OTSI Office of Transport Safety Investigations

RAIL SAFETY INVESTIGATION

HAWKESBURY RIVER RAILWAY BRIDGE

BROOKLYN

14 SEPTEMBER 2015

RAIL SAFETY INVESTIGATION REPORT

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Due to the commercial sensitivities regarding the organisations involved as subject matter experts, tenderers and contractors, this report has de-identified the private organisations names and focused on the process, communications and issues resulting.

THE OFFICE OF TRANSPORT SAFETY INVESTIGATIONS

The Office of Transport Safety Investigations (OTSI) is an independent NSW agency whose purpose is to improve transport safety through the investigation of accidents and incidents in the rail, bus and ferry industries. OTSI investigations are independent of regulatory, operator or other external entities.

Established on 1 January 2004 by the *Transport Administration Act 1988*, and confirmed by amending legislation as an independent statutory office on 1 July 2005, OTSI is responsible for determining the causes and contributing factors of accidents and to make recommendations for the implementation of remedial safety action to prevent recurrence. Importantly, however, OTSI does not confine itself to the consideration of just those matters that caused or contributed to a particular accident; it also seeks to identify any transport safety matters which, if left unaddressed, might contribute to other accidents.

OTSI investigations are conducted under powers conferred by the *Transport Administration Act 1988* and the *Passenger Transport Act 1990*. OTSI investigators normally seek to obtain information cooperatively when conducting an accident investigation. However, where it is necessary to do so, OTSI investigators may exercise statutory powers to interview persons, enter premises and examine and retain physical and documentary evidence.

It is not within OTSI's jurisdiction, nor an object of its investigations, to apportion blame or determine liability. At all times, OTSI's investigation reports strive to reflect a "Just Culture" approach to the investigative process by balancing the presentation of potentially judgemental material in a manner that properly explains what happened, and why, in a fair and unbiased manner.

Once OTSI has completed an investigation, its report is provided to the NSW Minister for Transport and Infrastructure for tabling in Parliament. The Minister is required to table the report in both Houses of the NSW Parliament within seven days of receiving it. Following tabling, the report is published on OTSI's website at www.otsi.nsw.gov.au.

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EXECUTIVE SUMMARY

The Hawkesbury River Railway Bridge was completed on 1 July 1946, and replaced the original 1889 bridge. Responsibility for maintenance of the bridge now resides with Sydney Trains, an organisation that commenced operations on 1 July 2013. Prior to this date RailCorp (and its predecessor/s) was responsible for asset management and maintenance of the bridge.

A maintenance plan for the bridge specified inspection frequencies for all bridge and track components. In particular, the plan specified that an underwater examination of permanently submerged piers be conducted every six years. The previous underwater inspection of the bridge was carried out in 2006 during which minor damage was noted in Pier 2. A routine underwater inspection in May 2013 indicated that the condition of Pier 2 had deteriorated since 2006 and required rectification works.

Although the structural integrity of the bridge Pier 2 was deteriorating, the bridge remained above a safe operating threshold. This was confirmed by a load rating assessment which revealed the bridge was capable of sustaining loads above that of normal passenger and freight services.

By September 2015 no repairs had taken place which prompted the Minister of Transport and Infrastructure to write to the OTSI Chief Investigator on 17 September 2015 requesting him to investigate and establish the facts in relation to the management of the condition of the bridge and to consider the following issues:

1. How has Sydney Trains assured itself that the bridge is, and continues to be safe?

   Through increased inspection frequency and rectification within the given timeframes.

2. Did the process followed by Sydney Trains in managing the procurement of the remedial works adequately consider the ongoing safety of the bridge?

   A significant delay in the procurement process meant that safety was assured by frequent monitoring of the condition of the bridge. The works (concrete pour) was eventually completed in April 2016.

3. Has the delay to issuing the tender for repairs compromised the safety of the structure?

   The condition of the pier had deteriorated since the initial discovery of the defect in May 2013. At all times though, it was fit for purpose. This was validated by independent assessments.

4. What further arrangements could be considered to ensure ongoing confidence in the management of the remedial works?

   OTSI makes recommendations regarding processes that may have an impact on similar complex procurement/maintenance projects.

5. Examine the wider system of decision making processes in Sydney Trains that captures, considers and manages asset and infrastructure safety.

   Sydney Trains has processes in place to manage assets. The Asset Standards Authority had conducted surveillance on Sydney Trains and made recommendations to enhance the capability of their AEO status. However, in this case, the breakdown was in the scope of a particular element of asset management i.e. the procurement of suitable resources to conduct the repair.

6. What improvements could be made to the above process followed by Sydney Trains?

   During the investigation, OTSI identified processes it considered were contributory to the delay in rectification of the bridge. These included due diligence, procurement processes, internal and inter-agency communications, risk management, project scoping, reliance on third parties and independent safety assessments.

The terms of reference also required OTSI's Investigating Officer to:

a) address the issues raised in the Minister's request,

b) advise on any matters arising from the investigation that would enhance the safety of rail operations.

   Notwithstanding remedial actions in hand by Sydney Train and Transport for NSW, OTSI makes 13 recommendations to various organisations that address these systemic issues and should improve resilience. For more details, refer to ***PART 4 Recommendations***.

PART 1 CONTEXT

Historical context

1.1 The Hawkesbury River Underbridge[1] is a major railway bridge on the network that links Sydney to Newcastle and supports the two electrified Main Northern Lines. The bridge is an eight span (steel) truss railway bridge along with two concrete approach spans. All 10 spans all supported on reinforced concrete piers. It was opened in 1946 and replaced the original 1889 bridge.

1.2 The current and former Hawkesbury River rail bridges have State heritage significance. The Office of Environment and Heritage (NSW) had a listing for the Hawkesbury River Rail Bridge[2] which stated: "*The 1946 railway bridge was also a major technical achievement at the time of its construction, its large riveted steel trusses and its footings were still among the deepest in the world. It remains the longest purpose built rail bridge in the NSW network. The bridge itself as well as the remnant construction docks, platform and power station demonstrate the technical achievements in the construction of the bridge. The docks in particular provide direct evidence for the method of construction and the challenges associated with construction in this estuarine environment*".

Location

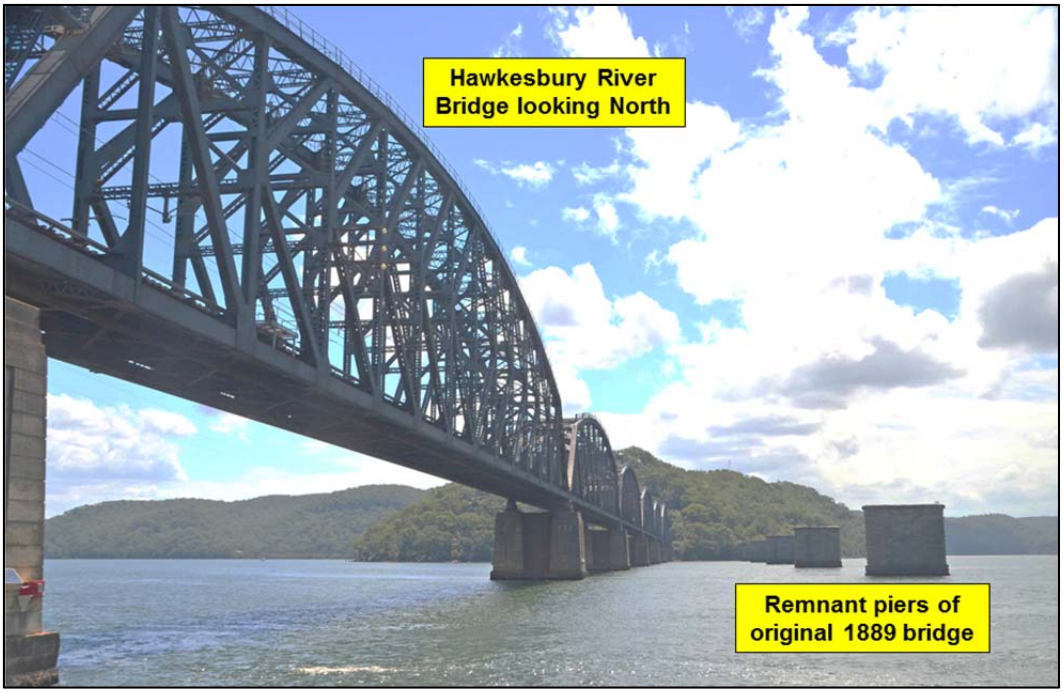
1.3 The bridge, located at 58.463 km,[3] crosses the Hawkesbury River from Long Island to the northern shore, approximately 1 km north of Hawkesbury River Railway Station. The bridge is located to the west of the remnant piers and abutments of the 1889 bridge (refer to *Photograph 1* and *Figure 1*).

1 The Oxford dictionary defines 'underbridge' as: "*A bridge spanning an opening under a railway or road".*

2 Office of Environment and Heritage (NSW), 4 June 2009, *Hawkesbury River Rail Bridge and Long Island Group*. Available from their website: www.environment.nsw.gov.au

3 All kilometrages are measured from the buffer stop at No. 1 platform at Central railway station, Sydney Terminal. The kilometrage shown for Hawkesbury River railway underbridge is referenced from the *ASA Technical Note TN 065:2014, Table 2 – Table of steel and concrete underbridges* (issued and effective 13 August 2014).

Figure 1: Bridge location

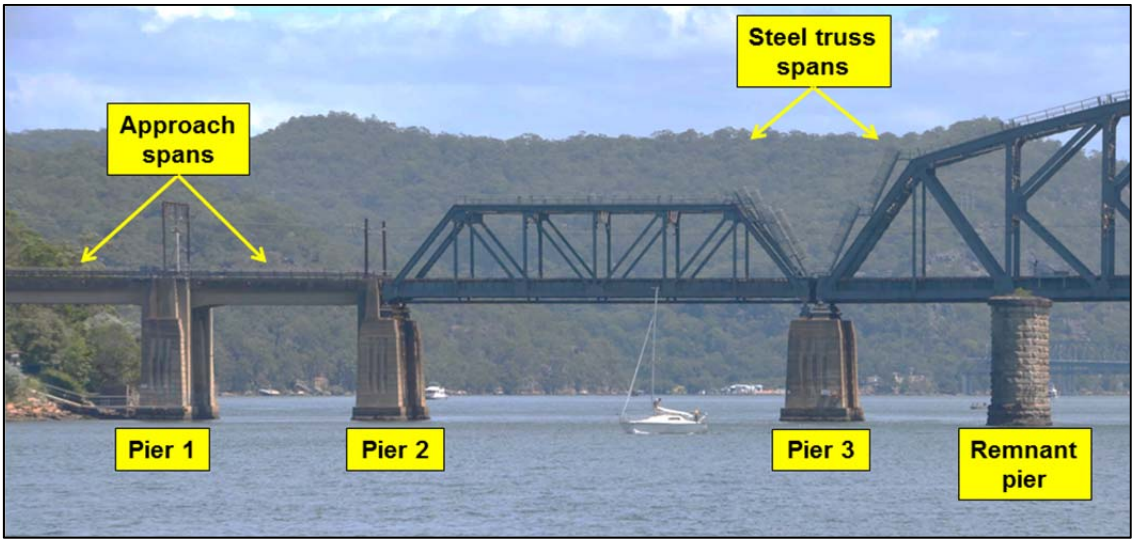


Photograph 1: Current bridge and remnants of original bridge

Design

1.4 The underbridge structure comprised of ten simply supported spans with a total length of approximately 842m.[4] Spans 1 and 2, the southern approach spans, are constructed of continuous reinforced concrete T-girders. Spans 3 to 10 are steel through trusses.

