Central Pier
CONDITION SUMMARY

2 January 2020

DEVELOPMENT VICTORIA

VICTORIA State Government

Purpose

This report has been prepared by Development Victoria for the purpose of describing:

- the current condition of Central Pier, and
- the scope of works and program which would be necessary to allow the pier to re-open.

It uses information provided by the engineer [Kellogg Brown Root] and the contractor [Fitzgerald Constructions Australia].

Preface

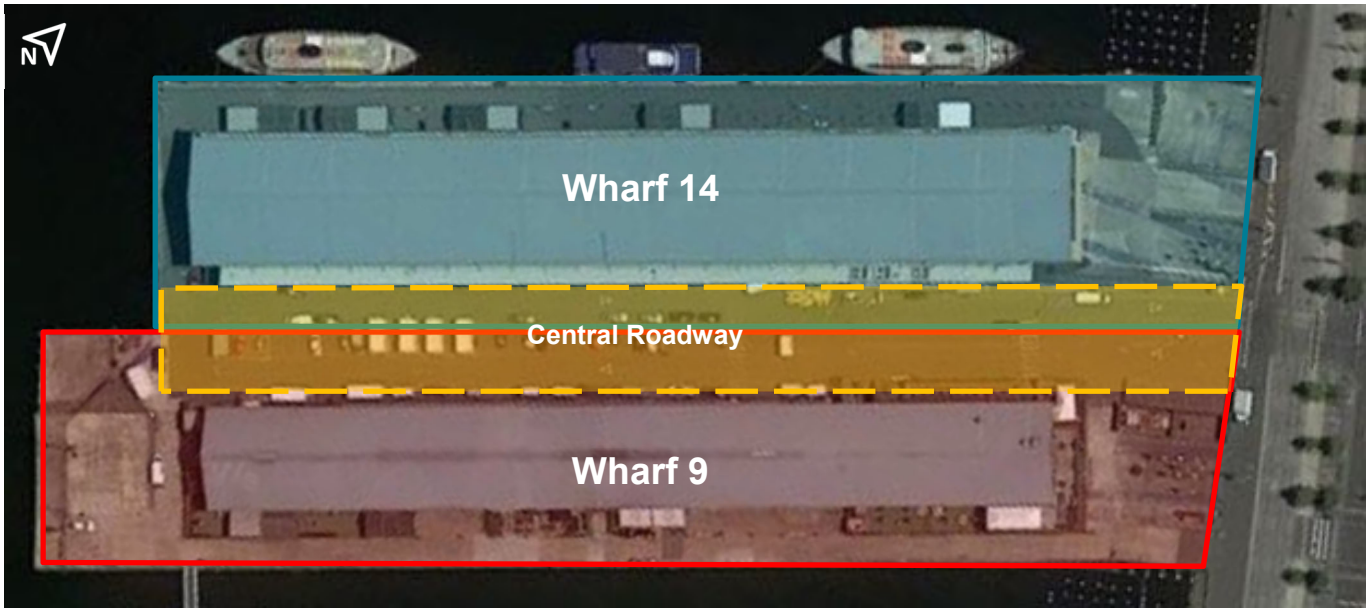


Figure 1: Central Pier with areas identified for reference.

Central Pier is an historic structure, with some parts built more than one hundred years ago. Historically, Wharf 14 was known to be in better structural condition than Wharf 9, noting they are structurally different. Wharf 9 has a grillage formed with timber crossheads supporting the concrete deck while Wharf 14 uses integral concrete beams to support the deck.

Since the closure of Central Pier on 28 August 2019, Development Victoria has implemented an inspection regime of on and under Wharf 14 to better understand the extent of the deterioration. The scope included removing spalled concrete from the underside of the deck, diver inspections of approximately 1,000 piles, localised repairs, and deck inspections.

Post the closure, safe access for inspections below Wharf 9 was not possible, however, an assessment was able to be completed by the engineer based on the information collated from prior investigations (2018 to August 2019).

Following the 28 August 2019 closure, an access plan to facilitate limited access to the pier under supervised conditions has been put in place. This has been necessary to enable the engineer, contractor, divers and the tenant to safely enter the pier.

Current Condition

Wharf 9

Wharf 9 consists of vertical timber piles supporting a horizontal grillage of timber beams and crossheads that, in turn, support a concrete deck (see appendix 1). The engineer has undertaken an assessment of the Wharf 9 investigation findings. The assessment found:

- a detailed pile inspection in 2017 classified 32% of Wharf 9 piles as "failed" and 16% as "poor"[1];
- repairs and maintenance works have been conducted on the pier since 2017, however sample pile inspections in 2019, when compared with the 2017 results, indicated that a further 7% of the piles could fail every two years and a further 29% will likely be downgraded to poor condition over the same period;
- there is evidence of substantial termite damage and rot across the timber elements of the structure;
- extensive parts of the southern section of the deck (public walkway) and the Central Roadway show such deterioration that they are not safe to bear any load in places;
- the overall condition of Wharf 9 is such that it is not currently safe for continued access above or below the deck;
- the engineers concluded that the 2019 inspection showed that significant changes to the condition of structural members across the pier may occur within as little as one year, and that the rate of pile failure appeared to be accelerating.

[1] **Good**: Over 90% original cross-sectional area remains. **Fair**: Between 70%-90% original cross-sectional area. **Poor**: A pile that is less than 70% of original cross-sectional area with limited structural integrity. **Failed**: A pile that is no longer capable of transmitting loads.

Figure 2: Wharf 9 split timber pile, August 2019

Figure 3: Example of a cavity in a pile under Wharf 9. August 2019.

