BARANGAROO CENTRAL

Sydney Metro Impact Assessment
Stage 2 Early Works (EWDA-2)

Aqualand B Development Holding Pty Ltd (Aqualand)

Reference: 754-SYDGE287887AV Rev4

13 March 2025

BARANGAROO CENTRAL

Sydney Metro Impact Assessment
Stage 2 Early Works (EWDA-2)

Report reference number: 754-SYDGE287887AV Rev4
13 March 2025

PREPARED FOR

Aqualand B Development Holding Pty Ltd (Aqualand)
Tower 1, L47, 100 Barangaroo Avenue,
Barangaroo NSW 2000

PREPARED BY

Tetra Tech Coffey
Level 20, Tower B, Citadel Tower, 799 Pacific Highway
Chatswood NSW 2067 Australia
p: +61 2 9406 1000

ABN 55 139 460 521

DOCUMENT TRACKING

Project Manager	Pawan Sethi
Prepared by	Helen Chow
Reviewed by	Patrick Wong
Approved by	Pawan Sethi
Status	Final
Version number	4
Changes made	1. Standard text updated with the latest version of preamble 2. Construction sequence for Section 1 updated
Last saved	13 March 2025

Restriction on Disclosure and Use of Data
Insert disclaimer here. If disclaimer statement is long, or if there are multiple disclaimers, text will flow to second page.

EXECUTIVE SUMMARY[1]

Tetra Tech Coffey Pty Ltd (TTC) has been requested by Aqualand B Development Holding Pty Ltd (AQL)to undertake impact assessment of basement excavation of Barangaroo Central Development (**CBD**) on Barangaroo Metro Station (**BMS**) structure.

This report responds in part to **Item 15** of the (Planning Secretary's Environmental Assessment Requirements) SEAR requirement with respect to and demonstrating compliance with the Sydney Metro Underground Corridor Protection Guidelines and/or Sydney Metro at Grade and Elevated Sections Corridor Protection Guidelines.

This report is required by Sydney Metro Authority (**SMA**) for the assessment of additional forces and actions induced on the structural walls and slabs of Barangaroo station box due to the adjacent basement excavation.

With reference to the Barangaroo Station Protection Guidelines (Ref: SMCSWSBR-MET-SBR-ID-REP-000030 Rev. P09) dated 11 February 2021 by Metron, the following issues were required to be addressed in the impact assessment.

1. Changes in the groundwater regime due to dewatering or installation of groundwater flow barrier.
2. Increase in structural actions supporting the metro underground infrastructure.
3. Deformation of the cavern support elements and the surrounding ground.

It should be noted that the general basement excavation level allowed for the CBD as per drawings SMCSWTSE-JAB-SBR-EX-DRG-530032 was RL -14.3 m, which is significantly lower than the current EWDA-2 bulk excavation level of RL -11.2 m, except for the localised area at the interface location which has an excavation level of RL -14.2 m. As such, the computed structural action effects due to the proposed CBD development should be smaller than those considered during the design of the BMS. The action effects computed by Tetra Tech Coffey will need to be checked by the BMS structural design team. The deformations assessed by Tetra Tech Coffey should be lower than those allowed for in the SMA design due to the higher CBD EWDA-2 bulk excavation level. Nevertheless, we have checked the computed deformations against the criteria specified in Table 5.2 of the structural interface report. The deformations satisfy Table 5.2 criteria, as discussed below.

This report summarises the findings from the impact assessment carried out at the location of interface between Barangaroo station and CBD and provide comments addressing to the above issues. Three different sections were analysed, namely:

- Section 1 – South of Shark Fin at interface of Barangaroo Station and CBD (in E-W direction)
- Section 2 – Across Shark Fin and Metro interface (in N-S direction)
- Section 3 – South of Barangaroo Station across Metro Tunnels (in E-W direction)

The impact assessment indicates that the movements in the BMS meet the criteria specified. Our assessed / reported structural actions should be checked by the BMS designers.

Provided good industry practice and construction techniques are employed, including implementation a detailed excavation and monitoring plan demonstrating that the risks can be managed so far as reasonably practical (SFAIRP), the proposed Central Barangaroo development is not expected to have an adverse impact the BMS and tunnels.

[1] This executive summary must be read in the context of the full report and the attached limitations.

CONTENTS

1. INTRODUCTION 1
1.1 Design development 1
2. PROJECT SUMMARY 2
3. THE SITE 2
4. BACKGROUND AND RELATED APPLICATIONS 4
4.1 Concept Application MP06_0162 4
4.1.1 The Approved Concept Plan 5
5. PROPOSED WORKS UNDER THE SUBJECT OF THIS SSDA 5
5.1 Site Establishment 5
5.2 Perimeter Retention Wall 5
5.3 Bulk Excavation 6
5.4 Construction Staging 6
6. BASEMENT EXCAVATION 7
7. REFERENCED INFORMATION 7
8. DESIGN MODEL 8
8.1 Geotechnical model 8
8.2 Geotechnical parameters 13
8.3 In-Situ Stress 13
8.4 Design Groundwater Level 14
9. METHODOLOGY 15
9.1 Analysed sections 15
9.2 Design assumptions 18
10. GEOTECHNICAL ASSESSMENT RESULTS 20
10.1 Section 1 – Metro interface and CBD (E-W Direction) 20
10.1.1 Modelling Sequence 20
10.1.2 Assessment Results 22
10.1.3 Horizontal Displacement 25
10.1.4 Structural actions 25
10.2 Section 2 – Across Shark Fin and Metro interface (N-S Direction) 26
10.2.1 Modelling Sequence 26
10.2.2 Assessment Results 27
10.2.3 Horizontal Displacement 29
10.2.4 Structural actions 30

10.3 Section 3 – Metro Tunnel (E-W Direction) 31
10.3.1 Modelling Sequence 31
10.3.2 Assessment Results 32
10.3.3 Liner Displacement 35
10.3.4 Structural Actions 35
11. FLOODING AND EARTHQUAKE CASES 35
12. RISK ASSESSMENT 37
13. INSTRUMENTATION AND MONITORING 37
14. CONCLUSION 37

LIST OF TABLES

Table 1: Site Description 3
Table 2: Summary of Geotechnical models developed for the sections 8
Table 3: Geotechnical Parameters for Soil (reproduced from Table 6 of GIR – see) 13
Table 4: Geotechnical Parameters for Rock (reproduced from Table 7 of GIR) 13
Table 5: In-situ stress ratios for Rock 14
Table 6: GWL cases considered in the assessment 22
Table 7: Summary of Results for Section 1 at Different Construction Stages 22
Table 8: Summary of Results for Section 2 at Different Construction Stages 27
Table 9: Summary of Results for Section 3 at Different Construction Stages 32

LIST OF FIGURES

Figure 1: Site Aerial (source Urbis) 4
Figure 2: Location of proposed direct connecting CBD and Barangaroo Station 7
Figure 3: Locations of Geological Sections 10
Figure 4: Geological section at Section 1 11
Figure 5: Geological section at Section 3 11
Figure 6: Geological section at Section 2 12
Figure 7: Stress Relationships for different values of rock mass stiffness (extracted from Oliveira and Parker (2014)) 14
Figure 8: Location of sections analysed 15
Figure 9: Section 1 – Cross section at interface of Barangaroo Station and CBD 16
Figure 10: Section 2 – Cross section Across Shark Fin and Metro Interface 17
Figure 11: Section 3 – Cross section Metro Tunnels 18
Figure 12: Lateral soil and groundwater pressures acting on walls and slabs diagram 20
Figure 13: Predicted movement at CBD interface (extracted from Drawing No. SMCSWTSE-JAB-SBR-ST-DRG-531046 sheet 40 of 482 30
Figure 14: Bending moment capacity of North (W15) and South (W13) Walls provided by BG&E 31

APPENDICES

APPENDIX A : LIMITATIONS 41

APPENDIX B : EARLY WORKS DA (EWDA) DRAWINGS 42

APPENDIX C : PLAXIS MODELS 43

APPENDIX D : PLAXIS RESULTS AND INVERTED CONE FAILURE CHECK 44

APPENDIX E : BMIA SCHEDULE 3 & STRUCTURAL ADEQUACY REPORT & DYNAMIC LOADING 45

APPENDIX F : GEOTECHNICAL INTERPRETATION REPORT (GIR) 46

ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
AQL	Aqualand B Development Holding Pty Ltd
CBD	Barangaroo Central Development
BMS	Barangaroo Metro Station
SMA	Sydney Metro Authority
EP&A Act 1979	Environmental Planning and Assessment Act 1979
FEA	Finite Element Analysis
GFA	Gross Floor Area
TTC	Tetra Tech Coffey
BEL	Bulk Excavation Level
PRW	Perimeter Retention Wall
SFAIRP	So far as is reasonably practical
2D	Two-dimensional

1. INTRODUCTION

Tetra Tech Coffey Pty Ltd (TTC) has been requested by Aqualand B Development Holding Pty Ltd (AQL)to undertake impact assessment of basement excavation of Barangaroo Central Development (**CBD**) on Barangaroo Metro Station (**BMS**) structure.

This report responds in part to **Item 15** of the (Planning Secretary's Environmental Assessment Requirements) SEAR requirement with respect to and demonstrating compliance with the Sydney Metro Underground Corridor Protection Guidelines and/or Sydney Metro at Grade and Elevated Sections Corridor Protection Guidelines.

This report is required by Sydney Metro Authority (**SMA**) for the assessment of additional forces and actions induced on the structural walls and slabs of Barangaroo station box due to the adjacent basement excavation.

With reference to the Barangaroo Station Protection Guidelines (Ref: SMCSWSBR-MET-SBR-ID-REP-000030 Rev. P09) dated 11 February 2021 by Metron, the following issues are required to be addressed in the impact assessment.

1. Changes in the groundwater regime due to dewatering or installation of groundwater flow barrier.
2. Increase in structural actions supporting the metro underground infrastructure.
3. Deformation of the cavern support elements and the surrounding ground.

This report summarises the findings from the impact assessment carried out at the location of interface between Barangaroo station and CBD and provide comments addressing to the above issues.

1.1 DESIGN DEVELOPMENT

Based on the latest architectural information provided via email by AQL on 16 February 2024 – included in Appendix B), the main changes associated with the revised basement layout appear to be as follows:

- The number of basement levels has reduced to three levels with revised levels at top of slab as follows:
    - B1 at RL -2.70 m AHD
    - B2 at RL -5.85 m AHD
    - B3 at RL -9.40 m AHD
- At the interface area at the proposed break out section with the Barangaroo Station Box has changed slightly from RL-15 m AHD to RL -14.2 m AHD (underside of B3 Slab) with the finished level at RL -12.7 m AHD (top of B3 slab) – Drawing set – DP-S-240 Station Structure – SWCSWTSE-JAB-SBR-ST-DRG-531000 series).
- The overall footprint of the basement has also increased on the western side i.e. the western boundary (harbourside) has moved westward following the footprints of the Buildings 2b, 3b and 4b.
- The bulk excavation level has changed by 2.7 (from RL -13.9 m AHD to RL -11.2 m AHD).

2. PROJECT SUMMARY

The proposed SSDA will seek approval for early works associated with the future mixed-use development of Central Barangaroo (set out under **MP06_0162**). The proposal sees to undertake bulk excavation and site establishment works for the installation of the perimeter retention wall, and conduct remediation and archaeological investigations within the site.

These works will facilitate the provision of future basements, consistent with the parameters set out under the approved Concept Plan for Barangaroo under MP06_0162.

The works subject of the SSDA include the following:

- Establish the site and installation of temporary plant and machinery, including dewatering and bentonite slurry plant and ancillary services,
- Construction of perimeter retention wall, including any required excavation, associated rock anchors and PRW capping beam construction,
- Associated remediation and Archaeological investigations in the area of excavation and works;
- Provision for future services,
- Associated “tie-in” works to Metro Interface Wall and the secant pile wall proposed by the applicant under SSD-39587022,
- De-stressing and removal of existing anchors supporting Sydney Metro pile wall
- Bulk excavation for the provision of a future basement and associated rock anchors (including anchors to support the secant pile wall approved in SSD-39587022),
- Construction of foundation piling,
- Installation of waterproofing membrane
- Construction of hydrostatic slab, and
- Structure and waterproofing for the Barangaroo Metro station southern entrance interface next to the existing Sydney Metro pile wall.

The proposal does not seek approval of any buildings, or the design, construct and use of the basement. These will be subject to future detailed SSDAs for Central Barangaroo, consistent with the outcomes of MP06_0162.

3. THE SITE

The site is located in Central Barangaroo, which forms part of the wider Barangaroo Precinct comprising a total area of 22ha. It is located in the north-western edge of Sydney CBD and falls within City of Sydney Local Government Area (**LGA**). Barangaroo Precinct interfaces with Hickson Road in the east, the foreshore in the west, Walsh Bay to the north and Darling Harbour in the south.

The Precinct is divided into three distinct development areas, including:

- **Barangaroo South (approx. 7.5ha)** – Located at the southernmost end of Barangaroo Precinct. Progressively built over the last six years and includes mixed-use neighbourhood comprising commercial office buildings, mixed use buildings, shops, cafes, hotel and community uses.

- **Central Barangaroo (approx. 5.2ha and area subject of SSDA)** – Located between Barangaroo South and Barangaroo Reserve. Currently vacant and undergoing site preparation works to facilitate a mixed-use area with a focus on retail activation, residential and community uses.
- **Barangaroo Reserve (approve 6.1ha)** – Located in the northern end of the Precinct featuring Barangaroo Reserve. Featuring open space and lookout points to Sydney Harbour, Nawi Cove and Marrinawi Cove. Barangaroo Reserve features the Cutaway – a future arts and cultural entertainment space.

The above results in a total area of 18.8ha. The residual 3.2ha is represented by the reshaping of the former industrial headland into Barangaroo Reserve and the creation of Nawi Cove as a substantial water body within the Barangaroo site, forming the original 22ha.

A summary of the site is provided below in Table 1.

Table 1: Site Description

Item	Description
Site Area	5.2ha (approx.) of the 22ha Barangaroo Precinct
Ownership	Infrastructure NSW
Legal Description	Lot 52 Deposited Plan 1213772

The location of the site in the surrounding context is illustrated in Figure 1.

The area currently features a large concrete hardstand area/construction site that is occupied by temporary structures for site preparation works, machinery, materials and vehicle parking for site workers. Hoarding is currently erected around the Central Barangaroo site.

Figure 1: Site Aerial (source Urbis)

4. BACKGROUND AND RELATED APPLICATIONS

4.1 CONCEPT APPLICATION MP06_0162

The Barangaroo Concept Plan was approved on 9 February 2007 under Part 3A of the EP&A Act 1979. It has been modified several times since 2007.

The original Concept Plan was facilitated through an amendment to Schedule 3 of State Environmental Planning Policy (Major Development) 2005 now consolidated into State Environmental Planning Policy

(Precincts – Eastern Harbour City) 2021 (PEHC SEPP). The SEPP establishes the land use, height, GFA and other provisions relating to the planning and development of Barangaroo.

4.1.1 The Approved Concept Plan

Following several modifications up to MOD 11, the approved Concept Plan that applies to Barangaroo currently is described in Condition A1 of the Instrument of Approval.

Central Barangaroo Early Works Phase 1 SSDA-39587022

SSDA-39587022 was approved by the Independent Planning Commission on 29 January 2025 and includes:

- Partial demolition of an existing shoring wall capping beam along Hickson Road,
- Construction of a new secant pile retention wall (approx. 150m long),
- Excavation of land related to construction of the secant pile retention wall,
- Localised remediation related to the secant pile retention wall,
- Associated Archaeological Investigations in the area of excavation and works,
- Sydney Metro / Hickson Road interfaces – perimeter retention wall interface works, and Hickson Road public domain interface works, and
- Relocation of stormwater and other services to enable the permanent works outlined above.

5. PROPOSED WORKS UNDER THE SUBJECT OF THIS SSDA

The proposed SSDA will seek approval for the Stage 2 early works associated with the future mixed-use development within Central Barangaroo (refer MP06_0162). The specific works associated under this SSDA are outlined in the following sections.

5.1 SITE ESTABLISHMENT

The proposal will establish a site construction establishment zone in the western portion of the site next to the proposed retention wall. The site construction establishment zone will include provision for the installation of site sheds, the water treatment plant, bentonite plant and a compound area for construction staging zones.

5.2 PERIMETER RETENTION WALL

The primary works proposed involve the construction of a reinforced concrete perimeter retention wall with supporting capping beams. The width of the wall is approximately 1000mm (subject to the detailed design) and will extend from the existing ground (approx. RL 2.5m) to a maximum depth of approximately, 17 m (RL-14.9 m) within the rock bed.

The junction of the capping beam and the wall will be constructed over the sea water line (at the ‘king’ tide level) which sits at approximately RL1.1m. The wall will extend around the northern, western, and southern perimeter boundaries of the extent of excavation.

The wall will continue below the level of bulk excavation subject to the existing rock profile to satisfy the design requirements.

The junction between the northern extent of the proposed wall and the existing Sydney Metro pile wall will be coordinated with Sydney Metro, structural engineering, geotechnical engineering and water-proofing consultants. Similarly, the junction between the southern extent of the proposed wall and the secant pile wall (proposed by the applicant, refer SSD-39587022) will be coordinated to ensure alignment.

5.3 BULK EXCAVATION

The proposed works seek consent for the bulk excavation required to accommodate the proposed perimeter wall and provision for a future basement associated with the approved Concept Plan MP06_0162.

It is estimated that approximately 277,400m^3 of material will be excavated from the site within the perimeter wall. Excavation will reach a maximum depth of approximately RL -11.2m, and approximately RL -14 m at the Sydney Metro interface, subject to design and Sydney Metro interface requirements.

Consent for the construction of the basement structure and future uses is not sought in this application and will be subject to a separate future detailed SSDA.

5.4 CONSTRUCTION STAGING

It is envisaged that the proposed early works will largely be carried out in the five following stages:

Stage 1:

- Carry out archaeological investigation works,
- Site establishment works (including installation of site sheds, Bentonite plant), and
- Installation of temporary construction pads and initial construction of approximately a 339m length of the perimeter retention wall.

Stage 2:

- Progress site establishment works as needed on site,
- Continue wall construction,
- Carry out associated remediation as required during construction of the wall,
- De-mobilise PRW plant and equipment,
- Mobilise de-watering and water treatment plant, and
- Construct capping beam.

Stage 3:

- Full extent of bulk excavation and remediation works (approximately 277,400m^3) undertaken in conjunction with dewatering and installation of temporary rock anchors,
- Tie in-works, including establishing waterproof connection, with Sydney Metro interface wall and proposed Central Barangaroo secant pile wall (refer SSD-39587022), and
- Removal of de-stressed Sydney Metro rock anchors

Stage 4:

- Foundation piling.

Stage 5:

- Installation of the waterproofing membrane and construction of the hydrostatic slab (approximately 1400mm thick).
- Construction of permanent basement walls, columns and slabs to ground level

Construction and excavation are anticipated to be undertaken over an approximated 28-month program.

6. BASEMENT EXCAVATION

As per the proposal, the CBD requires a common basement to be excavated across the different blocks of the CBD precinct. The bulk excavation levels are anticipated to be approximately -11.2 m AHD.

Block 4A, the northern most Block adjacent to the Barangaroo Headland Park will also connect into the BMS under Hickson Street at B3 (Concourse) level. The direct access is to be located to the south of Shark Fin of the Barangaroo station. Temporary shoring wall installed along the boundary of CBD and station, dividing the two sites, will be demolished locally to facilitate the construction of the direct access. Figure 2 (extracted from the Structural Interface report) illustrated the location of the proposed direct access.

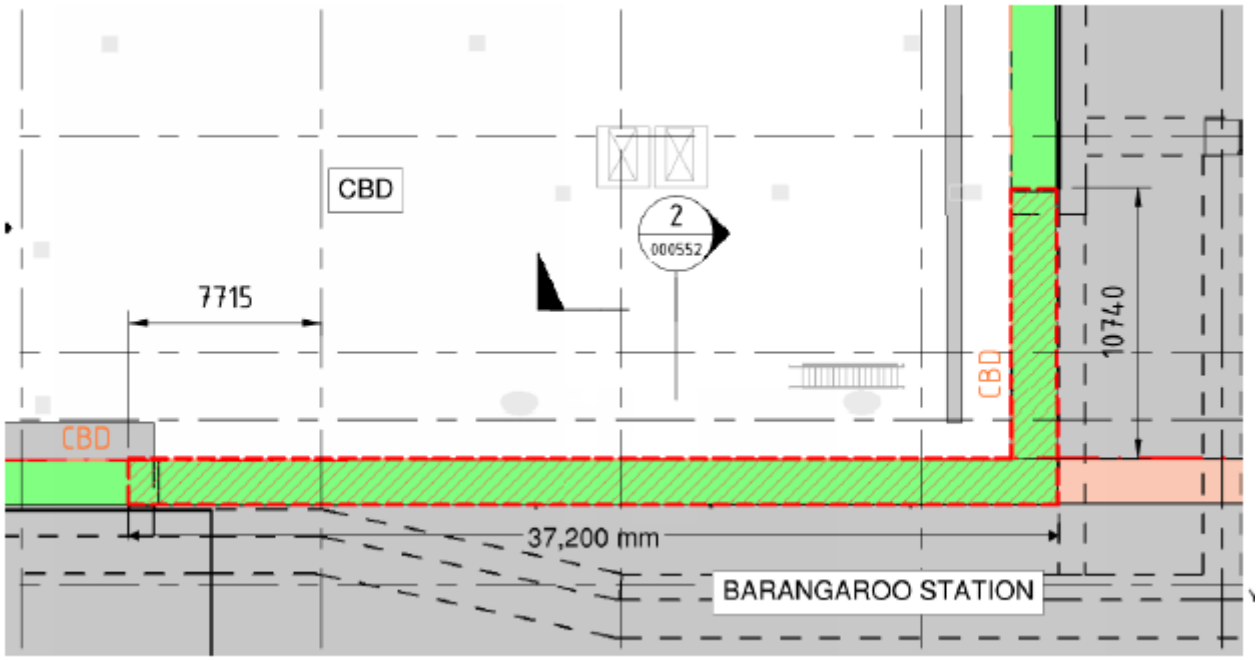


Figure 2: Location of proposed direct connecting CBD and Barangaroo Station

Temporary shoring walls are installed along the perimeter of the BMS with the pile diameters range between 600 mm and 1200 mm with multiple anchors. The piles are socketed into Class II or better Sandstone.

A depressurisation system is in operation to facilitate the excavation of the Barangaroo Station Box and CBD excavation. The purpose of the depressurisation system is to prevent the occurrence of out-of-balance groundwater loads between the east and west walls of the Barangaroo Station box during construction and dewatering of the adjacent CBD. The system will be decommissioned upon completion of construction and the base slabs of the structure will be subjected to hydrostatic uplift.

7. REFERENCED INFORMATION

- Architectural drawings (Drawing Nos. DA-00-0301 to DA-00-0703, DA-00-1051 to DA-001705 and DA-00-2251 to 2252) provided by Aqualand via Aconex on 3 March 2025.
- Selected drawings from Barangaroo Station Structural Details Drawings – Sydney Metro City and Southwest Tunnel and Station Excavations – DP-S-230 – Barangaroo Station and Precinct – Open

Excavation Shoring – Drawing set – SWCSWTSE-JAB-SBR-EX-DRG – 53000 Series – “Work As Executed” (WAE) Issue.

- Selected drawings from Barangaroo Station Structural Details Drawings – Sydney Metro City and Southwest Tunnel and Station Excavations - Barangaroo Station and Precinct – Station Structure – Drawing set – SWCSWTSE-JAB-SBR-ST-DRG – 53100 Series – “Work As Executed” (WAE) Issue.
- Structural Drawings - Sydney Metro City and Southwest – Barangaroo Station and Precinct – Station Structure – Movements at Station Interface - “Work As Executed” (WAE) Issue - SMCSWTSE-JAB-SBR-ST-DRG-531046 sheet 40 of 482.
- Barangaroo Station Protection Guidelines by Metron, report ref: SMCSWSBR-MET-SBR-ID-REP-000030 Rev. P09 dated 11 February 2021.
- Structural Interface Report – Barangaroo Station – Stage 3 Detail Design by Metron, report ref: NWRLSRT-MET-SBR-ST-REP-00003 Rev P03 dated 11 February 2021.
- Coffey GIR - Rev-1, dated 15 November 2022.
- Coffey Desktop study and Leapfrog Model report, ref: SYDGE287887AB- Rev 1, dated 28 July 2022.
- Coffey Report – Tension Piles and Interaction with Sydney Metro Station Preliminary Advice, report ref: SYDGE287887AC, dated, 15 October 2022.
- Coffey Report – Concept Design Advice for retaining wall and foundations, report ref: SYDGE287887-1 AH (Rev 2) dated, 22 November 2023.
- Rygate Survey Report for Metro Tunnels dated 30 November 2023.

8. DESIGN MODEL

8.1 GEOTECHNICAL MODEL

The generalised ground conditions encountered in the Barangaroo foreshore locality comprises fill, underlain by alluvial sediments and minor residual soils overlying Hawkesbury Sandstone. The depth of each material unit increases towards the western direction. Details of the ground conditions of the CBD are provided in the GIR.

Geological sections as shown in the location plan (Figure 3) are presented in the following figures:

- Figure 4 – At the interface of Barangaroo Station and CBD (Section 1)
- Figure 5 – South of Barangaroo Station (approximately 20 m from south end of station)
- Figure 6– Across Shark Fin along the East side (Section 2)

Table 2: Summary of Geotechnical models developed for the sections

Unit	Material	Typical Description	Inferred Upper Surface of Material – RL (m AHD)		
			Section 1	Section 2	Section 3
1	Fill	Variable soils, boulders, building rubble and timber	2.7	2.6	2.6
2	Alluvium	Stiff clays and loose to medium dense sands/clayey sands	-3 (East) to -12 (West)	-4 (North) to -2 (South)	-2.5 (East) to -11 (West)

Unit	Material	Typical Description	Inferred Upper Surface of Material – RL (m AHD)		
			Section 1	Section 2	Section 3
3	Residual Soil/Class V	Very stiff/hard clay and XW sandstone.	-5 (East) to -19 (West)	-7.5 (North) to -4.5 (South)	-2.5 (East), Not encountered (West)
4B	Class IV Sandstone	HW to MW low or medium strength, often with closely spaced defects	-	-8 (North) to -6 (South)	-11 (East) to -16.5 (West)
4C	Sandstone Class III	MW to fresh, medium or high strength, with moderately spaced defects and/or shale breccia	-6 (East) to -20 (West)	-8.5 (North) to -6.5 (South)	-4 (East) to -17 (West)
4D	Sandstone Class II or better	Slightly weathered to fresh, medium or high strength, with widely spaced defects	-10 (East) to -21.5 (West)	-11.5 (North) to -8 (South)	-5.5 (East) to -20 (West)

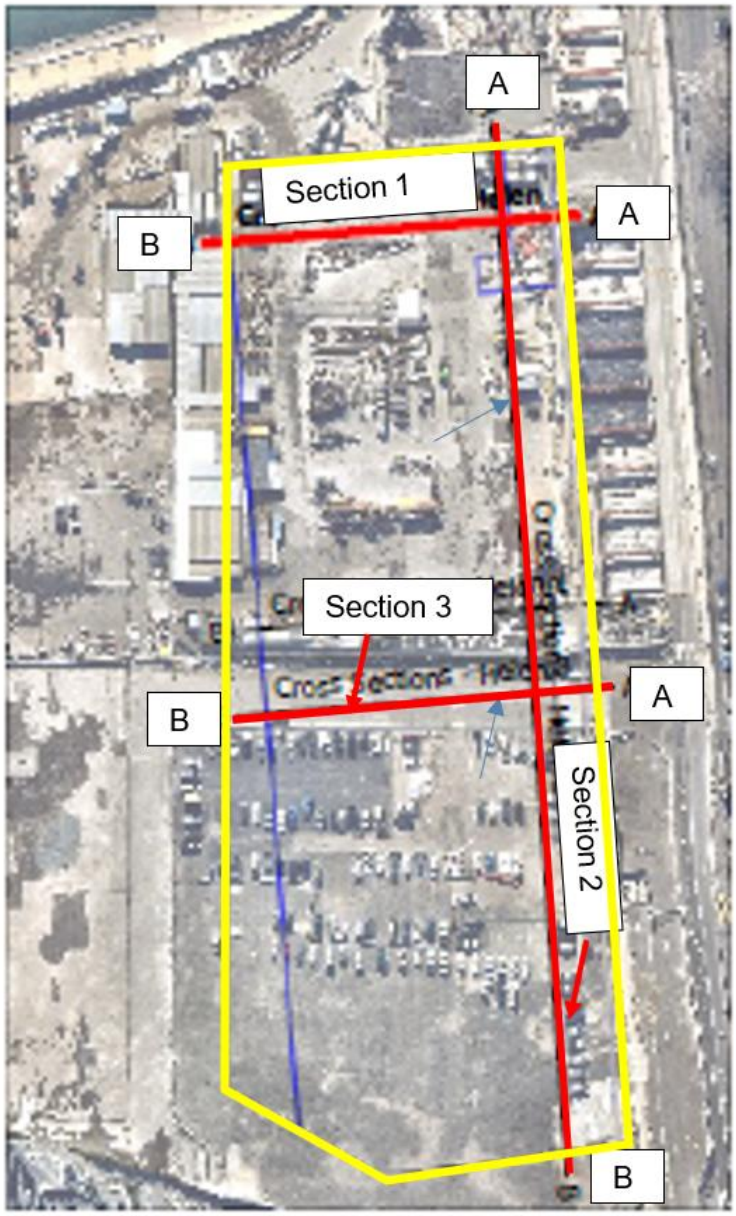


Figure 3: Locations of Geological Sections

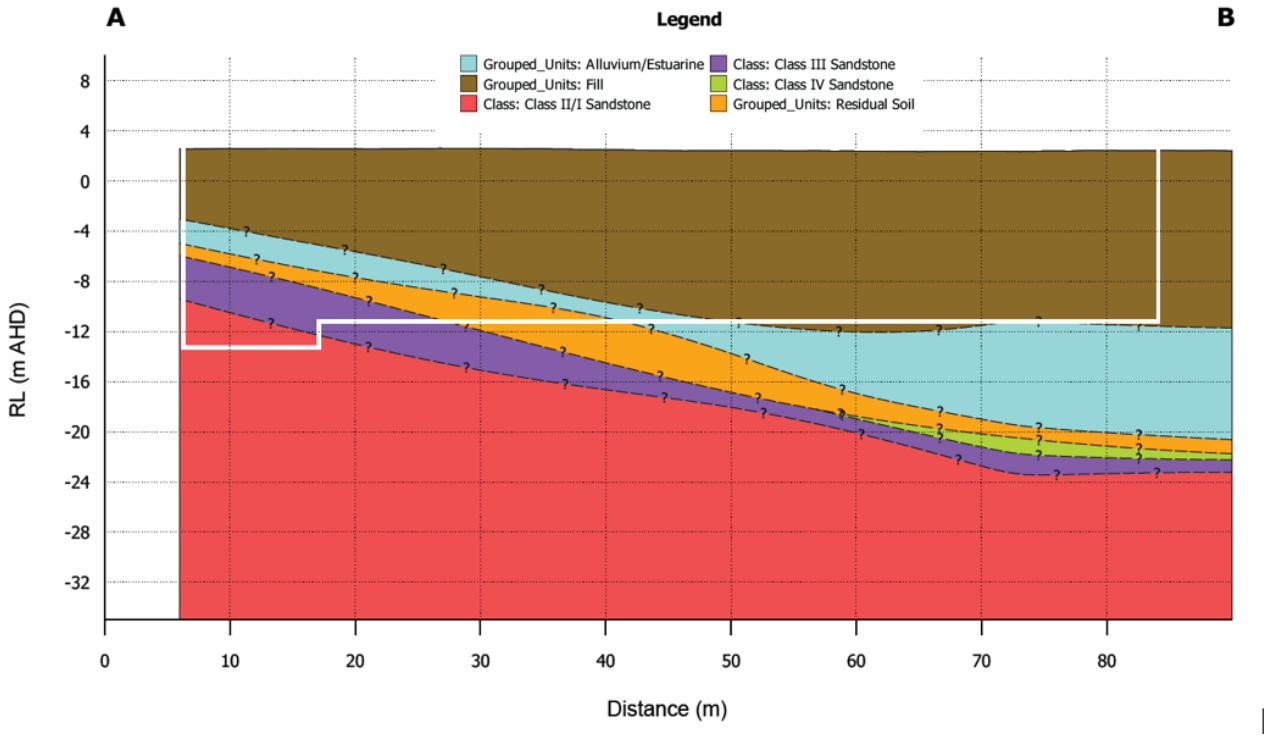


Figure 4: Geological section at Section 1

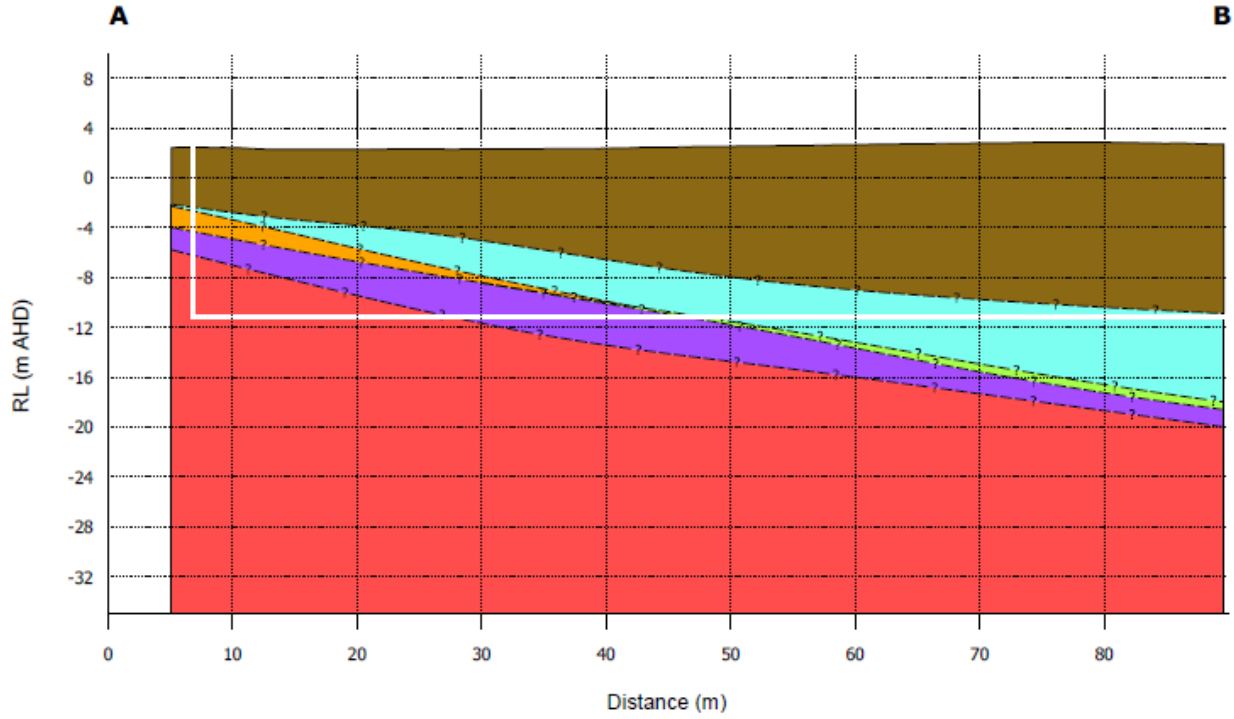


Figure 5: Geological section at Section 3

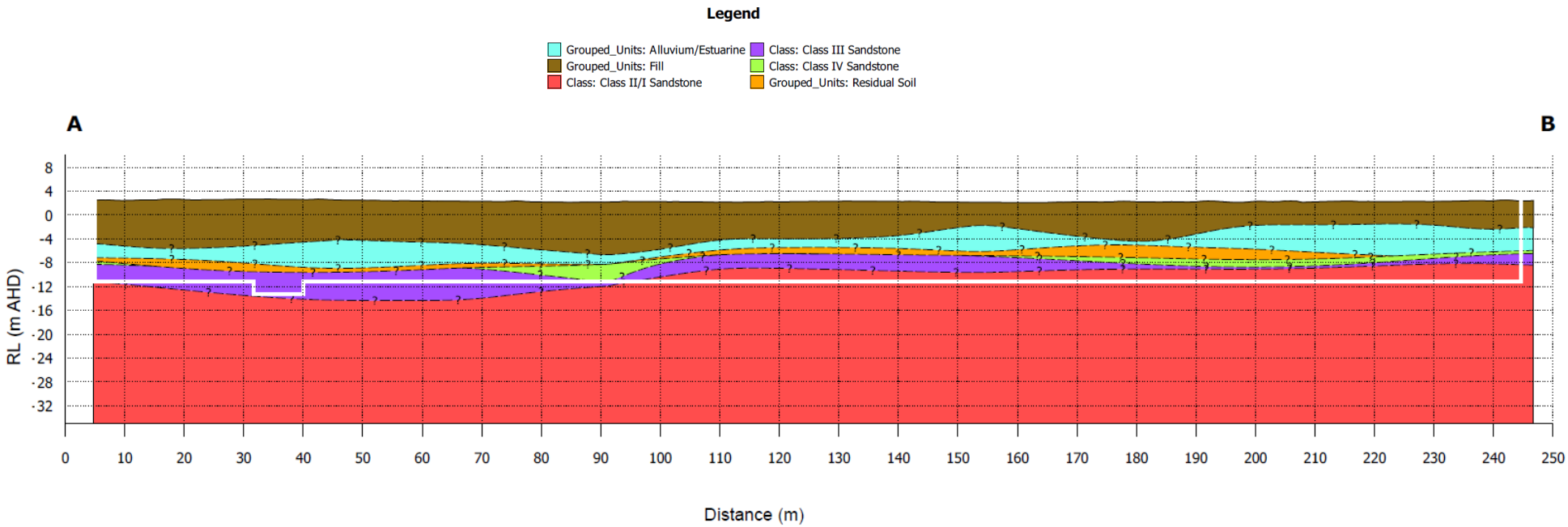


Figure 6: Geological section at Section 2

8.2 GEOTECHNICAL PARAMETERS

The geotechnical parameters adopted for soil and rock are presented in Tables 6 and 7 of the GIR and reproduced in Table 3 and Table 4.

Table 3: Geotechnical Parameters for Soil (reproduced from Table 6 of GIR – see)

Unit	Description	Bulk Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Undrained Shear Strength (kPa)	Elastic Modulus (MPa)			Poisson's Ratio	'At Rest' Earth Pressure Coefficient. K_0(1)
						E_{50}	E_{oed}	E_{ur}		
1	Fill	18	0	30	-	10	10	30	0.35	0.5
2	Alluvium	19	2	30	-	20	20	60	0.3	0.5
3	Residual Soil & Class V Sandstone	20	5	25	75	60	60	180	0.35	0.5

Table 4: Geotechnical Parameters for Rock (reproduced from Table 7 of GIR)

Unit	Sandstone Class	Bulk Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Elastic Modulus (MPa)	Poisson's Ratio
4C	Class III	24	300	35	1000	0.3
4D	Class II or Better	24	500	50[1]	1800	0.3

[1] The adopted friction angle for Class II or better is reference in Oliveira (2014).

8.3 IN-SITU STRESS

Variability in situ stress magnitudes and directions can be due to the local topography (e.g. stress relief may occur at incised valley locations) and built environment (e.g. quarrying or adjacent basements) or local geological features such as faults and dykes. The harbour front location of Barangaroo Central, its previous development history and the proximity to local geological structures may mean that stress fields may vary at different parts of the site.

The in-situ stresses are assessed based on the approach described by Oliveira and Parker (2014) which takes into account relationship between interdependency of all principal stresses and the rock mass quality using Figure 7 below. The horizontal stress in rock stratum was assessed based on the average depth of each rock stratum from the surface and the modulus of the corresponding rock layer. The in-situ stress ratio for each rock stratum is then calculated based on the assessed horizontal stress and vertical overburden stress.

The in-situ stress ratios for k_H and k_h are defined as follows:

$$k_H = \text{Total Horizontal Stress, } \sigma_{h(N\text{-}S)} \text{ / Total Vertical Stress, } \sigma_v \quad (1)$$

$$k_h = \text{Total Horizontal Stress, } \sigma_{h(E\text{-}W)} \text{ / Total Vertical Stress, } \sigma_v \quad (2)$$

The adopted values of k_H and k_h are presented in Table 5.

Table 5: In-situ stress ratios for Rock

Section	Unit	In-situ Stress Ratio [2]		
		k_H (N-S direction)		k_h (E-W) direction
1 & 3	4C	3		2
	4D	East	4.6 (< RL -20 m AHD)	2.8 (< RL -20 m AHD)
			3.8 (> RL -20 m AHD)	2.3 (> RL -20 m AHD)
		West	5.3 (< RL-20 m AHD)	3.2 (< RL-20 m AHD)
			4 (> RL -20 m AHD)	2.5 (> RL -20 m AHD)
2	4C	3		2
	4D	2.5 (< RL-20 m AHD)		1.5 (< RL-20 m AHD)
		2 (> RL -20 m AHD)		1.2 (> RL -20 m AHD)

[2] In-situ stress ratio based on the average depth of rock stratum

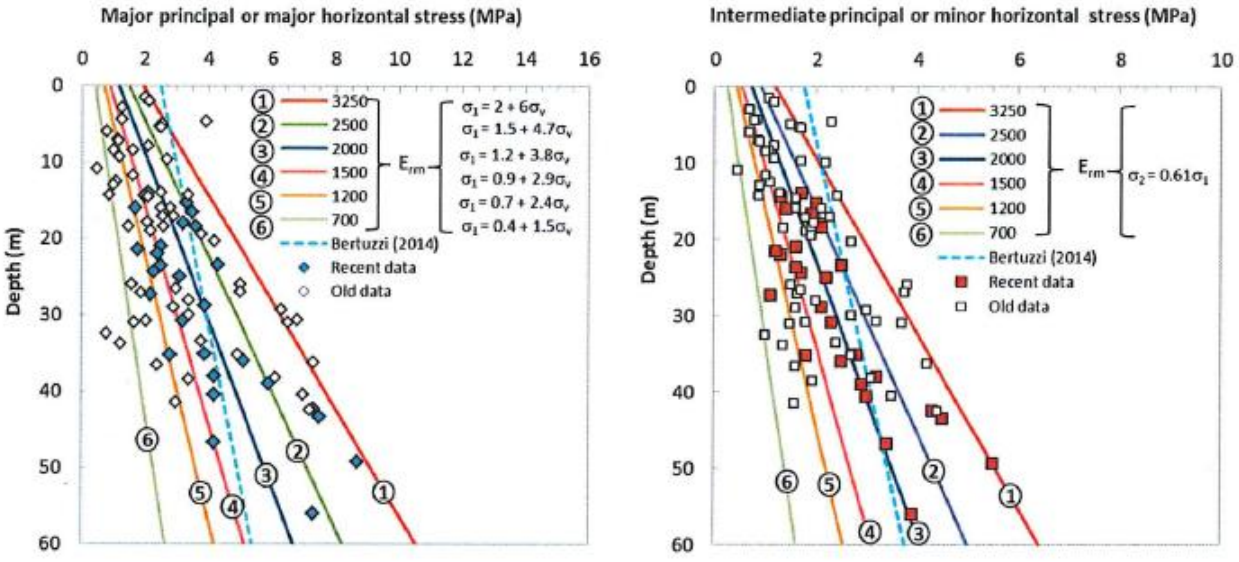


Figure 7: Stress Relationships for different values of rock mass stiffness (extracted from Oliveira and Parker (2014))

8.4 DESIGN GROUNDWATER LEVEL

In 2017, groundwater levels were measured at the site at elevations between 0.6 m AHD to -0.6 m AHD. Groundwater levels are expected to vary due to tidal influence. The Mean High Water Spring level is about 0.62 m AHD and the Mean Low Water Spring (MLWS) level is at -0.7 m AHD.

The highest astronomical tide (HAT) level measured at Fort Denison is about 2.1 m which corresponds to RL1.18 m AHD approximately. This HAT level does not allow for storm surges and climate change effects. Based on our experience of previous projects on this precinct, the design groundwater level is adopted to be

RL 1.5 m AHD for the base case and a long-term design groundwater level of +2.575 m AHD, allowing for climate change including sea level rise, tide and storm surge effects, was adopted.

9. METHODOLOGY

The geotechnical impact assessment of CBD on Barangaroo Station Box was carried out using a simplified 2-dimensional (2D) numerical analyses of three selected sections by a commercially available Finite Element Analysis (**FEA**) program Plaxis 2D Version 2023.

In the analysis, the soil materials (Fill, Alluvium and Residual) are modelled as Hardening Soil model, while the rock materials are modelled as Mohr-Coulomb model with in-situ rock stresses calculated with reference to the approach described in Section 8.3.

The perimeter wall along Barangaroo Station and the diaphragm wall at CBD are modelled by plate elements with equivalent smeared wall properties. The anchors are modelled by node-to-node anchors for the free length and embedded beam elements for the bond length. The structural slabs are modelled by plate elements.

