north-western portion of the Site.
Proposed land use	Materials storage and handling area for the proposed dam raising

Surrounding land use	Dense bushland bounds the site to the north, east and west. A Sydney Water, water filtration plant is located immediately off-site to the south and outside land operated by WaterNSW.

Table 2-6 Site 5b Summary

Address	Intersection of Production Avenue and Warehouse Road, Warragamba, NSW
Title Identifiers	Part of Lot 1124 DP1159978
Area	Approximately 49,190m^2 (4.919ha)
Zoning	SP2 Infrastructure (Wollondilly Local Environmental Plan, 2011)
Current Land use	Generally vacant, grassed area bordered by mature trees with a helicopter landing area located within the central portion of the site. At the time of the Site walkover, the south-eastern portion of the Site appeared to be used for informal car parking.
Proposed land use	Materials storage and handling area for the proposed dam raising
Surrounding land use	Dense bushland surrounds the Site to the east and north-west. A water filtration plant is located off-site to the south west. A grassed parkland area is located off-site to the south.

2.2 Construction details

Based on information provided by a WaterNSW representative, the expected ground disturbance at each Site during the proposed construction phase is summarised in the following sections:

2.2.1 Proposed disturbance (Site 1, Site 3, Site 4, Site 5a and Site 5b)

Our current understanding of the proposed construction activities at these sites is that the areas will mainly be used for storage of construction materials and equipment. As vegetation needs to be removed prior to materials storage, the ground engagement will likely be limited to vegetation/topsoil removal and stockpiling/storage for later use during reinstatement of these areas. Topsoil stripping where required may only be in the upper 0.2m.

Chapter 5 of the EIS (SMEC, 2021) also provides the following information with regards to the proposed activities at Site 3 and Site 4.

The proposed establishment of batching plants at Site 3 and Site 4 is understood to comprise the following:

- Hardstand area with drainage to environmental control ponds
- Concrete testing and geotechnical laboratory
- Weighbridge and office
- Materials storage bins and sheds (for aggregates, sand, fly ash, and other materials)
- Silos, mixers, conveyors, above ground tanks, control facilities and dust control facilities
- Water and material chilling plant
- Connections to communication, power and water supply services
- Other environmental controls if required (for example, noise walls).

We note that some of the above proposed activities may require excavations to greater depths than 0.2m below ground level, however, the exact locations of these structures are currently unknown.

2.2.2 Proposed disturbance (Site 2 - Proposed vegetation clearance area)

Our current understanding of the proposed construction activities at Site 2 is that vegetation and topsoil would be removed and stockpiled for rehabilitation post construction. The areas will be excavated out or just cleared, dependant on the area/activity (i.e. left and right bank access roads, toe of dam and side walls of auxiliary spillway would need to be excavated) (details will only be known at detailed design stage), but the access roads to those areas would just have vegetation and topsoil removed and a wearing course placed to create a road.

2.3 Site environmental setting

2.3.1 Topography

Topography details were obtained from publicly available mapping. Topographic contours are presented in Figure 2 Appendix A.

The Warragamba Dam has been constructed at the base of a steeply sloping river valley, elevations at the top of the valley slopes within the vicinity of the dam typically range from around 180m AHD down to 20m AHD at the valley floor.

A summary of topography at each of Sites 1 to Site 5 is presented below.

Site 1 – Former Painters/grit blasting area

The shed area and immediate surrounds represent a high point in the area (approximately 185m AHD). In broad terms, the area comprising the shed and loop road were relatively flat with an overall slight slope down to the north. The topography slopes down more steeply beyond the tree lines to the west, east and south.

Site 2 – Proposed vegetation clearance area

The majority of Site 2 generally comprises steeply sloping sandstone rock faces either side of the Warragamba River and a section of the valley floor (western portion of Site 2). High points are around 175m AHD and 130m AHD for the north bank and south banks respectively, the topography slopes down steeply toward the valley floor on both sides of Site 2 where elevations are typically around 20m AHD. Stormwater run-off at Site 2 would generally be expected to flow towards the Warragamba River at the base of the valley (orientated NE-SW through the centre of the Site).

Site 3 – Terraced Gardens Area

Site 3 occupies several distinct topographic levels separated by exposed sandstone cliff faces or concrete retaining walls, a pedestrian stairway links each terrace. The lower terrace is at approximately 60m AHD, the upper level is situated at around 110m AHD in the north-western corner of the Site. Stormwater run-off from Site 3 would generally be expected to flow west/north-west toward the Warragamba River.

Site 4 – Haviland Park

Haviland Park is generally flat at an approximate elevation of 165m AHD. It is located on a crest area with a broad downward slope to the north-west, but slopes down towards the sealed roads which surround the Site on all sides to the east, west and north.

Site 5a – Storage area

The high point at Site 5a is a broad area around the weather station and communication hut (approximately 185m AHD), from this high point, the Site slopes to around 180m AHD in the south and south-eastern portions of the Site before the topography begins to slope fairly sleepy along the southern boundary of the Site. Stormwater run-off would be expected to flow south and south-west from the Site.

Site 5b – Helipad/former houses

A broad, relatively flat area occupies the southern half of Site 5b, with this flat area is at an approximate elevation of 180m AHD. The topography in the northern half of Site 5b slopes fairly steeply down to a low point of 155m AHD in the north-eastern corner of the Site. Stormwater run-off would generally be expected to flow towards the south from Site 5b.

2.3.2 Vegetation

During the site walkover it was observed that large portions of Site 1, Site 2 and Site 5b were densely vegetated with natural or regrowth bushland.

Based on the EIS (SMEC, 2021) most of the vegetation across the relatively level areas of the site is Dry Sclerophyll Forest (Shrubby sub-formation) of common plant community types found in the locality on sandstone ridgetops. Some wet Sclerophyll Forest communities are present in the gullies and one area on the north bank is the Threatened

Sydney Turpentine Ironbark Forest community (refer to relevant section of the EIS for additional details). No apparent evidence of die back or vegetation stress due to contamination was noted during the site visit.

2.3.3 Heritage

With reference to Department of Finance, Services and Innovation 2022 Heritage mapping (accessed 13 May 2022), Haviland Park is listed as a State Heritage Register Item (ID 5051583). The Greater Blue Mountains Area is recorded on the National Heritage List and is located approximately 100m north of the northern extent of Site 1.

2.3.4 Regional geology

With reference to the Penrith 1:100,000 Geological mapping, Site 1 to Site 5 are all reportedly underlain by Hawkesbury sandstone described as medium to very coarse-grained quartz sandstone with minor laminated mudstone and siltstone lenses.

Some areas of filling have been identified at the site from the site visit and are highlighted in Figure 3, Appendix A.

2.3.5 Acid Sulfate Soils

Reference to the Atlas of Australian Acid Sulfate Soils 1 (CSIRO, 2013) accessed 27 May 2022, indicates that Site 1 to Site 5 are mapped as having an extremely low (1-5%) probability of Acid Sulfate Soils (ASS) occurrence, furthermore, based on site observations from the site walkover and the topographic elevations of Site's 1 to 5 we consider that ASS materials are unlikely to be present at the sites.

Lake Burragorang (i.e. upstream/to the west of the dam wall) are mapped as having a high probability (>70%) probability of Acid Sulfate Soils occurrence, this area is outside of the Site boundaries for the purposes of this assessment.

2.3.6 Hydrology and hydrogeology

Based on topographic contour mapping for the site, site observations and with reference to NSW spatial services data set (perennial and non-perennial) water courses (viewed through the MinView website – accessed 27 May 2022), stormwater run-off from Site 1 to Site 5 is generally anticipated to flow downslope toward gulley low points and then eventually discharge (via drainage lines/creeks) into either Lake Burragorang (upstream of dam wall) or into the Warragamba River (downstream of dam wall).

Site 1 to Site 5 are all located proximal to Lake Burragorang, groundwater at each site is therefore expected to be located at approximately the AHD of the surface water of the lake, groundwater levels in the immediate vicinity of the dam and immediately downstream may be elevated above the downstream creek level due to the presence of the dam wall. Groundwater is expected to be located within fractured rock.

The EMM Technical Memorandum (2022) Re: *Expert Groundwater Technical Report, Warragamba Dam Raising EIS – Response to Submissions* indicated the following:

'The Hawkesbury Sandstone geologic unit hosts a major regional aquifer in the area surrounding Lake Burragorang' (refer to Figure A below). *'The aquifer occurs below lake Burragorang and beneath the adjacent ridgelines and is essentially a single hydrogeological unit that comprises a series of layered aquifers. It is a semi-confined, dual porosity (matrix and fracture) unit exhibiting variable permeability that is dependent on the extent of fracturing and faulting. Groundwater flows through interconnected void space between grains of the rock matrix and the secondary features consisting joints, fractures, faults shear zones and bedding planes. Groundwater flow is predominantly through these defects in the sandstone (Parsons Brinckerhoff, 2009). The groundwater flow is consistently west to east from Lake Burragorang. There are no obvious, local groundwater discharge areas for the sandstone aquifer, although groundwater discharge to the alluvium (where present) and to the Nepean River is assumed based in groundwater flow contours'.*

During the Millennium drought, groundwater investigations were undertaken at Warragamba and Wallacia, the closest test bores that targeted the Hawkesbury sandstone aquifer were 1.9km south of Warragamba Dam, the groundwater level in this bore was 97 metres below ground level (bgl) in mid-2006 and 99mgl in mid-2008. A data logger was installed between 2008 and 2012 which indicated that dam water levels were always higher than the sandstone aquifer water table level (which confirmed that the dam is losing water to the regional sandstone aquifer). The reported hydraulic conductivity from field testing of the deep sandstone aquifers at Warragamba is around

0.1m/day (Parsons Brinckerhoff, 2009) and for the shallow sandstone in the vicinity of the dam it is mostly within the range of 0.001 to 0.09 m/day (Stantec/GHD 2019).

Groundwater quality sampling from bore W7A (refer to Figure A below) indicates conditions are fresh, with an approximate electrical conductivity (EC) of 300us/cm, and slightly acidic (pH approximately 6.5) (Parsons Brinkerhoff, 2008). The water quality in Lake Burragorang was considered to be slightly fresher, with an approximate EC of 250us/cm, and neutral pH (pH7) (Ecological, 2020).

Parsons Brinckerhoff (2008 and 2009) completed environmental and radioisotope studies on groundwater samples from Warragamba to Wallacia and found that groundwater within the Hawkesbury Sandstone aquifer was meteoric in origin (i.e. derived from rainfall) with a corrected age of 4,800 years before present at Warragamba up to 30,600 years before present at Wallacia. This age data confirms low permeability for the sandstone aquifer and slow natural migration.

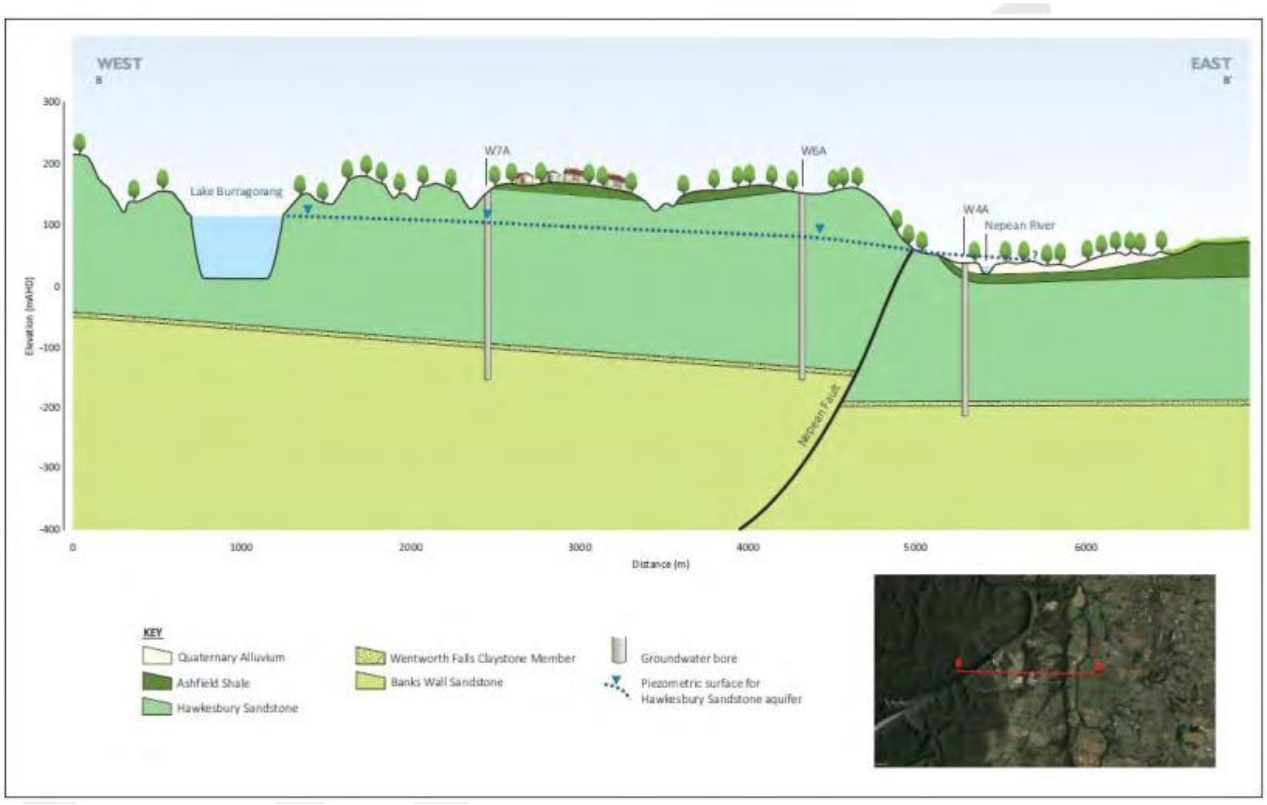


Figure A – Conceptual west-east geological cross section through Lake Burragorang (EMM, 2022).

