



Homebush Bay Bridge | Environmental Assessment
Fairmead Business Proprietary Ltd

HOMEBUSH BAY BRIDGE

Environmental Assessment

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Homebush Bay Bridge | Environmental Assessment

APPENDIX I

Contamination assessment and management plan







February 2012

HOME BUSH BAY BRIDGE

Contamination Management Plan for Proposed Bridge Construction

Submitted to:
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REPORT



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Abbreviations / Glossary

| | |
|--------------------------------------|-------------------------------------------------------------------------------------|
| 2,3,7,8-TCDD | 2,3,7,8-tetrachlorodibenzodioxin, a dioxin compound |
| AHD | Australian height datum |
| ANZECC | Australian & New Zealand Environment & Conservation Council |
| ASS | Acid sulfate soil |
| ASSMAC | Acid Sulfate Soil Management Advisory Committee |
| BTEX | Benzene, toluene, ethylbenzene, xylene |
| CLM Act | Contaminated Land Management Act 1997 |
| C₆-C₉ | Light hydrocarbon chain groups (for example petrol) |
| C₁₀-C₃₆ | Medium to heavy hydrocarbon chain groups |
| DDT | Dichlorodiphenyltrichloroethane, an organochlorine pesticide |
| DDD | Dichlorodiphenyldichloroethane, an organochlorine pesticide |
| DDE | Dichlorodiphenyldichloroethylene, an organochlorine pesticide |
| DECCW | Department of Environment, Climate Change and Water (formerly DECC, DEC) |
| DGRs | Director-General's Requirements |
| DP | Deposited Plan |
| DSI | Detailed Site Investigation |
| EPA | Environment Protection Authority |
| EPL | Environment Protection Licence |
| GCRCS | Guidelines for Consultants Reporting on Contaminated Sites (EPA 1997) |
| Golder | Golder Associates Pty Ltd |
| GSW | General solid waste |
| ISQG | Interim Sediment Quality Guidelines |
| <1, <100 | Less than the PQL, that is, less than 1 or 100 units |
| Lednez site | The former Union Carbide site |
| LOQ | Limit of quantitation (also see LOR or PQL) – of chemical concentrations attainable |
| Meriton site | The former Allied Feeds site |
| mg/kg | Milligrams per kilogram (or part per million)- equal to ppm |
| NATA | National Association of Testing Authorities |
| ND | Not detected above the LOQ or PQL |
| NEPC | National Environment Protection Council |



| | |
|-----------------|----------------------------------------------------------------------------|
| NEPM | National Environment Protection (Assessment of Site Contamination) Measure |
| OEH | Office of Environment and Heritage (formerly DECCW, DECC, DEC, EPA) |
| OCP | Organochlorine pesticides |
| OPP | Organophosphate pesticides |
| PAH | Polycyclic aromatic hydrocarbons |
| PCB | Polychlorinated biphenyls |
| PCDD | Polychlorinated dibenzodioxins (“dioxins”) |
| PCDF | Polychlorinated dibenzofurans (“furans”) |
| POEO Act | Protection of the Environment Operations Act 1997 |
| PQL | Practical quantitation limit (of chemical concentration) |
| RMS | Roads and Maritime Services, a NSW State Government agency |
| RSW | Restricted solid waste |
| TCLP | Toxicity Characteristics Leaching Procedure |
| TPH | Total petroleum hydrocarbons |
| µg/L | Micrograms per litre (or part per billion) |
| UST | Underground storage tank |
| US EPA | United States Environment Protection Agency |
| WARR Act | Waste Avoidance and Resource Recovery Act 2001 |
| WCG | Waste Classification Guidelines (DECCW 2009) |



1.0 INTRODUCTION

Golder Associates (Golder) was engaged by Billbergia Developments Pty Ltd on behalf of Fairmead Business Proprietary Ltd to prepare this Contamination Management Plan (CMP) for the proposed bridge construction works to be carried out within Homebush Bay. The new bridge is proposed to traverse Homebush Bay (the "Bay") from the Rhodes Peninsula to Wentworth Point (formerly known as Homebush Bay West). The Homebush Bay Bridge is envisaged to be 11.5 m wide and some 455 m long (hereafter referred to as "the site"). A site Locality Plan is presented as Figure 1.

The purpose of this CMP is to provide a plan for the management of identified and potential contamination related issues within the site during the implementation of construction.

The CMP is submitted as supporting documentation in response to the Director-General's Requirements (DGRs) issued 21st December 2010 for the proposal. The DGRs relating to contamination issues are:

- An assessment of potential impacts on disturbance of contaminated sediments in the Bay and on contaminated land in Wentworth Point and Rhodes.
- Details of construction mitigation measures and any proposed remediation works.
- A site audit statement and site audit report by an auditor accredited under the *Contaminated Land Management Act 1997 (CLM Act)*.
- Details of compliance with any order issued under the CLM Act.

1.1 Proposal description

The proposal is for a new bridge across Homebush Bay to connect Rhodes Peninsula and Wentworth Point. The western end of the bridge will land on Lot 122 in Deposited Plan (DP) 1156412, with the eastern end of the bridge landing on Lot 310 in DP 1163025, and possibly impinging on Lots 311 and 316 in DP 1163025.

The bridge will allow a mix of pedestrian access, cycleway access, public transport (bus) services and emergency services access, whilst accommodating a range of utilities within its structure and enabling continued navigation of the Bay. The bridge will have a connecting ramp of some 80 m on the Rhodes Peninsula side linking with Gauthorpe Street and a connecting ramp of up to 80 m on the Wentworth Point side.

NSW Maritime has indicated that the deepwater channel along the western edge of the Bay needs to be maintained and this will need to correspond with a minimum clearance. The height of the bridge and clearance above mean high water for the remainder of the structure will be established to ensure that there is sufficient clearance and spacing between piers to allow rowing and canoeing craft to use the Bay. The current design for the bridge involves four piers installed in Homebush Bay.



Figure A: Photomontage of the proposed Homebush Bay Bridge, looking north towards Parramatta River from the Wentworth Point foreshore promenade

1.2 Background

Homebush Bay, and former industrial/commercial sites along both the eastern and western shorelines, have been the subject of numerous investigations over the past 20 years. The levels of dioxin and chlorinated compound contamination in the Bay are amongst the highest identified in studies from around the world. All fishing in Homebush Bay was banned in 1989 due to unacceptable risks posed by sediment contamination and subsequent bioaccumulation in edible species. In 2006 a total ban was placed by the Department of Primary Industries on commercial fishing in Sydney Harbour as a precautionary measure following the identification of elevated levels of dioxin in a number of species of fish and crustaceans.

