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Seawall Design, Construction and Performance in Sydney Harbour and Lower Parramatta River

Presentation to COPEP Half Day Seminar by Gary Blumberg

20 August 2012

Outline

- Definitions
- Extent of reclamation / shoreline protection
- Seawall types
- Damage, failures and inappropriate materials
- Some design considerations
- Environmentally friendly seawalls
- Example projects

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Definitions

- Seawall – a structure separating land from sea (RMS)

- Revetment – and inclined face of stone, concrete or synthetic material protecting an embankment from waves or currents (RMS)

This presentation will generalise and refer to both as seawalls

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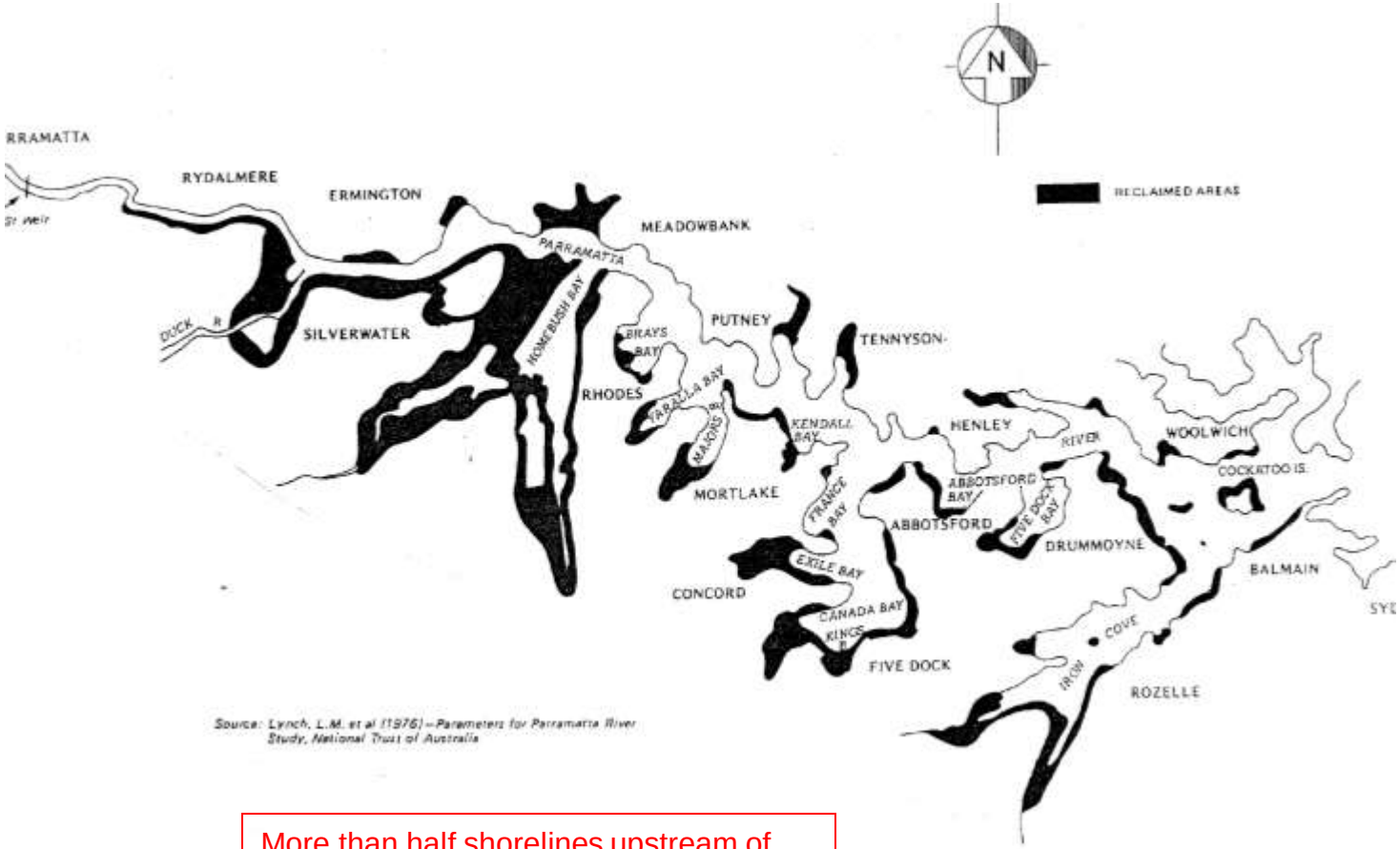
History of reclamation / shoreline protection



More than half shorelines upstream of Balmain reclaimed – all need protection

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Seawall types

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Seawall types

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Seawall types

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Damage and failures

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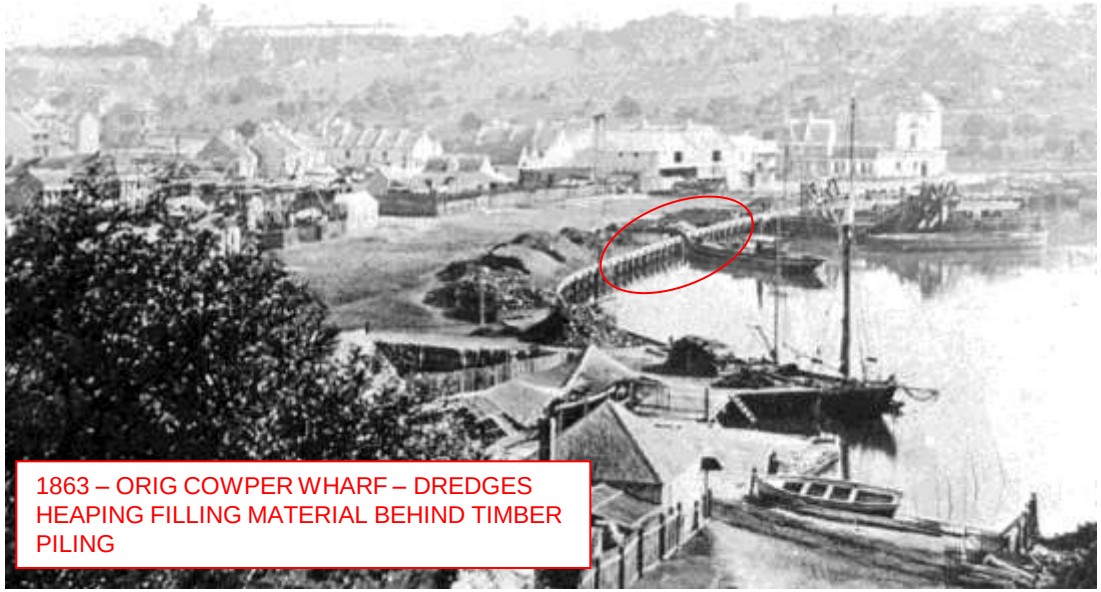
Damage and failures

