ROCKLEA TO DARRA Ipswich Motorway Upgrade – Little Doris Creek Bridge

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All Photos, Images, and BIM views are courtesy of TMR / BCC, Bielby Hull & Albem and BG&E/Cardno JV.

Project Overview

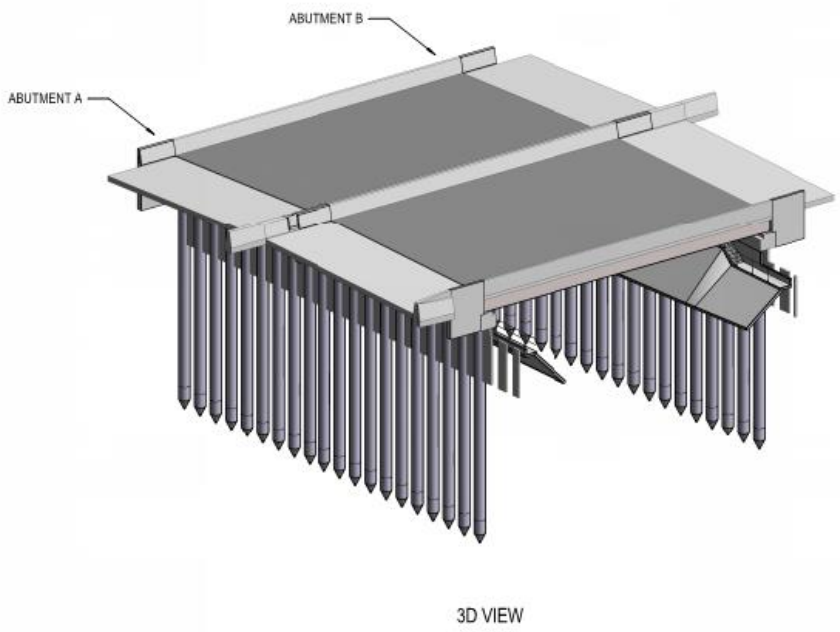
- Upgrade of Ipswich Motorway Rocklea to Darra stage 1 between Grannard Rd to Oxley Roundabout. Approximately 3km of Mwy upgrade from 4 to 6 lanes
- Design and Construct Team – BG&E/Cardno with Bielby Hull & Albem (BHA)
- Client – TMR (Motorway upgrade) / (BCC Service Road Upgrade)
- Project cost is approximately $400M which is a 50:50 joint funded project between the Australian and Queensland Government
- 3 bridge crossings over creeks with a total of 12 bridges for the Project
- Oxley Creek Bridges – 2 Motorway Bridges and 2 Service Rd Bridges
- Oxley Creek Overflow Bridges - 2 Motorway Bridges and 2 Service Rd Bridges
- Little Doris Creek - 2 Motorway Bridges and 3 Service Rd Bridges/Ramps
- Randolph Street Culverts replacement
- 8 retaining walls (RC cantilever, mass block wall & soldier pile wall)
- All Structural Design delivered as a Building Information Model (BIM) using Revit

Typical Bridge Structural Form

- Bridge Superstructure Form
  - Standard QLD 20 TO 25m long Deck Unit bridges with in-situ deck (Motorway Bridges for TMR)
  - Modified 20m long deck unit bridges (winged planks) for Service Rd bridges for BCC
- Bridge substructure Form
  - Driven PSC Piles (550 octagonal)
  - Driven steel tubes filed with RC concrete with precast concrete driving shoe. (supplementary Specification developed based off MRTS64.)
- 1 new 5 cell RCBC culvert crossing at Randolph street (constructed in stages)
- 2 existing culvert widenings at Little Doris Creek

Typical Bridge Arrangement

Oxley Creek Overflow Bridge – Winged Planks with PSC Driven Piles



Little Doris Creek Bridge – Std TMR Deck Unit Bridge with in-situ RC deck founded on Steel Driven Tube Piles filled with RC

Wall structures

- 8 Retaining Wall designs including one Early Works Design package
- Reinforced Concrete Cantilever Walls up to 3m high
- RC walls with integral road barriers
- Soldier pile wall with in-situ concrete facing
- Mass block walls
- Temporary sheet pile walls at Little Doris Creek Bridges

Walls

RC Wall with
Integrated barrier

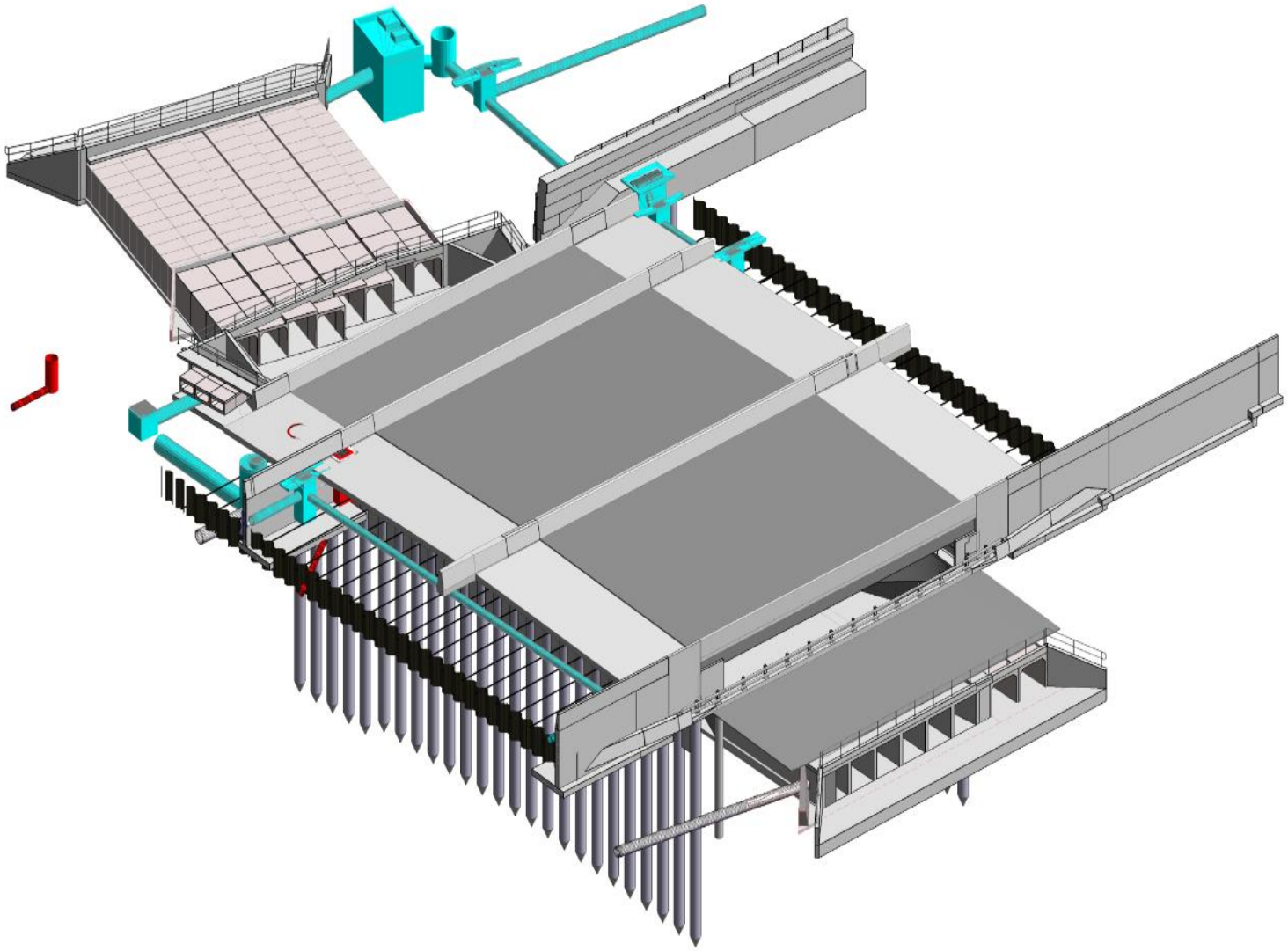
Soldier Pile Wall

Mass Block Wall

Mass Concrete Block Wall

Little Doris Creek Bridge - Features

- Single 25m span Std TMR Deck Unit Bridge with composite RC Deck
- Top down construction method
- Abutments supported on non standard Steel driven tube piles (filled with RC) at 1.75m c/c with a precast concrete driving shoe
- Temporary tie back system incorporating steel tie rods connected to a sheet pile wall
- Rock filled concrete lined berm (looks like spill through but it’s not)
- Staged construction over existing 8 cell box culvert structure
- Staged demolition of existing culverts