9.1 ANALYSED SECTIONS

The assessment considered the following sections as shown in Figure 8:

- Section 1 – South of Shark Fin at interface of Barangaroo Station and CBD (in E-W direction) (Figure 9)
- Section 2 – Across Shark Fin and Metro interface (in N-S direction) (Figure 10)
- Section 3 – South of Barangaroo Station across Metro Tunnels (in E-W direction) (Figure 11)

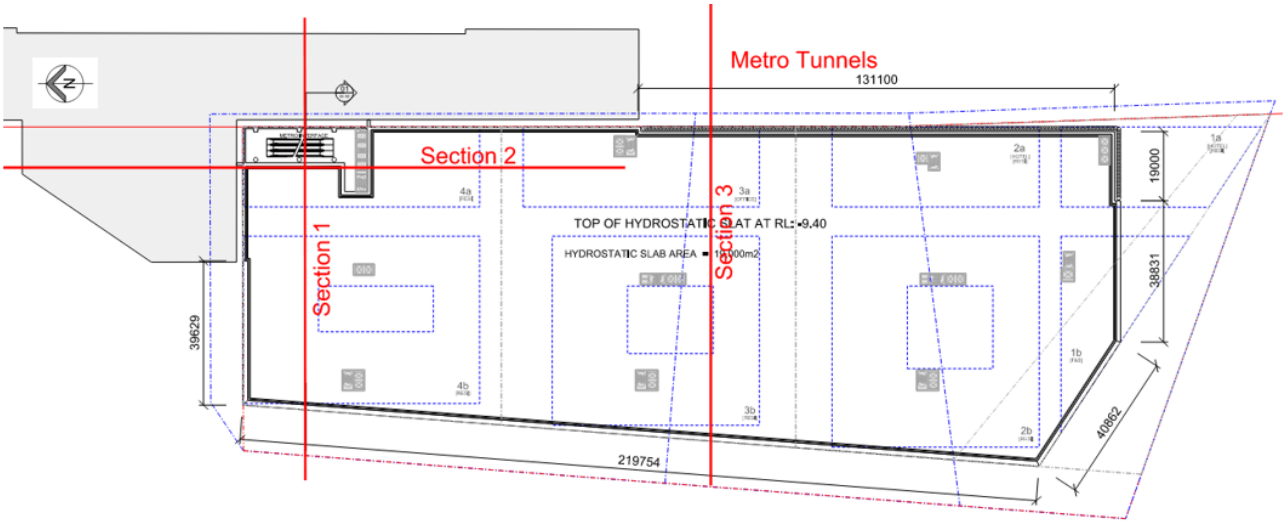


Figure 8: Location of sections analysed

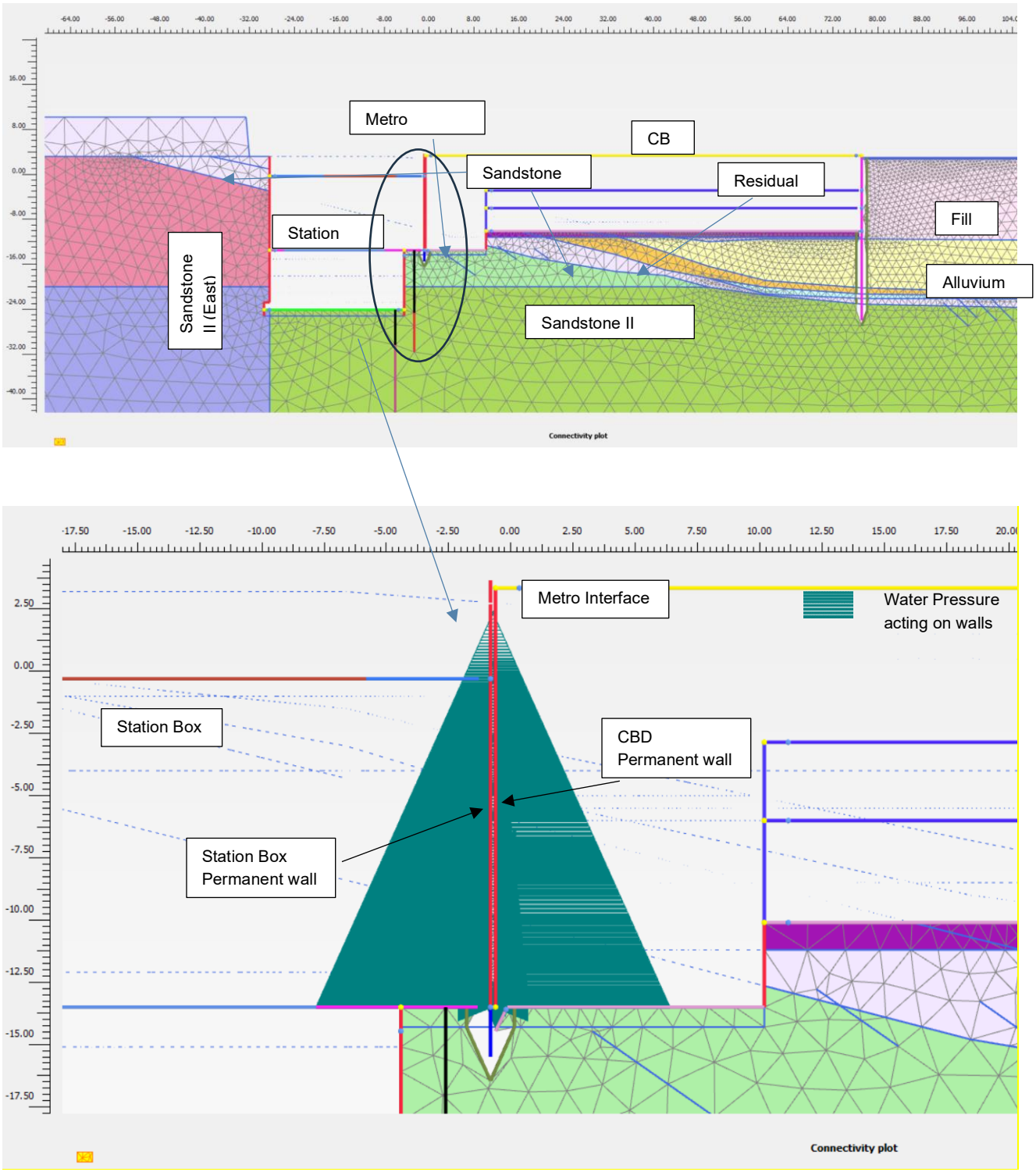


Figure 9: Section 1 – Cross section at interface of Barangaroo Station and CBD

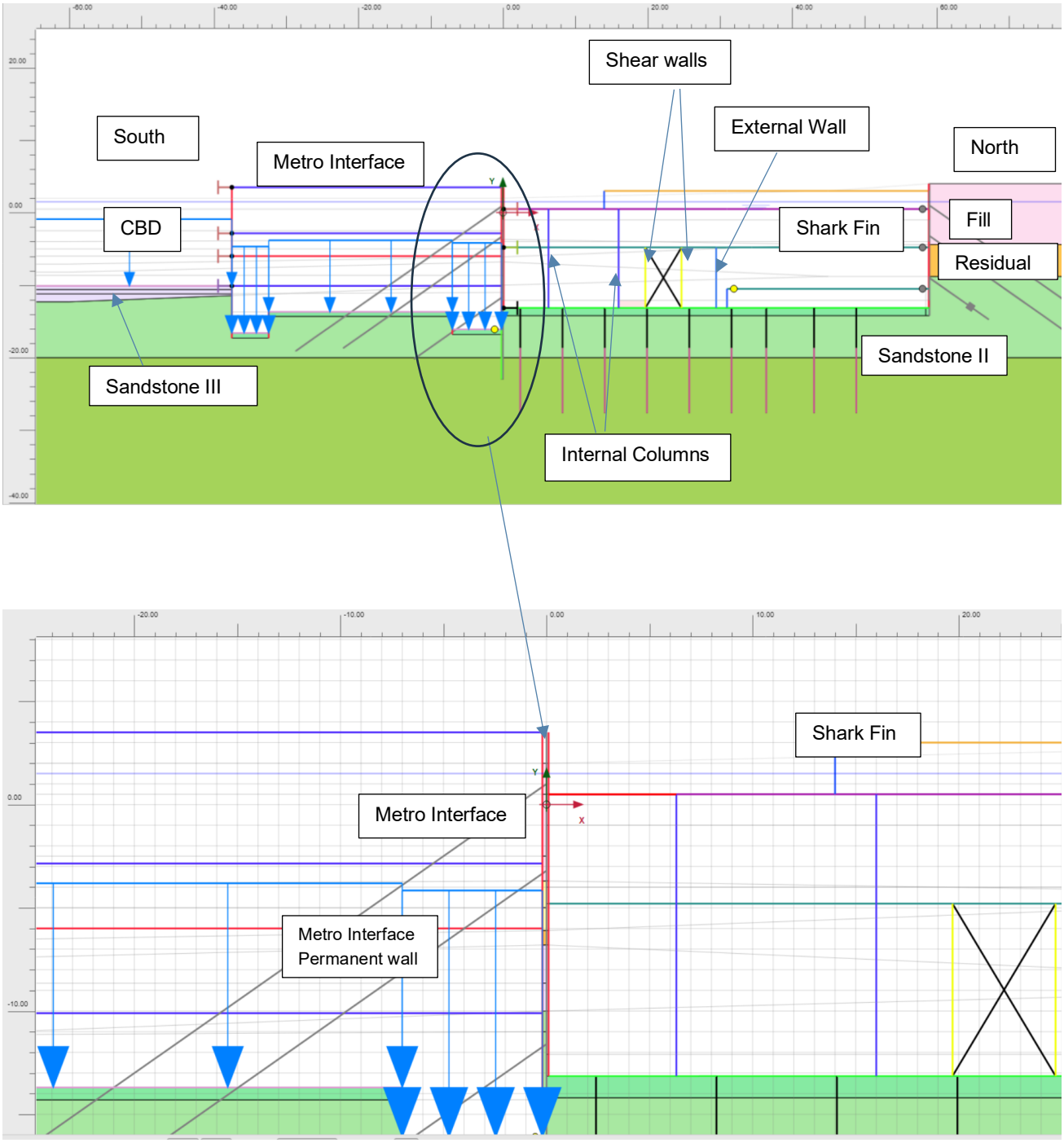


Figure 10: Section 2 – Cross section Across Shark Fin and Metro Interface

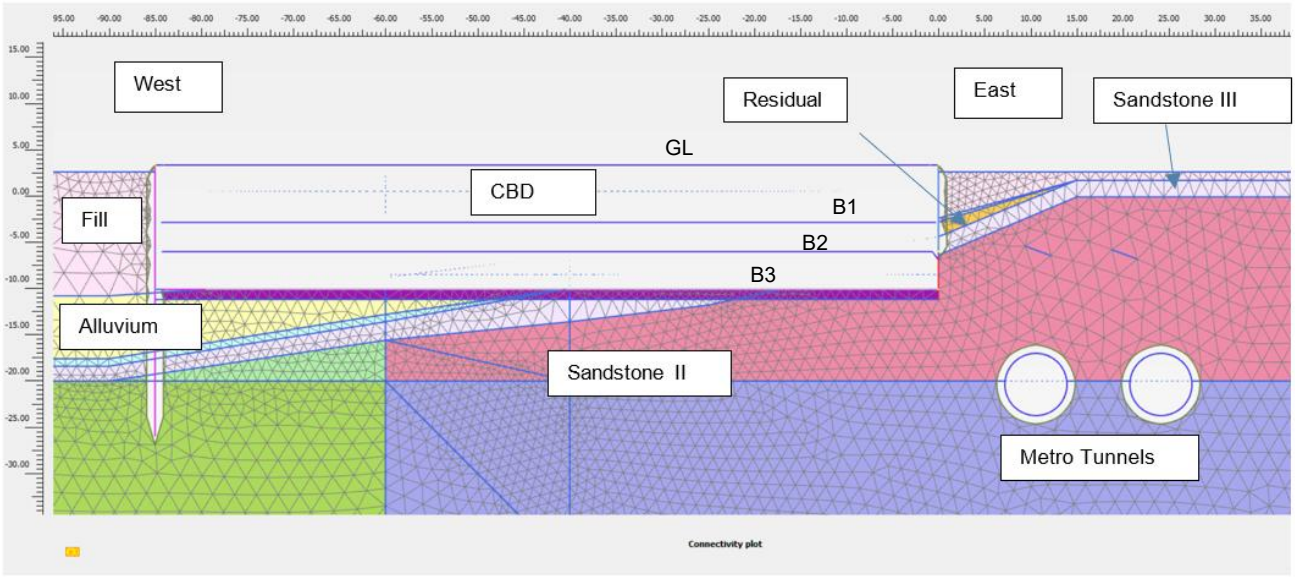


Figure 11: Section 3 – Cross section Metro Tunnels

9.2 DESIGN ASSUMPTIONS

In order to simulate the stress relief in rock, the excavation and installation of slabs at Barangaroo station and tunnels are modelled followed by the excavation of CBD. Details of modelling sequence is summarised in Section 10. The following assumptions were made in the assessment:

- Structural details of the walls and slabs, geometry of excavation and construction sequence for the station box was modelled using the details from the drawing sets – Station open excavation SWCSWTSE-JAB-SBR-EX-DRG – 53000 series and Station structure - SWCSWTSE-JAB-SBR-EX-DRG – 531000 Series. These drawings are a “Work As Executed (WAE)” Issue.
- Depressurisation system is in operation throughout the construction period to maintain water level at specified levels.
- For Sections 1 and 2:
    - During excavation of Barangaroo station, the groundwater level will be lowered to the bulk excavation level (BEL), and upon the completion of the station slab construction, the water level will be raised to the level approximately at the BEL of CBD (i.e. RL -14.2 m AHD near adjacent to the interface).
    - Design waterhead difference between the West and East wall along CBD to be maintained at 4 m.
- Rock excavation by vertical cut along the east wall of Barangaroo station
- Anchors for both Barangaroo station and CBD are embedded to Class III or better Sandstone
- Permanent ground anchors are installed at the base slabs of Barangaroo station and Shark Fin to resist the hydrostatic uplift pressure acting at the base slabs.
    - These anchors are modelled using the WAE drawings SMCSWTSE-JAB-SBR-ST-DRG-531249, 531250 and 531252.
    - Details of the anchors are as follows:
        - Barangaroo Station – B6 Level – Anchor Type P8 (49 strands) – a total length of 19.5 m with a minimum free length of 7.5 m and a minimum bond length of 12 m embedded in Class II or better sandstone. The lock-off (prestress) load of the anchor was 2499 kN.

  - Barangaroo Station – B3 Level – Anchor Type P6 (35 strands) – a total length of 18.5 m with a minimum free length of 11.5 m and a minimum bond length of 7 m embedded in Class II or better sandstone. The lock-off (prestress) load of the anchor was 3548 kN.
  - Shark Fin – B3 Level – Anchor Type P5 ((35 strands) – a total length of 14.5 m with a minimum free length of 5.5 m and a minimum bond length of 9 m embedded in Class II or better sandstone. The lock-off (prestress) load of the anchor was 3548 kN.

- For Section 1, the connection of the walls and slabs of Barangaroo Station is assumed to be semi-rigid. The rotational stiffness of the connection is computed based on the fixed end moment of the two connecting members-rigid with an individual rotational stiffness of as 4EIi/Li for (i = 1,2), then taking 75% of the larger value plus 25% of the lesser value.
- For Section 2, the model incorporated in the following (reference to WAE Drawing SMCSWTSE-JAB-SBR-ST-DRG-531496):
    - Metro temporary walls (North and South walls) to facilitate the excavation of Shark Fin. These walls are deactivated upon the decommissioning of the temporary anchors
    - Metro permanent walls (W13 and W14) are modelled after the construction of Metro B3 slab.
    - Structural columns C001, C002, C004 and C005 and shear wall SW18, SW21 and SW75 are modelled with equivalent smear properties based on the dimension and the spacing.
    - Connections of the walls, columns and slabs are assumed to be rigid.
    - Existing soil between the permanent walls for Metro and CBD.
    - Lateral soil and groundwater pressures as shown in Figure 12 will spread out to the walls and slab B1 via the shear and external walls. It is anticipated that this load will be transferred to the eastern wall of the Shark Fin and then spread out to the Metro Station box. Also, due to the 2D numerical analysis method, the full soil and water pressures acting normal to W14 are transferred to W13 whereas this is not the case due to the inclination of W14 to W13. To simulate the propping effect of the diaphragm action of the slabs in providing propping to W13 and the reduced load component applied from W14 to W13, the following combined methods were employed in the modelling:
        - Slabs at each level are assumed to extend through to the station box, providing additional lateral stiffness to the Shark Fin structures. The stiffness component normal to W13 is applied at each slab level to simulate to propping effect.
        - The full earth and water loading normal to W14 (P_{N14}) from an initial run is resolved by trigonometry to give the component normal to W13 (P_{N13}), the excess load (i.e. P" = P_{N14} - P_{N13}) is then applied as a component normal to W13 as reaction forces (i.e South to North) at slab levels.

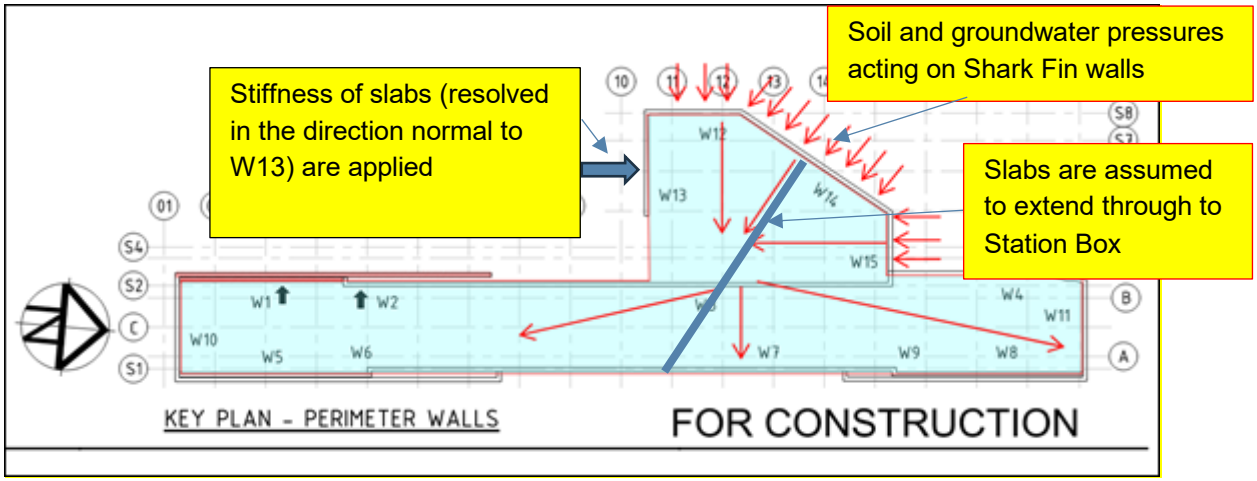


Figure 12: Lateral soil and groundwater pressures acting on walls and slabs diagram

- The BEL of CBD is at approximately RL -14.2 m AHD (East) and -11.2 m AHD (West), respectively
- Diaphragm wall of thickness 1.2 m (assumed) would be installed along the western perimeter of CBD with 4 rows of anchors. The wall and anchors are embedded in Class III or better Sandstone. The details of anchors are as follows:
  - 1st and 2nd rows of anchors are 10 strands installed at 45 degrees to horizontal with a spacing of 1.5 m
  - 3rd and 4th rows of anchors are 12 strands installed at 45 degrees to horizontal with a spacing of 1.5 m
- Secant pile wall with two rows of temporary anchors. The piles have a diameter of 1.2 m at a centre-to-centre spacing of 1.8 m will be installed along Hickson Road and southern perimeter. The piles are proposed to terminate at RL -6 m AHD. The anchors are 4 strands installed at 20 degrees to horizontal (to remain clear of the 1st reserve) with a spacing of 1.8 m.
- Equivalent uniform loads are applied on base slab of CBD to simulate the uplift resistance provided by the tension piles installed underneath the slab. The equivalent loads are calculated based on the hydrostatic pressure at the underside of the base slab (i.e. unit weight of water x (long term ground water level – level of underside of base slab)).
- The design groundwater level for the base case (normal condition) is approximately RL 1.5 m AHD.
- The design groundwater level for the climate change case (high tide and extreme weather condition) is approximately RL 2.575 m AHD.
- The thickness of the concrete tunnel liner for Metro tunnels is 260 mm based on our experience on other projects around the area.

10. GEOTECHNICAL ASSESSMENT RESULTS

10.1 SECTION 1 – METRO INTERFACE AND CBD (E-W DIRECTION)

10.1.1 Modelling Sequence

The following modelling stages have been assumed for the assessment (see Appendix C for Plaxis models):

1. Initialise in-situ ground stresses in layered soil and rock
2. Install pile wall along the interface of the station box and CBD

3. Lower Groundwater level (GWL) to RL -2 m AHD
4. Excavate station to RL -1 m AHD
5. Install 1st row of anchors (T3)
6. Lower GWL to RL -4.5 m AHD
7. Excavate station to RL -4 m AHD
8. Install 2nd row of anchors (T5)
9. Lower GWL to RL -12.6 m AHD
10. Excavate station to R -12.1 m AHD
11. Install 3rd row of anchors (T6)
12. Lower GWL to RL -25.2 m AHD
13. Excavate station to BEL at RL -25.2 m AHD in stages
14. Install base slab and B3 (Concourse) slab
15. Install ground slab anchors
16. Install side walls around station box (reset displacement to zero at the end of stage 16)
17. De-stress 3rd row of anchors (T6)
18. Install top slab
19. De-stress 1st row of anchors (T3)
20. Raise GWL to RL -15 m AHD at station box and RL -11 m AHD at CBD interface (behind the TSE west wall) and raise the existing ground level to RL 3 m AHD
21. Reset displacement to zero
22. Install diaphragm wall (1.2 m thick) along the western perimeter of CBD
23. Lower GWL to RL -15 m AHD and RL -11.7 following the excavation profile of CBD
24. Excavate CBD to RL 0.5 m AHD
25. Install 1st row of anchors at RL 1 m AHD on CBD West wall
26. Excavate CBD to RL -2.5 m AHD
27. De-stress anchors (T5) at station box
28. Install 2nd row of anchors at RL -2.0 m AHD on CBD West wall
29. Excavate CBD to RL -5.5 m AHD
30. Install 3rd row of anchors at RL -5 m AHD on CBD West wall
31. Excavate CBD to RL -8.5 m AHD
32. Install 4th row of anchors at RL -8 m AHD on CBD West wall
33. Excavate CBD to BEL at RL -14.2m AHD (East) and -11.2 m AHD (West)
34. Reset displacement to zero
35. Install CBD base slab and apply equivalent loads to resist buoyant force due to hydrostatic pressure
36. Install floor slabs and de-stress anchors in stages
37. Raise GWL to RL -11 m AHD at Station box and underside of base slab of CBD
38. Depressurisation system decommissioned (see Table 6 for GWLs)

Analyses have been carried out considered the following cases with different groundwater regimes as summarised in Table 6 upon the decommission of the depressurisation system.

Table 6: GWL cases considered in the assessment

Case	GWL at Landward side RL (m AHD) – Station Box and CBD	GWL at Seaward side RL (m AHD) – West of CBD
1	1.5	1.5
2	1.5	0.5
3	2.575	2.575
4	2.575	1.575

10.1.2 Assessment Results

Table 7 summarises the displacements and structural actions of the structural walls and slabs of the Barangaroo station box at different construction stages. Permanent forces acting on the slabs after the completion of structures are not considered in the analysis. It should be noted that the displacements are reset to zero following construction stages:

1. After the installation of Barangaroo station box structure (After Stage 16)
2. After groundwater level raised to RL -15 m AHD at station box and RL -11 m AHD at CBD site (Stage 21)
3. After the excavation of CBD (Stage 34).

Plots for displacement profile, structural actions are provided in Appendix D.

Table 7: Summary of Results for Section 1 at Different Construction Stages

Stage		East Wall	West Wall	Base Slab (E-W)	B3 (Concourse)Slab (E-W)	Roof Slab (E-W)
After Barangaroo Station Excavation (Stage 13)	**Maximum Lateral Displacement (mm)**	13 (at rock face)	26 (at rock face)	-	-	-
After installation of Barangaroo Station slabs and walls (Stage 19)(1)	**Maximum Lateral Displacement (mm)**	0.4	1.3	0.1	1.3	0.9
	Maximum Bending Moment (kNm/m)	195	287	754	8	7
	Maximum Shear Force (kN/m)	185	105	569	0.5	0.5

GWL at RL-15 for Barangaroo Station and RL-11 West of Barangaroo Station (Stage 20)	**Maximum Lateral Displacement (mm)**	0.5	1	0.5	1.2	0.9
	Maximum Bending Moment (kNm/m)	195	352	754	8	17
	Maximum Shear Force (kN/m)	184	105	569	0.5	1
Excavate CBD to BEL at RL-14.3 and RL-11.2 (Stage 33)[2]	**Maximum Lateral Displacement (mm)**	0.4	0.6	0.5	0.6	0.2
	Maximum Bending Moment (kNm/m)	195	354	754	13	33
	Maximum Shear Force (kN/m)	184	194	569	1	3
After installation of CBD slabs and walls (Stage 36) [3]	**Maximum Lateral Displacement (mm)**	0.4	0.8	0.6	0.5	0.1
	Maximum Bending Moment (kNm/m)	195	379	754	13	33
	Maximum Shear Force (kN/m)	184	379	569	1	3
GWL at RL-10 for Barangaroo Station and	**Maximum Lateral Displacement (mm)**	0.4	1	0.6	0.5	0.2

RL-11.2 for CBD (Stage 37)	**Maximum Bending Moment (kNm/m)**	195	379	754	13	33
	Maximum Shear Force (kN/m)	184	379	569	0.9	3
GWT at RL1.5 (GWL case 1)	**Maximum Lateral Displacement (mm)**	1.6	3.2	0.6	3	2.4
	Maximum Bending Moment (kNm/m)	652	1971	3792	14	52
	Maximum Shear Force (kN/m)	501	895	1002	1	4
GWL at RL 1.5 at landward side and RL 0.5 at seaward side (GWL Case 2)	**Maximum Lateral Displacement (mm)**	1.5	2.8	0.5	2.7	2
	Maximum Bending Moment (kNm/m)	628	2056	4005	13	44
	Maximum Shear Force (kN/m)	523	930	1064	1	3
GWT at RL2.575 (GWL Case 3)	**Maximum Lateral Displacement (mm)**	1.8	3.5	0.6	3.5	3
	Maximum Bending Moment (kNm/m)	736	2496	4930	14	60

	Maximum Shear Force (kN/m)	580	1060	1230	1	4
GWL at RL 2.575 landward side and RL 1.575 at seaward side (GWL Case 4)	**Maximum Lateral Displacement (mm)**	1.9	4.2	1	4	3
	Maximum Bending Moment (kNm/m)	741	2384	4838	16	59
	Maximum Shear Force (kN/m)	575	1016	1253	1.2	4

Note:

(1) Displacement reset to zero after station box structures installed (after Stage 16)

(2) Displacement reset to zero prior to the excavation of CBD (Stage 21)

(3) Displacement reset to zero after CBD excavation reach BEL (Stage 34)

10.1.3 Horizontal Displacement

Based on the assessment results, the BMS east and west rock face maximum lateral movements were computed to be 13 mm and 26 mm, respectively, during excavation (Stage 13). For the west rock face, the majority of rock face movement is assessed to be in the range of 10 mm to 26 mm.

Following completion of the station box and the groundwater level allowed to be raised to RL -15 m and RL –11 m on the east and west sides of the station box (Stage 20), the displacement of the walls and slabs are assessed to be less than 2 mm.

The FEA indicate that the basement excavation of CBD (Stage 36) would induce horizontal displacement of approximately 1 mm to the walls and slabs of the station box. Considering the out-of-balance groundwater loads (4 m difference between the west and east walls along CBD), there is no significant changes in the horizontal displacement on the structures. Upon the decommission of the depressurisation system and GWL raises to the normal condition (RL 1.5 m AHD) and the climate change (RL 2.575 m AHD) conditions could induced additional <1 (Stage 38 GWL at RL 1.5 m AHD) to 4 mm (Stage 38 GWL at RL 2.575 m AHD) horizontal displacement to the station box structure. The assessed total lateral movement at the CBD interface is ≤ 5 mm which is less than the predicted transverse SLS movement of 7 mm and ULS movement of 12 mm at the B3 slab as shown in the WAE drawing SMCSWTSE-JAB-SBR-ST-DRG-531046 sheet 40 of 482.

10.1.4 Structural actions

The assessed results indicated that the structural actions of the walls of the station box structure increases significantly upon the decommission of depressurisation system.

The assessed bending moment of the East wall is approximately 195 kNm/m after the completion of the station box and remains the same upon the completion of CBD. The bending moment increases to

652 kNm/m when the GWL rises to RL1.5 m AHD. The assessed shear force of the wall is approximately 184 kN/m upon the completion of the station box and CBD and increases to 501 kN/m when the GWL rises to RL1.5 m AHD.

For the West wall, the bending moment increases from 287 kNm/m to 379 kNm/m upon completion of CBD. When the depressurisation system is decommissioned, the bending moment increases significantly to over 2496 kNm/m. A similar trend is observed for the shear forces.

For the top and B3 (Concourse) slabs, the results indicated that there is no significant increase in the structural actions at different stages. However, for the base slab (B6), there is a significant increase in bending moments in the slab upon the completion of CBD (754 kNm/m) and groundwater level raise to RL 2.575 m AHD (4930 kNm/m). In the analysis, the connections between the slabs and walls at the Barangaroo station are assumed to be semi-rigid with the rotational stiffness computed as stated in Section 5.2. We note that the computed base slab bending moment may be over-estimated due to the large span adopted in the FEA. It is possible that the uplift resisting rock anchors would reduce the bending moment induced by the hydrostatic loading.

We note that from Stage 38 onwards, the high bending moments and shear forces on the BMS walls and base slabs are a direct result of decommissioning of the depressurisation system, and not due to the CBD. The hydrostatic pressures at the base of the structure at RL -25.2 m equates to 267 kPa and 278 kPa for design groundwater levels of RL 1.5 m and RL 2.575 m, respectively, and it is not surprising that these pressures will cause significant bending moment and shear forces on the BMS structural elements.

The assessed maximum anchor forces for B6 slab anchor (P8) and B3 slab anchor (P6) are 2413 kN and 6194 kN.

10.2 SECTION 2 – ACROSS SHARK FIN AND METRO INTERFACE (N-S DIRECTION)

10.2.1 Modelling Sequence

The following modelling stages have been assumed for the assessment (see Appendix C for Plaxis models):

1. Initialise in-situ ground stresses in layered soil and rock
2. Install Shark Fin temporary retaining walls
3. Lower Groundwater level (GWL) to RL -1.5 m AHD
4. Excavate station to RL -1 m AHD
5. Install 1st row of anchors along North and South walls (T13 and T22)
6. Lower GWL to RL -4.5 m AHD
7. Excavate station to RL -4 m AHD
8. Install 2nd row of anchors along North and South walls (T14 and T23)
9. Lower GWL to RL -12.6 m AHD
10. Excavate station to R -12.1 m AHD
11. Lower GWL to RL -14.2 m AHD
12. Install 3rd row of anchors along North and South walls (T15 and RB3)
13. Excavate station to BEL at RL -14.2 m AHD
14. Install B2 slab
15. Install permanent ground anchors and B3 slab
16. Install permanent walls (W13 and W14) around Shark Fin

17. De-stress 3rd row of anchors (T15 and RB3)
18. Install B1 slab and apply reaction forces (simulation of earth and water pressures)
19. Install LG slab and apply reaction forces (simulation of earth and water pressures)
20. De-stress 1st and 2nd rows of anchors (T13, T22 and T23)
21. Install EL slab
22. Raise GWL to RL 1.5 m AHD
23. De-stress anchor T14
24. Install CBD Dwall and lower GWL at CBD to RL -11.7 m AHD
25. Excavate CBD to RL 0.5 m AHD
26. Excavate CBD to RL -2.5 m AHD
27. Excavate CBD to RL -6.0 m AHD
28. Lower GWL at CBD to RL -14.3 m AHD
29. Excavate CBD to RL -8.5 m AHD
30. Excavate CBD to BEL at RL -14.2m AHD at Metro Interface and -11.2 m AHD at CBD
31. Backfill to bottom of B3 slab
32. Install hydro slab (B3) and apply equivalent loads to resist buoyant force due to hydrostatic pressure
33. Install B2 Slab
34. Install B1 Slab
35. Install GF Slab
36. Depressurisation system decommissioned and GWL raises to (a) RL 1.5 m AHD – original level; (b) RL 2.575 m AHD – climate change condition.

It should be noted that if the depressurisation system is deactivated during the excavation of CBD, significant hydrostatic pressure will build up between the station wall and temporary wall (anchors de-stressed). To reduce the risk of structural failure of the temporary wall, we have assumed that measures will be implemented, such as the installation of drainage holes through the temporary wall at regular spacings, until the basement is completed to allow for the relief of groundwater pressure.

10.2.2 Assessment Results

Table 8 summarised the displacements and structural actions of the structural walls and slabs (B3, B1 and LG slabs connecting North (W15) and South walls (W13)) of the Barangaroo station box at different construction stages. In the analysis, the groundwater is assumed to rise to the original level of RL +1.5 and the temporary retaining walls for the station box are deactivated after all of temporary anchors are de-stressed following the completion of Shark Fin area.

Permanent forces acting on the slabs after the completion of structures are not considered in the analysis. It should be noted that the displacements are reset to zero after the completion of the Metro station (i.e. after stage 23).

Plots for displacement profile, structural actions are provided in Appendix D. Negative lateral displacement indicates movement towards the Southern direction and positive lateral displacement indicates movement towards the Northern direction.

Table 8: Summary of Results for Section 2 at Different Construction Stages

Stage		North Wall (W15)	South Wall (W13)	B3 (Concourse) Slab	B1 Slab	LG Slab
After installation of Shark Fin slabs and walls (Stage 21)	**Maximum Total Lateral Displacement (mm)**	-4	3	0.5	4	-4
	Maximum Bending Moment (kNm/m)	252	38	415	17	18
	Maximum Shear Force (kN/m)	191	8	327	9	5
Raise GWL to RL1.5 (Stage 22)[1]	**Maximum Total Lateral Displacement (mm)**	-5.3	3	0.5	-6	-5
	Maximum Bending Moment (kNm/m)	572	156	527	23	47
	Maximum Shear Force (kN/m)	327	38	327	9	13
Excavate Metro Interface to BEL at RL-14.3 and RL-11.2 (Stage 29)	**Maximum Total Lateral Displacement (mm)**	-0.8	-1.5	-0.8	-0.7	-0.2
	Maximum Bending Moment (kNm/m)	589	413	539	23	91
	Maximum Shear Force (kN/m)	361	444	394	9	28
After installation of CBD slabs and walls (Stage 34)	**Maximum Total Lateral Displacement (mm)**	-0.7	-1.6	-0.7	-0.8	-0.3

	Maximum Bending Moment (kNm/m)	589	413	539	38	156
	Maximum Shear Force (kN/m)	361	444	395	12	47
GWT at RL1.5 (GWL case 1)	**Maximum Total Lateral Displacement (mm)**	0.4	0.8	-0.1	0.5	0.3
	Maximum Bending Moment (kNm/m)	589	415	539	38	156
	Maximum Shear Force (kN/m)	367	444	416	12	47
GWT at RL2.575 (GWL Case 3)	**Maximum Total Lateral Displacement (mm)**	0.3	1	-0.2	0.6	0.3
	Maximum Bending Moment (kNm/m)	601	467	565	38	156
	Maximum Shear Force (kN/m)	385	476	421	12	47

Note:

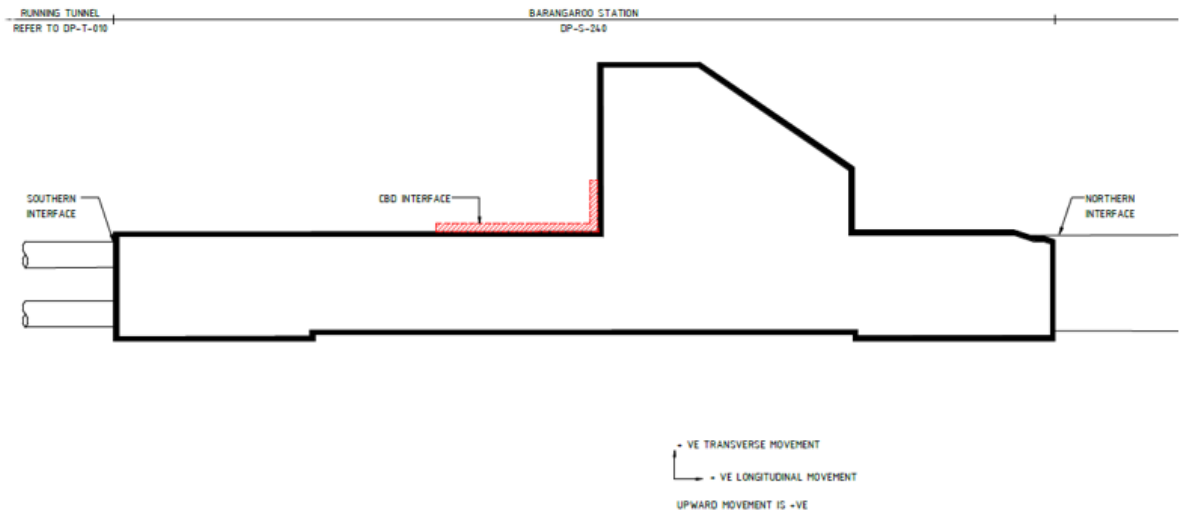
(1) Displacement reset to zero after GWL rises to RL 1.5 m AHD (After Stage 22)

10.2.3 Horizontal Displacement

Following completion of the Shark Fin, the groundwater level within Shark Fin is raised to RL 1.5 m AHD. The lateral displacements of the Shark Fin north and south walls prior to the CBD excavation are 6 mm and 3 mm, respectively, displacing towards Metro Station.

Upon the completion of CBD, the induced displacements to the Metro walls are less than 2 mm towards the CBD (i.e. displacing to the southern direction). When the GWL raises to the normal condition (RL 1.5 m AHD) and the climate change (RL 2.575 m AHD) conditions, both walls are displacing towards the northern direction by approximately 3 mm (i.e. for wall W13 wall displacement from -1.6 mm to 1 mm).

The results indicated that the total induced wall displacement due to CBD excavation is approximately 5 mm which agrees with the predicted SLS displacement of 5 mm longitudinal to the south at B3 or higher as stated in WAE drawing SMCSWTSE-JAB-SBR-ST-DRG-531046 sheet 40 of 482) and the predicted ULS longitudinal movement to the south including factored loads and groundwater is 45 mm.



MOVEMENT SCHEDULE

LOCATION	SLS VERTICAL UPWARD (mm) + VE	SLS VERTICAL UPWARD (mm) - VE	SLS LONGITUDINAL MOVEMENT (mm) + VE	SLS LONGITUDINAL MOVEMENT (mm) - VE	SLS TRANSVERSE MOVEMENT (mm) + VE	SLS TRANSVERSE MOVEMENT (mm) - VE
RUNNING TUNNEL (INTERFACE WITH SOUTH OF STATION)	0	0	0	0	0	0
RUNNING TUNNEL (INTERFACE WITH CAVERN HEADWALL)	0	0	0	0	0	0
STATION-SOUTH END (B6 SLAB)	<1	5	38	0	4	4
STATION-NORTH END (B6 SLAB)	2	3	0	38	4	4
STATION-CBD INTERFACE (B3 SLAB)	0	10	17	5	7	5
STATION-CBD INTERFACE (ABOVE B3, LGF INCLUSIVE)	0	14	17	5	25	5
CROSSOVER CAVERN INVERT (NORTHERN INTERFACE)	12	2	1	0	0	0
CROSSOVER CAVERN CROWN (NORTHERN INTERFACE)	2	12	1	0	0	0
CROSSOVER CAVERN INVERT (CAVERN HEADWALL)	3	1	3	3	3	3
CROSSOVER CAVERN CROWN (CAVERN HEADWALL)	3	3	3	3	3	3

ULS STATION MOVEMENTS AT THE CBD INTERFACE

EXPANSION JOINT LOCATION	ULS VERTICAL MOVEMENT (mm) +VE	ULS VERTICAL MOVEMENT (mm) -VE	ULS LONGITUDINAL MOVEMENT (mm) +VE	ULS LONGITUDINAL MOVEMENT (mm) -VE	ULS TRANSVERSE MOVEMENT (mm) +VE	ULS TRANSVERSE MOVEMENT (mm) -VE
B3 SLAB	12	20	60	45	12	12
ABOVE B3 (LGF INCLUSIVE)	12	20	60	45	45	12

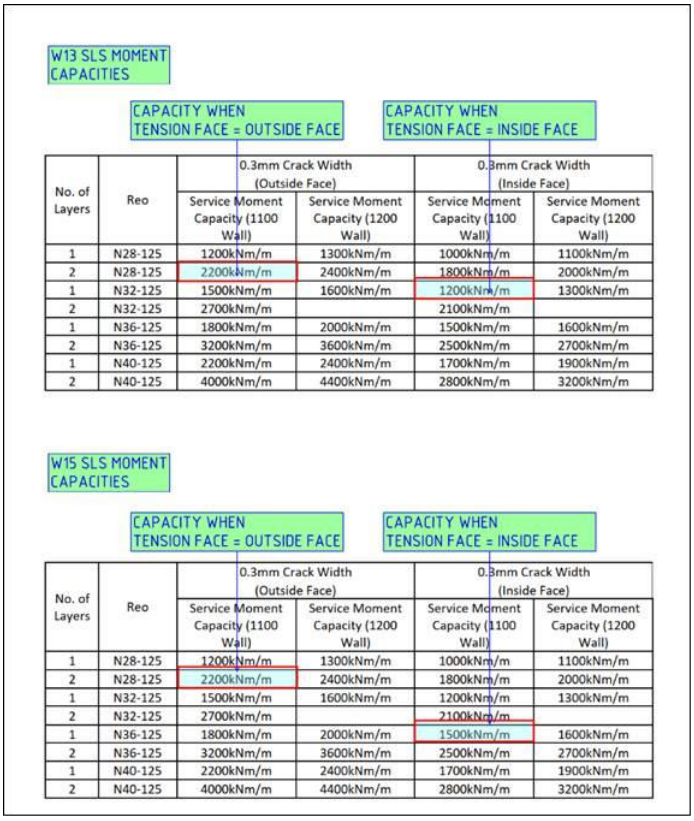
Figure 13: Predicted movement at CBD interface (extracted from Drawing No. SMCSWTSE-JAB-SBR-ST-DRG-531046 sheet 40 of 482

10.2.4 Structural actions

The assessment results indicated that the assessed maximum bending moments for North (W15) and South (W13) walls (a wall thickness of 1.1 m) are approximately 601 kNm/m and 467 kNm/m, respectively. The assessed maximum shear forces for North and South walls are approximately 385 kN/m and 476 kN/m, respectively.

With reference to the bending moment capacities of the walls considering a crack width of 0.3 mm as shown in Figure 14 (provided by BG&E), the minimum SLS bending moment capacities of the North (W15) and South (W13) walls with a thickness of 1.1 m are 1500 kNm/m and 1200kNm/m respectively. The assessed bending moments for both walls are less than the minimum SLS bending moment capacity of the walls.

For slabs, the results indicated that there is no significant increase in the structural actions at different stages.



W13 SLS MOMENT CAPACITIES

No. of Layers	Reo	0.3mm Crack Width (Outside Face)		0.3mm Crack Width (Inside Face)	
		CAPACITY WHEN TENSION FACE = OUTSIDE FACE		CAPACITY WHEN TENSION FACE = INSIDE FACE	
		Service Moment Capacity (1100 Wall)	Service Moment Capacity (1200 Wall)	Service Moment Capacity (1100 Wall)	Service Moment Capacity (1200 Wall)
1	N28-125	1200kNm/m	1300kNm/m	1000kNm/m	1100kNm/m
2	N28-125	2200kNm/m	2400kNm/m	1800kNm/m	2000kNm/m
1	N32-125	1500kNm/m	1600kNm/m	1200kNm/m	1300kNm/m
2	N32-125	2700kNm/m		2100kNm/m	
1	N36-125	1800kNm/m	2000kNm/m	1500kNm/m	1600kNm/m
2	N36-125	3200kNm/m	3600kNm/m	2500kNm/m	2700kNm/m
1	N40-125	2200kNm/m	2400kNm/m	1700kNm/m	1900kNm/m
2	N40-125	4000kNm/m	4400kNm/m	2800kNm/m	3200kNm/m

W15 SLS MOMENT CAPACITIES

No. of Layers	Reo	0.3mm Crack Width (Outside Face)		0.3mm Crack Width (Inside Face)	
		CAPACITY WHEN TENSION FACE = OUTSIDE FACE		CAPACITY WHEN TENSION FACE = INSIDE FACE	
		Service Moment Capacity (1100 Wall)	Service Moment Capacity (1200 Wall)	Service Moment Capacity (1100 Wall)	Service Moment Capacity (1200 Wall)
1	N28-125	1200kNm/m	1300kNm/m	1000kNm/m	1100kNm/m
2	N28-125	2200kNm/m	2400kNm/m	1800kNm/m	2000kNm/m
1	N32-125	1500kNm/m	1600kNm/m	1200kNm/m	1300kNm/m
2	N32-125	2700kNm/m		2100kNm/m	
1	N36-125	1800kNm/m	2000kNm/m	1500kNm/m	1600kNm/m
2	N36-125	3200kNm/m	3600kNm/m	2500kNm/m	2700kNm/m
1	N40-125	2200kNm/m	2400kNm/m	1700kNm/m	1900kNm/m
2	N40-125	4000kNm/m	4400kNm/m	2800kNm/m	3200kNm/m

Figure 14: Bending moment capacity of North (W15) and South (W13) Walls provided by BG&E

10.3 SECTION 3 – METRO TUNNEL (E-W DIRECTION)

10.3.1 Modelling Sequence

The following modelling stages have been assumed for the assessment (see Appendix C for Plaxis models):

1. Initialise in-situ ground stresses in layered soil and rock
2. Excavate tunnels (Stress relief by 80%)
3. Install tunnel liner (reset displacement to zero after this stage)
4. Install secant pile wall / Diaphragm wall
5. Lower Groundwater level (GWL) to RL 0 m AHD
6. Excavate to RL 0.5 m AHD
7. Install 1st row of anchors at RL 1 m AHD
8. Lower GWL to RL -3.0 m AHD
9. Excavate station to RL -2.5 m AHD
10. Install 2nd row of anchors at RL-2 m AHD

11. Lower GWL to RL -6.0 m AHD
12. Excavate to RL -5.5 m AHD
13. Install 3rd row of anchors at RL -5 m AHD
14. Lower GWL to RL -9.0 m AHD
15. Excavate to RL -8.5 m AHD
16. Install 4th row of anchors at RL -8 m AHD
17. Lower GWL to RL -11.7 m AHD
18. Excavate to BEL at RL -11.2 m AHD (reset displacement to zero after this stage)
19. Install B3 Slab and apply equivalent loads to resist buoyant force due to hydrostatic pressure
20. Install B2 slab
21. De-stress 4th row of anchor
22. Install B1 slab
23. De-stress 3rd row of anchor
24. Install GF slab
25. De-stress 1st and 2nd rows of anchors (reset displacement to zero after this stage)
26. Raise GWL as Table 6.

10.3.2 Assessment Results

Table 9 summarises the displacements and structural actions of the structural walls and slabs of the Barangaroo station box at different construction stages. It should be noted that the displacements are reset to zero following construction stages:

1. After the installation tunnel liner (after Stage 3)
2. After excavation of CBD (after Stage 18)
3. After the installation of CBD slabs and walls (after Stage 25)

Plots for displacement profile, structural actions are provided in Appendix D.

Table 9: Summary of Results for Section 3 at Different Construction Stages

Stage		Westbound Tunnel	Eastbound Tunnel
After Installation of Tunnel Liner (Stage 3) (1)	**Maximum Total Displacement (mm)**	5	5
	Maximum Bending Moment (kNm/m)	25	25
	Maximum Shear Force (kN/m)	16	16
	Maximum Axial Force (kN/m)	1205	1218

Stage		Westbound Tunnel	Eastbound Tunnel
After CBD Excavation to RL -11.2 (Stage 18) [2]	**Maximum Total Displacement (mm)**	2 (in the west direction)	1.5 (in the west direction)
	Maximum Bending Moment (kNm/m)	25	25
	Maximum Shear Force (kN/m)	16	16
	Maximum Axial Force (kN/m)	1206	1219
After installation of CBD slabs and walls (Stage 25) [3]	**Maximum Total Displacement (mm)**	0.5 (in the east direction)	0.5 (in the east direction)
	Maximum Bending Moment (kNm/m)	25	25
	Maximum Shear Force (kN/m)	16	16
	Maximum Axial Force (kN/m)	1206	1219
GWT at RL1.5 (GWL case 1)	**Maximum Total Displacement (mm)**	0.8 (upward in easterly direction)	0.4 (upward in easterly direction)
	Maximum Bending Moment (kNm/m)	26	25
	Maximum Shear Force (kN/m)	17	16
	Maximum Axial Force (kN/m)	1206	1219

Stage		Westbound Tunnel	Eastbound Tunnel
GWL at RL1.5 landward and RL 0.5 seaward (Case 2)	**Maximum Total Displacement (mm)**	0.8 (upward in easterly direction)	0.4 (upward in easterly direction)
	Maximum Bending Moment (kNm/m)	27	25
	Maximum Shear Force (kN/m)	17	16
	Maximum Axial Force (kN/m)	1206	1219
GWT at RL2.575 (GWL Case 3)	**Maximum Total Displacement (mm)**	0.9 (upward in easterly direction)	0.5 (upward in easterly direction)
	Maximum Bending Moment (kNm/m)	27	25
	Maximum Shear Force (kN/m)	17	16
	Maximum Axial Force (kN/m)	1234	1241
GWL at RL 2.575 landward side and RL 1.575 at seaward side (GWL Case 4)	**Maximum Total Displacement (mm)**	0.8 (upward in easterly direction)	0.4 (upward in easterly direction)
	Maximum Bending Moment (kNm/m)	27	25
	Maximum Shear Force (kN/m)	17	16
	Maximum Axial Force (kN/m)	1234	1240

Note:

(1) Displacement reset to zero after tunnel liner installation (After Stage 3)

(2) Displacement reset to zero after the excavation of CBD (After Stage 18)

(3) Displacement reset to zero after installation of CBD slabs and walls (Stage 25)

10.3.3 Liner Displacement

Based on the assessment results, the displacement induced on the liner on the westbound and eastbound tunnels due to CBD excavation is approximately 2 mm in the direction towards the excavation zone. Upon the installation of the CBD slabs and walls, the induced liner displacement is 0.6 mm (in the direction away from the excavation). An additional displacement of 1 mm for the westbound tunnel and 0.5 mm for the eastbound tunnel could be induced on the liner upon the GWL raises to the normal condition (RL 1.5 m AHD) and the climate change (RL 2.575 m AHD) conditions.

10.3.4 Structural Actions

The assessed results indicated that there is no significant changes in the bending moment, shear force and axial force on the tunnel liner for both the westbound and eastbound tunnel upon the completion of CBD excavation and CBD structures. The bending moment of the liner increases by approximately 2 kNm/m upon the GWL raises to the normal condition (RL 1.5 m AHD) and the climate change (RL 2.575 m AHD) conditions. The axial force on the liner for both tunnels slightly increase by approximately 28 kN/m and 20 kN/m for the westbound and eastbound tunnels, respectively, upon the GWL rises to the climate change (RL 2.575 m AHD) conditions.

11. FLOODING AND EARTHQUAKE CASES

The Sydney Metro Authority has previously commented that flooding and earthquake cases have not been considered in our previous assessment for a different basement level proposed for the CBD.

Our proposed scope of work was not to analyse these cases because the intention was to conduct the static cases only, and only carry out further analyses if required should the results of the static case differ significantly to those considered by SMA. At the request of Aqualand, we provide the following additional commentary for the flooding and earthquake cases.

For the flooding case, the water pressures on both the eastern and western sides of the CBD should be equalised and there should therefore be no unbalanced water loads from the CBD development acting on the station box.

