

TRANSPORT FOR NSW (TfNSW)

QA SPECIFICATION M772

CONCRETE BRIDGE REPAIRS – INVESTIGATION

NOTICE

This document is a Transport for NSW QA Specification. It has been developed for use with roadworks and bridgeworks contracts let by Transport for NSW or by local councils in NSW. It is not suitable for any other purpose and must not be used for any other purpose or in any other context.

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REVISION REGISTER

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 1/Rev 0		First edition	GM, IC	19.11.12
Ed 1/Rev 1	Guide Notes Annex A3 Annex M	Reference to M769 updated due to change in spec no. Reference standard for chloride/sulfate analysis updated. Referenced documents updated.	MCQ	18.09.18
Ed 1/Rev 2	Global	References to “Roads and Maritime Services” or “RMS” changed to “Transport for NSW” or “TfNSW” respectively.	DCS	22.06.20

GUIDE NOTES

(Not Part of Contract Document)

These guide notes provide guidance to TfNSW personnel on the application of the Specification and preparation of the project-specific annexures. They do not form part of the Specification or of the Contract [or Agreement].

USING M772

M772 has been developed specifically for use under TfNSW internal Alliance arrangements or Single Invitation Maintenance Contracts for concrete investigation work on existing bridges that are the responsibility of the TfNSW, using TfNSW “contract” personnel, consultants and other external specialist personnel. It should not be used for any other types of contracts, without a full review of its suitability for that application.

M772 is a QA specification and the use of M772 requires the implementation of a quality management system by the Contractor that meets the quality management system requirements specified in TfNSW Q.

EDITION 1

This is the first issue of the Specification. Suggestions for improvement and amendments on technical issues following use of the Specification in the field should be directed to the Senior Bridge Engineer (Rehabilitation Design), Bridge & Structural Engineering. Any other comments or suggestions should be forwarded to the Contracts Quality Manager, Commercial Services Branch.

OUTLINE OF M772

Specifications for concrete bridge repairs

Existing concrete bridge repairs are covered by three TfNSW Maintenance Specifications and one TfNSW guidelines document as follows:

M772: Concrete Bridge Repairs – Investigation

M773: Concrete Bridge Repairs – Design

M774: Concrete Bridge Repairs – Construction

TfNSW Concrete Bridge Repairs – Guidelines

M772 covers the detailed investigation required for the assessment of defective (damaged or deteriorated) concrete bridge members, with a view to their subsequent repair. It constitutes the first of three specifications covering the repair process. The flowchart in Fig. GN.1 outlines the full repair process and the links between the three specifications.

Preliminary assessment by the Principal

The Principal (normally the Bridge Maintenance Planner) must initiate the repair process by organising and carrying out a preliminary assessment and then, based on its outcome, deciding on the actions required, as shown in the flowchart in Fig. GN.1.

Where there is an immediate need to open the bridge to traffic or to restore structural integrity as part of an emergency response to impact damage, the Principal should organise this before calling up Work under this Specification, which DOES NOT cover such emergency response.

Main activities to be executed under M772

Desktop review.

Field assessment:

- Visual inspection;
- Delamination survey; and
- Diagnostic testing.

Provision of investigation report:

- Extent and location of defects;
- Causes, diagnosis; and
- Repair options/methods.

SECTION 1 GENERAL

Scope

This Specification covers investigation work for the repair of all defective concrete bridge members, except those which are:

- (a) located permanently underwater;
- (b) buried in the ground; or
- (c) fire damaged.

Work required as part of an emergency response to stabilise the bridge immediately after impact damage is not covered by this Specification.

Details of Work

ANNEXURE A must be completed by the Principal after carrying out a preliminary assessment of the damaged bridge.

ANNEXURE M772/A1 covers general bridge information, locations and extent of investigation and constraints that may impact on repair options such as allocated budget and time constraints, etc.

The Principal must nominate the members to be investigated, percentage of areas to be covered and number of diagnostic testing areas (DTA) on each member. Enter the required number and types of diagnostic tests for each DTA in Annexure M772/A2.

Details of tests, number of samples required and test method are specified in Annexure M772/A3.

Enter the information to be supplied by the Principal in Annexure M772/A4.

SECTION 2 PLANNING

PROJECT QUALITY PLAN

The PROJECT QUALITY PLAN (PQP) is critical to this Specification. The PQP should be prepared before the Work commences, and must be based on TfNSW Guidelines, TfNSW Manuals and other appropriate information.

The PQP must be used by the Contractor at all times during the Work. Amendments are to be kept up to date by the Contractor and periodically resubmitted to the Principal.