Little Doris Creek Bridge –
Isometric View

Aerial View Project to Date

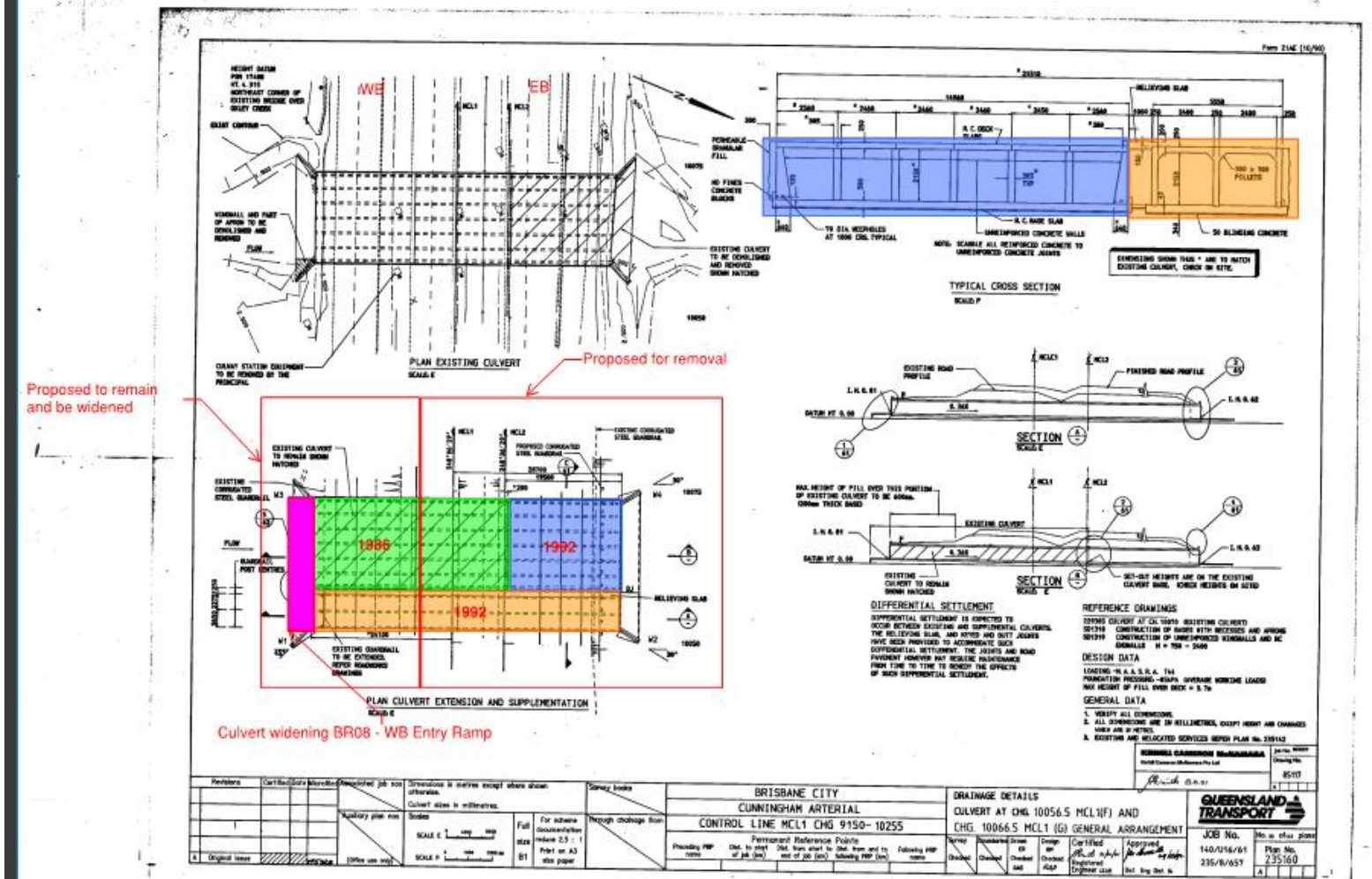
Little Doris Creek Site

Little Doris Creek Site

Little Doris Existing Culverts

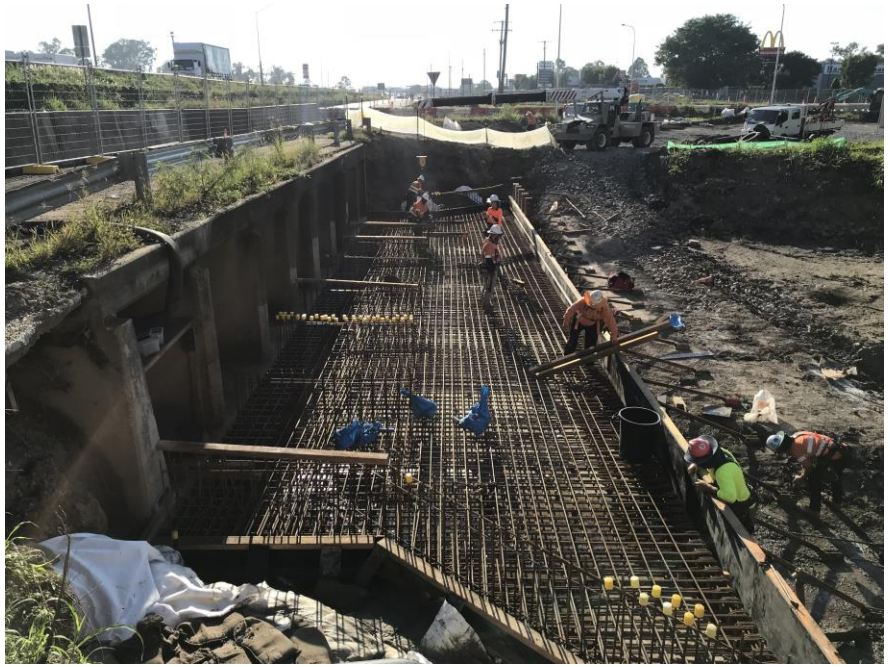
- 6 / 2135 x 2135 precast culverts and a twin cell culvert 2400 x 2400 on the western most side
- culverts were constructed over two stages between the late 1980s and early 1990s and were a replacement of the original 6 / 7’ x 7’ culverts which were constructed in the 1960s.
- 200mm thick reinforced concrete base slab, 305mm thick unreinforced concrete walls and simply supported reinforced concrete roof slabs
- determined that the existing six cell culverts have sufficient structural capacity to support the increased fill heights of 2.0m

Existing Culverts Level 2 Inspections



Existing Culvert widening
BR08 – Blunder Rd Exit Ramp

Culvert Apron Slab



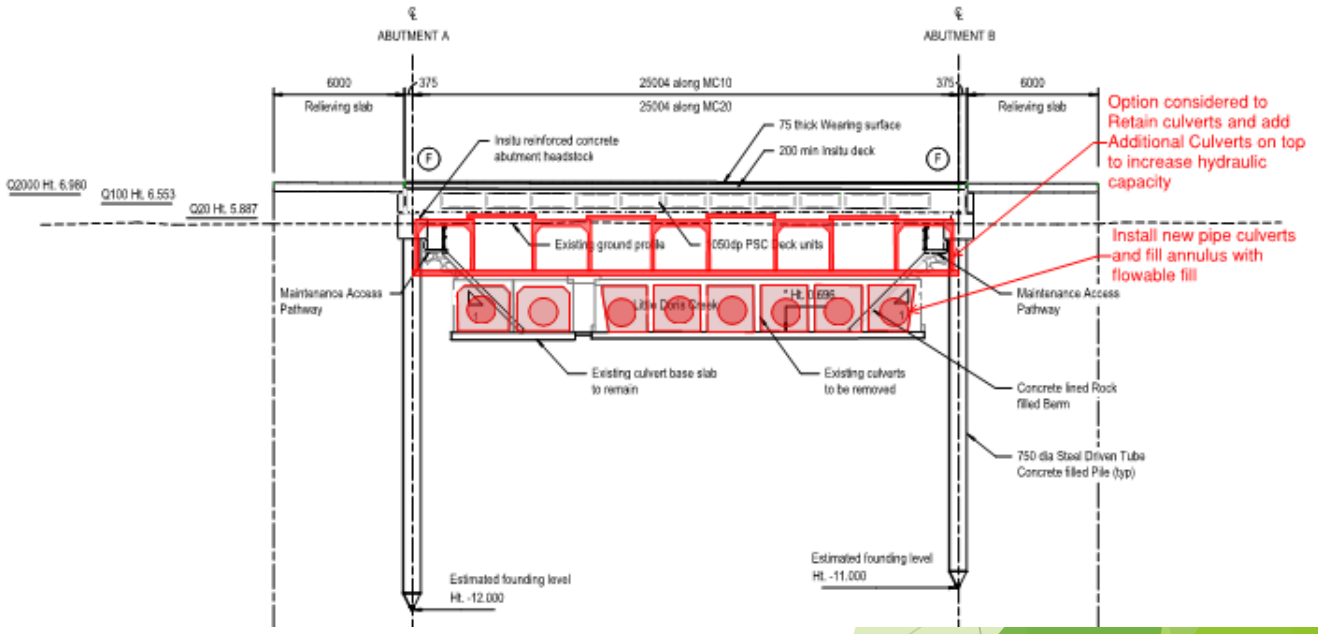
Culvert Wingwall / Headwall Construction

Retention and Strengthening Options

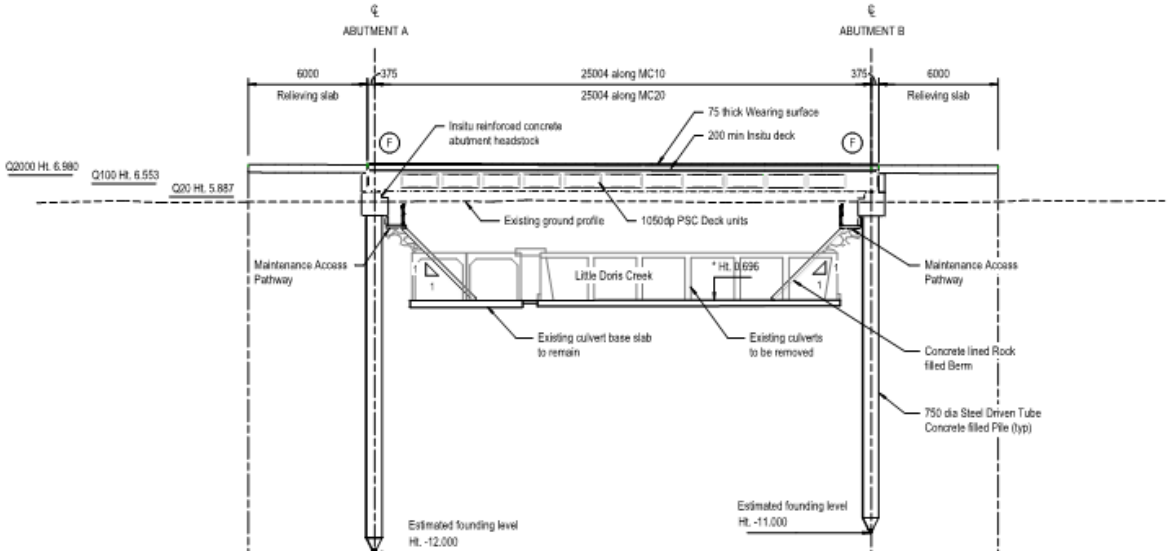
- Option developed to strengthen and retain existing culverts
- Insert pipes and fill annulus with flowable fill
- Rehabilitate to ensure a 100 year design life
- Enhance hydraulic capacity with construction of additional row of culverts on top of the existing culverts