Following extensive investigations, including a detailed human health and ecological risk assessment (SKM 2002), the scope of the remediation of Homebush Bay sediments was determined. The investigations found elevated concentrations of dioxins (PCDDs) and furans (PCDFs), DDT, heavy metals particularly copper, zinc and lead and PAH in the Homebush Bay sediments (see Section 2.2). A remedial strategy for the Bay was developed and implemented in the period 2002-2010. The remediation included the removal of sediments to a depth of 0.5 ± 0.15 m, or a minimum of 0.5 m where contamination hotspots had been identified, adjacent to the former Union Carbide and former Allied Feeds properties, and replacement with clean materials to restore bathymetric levels. The clean materials (the “cap”) are intended to provide environmental isolation from deeper, more highly contaminated sediments.

Residual contamination remains in surficial materials within Homebush Bay, however, it is at levels thought not to present unacceptable risks of adverse effects to the environment or human health. Higher concentrations of contaminants in sediments have been isolated below the “cap” on the eastern side of the Bay and may be present at depth elsewhere in the Bay.

NSW Maritime restrict the activities which may be undertaken in the vicinity of the remediated area to maintain the integrity of the “cap”, including not allowing piling through the “cap”, or permanent mooring of vessels and restricting the area where marinas may be constructed. Potential disturbance to sediments during the proposed bridge construction will need to be carefully considered, including identification and implementation of appropriate mitigation measures to address this significant issue.

On the western shore of the Bay, the land was extensively reclaimed by filling from the late 1940s. Investigations indicate that in the area of the proposed bridge landing contamination issues are likely to be limited and localised. Further investigations and monitoring were recommended, however, there is nothing in the investigation outcomes to suggest that the area, (subject to appropriate remediation) would be unsuitable for the proposed redevelopment. These issues are further discussed in Section 2.1.



The former Union Carbide site on the eastern shore of the Bay has been recently remediated, with removal and treatment of contaminated fill, soils and sediments and replacement with clean materials. In the area in which bridge construction will be undertaken it is understood that the area has been remediated to a standard suitable for open space land use (see Section 2.3.2), and is subject to an environmental management plan (EMP). The EMP (Thiess 2011) requires that approvals from the Office of Environment and Heritage (OEH) be obtained prior to intrusive works commencing in this area (see Section 2.3).

For the above reasons, it is considered that it is appropriate to develop a project specific contamination management plan (CMP) to address potential impacts from the construction of the proposed bridge.

1.3 Proposed construction works

Construction of a bridge across the Bay will require that piles be driven through the soft sediment and into firmer ground. The construction techniques and accompanying environmental management process will need to be undertaken with minimal impact and disturbance upon the Bay and its sediments, particularly in the capped area along the eastern shore, to avoid the potential for mobilisation and redistribution of contaminants to other parts of the Bay and the Harbour. The proposed piling methodology has been selected to prevent the potential for generation of sediment wastes which would consequently require disposal. Given the low cross sectional area of the piles compared to the width of the Bay, the low water velocities in the Bay (see Section 2.2) and the net sedimentation rate (see Section 1.2 of Appendix B), it is considered that the risk of scouring around piles is low.

Appropriate turbidity containment devices, e.g. silt curtains, will be required around piling areas to contain resuspended materials and minimise suspension of sediments and associated contaminants in the Bay.

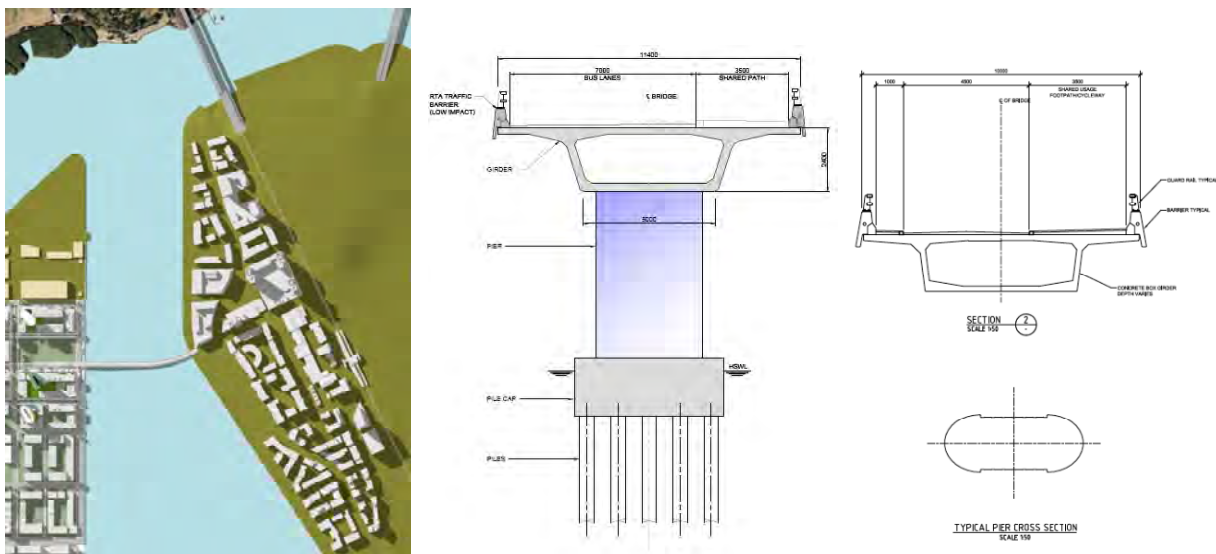


Figure B: Indicative bridge alignment and cross sections through the bridge deck (typical pier and typical span)

1.4 CMP objectives and context

This CMP addresses chemical contamination previously identified within the bridge alignment and is to accompany a Construction Plan which details proposed construction activities. The general objectives of this CMP are to assist in:

- Addressing the DGRs relating to contamination issues.