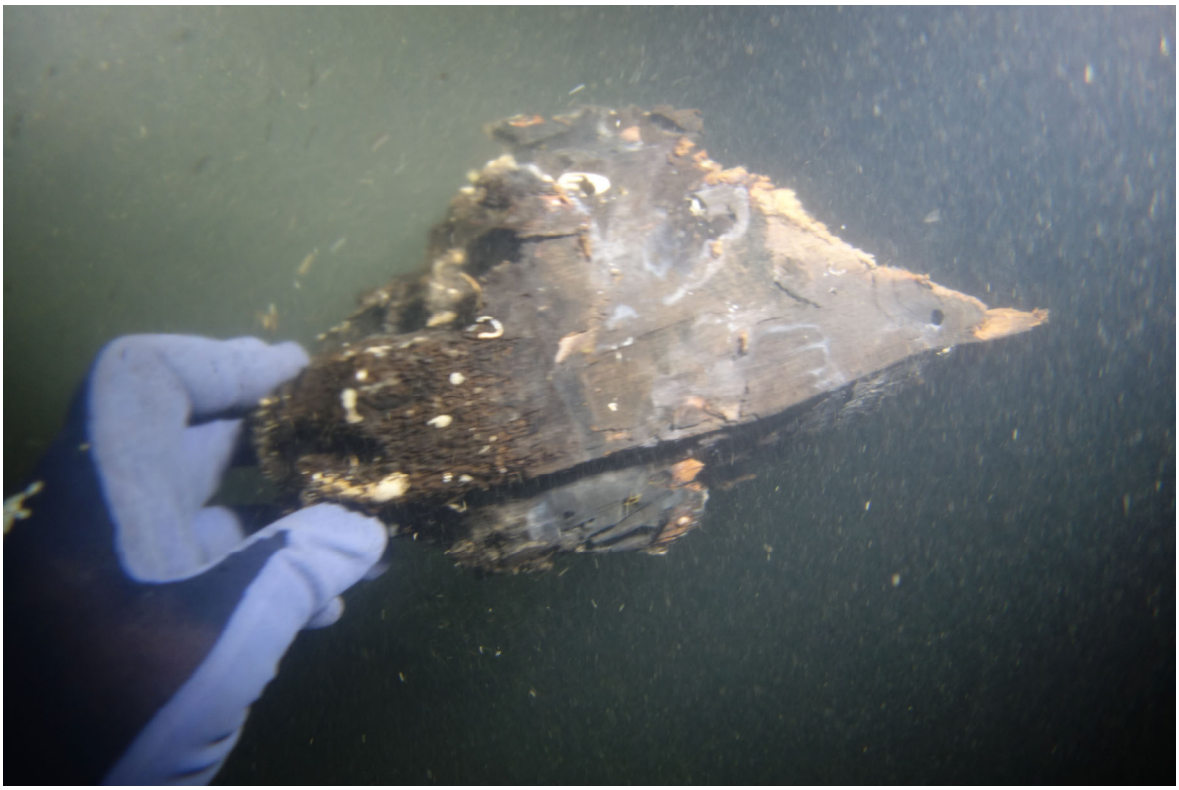


Figure 4: Broken timber that formed part of a pile under Wharf 9. August 2019.

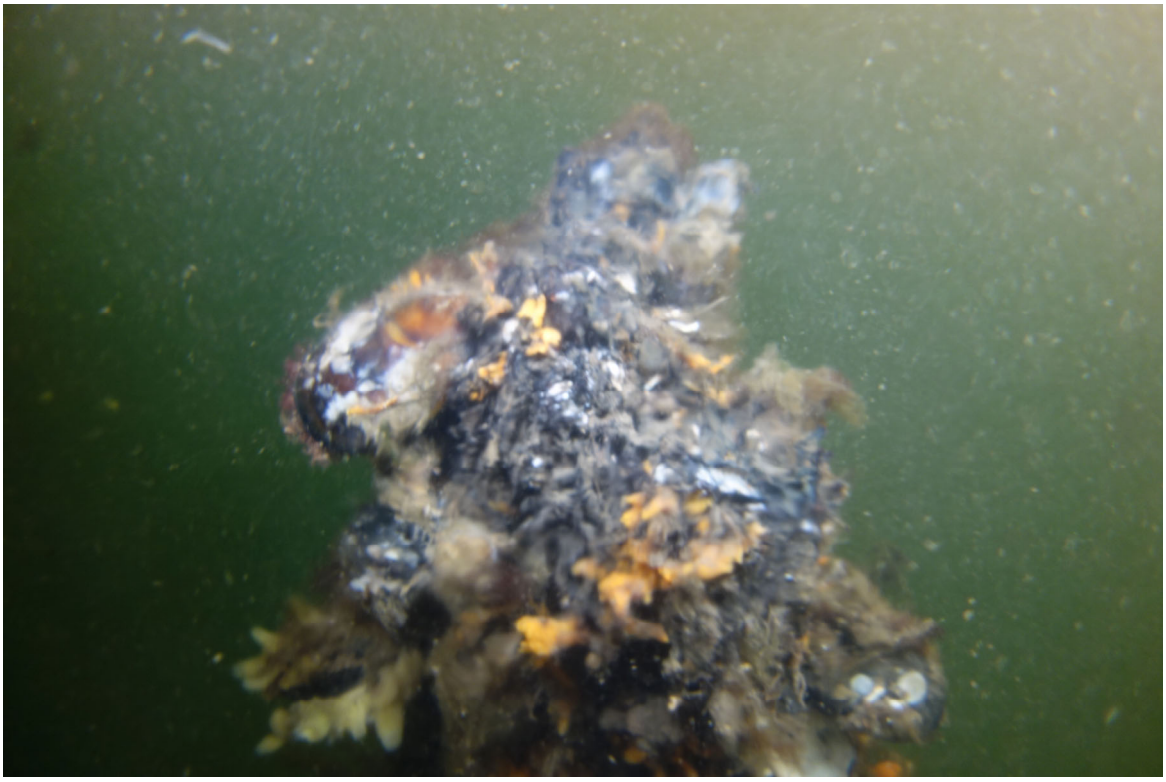


Figure 5: The head of a broken pile under Wharf 9. August 2019.