Bridge Option Comparison

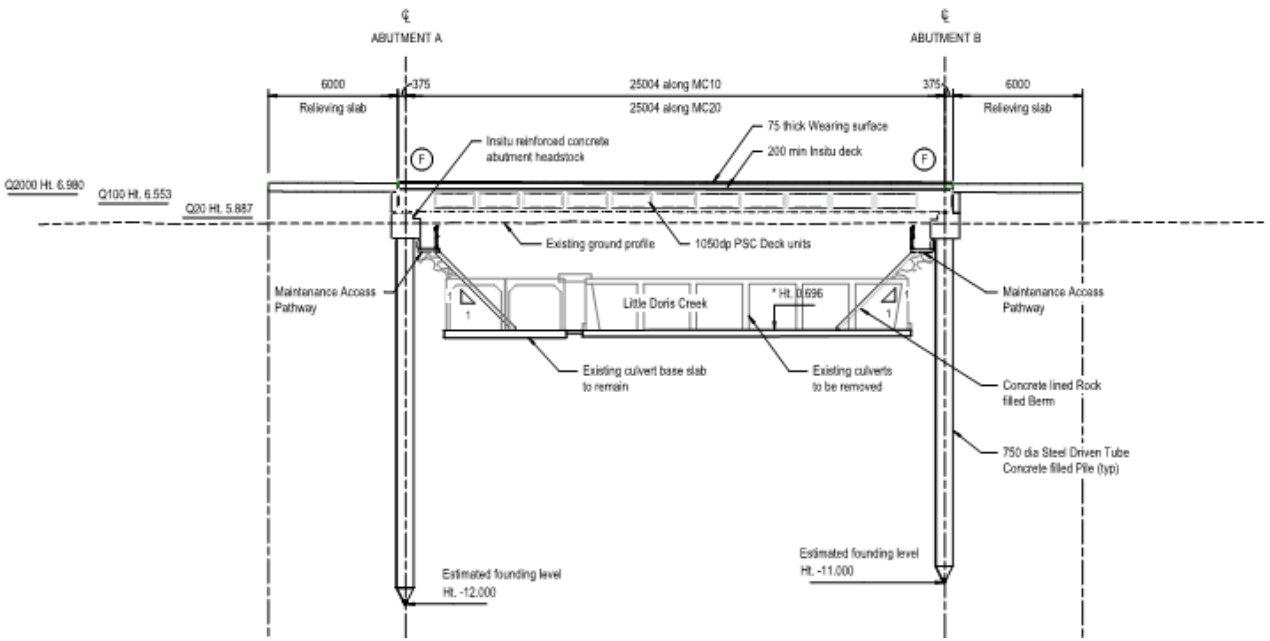
Retain Culverts Option



Replace Culverts with Bridge

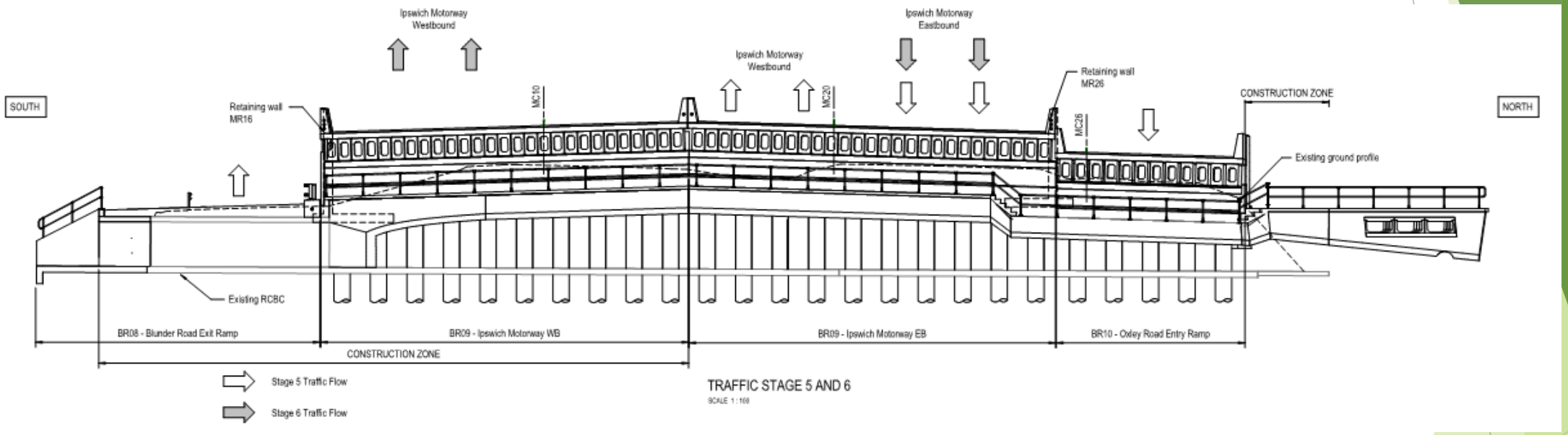


Final Bridge Option



- Single Span 25m 1050mm deep Deck Unit
- 200mm Min RC Deck
- Twin bridges separated by 40mm
- Top down Construction supported by abutment piles and shotcrete facing
- Propped bridge (Fixed each end)
- Steel tube piles filled with RC
- Constructed in stages. EB Constructed first followed by WB. Existing culverts demolished in stages
- Temporary tie back system during construction
- RC berm to aid water flow and temporary stability

Final Bridge Layout

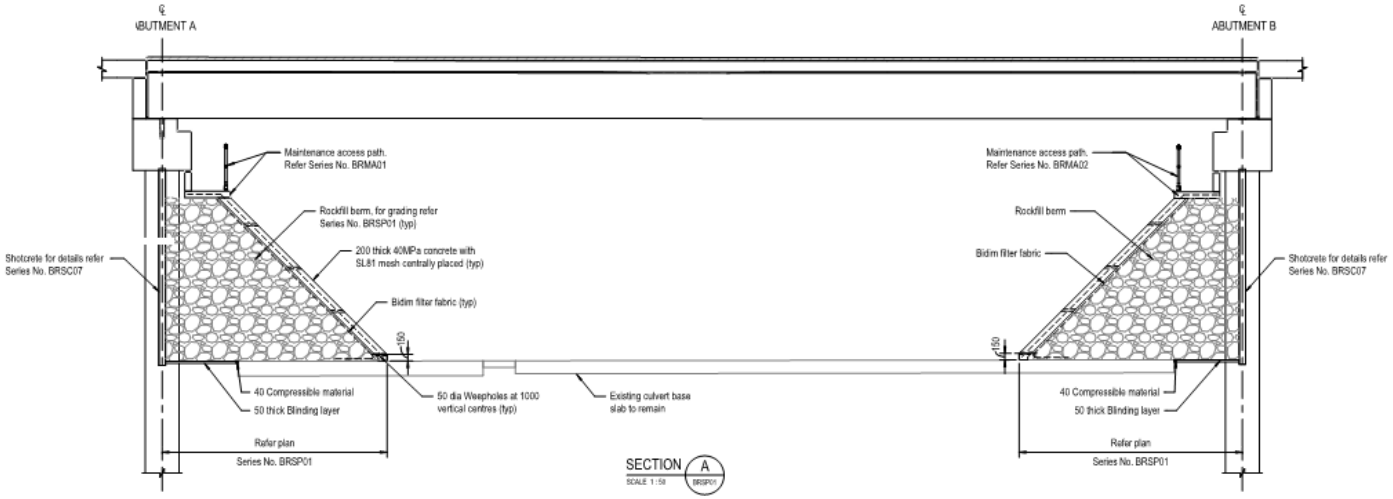


BR08 - WB
culvert widening

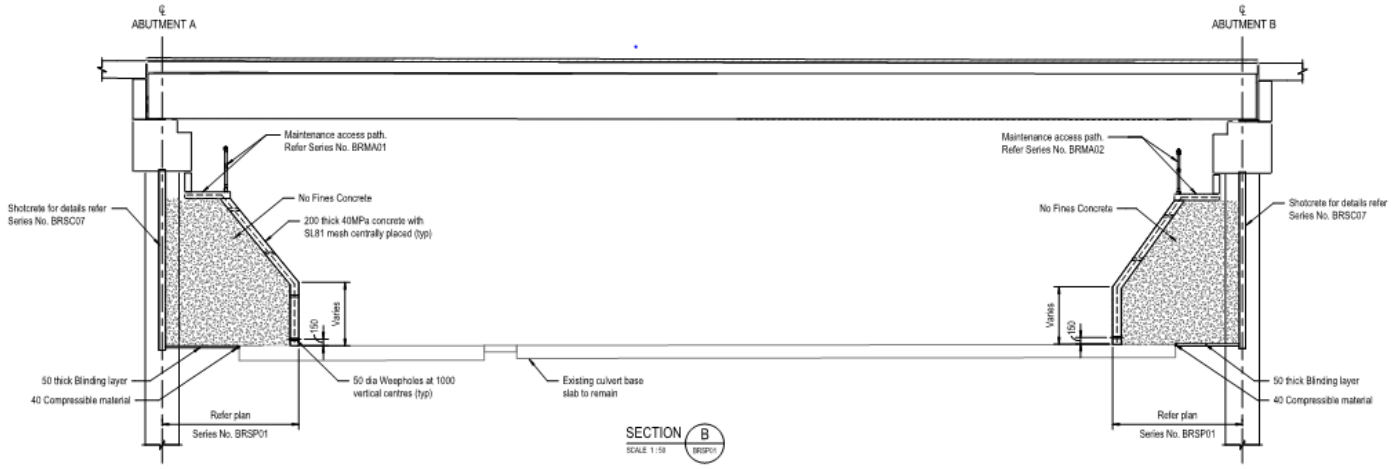
BR09 Ipswich Motorway
WB & EB

BR10 EB Entry
Ramp

Typical Berm Details



Typical berm detail under Motorway



Berm detail filled with mass concrete at tie in to existing culverts

Design Journey

- **Substructure Pile Options**
  - 1050 Dia. CIP Bored Piles – with Permanent Liner
  - 550 PSC Driven Piles – with Soil Nail retention
  - 1050 Dia. CIP Bored Piles with Polymer and temporary Liner
  - **750 Dia. Driven Closed end Steel tube filled with Reinforced Concrete (Precast concrete Driving Shoe)**

