Appendix F

Preliminary Remediation Action Plan

Moorebank Intermodal Company

Moorebank Intermodal Terminal Preliminary Remediation Action Plan

30 May 2014

PARSONS BRINCKERHOFF
A BALFOUR BEATTY COMPANY

Document information
Client: Moorebank Intermodal Company Title: Moorebank Intermodal Terminal Preliminary Remediation Action Plan Document No: 2189293C-CLM-REP-2 RevC Date: 30 May 2014

Rev	Date	Details
C	30/05/2014	Draft

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Distribution
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Abbreviations

ABC	Ambient background concentration
ACL	Added contaminant limit
ACM	Asbestos containing materials
AFFF	Aqueous film forming foam
AHD	Australian height datum
ANZECC	Australian and New Zealand Environment and Conservation Council
AOPC	Area(s) of potential concern
ASS	Acid sulfate soils
ASSMAC	Acid Sulfate Soils Management Advisory Committee
AST	Above ground storage tank
BTEX	Benzene, toluene, ethyl Benzene, xylenes
C_6–C_9	Light hydrocarbon chain groups (for example, petrol)
C_{10}–C_{14}	Medium hydrocarbon chain groups (for example, kerosene)
C_{15}–C_{28}	Heavy hydrocarbon chain groups (for example, diesel)
C_{29}–C_{36}	Heavy hydrocarbon chain groups (for example, lube oil)
CE	Combat engineering
CEMP	Construction environment management plan
CLM	Contaminated land management
CHC	Chlorinated hydrocarbons
COPC	Contaminants of potential concern
C-RAT	Contaminant risk assessment tool
CSIRO	Commonwealth, Scientific and Industrial Research Organisation
DCE	Dichloroethene
DECCW	Department of Environment, Climate Change and Water NSW (now the NSW EPA)
DNSDC	Defence National Support and Distribution Centre
Defence	Department of Defence
DQO	Data quality objective
EIL	Environmental investigation level
EOW	Explosive ordnance waste
EPA	Environment Protection Authority
ESA	Environmental site assessment
ESL	Environmental screening level
FTA	Fire training area

GIL	Groundwater investigation limit
G-Tek	G-Tek Pty Ltd
GPR	Ground penetrating radar
GPS	Geographical positioning system
Ha	Hectare
HA	Hand auger
HESP	Health, environment and safety plan
HIL	Health investigation level
HSL	Health screening level
IMT	Intermodal terminal
ISQG	Interim sediment quality guideline
L	Litres
LC	Leachable concentration
LOQ/ LOR	Limit of quantitation/limit of reporting of chemical concentrations attainable from laboratory analysis. (also see PQL)
m BGL	Metres below ground level
mg/kg	Milligram per kilogram (or part per million)
mg/L	Milligram per litre (or part per million)
m btoc	Meters below top of casing
MW	Monitoring well
NA	Not applicable
NAPL	Non aqueous phase liquid
NATA	National Association of Testing Authorities
ND (nd)	Not detected above the LOQ or PQL
NEPC	National Environmental Protection Council
NEPM	National Environmental Protection Measure
NK	Not known
OCPs	Organochlorine pesticides
OPPs	Organophosphorus pesticides
OS	Oxidisable sulfur
PAHs	Polycyclic aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
PID	Photo ionisation detector
PFOA	Perfluorooctanoate
PFOS	Perfluorooctanesulfonic acid
PQL	Practical quantitation limit (of chemical concentration)
QA	Quality assurance

QC	Quality control
RA	Risk assessment
RAE	Royal Australian Engineers
RAP	Remedial action plan
SAQP	Sampling, analysis and quality plan
SB	Soil bore
SCC	Specific contaminant concentration
SME	School of Military Engineering
SPOCAS	Suspension peroxide oxidation combined acidity and sulfate test
S_{POS}	Peroxide oxidisable sulfur
SRS	Seismic refraction survey
STP	Sewage treatment plant
SVOC	Semi volatile organic compounds
SW	Surface water
SWL	Standing water level
TCE	Trichloroethene
TCLP	Toxicity characteristics leaching procedure
TDS	Total dissolved solids
TPA	Titratable peroxide acidity
TRH	Total recoverable hydrocarbon
TP	Test pit
TSA	Total sulfidic acidity
UCL	Upper confidence limit of data set
µg/L	Micrograms per litre
USEPA	United States Environmental Protection Agency
UST	Underground storage tank
UXO	Unexploded ordnance
VOC	Volatile organic compounds

Executive summary

Parsons Brinckerhoff Australia Pty Ltd (Parsons Brinckerhoff) was commissioned by Moorebank Intermodal Company (MIC) to prepare a preliminary remediation action plan (RAP) for the Moorebank Intermodal Terminal (IMT) Project (the Project) in NSW.

The proposed site for development is located on land in the suburb of Moorebank, within the Liverpool local government area, approximately 30 km south-west of the Sydney CBD and approximately 4 km south of the Liverpool CBD. The Project site (the Moorebank IMT site) is approximately 220 ha in area and is shown in Appendix A, Figure 1.

The purpose of this RAP is to document the actions required to address the contamination issues identified at the Moorebank IMT site during the Parsons Brinckerhoff Phase 2 environmental site assessment (ESA), in order to remove the potential risks associated with contamination sources and to render the Moorebank IMT site suitable for the proposed development.

The Phase 2 ESA found that the surficial geology on-site generally comprised localised fill (comprising building demolition materials such as concrete, bricks, metals and plastic) with variable alluvial deposits. Asbestos cement fragments were also detected in surface soils at a limited number of locations. Based on analytical soil results, shallow soil impacts were detected on-site, generally consisting of localised detections of total recoverable hydrocarbons (TRH), polycyclic aromatic hydrocarbons (PAHs), benzene, toluene, ethylbenzene and xylene (BTEX), pesticide products DDD, DDE and chlordane, bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS). Soils that have acid generating potential (ASS) were also identified based on limited sampling.

Based on the results of a survey undertaken by G-Tek, artefacts of military origin and exploded ordnance waste (EOW) were also present at the Moorebank IMT site. Unexploded ordnance (UXO) and EOW items were generally found within active and former training areas. The observed items were all confirmed to be inert training ordnance with the appearance of UXO/EOW. Based on specialist advice provided by G-Tek, the Project site was considered to have a very low potential to contain remnant UXO/EOW containing high explosive or other energetic material, other than propellants/primers in unfired/misfired small arms ammunition blank cartridge cases.

During drilling works undertaken by Parsons Brinckerhoff in 2011, saturated horizons were encountered between 7 and 15 m BGL within the natural alluvium aquifer. Groundwater levels were subsequently measured at depths of between 5.2 and 12.4 m BGL (1.7 and 9.11 m Australian Height Datum (AHD)). Based on the gauging data, groundwater flow is inferred to be west to the north-west towards the Georges River.

Groundwater sampled from beneath the site was found to contain elevated concentrations of dissolved metals, chlorinated hydrocarbons (trichloroethene (TCE) and cis-1, 2-dicloroethene (DCE)), TRH, formaldehyde, chloroform and perfluorinated chemicals. Dissolved concentrations of cadmium, copper, lead, nickel and zinc, PFOA and PFOS and TCE were reported at concentrations exceeding the adopted site assessment criteria. Perfluorinated chemicals (PFOA and PFOS) were identified both in soil and groundwater. These chemicals are emerging environmental pollutants with limited toxicity information available.

The two key aims of remedial actions are to limit the potential for any ongoing risk or liability associated with the contamination issues identified across the Moorebank IMT site and to better inform management decisions for remediation prior to or during early works and following site development.

These management measures generally include:

- site-wide clearance of UXO/EOW (as per an appropriate UXO management plan and subject to ground disturbance and access), to be prepared and completed by a specialist contractor experienced in UXO detection and management
- targeted remediation including removal of all existing chemical storage tanks and infrastructure and areas known to be impacted by asbestos (such as fill mounds)) and validation in accordance with the RAP
- further targeted site investigations that are designed to augment the existing data relating to contamination impacts and potential environmental issues previously identified (such as additional groundwater monitoring, sediment sampling, surface water sampling and an investigation of potential acid sulfate soils (PASS)) so that the requirements for soil, groundwater, surface water, sediment management/remediation strategies (if required) can be established prior to site development
- appropriate management of excavated soils during bulk earthworks.

Techniques for the appropriate management of excavated soils will be largely dependent on the development construction design (such as cut and fill requirements in relation to current site topography, drainage design and the types of materials encountered, which is why volumes of material to be remediated has not been prescribed within this RAP. The approach to soil management is a combination of avoidance (where possible, avoiding or minimising the disturbance of potentially impacted areas and managing any exposure risks by capping with impervious pavement) and management of material on-site. A number of techniques will facilitate successful management and/or remediation of soils such as on-site treatment for reuse in the subsoil profile (strategic reburial), capping and ongoing management via an environmental management plan (EMP) (as appropriate) and excavation and reuse of materials in less sensitive areas (i.e. using impacted material as stabilised fill beneath roads or slabs). Where material is not suitable to be managed by any of the above approaches, material will be disposed off-site.

Remediation goals

A combination of remedial options is considered appropriate to address potential contamination at the Project site. The remedial goals are:

- to remove and manage identified UXO/EOW as per a UXO management plan (to be developed and implemented in conjunction with the RAP
- to remove and validate underground storage tanks (USTs) as per the *Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008* (UPSS Regulation)
- to remove known asbestos mounds that have been identified during previous investigations, to mitigate the potential for mixing of these materials into graded soils and to mitigate the occupational risks associated with handling asbestos impacted materials
- contamination ‘hotspot’ removal, comprising excavation of soil/fill materials that were identified to be impacted by contamination at concentrations above the level of acceptable risk as identified in Phase 2 ESA (Parsons Brinkerhoff, 2011), to render these areas suitable for commercial industrial land use
- to appropriately manage/remediate contaminated materials that are found unexpectedly during Project works that were not identified during previous site investigations in accordance with the contingency measures outlined within the RAP
- to consider and apply sustainability principles with a view to minimising off-site disposal of materials and maximising reuse of material on-site
- to validate/assess materials on-site in order to evaluate suitability for beneficial reuse without off-site disposal

- to undertake additional investigations to augment the existing data relating to PASS, surface water quality, residual sediments and groundwater to inform if any additional control, management or remediation measures to be implemented during future development.

Remedial strategy and approach

The preferred remedial strategy is a two-staged approach which will initially remediate the known sources of contamination (including USTs, asbestos mounds and 'hotspots') and subsequently use a combination of techniques to remediate/manage contaminated materials should they be uncovered during development of the Moorebank IMT. The overall strategy aims to address the identified risks while providing opportunities for containment and beneficial reuse of material as appropriate. It is considered that, depending on the extent of impacted materials identified during site development works, retention on-site through containment and capping (or possible bioremediation and reuse for hydrocarbon impacted materials) would be a more sustainable option than off-site disposal.

The recommended remedial approach includes the following actions:

- removal of all UXO/EOW and items of military origin and ongoing management of the risks under a UXO management plan which should be developed and used in conjunction with this RAP
- a tank inventory survey to confirm the exact locations of USTs, and decommissioning and removal of all UPSS infrastructure (as identified during the tank inventory survey) as per the UPSS Regulation to limit the potential ongoing risk/liability associated with underground chemical storage
- excavation and off-site disposal of fill materials known to be impacted by contamination based on previous investigation data (such as stockpiles with asbestos containing materials (ACM) and surficial soils impacted by contamination 'hotspots' (elevated TRH and lead) with the aim of immediately removing impacted known material within these areas
- additional investigations to augment the existing data relating to:
    - PASS (particularly in low-lying areas identified to have a high probability of ASS and where dewatering is likely to be required to facilitate Moorebank IMT construction)
    - surface water quality (to gather data to inform management of dewatering/discharges anticipated to be required to achieve the built design)
    - residual sediments (to gather data to inform management of sediments likely to be disturbed/dewatered during construction)
    - groundwater beneath the north-western area of the proposed Moorebank IMT site to inform if any additional control, management or remediation measures for groundwater in this area.
- continued site risk management and assessment of remediation options to maximise reuse of resources and minimise importation of materials including containment and/or capping and the segregation of excavated materials (such as wood, metals, rubble not containing ACM, material free from contamination) and stockpiling on-site to allow for further processing and/or validation, for on-site reuse.

1. Introduction

Parsons Brinckerhoff Australia Pty Ltd (Parsons Brinckerhoff) was commissioned by Moorebank Intermodal Company (MIC) to prepare a preliminary remediation action plan (RAP) for the Moorebank Intermodal Terminal (IMT) Project (the Project) in NSW. The RAP has been developed in general accordance with the requirements of the NSW Environment Protection Authority (EPA) *Guidelines for Consultants Reporting on Contaminated Sites* (NSW EPA, 2000).

The proposed site for development is located on land in the suburb of Moorebank, within the Liverpool local government area, approximately 30 km south-west of the Sydney CBD and approximately 4 km south of the Liverpool CBD. The Project site is approximately 220 ha in area and is shown in Appendix A, Figure 1. The legal definition of the land to be developed for the Project is summarised in section 2.1.

1.1 Key features of the Project

The primary function of the Moorebank IMT is to be a transfer point in the logistics chain for shipping containers and to handle both international import/export cargo and domestic interstate and intrastate (regional) cargo. The aims are to increase Sydney's rail freight mode share including: promoting the movement of container freight by rail between Port Botany and western and south-western Sydney; and to reduce road freight on Sydney's congested road network.

The Moorebank IMT project also includes a rail link connecting the Moorebank IMT site to the Southern Sydney Freight Line (SSFL) and road entry and exit points from Moorebank Avenue. Three separate rail access options are being considered, including northern, central and southern rail access options. The concept design layouts for each of the options being considered is presented in Appendix A, Figures 2a, 2b and 2c.

1.2 RAP development

The rationale for the staged remediation approach comprising removal of known contamination sources and later management of materials during project site development is to avoid unnecessary excavation, remediation and treatment of areas that could otherwise be adequately managed via a management plan if undisturbed or under a construction and environment management plan (CEMP) if disturbed during future bulk earthworks to avoid double handling of soils.

Frank Mohen of AECOM was appointed as the accredited Site Auditor to oversee the contaminated land assessment element of the Project environmental site assessments (ESAs) and RAP. The NSW site auditor scheme is administered by the EPA under Part 4 of the *Contaminated Land Management Act 1997* (CLM Act). The scheme provides a pool of accredited site auditors who can be engaged to review investigation, remediation and validation work conducted by contaminated land consultants. The aim of the scheme is to ensure the protection of the environment and human health through proper management of contaminated land particularly during changes in land use. The scheme provides increased certainty in the 'sign-off' of contaminated land assessments and remediation. This RAP is subject to review, endorsement and sign-off by the appointed Site Auditor. The additional monitoring works outlined within the RAP should also be undertaken under the supervision (and subsequent sign-off) of a NSW Site Auditor.

1.3 RAP scope

The scope of this RAP includes the entirety of the proposed Project site located to the east of the Georges River and excludes land on the western bank of the Georges River associated with the northern, central and southern rail access options. Further environmental assessment of land on the western bank of the Georges River will be required (dependant on the selected option for rail access) prior to developing a management or remediation strategy (as required). The scope of the RAP also excludes management of areas designated for revegetation/conservation within the main Moorebank IMT site. A management or remediation strategy would be determined for these areas once the proposed level and extent of ground disturbance for vegetation establishment has been determined. It is anticipated that this would be undertaken during detailed design and subsequent project approval phases.

1.4 Purpose of the RAP

The purpose of this RAP is to document the actions required to address the contamination issues previously identified at the proposed Moorebank IMT site (as specified in Section 1.3) in order to remove potential risks associated with contamination sources and to render the site suitable for the proposed development. The RAP has predominantly been based on the results of the Phase 2 ESA (Parsons Brinckerhoff, 2011) with consideration for previous environmental reports pertaining to land associated with the Moorebank IMT site (as detailed in Section 2.7) and the proposed concept design.

1.5 Objective of the RAP

The overall remediation objective is to remove any unexploded ordnance (UXO) or explosive ordnance waste (EOW) and potential ongoing sources of contamination that have been identified and to remediate and/or manage contaminated soils in order to render the site suitable for the Project whilst eliminating/mitigating potential ongoing risks or liabilities associated with contamination.

Management of soils during bulk earthworks constitutes a major part of the RAP. Techniques for the appropriate management of excavated soils will be largely dependent on the types of materials encountered and factors such as topography, drainage, development construction design and the extent of works. The key approaches to soil management are likely to be a combination of avoidance (where possible, avoiding or minimising the disturbance of potentially impacted areas and managing any exposure risks by capping with impervious pavements) and management of material on-site.

Considering the current site setting, a combination of remedial options is considered to be appropriate to address potential contamination. Parsons Brinckerhoff considers that the overall goals for the remediation are:

- to remove and manage identified UXO/EOW as per a UXO management plan (to be developed and implemented in conjunction with the RAP
- to remove and validate underground storage tanks (USTs) as per the *Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008* (UPSS Regulation)
- to remove known asbestos mounds that have been identified during previous investigations, to mitigate the potential for mixing of these materials into graded soils and to mitigate the occupational risks associated with handling asbestos impacted materials
- contamination ‘hotspot’ removal, comprising excavation of soil/fill materials that were identified to be impacted by contamination at concentrations above the level of acceptable risk as identified in Phase 2 ESA (Parsons Brinkerhoff, 2011), to render these areas suitable for commercial industrial land use

- to appropriately manage/remediate contaminated materials that are found unexpectedly during Project works that were not identified during previous site investigations in accordance with the contingency measures outlined within the RAP
- to consider and apply sustainability principles with a view to minimising off-site disposal of materials and maximising reuse of material on-site
- to validate/assess materials on-site in order to evaluate suitability for beneficial reuse without off-site disposal
- validate materials to be reused on-site, and assess where these materials may be put to beneficial use without off-site disposal
- to undertake additional investigations to augment the existing data relating to potential acid sulfate soils (PASS), surface water quality, residual sediments and groundwater to inform if any additional control, management or remediation measures to be implemented during future development.

1.6 Overview of the RAP

The RAP details:

- the current site conditions
- a summary of the available information on the current contamination status of the site and the associated potential risks to human health and the environment
- a summary of identified data gaps
- remedial goals and validation criteria
- a review of the possible remedial technologies and their applicability
- a feasibility assessment and overview of the remedial strategies which would achieve suitable remedial objectives
- the remediation/validation program and reporting requirements
- the requirements for the validation report that will detail the remediation works undertaken and assess the contamination status and environmental condition of the site following remediation
- the environmental safeguards required to ensure that remedial works are undertaken in such a way as to minimise potential impacts to the environment
- a framework for the health and safety aspects of the remedial site works
- the necessary approvals and licences required by regulatory authorities
- a basis for contractor work specifications for the remediation works (the RAP does not contain prescriptive instructions on how works shall be performed which will be determined by the contractor prior to commencement of remediation works on-site).

2. Site information

This section provides a description of the physical site setting, an overview of current and historical uses of the site in respect of contamination potential, a summary of previous environmental investigations and the overall site context to the RAP.

2.1 Site location and description

The proposed Moorebank IMT site is located approximately 30 km south-west of Sydney between Liverpool and Campbelltown along the Georges River, immediately west of Moorebank Avenue and south of the M5 South Western Motorway. The main access road is from Moorebank Avenue which runs north to south on the eastern boundary of the Moorebank IMT site. A summary of the land that would be impacted by the footprint of the proposed Moorebank IMT is presented in Table 2.1.

Table 2.1 Site legal identification

Lot	Deposited Plan	Approximate area of entirety of Lot/DP (m^2)	Maximum area affected by construction footprint (m^2)	Site area description
100	1049508	54,030	24,090	Main Moorebank IMT site
3001	1125930	3,094,870	1,557,910	
10	881265	144,950	106,365	Land associated with the northern alignment on the western bank of the Georges River Casula
4	1130937	32,100	13,855	Land associated with the central alignment on the western bank of the Georges River Casula
5	833516	190,400	13,045	Land associated with the southern alignment on the western bank of the Georges River Casula
51	515696	20,260	2,770	
103	1143827	73,570	4,820	
104	1143827	105,070	18,480	

Source: NSW Government Land and Property Management Authority

The Moorebank IMT site also includes land along Moorebank Avenue and Bapaume Road associated with the proposed road realignment works required to facilitate the Moorebank IMT development.

2.2 Current site uses

The majority of the Project site is located on land currently used for Department of Defence (Defence) purposes, including the School of Military Engineering (SME) and other minor Moorebank units. The northern portion of the site is known as Moorebank Barracks and the southern portion as Steele Barracks.

Steele Barracks houses the Royal Australian Engineers (RAE) SME and is the regional headquarters of the NSW Brigade of the Australian Army Cadets and is also home the RAE Museum and RAE Golf Club. Within Steel Barracks land is predominantly used for accommodation, administration offices, engineering workshops, sports ovals and military training areas including a parade ground, bomb detection and disposal compounds, a small arms range, firefighting training areas, a large bulk earth movement training area (known as the ‘dustbowl’), a bridging yard and a dog training compound.