Wharf 14

A comprehensive inspection of each of the piles beneath Wharf 14 has occurred to confirm the extent of structural deterioration and failure (see appendix 2).

An assessment of the inspection data has been undertaken by the engineers:[2]

Total	Good	Fair	Poor	Failed
997	26	779	151	41
100%	3%	78%	15%	4%

From these findings the engineers have determined:

- the rate of deterioration of the piles is accelerating (similar to Wharf 9), in that 5% of the piles could fail every 2 years and a further 23% will significantly deteriorate over this time.
- the Wharf 14 deck consists of a cast in-situ concrete deck with integral concrete beams spanning between the piles. Engineers have confirmed that the Wharf 14 deck is in better condition, when compared to the Wharf 9 deck, except for:
  - the Central Roadway and the northern section of the deck (public walkway) which has significant concrete spalling and exposed reinforcement;
  - the eastern section of deck (providing the public access to the pier), which is a similar construction to Wharf 9 (timber) and is in poor condition;
- the underside of the concrete deck and beams will need ongoing maintenance and repair works to remedy the spalled sections and exposed reinforcement;
- Wharf 14 has areas of reduced deck load capacity, such that it is not safe for public access (primarily due to pile deterioration) that require repair works to complete prior to reoccupation;
- the engineers concluded the rate of deterioration has increased since the inspections in 2017.

[2] **Good**: Over 90% original cross-sectional area remains. **Fair**: Between 70%-90% original cross-sectional area. **Poor**: A pile that is less than 70% of original cross-sectional area with limited structural integrity. **Failed**: A pile that is no longer capable of transmitting loads.

Figure 6: Wharf 14, showing cracking and delamination of concrete of a integral beam (top left). September 2019

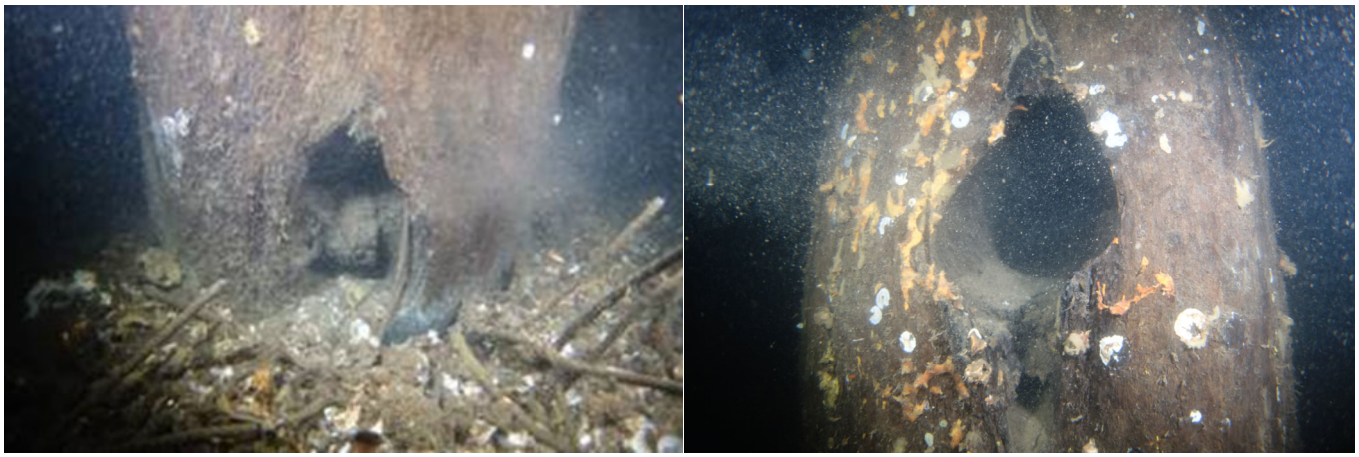


Figure 7 & 8: Deteriorated piles beneath wharf 14. September 2019.

Figure 9: Wharf 14 failed timber pile beneath wharf 14 with a large part of the pile missing. September 2019.

Figures 10, 11, 12, 13: Wharf 14 concrete spalling and cracking to the integral beams underneath wharf 14. September - October 2019.

Scope of Repair

Wharf 9

The engineer has advised the works necessary to inspect and rectify Wharf 9 to a serviceable condition are extensive and would require demolition and reconstruction of parts of the wharf and Central Roadway, including potentially the demolition and reconstruction of the northern wall to the shed. The scope to return the Wharf 9 to service is:

- Piles:
  - re-inspecting every pile;
  - replacing missing piles with new piles and encasing deteriorated and marine borer-affected piles.
- Deck:
  - replacing failed timber beams and encasing degraded timber beams;
  - removing the deteriorated concrete deck and re-construction of a composite slab along the central roadway and any other location beneath the wharf where significant deterioration is identified;
  - further detailed termite inspections to identify all termite affected timber elements;
  - installation of a termite barrier requiring the abutment between the pier and Harbour Esplanade to be partially demolished and re-built;
  - if the detailed termite inspection results or other inspection findings show that the timber beams supporting the northern masonry wall of Shed 9 have to be replaced, this wall will also have to be demolished and re-built;
  - reconstructing the southern section of the apron deck (being the public walkway);
  - repairing all piles under the Central Roadway and reconstructing the Central Roadway from end to end.
- Undertaking load testing across the wharf prior to reoccupation to confirm the structure is safe.

The scope of works described above is projected to take 14 months (see appendix 3). Following the completion of the works a load testing regime, led by the engineer, will be undertaken to establish if the structure is safe for reoccupation. The duration of the load testing cannot be established at this time but would be determined by the engineer upon completion of the works.