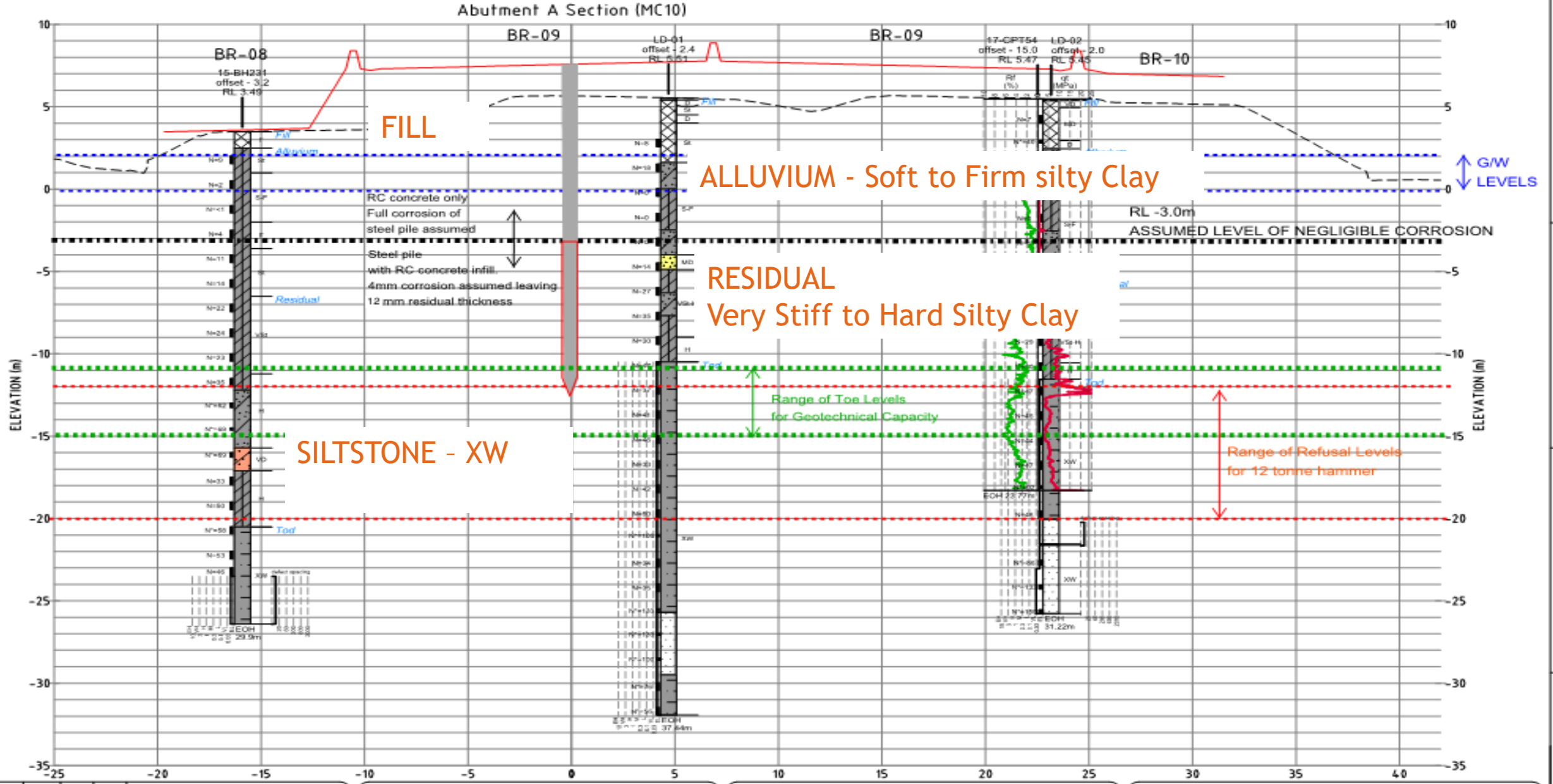
- **Temporary works Options**
  - Soil Nail Wall in front of PSC Piles
  - Prop bridge prior to excavation. (would involve demolition below superstructure with limited headroom)
  - **Temporary tie backs to sheet pile wall & remove culverts prior to placing deck**

Pile Multi Criteria Analysis

Option	Pile Type	Vertical Loading	Lateral Loading	Construction	Risk	Cost	Overall
1	CIP Bored Pier with Permanent Liner	4 Long Socket	1	4 Socket collapse Shotcrete bond to steel liner	4 Socket collapse and extension Tremmie pour	3 Liner plus Long socket	4
2	Driven PSC pile with soil nail retention[1]	1 High founding level. Piles tested for capacity	4 Separate retention system	3 Separate system for vertical and lateral load	3 Soil-structure interaction between PCS and soil nails	4 Two systems	3
3	CIP drilled with polymer and temporarylin er[2]	3 Longer pile length compared to driven options	1	2 Polymer management	2 Option 1 with reduced risk of socket collapse	1 Polymer with no liner	2
4	Driven, closed end steel tube[2]	1 High founding level. Piles tested for capacity	1	1 Shotcrete bond to steel liner for temporary works	1 Relatively low construction risk. Needs appropriate design for durability.	2	1

Note: [1] - PSC and other combinations may also apply such as CFA or other ground stiffening options

[2] – Not currently approved by TMR



REV	DATE	DRAWN	REV'D	APP'D	REVISION

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CLIENT

PROJECT

DRAWN JP	DRAWING CHECK	REVIEWED	APPROVED
DESIGNED	DESIGN REVIEW	DATE	DATE

TITLE
Abutment A
Little Doris Creek Bridge Cross Sections

SCALE	DRAWING No	REV
AS SHOWN		A

Closed End Steel Driven Pile Detail

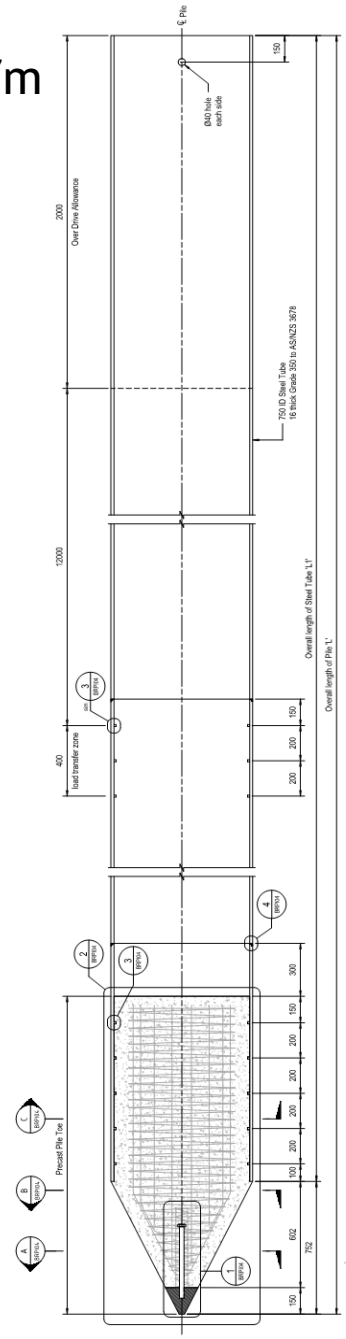
Top of Pile RL 4.7m

Level of No Corrosion RL -3.0m

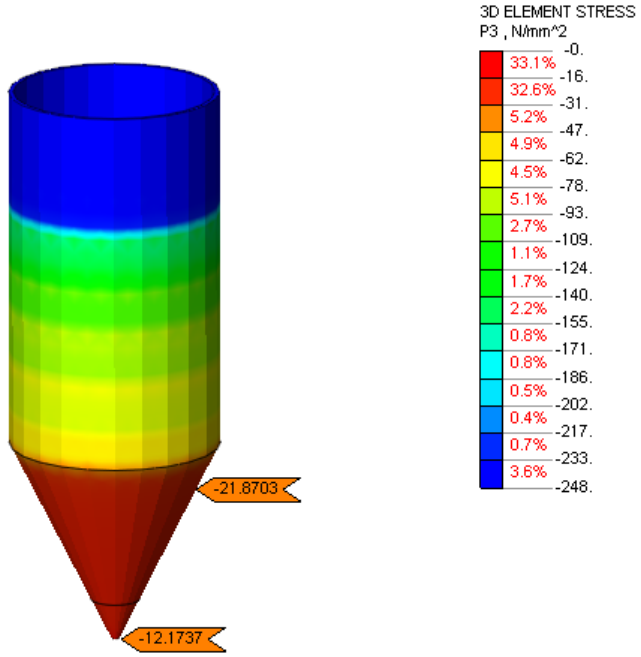
Shear Transfer Zone

Precast concrete driving shoe with shear transfer zone

Toe of Pile RL -12m



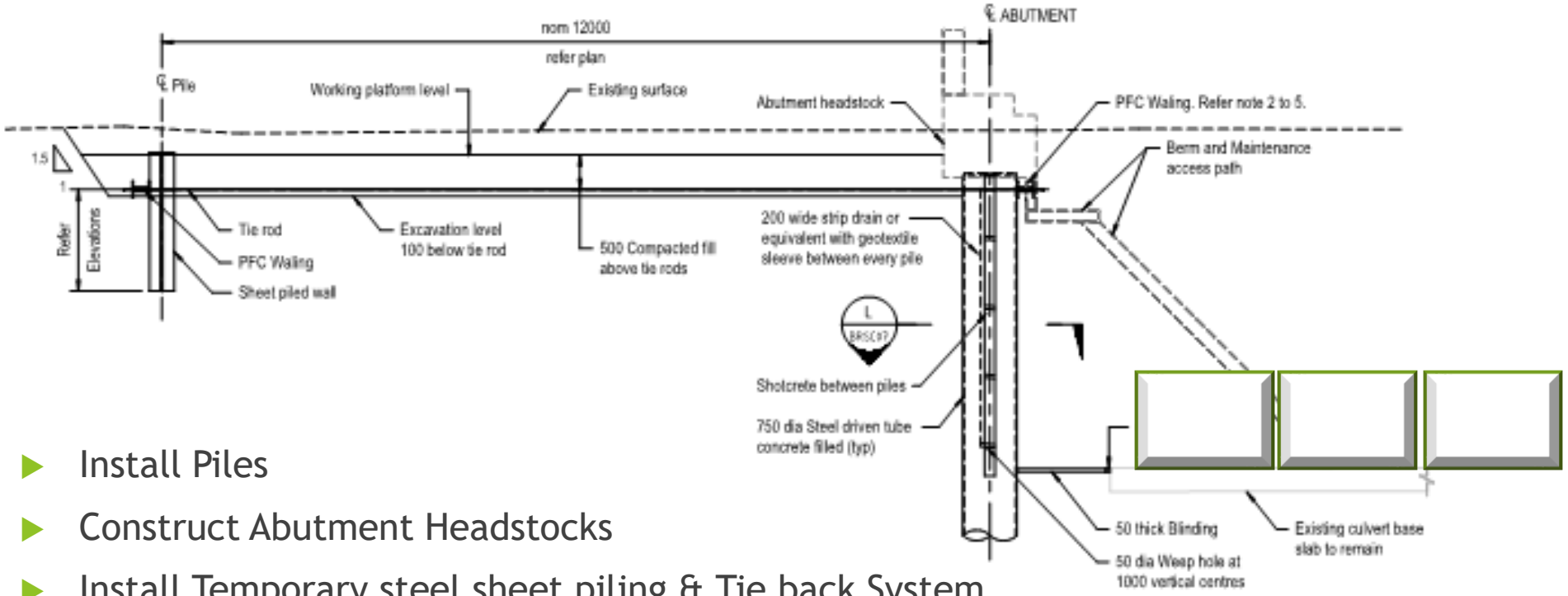
Precast Pile Driving Shoe



Design Details

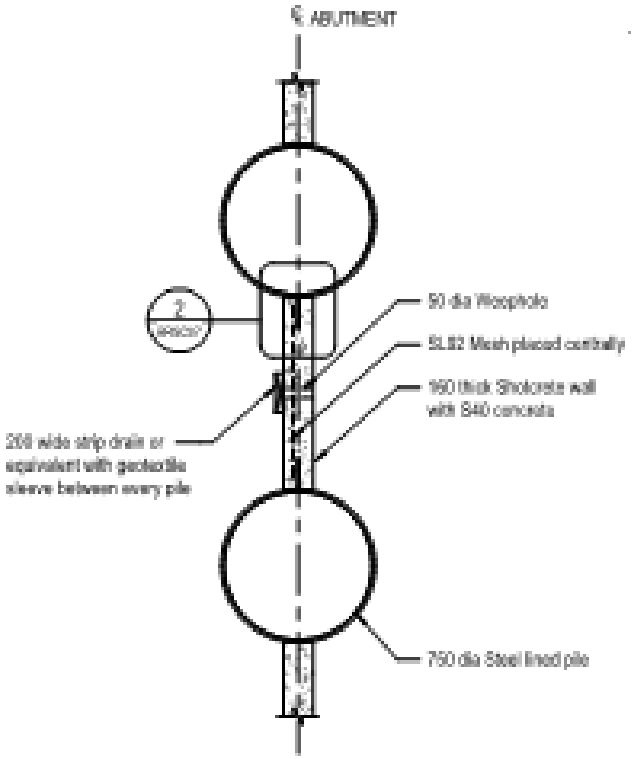
- Pile Driving Analysis prepared by geotechnical designers FSG
- Loads during driving used to check Pile Driving Shoe (load up to 7 times higher than ULS loads)
- A strand 7 model was analysed using the loads during driving to assess the stresses