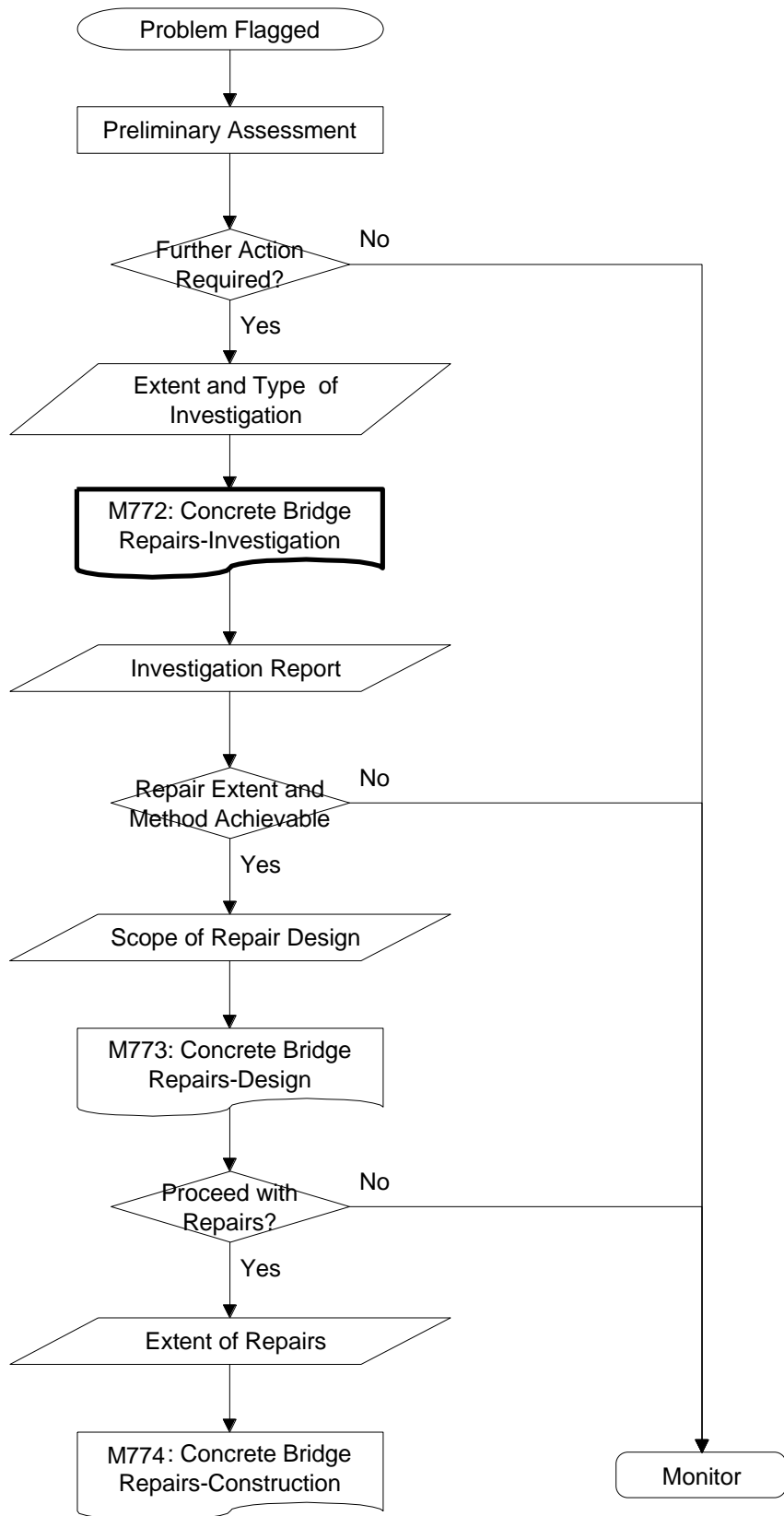


Figure GN.1 - Full Concrete Bridge Repair Process

The Principal must carry out regular surveillance of the Work using experienced officers.

The PQP must address the type of investigation nominated, including investigation procedures, and associated testing and sampling equipment and techniques.

Other Plans

Depending on the type of investigation and the location of, and access to, defects a TRAFFIC CONTROL PLAN may be required.

Documents

The Principal should provide the Contractor with all the available information on the bridge listed in ANNEXURE 0. Principal-supplied information includes drawings and reports. Reports may include the preliminary investigation report, Bridge Information System condition and inspection reports, structural assessment reports, repair records etc. Drawings may include the ORIGINAL DRAWINGS and WORK-AS-EXECUTED DRAWINGS, etc.

The Contract Manager must collate all the relevant information for the contract and supply it to the Contractor. Ensure that irrelevant or out of date documents are not provided to the Contractor.

Note that ORIGINAL DRAWINGS for most bridges are available electronically from TfNSW Plan Manager.

SECTION 3 RESOURCES

Personnel

Experienced and qualified personnel are required to supervise and carry out the desk top analysis of relevant documents, and the field assessment and evaluation of current condition of concrete members.

Refer names of consultants and structural engineers proposed by the Contractor to Bridge & Structural Engineering for review.

Surveyors may be required to verify the location and levels of concrete members to assist in the measurements of settlements and misalignment.

The following personnel must be nominated in the PQP and their suitability should be reviewed by the Principal:

- Consultants, where required;
- Bridge Inspectors;
- Project Engineer (the Project Manager);
- Site Supervisor (Works Supervisor);
- Scaffolder and Rigger, where required.

Plant and equipment

All items of equipment used for inspection, testing, sampling and/or measurements must be used within their specified working range.

SECTION 4 EXECUTION

Investigation

The Principal must nominate the type of investigation in Annexure M772/A1 as a BASIC INVESTIGATION or a COMPLEX INVESTIGATION.

A BASIC INVESTIGATION is recommended where:

- The exact nature and causes of defects are readily identifiable;
- Defects have limited extent and effects on the bridge; and
- Members to be repaired and/or extent of repairs have already been predetermined.

Otherwise, carry out a COMPLEX INVESTIGATION.

The Contractor must carry out a desktop review appropriate to the nominated investigation type before field assessment. Principal-supplied information is the main resource for this review.

Based on the outcome of preliminary investigation, the Principal must nominate the bridge members to be investigated and the extent to be covered on each member by visual inspection, delamination survey and diagnostic testing, as detailed in Annexures M772/A1, A2 & A3.

Field Assessment

Defects include all visible or hidden deterioration and/or damage in concrete bridge members resulting from design errors, construction faults, applied loads or environmental conditions, together with contributing mechanical, physical or chemical factors.

Visible defects include:

- (a) construction faults - such as blow holes, honeycombing, cold joints, exposed reinforcement, irregular surfaces and misalignment;
- (b) discolouration - such as efflorescence, dampness, and rust stains;
- (c) rupture of the concrete - such as cracking, disintegration, spalling, and delamination;
- (d) displacement of the concrete member.

Diagnostic testing/sampling used in the field assessment must be in accordance with Annexure A3. Diagnostic testing/sampling must be planned and designed to limit damage to the bridge from testing to a minimum. Consider firstly the use of non-destructive techniques for testing and/or inspection before allowing destructive testing or inspection.

Before core drilling prestressed concrete members, physically locate and mark the lines of prestressing tendons and proposed core locations and submit drilling proposal for review and approval by an experienced bridge design engineer. Exercise extreme care during core drilling.

Where symptoms of concrete deterioration cannot be linked to specific causes, seek specialist advice.

Repair options

Conclude the investigation by submitting an investigation report, regardless of the investigation type.

Sufficiently detail the repair options together with cost estimates to enable the selection of final repair option.

For a BASIC INVESTIGATION, the Contractor may recommend a single repair option in the report rather than several options.

Identification of the causes of defects and strategies for their mitigation must be central to all repair options. Removal or elimination of the causes of damage must form part of the mitigation strategy.

Where the causes cannot be removed, mitigation should aim at reducing their impact.

In some situations (e.g. freeze-thaw conditions), the causes of damage can only be counteracted by the use of specially designed repair materials. In some other situations (e.g. corrosion in marine environment), the causes of damage can only be counteracted by the use of specialised techniques, such as cathodic protection.

Consider relevant constraints and work specific factors and provisions when developing repair options to assist the Principal's selection of the final repair option.

SECTION 5 CONFORMITY

Comply with the applicable standards for the diagnostic test methods listed in Annexure M772/A3.



CONCRETE BRIDGE REPAIRS - INVESTIGATION

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VERSION FOR: DATE:

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FOREWORD

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REVISIONS TO PREVIOUS VERSION

This document has been revised from Specification TfNSW M772 Edition 1 Revision 1.

All revisions (other than minor editorial and project specific changes) are indicated by a vertical line in the margin as shown here, except when it is a new edition and the text has been extensively rewritten.

PROJECT SPECIFIC CHANGES

Project specific changes are not permitted in this document.