For the earthquake case, the structure of the CBD is independent of the station box. There may be a minor amount of dynamic loading from the CBD structure transmitted via the piled foundations to the rock, and we comment on this as follows:

Current condition

Under the current condition, the west wall of the station box is subject to the following dynamic horizontal loads during the design earthquake:

- Dynamic earth pressure of the soil above the rock (approximately RL -6 m AHD),
- Dynamic rock loading when the wall of the station box is cast against the rock (RL -6 m AHD to RL -11.2 m AHD with the latter being the general bulk excavation of the CBD other than an area to the north which has a proposed bulk excavation level of RL -14.2 m AHD,
- Dynamic rock loading when the wall of the station box is cast against the rock (RL -11.2 m AHD to RL -25.2 m AHD with the latter being the base of the station box base slab),

The first of these can be computed using the Mononobe Okabe method adopting an average friction angle of 29^o, and has been computed to be 169.7 kN per metre run of wall from RL 2.7 m AHD to RL -6 m AHD assuming a design peak ground acceleration x probability factor of 0.09 g.

The dynamic rock loadings below RL -6 m AHD are extremely complex to analyse, and will depend on the frequency of excitation of the CBD structure versus the frequency of earthquake loading from the wall onto the basement wall, whether they are in-phase or out-of-phase with the structural movements under earthquake loading. Given that the western wall of the station box is sub-parallel to the major NNE striking joint set in the Sydney CBD, we have adopted a 70^o potential wedge failure mechanism and also adopted the Mononobe-Okabe method with a friction angle of 50^o for the joints. For the section between RL -6 m AHD to RL-11.2 m AHD, the dynamic rock load is assessed to be 144.2 kN per metre run of wall of the Metro box.

The dynamic rock load on the western wall of the station box beneath the proposed CBD excavation will remain the same and therefore need not be considered.

Summing the dynamic soil loading from ground level to RL -6 m AHD and the dynamic rock loading from RL -6 mAHD to RL -11.2 m, we considered that the western wall of the station box should have been currently designed for a total dynamic loading of 169.7 + 144.2 = 313.9 kN per metre run of wall.

Following CBD construction

The CBD will be excavated to RL -11.2 m AHD generally, and RL -14.2 m AHD at the north-eastern corner of the site. It has a width of 76 m, therefore all the soil and a large weight of the rock is removed. Further, the CBD structure will be constructed independently of the station box, and therefore no horizontal shear load from the CBD will be transmitted from ground level to RL -11.2 m or RL -14.2 m AHD. However, structural shear loading may be transmitted via the CBD foundation piles which would be immediately adjacent to the station box. Reference should be made to Robert Bird Group (RBG) Structural Adequacy Report – Central Barangaroo Basement (Document No. 22447-RBG-ZZ-XX-RP-ST-TG001 Issue 4) dated 12 March 2025 (see Appendix E).

RBG has advised TTC that the order of magnitude of dynamic horizontal loading from the CBD structure is 850 MN (see Appendix E). RBG stressed that they have not conducted a dynamic analysis of the CBD structure at this stage, and the 850 MN load indicated above is an order of magnitude estimation only.

The basement area of the CBD is 19,000 m^2, and therefore the dynamic horizontal loading is 850,000 kN/19,000 m^2 = 44.7 kN/m^2. For an approximate foundation pile spacing of 8 m, the dynamic horizontal pile load would be 44.7 x 8^2 = 2,861 kN per pile. The lateral loading on the piles would dissipate at 3 to 4 pile diameters away. Therefore, only the piles situated along the eastern boundary of the CBD would potentially impose dynamic loading on the western wall of the station box.

In the worst case scenario that the excitation of the CBD foundation has an opposing phase to that of the station box, the dynamic horizontal load from the CBD foundation piles would be 2,861/8 m pile spacing = 357.6 kN per metre run of wall.

Change in Dynamic Horizontal Loading

Therefore, the net change in dynamic horizontal loading above RL -11.2 m AHD after the CBD construction and the current condition would be:

Net change in dynamic horizontal loading = 368 – 313.9 = 43.7 kN per metre run of wall

Putting this in context with the current design dynamic soil and rock loading (313.9 kN/m) and groundwater loading of from the normal groundwater level of RL 1.5 m AHD to RL -11.2 m (806.5 kN/m), the increase in dynamic horizontal loading from the CBD development is 43.7/(313.9 + 806.5) = 0.039 which implies only a

3.9 % increase from the current dynamic loading. The percentage increase would reduce further if dynamic water pressure is to be accounted for in the design earthquake. Furthermore, if the CBD foundation excitation is in phase with the station box during an earthquake, there will be no dynamic loading from the CBD development on the station box.

The small increase indicated above confirms that conducting detailed dynamic analysis of the structure and foundation system to assess dynamic loading impact of the CBD development on the station box is not warranted at this stage, i.e. unlikely to add significant value.

As we do not know the magnitude of the dynamic horizontal rock loading was allowed for in the station box design, it would be useful if this information can be provided by SMA to assess if detailed earthquake analysis is required. If the dynamic loading used in the design of the station box is less than the 313.9 kN per metre run of wall indicated above, further earthquake analyses may be warranted at the detailed design phase of the CBD.

12. RISK ASSESSMENT

Prior to any excavation works, a detailed excavation methodology plan will need to be implemented which will outline the proposed excavation methodologies in each soil/rock unit with consideration of the proposed construction staging and material volumes.

This plan shall also detail the hold points at the critical stages / activities of excavation and details of contingency or risk mitigating measures should unforeseen circumstances are encountered during basement excavation works, including the perimeter retention wall (PRW) installation phase.

13. INSTRUMENTATION AND MONITORING

A detailed instrumentation plan will need to be completed before construction based on the final approved designs and the proposed construction methodology by the contractor to confirm that all risks can be and will be managed so far as is reasonably practicable (SFAIRP) along with controls that are required to manage the risks associated with the works associated with the basement construction, particularly adjacent to the Barangaroo Station box.

The instrumentation and monitoring plan will need to be developed in accordance with the Section 10 of the Sydney Metro Underground Corridor Protection Technical Guidelines.

The plan will also outline a monitoring system that will be installed on site to measure excavation induced vibrations and ground movements along with any movement of the PRW during excavation. This may include the use of survey prisms, tilt sensors, vibration monitors or other instruments to quantitatively measure these changes in ground conditions both within the site and surrounding structures. This should be undertaken in conjunction with dilapidation surveys of adjacent infrastructure to further reduce the risk of excavation-inducted damages.

14. CONCLUSION

The assessment indicated the following results:

For Section 1:

- The assessed lateral displacement of the BMS structure during construction is less than 5 mm which agrees reasonably well with the predictions as shown on the WAE drawing SMCSWTSE-JAB-SBR-ST-DRG-531046 sheet 40 of 482 such that the modelling can be relied upon for the impact assessment from the proposed CBD excavation, on the assumption that the actual measured deformation did not exceed the predictions shown on the WAE drawings.
- The induced horizontal displacement to the BMS structure due to the CBD basement excavation is approximately 1 mm.
- The out-of-balance water loads (4 m water head difference) on the East and West wall along the CBD does not have significant influence on the wall and slab displacements, however, the bending moments and shear force on the West wall and base slab increase accordingly due to this assumed 4 m water head difference.
- Upon the decommission of the depressurisation system and GWL raises to the normal condition (RL 1.5 m AHD) and the climate change (RL 2.575 m AHD) conditions could induced additional <1 (Stage 38 GWL at RL 1.5 m AHD) to 4 mm (Stage 38 GWL at RL 2.575 m AHD) horizontal displacement to the station box structure.
- The structural actions in the BMS walls and base slab increase significantly upon decommissioning of the depressurisation system. However, there is no significant increases in structural actions in the B3 (Concourse) and top slabs. These changes are not due to the CBD, but related directly to the high hydrostatic pressure on the walls and base slab of the BMS.

The assessment modelled the construction stages from greenfield (prior to the BMS excavation – Stage 1) to the completion of BMS construction and continue to simulate the construction stages to the completion of CBD construction (Stage 21 and onwards). Stage 1 to Stage 20 simulates the in-situ stress relaxation within the rock mass as a result of BMS excavation which set up the stress field for subsequent construction activities for CBD.

Based on the above assessment results, the CBD basement construction could induce a total horizontal movement of less than 5 mm to the station box structure with the consideration of various groundwater regimes. Such movement satisfies the design criteria of 5 mm in Table 5-1 of the Structural interface report.

The assessed structural actions considering different groundwater regimes were significantly increased, these actions have to be checked by the structural engineers for the structural capacity of the constructed walls and slabs.

For Section 2:

- The maximum lateral displacement of the Shark Fin walls due to CBD excavation and long-term groundwater rise were computed to be approximately 5 mm which agrees with the predicted SLS displacement of 5 mm longitudinal to the south at B3 or higher as stated in WAE drawing SMCSWTSE-JAB-SBR-ST-DRG-531046 sheet 40 of 482) and the predicted ULS longitudinal movement to the south including factored loads and groundwater is 45 mm.
- For walls, the results indicated that there is an increase in the structural actions when the ground water raise after the completion of CBD.
- For slabs, there is no significant changes in the structural actions at different stages

The assessment modelled the construction stages from greenfield (prior to the Shark Fin excavation – Stage 1) to the completion of BMS construction and continue to simulate the construction stages to the completion of CBD construction (Stage 22 and onwards). Stage 1 to Stage 21 simulates the in-situ stress relaxation within the rock mass as a result of Shark Fin excavation which set up the stress field for subsequent construction activities for CBD.

The slab stiffness normal to W14 is resolved into its component normal to W13 and applied at slab levels to simulate the diaphragm propping effect on the wall. Furthermore, the internal columns and shear walls are incorporated in the model with equivalent smeared properties, to simulate the supports of the slabs within Shark Fin.

In addition, a compensation load calculated as described in Section 9.2 is applied in the south to north direction on wall W13 at the slab levels to account for the fact that the lateral soil and groundwater pressures acting on the northern and north-western walls (W14) of Shark Fin are not normal to wall W13.

For Section 3:

- The assessed total displacement of the tunnel liner upon the completion of CBD excavation is approximately 2 mm towards the excavation zone.
- Upon the construction of the CBD structure, the total displacement of the tunnel liner is 0.6 mm in the west direction, i.e. a net displacement of 1.4 mm in the west direction.
- When the GWL is raised, an additional displacement of 1 mm (upward in easterly direction) for the westbound and 0.5 mm for the east bound.
- There is no significant increase in the structural actions on the tunnel liners for both westbound and eastbound tunnels upon the completion of the CBD structures.
- The axial force of the liner increases by approximately 28 kN/m on the westbound tunnel and 20 kN/m on the eastbound tunnel when the GWL rises to the climate change conditions (i.e. RL 2.575 m AHD).

Based on the above assessment results, the CBD basement construction could induce a total horizontal displacement to the tunnel liner of less than movement criteria of 10 mm as stated in Sydney Metro Underground Corridor Protection Technical Guideline April 2021.

The assessed structural actions considering different groundwater regimes were slightly increases, these actions have to be checked by the structural engineer from Sydney Metro for structural capacity of the tunnel liner.

Flood Loading:

- The water pressures on both the eastern and western sides of the CBD should be equalised and there should therefore be no unbalanced water loads from the CBD development acting on the station box.

Earthquake Loading:

- We have assessed that in the current situation, the western wall of the station box from ground level to RL 11.2 mAHD (general bulk excavation of the proposed CBD excluding the northern most section which has a deeper excavation level of RL 14.2 mAHD) could be subjected to a dynamic soil and rock load of 313.9 kN per metre run of wall, and a water pressure loading of 806.5 kN per metre run of wall, giving a total horizontal load of 1120.4 kN per metre run of wall.
- Following the CBD development, the potential impact of the CBD foundation piles located along the adjoining boundary of the station box may impose a net change in dynamic horizontal load of 43.7 kN/m assuming a worst case scenario that the CBD foundation excitation during the design earthquake is at opposing phase with the station box.
- The net increase represents an increase of 3.9% from the total current dynamic horizontal loading between the ground level and RL 11.2 mAHD. The assessed net increase in dynamic horizontal

loading is small and confirms that conducting detailed dynamic analyses for the CBD development is not warranted at this stage.

- We recommend that the allowance of earthquake dynamic loading on the western wall of the station box be obtained from SMA to assess whether detailed dynamic analyses of the CBD development is warranted at the detailed design phase of the project.

The assessed movements in the BMS meet the criteria specified in the Table 5.2 of the structural interface report. Our assessed / reported structural actions should be checked by the BMS designers.

Provided good industry practice and construction techniques are employed, including implementation a detailed excavation and monitoring plan demonstrating that the risks can be managed so far as reasonably practical (SFAIRP), the proposed Central Barangaroo development is not expected to have an adverse impact the BMS and tunnels.

APPENDIX A: LIMITATIONS

IMPORTANT INFORMATION ABOUT YOUR TETRA TECH COFFEY REPORT

As a client of Tetra Tech Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Tetra Tech Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Tetra Tech Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Tetra Tech Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Tetra Tech Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Tetra Tech Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Tetra Tech Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Tetra Tech Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Tetra Tech Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Tetra Tech Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Tetra Tech Coffey to work with other project design professionals who are affected by the report. Have Tetra Tech Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Tetra Tech Coffey for information relating to geoenvironmental issues.

Rely on Tetra Tech Coffey for additional assistance

Tetra Tech Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Tetra Tech Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Tetra Tech Coffey to other parties but are included to identify where Tetra Tech Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Tetra Tech Coffey closely and do not hesitate to ask any questions you may have.

APPENDIX B: EARLY WORKS DA (EWDA) DRAWINGS

SJB Architects

We would like to Acknowledge the Traditional Custodians of the land on which we live and practice. We pay our respects to elders past, present and emerging, whose knowledge has cared for, and will continue to care for Country. We acknowledge that sovereignty was never ceded.

Central Barangaroo

Hickson Road, Barangaroo NSW

Country: Gadigal Country

SJB Architects
Level 2, 490 Crown Street
Surry Hills NSW
2010 Australia
T 61 2 9380 9911
www.sjb.com.au

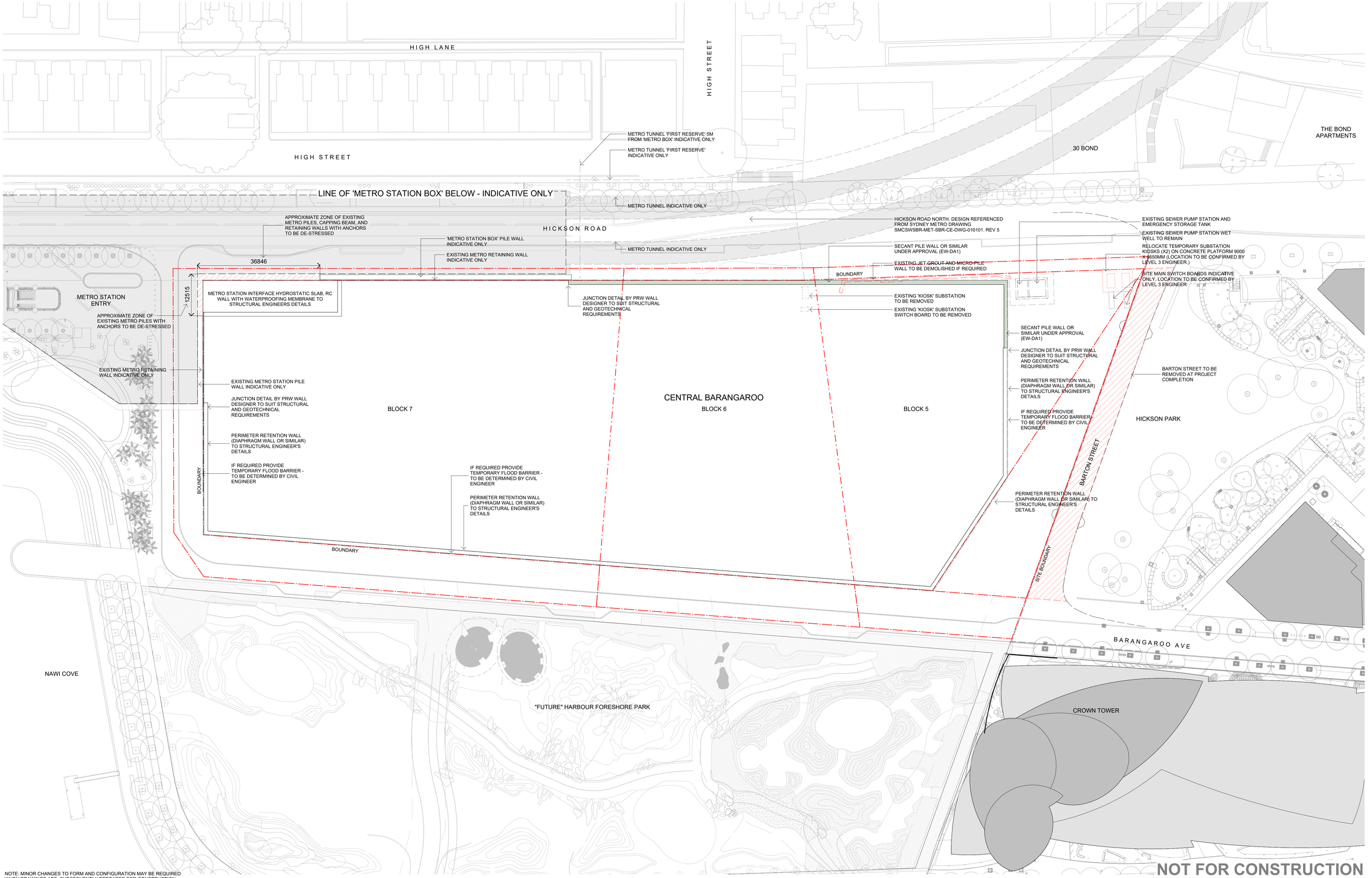
Project Number: **6759**
Date: **25.04.25**
Client: **Aqualand**

FOR APPROVAL

Contents

EWDA DRAWING LIST		
Sheet Number	Sheet Name	Current Revision
DA-00-0000	COVER	5
DA-00-0101	EARLY WORKS SITE PLAN	8
DA-00-0301	FLOOR PLAN - B3 (HYDROSTATIC SLAB ONLY)	9
DA-00-0401	BULK EXCAVATION PLAN	7
DA-00-0501	INDICATIVE PILING PLAN AND GRID SETOUT	6
DA-00-0601	OVERALL BASEMENT ELEVATIONS SHEET 1	5
DA-00-0602	OVERALL BASEMENT ELEVATIONS SHEET 2	5
DA-00-0701	OVERALL SECTIONS - EAST WEST - SHEET 1	10
DA-00-0702	OVERALL SECTIONS - EAST WEST - SHEET 2	9
DA-00-0703	OVERALL SECTIONS - NORTH SOUTH	10
DA-00-1051	METRO INTERFACE PLAN	4
DA-00-1551	METRO SECTIONS	4
DA-00-1701	DETAIL WALL SECTIONS - SHEET 1 (NORTH)	3
DA-00-1702	DETAIL WALL SECTIONS - SHEET 2 (EAST)	4
DA-00-1703	DETAIL WALL SECTIONS - SHEET 3 (EAST)	2
DA-00-1704	DETAIL WALL SECTIONS - SHEET 4 (SOUTH)	3
DA-00-1705	DETAIL WALL SECTIONS - SHEET 5 (WEST)	2
DA-00-2251	HYDROSTATIC SLAB AND PRW WP DETAILS - 1	3
DA-00-2252	HYDROSTATIC SLAB AND PRW WP DETAILS - 2	4

NOT FOR CONSTRUCTION



NOTE: MINOR CHANGES TO FORM AND CONFIGURATION MAY BE REQUIRED WHEN DRAWINGS ARE SUBSEQUENTLY PREPARED FOR CONSTRUCTION PURPOSES AFTER THE GRANT OF DEVELOPMENT CONSENT.

NOT FOR CONSTRUCTION

In accepting and utilising this document the recipient agrees that SJB Architecture (NSW) Pty. Ltd. ACN 081 094 724 T/A SJB Architects, retain all common law, statutory law and other rights including copyright and intellectual property rights. The recipient agrees not to use this document for any purpose other than its intended use; to waive all claims against SJB Architects resulting from unauthorised changes; or to reuse the document on other projects without prior written consent from SJB Architects. Under no circumstances shall transfer of this document be deemed a sale. SJB Architects makes no warranties of fitness for any purpose. The Builder/Contractor shall verify job dimensions prior to any work commencing. Use figured dimensions only. Do not scale drawings.

FOR APPROVAL

0 5 10 25m
1:500 @A1

Nominated Architects: Adam Haddow-7188 | John Pradel-7004

Rev	Date	Revision	By	Chk.
1	31.01.24	DRAFT ISSUE	TM	JT
2	09.02.24	2ND DRAFT - UPDATED FOLLOWING AQUALAND REVIEW	JR	JT
3	21.02.24	DRAFT - BASEMENT AREA INCREASED AS INSTRUCTED	JR	JT
4	01.03.24	EWDA-2 DRAFT ISSUE	JR	JT
5	14.03.24	FOR INFORMATION	JR	JT
6	20.03.24	FOR INFORMATION	JR	JT
7	03.04.24	EWDA-2 - FOR APPROVAL	JR	JT
8	25.04.25	EWDA-2 - Updated to incorporate revised Metro Interface	JR	JT

Client

AQUALAND

Project

Central Barangaroo
Hickson Road, Barangaroo NSW

Country: Gadigal Country

Drawing Name

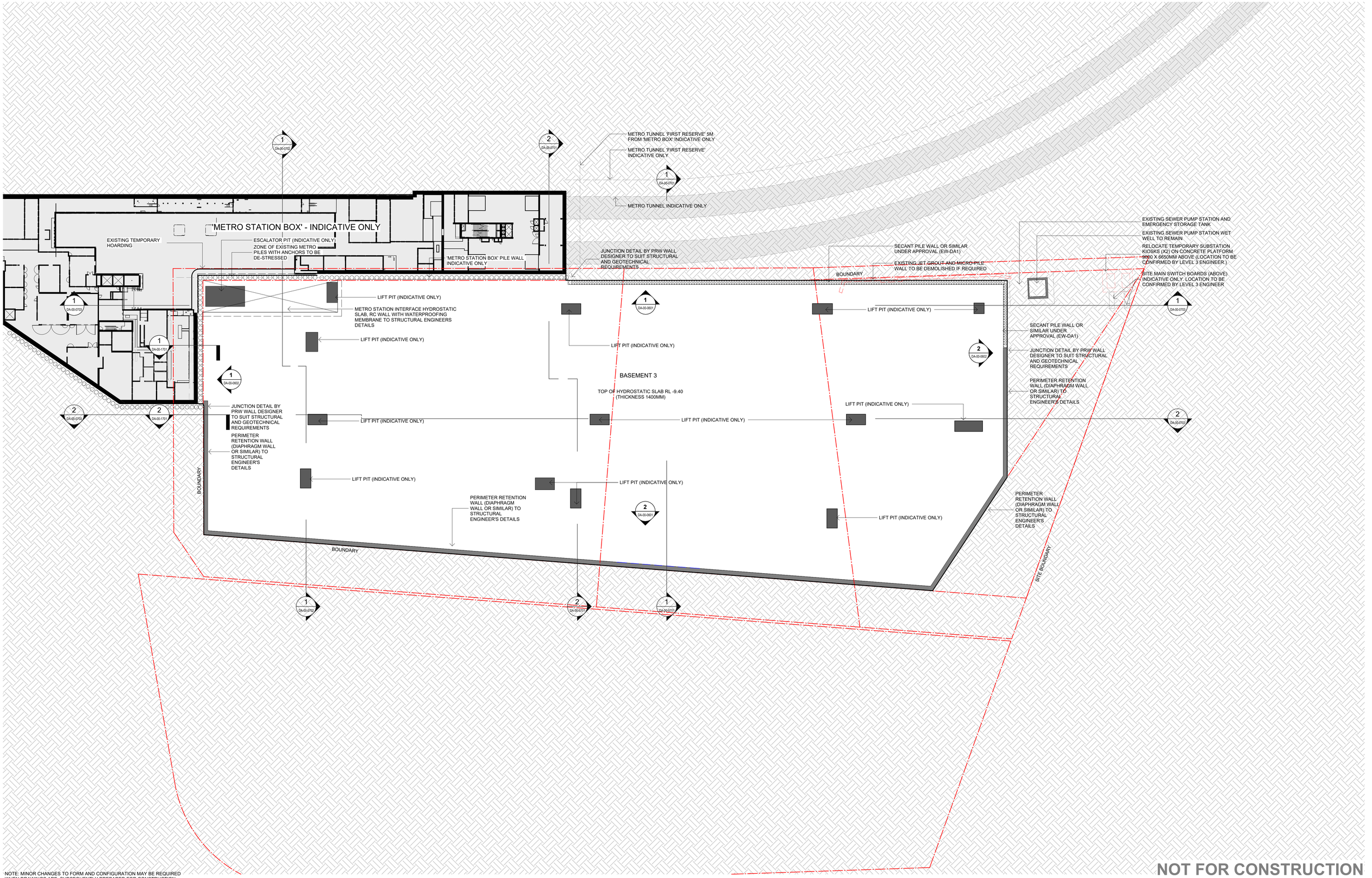
EARLY WORKS SITE PLAN

Date	Scale	Sheet Size
25.04.25	1:500	@ A1
Drawn	Chk.	Job No.
TM	JT	6759
Drawing No.		Revision
DA-00-0101		/ 8

SJB Architects
Level 2, 490 Crown Street
Surry Hills NSW 2010

T 61 2 9380 9911

www.sjb.com.au



NOTE: MINOR CHANGES TO FORM AND CONFIGURATION MAY BE REQUIRED WHEN DRAWINGS ARE SUBSEQUENTLY PREPARED FOR CONSTRUCTION PURPOSES AFTER THE GRANT OF DEVELOPMENT CONSENT.

NOT FOR CONSTRUCTION

In accepting and utilising this document the recipient agrees that SJB Architecture (NSW) Pty. Ltd. ACN 081 094 724 T/A SJB Architects, retain all common law, statutory law and other rights including copyright and intellectual property rights. The recipient agrees not to use this document for any purpose other than its intended use; to waive all claims against SJB Architects resulting from unauthorised changes; or to reuse the document on other projects without prior written consent from SJB Architects. Under no circumstances shall transfer of this document be deemed a sale. SJB Architects makes no warranties of fitness for any purpose. The Builder/Contractor shall verify job dimensions prior to any work commencing. Use figured dimensions only. Do not scale drawings.

FOR APPROVAL

0 5 10 25m
1:500 @A1

Nominated Architects: Adam Haddow-7188 | John Pradel-7004

Rev	Date	Revision	By	Chk.
1	29.01.24	DRAFT ISSUE	TM	JT
2	09.02.24	2ND DRAFT - UPDATED FOLLOWING AQUALAND REVIEW	JR	JT
3	20.02.24	DRAFT - B3 CHANGED TO SSL-9.00 AS INSTRUCTED	JR	JT
4	21.02.24	DRAFT - BASEMENT AREA INCREASED AS INSTRUCTED	JR	JT
5	01.03.24	EWDA-2 DRAFT ISSUE	JR	JT
6	14.03.24	FOR INFORMATION	JR	JT
7	20.03.24	FOR INFORMATION	JR	JT
8	03.04.24	EWDA-2 - FOR APPROVAL	JR	JT
9	25.04.25	EWDA-2 - Updated to incorporate revised Metro Interface	JR	JT

Client

AQUALAND

Project

Central Barangaroo
Hickson Road, Barangaroo NSW

Country: Gadigal Country

Drawing Name

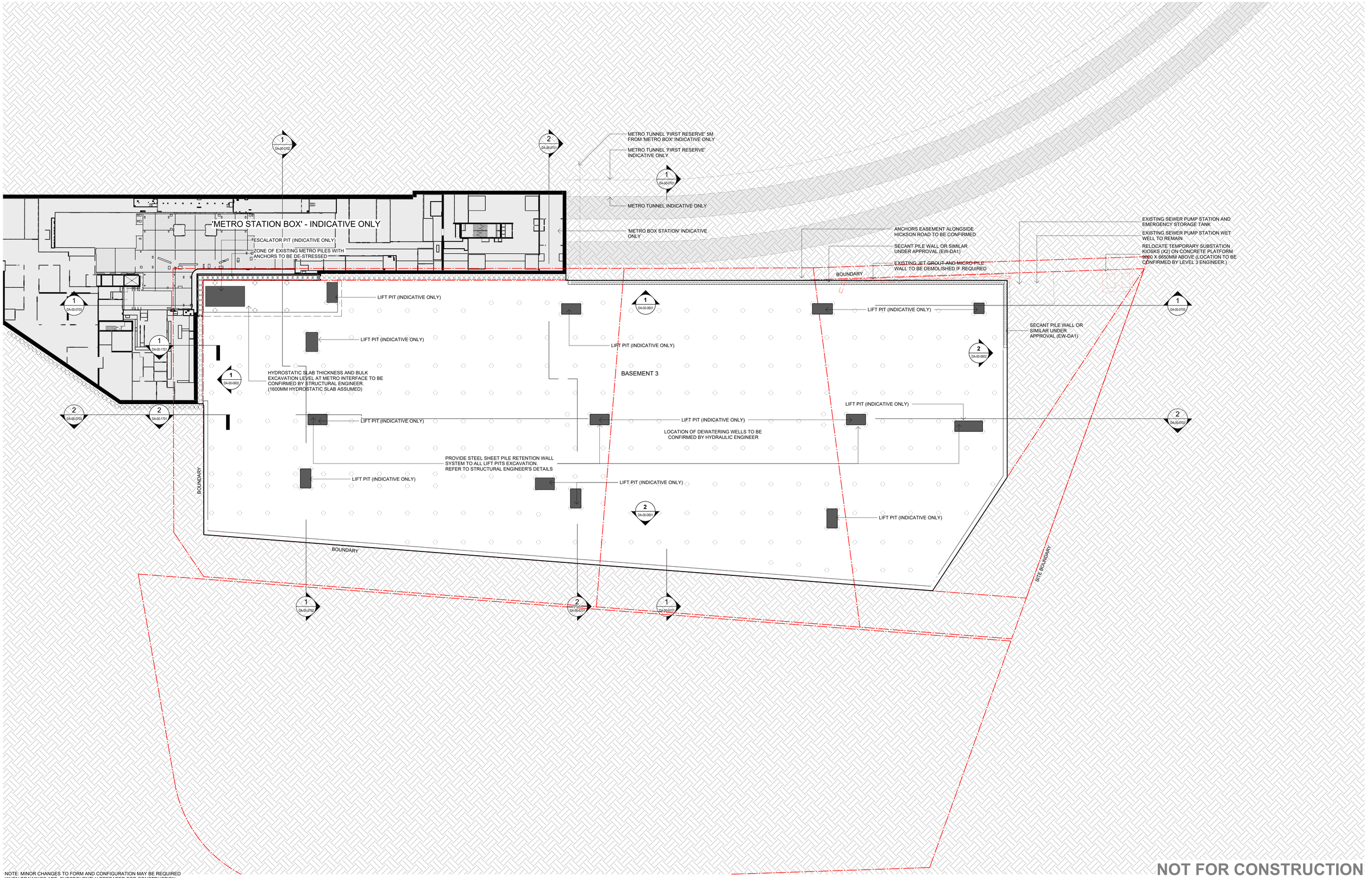
FLOOR PLAN - B3 (HYDROSTATIC SLAB ONLY)

Date	Scale	Sheet Size
25.04.25	1:500	@ A1
Drawn	Chk.	Job No.
TM	JT	6759
Drawing No.		Revision
DA-00-0301		/ 9

SJB Architects
Level 2, 490 Crown Street
Surry Hills NSW 2010

T 61 2 9380 9911

www.sjb.com.au



NOTE: MINOR CHANGES TO FORM AND CONFIGURATION MAY BE REQUIRED WHEN DRAWINGS ARE SUBSEQUENTLY PREPARED FOR CONSTRUCTION PURPOSES AFTER THE GRANT OF DEVELOPMENT CONSENT.

NOT FOR CONSTRUCTION

In accepting and utilising this document the recipient agrees that SJB Architecture (NSW) Pty. Ltd. ACN 081 094 724 T/A SJB Architects, retain all common law, statutory law and other rights including copyright and intellectual property rights. The recipient agrees not to use this document for any purpose other than its intended use; to waive all claims against SJB Architects resulting from unauthorised changes; or to reuse the document on other projects without prior written consent from SJB Architects. Under no circumstances shall transfer of this document be deemed a sale. SJB Architects makes no warranties of fitness for any purpose. The Builder/Contractor shall verify job dimensions prior to any work commencing. Use figured dimensions only. Do not scale drawings.

FOR APPROVAL

0 5 10 25m
1:500 @A1

Nominated Architects: Adam Haddow-7188 | John Pradel-7004

Rev	Date	Revision	By	Chk.
1	21.02.24	DRAFT ISSUE	JR	JT
2	01.03.24	EWDA-2 DRAFT ISSUE	JR	JT
3	14.03.24	FOR INFORMATION	JR	JT
4	18.03.24	FOR INFORMATION	JR	JT
5	20.03.24	FOR INFORMATION	JR	JT
6	03.04.24	EWDA-2 - FOR APPROVAL	JR	JT
7	25.04.25	EWDA-2 - Updated to incorporate revised Metro Interface	JR	JT

Client

AQUALAND

Project

Central Barangaroo
Hickson Road, Barangaroo NSW

Country: Gadigal Country

Drawing Name

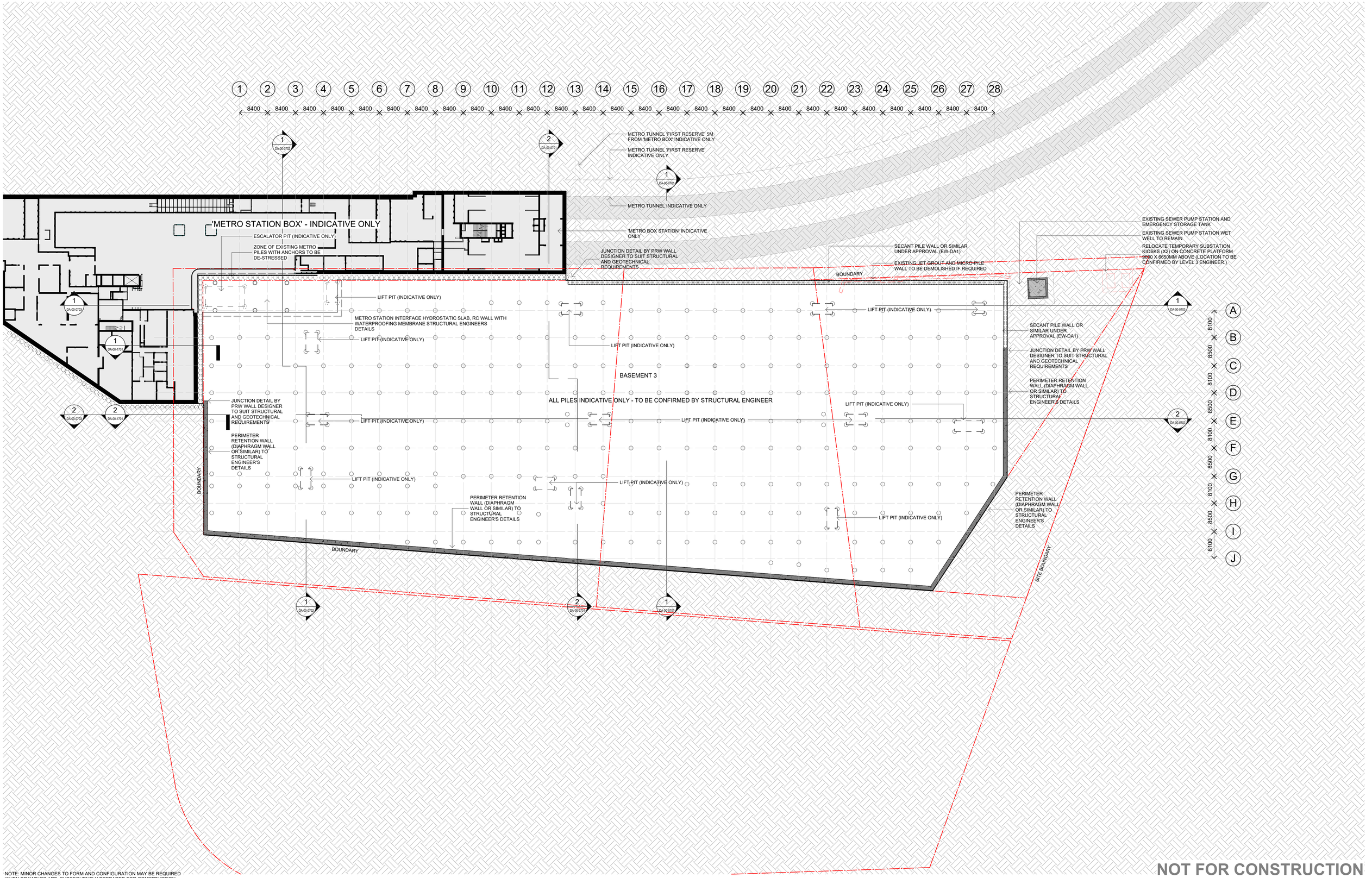
BULK EXCAVATION PLAN

Date	Scale	Sheet Size
25.04.25	1:500	@ A1
Drawn	Chk.	Job No.
TM	JT	6759
Drawing No.		Revision
DA-00-0401		/ 7

SJB Architects
Level 2, 490 Crown Street
Surry Hills NSW 2010

T 61 2 9380 9911

www.sjb.com.au



NOTE: MINOR CHANGES TO FORM AND CONFIGURATION MAY BE REQUIRED WHEN DRAWINGS ARE SUBSEQUENTLY PREPARED FOR CONSTRUCTION PURPOSES AFTER THE GRANT OF DEVELOPMENT CONSENT.

NOT FOR CONSTRUCTION

In accepting and utilising this document the recipient agrees that SJB Architecture (NSW) Pty. Ltd. ACN 081 094 724 T/A SJB Architects, retain all common law, statutory law and other rights including copyright and intellectual property rights. The recipient agrees not to use this document for any purpose other than its intended use; to waive all claims against SJB Architects resulting from unauthorised changes; or to reuse the document on other projects without prior written consent from SJB Architects. Under no circumstances shall transfer of this document be deemed a sale. SJB Architects makes no warranties of fitness for any purpose. The Builder/Contractor shall verify job dimensions prior to any work commencing. Use figured dimensions only. Do not scale drawings.

FOR APPROVAL

0 5 10 25m
1:500 @A1

Nominated Architects: Adam Haddow-7188 | John Pradel-7004

Rev	Date	Revision	By	Chk.
1	21.02.24	DRAFT ISSUE	JR	JT
2	01.03.24	EWDA-2 DRAFT ISSUE	JR	JT
3	14.03.24	FOR INFORMATION	JR	JT
4	20.03.24	FOR INFORMATION	JR	JT
5	03.04.24	EWDA-2 - FOR APPROVAL	JR	JT
6	25.04.25	EWDA-2 - Updated to incorporate revised Metro Interface	JR	JT

Client

AQUALAND

Project

Central Barangaroo
Hickson Road, Barangaroo NSW

Country: Gadigal Country

Drawing Name

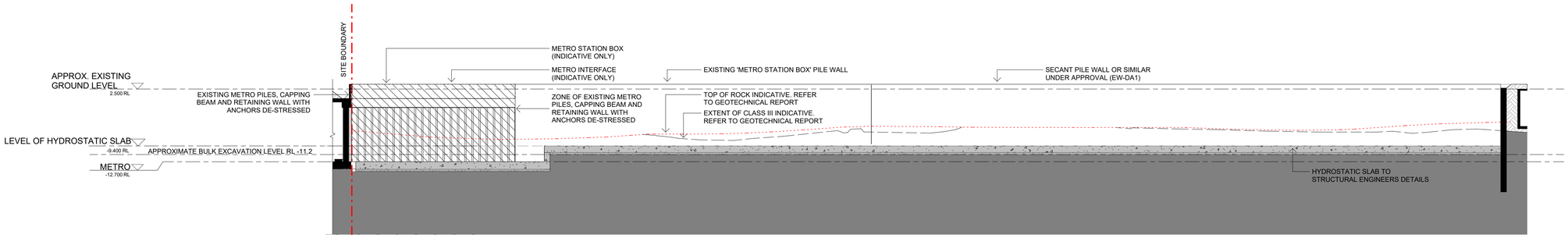
INDICATIVE PILING PLAN AND GRID SETOUT

Date	Scale	Sheet Size
25.04.25	1:500	@ A1
Drawn	Chk.	Job No.
TM	JT	6759
Drawing No.		Revision
DA-00-0501		/ 6

SJB Architects
Level 2, 490 Crown Street
Surry Hills NSW 2010

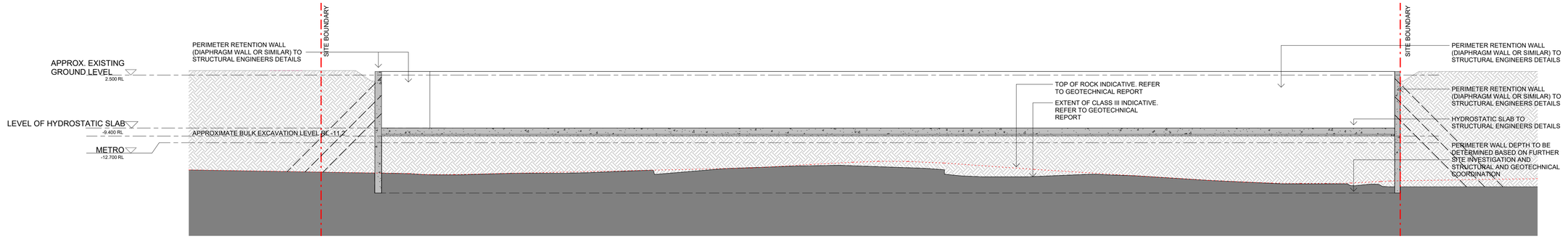
T 61 2 9380 9911

www.sjb.com.au



1 / - SHORING ELEVATION - EAST

SCALE 1 : 500



2 / - SHORING ELEVATION - WEST

SCALE 1 : 500

NOTE: MINOR CHANGES TO FORM AND CONFIGURATION MAY BE REQUIRED WHEN DRAWINGS ARE SUBSEQUENTLY PREPARED FOR CONSTRUCTION PURPOSES AFTER THE GRANT OF DEVELOPMENT CONSENT.

NOT FOR CONSTRUCTION

In accepting and utilising this document the recipient agrees that SJB Architecture (NSW) Pty. Ltd. ACN 081 094 724 T/A SJB Architects, retain all common law, statutory law and other rights including copyright and intellectual property rights. The recipient agrees not to use this document for any purpose other than its intended use; to waive all claims against SJB Architects resulting from unauthorised changes; or to reuse the document on other projects without prior written consent from SJB Architects. Under no circumstances shall transfer of this document be deemed a sale. SJB Architects makes no warranties of fitness for any purpose. The Builder/Contractor shall verify job dimensions prior to any work commencing. Use figured dimensions only. Do not scale drawings.

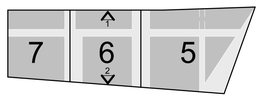
FOR APPROVAL

0 5 10 25m

1:500 @A1

Nominated Architects: Adam Haddow-7188 | John Pradel-7004

Rev	Date	Revision	By	Chk.
1	01.03.24	EWDA-2 DRAFT ISSUE	JR	JT
2	14.03.24	FOR INFORMATION	JR	JT
3	20.03.24	FOR INFORMATION	JR	JT
4	03.04.24	EWDA-2 - FOR APPROVAL	JR	JT
5	25.04.25	EWDA-2 - Updated to incorporate revised Metro Interface	JR	JT



Client

AQUALAND

Project

Central Barangaroo
Hickson Road, Barangaroo NSW

Country: Gadigal Country

Drawing Name

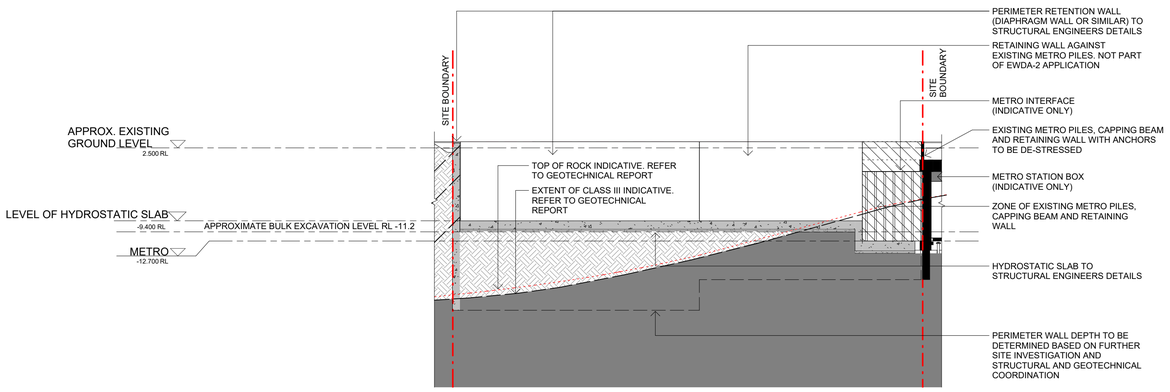
OVERALL BASEMENT ELEVATIONS SHEET 1

Date	Scale	Sheet Size
25.04.25	1:500	@ A1
Drawn	Chk.	Job No.
TM	JT	6759
Drawing No.		Revision
DA-00-0601		/ 5

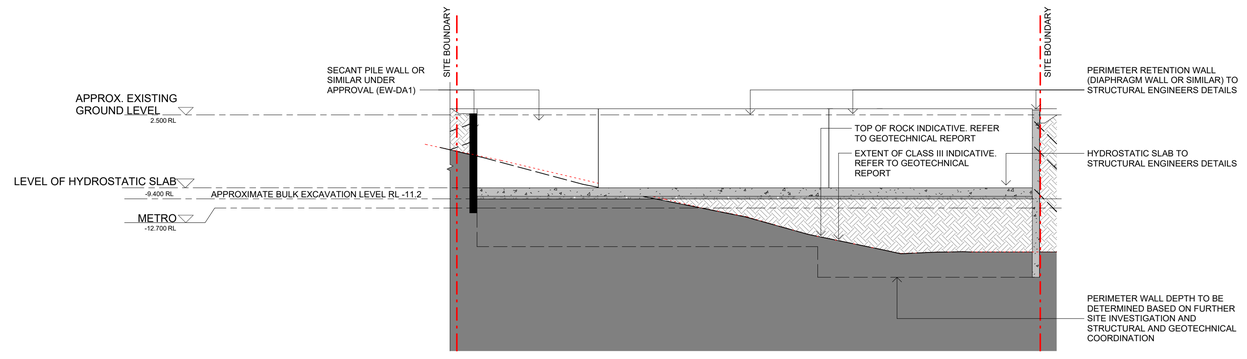
SJB Architects
Level 2, 490 Crown Street
Surry Hills NSW 2010

T 61 2 9380 9911

www.sjb.com.au



1 - SHORING ELEVATION - NORTH
SCALE 1 : 500



2 - SHORING ELEVATION - SOUTH
SCALE 1 : 500

NOTE: MINOR CHANGES TO FORM AND CONFIGURATION MAY BE REQUIRED WHEN DRAWINGS ARE SUBSEQUENTLY PREPARED FOR CONSTRUCTION PURPOSES AFTER THE GRANT OF DEVELOPMENT CONSENT.

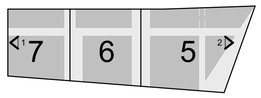
In accepting and utilising this document the recipient agrees that SJB Architecture (NSW) Pty. Ltd. ACN 081 094 724 T/A SJB Architects, retain all common law, statutory law and other rights including copyright and intellectual property rights. The recipient agrees not to use this document for any purpose other than its intended use; to waive all claims against SJB Architects resulting from unauthorised changes; or to reuse the document on other projects without prior written consent from SJB Architects. Under no circumstances shall transfer of this document be deemed a sale. SJB Architects makes no warranties of fitness for any purpose. The Builder/Contractor shall verify job dimensions prior to any work commencing. Use figured dimensions only. Do not scale drawings.

