South Road Tram Overpass Shared Path Bridge

Remediation Options Report

Department of Planning, Transport, and Infrastructure

5 May 2017

Revision: 3

Reference: 255258

Bringing ideas to life

Document control record

Document prepared by:

Aurecon Australasia Pty Ltd

ABN 54 005 139 873

Level 10, 55 Grenfell Street
Adelaide SA 5000
Australia

T +61 8 8237 9777
F +61 8 8237 9778
E adelaide@aurecongroup.com
W aurecongroup.com

Document control						aurecon
Report title		Remediation Options Report				
Document ID			**Project number**		255258	
File path		http://cs.au.aurecongroup.com/cs/llisapi.dll/open/176730121nt1				
Client		Department of Planning, Transport, and Infrastructure				
Client contact			**Client reference**			
Rev	**Date**	**Revision details/status**	**Author**	**Reviewer**	**Verifier** (if required)	**Approver**
0	17 March 2017	Draft for Client Comment	James Hubbard	Harry Turner	John Hilton	James Trezona
1	24 March 2017	Final	James Hubbard	Harry Turner	John Hilton	James Trezona
2	4 May 2017	Final revised following cost estimate, constructability input, internal review and client feedback	James Hubbard	Harry Turner	John Hilton	James Trezona
3	5 May 2017	Final	James Hubbard	Harry Turner	John Hilton	James Trezona
Current revision		**3**				

Approval			
Author signature		Approver signature	
Name	James Hubbard	Name	James Trezona
Title	Senior Bridge Engineer	Title	Buildings Leader

Contents

Appendices

Figures

Tables

1 Executive Summary

On 18 January 2017 DPTI became aware of girder rotation and displacement to two spans of the South Road Tram Overpass shared pedestrian and cycle path bridge (Shared Use Path Bridge). As a result of the incident, South Road was temporarily closed to traffic until temporary stabilisation of the deck was installed. This stabilisation is a short term measure only.

A subsequent investigation by Aurecon revealed that the girder misalignment is attributed to horizontal movement of support bearings due to a lack of restraint and out of balance loading. Varying degrees of girder misalignment have been identified on all spans.

The investigation revealed two specific deficiencies relating to the Shared Use Path Bridge;

1. Bearings overloaded laterally, and with the propensity of walking out, at all piers and abutments.
2. External keeper walls overloaded and cracked at the piers. This does not apply at the abutments where calculations indicate the keeper walls have sufficient strength.

Following optioneering, a high level concept has been developed in order to address these deficiencies.

In order to reduce the lateral load on the bearings to their design capacity and prevent the bearing walking out in service, it is recommended that the bearings be replaced by new pot bearings located on or close to the centroid of dead load of the superstructure.

This option has the advantages of being visually discrete, requiring minimal or no modification to the bearing plinth, providing a simple load path and allowing efficient construction with minimal disruption to traffic on South Road in particular.

In order to remove loading on the understrength pier external keeper walls, it is recommended that the girder is fixed at deck level to the adjacent Tram Bridge using a tie. The tie can be readily facilitated via a steel connection, hinged at both ends to allow for differential movement between adjacent bridges.

The tie option is the most visually unobtrusive and allows efficient construction with minimal disruption to traffic on South Road.

Concept sketches 255258-0005-SKT-SS-0001 and 0003 in Appendix A provide details of the recommended remediation works.

A construction methodology for the remediation has been developed by McConnell Dowell dated 2nd May 2017, outlining a proposed scope of works and methodology for minimising disruption to tram services and South Road users. Whilst the detailed design and reviews of the remediation have yet to be undertaken, Aurecon considers the proposed scope and methodology to generally be reasonable and in line with workshop discussions.

2 Introduction

2.1 Existing Structure

The South Road tram overpass structure consists of four independent sections of deck. The up and down tracks are each supported by two 1200 mm deep Super T girders. Each pair of girders is connected by a concrete topping slab. There are eight spans in total situated between approach embankments.

At span 4, which is located over South Road, a section of deck is located between the up and down track decks, forming the station platform. This section of deck again consists of a pair of pre-stressed Super T girders connected by a topping slab. Figure 1 below shows a typical section of the structure at span 4.

The northern most part of structure consists of a shared use path deck (denoted “tramway park” in Figure 1 below), which extends for all eight spans. This is a single Super-T girder with a topping slab. Keeper walls are located either side of the girder at piers and abutments. The outer keeper walls at piers have less capacity than the inner keeper walls. Protection screens are mounted to the northern edge of this deck for spans 2 to 7.

The four independent sections of superstructure share a common substructure at all piers and abutments.

Further details of the existing shared use path structure are described in Aurecon’s Incident Investigation Report dated 18th February 2017.

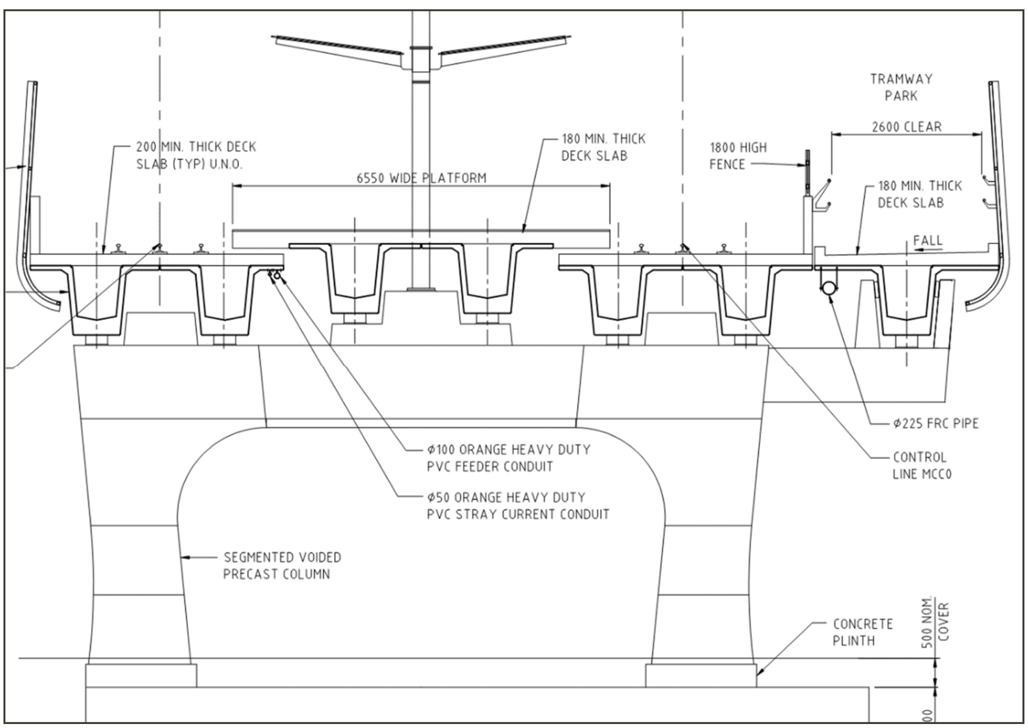


Figure 1 Typical Bridge Cross Section at Station Platform

2.2 Incident

On 18 January 2017 DPTI became aware of girder dislodgement to two spans of the South Road Tram Overpass shared pedestrian and cycle path bridge (Shared Use Path Bridge). The girder dislodgement occurred in Spans 4 and 5, between Piers 3 and 5 and resulted from a loss of support caused by a gross transverse movement of the elastomeric bearings beneath the girder soffit. The two girders of Spans 4 and 5 subsequently became unstable and have tilted about their longitudinal axis. Reinforced concrete keeper walls have acted to restrain the girders and prevented them from falling off the piers.

Figure 2 Temporary stabilising tiebacks

As a result of the incident, South Road was temporarily closed to traffic whilst stabilisation of the structure was installed. The girders have been stabilised using temporary tiebacks to the piers, as shown in Figure 1. This stabilisation is a short term measure only.

Following the installation of this temporary stabilisation, South Road was reopened to traffic, however the shared use path bridge remains closed to pedestrians and cyclists due to the gross misalignment of the footpath sections and the hazards presented by the temporary support anchors installed in the pathway.

2.3 Project Scope and Objectives

DPTI has commissioned Aurecon for the following Stages as noted in the Statement of Requirements for the project:

1. A detailed investigation into the cause of the incident. The deliverable being a report to be released by the Commissioner of Highways and appropriate for tabling in Parliament. The report will assist to inform the long term remedial solution for the shared path bridge.

   This work has now been completed.