Temporary Tie Back System

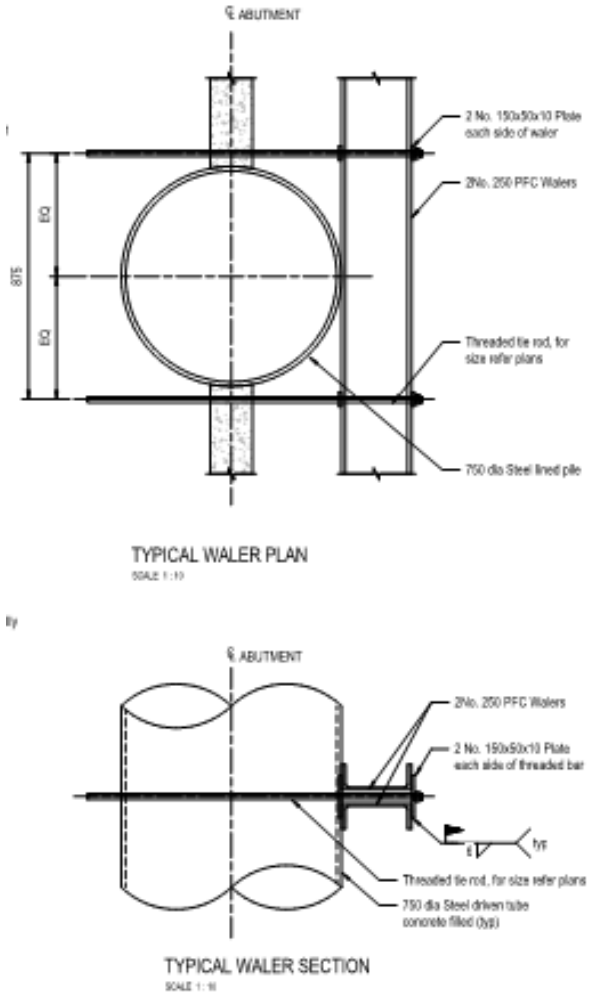


- Install Piles
- Construct Abutment Headstocks
- Install Temporary steel sheet piling & Tie back System
- Install Pile Deflection Monitoring
- Excavate to top of existing culvert base slab in 1.0m lifts while installing a sacrificial shotcrete support between piles
- Remove existing culverts