Moorebank Barracks predominantly comprises areas of open space interspersed with heavy vegetation. Land use within Moorebank Barracks generally comprises administration and accommodation buildings, a warehouse structure (utilised for the storage and maintenance of vehicles) and a concrete lined surface water drainage culvert, which runs east to west across the area and flows towards the Georges River.

2.3 Site history

From the historical land use records reviewed as part of the Phase 1 ESA (Parsons Brinckerhoff, 2011), it is understood the majority of the Moorebank IMT site has been owned by the Commonwealth of Australia from 1913 to present day and has been utilised by Defence since the 1940s, with various construction, demolition and excavation events occurring across the site over time. In the surrounding locality, residential and industrial development has gradually increased since the 1970s with expansion and development of transport infrastructure including the M5 Motorway, the East Hills railway line, the Liverpool to Holsworthy railway and the SSFL. The Defence National Support and Distribution Centre (DNSDC) facility located to the east of the site has been present since the early 1950s.

2.4 On-site storage of chemicals

Based on information within an above ground storage tank (AST) and UST management plan (HLA 2005), several chemical storage tanks exist at the Project site. Details are summarised in Table 2.2.

Table 2.2 Summary of known chemical storage tanks

Tank ID	Type (material stored)	Location description	Age (years)	Details
Non-operational				
0367/B_UST_001	UST, abandoned (unknown)	North of building 30	>30	Single walled steel, no cathode protection
3767S_UST_008	UST, decommissioned (unknown)	South of building 70	Not known	
Operational				
3767S_AST_002	AST (waste oil)	West of building 16	Not known	
3767S_UST_003	UST (waste oil)	East of building 16	>20	Single walled steel, no cathode protection
3767S_UST_004	UST (waste oil)	East of building 16	>20	
3767S_UST_005	UST (waste oil)	North of building 141	>20	
3767S_UST_006	UST (unknown)	West of building 23	>20	
SWSS0285	UST (unknown)	West of building 20	Not known	
44467	UST (diesel)	South of building 14	>25	Single walled steel, no cathode protection or bowser protection

Source: *HLA Envirosciences AST and UST Management Plan, Volume 10, Sydney West Defence Region (2005).*

Limited information is available on the condition, volumes and usage of the operational USTs and no information pertaining to decommissioning, removal or validation of the non-operational USTs was forthcoming. Based on the HLA report, USTs are all single bunded tanks which are over 25 years in age with no cathodic protection. Should leaks from these tanks have occurred in the past, there may be localised soil and groundwater impacts. Results suggest that impacts may have occurred, based on the fact that total recoverable hydrocarbons (TRH) were identified in groundwater sampled from wells installed in the vicinity of the UST during the Phase 2 ESA.

2.5 Surrounding land uses

Based on a review of available aerial photos, areas surrounding the Project site are characterised by industrial and residential uses. Surrounding uses in the immediate vicinity are presented in Table 2.3. The Moorebank IMT site location showing surrounding features is presented in Appendix A, Figure 3.

Table 2.3 Surrounding land uses

Direction	Description
North	Factory and warehouse facilities (ABB Transmissions Pty Ltd (ABB)) with the M5 South Western Motorway and industrial, commercial and residential land uses beyond.
North-east	Moorebank Business Park on the corner of Moorebank Avenue and Anzac Road comprising commercial warehousing premises.
East	Moorebank Avenue, the DNSDC facility and Wattle Grove residential area beyond.
South	The East Hills passenger railway line with Cambridge Avenue beyond and Defence land including an explosives confidence range, practice mine fields and munitions training areas.
South-west	Former quarry and current Glenfield Waste Services landfill and waste transfer station across the Georges River, with residential development beyond.
West	Georges River, Casula Powerhouse Arts Centre (formerly a diesel fuelled power station), Casula Railway Station, Powerhouse Road and the South/Cumberland passenger rail line, SSFL and residential properties beyond.

Source: Based on a review of Google maps (2014)

2.6 Physical setting

A summary of the physical site setting is provided in Table 2.4.

Table 2.4 Summary of physical site setting

Aspect	Description
Regional soils	The surface geology comprises Quaternary and Tertiary alluvium consisting of silt, sand and gravels from quaternary fluvial deposition. The soil landscape consists of Quaternary and Tertiary terraces of the Nepean River and the Georges River. The soils comprise poorly structured orange to red clay loams, clays and sands with the potential for ironstone nodules to be present.
Regional geology	Underlying geology comprises dark grey to black Ashfield Shale of the Wianamatta Group which are typically black to dark grey shales and laminates from the Triassic period, underlain by Triassic Hawkesbury Sandstone in the north-western area of the Moorebank IMT site, comprising mainly medium to very coarse grained quartz sandstone. The Ashfield Shale strata dip towards the north-west.
Site specific geology	Previous site investigations showed that surficial geology generally comprised localised fill with variable alluvial deposits consisting clay, sandy silty clay, sandy clay, sand, clayey sand, silty sand, silty clay and gravelly sand. Shale or sandstone bedrock was not encountered during fieldworks. The fill encountered is generally considered to be locally derived reworked natural material with localised occurrences of anthropogenic fill containing concrete and brick gravels and/or road base gravels and sands. Where present, fill depths ranged between 0.5 and 1 m BGL with an average fill depth of 0.6 m. The maximum extent of fill material encountered at the Moorebank IMT site during previous investigations is 3.2 m. Due to the physical limitations of the test pitting method used in some areas of the Moorebank IMT site (i.e. collapse of test pit excavations), the vertical extent of fill in some areas, particular the former sewage treatment plant (STP) and the dustbowl area was not fully delineated therefore in some areas, fill material may extend to depths beyond 3.2 m BGL.

Aspect	Description
Topography	The site is at an elevation between 4 and 18 m Australian Height Datum (AHD) and is generally flat to gently undulating with some localised steep topography associated with the river terraces in the north-west of the main Moorebank IMT area (along the bank of the Georges River). The lowest elevations are associated with the river with the majority of the Moorebank IMT site at an approximate elevation of 12 to 14 m AHD.
Acid sulfate soil (ASS)	A review of the ASS risk maps showed an extremely low probability of ASS for the majority of the Moorebank IMT site although high probability of ASS occurrence was shown within the immediate corridor of the Georges River. Whether or not a particular land use activity will contribute to any acidification hazard in an area by exposing ASS will depend on the extent of soil disturbance, and the depth of occurrence of ASS materials. The environmental risk associated with ASS will depend on the type of land use activity proposed. Should areas noted to have a high probability ASS occurrence remain relatively undisturbed, potential ASS impacts would be unlikely. Based on very limited sampling for ASS (Parsons Brinckerhoff, 2011) soils with acid generating potential (ASS) were present in locations across the Moorebank IMT site including areas that were not immediately adjacent to the Georges River. Additional ASS testing and investigation as recommended based on these findings.
Hydrology	The Georges River transects the Moorebank IMT site, flowing north-east towards Chipping Norton Lake before meandering back to flow south-east towards Botany Bay. The majority of the surface water from the Moorebank IMT site is directed via overland flow and a network of open surface drains and underground pipes towards the Georges River with some localised flow into surface water ponds and to the Anzac Creek present in the south-western portion of the site. The site is located in the Southern Sydney Catchment Management Board area. Surface water ponds are present across the Moorebank IMT site with two of the largest retention ponds present in the north-east and central areas. Historically a lake (Lake Sisinyak) existed in the central area which has now been filled. The presence, origin, depth, extent or period of infilling in this area is unknown. Several wetlands are located in the north-western area.
Drainage	An open concrete lined drain located on the boundary between Steele Barracks and Moorebank Barracks transects the site from east to west. It is understood that this drainage line conveys surface water runoff from the site and the DNSDC facility (to the east), discharging to the Georges River via a gross pollutant trap.
Flooding	The western boundary of the main Moorebank IMT site area is below the 20 and 100 year flood levels extending to the eastern edge of the 'dustbowl' (nominated as Area 11 within the Phase 2 ESA) and covering much of the vegetated area along the Georges River terrace.
Regional hydrogeology	Alluvial deposits occur in valleys, creeks and river beds in the region. The alluvial deposits are generally shallow, discontinuous and relatively permeable and are likely to be responsive to rainfall and stream flow. The shallow alluvium aquifer is likely to be hydraulically connected to the Georges River. Wetlands in the northern part of the study area confirm shallow groundwater conditions. The Hawkesbury Sandstone is a dual porosity regional aquifer system that occurs across the whole of the Sydney Basin. Groundwater flow is variable throughout the Hawkesbury Sandstone, and is generally dominated by secondary porosity and fracture flow associated with structures such as faults and fracture zones. The primary porosity of the rock matrix is generally low. Regionally and locally, the shale generally has a low hydraulic conductivity and groundwater within the shale has high salinity and thus behaves as an aquitard, restricting groundwater flow into the underlying Hawkesbury Sandstone unit. The Hawkesbury Sandstone is an important aquifer in the region, but is not considered in detail here since the Ashfield Shale aquitard is likely to act as a barrier for groundwater flow between the overlying alluvial aquifer and the underlying sandstone aquifer.
Local hydrogeology	There are two main groundwater systems present beneath the site, a shallow, unconfined aquifer in the Quaternary and Tertiary alluvium and a deeper regional aquitard in the Ashfield Shale. The Ashfield Shale is considered to be a low-permeability unit that can store groundwater and also transmit it slowly from one aquifer to another. Based on the environmental logs reviewed from previous investigations (HLA, 2003), the thickness of this unit varies across the study area, ranging from approximately 3 to 5 m in the south to approximately 5 to 10 m in the north-east. Locally, it is considered likely that groundwater flow is along the interface of the shale and alluvium following the gradient of the shale.

Aspect	Description
Groundwater levels	Based on previous gauging of site wells and registered borehole records in the vicinity of the Moorebank IMT site, groundwater levels in the alluvium ranged between 0.9 and 14.7 m BGL, within the shale between 3.0 and 5.4 m BGL and in the Hawkesbury Sandstone from 7.0 to 8.2 m BGL. The inferred local groundwater flow direction is considered to be towards the north-west towards the Georges River which flows to the north along the western side of the Moorebank IMT site. On a regional scale, groundwater flow in the alluvium is likely to be generally towards north/north-east, following the flow direction of the Georges River. Regional groundwater flow direction in the Ashfield Shale is likely to be to the north-west, influenced by the dip of the strata.
Groundwater salinity	Based on a review of records for surrounding registered bores (held by the NSW Office of Water), salinity of groundwater within the alluvium was generally low (500–1000 mg/L). Groundwater within the Ashfield Shale was more saline, typically exceeding 3,000 mg/L total dissolved solids. The measured salinity for the Hawkesbury Sandstone is also elevated and is likely to be influenced by groundwater within the overlying Ashfield Shale.

Sources: *CSIRO Australian Soil Resource Information System; Department of Lands Spatial Information Exchange; Department of Mineral Resources (1991) Penrith 1:100,000 Geological Series Sheet 9030.*

2.7 Previous site investigations

A number of contamination reports pertaining to the Project site have been prepared, dating from 1994. A list of previous site investigations is provided in Table 2.5. The main findings of the reports that were reviewed by Parsons Brinckerhoff are summarised in the following sections.

Table 2.5 Previous reports

Author (year)	Title
Groundwater Technology (1994)	Environmental Site Assessment
Dames and Moore (1996)	Environmental Management Plan
Dames and Moore (1996)	Environmental Audit
CMPS&F Environmental (1998)	Preliminary Environmental Investigation
Egis Consulting Australia (2000)	Stage 1 Preliminary Site Investigation
HLA (2002)	Soil and Groundwater Investigation Precinct H (DNSDC) Moorebank Defence Land
HLA Envirosciences (2003)	Preliminary Groundwater Study, Moorebank Defence Land
URS (2003)	Investigation of Potential Sources of TCE, North West Precinct of Moorebank Defence Lands
GHD (2004)	Groundwater Investigation of the North Western Portion of the Moorebank Defence Land
GHD (2005)	Proposed Intermodal Freight Hub, Moorebank, Summary of Environmental Planning Reports
HLA Envirosciences (2005)	AST and UST Management Plan, Volume 10, Sydney West Defence Region
Earth Tech (2006)	Stage 2 Environmental Investigation
HLA (2006)	Defence Integrated Distribution System (DIDS) Baseline Investigation
ERM (2006)	Technical Advice Document prepared by Andrew Kohlrusch in relation to the Earth Tech ESA Report
Parsons Brinckerhoff (2010)	Phase 1 Environmental Site Assessment
Parsons Brinckerhoff (2011)	Phase 2 Environmental Site Assessment

The majority of reports listed were reviewed during the Parsons Brinckerhoff Phase 1 ESA and selected data was used to inform the design of the intrusive investigation developed within a sampling, analysis and quality plan (SAQP), with results reported within the Phase 2 ESA (Parsons Brinckerhoff, 2011), therefore concentrations of contaminants identified previously were considered.

2.7.1 Phase 2 ESA (Parsons Brinckerhoff, 2011),

The most recent report to be produced pertaining to contamination status of the Project site was the Phase 2 ESA (Parsons Brinckerhoff, 2011 which was reviewed and updated in May 2014). Parsons Brinckerhoff fieldwork (January/February 2011) consisted of the advancement of 22 boreholes, 40 test pits, 10 hand auger locations, the sampling of 7 sediments and 8 surface waters, installation of 21 groundwater monitoring wells and groundwater monitoring and sampling of new and selected existing wells.

Representative soil, groundwater, surface water and sediment samples were collected and tested for an extensive suite of contaminants of interest, including analyses for the following:

- TRH
- benzene, toluene, ethylbenzene and xylene (BTEX compounds)
- polycyclic aromatic hydrocarbons (PAHs)
- heavy metals (including arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc)
- polychlorinated biphenyls (PCBs)
- volatile organic compounds (VOCs)
- semi-volatile organic compounds (SVOCs)
- asbestos
- aqueous film forming foams (AFFF) and surfactants
- organophosphate pesticides (OPPs) and organochlorine pesticides (OCPs);
- compounds associated with explosives
- particle size distribution (PSD)
- compounds associated with potential for ASS.

Based on analytical soil results, shallow soil impacts were detected on-site, generally consisting of localised detections of TRH, metals, pesticide products DDD, DDE and chlordane, bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS). A number of fill mounds were observed which (based on anecdotal evidence) may contain building and demolition type waste potentially containing asbestos.

Soil contamination is limited to TRH and heavy metals impacts identified in near surface soils in localised areas of the site, associated with areas of operational plant and machinery (such as the bridging yard (Area 8) and PRA yard and wash bay (Areas 12 and 13)), the vehicle maintenance and storage area (Area 2), the former fire training areas (Area 20) and where underground storage tanks (USTs) are or were present. Only one sample exceeded the adopted health investigation limit (HIL), for lead. Results were also assessed against the most conservative ecological investigation levels (EILs) provided within the *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1)* (NEPM, 2013) and these limits were exceeded for copper, lead, nickel and zinc.

TRH was found to exceed ecological and/or management limits, and to potentially exceed health screening levels (HSLs), in Area 2 (PB_MW5, SW0201_SB036), Area 8 (SW0204_TP039), Area 10 (SW0191_TP032), Area 11 (SW0195_TP067, SW0207_SB074) and Area 20 (SW0185_TP001, SW0185_TP005). Ecological criteria and HSL comparisons were conservative as the data required for a complete assessment under the revised NEPM was not available; however, the results indicate that the potential for vapour intrusion risk and/or ecological impact may exist. The exceedances of management limits indicate that the TRH impact in soil may present an ongoing risk of light non-aqueous phase liquid (LNAPL) formation, explosive atmospheres or damage to sub-surface structures. A summary of TRH exceedances is provided as Table 2.6 and presented in Figure 7.

Table 2.6 Summary of TRH exceedances (soil)

Location	Area	Depth m BGL	Matrix Description	Analyte	Conc. (mg/kg)	Exceeds
PB_MW05	Area 2 Vehicle storage and maintenance	1.8	Natural (Sandy clay)	C_{10}–C_{14}	460	HSL D[1] and ESL
		5.8	Natural (Sandy clay)	C_{10}–C_{14}	200	ESL
SW0201_SB036		0.2	Fill (Clayey sand)	C_{15}–C_{28}	4,200*	PHML
				C_{29}–C_{36}	8,260	PHML[1]
SW0204_TP039	Area 8 Bridging yard	1.5	Fill (Sand)	C_{10}–C_{14}	310*	ESL
		2.2	Fill (Sand)	C_{15}–C_{28}	270*	ESL
SW0191_TP032	Area 10 Museum storage yard	1.0	Fill (Clayey sand)	C_{10}–C_{14}	380*	HSL D[1] and ESL
SW0195_TP067	Area 11 Dust bowl	1.7	Fill (Clayey sand)	C_{10}–C_{14}	540*	HSL D[1] and ESL
				C_{15}–C_{28}	9230*	PHML
				C_{29}–C_{36}	13,700	PHML
SW0207_SB074	Area 13PRA yard	0.2	Fill (Gravelly sand)	C_{10}–C_{14}	1,930	PHML and HSL D[1]
				C_{15}–C_{28}	6,940	PHML
SW0185_TP001	Area 20 Former FTA	1.0	Fill (Clayey sand)	C_{10}–C_{14}	1,160	PHML
				C_{15}–C_{28}	3,530*	PHML
SW0185_TP005	**Area 20_Former FTA**	**1.5**	Natural **(Silty sand)**	**C_{10}–C_{14}**	**430***	**HSL D[1] and ESL**

Samples with a SW prefix were sampled in 2006.

HSL D: based on NEPM (2013) Schedule B1 Guideline on Investigation Levels for Soil and Groundwater - Table 1A(3) –Health screening levels for vapour intrusion (commercial and industrial).

ESL: Ecological screening level based on NEPM (2013) Schedule B1 Guideline on Investigation Levels for Soil and Groundwater - Table 1B(6) – Ecological screening levels for TRH fractions F1 – F4, BTEX and benzo(a)pyrene in soil.

PHML: Petroleum hydrocarbon management limit based on NEPM (2013) Schedule B1 Guideline on Investigation Levels for Soil and Groundwater - Table 1 B (7) - Management limits for TRH fractions F1-F4 in soil.

* Indicates impact has been vertically delineated based on results of an underlying sample.

PID: Photoionisation detector result taken from the headspace sample at the time of sampling. Values are in ppm.

1 Exceedance is potential based on conservative TRH fraction grouping.

Based on the limited sample collection of sediments from drainage trenches and surface waters and subsequent laboratory analysis, results showed elevated heavy metals concentrations were present. Based on the limited testing for ASS, soils with acid generating potential were present in some locations. Subsurface materials with acid generating potential may pose an acid generation risk if exposed to oxygen during future site redevelopment.

Groundwater levels were measured at depths of between 5.2 and 12.4 m BGL with groundwater flow inferred to be towards the west/north-west (towards the Georges River). Groundwater sampled from beneath the Moorebank IMT site was found to be impacted by elevated concentrations of dissolved metals, chlorinated hydrocarbons (trichloroethene (TCE) and cis-1, 2-dichloroethene (DCE)), TRH, formaldehyde, chloroform and perfluorinated chemicals (which are associated with firefighting foams). Dissolved concentrations of cadmium, copper, lead, nickel and zinc, PFOA and PFOS and TCE were reported at concentrations exceeding the adopted site assessment criteria with PFOA and PFOS identified both in soil and groundwater. PFOA and PFOS are emerging environmental pollutants with relatively limited toxicity information.

In addition to the intrusive works, specialist contractor (G-Tek Pty Ltd) was engaged to undertake an assessment of potential UXO. The results of the survey confirmed that all UXO/EOW related items that were observed comprised inert training ordnance. Based on specialist advice provided by G-Tek, the Moorebank IMT site has a very low potential to contain remnant UXO/EOW containing high explosive or other energetic material, other than propellants/primers in unfired/misfired small arms ammunition blank cartridge cases.

Based on the findings of the Phase 2 ESA, it was determined that the identified chemical concentrations in soil did not pose a health risk to future site users based on the proposed development design (comprising limited retained vegetation areas with the majority of the Moorebank IMT site to be covered by impervious surfaces). A potential human health risk was identified from exposure of site workers to soil contamination during site excavation and development, however it was considered that this potential risk could be adequately managed through the use of a construction environmental management plan (CEMP) outlining management procedures, exposure mitigation controls and occupational hygiene practices to be implemented during excavation works to eliminate potential exposure pathways.