TRANSPORT FOR NSW (TfNSW)
QA SPECIFICATION M772
CONCRETE BRIDGE REPAIRS – INVESTIGATION

1 GENERAL

1.1	The Work to be executed under this Specification involves the investigation of defective (damaged or deteriorated) concrete bridge members and includes the following activities: .1 Desktop investigation. .2 Field assessment, including visual inspection, delamination surveys and diagnostic testing. .3 Diagnosis of causes of concrete defects. .4 Development of repair options. .5 Investigation report. This Specification does NOT include the investigation of concrete bridge members that are: .1 Normally underwater, i.e. below either: – Normal Water Level (inland or non-tidal waters); or – Mean Higher Low Water (MHLW) level (tidal waters). .2 Buried in the ground. .3 Fire-damaged. This Specification also does NOT cover emergency response to impact damage.	Scope
1.2	Details of the Work, including the nominated type of investigation and extent of investigation, are described in Annexure M772/A.	Details of Work
1.3	Payment for the activities associated with completing the Work detailed under this Specification will be made using the pay items listed the Schedule in Annexure M772/B.	Measurement and payment
1.4	Provide the Identified Records (refer to Specification TfNSW Q Annexure E2) summarised in Annexure M772/C2.	Records
1.5	The standards, specifications and test methods referred to by this Specification are referenced using an abbreviated form (e.g. AS/NZS 1234). The titles are given in Annexure M772/M.	Referenced documents
1.6	Unless otherwise specified, the issue of an Australian Standard or TfNSW Test Method to be used is the issue current one week before closing date for tenders. The TfNSW specification to be used is the issue contained in the contract documents.	Applicable issue

- 1.7 Some words and phrases have special meanings in this Specification. In some cases, the defined meaning is different from the meaning that the word or phrase might have in ordinary use. In order to understand the Specification, You need to take these special meanings into account.
- Defined terms have the special meanings set out in Annexure M772/M.
- All defined terms are indicated by using small capitals (e.g. DEFINED TERM) unless they are one of the following basic terms, which appear too often for small capitals to be used.
- | | |
|-----------------|-----------------------|
| - Principal | - Work |
| - You | - Bridge Site |
| - your | - Contractor |
| - Specification | - Structural Engineer |
- 1.8 Nomenclature and abbreviations used in this Specification are also defined in Annexure M772/M. **Definitions and abbreviations**
- 1.9 You are responsible for all activities, actions, works and supply of materials, unless specifically stated otherwise. Accordingly, this Specification does not generally use wording such as "You must ..." or "You shall ..." because this is the underlying requirement. However, such wording is used where actions in a clause involve both You and the Principal and the roles need to be unambiguous. **Interpretation**

2 PLANNING

2.1 PROJECT QUALITY PLAN

- 2.1.1 The requirements of the PROJECT QUALITY PLAN are defined in TfNSW Q. In addition, the PROJECT QUALITY PLAN must:
- | | |
|--|------------------------------------|
| .1 Address the Hold Points required by this Specification as summarised in Annexure M772/C1. The Principal will consider the submitted documents prior to authorising the release of the Hold Point. | HOLD POINTS |
| .2 Address each of the investigation process requirements in this Specification, as listed in Clause 2.1.2 to aid preparations for the Work, and as summarised in Annexure M772/D1. | Investigation Process |
| .3 Be revised as necessary to reflect the assessment findings and to ensure that the documented procedures continue to achieve conformity. | Revise PROJECT QUALITY PLAN |

- | | | |
|-------|--|--------------------------------|
| 2.1.2 | For the nominated type of investigation, the PROJECT QUALITY PLAN must include, where applicable: | |
| .1 | The Investigation Programme, showing the sequence and progress of the investigation in a structured manner. | Investigation Programme |
| .2 | Details of testing/inspection methods and equipment. | Methods/equipment |
| .3 | Procedures for the inspection of concrete bridge members in the tidal/splash/spray zones, where appropriate. | Tidal/splash zone |
| .4 | Procedure for core drilling and the method and material used to repair the core holes. | Core drilling |

2.1.3	Process Held: Commencement of work.	HOLD POINT
	Submission Details: At least 10 Business Days prior to the planned date of commencement of work, submit:	
.1	PROJECT QUALITY PLAN conforming to this Clause.	
.2	Project WORK HEALTH AND SAFETY MANAGEMENT PLAN (refer Clause 2.2).	
.3	TRAFFIC CONTROL PLAN (TCP) (refer Clause 2.2).	
	Release of Hold Point: The Principal will consider the submitted documents prior to authorising the release of the Hold Point.	

2.2 OTHER PLANS

- | | | |
|-------|---|-----------------------------|
| 2.2.1 | Provide your Project WHS MANAGEMENT PLAN in accordance with Specification TfNSW G22. | WHS MANAGEMENT PLAN |
| 2.2.2 | Where applicable, provide a TRAFFIC CONTROL PLAN (TCP) in accordance with Specification TfNSW G10 that: | TRAFFIC CONTROL PLAN |
| .1 | Is coordinated with field assessment and any other concurrent bridgeworks. | |
| .2 | Ensures safety with minimum disruption to the travelling public. | |

2.3 DOCUMENTS

- | | | |
|-------|---|---------------------------|
| 2.3.1 | The Principal will supply the information listed in Annexure M772/A4 to provide the background and references for the Work. | Information |
| 2.3.2 | Do not assume that the information supplied by the Principal is correct representation of the existing bridge. | Verify information |
| | You must assess the adequacy of the information supplied by the Principal for accuracy and consistency with current bridge and operating conditions observations. | |

3 RESOURCES

3.1 PERSONNEL

- | | | |
|-------|--|-------------------------------------|
| 3.1.1 | Manage investigation work using an Engineer with the following qualifications and experience who:

.1 Is a Member of Engineers Australia, or equivalent, with relevant expertise and experience in the investigation of concrete defects, deterioration and durability.

.2 Has experience in the structural design of concrete bridges. | Project Engineer |
| 3.1.2 | Supervise and carry out investigation work at the Bridge Site using personnel with relevant experience. | Site investigation personnel |
| 3.1.3 | Visually inspect concrete bridge members using a person who has completed within the last 5 years an authorised TfNSW Bridge Inspection Procedure training course and who has experience in inspections of concrete defects. | Inspectors |
| 3.1.4 | Non-destructive testing/inspection (NDT/I) and sampling personnel must be qualified and experienced in the methods of testing/inspection or sampling used. | NDT/I and sampling personnel |
| 3.1.5 | All structural assessment and design activities must be carried out by a Structural Engineer. | Structural Engineer |
| 3.1.6 | Any Consultants used must have the appropriate resources and expertise relevant to the Work. | Consultants |
| 3.1.7 | Any Surveyors used must have qualifications conforming to TfNSW Q. You may propose Surveyors with suitable experience who do not meet this requirement. | Surveyors |
| 3.1.8 | Alternative personnel qualifications or changes to personnel must be approved by the Principal. | Alternatives or changes |
| 3.1.9 | Document the names of all personnel together with their qualifications, experience and roles in the PROJECT QUALITY PLAN, including consultants and off-site laboratory testing personnel. | PROJECT QUALITY PLAN |

3.2 PLANT AND EQUIPMENT

- | | | |
|-------|--|--------------------|
| 3.2.1 | Comply with the obligations for plant and equipment specified in TfNSW G22. | Obligations |
| 3.2.2 | Ensure that all equipment used for measuring, inspecting and testing is currently calibrated within the appropriate tolerances and range or capacity necessary to carry out the intended assessment. Produce calibration certificates not more than six months old on request. | Calibration |