FOR APPROVAL

0 5 10 25m
1:500 @A1

Nominated Architects: Adam Haddow-7188 | John Pradel-7004

Rev	Date	Revision	By	Chk.
1	01.03.24	EWDA-2 DRAFT ISSUE	JR	JT
2	14.03.24	FOR INFORMATION	JR	JT
3	20.03.24	FOR INFORMATION	JR	JT
4	03.04.24	EWDA-2 - FOR APPROVAL	JR	JT
5	25.04.25	EWDA-2 - Updated to incorporate revised Metro Interface	JR	JT



Client
AQUALAND

Project
Central Barangaroo
Hickson Road, Barangaroo NSW

Country: Gadigal Country

Drawing Name
OVERALL BASEMENT ELEVATIONS SHEET 2

Drawing No.
DA-00-0602

Revision
/ 5

Date
25.04.25

Scale
1:500

Sheet Size
@ A1

Drawn
TM

Chk.
JT

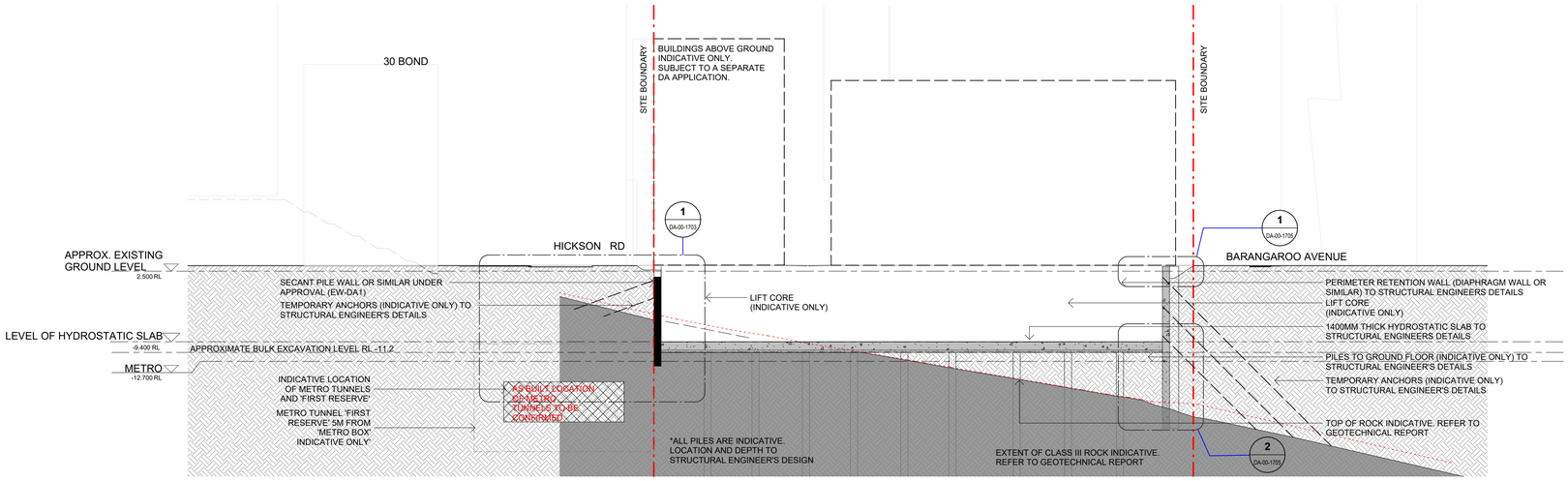
Job No.
6759

NOT FOR CONSTRUCTION

SJB Architects
Level 2, 490 Crown Street
Surry Hills NSW 2010

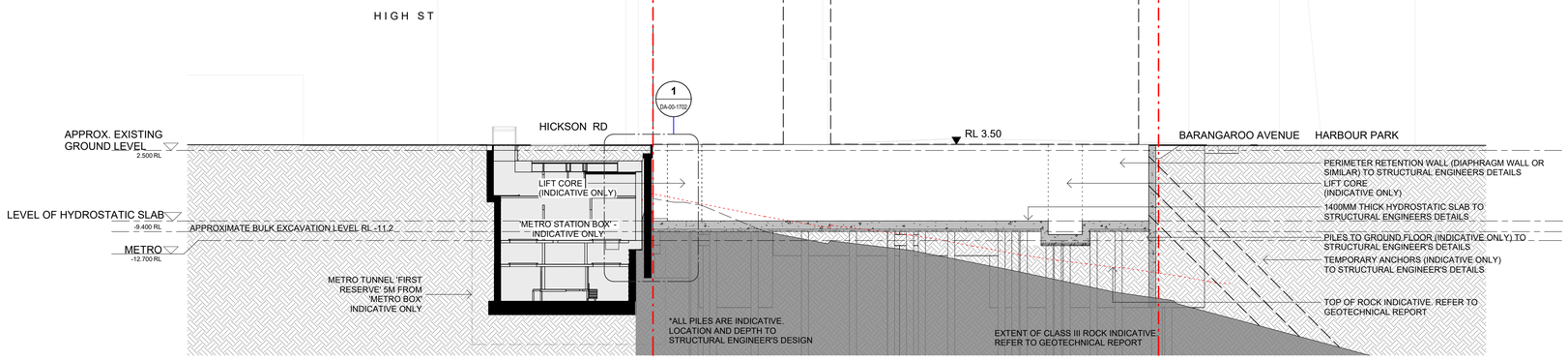
T 61 2 9380 9911

www.sjb.com.au



1 / - SITE SECTION B5

SCALE 1 : 500



2 / - SITE SECTION B6

SCALE 1 : 500

NOTE: MINOR CHANGES TO FORM AND CONFIGURATION MAY BE REQUIRED WHEN DRAWINGS ARE SUBSEQUENTLY PREPARED FOR CONSTRUCTION PURPOSES AFTER THE GRANT OF DEVELOPMENT CONSENT.

In accepting and utilising this document the recipient agrees that SJB Architecture (NSW) Pty. Ltd. ACN 081 094 724 T/A SJB Architects, retain all common law, statutory law and other rights including copyright and intellectual property rights. The recipient agrees not to use this document for any purpose other than its intended use; to waive all claims against SJB Architects resulting from unauthorised changes; or to reuse the document on other projects without prior written consent from SJB Architects. Under no circumstances shall transfer of this document be deemed a sale. SJB Architects makes no warranties of fitness for any purpose. The Builder/Contractor shall verify job dimensions prior to any work commencing. Use figured dimensions only. Do not scale drawings.

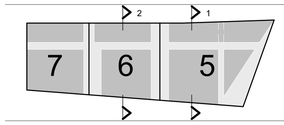
FOR APPROVAL

0 5 10 25m

1:500 @A1

Nominated Architects: Adam Haddow-7188 | John Pradel-7004

Rev	Date	Revision	By	Chk.
1	29.01.24	DRAFT ISSUE	TM	JT
2	09.02.24	2ND DRAFT - UPDATED FOLLOWING AQUALAND REVIEW	JR	JT
3	14.02.24	DRAFT ISSUE -TOP OF ROCK CLARIFIED	JR	JT
4	20.02.24	DRAFT - B3 CHANGED TO SSL-9.00 AS INSTRUCTED	JR	JT
5	21.02.24	DRAFT - BASEMENT AREA INCREASED AS INSTRUCTED	JR	JT
6	01.03.24	EWDA-2 DRAFT ISSUE	JR	JT
7	14.03.24	FOR INFORMATION	JR	JT
8	20.03.24	FOR INFORMATION	JR	JT
9	03.04.24	EWDA-2 - FOR APPROVAL	JR	JT
10	25.04.25	EWDA-2 - Updated to incorporate revised Metro Interface	JR	JT



Client

AQUALAND

Project

Central Barangaroo
Hickson Road, Barangaroo NSW

Country: Gadigal Country

Drawing Name

OVERALL SECTIONS - EAST WEST - SHEET 1

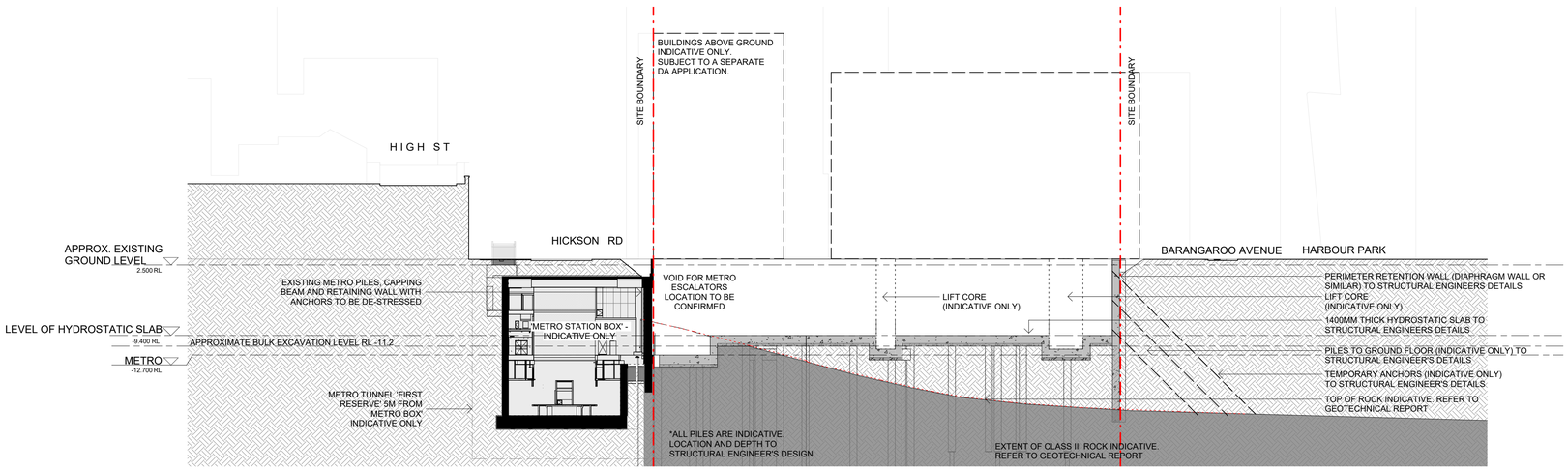
NOT FOR CONSTRUCTION

Date	Scale	Sheet Size
25.04.25	1:500	@ A1
Drawn	Chk.	Job No.
TM	JT	6759
Drawing No.		Revision
DA-00-0701		/ 10

SJB Architects
Level 2, 490 Crown Street
Surry Hills NSW 2010

T 61 2 9380 9911

www.sjb.com.au



1 / - SITE SECTION B7
SCALE 1 : 500

NOTE: MINOR CHANGES TO FORM AND CONFIGURATION MAY BE REQUIRED WHEN DRAWINGS ARE SUBSEQUENTLY PREPARED FOR CONSTRUCTION PURPOSES AFTER THE GRANT OF DEVELOPMENT CONSENT.

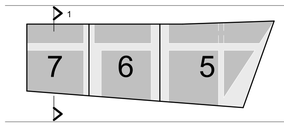
In accepting and utilising this document the recipient agrees that SJB Architecture (NSW) Pty. Ltd. ACN 081 094 724 T/A SJB Architects, retain all common law, statutory law and other rights including copyright and intellectual property rights. The recipient agrees not to use this document for any purpose other than its intended use; to waive all claims against SJB Architects resulting from unauthorised changes; or to reuse the document on other projects without prior written consent from SJB Architects. Under no circumstances shall transfer of this document be deemed a sale. SJB Architects makes no warranties of fitness for any purpose. The Builder/Contractor shall verify job dimensions prior to any work commencing. Use figured dimensions only. Do not scale drawings.

FOR APPROVAL

0 1 2 5m
1:100 @A1

Nominated Architects: Adam Haddow-7188 | John Pradel-7004

Rev	Date	Revision	By	Chk.
1	09.02.24	2ND DRAFT - UPDATED FOLLOWING AQUALAND REVIEW	JR	JT
2	14.02.24	DRAFT ISSUE -TOP OF ROCK CLARIFIED	JR	JT
3	20.02.24	DRAFT - B3 CHANGED TO SSL-9.00 AS INSTRUCTED	JR	JT
4	21.02.24	DRAFT - BASEMENT AREA INCREASED AS INSTRUCTED	JR	JT
5	01.03.24	EWDA-2 DRAFT ISSUE	JR	JT
6	14.03.24	FOR INFORMATION	JR	JT
7	20.03.24	FOR INFORMATION	JR	JT
8	03.04.24	EWDA-2 - FOR APPROVAL	JR	JT
9	25.04.25	EWDA-2 - Updated to incorporate revised Metro Interface	JR	JT



NOT FOR CONSTRUCTION

Client
AQUALAND

Project
Central Barangaroo
Hickson Road, Barangaroo NSW

Country: Gadigal Country

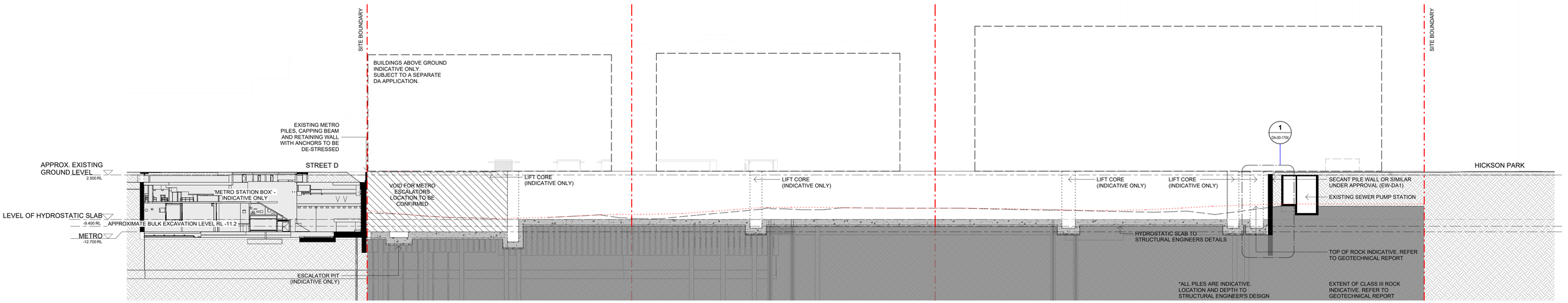
Drawing Name
OVERALL SECTIONS - EAST WEST - SHEET 2

Date	Scale	Sheet Size
25.04.25	1:100	@ A1
Drawn	Chk.	Job No.
JR	JT	6759
Drawing No.		Revision
DA-00-0702		/ 9

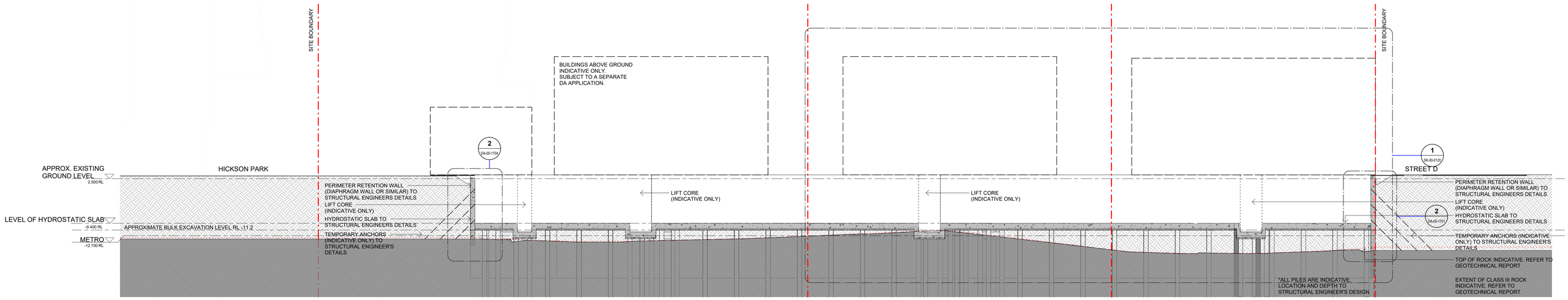
SJB Architects
Level 2, 490 Crown Street
Surry Hills NSW 2010

T 61 2 9380 9911

www.sjb.com.au



1 - SECTION NORTH SOUTH 1
SCALE 1 : 500



2 - SECTION NORTH SOUTH 2
SCALE 1 : 500

NOTE: MINOR CHANGES TO FORM AND CONFIGURATION MAY BE REQUIRED WHEN DRAWINGS ARE SUBSEQUENTLY PREPARED FOR CONSTRUCTION PURPOSES AFTER THE GRANT OF DEVELOPMENT CONSENT.

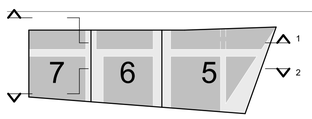
In accepting and utilising this document the recipient agrees that SJB Architecture (NSW) Pty. Ltd. ACN 081 094 724 T/A SJB Architects, retain all common law, statutory law and other rights including copyright and intellectual property rights. The recipient agrees not to use this document for any purpose other than its intended use; to waive all claims against SJB Architects resulting from unauthorised changes; or to reuse the document on other projects without prior written consent from SJB Architects. Under no circumstances shall transfer of this document be deemed a sale. SJB Architects makes no warranties of fitness for any purpose. The Builder/Contractor shall verify job dimensions prior to any work commencing. Use figured dimensions only. Do not scale drawings.

FOR APPROVAL

0 5 10 25m
1:500 @A1

Nominated Architects: Adam Haddow-7188 | John Pradel-7004

Rev	Date	Revision	By	Chk.
1	29.01.24	DRAFT ISSUE	TM	JT
2	09.02.24	2ND DRAFT - UPDATED FOLLOWING AQUALAND REVIEW	JR	JT
3	14.02.24	DRAFT ISSUE -TOP OF ROCK CLARIFIED	JR	JT
4	20.02.24	DRAFT - B3 CHANGED TO SSL-9.00 AS INSTRUCTED	JR	JT
5	21.02.24	DRAFT - BASEMENT AREA INCREASED AS INSTRUCTED	JR	JT
6	01.03.24	EWDA-2 DRAFT ISSUE	JR	JT
7	14.03.24	FOR INFORMATION	JR	JT
8	20.03.24	FOR INFORMATION	JR	JT
9	03.04.24	EWDA-2 - FOR APPROVAL	JR	JT
10	25.04.25	EWDA-2 - Updated to incorporate revised Metro Interface	JR	JT



Client
AQUALAND

Project
Central Barangaroo
Hickson Road, Barangaroo NSW

Country: Gadigal Country

Drawing Name
OVERALL SECTIONS - NORTH SOUTH

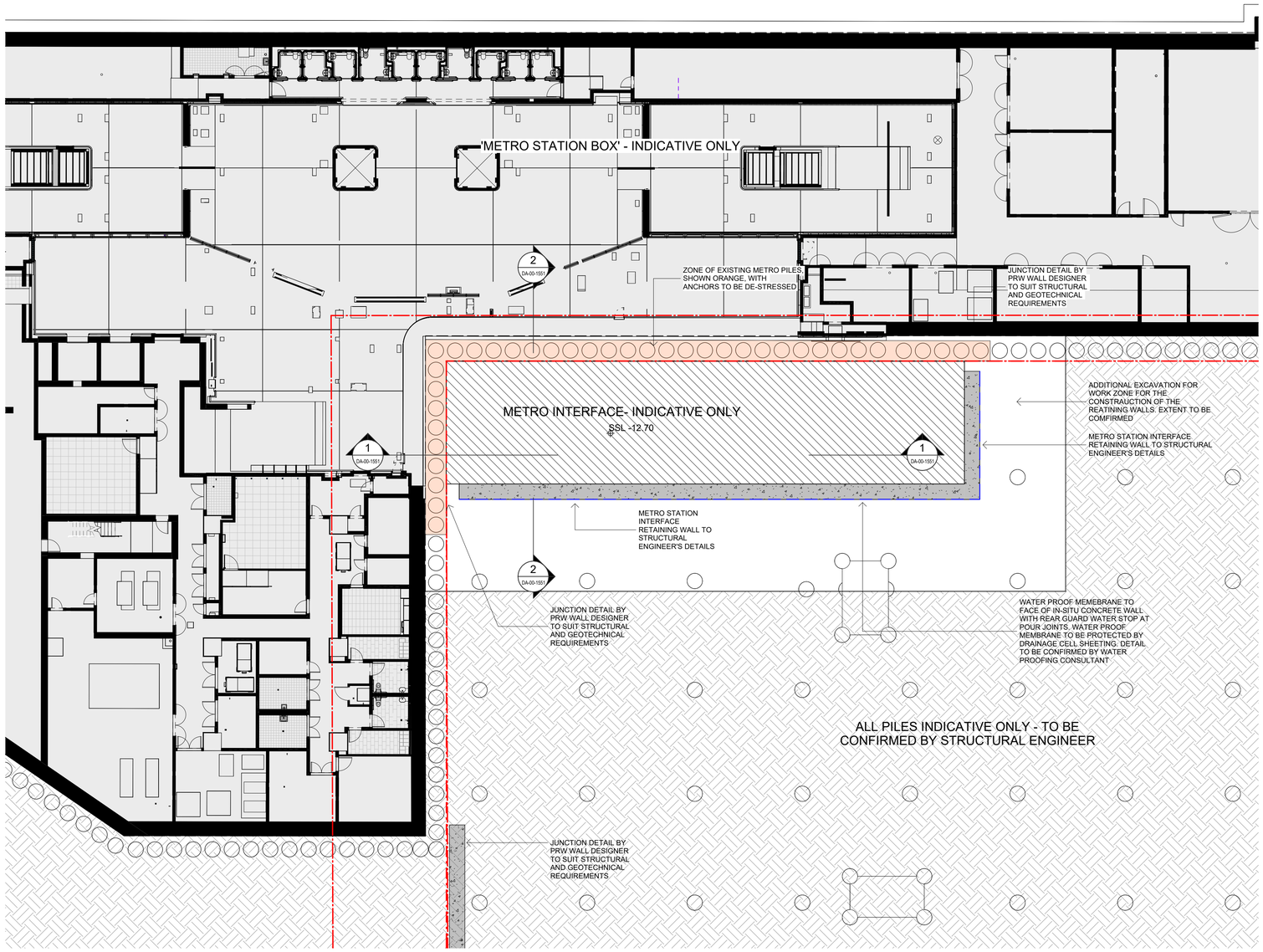
NOT FOR CONSTRUCTION

Date	Scale	Sheet Size
25.04.25	1:500	@ A1
Drawn	Chk.	Job No.
TM	JT	6759
Drawing No.		Revision
DA-00-0703		/ 10

SJB Architects
Level 2, 490 Crown Street
Surry Hills NSW 2010

T 61 2 9380 9911

www.sjb.com.au



NOTE: MINOR CHANGES TO FORM AND CONFIGURATION MAY BE REQUIRED WHEN DRAWINGS ARE SUBSEQUENTLY PREPARED FOR CONSTRUCTION PURPOSES AFTER THE GRANT OF DEVELOPMENT CONSENT.

In accepting and utilising this document the recipient agrees that SJB Architecture (NSW) Pty. Ltd. ACN 081 094 724 T/A SJB Architects, retain all common law, statutory law and other rights including copyright and intellectual property rights. The recipient agrees not to use this document for any purpose other than its intended use; to waive all claims against SJB Architects resulting from unauthorised changes; or to reuse the document on other projects without prior written consent from SJB Architects. Under no circumstances shall transfer of this document be deemed a sale. SJB Architects makes no warranties of fitness for any purpose. The Builder/Contractor shall verify job dimensions prior to any work commencing. Use figured dimensions only. Do not scale drawings.

FOR APPROVAL

0 2 4 10m
1:200 @A1

Nominated Architects: Adam Haddow-7188 | John Pradel-7004

Rev	Date	Revision	By	Chk.
1	01.03.24	EWDA-2 DRAFT ISSUE	JR	JT
2	20.03.24	FOR INFORMATION	JR	JT
3	03.04.24	EWDA-2 - FOR APPROVAL	JR	JT
4	25.04.25	EWDA-2 - Updated to incorporate revised Metro Interface	JR	JT

Client

AQUALAND

Project

Central Barangaroo
Hickson Road, Barangaroo NSW

Country: Gadigal Country

Drawing Name

METRO INTERFACE PLAN

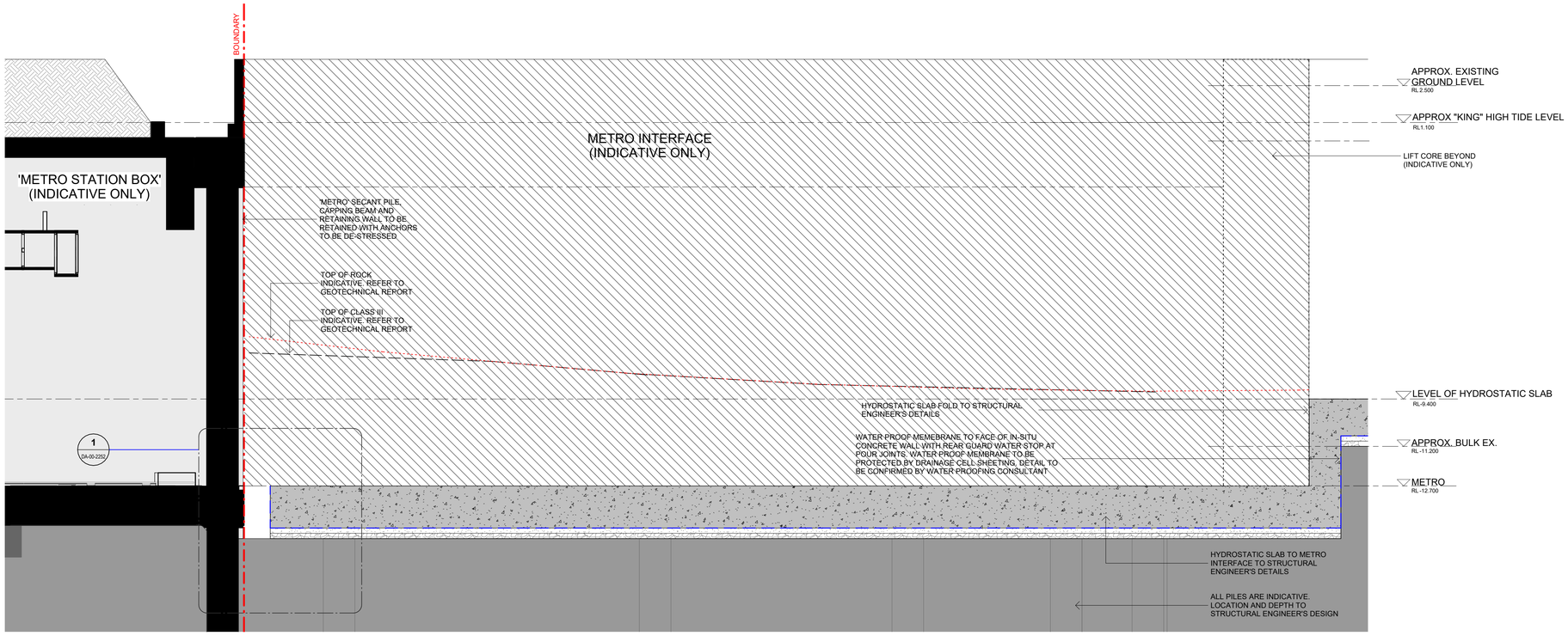
NOT FOR CONSTRUCTION

Date	Scale	Sheet Size
25.04.25	1:200	@ A1
Drawn	Chk.	Job No.
JR	JT	6759
Drawing No.		Revision
DA-00-1051		/ 4

SJB Architects
Level 2, 490 Crown Street
Surry Hills NSW 2010

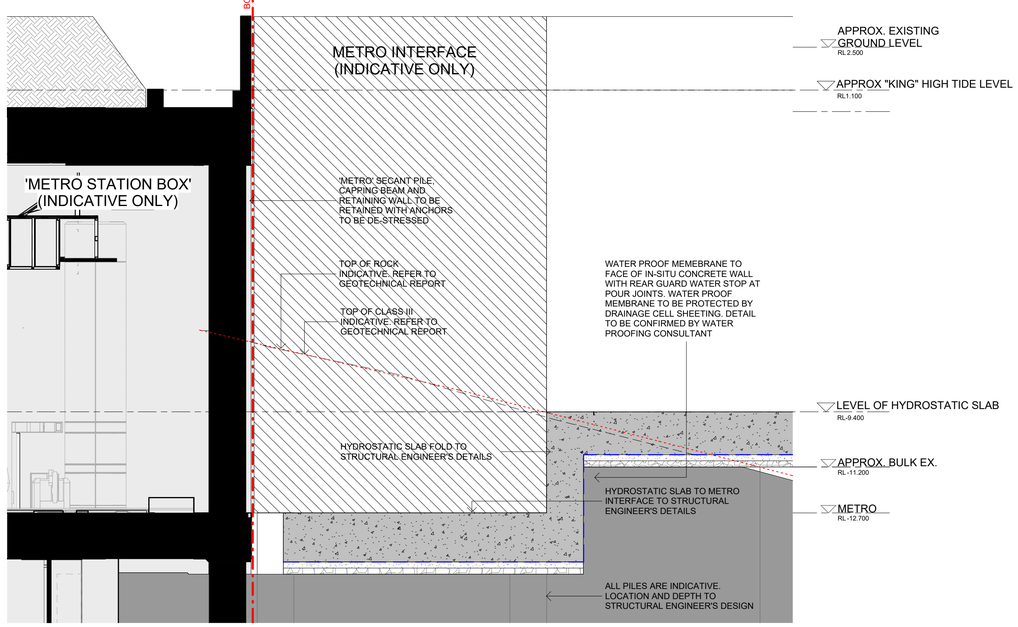
T 61 2 9380 9911

www.sjb.com.au



1 DA-00-1051 **METRO INTERFACE LONG SECTION**

1 : 100@A1



2 DA-00-1051 **METRO INTERFACE CROSS SECTION**

1 : 100@A1

NOTE: MINOR CHANGES TO FORM AND CONFIGURATION MAY BE REQUIRED WHEN DRAWINGS ARE SUBSEQUENTLY PREPARED FOR CONSTRUCTION PURPOSES AFTER THE GRANT OF DEVELOPMENT CONSENT.

In accepting and utilising this document the recipient agrees that SJB Architecture (NSW) Pty. Ltd. ACN 081 094 724 T/A SJB Architects, retain all common law, statutory law and other rights including copyright and intellectual property rights. The recipient agrees not to use this document for any purpose other than its intended use; to waive all claims against SJB Architects resulting from unauthorised changes; or to reuse the document on other projects without prior written consent from SJB Architects. Under no circumstances shall transfer of this document be deemed a sale. SJB Architects makes no warranties of fitness for any purpose. The Builder/Contractor shall verify job dimensions prior to any work commencing. Use figured dimensions only. Do not scale drawings.

FOR APPROVAL

0 1 2 5m

1:100 @A1

Nominated Architects: Adam Haddow-7188 | John Pradel-7004

Rev	Date	Revision	By	Chk.
1	01.03.24	EWDA-2 DRAFT ISSUE	JR	JT
2	20.03.24	FOR INFORMATION	JR	JT
3	03.04.24	EWDA-2 - FOR APPROVAL	JR	JT
4	25.04.25	EWDA-2 - Updated to incorporate revised Metro Interface	JR	JT

Client

AQUALAND

Project

Central Barangaroo
Hickson Road, Barangaroo NSW

Country: Gadigal Country

Drawing Name

METRO SECTIONS

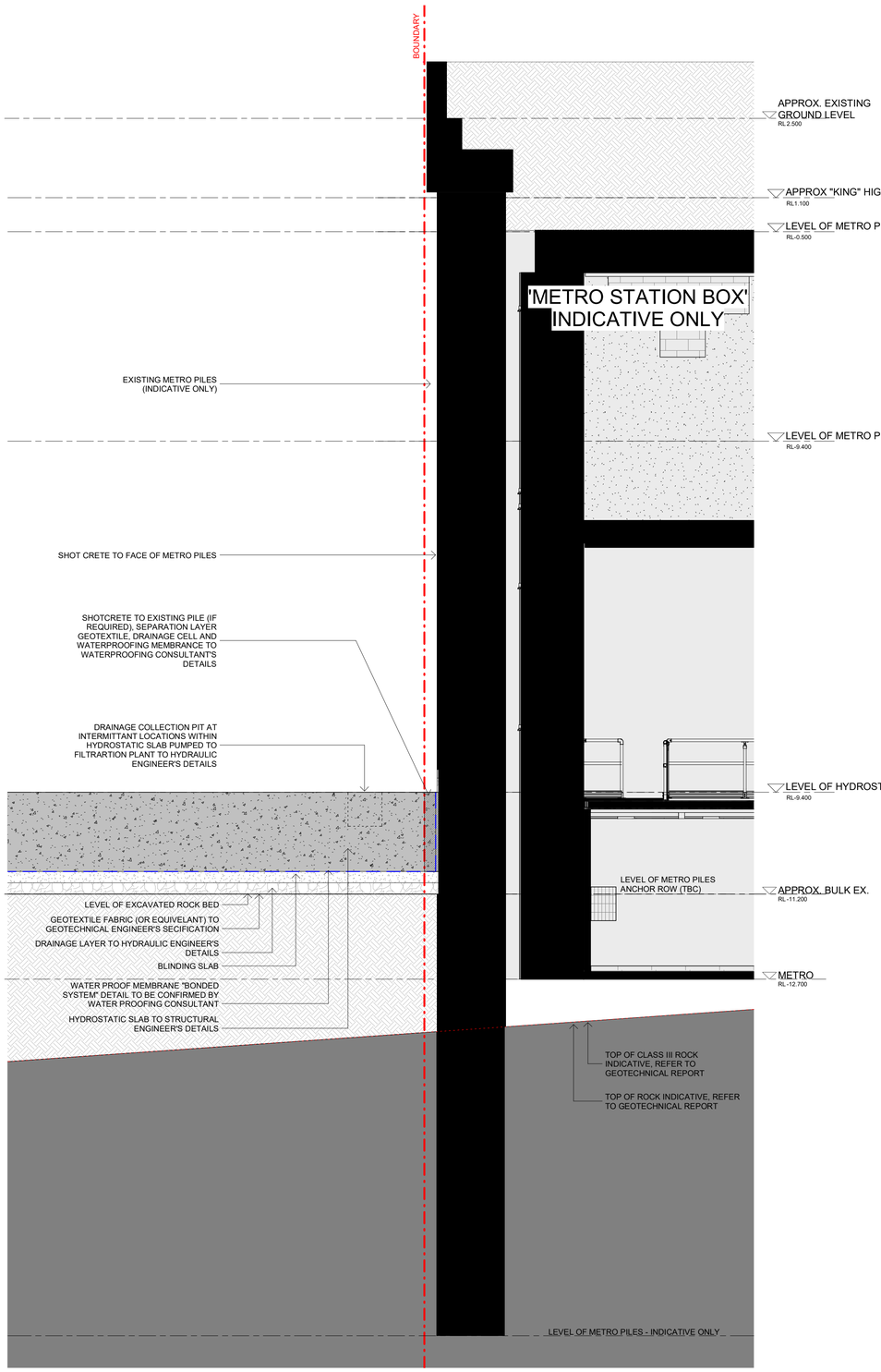
NOT FOR CONSTRUCTION

Date	Scale	Sheet Size
25.04.25	1:100	@ A1
Drawn	Chk.	Job No.
JR	JT	6759
Drawing No.		Revision
DA-00-1551		/ 4

SJB Architects
Level 2, 490 Crown Street
Surry Hills NSW 2010

T 61 2 9380 9911

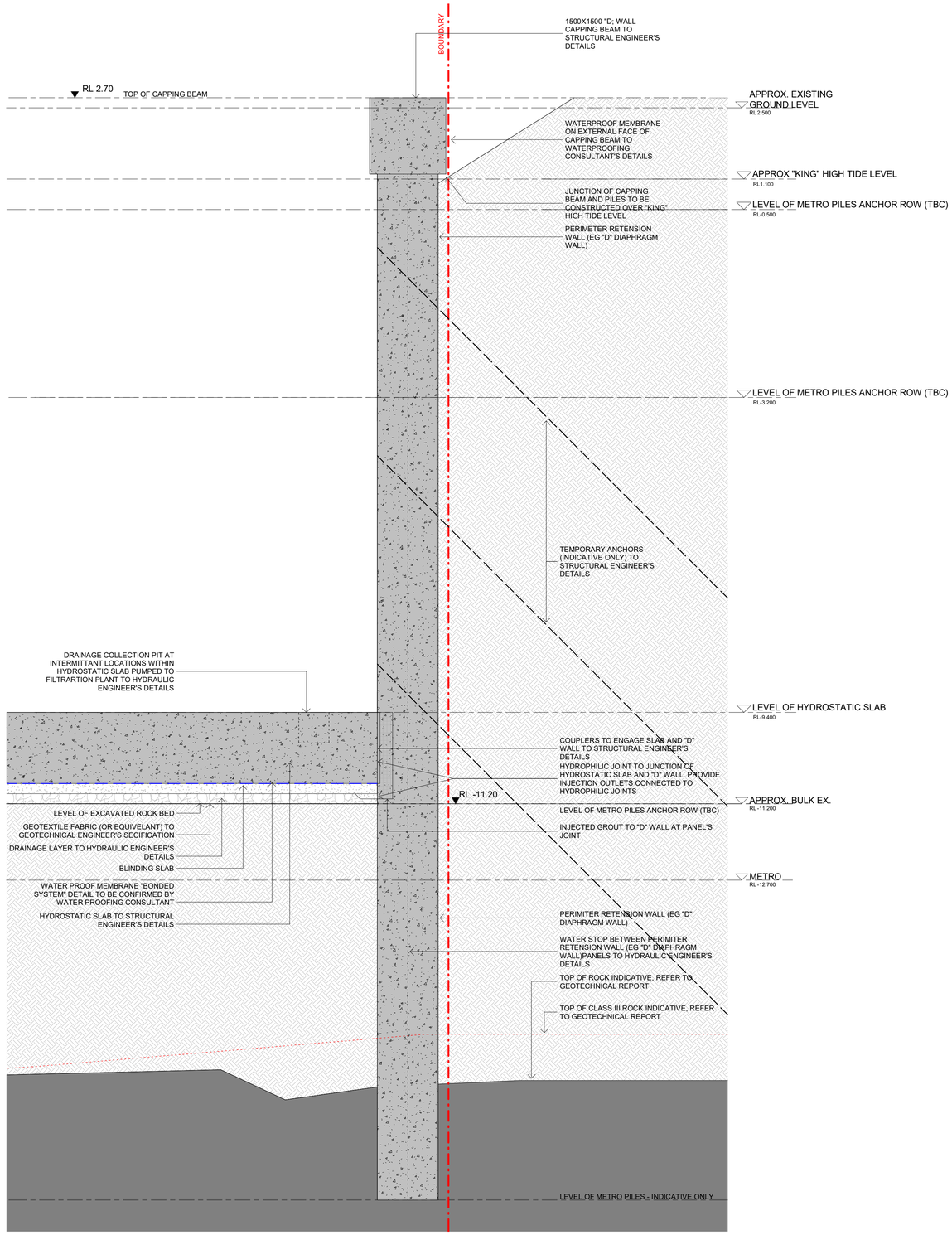
www.sjb.com.au



1 AR-00-0402 DETAIL - NORTHERN INSITU WALL

1 : 50@A1

NORTHERN BASEMENT WALL NEXT TO EXISTING METRO PILES



2 AR-00-0402 DETAIL - NORTHERN "D" WALL

1 : 50@A1

NORTHERN BASEMENT "D" WALL AT JUNCTION WITH EXISTING METRO PILES

NOTE: MINOR CHANGES TO FORM AND CONFIGURATION MAY BE REQUIRED WHEN DRAWINGS ARE SUBSEQUENTLY PREPARED FOR CONSTRUCTION PURPOSES AFTER THE GRANT OF DEVELOPMENT CONSENT.

NOT FOR CONSTRUCTION

In accepting and utilising this document the recipient agrees that SJB Architecture (NSW) Pty. Ltd. ACN 081 094 724 T/A SJB Architects, retain all common law, statutory law and other rights including copyright and intellectual property rights. The recipient agrees not to use this document for any purpose other than its intended use; to waive all claims against SJB Architects resulting from unauthorised changes; or to reuse the document on other projects without prior written consent from SJB Architects. Under no circumstances shall transfer of this document be deemed a sale. SJB Architects makes no warranties of fitness for any purpose. The Builder/Contractor shall verify job dimensions prior to any work commencing. Use figured dimensions only. Do not scale drawings.

FOR APPROVAL

0 500 1000 2500mm
1:50 @A1

Nominated Architects: Adam Haddow-7188 | John Pradel-7004

Rev	Date	Revision	By	Chk.
1	01.03.24	EWDA-2 DRAFT ISSUE	JR	JT
2	20.03.24	FOR INFORMATION	JR	JT
3	03.04.24	EWDA-2 - FOR APPROVAL	JR	JT

Client: AQUALAND

Project: Central Barangaroo
Hickson Road, Barangaroo NSW

Country: Gadigal Country

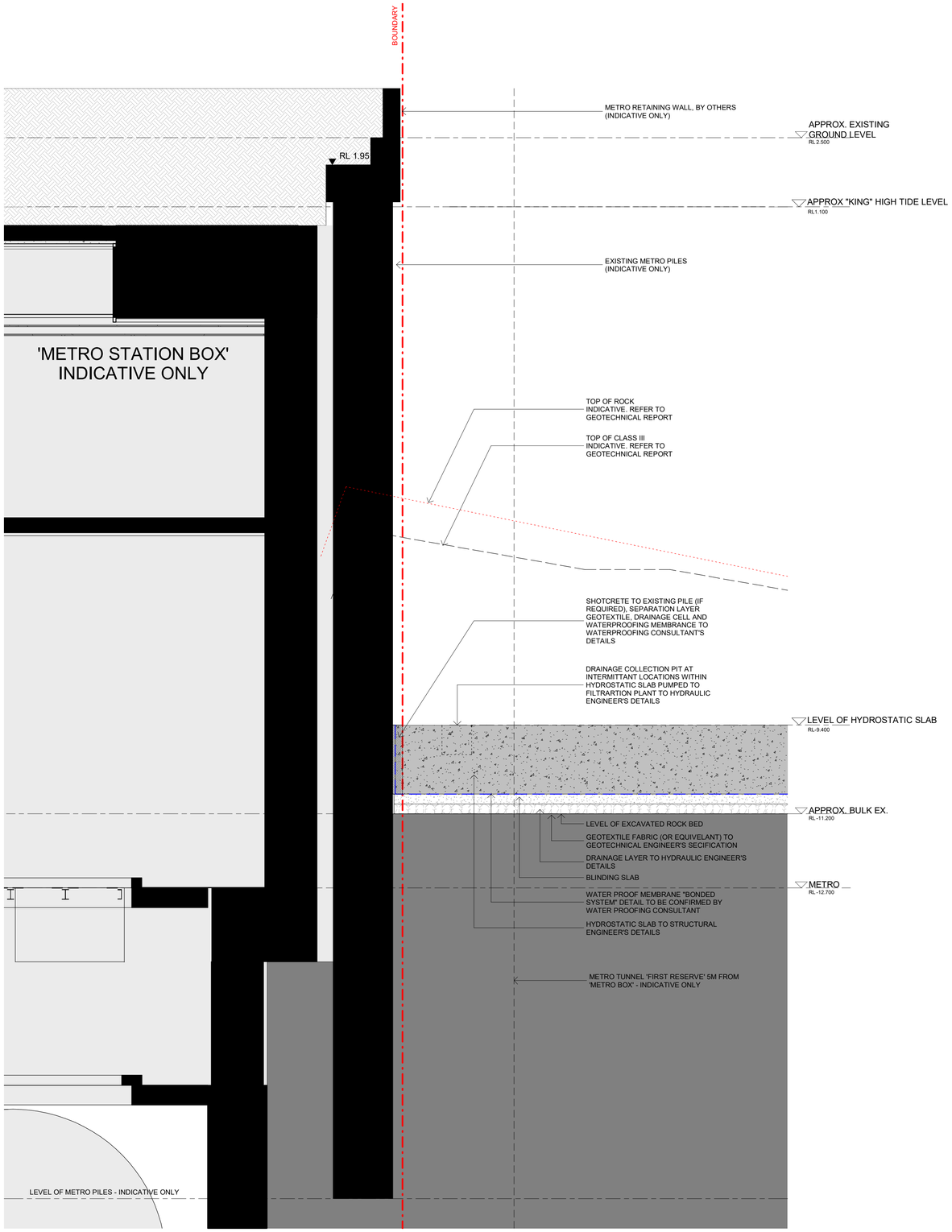
Drawing Name: DETAIL WALL SECTIONS - SHEET 1 (NORTH)

Date	Scale	Sheet Size
03.04.24	1:50	@ A1
Drawn	Chk.	Job No.
JR	JT	6759
Drawing No.		Revision
DA-00-1701		/ 3

SJB Architects
Level 2, 490 Crown Street
Surry Hills NSW 2010

T 61 2 9380 9911

www.sjb.com.au



1
DA-00-0701

DETAIL 1 - EASTERN BOUNDARY TO METRO

1 : 50@A1

EASTERN BASEMENT WALL NEXT TO EXISTING METRO PILES

NOTE: MINOR CHANGES TO FORM AND CONFIGURATION MAY BE REQUIRED WHEN DRAWINGS ARE SUBSEQUENTLY PREPARED FOR CONSTRUCTION PURPOSES AFTER THE GRANT OF DEVELOPMENT CONSENT.

NOT FOR CONSTRUCTION

In accepting and utilising this document the recipient agrees that SJB Architecture (NSW) Pty. Ltd. ACN 081 094 724 T/A SJB Architects, retain all common law, statutory law and other rights including copyright and intellectual property rights. The recipient agrees not to use this document for any purpose other than its intended use; to waive all claims against SJB Architects resulting from unauthorised changes; or to reuse the document on other projects without prior written consent from SJB Architects. Under no circumstances shall transfer of this document be deemed a sale. SJB Architects makes no warranties of fitness for any purpose. The Builder/Contractor shall verify job dimensions prior to any work commencing. Use figured dimensions only. Do not scale drawings.

FOR APPROVAL

0 500 1000 2500mm
1:50 @A1

Nominated Architects: Adam Haddow-7188 | John Pradel-7004

Rev	Date	Revision	By	Chk.
1	01.03.24	EWDA-2 DRAFT ISSUE	JR	JT
2	08.03.24	DRAFT - UPDATE FOLLOWING CLIENT COMMENTS	JR	JT
3	20.03.24	FOR INFORMATION	JR	JT
4	03.04.24	EWDA-2 - FOR APPROVAL	JR	JT

Client: AQUALAND

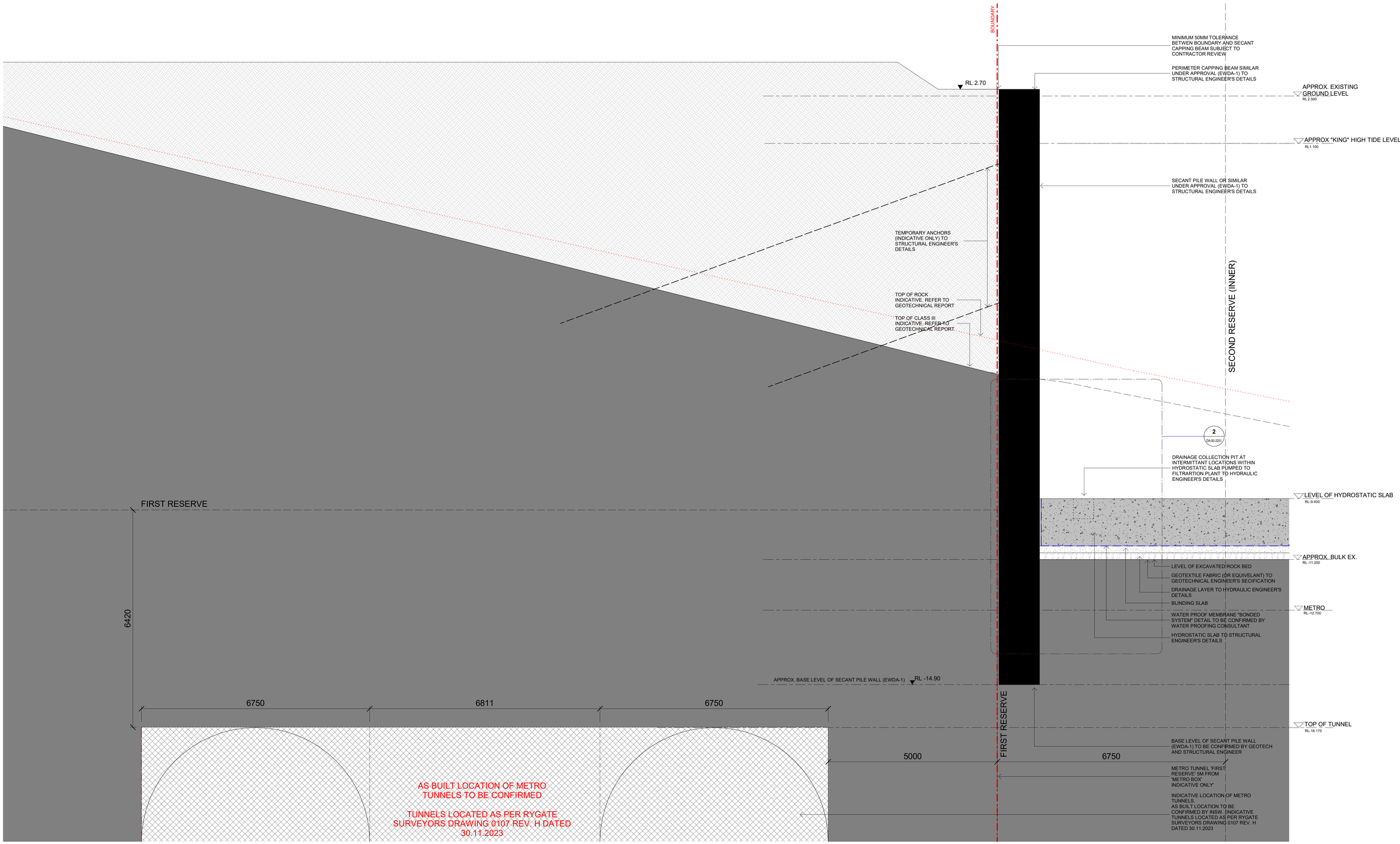
Project: Central Barangaroo
Hickson Road, Barangaroo NSW

Country: Gadigal Country

Drawing Name: DETAIL WALL SECTIONS - SHEET 2 (EAST)

Date	Scale	Sheet Size
03.04.24	1:50	@ A1
Drawn	Chk.	Job No.
JR	JT	6759
Drawing No.		Revision
DA-00-1702		/ 4

SJB Architects
Level 2, 490 Crown Street
Surry Hills NSW 2010
T 61 2 9380 9911
www.sjb.com.au



1
DA-00-0701

DETAIL 2 - EASTERN BOUNDARY TO EWDA-1

1 : 50@A1

NOTE: MINOR CHANGES TO FORM AND CONFIGURATION MAY BE REQUIRED WHEN DRAWINGS ARE SUBSEQUENTLY PREPARED FOR CONSTRUCTION PURPOSES AFTER THE GRANT OF DEVELOPMENT CONSENT.