HEAD OF WOOLLOOMOOLOO BAY



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Damage and failures

HEAD OF WOOLLOOMOOLOO BAY

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Inappropriate materials

Poor quality sandstone – pay attention to strength (higher Fe content helpful) and sodium sulphate soundness (<30% weight loss)

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Inappropriate materials

Probably costly, questionable durability and unsightly

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Inappropriate materials

Asbestos pipe offcuts – Camellia, Parramatta River ~late 1990's

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Some key design considerations

- Design life
- Methodology – “deterministic” or “probabilistic”
- Key dimensions (eg wall height)
- Gross stability (gravity or piled structure ?)
- Foundation
- Design actions (eg waves)
- Materials and durability (rock and/or concrete)
- Sizing of armour materials
- Key failure modes

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Design life

Time that structure remains fit for purpose with appropriate maintenance

AS 4997 – 50 yr design working life for normal maritime structure

RMS – min 25 yrs for seawalls

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Design methodology

Deterministic or probabilistic design

Deterministic – design to resist design event (eg storm) with acceptable “safety margin”

Argued by some that deterministic is conservative, and by others that deterministic risk can vary substantially. **Probabilistic** approach is to use reliability/risk analysis methods.

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Geotechnical investigation to gauge construction of existing walls and subsurface conditions

- Test pits, boreholes and penetrometer testing
- Jet probing

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Borehole work at Rose Bay

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Jet probing work at Rose Bay

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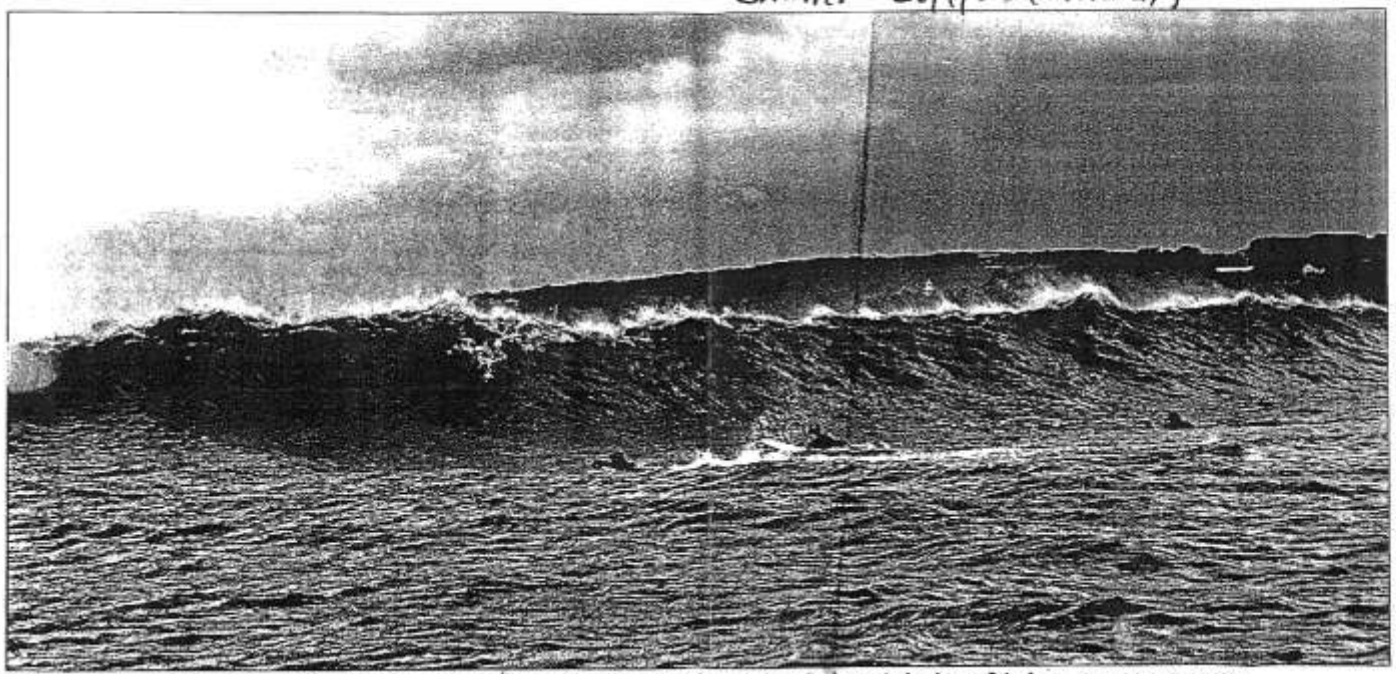
Wave loading

- Swell

No, it's not Waimea Bay . . . this is Sydney Harbour

S.M.H. 26/4/99 (Monday)



Catching the high surf off Nielsen Park, Vaucluse. Waves as high as three metres broke on Sydney's beaches yesterday, after four-metre breakers on Saturday. Photograph by DAL HARPER

A pounding surf lured board riders into Sydney Harbour at the weekend to catch rare breakers off Nielsen Park, Vaucluse.

Huge swells off Sydney will continue today, the Bureau of Meteorology said yesterday.

Waves as high as three metres broke yesterday on Sydney's beaches, after four-metre breakers on Saturday.

The waves were so wild and unrideable on many beaches outside the Heads on Saturday that surfers retreated to Nielsen Park.

A bureau spokesman, Mr Tony Verbruggen, said gale-force winds of more than 35 knots whipped up the surf.

"You will still get decent swells for a few days to come," he said, adding that waves of up to four metres could be expected again today.

"That's pretty big . . . higher than your ceiling."

A spokesman for Sydney Surf Life Saving, Mr Rob Barnes, appealed to swimmers to be cautious: "Volunteer lifeguards are no longer on duty."

In Wollongong yesterday, a 16-year-old boy drowned while surfing at Sandon Point, a popular swimming spot at Bulli. When the teenager failed to return to the beach as dark fell, his father, who was on the beach, raised the alarm and the Westpac LifeSaver helicopter was called in to illuminate the search area.

An hour and a half later the helicopter crew found the boy's body about two kilometres away.

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Wave loading

April 1999 storm

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Wave loading

- Wind waves and boat waves

WIND WAVES (ROSE BAY)

Wall crest RL1.6m AHD

Runup level ~ RL3 ?