1.5 The reinforced concrete substructure comprised abutments on shallow foundations and piers supported by caissons bedded in river soils or rock. Piers 1 and 2, located at the Southern end of the bridge, supported the concrete approach spans and have pairs of circular caissons. Piers 3 to 9 had single rectangular caisson structures. Design drawings indicated the circular caissons were filled with concrete and the rectangular caissons had internal steel cylinders filled with sand and water (refer to *Photograph 2*).



Photograph 2: Southern end of bridge showing piers and spans

Legislative framework and asset management (guideline)

1.6 On 20 January 2013, the Office of the National Rail Safety Regulator (ONRSR) commenced operations and assumed regulatory responsibility for rail safety in NSW under the *Rail Safety National Law 2012*.[5] The NSW Independent Transport Safety Regulator (ITSR) delivers a range of services on behalf of the ONRSR under a service level agreement.

4 Length referenced from RailCorp document *TMC 113 Maintenance Plan – Hawkesbury River Bridge*.

5 The *Rail Safety National Law* was enacted in NSW and is applied as a law of NSW by the NSW *Rail Safety (Adoption of National Law) Act 2012*. Relevant legislation is available at http://www.legislation.nsw.gov.au/

1.7 Within the associated *National Regulations,*[6] requirements were prescribed for safety management systems (SMSs), which the ONRSR website defined as: "…*a rail transport operator's primary means for identifying hazards, recording the risks to safety it has identified within its operations and detailing how those risks are managed and monitored. It is a legislative requirement of accreditation that rail transport operators (RTOs) have an appropriate SMS in place. RTOs are legally obliged to implement and then comply with their SMS (RSNL s101). The level of detail included in an SMS will be determined by the complexity of the rail operations for which it has been designed*".

1.8 The *Rail Safety National Law* (NSW) prescribes *rail safety duties* for rail transport operators under Division 3, Sub Division 1 and states under Section 51 (1): "*Duty under this Law cannot be transferred to another person*". The Rail Safety National Law Section 46 introduces the duty to managing risks 'so far as is reasonably practicable' (SFAIRP)[7] and additionally, Section 47 explains the Law's meaning of 'reasonably practicable".

1.9 SMSs mandate all matters listed in the *National Regulations*, *Schedule 1 Content of safety management system*. The 29 elements that were listed include (but were not limited to):

- *14 Internal communication:* Systems and procedures:

  a) for the dissemination of information about the content of the SMS to people who were to participate in, or were affected by, the implementation of the system,

  b) for the communication of the rail transport operator's safety policy and safety objectives to all people who were to participate in the implementation of the SMS,

  c) for the internal reporting of accidents and incidents involving the operator's railway operations, including those involving contractors and subcontractors; and

6 The *Rail Safety National Law National Regulations 2012, Division 1 Safety management systems* and *Schedule 1 Content of safety management system*. Relevant legislation is available at http://www.legislation.nsw.gov.au/

7 The concept of SFAIRP is to achieve the best possible safety outcome, to the extent that is 'reasonably practicable'. ONRSR's "Meaning of Duty to Ensure Safety So Far As Is Reasonably Practicable Guideline" refer ONRSR website.

d) to support communication and the dissemination of information throughout, and between all levels of, the operator's railway operations.

- *16 Risk management:*

  a) Systems and procedures for compliance with the risk management obligations,

  b) A risk register which included a listing and assessment of identified risks, description of any elimination or risk control measures that were to be used to manage those risks, so far as is reasonably practicable (SFAIRP), and identification of who was responsible for implementing the measures; and

  c) Systems and procedures to ensure that the details in the register were current SFAIRP.

- *18 Procurement and contract management: Systems and procedures:*

  a) for the review of tender documents and contracts to ensure that safety requirements under the SMS were adequately defined and documented in those tender documents and contractsm

  b) to ensure that the terms of any tender documents or contracts did not lead to unsafe work or an activity that may have affected the safety of railway operations; and

  c) for the selection and control of contractors and to ensure the monitoring of the performance of contractors, including conducting or commissioning audits of the contractor's performance in relation to the safety aspects of the contract.

- *19 General engineering and operational systems safety requirements:*

  a) A documented set of engineering standards and procedures, and operational systems, safety standards and procedures, to cover rail infrastructure, rolling stock and operational systems, and, if relevant, the interface between any 2 or more of these,

b) Procedures for the control and verification of the design of structures, rolling stock, equipment, and systems, in accordance with the engineering standards and procedures, and operational systems safety standards; and

c) Systems, procedures and standards for the following in relation to rail infrastructure through its entire lifecycle - design, construction, implementation and commissioning, monitoring and maintenance, system operation, modification, decommissioning or disposal.

- *21 Asset management:* an asset management policy and processes that address all phases of the asset life cycle of the rail infrastructure or rolling stock operations.
- *30 Resource availability:* systems and procedures for estimating the resources, including people and equipment, that the rail transport operator would need to operate and maintain the operator's railway operations and to implement, manage and maintain its SMS, and for the preparation of plans to ensure that it had adequate access to those resources.

1.10 According to the ONRSR website, asset management: "…*is an integral element of any rail transport operator's safety management system. It is used to manage the risks associated with the design, use and disposal of physical assets throughout their lifecycle, ensuring assets are safe to operate and maintain*".

1.11 In November 2014, the ONRSR published their *Asset Management Guideline.*[8] Accredited rail infrastructure managers with assets under their control were to ensure these assets were safe, fit for purpose and commercially viable. The aim of the guideline was to provide industry guidance on how to comply with asset management obligations under the *Rail Safety National Law*.

[8] The *Asset Management Guideline* was published by ONRSR in 2014 and is available from the ONRSR website: http://www.onrsr.com.au/safety-improvement/asset-management

1.12 Whilst the regulatory framework and asset management guideline had been recently established, they were still maturing. Nonetheless, ONRSR indicated that Sydney Trains held the necessary accreditation as both a rail operator and rail infrastructure manager. ONRSR also verified that Sydney Trains had a satisfactory SMS in place and which included asset management as an element.

1.13 In regards to the issue involving the Hawkesbury River Bridge, ONRSR confirmed they had not undertaken regulatory activity in relation to the Hawkesbury River Bridge. Following media reports, ONRSR engaged with Sydney Trains and obtained relevant technical reports which were reviewed by their structures specialist. ONRSR provided an internal memo (dated 15 September 2015) where they stated that Sydney Trains were aware of the risks relating to the Pier 2 and Sydney Trains were managing the issue. ONRSR concluded that there were no immediate safety issues relating to the structure of the Hawkesbury River Bridge.

1.14 OTSI asked Sydney Trains: "*As procurement and contractors is an SMS element at Sydney Trains, what audits/investigations have been conducted by HSEQ into procurement/tender processes of safety critical assets. Can you provide examples?*" Sydney Trains response included: "*Sydney Trains has not conducted any audits specifically into the procurement/tender process for safety critical assets.*" Notwithstanding, Sydney Trains provided OTSI with a briefing from a senior manager in their Maintenance Directorate who advised that the asset itself would not be defined as safety critical, however, the maintenance activity to be performed would have a criticality assigned, or a priority assigned to the defect and its associated repair.

Framework amongst relevant transport agencies

1.15 From 1 January 2004 until 30 June 2013, RailCorp provided metropolitan and interurban passenger rail services via CityRail and long distance services via CountryLink. RailCorp (and their government railway predecessors) also owned and maintained the metropolitan rail network and provided access to freight operators in the metropolitan area.

1.16 On 1 November 2011, Transport for NSW (TfNSW) was created with a role to coordinate transport services, transport infrastructure, transport policy and integrate planning and service delivery across all modes of transport on behalf of the Government.

1.17 On 1 July 2013, two new organisations, Sydney Trains and NSW Trains, started operations. Sydney Trains became accredited as both a rail operator and infrastructure manager under the *Rail Safety National Law* (NSW) and inherited a number of staff, documents, systems, assets, responsibilities and duties from RailCorp. RailCorp, as an entity, remains the owner of real property, rail infrastructure and rolling stock, but its functions as operator and maintainer of rail passenger services were transferred to these two new government agencies.

1.18 Sydney Trains operated passenger trains in the greater Sydney suburban area. It also operated and maintained the metropolitan rail network and provided maintenance services to NSW Trains. Part of its asset maintenance responsibilities included approximately 1,588km of track, 178 stations, 2,185 electric and diesel cars, 1,526km of overhead wiring and a substantial number of viaducts and bridges, including the Hawkesbury River Bridge.

Rail Services Contract

1.19 Sydney Trains operated under a *Sydney Trains Rail Services Contract* (RSC) with TfNSW. The contract stipulated the NSW Government's expectations around service levels, and set out how Sydney Trains and TfNSW would work cooperatively to address service alterations, community consultation, regular service reviews, performance standards and the handling of complaints. In doing so, both agencies must also meet the requirements of the *Transport Administration Act 1988 (NSW)*.

1.20 The RSC dealt with funding at a high level. It did not provide funding detail by asset or by asset class; hence, there was no reference to the Hawkesbury River Bridge in the document. The contract did include the following relevant asset management obligations in its schedule:

a. Asset Management Plan (AMP): responsibility of Sydney Trains and provided various amounts of data including existing and forecasted condition risks, which were highlighted at an asset class, or program level. Once the AMPs were agreed, operators provided a monthly report which included progress on completion of major maintenance activities. This report focused on performance against the RSC and identified where asset failures contributed to degradation in the required service performance.

b. Total Asset Management Plan (TAMP): responsibility of TfNSW and produced annually. According to *Sydney Trains Annual Report 2014/15* (Page. 7) TAMP*:* "….*is a strategic approach to physical asset planning and management, outlining the asset and capital requirements to deliver service priorities and strategies. Sydney Trains works with TfNSW to develop and manage assets in accordance with NSW Government's Total Asset Management policies*".

1.21 Allocations of funding for asset maintenance were in accordance with the priorities established by the TAMP.

PART 2 ANALYSIS

Analytical Model

2.1 OTSI undertook to determine the best process and model to investigate an adverse occurrence. Due to the complexity and nature of this investigation, OTSI chose to include organisational, contextual, communications, regulatory, business and risk processes.

