Gladesville Bridge Marina Pty Ltd

Gladesville Bridge Marina DA
Water Management Report

October 2019

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1. Introduction

1.1 Background

GHD Pty Ltd (GHD) was commissioned by Gladesville Bridge Marina (GBM) to prepare a Water Management Report for the proposed redevelopment of the GBM ('the project'). The project is located in Gladesville, NSW as shown in Figure 1.

Development consent is required for the development under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and is deemed a Designated Development requiring the preparation of an Environmental Impact Statement (EIS).

The Secretary's Environmental Assessment Requirements (SEARs) (refer SEAR 1268 received from NSW Planning & Environment, dated 15/11/2018) requested details on water resources impacts from the construction and operation of the project.

This assessment has been prepared to inform an EIS and development application under Part 4 of the EP&A Act. The assessment has been prepared in accordance with relevant statutory considerations.

1.2 Project Appreciation

The development is located at the centre of Sydney Harbour in Gladesville / Drummoyne, which is ten minutes from Sydney's central business district by road or water. The location of the development is shown in Figure 2.

The proposed development constitutes alterations and additions to the marina berth layout to provide overall storage for 130 vessels comprising 15 swing moorings and 115 floating berths. The works include:

- removal of 29 existing moorings and retention of 15 existing swing moorings;
- construction of 65 new floating berth spaces of varying sizes, that increases the number of floating berths from 50 to 115;
- cessation of slipway activities;
- demolition of the slipway rails and demolition of the internal office mezzanine structure within the covered slipway area; and
- provision of 8 new valet car parking spaces within the existing slipway area.

No dredging is understood to be required for mooring berth deepening as sufficient water depths exist for the proposed facility. Piles into rock (rock-socketed) are envisaged for the new mooring berths.

1.3 Purpose of this report

The purpose of this assessment report is to inform the EIS of potential water resources impacts of the proposed redevelopment of GBM on the existing environment and develop appropriate measures to avoid, minimise, mitigate and/or manage these potential impacts.

1.4 Site Location

The GBM site ("the Site") is located on the southern side of the Parramatta river directly upstream of the existing Gladesville bridge crossing between Drummoyne to the south and Huntley's Point and Hunters Hill to the north. The Site is accessed by road via Victoria Place just south of Howley Park. A Google maps image of the Site area is presented below in Figure

1. Figures showing the approximate extent of the offshore and onshore works are presented in Figure 1 and Figure 2 respectively.