BOAT WAVES (LANE COVE RIVER)

12m power boat

Hmax~0.4m, T~1.5s

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Dominant wave actions

- Swell – to Nielsen Park, Balmoral / Chinamans and North Harbour/Manly Cove

- Wind waves – to Spit, Harbour Bridge, and longer fetch shorelines (say > 500m) in Middle Harbour and say up to Cockatoo Island

- Boat waves become more dominant into Lane Cove River and Parramatta River upstream of Gladesville, particularly at shorelines within say 200 m of navigation channels and close to ferry berths

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Correlation of wave parameters to erosion

Table 5.3 CORRELATION OF BOAT WAKE WAVE PARAMETERS TO BANK EROSION MEASURED ON THE GORDON RIVER IN TASMANIA

Wave Parameter	*Correlation Coefficient*
Significant wave power[2]	0.93
Peak wave power	0.86
Wave length	0.85
Significant wave height[1]	0.84
Wave period	0.83
Maximum wave height	0.79

Source: Nanson et al (1994)

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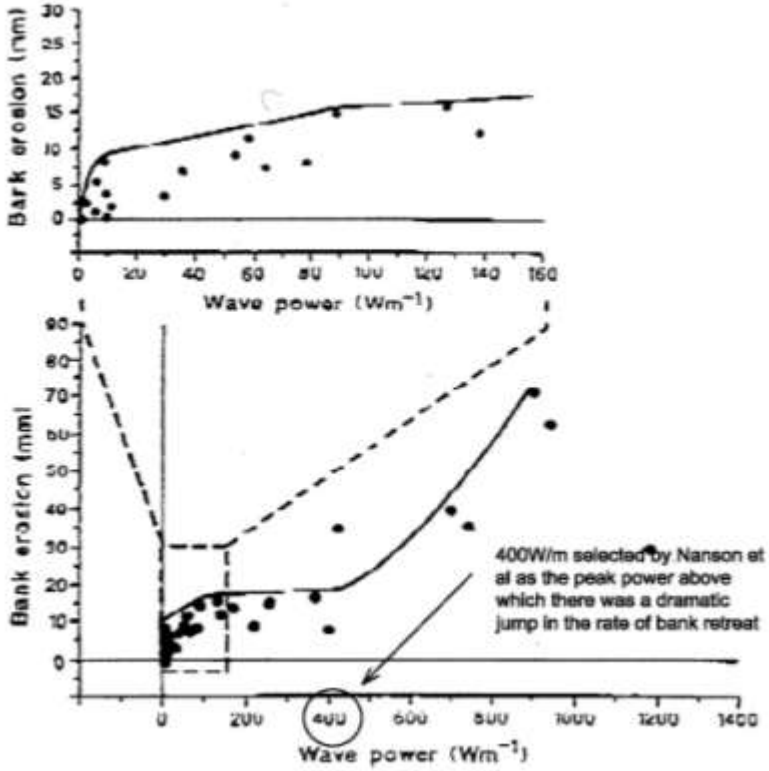
Relationship between peak wave power and bank erosion



Source: Nanson et al (1994)

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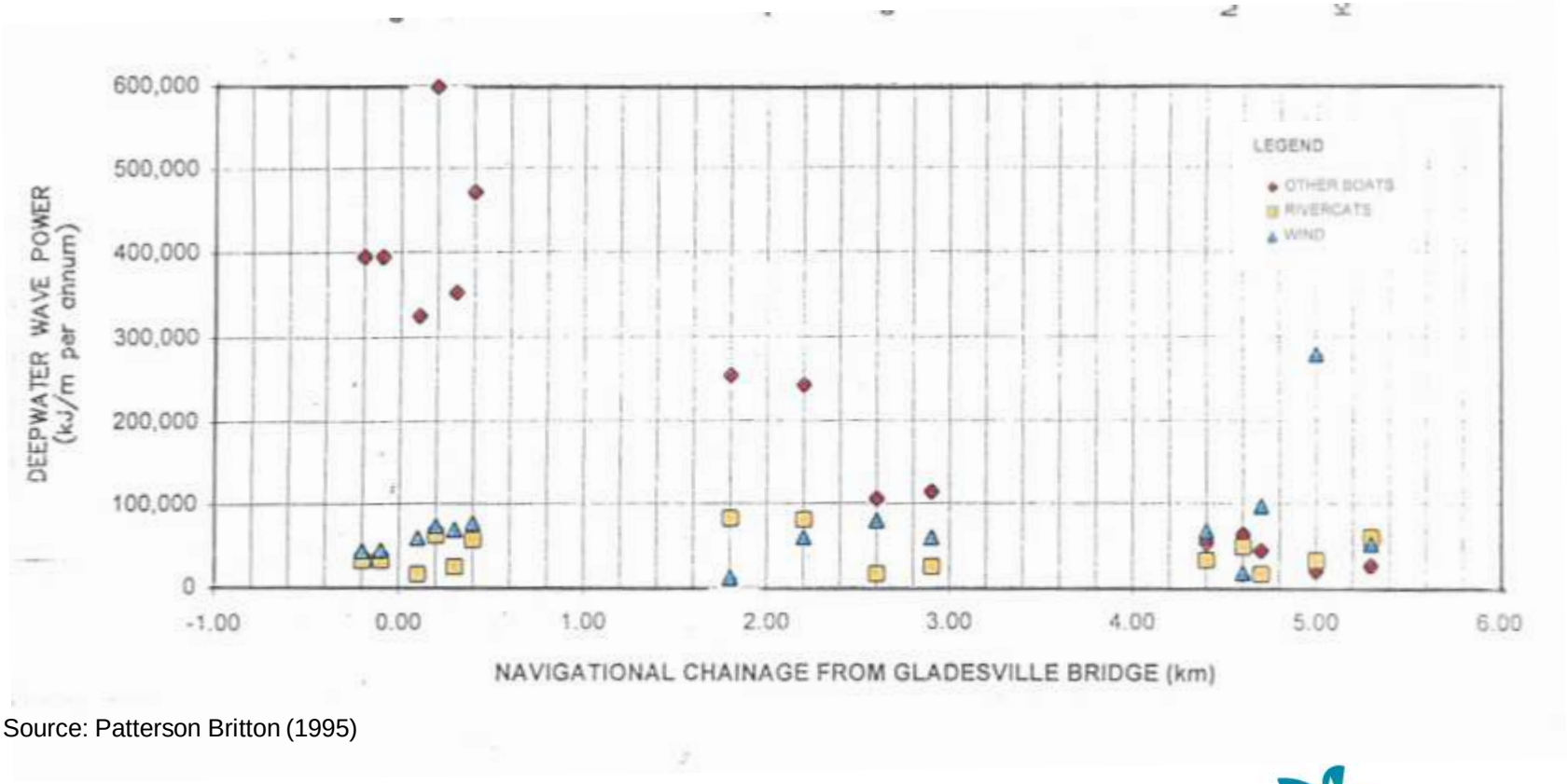
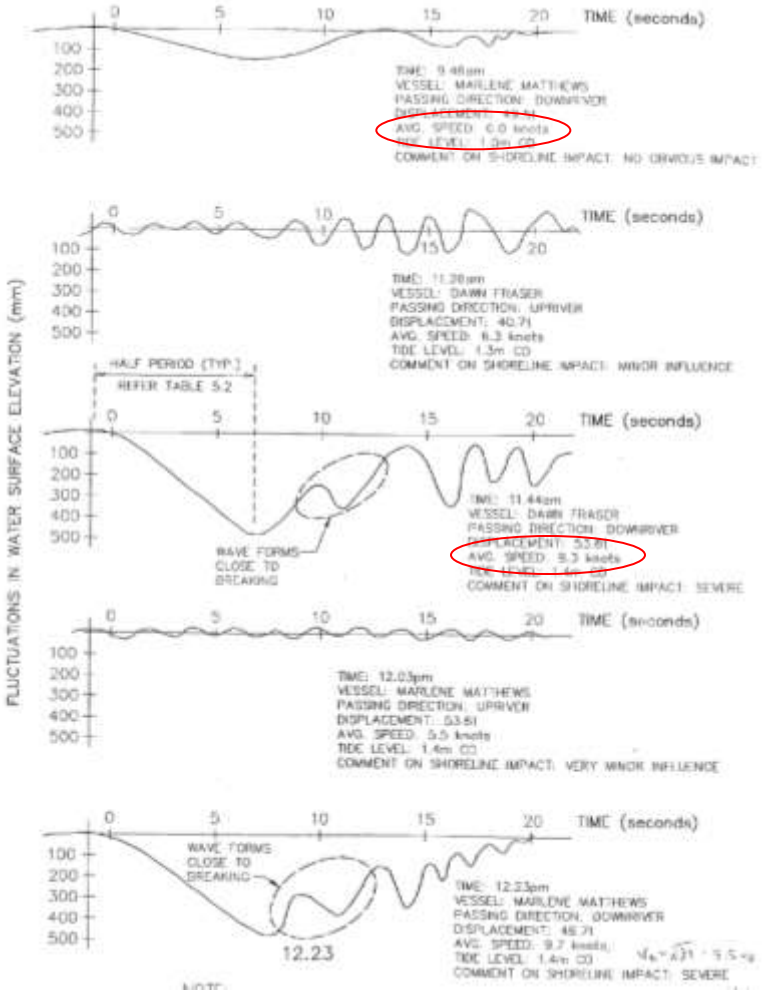
Power delivery to shoreline upstream of Gladesville, Parramatta River