Bridge engineering standards and inspection regime

2.2 A suite of rail specific engineering documents called the Engineering Standards existed within RailCorp (and now with the Asset Standards Authority - ASA[9]) to provide work plans, instructions and examination schedules for persons authorised to work on, or near, civil assets (such as the bridge).

2.3 *Civil Technical Maintenance Plan ESC 100*[10] prescribed the maintenance policy for civil infrastructure in terms of mandatory preventive maintenance and minimum inspection frequency by asset type. It was provided for use by personnel responsible for implementing the policy and programming preventive maintenance activities.

2.4 Examination schedules applicable to the bridge were as follows:

a. Detailed structural examination every two years, with a 72 day latitude.

b. Underwater examination of piers and bases (which were permanently submerged) every six years, with a 216 day latitude.

2.5 Documents provided by Sydney Trains noted that the previous underwater inspections on the bridge were carried out in March 2000 (nil defects noted) and September 2006 during which minor damage was noted in pile 2 of Pier 2.

9 The Asset Standards Authority (ASA) was an independent unit established within Transport for NSW, and was the network design and standards authority for NSW transport assets. The ASA was responsible for developing engineering governance and frameworks to support industry delivery in assurance of design, safety, integrity, construction and commissioning of transport assets for the whole asset life cycle. Refer to their website: http://www.asa.transport.nsw.gov.au . The role of ASA is discussed in more detail in section *2.48* of this report.

10 RailCorp document ESC 100 was still available amongst a subset of documents that resided within their suite of Standards managed by the Asset Standards Authority (ASA) and could be found on the ASA website. Content of the engineering standards was now managed by ASA. The responsibility for ongoing management of the technical maintenance plans resides with Sydney Trains.

2.6 In May 2013, the then RailCorp engaged a diving contractor to undertake the routine underwater inspection. This inspection showed significant deterioration at the top of the circular reinforced concrete caisson of pile 2 of Pier 2. Pile 2 (the downstream pile) had approximately 50% of the first metre of concrete missing, exposing much of the steel reinforcing.

2.7 Documents indicated that whilst the pier needed attention and repairs, the damaged pier was structurally adequate and had no effect on the load rating[11] of the bridge (for details on the defect and load rating as at October 2015, refer to *Appendix 3: Extracts from independent report into the condition of the pier*).

2.8 By 22 May 2013, internal Civil Engineering personnel had further examined these findings on the effects of the concrete degradation and concluded that the pier was "*structurally adequate*" and: "…*that the stress in the pier was low and the bridge was safe*".

2.9 Despite these initial findings, RailCorp immediately committed to undertake further investigation to establish the root cause of the concrete degradation and to conduct a more detailed bridge load rating assessment.

Procurement framework, policy and process

2.10 The NSW Government provided a framework for agencies to achieve value for money from their procurement activities whilst being fair, ethical and transparent. A suite of documents were provided which were relevant to all categories and steps within the procurement process.

2.11 The *NSW Procurement Policy Framework* set out the policy and operating framework for the NSW public sector procurement system, and provided a single source of guidance on the rules for procurement. This policy was applicable across all departments, statutory authorities, trusts and other NSW Government entities.

[11] RailCorp document *ESC 301 Load Rating of Underbridges* and its appending technical note *TN 075:2014* stipulated a number of load rating parameters applicable to the Bridge. ASA acknowledged that the new standard *T HR CI 12008 ST Load Rating of Underbridges* (version 1.0 dated 21 October 2015) contained a minor error with the type of wagons nominated. This error was rectified in a *Technical Note TN 006: 2016* (issued 1 February 2016).

2.12 The fundamental objective of the Framework was to ensure that government procurement activities achieved best value for money in supporting the delivery of government services.

2.13 In early June 2013, RailCorp's procurement area commenced a formal '*Request For Proposal*' (RFP) process to initiate bridge repairs. This RFP involved inviting submissions from organisations that were members of a pre-existing 'panel'. Panel members had all previously undergone and satisfied a broad RailCorp procurement evaluation process. Further, they had all demonstrated to RailCorp that they had the necessary subject matter expertise in bridges, concrete and/or marine environments to undertake a particular scope of work involving these areas.

2.14 The initial scope of works was defined as: "*RailCorp requires that an engineering specialist (SME) in concrete in marine environment be involved in this investigation in order to determine the cause of the concrete degradation. The other pier caissons shall also be investigated to assess whether issues arising at Pier no. 2 might exist at these piers as well as* (sic)*. At the end of this investigation the service provider shall submit a report that identifies the causes, damages, rates of further deterioration, expected life and remediation of the problems*".

2.15 Using their standard tender evaluation process, RailCorp received proposals from all three panel members and by 12 July 2013 the contract had been awarded to a contractor/subject matter expert (SME - referred to as SME1 in this report).

2.16 Up to this point, it was residual RailCorp engineering processes that had proved effective in detecting the change in condition of the pier between the 2006 and May 2013 inspections. It was also their residual tender processes that had reacted quickly and commenced the procurement process to secure a subject matter expert (SME1) to carry the inspection, reporting and remediation processes forward. However, from 1 July 2013, legislative responsibilities and systems for actioning the findings and effecting the necessary repairs to the pier rested with Sydney Trains. Sydney Trains advised: "*On 1 July 2013 Sydney Trains adopted all applicable RailCorp*

engineering processes (or followed those that were vested to ASA) consequently any residual RailCorp engineering processes were actually Sydney Trains processes at that point in time."

Actual procurement processes for pier inspections and repairs

2.17 Sydney Trains was confronted with a technically challenging repair requiring specific skills and experience in a marine environment. Sydney Trains position on this was communicated in their Procurement Strategy, which stated: "*Sydney Trains does not have the internal resources to carry out a construction project of this scale.*" Further: "*The intended procurement strategy is to approach open market as Sydney Trains does not have resources available for this type of project and does not have any registered suppliers.*"

2.18 Notwithstanding this position, this same document assessed the procurement complexity, scope of works complexity and value (estimated cost) of the project all to be '*low*'. The procurement project schedule (refer to *Appendix 2*) was ambitious when compared to the actual resultant elapsed timeframe of the procurement process (refer to *Appendix 1*). OTSI noted a lack of continuity in procurement and project management personnel in an evolving organisational environment.

2.19 Between 19 July 2013 and 7 April 2014, as the nominated contractor (subject matter expert SME1)[12] undertook a series of inspections and minor remedial work at the pier. This work mainly involved clearing marine growth, patching of core holes and removal of a steel collar to facilitate closer inspection and eventual major repair work. A series of reports were generated, reviewed and finalised collaboratively between SME1 and Sydney Trains personnel involved in procurement, project management and engineering. Two key SME1 reports *Hawkesbury River Underbridge Pier 2 Investigation Inspection Report* (dated 7 November 2013) and *Hawkesbury River Underbridge 58.463km Main North Line Investigation of Concrete Degradation at Pier 2 Interim Load Rating* (dated 8 November 2013) confirmed the following:

[12] After engagement, SME1 then subcontracted further inspection and remedial repair work to a diving subcontractor. SME1's were also engaged to develop the pier repair specification and complete a technical evaluation of potential repair tenderers.

- Deterioration of pier 2 was due partly to localised poor quality concrete
- Three repair options were put forward for consideration ranging from monitoring, stabilisation and full repair, with a recommendation that any repairs be undertaken '…*within 1 year*' (from November 2013).
- A calculation of the load rating for pier 2 in '*as new*' and '*as is*' condition found it was still capable of supporting rail freight rolling stock to current standards, without any additional operational restrictions at that time.

2.20 Between November 2013 and March 2014, SME1 were again engaged by Sydney Trains to remove steel collars around piles 1 and 2 of pier 1, and pile 1 of pier 2, to see if further remedial work was required and if so, that the work could be consolidated. SME1 engaged a subcontractor to remove the steel collars and their report was included as *Appendix A* to the SME1 report *Hawkesbury River Underbridge Pier 2 Investigation Diving Inspection Report* (dated 24 March 2014). The report recommended further durability testing be carried out on Pile 1 of Pier 2 to determine the cause of deterioration and determine a suitable repair method.

2.21 A key outcome of these processes was the evolution and development of a proposed repair strategy (methodology) which was detailed by SME1 as the *Hawkesbury River Underbridge Technical Specification Concrete Repair* (*FINAL* version dated 7 April 2014). On 7 May 2014, Sydney Trains commenced an 'open market' procurement process, whereby they sourced submissions from suitably capable external independent organisations to undertake the pier repair in accordance with the *Final* 7 April 2014 repair specification.

2.22 This *Final* 7 April 2014 repair specification was included amongst a suite of documents provided to four potential 'open market' repair tenderers. Significantly, the repair work required construction of a cofferdam[13]. The SME1's repair strategy and specification contained contemporary documentation which directly referenced original design diagrams dating back to the construction of the bridge in the 1940s. These diagrams contained

[13] The Oxford dictionary defines 'cofferdam' as: "*A watertight enclosure pumped dry to permit construction work below the waterline, as when building bridges or repairing a ship".*

historical data and information pertaining to water depths, based on an unknown contemporary datum, specifically the highest expected tidal water level.[14] SME1's assessment of the high water of ordinary spring tide (HWOST) was shown incorrectly at a lower level on their contemporary repair design sectional diagrams.

2.23 Sydney Trains advised tenderers in May 2014 (via an Addendum No. 2) that: "…*the water depth between Piers 2 and 3 is approximately 11.5 metres*." It is difficult to understand the relevance of a water depth figure between pier 2 and pier 3, when the repair work was concentrated around pier 2. Further, there would be a variety of water depth values assumed by all stakeholders in the course of the procurement process. From the data collected during the investigation, it was evident that SME1 had relied on a historical datum based on original design diagrams which were in imperial measurements. SME1 calculated the water depth as 13.594 metres (44 feet 6 inches). It was unknown what datum Sydney Trains had used to calculate the water depth at 11.5 metres. A hydrographic survey undertaken on 4 September 2015 measured the water depth at approximately 12.7 metres. The significance of the multiple water depth measurements was not recognised in the context of the cofferdam height, design, construction and associated costs.

2.24 By 15 June 2014, a Tender Evaluation Committee (TEC) was formed to represent a number of stakeholders during this phase of the procurement and to evaluate the submissions from the four potential tenderers. The TEC was made up of Sydney Trains procurement specialists, project management, and engineering, as well as SME1. By 21 July 2014, two preferred tenderers (referred to as Tenderer 1 and Tenderer 2) had emerged and SME1 were again engaged by the TEC to complete a '*Technical Evaluation for Tender Compliance*' (a technical review) of their submissions against the repair specification.