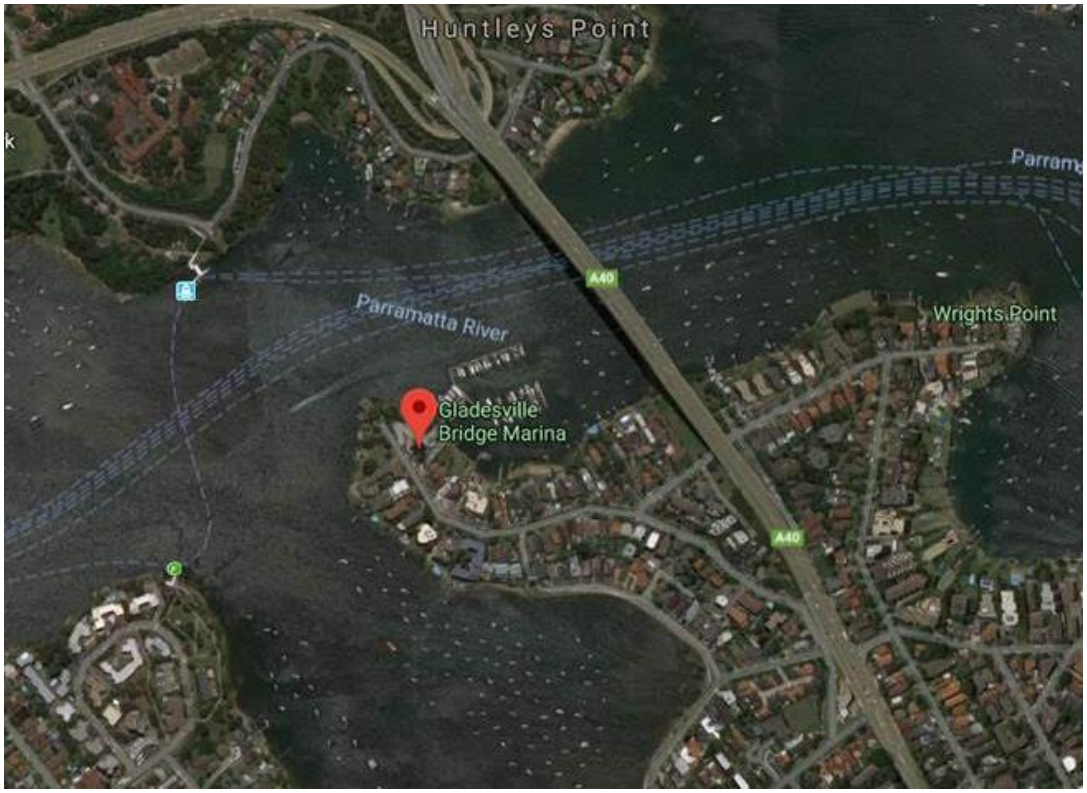

Figure 1 Site location

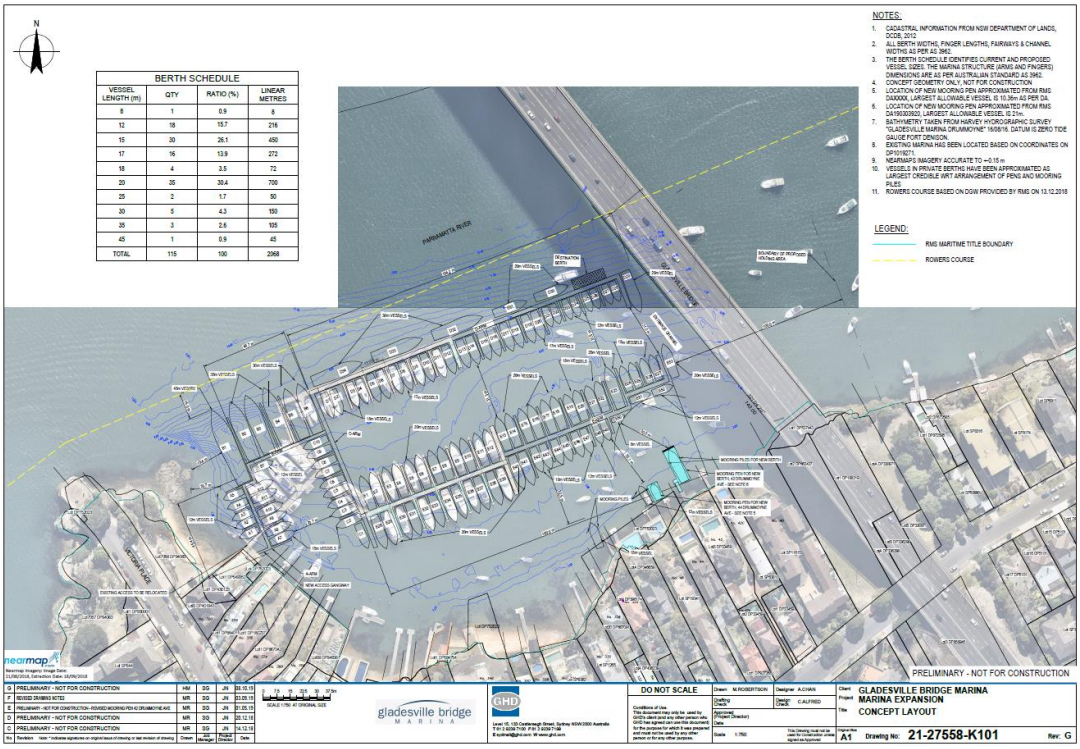

Figure 2 Aerial image of proposed offshore works

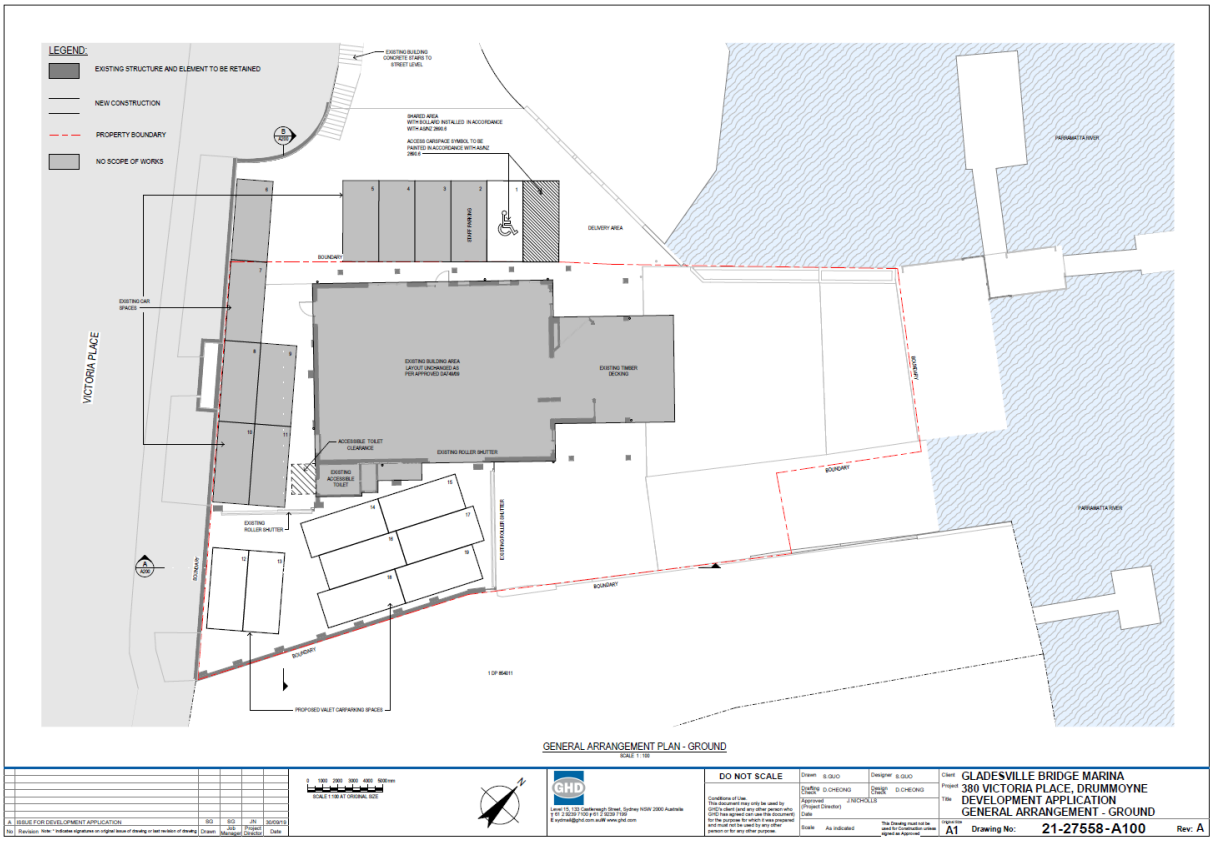

Figure 3 Approximate location of proposed car spaces

1.5 Assumptions and limitations

This report: has been prepared by GHD for Gladesville Bridge Marina Pty Ltd and *may only be used and relied on by Gladesville Bridge Marina Pty Ltd for the purpose agreed between GHD and the Gladesville Bridge Marina Pty Ltd as set out in section 1.4 of this report.*

GHD otherwise disclaims responsibility to any person other than Gladesville Bridge Marina Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Gladesville Bridge Marina Pty Ltd and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. Assessment Requirements

This section outlines key planning and environmental regulatory framework applicable to the project, including the identification of relevant environmental planning instruments and key development approval requirements.

2.1 Secretary's Environmental Assessment Requirements (SEARs)

The SEARs assessment ref. SEAR 1268 received from NSW *Department of Planning and Environment* (dated 15/11/2018) indicated the following key issues relating to water resources.

Table 1 SEARs relating to water resources

SEARs	Reference
A description of local soils, topography, drainage and landscapes	• Relevant descriptions provided in Section 3. •
An assessment of potential impacts on the quality and quantity of surface and groundwater resources	• Description of existing surface and groundwater resources provided in Section 3. • Potential impacts and management measures relating to surface and groundwater resources provided in Sections 4 and 3 respectively. • Further details relating to surface water resources provided in the Stormwater Management Report. • Further details relating to contamination of surface and groundwater resources provided in the Contamination Investigation. • Further details relating to the impacts of surface and groundwater resources on aquatic ecology provided in the Marine Ecology Study.
Details of sediment and erosion controls	• Relevant descriptions provided in Section 3. • Further details provided in the Erosion and Sediment Management Plan.
Details of proposed stormwater and wastewater management systems (including sewerage), water monitoring and other measures to mitigate surface and groundwater impacts	• Relevant descriptions provided in Section 3. • Water monitoring and other mitigation measures provided in Section 3. • Further details provided in the Civil Infrastructure and Stormwater Plans.

SEARs	Reference
Benthic morphology, water flow in and around the development, flushing and wave bounce	• Benthic morphology assessment provided in the Marine Ecology Study. • Metocean and hydrodynamic assessment provided in the Wave Climate Report.
Details of construction methodology and any proposed dredging, including measures to manage and minimise disturbance of the shoreline, substrate stability and potentially contaminated sediments	• Details of the construction methodology and proposed management measures are provided in the project specific Construction Management Plan.
A description and appraisal of mitigation and monitoring measures	• Recommendations for management measures relating to contaminated sediments and the need for a Remediation Action Plan provided in the Contamination Investigation. • Specific requirements for the protection of the aquatic environment to be incorporated into the Construction Environmental Management Plan (CEMP) and Operational Environmental Management Plan (OEMP) provided in the Marine Ecology Study. • Remaining management measures relating to water resources provided in Section 5.
Details of any licensing requirements or other approvals under the Water Act 1912 and/or Water Management Act 2000	• Details provided in Section 2.
An assessment of potential impacts on floodplain and stormwater management and any impact to flooding in the catchment	• Potential impacts and management measures relating to floodplain and stormwater management provided in Sections 4 and 3 respectively.
A description of the measures proposed to ensure development can operate in accordance with the requirements of any relevant Water Sharing Plan or water source embargo.	• Details provided in Section 2.