2. Development of a proposal for the remediation of the shared path bridge. This will consist of high level concept designs of suitable options, documented as engineering sketches. Order of cost estimates for the various options will be calculated, by others. We will present the options in the context of relative ongoing maintenance/inspection needs, risk and also consider the impact of construction on South Road traffic.
3. Conduct an independent review of the DPTI bridge inspection processes. The deliverable for this scope item will be a report that assesses DPTI's approach to periodic bridge inspections, in the context of best industry practice.

This Report summarises the findings relating to Stage 2 above, specifically identifying concept options for long term remediation, and providing recommendations to proceed. Cost estimates have been prepared by others for DPTI, as discussed in Section 5.

Unlike Stage 1 of the project, which served as a stand alone independent body of work, this report acknowledges the collaborative nature of the remediation design development. As directed by DPTI, Aurecon has participated in collaborative technical workshops, along with representatives from the original bridge Contractor, Designer and Proof Engineer, in the development of remedial measures. Whilst this report outlines remediation options identified by Aurecon as feasible, we have also been involved in the collective review of concepts originally developed by others.

2.4 Stage 1 Investigation Summary

Reference is made to the separate Aurecon report “South Road Tram Overpass Shared Path Bridge – Incident Investigation Report” (ref. 255258, rev.1 18th Feb 2017), which was prepared in response to Stage 1 of the project.

The key conclusions, observations and recommendations made from the Stage 1 investigation are summarised below. This is only a partial list, covering items that relate specifically to the long term remediation of the Shared Use Path Bridge. Reference is made to the Stage 1 report for the full list of recommendations.

2.4.1 Conclusions and Observations

- The design of the bearings does not meet certain requirements of the Australian Bridge Design Standard – AS5100.
- The design did not allow for adequate restraint of the main elastomeric bearings, resulting in a loss of girder support due to gross transverse bearing movement. Lateral forces and imposed rotations on the main bearings due to the combined effects of self-weight eccentric to the bearings and wind load on the anti-throw screens has resulted in the girder tilting sufficiently to lift the top lateral restraint bar clear of the top of the bearing and essentially free the bearing, allowing it to walk transversely. Lateral movement of the bearing would then have occurred incrementally over a period of time under cycles of wind load, until the bearing had moved sufficiently for the girder to lose support and become unstable.
- All spans of the bridge are exhibiting signs of this phenomenon, with noticeable bearing deformation and girder rotation. It is likely that Spans 4 and 5 have experienced more significant girder rotation due to the exposed nature of these spans over South Road.
- The outer keeper walls that restrain the girders against transverse loading are considered inadequate for the wind loads required to be considered by the Australian Bridge Design Standard – AS5100. These walls have been overloaded resulting in horizontal cracking at their base in addition to some vertical cracking extending into the top of the crossheads.
- As a result of the large tilt of the girders at Spans 4 and 5, the deck expansion joints at the finished surface of the shared path became misaligned above Piers 3 and 5. This has resulted in distortion of the joint plates, damage to the fixings, and local concrete spalling. Failure of some connecting steel plates for the anti-throw screen as well as disconnection and misalignment of handrail spigot joints is also apparent.

2.4.2 Recommendations

- Until remediation work is complete, the anti-throw screens should be temporarily removed from the Shared Path Bridge, in order to reduce the lateral loading on the bearing system for Spans 1, 2, 3, 6, 7 & 8. It is noted that there is no need to remove screens from the southern side of the adjacent Tram Bridge. This work has now been completed by DPTI.
- A design of remediation measures should be undertaken to all spans. As part of the remediation design, all girders should be restored to their original design location, by means of jacking, incorporating an appropriate lateral restraint system.
- Repair of the damaged concrete headstocks should be undertaken.

Reference is made to Section 3 below for further discussion in relation to these two items.

3 Remediation Works

3.1 Objectives

Remedial options are directed to the deficiencies and recommendations noted in Section 2.4 above. These deficiencies are as follows;

1. Bearings: Bearing overloaded laterally with the capability of walking out, and large imposed lateral rotations, at all piers and abutments.
2. External keeper walls: Walls overloaded and cracked at the piers. A solution that either does not require load transfer to the existing outer walls or that looks to replace the existing walls is required. The walls have been overloaded and therefore can no longer be relied upon.

   This does not apply at the abutments where calculations indicate the keeper walls have sufficient strength and there are no visual signs of overloading.

3.2 Workshops

In keeping with DPTI's request for a collaborative effort to establish the best remedial solution, Aurecon attended workshops on 2nd March 2017 and 7th March 2017 held with DPTI and the Contractor for the original construction of the bridge, the Contractor's designer and the Contractor's proof engineer. Various options were presented and discussed.

The following presents a list of options that Aurecon considers feasible, and provides a recommendation of the preferred option.

3.3 Bearings

The following sections describe available solutions identified for the bearing rectification.

3.3.1 New Pot Bearing

The existing laminated elastomeric bearing has become overloaded, and subsequently failed due to the inability of the bearing to resist lateral loads generated by both an eccentric dead load and wind load applied to the protection screen. Simply put, elastomeric bearings resist lateral load by shearing of the elastomer, and on Aurecon's calculations no elastomeric bearings are suitable for this purpose without additional lateral restraint.

This solution therefore comprises replacing the existing elastomeric bearings with pot bearings. Two types of pot bearings are required to suit the existing bridge articulation; fixed (pot-stay) bearings and guided (pot-glide) bearings. Both bearing types resist lateral load by a positive steel on steel contact with negligible deflection.

The new pot bearings would be aligned as close as practical with the dead load centroid of the superstructure, thus reducing the permanent lateral load and rotation. The pot bearings are a smaller unit than the elastomeric bearings that they are replacing, and based on a preliminary assessment, it appears that the new bearings can be simply located on the existing bearing plinths with new holding down bolts cored into the existing headstock. It is noted that the lower baseplate on the bearing can be rotated in plan if necessary to avoid striking reinforcement in the headstock.

3.3.2 New Laminated Elastomeric Bearing

This option comprises a new elastomeric bearing, located as near as possible to the centre of mass to reduce the dead load eccentricity and resultant lateral load. Due to the inability of elastomeric bearings to resist significant lateral loading as described above, and to ensure the bearing does not walk out, this option must also include the following;

1. Provide steel keeper plates to restrain the main elastomeric bearing at both the top of the bearing (connected to the girder via the bearing top plate) and at the bottom of the bearing (connected to the headstock via the bearing bottom plate).
2. Installation of an additional restraint to minimise the lateral demands on the bearing. This could be in the form of bottom side bearings against the keeper walls, or a separate restraining device. Where side bearings are required, the bearings should be in contact with girder webs following girder alignment correction. A PTFE strip/pad or similar would therefore be required at the contact interface to permit free longitudinal girder movement and rotation. There would also need to be strain compatibility between the bottom side bearings and bottom main bearing.

3.4 External Keeper Walls

The following sections describe available solutions identified for the keeper wall rectification at the piers.

3.4.1 Rebuild the keeper wall as a stronger unit using cast in situ concrete

Due to the large extent of reinforcement in the top face of the headstock this option would require coring into the end face of the headstock and grouting reinforcement as starter bars for a new cast in situ keeper wall running up from the end face of the headstock. For this option there is the alternative of either leaving the existing keeper wall in place, and building in front of it or demolishing the existing keeper wall. It is noted that this option requires extensive work to each of the piers and substantial disruption to the traffic on South Road is anticipated.

This solution will be very noticeable visually and could make the keeper walls a dominant visual element.

3.4.2 Rebuild the keeper wall as a stronger unit using precast concrete

- Refer sketches: 255258-0001-SKT-SS-0001 to 0004 (Appendix A)

This option is similar to the option described above except that the new keeper wall would comprise a single precast unit stressed against the end of the headstock. Significant coring will be required for the connecting stress bars. This option is expected to require less construction time on site than a cast in situ keeper wall, although significant disruption to the traffic on South Road is still required.

As per the in situ wall, this could make the keeper walls a dominant visual element.

As for the cast in situ option, the existing keeper wall could be retained avoiding demolition, although this would require a local modification to the curved base of the anti-throw screen to provide clearance to the new keeper wall, as illustrated on sketch 255258-0001-SKT-SS-0004.

Whilst the sketches show a new laminated elastomeric bottom bearing with new bottom side bearings, as previously outlined in Section 3.3, a bottom pot bearing may be used instead which would negate the need for the bottom side bearings and potential extension of the bearing plinth.