2.25 Documentation provided by Sydney Trains confirmed that these two tenderers were evaluated against TEC's standard procurement evaluation criteria (referred to as *assessment and scoring of tenders*). These documents

[14] Various tender diagrams and documents showed a variety of descriptions of water depths, some referring to the high water of ordinary spring tides 'HWOST'.

indicate that both organisations satisfied the minimum procurement evaluation criteria. Sydney Trains then requested SME1 to undertake a *Technical Evaluation for Tender Compliance* on these tenderers. The results of SME1s evaluation identified a number of issues that needed to be resolved by both tenderers.

2.26 On 5 August 2014 the TEC met with both tenderers and requested that additional information be provided to address the issues identified by SME1. Both tenderers provided sufficient documentation to satisfy the initial concerns and both continued in negotiations with Sydney Trains. Over the next five months, there were detailed discussions between Sydney Trains, SME1 and both tenderers about potential changes to the repair specification and methodology.

2.27 In November 2014, Sydney Trains re-engaged SME1 to undertake another underwater inspection of pier 2 and provide a comparison against that done in November 2013. SME1's report found a significant loss of concrete since the previous 2013 inspection, although the load rating was still satisfactory. They established three possible strategies:

- no immediate action was needed apart from initiating a program of routine monitoring
- that Sydney Trains consider two options for repair, whilst Sydney Trains suggested a third option. SME1 were asked to develop an option report and provide two weeks later. Sydney Trains undertook track patrols to check whether there was any track movement above pier 2 pile 2. None was found.
- they carry out repairs to the deteriorated concrete within 12 months.

Subsequently they recommended:

- *Repair of deteriorated concrete observed in Pier 2 Pile 2 be undertaken within 12 months.*
- *Installation of temporary supports for the remediation of the cylinder, or alternative methods of completing the remedial work be pursued.*

- *Monitoring of the crack observed on Cylinder 1, Pier 2 of the Hawkesbury River Bridge be undertaken routinely, until such a time where remedial measures are required.*

2.28 Up until February 2015, consultation with both tenderers and outcomes from the November 2014 inspection meant progressive redesign of the repair strategy and tender specification. Each of the contract/tender variations involving the repair specification extended the project resource requirements.

2.29 Between 2 February and 30 April 2015, SME1's original *Final* repair specification had evolved into a document with an identical title, but with a new revision and status. This evolution culminated in a document titled: *Hawkesbury River Underbridge Technical Specification Concrete Repair* (*Final – Rev02* version dated 30 April 2015). Similar to all previous versions of the repair specification, this document still referenced the original design diagrams dating back to the construction of the bridge, contemporary diagrams (dated 25 February 2015) and containing a diagram (produced by SME1) that conflicted with the original design diagrams regarding HWOST.

2.30 In March 2015, one of the two tenderers, Tenderer 2, contacted a procurement representative within the Sydney Trains TEC and raised doubts about the high water levels. They also made further claims that Sydney Trains redesign and methodology submitted in the post tender addendum appeared similar to their sketch supplied with the previous tender. The allegation concerning intellectual property was investigated internally by Sydney Trains. Sydney Trains subsequently advised Tenderer 2 that they had investigated the matter in detail and found no evidence to support their claim.

2.31 Tenderer 2 also received a response to the high water level issue, which drew their attention to 'conditions of tendering' (a part titled '*Information and Reliance*'):

1. *Any and all information made available to tenderers by the Principal is provided in good faith, but may be inaccurate or incomplete. The Principal does not warrant or make any representation about the accuracy, currency or completeness of any information provided by it.*

2. *Tenderers should carefully consider any and all information provided by the Principal, or otherwise available to them and make such further enquiries and assessments that are appropriate so that the tenderer takes into account of all relevant circumstances and risks and is fully informed.*

3. *Tenderers acknowledge and agree that they have no claim against the Principal or any officer, employee, agent or contractor of the Principal (whether at law or otherwise) from or in connection with any information communicated or provided to tenderers during the RFT process.*

4. *Tenderers prepare and lodge their tenders based on the acknowledgement and agreement that they are aware of the Competition and Consumer Act 2010 (Cth) in relation to the giving of false and misleading information.*

5. *Any agreement entered into between the Principal and any tenderer may place the liability for some risks or unexpected events upon the contractor.*"

2.32 The Sydney Trains procurement process 'conditions of tendering' under '*Information and Reliance'* was at odds with the risk policy of Sydney Trains. Also, the Sydney Trains *Risk Management Policy* (dated 1 July 2014) differed in content to the TfNSW's *Risk Policy* (Version 3.0 dated 2014), albeit both organisations exist within the Transport Cluster. The Sydney Trains risk management policy, '*Purpose*' states: "*Sydney Trains will manage risk to reduce effect of uncertainty on objectives through the implementation of a proactive risk management framework across the entire organisation.*" Uncertainty regarding the water depth by contractors was a key issue amongst the protracted procurement process during the specification design and repair methodology by tenderers and SME1.

2.33 By the end of May 2015, the TEC considered that Tenderer 2s submission did not satisfy the necessary tender requirements and continued detailed tender negotiations with Tenderer 1.

2.34 On 24 July 2015, procurement advised Tenderer 1 that they were deemed successful in satisfying the tender specification requirements. This advice

included a draft contract and request for additional documentation (insurances and bank guarantees). It was stated in this advice that formal awarding of the contract would be dependent on provision of the necessary documents and only then could the draft contract be signed and formally executed.

2.35 On 28 July 2015, Tenderer 1 and their diving subcontractor arrived at the site to undertake 'due diligence', consisting of precise measurements of the existing pier structure, marrying slab and bridge height clearances. Tenderer 1 engaged their subcontractor to carry out a hydrographic survey of the proposed work area to determine water depth and provide an overall condition report of pile 2 of Pier 2.

2.36 On 3 August 2015, Tenderer 1 advised procurement: "*Upon further consideration of the most recent information obtained by detailed site investigations, we have formed the view that this job is not practically viable nor financially feasible, particularly in light of the significant restrictions on this project. As such, based on this we regretfully inform you that we will not be able to proceed with the project in its current form, however we are open to discuss possible alternatives*." On 4 August 2015, based on Tenderer 1s apparent willingness to discuss possible alternatives, procurement advised Tenderer 1 that: "*Until a Contract is formally executed, Sydney Trains shall not be under any obligation to Tenderer 1. Any changes to the offer from Tenderer 1 needs to be reviewed in according with the tender conditions which include Sydney Trains procurement guidelines, procedures and policies*." They also sought a summary of Tenderer 1s reasoning and "…*gaps in the offer and current position*".

2.37 On 13 August 2015, Tenderer 1 provided procurement with more details about the detailed due diligence at the site, finding: "….*a substantial increase in riverbed depth*". In their estimations, the impact of increased water depth meant structural changes were needed to the repair methodology, such that: "….*This required the tenderer to significantly strengthen the structure by increasing pile diameters, sheet sizes and embedment depths, which in turn has added complexities in the construction methodology and proposed an increase in price of $586K*". Procurement immediately asked Tenderer 1 to

provide the more detailed 'gap analysis', showing precisely where the differences were in comparison with the original tendered amount.

2.38 On 14 August 2015, Tenderer 1 responded with a copy of the detailed gap analysis. It included the following information related to increased water depth: "*At the time of tender, information on the water depth was provided stating that between pier 2 and 3 there was approximately 11.5m of water. It is now confirmed that the river bed depths between 2 and 3 varies up to 15m at most with the water depth adjacent to the pier being approximately 14m. This increase in water depth puts immense pressures on the coffer dam which was not previously accounted for thus requiring the following strengthening works.*"

2.39 On 18 August 2015, procurement responded to Tenderer 1 as follows: "*Thank you for sending the gap analysis compared to the original offer. After careful consideration to all facts put forward, tender conditions and procurement guideline, I regret to inform that Sydney Train cannot accept the……..revised offer. Accordingly, ST will cancel the current tender and reinitiate a procurement process for this project in the near future*." Sydney Trains procurement stated that this cancellation appeared to be a unique situation for themselves and the organisation and there was no associated documented process to follow.

2.40 Sydney Trains formally rejected this revised offer, cancelled the tender and advised both tenderers accordingly. Shortly after, Sydney Trains re-engaged SME1 to arrange for a diving company to undertake a hydrographical survey around the Pier 2 and update the repair strategy and specification.

2.41 On 28 September 2015, Sydney Trains re-initiated a procurement process for the repairs to Pier 2 of the bridge. They approached Roads and Maritime Services (RMS) and sought advice as to potential tenderers with the necessary subject matter expertise in bridges, concrete and/or marine environments to carry out the pier repairs. RMS confirmed that they had their own pre-existing 'panel' members who were offered the opportunity to provide submissions to Sydney Trains. Sydney Trains advised that the exiting tenderers were also asked to tender. Shortly after, they awarded the repair

tender to a new Tenderer 3, who were provided with an updated specification by SME1.

2.42 On 18 December 2015, OTSI asked Sydney Trains for clarification on the water depth issue and responsibility for due diligence. Sydney Trains stated in their reply (dated 15 January 2016) that: "*The HWOST was indicated on the revised drawings prior to the first tender closing. The HWOST is marked on the drawing located on the top of the marrying slab, with no exact location given. This location was checked by a visual examination on site and was acceptable for tendering processes. The exact location is not a requirement of ST to verify as this is part of the temporary design works to be determined by the winning tenderer*".

2.43 Sydney Trains maintain that it was their expectation: "…. *that tenderers (potential or awarded) have responsibility for conducting due diligence. As the tender scope includes design and construction of temporary works (i.e. the cofferdam and formwork) all tenderers have to carry out their own due diligence to satisfy themselves regarding the temporary works design and construction (for which they are responsible for development and certification). The winning Tenderer would be the Principal Contractor for the site*".

2.44 Concerns about water depths were raised during the tendering process, so they were foreseen. Sydney Trains' processes for due diligence meant the issue was not considered a significant enough to trigger a more pro-active intervention. When the preferred tenderer conducted detailed site due diligence, they determined that the water level was higher to that provided in the tender documentation. This resulted in the tenderer submitting a variation to their submission which ultimately increased the cost. Sydney Trains were then confronted with a situation that was unacceptable in terms of cost. Considering previous inspections it was evident that the rate of decay of concrete on pier 2 was increasing, hence the accelerated inspection frequency.

2.45 Sydney Trains procurement relied on tenderers to carry out the necessary due diligence on a water depth issue. Additionally, there was no mechanism to cater for a re-assessment of risk if a protracted, or technical tender process

failed. However, the bridge remained above a safe operating threshold. The new procurement process commenced in September 2015 and a contract signed with the preferred tenderer on 4 December 2015. The concrete pour at the pier was carried out on 24 April 2016.

Asset Standards Authority and Engineering Oversight

2.46 On 1 July 2013, the Asset Standards Authority (ASA) was created within TfNSW to set design, engineering and maintenance standards for rolling stock and infrastructure in the metropolitan rail network owned by RailCorp (and now managed by Sydney Trains).