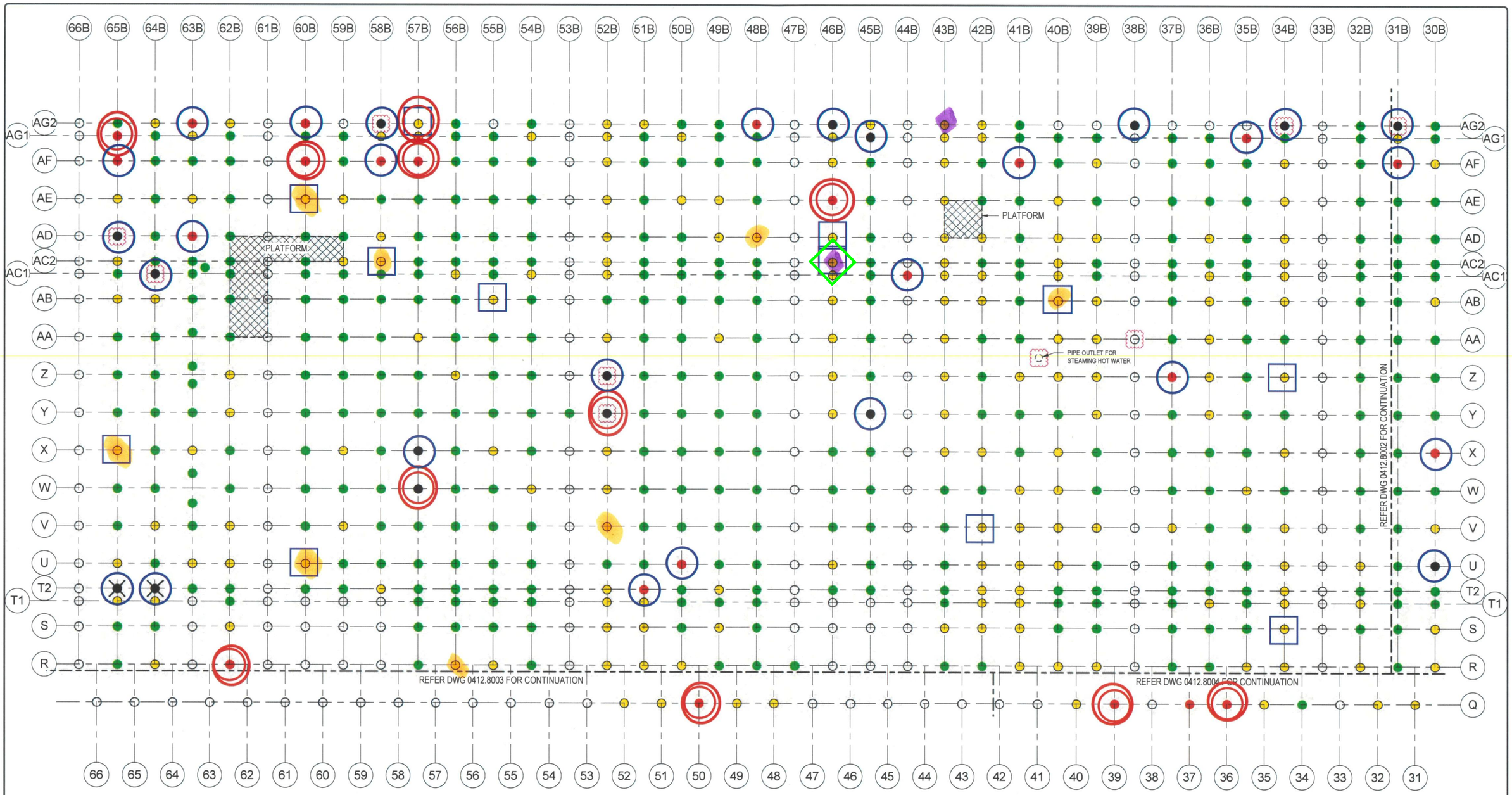
Wharf 14

The works necessary to repair Wharf 14 to a serviceable condition are less extensive than Wharf 9. Spalled concrete has already been removed allowing safe access below the deck, and all piles have been inspected (approximately 1,000 piles). The repair works would include:

- Piles:
  - repairing the balance of the failed piles, as well as those piles that are likely to fail over the medium term.
- Deck:
  - re-inspecting the deck for critical deterioration;
  - if critical deterioration is identified, clearing the concrete around the deteriorated bars, drilling and installing new reinforcing bars into the beams, then patch repairing with shotcrete (or similar);
  - cleaning of exposed reinforcement and patch repairing with shotcrete (or similar) will be required on an ongoing basis to keep the structure safe and serviceable;
  - full reconstruction of the eastern decks.
- Undertaking load testing across the wharf prior to reoccupation to confirm the structure is safe for reoccupation.
- If Shed 14 is repaired and Shed 9 is not, then Shed 9 would need to be fenced off to prevent access.

The scope of works described above has been projected to take 7 months (see appendix 3). The duration of the load testing cannot be established at this time but will be determined by the engineer upon completion of the works.

Appendix 1



CENTRE PIER - PILE CONDITION - SHEET 1

1 : 150

Piles subject to at least moderate marine borer attack

Piles identified as having hollows during drill testing

Piles repaired

Redundant piles

Piles require repairs

PILE CONDITION (AUG 2019)

FAIL

POOR

TAKEN FROM SAMPLE OF 82NO PILES ONLY.