CMP FOR PROPOSED HOMEBUSH BAY BRIDGE CONSTRUCTION

- Evaluation of potential environmental impacts at the planning stage so that these impacts may be addressed prior to the proposed bridge construction works.
- Compliance with relevant environmental legislation and the management of contamination during construction in a manner consistent with the Office of Environment and Heritage (EPA) requirements.
- Ensuring all employees and contractors involved in the proposed bridge construction are aware of their environmental responsibilities and of the procedures for management and reporting of environmental incidents.
- Ensuring that proposed construction works are conducted in a way that minimises disturbance to the sediment environment, soil and groundwater.
- Establishing the basis for a sound monitoring and reporting approach during the maritime based construction activities.



2.0 CONTAMINATION ISSUES

A review of available contamination investigations within and adjacent to the proposed bridge alignment has been undertaken and a summary of the investigation results are provided below. The available reports are listed in Appendix A and include the rationale for the reports considered to be relevant to the location of the proposed bridge.

2.1 Western shore

A series of investigations of the properties on Wentworth Point have been performed, focussing on the area bounded by Burroway Road to the north and Hill Road to the west. Relevant investigations were performed on Lot 10 in Deposited Plan (DP) 776611, which has been subdivided into Lots 121 and 122 in DP 1156412 since the contamination investigations were undertaken (see below).

The geology of the western shore was described in the ERM Masterplan (ERM 2003B) as fill material underlain by soft, dark grey, estuarine clays with an organic odour to the maximum investigation depth of 4.5 m. The depth of the fill layer varied from 0.4 to 2.2 m thick across the site. In 14 of the 32 sampling locations, predominately sandy, shell was encounter at depths ranging between 0.4 and 1.7 m. This material was thought to be dredged sediments which were excavated from Homebush Bay and used for land reclamation. Generally, overlying the shelly sand horizon was firm, moist, light brown clay that was thought to have been imported to improve the load bearing capacity of the soils.

A subsequent investigation completed in 2006 (ERM 2006) provided a detailed description of the western shore site geology. Fill material at a borehole located close to the western landing of the bridge was described as black sandy clay, shell and some gravel which overlaid sandy, silty clay.

Moderate to high potential acid sulfate soil capacity in material from depths of 1.0 m below ground level at most investigation locations was identified (ERM 2004A).

Remediation works have involved the removal of underground storage tanks (USTs) identified at five areas on the western shore (ERM 2003A). One of the areas, Area D, was located approximately 30 m from the location of the proposed bridge. Soil samples collected from Area D as part of the site investigation works were reported to contain TPH, BTEX, inorganics and phenols concentrations which were less than the adopted site assessment guidelines (NEPM Level 'D' guidelines). The excavation of two trenches to the north of the proposed bridge landing did not indicate the potential presence of USTs or associated service lines. As such, it was considered that the soils in this area were suitable for combined commercial/residential land use with minimal access to soil.

Further information on the site investigation and remediation works performed is presented in Appendix B.

2.2 Homebush Bay

Homebush Bay is a tidally-influenced estuarine environment, which is characterised by a deeper (up to 4 m) channel along the western margins that shoals to the eastern and north-eastern shores. Water depths near the eastern and north-eastern shores are generally <1 m.

Tides at Homebush Bay are semi-diurnal and asymmetric, with the tidal ranges varying significantly throughout each lunar month (spring-neap cycle) and from month to month. Very high and very low tides occur more frequently at solstices around Christmas and the mid-winter months. The spring high tide range varies from 1.8 m to 2.2 m.

Tidal currents cause a periodic flow into and out of the Bay, and coupled with turbulent mixing, this process effectively replaces the Bay water with adjacent main body estuarine water from the Parramatta River. The flushing time for Homebush Bay is estimated to be around three to four days.



Sedimentation rates for the Bay for the period from 1978 to 1985 were estimated by AWACS (AWACS, 1989 cited in PB 2002) using data from hydrographic surveys (MHL 2001 cited in PB, 2002). Sedimentation in the Bay was reported to range from minimal change to greater than 215 mm/yr. The average rate is between 25 mm and 30 mm/yr. As part of regional contaminant assessment throughout Port Jackson, sedimentation rates at three core locations were estimated on the eastern shoreline of Homebush Bay (Taylor 2000). The average sedimentation rate at the location closest to the proposed bridge was 6.8 ± 1.5 mm/yr.

A number of studies have reported water velocities in the Bay. Sydney Ports Corporation (SPC, 1996) estimated maximum tidal currents of 0.2 m/s in the deeper water close to the Bay entrance. The University of New South Wales (UNSW, 2004) stated an average velocity of 0.07 m/s through the entry cross section to the Bay, with a maximum of approximately 0.1 m/s (and up to 0.2 m/s in the deeper water near the Bay entrance) which is consistent with SPC (1996). Parsons Brinckerhoff (PB, 2004) calculated a long term tidal velocity of 0.081 m/s, which was based on a weighted average of the dry (0.067 m/s) and wet (0.13 m/s) weather velocities.

Sediment quality investigations undertaken prior to remediation (Parametrix 1996, EVS 1998 and URS 2002) are summarised in the Environmental Impact Statement for the Bay (PB 2002).

Parametrix Inc. and AWT Ensignt undertook a screening level human health and ecological risk assessment of Homebush Bay sediments in 1996 (Parametrix 1996). Three of the sampling locations in the study on the western shore of Homebush Bay (not sampled in later investigations) are understood to have not been remediated. Sediment sample locations of greatest interest include locations 11, 12 and 13 and location 14 on the western shore. Surface sediment at location 14 contained 690 $\mu\text{g}/\text{kg}$ DDT and <0.64 $\mu\text{g}/\text{kg}$ 2,3,7,8-TCDD. It should be noted that a sample at location 9, also on the western shore, but not in the proposed bridge alignment contained 1,180 $\mu\text{g}/\text{kg}$ of DDT. The locations of the sample locations and graphical representations of the dioxin concentrations were presented in Figures 5.2 to 5.8 which are reproduced in Appendix B-11.

Subsequent sediment investigations were undertaken by EVS Environmental Consultants (EVS) and URS Australia Pty Ltd (URS). The sampling was concentrated along the eastern seawall between the former Union Carbide and Allied Feeds sites, with lower sampling densities in the central, western and southern portions of northern Homebush Bay. The URS investigation, performed in 2001, was reported in 2002 (URS 2002, summarised in PB 2002). The results of the investigations indicated widespread contamination across the Bay, that contaminant concentrations generally decreased from the eastern shore to the western shore of the Bay, and contamination concentrations were typically higher in the subsurface sediments. The URS report identified concentrations of 2,3,7,8-TCDD of up to 360 $\mu\text{g}/\text{kg}$ (equivalent to 360,000 pg/g), with an average concentration of 5.2 $\mu\text{g}/\text{kg}$ (5,200 pg/g) in the sediment samples analysed.