2.3.7 Groundwater Use

A search of registered groundwater bores was carried out on 13 May 2022 (data sourced from Department of Finance, Services and Innovation). The results indicated that there was one registered groundwater bore (GW075142) located within a 1km radius of the Sites. The bore is located approximately 600m south of the Sites and was reportedly installed to a depth of 246m below ground level (bgl) with a standing water level of 92m bgl. The registered purpose of the bore is for 'monitoring'. The EMM Technical Memorandum (2022) states that landholder owned groundwater bores target the Hawkesbury Sandstone and the closest landholder bore is located 3km away from the dam wall. Terrestrial vegetation around Lake Burragorang is unlikely to be relying on groundwater in sandstone aquifers due to deep groundwater levels (i.e. typically greater than 50m bgl) and therefore vegetation fringing the lake is highly unlikely to be groundwater dependant.

The EMM Technical Memorandum (2022) indicated that the Water Sharing Plan (WSP), i.e. Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 Sydney Basin Blue Mountains and Sydney Basin Central Groundwater Sources, and the Groundwater Dependent Ecosystem Atlas (managed by the Bureau of Meteorology (BoM)) were reviewed to determine whether any groundwater dependent ecosystems (GDE) are likely to exist in the vicinity of Lake Burragorang. These are no listed high priority GDEs in the WSP and the BoM potential GDEs. These are listed as moderate potential GDEs but given that the depth to groundwater is generally between 50 and 100 mbgl

across the plateau area above Lake Burragorang, the potential GDEs shown in the BoM atlas are highly unlikely to be groundwater dependent.

With reference to the EIS (SMEC, 2021), there are no plans to use groundwater as a water supply source during the construction program.

2.4 Site history and site observations summary

2.4.1 A summary of the history and observations from the PSI are provided below.

2.4.2 Site 1 – Former painters/grit blasting area

Earliest available aerial imagery from 1949 shows the Site to mostly comprise dense bush land with some cleared areas including several un-sealed roads. Structures appear on-site around 1970, with dark ground staining (possibly associated with known grit blasting activities) appearing around 1978. The 2001 bushfires caused the destruction of the majority of on-site structures, a large steel framed shed was later re-built, the shed is predominately used for the storage of rock core.

Reports reviewed by SMEC indicate that a large portion of land (approximately 8,000m^2) located to the west of the existing shed structure and a smaller area to the north of the existing shed area were historically contaminated with heavy metals (copper, lead and zinc) as a result of historical grit blasting activities. In addition, hydrocarbon soil contamination was recorded in areas of visible oil staining. A remedial action plan was created and remedial activities were reportedly carried out (which included scraping visually contaminated soils into a lined call (on-site). Validation reports were reportedly lost during the 2001 bushfires, however, one letter report indicates that remediation was carried out as per the remedial action plan.

At the time of the Site walkover, Site 1 appeared to be used as a storage area for various pieces of equipment associated with the dam. Clusters of equipment were observed adjacent to the sealed road, including, large bundles of steel rope, large pieces of steel (assumed to be parts/components etc related to operation of the dam), large skip bin, timber etc). A large steel framed shed was observed in the central portion of the Site, the contents of the shed mostly included rock core inside core boxes. The shed was constructed on a concrete slab. Several smaller vacant structures (two portacabins and a small empty shed) were observed to the west of the main storage shed. An earthen bund (ranging from around 2-3m above ground level to around 0.5m above ground level) was observed within the southern portion of the Site. An old silt fence was observed to the south of the earthen bund. There were no apparent surface indicators as to the location of the contaminated cell which is reportedly located within the south-eastern portion of the Site. The perimeter of Site 1 was densely vegetated with trees and bushes, the ground surface in these areas was also covered with leaf litter.

No surface evidence of sandblasting grit was easily evident.

2.4.3 Site 2 – proposed vegetation clearance area

From circa 1949 to the present day, Site 2 appears to have predominantly comprised dense bushland and steeply sloping sandstone cliffs. Several structures were constructed in the western extent of the Site to support the original dam wall construction (e.g. Tail Tower). Two clusters of historical structures (eastern portion and northern portion of site respectively) were formerly present at the Site until demolition circa 1965.

In 2016, three asbestos impacted areas and an open landfill area containing approximately 20 x 44 gallon drums were observed immediately off-site of Site 2.

During the walkover it was not possible to access the majority of Site 2 because the majority of the Site was densely vegetated and/or comprised steeply sloping cliff faces, however observations were made from the top of the dam wall (which was a good vantage point to get a general appreciation of the area). The majority of the Site appeared to be densely vegetated with mature trees and bushes, sandstone bedrock was observed to be outcropping on the steeply sloping valley sides.

2.4.4 Site 3 – Terraced gardens

The Terraced garden area appears to have been predominantly utilised during the original dam wall construction, during this period, the lower terrace appears to have been utilised for car parking. A 'Tail Tower' structure was formerly located within the second (middle) terrace of Site 2 from around 1949 to 1965, circa 1965 the middle terrace appears to have been landscaped into the park area observable today. Various smaller building structures have been constructed within Site 3 since 1949, the majority of which are still visible on site today.

Observations of Site 3 were made by looking down onto the Site from the dam wall and by walking over the Site itself. Several structures were observed on the lower terrace, this area was sealed with asphalt. The structures nearest the dam wall reportedly contained electrical switchboards and a backup generator (including fuel tank) although it was not possible to view inside the structures. Several other structures were observed in the north-eastern portion of the Site on the lower level, these structures included a toilet block and shaded picnic area. Several sets of stairways allowed access between the different levels of the terraced gardens. The second level mostly comprised a grassed lawn area (a small electrical transformer was observed on this level within the western portion of the Site). A concrete structure was observed in the floor of this terrace, the structure looked like a typical concrete path but was later understood to be a component of the former 'Tail Tower' structure. Several small building structures (which appeared to be unused) were present within the eastern extent of this terrace – these were later understood for the storage of gardening equipment. Outcropping sandstone bedrock was visible between each terrace.

2.4.5 Site 4 – Haviland Park

Earliest available aerial imagery appears to show a portion of Haviland Park being used for storage of stockpiles (reportedly a one-week supply of gravel and sand) to supply the concrete laboratory.

Several larger building structures appear within the eastern extent of the Site circa 1955 but disappear prior to the 1965 aerial image. Circa 1965 the park appears to have undergone some landscaping works to create the present-day park area. Two small structures were formerly present within the south-west portion of the site from around 1965 to 2011. Fill material appears to have been spread across the north-western half of Haviland Park in 2009, a WaterNSW representative advised that the source of the material was from excavations associated with the construction of the WaterNSW offices and visitor centre located immediately to the north-west of Site 4. A workshop area (with known historical contamination issues associated with above and below ground fuel tanks) is located immediately off-site to the east but is considered to be topographically lower than Haviland Park and unlikely to be a valid contamination source for the site.

Haviland Park was observed to be an open grassed parkland area comprising scattered mature trees and park benches. The area appeared to be well maintained.

2.4.6 Site 5a – Materials storage/former housing

From approximately 1949 to present day, the majority of Site 5a appears to have comprised dense bushland, including a weather station and an adjacent small communications hut (suspected to be constructed using asbestos containing materials (ACM)).

Several areas of possible filling and stockpiling are visible at the site. Several portions of the site appear to have been utilised for equipment storage, for example either side of the main access road (southern portion of the Site) and within the cleared area located in the south-west portion of the site. An historical explosives store is located off-site to the south.

At the time of the walkover, the majority of the area was densely vegetated and at the time of the walkover and appeared to be either unused bushland or utilised for storage of general equipment (mostly metal components/parts and large concrete/metal pipes associated with the dam. These areas were predominantly stored adjacent to the access road. The western portion of the Site was observed to comprise an area of hummocky ground (assumed historical stockpiling/filling), with some mulch stockpiles also visible. Rock was observed to be outcropping at the ground surface in several area to the south of the access road. The southern portion of the Site appeared to slope away steeply toward the valley below. A weather station area (with a small fenced compound) and an old communications hut and associated aerial tower were observed within the northern portion of the Site. The communications hut appeared to be of fibre cement construction and was labelled with some stickers which warned of the presence of asbestos. Some holes/damage was evident in the fibre cement.

2.4.7 Site 5b – Heliport/former housing

Site 5b appears to have been predominantly utilised as a residential area comprising over 50 individual houses at its peak, each house appears to also be associated with a small shed structure. Construction of the residential area appears to have commenced around 1949 and we understand they were used to house some of the dam construction workers. Demolition of the houses appears to have occurred in several stages between 1978 and 2005. It is unknown if any remediation occurred at this Site following the demolition of the residential structures. More recently, fill materials appear to have been imported to the Site and used for landscaping, some of the fill reportedly came from the auxiliary spillway construction, and some also reportedly came from construction of the visitor centre, although other sources are possible.

A heliport is visible in the aerial imagery from 2018 but the area may have been used for helicopter landing prior to 2018.

At the time of the walkover, the Site appeared to be a generally vacant, open grassed field area with a helipad area demarcated within the central portion of the Site. Some scattered trees and bushes were observed. The Southern portion of the Site was approximately flat but sloped downwards to the north to a drainage line at the toe of the slope. The northern extent of the Site was not accessed during the walkover due to dense vegetation. Some vehicles were parked along the southern perimeter of the Site.

2.4.8 Site history data gaps

The PS) identified several data gaps in our current understanding of the Site history, as follows:

- The large scale of the Site and the relatively poor quality of some of the historical aerial photographs means that it is difficult to discern every potentially activity at the site, and the exact activity and feature is not known
- Although several available reports refer to Site 1 as a proposed ‘Truck maintenance and explosives store area’, we have no additional evidence to corroborate this
- Validation reports associated with the remediation at Site 1 were reportedly destroyed during the 2001 bushfires, the only evidence of validation being carried out is a letter report which states that remediation was carried out as per the SKM Remedial Action Plan (RAP)
- The mapping provided within the Lotsearch report (Appendix B) indicates that the contamination associated with the Warragamba dam viewing platform extends across the eastern boundary of Site 2 into the site, however, discussions with WaterNSW indicate that this portion of the site will not be disturbed by the proposed construction works.

3. Preliminary Conceptual Site Model

3.1 Contamination Sources-Pathways-Receptors

Contamination source(s), pathway(s) and ecological/human receptor(s) linkages have been assessed based on the Conceptual Site Model (CSM). The following assessment has been undertaken in the context of the proposed construction activities at each site as described in Section 2.2.

3.1.1 Sources

Areas of Environmental Concern (AEC) and Contaminants of Potential Concern (CoPC) were assessed based on Site history information and Site walkover. Identified AEC and CoPC are summarised in Table 3-1.

AECs are presented in Figure 2, Appendix A.

Table 3-1 Summary of identified potential AEC and CoPC

No.	AEC / Source(s)	Likelihood of Contamination[1]	Media Potentially Affected	CoPC[3]	Comment[1]
AEC 1	Areas near former/existing building structures from weathering and/or ineffective demolition of hazardous building materials.	Low to high (refer to comments column)	Soil	Asbestos Lead (from lead-based paints) Zinc (from weathering of galvanised iron) TRH/TPH (from oils/greases used for Tail Tower track lubrication etc)	**Site 1**: Structures at Site 1 were reportedly burned down during bushfires in 2001. It is unknown what happened to the remnants of the structures but assumed to be disposed offsite. Some residual surface contamination could remain depending on the effectiveness of previous clean up works. The likelihood of contamination being present is assesses as **low-moderate.** **Site 2 (western area):** The majority of structures in this area appear to have been equipment such as a Tail Tower and associated rail tracks (see item 2.01, 2.02, 2.03 to 2.06 – Figure 2, Appendix A). There is some potential for contamination from weathering of these structures/lubrication used on the rail tracks however the likelihood of contamination is assessed to be **low.** **Site 2 (eastern areas)**: Two clusters of historical structures (unknown use) have been identified within the eastern portion of Site 2 (specifically item 2.07 and 2.08 (refer to Figure 2, Appendix A)), these structures were demolished circa 1965. The area opposite the viewing platform has been reported to contain asbestos and has been capped. The likelihood of contamination at these two areas is assessed to be **moderate to high.** **Site 3:** The structures at this site appear to have either been equipment (e.g. Tail Tower and associated tracks or building structures that are generally still present on the site today), the likelihood of contamination in this area is assessed to be **low to moderate.** **Site 4**: Several historical structures have been identified in the eastern portion of Site 4, the majority of which appear to have been demolished circa 1965, due to unknown demolition practices at this time the likelihood of contamination in this areas is assessed to be **moderate to high.** **Site 5a:** The only structures identified in this area was the weather station area, the tennis courts and the communications hut, the likelihood of contamination at the tennis court/weather station is considered to be **low**, however, the communications hut is suspected to contain ACM and potentially PCBs, therefore the likelihood for contamination is assessed to be **moderate to high**. **Site 5b**: The majority of this site was historically occupied by a large number of residential and ancillary structures that were demolished in various stages. Due to unknown demolition practices and the number of structures historically present at the site, the likelihood of contamination is assessed to be **high**.
AEC 2	Historical and/or existing equipment storage areas (from weathering of equipment stored on unsealed ground for long periods) and historical construction areas (e.g. from equipment/machinery leaks and/or other general construction practices)	Low	Soil	Heavy metals, asbestos, TRH, BTEX, PAH, heavy metals	Multiple storage areas were identified across the Sites, the majority of items stored in these areas appeared to be steel objects/parts associated with the dam wall, timber, concrete/steel pipes etc. For the most part these objects were observed to be stored on un-sealed ground and there is some potential for weathering of these objects to have led to some contamination of shallow surface soils, however the likelihood is assessed to be **low** for all sites as the materials were most likely inert.
AEC 3	Areas of stockpiling/filling (from materials of unknown origin and/or quality)	Low to moderate (refer to comments column)	Soil	Heavy metals PAHs, TRH, BTEX, PCB, OCP, OPP, asbestos (+ others depending on source)	**Site 1:** the identified areas of stockpiling/filling within area have the potential to have been impacted with known contamination at this Site, the likelihood of contamination is assessed to be **moderate.** **Site 2 and Site 3:** the site history review did not indicate any areas of filling/stockpiling **Site 4:** Two areas of filling were identified within Haviland Park, the filling appeared to have occurred circa 2009 and anecdotal evidence indicates the source of the fill was from beneath the Warragamba Dam visitor centre, several structures were historically located at the location of the visitor centre, due to unknown demolition practices, these fill materials are of unknown quality, therefore the likelihood of contamination is assessed to be **moderate.** **Site 5a:** Two areas of filling have been identified. The filling area in the western portion of the Site (item 5a.04) appears to have a long history of filling/ground disturbance and stockpiling (from circa 1960 to 2005). Due to the unknown quality of fill or exact activities the likelihood of contamination is assessed to be **moderate.** The eastern area of filling (item 5a.02) is suspected to comprise materials sourced from the clearing of the trees in this area circa 1970-1986, therefore the likelihood of contamination is assessed to be **low.**