2.2 Water Management Act 2000

The *Water Management Act 2000* (WM Act) is intended to ensure that freshwater water resources are conserved and properly managed for sustainable use benefitting present and future generations. It is also intended to provide a formal means for the protection and enhancement of the environmental qualities of waterways and their catchments.

Part 2 of the WM Act requires a licence for the “taking of water” from a water source. A licence entitles its holder to specified shares in the available water within a defined water management area or from a specified water source. It enables the licence holder to take water from the environment in accordance with specified rates and conditions under the terms of the licence.

Part 3 of the WM Act specifies approval requirements for water use, water management works approvals and activity approvals. There are two kinds of activity approvals including controlled activity approvals and aquifer interference approvals.

Controlled activity approvals confer a right for the holder to carry out a specified controlled activity on waterfront land which is defined as land within 40 metres of a river, lake, estuary or shoreline. An aquifer interference approval may be required for any works that involve:

a. the penetration of an aquifer;

b. the interference with water in an aquifer;

c. the obstruction of the flow of water in an aquifer;

d. the taking of water from an aquifer in the course of carrying out mining, or any other activity prescribed by the regulations; and

e. the disposal of water from an aquifer as referred to in paragraph (d).

The project will involve construction activities within 40 metres of the shoreline of the Parramatta River. However, the project is not anticipated to require major dewatering of a water source and is not expected to trigger the need for a water use approval, water management works approval or controlled activity approval under sections 89, 90 or 91 of the WM Act as the project is exempt under Clause 36 of Schedule 4 of the Water Management (General) Regulation 2018.

2.3 Other relevant guidelines

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality
- National Water Quality Management Strategy (NWQMS)
- NSW Water Quality Guidelines
- NSW Water Quality Objectives
- Protection of the Environmental Operations Act 1997

3. Existing Environment

3.1 Current land use

The current marina layout was completed in 2000 and provides the following services:

- 50 floating marina berths
- 29 swing moorings for vessels up to 50’
- 15 commercial mooring spaces
- Tender service is available 7 days a week
- Dinghies for after-hours mooring access
- Slipway for vessels up to 40t and 16’ beam
- Undercover slipway area for all weather painting and repairs
- Cleaning and detailing services; including polish, carpet cleaning and stainless steel polishing
- Power and Water to all berths
- Sewer Pump-Out
- Garbage disposal and recycling
- Boat brokerage

3.2 Existing flood risk and drainage infrastructure

A review was undertaken of the potential floodplain impact of the proposed marina development.

A desktop review of local floodplain mapping was undertaken. The marina does not fall within the flood planning level area of the Canada Bay Council LEP. However, no flood study or floodplain risk management study and plan for the local area has been prepared by Council.

A study of still sea levels was undertaken by the Office of Environment and Heritage (then DECC, 2010). As noted in the Wave Climate Study for the site (MetOcean Solutions, 2019), the 1% Annual Exceedance Probability (1 in 100 year ARI) ocean level, excluding storm, wave and wind action, for the site is 1.44 mAHD, taken at Fort Denison.

Stormwater drainage is currently provided via a series of grated stormwater drains across the site as shown in Figure 4 and Figure 6. Surface waters is collected within these drains and discharged into the Parramatta River via a series of discharge points as shown in Figure 5.

Roadside drainage off Victoria Place exists immediately adjacent to the eastern and western boundaries of the property which drains to the Parramatta River.

Surface water falling on the undeveloped area north of the existing driveway is expected to penetrate ground surfaces as described in Section 3.6. During high rainfall events, it is expected that surface water will flow directly into the Parramatta River.

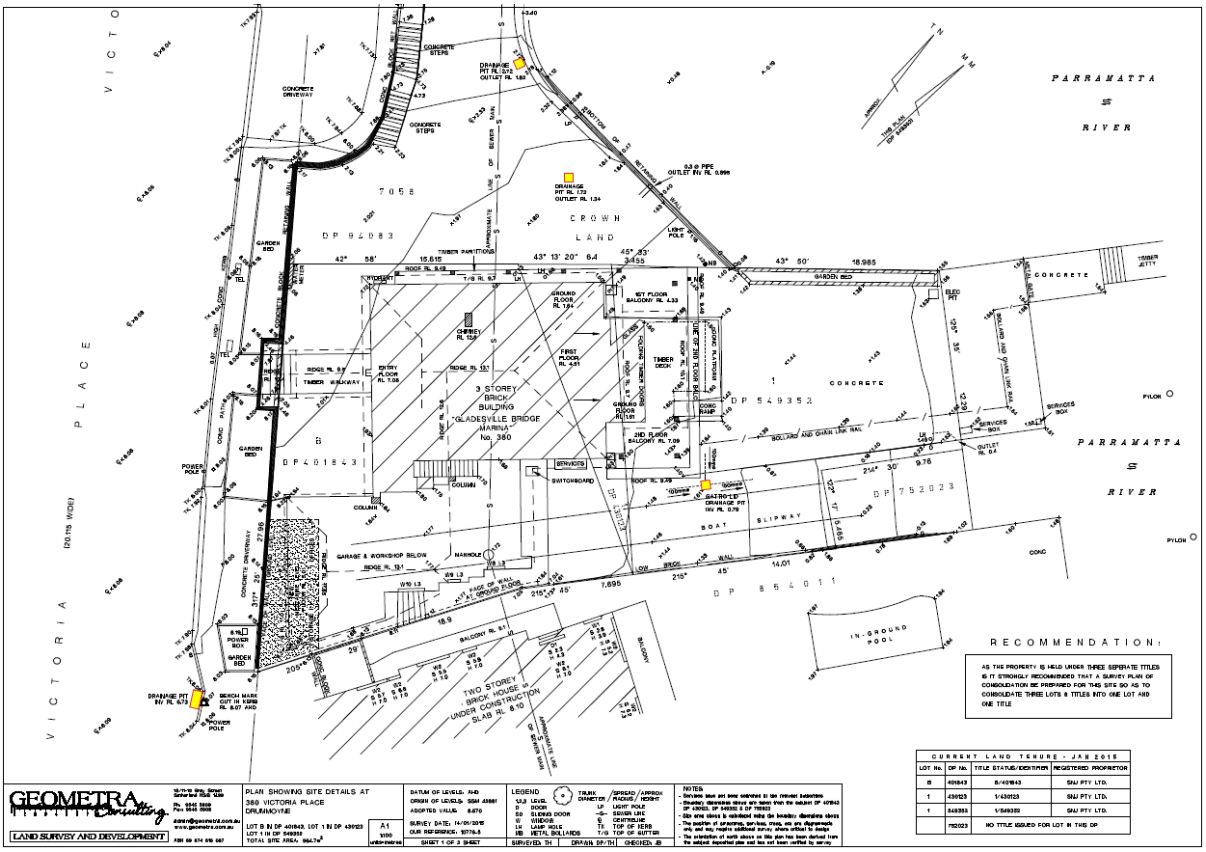

Figure 4 Existing drainage infrastructure (highlighted in yellow) (Source: Geometra Consulting – Land Survey and Development)