Following a qualitative analysis, a potentially complete exposure pathway was identified for the chlorinated hydrocarbon contamination TCE identified in groundwater in the north-west (adjacent to the boundary with ABB). It is considered that a potential risk may exist to down gradient environmental receptors should contamination have migrated off-site to the Georges River. Based on an indicative risk assessment, potential vapour risks associated with the groundwater plume are negligible based on theoretical input values. Further assessment of the potential vapour risk may be required should the built design of Moorebank IMT incorporate buildings in this area. It is considered that, based on the dissolved metals, TRH, TCE and perfluorinated compounds identified in groundwater samples, groundwater is not suitable for potable use. The potential health risk to humans may be mitigated by restricting groundwater abstraction and use on-site.

The Phase 2 ESA concluded that the Moorebank IMT site would require some level of remediation and ongoing management to mitigate the potential risks associated with the contamination identified. It was recommended that a RAP be developed incorporating:

- requirements to decommission and remove of all on-site USTs
- clearance/clean-up of spent UXO/EOW items prior to site development
- management requirements for known waste fill and fill encountered during site development, including asbestos in soil
- additional groundwater monitoring of TCE groundwater impacts identified the north-west of the IMT site (Area 1).

In addition the following management plans should be developed prior to site works commencing:

- CEMP to manage surface soils, excavated materials and incorporating measures to be implemented during redevelopment of the Moorebank IMT site to mitigate any potential human health risks
- UXO/EOW management plan which documents a procedure to manage military related finds encountered during redevelopment works.

2.8 Quantitative summary of previous investigation findings

2.8.1 Identified contaminants in soil

The findings of the Phase 2 ESA identified a number of areas requiring remediation. It is noted that the scope of the Phase 2 ESA was limited and that unidentified areas of contamination may exist.

Table 2.7 Summary of previous soil data

Contaminant	Location (area as per Phase 2 ESA)	Vertical extent detected (m BGL)	Rationale for remediation
TRH	Vehicle maintenance yard (Area 2)	0.0–1.8	Soil results showed marginal and localised exceedances of the commercial land use HSLs for TRH fractions C_6 to C_{10} and petroleum hydrocarbon management limits (PHML) (NEPM, 2013).
	Dustbowl (Area 11)	0.0–1.7	One soil sample exceeded the commercial land use HSLs for TRH fractions C_6 to C_{10} and C_{10} to C_{16} and for PHML TRH fractions C_{16} to C_{34} and C_{34} to $C_{40.}$ (NEPM, 2013).
	Plant, roads and airfield (PRA) yard (Area 13)	0.0–1.6	One soil sample exceeded the commercial land use HSLs for TRH fractions C_6 to C_{10} and C_{10} to C_{16} and for PHML TRH fractions C_{16} to C_{34}.
	Fire training area (Area 20)	0.0–1.5	One soil sample exceeded the commercial land use HSLs for TRH fractions C_6 to C_{10} and C_{10} to C_{16} and one sample exceeded the HSLs for TRH fractions C_{10} to C_{16} and for PHMLTRH fractions C_{16} to C_{34} (NEPM, 2013).
Metals	Bridging yard - near grit blasting facility (Area 8)	0.0–0.5	One sample exceeded the adopted HIL for lead.
PFOA and PFOS	Dustbowl (Area 11)	0.0–0.5	Concentrations of 0.0059 mg/kg of PFOA and 0.418 mg/kg of PFOS were detected. No assessment criteria available.
Asbestos	Museum storage yard, former STP, vehicle maintenance yard, dustbowl and north of drainage line (Areas 10, 4, 2, 11 and 3)	0.0–0.5	A total of 68 samples were analysed for asbestos in soil. Chrysotile and amosite asbestos fibres were detected in eight samples.
ASS	Presented in Appendix A Figure 5	Various (0.4, 1.0, 2.0 and 13.0).	Nine samples were tested for ASS. Five had percentages of potential S_{POS} equal to or above the adopted criteria indicating that sulfidic materials are present in soils. Total - potential acidity values were above the assessment criteria for 5 samples. Based on these results, it was considered that subsurface materials encountered may pose an acid generation risk if exposed to oxygen during redevelopment. As the water table impedes oxidation of potential iron sulfides in the subsurface, dewatering/lowering of the groundwater table during redevelopment may result in oxidising conditions at depth.

PFOA: perfluorooctanoic acid

PFOS: perfluorooctanesulfonic acid

S_{POS}: peroxide oxidisable sulfur (net acidity (sulfur units)

2.8.2 Identified contaminants in groundwater

Table 2.8 Summary of previous groundwater data

Contaminant	Detections	
TRH C_6–C_9	MW_BHB2 (340 µg/L) at ABB boundary. This detection is considered likely to be associated with chlorinated hydrocarbon compounds detected in this area.	
TRH C_{10}–C_{36}	Detected in 16 of the 39 groundwater samples analysed at concentrations between 50 and 820 µg/L.	
Metals[1]	Cadmium	Dissolved cadmium detections ranged from 0.1 to 1.5 µg/L. The maximum cadmium concentration was reported in groundwater sampled from monitoring well PB_MW09 in Area 13 (PRA yard). Of the 13 detections, 8 exceeded the adopted assessment criteria (0.2 mg/kg).
	Copper	Dissolved copper detections generally ranged between 1 and 7 µg/L. Elevated concentrations of dissolved copper were reported in groundwater sampled from wells PB_MW06 (37 µg/L) in Area 10 (museum storage yard) PB_MW09 (56 µg/L) located in Area 13 (PRA yard) and MW083 (maximum concentration of 79 µg/L) in Area 20 (former FTA). Of the 25 detections, 21 exceeded the adopted assessment criteria (1.4 µg/L).
	Lead	The maximum concentration of dissolved lead (114 µg/L) was reported in groundwater sampled from monitoring well MW083 located in Area 20 (former FTA). Of the 16 detections, 8 exceeded the adopted assessment criteria of 3.4 µg/L.
	Nickel	Dissolved nickel detections ranged from 1 to 168 µg/L. The maximum nickel concentration was reported in groundwater sampled from monitoring well PB_MW19 in Area 13 (PRA yard). Of the 32 nickel detections, 17 were above the adopted assessment and 7 were reported for groundwater samples collected from monitoring wells in Area 13 (PRA yard).
	Zinc	Dissolved zinc detections ranged from 5 to 408 µg/L. The maximum concentration was reported in groundwater sampled from PB_MW19 in Area 13 (PRA yard). Of the 30 zinc detections, 28 were above the adopted assessment criteria (8 µg/L).
PAH	The most elevated PAH detections were reported in groundwater sampled from well PB_MW14 in Area 27 (non-operational UST), where benzo(a)pyrene (0.7 µg/L), fluoranthene (0.3 µg/L) phenanthrene (0.4 µg/L) and pyrene (0.2µg/L) was reported. Naphthalene (0.4 µg/L) was detected in groundwater sample MW083 located in Area 21 (small arms range). All other detections were either below the laboratory PQL or below the respective site assessment criteria.	
VOCs	Of 31 samples analysed for VOC, the following detections were reported: ▪ Chloroform (TCM) in groundwater sampled from well PB_MW18 (6 µg/L) located in Area 2 (vehicle maintenance yard) ▪ Cis-1,2-DCE in groundwater sampled from well MW_BHB2 (22 µg/L) located in Area 1 (ABB boundary) ▪ TCE in groundwater sampled from well MW_BHB2 (297 µg/L) and of TCE MW_BHB4 (18 µg/L) both located in Area 1 (ABB boundary). All other VOC compounds were reported below the laboratory detection limit. However, it is noted that the PQL for vinyl chloride was an order of magnitude above the Australian Drinking Water Guideline of 0.3 µg/L therefore vinyl chloride (a breakdown product of TCE) may also be present in groundwater. TCE results are presented in Appendix A Figure 6.	
Formaldehyde	Two samples were analysed for formaldehyde. In groundwater from MW009 (Area 16) concentrations were reported at 200 µg/L. Formaldehyde was also detected in sample PB_MW15 (Area 22) at a concentration of 100 µg/L. Concentrations were below the Australian Drinking Water Guideline (500 µg/L).	

Contaminant	Detections
PFOA and PFOS	Five groundwater samples were analysed for PFOA and PFOS to establish if residual AFFF used in fire training activities was present in groundwater. PFOA was detected in three groundwater samples from BHA-1 (0.91 µg/L), MW083 (1.4 µg/L) and MW108 (0.17 µg/L) and PFOS was detected in four groundwater samples from BHA-1 (1.57µg/L), MW083 (23.2µg/L) MW108 (0.43 µg/L) and PB_MW07 (0.07 µg/L). BHA-1 and MW108 are located within the dustbowl and former FTA, MW083 is located within the southern small arms range and PB_MW07is located in the bridging yard.
PCBs	All reported concentrations were below the laboratory PQL for all eight groundwater samples that were analysed for PCBs.

(1) The most elevated metals concentrations were generally reported in groundwater beneath the PRA Yard

2.9 Conceptual site model

A conceptual site model (CSM) has been developed based on the information obtained during previous investigations to allow assessment of potential sources of impacts, chemicals of concern, transport mechanisms and receptors. For a potential risk to be present, a source (e.g. primary sources such as leaking fuel tanks or secondary sources such as residually impacted soils/groundwater), a receptor (human or environmental) and a transport mechanism between the source and receptor (e.g. groundwater migration) must be present for a complete exposure pathway to exist. The CSM is summarised in Table 2.9.

Table 2.9 Conceptual site model

CSM	Factors
Potential sources	Surface soils impacted by operational Defence activities including remnant items of military ordnance (described as UXO) and residual metals and aqueous film forming foam (AFFF) compounds.
	Fuel and waste oil storage (existing ASTs and USTs).
	Buried fill and soils (potentially contaminated with asbestos).
	Localised TCE and impacted groundwater (north-western area).
	Potential for ASS.
Potential pathways	Leaching and migration of contaminants vertically into underlying groundwater systems and migration/seepage including lateral migration of contaminated water through preferential pathways such as drainage lines or geological features.
	Direct contact with contaminated soils (dermal contact, ingestion and inhalation).
	Direct contact with surface water or groundwater via pumping to other areas of the IMT site or abstraction of potentially impacted groundwater from the identified registered bores.
	Vapour migration from soil or groundwater.
Potential receptors	Groundwater beneath the Moorebank IMT site and potential down gradient users of abstracted groundwater for domestic use.
	Georges River.
	Current and future site users and utility/construction personnel undertaking works at the IMT site.
	Organic and inorganic contaminants which may present a risk of harm to construction and maintenance workers.

2.10 Potentially complete exposure pathways

An indicative risk assessment was conducted as part of the Phase 2 ESA to provide an evaluation of the potential risks to human health and the adjacent water body (Georges River) due to the contaminants identified in soil and groundwater on-site. A summary of the exposure pathway analysis is provided in Table 2.9.

Table 2.10 Indicative risk assessment exposure analysis summary

Source media	Exposure scenario	Chemicals of potential concern	Receptor
Soil	Inhalation of chemical vapours volatilised into an indoor commercial space	TRH C_6–C_{10}	Commercial and construction workers
Soil	Inhalation of chemical vapours volatilised into a shallow excavation trench	TRH C_6–C_{10}	Maintenance workers
Soil	Direct contact with impacted soil or dust generated from impacted soil	Perfluorinated compounds, heavy metals	Maintenance workers (utility and landscape)
Groundwater	Direct dermal contact with or ingestion of impacted groundwater (via abstraction wells)	TRH C_{10}–C_{40}, perfluorinated compounds, dissolved heavy metals	Potential on-site and off-site users of groundwater
Groundwater	Inhalation of chemical vapours volatilised into an indoor commercial space	TCE, DCE, vinyl chloride	Commercial workers
Groundwater	Inhalation of chemical vapours volatilised into a shallow excavation trench	TCE, DCE, vinyl chloride	Maintenance workers

Concentrations of TRH, dissolved metals, TCE and perfluorinated compounds identified in groundwater which exceeded the respective criteria for potable use pose a potential health risk to humans should groundwater be abstracted for potable use. It was considered that this risk may be mitigated by restricting abstraction of groundwater at the site.

Based on Moorebank IMT Project concept design, the majority of the site will be capped with impervious hardstand thus mitigating the potential exposure risk to future site users from direct contact with contaminated soils. A complete exposure pathway may exist to site workers during excavation and construction activities but it is considered that the direct contact exposure risk could be adequately managed via the implementation of appropriate management controls under a CEMP, which documents the management measures required for the protection of human health and the environment during Project excavation and construction activities. A potential vapour inhalation risk has been identified relating to chlorinated solvents in groundwater in the north western area of the site. The outcome of an indicative risk assessment undertaken during the Phase 2 ESA (Parsons Brinkerhoff, 2011) considered the risk associated with vapour inhalation to be low, however further monitoring of groundwater in this area has been recommended as part of this RAP under additional monitoring works.

2.11 Data gaps

Based on the results of the Phase 2 ESA, Parsons Brinckerhoff recommended that additional investigation works be carried out prior to, or in conjunction with, remediation works. Details are provided in the following sections.

2.11.1 Acid sulfate soils

Only limited ASS testing has been undertaken previously. Additional data collection would include additional testing for ASS so that informed decisions can be made in relation to ASS management, particularly in areas to be dewatered to facilitate the built design (such as existing ponds that will not be retained).

Should further testing confirm the presence of ASS:

- a management plan will need to be developed in accordance with the Acid Sulfate Soils Management Advisory Committee (ASSMAC) Assessment Guidelines (1998)), with active ongoing management through the construction phase as prescribed within the plan (as required)
- off-site disposal would need to be in accordance with the NSW DECC (2008) *Waste Classification Guidelines Part 4: Acid Sulfate Soils*.

2.11.2 Existing surface water bodies

Existing surface water bodies (detention ponds) that exist at the site may be removed to facilitate the Project, however, limited information is available relating to the quality of surface water bodies and associated sediments. It is recommended that additional information should be collected on the nature of the surface water and sediment quality in order to inform planning and control measures that will need to be implemented during their removal. Surface water quality and sediment data may be required to feed into the discharge consent applications that may be associated with dewatering activities. A dewatering management plan may also be required. Aquatic ecology, the potential for UXO to exist on the beds of water bodies and the geotechnical attributes of void space created also merits consideration.

2.11.3 Groundwater conditions – ABB boundary

Groundwater impacted with TCE was detected in the north-west of the main Moorebank IMT site in January 2011. The reported concentrations of TCE in groundwater sampled from the existing wells in this area were lower than those reported during previous investigations, indicative of a generally declining trend in contaminant concentrations. As contamination can naturally attenuate over time and given the time elapsed since January 2011, it is recommended that further groundwater monitoring of wells in the ABB boundary area (referred to as Area 1 in the Phase 2 ESA) be undertaken, in order to evaluate the current concentrations of chlorinated hydrocarbon compounds and evaluate if additional action is likely to be required to manage contaminated groundwater in this area going forward.

To address the remaining data gaps it is recommended that a SAQP be developed to design the additional investigation works to be reviewed and endorsed by the appointed NSW EPA accredited Site Auditor.

3. Remediation goals and strategy

3.1 Remediation hierarchy

Remediation of the main Moorebank IMT site area is dependent on both geotechnical and geochemical factors. Based on the contamination identified during the Parsons Brinckerhoff Phase 2 ESA, it was concluded that the risks posed to human health and/or the environment were generally considered to be low. In cases where there is limited risk to human health and the environment, the extent of the remediation necessary at a site may be greatly reduced. Based on the ANZECC (1992) *Guidelines for the Assessment and Management of Contaminated sites*, the preferred order of options for site clean-up and management are:

- on-site treatment of the soil so that the contamination is either destroyed or the associated hazard is reduced to an acceptable level
- off-site treatment of excavated soil, which, depending on the residual levels of contamination in the treated material is then returned to site for reuse or removed to an approved waste disposal site.

Should it not be possible, or sustainable, for either of these options to be implemented, then options that should be considered include:

- removal of contaminated soil to an approved site/facility followed where necessary by replacement with clean fill
- isolation of the soil by covering with a properly designed barrier
- choosing a less sensitive land use to minimise the need for remedial works which may include partial remediation
- leaving contaminated material in situ provided there is no immediate danger to the environment or community and the Moorebank IMT site has appropriate controls in place.

In addition, the guidelines state that if remediation is likely to cause a greater adverse effect than would occur were it left undisturbed, then remediation should not proceed.

The key driver for the excavation works at the Moorebank IMT site would likely be cut and fill excavations that are required to achieve desired site levels and topsoil stripping to render the land geotechnically suitable to accommodate the final built design of the Moorebank IMT. Geotechnical constraints identified within the proposed redevelopment area are predominantly fill materials which are unsuitable for founding of load bearing structures. The extent of excavations will therefore depend upon the detailed design.

Where previous investigations have not identified contamination to be present at unacceptable levels within fill and where the preferred design does not require land to be excavated, it may be that no remedial works would be required or, at a minimum, an environmental management plan (EMP) could be implemented.

In addition, excavated fill materials that are encountered during excavations may be suitable for reuse as engineered fill, provided foreign objects such as plastics, glass and metals are screened out from the matrix (soils and rock fragments). In the interests of financial and environmental sustainability, the remediation and management strategies will incorporate engineering design solutions to maximise the reuse of materials and reduce the volume of material requiring disposal off-site. The preferred remedial approach should consider integration of potential beneficial uses with remedial design.

Remediation of groundwater will also be considered based on the results of additional sampling of groundwater.

3.2 Remediation goals

A combination of remedial options is considered appropriate to address potential contamination at the Project site. The remedial goals are:

- to remove and manage identified UXO/EOW as per a UXO management plan (to be developed and implemented in conjunction with the RAP
- to remove and validate USTs as per the UPSS Regulation
- to remove known asbestos mounds that have been identified during previous investigations, to mitigate the potential for mixing of these materials into graded soils and to mitigate the occupational risks associated with handling asbestos impacted materials
- contamination ‘hotspot’ removal, comprising excavation of soil/fill materials that were identified to be impacted by contamination at concentrations above the level of acceptable risk as identified in Phase 2 ESA (Parsons Brinkerhoff, 2011), to render these areas suitable for commercial industrial land use
- to appropriately manage/remediate contaminated materials that are found unexpectedly during Project works that were not identified during previous site investigations in accordance with the contingency measures outlined within the RAP
- to consider and apply sustainability principles with a view to minimising off-site disposal of materials and maximising reuse of material on-site
- to validate/assess materials on-site in order to evaluate suitability for beneficial reuse without off-site disposal
- to conduct additional investigations to augment the existing data relating to PASS, surface water quality, residual sediments and groundwater to inform if any additional control, management or remediation measures to be implemented during future development.

3.3 Extent of remediation

The extent of excavations under this RAP is proposed to address contamination and does not consider the necessary works that would be required to achieve suitable geotechnical conditions for the proposed end use. This means that the RAP considers management of contaminated material only and offers solutions to manage this. The extent of other material that is not contaminated that must be excavated to achieve site levels or to achieve geotechnical suitability is separate from contamination so has not been included in the RAP extent. Where these activities are undertaken and contamination is encountered, the contingency approach as detailed in the RAP will apply.

Based on the available information, key remediation areas are shown in Appendix A, Figure 5 and have been outlined in the Table 3.1.

Table 3.1 Key remediation areas

Area	Phase 2 ESA area	Remediation driver	Comments
Areas impacted by UXO/EOW	Whole site	UXO clearance/removal.	Undertaken by specialist contractor with ongoing management via a UXO Management plan.
Fuel storage infrastructure (ASTs and USTs)	Identified tanks (Table 2-2)	Source removal to remove potential ongoing liability.	Tank and associated infrastructure removal and off-site disposal of impacted materials*.
Removal of visually impacted soils in vehicle maintenance yard	Area 2	To address any localised TRH soil impacts.	Following removal of buildings and slabs, scrape to remove any visually impacted soils that appear to have been impacted by hydrocarbons (if any).
Removal of visually impacted soils in vehicle maintenance yard	Area 20	To address any localised TRH soil impacts.	Following removal of buildings and slabs, scrape to remove any visually impacted soils that have been impacted by TRH hydrocarbons (if any).
Removal of surficial soils in the bridging yard	Area 8	Elevated lead in the vicinity of the former grit blasting facility.	Surface scrape of lead hotspot identified during 2006 Phase 2 ESA investigation (Parsons Brinckerhoff) in the vicinity of SW0204_TP045.
Removal of fill mound adjacent to Jacquinot Court	Area 18	Removal of ACM fill mound.	Removal and appropriate off-site disposal of ACM impacted soil stockpile.

* to include surficial soils previously identified to be impacted by contamination within the PRA Yard (Table 2.7)

Remediation of TRH exceeding the commercial land use HSLs for TRH fractions C_6 to C_{10} and C_{10} to C_{16} and for PHML TRH fractions C_{16} to C_{34} and C_{34} that was historically identified within Area 11 (the dustbowl) has not been included as a key remediation area due to the fact that this area has been utilised for operational training for plant and machinery. Material in this area has been significantly reworked over time therefore it is considered that there would be little benefit in targeting this historical ‘hotspot’ in the locality where it was previously identified.