4 EXECUTION

4.1 GENERAL

- | | | |
|-------|---|--|
| 4.1.1 | Manage traffic during bridge assessment in accordance with your TCP. | Traffic control |
| 4.1.2 | Use AS HB 84 <i>Guide to Concrete Repair and Protection</i> as a guide for concrete investigation work. | Guide for concrete investigation work |

4.2 INVESTIGATION

- | | | |
|-------|---|------------------------------|
| 4.2.1 | Carry out a desktop review of the Principal-supplied information before starting field assessment. The review must be appropriate to the type of investigation nominated in Annexure M772/A1. | Desktop review |
| 4.2.2 | Carry out field assessment in accordance with the objectives for the type of investigation specified. | Assessment objectives |
| 4.2.3 | A BASIC INVESTIGATION must:
.1 Confirm the extent and locations of existing defects.
.2 Identify the causes of defects.
.3 Enable the development of repair method. | BASIC INVESTIGATION |
| 4.2.4 | A COMPLEX INVESTIGATION must:
.1 Confirm the material properties of the members investigated.
.2 Confirm the extent, locations, history and rate of progression of existing defects.
.3 Assess the effect/consequence of the defects on the structural integrity/serviceability and performance of the bridge.
.4 Identify and, where appropriate, differentiate between causes of defects of a similar type.
.5 Report on the effects of deterioration in the short-term and whether repairs are required immediately to keep the bridge in service.
.6 Facilitate development of repair options and final repair. | COMPLEX INVESTIGATION |
| 4.2.5 | Document investigation findings in an investigation report. | Investigation report |

4.3 FIELD ASSESSMENT

4.3.1 General

- | | | |
|---------|---|-----------------------------------|
| 4.3.1.1 | Carry out field assessment in accordance with this Specification based on the type and extent of investigation specified in Annexure M772/A1. | Extent of field assessment |
|---------|---|-----------------------------------|

4.3.1.2 Where You consider it necessary to change the location, extent or level of detail of the inspection from that specified, obtain approval from the Principal before proceeding with the change.	Changes in scope of investigation
4.3.1.3 All accesses and scaffolding for the investigation must be designed by a Structural Engineer. Do not remove, demolish, dismantle, weld, cut, drill or otherwise disturb existing bridge members except as approved by the Principal.	Access and scaffolding
<p>4.3.1.4 Process Held: Erection of accesses and scaffolding.</p> <p>Submission Details: Submit details of accesses and/or scaffolding, including design calculations and Engineer’s certification, at least 10 Business Days prior to the erection of accesses or scaffolding.</p> <p>Release of Hold Point: The Principal will consider the submitted documents prior to authorising the release of the Hold Point.</p>	HOLD POINT
4.3.1.5 Report all defects on public utility services and the like attached to the bridge not covered by Annexure M772/A1 to the Principal.	Public utilities
4.3.1.6 Include visual inspection, delamination surveys and diagnostic testing in the field assessment.	Scope of field assessment
4.3.1.7 The visual and delamination survey must provide sufficient information to locate the required number of Diagnostic Test Areas (DTAs) for diagnostic testing.	Diagnostic Test Areas
4.3.1.8 Carry out diagnostic testing in accordance with Annexure M772/A3.	Diagnostic testing
4.3.1.9 Collect and report information on defect history. Take note of all defects and information already marked on bridge members.	Defect history
4.3.1.10 Record separately the extent of defective concrete and previous repairs (sound and failed) for each member type, in m ² , and as a percentage of the surface area of the member.	Recording of defective areas
<p>4.3.1.11 Take clear high-resolution scaled digital photographs, using artificial light as required, to assist understanding of the defects and the development of repair options.</p> <p>Take general photographs to orient the viewer and close-up photographs of defect details.</p>	Digital photographs
<p>4.3.1.12 Prior to field assessment, confirm whether or not the bridge members to be assessed are free from hazardous materials by examining the information supplied.</p> <p>When hazardous materials are found, e.g. asbestos or lead-based paints, apply the relevant procedures in the PROJECT QUALITY PLAN for the safe handling of these materials (refer Clause 2.1.2).</p>	Hazardous materials

- 4.3.1.13. Where appropriate, record the width normal to the gap of expansion joint openings, together with ambient bridge temperature. **Joint gaps**
- Record all defects resulting from leaking or jammed deck joints.
- 4.3.1.14 Measure and report the locations of bridge members relative to each other, as this may control the design of the repair. **Controlling dimension**
- 4.3.1.15 When reporting member conditions, consider how it may be repaired and highlight any matters that may assist the design of the repair, such as constraints on the installation of jacks, and the presence of cable racks, water pipes or other services that might be affected by jacking and other operations. **Repair design constraints**
- 4.3.1.16 Map defects on bridge drawings to clearly identify their locations and extent, using legends to clearly distinguish defect types (e.g. cracks, spalling, scaling, weathering, staining, honeycombing, dampness, etc.). Subsequently scan the drawings for despatch. **Defect mapping output**
- 4.3.2 Visual Inspection**
- 4.3.2.1 Record all defects on the surface of nominated members by systematically planning and carrying out a visual inspection. **Visual survey**
- 4.3.2.2 Mark discrete cracks and defective areas of concrete (e.g. spalls, disintegration, efflorescence, staining, damp or wet areas etc.) with permanent markers to track the growth of defects and any repairs. **Defect marking**
- Mark the main features of defects e.g. maximum crack width, start and end of crack, maximum depth of spall, boundary of scaling or delaminated area etc.
- 4.3.2.3 When inspecting bridge members damaged by impact, report on: **Impact damage**
- .1 Type, severity and extent of damage; and
- .2 Type and severity of damage to reinforcement or prestressed members, e.g. loss of cover, nicks, kinks, dislocation, yielded or cut reinforcement or tendons.
- 4.3.2.4 For each member, map cracks on WORK-AS-EXECUTED DRAWINGS or sketches using descriptive legends and/or use spreadsheet tables. **Crack representation**
- 4.3.2.5 Mark the boundaries of areas of extensive cracking. In such areas, only individual cracks critical to safety need to be mapped. **Extensive cracking**
- Where sketches are not practical, use spreadsheet tables to describe crack intensity, width, spacing, direction, pattern, nature, etc.
- 4.3.2.6 Report crack dimensions (length, width, depth), pattern (discrete, isolated, random, mapping, crazing), direction (relative to member or near reinforcement), state (active or dormant), nature (structural, e.g. flexural, shear or non-structural, e.g. plastic or thermal shrinkage). **Crack reporting**