Figure 5 Existing stormwater discharge outlets

Figure 6 Existing stormwater collection points

Figure 7 Roadside drainage east of the marina office

Figure 8 Roadside drainage west of the marina driveway

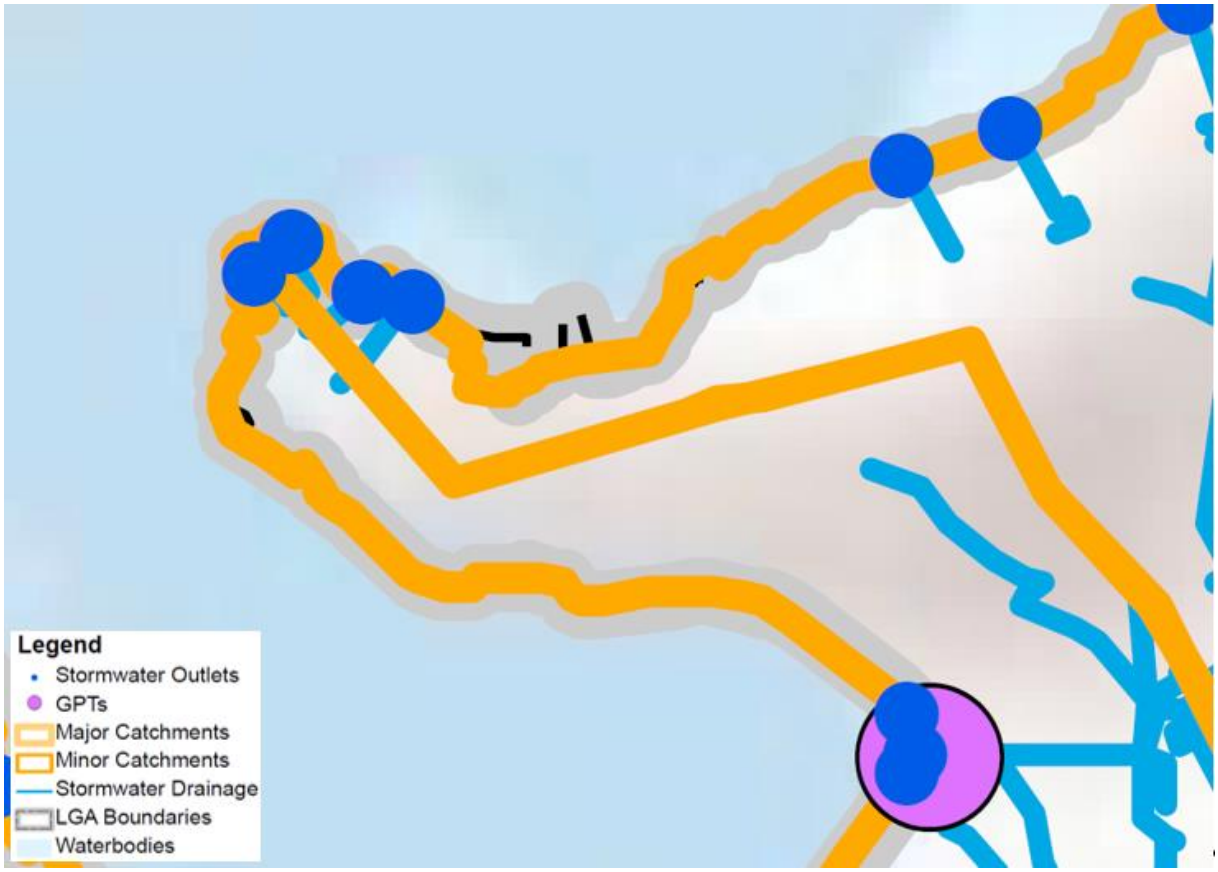

Figure 9 Existing roadside stormwater network (Cardno, 2013)

3.3 Water Quality

3.3.1 Marine Water Quality Objectives

The National Water Quality Management Strategy (NWQMS) provides a national framework for improving water quality in Australia's waterways. The main policy objective of the NWQMS is to achieve sustainable use of the nation's water resources, protecting and enhancing their quality, while maintaining economic and social development.

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000) is a benchmark document of the NWQMS which provides a guide for assessing and managing ambient water quality in a wide range of water resource types and according to specified environmental values. The guidelines provide a framework for determining appropriate values or performance criteria to evaluate the results of water quality monitoring programs against defined objectives or values for the receiving waters. For each environmental value, the guidelines identify particular water quality characteristics or 'indicators' that are used to assess whether the condition of the water supports that value.

The Marine Water Quality Objectives (WQOs) were adopted by the NSW Government in 2005 and are intended as a guideline tool for strategic planning and development assessment (DEC 2006). The WQOs are consistent with the national framework for assessing water quality set out in the ANZECC 2000 Guidelines and include five objectives which describe the water quality needed to protect the following marine water quality values:

- Aquatic ecosystems i.e. aquatic ecosystem health;
- Primary contact recreation i.e. swimming, surfing;
- Secondary contact recreation i.e. boating, wading;
- Visual amenity i.e. aesthetic qualities of waters; and
- Aquatic foods i.e. water suitable for growing seafood.

The relevant water quality objectives for the upper estuary of Parramatta River are presented in Table 2.

The River Flow Objective (RFOs) are the agreed high-level goals for surface water flow management. They identify the key elements of the flow regime that protect river health. For the upper estuary the river flow objectives are:

- Maintain wetland and floodplain inundation;
- Manage groundwater for ecosystems;
- Minimise effects of weirs and other structures; and
- Maintain or rehabilitate estuarine processes and habitats.
- The relevant river flow objectives for the upper estuary of Parramatta River are presented in Table 3.