3.4.3 Tie the deck to the adjacent Tram Bridge

- Refer sketches: 255258-0005-SKT-SS-0001 and 0003 (Appendix A)

The structural purpose of the keeper wall is to stabilise the girder under the couple produced by the wind load and eccentric dead load. This couple translates to a lateral load applied near the top of the keeper wall via a side bearing and at the bottom via the main bearing. The lateral load applied to the keeper wall can be eliminated by tying the girder at deck level to the adjacent Tram Bridge. It is noted that the Tram Bridge resists lateral loading via a secure shear key at bearing level. The tie can readily be facilitated via a steel connection, hinged at both ends to allow for any small differential movement the adjacent bridges.

Whilst the feasibility of this option is subject to a detailed assessment of the structural adequacy of the tram bridge, at this stage no issues have been identified with respect to the tram bridge that would preclude this option. If connecting the two sections of deck, an assessment of earthing and bonding requirements is required.

3.5 Comparison of Options

The following tables provide a summary of the options for the purposes of comparison for both the bearing and keeper wall remediation.

Table 1 Bearing Remediation Comparison

Option	Advantages	Disadvantages
1 – New pot bearing	-The most visually discrete option - Minimal (or no) modification to existing bearing plinth - Simple load path - Very positive lateral restraint	- Holes will need to be cored for the new holding down bolts
2 – New elastomeric bearing	- In keeping with current structural system	- Difficulty in installing bottom side bearings (if used in lieu of an alternative lateral restraint) - Bearing plinth will need to be widened

Table 2 Keeper Wall Remediation Comparison

Option	Advantages	Disadvantages
1 – New keeper wall, cast insitu concrete	- In keeping with current structural system - Very low maintenance	- Visually very intrusive - More disruption to South Road traffic - Some construction risk - Very slow construction time
2 – New keeper wall, precast concrete **(Sketches: 255258-0001-SKT-SS-0001 to 0004)**	- In keeping with current structural action - Little maintenance required	- Visually very intrusive - More disruption to South Road traffic - Moderate construction risk - Slow construction time

3 – Tieback to adjacent tram bridge **(Sketches 255258-0005-SKT-SS-0001 and 0003)**	- Least visually intrusive - Less disruption to South Road traffic - Low construction risk - Fast construction time - Lowest cost - Locations of tieback not confined to piers (multiple ties permitted along girder length, if required)	- Requires some access to tram bridge deck - External system requires selection of durable materials. Some maintenance of protective coatings is required, but this is expected to be minimal. - The tie would need to be detailed to avoid the longitudinal drainage pipe

3.6 Other options reviewed and discarded

Other options that have been considered, but eventually discarded, are summarised below.

3.6.1 New Anti-throw Screen

All options discussed in the preceding sections consider the existing anti-throw screens being reinstalled. These options can be designed to readily cater for the existing screens.

We have considered replacement of the existing anti-throw screen with a more lightweight, porous structure. This option would reduce both the weight of the screen and horizontal wind load, and therefore reduce demands on the bearing. However, this would only partially solve the problem, and a system as described above to resist rotation of the girder would still be required. Thus strengthening of the keeper walls or connecting the superstructure to the Tram Bridge, for example, would still be necessary.

Given that some form of strengthening, albeit of a reduced scope/price due to reduction in load would still be required, and that a significant change of appearance would result from a change of screen, this option was not pursued further by Aurecon.

3.6.2 Rotationally Fixed Pot Bearing

By providing full translational horizontal and rotation fixity at bearing level, either the need for keeper walls or tying the structure back to the Tram Bridge is obviated. However, there are no proprietary bearings that would achieve this. There is also insufficient space available to purpose design a bearing connection both tying the girder down and facilitating longitudinal movement.

3.6.3 External vertical tie-down

This involves providing an external vertical tie-down from the deck to the headstock. Due to the bridge skew, and the geometric inability to readily align the tie down with the bearing centreline, this detail will induce fixity into the girder at the ends, and also has the potential to induce excessive vertical load into the girder. It is also a more complex system likely to involve a higher level of maintenance compared with other solutions.

3.7 Remediation at Abutments

The concepts outlined in preceding sections have been developed specifically in relation to the piers.

At the abutments, remediation of the bearing is required, as described for the piers.

As previously noted, remediation of the keeper wall is not required at the abutments. As per the typical abutment cross section shown on sketch 255258-0000-SKT-SS-0003, the internal keeper wall detail is provided either side of the shared use path girder at the abutments. The abutment keeper walls have a higher capacity than the external keeper walls provided at the piers, and no cracking of the abutment walls was observed during the Stage 1 investigation.

Further, anti-throw screens are not installed on end spans 1 and 8 of the Shared Path Bridge, and thus lateral loads are also greatly reduced at abutment bearings.

3.8 Miscellaneous Repair Items

In addition to the work required to remediate the bearings and external keeper walls, the following works will also be required as a minimum, irrespective of the remediation option adopted.

- Confirm extents and repair cracking at base of outer keeper walls by suitable method, such as epoxy injection
- Replace top side keeper bearings at Piers 3, 4 and 5, if these bearings are required under the final remediation solution. Top side keeper bearings at remaining piers and abutments may be reused provided it can be demonstrated that they have not been damaged as a result of the girder movement.
- Repair damaged path joint plates and connections, and concrete spalling
- Remove temporary stabilising brackets and suitably reinstate corresponding cored holes through the deck
- Reinstating jointing material between the shared use path girder and the tram bridge girder, as required
- Repair anti-throw screen connections to posts
- Repair handrails at joints
- Assess the condition and need to repair or replace CCTV conduits/cables
- Assess the condition and need to repair or replace foot lighting and corresponding cables
- Assess the condition and need to repair or replace the drainage pipe
- Reinstate anti-throw screens

3.9 Construction Methodology

As part of the collaborative workshops referred to in Part 3.2 above, a construction methodology for the remediation was presented by McConnell Dowell. Following issue of Revision 1 of this report, McConnell Dowell has further developed a construction methodology and presented it with a letter to DPTI, dated 2 May 2017. Annexures 2 and 3 to this letter provide, respectively, a proposed scope of works for the remediation solution and a methodology for minimising disruption to tram and South Road users during the remediation works.

Aurecon has reviewed this submission from McConnell Dowell, including the above referenced Annexures and finds the contents to be satisfactory in general, noting that the methodology is at a high level only. Our only specific comment on the Draft Scope of Works relates to the temporary bracing structure, which will require modification prior to beam lifting/re-alignment.

Noting this comment and the fact that detailed design, verification, review, etc have yet to be undertaken, the proposed methodology is consistent with the discussions at the workshops and is considered to be appropriate.

3.10 Additional Considerations for Detailed Design

Before the preferred scheme is developed, it is recommended that all aspects of the design basis are agreed upon.

Some additional items for consideration during design development of the remediation works include:

- Provision for out of balance live load. For example, under serviceability limit state conditions, out of balance live load should be considered in combination with wind load (i.e. Ws+0.7LL or 0.7Ws+LL). This applies to new and existing portions of structure.
- Fatigue design under wind loading. For example, where reliance is on the existing ferrules in the girder soffit for connecting the bearing to the girder, both bolt strength and fatigue requirements are to be assessed. Design fatigue wind speed and number of stress cycles need to be confirmed and agreed, if not originally specified as part of the original bridge design.

4 Recommendations

In order to reduce the lateral load on the bearings to their design capacity and prevent the bearings walking out in service, it is recommended that the bearings be replaced by new pot bearings located on or close to the centroid of dead load of the superstructure.

This option has the advantages of being visually discrete, requiring minimal or no modification to the bearing plinth, providing a simple load path and allowing efficient construction with minimal disruption to traffic on South Road in particular.

Whilst elastomeric bearings may be technically feasible if properly designed and detailed (e.g. adequately restrained and demands kept to a minimum through the use of an additional lateral restraint), Aurecon considers a pot bearing provides the most long term certainty with respect to dealing with lateral forces.

In order to remove loading on the understrength pier external keeper walls, it is recommended that the girder is fixed at deck level to the adjacent Tram Bridge using a tie. The tie can be readily facilitated via a steel connection, hinged at both ends to allow for differential movement between adjacent bridges.

The tie option is the most visually unobtrusive and allows efficient construction with minimal disruption to traffic on South Road.

A number of miscellaneous repair items are also required as noted in Section 3.7 of this Report.

A broad construction methodology has been developed by McConnell Dowell which appears to be consistent with the preferred solution. This methodology has been reviewed by Aurecon and is considered appropriate.