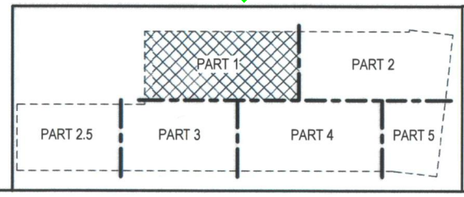
LEGEND

- PILES THAT ARE NOT IN SCOPE OR BEEN RATED
- CONDITION - GOOD
- CONDITION - FAIR
- CONDITION - POOR
- CONDITION - FAILED
- CONCRETE ENCASEMENTS
- DENOTES PILES THAT ARE A SAFETY HAZARD
- DENOTES PILES MISSING ABOVE WATER
- PILES SUPPORTED BY BRACING
- DIRECTION OF BRACING

PILE TAGGING LEGEND

51-AA-1

- DENOTES ADDITIONAL PILES
- DENOTES VERTICAL GRID LOCATION
- DENOTES HORIZONTAL GRID LOCATION



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CLIENT: FITZGERARD CONSTRUCTION
PROJECT: CENTRAL PIER REMEDIATION
LOCATION: CENTRAL PIER
SUBJECT:
DWG NAME: CENTRE PIER - PILE CONDITION - PART 1

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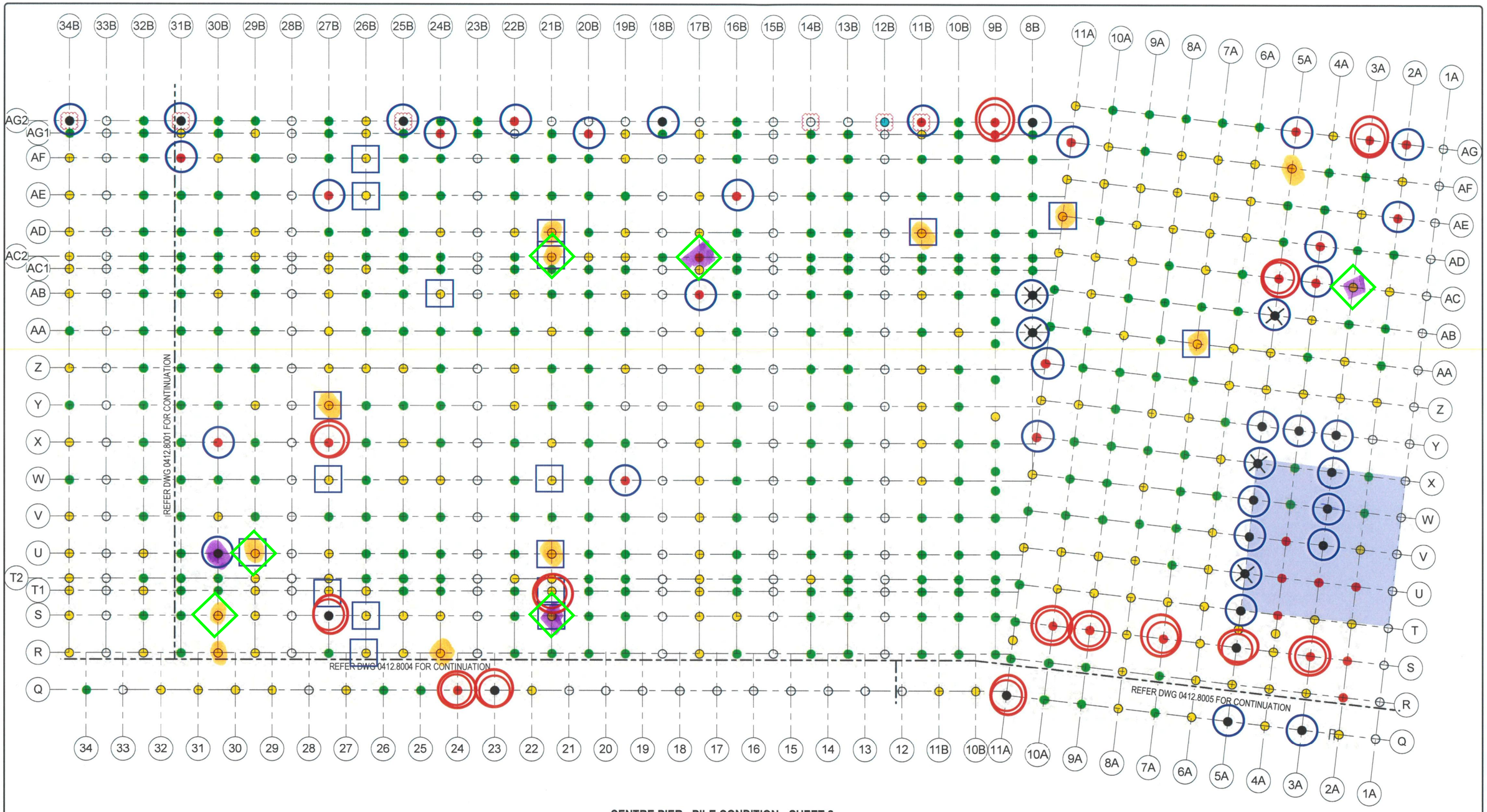
POS (CGM) 9/9/2019



CENTRE PIER - PILE CONDITION - SHEET 2

1 : 150

Piles subject to at least moderate marine borer attack

Piles identified as having hollows during drill testing

Piles repaired

Redundant piles

Piles require repairs

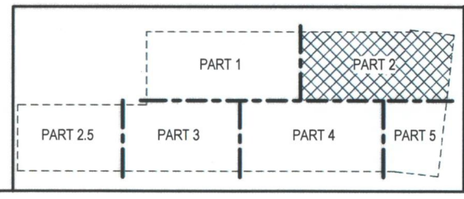
LEGEND

- PILES THAT ARE NOT IN SCOPE OR BEEN RATED
- CONDITION - GOOD
- CONDITION - FAIR
- CONDITION - POOR
- CONDITION - FAILED
- CONCRETE ENCASEMENTS
- DENOTES PILES THAT ARE A SAFETY HAZARD
- DENOTES PILES MISSING ABOVE WATER
- PILES SUPPORTED BY BRACING
- DIRECTION OF BRACING

PILE TAGGING LEGEND

51-AA-1

- DENOTES ADDITIONAL PILES
- DENOTES VERTICAL GRID LOCATION
- DENOTES HORIZONTAL GRID LOCATION



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PROJECT: CENTRAL PIER REMEDIATION
LOCATION: CENTRAL PIER
SUBJECT:
DWG NAME: CENTRE PIER - PILE CONDITION - PART 2