Table 2 Water Quality Objectives

Marine Water Quality Objectives	Aquatic ecosystem health	Primary contact recreation	Secondary contact recreation	Visual amenity	Aquatic foods
	To maintain or improve the ecological condition of ocean waters.	To maintain or improve ocean water quality so that it is suitable for activities such as swimming and other direct water contact sports.	To maintain or improve ocean water quality so it is suitable for activities such as boating and fishing where there is less bodily contact with the waters.	To maintain or improve ocean water quality so that it looks clean and is free of surface films and debris.	To maintain or improve ocean water quality for the production of aquatic foods for human consumption (whether derived from aquaculture or recreational, commercial or indigenous fishing).
Examples of indicative guideline levels for environmental (ambient) water quality The indicative guideline levels (indicators and numerical criteria) listed are examples only of some of the relevant water quality guideline levels recommended in the ANZECC & ARMCANZ Guidelines 2000. For a full list, refer to the appropriate tables as referenced in the ANZECC & ARMCANZ Guidelines 2000. These are available at www.deh.gov.au/water/quality/nwqms/index.html	**Biological** • Frequency of algal blooms – no change from natural conditions • Bioaccumulation of contaminants – no change from natural conditions. **Physico-chemical** • **Nutrients** Total Nitrogen < 120 µg/L Total Phosphorous < 25 µg/L • **Turbidity** 0.5–10 NTU* **Toxicants in coastal waters** • **Metals** Copper < 1.3 µg/L Lead < 4.4 µg/L Zinc < 15 µg/L • **Pesticides** Chlorpyrifos < 0.009 µg/L **Toxicants in bottom sediments** • **Metals** Copper < 65 mg/kg dry weight Lead < 50 mg/kg dry weight Zinc <200 mg/kg dry weight Mercury < 0.15 mg/kg dry weight • **Organochlorines** Chlordane < 0.5 µg/kg dry weight Total PCBs < 23 µg /kg dry weight	**Biological** • **Faecal coliforms** Median over bathing season of less than 150 faecal coliforms/100 mL with 4 out of 5 samples < 600/100 mL (minimum of 5 samples taken at regular intervals not exceeding one month). • **Enterococci** Median over bathing season of less than 35 enterococci/100 mL; (maximum number in any one sample: 100 organisms/100 mL) **Physico-chemical** • **Visual clarity** A 200-mm diameter black disc should be able to be sighted horizontally from a distance of more than 1.6 metres (approximately 6 NTU**).	**Biological** • **Faecal coliforms** Median bacterial content in marine waters of <1000 faecal coliforms per 100 mL, with 4 out of 5 samples <4000/100 mL (minimum of 5 samples taken at regular intervals not exceeding one month) • **Enterococci** Median bacterial content in marine waters of < 230 enterococci per 100 mL (maximum number in any one sample: 450–700 organisms per 100 mL)	**Indicators to ensure water looks clean and free from pollutants** • **Surface films and debris** Oils and petrochemicals should not be noticeable as a visible film on the water, nor should they be detectable by odour. Waters should be free from floating debris and litter. • **Nuisance organisms** Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae, and sewage fungus should not be present in unsightly amounts.	**Biological (as applied to the consumption of aquatic foods)** • **Faecal coliforms** The median faecal coliform concentration should not exceed 14 MPN#/100mL, with no more than 10% of the samples exceeding 43 MPN/100mL. Standard in *edible tissue*: Fish destined for human consumption should not exceed a limit of 2.3 MPN *E Coli*/g of flesh with a standard plate count of 100,000 organisms/g. **Toxicants (as applied to aquaculture activities)** • **Metals** Copper < 5 µg/L Mercury < 1 µg/L Zinc < 5 µg/L • **Organochlorines** Chlordane < 0.004 µg/L PCBs < 2 µg/L **Physico chemical (as applied to aquaculture activities)** • **Suspended solids** < 5 µg/L • **Temperature** < 2 degrees Celsius change over one hour

Table 3 River Flow Objectives

River Flow Objective	 **Maintain wetland and floodplain inundation** **To maintain or restore natural inundation and distribution of floodwaters supporting natural wetland and floodplain ecosystems.**	 **Manage groundwater for ecosystems** **To maintain groundwater within natural levels and variability, critical to surface flows and ecosystems.**	 **Minimise effects of weirs and other structures** **To minimise effects of weirs and other structures.**	 **Maintain or rehabilitate estuarine processes and habitats** **To maintain or rehabilitate estuarine processes and habitats.**
Measures to achieve objective	• Management plans and actions for waterways need to include strategies to maintain, restore or mimic natural patterns of inundation, water movement and drying in natural and semi-natural wetlands, and remaining native floodplain ecosystems. • Ensure adequate access for native fish to and from floodplain wetlands. • Flooding patterns should not be altered without proper environmental assessment.	• Implement the State Groundwater Policy (DLWC 1997a, 1998b). • Identify any streams or ecosystems that may depend on high groundwater levels, and assess impacts of reduced recharge or excessive pumping or drainage. • Identify areas where rising groundwater may threaten ecosystems or surface-water quality. • Determine appropriate action to keep ground-water level changes within acceptable bounds.	• Implement the NSW Weirs Policy (DLWC 1997b). • Identify, and take action to minimise, the impact on native fauna of other structures that impede movement of water-e.g. floodgates, tidal barriers, culverts.	• Dredging beyond minimal maintenance dredging for navigation requires environmental assessment. • Draining or disturbance of areas of potential acid sulfate soils must be minimised. • Water-based activities should be controlled to minimise impact on fish habitat. • Other processes affecting or potentially affecting estuary health need to be addressed-e.g. the impact of increasing urbanisation.

3.3.2 Water quality within Sydney Harbour

The Sydney Harbour Water Quality Improvement Plan provides a coordinated management framework that encompasses the whole of Sydney Harbour's Catchment (LLS, 2015). The main objective of the plan is to identify threats to water quality in the Harbour and its tributaries and to set targets for pollutant load reductions (in terms of total nitrogen, total phosphorus, suspended sediment and pathogens). It also provides direction to manage specific pollution problems arising from past activities, for example issues with toxic sediments derived from past industrial activities in the catchment.

During the development of the plan, the authors held a number of community workshops to assess key concerns relating to water quality within Sydney Harbour. In relation to boating activities, community members raised concerns regarding recreational boats dumping sewerage into the harbour and the impact of boat wakes on foreshore areas. Nevertheless, it was concluded that the majority of water quality issues relate to pollutant sources from urban development within the broader catchment.

Similarly, the 2018 Scoping Study for Sydney Harbour noted that water quality is an issue that requires co-ordinated catchment scale action as it is primarily related to pressures from the catchment and from past and present uses. The Study noted that water quality modelling for the Parramatta River indicates that, due largely to increasing population density, water quality in the River will decrease over the next decade (BMT 2018).

In support of the current EIS, water quality sampling was undertaken on 1st May 2019 in the vicinity of Gladesville Marina by Marine Pollution Research at twelve monitoring sites as shown in Figure 10.

Figure 10 Sediment and water quality sampling locations (MPR, 2019)

Water quality sampling comprised the following:

- Sampling of surface and bottom waters from 12 locations over three events; neap dry, spring dry and wet weather conditions

- Samples were analysed for total suspended solids (TSS), Copper and dissolved organic carbon (DOC).
- A submersible data logger was used to record water depth, temperature, dissolved oxygen concentration and saturation, pH, conductivity and turbidity.

At the time of writing, results for the initial dry weather neap tide sampling were available and are summarised as follows:

- Turbidity was low, indicating generally clear waters at all sites. This was reflected in TSS results with most results at or below 3mg/L
- Salinity and the dissolved oxygen values were similar throughout the depth profiles ranging between 35.1 and 35.2 ppt and 79.8% and 82.5% saturation respectively
- Water pH was uniform throughout the survey with values of 7.7 to 7.8 pH units.
- Dissolved copper and DOC were low and uniform across sites and with depth (MPR, 2019)

3.4 Bathymetry

Recent hydrographic surveys have been undertaken by Harvey Hydrographic Surveys in 2005 and 2016 covering the Gladesville Marina and proposed development areas.

Bed levels in the vicinity of the current marina range from -3m to -5m below Zero Tide Gauge Fort Denison or lowest astronomical tide (LAT) for the inner berths, and -6m to -8m LAT for the outer berths. Bed levels within the existing fairway vary between -5m and -6.5m LAT

Bed levels in the vicinity of the proposed expansion are consistent with the existing berths.