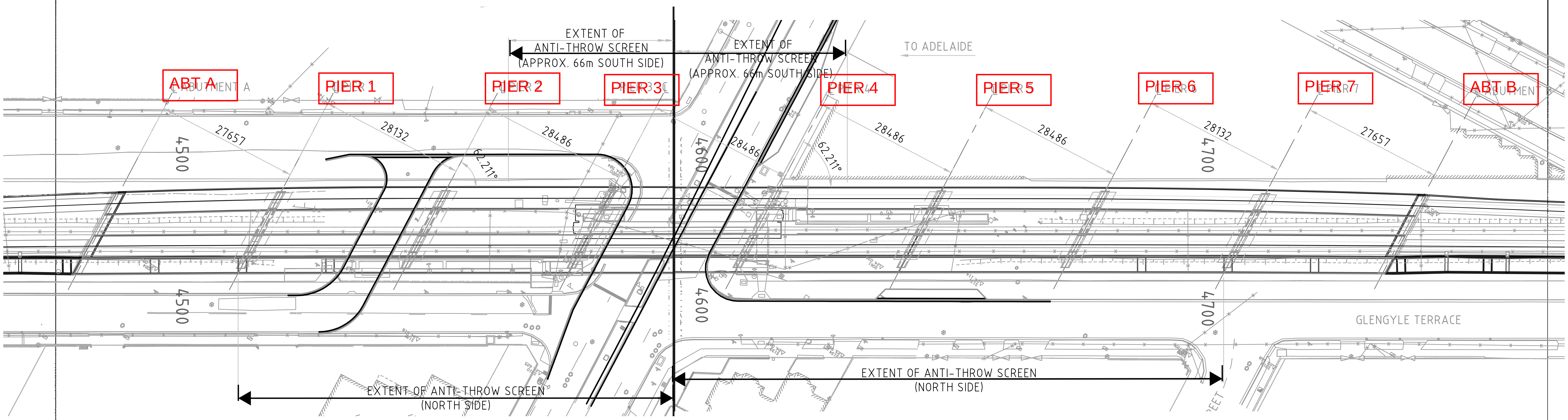
Design development of the preferred remediation option should be undertaken to a level suitable for construction purposes.

5 Costing

A high level preliminary costing estimate of the preferred remediation option has been prepared by Costplan for DPTI. This has been prepared for the purposes of an “order of cost” understanding.

The total estimate associated with the preferred solution incorporating a new pot bearing and connecting to the Tram Bridge is $1.84 M.

Appendix A
Concept Options Sketches



NOTE - REMEDIATION WORKS REQUIRED TO ALL PIERS AND ABUTMENTS

PRELIMINARY
NOT FOR CONSTRUCTION

No.	Date	Revision Details	By	Ver.	App.
B	5/5/17	FOR FINAL REPORT	JMH		
A	24/2/17	PRELIMINARY	JMH		

aurecon

ABN 54 005 139 873

A person using Aurecon Group drawings and other data accepts the risk of:
- using the drawing and other data in electronic form without requesting and checking them for accuracy against the hard copy version.
- using the drawings or other data for any purpose not agreed to in writing by Aurecon Group.

Client: DPTI

Project: SOUTH ROAD TRAM OVERPASS SHARED PATH BRIDGE - REMEDIATION OPTIONS

	Signed	Date
Drawn JMH		24/2/17
Designed JMH		
Verified		
Approved		

Drawing Title: REMEDIATION CONCEPT BRIDGE PLAN

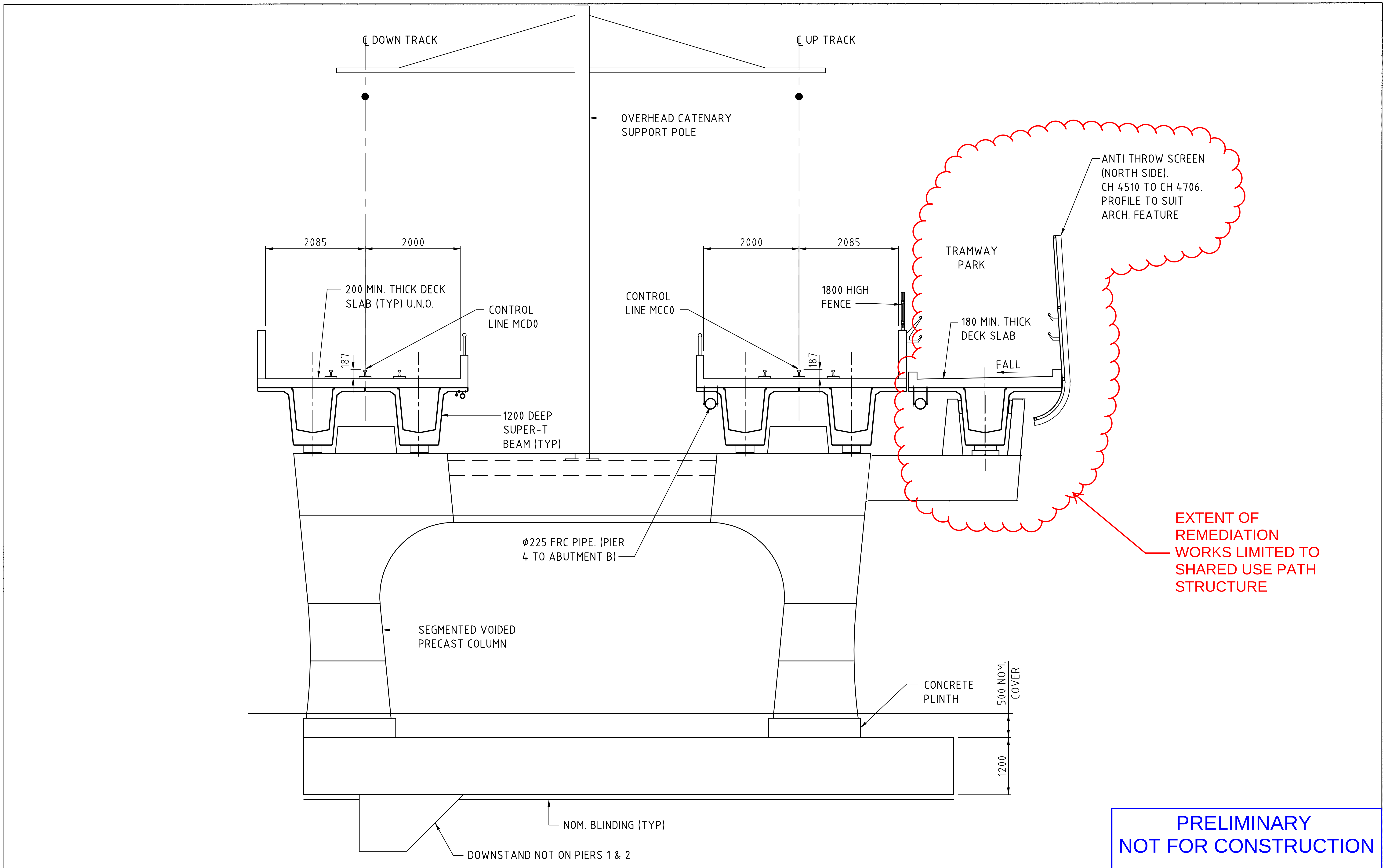
Aurecon Group Project No. 255258

Scale NTS

Drawing No. 255258-0000-SKT-SS-0001[B]

Rev.

20 10 0 10 20 30 40 50mm



PRELIMINARY
NOT FOR CONSTRUCTION

No.	Date	Revision Details	By	Ver.	App.
B	5/5/17	FOR FINAL REPORT	JMH		
A	24/2/17	PRELIMINARY	JMH		

aurecon
ABN 54 005 139 873

A person using Aurecon Group drawings and other data accepts the risk of:
- using the drawing and other data in electronic form without requesting and checking them for accuracy against the hard copy version.
- using the drawings or other data for any purpose not agreed to in writing by Aurecon Group.