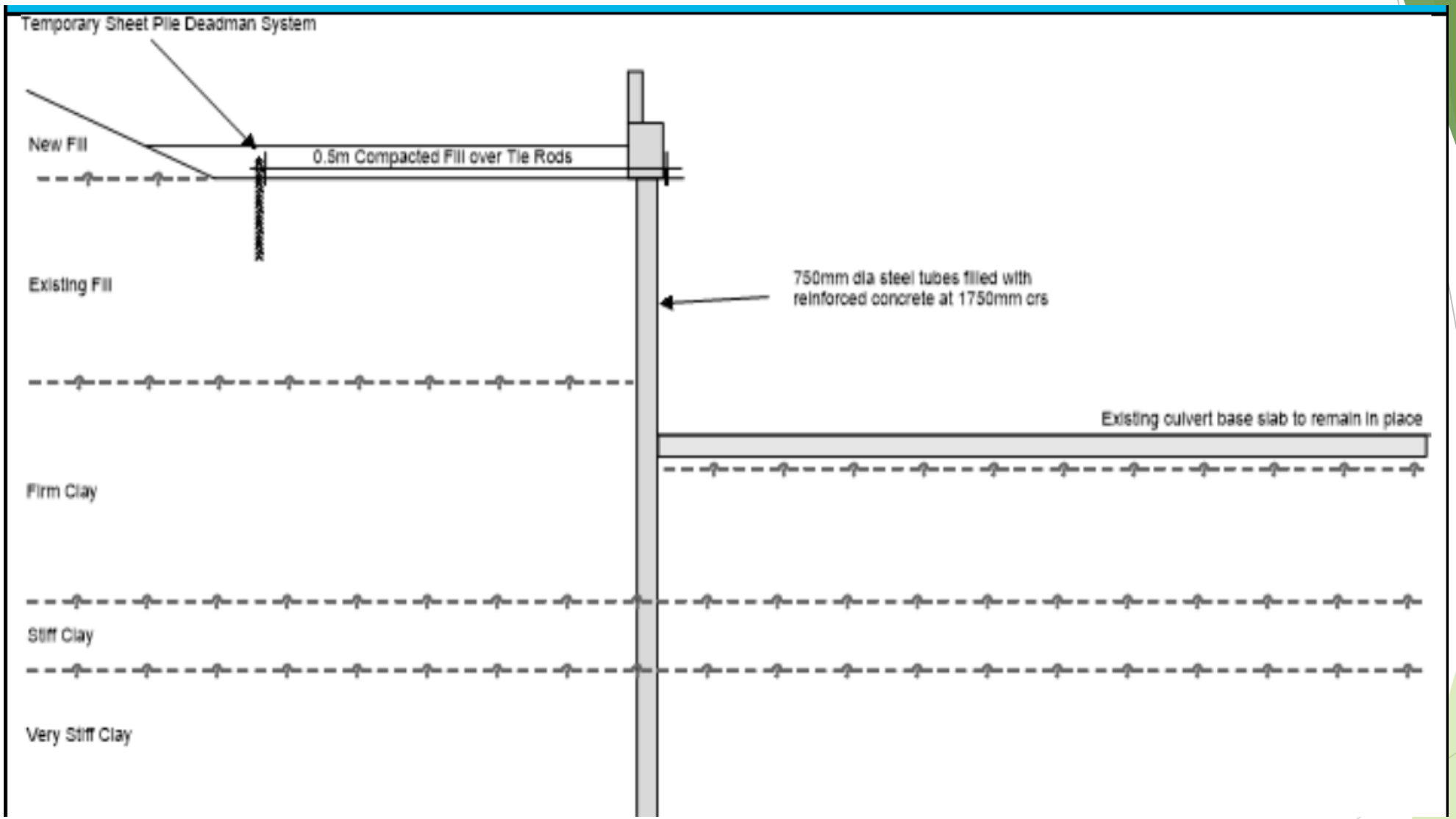
Typical Tie Back Details



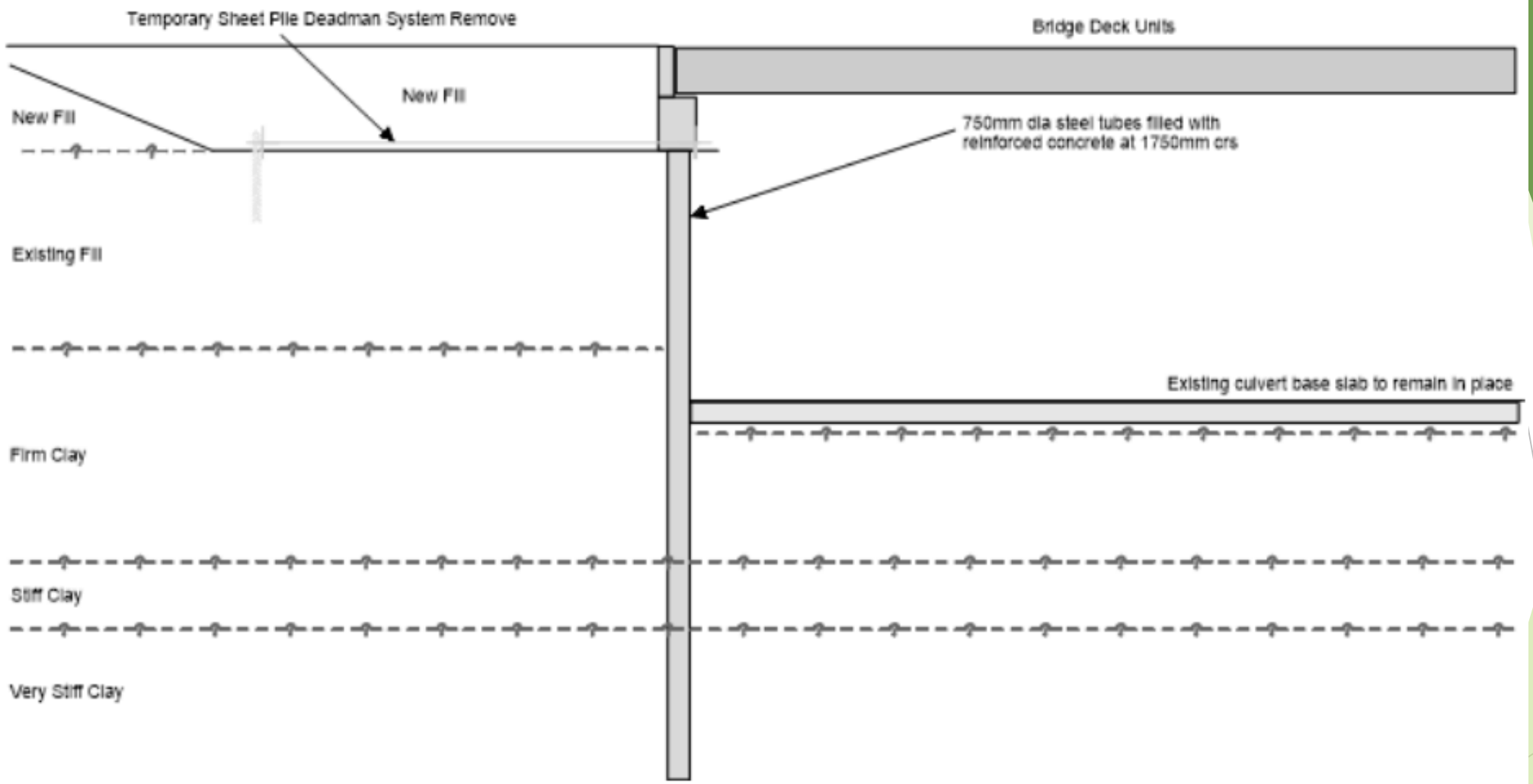
Pile / Shotcrete wall interface



Tie back connection to Piles Detail



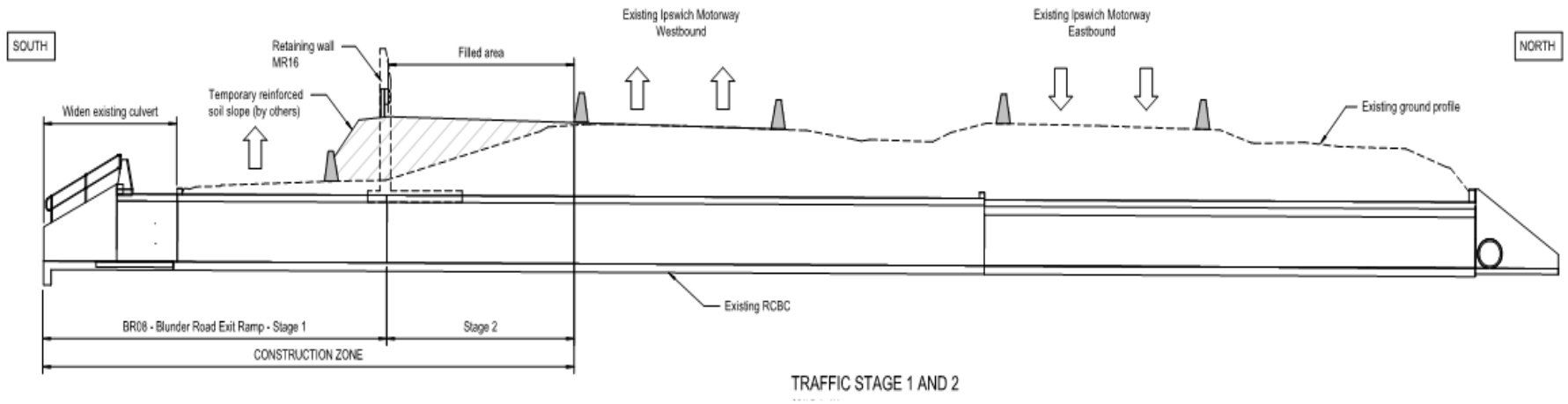
WALLAP Analysis of Temporary Tie System



WALLAP Analysis of Permanent System

Construction Sequence and Traffic Staging

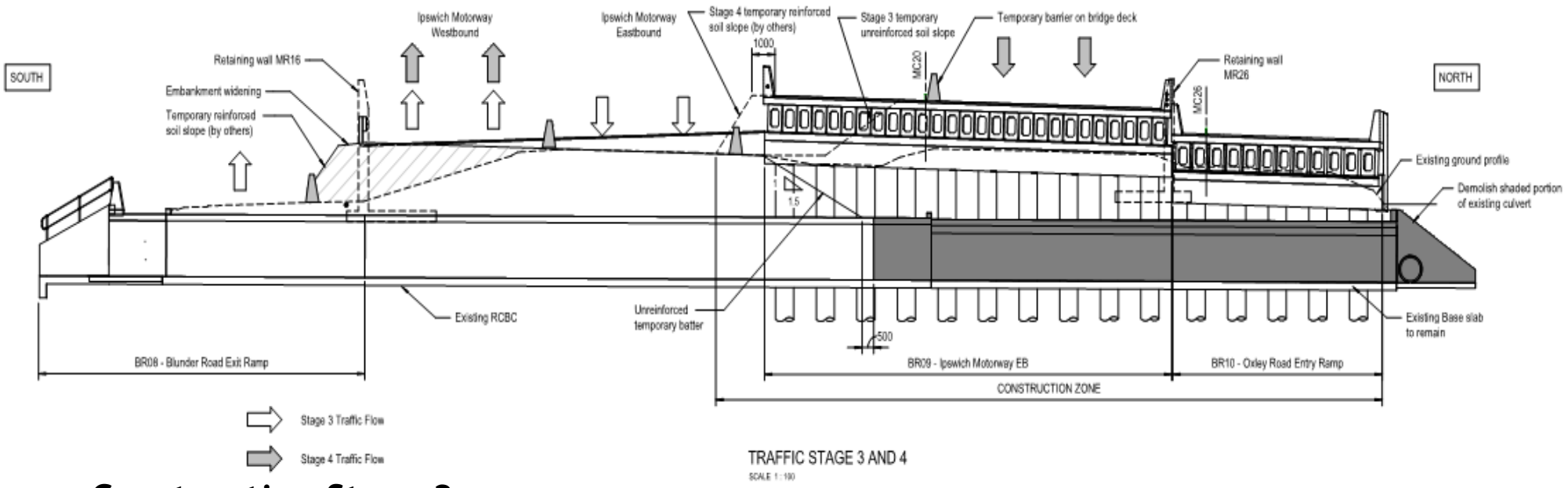
Construction Stage 1 & 2



Construction stage 1 & 2

1. Maintain existing Motorway traffic.
2. Extend existing culverts below Blunder Road Exit Ramp (BR08) under local traffic controls
3. Construct RC wall MR 16 and temporary reinforced soil slope and widen existing westbound carriageway embankment.
4. Install temporary PCB's

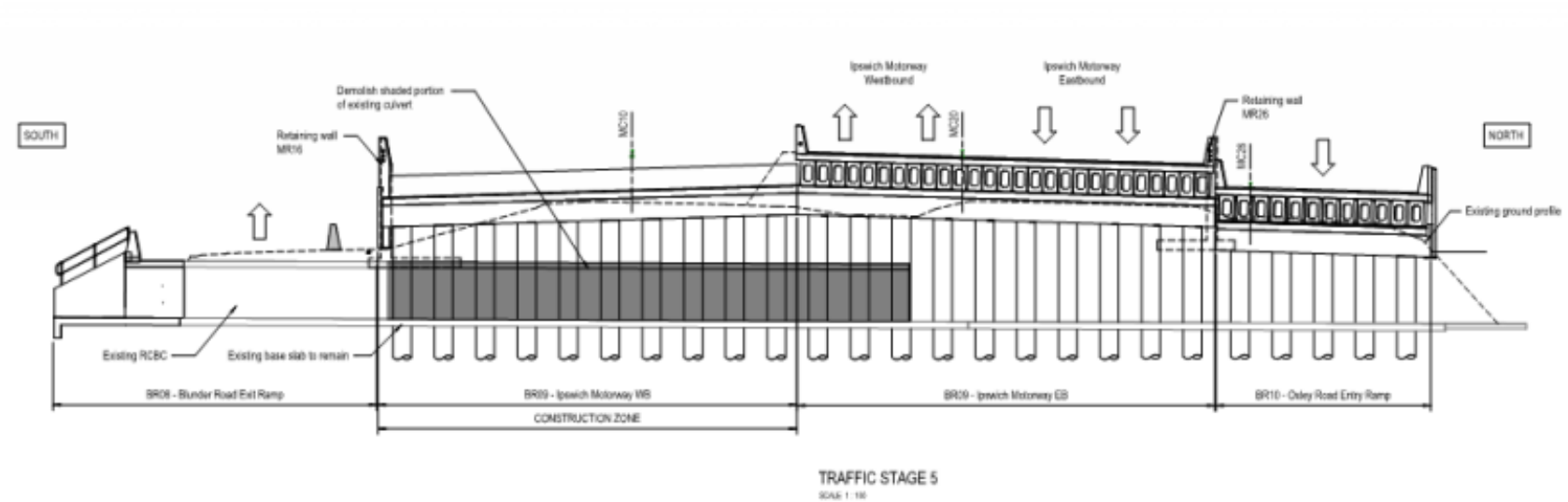
Construction Stage 3



Construction Stage 3

1. Shift existing Ipswich Motorway Westbound and Ipswich Motorway Eastbound traffic to widened embankment.
2. Construct substructure BR09 EB and BR10.
3. Construct RC Retaining wall MR26.
4. Install temporary works tie back anchor system.
5. Excavate to base slab level, remove culvert units, place rock filled berms.
6. Construct temporary reinforced soil slope in median and temporary batter over existing culverts to stabilize the westbound carriageway.
7. Construct bridge superstructure BR09 EB and BR10.
8. Construct approach embankment evenly from both sides.

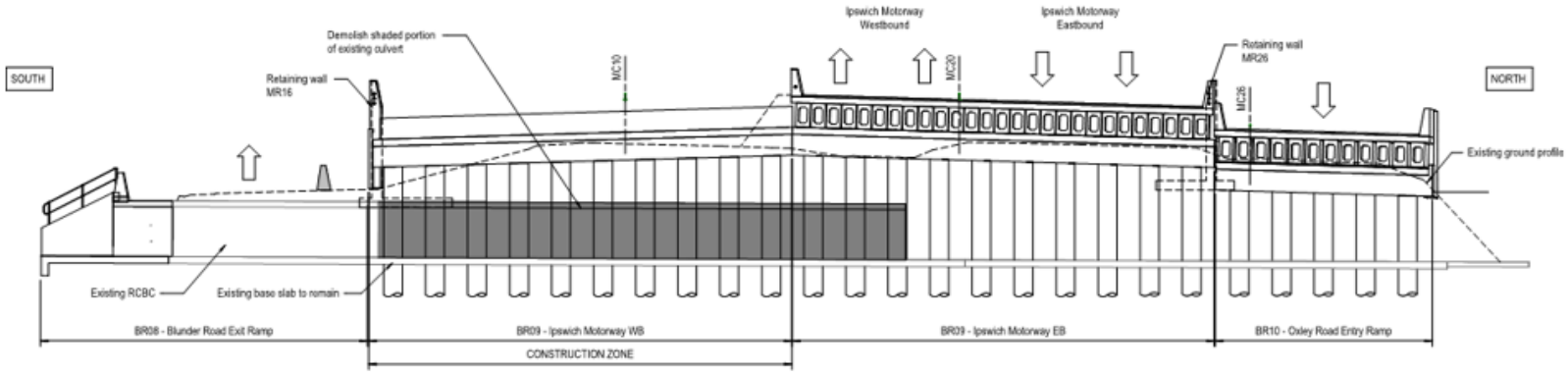
Construction Stage 4



Construction Stage 4

1. Shift Ipswich Motorway Eastbound onto BR09 EB
2. Construct temporary reinforced soil slope to facilitate completion of BR09 EB approaches