Bed levels beyond the marina continue to deepen to the north reaching a maximum depth of -17.9m below LAT.

Comparison of the available survey information reveals no significant bed level changes in the vicinity of the marina.

3.5 Topography

The landside marina area comprises a relatively flat section of reclaimed foreshore varying in elevation from approximately 1.5 to 2m AHD. The area is bounded to the south-west by a retaining wall extending approximately 6m in height to Victoria Place (approximate elevation of 8m AHD).

The landside area is generally developed comprising buildings and concrete wharf / berth frontages, small jetties and parking / access routes. Vehicle access to the site is provided by a switch-back driveway of relatively consistent slope supported by retaining walls on the northern and southern extremities, see Figure 11 below.

The surrounding area comprises the wide Parramatta river channel which abuts against elevated terrain of Huntley's Point and Drummoyne.

Figure 11 GBM Site area looking east towards Gladesville Bridge

3.6 Geology

Based on the 1:100,000 scale Geological Series Sheet for Sydney (Sheet 9130, Edition 1, Geological survey of NSW, Department of Mineral Resources, 1983), the Gladesville bridge area comprises a relatively low-lying wide river valley / harbour side area becoming elevated terrain inland generally on bedrock. Figure 12 shows an extract from Geological Series Sheet 9130 covering the Gladesville Bridge area.

Figure 12 Geological Series Sheet 9130 (Edition 1) 1983

The sediments, (Qha) which are present in the widened river valley, are expected to generally consist of peat, sandy peat and mud, and silty to peaty quartz sand, silt and clay, with common shell layers. Localised dredged estuarine sand and gravel, or man-made fill (mf) is indicated to the west of the Site. Localised fill and alluvial and beach deposits are present alongside the Site area.

Sandstone bedrock (Rh) in the Site area and Drummoyne typically consists of medium to coarse grained quartz Sandstone, with very minor shale and laminate lenses. A site inspection undertaken by GHD geotechnical staff on Wednesday 27 February 2019 indicates that the sandstone bedrock is observed as localised outcrops along the river banks and at shallow depths, extending outwards from the river banks as rock shelves and ledges. Further details are provided in the Geotechnical Report.

Figure 13 Rock outcrops and shelves / ledges at the Site area

3.7 Soil and sediment quality

Investigations to assess the contamination of the soils and marine sediments in the vicinity of the slipway were undertaken by Zoic Environmental Solutions 2019.

From the investigations, the following points are noted:

- Heavy metals commonly exceeding the screening levels
- Tributyltin TBT, dioxins and PAHs were reported above the nominated guidelines in several
- The investigations identified a number of activities that would have likely contributed to the possible contamination of marine sediments including
- Industrial discharges
- Catchment road and industrial runoff

Further sampling that was undertaken to characterise sediment quality in the offshore development area by MPR. Sediments were collected from eight inshore locations (see Figure

10) by divers, using a 100mm diameter by 500mm length corer. Samples were analysed for a range of metals and for Total Organic Carbon. Key results are summarised below:

- Sediment composition was variable with % fines ranging from 13 to 54% and sediments from the sites closer to the slipway generally had higher fines proportions in bottom samples compared to surface.
- Whilst lead concentrations were uniformly above the ISQG low value, MPR noted that the concentrations were generally below the mean Port Jackson concentration of 364mg/kg.
- Sediments in close proximity to the slipway recorded elevated levels of copper and zinc however levels were well below the Port Jackson means of 188 and 651mg/kg respectively.
- Whilst mercury concentrations were generally below detection three surface sediment samples from sites remote to the slipway had concentrations just above the ISQG low value

For detail on the samples taken, the exceedances/non-conformances reported and the recommendations and conclusions made, refer to the Contamination Investigation and Marine Ecology Study.

3.8 Groundwater hydrology

Zoic Environmental ("Zoic") carried out site investigations of soil, sediments and groundwater at the site between 4th to 13th June 2019 (reference No. 5, Zoic 2019), as part of their contamination investigation. The site investigation comprised the sinking of five (5 No.) auger boreholes (BH01 – BH05) and the collection of three (3 No.) sediment samples. Boreholes BH01 and BH02 were combined borehole / groundwater well locations. The five boreholes were located within the GBM site facilities landside area (comprising buildings and concrete wharf / berth frontages as shown in Figure 5) at locations indicated in Zoic Figure 3. The three sediment samples were collected immediately offshore near this area.

The following observations are made in relation to groundwater from the Zoic site investigation report:

- Soils were observed to be 'wet' immediately below the concrete (Marina hard standing surface) with a depth to groundwater ranging from approximately 0.4m (south-western portion) to 0.9m below ground surface (north-eastern portion) indicating groundwater flows running through the fill / soil layer immediately above the Sandstone bedrock. These were noted to follow the topographical decline towards the Parramatta River.
- Groundwater was observed to be slightly alkaline to alkaline with reducing conditions in MW02. Highly saline conditions were observed in boreholes MW01 and brackish waters were encountered in borehole MW02;
- An Enviro-Screen report appended to Zoic's report indicates that a Class 5 acid sulphate soil risk exists on the site (works likely to lower water table or advancement to classes 1-4) with a high probability of occurrence (>70%).

A desktop study and intrusive investigation on site, including installation of groundwater monitoring wells was conducted by Zoic Environmental Pty Ltd. The desktop study found two underground petrol storage tanks had been removed from site, and that the use of Organotins (tributyltin – TBT) was likely in boat cleaning and maintenance activities.

Reported concentrations of petroleum hydrocarbons (TPH), heavy metals (copper, nickel, lead, mercury and zinc), and organotins (TBT) in slipway sediments indicate potential ecological and human health exposure risk.

The Contamination Report notes that the sediments accumulated in the slipway pose a potential exposure risk to ecological and human health. In order to ensure the site is suitable for the proposed development, a Remediation Action Plan (RAP) has been prepared which details remediation requirements along with additional assessment necessary to address remaining data gaps.

3.9 Acid Sulphate Soils

The 1:25000 scale Prospect-Parramatta River Acid Sulphate Soil Risk Map (Edition 2), indicates that an area of 'DTxx – Disturbed Terrain' is present in the proposed project area. The disturbed materials, as defined by the Sydney Geological Series Map (Sheet 9130), as manmade fill, comprising dredged estuarine sand and mud, demolition rubble, industrial and household waste. The risk map has been reproduced in Figure 14 and indicates that there is a high probability of encountering Acid Sulphate Soils in the bottom sediments across infilled / reclaimed areas. These materials likely underlie the disturbed materials described above.

Further details regarding Acid Sulphate Soil risks are provided in the Contamination Report, the Remediation Action Plan and Sediment Management Report.