No.	AEC / Source(s)	Likelihood of Contamination[1]	Media Potentially Affected	CoPC[3]	Comment[1]
					Site 5b: The fill identified at Site 5a (placed circa 2007-2009) was anecdotally sourced from the construction of the visitor centre, for the same justifications provided for Site 4, the likelihood of contamination in this fill material is considered to be **low.**
AEC4	Fuel storage/re-fuelling from possible leaks and/or spills	Low	Soil	TRH,TPH, BTEX, PAH, lead	**Site 3:** An above ground fuel tank (200-300 litres) is reported to be at the back-up generator within a small structure . This is a well-maintained area and managed by WaterNSW, therefore the likelihood of contamination is assessed to be **low**. **Site 4:** Re-fuelling of helicopters apparently occurs at the grassed helipad area. Based on the small volumes of fuels involved and no evidence of leaks or spills the likelihood is considered to be **low.**
AEC 5	Electrical sub-station from possible leaks/spills of insulation oils	Low (refer to comments column)	Soil	TRH	**Site 3**: A small electrical transformer was identified., Anecdotal information indicates that transformer was constructed circa 2007. No evidence of leaks was observed during the Site walkover, the likelihood of contamination is assessed to be **low.**
AEC 6	Contamination containment cell located within Site 1 (comprising grit blasting waste known to be contaminated with lead, zinc and copper and hydrocarbons).	High	Soil	lead, chromium, zinc, copper	**Site 1:** The exact location of the containment cell is currently unknown; however, the cell is known to contain soil contaminated with lead, zinc, copper, chromium and hydrocarbons. The likelihood for contamination is assessed to be **high.**
AEC 7	Area of potential metal contamination associated with former girt blasting activities (isolated areas of hydrocarbon contamination were also historically identified in this area).	Moderate	Soil	Lead, copper, zinc, chromium	**Site 1**: This area was reported to have metal contamination from past grit blasting activities and reportedly remediated in 1998. However, the 2001 bushfires destroyed the validation reports. A single letter report was reviewed which indicates that the area was remediated as per the remediation action plan (RAP), the RAP indicates that the proposed remediation was to scrape shallow soils and place into an on-site lined cell. Validation of the area was reportedly carried out by visual assessment only (i.e. no validation sampling). Based on the data gaps relating to the remediation and validation of this area, we assess the likelihood of residual contamination to be **moderate**.
AEC 8	Core park road dump area (reported to contain approximately 20 x 44 gallon drums and light fittings – unknown if any remediation has occurred	Moderate to high (refer to comments column)	Soil	Heavy metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn), PAHs, TRH, BTEX, PCB, OCP, OPP, asbestos (+ others depending on waste types)	**Site 2**: A report by Integrated Environmental (2016) describes observations of a dumping area (mostly considered to be off-site to the east of Site 2, but a portion of the dump area may cross into Site 2) (refer to Figure 2-2), Appendix A. The waste area was observed to contain 20 x 44 gallon drums which previously contained unknown liquids, the likelihood of contamination is considered to be **moderate to high.**

Notes:

1. This is our qualitative assessment of likelihood of contamination being detected from the data reviewed, not financial or other risk associated if contamination were to be detected. The likelihood of contamination has been assessed based on our current understanding of the proposed future use of each site during construction.

2. Heavy metals (arsenic, chromium (III&VI), copper, lead, mercury, nickel, zinc) TRH (Total Recoverable Hydrocarbons), BTEX (benzene, toluene, ethylbenzene, xylene), PCB (polychlorinated biphenyl's), PAH, (Polycyclic Aromatic Hydrocarbons), OCP (Organochlorine Pesticides), OPP, (Organophosphorus Pesticides).

The workshop area located approximately 25m west of Haviland Park was previously investigated and (reportedly remediated), based on the reported remediation and location of the workshop area in comparison to Haviland Park (located down topographic gradient) the workshop area is unlikely to represent a viable source of contamination to Site 1 to Site 5b.

SMEC queried WaterNSW with regards to use of herbicides and pesticides at the Site, a WaterNSW representative stated that 'WaterNSW undertake routine weed control on all their sites using targeted/selective methods'.

3.2 Exposure pathways

The pathways of exposure consist of:

- A transport mechanism
- A route of exposure.

Based on Site information, there is potential for the following contamination pathways to exist at the Site:

- Disturbance of potential soil contamination and exposure by ingestion, dermal contact or inhalation
- Air transport of particulates (dust) and exposure by inhalation
- Migration of contaminated run-off and exposure of down gradient ecological receptors (aquatic and terrestrial ecosystems).

3.3 Potential receptors

3.3.1 Human receptors

Based on the information available, potential human receptors have been assessed to include:

- Construction workers during construction phase
- Future Site maintenance/operational workers and visitors.

3.3.2 Ecological receptors

Ecological receptors may include:

- Terrestrial and aquatic organisms and plants (on-site and off-site)

3.3.3 Groundwater receptors

EMM (2022) indicated that groundwater level proximal to the dam is generally lower than the surface water level of the dam, in the context of the topographic elevation at each Site (refer to Section 2.3.1), depth to groundwater at each site is generally expected to be greater than 50m below ground level (except for Site 3 where groundwater would be expected at less than 30m below ground level). Radioisotope studies have indicated that the Hawkesbury Sandstone aquifer in the area has low permeability and slow natural migration. There is one registered groundwater bore located within 1km of the Site (located 600m south of the Site). EMM (2022) indicate that the nearest privately owned bore is located 3km from the Site and that mapped groundwater dependent ecosystems (GDE) are highly unlikely to be groundwater dependent.

Based on our current understanding of the proposed construction activities at the Sites (generally comprising topsoil removal and/or vegetation clearance) interaction with groundwater during construction is considered unlikely and with reference to the EIS (SMEC, 2021), there are no plans to use groundwater as a water supply source during the construction program. For the aforementioned reasons, we do not consider groundwater to be a viable pathway or receptor of contaminants from Site 1 to 5.

3.3.4 Potential source-pathway-receptor linkages

Potential source-pathway-receptor (S-P-R) linkages are where soil, surface water and/or groundwater contamination (if present) has the potential for adverse impact on human health or ecological values for the Site via complete exposure pathways.

Based on the findings of the PSI there are a number of plausible source-pathway-receptor linkages for the site (in the context of the proposed construction activities) as presented within Table 3-2.

Table 3-2 Potential contamination source, pathway and receptors

Source		Potential Pathway		Potential Receptor(s)
Primary	Secondary	Scenario	Exposure Pathway(s)	
• Contaminants associated with AEC 1 , AEC2, AEC 3, AEC 4. AEC 5, AEC 6, AEC 7, AEC 8	• Soil contamination	• Direct exposure during excavation/stockpiling of contaminated soils • Surface water runoff from excavated/exposed soils during construction impacting down-gradient soils and surface waters	• Dermal contact • Inhalation of soil dust and/or fibres • Incidental ingestion (humans and animals) • Absorption (plants)	• Future Site maintenance/operational workers and visitors • Construction workers during construction phase • Terrestrial and aquatic organisms and plants (on-site and off-site) • Surface waters (on-site and off-site)

Table notes

This table has been completed in the context of our current understanding of proposed disturbance to each of the Sites (proposed activities are summarised in Section 2.2), should proposed construction activities differ to those specified in Section 2.2 this assessment will need to be reviewed in the context of these activities.

4. Approach to the Investigation

Based on the CSM, the contamination sources identified are likely to cause 'top down' contamination and if present is likely to be relatively shallow in near surface soils or fill materials. Intrusive investigations to assess the potential for soil contamination is proposed in most identified AECs. Some selected AECs where the likelihood of contamination was assessed to be 'low', have existing pavements, may have poor access for initial observations and/or may not actually be subject to disturbance, are not proposed to be directly assessed in the DSI. These specific AECs are justified and discussed in later sections, but we consider that these areas can be managed through an unexpected finds protocol as part of construction and would be documented and implemented by the construction contractor within their Construction Environmental Management Plan (CEMP).

Based on the CSM and scope of construction works, groundwater is not likely to be intersected and therefore we consider does not warrant direct assessment. In addition, the likelihood of groundwater at the sites being contaminated from past or current on-site land uses that would pose unacceptable risks to health or environmental receptors is considered to be low for the following main reasons:

- On site contamination sources are assessed to be 'top down' sources with soil contamination (if any) likely to be relatively shallow.
- As described in Section 2.3.6 the depth to groundwater beneath the sites is likely to be relatively deep, potentially tens of metres below ground within a fractured rock aquifer. Contamination sources have not included deep landfills, underground fuel tanks or other sources that would likely cause deep or widespread impact. The likelihood of the contamination sources transporting contaminants down deep through a soil and rock profile to these depths is highly unlikely.

5. Assessment Criteria

5.1.1 General

Evaluation against assessment criteria is used to identify levels of contamination that may pose ecological or health risks to potential receptors or future users of the Site.

The National Environment Protection (Assessment of Site Contamination) Measure (NEPM) was first published in 1999 and updated in 2013 by the National Environment Protection Council (NEPC) and provides national standards for a variety of environmental issues, including the assessment of Site contamination in Schedule B (1) *Guideline on Investigation Levels for Soil and Groundwater*.

The NEPM requires consideration be given to Health-based Investigation Levels (HIL), Health-based Screening Levels (HSL), Ecological Investigation Levels (EIL), Ecological Screening Levels (ESL), Management Limits, asbestos criteria and aesthetic issues. The following outlines the rationale for the selection of the appropriate levels for this SAQP.

5.1.2 Health Investigation Levels (HILs) and Health Screening Levels (HSLs)

Health investigation levels (HIL) are scientifically based, generic assessment criteria designed to be used in the first stage (Tier 1 or 'screening') of an assessment of potential risks to human health from chronic exposure to contaminants. They are intentionally conservative and are based on a reasonable worst-case scenario for four generic land use settings.

- HIL A – residential with garden/accessible soil (home grown produce <10% fruit and vegetable intake, (no poultry), also includes children's day care centres, preschools and primary schools.
- HIL B – residential with minimal opportunities for soil access includes dwellings with fully and permanently paved yard space such as high-rise buildings and flats.
- HIL C – public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and footpaths. It does not include undeveloped public open space (such as urban bushland and reserves) which should be subject to a site-specific assessment where appropriate.
- HIL D – commercial/industrial such as shops, offices, factories and industrial sites.

Based on our understanding of the proposed uses of the Sites during the dam wall raising construction phase (refer to Section 2.2) SMEC have adopted the HIL D 'commercial/industrial' criteria as initial assessment criteria. We understand that the upper soil layers (predominantly topsoil) that may be stripped as part of construction, will be reused to rehabilitate these same areas post construction. Assuming soils will be kept separate from separate areas, recreational criteria will also apply to Sites 3, 4 and 5b.

Adopted human health site assessment criteria were sourced from NEPM (2013) Schedule B1.

Health Screening Levels (HSLs) for petroleum hydrocarbons are available from ASC NEPM (2013) and CRC Care (Friebel E and Nadebaum P, 2010). These references provide HSLs for vapour intrusion for soil at various depth ranges. CRC Care also provides HSLs for direct contact and for vapour intrusion for intrusive maintenance worker (shallow trench). For initial assessment, we will conservatively assume a soil type of 'sand' and coarse-grained soils for application of relevant criteria, otherwise the specific soil type will be used.

5.1.3 Ecological screening and investigation levels (EILs/ESLs)

EILs and ESLs are relevant where ecological receptors are likely to be present and exposure pathways are complete. The Sites are in or proximal to bushland settings where soils would be expected to be protective of ecological receptors, including:

- biota supporting ecological processes, including micro-organisms and soil invertebrates
- native flora and fauna
- introduced flora and fauna
- transitory or permanent wildlife.

Soil analytical results will therefore be compared with the NEPM (2013) Generic EILs to assess potential risks to current and future ecological receptors at the site for selected analytes (Arsenic, DDT, lead, and naphthalene). For other analytes (including copper, chromium, nickel and zinc) the EIL values rely on site-specific inputs and calculations which will be calculated using the ASC NEPM (2013) Toolbox, the input parameters used for the NEPM toolbox calculation will be from soil physicochemical parameters (%clay, pH and CEC of sampled fill materials) derived from samples of site soils. Derived physiochemical parameters will be inputted into the NEPM Ecological Investigation Level Calculation Spreadsheet (http://www.nepc.gov.au/nepms/assessment-site-contamination/toolbox). EILs only apply to the top 2 metres of soil which corresponds to the root-zone of most plant species.