2.47 The ASA's Charter included a requirement to identify: "…*the duties, of Transport Agencies, Service providers and Authorised Engineering Organisations (AEOs) in relation to the ASA*".[15] On 31 May 2013, the ASA carried out an 'authorisation assessment' of the Sydney Trains' engineering services and assurance arrangements, measured against AEO requirements. This assessment by the ASA: "…*determines if a supplier organisation can demonstrate the competence and capability necessary to deliver engineering services for NSW transport infrastructure and assets, and to provide assurance that it performs those services at the necessary level of capability*". ASA advised that this assessment: "….*was conducted only on the system documentation, which was a combination of Sydney Trains documentation (where it already existed) and RailCorp documentation actively used by Sydney Trains (where it did not)*".

2.48 On 1 July 2013,[16] Sydney Trains were successful in satisfying the AEO requirements and *certificate 0001* was subsequently issued by the ASA, along with a letter of Authorisation.[17] There were no restrictions or conditions attached to the Authorisation. However, as the assessment was conducted only on the documented system (using RailCorp documents and processes), ASA confirmed with Sydney Trains that they would undertake surveillance

15 The *Asset Standards Authority Charter* defined an AEO as: "…*a legal entity (which may include a Transport Agency as applicable) to whom the ASA has issued an ASA Authorisation*".

16 This date coincides with the date that both ASA and Sydney Trains started operations.

17 The ASA Charter defined an ASA Authorisation as: "…*an authorisation issued by the ASA to a legal entity (which may include a Transport Agency as applicable) which verifies that it has the relevant systems in place to carry out the class of Asset Lifecycle work specified in the authorisation, subject to any conditions of the authorisation*".

auditing to further determine Sydney Trains' maturity levels and deployment of new processes, documentation and implementation. Any adverse findings would be used by ASA to determine their requirements for a short to medium term surveillance program.

2.49 By 16 January 2014, ASA had undertaken a surveillance audit and concluded: "*The audit found that the deployment of the ST engineering management function across the sample of existing project examined appears to be occurring although there are some gaps evident since the original assessment in system documentation. The evidence also showed that the consistency of this deployment differs for AEO Requirements across projects. The audit team were able to identify specific areas where this consistency could be improved*".

2.50 One of the 'opportunities for improvement' related to 'asset management systems' where the report stated: "*It appears from the evidence provided that the mixture of documentation produced for an 'asset management system' is at times conflicting and confusing…….and thereby make the overall dissemination and briefing of asset management requirements difficult for line management*".[18]

2.51 The report also mentioned the effect on the organisation's capacity and focus from the Harris Park crib wall failure which occurred on 30 June 2013, one day prior to the formation of Sydney Trains. Effectively, the report reflected on compliance and maturity of the organisation's systems, processes and procedures supporting their engineering management function (including asset management).

2.52 Factors which Sydney Trains had to contend with included:

a. that the organisation was still transitioning some RailCorp legacy systems, processes and procedures, whilst it introduced new ones.

b. that it was subjected to newly created independent AEO auditing processes.

[18] The ASA *Sydney Trains Surveillance Audit Report (Effective 16/01/2014)*, also stating this as the *Final ST ASA Surveillance Audit Report 2013*.

c. dealing with the ramifications and response to the Harris Park crib wall failure.

2.53 Between November 2014 and January 2015, ASA undertook five more detailed surveillance audits and assurance activities of Sydney Trains. Only selected business units were audited. These audit findings were categorised as:

a. 31 'areas of concern' – seven associated with asset management

b. 25 'opportunities for improvement' – seven associated with asset management

c. 12 'positive observation' – six associated with asset management

2.54 The findings stated, in part; "… *the inconsistencies and areas of concern identified result in reduced confidence that Sydney Trains as a whole is adequately managing the configuration of TfNSW transport assets under its control and meeting their AEO obligations*". ASA sought and received draft action management plans from Sydney Trains to address these findings, as well as 47 outstanding actions from the 2013/14 audit findings. These action plans were consolidated, agreed and finalised between the two agencies by 14 September 2015.

2.55 On 16 October 2015, ASA confirmed these findings in a letter to Sydney Trains, which accompanied a *Sydney Trains Consolidated Surveillance Audit Report*: The letter stated that Sydney Trains: "….*were successful in continuing to satisfy the AEO authorisation requirements subject to satisfactorily addressing the resultant findings*". The letter added: "*Based upon the evidence we have determined that we have a sufficient level of confidence in your ability to deploy your engineering management arrangements to the needs and integrity of the TfNSW rail assets. As a result of the surveillance audit, the ASA have identified a number of findings that need to be addressed in a timely manner in order to maintain your authorised status. You are requested to provide evidence to the ASA demonstrating the actions you have undertaken to address these findings, in accordance with the agreed action plan*".

Status of ongoing surveillance

2.56 Surveillance by ASA was continuing and both they and Sydney Trains were maturing in their approach to managing outcomes from the AEO processes. As at 19 January 2016, ASA confirmed they were satisfied that Sydney Trains had demonstrated a commitment to addressing the findings in accordance with an agreed action plan and had finalised and closed 22 of the actions. The remainder were pending verification, or on schedule for their respective targets dates with the last due to be closed November 2016 at the latest.

Civil Management Meetings

2.57 To effectively execute the contractual requirements of the current RSC, relevant agencies relied heavily on collaboration amongst its officers, particularly in regards to information sharing, oversight, auditing and surveillance activities. During the investigation, several engineering stakeholders in ASA and Sydney Trains stated they were somewhat 'surprised' when they heard about the failings of the procurement processes in August 2015.

2.58 TfNSW, ASA and Sydney Trains utilised several mechanisms for engagement and communications to facilitate awareness for stakeholders on progress of engineering and asset management issues. Only one forum was specifically relevant to the status of the pier and Bridge and this was a consultative forum called *ASA and Sydney Trains Civil Management Meetings*.

2.59 ASA advised OTSI that these meetings covered a wide range of civil engineering matters, activities and standards for the rail network. The meetings, which commenced in August 2014, were a useful high level tool for information sharing and coordination, particularly following the creation of both the ASA and Sydney Trains in July 2013. ASA added that these meetings contributed to their understanding of:

- *"how the civil asset is being managed*
- *the general condition of the civil asset (including any emerging trends)*
- *any significant incidents and how they are being managed"*

2.60 Further, ASA indicated that these meetings were intended to: "…. *identify any related actions arising for ASA and any issues that can be addressed by ASA and Sydney Trains to improve efficiency and effectiveness of asset management. These meetings occur between the ASA lead engineers in each discipline and the respective engineering managers from Engineering and System Integrity, Sydney Trains (the nominated point of contact within Sydney Trains for engineering issues). These participants have the authority to make relevant engineering decisions on behalf of their respective organisations.*" Significantly, as they were high level and covered many civil matters, they only reported and recorded issues by exception, or when items were likely to cause significant interest or problems.

2.61 *Table 1* (below) shows the key milestones relating to discussions on the damaged Pier 2 as they appeared in the minutes of the meetings. This is shown alongside the actual status of the situation with the Pier 2.

Meeting Date	**Entry in minutes**	**Actual status of Pier 2 issue (source)**
18/08/14	**11 Any other business** *Hawkesbury River Underbridge – pier repair design complete. Gone to tender and about to award contract.*	*Hawkesbury River Underbridge Concrete Repair Specification* progressively evolved in two main phases between 15 January 2014 and 30 April 2015. The date of this entry appeared to be in reference to the 1st phase *FINAL* version dated 7 April 2014, which was included in documents during the initial 'open tender' process. The preferred tenderer would not be provided with a 'draft' contract until 24 July 2015.
20/03/15	**7 Significant Incidents and Investigations** *Hawkesbury River Underbridge – full load rating and fatigue assessment to be carried out followed by a painting strategy.*	Sydney Trains engaged SME1 in November 2013 and again in November 2014 to undertake underwater inspections and load rating assessments of the pier. By March

		2015, both tenderers were in detailed negotiations on the repair methodology, whilst the second phase of the repair specification continued to evolve. Tenderer 2 went into conflict with Sydney Trains during March 2015. The reference to a 'painting strategy' is a routine process unrelated to the pier issue.
20/07/15	**4 Asset Management** *Repairs to Hawkesbury River Underbridge pier under way.*	The repair work never commenced. The preferred tenderer (Tenderer 1) was provided with a 'draft' contract on 24 July 2015. Tenderer 1 undertook detailed site due diligence, which led to a tender price increase of $586K. This variation was similar in magnitude to the forecast '*total estimated spend*' of the project. This cost increase was rejected by Sydney Trains. Tender process was cancelled by Sydney Trains and a new tender process re-initiated 28 September 2015.
20/08/15	**4 Asset Management** *Repairs to Hawkesbury River Underbridge pier delayed – contract not signed as tenderer withdrew offer. Delay could be up to 12 months.*	See above entry for meeting date 20/07/15.
17/09/15[19]	Two separate entries: **4 Asset Management** *Hawkesbury River Underbridge – work progressing.*	**Item 4**: see above entry for meeting date 20/07/15. **Item 7**: Refer to report ***Remedial actions***, **section 1.75**. TfNSW engaged a new SME (SME2) as an

[19] This date corresponded with the direction by the Minister for Transport and Infrastructure for OTSI to investigate.

	7 Significant Incidents and Investigations *Hawkesbury River Underbridge – new RFT to be issued by ST for Pier 2 repair works. Independent assessment being arranged by TfNSW Infrastructure and Services division (via ASA).*	independent engineering organisation to provide a report on the condition of pier 2 of the bridge and an engineering assessment to assess whether the bridge was able to safely carry the loads it was being utilised for. In addition, TfNSW's engagement of SME2 included a desktop review of the scope of works proposed by Sydney Trains to return the asset to its pre defect status. This review found the scope to be adequate

Table 1: Civil Management Meetings and status of Pier repairs

2.62 OTSI noted that there was no follow-up of the status of the bridge between the meetings on 18 August 2014 and 20 March 2015. Similarly, between March 2015 and July 2015, there was a four month gap where there was no update on the status of the bridge.

2.63 By their nature, procurement processes have probity and confidentiality requirements, such that information and communication is limited to specific roles and stakeholders (internal and external). Whilst the RSC was a high level document, successful execution relied significantly on collaboration between agencies in developing and implementing asset management plans and strategies within an existing and mature framework. Oversight of the bridge and status of the Pier were regularly discussed at meetings between ASA and Sydney Trains. Minutes confirmed that the Pier defect was a known condition. In contrast, the quality of the information documented in these minutes on the status of repairs was limited in scope and accuracy and did not reflect the impact that tendering delays had on the actual repair schedule. In summary, this situation reflected a communication disconnect between the procurement area and engineering stakeholders in Sydney Trains.