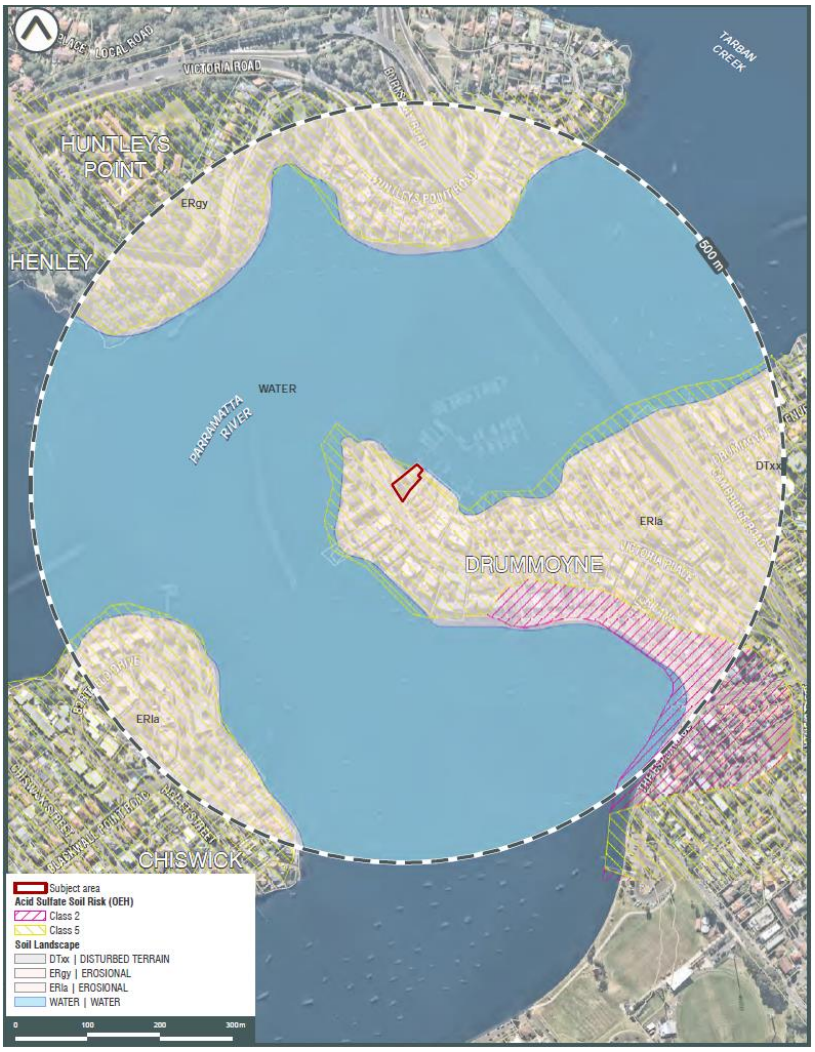

Figure 14 Acid Sulphate Soil Risk (Source: Enviro-Screen Report)

3.10 Benthic morphology, water flow, flushing and wave bounce

A numerical modelling study was undertaken in order to characterise the wave climate and hydrodynamic processes near the marina. A wave model (SWAN) was setup to allow simulation

of 25 years (1993-2018) of wind generated waves within the area to provide ambient statistics and extreme values analysis (determination of the 1, 10, 50- and 100-year Return Period wind and waves) at six selected locations within the marina.

The accompanying report notes that the design local wind sea wave heights and wave periods satisfy the conditions for an ‘excellent’ wave in accordance with the Australian Standards AS 3962 – Guidelines for the Design of Marinas.

Boat wakes from the RiverCat and harbour ferries have been implicated in shoreline erosion along the estuary. A no-wash zone however is located between Gladesville Bridge and Five Dock Point and although vessel speed limits are not specified it is anticipated that such vessels travel at lower speeds near the Gladesville Bridge Marina to minimise wash and therefore wake waves are expected to be minimal (Cardno, 2013).

Further details relating to hydrodynamics, wave climate and climate change are presented in Wave Climate Report.

Existing conditions relating to benthic morphology has been addressed separately with Marine Ecology Study.

4. Potential Impacts

4.1 Methodology overview

This section provides a description of the potential impacts to water resources associated with the proposed redevelopment of marina. Measures to mitigate and monitor these potential impacts are presented in Section 5.

Site investigations and numerical modelling has been undertaken as part of the associated specialist studies relating to geotechnical, marine ecology, contamination and hydrodynamics. Relevant information has been cross referenced below but is not repeated in full. This assessment must therefore be read in conjunction with other specialist assessment reports.

4.2 Construction Impact Assessment

Potential construction phase impacts are primarily associated with water quality impacts generated during construction and demolition works, including:

- Piling operations and demolition works including removal of the slipway rails and pile extraction has the potential to disturb sediments
- Movement and anchoring of construction vessels such as spudded barges, crew transfer vessels and survey vessels, which may lead to hydrocarbon spills, disturbance of bottom sediments and may contribute to dispersal of suspended sediments

Potential impacts associated with these activities are described in greater detail below.

4.2.1 Piling operations and demolition works

Proposed construction and demolition activities include piling works, removal of the slipway rails, pile extraction and removal of mooring blocks and chains from the existing swing moorings. These activities have the potential to disturb sediments leading to localised plumes and increased rates of sedimentation in the immediate vicinity of the works.

Given that recent studies have identified elevated contaminant levels in marine sediments, care must be taken to avoid mobilisation of sediments and associated contaminants.

Nevertheless, in evaluating the potential impacts of such activities, it should be noted that the relative scale of sediment disturbance will be minor. In particular, piling activities involve the driving of piles downwards into the bed sediments. Whilst sediments are displaced horizontally, no significant quantities of sediment will be put into suspension.

The removal of existing piles has the potential to disturb sediments where piles may be extracted and lifted through the water column. In such instances, it is recommended that the Contractor install silt curtains or other turbidity barriers around the pile to be extracted as shown in Figure 15.

Silt curtains are available in a range of designs and would be provided by the successful Contractor. It is envisaged that the silt curtain would comprise a geocomposite material consisting of a non-woven geotextile sewn to a woven geotextile, which would provide the required filtering capacity and rigidity respectively. Vessel access would be via gated or overlapped curtains or through installation of a bubble curtain. The top of the curtain would be supported by a floating boom, whilst the lower portion of the curtain would be weighted with appropriate ballasting (eg. bars or chains) to ensure that the full length if the curtain is maintained at all times. The curtain would be anchored or fixed to existing structures as necessary.

Figure 15 Example of a silt curtain surrounding marine construction works

Sediments adhering to the pile should not be hosed or scraped into the water but should be collected, tested and disposed of in accordance with the requirements outlined in the RAP.

The removal of the slipway rails is proposed to be undertaken in close proximity to sediments known to contain elevated levels of contaminants. The RAP stipulates that sediments accumulated in the slipway will be collected and disposed of offsite in accordance with the *NSW EPA Organotin Waste Materials Chemical Control Order 1989* and other relevant guidelines. It is recommended that the require remediation actions be undertaken prior to removal of the slipway rails to minimise the potential disturbance of contaminated sediments. Nevertheless, due to the shallow water depths and associated risk of surface plume generation during the removal of the rails, it is recommended that a silt curtain or other effective turbidity barrier be installed prior to commencement of the works. Further details regarding the proposed approach to remediation are provided in the RAP. Similarly, details of the stormwater management plan are provided in Civil Infrastructure and Stormwater Plans.

