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Attention: **Mr John Dawson**
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Subject: **WALSH BAY ARTS PRECINCT**
MARITIME FACILITIES
WATERFRONT SQUARE

Dear Sir

Following your telephone instructions, we are writing to provide a comments on technical aspects of the maritime facilities proposed as part of the redevelopment of the Walsh Bay Arts Precinct; that is, the Waterfront Square development.

1. PROJECT DEFINITION

The maritime works will comprise a Waterfront Square consisting of a 50 metre x 40m deck area as shown on *ASPECT Studios* Option 1a, but with water-steps as illustrated on Option 1b.

2. BACKGROUND

The structure proposed at Walsh Bay will be connected to the original Walsh Bay commercial wharves which are approaching 100 years of age. These are all timber wharves consisting of turpentine timber piles with hardwood pile caps, beams and decking. Some of the exposed apron decks were replaced with thin concrete slabs in the 1930s (due to weathering of the exposed timber planking).

The wharves are generally located in 10 to 12 metres depth of water, but the seabed here is extremely soft marine mud and the depth to hard founding materials can exceed 20 metres below seabed level.

Apron deck levels typically are about RL 3.4m AHD - Australian Height Datum, equivalent to RL 4.3m CD. [CD = Chart Datum, which is 0.925m below AHD].

The area where the new platform structure is to be installed is generally well protected from wind waves generated over long fetches. Other parts of Sydney Harbour can experience wind waves in excess of 1.2 metres amplitude (eg RSYS marina at Kirribilli), but natural shoreline features protect this stretch of waterway. However, there is a considerable amount of surface disturbance resulting from vessel movements from boats ranging from ferries to large motor boats, tugs, water-police vessels and water taxis. High speed vessels such as the catamaran ferries have a wash-wave with a low amplitude (up to 200mm) and long period (5 to 6 seconds), which creates difficult conditions for floating structures. This wash-wave is very fast moving, has high energy and is not easily detectible to people standing on small pontoons, sometimes resulting in their falling down.

3. WATERFRONT SQUARE

3.1 Design Assumptions

The Waterfront Square is generally a large, level, fixed-deck area, set down below wharf apron deck levels with stepped seating, access steps, and ramps down to the lower deck level.

The deck levels abutting the Square are about RL 3.40m AHD (RL 4.3m CD) which is 2.2m above HAT (Highest Astronomic Tide = 2.1m CD). The concept design sketch of the Square indicate that the new Square will be considerably lower than this, at RL 2.00m AHD (RL 2.9m CD), about of 1.4 metres below the Wharf 4 apron.

In addition, there is a set of Water Steps (narrow terraces) along the northern edge, providing more direct pedestrian access to the water. These extend down to RL 0.40m AHD or 1.30m CD. It is not intended (nor is it practical) for these steps to provide access to vessels.

The whole of the Waterfront Square is to be timber decking. As with other recent structures around Sydney Harbour, the surface of the deck would likely comprise 200mm x 50mm (or 150mm x 45mm) hardwood planks, sawn face uppermost with other three sides machined. Some of the timber planking area may be substituted with proprietary fibreglass mesh decking systems for functional and visual purposes.

It is assumed that the supporting structure will be constructed with reinforced concrete headstocks and beams, with hardwood timber bearers supporting the deck planks. All concrete could be reinforced with V-rod reinforcing (glass fibre reinforced deformed plastic reinforcing system imported from Canada) to avoid chloride attack on carbon steel reinforcing. (The Roads and Maritime Services have been using V-rod reinforcing on all the Sydney Harbour Ferry Wharf Upgrade projects in the last three years. V-rod is manufactured in Canada where it is widely used in high salt environments such as ice encrusted motorway bridges).

It is further assumed that piles will all be spirally wound steel tube piles, driven to appropriate foundation levels (weathered or fresh sandstone) below the deep marine muds. Piles would be coated with high-build (minimum 1.0mm thick) epoxy paint, which, depending where the piles are sourced, could be factory-applied at the pile manufacturer’s plant.

3.2 Design and Construction Issues

<u>3.2.1 Geotechnical</u>

We do not yet have access to any site specific or project specific geotechnical investigation reports of this area, but based on observation and past experience, the seabed between Piers 3 and 4 is likely to comprise deep, very soft overburdens overlying Hawkesbury Sandstone. This founding rock is typically characterised by a number of buried “cliffs”, (similar to the sandstone cliffs that can be observed in above ground sandstone formations). This will result in long piles and also variable lengths of pile penetrations. It would be desirable to undertake adequate site investigations (including a geophysical or “pinger” survey to measure rock-head profiles) to minimise this piling construction risk.

The softness of the overlying overburdens is likely to result in a requirement for lateral loads to be carried by raking tension and compression piles, rather than cantilever piles.