Elevated dioxin concentrations were identified in surface and subsurface sediments in areas along the foreshore of the former Union Carbide and Allied Feeds sites. Concentrations of dioxins were reported at levels of up to 154,000 pg/g I-TEQ in sediments collected from 0-0.1m depth, 380,000 pg/g I-TEQ in sediments collected from 0.4-0.5m depth and 238,000 pg/g I-TEQ in sediments collected from 0.9-1.0m depth. Graphical representations of the dioxin concentrations at the sampling depths were presented in Figures 5.17, 5.18 and 5.19 of PB 2002, which are reproduced in Appendix B-13.

The highest concentrations of dioxins reported by URS in the 0-0.1m and 0.9-1.0m depth ranges were from samples in the vicinity of the proposed bridge alignment. It should be noted that sediments to a depth of approximately 0.5m adjacent to the eastern seawall of the Bay were removed as part of the sediment remediation works (see Section 2.3.1).

Due to the history of dredging in the Bay and the limited of the sampling programs, it is possible that isolated areas of sediment containing higher levels of contaminants are present in the Bay.

Additional information on the sediment and water quality in the Bay prior to remediation is presented in Appendix B.



2.3 Eastern shore

Background information on the geology and contamination status of the former Union Carbide site is presented in Appendix B.

The remediation of the former Union Carbide site included the removal of sediments along the eastern foreshore of the Bay adjacent to the former Union Carbide and Allied Feeds properties, and the removal and treatment of contaminated fill, soils and sediments from the land based areas and replacement with clean materials. Samples were collected from the remediation excavations for chemical analysis.

2.3.1 Sediment remediation

The AECOM Site Audit Report (AECOM 2011A) provides verification of the Homebush Bay remediation works undertaken by Thiess Services Pty Ltd. Contaminated sediments along the eastern foreshore of the Bay were excavated, and classified and/or treated prior to placement on the former Union Carbide site. The seawall was reconstructed as part of the remediation works. A geofabric marker layer was then placed over the excavated surface prior to the placement of backfill. A mixture of imported sandstone (VENM) and shale from the former Union Carbide site was used to backfill the sediment excavation. AECOM 2011A reported that the Bay remediation and sediment classification works were performed in accordance with the remedial action plans, validation plan, excavation management plan and remediation protocol for the works.

The samples collected from the residual excavation surface were analysed for organochlorine pesticides, monocyclic aromatic hydrocarbons, oxygenated compounds, halogenated aromatic compounds, phenolic compounds, polynuclear aromatic compounds, phthalate esters and chlorinated hydrocarbons.

The results for the organic contaminant analyses were generally below the laboratory detection limits. However, it is noted that the laboratory detection limits for a number of analytes were orders of magnitude greater than the interim sediment quality guidelines (ISQG)-low and ISQG-high guidelines (ANZECC 2000). DDE and DDD exceeded the ISQG-high guidelines, and naphthalene, phenanthrene and anthracene exceeded the ISQG-low guidelines. The residual sediments also contained highly elevated concentrations of dioxins, with concentrations ranging from approximately 3,500 pg/g to 13,500 pg/g TEQ. These concentrations exceed the US EPA Region 5 ecological screening level of 11.0 pg/g for polychlorinated dibenzo-p-dioxins and the Canadian ISQG of 0.85 pg/g TEQ and Probable Effect Level (PEL) of 21.5 pg/g TEQ.

The dioxin concentrations reported by Thiess in AECOM 2011A in the vicinity of the proposed alignment of the bridge for the residual excavated surface are generally lower than those reported in URS 2002 for the 0.4-0.5m depth interval.

Significant variations in the minimum and maximum concentrations of analytes across the remediation area were observed. This high variability suggests that the maximum concentrations identified during characterisation of the Bay sediment should be taken into account for the bridge construction, as it appears that even small changes in sample location can have a significant influence on the analytical results.

It is understood an environmental management plan (EMP) for Homebush Bay has been commissioned by Roads and Maritime Services (RMS). This EMP has not been completed at the time of issue of this report.

2.3.2 Land remediation

AECOM undertook a site audit of the remediation of Lots 305 to 313 and 316 in DP 1163025, being part of the former Union Carbide Site (AECOM 2011B). The purpose of the audit was to confirm the suitability of areas of the site for specific land uses. The eastern end of the proposed bridge will land on Lot 310 in DP 1163025, with associated works possibly impinging on Lots 311 and 316 in DP 1163025.

The Site Audit Statement (SAS) for the Site Audit Report (SAR) includes an environmental EMP (Thiess 2011) for Lots 310, 312, 313 and 316. Lots 310 and 316 were remediated to a standard suitable for use as Open Space Foreshore. Lot 313 was remediated to a standard suitable for use as Open Space Parkland, and Lot 312 was remediated to a standard suitable for use as both Open Space Foreshore and Open Space Parkland.



The SAR and EMP describe the subsurface conditions on the eastern shore of Homebush Bay in the vicinity of the landing area of the proposed bridge. As part of the remediation of the former Union Carbide site contaminated materials were excavated and either treated and reused, or re-used without treatment, by placement at depth on the site subject to meeting soil remediation criteria based on the location and depth of the material. Imported virgin excavated natural material (VENM) was used to reinstate the area immediately adjacent to Homebush Bay, and as a capping layer in the 40m wide foreshore reuse zone.

The EMP requires that any party proposing intrusive works within 40m of Homebush Bay must consult with and satisfy the requirements of the OEH prior to commencement of any activity that disturbs the subsurface of the area. It is understood that the requirement to notify OEH prior to commencement of intrusive works applies to the entire former Union Carbide site.

Cross sections presented in Thiess 2011 indicate the elevations of subsurface layers on the site. The cross sections show the presence of a 1m deep maintenance layer of VENM extending from the current surface of the site. Fill material of varying depths is present below the maintenance layer and the validated surface of the remedial excavations.

Subsurface conditions for the area subject to the EMP are summarised as follows:

- The area within 3m of Homebush Bay was reinstated with VENM.
- The area between 3m and 40m from Homebush Bay was reinstated with fill complying with the adopted re-use criteria and capped with a 1m layer of VENM.
- The open space area greater than 40m from Homebush Bay was reinstated with fill complying with the adopted re-use criteria for open space <1m depth and open space 1-5m depth.