Remedial Actions

Transport for NSW

2.64 In September 2015, on behalf of the Minister for Transport and Infrastructure, TfNSW engaged a new SME (SME2): "…*as an independent engineering organisation to provide a report on the condition of pier 2 of the bridge and an engineering assessment to assess whether the bridge was able to safely carry the loads it was being utilised for. A copy of this report has been provided to OTSI and to the Minister."* In addition, TfNSW's engagement of SME 2: "….*included a desktop review of the scope of works proposed by Sydney Trains to return the asset to its pre defect status. This review found the scope to be adequate*."

Sydney Trains

2.65 Sydney Trains commissioned a new Tenderer 3 and they commenced the repairs. These repairs are scheduled to be completed by the end of April 2016.

2.66 Sydney Trains advised the status of action in implementing a number of remedial actions and, as at 18 January 2016, these included:

- *"Civil incidents and asset condition trends and emerging issues are reported in Visual Management Cells (VMC) on a fortnightly basis and also in monthly stakeholder collaboration meetings to discuss incidents/issues and how to address them.*
- *Monthly system assurance reports are published to ensure managers are aware of asset condition trends and emerging issues.*
- *A Hawkesbury River – Assurance Plan has been developed.*
- *Underwater inspections of pier 2 have been underway every two months since September 2015.*
- *An immediate review and assessment of other bridges with underwater piers in the network is being undertaken and an engineering condition assessment of these structures is to be incorporated into future underwater inspection processes.*

- *Engineering instructions and advice are regularly issued on emerging trends and issues.*
- *Four new senior civil engineering positions will be established and based where assets are located. These positions will directly manage structural and geotechnical issues within their area. One of the positions will be based in Gosford and be responsible for the Hawkesbury River Bridge.*
- *An extra track inspection of the Hawkesbury River bridge was undertaken during September 2015 to assess any issues that may be developing on the bridge.*
- *An improved REVTAR (Revise Maintenance Target) process has provided improved definition and governance to the management of deferrals of preventative routine maintenance activities.*
- *There is an ongoing process of development (both new and existing), review and updating of TMP's and Manuals. This includes the Hawkesbury River Bridge TMP.*
- *Approval has been given to fill additional positions across the Maintenance Directorate including; a dedicated Bridge Management System engineer, additional asset engineers and a maintenance structural engineer to better detect and manage asset defects.*
- *Continuing development of the Sydney Trains Engineering Management Manual will be undertaken."*

2.67 OTSI acknowledges these remedial actions.

PART 3 FINDINGS

Sydney Trains

3.1 The required 6-yearly routine underwater inspections were carried out on the Hawkesbury River Bridge in 2000, 2006 and May 2013. The 2013 inspection detected significant deterioration at the top of the circular reinforced concrete caissons of pile 2 of Pier 2. A further inspection in November 2015 indicated there was ongoing deterioration, however, the bridge integrity was not compromised. Inspections were to be carried out every two months, with repairs to be completed within six months.

3.2 It was residual RailCorp engineering processes that had proved effective in detecting the change in condition of the pier between the 2006 and May 2013 inspections. It was also their residual tender processes that had reacted quickly and commenced a procurement process with a pre-existing contractor panel. However, from 1 July 2013, responsibility for effecting the necessary repairs to the pier rested with Sydney Trains.

3.3 The newly created Sydney Trains was confronted with challenges posed by the marine environment and a unique technical and procurement situation. Sydney Trains sourced, evaluated, engaged and managed external tenderers within a routine procurement framework and reflected in an ambitious 3.5 month timeline to the start of works. 17 months later that tender process was cancelled and a new tender process started.

3.4 Between July 2013 and April 2014, SME 1 undertook a series of inspections and remedial work including the development of a repair strategy and specification. As the repair design concepts were critical to the success of the project, further details and validation would have enhanced the specification completion. In contrast, this specification continued to evolve with input from tenderers until 30 April 2015.

3.5 Significantly, the repair strategy and specification documentation contained non-validated information pertaining to the water depth. Despite being critical to the design and construction of the cofferdam, there was a significant variety of interpretations of the water depth amongst the SMEs, tenderers and

Sydney Trains. This latent condition remained until 24 July 2015, when a preferred tenderer was selected and shortly after undertook detailed due diligence at the site, finding a significant increase in water depth and put forward a revised scope of works and costs. This was rejected by Sydney Trains and the tender cancelled in August 2015.

3.6 Sydney Trains procurement relied on tenderers to carry out the necessary due diligence on the water depth issue. Sydney Trains expectation was that tenderers must carry out this responsibility and may be liable for some risks, even when confronted with incomplete or inaccurate information in tender documents. This was not ideal in terms of assurance and safety and had a flow on effect of delays and costs in more complex, or technical procurements, like the pier repair.

3.7 By its nature, procurement processes had probity and confidentiality requirements such that information and communication was limited to specific roles and stakeholders (internal and external). Nonetheless, oversight of the bridge condition and status of the pier were regularly discussed at meetings between ASA and Sydney Trains. Minutes confirm that the pier defect was a known condition. In contrast, the quality of the information documented in these minutes on the status of repairs was limited in scope and accuracy and did not reflect the impact that tendering delays had on the actual repair schedule. This situation reflected a communication disconnect between the procurement area and engineering stakeholders in Sydney Trains and to a lesser extent ASA, who were wholly reliant on information from Sydney Trains' engineering and asset management stakeholders involved in these meetings.

3.8 Sydney Trains procurement 'conditions of tendering' states: "*Any agreement entered into between the Principal and any tenderer may place the liability for some risks or unexpected events upon the contractor*". This is ambiguous and may lead to an inference being made by tenderers or Sydney Trains staff to relate to operational risk. Sydney Trains responded: "*While Sydney Trains sought to transfer commercial risk (in relation to cost and time of project delivery), any tender submission would be required to ensure no safety detriment during the delivery of the required works.*"

3.9 ASA undertook a series of surveillance audits on Sydney Trains' systems and processes between May 2013 and Sept 2015. A number of issues were documented for Sydney Trains to resolve, some related to asset management. As at 19 January 2016, Sydney Trains had demonstrated a commitment to addressing the findings in accordance with an agreed action plan and had finalised and closed 22 of the actions. The remainder were pending verification, or on schedule for their respective targets dates with the last due to be closed November 2016 at the latest and these agencies have agreed on a plan for their resolution.

3.10 ONRSR had developed asset management guidance in November 2014; however, indicated no specific targeted asset management surveillance had been carried on the bridge up until September 2015. ONRSR advised OTSI that they were aware of the condition of the bridge at this stage and were monitoring the situation closely. The ONRSR had a risk based compliance strategy, specific surveillance regarding asset management would be conducted in the future.

Transport for NSW

3.11 Risk management policies across the Transport Cluster had similar objectives; but differ in terms of structure and categorisation such as principles, risk appetite, risk tolerance, vision and purpose. This may reduce effectiveness in achieving safety objectives.

General Findings

3.12 Sydney Trains initiated a new tender process with corrected water depth information confirmed by hydrographic surveys. This information was embedded in the new tender documentation. Potential tenderers were selected from a pre-existing RMS 'panel'.

3.13 The bridge remained above a safe operating threshold. The new procurement process commenced in September 2015 and a contract signed with the preferred tenderer on 4 December 2015. The concrete pour at the pier was carried out on 24 April 2016.

3.14 Sydney Trains has also considered, or initiated, a number of remedial actions which are detailed at section *2.66*.

PART 4 RECOMMENDATIONS

In accepting Sydney Trains' stated intention to fully implement the necessary repairs, address the findings from AEO surveillance audits and implement their remedial actions, OTSI makes the following additional recommendations to Sydney Trains in relation to other matters identified in the course of this investigation:

Sydney Trains

4.1 In view of the findings within Sydney Trains' procurement framework, analyse, validate and demonstrate:

a) That the intent behind the procurement 'conditions of tendering' which state: "*Any agreement entered into between the Principal and any tenderer may place the liability for some risks or unexpected events upon the contractor*" is not ambiguous, or in conflict with the *Rail Safety National Law* and associated *Rail Safety National Law National Regulations (2012).*

b) That their procurement 'conditions of tendering' which state: "*Any and all information made available to tenderers by the Principal is provided in good faith, but may be inaccurate or incomplete. The Principal does not warrant or make any representation about the accuracy, currency or completeness of any information provided by it",* are not in conflict with their risk management policy.

c) How they assure themselves that the detail within the package of information given to tenderers is commensurate with the level of technicality/complexity of the work.

d) The various levels of engineering expertise and involvement needed at key decision making stages during the tendering processes, especially during the development of technical specifications and in tender evaluation.

e) The appropriate level of operational involvement in developing scopes of work and specifications.

f) That there are processes in place to eliminate barriers to timely and accurate reporting of technical and safety information to technical specialists affected by the procurement process and, where appropriate, senior management.

g) That a SFAIRP approach exists to understanding the risks associated with a variety of outcomes from a technical or complex process involving engineering, maintenance and other internal service providers such as procurement (e.g. in terms of a good/expected outcome, delayed outcome, or failed outcome).

h) How Sydney Trains provides assurance for significant variables (such as water depth) that may affect project outcomes. OTSI accepts that it is good practice to involve independent safety assessors in the validation process.

i) That their Safety, Environment, Quality & Risk (SEQR) Directorate monitor complex procurement project risks via the risk register under their risk management accredited processes.

4.2 Improve the recognition of and interaction between SMS elements like procurement and asset management in fulfilling the responsibilities and duties under the Law.

Transport for NSW

4.3 Analyse the risk polices in existence across the Transport Cluster and determine if having a single policy for its entities would enhance safety.

4.4 In collaboration with ASA, continue to develop and execute surveillance on asset management, including sampling of the full asset life cycle.

4.5 ASA to nominate key issues of the civil management meeting agenda/action items to be documented by written submission, rather than individual opinion, or verbal update.

PART 5 APPENDICES

Appendix 1: OTSI Investigation Pier 2 Timeline

OTSI Investigation Timeline - Hawkesbury River Bridge Pier 2 Repair

KEY:	Orange = pier repair timeline Blue = ASA AEO process timeline Green = Civil maintenance meetings timeline									
TfNSW – Transport for NSW; ST – Sydney Trains; RC – RailCorp; STP – Sydney Trains Procurement; ASA – Asset Standards Authority; SME1 – Subject Matter Expert 1; SME2 – Subject Matter Expert 2; T1 – Tenderer 1; T2 – Tenderer 2; T3 - Tenderer 3; RMS - NSW Roads & Maritime Services.										