4.3.2.7	When necessary, use a Structural Engineer to assess the effects of cracks on member strength.	Structural cracks
4.3.2.8	Where crack propagation history records are not provided, monitor the rate of crack propagation as long as practicable.	Crack monitoring
4.3.2.9	Assess the condition of exposed reinforcement and use a Structural Engineer to assess the loss of cross-section due to corrosion. Where chlorides are present, expose and inspect the reinforcement for pitting corrosion even if cracking is not evident.	Assessment of reinforcement
4.3.3 Delamination Survey		
4.3.3.1	To detect delamination, use chain dragging, manual rodding or hammer tapping to ASTM D4580. Locate the exact boundary of delamination by hammering. On horizontal surfaces, use loose sand together with sounding.	Delamination boundaries
4.3.3.2	Mark out delaminated area on concrete surface and record its location.	Delamination marking
4.3.4 Diagnostic Testing		
4.3.4.1	Following the visual inspection and the delamination survey, select Diagnostic Test Area (DTA) locations representative of the various member condition states.	
4.3.4.2	Process Held: Selection of DTA locations. Submission Details: Drawings nominating DTA locations at least 10 Business Days prior to commencing diagnostic testing. Release of Hold Point: The Principal will consider the submitted documents prior to authorising the release of the Hold Point.	HOLD POINT
4.3.4.3	Plan diagnostic testing to limit the damage to the bridge by reducing the number of test holes and the extent of breakouts.	Limiting damage to structure
4.3.4.4	Select DTAs so as to limit damage and additional corrosion of prestressing tendons.	Prestressing tendons
4.3.4.5	Within DTAs, choose the locations and testing sequence of holes and breakouts so as to optimise the testing program.	Locations and sequence
4.3.4.6	Carry out diagnostic testing in accordance with the test methods and sampling plans specified in Annexure M772/A3.	Diagnostic test samples
4.3.4.7	Use extreme care when core drilling. Locate cast-in metal components and mark their locations on the concrete surface before coring. For prestressed concrete members, submit a certificate from a Structural Engineer experienced in prestressed concrete design	Cutting metal components

stating that the proposed coring will not be detrimental to the strength of the member.

Keep core drilling away from tendons. Where there is a need to core adjacent to tendons or on top of them, use only percussive drilling tools and only to depth shallower than the tendon. Where tendons are to be exposed, excavate the remainder of the hole manually using hammers and cold chisels.

<p>4.3.4.8 Process Held: Core drilling of prestressed members.</p> <p>Submission Details: Core drill locations and certificate from a Structural Engineer at least 10 Business Days prior to commencing diagnostic testing.</p> <p>Release of Hold Point: The Principal will consider the submitted documents prior to authorising the release of the Hold Point.</p>	<p>HOLD POINT</p>
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4.3.4.9 Stop core drilling if metal components are encountered and report to the Principal for directions. **Accidental metal cutting**

4.3.4.10 Use an electromagnetic covermeter with audio alarm to survey the steel reinforcement in the concrete member. In doing this, You must: **Concrete cover survey**

- .1 Calibrate the covermeter before use in each DTA.
- .2 Mark out the reinforcement in each covermeter survey area.
- .3 Record the diameter, locations and covers for all reinforcement.
- .4 Verify the concrete cover thickness by exposing the reinforcement locally and measure the cover using a depth gauge.
- .5 Assess the condition of buried steel reinforcement by exposing the steel at areas with low concrete cover (maximum of 2 locations per test sample), and/or at breakouts used for other tests.

4.3.4.11 To identify areas at risk of corrosion, mark out a grid on the member to locate points for potential measurements. **Potential survey**

When doing potential measurements, You must:

- .1 Carry out regular maintenance and calibration checks on reference electrode.
- .2 Check electrical continuity of reinforcement by measuring electrical resistance across element boundaries.
- .3 Locate reinforcement and adjust the grid accordingly.
- .4 Record moisture content, intensity of steel reinforcement, concrete cover, member thickness and temperature and other relevant variables in the grid square.
- .5 Remove any coatings from the test area.
- .6 Obtain uniform moisture content for the test by wetting the

concrete surface.

- .7 Wet the reference electrode sponge periodically.
- .8 Use grid spacing smaller or equal to that specified.
- .9 Submit details of equipment before use, i.e. single/multiple wheel or multiple rod electrode system.
- .10 Adjust potential readings during data analysis for bias caused by concrete carbonation, chlorides, local variations in concrete cover, moisture content and stray currents.
- .11 Analyse survey results to determine whether corrosion is at the passive, initiation or propagation stages.

4.3.4.12 Chloride/sulfate sampling must comprise either cores or dust samples. In doing this, You must:

Chloride/sulfate testing

- .1 Drill holes to minimum length equal to the average concrete cover plus 20 mm.
- .2 Use drilling equipment with sufficient vacuum (suction capacity) to recover all material being drilled.
- .3 Collect dust samples successively from 4 depth increments so that the third depth increment corresponds to the average concrete cover.
- .4 Mix the dust samples collected at the same depth from the three drilled holes into the one sample for that depth.
- .5 To prevent sample contamination, clean the drilling equipment before each successive hole drilling
- .6 Slice and grind cores, where extracted for other tests, into 4 depth increments so that the third slice corresponds to the average concrete cover.
- .7 Use a NATA accredited laboratory to determine the sample acid-soluble chloride/sulfate contents by weight.
- .8 Carry out cement content analysis on at least one sample and report chlorides/sulfates as a percentage of cement content.
- .9 Establish the original concrete chloride/sulfate concentration by testing at least two samples collected by extending drilling to well below reinforcement depth into virgin concrete.
- .10 Correct the drilling depth for the taper of the drilling bit.
- .11 Include with the test results the type of sample used and range of accuracy of measurements.
- .12 Assess the risk of chloride-induced corrosion when corrosion is still at the passive or initiation stages.
- .13 Use chloride diffusion modelling to assess whether existing chloride levels within the concrete are corrosion risk.
- .14 Establish chloride profiles and diffusion coefficients and use with corrosion survey results and visual inspection to estimate the remaining service life.

4.3.4.13 Commence carbonation testing by on-site testing breakouts, i.e. use

Carbonation testing

shallow marks/holes in the concrete surface just sufficient for testing. Where breakout tests are not conclusive, drill cores as specified for laboratory testing. In doing this, You must:

- .1 Use an indicator solution of 1 g phenolphthalein in 100 ml mixture of 1:1 alcohol to water.
- .2 Apply the indicator solution in fine spray layers. Do not use drops. Carbonation is present when the indicator is clear.
- .3 Continue breaking out concrete progressively and testing until no carbonation is present, at which point the indicator solution is uniformly pink.
- .4 Apply the indicator solution to freshly exposed concrete surfaces.
- .5 Advise the Principal before extracting cores for laboratory assessment where breakouts are not sufficient to determine the depth of carbonation, even if not specified in Annexure M772/A2.
- .6 Report carbonation depth using mean values, standard deviation and range.
- .7 Use an appropriate carbonation prediction model for analysis of the results.