Analytical results for backfill material placed in the area were reported in Appendix D of Thiess 2011.

A copy of the Thiess EMP detailing prerequisites for performing intrusive works and including analytical results reported for the capping layer and backfill placed in the area of proposed bridge land is presented in Appendix B-17.



3.0 REGULATORY NOTICES

A search of the CLM record of notices maintained by the OEH was undertaken in February 2012. The contaminated land public record is a searchable database of:

- Orders made under Part 3 of the *Contaminated Land Management Act 1997* (CLM Act).
- Approved voluntary management proposals under the CLM Act that have not been fully carried out and where the approval of the OEH has not been revoked.
- Site audit statements provided to OEH under section 53B of the CLM Act that relate to significantly contaminated land.
- Where practicable, copies of anything formerly required to be part of the public record.
- Actions taken by OEH under section 35 or 36 of the *Environmentally Hazardous Chemicals Act 1985* (EHC Act).

There is one current notice for the sediments in Homebush Bay, and 8 current notices for land parcels comprising portions of the former Union Carbide site.

The EPA declared a portion of the bed of Homebush Bay a “remediation site” pursuant to the CLM Act (notice 21001 issued 1 December 1998). The notice applies to an area of the Bay adjacent to the Former Union Carbide and Allied Feeds sites. The EPA found that the area was contaminated with dioxin in such a way as to present a significant risk of harm to aquatic life in the vicinity of the remediation site and to humans eating aquatic biota from the Bay.

Of the current notices for land parcels, four maintenance of remediation notices apply to land which may be associated with the proposed bridge (notice 28016 issued 14 January 2000 and notices 28016A, 28016B and 28016C issued 7 August 2008). The notices require the owner of the land to maintain remediation action on the land.

OEH records also note that the contamination on the former Union Carbide site and in Homebush Bay is being managed via the planning approval process.

Copies of the current notices are presented in Appendix C.



4.0 ENVIRONMENTAL CONTROL MEASURES

4.1 Proposed construction works based on concept design

The main physical features of the proposed bridge construction involving potential disturbance of soils and sediment, and for which mitigation measures have been developed (See Table 2), are listed as follows:

- Construction of four marine piled structures to bedrock to support the cantilevered section of the bridge (the “Main Bridge”). The marine piles would be installed from a barge, and would involve driving precast piles through the soft sediments and installation of pile caps at the waterline. During construction, the activities of vessels (including propeller wash) may locally resuspend surficial sediments into the water column. Driving piles through the sediment would displace and may resuspend surficial materials into the water column. The re-suspended materials would be either VENM backfill in the remediated area adjacent to the eastern foreshore of the Bay, or ambient surficial sediments in the central and western areas of the Bay. Based on experience the predominant movement of sediment caused by piling would be down and sideways - with a low potential for sediments to migrate upward along the side of the pile.
- The eastern end of the bridge (the “Approach Bridge”) will be supported on piles spaced at maximum 4.5m centres through the remediated area adjacent to the former Union Carbide site. The precast concrete piles will be driven through the capping layer and sediments to bedrock. Driving piles through the sediment would displace and may locally resuspend surficial VENM materials into the water column. The piles are expected to perforate the geotextile marker layer (Bidim A44) without causing widespread pulldown or disturbance of the marker layer. The Approach Bridge would be built incrementally and westward from the foreshore. No barges would be utilised during the construction of this section of the bridge.
- Construction of 1 land pier and 2 abutments. The concept design for the bridge includes approximately 6 precast driven piles for each abutment. Piles for these would be driven through the layers of fill soil and underlying natural soil into bedrock. Minor earthworks would be needed to create a level piling and work platform and involve placement of fill. The proposed land based works on Wentworth Point will include disturbance of surface material to a depth of approximately 0.4 m below existing ground level. Proposed land based excavations on the former Union Carbide site will include excavations to less than 1 m below the capped level, which will be limited to within the imported VENM capping layer. Construction of pile caps may involve excavation and backfilling.
- Excavation of fill soils and natural soils landward of the two abutments and if practical, reuse and compaction of these materials in the same vicinity (engineered in situ fill).
- Importation and compaction of fill material over the engineered reused/fill soils.
- Construction of drainage in the filled zones.
- Removal of stockpiled waste soil (offsite disposal). Based on previously reported results, it is expected that the waste soil generated from near-surface land based works could be disposed to landfill as General Solid Waste (see Appendix B, Section 1.5).



4.2 Exposure pathways

A summary of the potential exposure pathways resulting from construction activities described above and considered for each receptor type in this assessment are shown in Table 1.

Table 1: Exposure pathways considered

| Human Exposure Pathway | Workers | Pedestrians | Marine |
|----------------------------------------------------------------------------------------|----------------|--------------------|---------------|
| Incidental ingestion of soil/sediment | ✓ | x | N/A |
| Dermal adsorption from soil/sediment | ✓ | x | N/A |
| Inhalation of dust from soil | ✓ | ✓ | N/A |
| Inhalation of vapours | x | x | N/A |
| | | | |
| Ecological Exposure Pathway | | | |
| Dispersal of sediment and ingestion by marine species | N/A | N/A | ✓ |
| Leaching of contaminants to groundwater and waterways and ingestion by marine species. | N/A | N/A | ✓ |

4.3 Proposed mitigation measures for construction works

To ensure that pathways of contaminants to a receptor (including the associated routes of exposure) are not complete (or significantly reduced), the site management measures must:

- Minimise dispersal of sediment and associated contaminants.
- Prevent exposure of soil-bound contaminants to humans.
- Minimise leaching of soil contaminants to groundwater and the receiving environment.

The following summary of impacts and measures in Table 2 is based on the concept design and would require refinement in association with the finalised construction works plans. The detailed measures are to be documented in site management plans to be implemented during the construction phase of the proposal.