Date	Item of Interest	TfNSW	ST	RC	STP	ASA	SME1	T1	T2	RMS	T3	SME2	Significance
01/03/00	Pier inspection			RC									No defects reported
01/09/06	Pier inspection			RC									Minor damage to Piers 1 & 2
01/11/11	TfNSW created	TfNSW											Portfolio for transport coordination in NSW
01/05/13	RC engage dive contractor			RC									Divers find further deterioration Pier 2
22/05/13	Bridge integrity cert			RC									ST civil engineering certify bridge as safe
22/05/13	RC immediate response			RC									RC investigate cause of Pier 2 concrete degradation
31/05/13	ASA assesses ST for AEO		ST			ASA							ASA satisfied ST have competence/capacity
10/06/13	RC assess Panel			RC	STP		SME1						RC approaches panel members

30/06/13	Harris Pk crib wall failure			RC									Effect on resources during transition RC to ST
30/06/13	RC cease as operator/infrastructure manager			RC									ST replace RC as operator/ infrastructure manager
01/07/13	TfNSW creates ASA	TfNSW				ASA							Standards & authorise AEO
01/07/13	ASA issue ST AEO		ST			ASA							ASA satisfied ST meet the requirements and ASA issues ST with AEO authorisation No. 0001
01/06/13	Request For Proposal				STP								STP invite submissions from panel
01/07/13	RC duties vested in ST		ST	RC									ST now responsible for pier repair
12/07/13	ST appoints SME1		ST				SME1						SME1 engaged as ST's SME
19/07/13	SME1 start pier inspect						SME1						SME1 conducted series of pier inspect Jul 13-Apr 14
07/11/13	SME1 delivers report		ST		STP		SME1						Pier 2 Investigation Inspection Report
07/11/13	SME1 suggest Pier 2 repair timeframe		ST		STP		SME1						SME1 advise repairs must be done within 12 months (by Nov 2014)
08/11/13	SME1 delivers report		ST		STP		SME1						Pier 2 Interim Bridge Load Rating Report
16/01/14	ASA surveillance audit ST		ST			ASA							Negative findings
01/03/14	ST re-engage SME1		ST				SME1						SME1 between Nov 13 & Mar 14, remove collars – inspect Piers 1&2 - advice on works.
24/03/14	SME1 dive report						SME1						SME1 provides Pier 2 Dive Inspection Report

07/04/14	SME1 continue inspect						SME1						SME1 conducted series of pier inspect Jul 13-Apr 14
07/04/14	SME1 repair spec						SME1						SME1 provided Tech Spec Concrete Repair Final
01/05/14	STP release proposed Procurement Project Timeline				STP								STP release Sydney Trains Procurement Project Timeline dated 1 May 14. Timeframe is ambitious for a project of this scale and context.
07/05/14	ST commence procurement				STP								ST go to open market procurement for Pier 2 repairs
26/05/14	ST advise of water depth				STP			T1	T2				STP advise tenderers that water depth between Pier 2 & 3 is approx. 11.5 metres
01/06/14	TEC formed				STP								Technical Evaluation Committee formed
21/07/14	SME1 re-engaged						SME1						SME1 conduct tech evaluation repair submissions
05/08/14	TEC met both tenderers				STP			T1	T2				TEC requested further information
18/08/14	ASA-ST Civil Mgmt meeting		ST			ASA							Hawkesbury River Bridge discussed noting the repair design completed
01/11/14	Series of audits by ASA		ST			ASA							ASA conduct a series of audits from Nov 14 to Jan 15. Negative findings some related to AM

01/11/14	ONRSR AM Guideline												Industry guideline on good AM practice
01/11/14	ST re-engage SME1		ST				SME1						ST re-engaged by SME1 to conduct further underwater inspection of Pier 2 to compare against previous inspections
01/11/14	SME1 suggest updated Pier 2 repair timeframe						SME1						SME1 advise repairs must be done within 12 months
05/01/15	Ongoing engagement ST, SME1, T1 & T2.				STP		SME1	T1	T2				Discussion with SME1, T1, T2 and ST over 5 months since meeting on 5/8/14 to discuss potential changes to repair spec & methodology.
02/02/15	Repair Spec evolution starts						SME1						SME1 evolves repair spec between 2/2/15 to 30/4/15 through consultation with tenderers and outcomes from inspections
01/03/15	Tenderer 2 raised doubts								T2				T2 raised doubts about high water level data, IP and specification
06/03/15	T2 rec response from ST				STP								ST advise T2 that T2 are responsible for data validation
20/03/15	ASA-ST Civil Mgmt Meeting		ST			ASA							Hawkesbury River Bridge discussed – full load rating & fatigue assessment carried out

30/04/15	Repair Spec evolution concludes, new spec produced						SME1						SME1 evolves repair spec between 2/2/15 to 30/4/15 through consultation with tenderers and outcomes from inspections
30/04/15	SME1 issue V2 spec						SME1						SME1 issue new repair spec Final Rev02 date 30 April 15. Document contained (conflicting HWOST) construction & contemporary data
01/05/15	TEC not satisfied with T2's submission												TEC not satisfied with T2's submission and continued detail tender discussions with T1
20/07/15	ASA-ST Civil Mgmt Meeting		ST			ASA							Hawkesbury River Bridge discussed – noted repairs to pier under way.
24/07/15	STP satisfied with T1's submission												STP provides T2 with draft contract and request further documentation (insurances, Bank G'tee)
28/07/15	T1 arrive on site to conduct due diligence												T1 & its diving subcontractor arrive on site to undertake due diligence and carry out hydrographical survey.
03/08/15	T1 advise they will not proceed with contract.				STP			T1					T1 advise STP the job is not practically viable nor financially feasible in light of project restrictions and requested improvement discussions with ST
04/08/15	ST advise T1 that further discussion were not possible				STP			T1					ST advised T1 that until a contract is executed, no further discussions can take place
13/08/15	T1 provide STP with more detail from T1 due diligence				STP			T1					T1 shared details of their due diligence results with STP noting the substantial difference in water depth

13/08/15	STP ask T1 for gap analysis				STP			T1					STP immediately requested a gap analysis from T1 of the tender submission and T1 due diligence results
14/08/15	T1 provided STP with detailed gap analysis				STP			T1					T1 provided STP with detail gap analysis between tender submission and T1's due diligence. T1 highlight actual 14 metres adjacent Pier 2
18/08/15	ST responds to T1				STP			T1					STP respond to T1 advising that ST cannot accept T1's offer and hence cancelled the tender process.
20/08/15	ASA-ST Civil Mgmt Meeting		ST			ASA							Hawkesbury River Bridge discussed – repairs delayed – contract not signed – tenderer withdrew offer. Delay could be 12 months.
01/09/15	TfNSW for the Minister for Transport & Infrastructure engage SME2	TfNSW										SME2	TfNSW engage new SME2 as an independent engineering organisation to report on the condition of Pier 2
15/09/15	ST aware of Pier 2 issue		ST										ONRSR provided memo detailing ST awareness
17/09/15	ASA-ST Civil Mgmt Meeting		ST			ASA							Hawkesbury River Bridge discussed – AM section noted work progressing, and, new RFT to be issued for Pier 2 works.

17/09/15	OTSI asked to investigate												OTSI asked by Minister for Transport & Infrastructure to investigate.
28/09/15	ST/STP re-initiated a procurement process		ST		STP								ST/STP re-initiated a procurement process for repair of Pier 2. STP approach RMS for advice on potential tenderers with suitable SME knowledge.
16/10/15	ASA audit report to ST		ST			ASA							ASA required ST to remedy issues
04/12/15	ST/STP award new contract		ST		STP						T3		ST/STP award new contract to tenderer (T3) from RMS pre-existing panel
04/12/15	T3 commence repair process										T3		T3 commence repair process – cement pour due completion April 2016
18/12/15	OTSI request ST for info		ST										ST asked to clarify water depth and responsibility for due diligence
15/01/16	ST reply to OTSI		ST										ST stated data to be determined by tenderer
18/01/16	ST suggest a range of remedial actions		ST										ST advised a raft of remedial actions
19/01/16	ASA report ST update		ST			ASA							ASA audit satisfied with ST action/progress. AEO status continues. Corrective action closure date Nov 2016.
30/04/16	T3's scheduled repair (cement pour) Pier 2				STP						T3		T3 expect to complete cement pour for Pier 2 by end April 2016

Appendix 2: Sydney Trains Procurement Project Timeline

The *Project Timeline* (below) was extracted from the Sydney Trains *Procurement Strategy for Request for Tender* (dated 1 May 2014)

Key Milestone	Proposed Date
Project Start / Kick-Off	20/3/14
Opportunity Assessment	26/3/14
Procurement Strategy	5/5/14
Tender Evaluation Methodology	5/5/14
Scope of Works finalised	30/4/14
Tender Out	12/5/14
Tender Close	11/6/14
Tender Evaluation Report Draft	18/6/14
Negotiation Strategy	23/6/14
Negotiation Meetings	
Tender Evaluation Report Completed	26/6/14
Letter of Intent	
Approval To Award	26/6/14
Contract Award	27/6/14
Works Start	2/7/14

Appendix 3: Extracts from independent report into the condition of the pier

In September 2015, TfNSW (ASA) engaged SME2 as an independent engineering organisation to provide a report on the condition of pier 2 of the bridge and an engineering assessment to assess whether the bridge was able to safely carry the loads it was being utilised for. In addition, TfNSW's engagement of SME2 included a desktop review of the scope of works proposed by Sydney Trains to return the asset to its pre defect status.

Findings were published in the final report *Hawkesbury River Underbridge Pier 2 Investigation 12 November* 2015.

Included below are extracts from this final report.

Executive Summary

Underwater inspections conducted as part of routine bridge maintenance indicated there was deterioration of the concrete at the top of Pile No.2 at Pier 2. This report documents an assessment of the current condition of this pile. The report also details an assessment of the structural capability of Pier 2 to support a 300LA and Main Freight (MF) load.

As part of the current assessment, underwater visual inspections and measurements were made of the deteriorated concrete at the top of Pile No.2 at Pier 2. These indicated there had been additional deterioration of the pile since the inspection and measurements recorded in late 2014. The rate of concrete loss from the 2014 and 2015 measurements ranges from 50 mm to 260 mm per year.

The concrete testing indicated sufficient concrete compressive strength in the caisson and infill. The cement content in the upper part of the caisson and in the infill is considered not to meet current durability requirements when exposed to the atmosphere. Based on the sea level records obtained from Bureau of Meteorology, the top of the pile is in the tidal/splash zone and is exposed to the atmosphere. This is more severe compared to it being permanently submerged. The lower cement content, being in the tidal/splash zone exposed to sea water, probable batch of lower

grade concrete and poorer construction/compaction, would have collectively contributed to the corrosion of the outer ring of vertical reinforcement and deterioration of the concrete at the top of Pile No.2 at Pier 2.

This assessment considered 300LA and MF load cases, which represent the normal operation loads of the railway. Low occurrence transient effects such as earthquake loads, derailment loads and vessel collision load were not considered as part of this assessment. Based on the assessment conducted……, it was determined that Pier 2 was of sufficient current condition to support the load cases described above, despite the deterioration at the top of the pile.

The Hawkesbury Bridge is a major and vital public infrastructure servicing Sydney and the Central Coast. While Pier 2 in its current condition is adequate to support the load cases described above, despite the deterioration of concrete at the top of the pile, it is considered prudent to adopt a conservative approach in determining the rate of concrete loss. Based on the maximum rate of concrete loss measured, it is recommend that repairs to the deteriorated concrete at the top of Pile No. 2 at Pier 2 be carried out within 6 months. If this is not practical, temporary measures should be adopted to prevent further deterioration until permanent measures could be implemented.