With the exception the fenced asbestos mound located within Area 18 (near the former Jacquinot Court) which will be specifically targeted for excavation and removal, localised asbestos impacts that have been identified in soils across the site have not been specifically targeted for remediation. It is considered that site wide management of asbestos encountered in soils will be covered under the CEMP and managed accordingly during future earthworks to avoid the double handing of site materials.

Any contaminated soil/fill material encountered during excavation works would be mitigated through contingency plan measures outlined in section 10.

Plans that should be developed and referenced in conjunction with this RAP should include, at a minimum:

- an unexploded ordnance (UXO) management plan
- a construction environmental management plan (CEMP).

Additional plans developed may include, as required:

- an ASS management plan
- a dewatering management plan.

4. Rationale for the selection of remedial technologies

A review of remedial technologies has been undertaken in order to provide a detailed qualitative assessment of the appropriateness and applicability of available remediation technologies to reach the desired remedial goals.

4.1 Soil

To remediate the soils at the Moorebank IMT site to a level commensurate with the applicable site validation criteria, several methodologies are considered to be appropriate, each with a number of advantages and disadvantages. Remediation risk management may comprise implementation of one or a combination of the remedial management measures presented in Table 4.1.

Table 4.1 Remedial technology review matrix – soils

Remediation methodology	Description	Advantages	Disadvantages	Suitability
Ongoing site management	Containment and monitoring can be considered a risk management technique for contamination that is neither destroyed nor removed from the IMT site. Commonly ongoing management involves an ongoing monitoring program to assess the contaminant conditions at the IMT site and provide assurance that no changes are occurring that may impact sensitive receptor.	Ongoing site risk management is considered appropriate for sites where contamination presents a low or minimal risk to human health and/or the environment and the risk of off-site migration is negligible. Risk management is a method that could be economical in dealing with the contamination that may be present in areas of heterogeneous fill.	Though risk management may reduce costs in the short term, an annual allowance would be required for ongoing monitoring. Some ongoing liability associated with contamination may remain.	Suitable. This approach may be appropriate for certain areas of the Moorebank IMT site, where there is limited evidence of high risk contamination and where the proposed end use is not sensitive.
On-site bioremediation	Excavated soils are thoroughly broken down and aerated, mixed with microorganisms and nutrients, stockpiled and aerated in above ground enclosures.	Cost effective if soils are utilised on-site. Lower disposal costs. Limited requirement to import fill material to site. Retains material on-site.	Significant area of site required to treat material. Undefined remediation timeframe. Potential odour issues. Uncertainty of success, particularly for heavy-end hydrocarbons. Not suitable for metals contamination.	Not suitable. However bioremediation and subsequent reuse may become appropriate should volumes greater than 250 m^3 of suitable material be generated during tank removal works.
In situ treatment	In situ treatment of impacted soils within the smear zone and saturated zone using in situ treatment methods such as soil vapour extraction (SVE), steam stripping or injection of oxygen releasing compounds.	Minimal disturbance to the Moorebank IMT site (no excavation). Cost effective for large scale site remediation projects of light end petroleum hydrocarbons. Potential to simultaneously remediate dissolved phase hydrocarbons in site groundwater (if present).	Not applicable to the kind of contamination encountered at the Moorebank IMT site. Expensive establishment costs. Potential for odour issues. Requires detailed design, pilot trials and management.	Not suitable.
Consolidation and/or capping	Risk minimisation approach where impacted soils are managed on-site by capping the ground surface with a clean, impermeable layer. The base of the cap would be clearly marked with a geotextile to indicate that workers could potentially be exposed to contamination below the marker, which would then trigger additional health, safety and environmental controls.	Effectively removes risk by eliminating exposure pathways.	Importance of capping materials. Contamination would remain in situ allowing potential off-site migration of contamination and further impacts on groundwater. Land use limitations. Requirement for an environmental management plan.	Suitable. For some areas dependent on proposed end use.

Remediation methodology	Description	Advantages	Disadvantages	Suitability
Excavation and off-site disposal	Excavate impacted materials. Transport directly to a licensed landfill facility.	Impacted material removed immediately. No storage or treatment issues. Reduced vapour/odour issues as impacted materials removed from site. Minimal design and management costs.	Transfer of waste to another location. High costs associated with the haulage and disposal (an importation of clean fill for backfilling if required). Waste classification of all materials required prior to disposal. Sustainability issues related to disposal to landfill.	Suitable in areas where contaminant hotspots have been identified in previous investigations or where ACM material is found to be present. For other fill materials, excavation and off-site disposal would only be considered a last resort.
Excavation and on-site treatment/ processing	Excavate materials and segregate specific components of the waste mass, for appropriate processing.	Relatively fast method. Aligns with the sustainability principles by reducing off-site disposal to landfill, recycling of metal and wood components of fill (where suitable) and increasing reuse of suitable material on-site.	Cost of processing materials for use as sub-grade. May require some additional testing (including toxicity characteristics leaching procedure (TCLP)) to validate material prior to reuse. Storage or treatment problems associated with processed materials that are subsequently found to be unsuitable for reuse. This strategy may result in cross contamination if processing material containing asbestos fibres, fragments.	Suitable
Natural attenuation	Allowing the contaminants to biodegrade naturally following removal of the contamination source.	No remedial excavation of site. Retains materials on-site. Sustainable, cost effective remediation method.	Slow process. Potential for contamination to further impact on the groundwater aquifer and nearby environmental receptors. Unlikely to improve the geotechnical characteristics of contaminated fill. Not applicable for all contaminants.	Unsuitable

4.2 Groundwater

There are several possible remedial strategies to treat and manage impacted groundwater however no significant groundwater impacts were identified at during previous investigations, therefore active remediation technologies are not considered necessary.

Groundwater impacted with chlorinated hydrocarbons (TCE) has been identified in the northern portion of the main Moorebank IMT site (adjacent to the ABB property boundary and to the Georges River). However, insufficient data exists to determine the remediation requirements for managing groundwater in this area (if any). The collection of additional groundwater data should be undertaken to inform this decision. Depending on the current contaminant conditions, the most appropriate approach might be monitored natural attenuation. This method relies on the existing conditions of the aquifer and the nature of the contaminated groundwater to naturally attenuate the contaminants. Under suitable conditions the processes within the aquifer such as biodegradation, adsorption, chemical decay, dilution and dispersion will slowly reduce the concentration of various compounds. Groundwater data from the additional assessment works should be used to establish if monitored natural attenuation would be a suitable remedial approach.

5. Preferred remedial strategy

The preferred remedial strategy is a staged remediation approach which will initially aim to remove the known sources of contamination (such USTs and surficial soils that are known to be impacted by contamination), and includes a combination of techniques to manage potentially contaminated materials should they be uncovered during site development.

Remedial approaches which address the identified risks while providing opportunities for beneficial reuse are preferred however this will be dependent on the detailed design and schedule of works.

It is considered that retention of materials on-site through containment and capping or bioremediation and reuse may be an alternative option to off-site disposal. The remediation options should be assessed and evaluated during the detailed design development process.

The recommended remedial approach includes the following stages:

- removal of all UXO/EOW and items of military origin and ongoing management of the risks under a UXO management plan which should be developed to be used in conjunction with this RAP
- a tank inventory survey to confirm the exact locations of USTs and decommissioning and removal of all UPSS infrastructure (as identified during the tank inventory survey) as per the UPSS Regulation to limit the potential ongoing risk/liability associated with underground chemical storage
- excavation and off-site disposal of fill materials known to be impacted by contamination based on previous investigation data (such as stockpiles with asbestos containing materials (ACM) and surficial soils impacted by contamination 'hotspots' (elevated TRH and lead) with the aim of immediately removing impacted known material within these areas
- additional investigations to augment the existing data relating to:
  - PASS (particularly in low-lying areas identified to have a high probability of ASS and where dewatering is likely to be required to facilitate Moorebank IMT construction)
  - surface water quality (to gather data to inform management of dewatering/discharges anticipated to be required to achieve the built design)
  - residual sediments (to gather data to inform management of sediments likely to be disturbed/dewatered during construction)
  - groundwater beneath the north-western area of the proposed Moorebank IMT site (adjacent to ABB) to inform if any additional control, management or remediation measures for groundwater in this area.
- continued site risk management and assessment of remediation options to maximise reuse of resources and minimise importation of materials including containment and/or capping and the segregation of excavated materials (such as wood, metals, rubble not containing ACM, material free from contamination) and stockpiling on-site to allow for further processing and/or validation, for on-site reuse.

The above elements are described in more detail in Section 7.

6. Remediation criteria

With regards to environmental factors that will influence the remediation strategy, it is necessary to define the concentrations to be used for comparison to assess the significance of any contamination detected in soil during site remediation works and to ensure an acceptable level of contaminant concentrations is reached based on proposed and land use. This would be achieved by application of the appropriate remediation criteria.

6.1 Soil

Considering the proposed future site use, analytical results from further sampling or validation should be assessed against the criteria and investigation methodologies detailed within the National Environment Protection Council (NEPC) 2013, *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1)* (NEPM). The criteria that will be used to assess the analytical data are summarised in Tables 6.1 and 6.2.

Applicable HSLs, HILs and ecological investigation and screening levels (EILs and ESLs) from the NEPM (2013) should be applied. Any contaminants which have concentrations greater than the investigation levels detailed should be further remediated (or further assessed using a Tier 2 risk assessment). The HSLs depend on specific soil physicochemical properties, land use scenarios, and the characteristics of building structures. They apply to different soil types, and depths below surface to >4 m BGL. The Cooperative Research Council for Contamination Assessment and Remediation of the Environment (CRC CARE) Technical document no. 10 (Friebel and Nabedaum, 2011) provides soil HSLs for select petroleum hydrocarbons where direct contact is deemed likely, such as surface soil (to 1 m) and for intrusive maintenance workers working in the shallow trenches (<1 m). Hydrocarbon staining can be present even where analytical results are reported to be below site soil criteria. Where there is a potential for future exposure to site users, stained or odorous materials may require excavation.

Although the site is considered of limited terrestrial ecosystem value based on the proposed commercial/industrial development, consideration should also be given to the ecological investigation and screening levels (EILs and ESLs) from the NEPM (2013). EILs and ESLs depend on specific soil physicochemical properties and land use scenarios and generally apply to the top 2 m of soil. EILs are site specific and are determined by calculating an ambient background concentration (ABC) and an added contaminant limit (ACL) for the site, which are added together to get the EIL. The ABC and ACL are based on other properties of the soil, including pH, cation exchange capacity and clay content. In the absence of data of these specific soil properties at this stage, the most conservative value has been adopted. These values should be amended and applied during validation assessment where there is sufficient data available.

Assessment and characterisation of the Moorebank IMT site has also considered the 95% upper confidence limit (UCL) of the arithmetic mean of contaminant concentrations which have been compared to the nominated criteria. Assessment follows the method in NEPC (2013), whereby the standard deviation is less than 50% of the relevant screening level and no single value is above 250% of the relevant screening level.

Table 6.1 Soil HSLs for vapour intrusion

Chemicals	Commercial/industrial (HSL D)			
	SAND[1]			
	0 to <1 m	1 m to <2 m	2 m to <4 m	≥4 m
F1: TRH C_6-C_{10} less BTEX	260	370	630	NL
F2: TRH >C_{10}-C_{16} less naphthalene	NL	NL	NL	NL
Benzene	3	3	3	3
Toluene	NL	NL	NL	NL
Ethylbenzene	NL	NL	NL	NL
Xylene	NL	NL	NL	NL
Naphthalene	NL	NL	NL	NL

Values provided in mg/kg

NL – not limiting i.e. the soil vapour source concentration for a petroleum mixture could not exceed a level that would result in the maximum allowable vapour risk for the given scenario

(1) Soil type: sand is adopted here as a conservative approach.

Table 6.2 Soil investigation levels

Chemicals	HILs (1)	ESLs (2)	EILs (3)	Management limits (4)
	Commercial/ industrial D	Commercial/ industrial coarse soil		Commercial/ industrial coarse soil
F1: TRH C_6-C_{10} less BTEX	-	215	-	-
F2: TRH >C_{10}-C_{16} less naphthalene	-	170	-	-
TRH C_6-C_{10}	-	-	-	700
TRH C_{10}-C_{16}	-	-	-	1,000
F3: >C_{16}-C_{34}	-	1,700	-	3,500
F4: >C_{34}-C_{40}	-	2,500	-	5,000
Benzene	-	75	-	-
Toluene	-	135	-	-
Ethylbenzene	-	165	-	-
Xylene	-	180	-	-
Naphthalene	-	-	370	-
Benzo(a)pyrene	-	0.7	-	-
Carcinogenic PAHs (6)	40	-	-	-
Total PAHs	4,000	-	-	-
Arsenic	3,000	-	100	-
Cadmium	900	-	-	-
Chromium (VI)	3,600	-	-	-

Chemicals	HILs (1)	ESLs (2)	EILs (3)	Management limits (4)
	Commercial/ industrial D	Commercial/ industrial coarse soil		Commercial/ industrial coarse soil
Chromium (III)	-	-	310	
Copper	240,000	-	140	-
Lead	1,500	-	1800	-
Mercury	730	-	-	-
Nickel	6,000	-	55	-
Zinc	400,000	-	110	-
PCB Total	7	-	-	-
Organochlorine pesticides				
DDT + DDE + DDD	3,600	-	640	-
Aldrin and dieldrin	45	-	-	-
Chlordane	530	-	-	-
Endosulfan	2,000	-	-	-
Endrin	100	-	-	-
Heptachlor	50	-	-	-
Other				
Perfluorooctanoic acid (PFOA)	16 (7)		-	-
Perfluorooctanoic sulfonate acid (PFOS)	6 (7)		-	-

(1) NEPM (2013) Schedule B1 Guideline on Investigation Levels for Soil and Groundwater - Table 1A(1) - Health investigation levels for soil contaminants.

(2) NEPM (2013) Schedule B1 Guideline on Investigation Levels for Soil and Groundwater - Table 1B(6) – Ecological screening levels for TRH fractions F1 – F4, BTEX and benzo(a)pyrene in soil.

(3) EILs: NEPM (2013) Schedule B1, Soil specific added contaminant limits for aged zinc (Table 1B(1)), copper(Table 1B(2)), chromium III and nickel(Table 1B(3)) and generic added contaminant limits for lead irrespective of their physiochemical properties (Table 1B(4)), fresh DDT and fresh naphthalene in soils irrespective of their physiochemical properties, commercial and industrial.

(4) NEPM (2013) Schedule B1 Guideline on Investigation Levels for Soil and Groundwater - Table 1 B (7) - Management limits for TRH fractions F1-F4 in soil.

(5) NSW EPA (1994) Guidelines for Assessing Service Station-sites.

(6) Carcinogenic PAHs: HIL is based on the 8 carcinogenic PAHs and their toxicity equivalent factor relative to benzo(a)pyrene.

(7) USEPA RSL regional screening level for residential soil (2010).

\- denotes that there is no threshold value available.

PFOA and PFOS are persistent in all media in the environment and can bioaccumulate and biomagnify in terrestrial and marine mammals. These chemicals are emerging environmental pollutants with relatively limited toxicity information. There is not currently an Australian guideline for perfluorinated chemicals in soils, therefore the US EPA regional screening level (RSL) for residential soil has been adopted.

For the purpose of remediation and management of asbestos impacted soil, the NSW EPA has adopted the technical aspects of the Guidelines for the Western Australia (WA) Department of Health (DOH) Assessment, Remediation and Management of Asbestos-contaminated Sites in Western Australia (May 2009). This document refers to the criteria of 0.001% weight per weight (w/w) for asbestos for friable asbestos and asbestos fines, below which the material can be used for 'all site uses'. The threshold criterion for commercial/industrial land use is 0.05% w/w.

The WA Guidelines (Section 4.1.6) state that when assessing the suitability of stockpiled material that contains ACM, ‘if the contamination is below the investigation criteria then the stockpile may be used as non-contaminated fill, subject to suitable controls (…). If any fibre of Fibrous Asbestos (FA) is found in the stockpile [Note; encompasses friable asbestos material, such as weathered ACM, and asbestos in the form of loose fibrous material such as insulation products], it would not normally be useable as 'clean’ fill and would be regarded as contaminated unless extensive sampling demonstrates otherwise.’

6.2 Acid sulfate soil criteria

The assessment criteria for field and laboratory testing of ASS have been derived with reference to the ASSMAC guidelines (1998).

Action criteria are based on texture and clay content of the soil being analysed and the volume of soil to be disturbed. For the purpose of this investigation the adopted action criteria is for medium texture soils (sandy loams to light clays) with over 1,000 tonnes to be disturbed. The criteria are outlined in Table 6.2. Should a lesser volume is disturbed or the nature of the material excavated is different, the criterion should be adapted accordingly using the ASSMAC guidelines. Further detail will be available in the ASS management plan (if required).

Table 6.3 ASSMAC (1998) adopted action criteria

Test	Units	Action criteria for medium textured soils (medium to heavy clays and silty clays)
S_{POS}	%	0.03
TPA/TSA	mol H^+/tonne	18

S_{POS}: peroxide oxidisable sulfur
TPA: total potential acidity
TSA: total sulfuric acidity

Should analytical results exceed these criteria and where excavation works are proposed where there is potential for ASS, an ASS management plan should be prepared and development consent obtained. For projects that disturb >1,000 tonnes of ASS soil with oxidisable sulfur criteria of less than or equal to 0.03%, a more detailed management plan and development consent would be required.

6.3 Waste classification criteria for soils

In order to assess the likely waste classification of soil excavated, analytical results for soils will also be compared to the values presented within the NSW Department of Environment, Climate Change and Water (DECCW) Waste Classification Guidelines (2009). The two measurable properties of contaminants used to classify waste are:

- the specific contaminant concentration (SCC) of any chemical contaminant in the waste expressed as milligrams per kilogram (mg/kg)
- the leachable concentration of any chemical contaminant using the toxicity characteristics leaching procedure (TCLP) expressed as milligrams per litre (mg/L).

The SSC test is an initial screening test for the classification of waste. Based on the SCC test alone, the concentration for each contaminant must be below the threshold concentrations as set out in the Waste Classification Guidelines. If a waste SCC test exceeds the SCC contaminant threshold values for general solid waste, further assessment using TCLP analysis may be used to determine the leachable concentration and class of waste.

If the SCC and TCLP values are exceeded for general solid waste, the waste must be classified as restricted solid waste. If the SCC and TCLP are exceeded for restricted waste, the waste must be classified as hazardous waste.

Where asbestos is positively identified within waste material, this may be classified as 'special waste'. However, if asbestos is mixed with other waste materials to form asbestos waste it must be assessed in accordance with the SCC and TCLP test described above and disposed of at a waste facility that can lawfully receive asbestos wastes.

The specific contaminant concentrations (SCC) and leachable concentration (LC) contaminant thresholds (CT) for general solid waste and restricted solid waste are set out in the Table 6.3.

Table 6.4 Waste classification criteria

Analyte	SCC (without TCLP)		SCC (with TCLP)		SCC (with TCLP)	
	Maximum values for classification without TCLP		Maximum values for leachable concentration and SCC when used together			
	General solid	Restricted solid	General solid		Restricted solid	
			LC	SCC	LC	SCC
Arsenic	100	400	5	500	20	2,000
Cadmium	20	80	1	100	4	400
Chromium	100	400	5	1,900	20	7,600
Lead	100	400	5	1,500	20	6,000
Mercury	4	16	0.2	50	0.8	200
Nickel	40	160	2	1,050	8	4,200
Benzene	10	40	0.5	18	2	72
Benzo(a)pyrene	0.8	3.2	0.04	10	0.16	23
Trichloroethylene	10	40	0.5	18	2	72
Total xylenes	1,000	4,000	50	1,800	200	7,200

All values in mg/kg unless otherwise stated
Copper and Zinc: no threshold values specified in waste guidelines
SCC: specific contaminant concentration
TCLP: toxicity characteristic leaching procedure
LC: leachable concentration (in ug/L)

6.4 Sediment assessment criteria

The concept design incorporates infilling of some existing water bodies at the Moorebank IMT site including ponds and drainage lines. Contaminated sediments that accumulate beneath such surface water bodies may contain substances that can adversely affect human health or the environment. Sediments may act as a source and a sink of dissolved contaminants and have the potential to influence surface water quality and aquatic ecosystems.

The ANZECC Fresh and Marine Waters Quality Guidelines (2000) recommend a hierarchical approach to the assessment of sediments based on an initial assessment of total contaminant concentrations against the Interim Sediment Quality Guidelines (ISQG) followed by further investigations/ analysis to determine bioavailability and toxicity of contaminants (as appropriate).

Where total concentrations of metals exceed the ISQG low criteria, no action is required. Where total concentrations exceed the ISQG low criteria but are less than ISGQ high criteria, an assessment against background concentrations should be made. Where reported concentrations exceed the low and high and background values, assessment of the bioavailability of the contaminants should be undertaken. Where the bio-available concentrations are below the ISQG low criteria, no further action is required. If concentrations exceed the ISQG low criteria, toxicity testing is required and contaminants that are found to be toxic would require remediation.