<u>3.2.2 Lateral loads.</u>

There are no significant lateral loads on this deck, but AS4997 requires that all such decks be designed for a nominal lateral load to ensure stability. This minimum load is set at 2.5% of the total dead and live load.

In the past, such structures have been permitted to “lean against” adjacent structures, but more recently, we have seen a philosophical and administrative policy change towards ensuring that structures such as these should be completely independent from any adjacent structures. Thus, this will require that the piling should provide adequate lateral stiffness as cantilevers (difficult), or alternatively several pairs of raking piles which should be distributed around the structure.

<u>3.3.3 Durability</u>

The need for adequate durability of building materials in this saltwater environment and exposed to rainwater and sunlight results in several design considerations:

Piles

Generally the industry standard practice for marine piling these days is for steel tube piles, coated with high-build epoxy (0.5mm up to 2.0mm thick). There are other protection systems, including a triple wrap polyethylene system which is stated to provide a 100 year design life for steel tube piles. The use of HDPE jackets with heat-welded collars over the top of the pile and a cast insitu concrete plug infill is also a practical and very durable protection system.

Substructure

Use of steel substructures is acceptable and widespread, although the issue of maintenance of steelwork, particularly in these low headroom work spaces (classified as WHS “Confined Spaces”) make this solution dubious.

A more suitable solution is to use reinforced concrete substructures (beams and headstocks) with preferably non-corroding reinforcing or attention paid in the design to appropriate methods of providing corrosion free life of the reinforced concrete elements. [The use of good concrete with extra cover is not in our view sufficient to provide a suitable design life. Use of pre-tensioned concrete is dangerous.]

Deck

It is understood that for various architectural aesthetic design and functional planning reasons, a concrete deck is not favoured. A hardwood timber deck such as was designed at Pyrmont Point and many of the similar boardwalks around Pyrmont, Cockle Bay and Darling Harbour has been selected as more suitable.

[However it must be recognised that the durability of hardwood timber subjected to freshwater (rainwater) is limited. Several design refinements can be incorporated (*such as heartwood side down, aluminium flashing on top of bearers, proper selection of timber sizes, preservation of sawn ends, etc)* to extend design life, but notwithstanding, it could be expected that replacement of some decking members could begin at about 15 years after installation.]

Care must also be taken in design to ensure termites cannot access the overwater timber, which traditionally has been a problem for Sydney's timber wharves.

An alternative to be considered instead of the above suspended hardwood decking would be a concrete slab structure supporting a paved deck on sand or mortar bedding. The paving could be selected for its low heat and light-reflecting qualities. This would have a higher capital cost but whole-of-life cost may be comparable to timber.

Modular Construction

Like Pyrmont Point decking, the large deck area lends itself to the concept of modular construction, where large component areas of the deck can be constructed off-site in easier and highly controlled conditions and then using a floating crane to install the modules onto the piles, with site cut matching infill pieces to complete the deck.

3.3 Water Steps

It is proposed to install a series of long steps (or low-level landings - or narrow terraces) leading down to water-level on the northern edge of the Square. Consideration needs to be given to the geometry of these steps, the depth to which they extend down to, the material of construction and a number of related issues.

Obviously, the whole concept of such a structure is borne out of promoting a close-to-the-water experience. Against this objective are the constraints of public safety and liability.

At this stage it is useful to consider various water levels. These water levels do not include sea level rise:

WATER LEVELS AT WALSH BAY

Level	Chart Datum m	AHD m	Comment
Wharf 4 Apron Deck	4.3	3.4	Requires confirmation
Waterfront Square	2.9	2.0	Requires confirmation
Present Design Water Level	2.3	1.4	Based on 1974 storms (100yr) ARI
Highest Astronomic Tide	2.1	1.2	Occurs once a year
Spring High Tide	1.6	0.7	Occurs two or three days every fortnight.
Mean High Water Neaps	1.4	0.5	The lowest level of all high tides. Equalled twice a day.
Mean Sea Level	1.0	0.1	About AHD.
Spring Low Tide	0.4	-0.5	
Chart Datum	0.0	-.925	Datum for all navigation charts and the tidal predictions.
Wave Crest Level at spring tide	2.0	1.1	Wave crest at spring high tide and wash-wave 700mm high.

The water steps are proposed to extend down to the current level of high water neaps. That is, the lower steps will be covered or splashed by waves each high tide.

Discussion

Extending steps into this intertidal zone will allow persons to stand quite close to the water surface at higher stages of the tide. However a number of factors need to be addressed:

(a) surfaces which are periodically covered in seawater will promote marine growth such as hard shelled animals e.g. molluscs, barnacles, oysters, which can be injurious to pedestrians; also soft marine growth, which creates extremely hazardous slippery surfaces.
(b) The lowest steps will be subject to vessel wash. In particular, high speed catamarans have a low amplitude long wave which is hard to detect and contains high energy and travels fast. The chance of persons standing in or close to the water surface being impacted by such wash is high, with the possible consequence of becoming partly immersed when not expecting to be, or even of falling or being thrown into the water or onto the steps.
(c) At the edge of the steps will cease and a person descending might suddenly be in deep water. The point at which this occurs will not always be discernable from above water level, depending on tide levels and light and water clarity conditions. (It is noted that in design of swimming pools and the like, sudden increases in depth or gradient underwater are not permitted because of the very high associated risk.) It will be necessary to install safety handrail along this seaward edge to prevent persons accidentally stepping off the edge.