5.1.4 Management Limits

Management Limits have been considered as investigation levels. The purpose of these is to avoid or minimise potential effects of petroleum hydrocarbons. The ASC NEPM identifies these effects as:

- Formation of observable light non-aqueous phase liquids (LNAPL)
- Fire and explosive hazards
- Effects on buried infrastructure.

The following management limit criteria will be adopted for this assessment:

- Table 1B (7) Management Limits Commercial and industrial.
- We understand that the upper soil layers (predominantly topsoil) that may be stripped as part of construction, will be reused to rehabilitate these same areas post construction. Assuming soils will be kept separate from separate areas, residential, parkland and public open space criteria will also apply to Sites 3 and Site 4.

5.1.5 Asbestos Criteria

Site 1, Site 2, Site 3, Site 4 and Site 5a.

The following asbestos criteria will be used as initial screening criteria for Site 1, Site 2, Site 3, Site 4 (northern portion only i.e. area 4.05 only) and Site 5a.

The adopted Site screening level in accordance with NEPM (2013) includes no visible asbestos for surface soil. A conservative criterion of no asbestos detected will be adopted for initial screening purposes.

As a preliminary approach, visual observations for suspected asbestos containing materials (ACM) will be carried out within fill materials and on the surrounding ground surface. Selected soil samples and material fragment samples (if any) will be collected from fill materials and tested for asbestos identification (presence/absence only). Where asbestos is detected, a further assessment may be required to quantify the risks to sensitive receptors.

Where suspected asbestos fragments are observed, a representative sample will be collected. Once the sample is double bagged, the environmental scientist will make observations with respect to the samples condition, as follows:

- Good condition = suspected ACM in sound condition where the asbestos is bound in a matrix (although possibly broken or fragmented) and would be unlikely to pass through a 7mm x 7mm sieve.
- Poor condition = ACM in a degraded condition such that it can be broken or crumbled by hand pressure.

Site 5b and southern portion of Site 4 only

The Site history review has indicated that Site 5b and the southern portion of Site 4 (i.e. area 4.01 to 4.04) has a higher likelihood with regards to potential asbestos contamination than the other sites, therefore, the following criteria (sourced from NEPM (1999) Schedule B1 Table 7: Health Screening levels for asbestos contamination in soil) will be adopted:

Site 5b (commercial/industrial setting)

- No visible ACM for surface soils, and
- <0.05% w/w bonded ACM within soils

Southern portion of Site 4 (public open space/park setting)

Post construction, we understand that the Southern portion of Site 4 is to be re-used as a public open space/parkland, therefore the following criteria apply to this area:

- No visible ACM for surface soils, and
- <0.02% w/w bonded ACM within soils

If friable asbestos (FA) and asbestos fines (AF) (were to be identified at either Site), the following criteria will be adopted:

- <0.001% w/w AF and/or FA within soils.

5.1.6 Aesthetic Criteria

Water NSW have indicated that following the completion of construction phase, Site 1 to Site 5 will be returned to their current/preconstruction land uses.

Site 3, Site 4 and Site 5b are currently publicly accessible therefore soils at these sites will be assessed against the following aesthetic criteria:

- Soils shall not be discoloured or affected by odours or inclusions, such as demolition rubble, litter or domestic waste, to an extent that this would be considered a hazard or nuisance.

Site 1, Site 2 and Site 5a are typically used for equipment storage and laydown areas (and other commercial uses) etc and are not generally considered to be publicly accessible, for these Sites, aesthetic criteria is generally not considered relevant

5.1.7 Waste Classification Criteria

Results will be compared to waste classification criteria in NSW EPA (2014) Waste Classification Guidelines, Part 1: Classifying Waste to gain a preliminary assessment of potential waste classification for future construction work in the event some soils require offsite disposal.

6. Data Quality Objectives

The data quality objectives (DQO) in Table 6-1 were developed for this project and are based on the requirements described in ASC NEPM (1999). Data Quality Indicators (DQIs) are included in Table 6-1 below:

Table 6-1 Data Quality Objectives

Step	Tasks
Step 1 **State the problem**	The primary objectives are outlined in Section 1.2. The findings of the SAQP will be used to inform the decisions identified in Step 2. A preliminary conceptual site model is presented within Section 3 based on current available desktop information. The main considerations are: • What sample layout should be used to achieve the above objectives? • How many samples should be collected? • What analytes should be tested? • What media should be tested? The key assessment team is currently unknown.
Step 2 **Identify the decisions**	The decisions to be made on the basis of the sampling is: • Are soils that will be disturbed within the defined construction areas contaminated with respect to use as construction areas and later for the defined uses post construction? • Is there contamination that would warrant direct assessment of groundwater quality? • Is further assessment or remediation/management required? • If remediation is required, what is the likely extent of remediation?
Step 3 **Identify information inputs**	The inputs required to make the decisions listed in Step 2 are as follows: • Site history information • Site observations made during the intrusive investigations, including observations of fill/natural soil depth, and contamination indicators (suspected asbestos containing material (ACM), unusual odours, staining or buried waste materials) • Field soil headspace screening for volatile organic compounds (VOCs) using a photo-ionisation detector during fieldwork • Soil concentrations of contaminants of potential concern (based on laboratory analytical results) • Applicable NSW EPA endorsed guidelines (refer to Section 4).

Step	Tasks
Step 4 **Define the study boundaries**	Laterally, the study boundary is defined by the Site boundaries (i.e. the coloured polygons referred to as Site 1 to Site 5 as presented in Figure 1, Appendix A). Based on our current understanding of the proposed actives at each site, the maximum depth of proposed excavations is just to allow topsoil clearing (assumed approximately 0.2m below ground level (bgl)), as a conservative approach, the adopted vertical study boundary for this investigation will be 0.5m bgl (or practical refusal, whichever occurs first). The timing of the proposed DSI has not yet been determined.
Step 5 **Develop the analytical approach (decision rule)**	The decision rule for soils will be as follows: • A data validation assessment will be carried out for all data collected with respect to quality assurance and quality control (QA/QC) and conclude if the data collected is useable, partially useable with some limitations, or unusable in forming conclusions to the assessment. • If there is no field evidence of contamination and contaminant concentrations for each sample are below the assessment criteria, then no further assessment will be required with respect to that contaminant or area • The 95% Upper Confidence Limit (UCL) of the arithmetic mean contaminant concentration should be below the assessment criteria and the results must also meet the following: – No single value is to exceed 250% of the human health remediation criteria – The standard deviation must be less than 50% of the human health remediation criteria • Exceedances outside the above will trigger the need for further assessment or remediation.
Step 6 **Specify performance or acceptance criteria**	We have assumed the following to be true in the absence of contrary evidence (i.e. the null hypothesis): • Contamination at the Site currently poses a potential risk to human and/or environmental receptors. The possibility exists of making the following decision errors based on the data obtained during this investigation: • Type 1 error – Deciding the above null hypothesis is false, when it is true • Type 2 error – Deciding the above null hypothesis is true, when it is false. The consequence of making a Type 1 error is more detrimental as it can result in adverse consequences or may include material impact to human and environmental health. The consequence of making a Type 2 error may result in 'over-conservatism' and unnecessary expense of conceptual remediation options. The potential for decision errors will be minimised by completing a robust QA/QC program and by completing an investigation that has an appropriate sampling and analytical density for the purposes of the investigation.

Step	Tasks
Step 7 **Optimise the design for obtaining data**	Sampling will be carried out in accordance with the methodology in Section 7 and will optimise the design for obtaining data using the following measures: • Field investigations would be carried out by trained environmental scientist/engineer, under direction of senior staff experienced contaminated land assessment. • Site observations of visual and olfactory evidence of contamination will be made at sampling locations. • Sampling will be carried out using a combination of judgemental and systematic sampling depending on the identified AEC and CoPC being targeted.

7. Soil Sampling Methodology

7.1 General

The Site investigation will include a combination of judgemental and systematic sampling locations to target specific AECs. In total, 164 sample locations are proposed using a combination of mechanical excavation methods, hand tools and surface samples as per below:

- 73 x mechanically excavated test pits (generally to a maximum depth of 0.3m below ground level (bgl))
- 61 x hand auger locations (generally to a maximum depth of 0.3m bgl)
- 30 x shallow surface samples (e.g. direct by hand or using a hand trowel) (generally to a maximum depth of 0.1m bgl)

Proposed sampling techniques and required soil sampling analysis for each AEC are presented in Table 7-1. AEC locations and proposed sampling locations are presented in Figure 2-1 to Figure 2-5, Appendix A.

Table 7-1 SAQP sampling and testing schedule

Site No.	Site Name	AEC		Area (approx.)	Proposed no. of sampling locations	Proposed sampling Technique*3			Contaminants of Potential Concern and Analysis Schedule*2										Comments
		AEC Descriptor/Source (refer to Figure 2 series, Appendix A)	AEC No.	(m^2)		Test Pit	Hand Auger Borehole	Surface Sample	TPH/BTEX	PAH	Metals	OC/OP Pesticides	PCB	Asbestos ID	Asbestos (NEPM)	Lead, zinc	Pb, Cu, Zn, Cr	TCLP**	
1	Former painters/grit blasting area	1.01 Area of former metal contamination	7	7,300	9	-	-	9	-	-	-	-	-	-	-	-	9	8	Note: Total number of sample locations for the AECs within Site 1 complies with NSW EPA (1995) Sampling Design Guidelines for characterisation, but broken down into the respective sub AECs. This area was previously remediated. Nine targeted samples proposed in areas where grit could accumulate (e.g. low points, overland flow paths) to check effectiveness of previous remediation. If these initial samples show any exceedances, then further sampling would be recommended.
		1.02 Containment Cell	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-		No sampling is proposed in this former containment cell. This area is to be demarcated during construction and not disturbed.
		1.03 Earthen bund	3	900	5	-	5	-	8	8	8	8	8	8	-	-	-		Judgemental sampling to assess the material contents within the bund soil and assess quality at a preliminary level. Bund assumed to be formed from natural soils. WaterNSW indicates that the bund is unlikely to be disturbed as part of construction
		1.04 Present equipment lay down area	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		No sampling proposed in this small area as only recent equipment stored. Likelihood of contamination was assessed to be low for this area
		1.05 Area of fly tipping/stockpiles	3	750	4	-	2	2	6	6	6	6	6	6	-	-	-		Judgmental sampling targeting areas near fly tipped materials/shallow stockpiles
		1.06 Hummocky ground	3	1,825	4	4	-	-	6	6	6	6	6	6	-	-	-		Systematic sampling to assess the type of material in this area and quality
		1.07 and 1.08 Equipment storage/structures	1 & 2	10,375	10		5	5	10	10	10	-	-	10	-	-	-		Judgemental sampling targeting remaining areas outside those already covered by the sampling in Area 1.06
2	Proposed vegetation clearance area	2.01-2.06 Former infrastructure/historical disturbance and clearing	1 & 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		Site observations to be made initially. No sampling currently proposed unless surface evidence of potential contamination observed. Type of infrastructure was mainly associated with tail tower to crane material for original dam construction. Likelihood of contamination was assessed to be low. To be managed through unexpected finds protocol
		2.07 Historical building structures	1	2,700	6	-	3	3	-	-	-	-	-	6	-	6	-		Site observations to be made. Judgemental sample locations proposed to target locations of former structures and based on observations. If no contamination found then to be managed through unexpected finds protocol
		2.08 Historical structures /area of known asbestos contamination	1	10,300	-	-	-	-	-	-	-	-	-	-	-	-	-		This area has previously been assessed and found to contain asbestos. Asbestos is capped and managed under a management plan. Area is to be assumed impacted and if any ground disturbance is proposed, asbestos protocols to be followed as per management plan under current regulations. Sampling is therefore not proposed.
		2.09 Core park road dump area	8	450	4		2	2	6	6	6	6	6	6					Site observations to be made with judgemental sampling targeting suspect areas otherwise systematic sampling.
3	Terraced gardens	3.01-3.02 Existing electrical building and back-up generator	1 & 4	120	-	-	-	-	-	-	-	-	-	-	-	-	-		Areas near these structures are not proposed to be disturbed as part of the works. Buildings constructed in 2000's and are on concrete and surrounded by asphalt. Likelihood of contamination was assessed to be low, therefore no sampling proposed.
		Areas on the grassed upper tiers - 3.03, 3.05, 3.07, 3.09, 3.15, 3.17, 3.18 Former infrastructure and structures and 3.22 heavily disturbed area during construction works	1 & 2	5,600	14	14	-	-	14	14	14	14	14	14					Approximate area of 5,600m^2 likely accessible. Combination of judgemental and systematic sampling targeting areas of former buildings and disturbed construction area. Number of locations to meet minimum number of locations to assess this area based on NSW EPA (1995) Sampling Design Guidelines