Table 2: Impacts and mitigation measures

| Item | Impact | Measure | Guideline / policy |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| 1 | <p>Piling and construction works for the bridge and approaches in and on the foreshore of Homebush Bay have the potential to disturb, intercept and expose contaminated material (containing elevated concentrations of metals, OCPs, dioxins (PCDDs) and furans (PCDFs), PAH and TPH) or acid sulfate soils. Contaminated materials exposed by piling works may come into contact with site workers, discharge from the site into Bay, and may affect ecological communities.</p> | <p>No dredging or boring of piles is proposed.</p> <p>Based on previous experience soft sediments, sediment movement caused by driving piles would be down and sideways, with a low potential for sediments to migrate up the side of the pile through the capping layer adjacent to the eastern foreshore. A further measure to mitigate the potential for voids and therefore minimise the potential exposure of the underlying sediment would be placing approximately 0.5m cover of pea gravel or similar materials at the piling locations prior to works. The gravel would fill voids in the capping if they occurred. The gravel would be lowered into place and carefully released to minimise disturbance of the sediments near the piles.</p> <p>Installation of a sediment boom and curtain (“sediment control device”) around barge works sites for over-water pile installation.</p> <p>The sediment curtain used would be the full depth of the Bay (i.e. from surface of the water, extending to the sediment of the Bay).</p> <p>The sediment control device will be installed, as much as practicable, during high tide periods from a boat, thereby minimising any disturbance to the existing sediments. The sediment control device will be designed to rise and fall with the tide to prevent sediments disturbed during the piling works dispersing in Homebush Bay.</p> <p>Inspection of the sediment control device will occur prior to commencement of each working day, following storm events, daily on ebbing tides and prior to re-commencement of work following rainfall of more than</p> | <p>CLM Act, POEO Act, WCG</p> |



CMP FOR PROPOSED HOMEBUSH BAY BRIDGE CONSTRUCTION

| Item | Impact | Measure | Guideline / policy |
|------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| | | <p>15 mm.</p> <p>As with installation, disturbance to surrounding sediments will be minimised by decommissioning the device by boat during high tide periods.</p> <p>Prior to removing the sediment control device, visual and field instrument verification that sediment has settled resulting in similar water turbidity to that outside the curtain.</p> <p>Attended turbidity monitoring during works, using a portable turbidity meter/logger, will be performed. A tiered response to sediment releases based on the magnitude of measured turbidity levels outside the primary silt curtain is proposed. (Further discussion of proposed monitoring is presented in Section 4.4)</p> <p>Monitoring of contaminants of potential concern in the water column will be performed using semi-permeable membrane devices (SPMDs) or alternative devices during the works to assess the impact of the construction works on the Bay.</p> <p>Details of this activity are to be provided in a site specific environmental management plan prepared for the construction stage of the project.</p> <p>Note: this measure is not required once pile installation is complete, and construction activities commence for pile caps and piers above seabed level.</p> <p>Contingency response protocols are to be incorporated in to the site specific environmental management plan. The protocols should identify contamination containment materials (e.g. oil containment booms, sediment control curtains) and personnel protective equipment to be used</p> | |



CMP FOR PROPOSED HOMEBUSH BAY BRIDGE CONSTRUCTION

| Item | Impact | Measure | Guideline / policy |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| | | during incident response. | |
| 2 | Barges and other vessels used during the construction phase have the potential to disturb, intercept and expose contaminated material. Contaminated materials remobilised (e.g. by propeller wash) may be advected from the work site to other parts of the Bay, with potential for adverse effects on environmental receptors. | <p>Dredging or other disturbance to sediment to allow barge movement/access is not proposed.</p> <p>Vessel movements will be, as far as practicable, at higher tidal levels to minimise the potential for disturbance of sediments.</p> <p>A sediment boom and curtain will be installed around barge works sites.</p> <p>Details of these mitigation measures are to be provided in a site specific environmental management plan prepared prior to the construction stage of the project.</p> <p>Contingency response protocols will also be incorporated into the site specific environmental management plan. The protocols should identify materials to contain contaminants (e.g. oil containment booms, sediment control curtains) and personnel protective equipment to be used during incident response.</p> | CLM Act, POEO Act |
| 3 | Land based excavations have the potential to intercept and expose contaminated soils and acid sulfate soil (ASS) material. ASS have the potential to oxidise and generate actual acidity following excavation. | <p>Proposed excavations on Wentworth Point include surface works to a maximum depth of 0.4m below existing ground level. Based on previous investigation results summarised in Section 2.1, ASS will not be disturbed by the surface works.</p> <p>Proposed excavations on the former Union Carbide Site are to be limited to a depth of less than 1.0m below the existing cap level. The original material in the area of the bridge landing on the former Union Carbide site has been excavated, assessed and/or treated prior to replacement as fill and covering with 1m of VENM. It is considered that there is a low probability of ASS being disturbed by land</p> | ASSMAC, WCG |



CMP FOR PROPOSED HOMEBUSH BAY BRIDGE CONSTRUCTION

| Item | Impact | Measure | Guideline / policy |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| | | <p>based excavations on the former Union Carbide Site.</p> <p>Store, characterise and assess contamination and ASS in excavation spoil, and treat and dispose at an appropriately licensed facility. Details of this activity are to be provided in a site specific acid sulfate soil management plan prepared for the construction stage of the project.</p> | |
| 4 | Contaminated materials (containing metals, PAHs and TPH) may be retained onsite (western foreshore) at depth following construction works (re-use of existing contaminated fill as engineered fill). | <p>Excavated fill on the western foreshore contaminated by metals, PAHs or TPH could be managed by placement at depth, with appropriate capping by imported “clean fill” and pavement.</p> <p>Future excavations within the site (e.g. for underground services), should be managed under a long-term environmental management plan prepared for the area, indicating the location of contaminated materials, and management processes for works in such areas.</p> <p>Details of the above management measures are to be provided in a site specific environmental management plan prepared for the construction and operational stage of the project.</p> | CLM Act, POEO Act, WCG |
| 5 | Fuels stored onsite may be released into the environment. | Store fuels in appropriate containers with secondary containment. Details of this activity are to be provided in a site specific environmental management plan prepared for the construction stage of the project. | CLM Act, POEO Act |
| 6 | Road materials removed during potential road works are a waste product. | It is noted that coal tar bitumen may be disrupted during road resurfacing works. Milled or excavated pavement material should be classified prior to off-site disposal. | WARR Act, CLM Act, WCG |
| 7 | Importation of fill materials for construction works must be validated as suitable for use onsite, and would not impact on the local environment. | Validate and assess imported fill material in accordance with NSW OEH requirements prior to importation onto the site. Details of this activity are to be provided in a site | CLM Act, WCG, GCRCS |



CMP FOR PROPOSED HOMEBUSH BAY BRIDGE CONSTRUCTION

| Item | Impact | Measure | Guideline / policy |
|------|-------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| | | specific environmental management plan prepared for the construction stage of the project. | |
| 8 | Surplus construction materials onsite would be considered a waste product. | Handle and store surplus construction materials in a manner to prevent unnecessary damage. Reuse or dispose surplus or damaged construction waste to an appropriately licensed facility. | WARR Act, WCG |
| 9 | Surface waters which discharge via storm water drains along the site may be contaminated. | Protect site stormwater drains with appropriate sediment control devices during construction and resurfacing works. Surface waters collected during works may need to be treated prior to disposal. Details of this activity are to be provided in a site specific environmental management plan prepared for the construction stage of the project. | CLM Act, POEO Act |



Unexpected finds in excavated fill such as asbestos containing materials (e.g. fibro fragments), odorous or visibly contaminated material would be managed through the site management plans including on-site assessment and management recommendations by a qualified contaminated land consultant.