The adopted sediment assessment levels are presented in Table 6.4. It is important to note that these are not threshold values at which an environmental problem is likely to occur if exceeded, rather, if the trigger values are exceeded, further action may be required as described above.

Table 6.5 Adopted assessment criteria – sediments (mg/kg)

Analyte	ISQG[1] Low[2] (trigger value)	ISQG High[3] (trigger value)	Adopted assessment criteria
Arsenic	20	70	20
Cadmium	1.5	10	1.5
Chromium	80	370	80
Copper	65	270	65
Lead	50	220	50
Mercury	0.15	1	0.15
Nickel	21	52	21
Zinc	200	410	200
PCB	23	-	23
Total PAHs	4,000	45,000	400
Benzo(a)pyrene	430	1,600	430

all values in mg/kg

(1) ISQG: Interim Sediment Quality Guidelines.

(2) ISQG Low: Probable effects, concentrations below which biological effects would rarely occur (i.e. no further action would be required).

(3) ISQG High: Probable effects, concentrations below which biological affects would possibly occur (i.e. further action may be required).

6.5 Groundwater and surface water investigation levels

As part of the additional investigation works recommended under this RAP, groundwater and surface water quality (prior to dewatering and discharge) will need to be assessed against relevant criteria. The threshold concentrations presented in the ANZECC (2000) Fresh and Marine Waters Quality Guidelines are considered applicable for the protection of aquatic ecosystems of the receiving waters. As these guidelines apply to receiving waters, it is generally conservative to apply these to groundwater discharging to receiving waters. As the receiving waters (Georges River) are freshwater bodies, freshwater trigger values are considered most applicable for screening groundwater and surface water.

The concentrations of contaminants presented as groundwater investigation levels (GILs) are applicable for assessing ecological risks and human health risks from direct contact (including consumption) with groundwater. The GILs are the concentrations of a contaminant in groundwater above which further investigation or a response should be undertaken. GILs are based on Australian Water Quality Guidelines 2000, Australian Drinking Water Guidelines 2011 and Guidelines for Managing Risk in Recreational Waters 2008. The GILs provide values for drinking water and protection of fresh and marine ecosystems. The GILs do not provide data for toluene, ethylbenzene and PAHs; however, as the GILs are based on the ANZECC (2000) Fresh and Marine Waters Quality Guidelines, ANZECC freshwater low reliability trigger values for toluene, ethylbenzene and PAHs have been considered. The threshold concentrations presented in the ANZECC (2000) Fresh and Marine Waters Quality Guidelines are considered applicable for the protection of aquatic ecosystems of the receiving waters. As these guidelines apply to receiving waters, it is generally conservative to apply these to groundwater discharging to receiving waters. As the receiving waters (Georges River and Anzac Creek) are freshwater bodies, freshwater trigger values are considered most applicable for screening the concentrations of COCs identified in groundwater and surface water at the Moorebank IMT site.

The groundwater investigation levels are presented in Table 6.6.

Table 6.6 Groundwater investigation levels

Analyte	Freshwater ecosystem(1) (µg/L)	Drinking water(2) (µg/L)
Benzene	950	1
Toluene	180	800
Ethylbenzene	80	300
m- & p-xylene	200 (as p-xylene)	–
o-xylene	350	–
Total xylene	–	600
Arsenic (as As^V)	24	10
Cadmium	0.2	2
Chromium (VI)	1	50
Copper	1.4	2,000
Lead	3.4	10
Mercury	0.06	1
Nickel	11	20
Zinc	8	-
Total PAHs	3	-

Analyte	Freshwater ecosystem(1) (µg/L)	Drinking water(2) (µg/L)
Benzo(a)pyrene	-	0.01
Naphthalene	16	-
PFOA(3)	-	0.4(3)
PFOS(3)	-	0.2(3)
1,1,2-TCE	6,500	-
1,2-DCE	-	3
Vinyl chloride	-	0.3
Formaldehyde	-	500

(1) National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1) – Schedule B1 Investigation levels for soil and groundwater derived from the ANZECC (2000) Australian and New Zealand guidelines for fresh and marine water quality, protection of 95% of freshwater ecosystem.

(2) National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1) – Schedule B1 Investigation levels for soil and groundwater derived from the health values of the Australian Drinking Water Guidelines (NHMRC 2011).

(3) There is not currently an Australian guideline for perfluorinated chemicals in groundwater, therefore, the US EPA tap water screening level has been adopted as a conservative guideline for assessment, USEPA screening value for tap water (2001)

- No threshold value available

All values in µg/L

Schedule B1 also provides a framework for assessing the human health risk from petroleum compounds and fractions via the inhalation and direct contact pathways through the development and implementation of HSLs. The adopted carbon fraction ranges for the HSLs are based on TRH analysis after subtraction of BTEX compounds and naphthalene. The HSLs have been developed for sand, silt and clay soils based on soil texture classifications and criteria are listed for several depth intervals. Where there is reasonable doubt as to the appropriate soil texture to select, either a conservative selection should be made (i.e. sand) or laboratory analysis carried out to determine particle size and hence soil texture sub-class.

The groundwater HSLs that been adopted for this ESA are summarised in Table 6.7.

Table 6.7 Groundwater HSLs for vapour intrusion

Chemicals	Commercial/industrial (HSL D) (1)		
	SAND		
	2 m to <4 m	4 m to <8 m	8 m +
F1: TRH C_6-C_{10} less BTEX	6,000	6,000	7,000
F2: TRH >C_{10}-C_{16} less naphthalene	NL	NL	NL
Benzene	5,000	5,000	5,000
Toluene	NL	NL	NL
Ethylbenzene	NL	NL	NL
Xylene	NL	NL	NL
Naphthalene	NL	NL	NL

(1) NEPC (2013) National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1) - Schedule B-1 Investigation Levels for Soil and Groundwater - Table 1A(4) Groundwater HSLs for vapour intrusion - HSL D.

Values provided in µg/L.

NL: not limiting as the maximum potential vapour concentration is below the acceptable risk level.

It is important to note that these screening values are not threshold values at which an environmental problem is likely to occur if exceeded, rather, if trigger values are exceeded, further action is required.

6.6 Quality assurance and quality control

A summary of the quality assurance and quality control (QA/QC) compliance criteria for sampling and testing of samples is presented in Table 6.6.

Table 6.8 Groundwater investigation levels

Item	Objectives
Environmental Consultant	The Environmental Consultant should maintain Quality Assurance Systems certified to AS/NZS ISO 9001:2000.
Procedures	All work conducted in accordance with relevant statutory workplace health and safety (WHS) and environmental sampling guidelines as well as standard environmental field procedures.
Sampling	Collection of samples undertaken by appropriately qualified and experienced personnel
	Collection of samples undertaken following standard field procedures which are based on industry accepted standard practice and in general accordance (for soil) with the Australian Standard AS4482.1 (2005) Guide to the Sampling and Investigation of Potentially Contaminated Soil.
	Chain of custody documentation used to ensure the integrity of the samples from collection to receipt by the analytical laboratory.
Field equipment (PID, water quality meter)	Equipment used is to be serviced and calibrated as per the manufacturer requirements.
	Equipment should be calibrated at the beginning of each day of fieldwork and during the day (as required).
Equipment decontamination	Decontamination of equipment should be undertaken after each sampling episode.
	One rinsate blank per day should be taken and rinsate blanks are to be non-detect for the potential contaminants of concern.
Transportation	Samples should be transported with appropriate sample preservations, within the specified holding times and accompanied by a chain of custody.
	One trip blank per sample batch should be sent to the laboratory to assess the potential for cross contamination to have occurred during fieldworks and/or sample transport. Trip blanks to be non-detect for the contaminants of concern.
Field QA/QC – sampling to industry standard procedures	Approximately 1 in 10 intra-lab duplicates.
	Approximately 1 in 20 inter-lab laboratory duplicates.
	1 trip blank per sampling event.
	1 trip spike per batch of volatiles.
	1 equipment rinsate per sampling event.
	Field and laboratory acceptable limits should be between 30–50% RPD for non-volatiles and semi volatiles as stated by AS 4482.1–2005.
	Non-compliances should be documented in respective reports.
Laboratory analysis	Analysis should be carried out by laboratories with NATA certification for all the required analysis.
	Detection limits should be sufficient to enable comparison against the appropriate guidelines.

Item	Objectives
Acceptable limits for laboratory QA/QC samples	Surrogates: 70% to 130% recovery.
	Matrix spikes: 70% to 130% recovery for organics or 80%-120% recovery for inorganics.
	Control samples: 70% to 130% recovery for soil or 80% to 120% recovery for waters.
	Duplicate samples: <4 PQL - +/- 2PQL 4-10PQL – 0.-25 or 50%RPD >10PQL – 0-10 or 30%RPD.
	Method blanks: zero to <PQL.
Reporting	Environmental assessment reports prepared following the additional works should generally comply with the NEPM (2013).

7. Remediation works methodology

This section outlines the processes and procedures that are to be followed in order to fulfil the objectives of the RAP whilst managing health safety and environmental controls.

7.1 Planning

The Contractor is required to have appropriate management plans in place prior to commencement of the demolition, remediation and validation works to control WHS, environmental and site security aspects.

7.2 CEMP

A CEMP should be prepared (by the appointed earthworks Contractor) for all excavation and remediation works. Any materials processing activities undertaken on-site should be appropriately designed and managed to minimise environmental impacts. The CEMP should also include requirements for decontamination facilities both to minimise the spread of dust and dirt to the surrounding locale and to ensure that a decontamination facility for workers (a station with showers, hand and eye washing facilities etc.) is available to on-site workers.

7.3 WHS plan

The objective of the WHS plan is to address the health and safety of workers and residents in the surrounding areas by considering site security, excavation safety, vibration, noise, odour and dust levels. The WHS plan should cover site specific requirements associated with the contaminants identified within the soils.

All works should conform at a minimum to the requirements of the NSW Work Health & Safety Act 2011 and associated Regulations. Typically the WHS plan should address the following issues:

- regulatory requirements
- responsibilities
- hazard identification and control
- air monitoring (including action levels) during excavation and construction (if necessary)
- noise
- odours
- chemical hazard control
- handling procedures
- personal protective equipment (PPE)
- work zones
- decontamination procedures
- emergency response plans

- contingency plans
- incident reporting.

7.4 Site preparation/preliminaries

Table 7.1 outlines the preliminary measures that are required to prepare the Moorebank IMT site for remediation works.

Table 7.1 Site preparation and preliminaries

Item	Requirement
Community consultation	Prior to conducting any remediation works, a community consultation plan may need to be developed and implemented. The notice should: ▪ indicate that remediation and excavation work is to be carried out ▪ state the time and date the work is to commence ▪ provide the contact information and processes required for registering any complaints. In general, any community consultation would be carried out in general accordance with Schedule B(8) *Community Engagement and Risk Communication* of the NEPM (2013). However, it is further noted that community consultation for the remediation activities may be incorporated into an overall community consultation strategy for the Project.
Access	Access to the remediation areas will be controlled by the lead contractor performing the works and will be off limits to all non-essential personnel. Public will not have access.
Signage	Signage will be installed, with direction to key areas (including to the site offices, decontamination units, wash down areas, lunch facilities, designated smoking areas, site toilets and exits) and traffic restrictions. Signage at the main access points will include afterhours contact details.
Fencing and hoarding	Perimeter security fencing will be maintained around remediation areas where physical barriers (such as walls and buildings) are not already in place. Shade cloth should be installed on fences and hoardings. Additional fencing will be erected where required to secure work areas and exclusion zones. Regular maintenance and repair of all retained fences and hoardings will be undertaken during the period of the remediation works.
Site haul roads/ parking	Parking for private, pick-up and delivery and site vehicles should be put in place. Additional designated areas may need to be marked as appropriate.
Decontamination facility installation	A wheel washing facility may have to be installed for all vehicles leaving the site, either for waste disposal or other activities. This will minimise spread of dust and dirt impacting off-site roads. A decontamination facility for workers (a station with showers, hand and eye washing facilities, etc.) should also be available during the works.
Supply of utilities	The installation and commissioning of all temporary site services (e.g. electricity, water, sewerage and telecommunications) required for the duration of the works and to the requirements of the appropriate regulatory authorities will be undertaken. All approvals in respect to the installation, operation and eventual removal of temporary services will be obtained.
Contractor's facilities	All site accommodation and facilities required for the remediation works will be established in conformance with relevant regulations and Authorities requirements. Existing site infrastructure may be utilised for this purpose. Licensed persons in accordance with statutory requirements will carry out all connections. The following accommodation facilities may be required: ▪ site offices, stores, work sheds (including decontamination facilities), lunchrooms and changing areas for the use of the remediation contractor, all subcontractors and consultants ▪ temporary site sheds, toilet blocks and decontamination units ▪ bins for rubbish generated by personnel.

Item	Requirement
Working hours	Works under the RAP would be undertaken in accordance with hours approved detailed within the environmental impact statement (EIS) for the Project.
Contact information	The contact details of the remediation contractor and environmental consultant should be displayed in a prominent location, such as the Moorebank IMT site entrance or entrance to specific remediation work areas.

7.5 Removal of UXO

It is understood that Defence has taken reasonable steps to locate and remove remnant explosive ordnance related material. However, UXO surveys undertaken within the Moorebank IMT site as part of the Project feasibility study have identified that some UXO and EOW is present.

A specialist contractor should be appointed to undertake site-wide clearance of UXO for all accessible areas prior to Defence disestablishment or in conjunction with remediation activities. There are some threatened species and heavily vegetated areas that are not proposed to be cleared or worked based on the Moorebank IMT concept design, therefore comprehensive UXO clearance may not be possible. For such areas, a management plan relating to UXO should be implemented.

There is the potential for future users of the Moorebank IMT site to encounter remnant UXO items that may include fired and unfired rifle and pistol ammunition (primarily blank training items), fired and unfired flares and smoke grenades, metallic smoke grenade levers and other components. Areas of the Moorebank IMT site that are considered more likely to be subject to EOW finds in the future are the areas obscured by the local topography or dense vegetation and where the depth of /EOW prevented detection during previous UXO related surveys.

A UXO management plan should be developed with the objective of detailing a framework for addressing the discovery of UXO/EOW to ensure a safe working environment for all project staff, visitors and contractors during remediation and site development works. The UXO management plan will document any areas that will not be cleared of UXO and will document measures for the management of any uncleared areas. Where the need for vegetation preservation outweighs the need for UXO clean-up, justification of this approach will be clearly documented within the UXO management plan.

Personnel with the highest potential for discovering remnant UXO/EOW are considered to be those engaged in survey works including (ecology, heritage and cadastral surveys), land investigation works (geotechnical and contamination investigation and remediation works), plant operations (vegetation removal or reestablishment works, soil excavation and movement).

Under the UXO management plan, appropriate management personnel have designated responsibilities in the event that UXO/EOW is identified. The implementation of the management plan will also involve UXO awareness training as part of the overall safety induction for all staff engaged in site works, regardless of whether they are directly involved in intrusive investigation or excavation activities.

7.6 Additional assessment

During, or prior to remediation works, further investigation works should be undertaken to address identified knowledge gaps. An SAQP should be developed which details the investigation design for the elements listed in the following sections. The SAQP should include rates and methods of testing (including testing of ASS), and development of data quality objectives (DQOs) and data quality indicators (DQIs).

7.6.1 Tank inventory survey

A specialist contractor should be appointed to use ground penetrating radar (GPR) or similar techniques in order to locate and document all existing ASTs and USTs and associated infrastructure to inform the tank removal program scope and ensure that all tanks and associated infrastructure are removed and appropriately validated.

7.6.2 Acid sulfate soil investigation

Further testing of soils is necessary to confirm the presence and extent of acid generating lithology. Should further testing confirm the presence of ASS a management plan should be developed in accordance with the ASSMAC Assessment Guidelines (1998), with active on-going management through the construction phase as prescribed within the plan (as required) and off-site disposal would need to be in accordance with the NSW Waste Classification Guidelines Part 4: Acid Sulfate Soils (2009).

7.6.3 Additional groundwater monitoring

It is recommended that additional groundwater monitoring be undertaken on all serviceable groundwater monitoring wells located in the vicinity of the ABB boundary. Results will be used to inform the remedial approach for groundwater in this area (if required).

Wells will be gauged prior to sampling with an interface probe to detect possible non-aqueous phase liquids. The wells will then be sampled using low flow techniques to minimise the generation of waste purged water and to reduce the loss of VOCs. All purged water (including water generated during well development) should be deposited into 205 L drums to be removed by a licensed waste contractor for off-site disposal to a waste facility licensed to accept the liquid waste. In situ monitoring of field parameters will be undertaken and parameters systematically recorded, including pH, reduction/oxidation potential, electrical conductivity, dissolved oxygen, temperature and a visual assessment of turbidity. Once these parameters have stabilised, a sample will be taken.

Groundwater samples will be obtained using dedicated tubing and nitrile gloves will be changed between each sampling episode to minimise the potential for cross contamination. Samples will be decanted into new laboratory-supplied containers and labelled with a water proof pen then sent (on ice) to a National Association of Testing Authorities (NATA) accredited laboratory via a courier under chain of custody documentation. Samples should be scheduled for TRH, BTEX compounds, PAHs (ultra-trace) dissolved heavy metals, PCBs, VOCs and SVOCs and compounds considered to be natural attenuation indicators. On receipt of the results a preliminary assessment should be made to evaluate whether monitored natural attenuation would be a viable option for groundwater remediation.

7.6.4 Surface water and sediment sampling

Surface water samples should be obtained using a stainless steel bucket to collect a 5 to 10 L volume of water. Water should then be decanted into laboratory supplied containers. The bucket is to be decontaminated with a phosphate free detergent and nitrile gloves changed between each sampling episode to minimise the potential for cross contamination. Field parameters should be recorded as for groundwater. The coordinates of the sample location should be recorded using a hand held GPS unit.

Sediments should be obtained using a stainless steel grab sampler. Decontamination procedures will be the same as for surface water.

Samples should be analysed for a range of potential contaminants of concern including TRH, BTEX compounds, PAHs, dissolved heavy metals, PCBs, VOCs and SVOCs and any additional analyses that may be required in order to apply for waste water discharge consents (additional analyses should consider Sydney Water Trade Waste Policy and will be specified under a trade waste management plan (if required).

7.7 Removal of fuel storage infrastructure

As part of the decommissioning works AST, USTs and any associated infrastructure are to be removed. If contaminated soil is identified in the vicinity of infrastructure during these works, it should also be removed. Removal of underground tanks should be undertaken in general accordance with the UPSS Regulation (2008).

Infrastructure currently present is understood to include, but is not necessarily limited to, the following:

- eight known USTs and one AST (as listed in Table 3.2)
- various aboveground and underground fuel lines, piping and other infrastructure associated with the tanks
- areas of concrete/bitumen paving including the forecourt area within the PRA Yard.

The following procedures should generally be followed for removal of tanks:

- A licensed liquid waste transporter should initially remove any liquid contents from the tank and dispose of any liquid waste to a suitably licensed liquid waste facility. The contractor must provide appropriate documentation for the waste disposal.
- The tank should then be excavated (for USTs) or dismantled (for ASTs), rendered safe and transported off-site by a licensed contractor for destruction/disposal. The contractor must provide formalised certification of the tank destruction/disposal.
- Associated infrastructure (including drains, lines and sumps) should also be removed and ‘chased out’. These should be disposed of appropriately.
- Any grossly contaminated soils immediately surrounding the tank and associated infrastructure should be excavated. The extent of impacted soil around each UST is currently unknown. Contaminated soil/fill material present in these areas will be ‘chased out’ during the excavation works based on visual, olfactory and preliminary field test results (measurement of VOCs using a PID.
- Excavated impacted soil is to be temporarily stockpiled, separately to any clean soils and sampled and analysed for waste classification purposes prior to transportation to an off-site waste disposal facility as soon as practicable following receipt of waste classification results to minimise dust and odour issues through storage of materials on-site.
- Stockpiled impacted soils should be stored on hardstand areas where possible or on high density polyethylene (HDPE) sheeting and the stockpiled areas are to be securely bunded using silt fencing and hay bales to prevent surface water (and silt laden surface water) from entering or leaving the stockpiles or the Moorebank IMT site.
- All excavation works should be undertaken by experienced licensed contractors, experienced in the remediation of hydrocarbon contaminated soils.
- Validation of excavations will be required as described in section 8 of this report.