Source: Patterson Britton (1995)

Vessel blockage affect in narrow channels – long period wave action



Very sensitive to boat speed

Source: Patterson Britton (1995)

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Soil drainage failure due to vessel blockage loading

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Key failure modes for seawalls in Sydney Harbour / Parramatta River

- Ocean walls – scour at toe and washout from overtopping

- Sydney Harbour / Parra River walls – inadequate filtration and drainage perhaps most important, and overtopping (related). Toe scour tends to be less important.

  RMS recommend design allows for 600 mm toe scour unless seawall founded on rock.

Crest level and overtopping

- Most seawalls in Sydney Harbour and Lower Parramatta River ~ RL1.7 m AHD. Sydney Harbour DCP (SREP 2005) recommends RL1.7
- So walls typically 200 mm above highest recorded water level in Harbour ~ RL1.5 m AHD in May/June 1974 (nominally 100 year event)
- OEH SLR benchmarks (400 mm to 2050; 900 mm to 2100), and water levels at Fort Dennison rising about 1-2 mm/yr in recent decades
- Grass burn immediately behind crest - good indicator that level is too low
- EuroTop (2007) manual gives methodology for estimating overtopping. Reported that 50 – 200 L/s/m will damage promenades behind seawalls

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Crest level and overtopping

Meadowbank

Spit Bridge

King Tide event 12/1/99 RL1.04 m AHD (9 cm below predicted)

Source: OEH

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Environmentally friendly seawalls

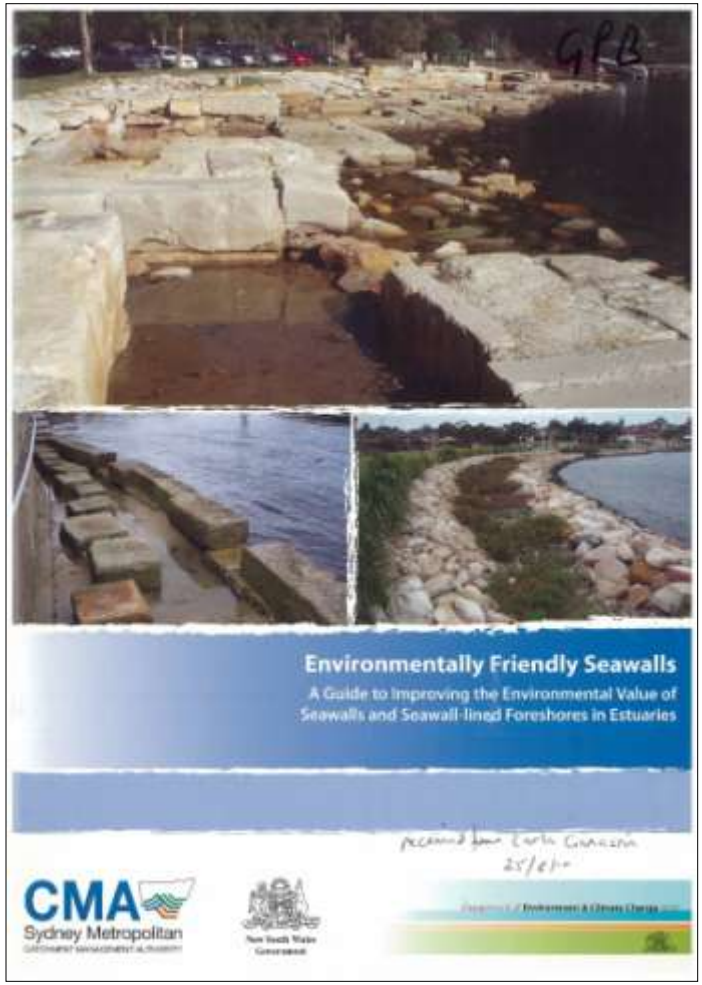

Figure 24: A seawall at McMahons Point, Sydney Harbour, purposely designed to include pools in the structure for habitat, and boulders at the toe for additional habitat.

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Environmentally friendly seawalls

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Example Projects

1. Investigation of increased boat wave loading at Lane Cove River site

Investigation into the effect of increased boat wave energy on the life of a particular seawall