4.4 Monitoring and Reporting

Sediment control devices will be inspected prior to piling commencing each working day. Defects or faults in the curtain(s) will be repaired prior to works commencing.

Turbidity in Homebush Bay will be monitored while piling and allied water based activities with potential to resuspend sediment within Homebush Bay occur. Turbidity will be measured regularly and at high frequency using a portable turbidity meter (submersible data logger). Adverse environmental effects are not anticipated from ephemeral, fugitive turbidity events, however turbidity is considered to indicate the potential for contaminant dispersion based on the close affiliation between the identified chemicals of concern and sediment particulate material. Attention should be paid to instrument calibration and the potential for anomalous turbidity readings caused by probe fouling following contact with bed sediments.

Measurements will be performed at 15 minute intervals at locations inside the sediment curtain and up and downstream of the sediment control device (and appropriate control locations as required) when piling and allied activities (e.g. barge movements) take place. Personnel performing the measurements will note the turbidity levels and record other observations including the presence of sheens, odours or excessive visual turbidity.

Operations will cease if the turbidity of the water inside the sediment control device AND outside the sediment control device downstream of piling operations is markedly lower than the turbidity of water upstream of the sediment control device. The cause/source of suspended sediment release (e.g. faulty sediment control curtains) would be determined and rectified before piling operations recommence.

Based on the measurement results, corrective actions such as the deployment of additional sediment controls may occur to manage suspended sediment. A tiered response, based on a three-level trigger system, is proposed to address potential sediment releases outside the silt curtain. The response system, including monitoring locations and depths, background control locations, and actions to be taken at nominated turbidity levels above background, are to be detailed in the site specific environmental management plan prepared for the construction stage of the project once the construction methodology has been finalised. The monitoring protocols will be agreed with OEH and will be consistent with the Homebush Bay EMP being prepared for RMS.

Monitoring reports will be prepared on a weekly basis by the construction contractor. The reports will include tabulated turbidity measurements, observations made during piling and allied activities (e.g. presence of oil sheens, odours, excessive turbidity), a photographic record of site activities, a record of piling activities and results of any additional chemical or physical analyses performed. In addition, reports will be submitted by the construction contractor to the superintendent if excessive turbidity is observed outside of the sediment control curtains during piling activities.

Monitoring of contaminants of concern in the water column will be performed using semi-permeable membrane devices (SPMDs), or alternative devices, during the works. SPMDs measure time-averaged concentrations of contaminants of concern during the deployment period (typically 28-days). This monitoring will provide analytical data to complement the turbidity measurements (a proxy for contaminant measurements during day to day operations). SPMDs will be used to assess the potential for concentrations of contaminants of concern (specifically dioxins) in the Bay to be increased by the proposed works.

The sampling devices will be placed in the vicinity of the works area and at control locations in the Bay to assess the potential for the bridge construction works to alter concentrations of contaminants of concern in Homebush Bay waters and adversely affect biota in the Bay. Similar to turbidity monitoring, protocols will be agreed with OEH.



The construction contractor would set up monitoring and reporting responsibilities, authority, communication chain and protocols for the monitoring and reporting regime discussed in this section. Such details would be included in the construction environmental management plan for the bridge. An organisational chart showing the communication chain is presented in the figure below. Note this chart is indicative only and would be fully detailed and finalised by the construction contractor as part of the construction environmental management plan for the bridge.

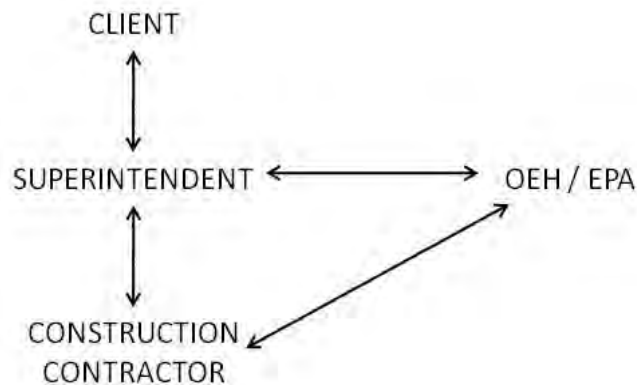


Figure 3: Indicative organisational chart

Any approvals or permits for the proposed bridge will include reporting requirements for pollution incidents e.g. release of sediments or hydrocarbons.

4.5 Conclusion

Due to the depth of the contamination in soil remaining on the western foreshore, the risk to human health and/or the environment is likely to be minimal. Therefore risks to human health posed by the identified soil contamination to remain on site would be mitigated by the placement of this material at depth (e.g. below the road way and imported “clean fill”) and also by implementation of the environmental management measures during construction works.

The area of the eastern foreshore at the proposed bridge landing has been remediated to a standard suitable for open space land use. The proposed construction works in this area should comply with the requirements of the EMP prepared by Thiess, which requires consultation with OEH prior to works commencing. Fill material in this area containing contaminants should not be exposed by the proposed works, therefore limiting the risk to human health and/or the environment.

In Homebush Bay contaminants in dissolved forms, or associated with suspended particulate materials have potential to be dispersed to possibly less contaminated areas of the Bay. Mobilised contaminants can pose higher risks to environmental receptors. Current risks posed by contaminated sediments residing in Homebush Bay may therefore be exacerbated by their disturbance and entrainment in the water column. Risks associated with disturbance of contaminated materials within the Bay would be proportional to the extent that sediment are resuspended by the construction works. The risk can be managed by effective implementation of a site environmental management plan aimed at minimising disturbance and dispersal of sediment during pile driving and allied works.