7.8 Excavation of contaminated surficial soils

During the excavation and removal of the areas identified in Table 3.1, the following process should be followed:

- Contaminated soil/fill material present in these areas will be 'chased out' during the excavation works based on visual, olfactory and preliminary field test results.
- Excavated impacted soil is to be temporarily stockpiled and sampled and analysed for waste classification purposes. Following receipt of waste classification results, the material should be transported to an off-site waste disposal facility as soon as practicable to minimise dust and odour issues through storage of materials on-site.
- Stockpiled impacted soils should be stored on a sealed surface and the stockpiled areas are to be securely bunded using silt fencing to prevent surface water (and silt laden surface water) from entering or leaving the stockpiles or the IMT site.
- All excavation works should be undertaken by experienced licensed contractors, experienced in remediation projects and the handling of contaminated soils.

During the removal of the identified asbestos impacted soil, the following additional processes should be undertaken:

- All asbestos removal, transport and disposal must be performed in accordance with the Work Health and Safety Regulation 2011 (WHS Regulation).
- The removal works are to be conducted in accordance with the National Occupational Health and Safety Commission Code of Practice for the Safe Removal of Asbestos, 2nd Edition [NOHSC 2002(2005)], April 2005.
- As non-friable asbestos cement fragments are the key concern, a bonded asbestos removal licence issued by WorkCover will be required for the removal of asbestos impacted soil.
- Environmental management and WHS procedures should be put in place for the asbestos removal during excavation to protect the workers, surrounding residents and environment.
- Temporary stockpiles of ACM impacted soils should be covered to minimise dust and potential asbestos release.
- An asbestos removal clearance certification will be prepared by an occupational hygienist at the completion of the removal work. This would be prepared following the systematic removal of ACM and any impacted soils from the IMT site and validation of these areas (through visual inspection and laboratory analysis of selected soil samples).
- Asbestos fibre air monitoring will be undertaken during the removal of the asbestos materials and in conjunction with the visual clearance inspection. The monitoring will be conducted in accordance with the National Occupational Health and Safety Commission Guidance Note on the Membrane Filter Method For the Estimating Airborne Asbestos Fibre, 2nd Edition [NOHSC 3003(2005)], April 2005.
- Validation of all excavations will be required as described in section 8 of this report.

Material should be tested for contaminants that are likely to exist in the area from which they were excavated. These are likely to comprise mainly TRH, BTEX compounds, PAHs, metals and asbestos but analyses requirements should be evaluated at the time of sampling.

7.8.1 Material segregation

During excavations, materials should be segregated based on visual, olfactory and preliminary field test results (measurement of VOCs using a PID). Excavated material will be segregated to separate material that can be reused on-site from material that cannot (in which case it will be disposed off-site). Waste materials will be appropriately classified and potentially reusable materials will be validated by sampling and laboratory testing to verify suitability for reuse. The works will be carried out in a manner designed to optimise the segregation of clean soil and likely contaminated materials. The segregated materials will be stockpiled on-site.

Material which has been found to be suitable for reuse will be used as backfill (subject to geotechnical suitability). Based on the previous environmental works, it is considered that the different categories of materials that could be encountered at the Moorebank IMT site and subject to segregation and the possible treatments for materials would be as detailed in Table 7.2.

Table 7.2 Summary of material segregation

Material description	Possible treatment after segregation
Ashy fill, coal or tar	Removal off-site by a licence waste operator
Metal components (car bodies, steel, corrugated iron but NOT items of military ordnance which should be managed via the UXO management plan)	Recycling
Putrescible waste (except green waste)	Disposal off-site to a licensed putrescible waste landfill
Materials with visible oily liquid/sheen and petroleum hydrocarbons odour	Removal off-site by a licence waste operator
Building rubble including metals, wood, bricks, concrete, glass, plastic, tiles (excluding concrete, metal and ACM)	Screening, then reuse of fine fraction for reinstatement at depth and recycling or disposal of coarse fraction
ACM	Disposal as asbestos waste either off-site or in containment cell on-site.
Green waste (including natural wood)	Disposal as green waste
Bitumen	Disposal as inert waste
Concrete	Crushing and recycling on-site for reuse as sub-base (provided geotechnically suitable)

Any proposed segregation technique should take into account the possible presence of ACM/asbestos waste within the fill material, and therefore prevent the dissemination of ACM during material processing.

7.8.2 Screening

The aim of screening is to eliminate oversize materials unsuitable to be reused directly as backfill, and to help with the segregation of materials. Equipment used to screen materials may include coarse static primary screens followed by a vibrating screen of appropriate mesh size.

As per segregation, any proposed screening technique should take into account the possible presence of ACM within fill, and implement measures to prevent the dissemination of ACM during material processing. This may include negative pressurisation within an enclosure, or dust suppression measures. Following screening, the soil should be placed segregated storage bays for future reuse.

7.8.3 Crushing

Crushing will be required particularly for large concrete blocks, as it will also enhance compaction following placement where reused. The equipment used to crush materials will be defined by the remediation contractor.

7.8.4 Waste classification

Materials that have been assessed to be unsuitable for reuse on-site (due to contamination or geotechnical reasons) should be classified according to the NSW Waste Classification Guidelines (2009). TCLP analysis may have to be undertaken to help reducing the waste classification and hence disposal costs. TCLP procedures involve the tumbling of a sample of soil within a vessel containing acidified water to simulate the infiltration of leachate through the soils which may occur when the waste is transferred to a landfill environment. Following TCLP, the extract is analysed to determine the leachable concentrations of any contaminants.

The transport to an off-site waste disposal facility should be carried out as soon as practicable to minimise dust and odour issues through storage of materials on-site.

7.9 Materials management

7.9.1 Tracking

A management tracking system for excavated materials will be developed to ensure the proper management of the material movements at the Moorebank IMT site, particularly during excavation works. The plan will aim to:

- maximise the volume of clean material recovered from excavation work
- minimise the cross-contamination of materials
- track materials from ‘cradle to grave’.

The plan will be implemented by personnel qualified and experienced in the operation, monitoring and response associated with similar management plans and material tracking systems.

A critical part of the material management plan will be the material tracking system, to control each of the different material handling phases that may occur during the project (i.e. excavation, demolition, stockpiling, pre-treatment, treatment, reuse or on-site or off-site disposal). The disposal locations will be determined by the remediation contractor.

The ‘cradle to grave’ tracking system will aim at tracking all site materials, in order to provide detailed and accurate information about the location and quantity of all materials both on and off-site from the time of their excavation until their treatment/reuse/disposal.

For any truck leaving, the origin of material, material type, approximate volume and truck registration number should be recorded. This information, along with the landfill docket number, should be provided in the remediation validation report.

7.9.2 Stockpiling of materials

Stockpiles should be managed in accordance with CEMP. Stockpiling of potentially contaminated materials should also consider the requirements included in the Table 7.3.

Table 7.3 Stockpiling of materials

Item	Requirement
General	All stockpiles should be maintained in an orderly and safe condition. Batters should be formed with sloped angles that are appropriate to prevent collapse or sliding of the stockpiled materials.
Stockpile locations	The location of the stockpiles will be selected to fit with the expected stages of the project. Stockpiles will only be placed at approved locations and will be strategically located to mitigate environmental impacts while facilitating material handling requirements. Contaminated materials or potentially contaminated materials will only be stockpiled in unremediated areas of the Moorebank IMT site or at locations that do not pose any risk of environmental impairment of the stockpile area or surrounding areas (e.g. hardstand areas).
Stockpile area preparation	Stockpiles will only be constructed in areas of the Moorebank IMT site that have been prepared in accordance with the requirements of this RAP. All such preparatory works will be undertaken prior to the placement of material in the stockpile. Stockpiles must be located on sealed surfaces such as sealed concrete, asphalt, high density polyethylene or a mixture of these, to mitigate appropriately potential cross contamination of underlying soil. The stockpile areas are to be securely bunded using silt fencing and hay bales around the perimeter of each stockpile area to prevent surface water/silt laden surface water from entering or leaving the stockpiles. Access routes will be established around the material stockpiles to enable access from adjoining haul roads.
Stockpile covering	The stockpiles of contaminated material will have to be covered with a waterproof membrane (such as polyethylene sheeting) to prevent increases of moisture due to rainwater infiltration and to reduce wind-blown dust or odour emission.
Validation of stockpile footprints	After removal of a stockpile in an area, the surface on which the stockpile was placed should be validated. The number of samples collected would depend of the area of the stockpile, and be representative of surface soil conditions.

7.9.3 Backfilling

Before any material is reused on-site, it should be validated as per the requirements set out in section 8.

Following excavation and validation works, the excavations should be backfilled (where necessary). Backfilling will be carried out either with processed materials from the Moorebank IMT site or imported clean material. Any backfilling material should be characterised and deemed appropriate before being used at the IMT site (with consideration also as to the geotechnical suitability of materials). Any processed materials/soil should be tested before reuse as described previously. Where clean fill importation is required, this should be certified suitable for the intended use. This procedure would involve:

- reviewing the history of the source of the material
- visually inspect it for foreign material, unusual staining and any odours
- test the material at a rate of one per 100 m^3, if the material is not virgin excavated natural material (VENM)
- if testing, analyse the material for heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc), TRH, BTEX compounds, PAHs, OCPs, PCBs and asbestos. The concentrations should be lower than the remediation criteria presented in section 6.

7.9.4 Capping

For any capping works, a geotextile layer should be placed above the fill to identify the limit between fill and capping. Areas where contamination has not been fully removed will require an EMP which will include details of the location and nature of the contamination left on-site and recommendations for the short-term and/or long-term management and maintenance of the control measures implemented.

8. Validation and monitoring plan

8.1 Data quality objectives

The data quality objectives (DQOs) for any validation and monitoring events (including a summary of inputs and methodology) are presented below. All field work (sampling and monitoring) will be carried out in general accordance with industry standard field procedures.

Table 8.1 Data quality indicators

Element	Summary
Purpose	Monitor effectiveness of remedial works undertaken, validate remediated soil and groundwater.
Procedures	All approvals and licenses required must be obtained prior to work commencing. Sign site register (and induction, if required), inspection of remediation equipment. All field work information to be recorded on field day sheets. Gauging and sampling undertaken to standard industry protocols by experienced staff.
Potential contaminants	TRH, PAHs, asbestos and heavy metals.
Storage and transport	Samples collected placed directly into laboratory prepared containers and stored in a secure chilled container. Chain of custody to be used to ensure the integrity of the samples from collection to receipt by the analytical laboratory.
Laboratory	All laboratories used should comply with AS/NZS ISO 9001:2001 quality assurance programs, be NATA accredited and perform their own internal QA/QC programs.
QA/QC – field	Sampling to standard industry procedures - 1 in 10 blind duplicates (intra-laboratory) to the primary laboratory and 1 in 20 blind duplicates (inter-laboratory) to the secondary laboratory. Field and laboratory acceptable RPD limits are to be less than 30% as stated in NEPM (2013). RPDs <100% are considered acceptable for volatiles. Non-compliance is to be documented in report and sample to be re-analysed or higher level to be conservatively adopted.
QA/QC – laboratory Duplicates, spikes, blanks and surrogates – acceptable limits	If duplicate results are not satisfactory, non-compliance is to be documented in laboratory reports. Primary laboratory QA/QC acceptance limits are as follows: ▪ surrogates, matrix spikes and control samples: 70% to 130% recovery or 80%-120% recovery for inorganics and waters; ▪ duplicate samples: <4PQL - +/- 2PQL, 4-10PQL – 0.-25 or 50%RPD, >10PQL – 0-10 or 30%RPD; and ▪ method Blanks: zero to <PQL.

8.2 Validation sampling

8.2.1 Excavations

Validation sampling is to be undertaken following removal of identified contaminated material to ensure that the lateral and vertical extent of the contamination has been defined.

For large excavations, the sampling density should be in accordance with NSW EPA Sampling Design Guidelines (1995). For walls, samples should be collected at an interval sufficient to assess the wall contamination status.

Validation samples collected would have a duplicate head-space sample taken, that will be screened on-site using a PID. Analysis of the head-space samples consist of a snap lock bag filled with the sampled soil to obtain a ratio of approximately 1:5 ratio of soil to air. The sample would then be left to equilibrate. A small hole is made through the snap lock seal and the probe of the PID inserted. The VOC reading for the sample would be recorded as a guide to vapour phase contamination.

All soil samples would be deposited into laboratory supplied containers and submitted to a NATA registered laboratory for certified analysis of selected analytes.

8.2.2 Stockpiles (reuse on-site and waste classification)

Samples will be obtained directly from the stockpile using a hand trowel or hand auger. Sample locations will be spread evenly over the material and taken from at least 0.3 m depth, so as to characterise the remediated soil as a whole and minimise any loss of volatiles.

Stockpiled soils and soils sampled as part of site validation process should to be screened for volatile organics using an appropriately calibrated PID.

8.2.3 Reuse on-site

Prior to reuse on-site, stockpiled material would be tested as specified in Table 8.2.

Table 8.2 Materials sampling for reuse

Material type	Rate of testing/analyses
Excavated natural material that is visually free from contamination	10 composite samples per 4,000 tonnes, as per excavated natural material exemption 2012[1].
Material excavated from the vicinity of underground fuel storage infrastructure	As per the Guidelines for Assessing Service Station Sites (EPA1995), one sample per 25 m^3 should be collected and analysed for site contaminants. Samples should be collected from the undisturbed bulk of the material, rather than from surface soils.
Material potentially containing asbestos	**14 samples per 1,000 m^3 (as per section 4.1.6 of the WA asbestos guidelines). These guidelines recommend that samples should be 10 L in size.**

(4) Protection of the Environment Operations (Waste) Regulation 2005 – General Exemption under Part 6, Clause 51 and 51A, The excavated natural material exemption 2012.

Reused material should be tested for contaminants that are likely to exist in the area from which they were excavated. The results of the analyses should be compared to relevant screening criteria for commercial/industrial land use.

8.2.4 Waste classification

Prior to off-site disposal, stockpiled material would be sampled at a rate of one sample per 100 m^3 (possibly less for large volume of uniform material) and analysed for TRH, BTEX compounds, PAHs, heavy metals and asbestos to classify the waste as per the Waste Classification Guidelines (2009).

For small volumes of material, enough samples must be collected to enable a statistical calculation of the overall contaminant concentration using the upper confidence limit (UCL) of 95% of the mean.

8.2.5 Imported fill material

Following characterisation/validation, suitable materials may be required to backfill remedial excavations created by short and medium-term remedial works. These materials should be sourced as follows (in the order of preference):

- from the site, provided they are chemically and geotechnically suitable for the proposed end use
- imported VENM.

Imported material should be inspected at the source and sampled at the rate of one sample per 100 m^3 (possibly less for large volume of homogenous material). Imported fill samples should be submitted for analysis of TRH/BTEX compounds, heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc), PAH, OCPs, PCBs and asbestos.

8.3 Groundwater

Wells to be monitored will be selected based on previous analytical data. The wells where contaminant impacts were identified during the Phase 2 ESA should be sampled. Wells will be gauged using an electronic air/oil/water interface probe cleaned between each well, purged, the physio-chemical parameters recorded and sampled using micro purge technique to reduce the generation of excess water for disposal.

The groundwater samples collected will be analysed for TRH, BTEX compounds, PAHs (ultra-trace), dissolved heavy metals, PCBs, VOCs and SVOCs.

8.4 Reporting

Following the remediation and validation works, a validation report should be prepared in general accordance with the NEPM (2013) and NSW EPA (2000) *Guidelines for Consultants reporting on contaminated sites*. The validation report should detail the extent and nature of the remedial works undertaken, characterisation and disposal of contaminated soils and the validation of imported clean fill and topsoil (if any). The report should include the sections listed below:

- executive summary
- scope of works
- site identification
- site history
- site conditions and surrounding environment
- geology and hydrogeology
- previous investigation results
- summary of RAP

- validation criteria
- nature and extent of the remediation undertaken
- sampling and analysis plan and sampling methodology
- field and laboratory QA/QC
- results of the sampling of imported fill materials, compared to the relevant guidelines
- results of any validation sampling, compared to the relevant guidelines
- result of the survey carried out after removal of the materials
- contractor supplied information
- discussion of the land use suitability at the completion of remedial works
- conclusions.

It should be noted that to enable the validation report to be produced, the contractor undertaking the works must supply information including (but not limited to) the following:

- quantities of waste disposed of or reused
- descriptions of the waste types disposed of or reused
- details of the receiving facility/facilities accepting waste from the Moorebank IMT site or areas where materials have been reused
- disposal dockets for the waste disposed
- details of any imported materials (including VENM certification, laboratory results, origin and supplier, quantities and areas of placement)
- survey data (including surveys of excavations and following backfilling works).

Any residual contamination issues, risk assessment and ongoing management or reporting should be documented in a post remediation EMP (as required). The development of the EMP and its contents will be dependent on the remediation measures undertaken and the subsequent validation outcomes.

9. Control measures

9.1 EIS

The remediation works would be carried out in accordance with the mitigation measures outlined in the EIS for the Project and any conditions of approval.

9.2 Dust

During earthworks, dust minimisation systems shall be put in place by the Contractor, such as water carts or sprinkler systems to prevent airborne migration of dust and contaminants. All stockpiled soil will be covered to minimise dust generation. Air monitoring shall be undertaken as required to establish that controls are satisfactory.

9.3 Noise

Increased noise levels may result from the use of additional mechanical equipment on the IMT site during the course of the project. Any excavation works would only be undertaken during normal working hours. To mitigate any noise, which may arise as a result of site works, all works will be carried out in accordance with all applicable state and local noise regulations and will be monitored.

9.4 Vapour and odours

Excavation and stockpiling of contaminated soil may result in the generation of vapours and odour, which may be unacceptable to site workers, nearby site workers and/or residents and regulators (such as Council and EPA). Organic vapours and odours are likely to be most significant during excavation and stockpiling of soils and loading of soils into trucks particularly during the underground tank removal works. At these times consideration should be given to prevailing weather conditions and should distinct odours be detected, site works should cease until the odours can be reduced or controlled.

Inhalation of odours or potentially toxic vapour is considered to be an acute health risk with the undertaking of subsurface excavations, hence periodic monitoring of the ambient air within the immediate work area should be undertaken. If the ambient air concentration of VOCs is greater than 5 ppm for a sustained period, work should cease until levels drop. Alternative control measures could be implemented, including the following:

- workers should be fitted with appropriate respirators for continuation of site works in the area
- wetting down the excavated material with the use of water sprays and/or commercial odour suppressants such as Biosolve
- all contaminated material loaded onto trucks for off-site disposal to be securely covered.

9.5 Water and sediment management

9.5.1 Surface water management

During soil remediation works, any stockpiled or land farmed soils should be suitably covered and bunded to prevent run off of contaminated water or soil to the surrounding environment, including storm drains or removed from site. Control measures should be established to prevent surface water runoff entering and leaving excavation and stockpile areas. Control measures may include:

- temporary bunding or diversion drains
- HDPE sheeting placed under stockpiles
- silt fences/hay bales to surround stockpiles
- protection of existing drains with silt fencing/hay bales.

These mitigation measures should be regularly inspected to ensure that they are in good condition and if necessary upgraded where their performance is deteriorating.

9.5.2 Sub surface seepage and accumulated excavation water

There is the potential for water to accumulate in excavation areas. If water does accumulate, it will require removal prior to validation and reinstatement. Water accumulated in excavations will be sampled for the appropriate contaminants of concern and upon receipt of the analytical results, management or disposal options will be formulated.

9.5.3 Sediment encroachment

Drains, gutters, roads and access ways shall be maintained free of sediment. Gutters and roadways should be swept regularly to keep them free of sediment. Control measures as for surface water should be implemented and maintained.

9.5.4 Traffic management planning

A traffic management plan should be prepared before the works commence. Relevant stakeholders should be consulted prior to selecting the most suitable transport route. All haulage routes for trucks transporting soil, materials, equipment and machinery to and from the IMT site shall:

- comply with all road traffic rules
- minimise noise, vibration and odour to adjacent premises
- utilise state roads and minimise use of local roads.

All site vehicles must:

- conduct deliveries of soil, materials equipment or machinery during the hours of remediation
- securely cover all loads to prevent any dust or odour emissions during transportation
- exit the IMT site in a forward direction
- not track soil, mud or sediment onto surrounding pathways or roadways.

10. Contingency planning

10.1 Remedial contingencies

At this stage it is anticipated the proposed remedial technologies should be effective in dealing with the contamination and geotechnical unsuitable material present, however remedial contingencies may be required should the scenarios detailed in Table 10.1 arise.