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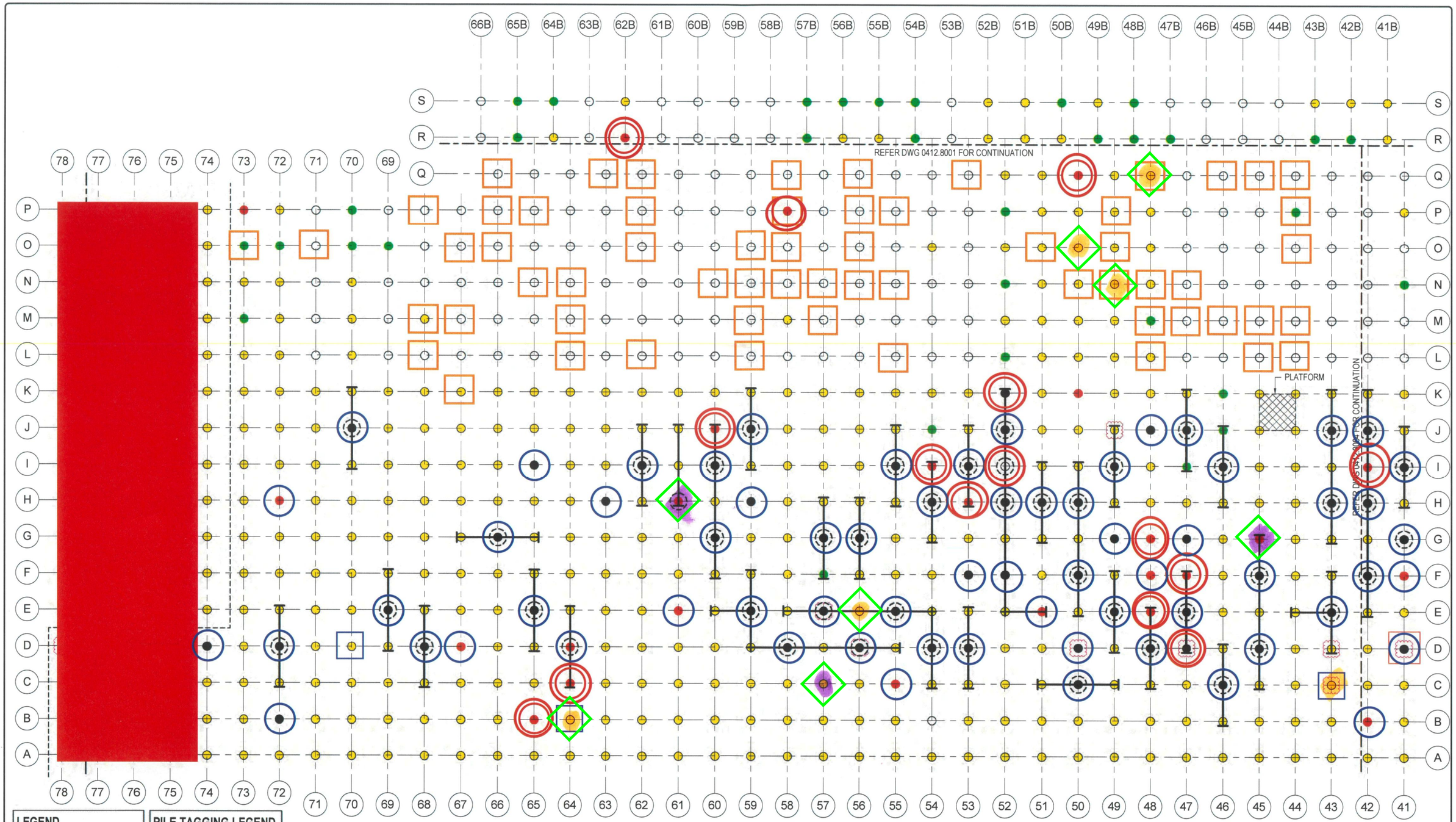


LEGEND

- PILES THAT ARE NOT IN SCOPE OR BEEN RATED
- CONDITION - GOOD
- CONDITION - FAIR
- CONDITION - POOR
- CONDITION - FAILED
- CONCRETE ENCASEMENTS
- DENOTES PILES THAT ARE A SAFETY HAZARD
- DENOTES PILES MISSING ABOVE WATER
- PILES SUPPORTED BY BRACING
- DIRECTION OF BRACING

PILE TAGGING LEGEND

51-AA-1

- DENOTES ADDITIONAL PILES
- DENOTES VERTICAL GRID LOCATION
- DENOTES HORIZONTAL GRID LOCATION

CENTRE PIER - PILE CONDITION - SHEET 3

1 : 150

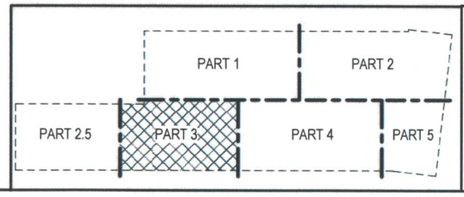
Piles subject to at least moderate marine borer attack