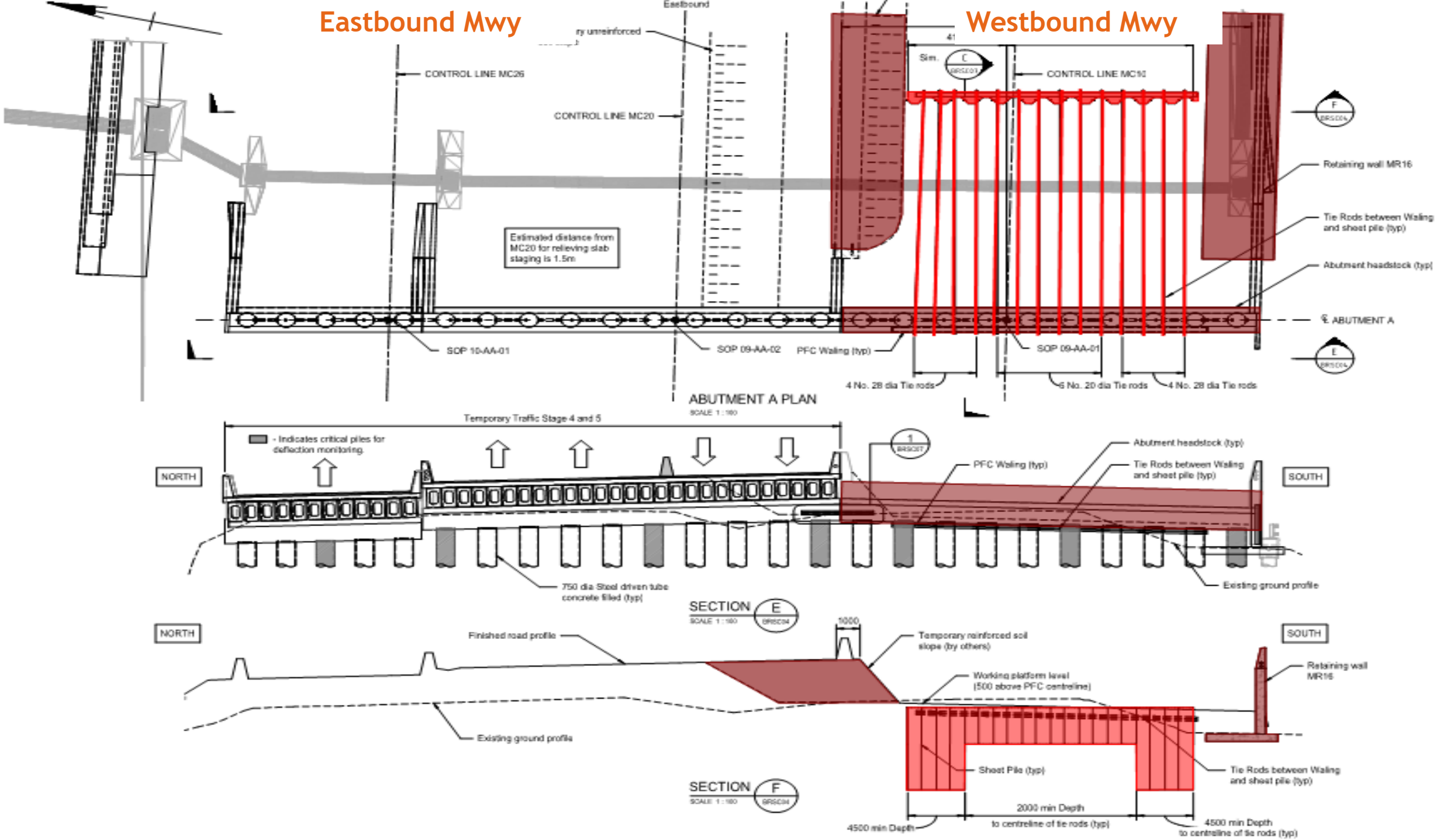
Construction Stage 5



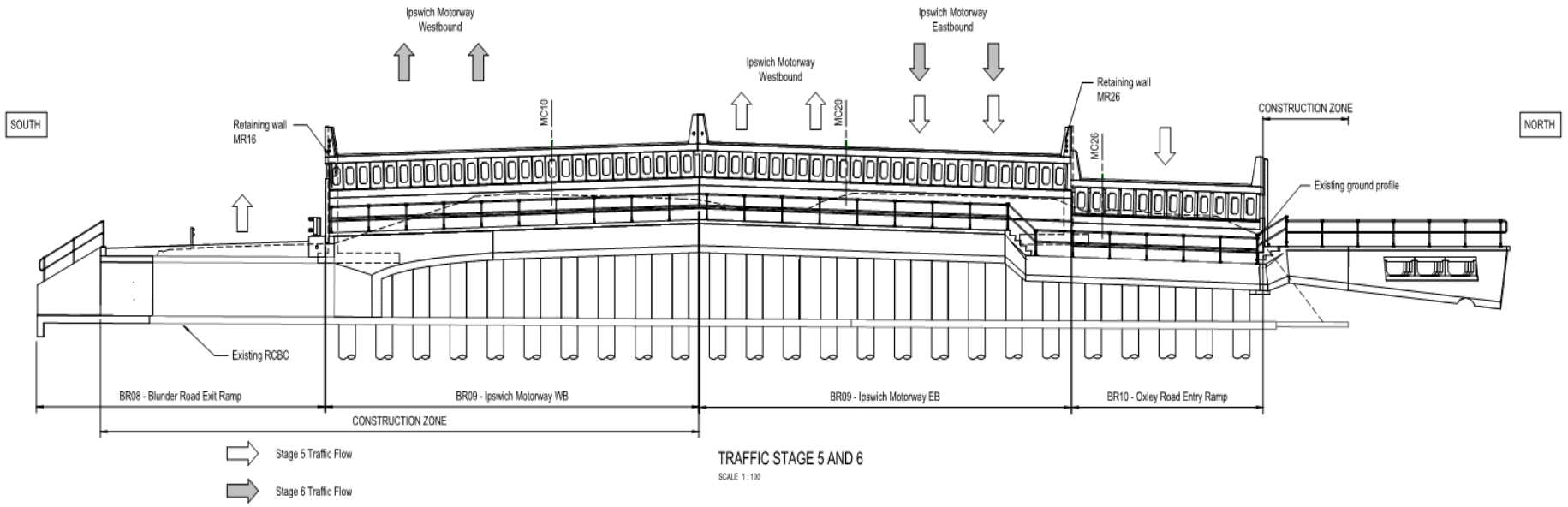
TRAFFIC STAGE 5

Construction Stage 5

1. Construct bridge substructure for Ipswich Motorway Westbound BR09 WB.
2. Install temporary works anchor system.
3. Demolish temporary retaining wall and remove fill over existing culvert units.
4. Remove remaining culvert units up to the limit of demolition required to build Ipswich Motorway Westbound.
5. Place rock filled berms.
6. Construct bridge superstructure BR09 WB.
7. Construct maintenance path and concrete lining layer on rock filled berms.
8. Complete Blunder Road Exit Ramp and associated culvert and maintenance path works.