It is considered that risks to both human health and the environment associated with disturbance of identified contaminated materials during the proposed works can be minimised through appropriate construction techniques (e.g. no dredging or pile boring) and through implementation of site environmental management plans (incorporating mitigation and monitoring measures outlined above). These plans are required to prevent short and long term exposure of receptors to contaminants in soil, waters (ground, storm and ambient) and sediment.



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6.0 LIMITATIONS AND USE OF THIS REPORT

Your attention is drawn to the following limitations, which must be read in conjunction with this report. The services performed by Golder Associate have been conducted in a manner consistent with the level of quality and skill generally exercised by members of its profession and consulting practice. No warranty or guarantee of site conditions is intended.

This report is solely for the use of the client and any reliance of this report by third parties shall be at such party's sole risk and may not contain sufficient information for purposes of other parties or for other uses. This report shall be presented in full and may not be used to support any other objective than those set out in the report, except where written approval with comments are provided by Golder Associates.

The information in this report is considered to be accurate at the date of issue in accordance to the current conditions of the Site. It is based solely on the site conditions encountered at the time of the site visit, supplemented by the historical information and data described in the report.

Golder Associates has relied in good faith on information provided as noted in this report. We believe that the information from documents cited is accurate and has been accurately interpreted; however, Golder does not provide any guarantees in this regard.

It should be noted that the results of an investigation of this nature should, in no way, be construed as a warrant that the Site is free from any and all impacts from past or current practise.

No sampling or chemical analysis of any kind at or in the vicinity of the site was conducted as part of this assessment.



Report Signature Page

GOLDER ASSOCIATES PTY LTD

A handwritten signature in blue ink that reads "Shane Doyle".

Shane Doyle
Senior Environmental Scientist

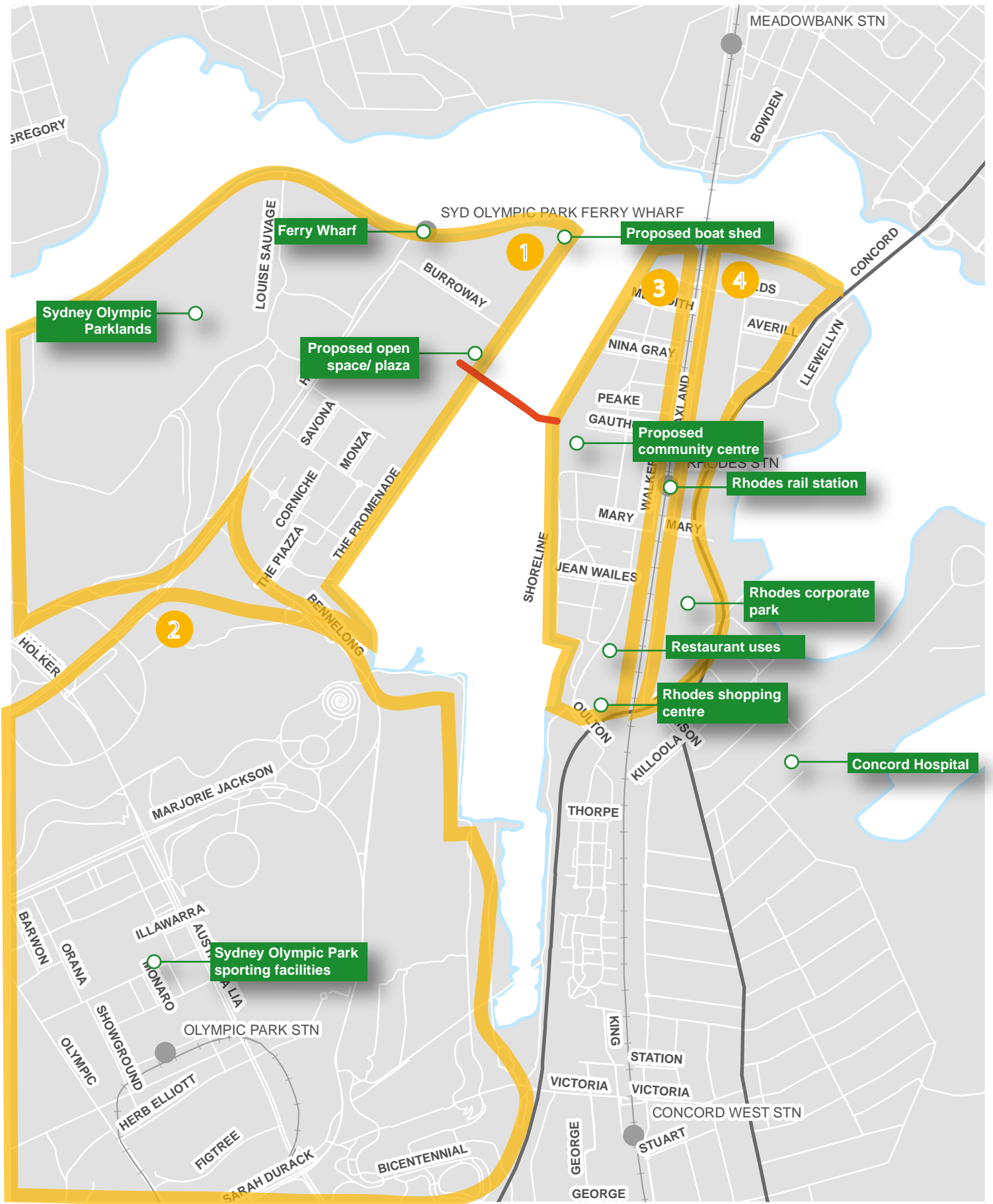
A handwritten signature in blue ink that reads "Seth Molinari".

Seth Molinari
Principal Environmental Engineer

RB:SPD/SM:TR/rb:spd

A.B.N. 64 006 107 857

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Legend

- Rail Station
- Ferry Stop
- Major Roads
- Rail line

- 1 Wentworth Point
- 2 Sydney Olympic Park
- 3 Rhodes West
- 4 Rhodes East

Proposed Bridge Location



Client
Fairmead Business Proprietary Ltd

Job Title
**Homebush Bay Bridge
Environmental Assessment**

Drawing Title
**Homebush Bay Bridge
Secondary Context**

Scale
0 250 500 Metres

| | | | | |
|-------|----------|--------|--|--|
| Draft | 08.04.11 | SLM | | |
| Draft | Date | Author | | |

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Scale at A4

Drawing Status

Draft

Job No
221379

Figure No

Issue