Table 10.1 Remedial contingencies

Anticipated problems/scenarios	Actions required
Soil/fill with obvious signs of contamination (visual, odour, staining, ACM) not identified during previous investigation are encountered, particularly at site boundaries	Work to be suspended until environmental consultant can further assess impacted soils/materials and associated risks.
LNAPL encountered	Review of groundwater conditions on-site, may require further groundwater investigations/remediation and longer-term management plan.
Additional underground tanks are encountered at the Moorebank IMT site during redevelopment works	Work to be suspended until environmental consultant can further assess impacted soils/materials and associated risks. Tank removal works to be overseen and validated by environmental consultant.
Asbestos wastes are encountered where not expected	Work to be suspended and asbestos waste removed by a suitably qualified contactor, in accordance with NSW regulations.
Screened material designated for reuse is assessed to be unsuitable to be reused on-site for geotechnical reasons	Removal off-site or use in areas of the Moorebank IMT site with less geotechnical constraints (non-load bearing areas or for earth bunds/noise walls etc.).
Additional groundwater monitoring reveals that contaminant impacts may present a risk to sensitive receptors	Groundwater modelling to be conducted to fully determine possible impacts to sensitive receptors.
Natural attenuation of groundwater impacts is not demonstrated or deemed to be ineffective	Consider alternative technologies for groundwater remediation.
Changes in proposed future land uses at the Moorebank IMT site	Review of the remediation works completed for the IMT site to ensure land is suitable for more sensitive end uses.
Chemical / fuel spill occurs	Stop work, use accessible soil or appropriate absorbent material on-site to absorb the spill (if practicable). Stockpile the impacted material in a secure location, sample and determine the appropriate disposal/ treatment option.
Elevated dust levels	Dust levels should be monitored during the remediation works. Use water sprays to suppress the dust or stop site activities generating the dust until it abates.
Noise levels exceeding applicable criteria	Noise levels should be monitored during the remediation works. Identify the source, isolate the source if possible, modify the actions of the source or erect temporary noise barriers if required.

Anticipated problems/scenarios	Actions required
Odours/ vapours noticeable outside site boundaries	Odour levels should not cause annoyance at sensitive receptors (site workers, adjacent site users and local residents) beyond the IMT site boundary. Odour and vapours outside site boundaries should be monitored during the remediation works. Stage works to minimise odours/vapours. If excessive organic odours/vapours are being generated, stop works and monitor ambient air for organic vapours with a PID and odours at the IMT site boundaries nearest to the work area. Implement control measures including respirators for on-site workers, use of odour suppressants, wetting down of excavated material.
LNAPL migrating to other areas of the Moorebank IMT site	While no LNAPL has been detected at the Moorebank IMT site, it may be present particularly in areas of underground fuel storage. Removal of the ground surface for the purpose of excavation may increase infiltration of surface water, potentially mobilising any residual LNAPL if present locally in the subsurface fill materials. Should surfacing need to be removed in sensitive areas, alternate covering may be required during periods of rain.
Heavy rain	Ensure sediment and surface water controls are operating correctly. If possible divert surface water away from active work areas or excavations. Cover stockpiles.
Water accumulating in excavations	Collect samples and assess against relevant assessment criteria, to enable disposal options to be formulated.
Leaking machinery or equipment	Stop the identified leak (if possible). Clean up the spill with absorbent material. Stockpile the impacted material in a secure location, sample and determine the appropriate disposal/treatment option.
Failure of erosion or sedimentation control measures	Stop work, repair failed control measure.
Unearthing unexpected materials, fill or waste	Stop activities, contact the environmental consultant. Prepare a management plan to address the issue.
Equipment failures	Ensure that spare equipment is on hand at site, or that the failed equipment can be serviced by site personnel or a local contractor.
Complaints are received directly relating to the works undertaken	Notify relevant Project Managers following complaint. Report complaint as per management procedures. Implement control measures to address reason of complaint (if possible).

11. Approvals and licenses

11.1 State environmental planning policies

State Environmental Planning Policy No 55 (SEPP 55) – Remediation of Land sets the regulatory framework for contaminated land and remediation works in NSW. It is considered that the remediation work falls under 'Category 1 work' (as defined in SEPP 55) as the Moorebank IMT site is associated with a designated development and has critical habitat. Appropriate permissions for remediation works should be obtained prior to commencement.

11.2 Statutory planning instruments and approvals

In conjunction with the EIS for the project, an application for a rezoning of the project site to IN1 (Industrial) on the majority of the Moorebank IMT site and RE3 (Environmental Management) along the east bank of the Georges River (the conservation area) is being undertaken. The future proposed zoning would provide for remediation consistent with this RAP.

Remediation works have also been addressed within the EIS which has been prepared for the Development Application (DA). Remediation works would be undertaken in accordance with the provisions of the EIS and associated conditions of approval. Further staged assessment and approvals would be required for subsequent DA approval.

11.3 Other licences required

Transporters of contaminated waste are required to be licensed to transport contaminated waste to the licensed landfills. Landfills are required to be licensed for the category of waste they are scheduled to receive.

Waste classification documentation and waste dockets from the receiving landfill should be kept on file for site validation purposes.

If water is to be discharged as part of any dewatering activities required at the Moorebank IMT site to facilitate remediation works or site development, the relevant discharge consents must be obtained.

12. Conclusions

The purpose of this RAP is to document the actions required to address the contamination issues previously identified in order to remove potential risks associated with contamination sources and to render the Moorebank IMT site suitable for the proposed development. The scope of this RAP covers the main area of the proposed Moorebank IMT site situated to the east of the Georges River. Land on the western bank of the Georges River associated with the three rail access options which will join the main Moorebank IMT site to the SSFL is out of the scope of this RAP.

The preferred remedial strategy is a staged remediation approach which will initially aim to remove the known sources of contamination (such as USTs and surficial soils that are known to be impacted by contamination), and include a combination of techniques to be used for contaminated materials should they be uncovered during site development.

The recommended remedial approach includes the following actions:

- removal of all UXO/EOW and items of military origin and ongoing management of the risks under a UXO management plan which should be developed to be used in conjunction with this RAP
- a tank inventory survey to confirm the exact locations of USTs and decommissioning and removal of all UPSS infrastructure (as identified during the tank inventory survey) as per the UPSS Regulation (2008) to limit the potential ongoing risk/liability associated with underground chemical storage
- excavation and off-site disposal of fill materials known to be impacted by contamination based on previous investigation data (such as stockpiles with ACM and surficial soils impacted by contamination 'hotspots' (elevated TRH and lead) with the aim of immediately removing impacted known material within these areas
- additional investigations augment the existing data relating to:
    - PASS (particularly in low-lying areas identified to have a high probability of ASS and where dewatering is likely to be required to facilitate Moorebank IMT construction)
    - surface water quality (to gather data to inform management of dewatering/discharges anticipated to be required to achieve the built design)
    - residual sediments (to gather data to inform management of sediments likely to be disturbed/dewatered during construction)
    - groundwater beneath the north-western area of the proposed Moorebank IMT site (adjacent to ABB) to inform if any additional control, management or remediation measures for groundwater in this area
- continued site risk management and assessment of remediation options to maximise reuse of resources and minimise importation of materials including containment and/or capping and the segregation of excavated materials (such as wood, metals, rubble not containing ACM, material free from contamination) and stockpiling on-site to allow for further processing and/or validation, for on-site reuse.

Based on the available data site data and subject to implementation of the RAP, it is considered that the site can be rendered suitable for the proposed commercial/industrial land use as an IMT.

13. Limitations

Scope of services

This remediation action plan (the report) has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the client and Parsons Brinckerhoff (scope of services). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

Reliance on data

In preparing the report, Parsons Brinckerhoff has relied upon data, surveys, analyses, designs, plans and other information provided by the client and other individuals and organisations, most of which are referred to in the report (the data). Except as otherwise stated in the report, Parsons Brinckerhoff has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report (conclusions) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Parsons Brinckerhoff will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Parsons Brinckerhoff.

Environmental conclusions

In accordance with the scope of services, Parsons Brinckerhoff has relied upon the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

On all sites, varying degrees of non-uniformity of the vertical and horizontal soil or groundwater conditions are encountered. Hence no monitoring, common testing or sampling technique can eliminate the possibility that monitoring or testing results/samples are not totally representative of soil and/or groundwater conditions encountered. The conclusions are based upon the data and the environmental field monitoring and/or testing and are therefore merely indicative of the environmental condition of the IMT site at the time of preparing the report, including the presence or otherwise of contaminants or emissions.

Also, it should be recognised that site conditions, including the extent and concentration of contaminants, can change with time.

Within the limitations imposed by the scope of services, the monitoring, testing, sampling and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

Report for benefit of client

The report has been prepared for the benefit of the client (MIC) and no other party. Parsons Brinckerhoff assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of Parsons Brinckerhoff or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

Other limitations

Parsons Brinckerhoff will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report. The scope of services did not include any assessment of the title to or ownership of the properties, buildings and structures referred to in the report nor the application or interpretation of laws in the jurisdiction in which those properties, buildings and structures are located.

14. References

Acid Sulfate Soils Management Advisory Committee (ASSMAC) Assessment Guidelines (1998).

ANZECC (1992) Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites.

ANZECC (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

Australian Standard AS4482.1 (2005) Guide to the investigation and sampling of sites with potentially contaminated soil – Part 1: Non-volatile and semi-volatile compounds.

AS/NZS 5667.11:1998 – Water Quality – Guidance on sampling of groundwater.

CSIRO Australian Soil Resource Information System – http://www.asris.csiro.au.

Dames and Moore, Environmental Management Plan (1996).

Department of Environment, Climate Change and Water (DECCW) (2009), Waste Classification Guidelines, Part 1: Classifying Waste.

Department of Environment, Climate Change and Water (DECCW) (2009), Waste Classification Guidelines, Part 4: Acid Sulfate Soils.

Department of Mineral Resources (1991), Penrith 1:100,000 Geological Series Sheet 9030.

Department of Lands Spatial Information Exchange – http://gsp.maps.nsw.gov.au.

Earth Tech, Stage 2 Environmental Investigation, (2006).

Egis Consulting Australia (ECA), Stage 1 Preliminary Site Investigation (2000).

Environmental Trust, CSIRO (2005) Handbook for Sediment Quality Assessment.

GHD, Groundwater Investigation of the North Western Portion of the Moorebank Defence Land (2004).

GHD Proposed Intermodal Freight Hub, Moorebank, Summary of Environmental Planning Reports (2005).

HLA Envirosciences, Preliminary Groundwater Study, Moorebank Defence Land (2003).

HLA Envirosciences, AST and UST Management Plan, Volume 10, Sydney West Defence Region (2005).

HLA report entitled ‘Soil and Groundwater Investigation Precinct H (DNSDC) Moorebank Defence Land’ (November 2002).

KPMG, Parsons Brinckerhoff and Deloitte, Moorebank Intermodal Terminal Project Summary: Detailed Business Case (April 2012).

National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1) (NEPM, 2013)

NSW Natural Resource Atlas – www.nratlas.nsw.gov.au.

NSW EPA (2007) Guidelines for the Assessment and Management of Groundwater Contamination.

NSW DECC (2009) Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997.

NSW EPA (2006) Guidelines for the NSW Site Auditors Scheme (2nd Edition).

NSW EPA (1997) Guidelines for Consultants Reporting on Contaminated Sites.

NSW EPA (1995) Sampling Design Guidelines.

NSW EPA (1994) Guidelines for Assessing Service Station-sites.

Sydney Water (2010) Trade Waste Policy.

Parsons Brinckerhoff, (2014) Phase 1 Environmental Site Assessment, Moorebank Intermodal Terminal, (Report 2103829A-CLM-RPT-3321 Rev B updated 15 May 2014).

Parsons Brinckerhoff, (2014) Phase 2 Environmental Site Assessment, Moorebank Intermodal Terminal, (Report 2103829A-CLM-REP-1 RevB updated 21 May 2014).

URS, Investigation of Potential Sources of TCE, North West Precinct of Moorebank Defence Lands (Letter Report 2003).

United States Environmental Protection Agency (USEPA) Guidance for the Data Quality Objectives Process EPAQA/G4 2000 (a).

USEPA (2009) Soil Screening Levels for Perfluorooctanoic Acid (PFOA) and Perfluooctyl Sulfonate (PFOS), USEPA Region 4.

Appendix A

Figures

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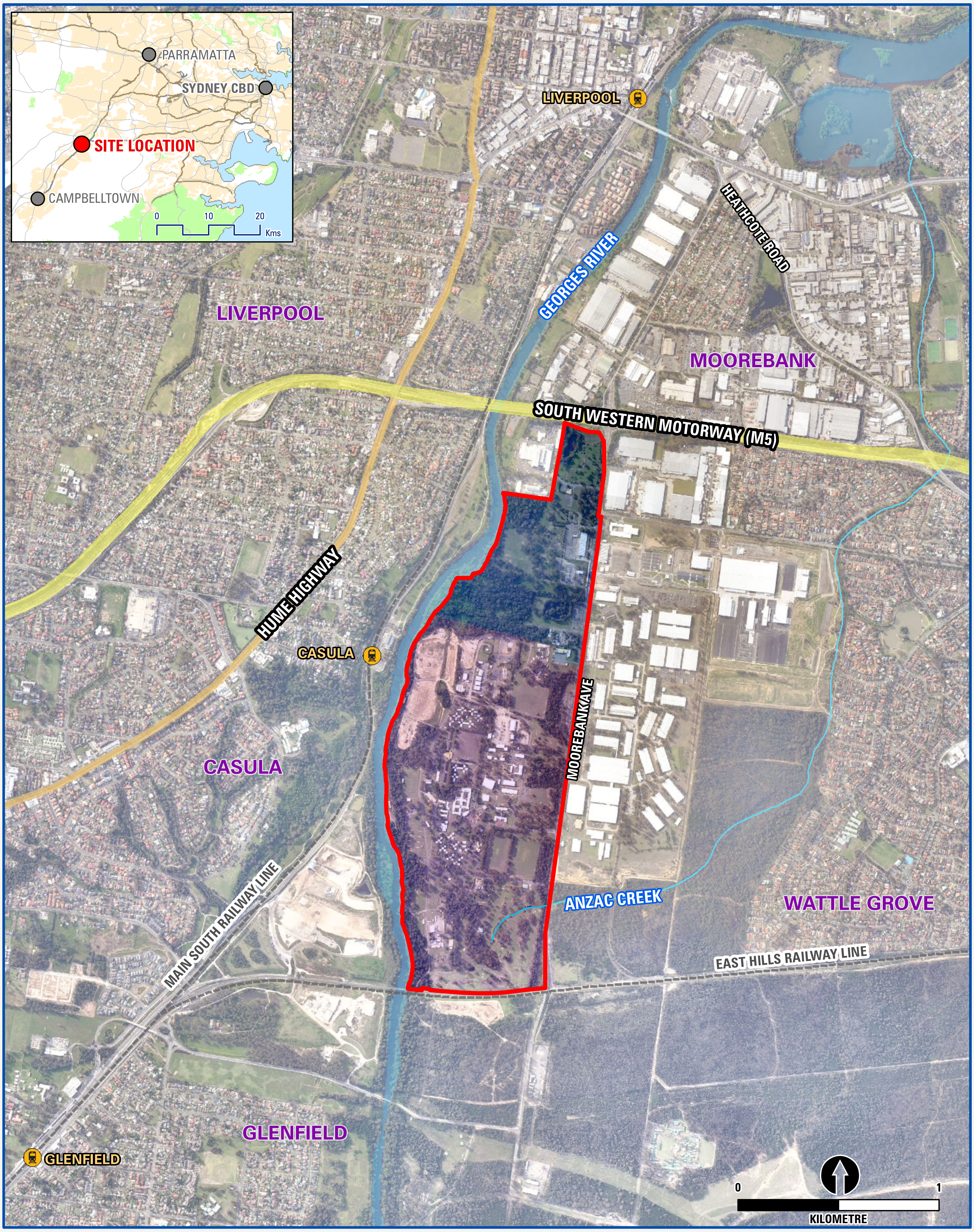
MOOREBANK INTERMODAL TERMINAL



Moorebank IMT main site
Rail line & station
Moorebank barracks
Steele barracks

Figure 1: Site location plan

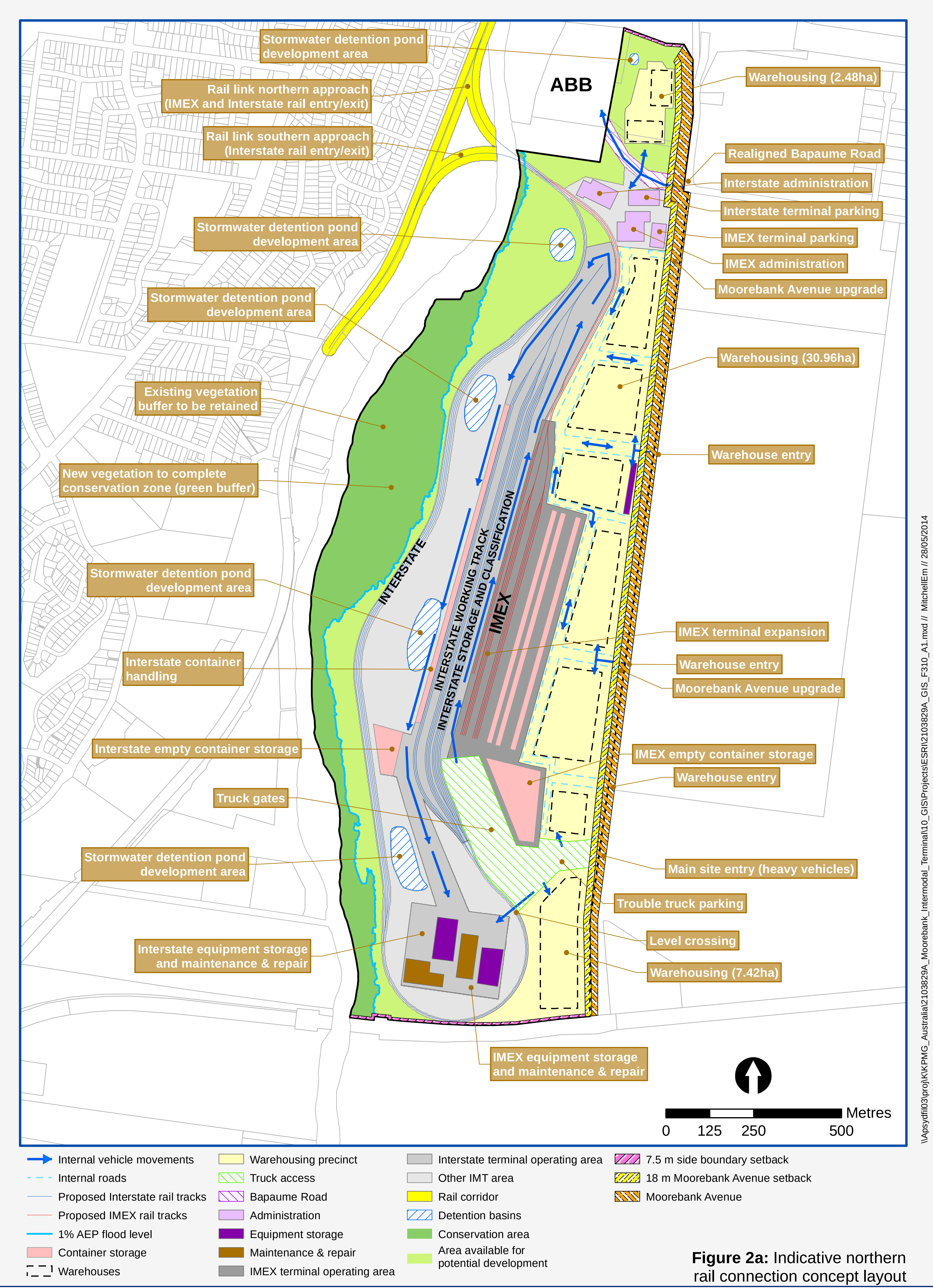


Figure 2a: Indicative northern rail connection concept layout

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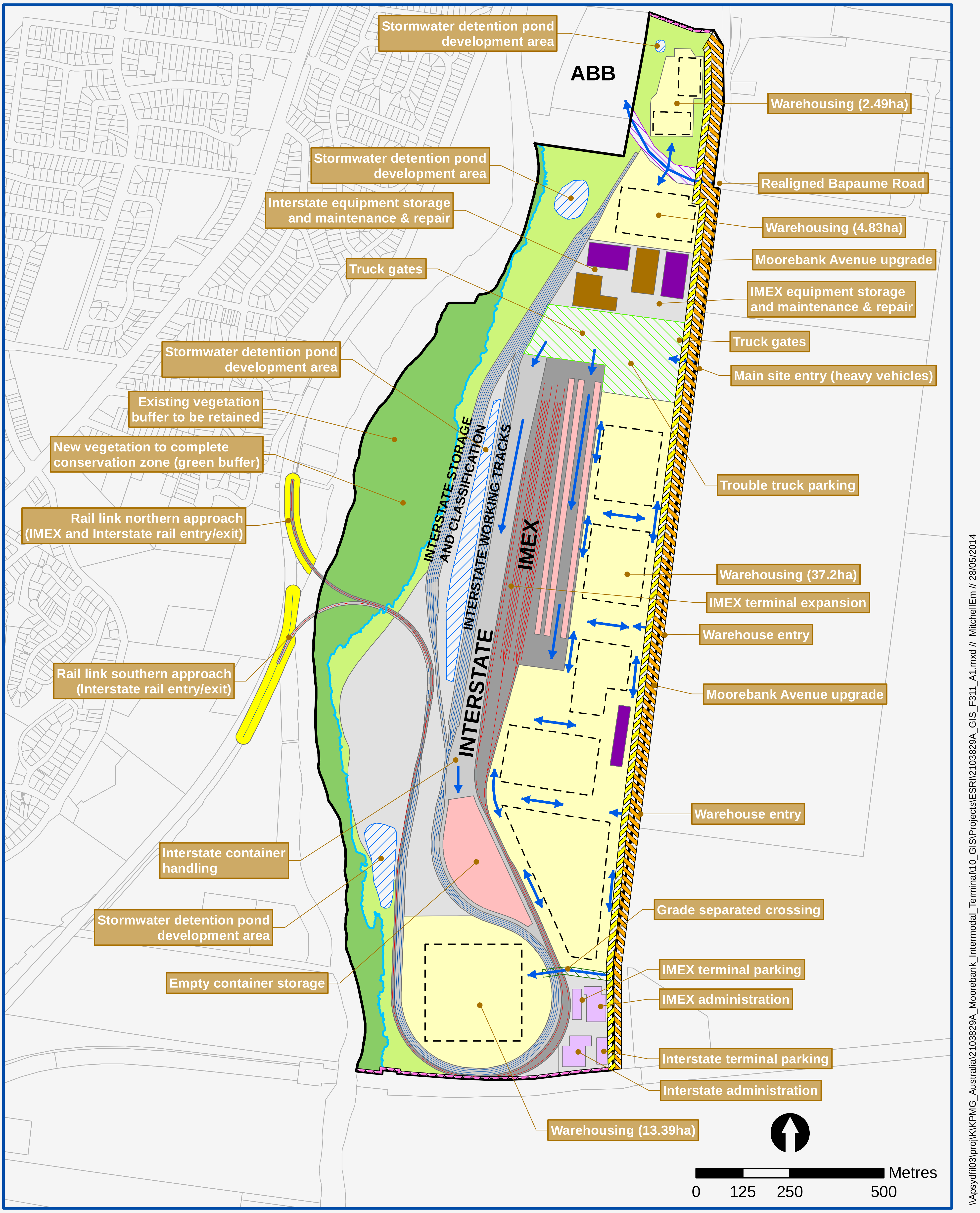
MOOREBANK INTERMODAL TERMINAL