Client: DPTI

Project: SOUTH ROAD TRAM OVERPASS SHARED PATH BRIDGE - REMEDIATION OPTIONS

Drawn: JMH	Signed	Date: 24/2/17	
Designed: JMH	Signed	Date	
Verified	Signed	Date	
Approved	Signed	Date	

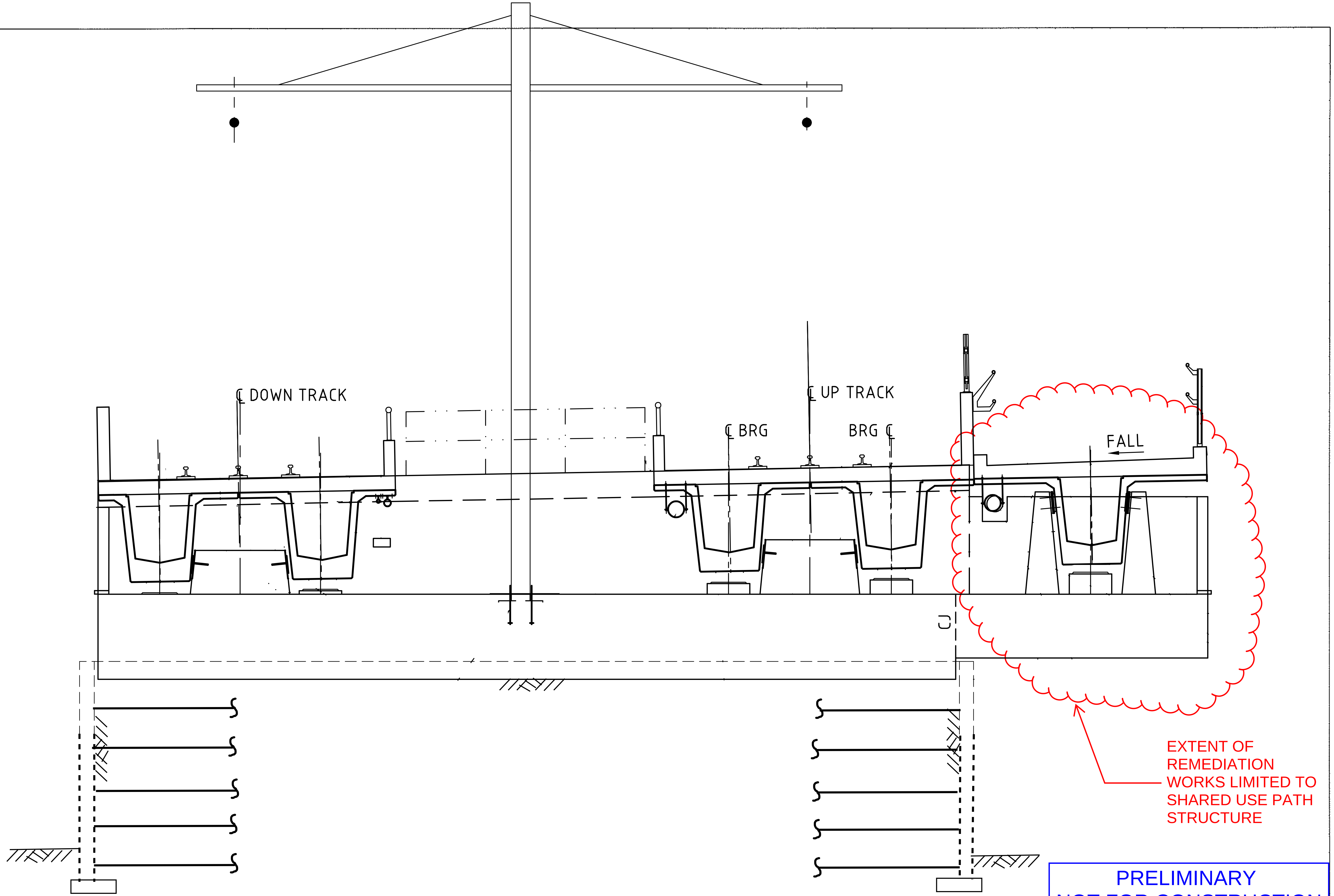
Drawing Title: REMEDIATION CONCEPT TYPICAL BRIDGE SECTION AT PIER

Aurecon Group Project No. 255258

Scale: NTS

Drawing No. 255258-0000-SKT-SS-0002[B]
Rev.

20 10 0 10 20 30 40 50mm



PRELIMINARY
NOT FOR CONSTRUCTION

No.	Date	Revision Details	By	Ver.	App.
B	5/5/17	FOR FINAL REPORT	JMH		
A	24/2/17	PRELIMINARY	JMH		

aurecon
ABN 54 005 139 873

A person using Aurecon Group drawings and other data accepts the risk of:
- using the drawing and other data in electronic form without requesting and checking them for accuracy against the hard copy version.
- using the drawings or other data for any purpose not agreed to in writing by Aurecon Group.

Client: DPTI

Project: SOUTH ROAD TRAM OVERPASS SHARED PATH BRIDGE - REMEDIATION OPTIONS

Drawn: JMH | Signed: | Date: 24/2/17
Designed: JMH | Signed: | Date:
Verified: | Signed: | Date:
Approved: | Signed: | Date:

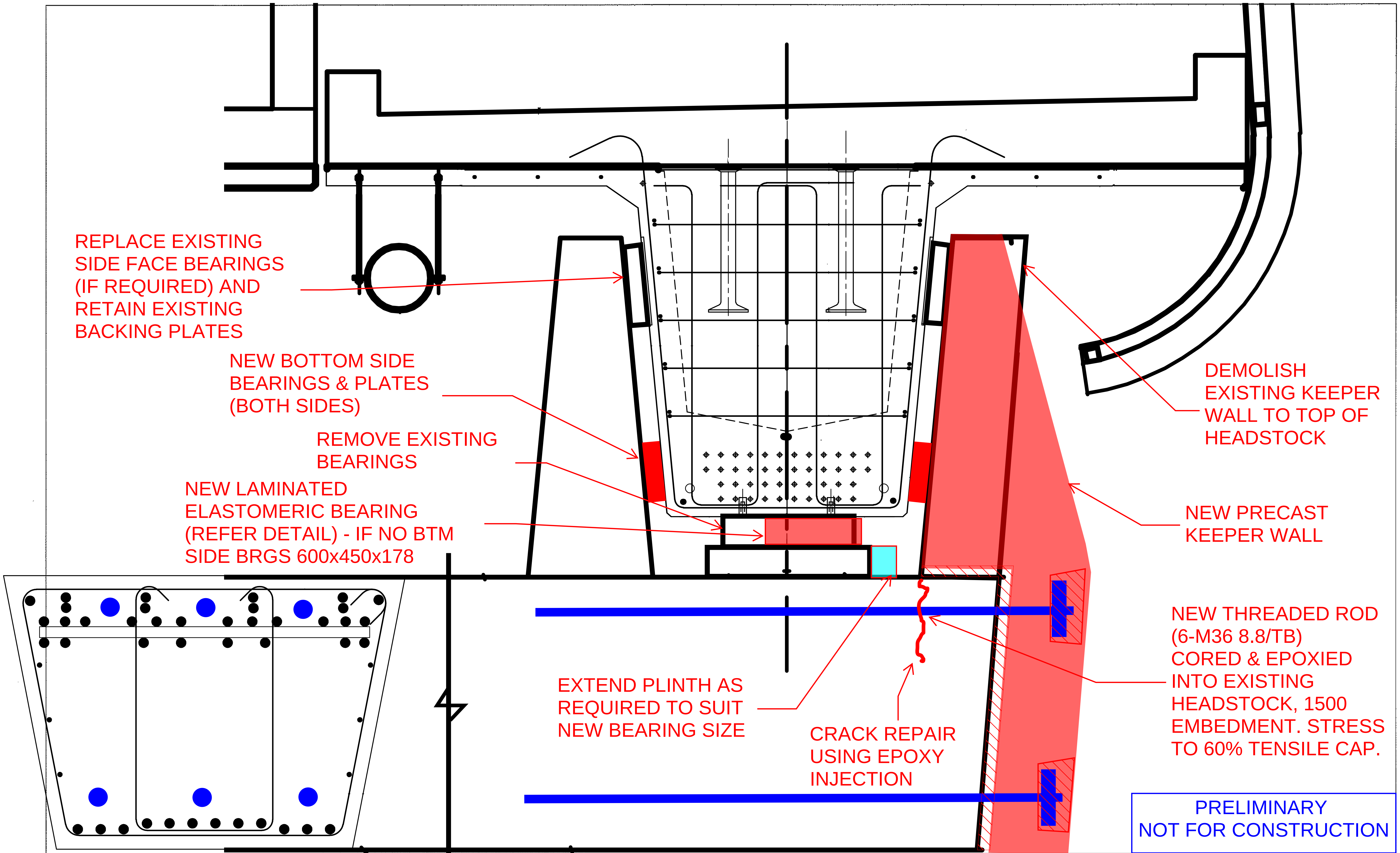
Drawing Title: REMEDIATION CONCEPT TYPICAL BRIDGE SECTION AT ABUTMENT

Aurecon Group Project No.: 255258

Scale: NTS

Drawing No.: 255258-0000-SKT-SS-0003 | Rev.: [B]

20 10 0 10 20 30 40 50mm



PRELIMINARY
NOT FOR CONSTRUCTION

No.	Date	Revision Details	By	Ver.	App.
D	5/5/17	FOR FINAL DESIGN	JMH		
C	6/3/17	PRELIMINARY	JMH		
B	4/3/17	PRELIMINARY	JMH		
A	24/2/17	PRELIMINARY	JMH		

aurecon
ABN 54 005 139 873

A person using Aurecon Group drawings and other data accepts the risk of:
- using the drawing and other data in electronic form without requesting and checking them for accuracy against the hard copy version.
- using the drawings or other data for any purpose not agreed to in writing by Aurecon Group.