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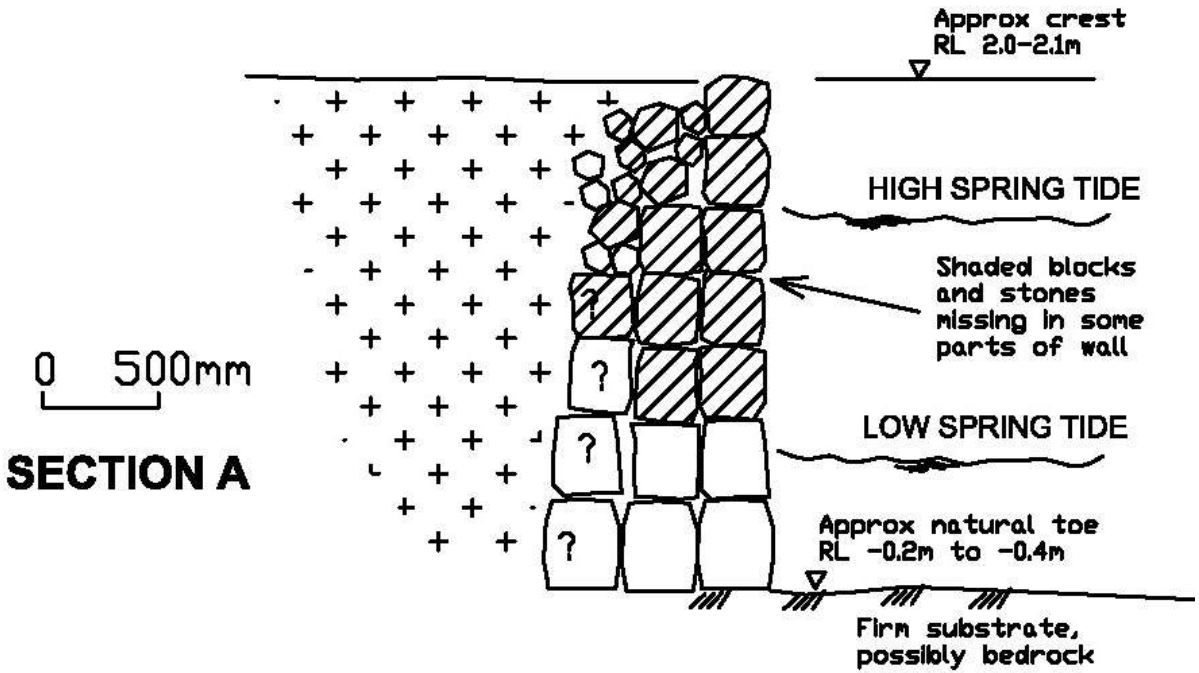

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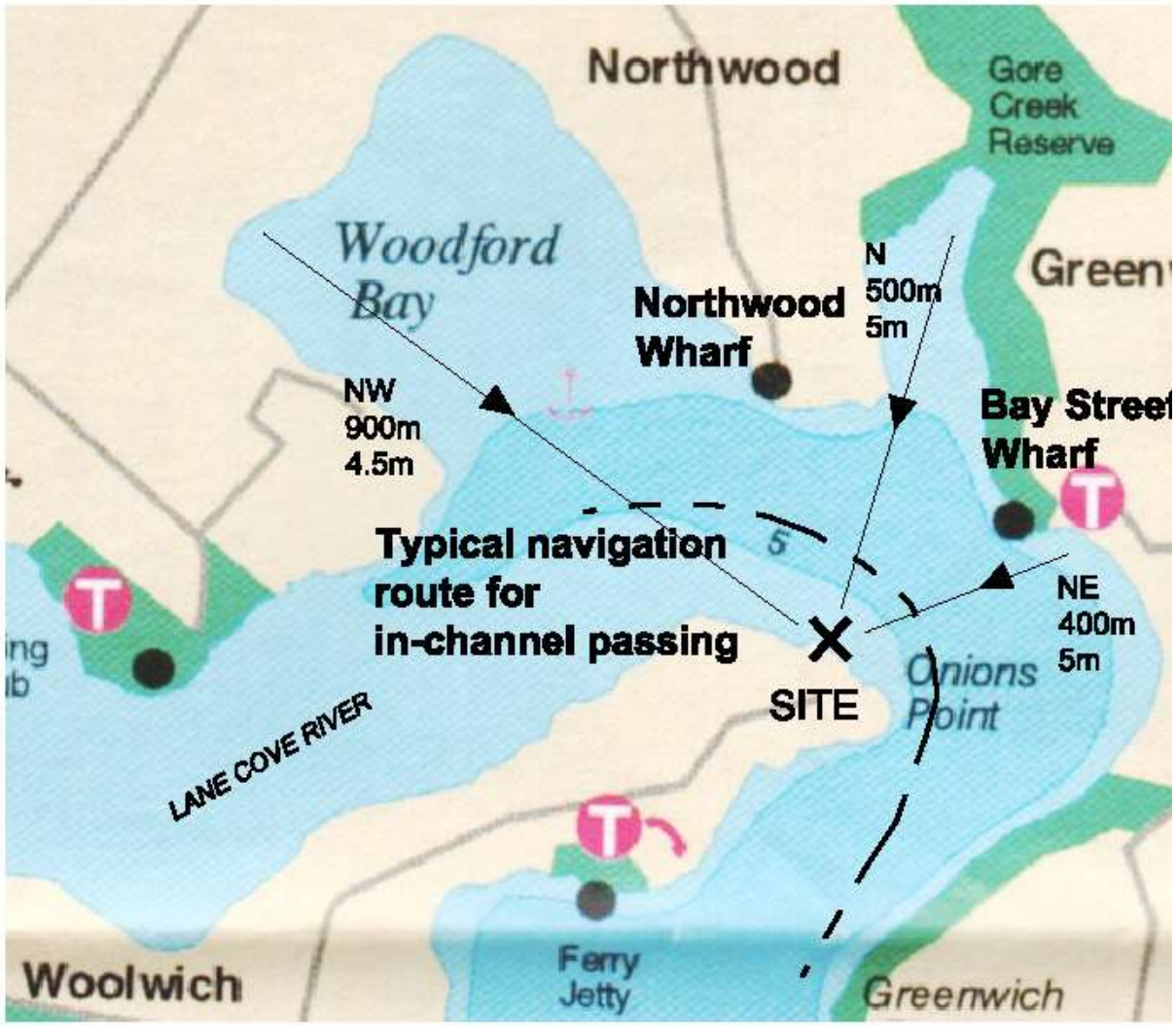