- 4.3.4.14 Measure concrete electrical resistivity using a four probe resistivity meter, e.g. Nilsson 400 meter, Wenner probe, as follows: **Electrical resistivity**
- .1 Calibrate readings to account for member dimensions, i.e. member geometry factor.
 - .2 Record and report temperature and relative humidity.
 - .3 Ensure consistent moisture content of concrete during measurements.
 - .4 Carefully choose test locations to reduce interference with reinforcing steel.
 - .5 Drill and insert the probes at least 30 mm into and in full contact with the concrete and take measurements.
- 4.3.4.15 To confirm if alkali-aggregate reaction (AAR) is present, carry out the specified rapid identification test or request a petrographic examination. If AAR is confirmed, map the stages of gel formation and the extent of current and predicted expansions in the member. **Alkali-aggregate reaction**
- 4.3.4.16 Where AAR is confirmed, provide your proposal for monitoring the remaining expansions in the member. **AAR expansion monitoring**
- 4.3.4.17 Carry out testing of steel items where specified. For welding steel reinforcement, determine the carbon equivalent of the steel and specify an appropriate welding procedure. **Steel testing**
- 4.3.4.18 Chemical analysis of steel reinforcement must cover at least the following chemical elements: C, Si, Mn, P and S. **Chemical analysis**
- 4.3.4.19 On at least 5 sections of each reinforcing steel sample, determine **Metallurgical**

microstructure, grain size and inclusion rating by metallurgical analysis, and test for Brinell and Vickers Micro hardnesses.

4.3.4.20 Determine yield strength, ultimate strength and percentage elongation from tensile tests. **Mechanical testing**

4.3.4.21 Measure concrete compressive strength and modulus of elasticity of cores drilled from the member. **Compressive strength**

4.3.5 Causes

4.3.5.1 Identify and report the causes of defects under one or more of the following categories: **Cause categories**

- .1 Physical – heavy loading, inadequate structural capacity, accidental impact, restraint to articulation, foundation settlement/movement and construction error.
- .2 Environmental – moisture, temperature, freeze-thaw, wind, fire, erosion, abrasion, weathering, bacteria and earthquake.
- .3 Chemical – internal, external and corrosion.

4.3.5.2 Distinguish between defect causes that are recurring or continuing and those that are one-off events, e.g. accidental impact. **Recurring causes**

Review any available information on previous repairs and use to identify the causes of deterioration.

4.3.5.3 Where alkali-aggregate reaction (AAR) is confirmed, determine the extent of expansion remaining to be accommodated by the repairs. If testing to confirm the residual expansion is required, obtain the Principal's approval before carrying out the tests. **AAR**

4.3.5.4 Where multiple causes contribute to the defect, identify if possible the initial cause and the causes of any continuing deterioration. **Multiple causes**

Distinguish between the causes of similar defects.

4.3.5.5 Where both carbonation and chloride contamination are confirmed, attribute corrosion defects to chlorides, except where the chloride levels are too low to cause such corrosion. **Chloride versus carbonation**

4.4 REPAIR OPTIONS

4.4.1 General

4.4.1.1 Where a COMPLEX INVESTIGATION is nominated in Annexure M772/A1, develop fully-costed repair options for the Principal's consideration. **Fully-costed options**

Prepare life-cycle cost analyses in accordance with AS/NZS 4536 to assist the Principal to select the final repair option.

For a BASIC INVESTIGATION, develop repair options or repair methods for the Principal's consideration.

- 4.4.1.2 When developing repair options, address the mitigation of defect causes in the following order: **Mitigation hierarchy**
- .1 Remove or stop the cause.
 - .2 Reduce or slow the cause.
 - .3 Stabilise or impede the cause.
- 4.4.1.3 When developing repair options, consider the following: **Factors for repair options**
- .1 Bridge safety, serviceability, risks, consequence of failure.
 - .2 Causes and extent of defects, and rate of deterioration.
 - .3 The requirements specified in Annexure M772/A1.
 - .4 Technical requirements:
 - Condition of substrate and defect type and geometry.
 - Conditions applying during the repair, e.g. ambient temperature, relative humidity, WHS, environmental protection constraints and allowance for downtime.
 - In-service conditions applying to the repair.

4.4.2 Opportunities and Constraints

- 4.4.2.1 When developing repair options, consider the following constraints and opportunities to improve or upgrade the bridge: **Constraints and opportunities**
- .1 Whether to repair to the original design or to upgrade when the original design is unsatisfactory and/or deficient.
 - .2 Whether improvements, such as deck drainage, expansion joint repairs, provision of or improvements to access for inspection or barrier upgrades, can be included in the repairs.
 - .3 Whether to rehabilitate/retrofit or replace bridge members.
 - .4 Heritage constraints on selection of options for repairs.
 - .5 Availability of repair materials and equipment.
 - .6 Traffic management during and after repairs, and extent of traffic disruption.
 - .7 Timing and staging of repair works, taking into account traffic flow, day or night work, flooding etc.
 - .8 The need for temporary supports and provision of access.

4.4.3 Repair Methods

- 4.4.3.1 You may recommend repair options or methods, including, but is not limited to, the following: **Repair options**
- .1 Patch concrete using cementitious repair materials. Use non-cementitious materials only where cementitious materials are unsuitable, if approved by the Principal. Patching may incorporate sacrificial ring anodes to counteract incipient corrosion.
 - .2 Replace corroded reinforcement with stainless steel or

consider the use of sacrificial anodes to counteract corrosion.

- .3 Encase and splice members using suitable techniques, e.g. concrete jackets, steel sleeves, carbon fibre laminates, etc.
- .4 Replace defective damaged members, especially precast items, not able to be repaired economically.
- .5 Repair cracks using injection methods.
- .6 Overlay damaged decks.
- .7 Apply anti-carbonation or chloride resistant or other coatings to concrete surfaces and waterproofing or hydrophobic or other coatings to steel reinforcement.

4.4.3.2 Surface applied corrosion inhibitors are prohibited. **Corrosion inhibitors**

4.4.3.3 Anti-carbonation coatings may be considered for repairs where the carbonation front has not reached steel reinforcement. **Anti-carbonation coatings**

4.4.3.4 Chloride resistant coatings, e.g. acrylics and epoxies, and penetrating systems, e.g. silanes and siloxanes, must resist chloride ingress. **Chloride resistant coatings**

Penetrating systems may be used only for surfaces subject to wear and abrasion, or for surfaces required to retain their appearance.

4.4.3.5 Exhaust methods for in-place repair of precast or prestressed members, before recommending full member replacement. **Precast in-place repairs**

4.4.3.6 Use only TfNSW approved waterproofing membranes for bridge decks. **Waterproofing membranes**

Waterproofing membranes for other bridge members may be rubberised or polymer modified bituminous surface treatments, slurry seals, prefabricated sheet membranes or sprayed-on liquid applied membranes including polyurethanes, acrylics or epoxies.