- Internal vehicle movements
- Proposed Interstate rail tracks
- Proposed IMEX rail tracks
- 1% AEP flood level
- Container storage
- Warehouses
- Warehousing precinct
- Truck access
- Bapaume Road
- Road bridge
- Administration
- Equipment storage
- Maintenance & repair
- IMEX terminal operating area
- Interstate terminal operating area
- Other IMT area
- Rail corridor
- Detention basins
- Conservation area
- Area available for potential development
- 7.5 m side boundary setback
- 18 m Moorebank Avenue setback
- Moorebank Avenue

Figure 2b: Indicative central rail connection concept layout

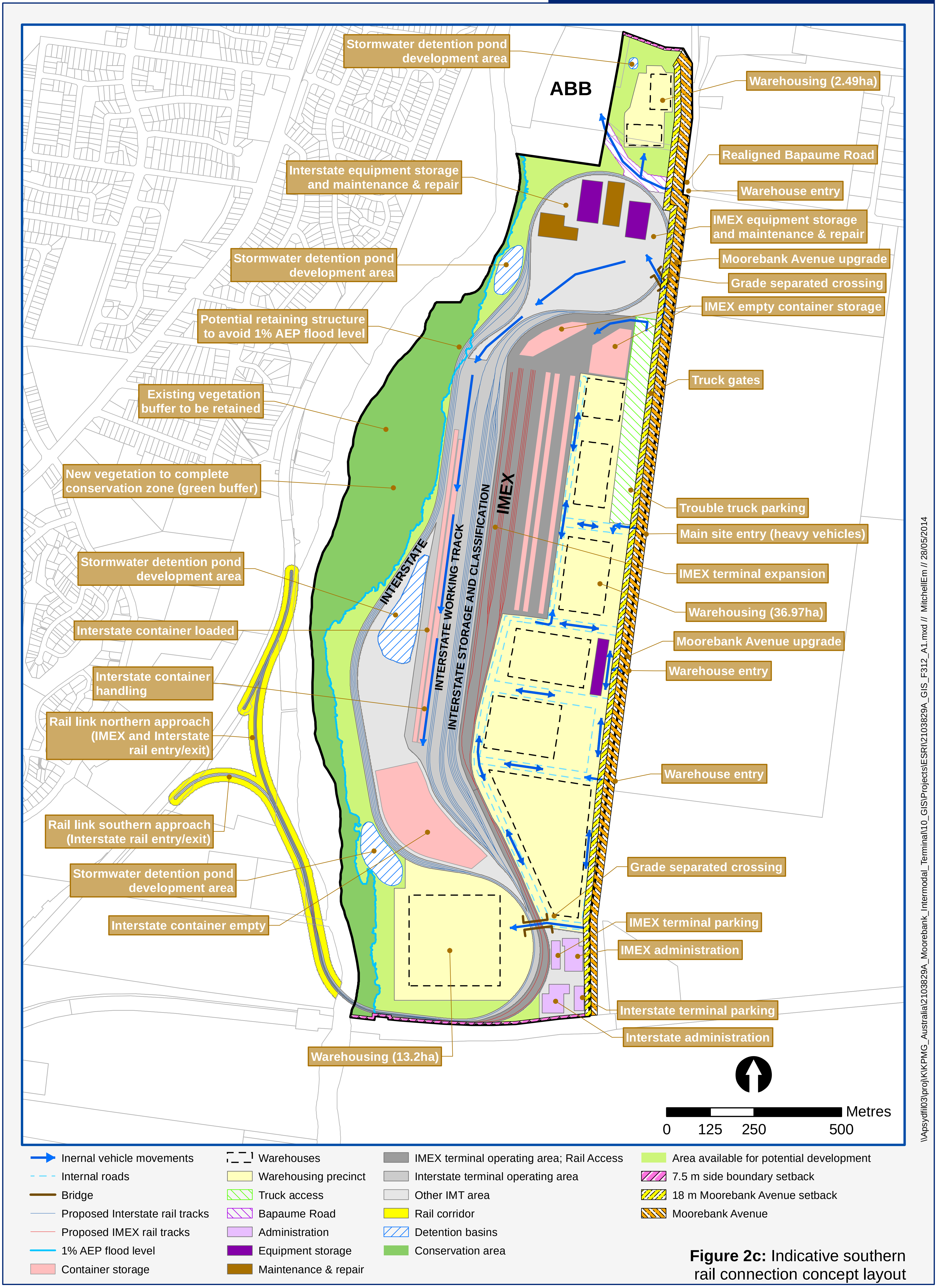


Figure 2c: Indicative southern rail connection concept layout

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Aerial Source: © 2014 NearMap // *Report: EarthTech - Stage 2 Environmental Investigation Moorebank, Sydney, NSW (2006).

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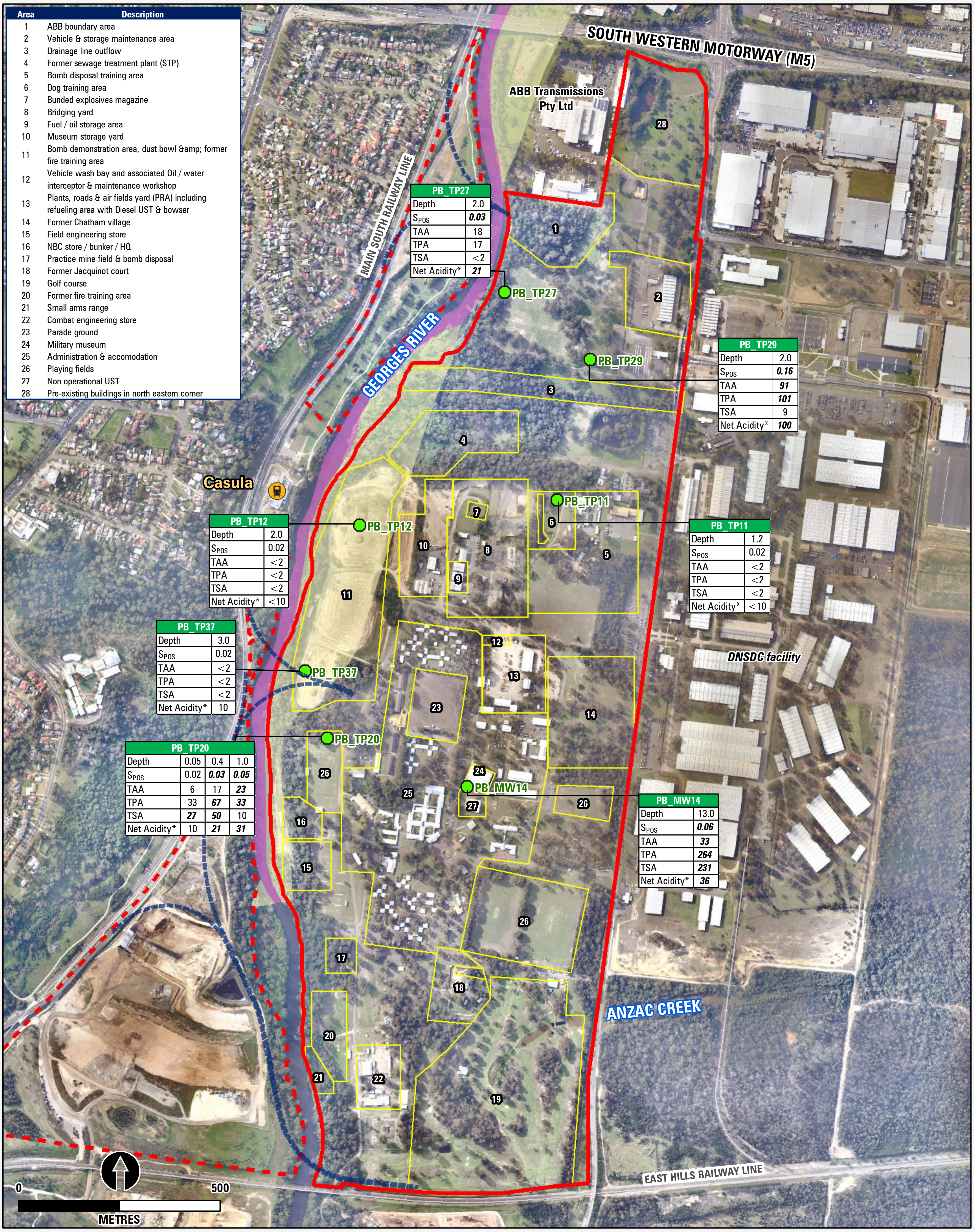
- Moorebank IMT main site
- Moorebank barracks
- Steele barracks
- Rail line
- Structures
- Stormwater drainage
- Water features / reticulation

Figure 3: Site area and surrounding features



Moorebank IMT main site
Land associated with Moorebank IMT rail access options
Footprint of rail corridor associated with the proposed rail access options
CLM investigation areas
Rail line
Structures
Acid sulfate soil location
H - High probability - Below water level
L - Low probability - greater than 3 metres below the ground surface
Extremely low probability of acid sulfate soils where no shading is present

Notes:
All values in mole H+/t unless otherwise specified
*Net Acidity without ANCE
Depth in mBGL
SPOS - Peroxide Oxidisable Sulfur (Net acidity (sulphur units in %S)
TAA - Total Actual Acidity
TSA - Total Sulfidic Acidity
TPA - Total Potential Acidity
Bold indicates value exceeds the adopted criteria for ASS

Figure 4: Acid sulfate soil (ASS) risk map

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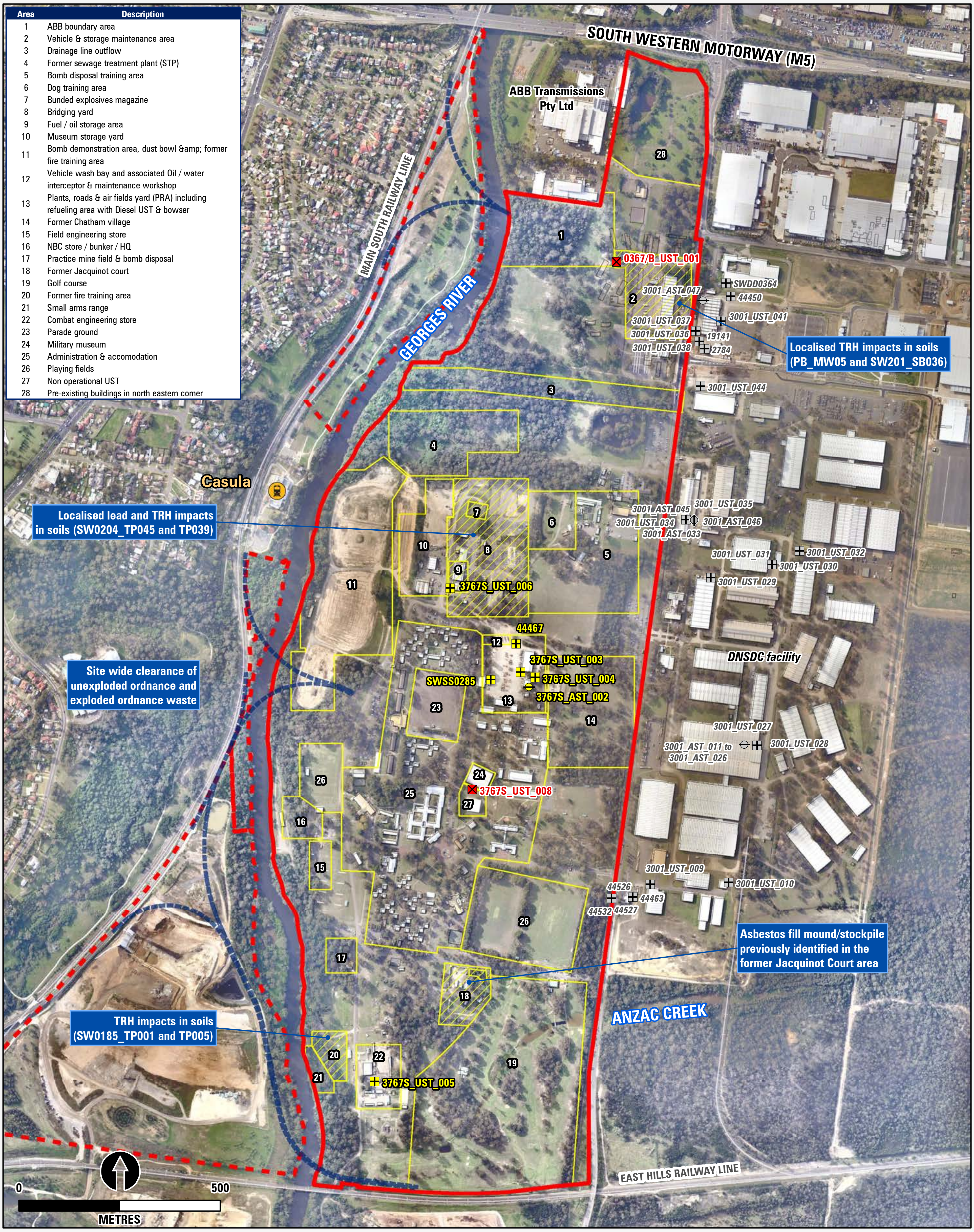
MOOREBANK INTERMODAL TERMINAL



Moorebank IMT main site
Land associated with Moorebank IMT rail access options
Footprint of rail corridor associated with the proposed rail access options
CLM investigation areas
Indicative remediation areas
Rail line
Structures

Approximate locations of USTs and ASTs to be removed as part of remediation work

Non-operational UST
Operational UST
Non-operational AST
Operational AST
Operational UST (offsite)
Non-operational AST (offsite)
Operational AST (offsite)
Non-operational UST (offsite)

Figure 5: Proposed targeted remediation scope

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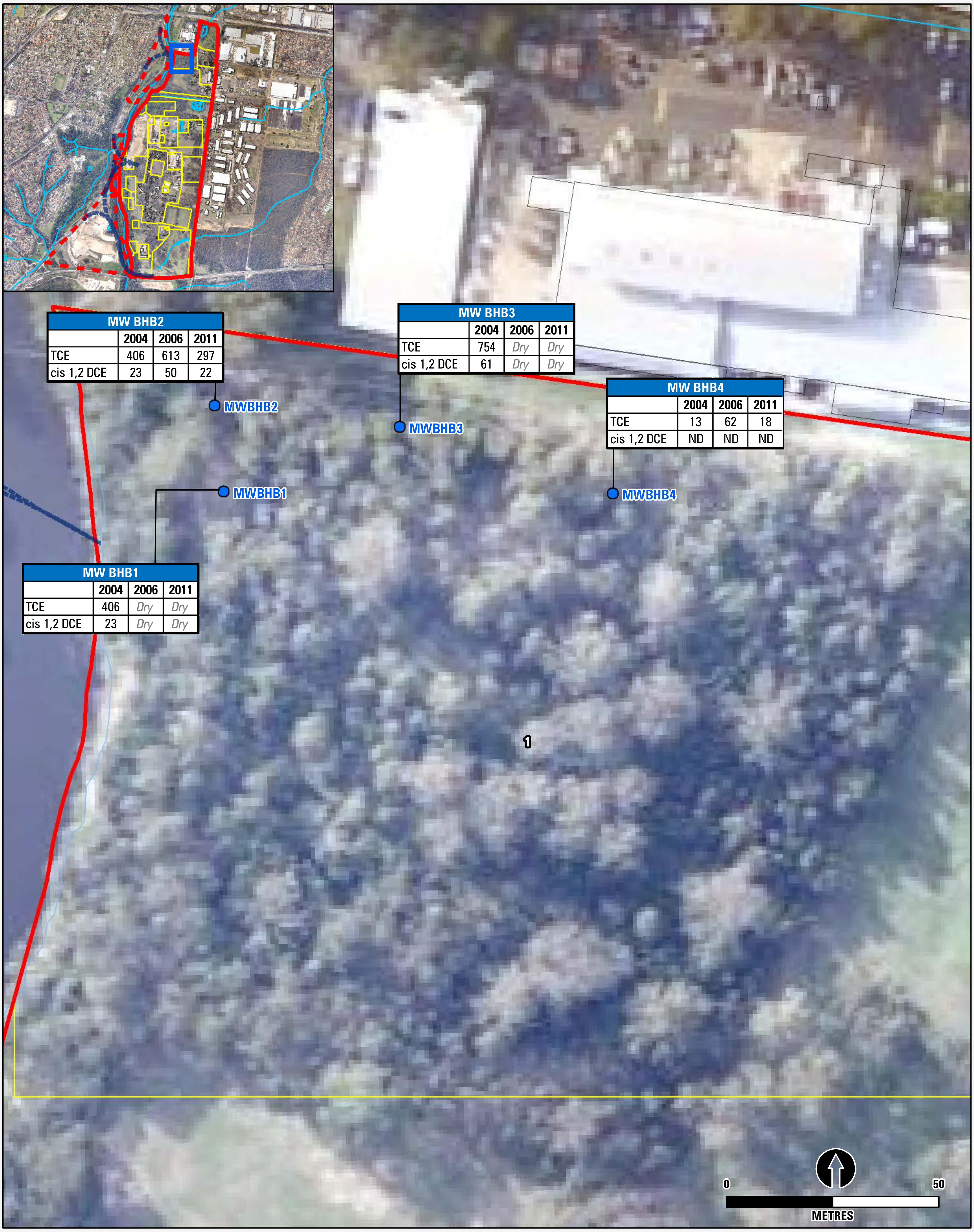

MW BHB2

	2004	2006	2011
TCE	406	613	297
cis 1,2 DCE	23	50	22

MW BHB3

	2004	2006	2011
TCE	754	*Dry*	*Dry*
cis 1,2 DCE	61	*Dry*	*Dry*

MW BHB4

	2004	2006	2011
TCE	13	62	18
cis 1,2 DCE	ND	ND	ND

MW BHB1

	2004	2006	2011
TCE	406	*Dry*	*Dry*
cis 1,2 DCE	23	*Dry*	*Dry*

Moorebank IMT main site
Land associated with Moorebank IMT rail access options
Footprint of rail corridor associated with the proposed rail access options
CLM investigation areas
Monitoring well

Note:
- All other samples results were reported below the laboratory PQL in 2004, 2006 & 2011.
- MW_BHB1, MW_BHB3, MW_BHB7 & MW_BHB12 were dry in January 2011
- All values in µg/L

Figure 6: TCE in groundwater *(area 1)*

*Aerial Source: © 2014 NearMap // **Report: EarthTech - Stage 2 Environmental Investigation Moorebank, Sydney, NSW (2006).*

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