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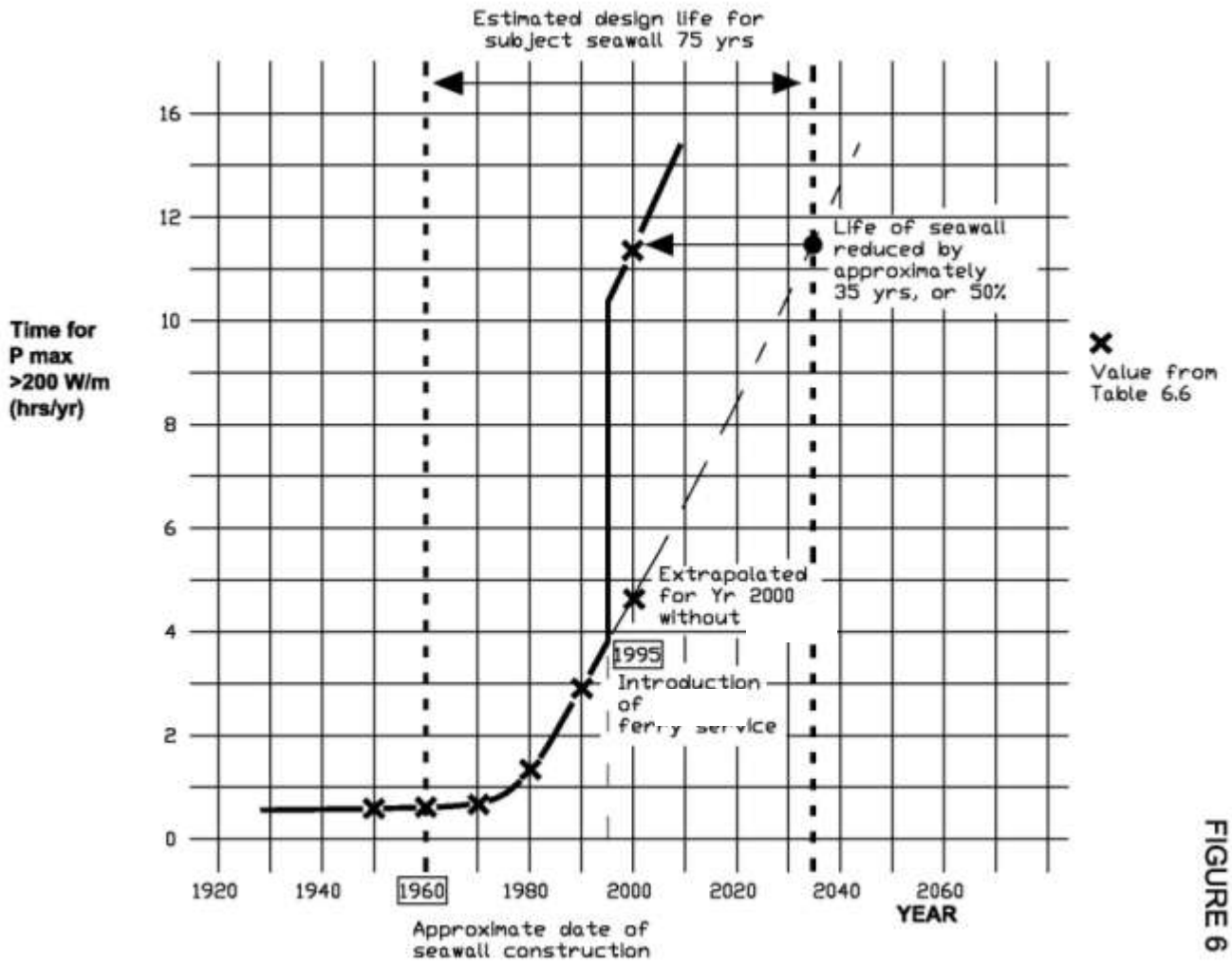

FIGURE 6

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2. Reconstruction of seawall at Wingadel Place, Point Piper

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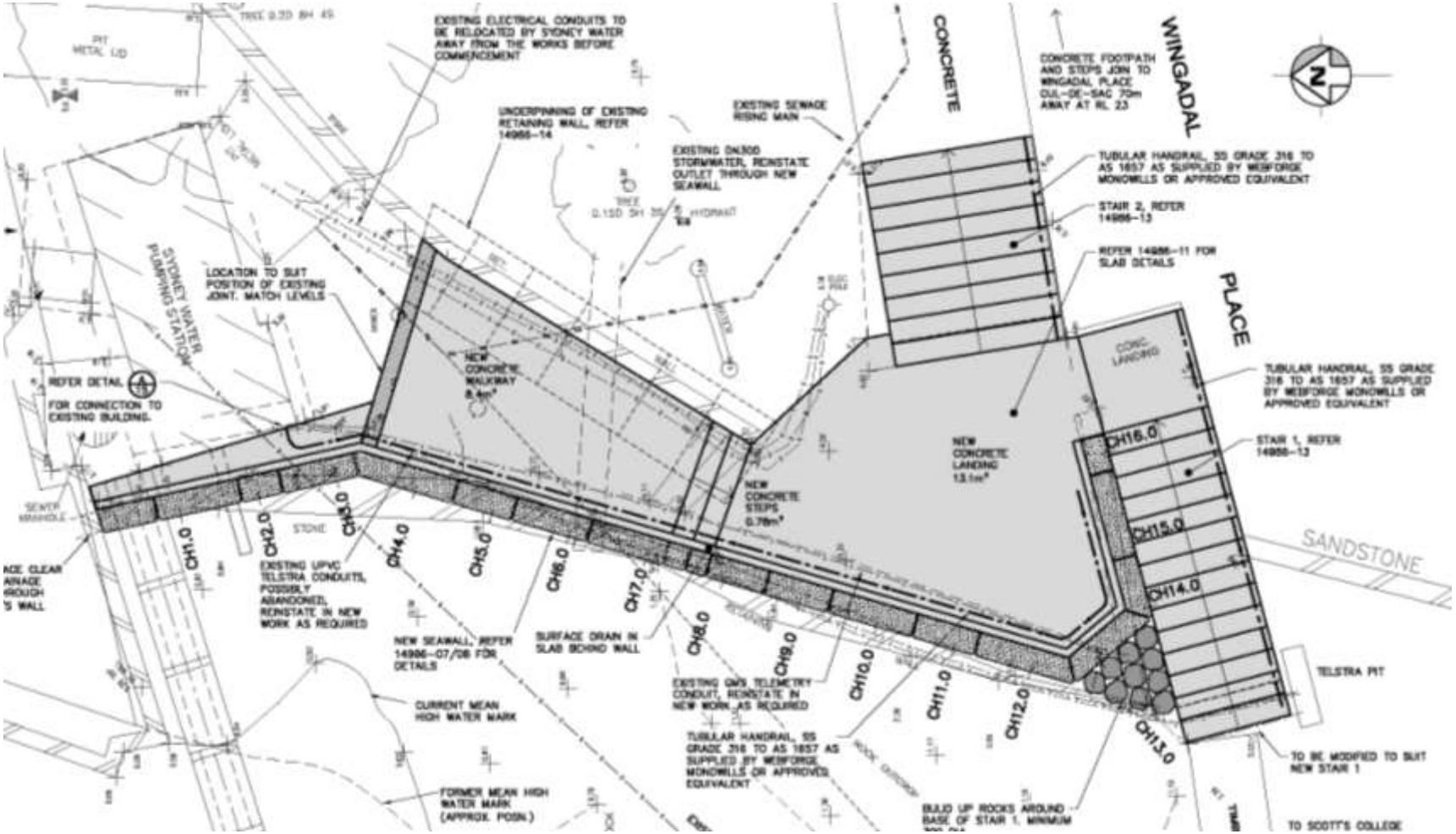