4.5 INVESTIGATION REPORT

4.5.1.1 Submit an investigation report covering at least the following: **Investigation report**

- .1 Conditions of bridge members covered by the Work.
- .2 Maps of defects showing the locations, extent and types of defects.
- .3 Conditions of associated bridge members and public utility services.
- .4 Assessment data (NDT/I and field and laboratory test reports)
- .5 Analysis of data and structural prognosis when a COMPLEX INVESTIGATION is specified.
- .6 Causes of defects for COMPLEX INVESTIGATION mitigation options.
- .7 Recommended repair methods/options as appropriate.

5 CONFORMITY

5.1 DIAGNOSIS CONFORMITY

- 5.1.1 Certify that all defects and concrete properties investigated have been diagnosed or assessed, using the diagnostic methods detailed in Annexure M772/A3. **Diagnostic methods**

ANNEXURE M772/A – DETAILS OF WORK

A1 WORK SUMMARY – LOCATION AND EXTENT OF INVESTIGATION

BRIDGE NAME AND LOCATION			
TfNSW BRIDGE NO			
INVESTIGATION TYPE¹		<input type="checkbox"/> BASIC INVESTIGATION	<input type="checkbox"/> COMPLEX INVESTIGATION
MEMBER TYPE	VISUAL INSPECTION (% EACH²)	DELAMINATION SURVEY (% EACH²)	DIAGNOSTIC TESTING DTA (NO. PER EACH³)
ABUTMENTS			
PILES			
PILE CAPS			
PIERS			
HEADSTOCKS			
X GIRDERS /DIAPHRAGM			
MAIN GIRDERS			
DECK			
APPROACH SLAB			
BARRIERS			
REPAIR OPTION CONSTRAINTS			
TIME			
COST			
CURRENT USE			
FUTURE USE			
MAINTENANCE			
NOTES:	¹ ² ³	TICK ONE OPTION. % AREA OF EACH MEMBER, UNLESS SPECIFIC MEMBER IS NOMINATED. NUMBER OF DTA PER MEMBER, UNLESS SPECIFIC MEMBER IS NOMINATED.	

A2 WORK SUMMARY - NUMBER OF DIAGNOSTIC TESTS IN EACH DTA

DIAGNOSTIC TEST ¹	COVERMETER SURVEY	POTENTIAL SURVEY	CHLORIDE/ SULFATE ANALYSIS	CARBONATION TESTING	RESISTIVITY TESTING	AAR PETROGRAPHIC EXAMINATION	AAR RAPID IDENTIFICATION	STEEL ANALYSIS CHEMICAL/ TENSILE/	COMPRESSIVE STRENGTH AND MODULUS OF
MEMBER ¹ TYPE									
ABUTMENTS									
PILES									
PILE CAPS									
PIERS									
HEADSTOCKS									
X GIRDERS /DIAPHRAGM									
MAIN GIRDERS									
DECK ²									
APPROACH SLAB									
BARRIERS									
NOTES :	1	PRINCIPAL TO ENTER THE NUMBER OF DIAGNOSTIC TESTS FOR EACH DTA ON A GIVEN MEMBER TYPE.							
	2	FOR LARGE DECK AREAS, A POTENTIAL WHEEL WITH READINGS TAKEN EQUIVALENT TO THE SPECIFIED GRID SPACING MAY BE USED.							

A3 DIAGNOSTIC TEST SAMPLES

Diagnostic Test	Test Sample	Standard
Covermeter survey	<input type="checkbox"/> 1 m ² <input type="checkbox"/> 2 m ²	BS 1881:204
Potential survey	<input type="checkbox"/> 2 m ² <input type="checkbox"/> 4 m ² <input type="checkbox"/> 250 mm grid <input type="checkbox"/> 500 mm grid	ASTM C876-15
Chloride/sulfate analysis	<input type="checkbox"/> 3 holes (Ø20 mm × 1*) <input type="checkbox"/> 2 Cores (Ø 50mm × 1*) (from other tests)	AS 1012.20.1
Carbonation testing	<input type="checkbox"/> 2 Breakouts <input type="checkbox"/> 2 Cores (Ø50 mm × 1*) only with carbonated concrete	RILEM Standard CPC-18
Resistivity testing	<input type="checkbox"/> One setup	BS 1881:201
AAR rapid identification	<input type="checkbox"/> One area of 200 mm × 200 mm freshly exposed concrete	ASTM C856-18 Annex A.1
AAR petrographic examination	<input type="checkbox"/> 2 Cores (50 mm × least of 150 mm or thickness)	ASTM C856-18
Steel analysis	<input type="checkbox"/> One 300 mm bar <input type="checkbox"/> Two 300 mm bar <input type="checkbox"/> Chemical <input type="checkbox"/> Tensile testing <input type="checkbox"/> Metallographic	AS/NZS 1050, AS 1391 & ASTM E45-18 respectively
Compressive strength & Young's modulus	<input type="checkbox"/> 3 Cores (Ø75 mm × least of 150 mm or thickness)	AS 1012.9
NOTE:	* Average concrete cover plus 20 mm.	

A4 INFORMATION SUPPLIED BY THE PRINCIPAL

Bridge Documentation	Supplied by Principal*	Paper copy	Electronic copy	Document Reference and Date (dd-mm-yyyy)
1. Preliminary investigation report	YES / NO			
2. BIS inspection reports	YES / NO			
3. ORIGINAL DRAWINGS	YES / NO			
4. WORK-AS-EXECUTED DRAWINGS	YES / NO			
5. Drawings of any repairs	YES / NO			
6. Bridge Survey Control	YES / NO			
7. Structural assessment reports	YES / NO			
8. Records of application or presence of toxic or hazardous chemicals or substances in bridge vicinity	YES / NO			
9. Other documentation: Future utilisation of bridge, forward planning etc. _____	YES / NO			
NOTE:	(*) Delete one option			

ANNEXURE M772/B – MEASUREMENT AND PAYMENT

B1 GENERAL

B1.1	Pay Items are identified in Annexure M772/B2.	Pay Items
B1.2	Price pay items in the schedule of pay items, taking into account all the costs associated with doing the work. Include the costs of any unpriced pay items in the priced pay items.	Prices
B1.3	Distribute overheads between priced pay items.	Overheads
B1.4	Pay item with a specified quantity of work must not be tendered as a lump sum.	No Lump Sum
B1.5	Pay Item 909 applies for work relating to provision for traffic.	Provision for traffic
B1.6	You will not be paid for work that does not conform to this Specification.	No payment

B2 SCHEDULE OF PAY ITEMS

Maintenance Activity Code	Item Name and Description	Units of Measurement
772.01	Field assessment	Each
	.1 Desktop review of Principal-supplied information	
	.2 Visual inspection	
	.3 Delamination survey	
	.4 Diagnostic testing	
772.02	Investigation report	Each
	.1 Reporting condition of inspected members	
	.2 Defect mapping	
	.3 Diagnostic test results and their analysis	
	.4 Defect causes	
	.5 Mitigation, repair options and repair methods	

ANNEXURE M772/C – SCHEDULES OF HOLD POINTS AND IDENTIFIED RECORDS

Refer to Clause 2.1.1.