Site No.	Site Name	AEC		Area (approx.)	Proposed no. of sampling locations	Proposed sampling Technique*3			Contaminants of Potential Concern and Analysis Schedule*2										Comments
		AEC Descriptor/Source (refer to Figure 2 series, Appendix A)	AEC No.	(m^2)		Test Pit	Hand Auger Borehole	Surface Sample	TPH/BTEX	PAH	Metals	OC/OP Pesticides	PCB	Asbestos ID	Asbestos (NEPM)	Lead, zinc	Pb, Cu, Zn, Cr	TCLP**	
		Areas on the lower tier/road - 3.06, 3.08, 3.10-3.14, 3.16, 3.19 and 3.20 Former infrastructure and 3.22 heavily disturbed area during construction works	1 & 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		Areas on the lower tiers are asphalt covered surface/road or on steep sandstone embankments. Type of infrastructure was mainly associated with tail tower to crane material for original dam construction. Likelihood of contamination was assessed to be low. To be managed through unexpected finds protocol
		3.04 Electrical transformer	5	7	1	-	-	1	1	-	-	-	-	-	-	-	-		Transformer is relatively new installed between 2007-2011. No knowledge of fires or leaks. One judgemental sample to be collected on a low side on exposed soil or targeted to any suspect area.
4	Haviland Park	4.01, 4.02 and 4.03 Former Structures	1	4,000	11	-	11	-	-	-	-	-	-	-	11	11	-		Structures were likely to be of ACM construction. Demolition practices were unknown and buildings may have been affected by bushfires. Sampling as per WA DoH (2009)[4] Guidelines proposed. Likelihood of asbestos is 'suspect' as per WA DoH Table 1 which requires sampling density 1 x the minimum number of sample points of the CSMS in Appendix A of the guidelines.
		4.04 Fill placed in 2009 (South-eastern portion of Haviland park)	3	2,060	2*1	-	2	-	7	7	7	7	7	-	-	-	-		This area is already targeted with sample locations and analysis from 4.01, 4.02 and 4.03. Two additional sample locations proposed to supplement this and meet minimum number of locations to assess this area based on NSW EPA (1995) Sampling Design Guidelines. The analysis shown in this row is also the extra analysis to supplement that from AEC 4.01, 4.02 and 4.03.
		4.04 Fill placed in 2009 (North-western portion of Haviland park)	3	7,300	11	11	-	-	11	11	11	11	11	11	-	-	-		Systematic sampling to assess the type of material in this area and quality. The fill is more recently placed circa 2009. Due to the more recent placement of fill and likely top dressing with imported topsoil a slightly reduced sample frequency is selected for initial assessment purposes.
5a	Materials storage/former housing	5a.01, 5a.02, 5a.4, 5a.05 lay down areas and fill/stockpiling	2 & 3	24,900	35	-	31	4	35	35	35	25	25	35	-	-	-		Combination of judgemental and systematic sampling targeting areas of equipment storage and areas with potential fill/ground disturbance. Number of locations proposed to meet minimum number of locations to assess this area based on NSW EPA (1995) Sampling Design Guidelines
		5a.03 Communications building	1	20	2	-	-	2	-	-	-	-	-	2	-	2	-		Two judgemental locations adjacent the structure to check for surface contamination from weathering/damage.
5b	Heliport/ former housing	5b.01 Historical structures	1	34,000	44	44	-	-	-	-	-	-	-	-	44	44	-		Structures were likely to be of ACM construction. Demolition practices were unknown Sampling as per WA DoH (2009) Guidelines proposed. Likelihood of asbestos is 'suspect' as per WA DoH Table 1 which requires sampling density 1 x the minimum number of sample points of the CSMS in Appendix A of the guidelines.
		5b.02 Heliport	4	500	2*1	-	-	2	2	-	-	-	-	-	-	-	-		Two locations proposed to target the helipad area to check for evidence of hydrocarbon impacts. Likelihood of contamination was assessed as low.
		5b.03 Stockpiling and placement of fill	3	8,000	-	-	-	-	11	11	11	11	11	-	-	-	-		This area will be assessed from test locations from AEC 5b.02 as this forms a sub area.
					Sub totals	73	61	30	117	114	114	94	94	104	55	63	9	8	

Table notes

*1 *Sampling primarily limited to the upper soil layers which are likely to be disturbed, this being the upper 0.5m*

*2 *Heavy metals (arsenic, chromium (total), copper, lead, mercury, nickel, zinc), TRH (Total Recoverable Hydrocarbons), BTEX (benzene, toluene, ethylbenzene, xylene), PCB (polychlorinated biphenyl's), PAH (Polycyclic Aromatic Hydrocarbons), OCP (Organochlorine Pesticides), OPP, (Organophosphorus Pesticides)*

*3 *Where permissible by WaterNSW, test pits will be used instead of a hand auger as this provides better observations of the subsurface*

4 WA DoH (2009) referenced instead of 2021 as NSW EPA have issued a position statement that they do no endorse all elements of the 2021 guidelines, however sampling densities are the same.

***TCLP analysis to be scheduled post receipt of initial total concentrations to assist with preliminary waste classification. Number of analysis is indicative only and will depend on total concentration results.*

7.2 Excavation and Soil Sampling Procedures

The following method will be adopted:

- Dial Before You Dig (DBYD) plans will be reviewed prior to breaking ground, the date on the plans will be no more than three weeks old at the time of the investigation
- For test pit locations only, an accredited services clearance person will be engaged to clear the proposed location prior to breaking ground
- Fieldwork will be attended on a full-time basis by a trained and experienced environmental scientist or engineer. All fieldwork will be carried out in accordance with this Sampling, Analysis and Quality Plan (SAQP), a task specific Safe Working Method Statement (SWMS) and site-specific environmental control measures adopted for the Site
- For test pits, the excavator will strip a section of turf and placed this to the side of proposed test pit (in grassed areas). For hand augers and surface samples a similar process should be adopted.
- Excavated spoil will be placed adjacent to the pit (opposite side of pit to turf) in order of excavation (e.g. top material furthest away from pit)
- Sample locations will be logged using the Unified Soil Classification system. A visual assessment will be made of encountered soil material for the potential presence of contamination indicators such as staining, odours, buried wastes or suspected ACM contamination, relevant information will be recorded clearly in field notes
- A new pair of nitrile gloves will be worn for each sample
- Soil samples will be collected at regular intervals down the fill profile or if there is a suspect layer/material or visual/olfactory evidence of contamination to a maximum depth of 0.5m below ground level. Surface samples will require excavation to a maximum depth of approximately 0.1m bgl. A minimum of 2 samples will be collected from sample locations, except surface samples where a minimum of 1 sample will be collected.
- Samples from test pits will be collected from spoil which has not come into direct contact with the excavator bucket
- As far as practicable, excavated spoil will be backfilled in reverse order (e.g. deepest material backfilled first) with test pits 'tamped' with the excavator bucket to reduce the likelihood of future settlement. Some settlement can occur and should be noted
- Surface samples will be collected with a new pair of nitrile gloves directly from the ground surface. A decontaminated stainless-steel trowel will be used to facilitate sampling if required.
- Each soil sample will be collected within clean laboratory-supplied 250 ml containers and placed immediately into a chest filled with ice. The ice should be double bagged within the chest to avoid meltwater coming into direct contact with sample containers. A new pair of nitrile gloves will be worn during the collection of each sample and during logging.
- Samples for asbestos analysis ID will be collected in zip lock bags (refer to Section 7.2.1 for asbestos sampling requirements at Site 5b and the southern portion of Site 4)
- Soil samples from areas where volatile contamination is noted as a potential CoC will be collected in duplicate into a separate zip lock bag and field-screened using a PID. The PID will be calibrated in accordance with manufacturer instructions and include regular calibration checks as required. Calibration certificates/records will be provided in the DSI report.
- Each soil sample for contamination testing will be collected within clean laboratory-supplied 250 ml containers (glass jars with teflon lined lids). Samples (50g) will also be collected in plastic zip lock bags for asbestos ID analysis. Details on preservation and holding times are shown in Appendix B.

7.2.1 Asbestos Gravimetric method (Site 5b and southern portion of Site 4 only)

Gravimetric sampling is proposed at Site 5b and the southern portion of Site 4 (i.e. areas 4.01 to 4.04) only due to the history of numerous previously demolished houses/structures, likely to have been of ACM construction. Soil samples will be collected as per Section 4.10 of ASC NEPM 1999 Schedule B2 of WA DoH (2009) guidelines hereafter referred to as the 'gravimetric method'.

The following procedure will be adopted:

- The excavator will strip a section of turf and place this to the side of the test pit (in grassed areas)
- A 10-litre soil sample will be collected from the soils immediately beneath the turf layer (a second sample should be collected from any additional fill layers that are observed down to a maximum depth of 0.5m bgl (but no greater than base of fill) where asbestos (if any) could potentially be located
- The 10-litre sample will then be weighed in the field (recorded as field 'wet weight') using a commercially available household scales, the field weight will be recorded clearly on field notes
- The sample will then be sieved through a 7mm sieve. The material retained within the sieve will then be spread out onto a piece of plastic, any visible ACM fragments (>7mm) (retained in the sieve) shall be collected, placed in a zip locked bag and photographed, the condition of each fragment will be recorded. Careful visual observations of the sieved soil material on the plastic will be made. Where the soil type is not amenable to sieving (e.g. clayey soil), this material will be spread out onto a contrasting piece of plastic to check for and pick out any ACM fragments >7mmx7mm
- Any suspected ACM fragments will then be collected into a zip lock bag and submitted to the laboratory for weighing and asbestos presence/absence testing (in some instances it may be acceptable to analyse only representative fragments rather than every fragment).
- The weight of asbestos within the ACM will be estimated and reported by the laboratory in general accordance with Australian Standard AS4964
- At each soil sampling location, a 500ml sub sample of soil will be collected from the test pit spoil which was considered to be representative of the sieved material (not from the sieved material)
- Where suspected ACM is retained in the sieve an additional 500ml sample will be collected from representative test pit spoil and submitted to the laboratory for moisture content analysis. This will be used to estimate the dry weight of soil within the 10L sample.

The concentration of asbestos in soil for bonded ACM will be calculated using the principals of the formula in the WA DoH (2009) Guidelines as per the following equation:

$$Asbestos\ in\ soil\ (\%\ w/w) = \frac{Asbestos\ content\ (\%) \times Bonded\ ACM\ weight(g)}{Soil\ Volume\ (L)\ x\ Soil\ Dry\ Density\ (g/L)}$$

The asbestos content of ACM will be assumed to be 15%, unless the material is of a different nature, in which case asbestos content estimation will be requested from the laboratory or selected samples.

7.2.2 Laboratories, sample containers and sample preservation requirements

All samples will be submitted to laboratories that are accredited by the National Association of Testing Authorities Australia (NATA) for the tests to be performed under chain of custody conditions.

A summary of sampling containers, sample volumes, preservation requirements and holding times for each parameter proposed to be tested are presented in Table 7-2:

Table 7-2 Summary of sample container, preservation and holding time requirements for all samples

Parameter	Container	Sample volume	Preservation	Holding Time
metals, TRH, BTEX, PAH, OCP, OPP, PCB	Glass jar with Teflon lined lid	250ml (zero headspace)	Cool to <6°C	Extract within 7 days (based on the lowest of all listed analytes - BTEX)
Asbestos ID	Zip lock bag	Approx. 50g	Nil	Indefinite
Asbestos (NEPM – 500ml)	Zip lock back	500ml	Nil	Indefinite

8. Quality Assurance and Quality Control Plan

The following quality assurance and quality control plan will be adopted for the environmental sampling in general accordance with ASC NEPM 1999 requirements.

8.1.1 Sample Handling, Storage and Transportation

Sampling of soils will be carried out by trained and experienced environmental staff using sampling protocols which minimise potential cross contamination occurring in between sampling locations.

Care will be taken to ensure that representative samples are obtained from each required depth and that the integrity of the sample is maintained, particularly when dealing with potentially semi-volatile components. The media will be transferred directly from the sampling equipment to the laboratory prepared sample jars. New nitrile gloves will be used for the collection of each sample.

During fieldworks, samples will be placed in an ice-filled chest to keep the samples below the recommended preservation temperature of approximately 6 °C. Samples will be kept chilled until delivered to the testing laboratory.

Samples, including quality assurance (QA) samples, will be transported to the laboratories with relevant Chain of Custody (CoC) documentation. The CoC form will be completed with the sample names, sampling date and required analyses. The samples will be sent in a sealed ice chest to the laboratory for analysis within the prescribed analyte holding times.

At a minimum, the CoC will detail the following information:

- Site identification
- The sampler's name
- Nature of the sample
- Collection time and date
- Analyses to be performed
- Sample preservation method
- Dispatch courier(s).

8.1.2 Equipment Decontamination

Reusable sampling equipment with the potential to cross contaminate samples (e.g. hand augers or stainless steel trowel, if required), will be decontaminated using a triple wash procedure; that is, washed in diluted Decon90 detergent solution, rinsed in potable water and then rinsed in distilled water. At a minimum, equipment decontamination will occur prior to use, in between each sample, at the end of each day and prior to equipment return to suppliers (if applicable).

If reusable sampling equipment is used one rinsate blank per piece of re-useable field equipment will be collected per day and analysed for potential contaminants of concern.

8.1.3 Equipment Calibration

The Photoionisation detector (PID) will have been serviced within 6 months of fieldwork. At a minimum, the PID will be bump tested on a daily basis. During the bump test, the 100ppm isobutylene calibration gas will be applied to the PID, if the resulting value is <95ppm or >105ppm (+/- 5%) then a re-calibration will be carried out. All bump tests and re-calibrations must be recorded within field notes.

8.1.4 Trip Blank and Trip Spike Samples

A minimum of one laboratory-prepared soil trip blank and BTEX trip spike will be taken into the field per sample batch (minimum of five trip blank/trip spike sets for the project). The trip blank and spike will be transported and analysed together with the soil samples collected from the Sites. The trip blank and spike samples will be analysed for volatile contaminants (i.e. BTEX, TRH C_6-C_9 fraction). Field Duplicate Samples

Duplicate samples will be collected and tested for each analyte to assess precision in field sampling techniques and laboratory methods. Duplicate samples (comprising both inter and intra-laboratory) will be analysed at a frequency as follows:

- Minimum of 1 in every 20 samples as recommended in NEPM (i.e. Analysis of intra-laboratory (5%) and inter-laboratory duplicates (5%)).

8.1.5 Laboratory QA/QC

Laboratory QA/QC, including matrix spikes, laboratory method blanks and laboratory duplicates, will be performed in accordance with the laboratory NATA accreditation and the requirements of the ASC NEPM, 2013.

8.1.6 Data Quality Indicators

The results will be assessed to be with respect to predetermined data quality indicators as referenced in the ASC NEPM, 2013 and as presented in Appendix B.