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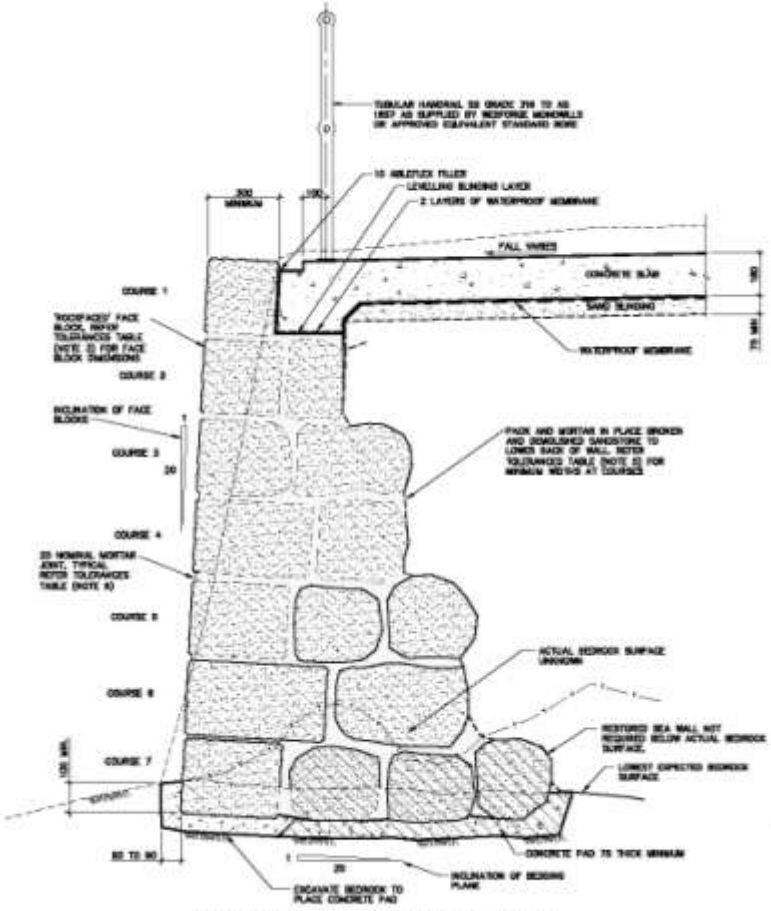
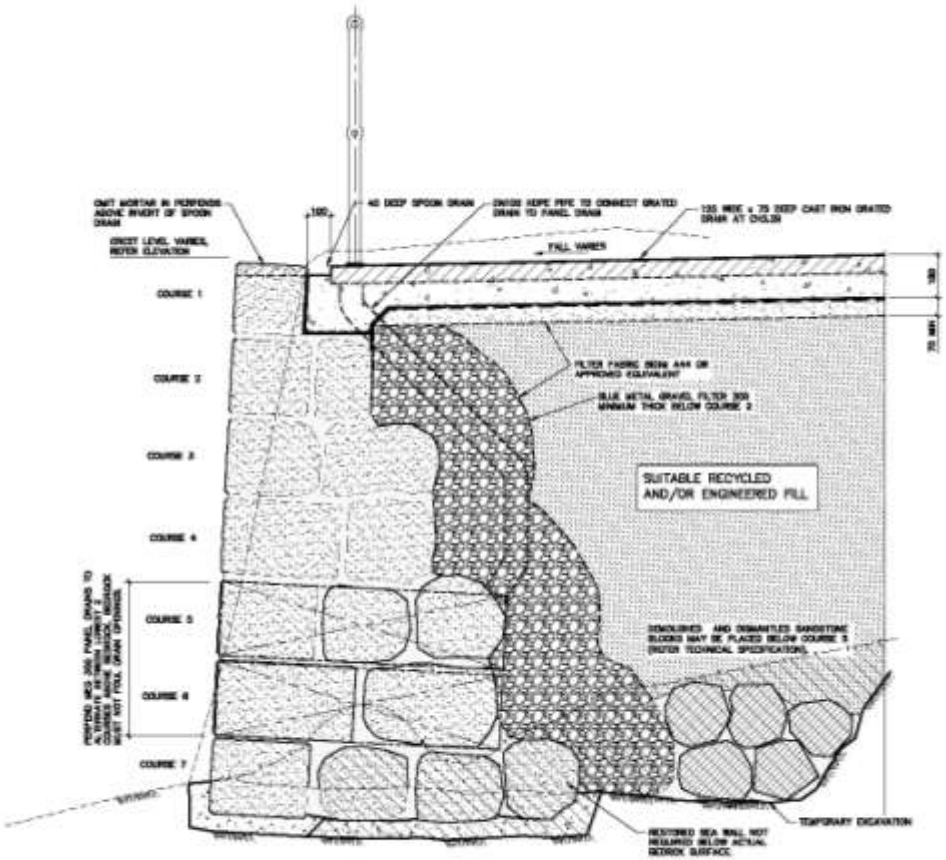


GROUTED STONE WALL TYPICAL DETAIL
1:10



WALL DRAINAGE, FILTRATION AND FILLING TYPICAL DETAIL
1:10

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3. Reconstruction of seawall Dumaresq Reserve, Rose Bay

WALLS IN PLACE IN EAST ROSE BAY IN MID 1920'S

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STORM WAVES
DATE??

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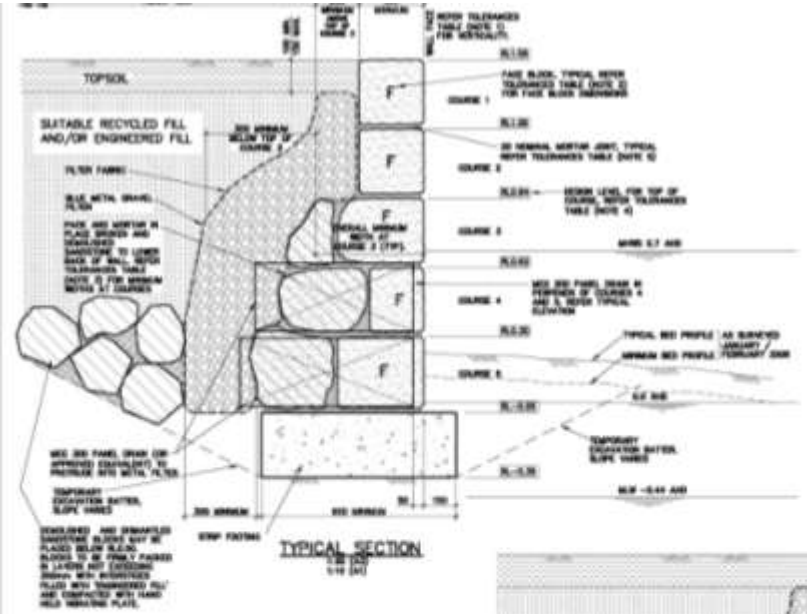