In accepting and utilising this document the recipient agrees that SJB Architecture (NSW) Pty. Ltd. ACN 081 094 724 T/A SJB Architects, retain all common law, statutory law and other rights including copyright and intellectual property rights. The recipient agrees not to use this document for any purpose other than its intended use; to waive all claims against SJB Architects resulting from unauthorised changes; or to reuse the document on other projects without prior written consent from SJB Architects. Under no circumstances shall transfer of this document be deemed a sale. SJB Architects makes no warranties of fitness for any purpose. The Builder/Contractor shall verify job dimensions prior to any work commencing. Use figured dimensions only. Do not scale drawings.

FOR APPROVAL

0 1 2 5m
1:100 @A1

Nominated Architects: Adam Haddow-7188 | John Pradel-7004

Rev	Date	Revision	By	Chk.
1	20.03.24	FOR INFORMATION	JR	JT
2	03.04.24	EWDA-2 - FOR APPROVAL	JR	JT

EASTERN BASEMENT WALL NEXT TO EWDA-1 PILES

Client

AQUALAND

Project
Central Barangaroo
Hickson Road, Barangaroo NSW

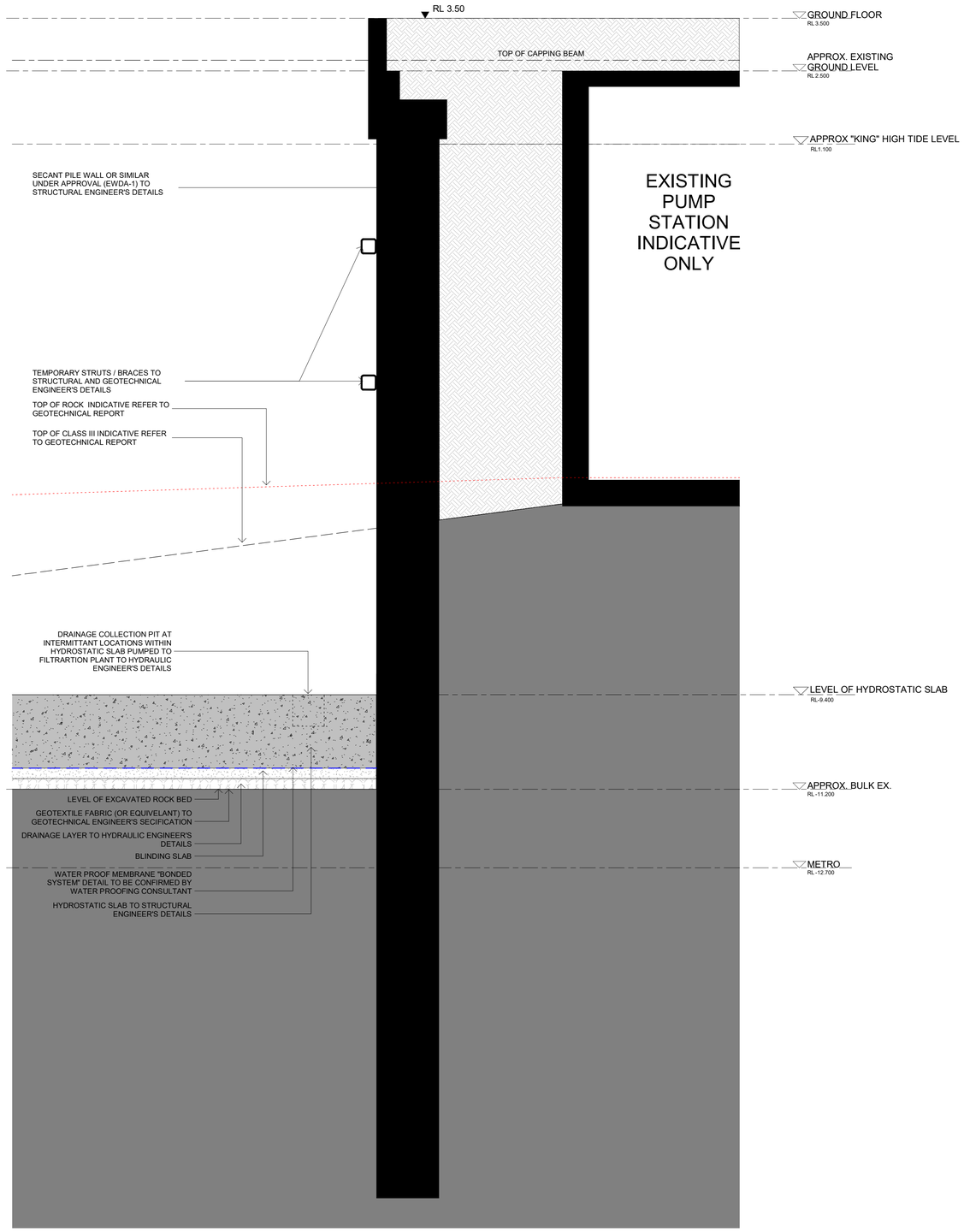
Country: Gadigal Country

Drawing Name
DETAIL WALL SECTIONS - SHEET 3 (EAST)

NOT FOR CONSTRUCTION

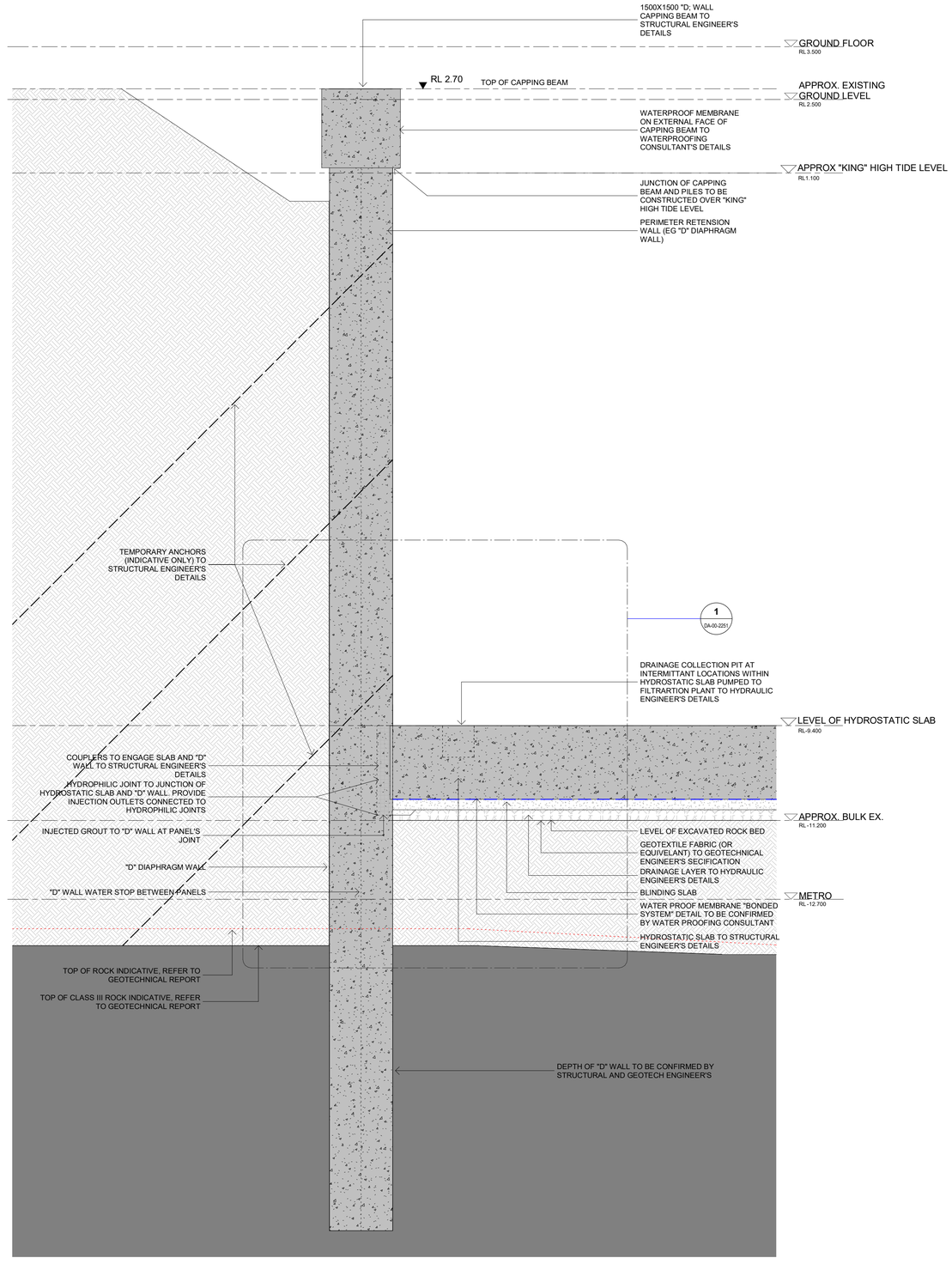
Date	Scale	Sheet Size
03.04.24	1:100	@ A1
Drawn	Chk.	Job No.
JR	JT	6759
Drawing No.		Revision
DA-00-1703		/ 2

SJB Architects
Level 2, 490 Crown Street
Surry Hills NSW 2010
T 61 2 9380 9911
www.sjb.com.au



1 DA-00-0703 **DETAIL - SOUTHERN INSITU WALL**

1 : 50@A1



2 DA-00-0703 **DETAIL - SOUTHERN "D" WALL**

1 : 50@A1

NOTE: MINOR CHANGES TO FORM AND CONFIGURATION MAY BE REQUIRED WHEN DRAWINGS ARE SUBSEQUENTLY PREPARED FOR CONSTRUCTION PURPOSES AFTER THE GRANT OF DEVELOPMENT CONSENT.

In accepting and utilising this document the recipient agrees that SJB Architecture (NSW) Pty. Ltd. ACN 081 094 724 T/A SJB Architects, retain all common law, statutory law and other rights including copyright and intellectual property rights. The recipient agrees not to use this document for any purpose other than its intended use; to waive all claims against SJB Architects resulting from unauthorised changes; or to reuse the document on other projects without prior written consent from SJB Architects. Under no circumstances shall transfer of this document be deemed a sale. SJB Architects makes no warranties of fitness for any purpose. The Builder/Contractor shall verify job dimensions prior to any work commencing. Use figured dimensions only. Do not scale drawings.

FOR APPROVAL

0 500 1000 2500mm

1:50 @A1

Nominated Architects: Adam Haddow-7188 | John Pradel-7004

Rev	Date	Revision	By	Chk.
1	01.03.24	EWDA-2 DRAFT ISSUE	JR	JT
2	20.03.24	FOR INFORMATION	JR	JT
3	03.04.24	EWDA-2 - FOR APPROVAL	JR	JT

Client

AQUALAND

Project

Central Barangaroo
Hickson Road, Barangaroo NSW

Country: Gadigal Country

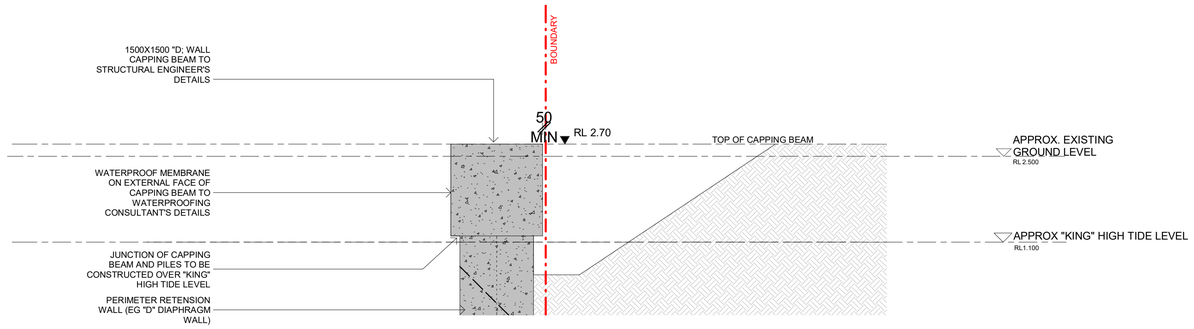
Drawing Name

DETAIL WALL SECTIONS - SHEET 4 (SOUTH)

Date	Scale	Sheet Size
03.04.24	1:50	@ A1
Drawn	Chk.	Job No.
JR	JT	6759
Drawing No.		Revision
DA-00-1704		/ 3

NOT FOR CONSTRUCTION

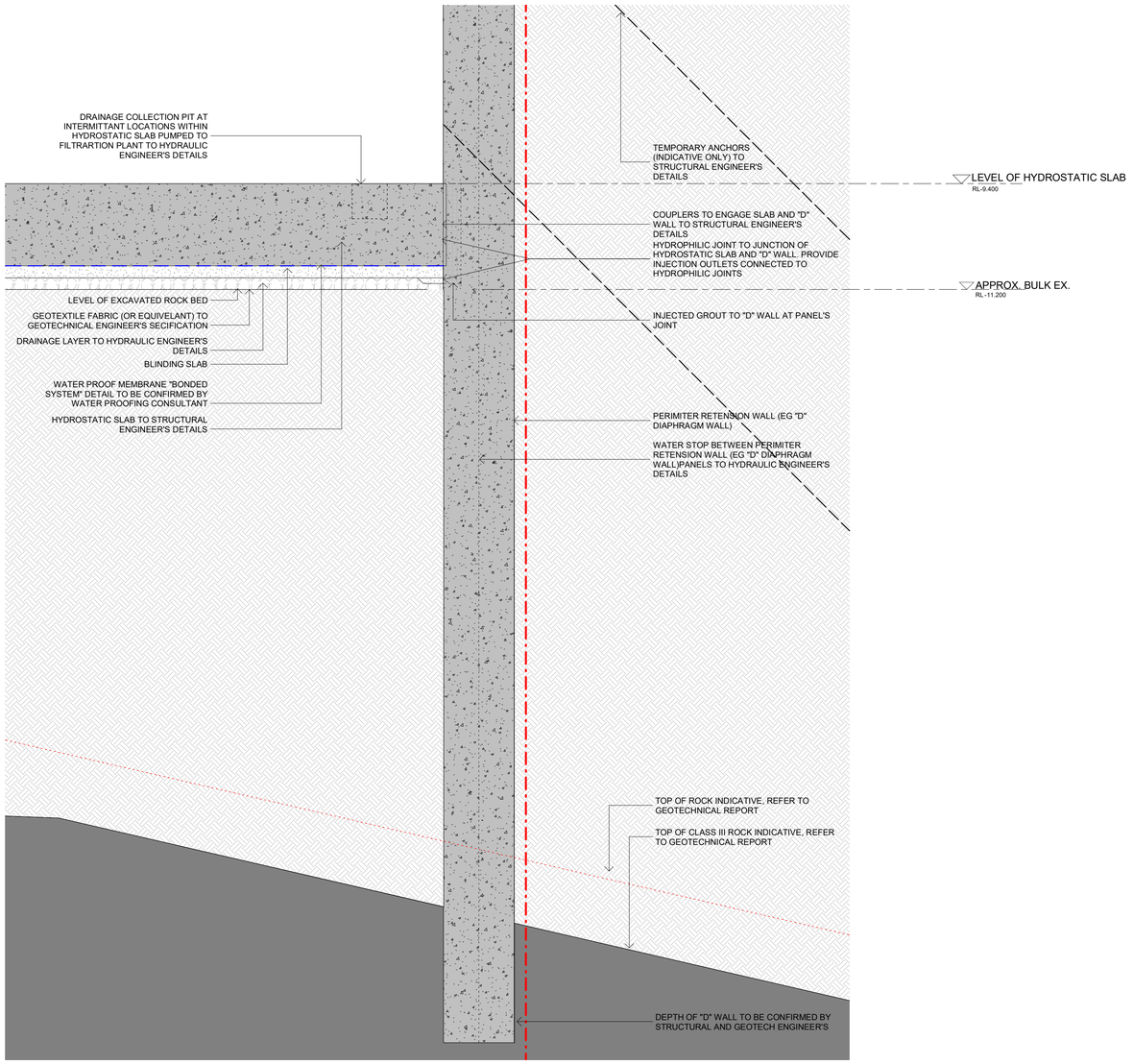
SJB Architects
Level 2, 490 Crown Street
Surry Hills NSW 2010
T 61 2 9380 9911
www.sjb.com.au



1 DETAIL - WESTERN "D" WALL (UPPER)

DA-00-0701

1 : 50@A1



2 DETAIL - WESTERN "D" WALL (LOWER)

DA-00-0701

1 : 50@A1

NOTE: MINOR CHANGES TO FORM AND CONFIGURATION MAY BE REQUIRED WHEN DRAWINGS ARE SUBSEQUENTLY PREPARED FOR CONSTRUCTION PURPOSES AFTER THE GRANT OF DEVELOPMENT CONSENT.

In accepting and utilising this document the recipient agrees that SJB Architecture (NSW) Pty. Ltd. ACN 081 094 724 T/A SJB Architects, retain all common law, statutory law and other rights including copyright and intellectual property rights. The recipient agrees not to use this document for any purpose other than its intended use; to waive all claims against SJB Architects resulting from unauthorised changes; or to reuse the document on other projects without prior written consent from SJB Architects. Under no circumstances shall transfer of this document be deemed a sale. SJB Architects makes no warranties of fitness for any purpose. The Builder/Contractor shall verify job dimensions prior to any work commencing. Use figured dimensions only. Do not scale drawings.

FOR APPROVAL

0 500 1000 2500mm

1:50 @A1

Nominated Architects: Adam Haddow-7188 | John Pradel-7004

Rev	Date	Revision	By	Chk.
1	01.03.24	EWDA-2 DRAFT ISSUE	JR	JT
2	20.03.24	FOR INFORMATION	JR	JT

Client

AQUALAND

Project

Central Barangaroo
Hickson Road, Barangaroo NSW

Country: Gadigal Country

Drawing Name

DETAIL WALL SECTIONS - SHEET 5 (WEST)

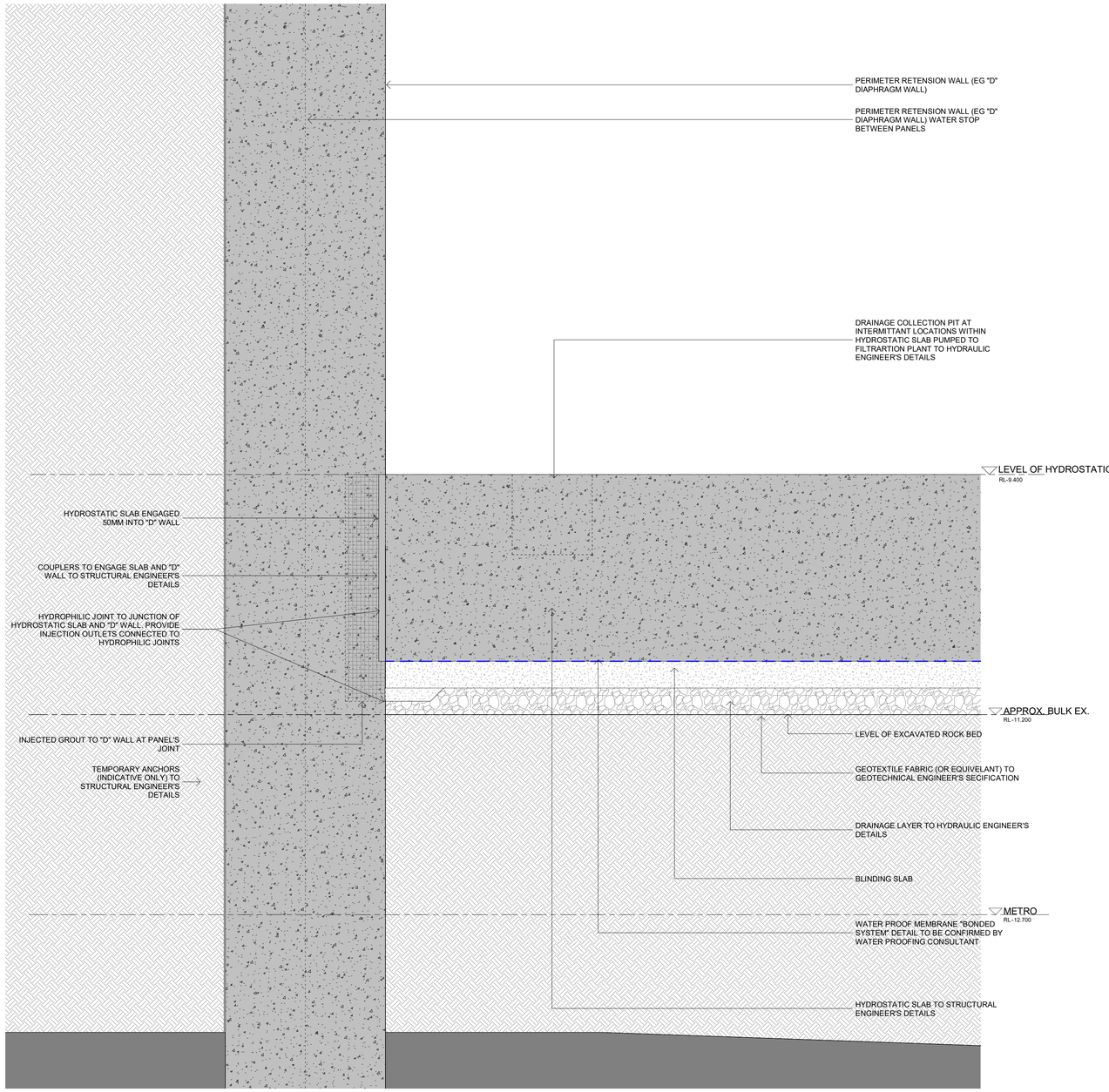
Date	Scale	Sheet Size
20.03.24	1:50	@ A1
Drawn	Chk.	Job No.
JR	JT	6759
Drawing No.		Revision
DA-00-1705		/ 2

SJB Architects
Level 2, 490 Crown Street
Surry Hills NSW 2010

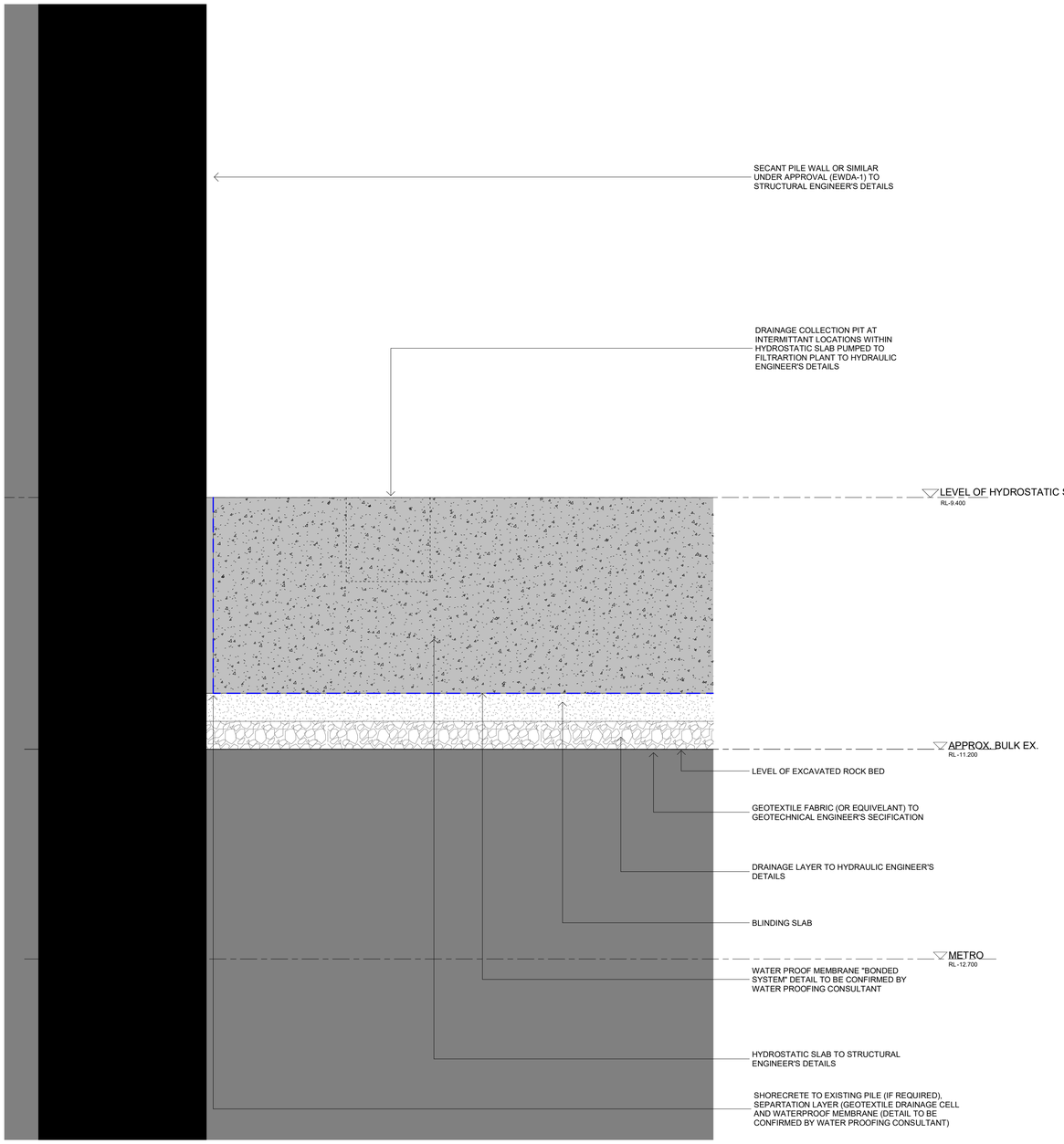
T 61 2 9380 9911

www.sjb.com.au

NOT FOR CONSTRUCTION



1 DA-00-1704 **"D" WALL TO HYDROSTATIC SLAB DETAIL**
1 : 20@A1



2 DA-00-1703 **IN-SITU WALL TO HYDROSTATIC SLAB DETAIL**
1 : 20@A1

NOTE: MINOR CHANGES TO FORM AND CONFIGURATION MAY BE REQUIRED WHEN DRAWINGS ARE SUBSEQUENTLY PREPARED FOR CONSTRUCTION PURPOSES AFTER THE GRANT OF DEVELOPMENT CONSENT.

In accepting and utilising this document the recipient agrees that SJB Architecture (NSW) Pty. Ltd. ACN 081 094 724 T/A SJB Architects, retain all common law, statutory law and other rights including copyright and intellectual property rights. The recipient agrees not to use this document for any purpose other than its intended use; to waive all claims against SJB Architects resulting from unauthorised changes; or to reuse the document on other projects without prior written consent from SJB Architects. Under no circumstances shall transfer of this document be deemed a sale. SJB Architects makes no warranties of fitness for any purpose. The Builder/Contractor shall verify job dimensions prior to any work commencing. Use figured dimensions only. Do not scale drawings.

FOR APPROVAL

0 200 400 1000mm
1:20 @A1

Nominated Architects: Adam Haddow-7188 | John Pradel-7004

Rev	Date	Revision	By	Chk.
1	01.03.24	EWDA-2 DRAFT ISSUE	JR	JT
2	20.03.24	FOR INFORMATION	JR	JT
3	03.04.24	EWDA-2 - FOR APPROVAL	JR	JT

Client
AQUALAND

Project
Central Barangaroo
Hickson Road, Barangaroo NSW

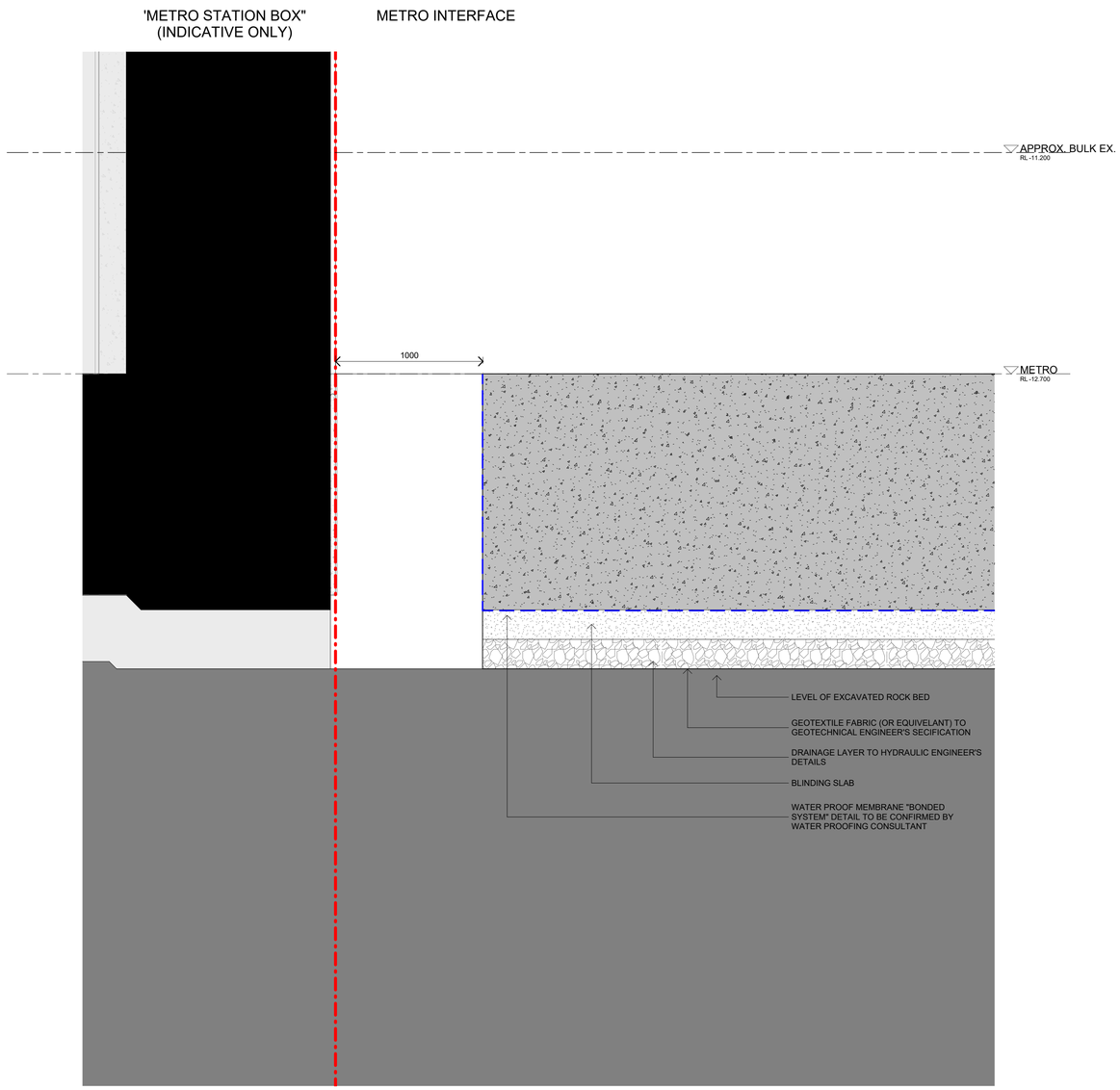
Country: Gadigal Country

Drawing Name
HYDROSTATIC SLAB AND PRW WP DETAILS - 1

Date	Scale	Sheet Size
03.04.24	1:20	@ A1
Drawn	Chk.	Job No.
JR	JT	6759
Drawing No.		Revision
DA-00-2251		/ 3

NOT FOR CONSTRUCTION

SJB Architects
Level 2, 490 Crown Street
Surry Hills NSW 2010
T 61 2 9380 9911
www.sjb.com.au



1
DA-00-1551

METRO INTERFACE SLAB DETAIL

1 : 20@A1

NOTE: MINOR CHANGES TO FORM AND CONFIGURATION MAY BE REQUIRED WHEN DRAWINGS ARE SUBSEQUENTLY PREPARED FOR CONSTRUCTION PURPOSES AFTER THE GRANT OF DEVELOPMENT CONSENT.

In accepting and utilising this document the recipient agrees that SJB Architecture (NSW) Pty. Ltd. ACN 081 094 724 T/A SJB Architects, retain all common law, statutory law and other rights including copyright and intellectual property rights. The recipient agrees not to use this document for any purpose other than its intended use; to waive all claims against SJB Architects resulting from unauthorised changes; or to reuse the document on other projects without prior written consent from SJB Architects. Under no circumstances shall transfer of this document be deemed a sale. SJB Architects makes no warranties of fitness for any purpose. The Builder/Contractor shall verify job dimensions prior to any work commencing. Use figured dimensions only. Do not scale drawings.

FOR APPROVAL

0 200 400 1000mm
1:20 @A1

Nominated Architects: Adam Haddow-7188 | John Pradel-7004

Rev	Date	Revision	By	Chk.
1	01.03.24	EWDA-2 DRAFT ISSUE	JR	JT
2	20.03.24	FOR INFORMATION	JR	JT
3	03.04.24	EWDA-2 - FOR APPROVAL	JR	JT
4	25.04.25	EWDA-2 - Updated to incorporate revised Metro Interface	JR	JT

Client

AQUALAND

Project

Central Barangaroo
Hickson Road, Barangaroo NSW

Country: Gadigal Country

Drawing Name

HYDROSTATIC SLAB AND PRW WP DETAILS - 2

Date	Scale	Sheet Size
25.04.25	1:20	@ A1
Drawn	Chk.	Job No.
JR	JT	6759
Drawing No.		Revision
DA-00-2252		/ 4

NOT FOR CONSTRUCTION

SJB Architects
Level 2, 490 Crown Street
Surry Hills NSW 2010

T 61 2 9380 9911

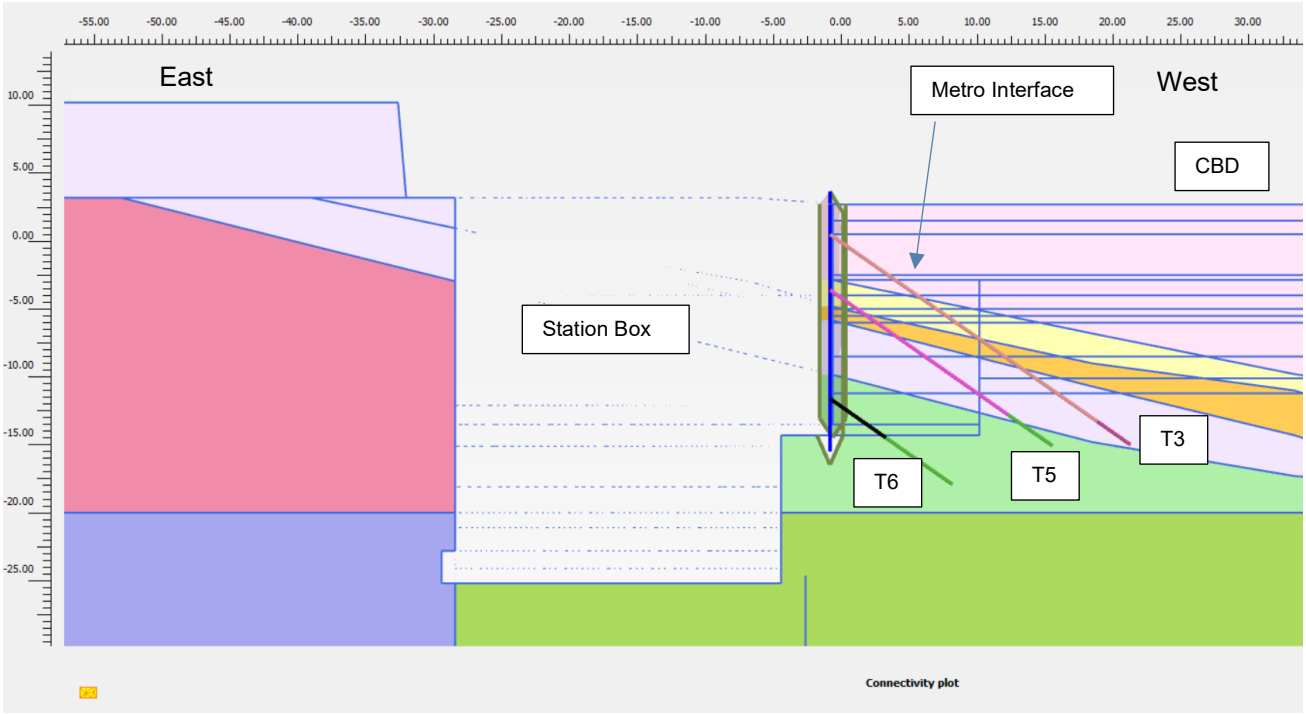
www.sjb.com.au

APPENDIX C: PLAXIS MODELS

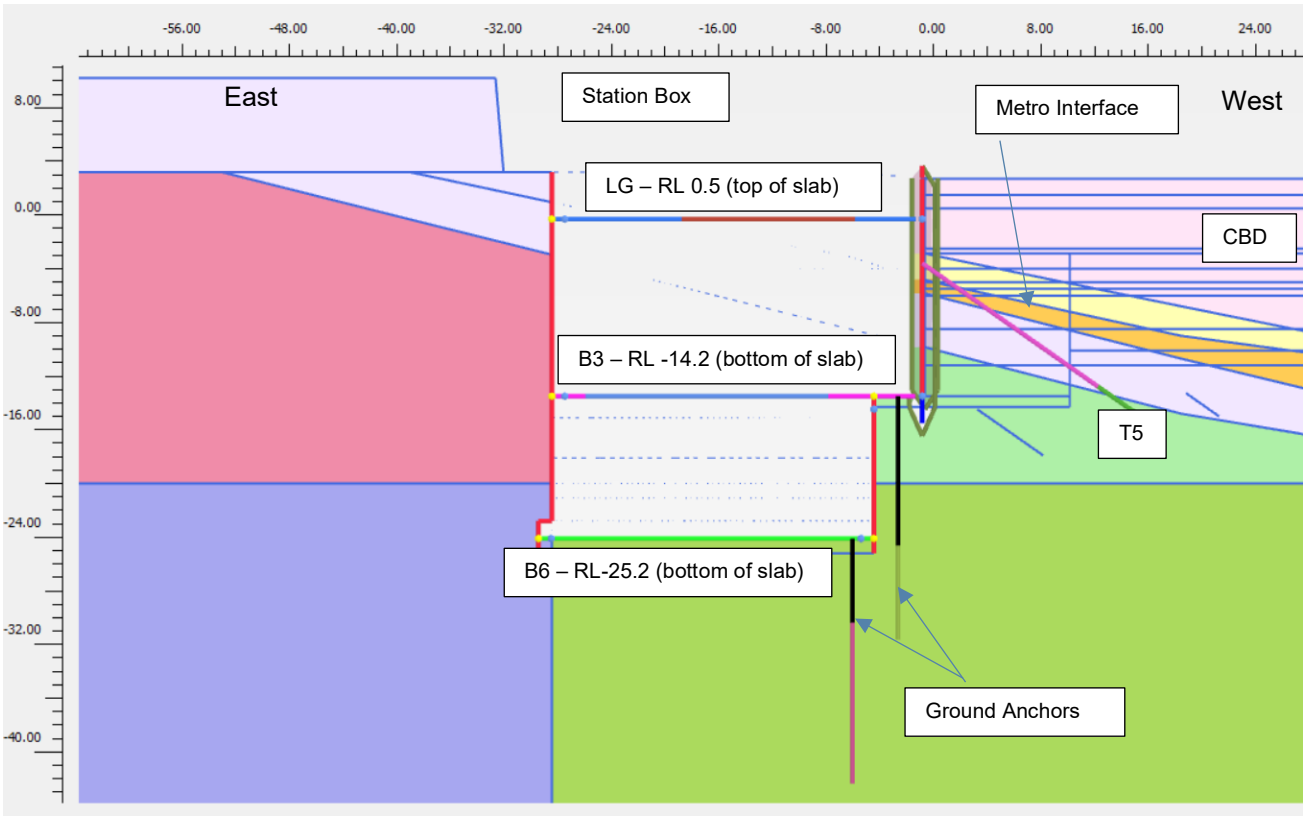
PLAXIS MODELS - CONSTRUCTION STAGING

Section 1

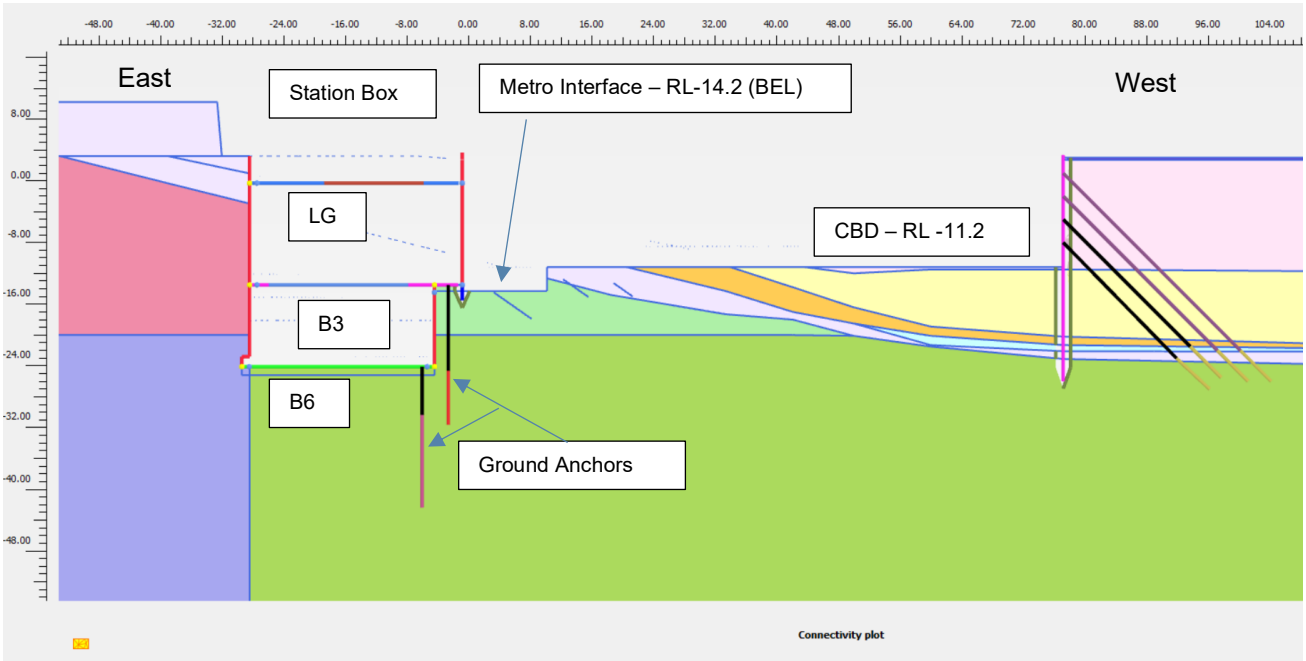
Stage 13 – After Barangaroo Station Excavation



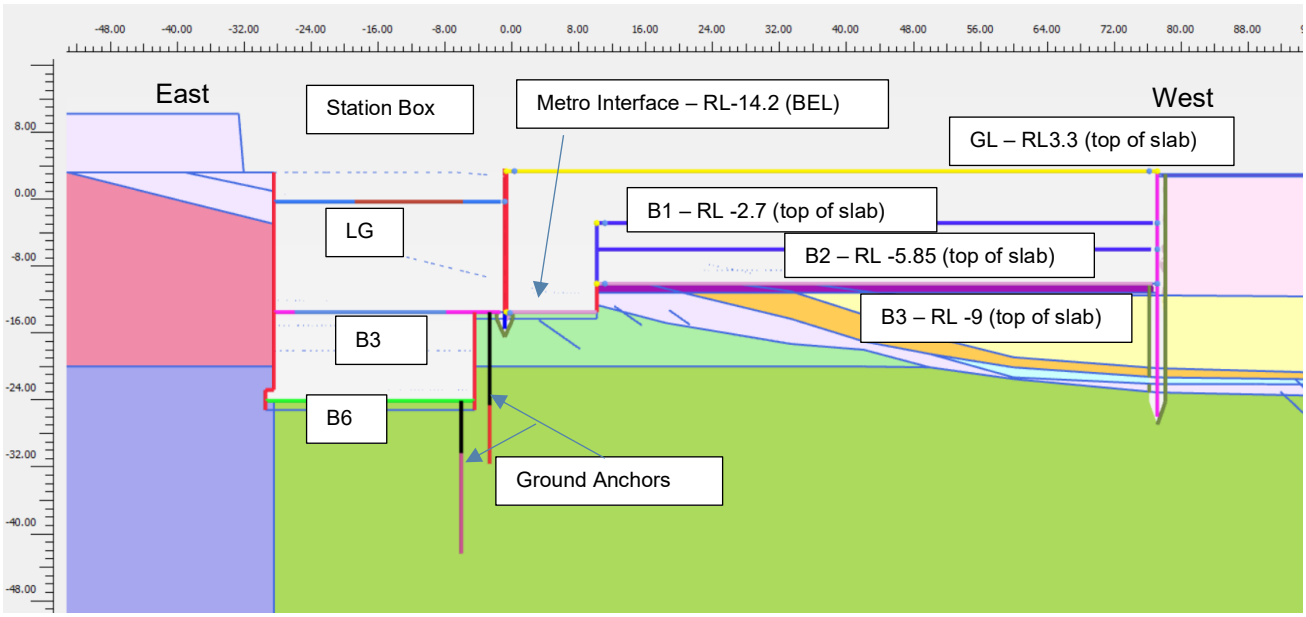
Stage 19 – After installation of Barangaroo Station slabs and walls