9. Reporting

Following completion of the investigations, a Detailed Site Investigation (DSI) report will be prepared for the Site with reference to relevant sections of NSW EPA (2020) Contaminated Land Guidelines: Consultants reporting on contaminated land

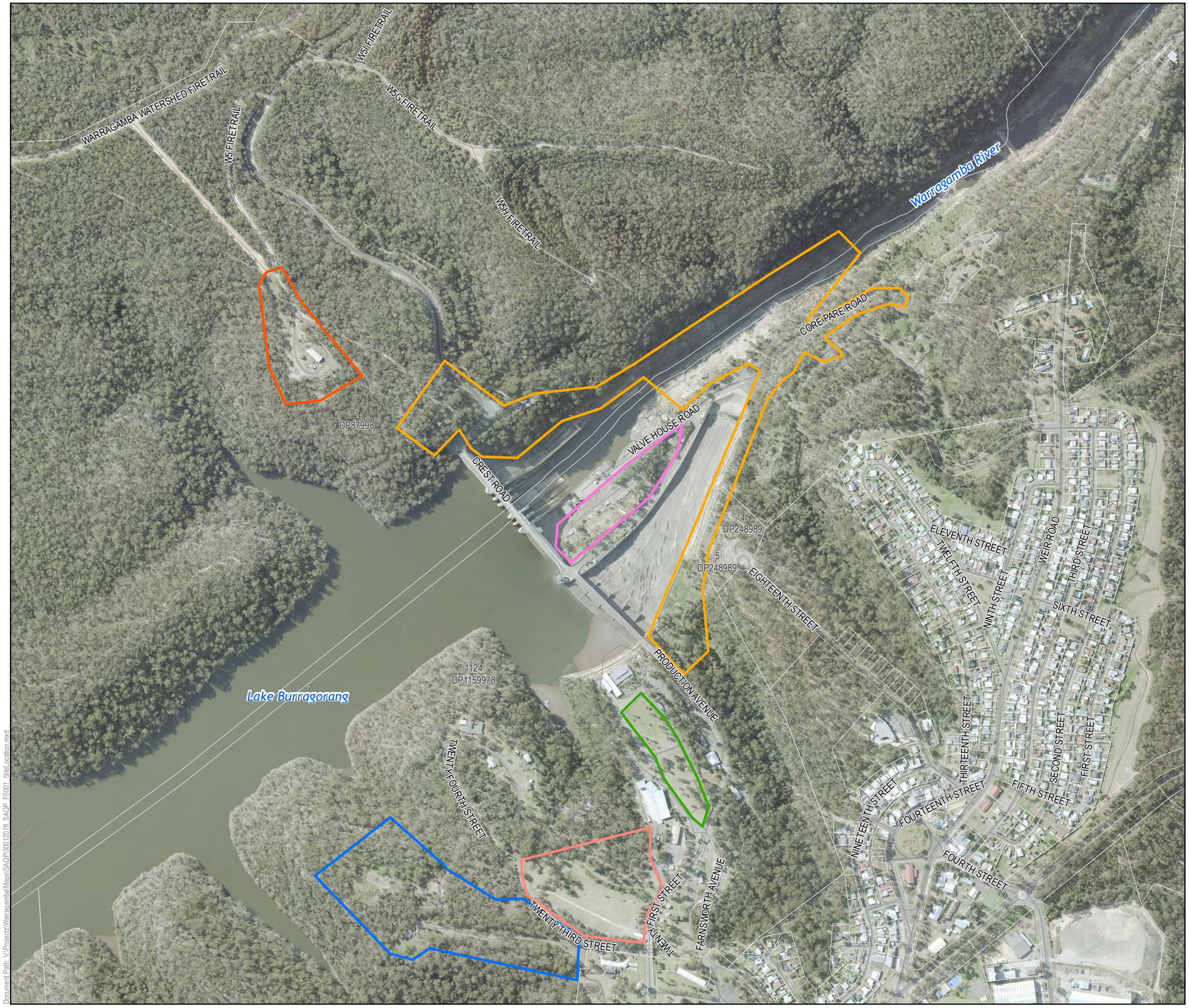
The report will include the following discussion/components at a minimum:

- Summary of site details, background, history and environmental setting
- Summary of field investigation activities, rationale, parameters, methods, properties, results, etc.
- Demonstration of compliance with this SAQP
- Site observations and field results
- Laboratory results and comparison against the adopted assessment criteria specified within this SAQP
- Quality assurance and quality control data evaluation
- Discussion of results and levels of contamination risk to human health and/or the environment
- Updated conceptual site model (CSM)
- Soil profile field logs, drawings and figures showing investigation/monitoring locations, surface observations, and locations of contamination exceeding key assessment criteria
- Conclusion arising from the investigations (as per the objectives) and recommendations on actions for management and remediation or further investigations (if required).

10. References

- Australian Standard AS4482.1-2005 Guide the investigation and sampling of site with potentially contaminated soil Part 1: Non-volatile and semi-volatile compounds
- EMM Technical Memorandum (2022) Re: Expert Groundwater Technical Report, Warragamba Dam Raising EIS – Response to Submissions
- Friebel and Nadebaum (2011) Health screening levels for petroleum hydrocarbons in soil and groundwater, part 1: Technical development document, Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE Pty Ltd) Technical Report Series No. 10
- Government of Western Australia: Department of Health (2009), Guidelines of the Assessment, Remediation and Management of Asbestos Contaminated Sites in Western Australia
- National Environment Protection Council, National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPM) as amended in 2013
- National Environment Protection Council (2013) Assessment of Site Contamination NEPM Toolbox
- NSW EPA (1995), Sampling Design Guidelines
- NSW EPA (2014) Waste Classification Guidelines, Part 1: Classifying Waste
- NSW EPA (2020) Contaminated Land Guidelines: Consultants Reporting on Contaminated Land
- SMEC (2021) Environmental Impact Statement (EIS) Warragamba Dam Wall Raising
- SMEC (2022) Preliminary Site Investigation Warragamba Dam Wall Raising Construction Laydown Areas

Appendix A – Site Figures



SMEC
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GDA 1994 MGA Zone 56

0 100 200 m

1 cm = 75 m (when printed @ A3)

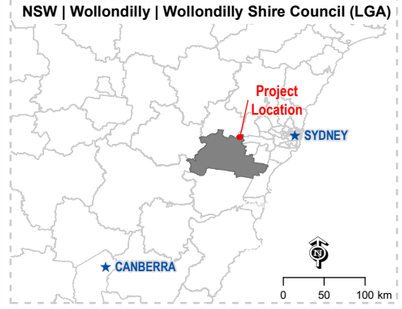
SENSITIVE: NSW GOVERNMENT

LEGEND

Construction Footprint

- Site 1 – Former painters/grit blasting area
- Site 2 - Proposed vegetation clearance area
- Site 3 - Terraced Gardens
- Site 4 - Haviland Park
- Site 5a - Materials storage
- Site 5b - Heliport/former housing
- Cadastre

PROJECT LOCATION
NSW | Wollondilly | Wollondilly Shire Council (LGA)



Data Sources:
1. Contours @ ELVIS - Elevation and Depth - Foundation Spatial Data, 2020
2. Localities, Roads, LGA, Base Data @ Road Net, 2020
3. MetroMap Imagery © Aerometrex Pty Ltd
4. NSW Transport Theme © Spatial Services 2021

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Warragamba Dam Wall Raising
Proposed Construction Disturbance Areas
Sampling, Analysis and Quality Plan

Site Location and Layout

PROJECT #:	30013187
CREATED BY:	FA
LAST MODIFIED:	FA13847, 10/06/2022
VERSION:	Draft

FIGURE 1

Document Path: \\A\Projects\Warragamba\Maps\SAQP\30012078_SAQP_F0001_SiteLocation.mxd

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GDA 1994 MGA Zone 56

0 75 150 225 m

1 cm = 75 m (when printed @ A3)

SENSITIVE: NSW GOVERNMENT

LEGEND

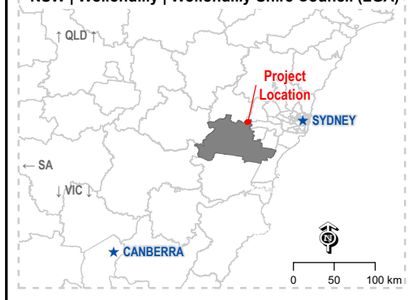
AEC Sites

- Site 1 – Former painters/grit blasting area
- Site 2 - Proposed vegetation clearance area
- Site 3 - Terraced Gardens
- Site 4 - Haviland Park
- Site 5a - Materials storage
- Site 5b - Heliport/former housing

Areas of Environmental Concern

- AEC-1: Former/existing building structures (from weathering and/or ineffective demolition of hazardous building materials)
- AEC-2: Historical and/or existing equipment storage areas and historical construction areas
- AEC-3: Areas of stockpiling/filling (unknown origin and/or quality)
- AEC-4: Fuel storage/re-fuelling (from possible leaks and/or spills)
- AEC-5: Electrical sub-station (from possible leaks of insulation oils)
- AEC-6: Known contaminated cell
- AEC-7: Area of potential metal contamination from grit blasting activities
- AEC-8: Core park road dump area (reported to contain 20 x 44 gallon drums)

PROJECT LOCATION
NSW | Wollondilly | Wollondilly Shire Council (LGA)



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Warragamba Dam Wall Raising
Proposed Construction Disturbance Areas
Sampling, Analysis and Quality Plan

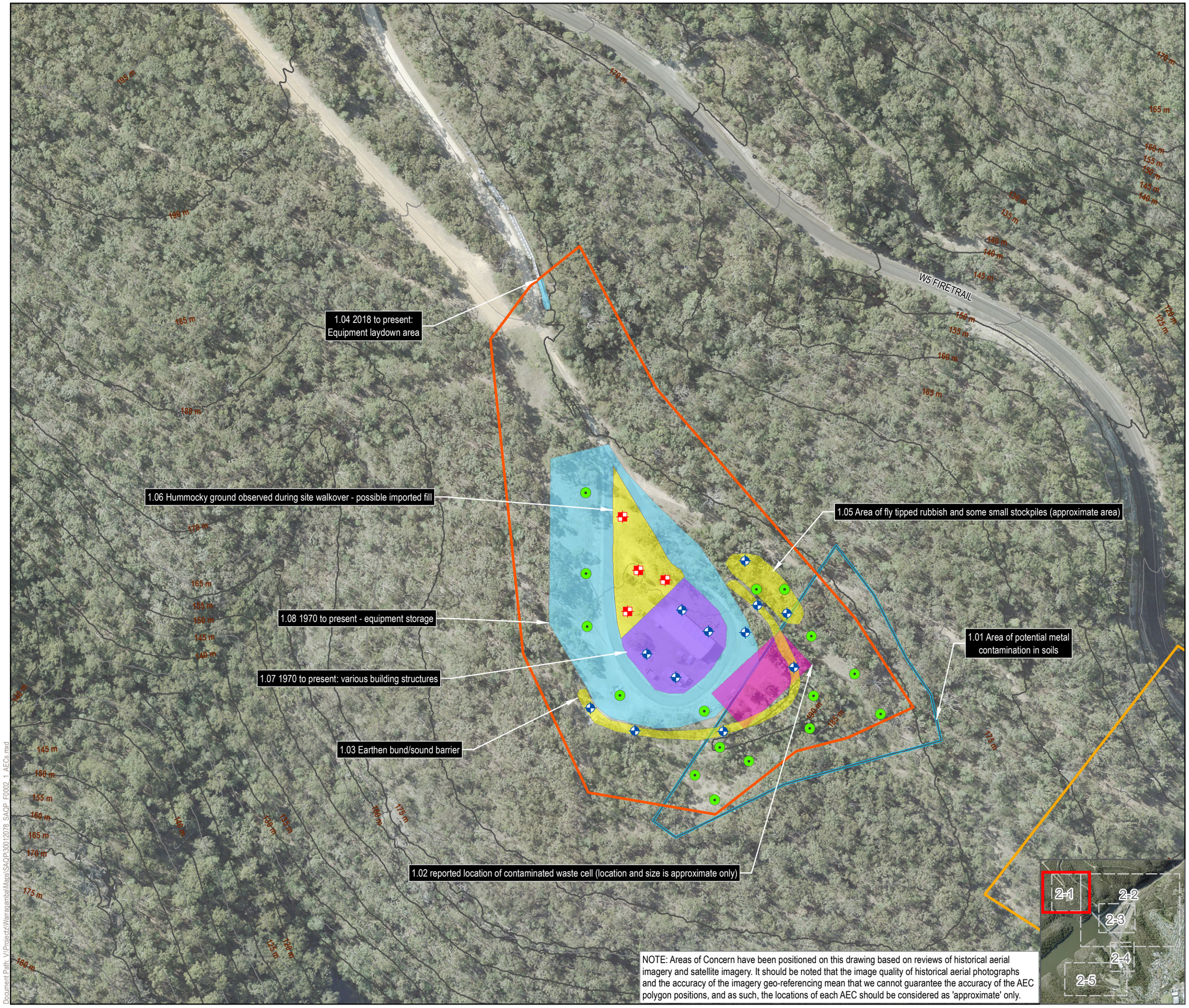
Proposed Sampling Locations

PROJECT #:	30013187
CREATED BY:	FA
LAST MODIFIED:	FA13847, 10/06/2022
VERSION:	Draft

FIGURE 2-0

NOTE: Areas of Concern have been positioned on this drawing based on reviews of historical aerial imagery and satellite imagery. It should be noted that the image quality of historical aerial photographs and the accuracy of the imagery geo-referencing mean that we cannot guarantee the accuracy of the AEC polygon positions, and as such, the locations of each AEC should be considered as 'approximate' only.