Piles identified as having hollows during drill testing

Piles repaired

Redundant piles

Piles require repairs



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PROJECT: CENTRAL PIER REMEDIATION
LOCATION: CENTRAL PIER
SUBJECT:
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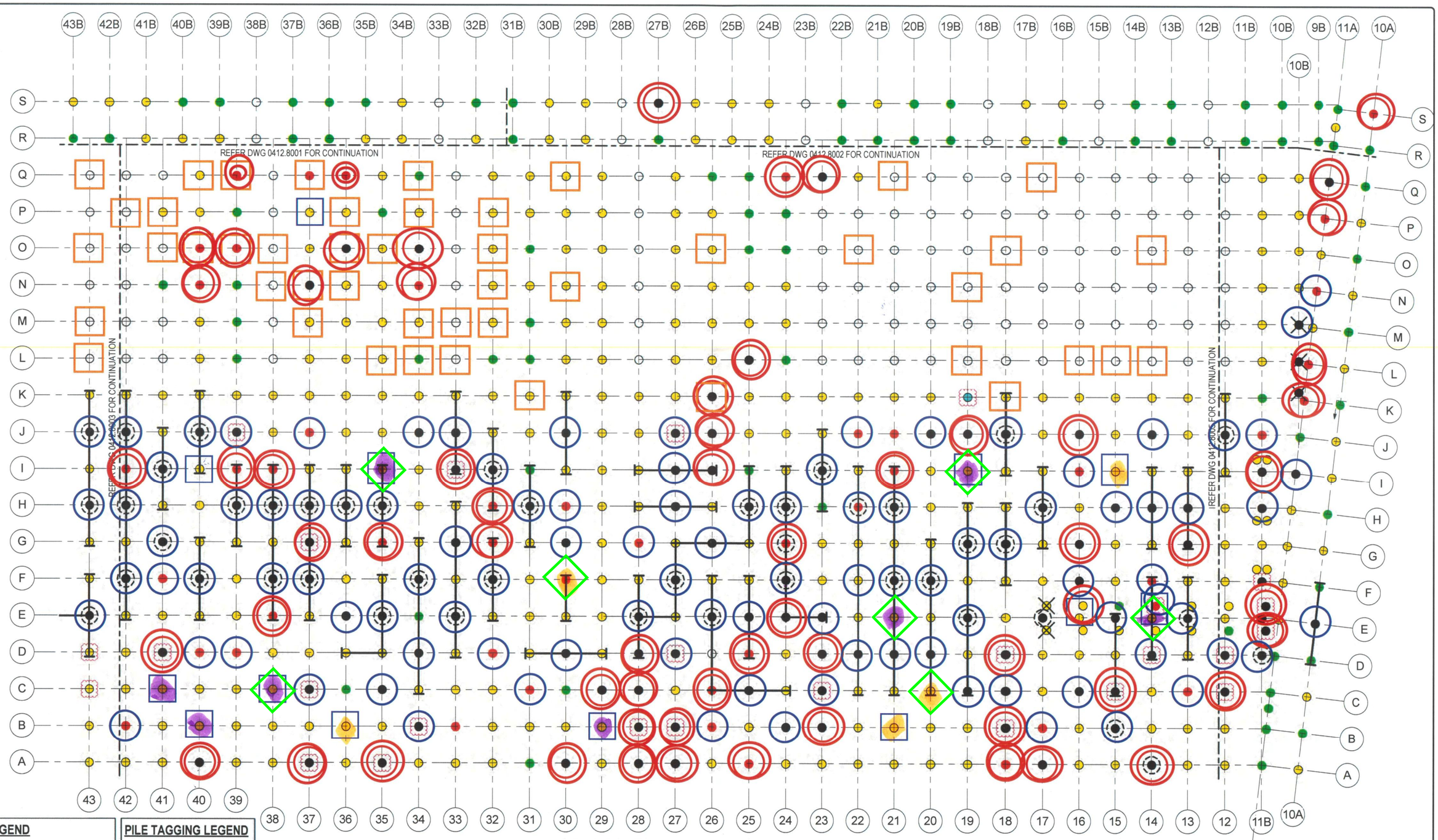


CENTRE PIER - PILE CONDITION - SHEET 4

1 : 150

Piles subject to at least moderate marine borer attack

Piles identified as having hollows during drill testing

Piles repaired

Redundant piles

Piles require repairs

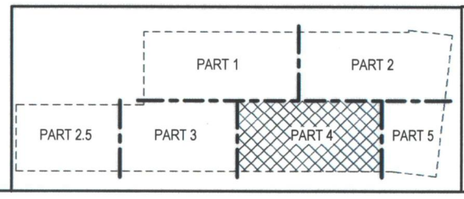
LEGEND

- PILES THAT ARE NOT IN SCOPE OR BEEN RATED
- CONDITION - GOOD
- CONDITION - FAIR
- CONDITION - POOR
- CONDITION - FAILED
- CONCRETE ENCASEMENTS
- DENOTES PILES THAT ARE A SAFETY HAZARD
- DENOTES PILES MISSING ABOVE WATER
- PILES SUPPORTED BY BRACING
- DIRECTION OF BRACING