Lifting and removal of mooring blocks and chains may also disturb bed sediments. However, it is noted that mooring blocks are regularly lifted for inspection and maintenance, meaning that only a relatively thin layer of recently deposited sediments are at risk of disturbance. Consequently the potential impacts of suspended sediment associated with removal of the mooring blocks and chains are considered minor and do not require additional management measures.

4.2.2 Movement and anchoring of construction vessels

Movement and anchoring of construction vessels such as spudded barges, crew transfer vessels and survey vessels, which may lead to hydrocarbon spills, disturbance of bottom sediments which may contribute to mobilisation of contaminants.

In assessing the risk of mobilisation of sediments, it is important to note that the bulk of overwater construction activities will be undertaken in water depths of three to ten metres (allowing for tidal influences) with an average depth of approximately six metres. Given the construction activities proposed to be undertaken as part of the works, it is considered highly unlikely that any of the proposed vessels will disturb bed sediments within the majority of the site.

Nevertheless, it is recommended that any construction activities which have the potential to disturb bed sediments be undertaken within a silt curtain where occurring in water depths of 2m or less. This does not negate the recommendations regarding the use of silt curtains to surround other activities specifically noted within this document.

Construction vessels are will be largely stationary during the works and re not expected to generate excessive wake. In addition there are regular RiverCat services along the Parramatta River to Circular Quay meaning that the existing foreshores are subject to boat wake at regular intervals as observed during the recent marine ecology study.

General risks associated with hydrocarbon spills, waste materials and other debris will be addressed through emergency spill plans and the objectives and management measures outlined in the CEMP.

4.3 Operation Impact Assessment

4.3.1 Water Quality Impacts

The marina industry depends on clean waterways for people to enjoy their boating and fishing. However it is recognised that marinas have the potential to impact on the marine environment due to their waterfront location, activities, chemicals used and the waste generated.

Around 80 marine businesses in NSW worked with the NSW EPA from 2002-2006 to develop the following booklet to guide environmental improvements to marina operations throughout the state.

Environmental Action for Marinas, Boatsheds and Slipways, DECC, June 2007.

The guide provides an overview of the key environmental issues for marinas. Those related to water resources have been reproduced below for reference (DECC, 2007),

- Water pollution caused by allowing any material other than rainwater to enter waterways
- Handling and disposing of dangerous goods such as solvents, fuel and paint wastes
- Water use

Minimising the risk associated with such operational impacts requires the development, implementation, assessment and review of a comprehensive environmental management system.

It is noted that by ceasing slipway operations, the marina is effectively minimising the risks associated with the key environmental issues listed above.

In addition, GBM is an accredited Clean Marina (as recognised by the Boating Industry Association of NSW) and part of that accreditation included assessment of an Environmental Management System (EMS). It is expected that the existing management systems would be reviewed and implemented in order to minimise the potential impacts associated with expanded operations.

4.3.2 Impacts to Flooding

The landside works are largely outside the present 1 in 100 year ocean flood level for the site. The proposed carstacker will be constructed entirely within the footprint of the roofed area. No substantial land filling activities are proposed and, relative to tidal inundation volumes, are considered insignificant. No impacts on the tidal floodplain are therefore expected.

The impact of the development on stormwater is discussed in the Civil Infrastructure and Stormwater Plans.

The effects of climate change on the marina are considered in the Hydrodynamic wave study associated with this EIS and are discussed further in the Wave Climate Report.

5. Suggested management measures

5.1 Construction phase management measures

Recommended mitigation measures relating to water resources are presented below in Table 4. It is envisaged that these measures will be incorporated into a project specific CEMP including any relevant environmental management sub-plans for the construction phase.

The CEMP would provide a centralised mechanism through which all potential environmental impact relevant to the proposal would be managed, and outline a framework of procedures and controls for managing environmental impact during construction.

The CEMP would incorporate as a minimum all environmental mitigation measures identified below in Table 4, any conditions from licences or approvals required by legislation, and a process for demonstrating compliance with such mitigation measures and conditions.

Table 4 Proposed Mitigation Measures

Item No	Environmental Issue	Environmental Management Measure	Responsibility	Timeframe
General Environmental Management				
	General Environmental Management	A Construction Environmental Management Plan (CEMP) will be prepared and implemented to ensure appropriate environmental management measures are followed during project delivery. The CEMP will provide a framework for environmental management during construction and will: • Outline all environmental management practices and procedures to be followed during construction and demolition works associated with the project • Describe all activities to be undertaken on the site during construction of the project • Detail how the environmental performance of the construction works will be monitored • Detail what corrective actions will be taken to address identified adverse environmental impacts • Describe the roles and responsibilities for all relevant	Construction Contractor	Construction

Item No	Environmental Issue	Environmental Management Measure	Responsibility	Timeframe
		employees involved in the project • Include relevant sub-plans (some are under preparation by relevant consultants): – Construction Noise and Vibration Management Plan – Construction Traffic Management Plan – Erosion and Sediment Control Management Plan – Waste Management Plan The CEMP will be developed in accordance with industry guidelines identified above		
Water Quality and Hydrology				
	Water quality during piling	Prior to commencement of piling driving and removal activities at each individual mooring arm, silt curtains will be installed between the inner piles and the shore to protect the remaining shoreline and rock substratum habitats from potential smothering or excessive turbidity. The silt curtains will remain in place for the duration of the piling activities for that wharf	Construction Contractor	Construction
	Water quality during demolition works	Prior to commencement removal of the slipway rails, silt curtains will be installed surrounding the works to protect the remaining shoreline and rock substratum habitats from potential smothering or excessive turbidity. The silt curtains will remain in place for the duration of the removal activities	Construction Contractor	Construction
	Erosion and Sedimentation	Prior to construction an erosion and sediment control management plan for all land construction activities will be developed in accordance with Managing Urban Storm Stormwater: Soils and Construction (The Blue Book) and included in the CEMP. The plan will require all erosion and sediment controls to be installed prior to any land works commencing, maintained throughout construction and	Construction Contractor	Pre-Construction Construction

Item No	Environmental Issue	Environmental Management Measure	Responsibility	Timeframe
		removed only once all disturbed areas have been reinstated. The establishment of the temporary construction compound will be done in accordance with The Blue Book and outlined in the CEMP.		
	Off-site disposal	All waste requiring off-site disposal will be classified in accordance with OEH's (2009) Waste Classification Guidelines prior to disposal.	Construction Contractor	Construction

5.2 Operational management measures

GBM is an accredited Clean Marina (as recognised by the Boating Industry Association of NSW) and part of that accreditation included assessment of an Environmental Management System (EMS).

Future operations would be undertaken in accordance with the industry standard Environmental Management System (EMS), which was developed as part of the EPA (awarded) program. In particular, operations will adhere to the most current version of the Operational & Environmental Management Plan (presently GBM, 2019) which outlines the marina's policy, rules, procedures and practices as required to comply with relevant legislation and regulations in relation to the following:

- Water quality management
- Noise abatement procedures
- Air emission procedures
- General waste management and storage procedures
- Emergency Procedures
- Fuelling Procedures & Hydrocarbon controls

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