Document Path: V:\Projects\Warragamba\Maps\SAQP\30012078_SAQP_F0002_AECs.mxd



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SMEC
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GDA 1994 MGA Zone 56

0 25 50 m

1 cm = 20 m (when printed @ A3)

SENSITIVE: NSW GOVERNMENT

LEGEND

AEC Sites

- Site 1 – Former painters/grit blasting area
- Site 2 - Proposed vegetation clearance area

Areas of Environmental Concern

- AEC-1: Former/existing building structures (from weathering and/or ineffective demolition of hazardous building materials)
- AEC-2: Historical and/or existing equipment storage areas and historical construction areas
- AEC-3: Areas of stockpiling/filling (unknown origin and/or quality)
- AEC-6: Known contaminated cell
- AEC-7: Area of potential metal contamination from grit blasting activities

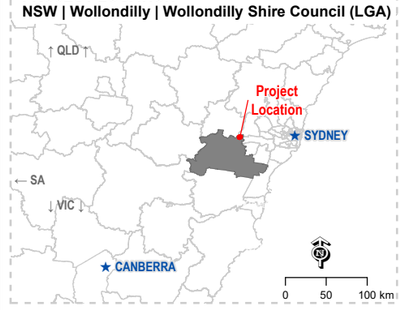
Proposed Sampling Locations

- Hand Auger
- Surface Sample
- Test Pit

Contours

- 10 m Contour Line
- 5 m Contour Line

PROJECT LOCATION
NSW | Wollondilly | Wollondilly Shire Council (LGA)



Data Sources:
1. Contours @ ELVIS - Elevation and Depth - Foundation Spatial Data, 2020
2. Localities, Roads, LGA, Base Data @ Road Net, 2020
3. MetroMap Imagery © Aerometrex Pty Ltd
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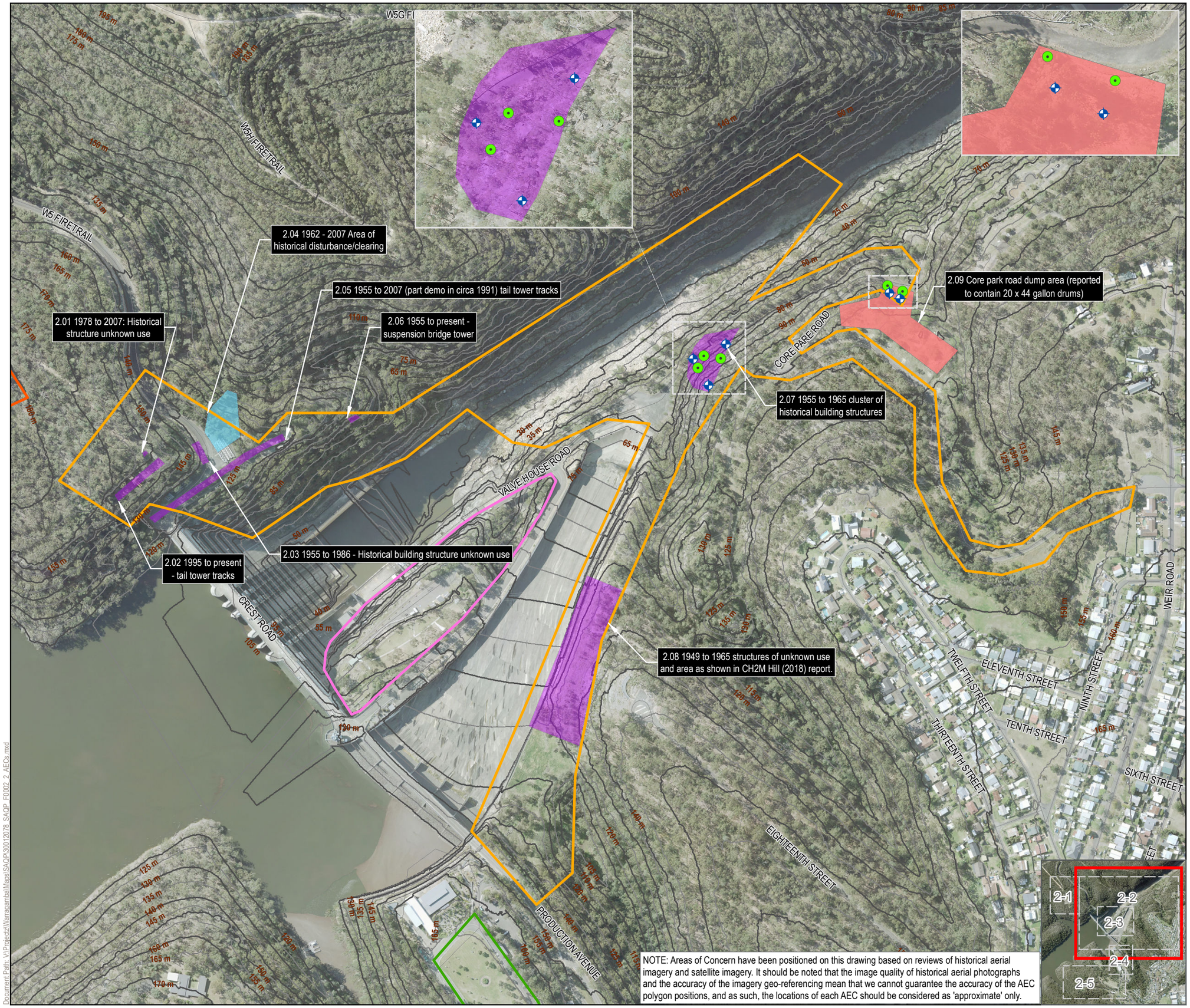
Warragamba Dam Wall Raising
Proposed Construction Disturbance Areas
Sampling, Analysis and Quality Plan

Proposed Sampling Locations

PROJECT #:	30013187
CREATED BY:	FA
LAST MODIFIED:	FA13847, 10/06/2022
VERSION:	Draft

FIGURE 2-1

Document Path: V:\Projects\WarragambaMains\SAQP\30012078_SAQP_F0002_1_AECs.mxd



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GDA 1994 MGA Zone 56

0 50 100 150 m

1 cm = 45 m (when printed @ A3)

SENSITIVE: NSW GOVERNMENT

LEGEND

AEC Sites

- Site 1 – Former painters/grit blasting area
- Site 2 - Proposed vegetation clearance area
- Site 3 - Terraced Gardens
- Site 4 - Haviland Park

Areas of Environmental Concern

- AEC-1: Former/existing building structures (from weathering and/or ineffective demolition of hazardous building materials)
- AEC-2: Historical and/or existing equipment storage areas and historical construction areas
- AEC-8: Core park road dump area (reported to contain 20 x 44 gallon drums)

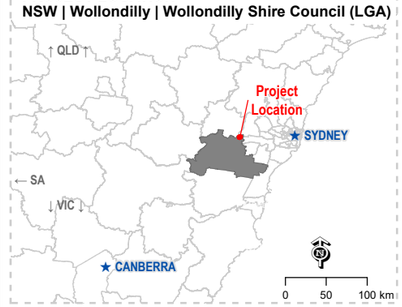
Proposed Sampling Locations

- Hand Auger
- Surface Sample

Contours

- 10 m Contour Line
- 5 m Contour Line

PROJECT LOCATION
NSW | Wollondilly | Wollondilly Shire Council (LGA)



Data Sources:
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3. MetroMap Imagery © Aerometrex Pty Ltd
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Warragamba Dam Wall Raising
Proposed Construction Disturbance Areas
Sampling, Analysis and Quality Plan

Proposed Sampling Locations

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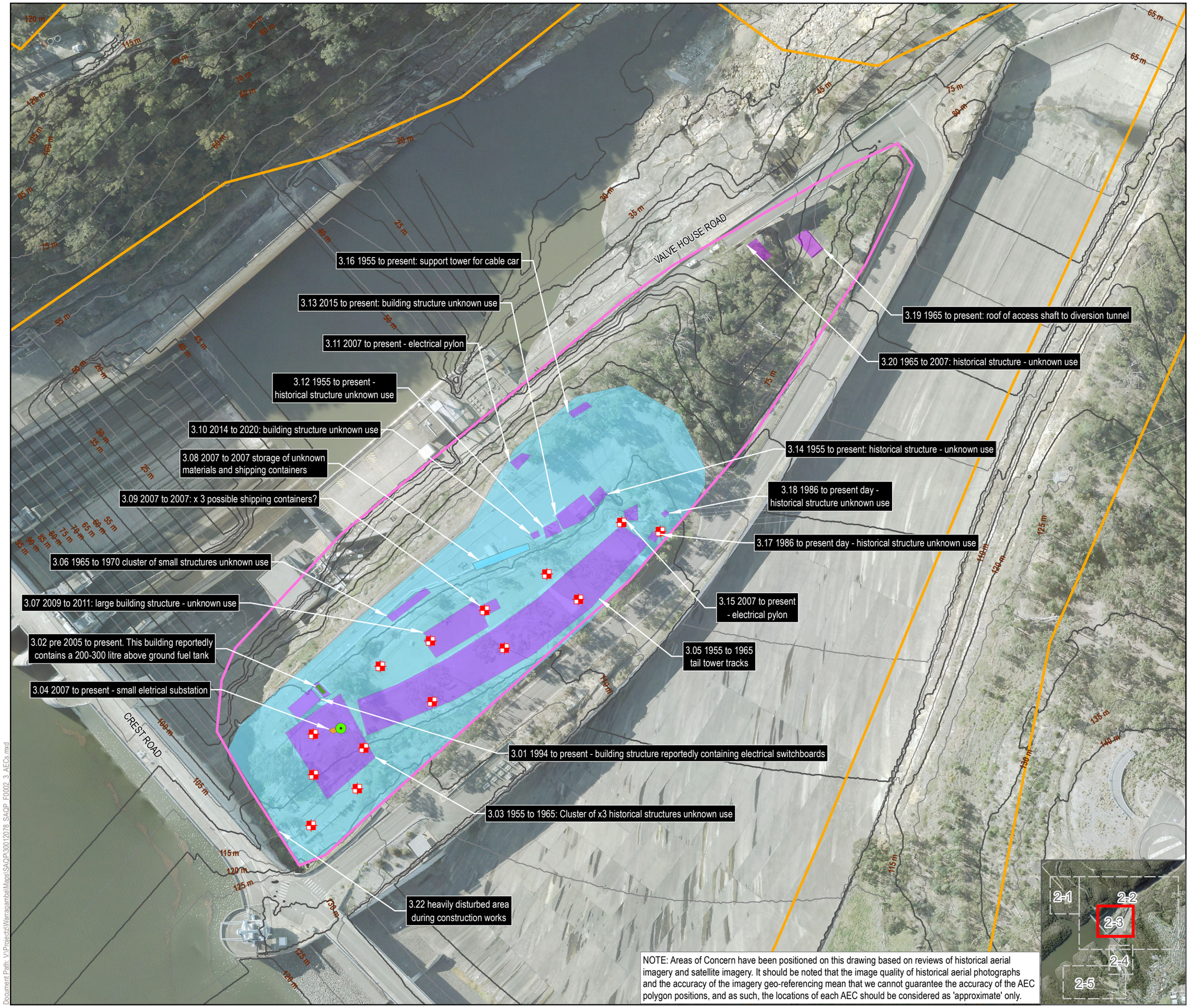
CREATED BY:	FA
LAST MODIFIED:	FA13847, 10/06/2022
VERSION:	Draft

FIGURE 2-2



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GDA 1994 MGA Zone 56

0 25 50 m

1 cm = 15 m (when printed @ A3)

SENSITIVE: NSW GOVERNMENT

LEGEND

AEC Sites

- Site 2 - Proposed vegetation clearance area
- Site 3 - Terraced Gardens

Areas of Environmental Concern

- AEC-1: Former/existing building structures (from weathering and/or ineffective demolition of hazardous building materials)
- AEC-2: Historical and/or existing equipment storage areas and historical construction areas
- AEC-4: Fuel storage/re-fuelling (from possible leaks and/or spills)
- AEC-5: Electrical transformer (from possible leaks of insulation oils)

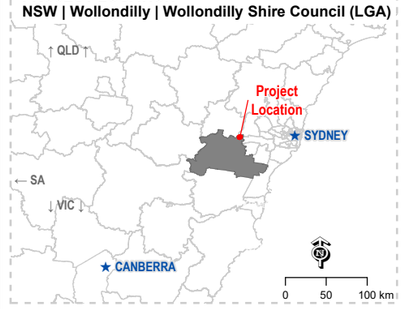
Proposed Sampling Locations

- Surface Sample
- Test Pit

Contours

- 10 m Contour Line
- 5 m Contour Line

PROJECT LOCATION
NSW | Wollondilly | Wollondilly Shire Council (LGA)



Data Sources:
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Warragamba Dam Wall Raising
Proposed Construction Disturbance Areas
Sampling, Analysis and Quality Plan