PILE TAGGING LEGEND

51-AA-1

- DENOTES ADDITIONAL PILES
- DENOTES VERTICAL GRID LOCATION
- DENOTES HORIZONTAL GRID LOCATION



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PROJECT: CENTRAL PIER REMEDIATION
LOCATION: CENTRAL PIER
SUBJECT:
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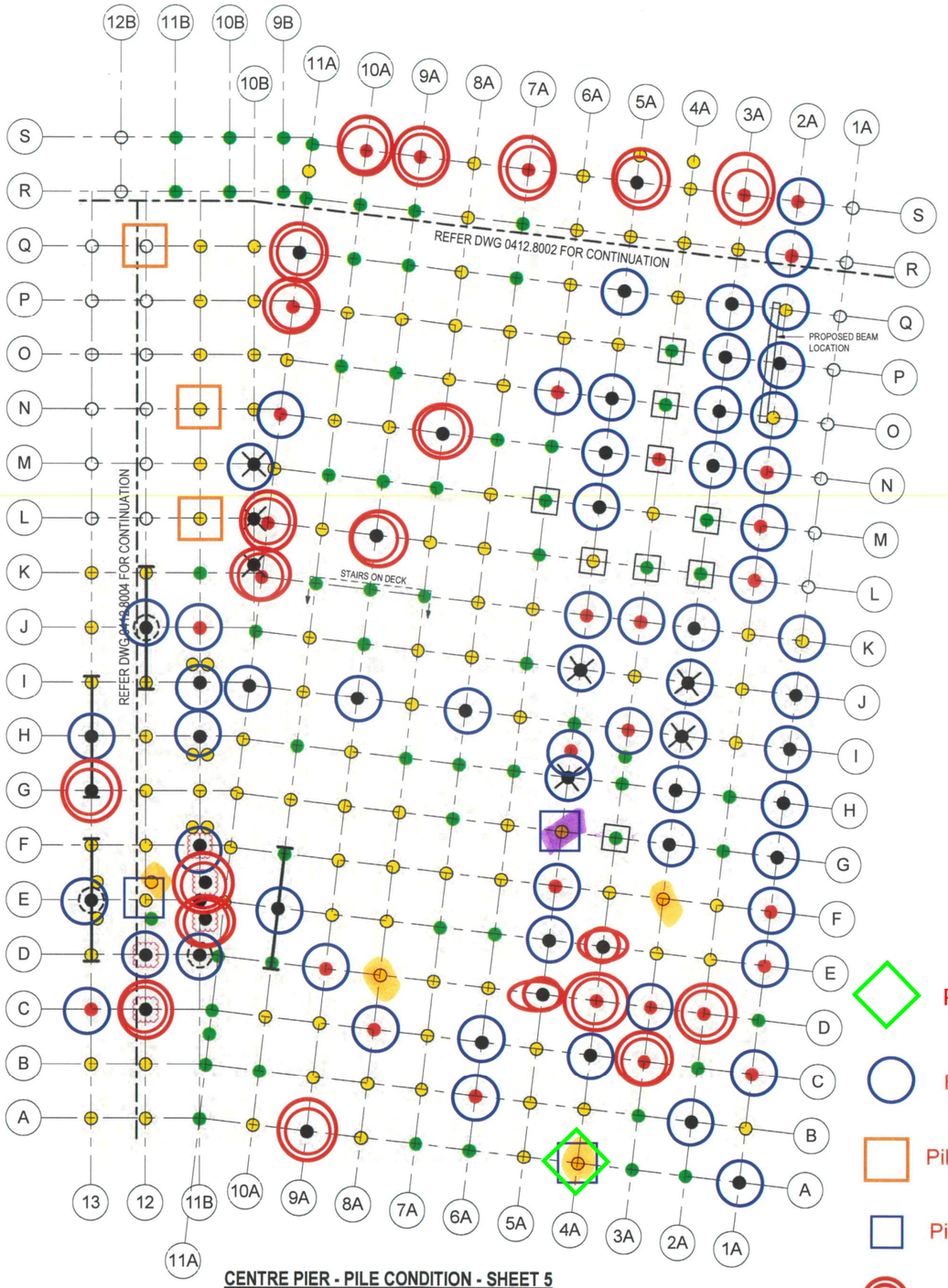


CENTRE PIER - PILE CONDITION - SHEET 5

1 : 150

Piles require repairs

Redundant piles

Piles identified as having hollows during drill testing

Piles subject to at least moderate marine borer attack

Piles repaired

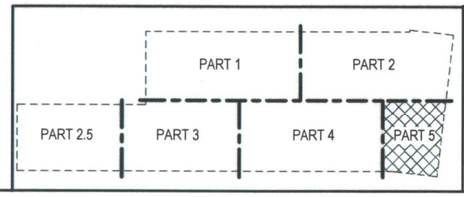
LEGEND

- PILES THAT ARE NOT IN SCOPE OR BEEN RATED
- CONDITION - GOOD
- CONDITION - FAIR
- CONDITION - POOR
- CONDITION - FAILED
- CONCRETE ENCASEMENTS
- DENOTES PILES THAT ARE A SAFETY HAZARD
- DENOTES PILES MISSING ABOVE WATER
- PILES SUPPORTED BY BRACING
- DIRECTION OF BRACING

PILE TAGGING LEGEND

51-AA-1

- DENOTES ADDITIONAL PILES
- DENOTES VERTICAL GRID LOCATION
- DENOTES HORIZONTAL GRID LOCATION



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CLIENT: FITZGERARD CONSTRUCTION
PROJECT: CENTRAL PIER REMEDIATION
LOCATION: CENTRAL PIER
SUBJECT:
DWG NAME: CENTRE PIER - PILE CONDITION - PART 5

ORIG. DWG. SIZE: A1 | JOB NO. 0412 | DWG NO. 0412.8005 | REVISION: 3

Appendix 2

er Data - Central Pier - Pile Detailed Survey (1000 piles in scope)

| Pile ID | | | | | | | Diameters | | | | | | |

er Data - Central Pier - Pile Detailed Survey (1000 piles in scope)

| Pile ID | | | | | | | Diameters | | | | | | |

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| Pile ID | | | | | | | Diameters | | | | | | |

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| Pile ID | | |

er Data - Central Pier - Pile Detailed Survey (1000 piles in scope)

| Pile ID | | |

Timber Data - Central Pier - Pile Detailed Survey (1000 piles in scope)

| Pile ID | | | | | | | | | | Diameters | | | | | | | | | |

Timber Data - Central Pier - Pile Detailed Survey (1000 piles in scope)

| Pile ID | | | | | | | | | Diameters | | | | | | | | |

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| Pile ID | | | | | | | | Diameters | | | | | | | |

Timber Data - Central Pier - Pile Detailed Survey (1000 piles in scope)

| Pile ID | | | | | | | | | Diameters | | | | | | | | |

Appendix 3

Central Pier
Indicative Repair Works Program
Revision 1
Date: 24.12.19

Task Breakdown	1	2	3	4	5	6	7	8	9	10	12	12	13	14
Pier 14														
Pile repairs														
Concrete deck repairs														
Pier 14 East (Harbour Esplanade)														
Preliminaries, establish compound														
Concrete deck removal														
Pile repairs														
Timber beam strengthening														
Construct new slab														
Demobilise compound														
Central Pier Drive (Central Roadway)														
Inspect and make safe, remove spalled concrete														
Pile repairs														
Concrete deck repairs														
Pier 9														
Concrete deck removal														
Pile repairs														
Timber beam strengthening														
Construct new slab														
Pier 9 East (Harbour Esplanade)														
Preliminaries, establish compound														
Concrete deck removal														
Pile repairs														
Timber beam strengthening														
Construct new slab														
Demobilise compound														