Client: DPTI

Project: SOUTH ROAD TRAM OVERPASS SHARED PATH BRIDGE - REMEDIATION OPTIONS

		Signed	Date
Drawn	JMH		24/2/17
Designed	JMH		
Verified			
Approved			

Drawing Title: REMEDIATION CONCEPT PIER OPTION 1 (NOT PREFERRED)

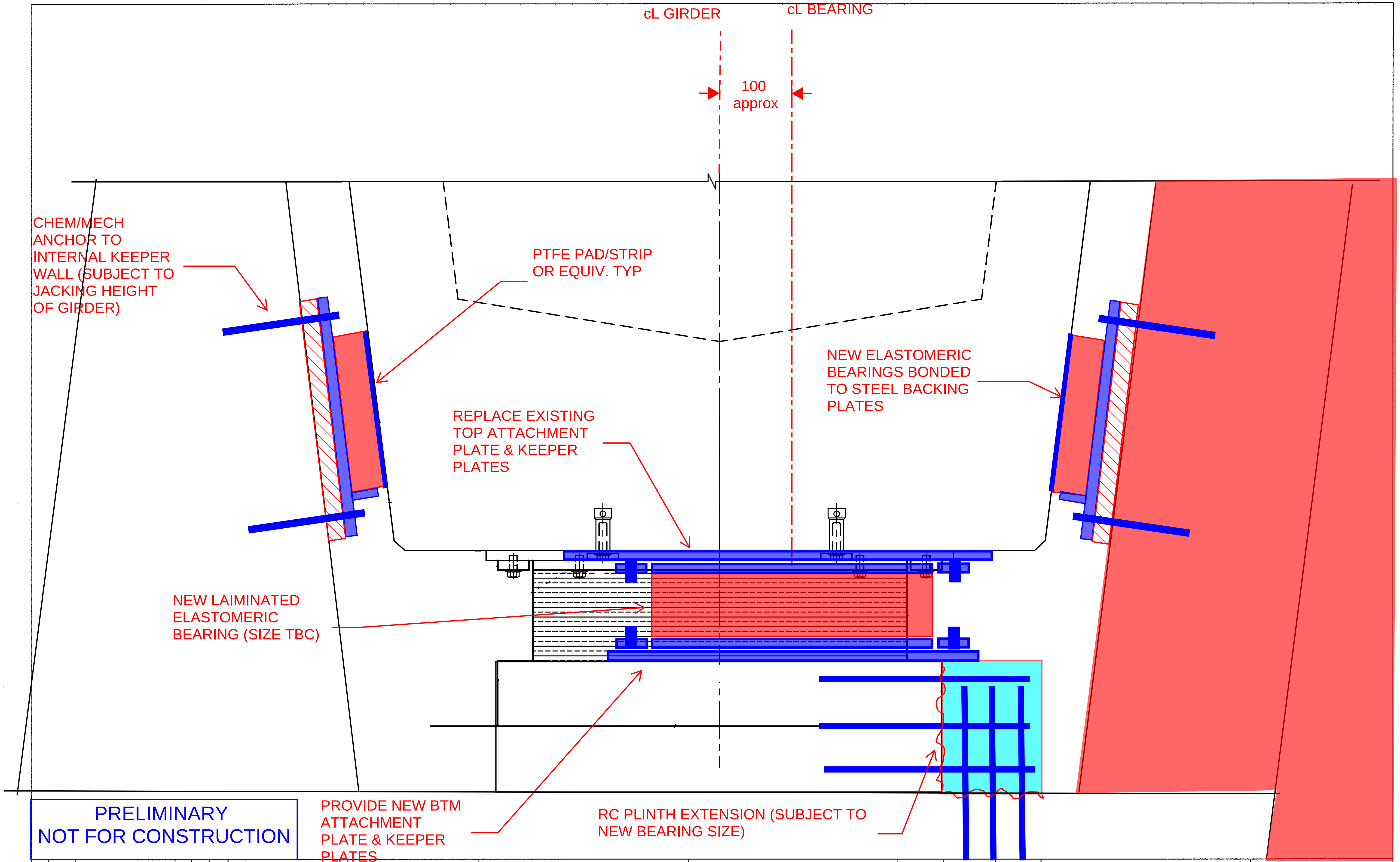
Aurecon Group Project No. 255258

Scale: NTS

Drawing No. 255258-0001-SKT-SS-0001[D]

Rev.

20 10 0 10 20 30 40 50mm



PRELIMINARY
NOT FOR CONSTRUCTION

No.	Date	Revision Details	By	Ver.	App.
D	5/5/17	FOR FINAL REPORT	JMH		
C	6/3/17	PRELIMINARY	JMH		
B	4/3/17	PRELIMINARY	JMH		
A	24/2/17	PRELIMINARY	JMH		

aurecon
ABN 54 005 139 873

Client: DPTI

Project: SOUTH ROAD TRAM OVERPASS SHARED PATH BRIDGE - REMEDIATION OPTIONS

Drawn	Signed	Date
JMH		24/2/17
Designed: JMH	Signed	Date
Verified	Signed	Date
Approved	Signed	Date

Drawing Title: REMEDIATION CONCEPT PIER OPTION 1 (NOT PREFERRED)

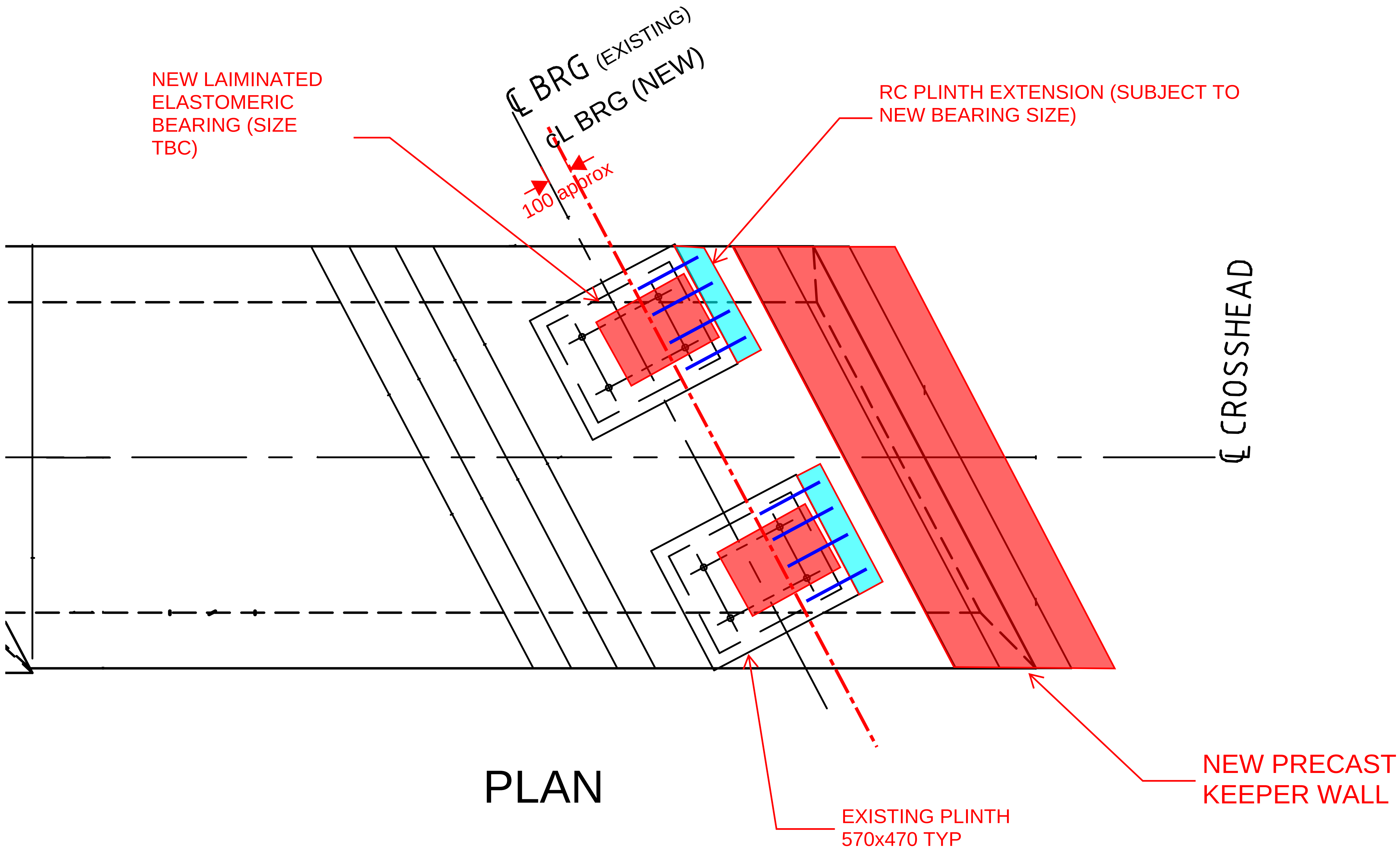
Aurecon Group Project No. 255258

Scale: NTS

Drawing No. 255258-0001-SKT-SS-0002

Rev. [D]