Proposed Sampling Locations

PROJECT #:	30013187
CREATED BY:	FA
LAST MODIFIED:	FA13847, 10/06/2022
VERSION:	Draft

FIGURE 2-3

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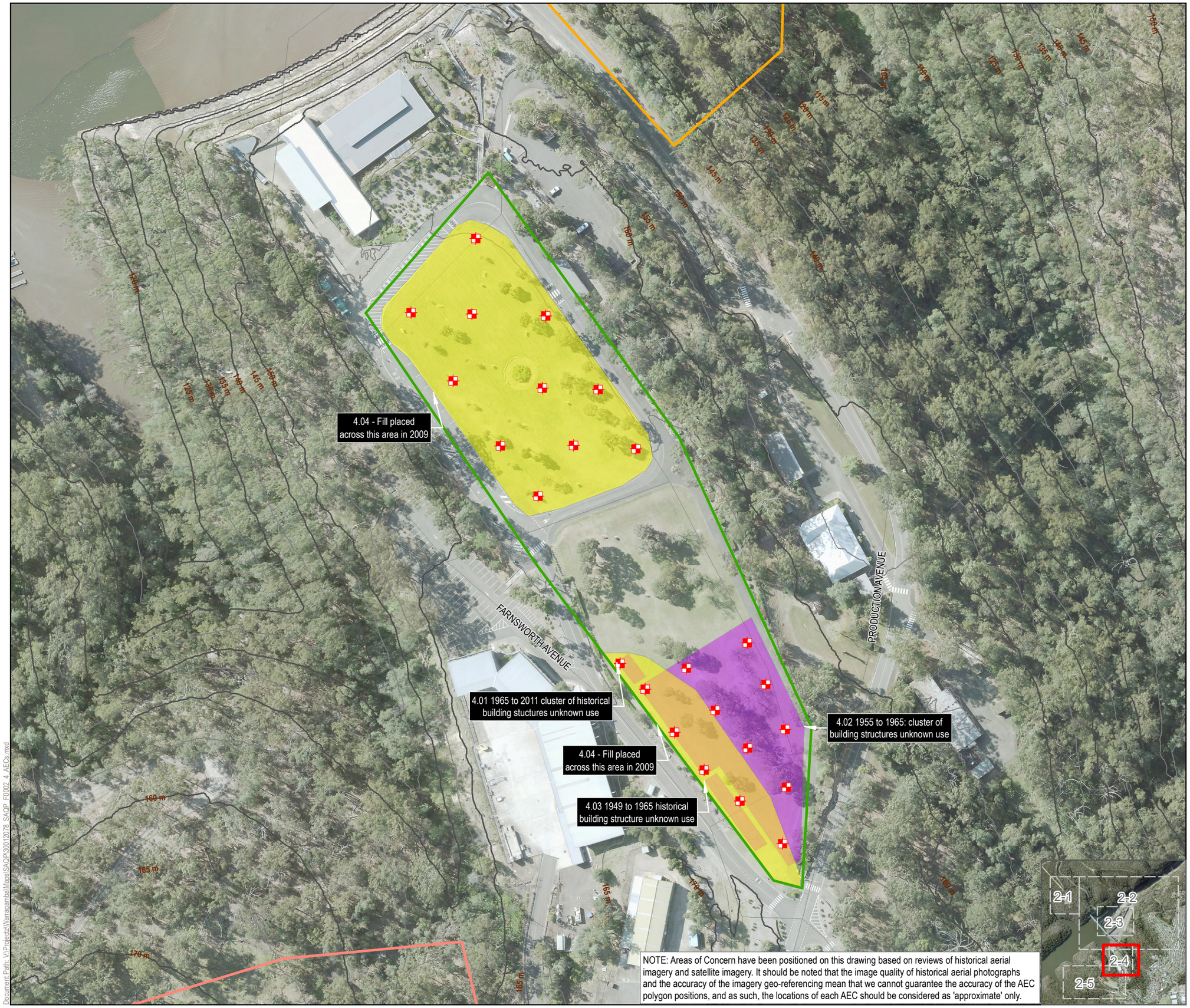

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GDA 1994 MGA Zone 56

0 25 50 m

1 cm = 15 m (when printed @ A3)

SENSITIVE: NSW GOVERNMENT

LEGEND

AEC Sites

- Site 2 - Proposed vegetation clearance area
- Site 4 - Haviland Park
- Site 5b - Heliport/former housing

Areas of Environmental Concern

- AEC-1: Former/existing building structures (from weathering and/or ineffective demolition of hazardous building materials)
- AEC-3: Areas of stockpiling/filling (unknown origin and/or quality)

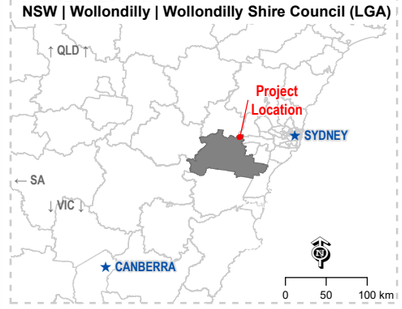
Proposed Sampling Locations

- Test Pit

Contours

- 10 m Contour Line
- 5 m Contour Line

PROJECT LOCATION
NSW | Wollondilly | Wollondilly Shire Council (LGA)



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Sampling, Analysis and Quality Plan

Proposed Sampling Locations

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VERSION:	Draft

FIGURE 2-4

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5a.05 <2005 to present day: Laydown area for dam equipment (rusted steel equipment, concrete pipes etc)

5a.04 Approximate area of filling/stockpiling (1960's to crica 2005)

5a.03 1982 - present (communications building - comprising suspected ACM)

5b.03 2007 to 2009 stockpiling and placement of imported fill materials

5b.02 2018 to present: Heliport - re-fuelling leaks and spills

5a.02 1970 to 1986 - Disturbed area - possible filling actvities

5a.01 <2005 to present day: Laydown area for dam equipment (steel equipment, concrete pipes etc)

5b.01 1949 to various: Historical building structures (former residential area)

TWENTY FOURTH STREET

TWENTY THIRD STREET

TWENTY FIRST STREET

FARNSWORTH AVENUE

PRODUCTION

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2-1 2-2 2-3 2-4 2-5

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GDA 1994 MGA Zone 56

0 25 50 75 m

1 cm = 30 m (when printed @ A3)

SENSITIVE: NSW GOVERNMENT

LEGEND

AEC Sites

- Site 4 - Haviland Park
- Site 5a - Materials storage
- Site 5b - Heliport/former housing

Areas of Environmental Concern

- AEC-1: Former/existing building structures (from weathering and/or ineffective demolition of hazardous building materials)
- AEC-2: Historical and/or existing equipment storage areas and historical construction areas
- AEC-3: Areas of stockpiling/filling (unknown origin and/or quality)
- AEC-4: Fuel storage/re-fuelling (from possible leaks and/or spills)

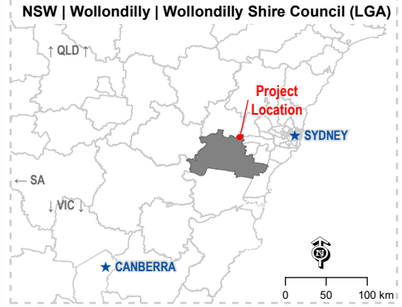
Proposed Sampling Locations

- Hand Auger
- Surface Sample
- Test Pit

Contours

- 10 m Contour Line
- 5 m Contour Line

PROJECT LOCATION
NSW | Wollondilly | Wollondilly Shire Council (LGA)



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Sampling, Analysis and Quality Plan

Proposed Sampling Locations

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FIGURE 2-5

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Appendix B – Data Quality Indicators

Data Quality Indicators (DQI) for the project will be based on the field and laboratory considerations in NEPM Schedule B2 Appendix B, (NEPC 1999), which include:

- Completeness – a measure of the amount of useable data (expressed as %) from a data collection activity
- Comparability – the confidence (expressed qualitatively) that data may be considered to be equivalent for each sampling and analytical event
- Representativeness – the confidence (expressed qualitatively) that data are representative of each media present on the site
- Precision – A quantitative measure of the variability (or reproducibility) of data
- Accuracy – a quantitative measure of the closeness of reported data to the true value.

The DQIs adopted for this assessment and checking of compliance is discussed in the tables below.

Table B1 Data Quality Indicators Compliance Table

Completeness					
Field considerations	**DQI**	**DQI Compliance**	**Laboratory considerations**	**DQI**	**DQI Compliance**
All critical locations will be sampled	Samples will be collected as per Section 7		All critical samples analysed.	Samples will be analysed as per Section 7.	
All samples collected	Samples will be collected from relevant media as per Section 7.		All analytes analysed according to sampling plan.	Samples will be analysed as per Section 7.	
Standard Operating Procedures (SOPs) appropriate and complied with	Standard operating procedures (SOP)/Field instructions will be implemented.		Appropriate methods and limits of reporting .	Samples will be analysed by laboratories NATA accredited for the analyses to be performed and appropriate methods will be used. LORs will be less than or equal to the assessment criteria.	
Experienced sampler	A suitably experienced and trained environmental engineer/scientist will conduct the sampling.		Sample documentation complete	CoCs will be returned, signed and dated by laboratory. NATA endorsed laboratory certificates will be completed in accordance with NEPC (1999). Field documentation will be completed in accordance with the nominated consultants SOP/field instructions.	
Documentation correct	Samples will be handled and transported under appropriate chain of custody documentation. Sample Receipt Advice (SRA) (or equivalent) from the laboratory will be reviewed to assess that samples are received cool and in good condition. Calibration certificates for the field instruments will be provided on a daily basis.		Sample holding times complied with.	Samples will be analysed within holding times specified by NEPC (1999, amended 2013)	

Table B2 Data Quality indicators – comparability compliance

Comparability					
Field considerations	**DQI**	**DQI Compliance**	**Laboratory considerations**	**DQI**	**DQI Compliance**
Same SOPs/Field instructions used on each occasion	Appropriate SOPs/field instructions will be implemented.		Same sample analytical methods used.	The same NATA accredited laboratory will be used to undertake analyses of all primary samples collected for this study. The laboratory will use the same analytical methods for each sample for each analytical parameter.	
Experienced sampler	A suitably experienced and trained environmental engineer/scientist will conduct the sampling.		Same sample LOR.		
Climatic conditions (temperature, rainfall, wind, barometric pressure…)	Where practical soil sampling will be carried out whilst not raining to reduce risk of cross contamination, noting that various methods can be implements to reduce this risk. Climatic conditions are not expected to cause issues for comparability of data. Works should cease where strong wind/gusts are present during test pitting works.		Same laboratories (justify/quantify if different).		

Same types of samples collected	Samples will be collected in the appropriate laboratory supplied container specific to the analyses performed.		Same units (justify/quantify if different).		

Table B3 Data Quality indicators – representativeness compliance

Representativeness					
Field considerations	**DQI**	**DQI Compliance**	**Laboratory considerations**	**DQI**	**DQI Compliance**
Appropriate media sampled according to sample plan	Samples will be collected and analysed as listed in Section 7. Any variations will be justified.		All samples analysed according to sample plan.	Samples will be collected and analysed as listed in Section 7. NATA accredited environmental testing laboratories will implement a quality control plan conforming to Schedule B(3) 'Guideline on Laboratory Analysis of Potentially Contaminated Soils' of the National Environment Protection (Assessment of Site Contamination Measure 1999 as amended (NEPC, 1999).	
All media identified in sample plan sampled	Samples will be collected and analysed as listed in Section 7.				

Table B4 Data quality indicators - precision compliance

Precision					
Field considerations	**DQI**	**DQI Compliance**	**Laboratory considerations**	**DQI**	**DQI Compliance**
SOPs appropriate and complied with	Appropriate SOPs/Field instructions will be implemented		Analysis of: laboratory duplicates.	The number of duplicate analyses should be the smaller of one per process batch or one per 10 samples.	
Analysis of: field duplicates	Collection of field duplicate samples including: • Field intra-laboratory duplicate samples (1 in 20 samples for other contaminants) • Field inter-laboratory duplicate samples (1 in 20 samples for other contaminants).		Analysis of: field duplicates.	Field duplicates have relative percentage difference (RPD) control limits: • Less than 50%, where result is greater than 10 times limit of reporting (LOR). • No limit where result is less than 10 times LOR.	
	Experienced and trained staff to carry out sampling. Sampling methodologies appropriate and complied with.		Analysis of: laboratory duplicates	Laboratory duplicates have RPD control limits: • Results <10 times the LOR: No Limit • Results between 10-20 times the LOR: RPD must lie between 0-50% • Results >20 times the LOR: RPD must lie between 0-30% • In accordance with laboratory specific QC Acceptance criteria.	
			Analysis of: laboratory-prepared trip spikes.	At least one soil BTEX trip spike per laboratory batch submission will be analysed for volatile contaminants (BTEX). Recovery to be 70-130%.	
			Analysis of: laboratory-prepared trip blanks.	At least one soil trip blank laboratory submission will be analysed for volatile contaminants (BTEX).Blanks should be <LOR.	

Table B5 Data quality indicators - accuracy compliance

Accuracy (bias)					
Field considerations	**DQI**	**DQI Compliance**	**Laboratory considerations**	**DQI**	**DQI Compliance**
SOP appropriate and complied with	Appropriate SOPs/field instructions will be implemented		Analysis of field blanks	At least one soil field blank per laboratory submission will be analysed for volatile contaminants (BTEX and TPH C6-C9).Blanks should be <LOR.	
Rinsate blank	Where reusable sampling equipment is utilised (if any) a rinsate blank will be analysed and results compared against the practical quantitation limit (PQL).		Analysis of method blank	Method blanks will be analysed as per NEPC (1999) at least 1 per process batch (typically 1 in 20). Results to be less than LOR	
Trip spike	One BTEX trip spike will be taken in the field and analysed. DQI - recoveries to be within 70% - 130% for organics		Analysis of matrix spike	Matrix spikes will be analysed as per NEPC (1999) (one matrix spike per soil type per process batch). Results to be within dynamic laboratory acceptance limits based on NEPC (1999). Acceptance limits are on the laboratory certificates (typically 70-130%, depends on analyte. A lower range typically accepted for phenols 30%-130%)	
Preservation, transport and storage	Samples appropriately preserved in laboratory supplied containers, stored and transported correctly and within holding times		Analysis of surrogate spike	Surrogates will be analysed as per NEPC Schedule B3 (1999). All samples spiked where appropriate (e.g. chromatographic analysis of organics). Acceptance limits as per laboratory dynamic recovery limits typically 70% to 130% (inorganics), or 50% to 150% (organics).	
			Analysis of laboratory control samples (LCS)	LCSs will be analysed as per NEPC Schedule B3 (1999) (at least 1 per batch). Results to be within laboratory acceptance limits based on NEPC (1999). Acceptance limits as per laboratory dynamic recovery limits on the laboratory certificates (typically 70-130%, depends on analyte)	
			Analysis of laboratory-prepared spikes (LPS)	LPS will be analysed as per NEPC Schedule B3 (1999). Recovery results to be within laboratory dynamic acceptance limits based on NEPC Schedule B3 (1999). Acceptance limits are on the laboratory certificates.	

SMEC

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