Stage 33 – After Excavation of CBD

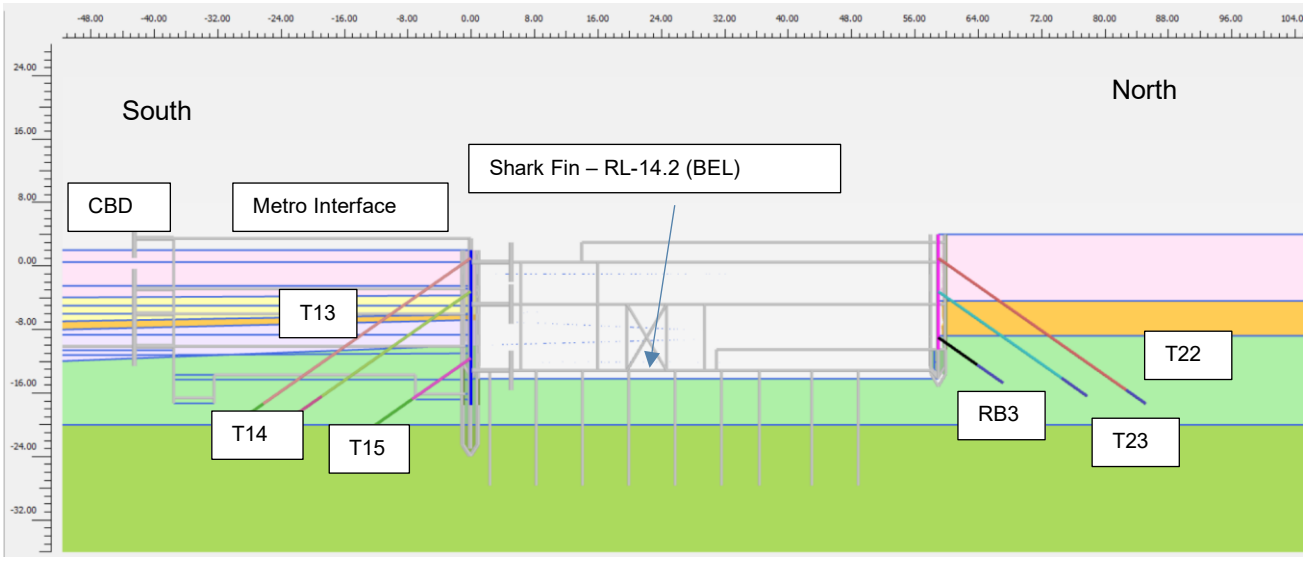


Stage 36 – After Installation of CBD Slabs and Walls

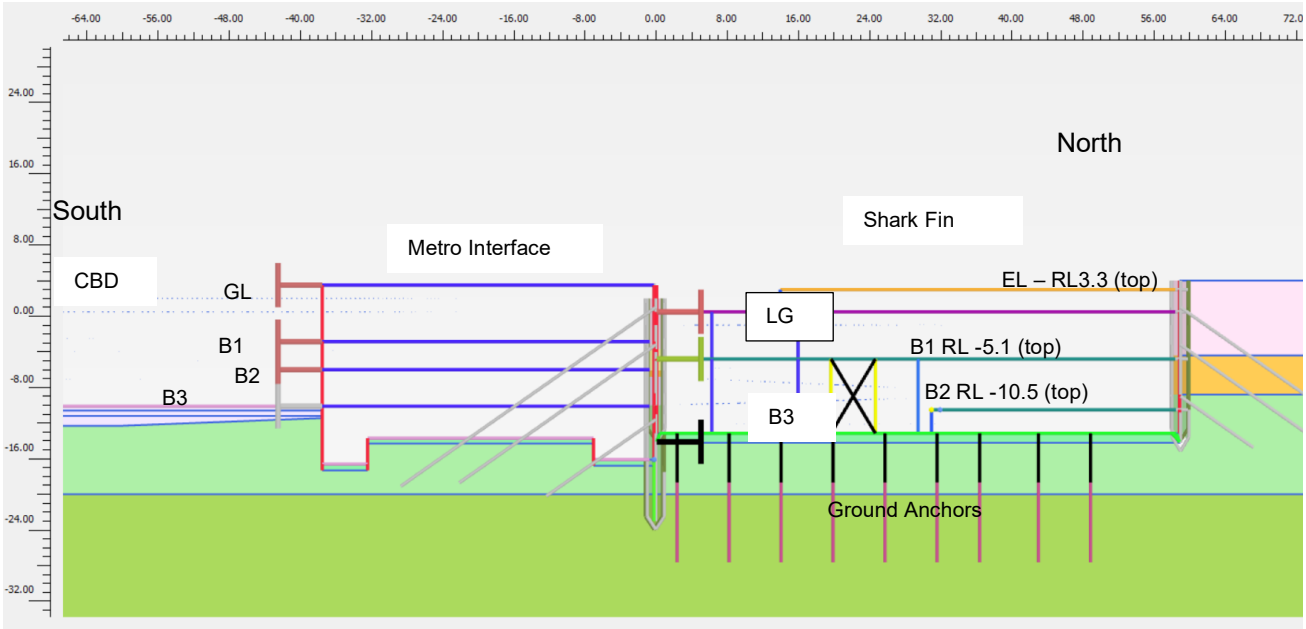


Section 2

Stage 13 – After Shark Fin Excavation



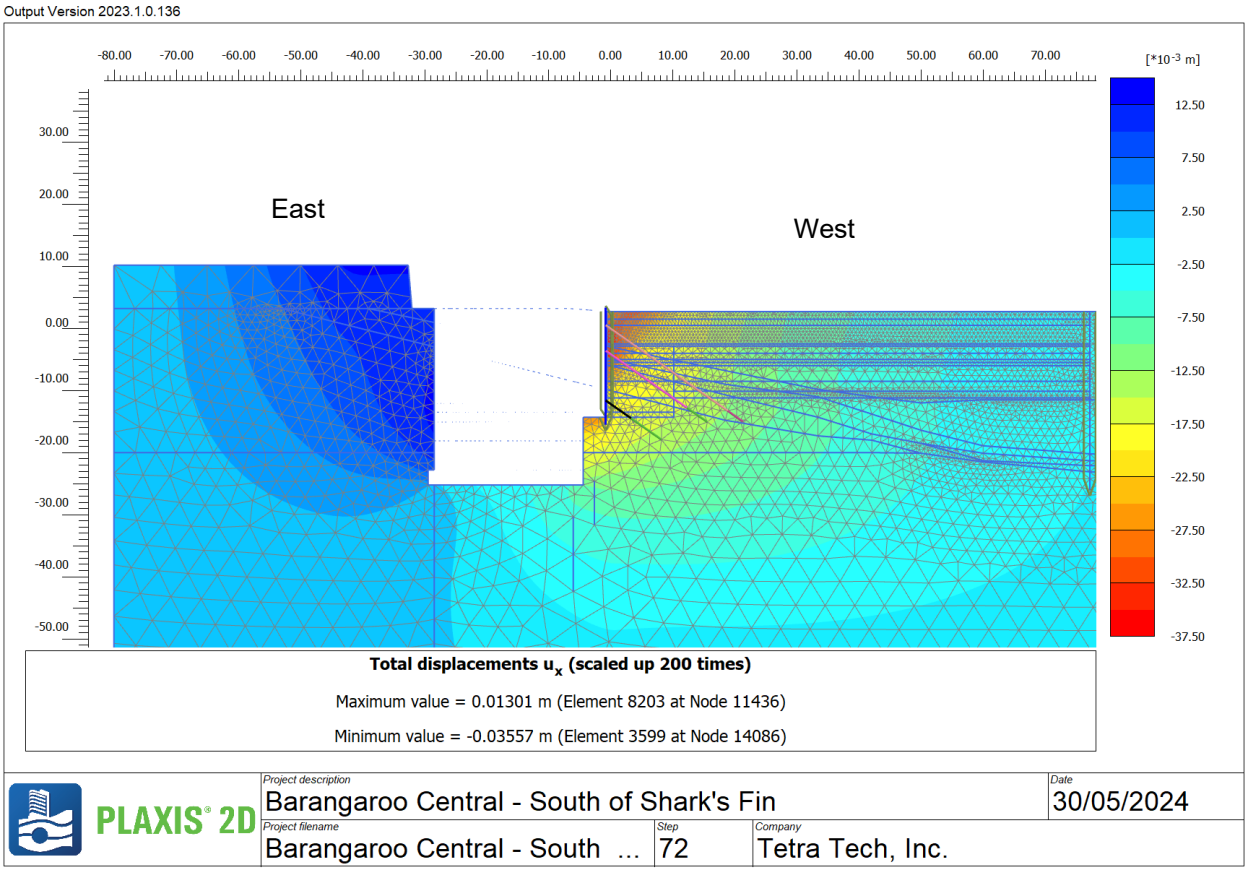
Stage 34 – After CBD Excavation



APPENDIX D: PLAXIS RESULTS AND INVERTED CONE FAILURE CHECK

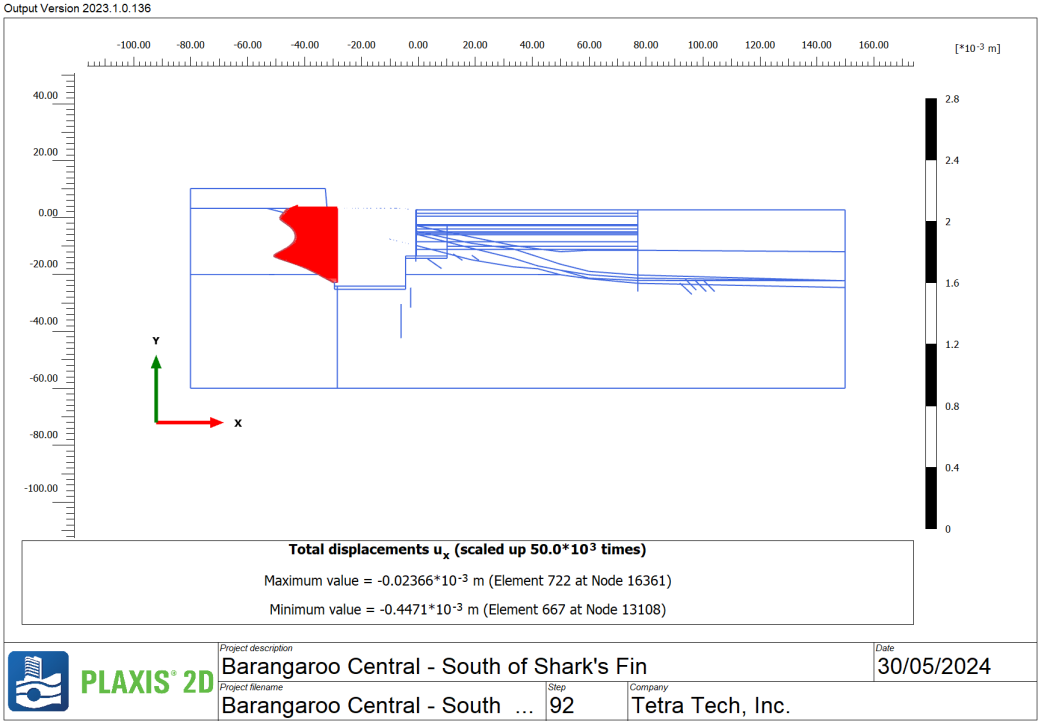
PLAXIS RESULTS – SECTION 1

A. Deformation Contours for Stage 13 (After completion of BMS excavation)

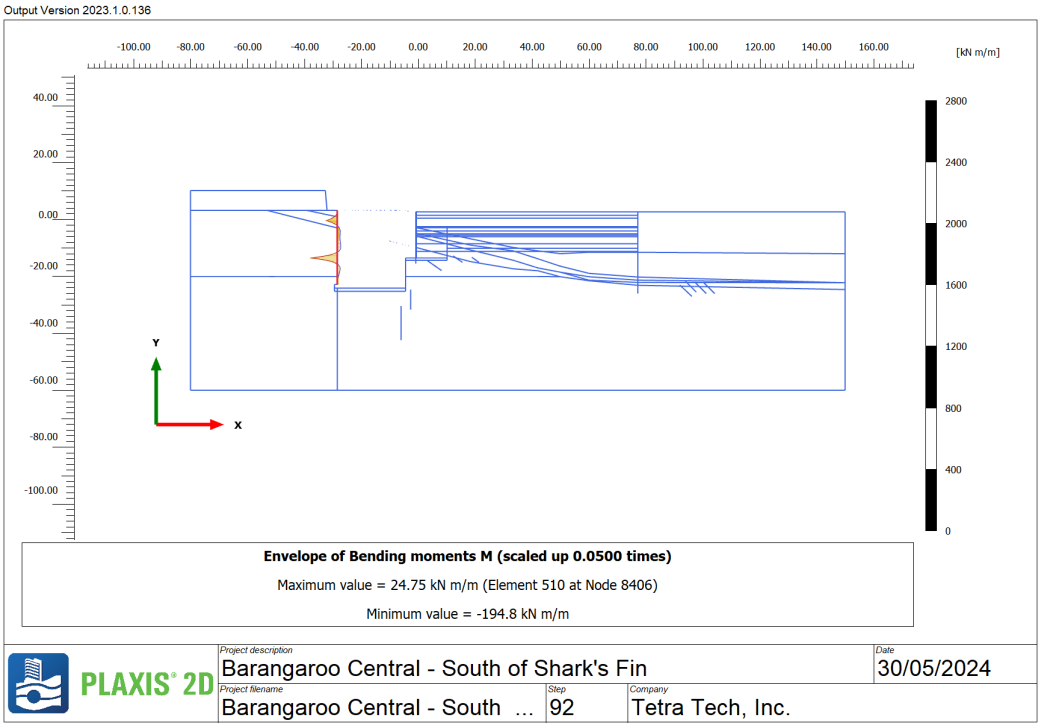


Deformation Contours at rock face after completion of BMS excavation for Stage 13

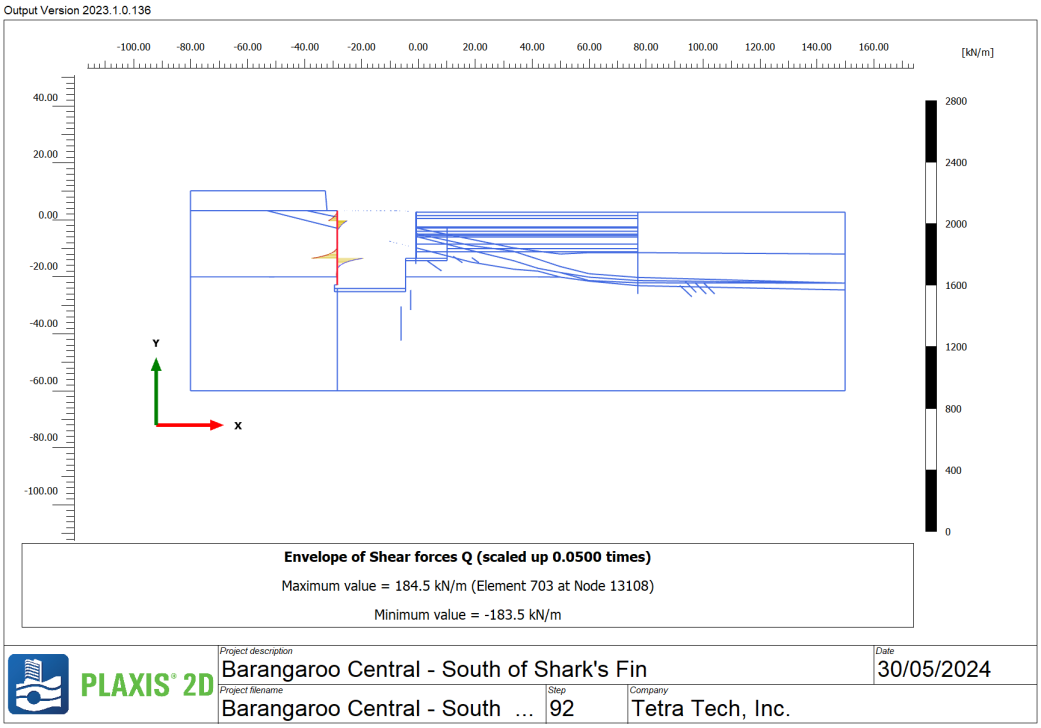
B. East Wall



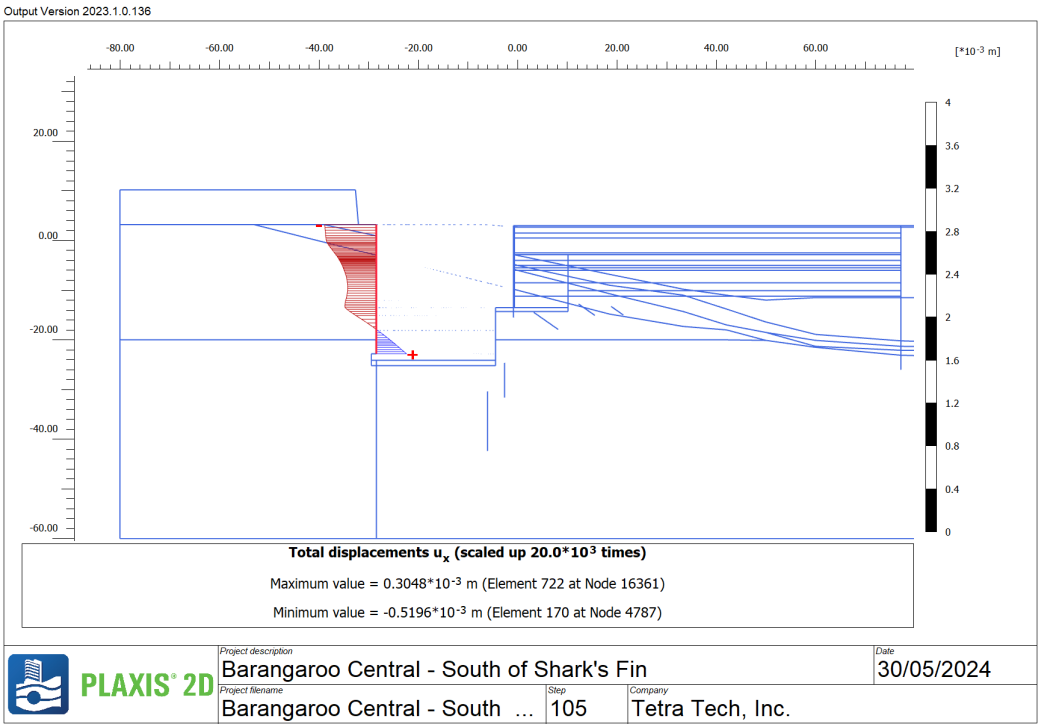
Lateral Displacement for East Wall at Stage 19 – After installation of Station slabs and walls (Total displacement from Stage 1 to Stage 19)



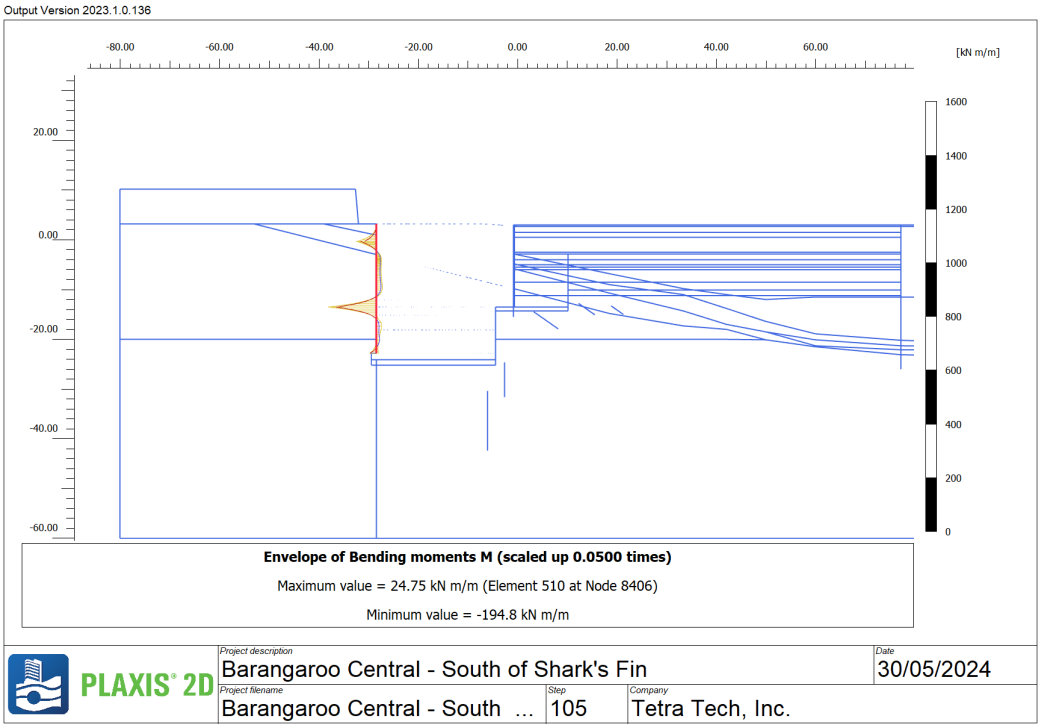
Bending Moment for East Wall at Stage 19 – After installation of Station slabs and walls



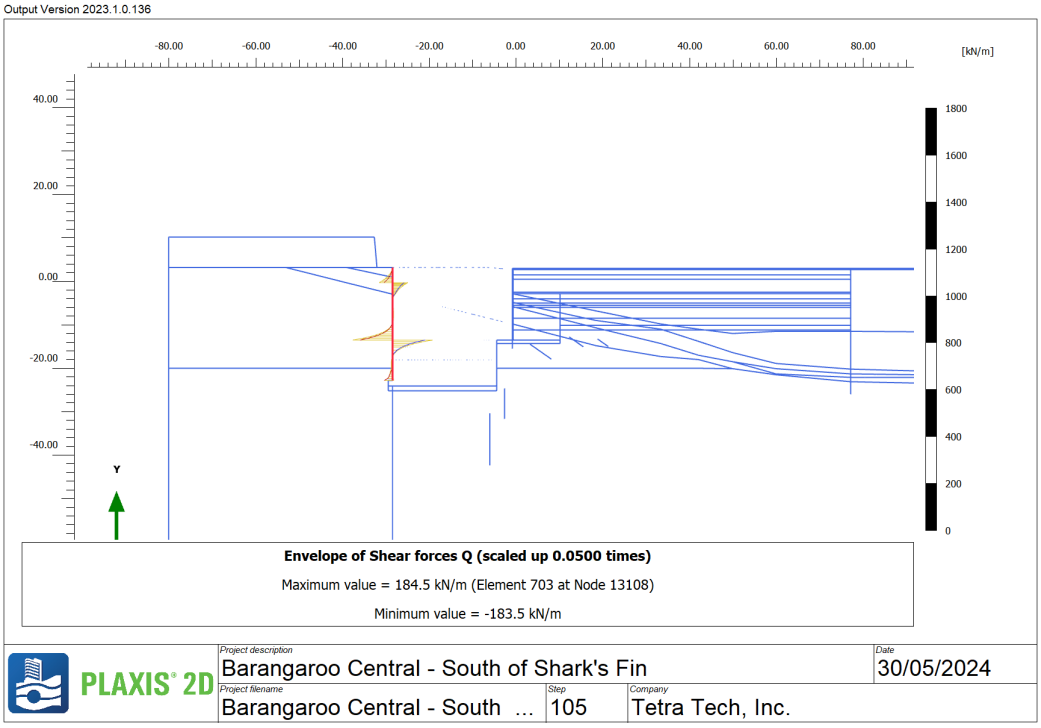
Shear Force for East Wall at Stage 19 – After installation of Station slabs and walls



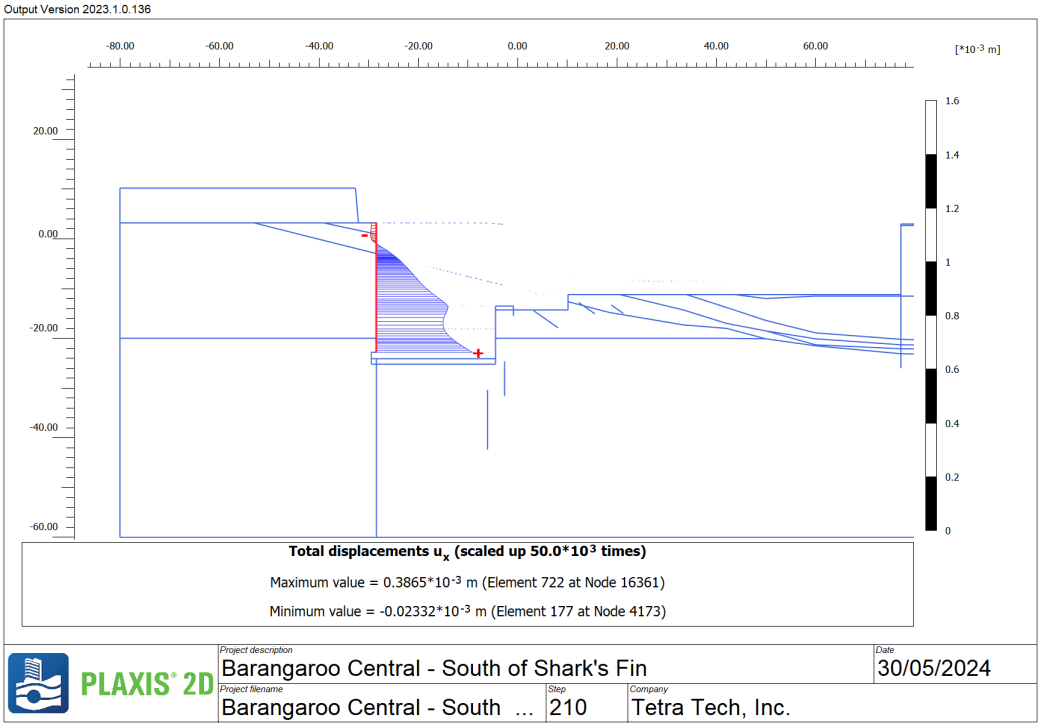
Lateral Displacement for East Wall at Stage 20 – GWL at RL -15 for Station and RL -11 West of station



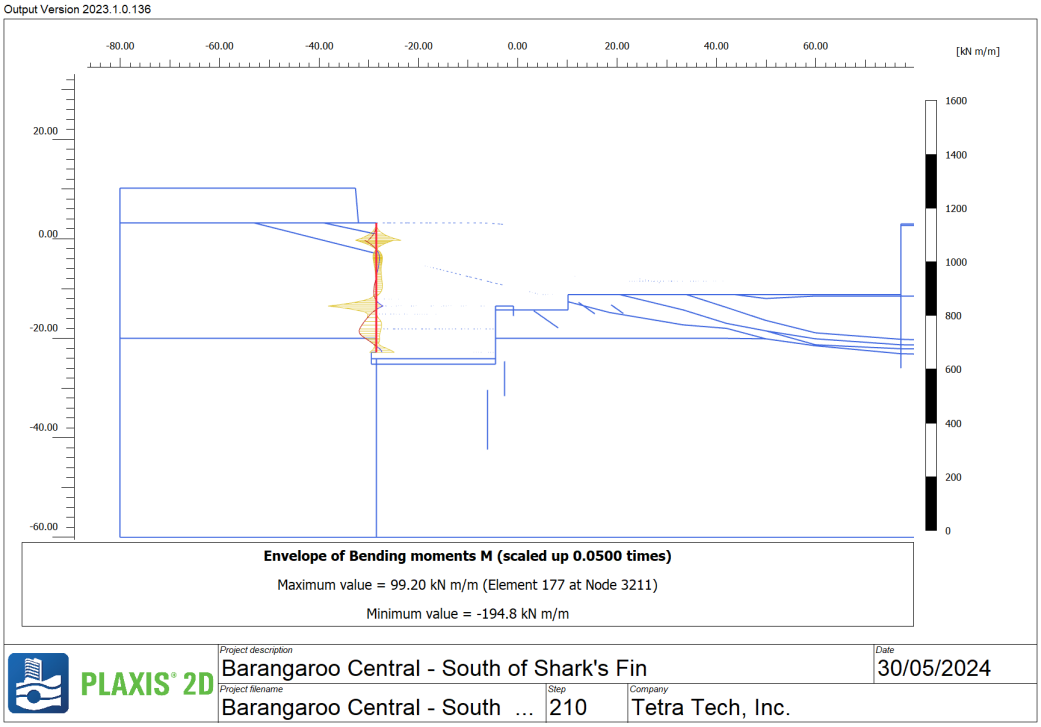
Bending Moment for East Wall at Stage 20 – GWL at RL -15 for Station and RL -11 West of station



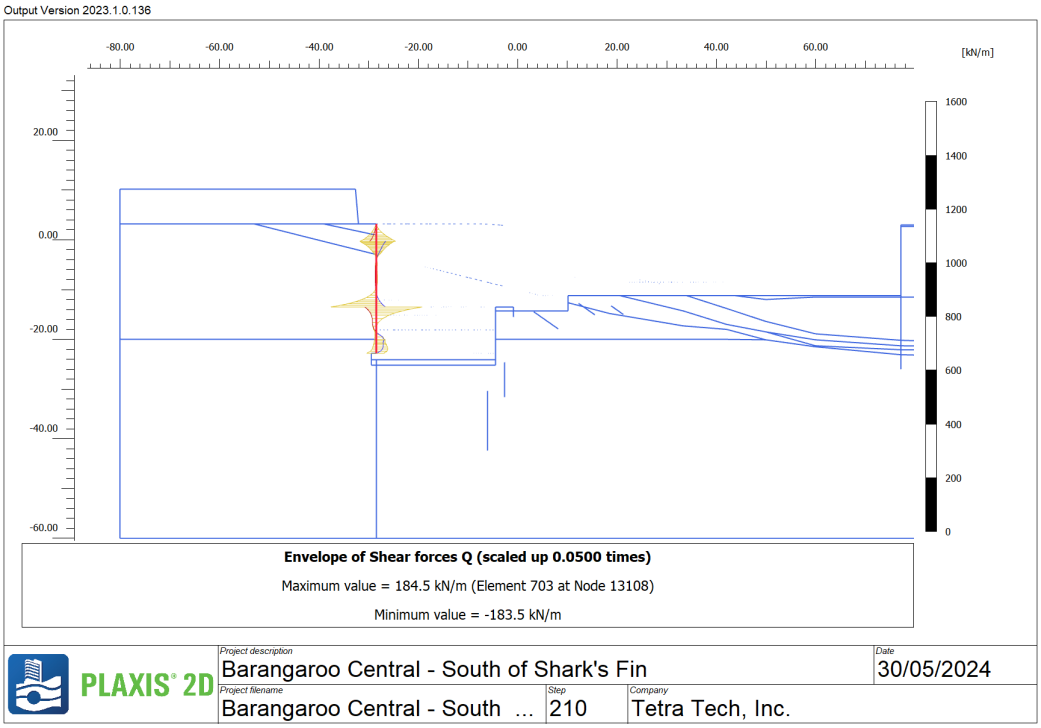
Shear Force for East Wall at Stage 20 – GWL at RL -15 for Station and RL -11 West of station



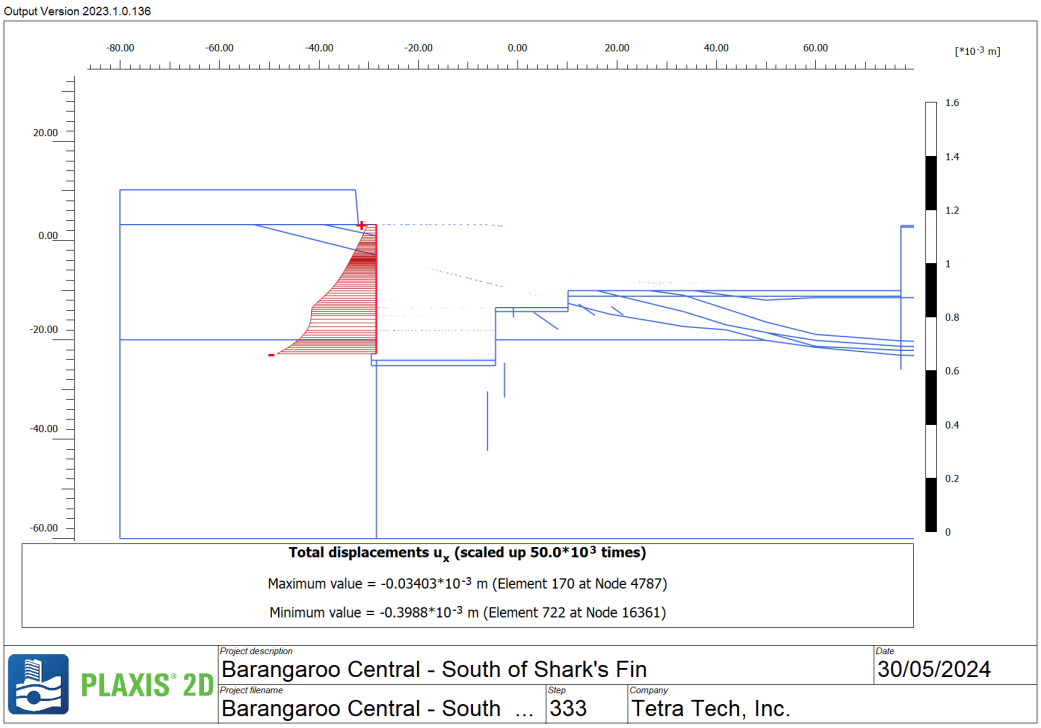
Lateral Displacement for East Wall at Stage 33 – Excavate CBD to BEL at RL -14.3 and RL -11.2



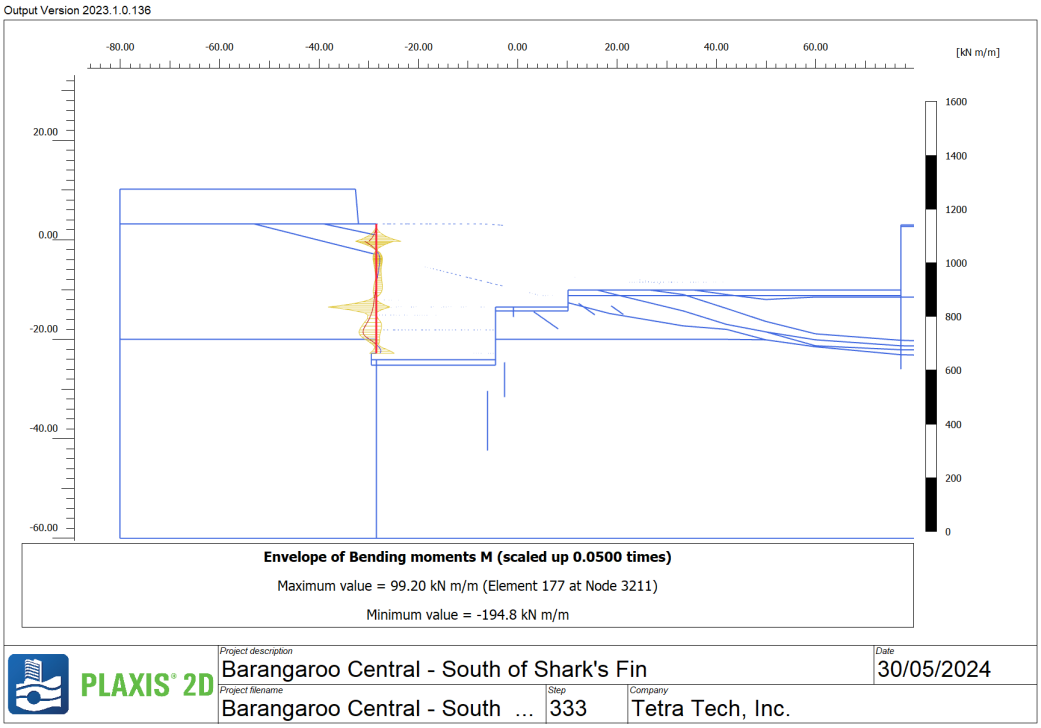
Bending Moment for East Wall at Stage 33 – Excavate CBD to BEL at RL -14.3 and RL -11.2



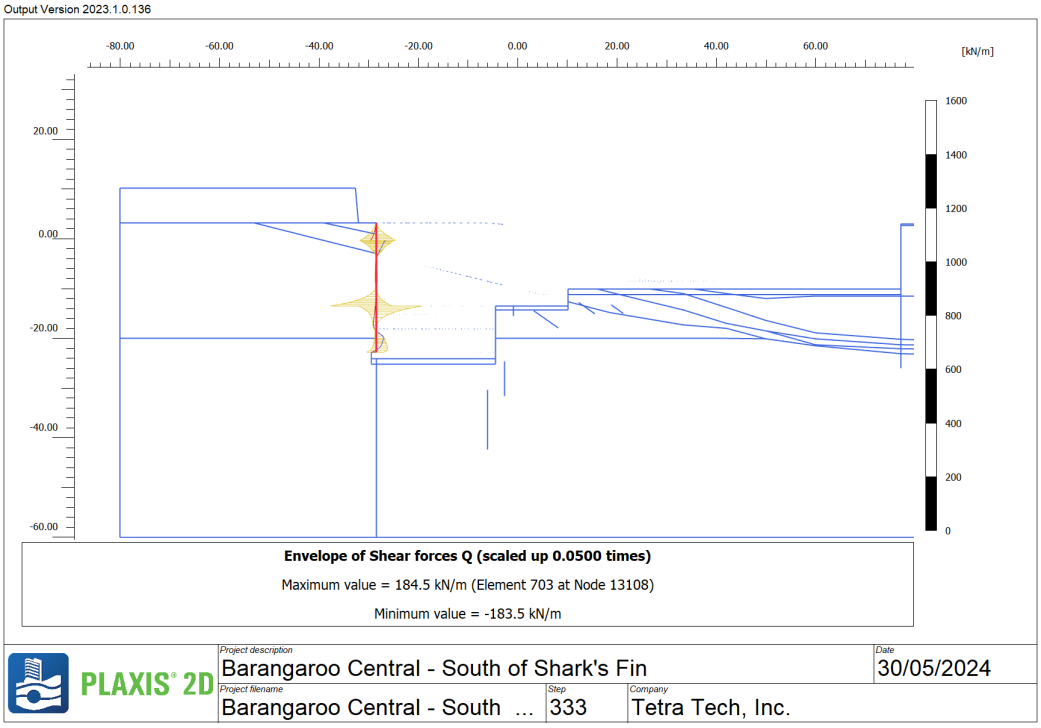
Shear Force for East Wall at Stage 33 – Excavate CBD to BEL at RL -14.3 and RL -11.2



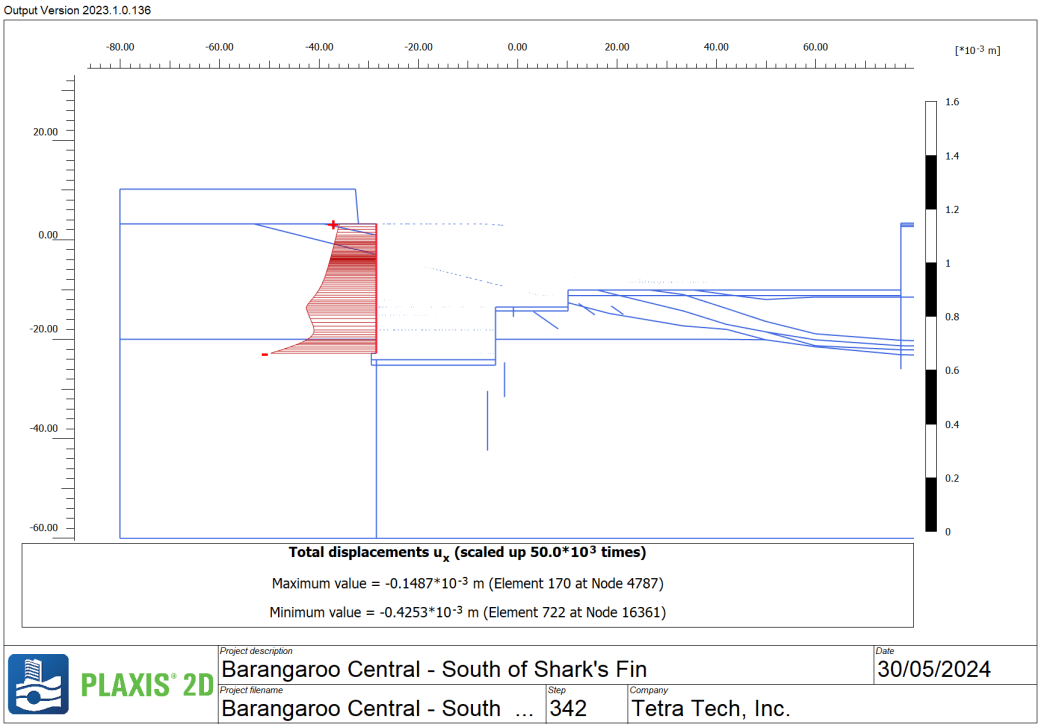
Lateral Displacement for East Wall at Stage 36 – After Installation of CBD slabs and walls



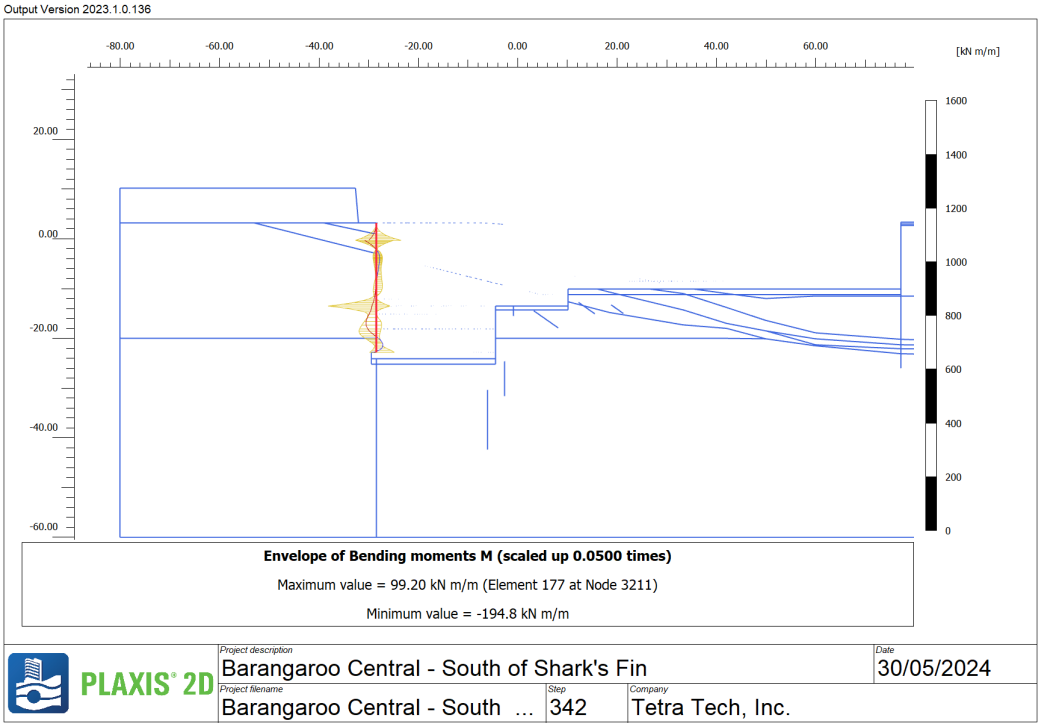
Bending Moment for East Wall at Stage 36 – After Installation of CBD slabs and walls



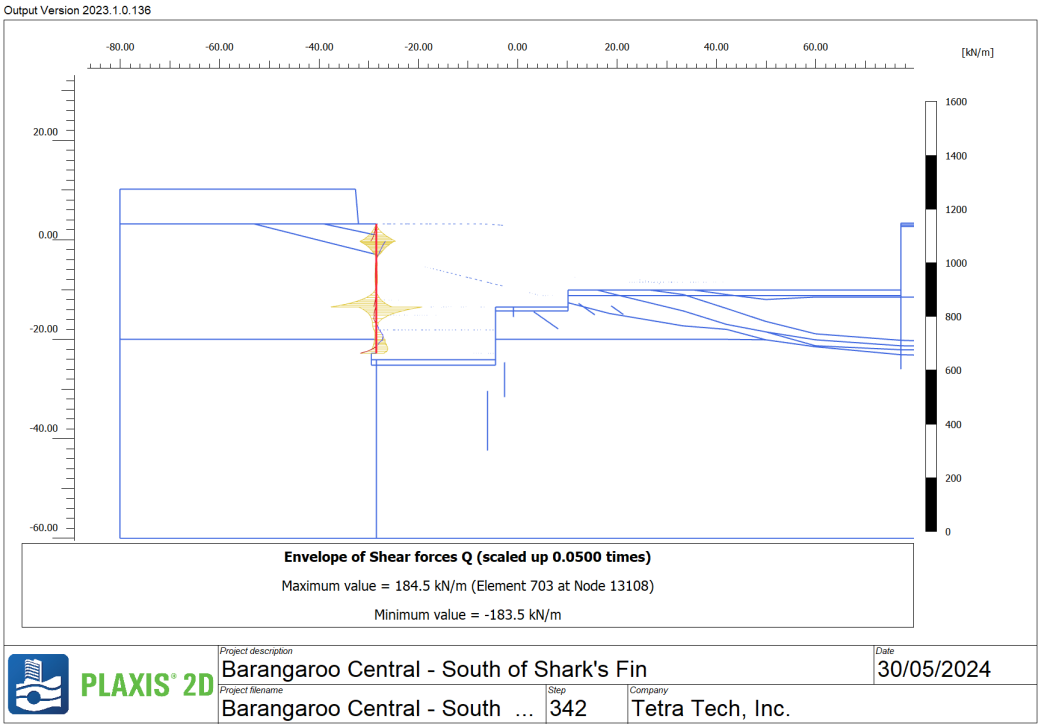
Shear Force for East Wall at Stage 36 – After Installation of CBD slabs and walls



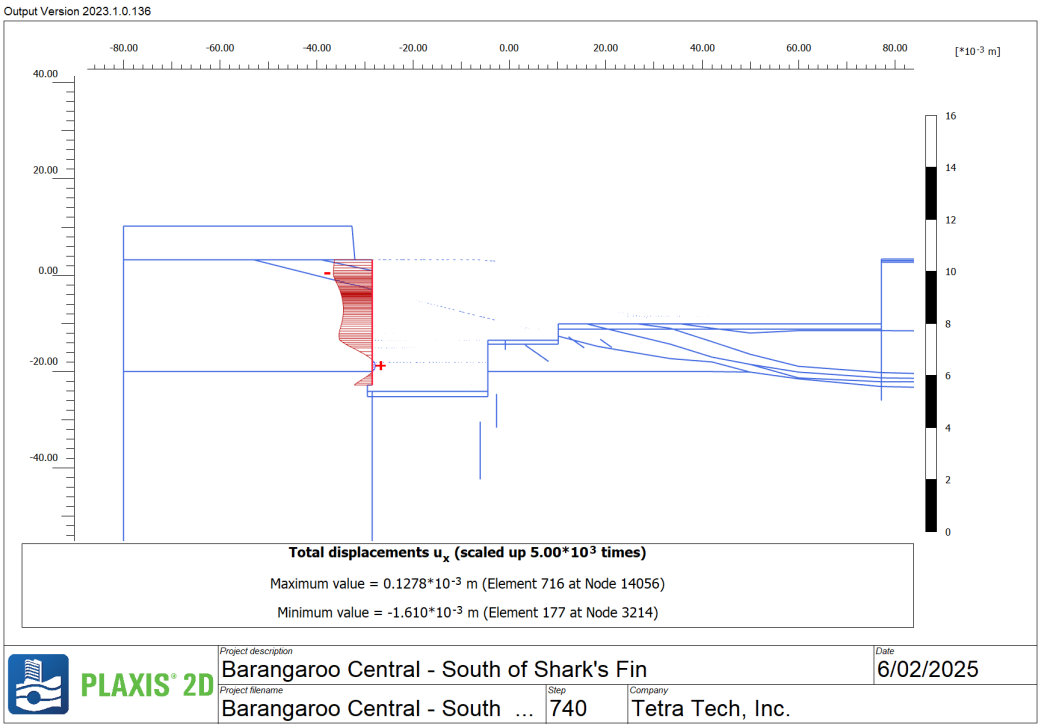
Lateral Displacement for East Wall at Stage 37 – GWL at RL-11 for Station and RL -15 for CBD



Bending Moment for East Wall at Stage 37 – GWL at RL-11 for Station and RL -15 for CBD

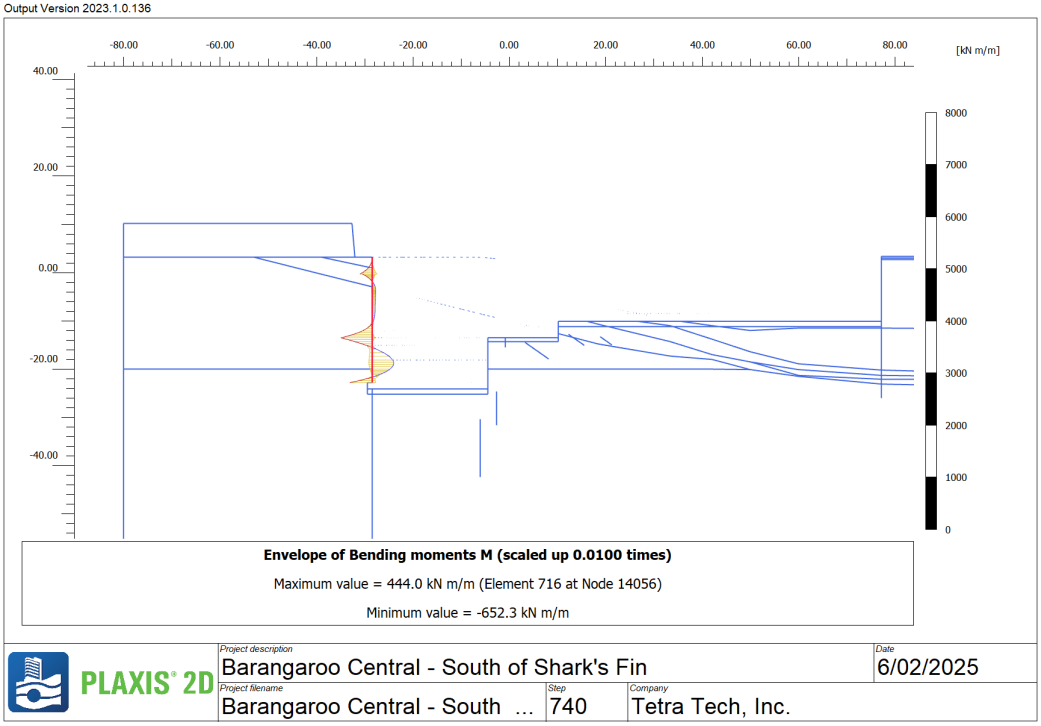


Shear Force for East Wall at Stage 37 – GWL at RL-11 for Station and RL -15 for CBD