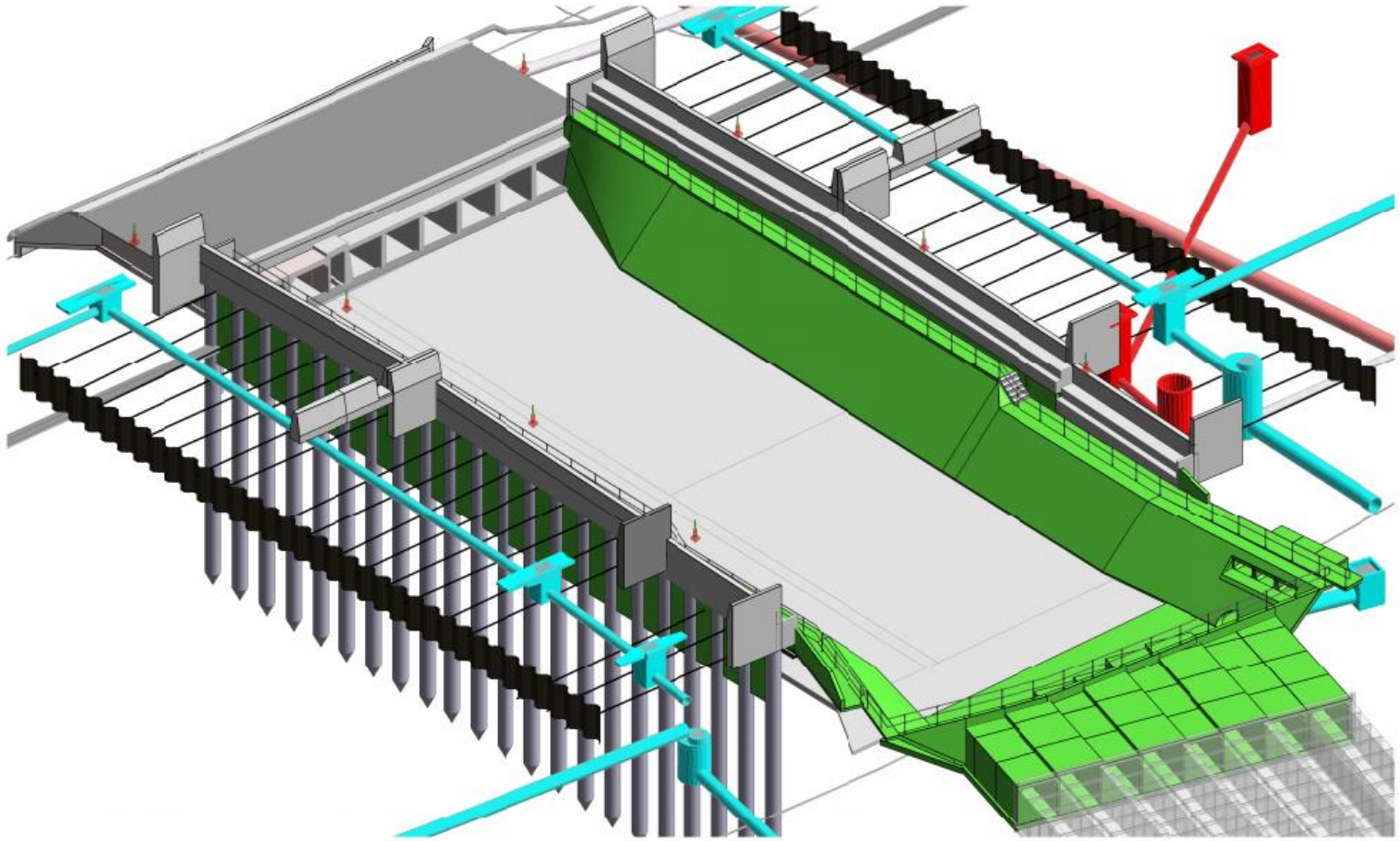

Eastbound Mwy
Westbound Mwy
Eastbound
CONTROL LINE MC26
CONTROL LINE MC20
CONTROL LINE MC10
Estimated distance from MC20 for relieving slab staging is 1.5m
Retaining wall MR16
Tie Rods between Waling and sheet pile (typ)
Abutment headstock (typ)
℄ ABUTMENT A
SOP 10-AA-01
SOP 09-AA-02
PFC Waling (typ)
SOP 09-AA-01
4 No. 28 dia Tie rods
6 No. 20 dia Tie rods
4 No. 28 dia Tie rods
ABUTMENT A PLAN
Temporary Traffic Stage 4 and 5
- Indicates critical piles for deflection monitoring
NORTH
SOUTH
PFC Waling (typ)
Abutment headstock (typ)
Tie Rods between Waling and sheet pile (typ)
750 dia Steel driven tube concrete filled (typ)
Existing ground profile
SECTION E
Finished road profile
1000
Temporary reinforced soil slope (by others)
Working platform level (500 above PFC centreline)
Retaining wall MR16
Existing ground profile
Sheet Pile (typ)
Tie Rods between Waling and sheet pile (typ)
SECTION F
2000 min Depth to centreline of tie rods (typ)
4500 min Depth
4500 min Depth to centreline of tie rods (typ)

Construction Stage 6



Construction Stage 6

1. Shift Motorway traffic to configuration shown and complete earthworks to approaches.



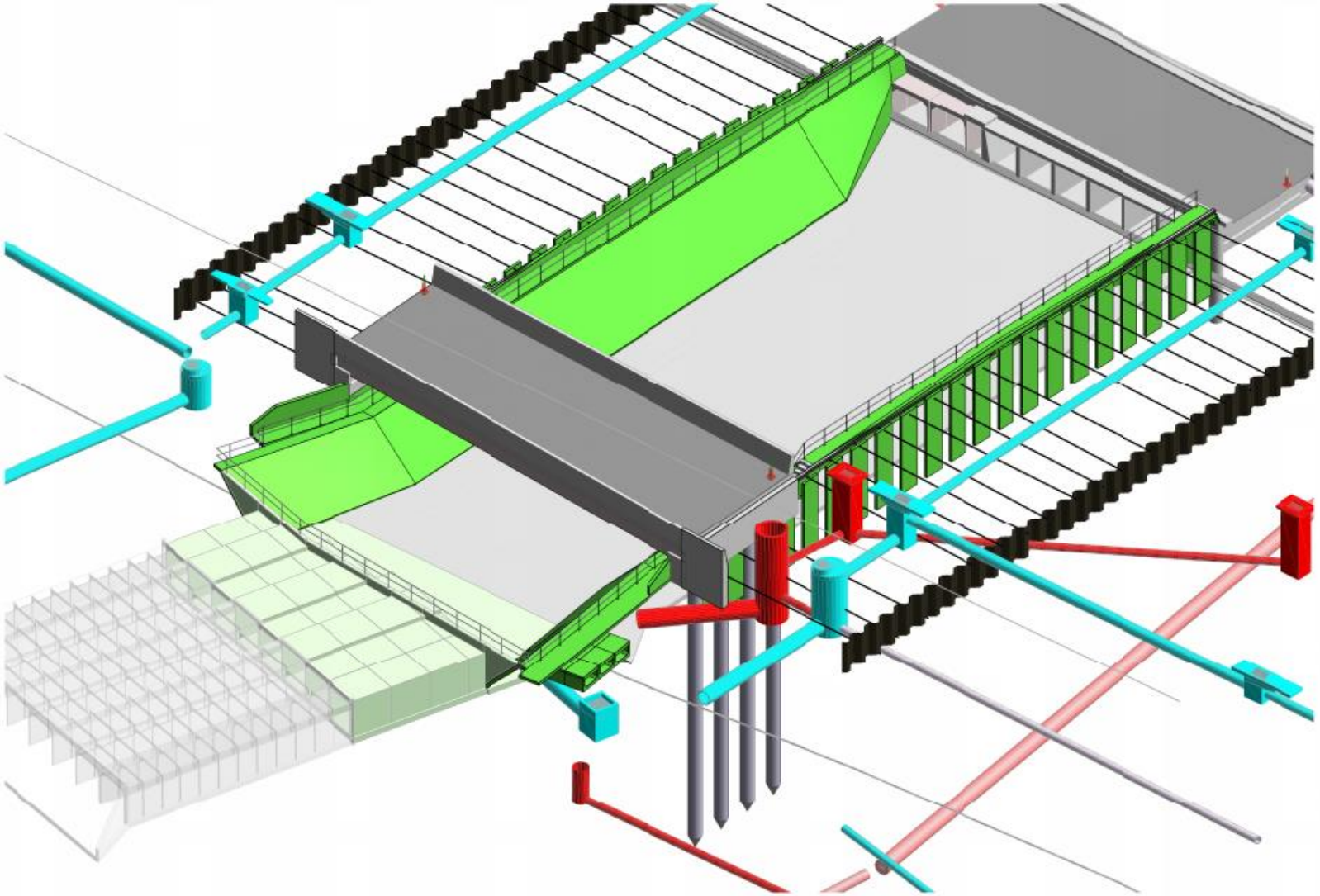
SPILL THROUGH SOUTH WEST ISOMETRIC VIEW

LEGEND

Existing Drainage to be removed

New Drainage works

BR09 LITTLE DORIS CREEL MOTORWAY EB/WB
ISOMETRIC VIEW - SHEET 2
201U163-DJV-30STB09-SK-005



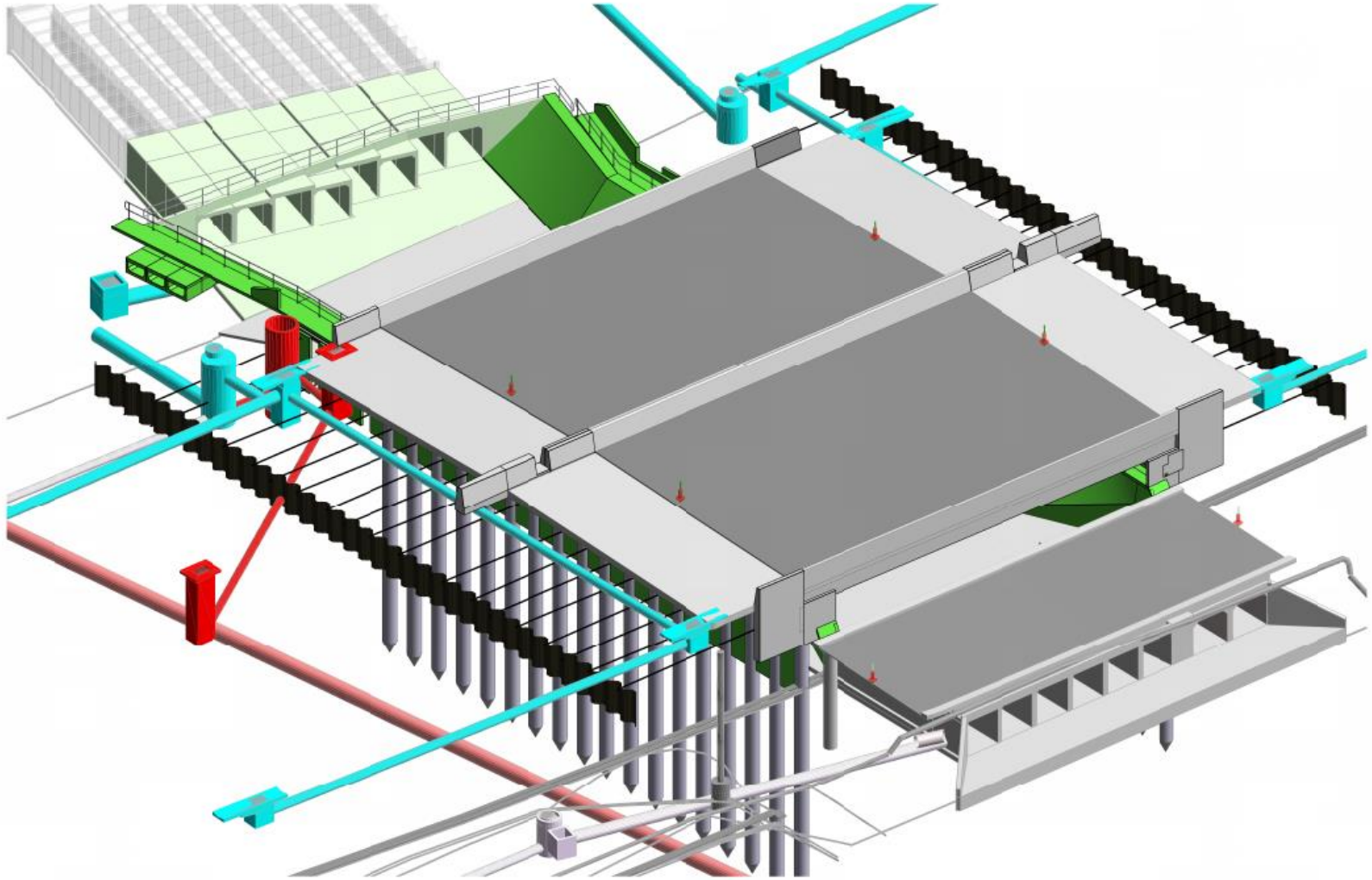
FINAL CONFIGURATION - SOUTH PERSPECTIVE

LEGEND

Existing Drainage to be removed

New Drainage works

BR10 LITTLE DORIS CREEK OXLEY ROAD ENTRY RAMP
ISOMETRIC VIEW - SHEET 3
201U163-DJV-30STB10-SK-006



FINAL CONFIGURATION - NORTH PERSPECTIVE

LEGEND

Existing Drainage to be removed

New Drainage works

BR09 LITTLE DORIS CREEK MOTORWAY EB/WB
ISOMETRIC VIEW - SHEET 3
201U163-DJV-30STB09-SK-006

Conclusion & Final Remarks

- Use of non standard piles – **Best Solution** for the situation
- **Communication** with CJV / TMR to achieve the best solution for the project
- **Collaboration** with TMR to develop acceptable piling solution and appropriate Supplementary Specification
- **Communication** with CJV to determine best construction sequence
- **Collaboration** with Geotechnical designers to ensure design models and geotechnical models are in sync.

QUESTIONS???