The intention is to allow and encourage people to have a water experience at Walsh Bay and this can be made feasible. Adequate safety provision should be designed into the project, including seaward safety barriers; a series of handrails; provision of special grid decking to provide anti-skid surfaces and also hinder hard-shell marine growth. This may be some form of maintainable grid mesh manufactured from FRP - fibre reinforced plastics or aluminium, which might include antifoul, or be capable of being easily cleaned, either on site or replaced and cleaned off site.

4. ENVIRONMENTAL CONSIDERATIONS

In addressing the issues raised in with the Director General Requirements, we advise as follows:

4.1 Item 8: The impacts on all users of Sydney Harbour

Since the closure of Walsh Bay as a commercial port area in the 1970s, the waterway area around these wharves has been little used. The waterway is exposed to considerable vessel wash from both long and short period waves and therefore has not been used much for mooring of small craft. The high deck heights of the wharf aprons are not very suitable for the discharge of passengers from small vessels, including cruise vessels. Thus alienation of this waterfront by construction of new overwater structures will have negligible negative impacts.

There will be positive benefits to the land-based users of the Harbour, insofar as access to the water will be significantly improved. Sightseeing, festival day and night viewing (New Year's Eve etc) and also land-water interactions will all be enriched. (Care will be required in design to ensure all users remain safe.)

4.2 Item 11: Risks from Sea Level Rise

There are a number of publications on the issue of sea level rise including the Draft Interim Floodplain Management Policy of the City of Sydney (July 2013); NSW Government's NSW Sea Level Rise Policy Statement published by Department of Environment, Climate Change and Water, October 2009; and The NSW Government's Chief Scientist and Engineer's "Assessment of the Science behind the NSW Government's sea level rise planning benchmarks"; April 2012. These publications all reference the reports of the IPCC (Intergovernmental Panel on Climate Change).

Based on the City of Sydney Floodplain Management Policy, the estimated sea level rise in 2050 is 40cm from 2009 levels, rising to 90cm in 2100.

4.2.1 Design Life

A consideration here is the design life of the project. Normal procedure is to design for an economic life of 50 years. Within Sydney Harbour, the exceptions are residential projects built over water such as Walsh Bay 6/7 and The Woolloomooloo Wharf. Most other structures are designed for a 50 year design life. It is noted in the Sydney City Council Floodplain Management Policy document that: "For those developments which have a lifespan of more than 50 years the impact due to sea level rise and impacts due to increased rainfall intensities shall be considered". This implies that for a project with a design life of 50 years or less, that sea level rise does not need to be included.

4.2.2 Sea Level Rise for Waterfront Square.

Notwithstanding the above, if we consider sea-level rise for the Waterfront Square Project, with a commencement date of 2019 and a sea level rise at 2050 of 40 cm, and by extrapolation, a further sea level rise to 2069 of 19 years @ 1cm per year, say 60 cm, the following water levels will be experienced at the end of the project design life.

WATER LEVELS AT WALSH BAY AFTER SEA LEVEL RISE

Level	Chart Datum m	AHD m	Comment
Wharf 4 Apron Deck	4.3	3.4	Requires confirmation
Waterfront Square	2.9	2.0	Requires confirmation
Design Storm Water Level	2.9	2.0	Based on 1974 storms (100yr) ARI
Highest Astronomic Tide	2.7	1.8	Occurs once a year
Spring High Tide	2.2	1.3	Occurs two or three days every fortnight.
Mean High Water Neaps	2.0	1.1	The lowest level of all high tides. Equalled twice a day.
Mean Sea Level	1.6	0.7	
Spring Low Tide	1.0	0.1	
Chart Datum	0.0	-.925	Datum for all navigation charts and the tidal predictions.
Wave Crest Level at Spring tide	2.6	1.7	Wave crest at spring high tide and wash-wave 700mm high.

4.2.3 Discussion of Sea Level Rise

Thus, with the current deck level proposal at RL 2.0m AHD, this is equal to the maximum storm water level plus sea level rise at 50 years after the structure is built.

The depths of inundation of the various low level steps will increase, and some modifications, including possible closures of some of the steps and alterations to handrails and safety rails may be required in the future.

However, the main floor level is satisfactory.

5. Conclusion

We trust this supplies the information you were seeking.

Yours faithfully
HASKONING AUSTRALIA

Andrew Patterson
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