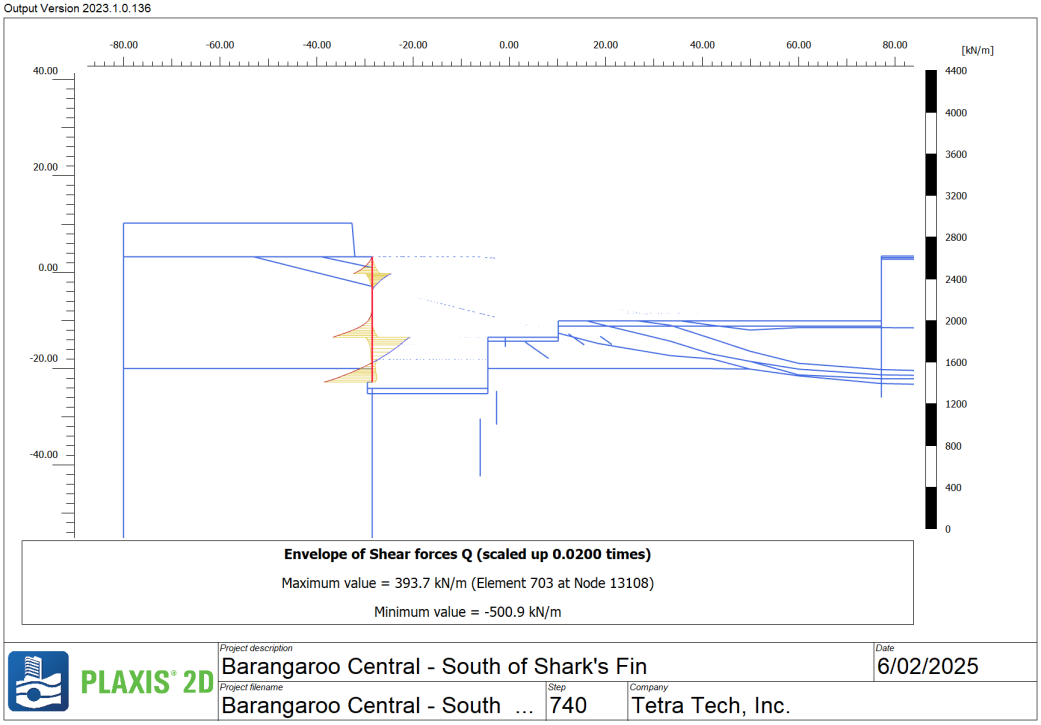
Lateral Displacement for East Wall for GWL Case 1 - GWL at RL 1.5

Output Version 2023.1.0.136

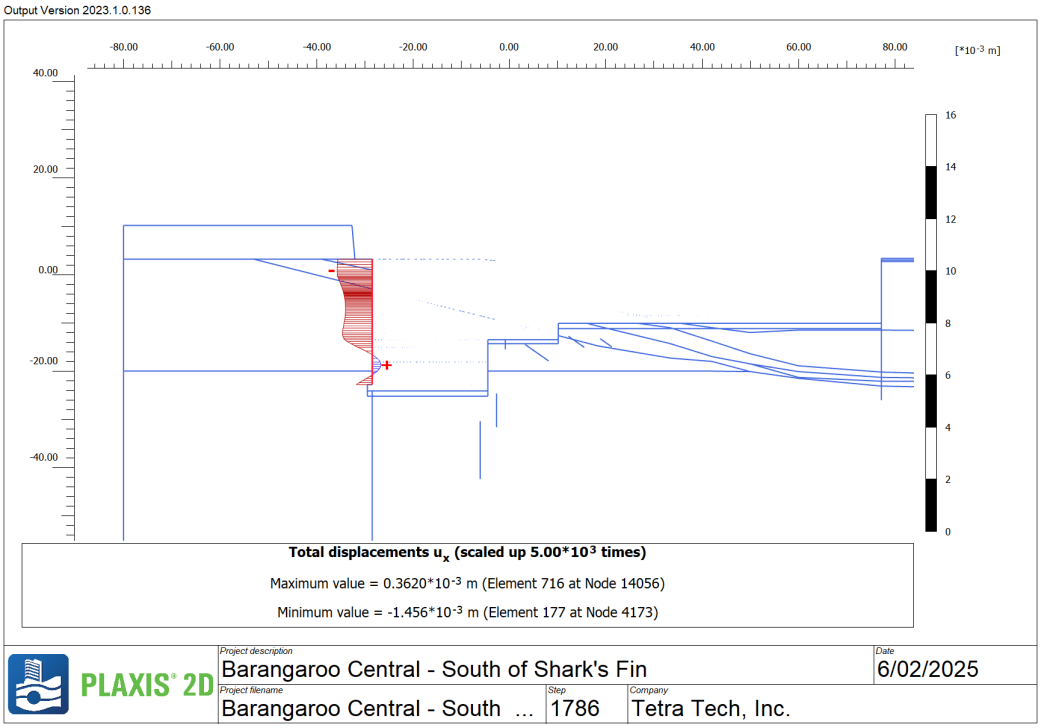


Bending Moment for East Wall for GWL Case 1 - GWL at RL 1.5

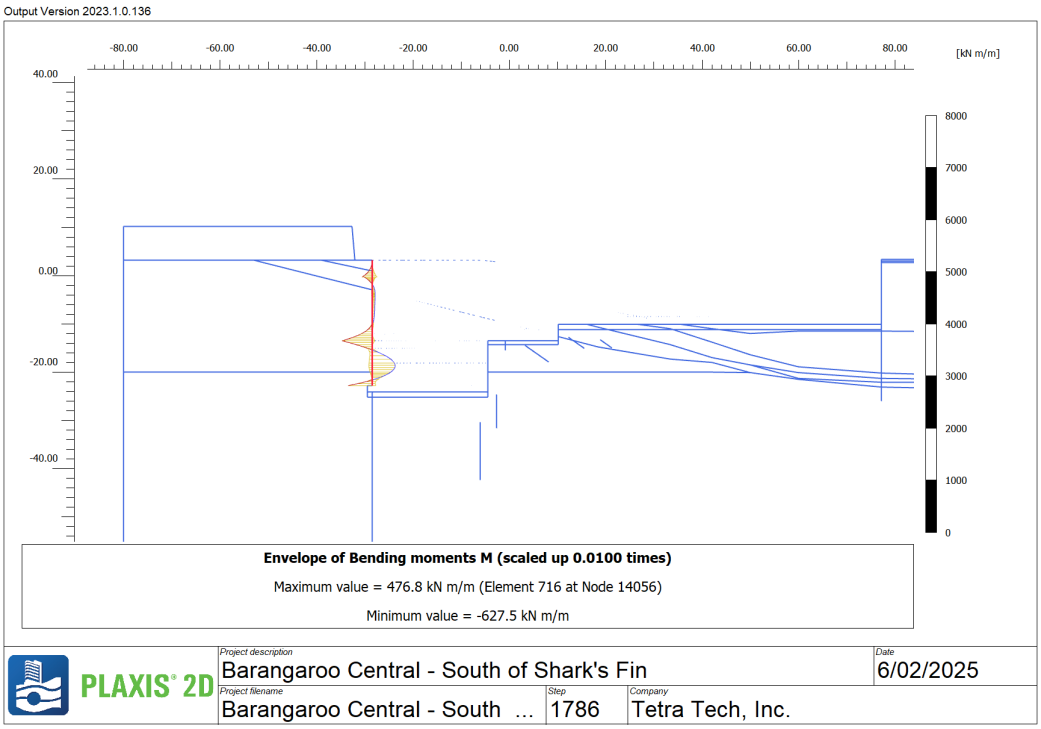
Output Version 2023.1.0.136



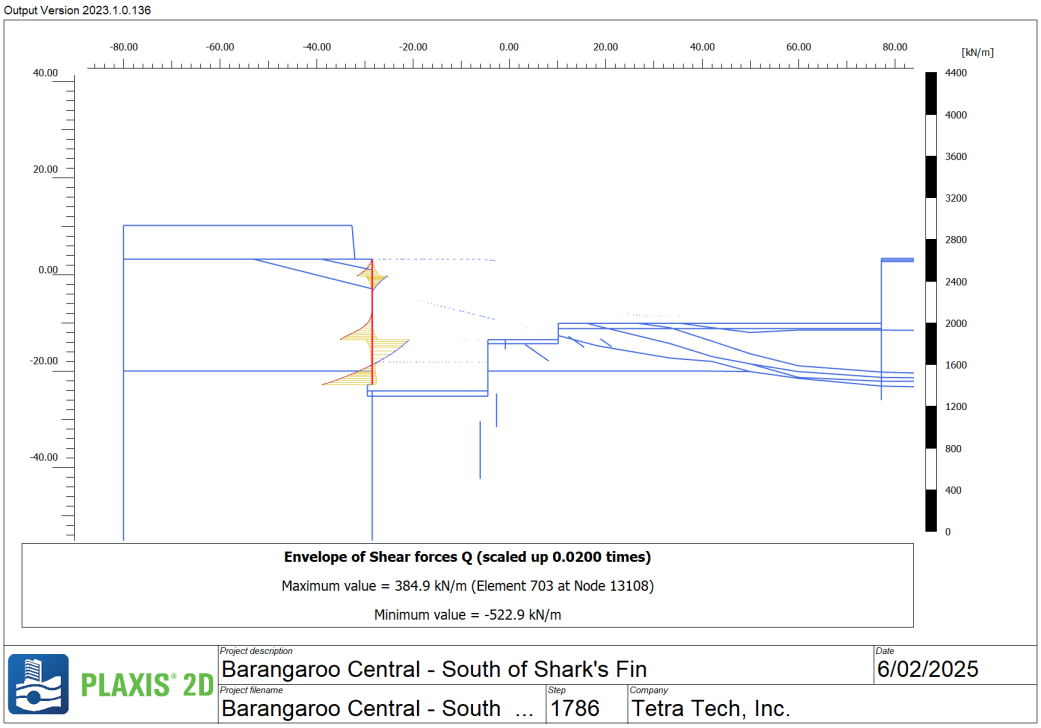
Shear Force for East Wall for GWL Case 1 - GWL at RL 1.5



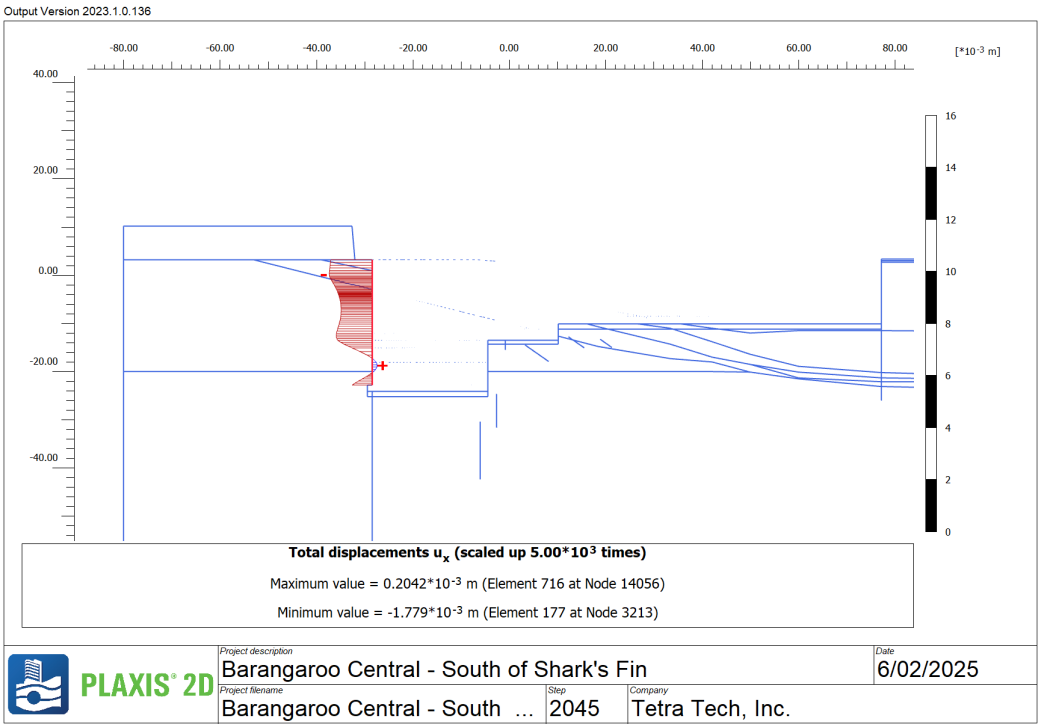
Lateral Displacement for East Wall for GWL Case 2 - GWL at RL 1.5 at landward side and RL 0.5 at seaward side



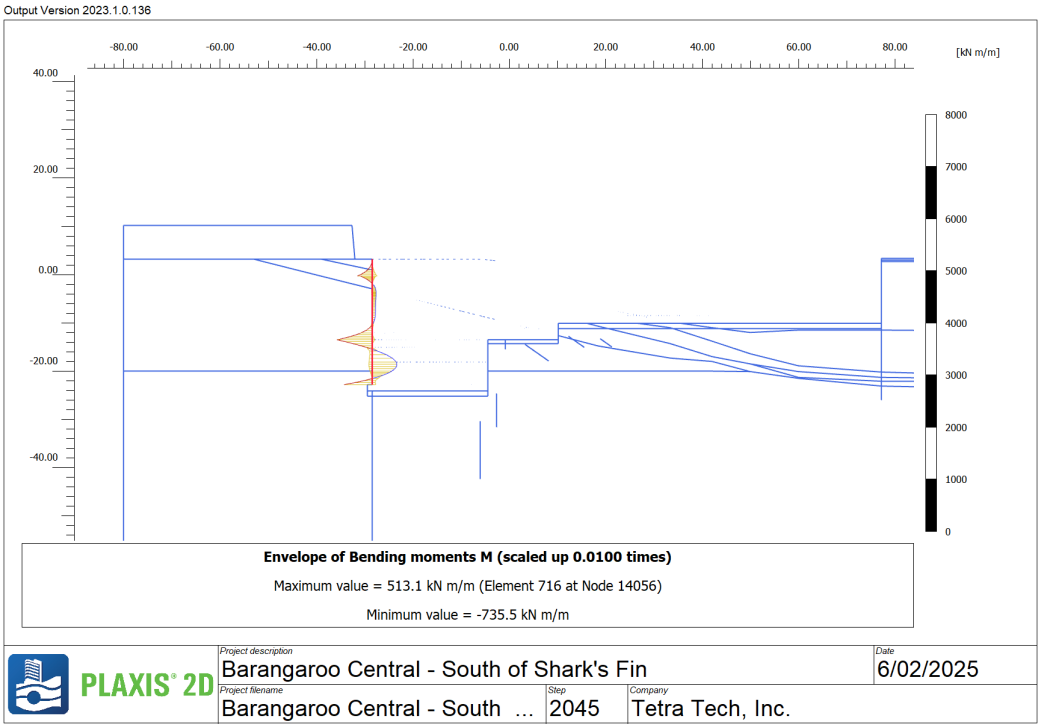
Bending Moment for East Wall for GWL Case 2 - GWL at RL 1.5 at landward side and RL 0.5 at seaward side



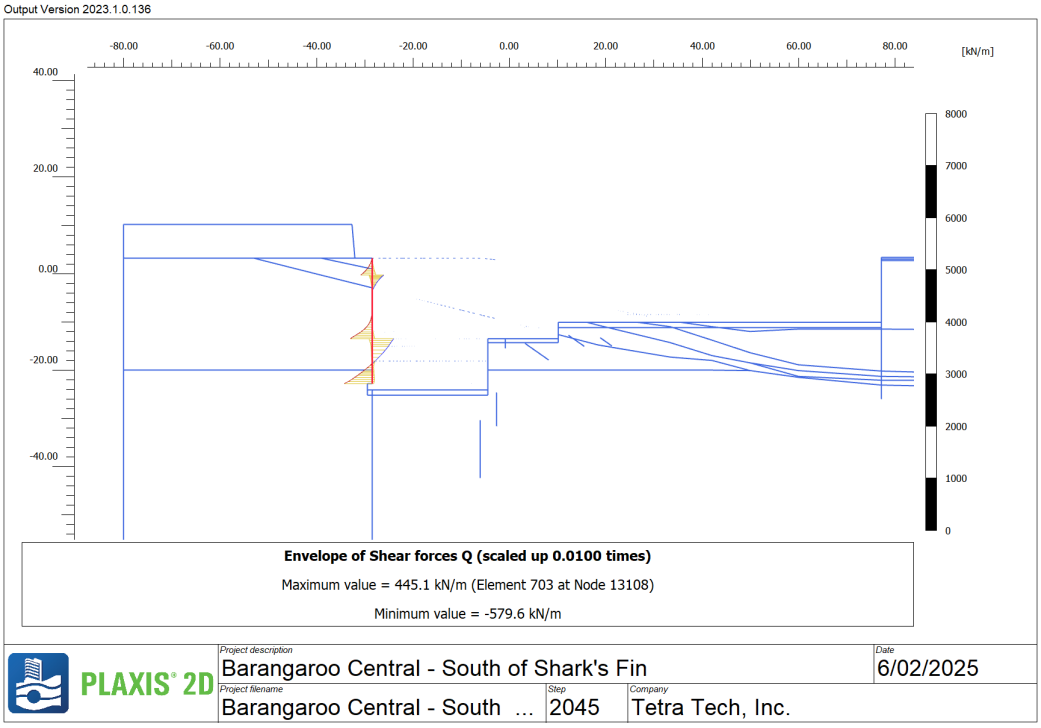
Shear Force for East Wall for GWL Case 2 - GWL at RL 1.5 at landward side and RL 0.5 at seaward side



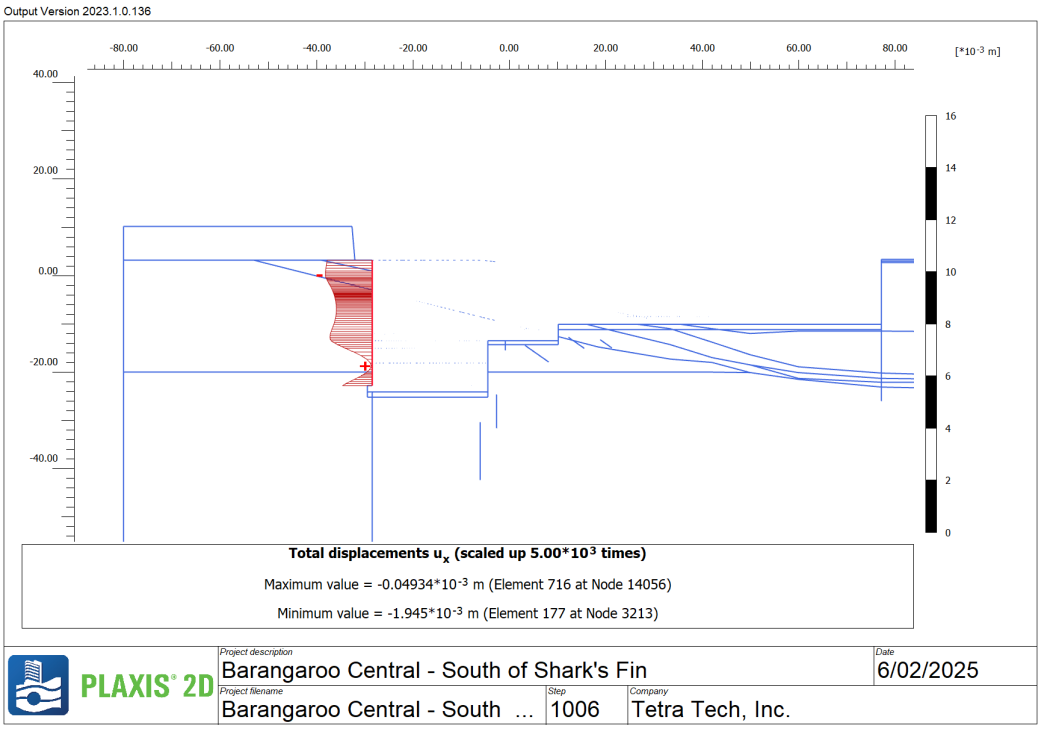
Lateral Displacement for East Wall for GWL Case 3 - GWL at RL 2.575



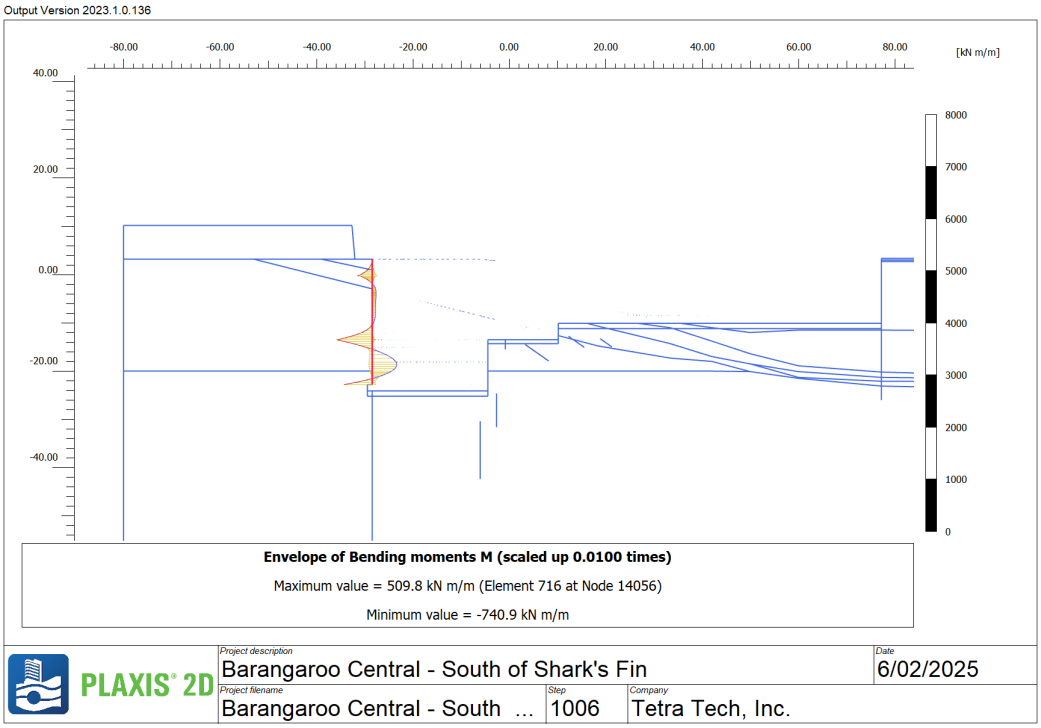
Bending Moment for East Wall for GWL Case 3 - GWL at RL 2.575



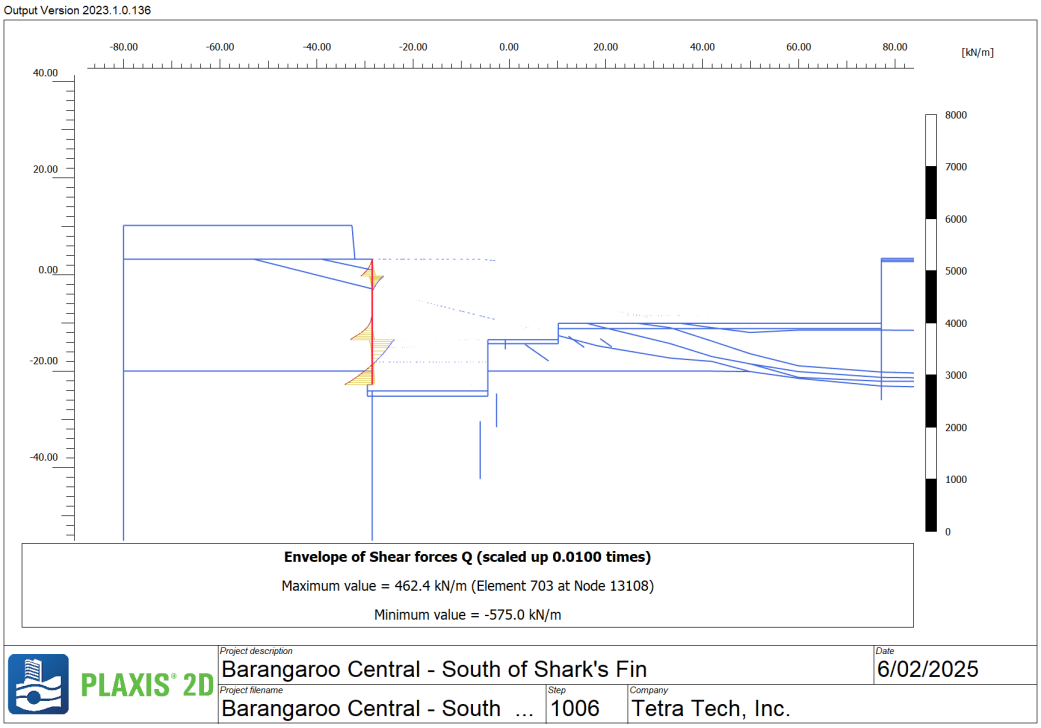
Shear Force for East Wall for GWL Case 3 - GWL at RL 2.575



Lateral Displacement for East Wall for GWL Case 4 - GWL at RL 2.575 at seaward side and RL 1.575 at landward side

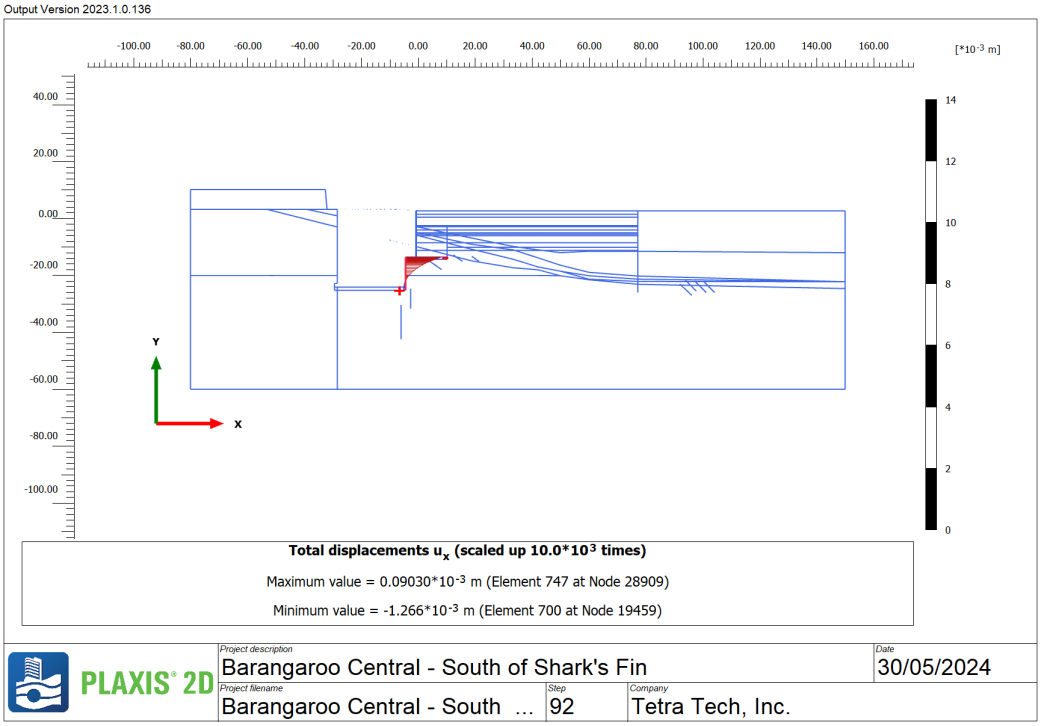


Bending Moment for East Wall for GWL Case 4 - GWL at RL 2.575 at seaward side and RL 1.575 at landward side

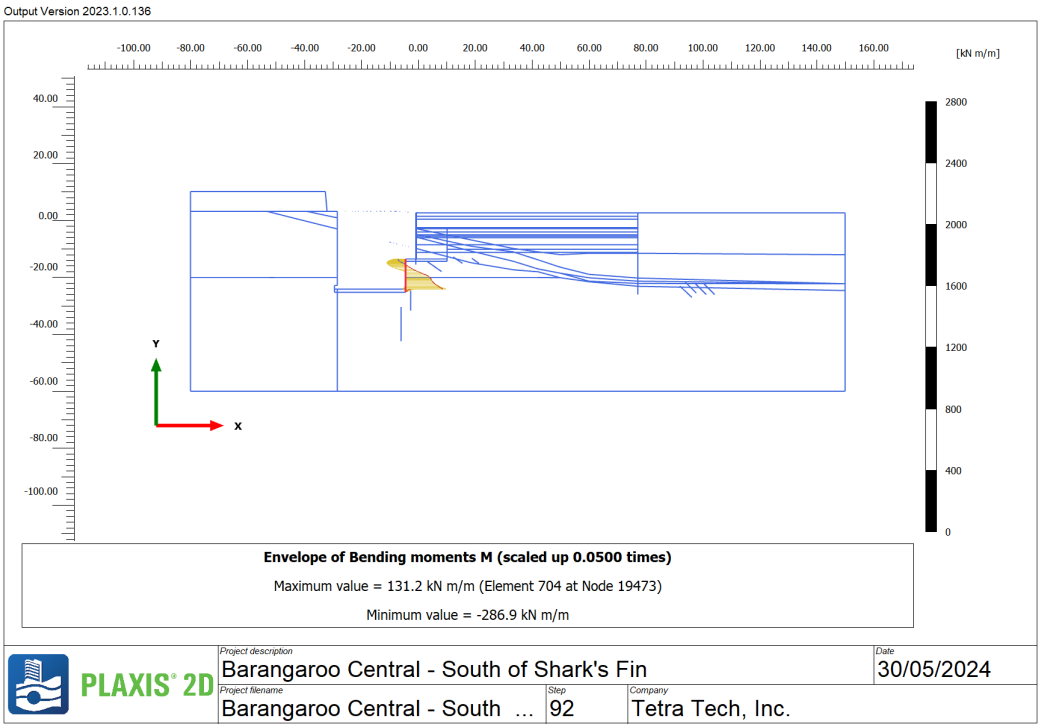


Shear Force for East Wall for GWL Case 4 - GWL at RL 2.575 at seaward side and RL 1.575 at landward side

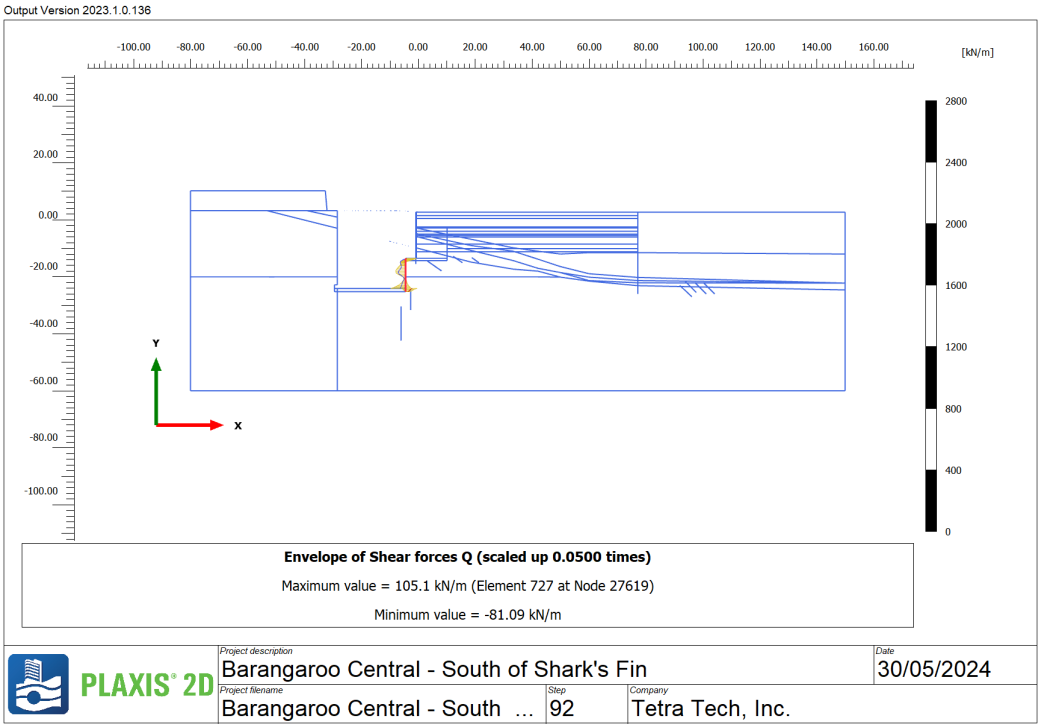
C. West Wall



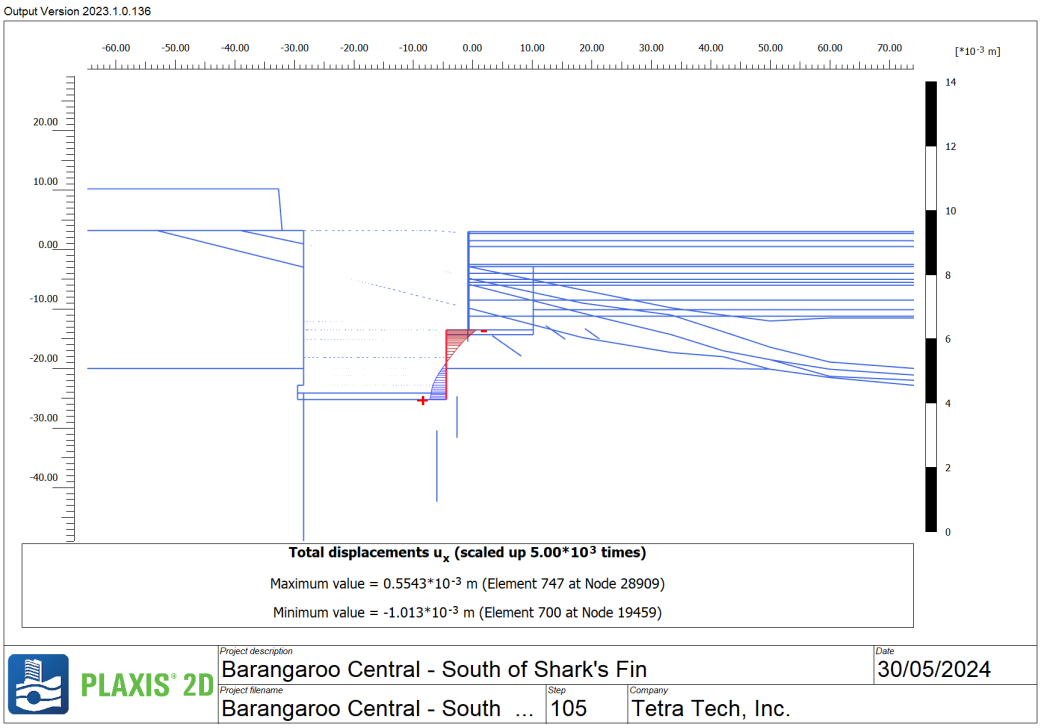
Lateral Displacement for West Wall at Stage 19 – After installation of Station slabs and walls



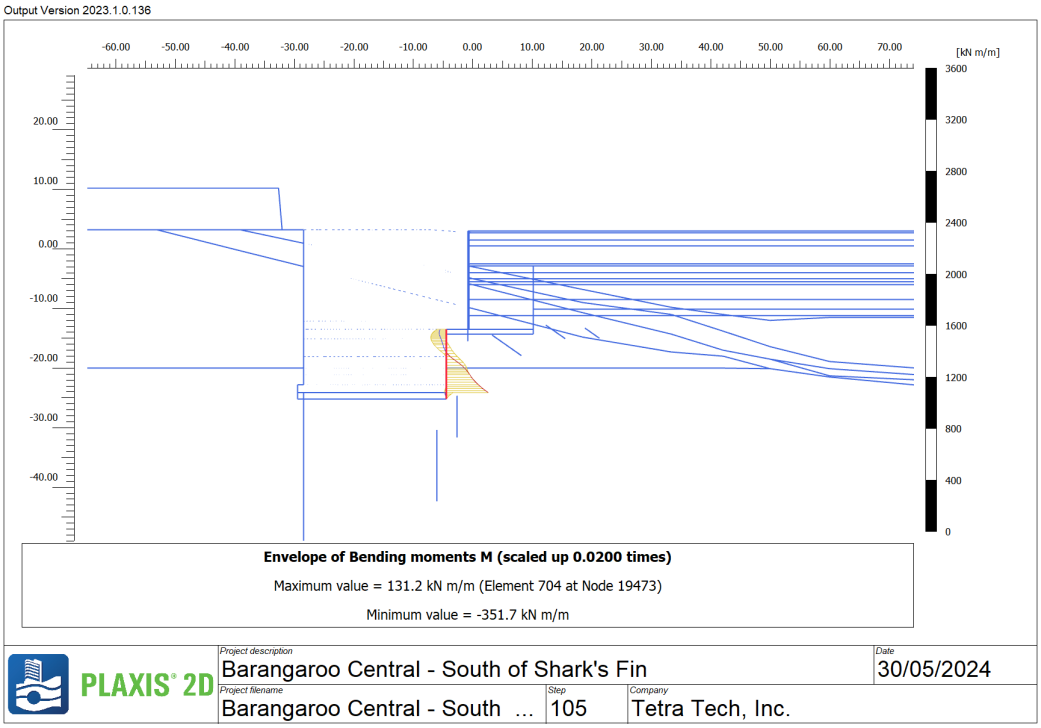
Bending Moment for West Wall at Stage 19 – After installation of Station slabs and walls



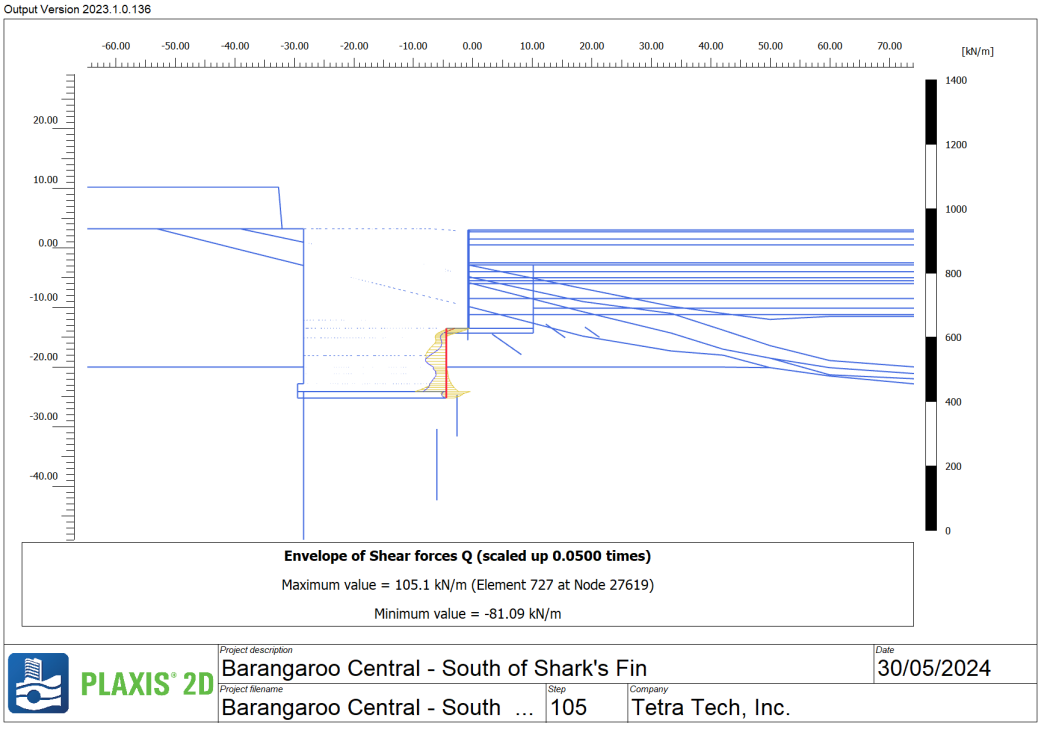
Shear Force for West Wall at Stage 19 – After installation of Station slabs and walls



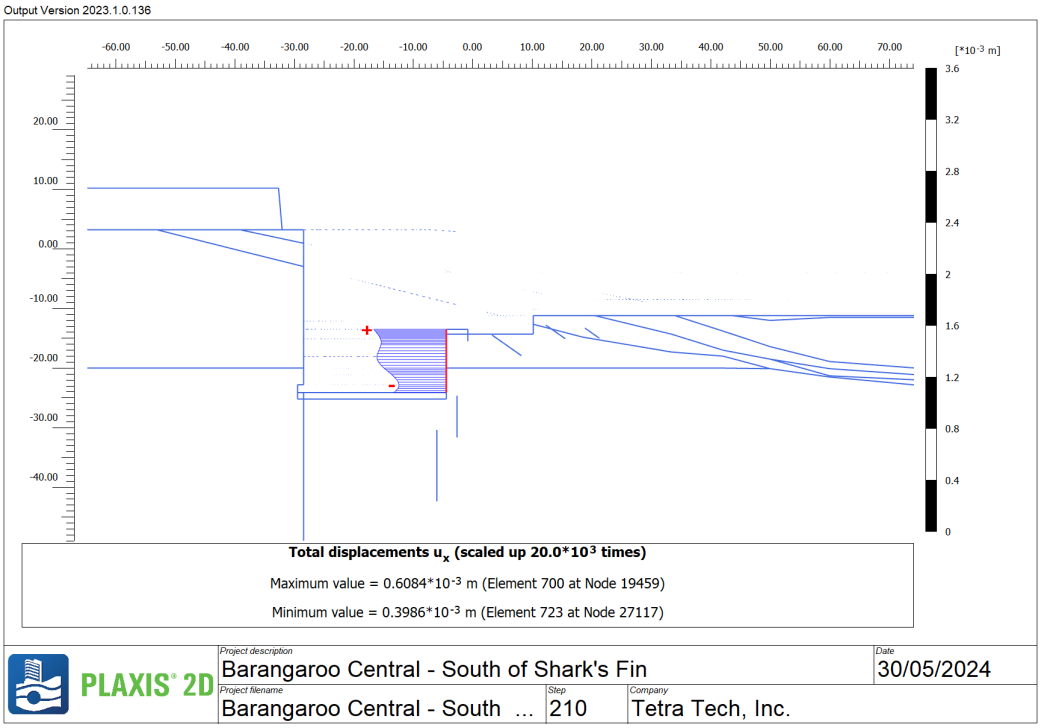
Lateral Displacement for West Wall at Stage 20 – GWL at RL -15 for Station and RL -11 West of station



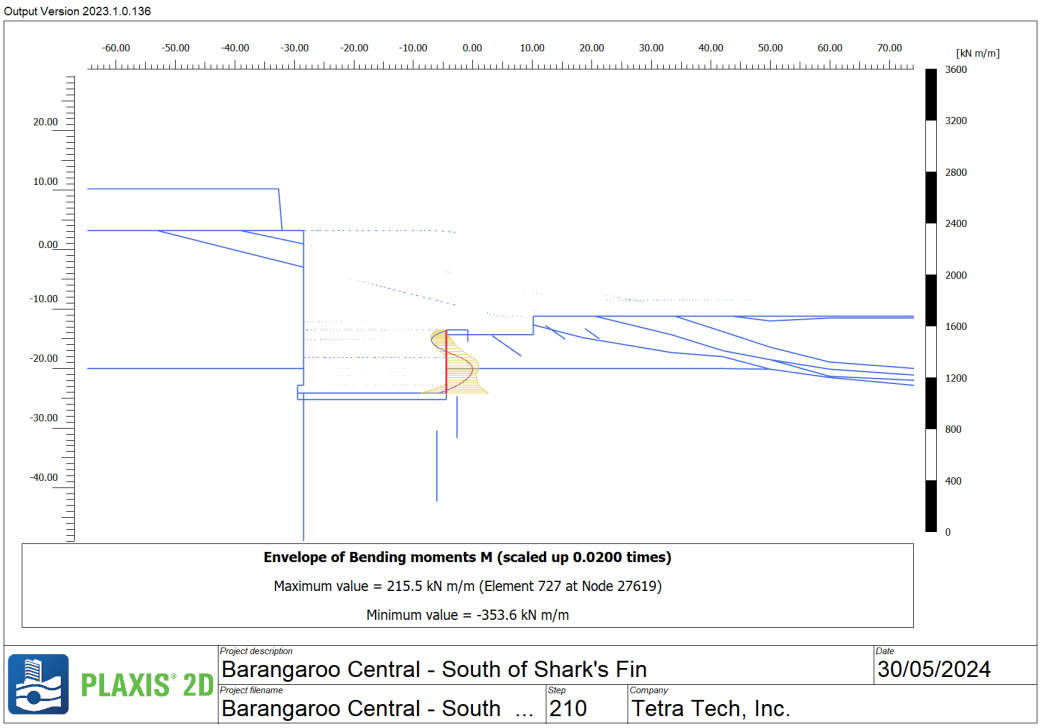
Bending Moment for West Wall at Stage 20 – GWL at RL -15 for Station and RL -11 West of station



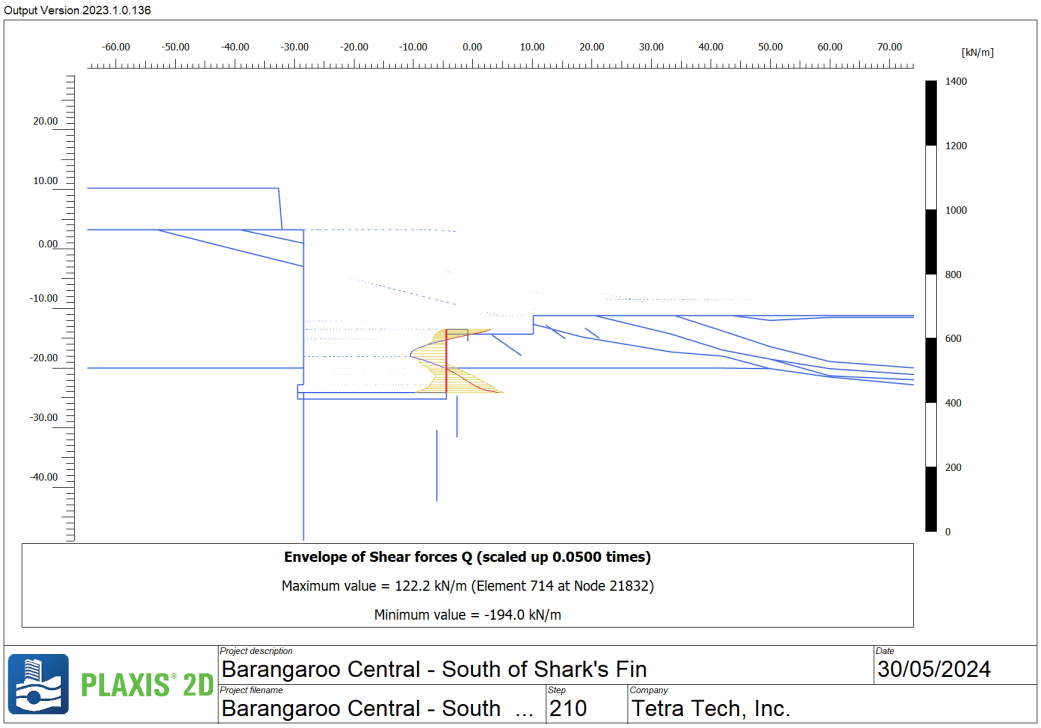
Shear Force for West Wall at Stage 20 – GWL at RL -15 for Station and RL -11 West of station



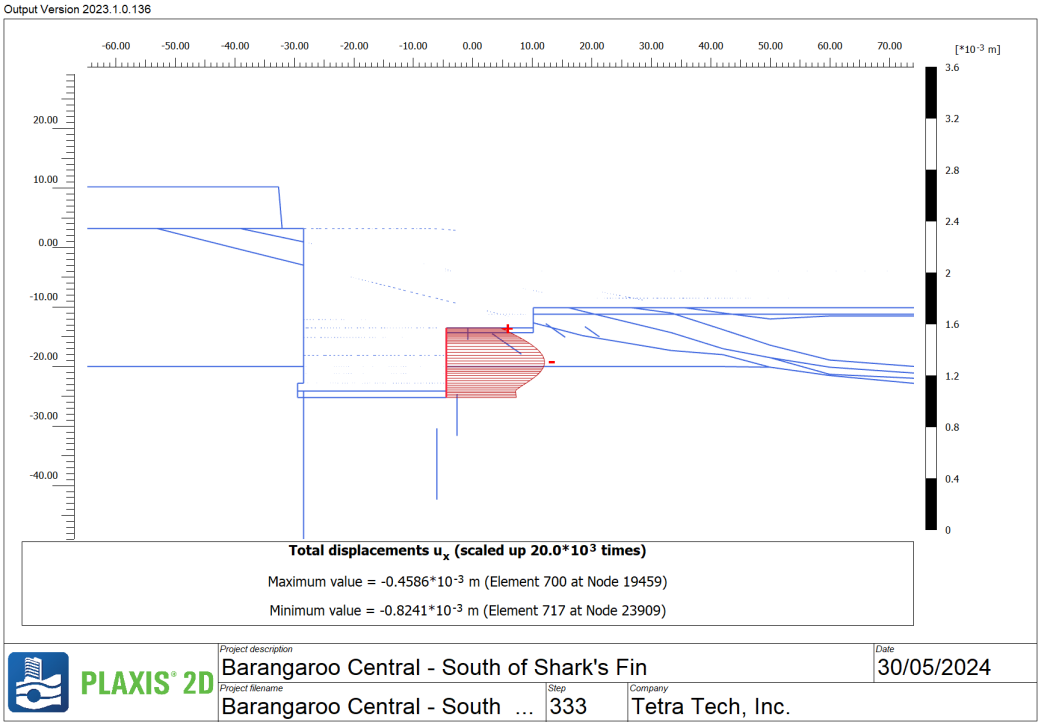
Lateral Displacement for West Wall at Stage 33 – Excavate CBD to BEL at RL -14.3 and RL -11.2