C1 SCHEDULE OF HOLD POINTS

Clause	Type	Process Held	Submission Details
2.1.3	Hold	Commencement of Work.	Submission of: .1 PROJECT QUALITY PLAN conforming to Clause 2.1.3. .2 Project WORK HEALTH AND SAFETY MANAGEMENT PLAN (refer Clause 2.2). .3 TRAFFIC CONTROL PLAN (TCP) (refer Clause 2.2).
4.3.1.4	Hold	Erection of accesses and scaffolding.	Submission of details of accesses and/or scaffolding, including design calculations and Engineer's certification.
4.3.4.2	Hold	Selection of DTA locations.	Submission of Drawings nominating DTA locations.
4.3.4.8	Hold	Core drilling of prestressed members.	Submission of core drill locations and certificate from a Structural Engineer..

C2 SCHEDULE OF IDENTIFIED RECORDS

Clause	Description of Identified Record
2.1.1	PROJECT QUALITY PLAN.
2.2.1	Project WORK HEALTH AND SAFETY MANAGEMENT PLAN.
2.2.2	TRAFFIC CONTROL PLAN (TCP).
4.2.5	Investigation report.
4.3.1.11	Photographs.
4.3.1.16	Drawings mapping defects.

ANNEXURE M772/D – PLANNING DOCUMENTS

D1 INVESTIGATION PROCESSES

The information to be supplied by the Contractor must include, but not be limited to, the following:

Clause	Process	Description
2.1.2	Inspection programme	Programme to show sequence of testing for the Works.
2.1.2	Inspection of tidal zone	Procedures covering inspection of tidal/splash zones where applicable.
3.1.5	Structural assessment	All structural assessments and certifications by a Structural Engineer.
3.2.2	Calibration	All testing and inspection equipment current and appropriate calibration records.
4.2.1	Desktop review	Desktop review carried out before site inspection to a level of detail appropriate to type of investigation specified.
4.3.1.3	Access and scaffolding	Full design calculations and drawings covering all access and scaffolding details.
4.3.1.16	Mapping of defects	Defect mapping with legend clearly differentiating between all types of defects by using a suitable format.
4.3.2.2	Defect marking	Defect marking using permanent markers suitable for each type of defect.
4.3.4.7	Core drilling	Core locations located and marked before drilling.

ANNEXURES M772/E TO M772/L – (NOT USED)

ANNEXURE M772/M – REFERENCED DOCUMENTS AND DEFINITIONS

M1 REFERENCED DOCUMENTS

M1.1 Australian Standards

AS 1012	Methods of testing concrete
AS 1012.9	Compressive strength tests - Concrete, mortar and grout specimens
AS 1012.20.1	Determination of chloride and sulfate in hardened concrete and aggregates
AS 1391	Metallic materials – Tensile testing at ambient temperature
AS/NZS 1050	Methods for the analysis of iron and steel
AS/NZS 1349	Bourdon tube pressure and vacuum gauges
AS/NZS 4536	Life cycle costing – An application guide
AS HB 84	Guide to Concrete Repair and Protection

M1.2 International Standards

ASTM C856-18	Standard Practice for Petrographic Examination of Hardened Concrete
ASTM C856 A1	Rapid Identification of Alkali-Silica Reaction Products in Concrete
ASTM C876-15	Standard Test Method for Corrosion Potentials of Uncoated Reinforcing Steel in Concrete
ASTM D4580	Standard Practice for Measuring Delaminations in Concrete Bridge Decks by Sounding
ASTM E45-18	Standard Test Methods for Determining the Inclusion Content of Steel
BS 1881: 201	Testing concrete. Guide to the use of non-destructive methods of test for hardened concrete.
BS 1881: 204	Testing concrete. Recommendations on the use of electromagnetic covermeters.
RILEM CPC-18	RILEM: Measurement for Hardened Concrete Carbonation Depth, TC14-CPC, CPC-18, 1988

M1.3 TfNSW Specifications

TfNSW G10	Traffic Management
TfNSW G22	Work Health and Safety (Construction Work)
TfNSW G71	Construction Surveys
TfNSW Q	Quality Management System

M2 ACRONYMS

PQP	PROJECT QUALITY PLAN
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NDT/I	Non Destructive Testing/Inspection
TCP	TRAFFIC CONTROL PLAN

M3 DEFINED TERMS

BASIC INVESTIGATION	An investigation that meets the objectives of Clause 4.2.3
Business Day	Any day other than a Saturday, Sunday or public holiday or 27, 28, 29, 30 or 31 December
COMPLEX INVESTIGATION	An investigation that meets the objectives of Clause 4.2.4
Hold Point	A point beyond which a work process must not proceed without the Principal's express written authorisation (refer TfNSW Q)
ORIGINAL DRAWINGS	The original bridge design drawings or original WORK-AS-EXECUTED DRAWINGS
Principal	Means the Transport for NSW
PROJECT QUALITY PLAN	Refer Clause 2.1
Specification	Means TfNSW M772
Structural Engineer	A Chartered Professional Engineer with membership of Engineers Australia practising in the field of structural engineering (or equivalent). An equivalent to membership of Engineers Australia would be an Engineer registered on the National Engineering Register (NER) in the general area of practice of Civil Engineering and experienced in structural engineering
TRAFFIC CONTROL PLAN	Refer Clause 2.2.2
Work	The scope of work covered by the Specification under the Contract (refer ANNEXURE M772/A, Clause 1 and TfNSW Q)
WORK-AS-EXECUTED DRAWINGS	Drawings recording details of the completed Work
You	Means the Contractor, including subcontractors, employees and agents of the Contractor

M4 DEFINITIONS

The following definitions apply to this Specification:

Term	Alternative Term	Definitions
Abrasion		Progressive loss of material from the concrete surface
Bridge Information System	BIS	General term for the approved TfNSW bridge inspection and condition rating reporting system and its database
Bridge Survey Control		The survey control network for the bridge (refer to Specification TfNSW G71)
Dampness		Wet or moist areas of concrete evidenced by the different colour of the concrete surface
Efflorescence		Deposition of white salts or lime mortar on the concrete surface

Term	Alternative Term	Definitions
Member	Component Element	Any member or part of a member acting as part of a structural assembly
Honeycombing		Voids or spaces within concrete, usually caused by lack of adequate compaction
Live cracks		Cracks showing progressive growth, excluding thermal cyclic opening/closing
Rust staining		Brown or rust coloured stains
Scaling		Local flaking or peeling away of the surface of the hardened concrete or mortar
Site Supervisor		The Works Supervisor supervising the Works at the Bridge Site
Spalling		Concrete fragments detached from the parent concrete
Substrate		The cleaned and roughened surface to which the repair material is applied
Temporary works		All works which are not part of the permanent repair but are required before or during completion of permanent repairs, including, but not limited to: interim repairs, access and scaffolding, temporary bracing and supports (e.g. supplementary bearings, shoring, blocking, and cribbing)
Weathering		Changes in concrete properties, such as colour, texture or strength, resulting from exposure to the environment