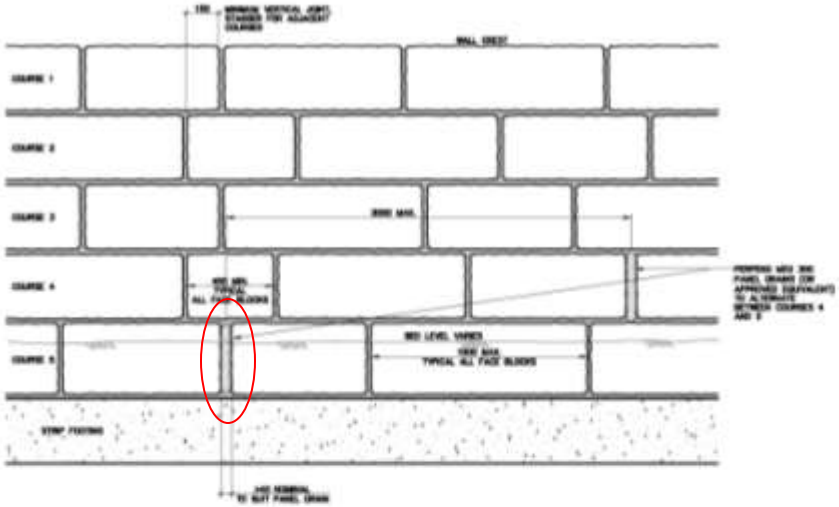

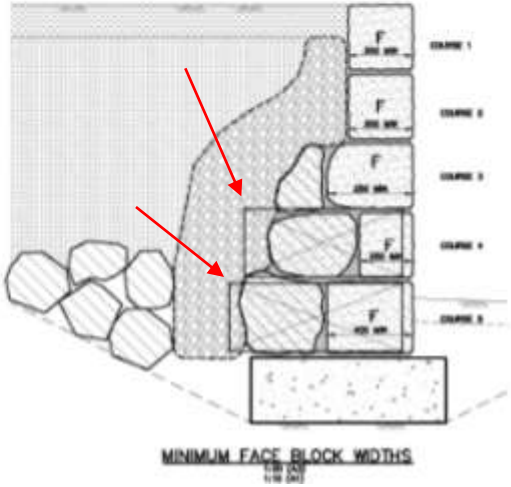

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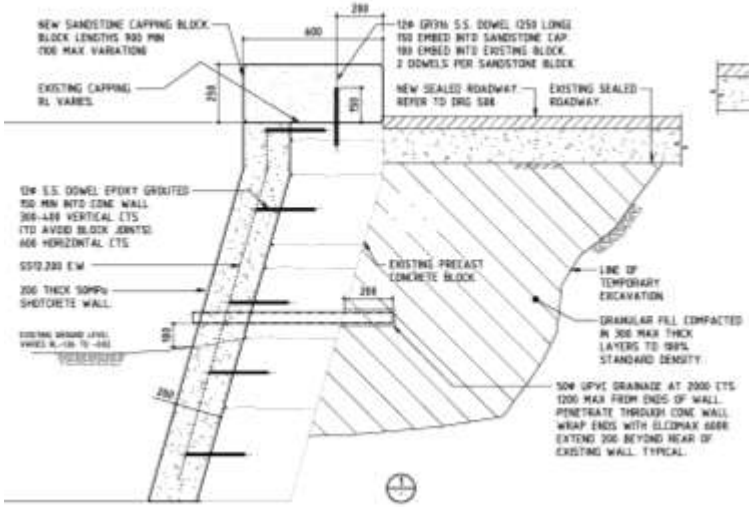
4. Repair of seawall at Rhodes, Parramatta River



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5. Reconstruction of seawall at Lyne Park, Rose Bay

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Wall built early 1900's to protect LP reclamation – dilapidated, unsightly and excessive maintenance

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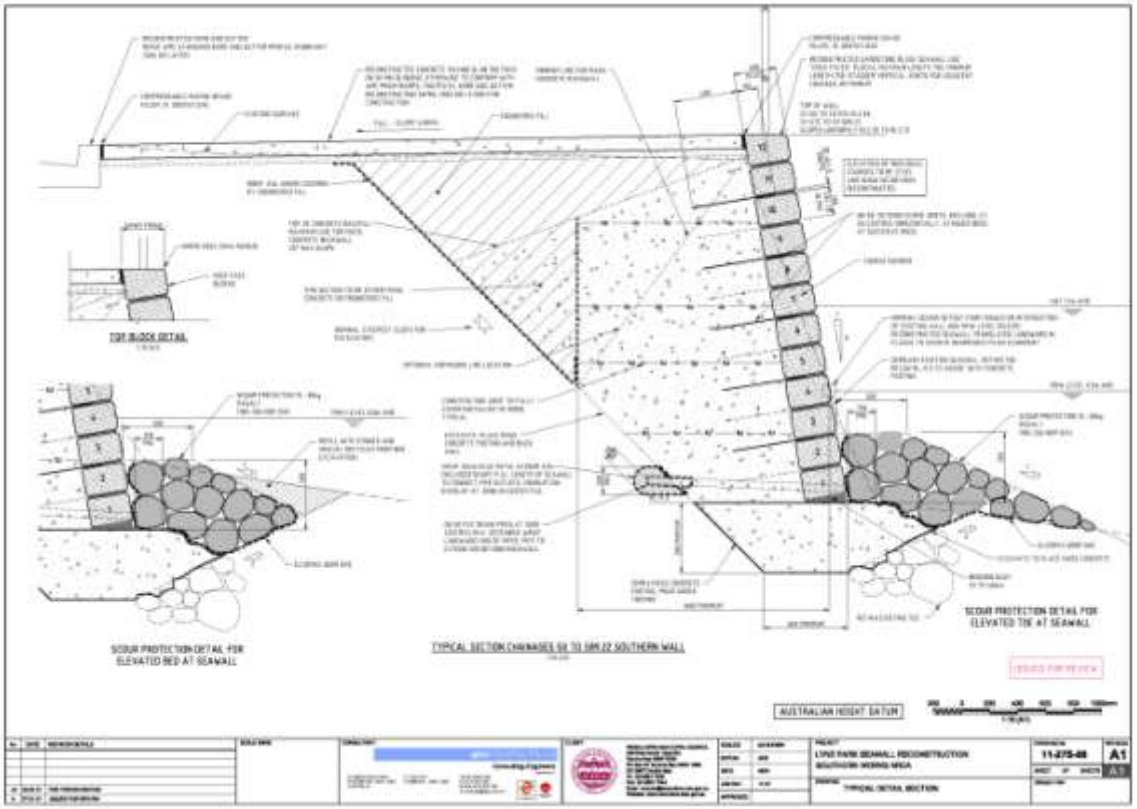

Existing repair ~10 yrs old

Existing dilapidated wall to be reconstructed

- Sandstone fabric tied to mass concrete to develop a gravity structure
- Drainage attended to
- Rock apron – secures toe and advantageous for marine habitat

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19-8-12

- Reconstructed HWM maintained at existing HWM
- Steeper reconstructed wall permitted retention of more excavated material – saved on disposal costs, particularly as material was mildly contaminated

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Thank you

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