Concrete condition and loss

Measurements taken at Pile No.2 at Pier 2 confirmed that the pile has deteriorated further since the previous inspection documented in November 2014. The additional deterioration did not represent a significant change in the pile cross section.

Prior to this inspection there were no location markers on the pile, which made it difficult to compare the exact location of measurements. Markers have now been attached to the pile to indicate each of the 12 clock positions around the pile, which will make it easier to benchmark these measurements and future measurements. The 12 o'clock position points northwards.

Figure 3.1 shows the measurements taken …….. These also show the extent of vertical deterioration from the soffit of the marrying slab/top of pile. The deterioration measurement was taken from the outer layer of reinforcement.

The cover to the outside reinforcement varies from 150mm to 200mm. As such, the maximum deterioration considered is the measured amount plus 200mm.

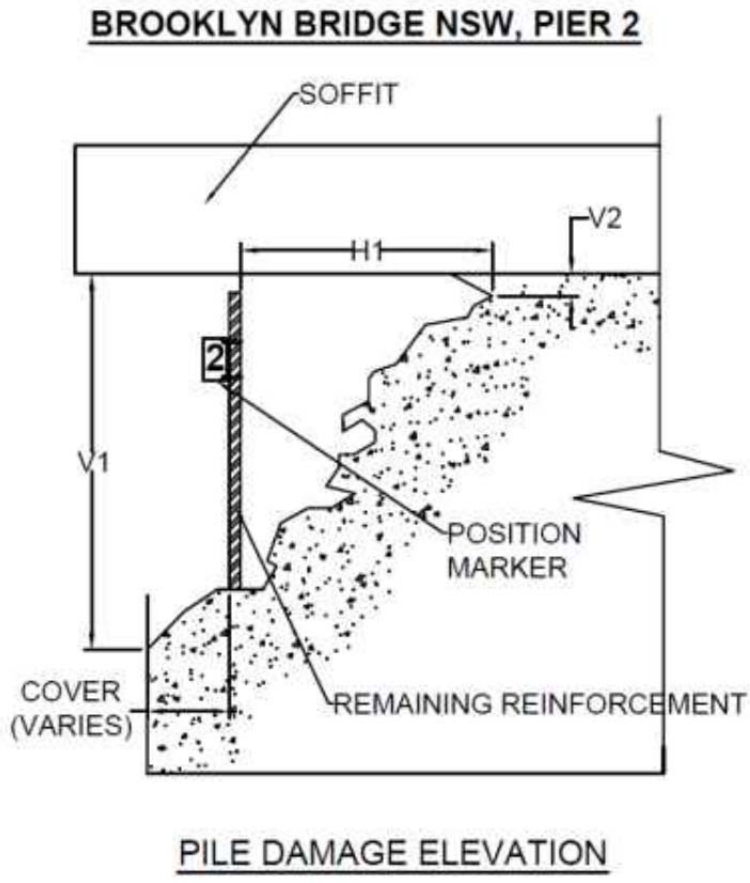


Figure 3.1 Measurements taken

Figure 3.2 below shows the measured loss of section around each position (o'clock) of Pile No. 2, measured in October 2015. Also plotted on the graph is the measurement from 2014 for comparison, obtained from Document 4. Where the 2015 measurement indicates less concrete loss, this is likely due to the accuracy of measurement as there were no permanent reference marks for ease of measurement in 2014.

The rate of concrete loss from the 2014 and 2015 measurements ranges from 50mm to 260mm per year with the greatest loss occurring at the 5 o'clock location. The cross section area remaining, compared to the original design, is approximately 65% and 60% respectively for the 2014 and 2015 measurements.

Based on the measured rate of concrete loss at the respective pile positions, the cross section area of the pile remaining in 12 months' time would be approximately 50% of the original area. Based on the maximum measured rate of concrete loss applied to all pile positions, the cross section area of the pile remaining in 6 months' time would be approximately 50%.

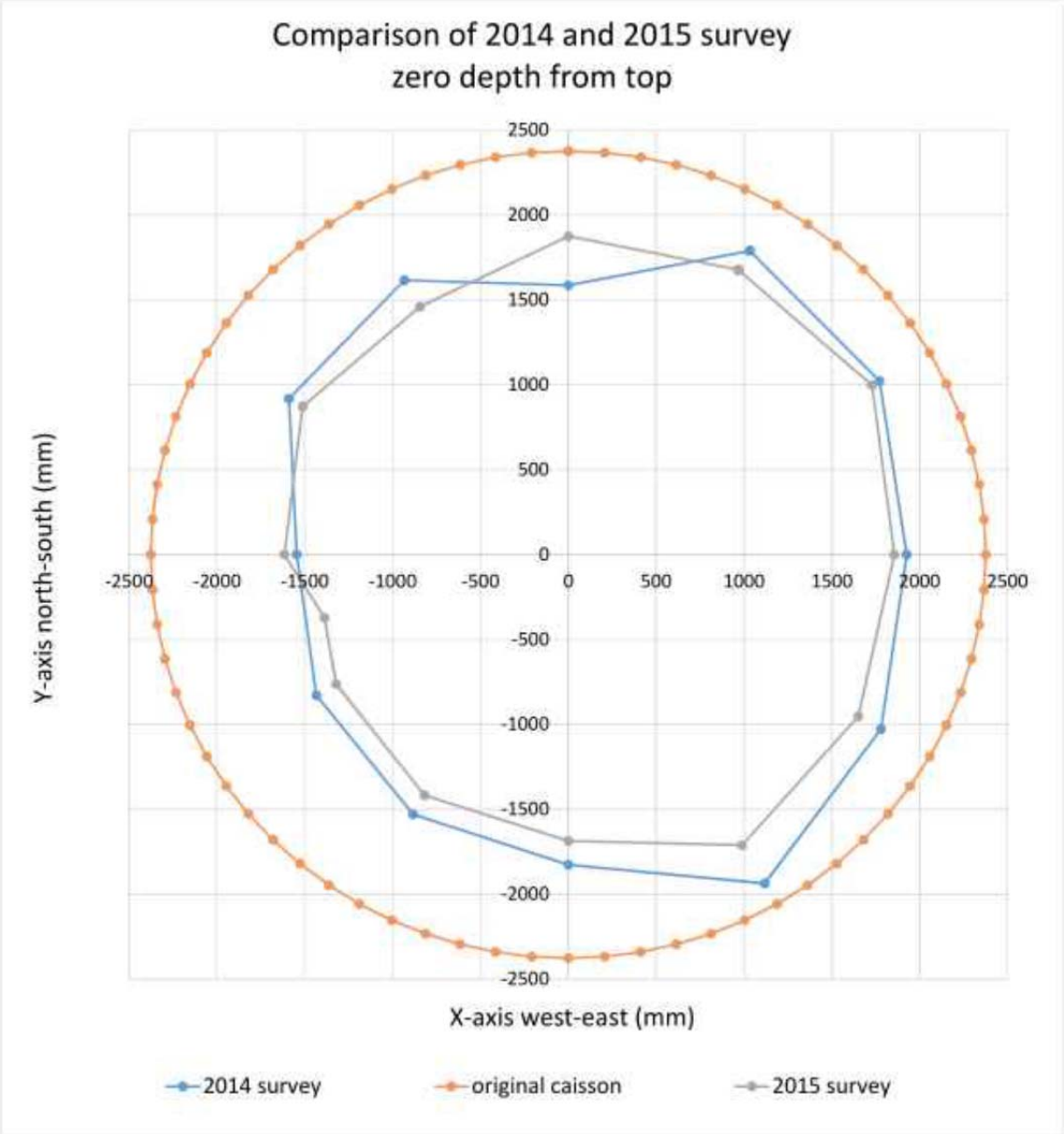


Figure 3.2 2015 measured loss of pile section

Conclusions/Recommendations

It is our opinion that the deterioration of the concrete at the top of Pile No. 2 at Pier 2 is due to the collective contribution of the lower cement content, being in the tidal/splash zone exposed to sea water, probable batch of lower grade concrete, poor construction/compaction. This also includes Scenario 1 where the vertical reinforcement is not continuous leading to tension/small gap opening at the interface of the marrying slab and the top of the pile under certain load combinations and possible ingress of sea water.

Based on the results of concrete testing on the cores on chloride levels in the outer 150 mm of the caisson concrete, it is expected that, any concrete in the tidal zone of the piles will currently be at risk of corrosion and if spalling has not yet commenced, it would be expected to occur within 5 to 10 years.

Based on the results of concrete testing on the cores obtained, the concrete tested is considered to be sound and has not undergone any significant deterioration. Therefore where the pile is fully submerged at all times, the risk of reinforcement corrosion is low. The rate of concrete loss from the 2014 and 2015 measurements ranges from 50 mm to 260 mm per year with the greatest loss occurring at the 5 o'clock position.

Based on the measured rate of concrete loss at the respective pile positions, the cross section area of the pile remaining in 12 months' time would be approximately 50% of the original area. Based on the maximum measured rate of concrete loss applied to all pile positions, the cross section area of the pile remaining in 6 months' time would be approximately 50%.

The 50% cross section area of the pile remaining was considered in the load rating where the concrete loss in the 2015 measurements with 50% additional concrete loss was also checked. Any cross section area loss beyond 50% is considered not desirable and it may also affect other parts of the structure as the forces are being redistributed due to the change in stiffness at the top of the pile.

As the Hawkesbury Bridge is a major and vital public infrastructure servicing Sydney, it is considered prudent to adopt a conservative approach in determining the rate of concrete loss in the pile. In addition the rate of deterioration may increase in the future.

We therefore recommend that major repairs to Pile No. 2 at Pier 2 to be carried out as soon as practically possible. If the major repair works is not able to be completed within the next 6-12 months, we recommend the deteriorated section of Pile No.2 at Pier 2 be patch repaired to curtail the current rate of deterioration. We recommend this work be carried out within the next 6 months based on our worst case rate of deterioration assessment.

Appendix 4: Sources and submissions

Sources of information

- Sydney Trains
- Transport for NSW
- Asset Standards Authority
- Office of the National Rail Safety Regulator
- SME1

Submissions

The Chief investigator forwarded a copy of the Draft Report to the Directly Involved Parties (DIPs) to provide them with the opportunity to contribute to the compilation of the Final Report by verifying the factual information, scrutinising the analysis, findings and recommendations, and to submit recommendations for amendments to the Draft Report that they believed would enhance the accuracy, logic, integrity and resilience of the Investigation Report. The following DIPs were invited to make submissions on the Draft Report:

- Sydney Trains
- Transport for NSW
- Asset Standards Authority
- Office of the National Rail Safety Regulator
- SME1

Responses were received from all DIPs and these were taken into consideration in finalising the Report.