20 10 0 10 20 30 40 50mm



PLAN

PRELIMINARY
NOT FOR CONSTRUCTION

No.	Date	Revision Details	By	Ver.	App.
C	5/5/17	FOR FINAL REPORT	JMH		
B	6/3/17	PRELIMINARY	JMH		
A	24/2/17	PRELIMINARY	JMH		

aurecon
ABN 54 005 139 873

A person using Aurecon Group drawings and other data accepts the risk of:
- using the drawing and other data in electronic form without requesting and checking them for accuracy against the hard copy version.
- using the drawings or other data for any purpose not agreed to in writing by Aurecon Group.

Client: DPTI

Project: SOUTH ROAD TRAM OVERPASS SHARED PATH BRIDGE - REMEDIATION OPTIONS

Drawn: JMH | Signed: | Date: 24/2/17
Designed: JMH | Signed: | Date:
Verified: | Signed: | Date:
Approved: | Signed: | Date:

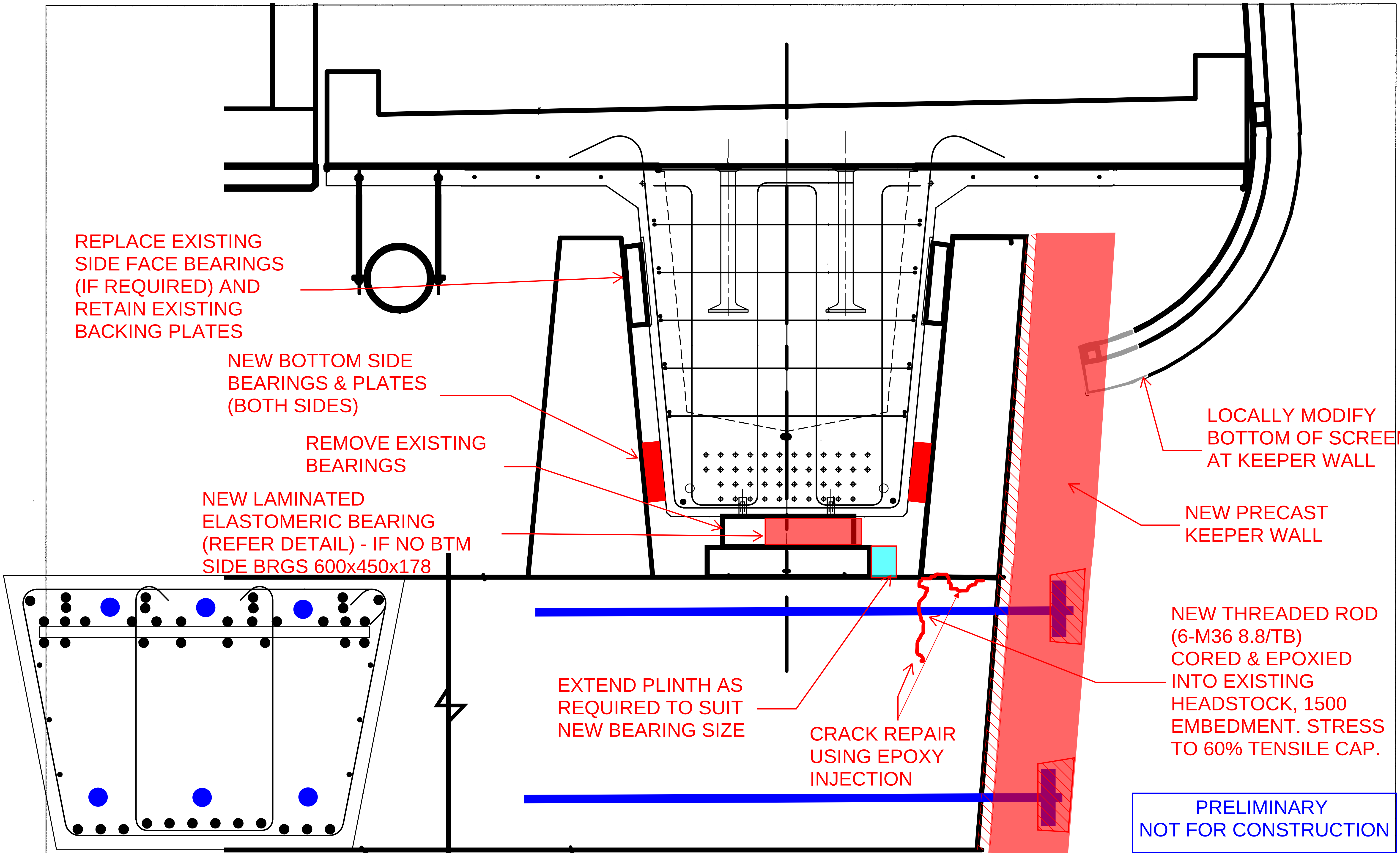
Drawing Title: REMEDIATION CONCEPT PIER OPTION 1 (NOT PREFERRED)

Aurecon Group Project No. 255258

Scale: NTS

Drawing No. 255258-0001-SKT-SS-0003[C] Rev.

20 10 0 10 20 30 40 50mm



PRELIMINARY
NOT FOR CONSTRUCTION

No.	Date	Revision Details	By	Ver.	App.
B	5/5/17	FOR FINAL REPORT	JMH		
A	6/3/17	PRELIMINARY	JMH		

aurecon
ABN 54 005 139 873

A person using Aurecon Group drawings and other data accepts the risk of:
• using the drawing and other data in electronic form without requesting and checking them for accuracy against the hard copy version.
• using the drawings or other data for any purpose not agreed to in writing by Aurecon Group.

Client: DPTI

Project: SOUTH ROAD TRAM OVERPASS SHARED PATH BRIDGE - REMEDIATION OPTIONS

	Signed	Date
Drawn: JMH		6/3/17
Designed: JMH		
Verified		
Approved		

Drawing Title: REMEDIATION CONCEPT PIER OPTION 1A (NOT PREFERRED)

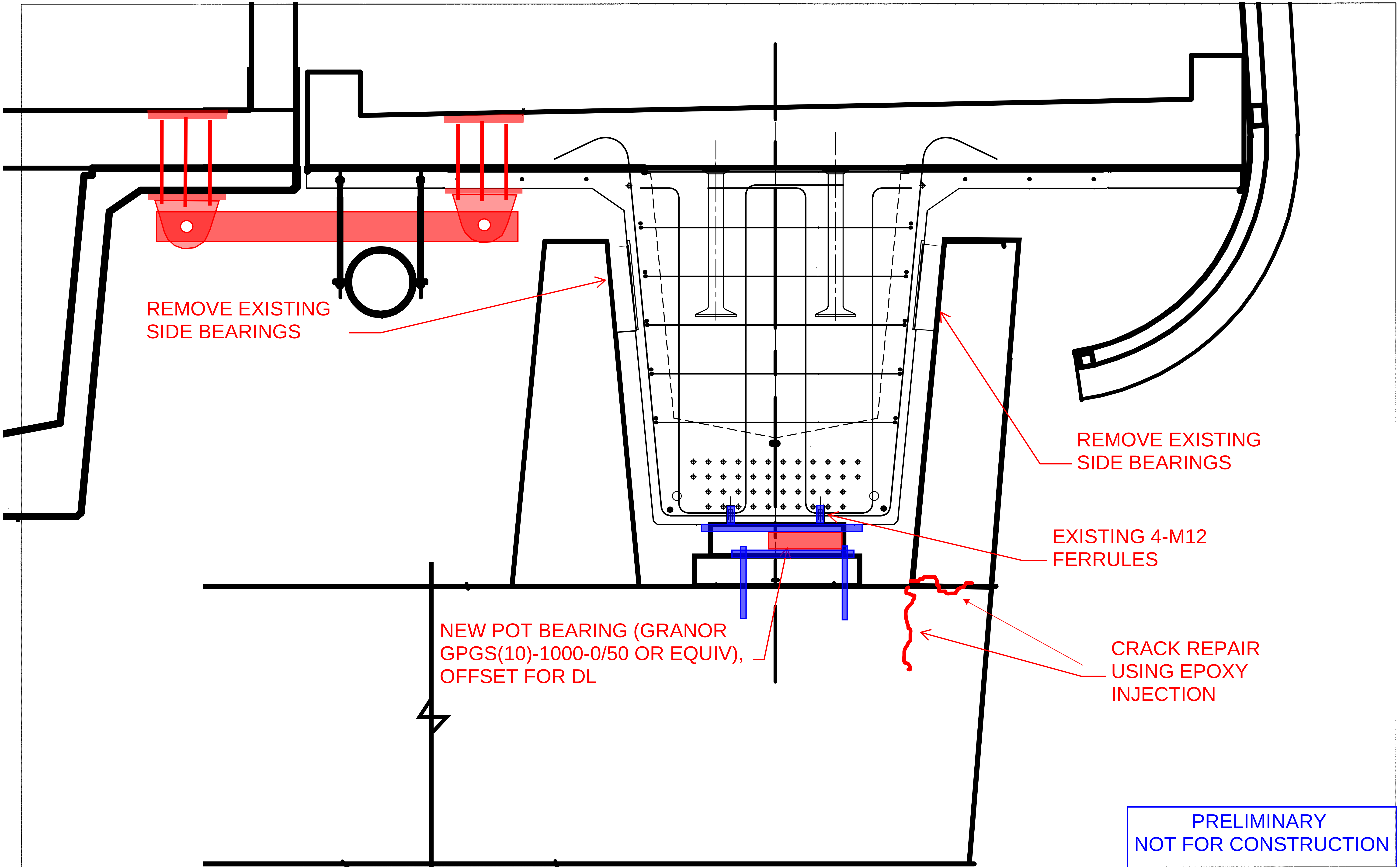
Aurecon Group Project No. 255258

Scale: NTS

Drawing No. 255258-0001-SKT-SS-0004[B]

Rev.

20 10 0 10 20 30 40 50mm



PRELIMINARY
NOT FOR CONSTRUCTION

No.	Date	Revision Details	By	Ver.	App.
D	5/5/17	FOR FINAL REPORT	JMH		
C	17/3/17	PRELIMINARY	JMH		
B	6/3/17	PRELIMINARY	JMH		
A	4/3/17	PRELIMINARY	JMH		

aurecon
ABN 54 005 139 873

A person using Aurecon Group drawings and other data accepts the risk of:
• using the drawing and other data in electronic form without requesting and checking them for accuracy against the hard copy version.
• using the drawings or other data for any purpose not agreed to in writing by Aurecon Group.

Client: DPTI

Project: SOUTH ROAD TRAM OVERPASS SHARED PATH BRIDGE - REMEDIATION OPTIONS

Drawn: JMH	Signed	Date: 4/3/17	
Designed: JMH	Signed	Date	
Verified	Signed	Date	
Approved	Signed	Date	

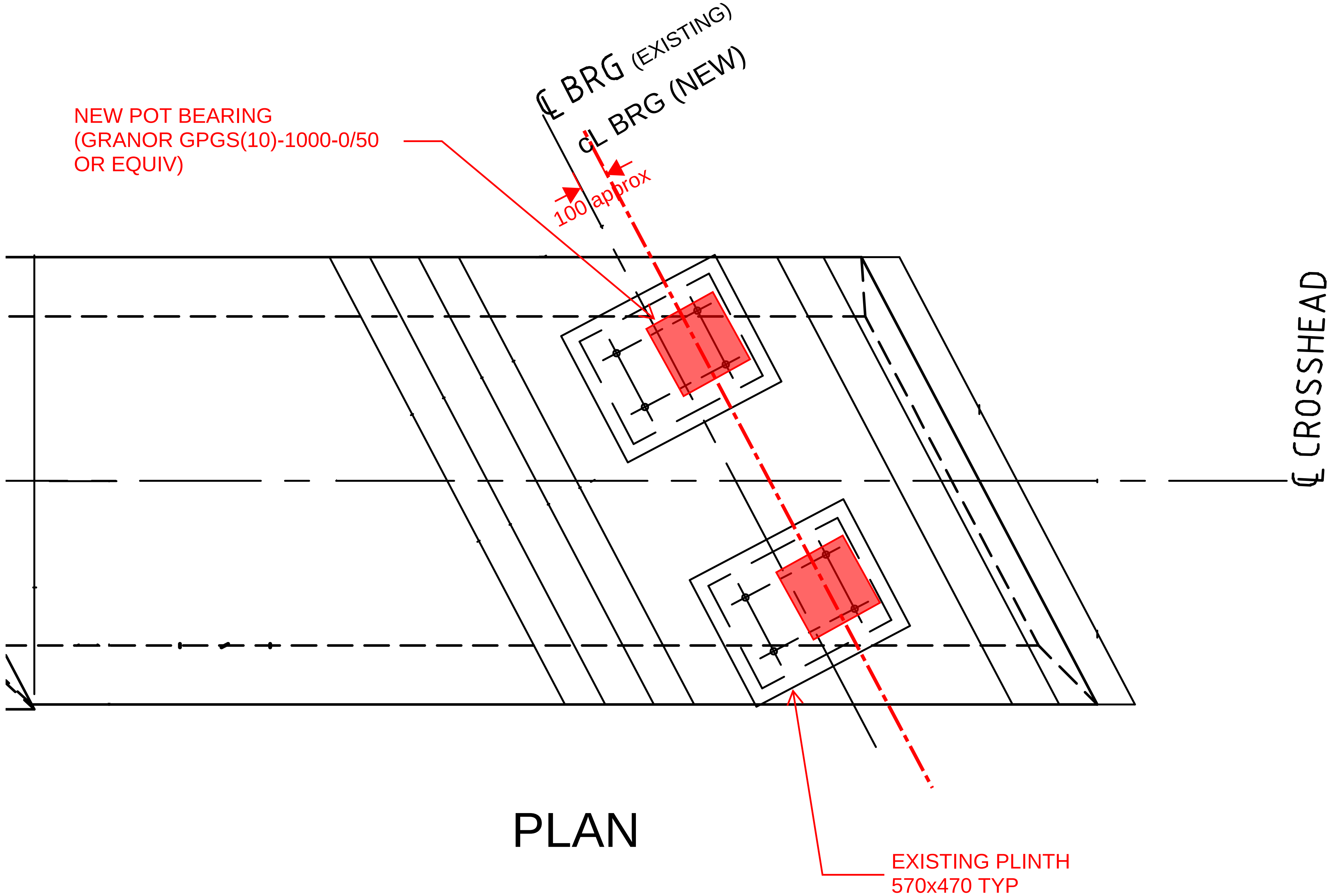
Drawing Title: REMEDIATION CONCEPT PIER OPTION 5 (PREFERRED)

Aurecon Group Project No.: 255258

Scale: NTS

Drawing No.: 255258-0005-SKT-SS-0001 Rev.: [D]

20 10 0 10 20 30 40 50mm



PLAN

PRELIMINARY
NOT FOR CONSTRUCTION

No.	Date	Revision Details	By	Ver.	App.
B	5/5/17	FOR FINAL REPORT	JMH		
A	17/3/17	PRELIMINARY	JMH		

aurecon
ABN 54 005 139 873

Client: DPTI

Project: SOUTH ROAD TRAM OVERPASS SHARED PATH BRIDGE - REMEDIATION OPTIONS

Drawn: JMH	Signed	Date: 17/3/17	
Designed: JMH	Signed	Date	
Verified	Signed	Date	
Approved	Signed	Date	

Drawing Title: REMEDIATION CONCEPT PIER OPTION 5 (PREFERRED)

Aurecon Group Project No.: 255258

Scale: NTS

Drawing No.: 255258-0005-SKT-SS-0003[B]

Rev.

20 10 0 10 20 30 40 50mm

Aurecon Australasia Pty Ltd
ABN 54 005 139 873
Level 10, 55 Grenfell Street
Adelaide SA 5000
Australia

T +61 8 8237 9777
F +61 8 8237 9778
E adelaide@aurecongroup.com
W aurecongroup.com

Aurecon offices are located in:
Angola, Australia, Botswana, China, Ghana, Hong Kong, Indonesia, Kenya, Lesotho, Macau, Mozambique, Namibia, New Zealand, Nigeria, Philippines, Qatar, Singapore, South Africa, Swaziland, Tanzania, Thailand, Uganda, United Arab Emirates, Vietnam.