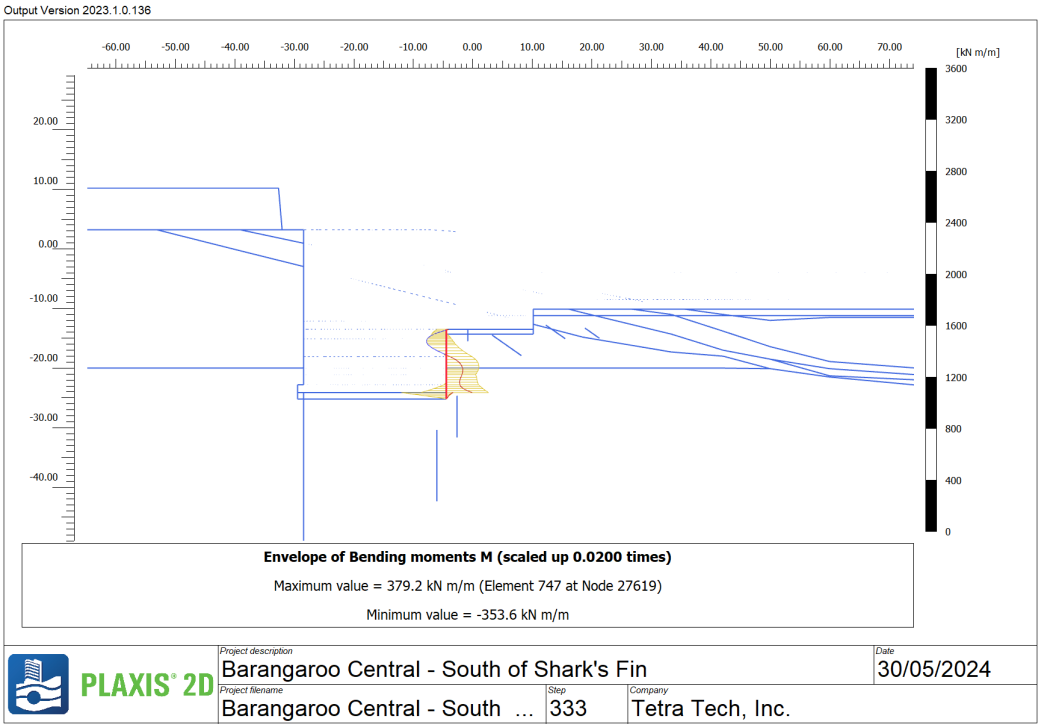
Bending Moment for West Wall at Stage 33 – Excavate CBD to BEL at RL -14.3 and RL -11.2



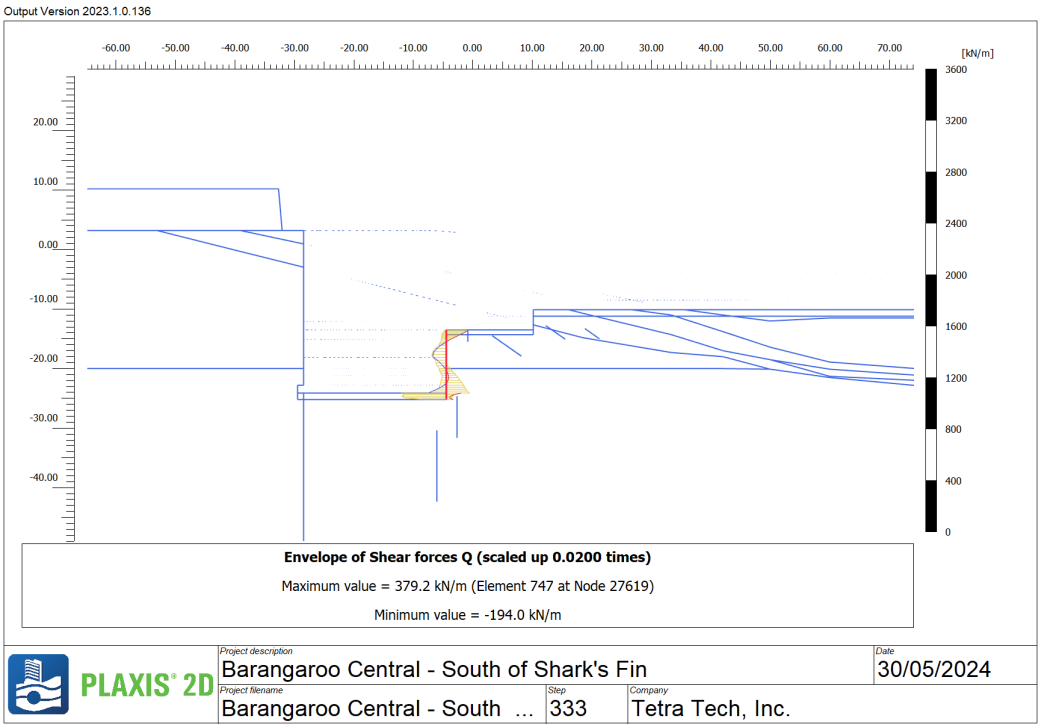
Shear Force for West Wall at Stage 33 – Excavate CBD to BEL at RL RL -14.3 and RL -11.2



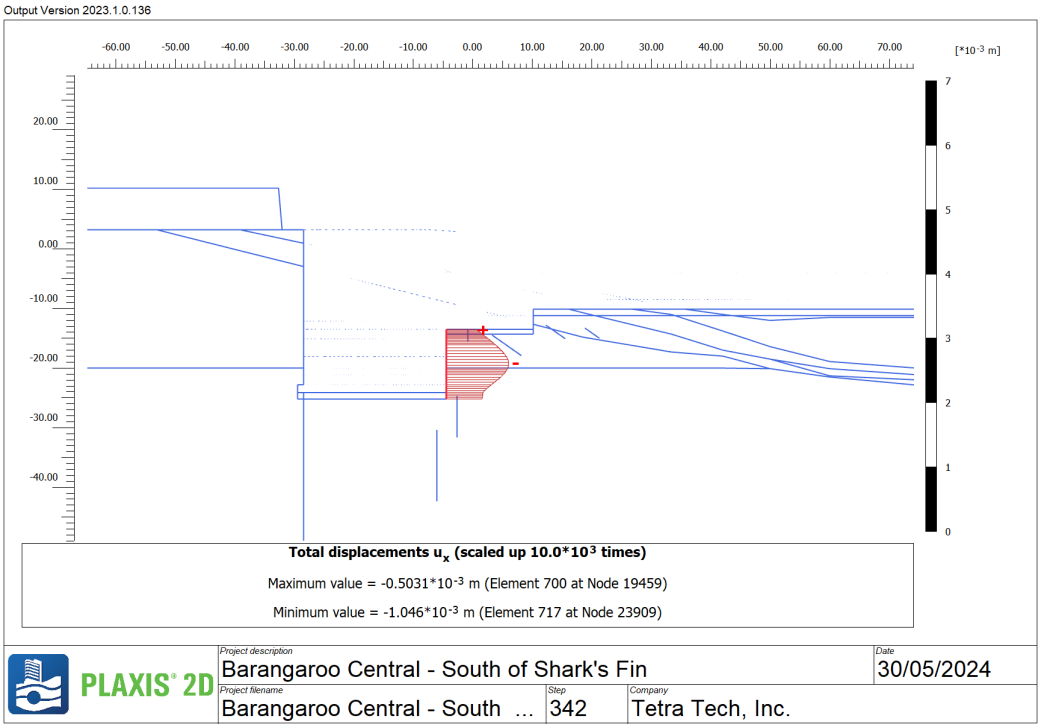
Lateral Displacement for West Wall at Stage 36 – After Installation of CBD slabs and walls



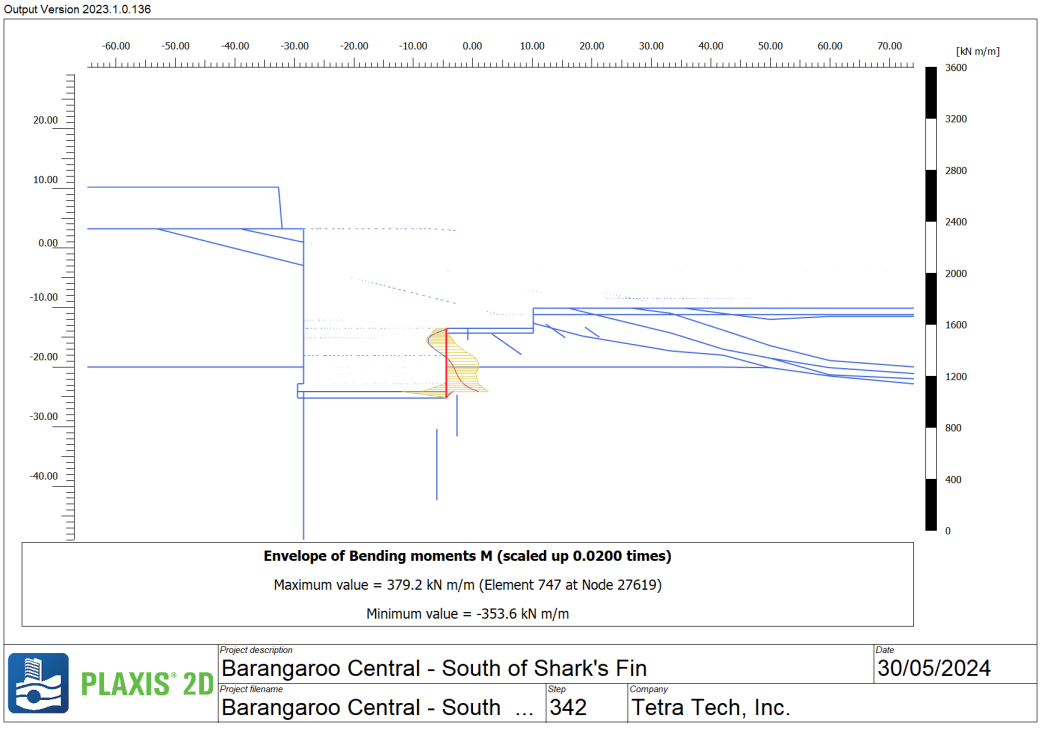
Bending Moment for West Wall at Stage 36 – After Installation of CBD slabs and walls



Shear Force for West Wall at Stage 36 – After Installation of CBD slabs and walls

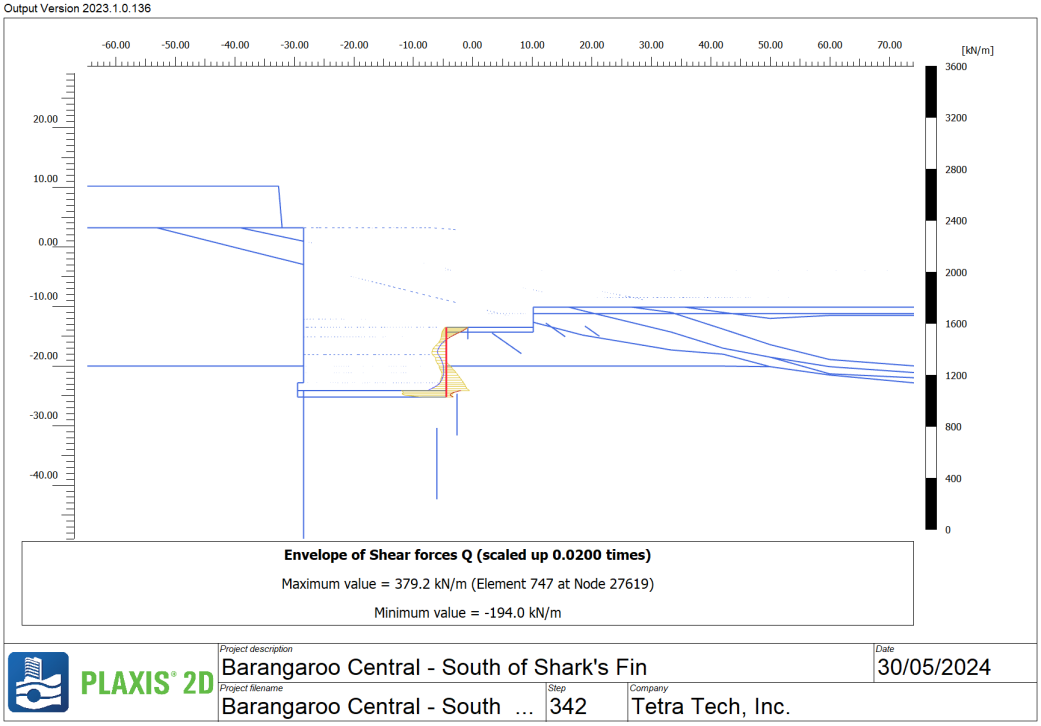


Lateral Displacement for West Wall at Stage 37 – GWL at RL-10 for Station and RL -11.2 for CBD



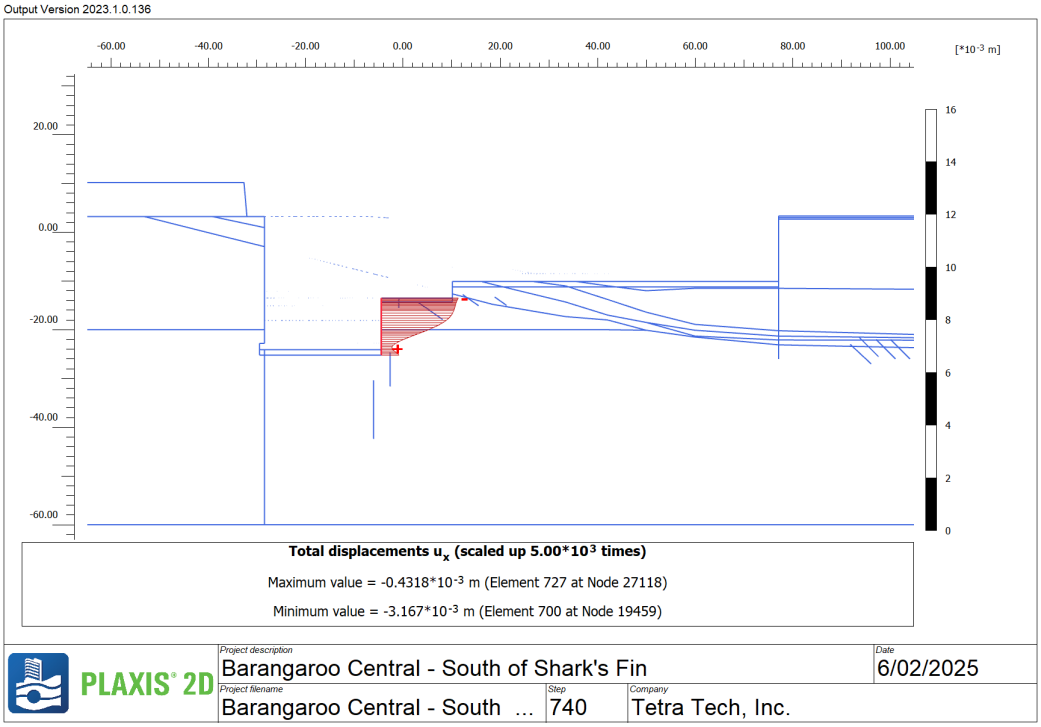
Bending Moment for West Wall at Stage 37 – GWL at RL-10 for Station and RL -11.2 for CBD

Output Version 2023.1.0.136



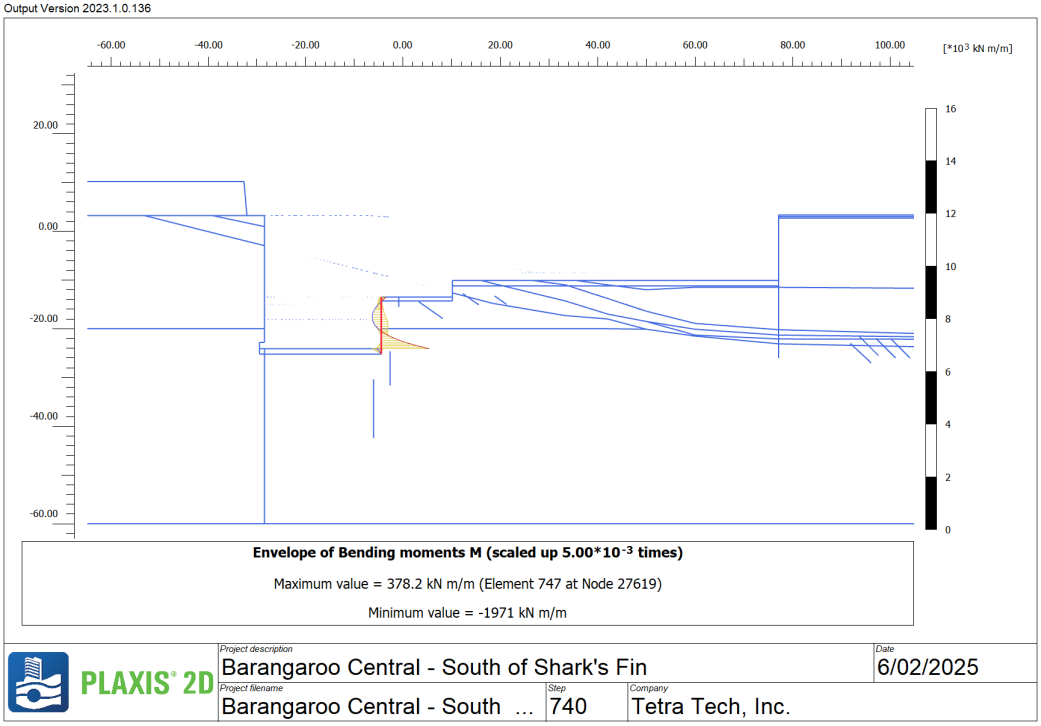
Shear Force for West Wall at Stage 37 – GWL at RL-10 for Station and RL -11.2 for CBD

Output Version 2023.1.0.136



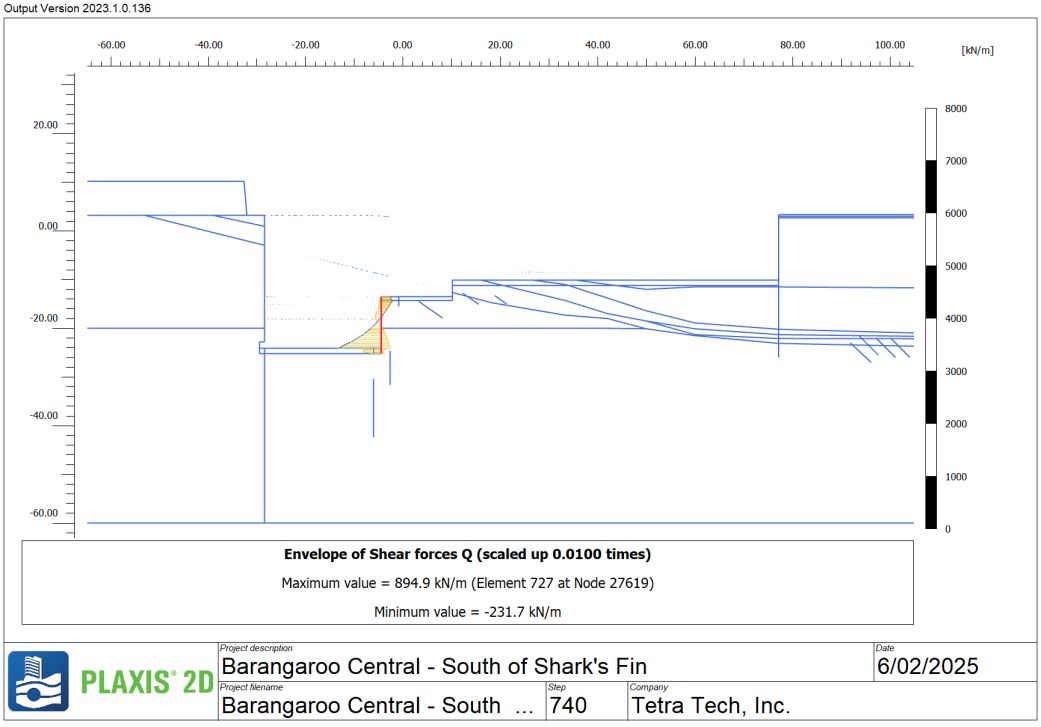
Lateral Displacement for West Wall for GWL Case 1 - GWL at RL 1.5

Output Version 2023.1.0.136

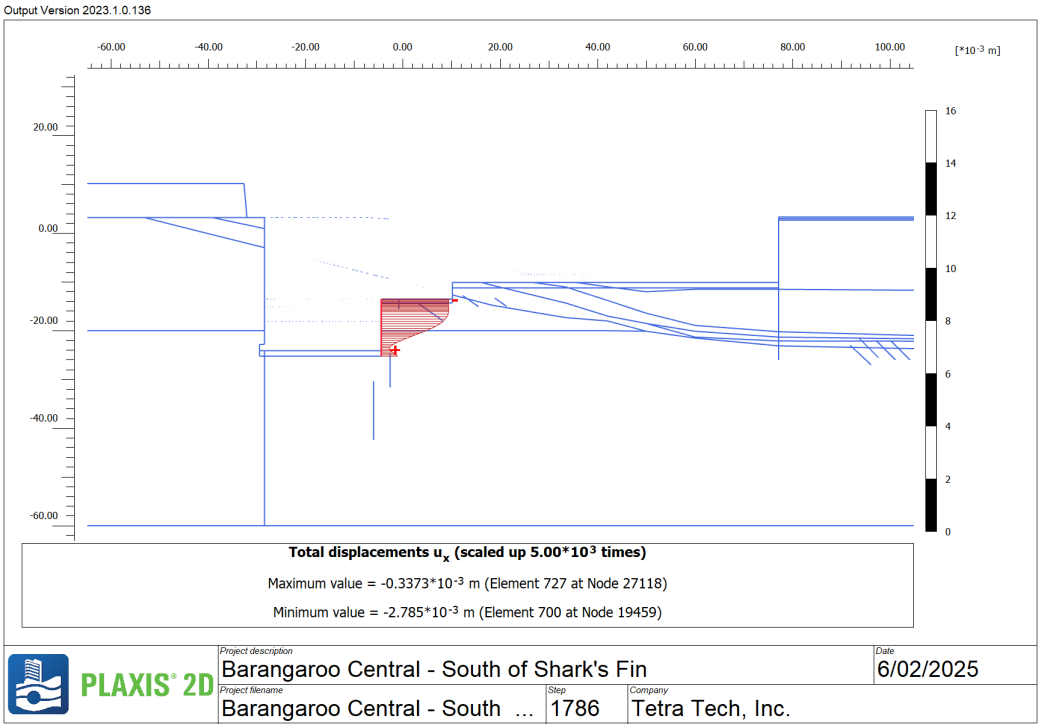


Bending Moment for West Wall for GWL Case 1 - GWL at RL 1.5

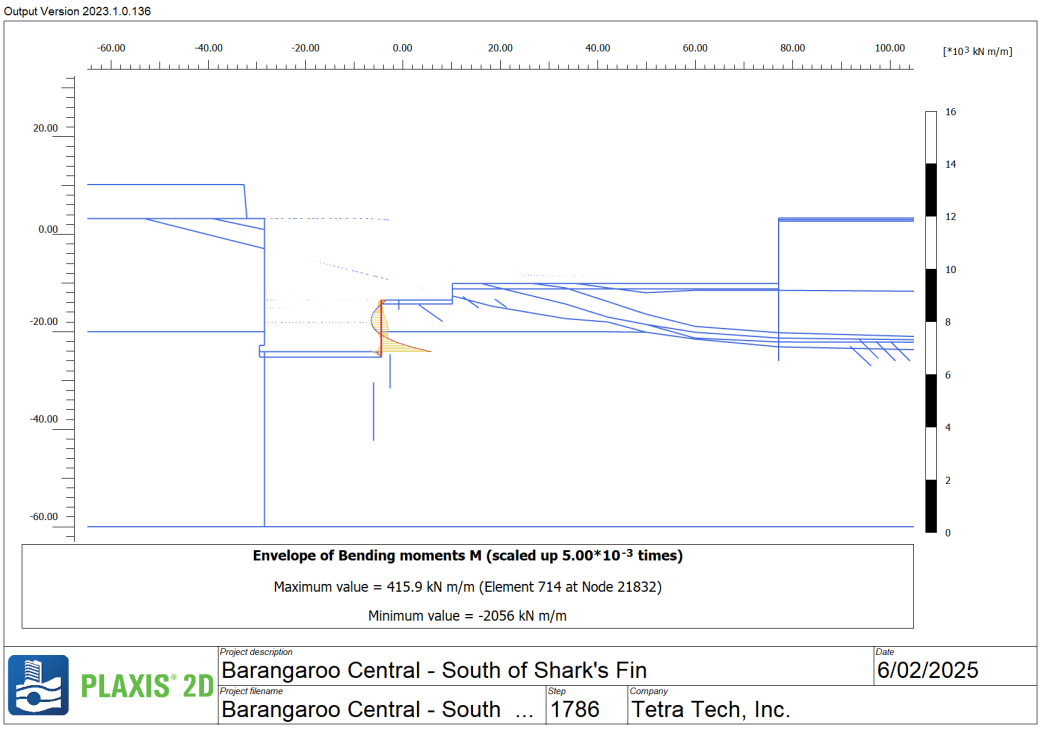
Output Version 2023.1.0.136



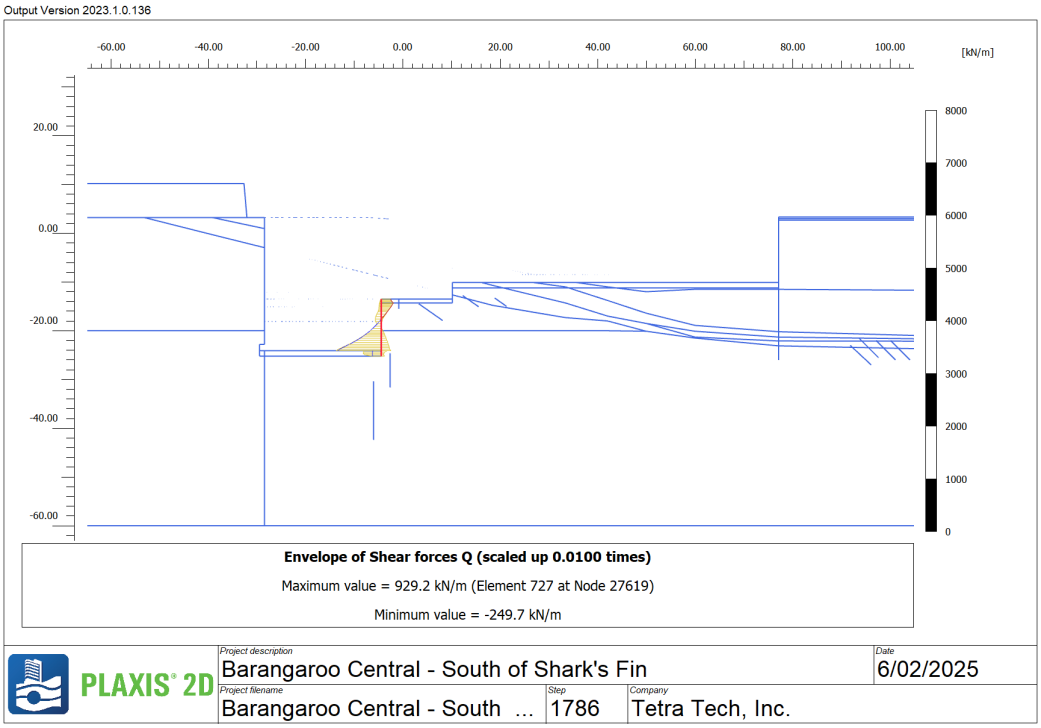
Shear Force for West Wall for GWL Case 1 - GWL at RL 1.5



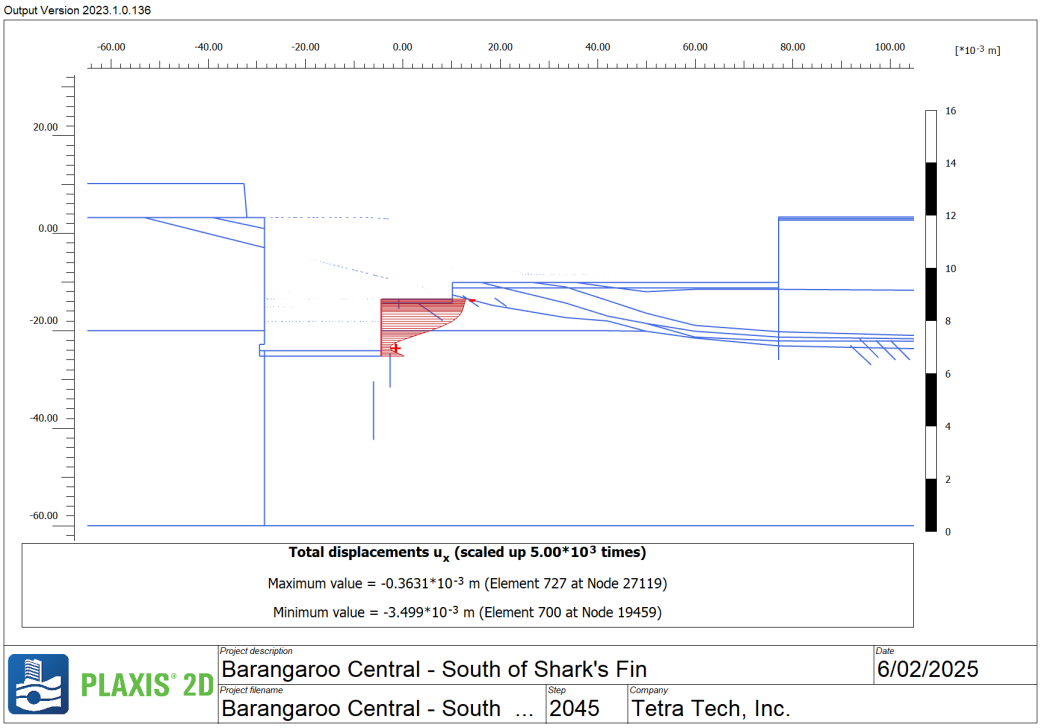
Lateral Displacement for West Wall for GWL Case 2 - GWL at RL 1.5 at landward side and RL 0.5 at seaward side



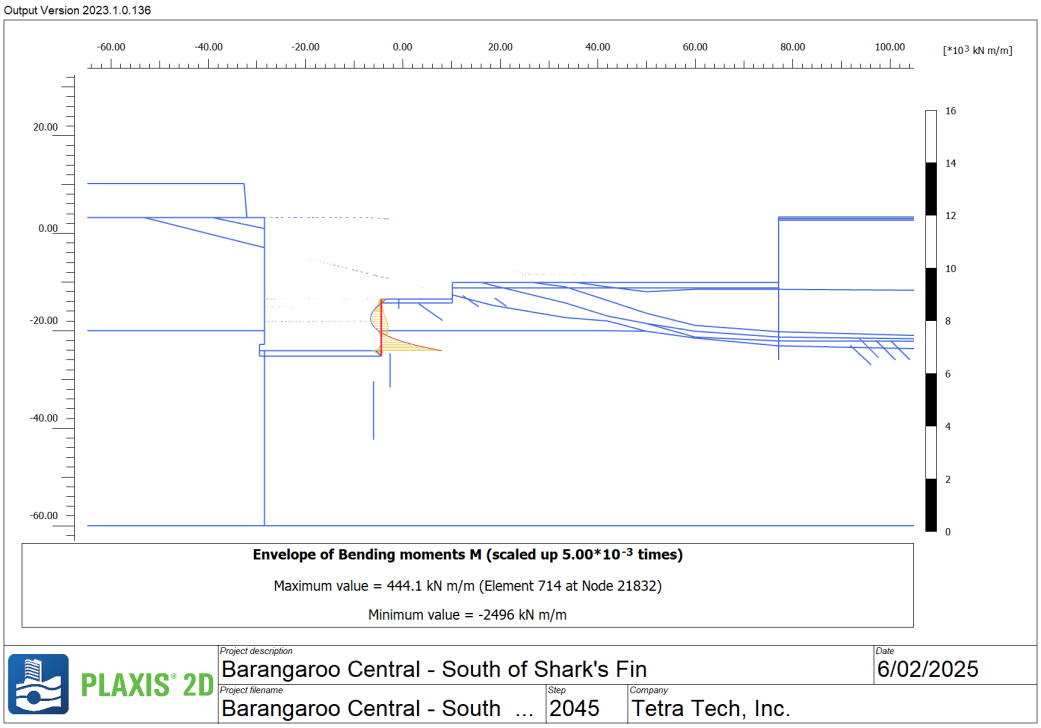
Bending Moment for West Wall for GWL Case 2 - GWL at RL 1.5 at landward side and RL 0.5 at seaward side



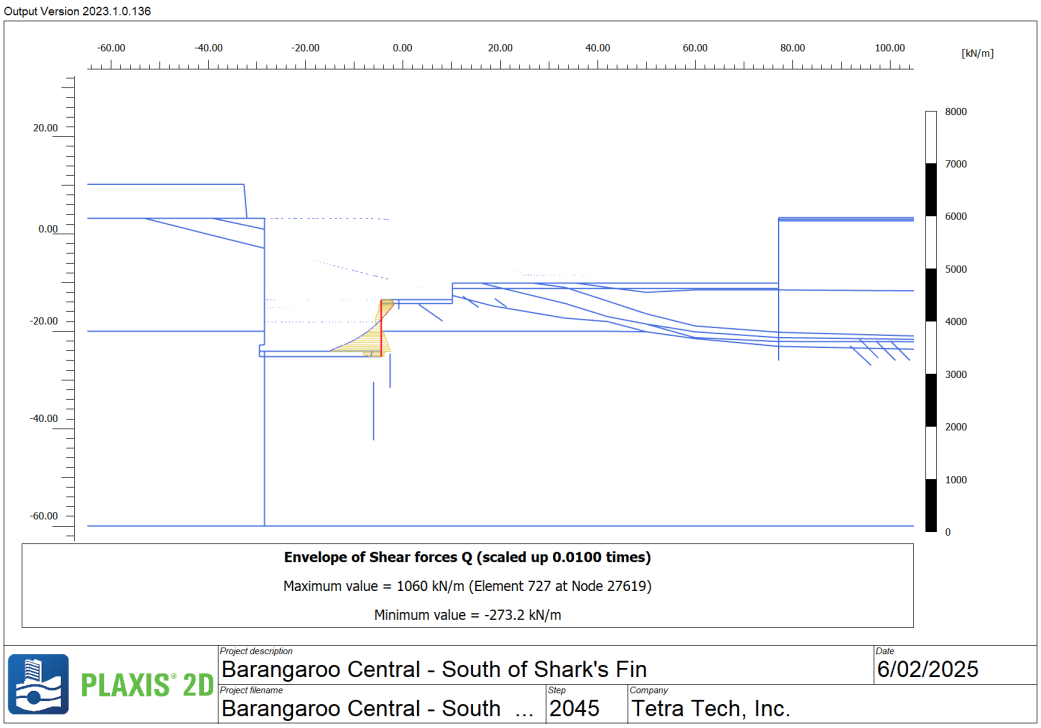
Shear Force for West Wall for GWL Case 2 - GWL at RL 1.5 at landward side and RL 0.5 at seaward side



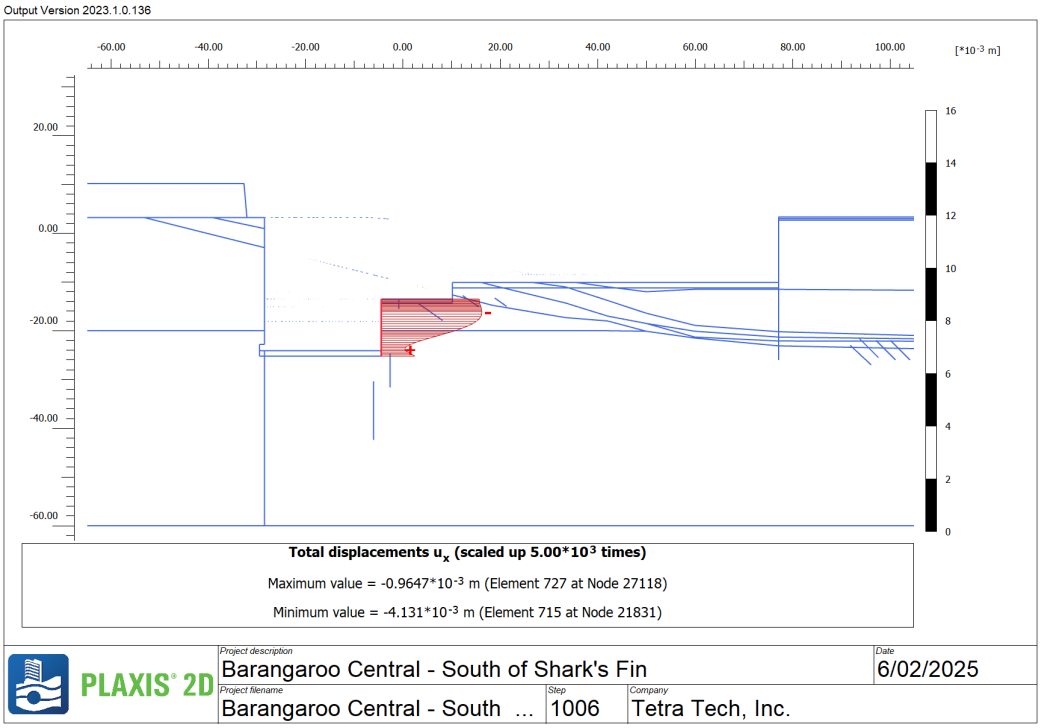
Lateral Displacement for West Wall for GWL Case 3 - GWL at RL 2.575



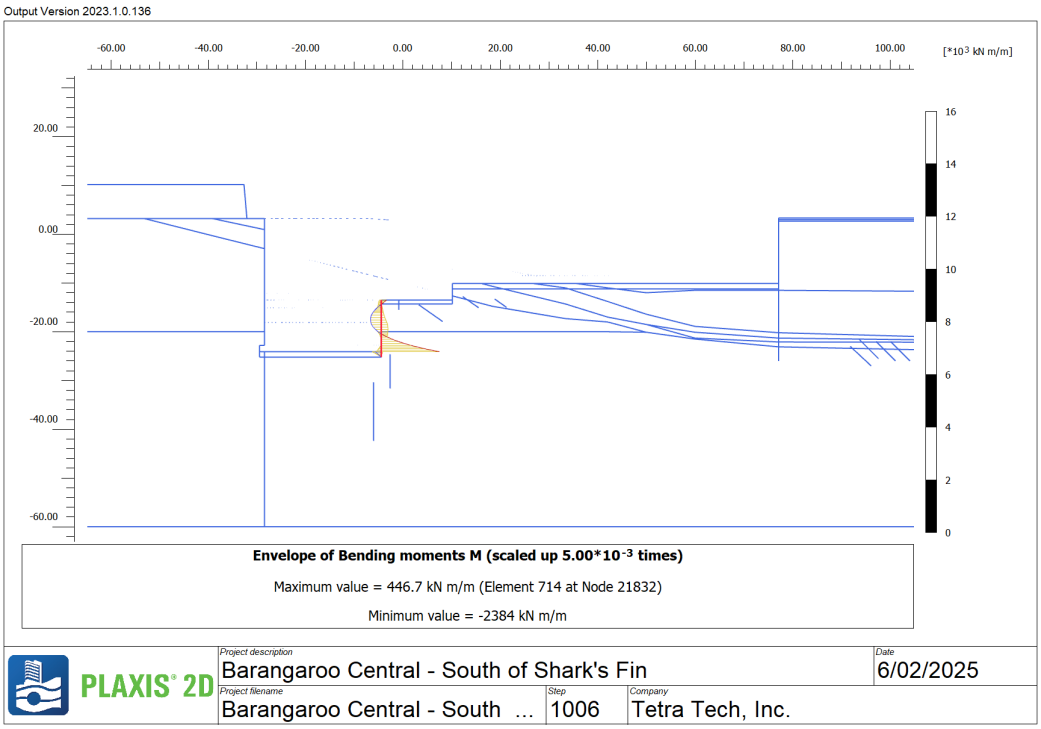
Bending Moment for West Wall for GWL Case 3 - GWL at RL 2.575



Shear Force for West Wall for GWL Case 3 - GWL at RL 2.575

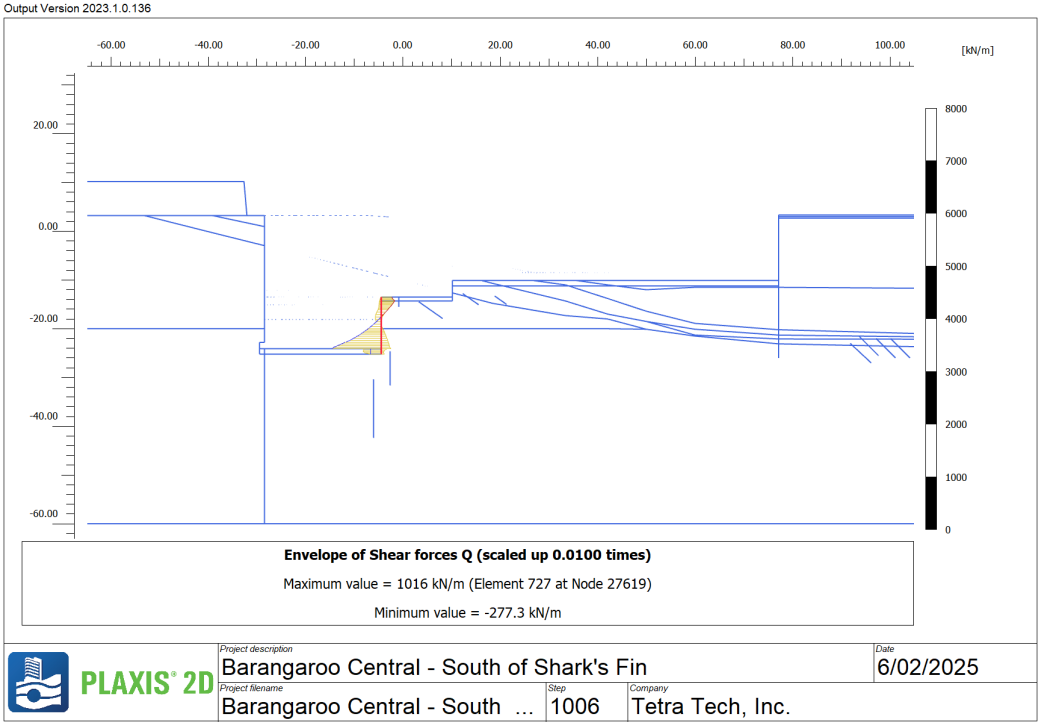


Lateral Displacement for West Wall for GWL Case 4 - GWL at RL 2.575 at seaward side and RL 1.575 at landward side



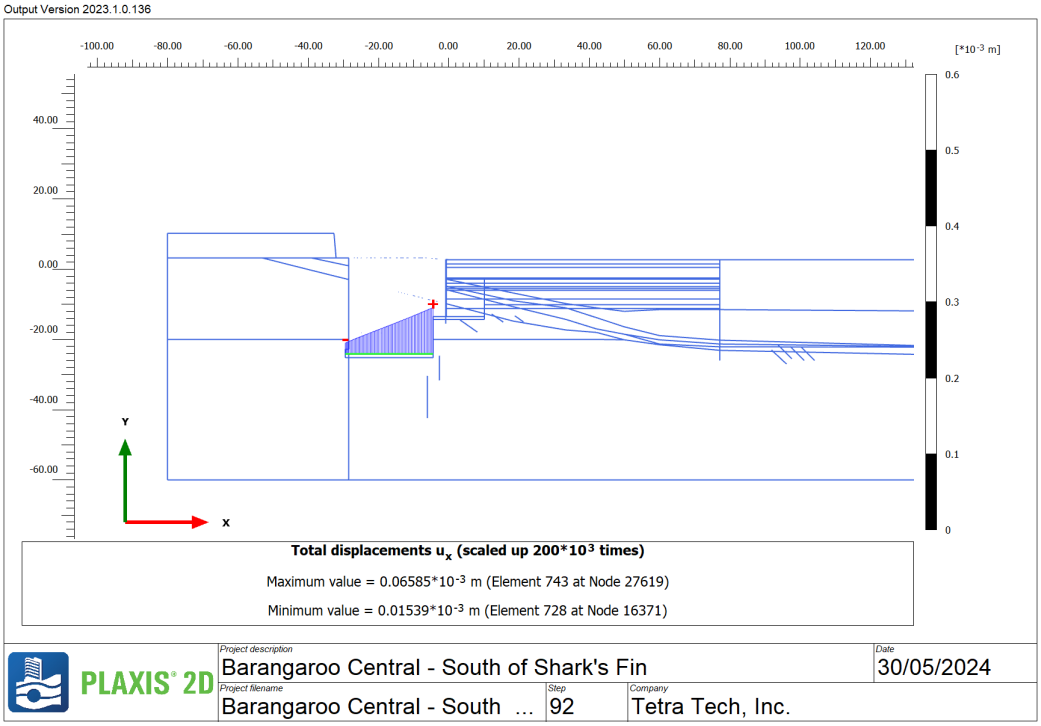
Bending Moment for West Wall for GWL Case 4 - GWL at RL 2.575 at seaward side and RL 1.575 at landward side

Output Version 2023.1.0.136

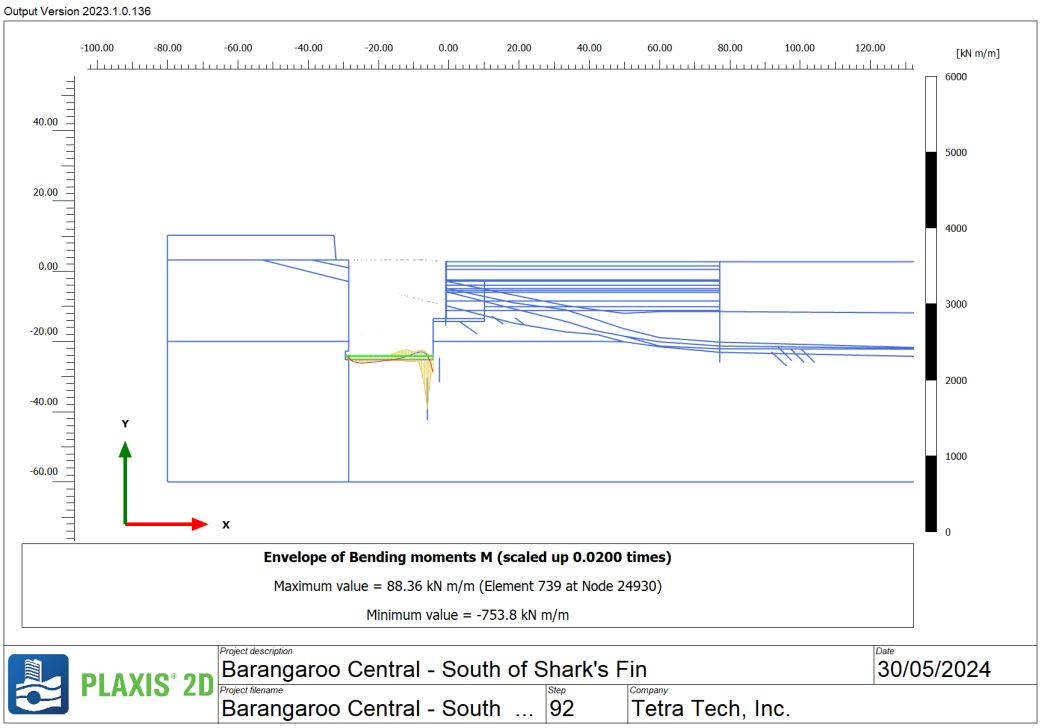


Shear Force for West Wall for GWL Case 4 - GWL at RL 2.575 at seaward side and RL 1.575 at landward side

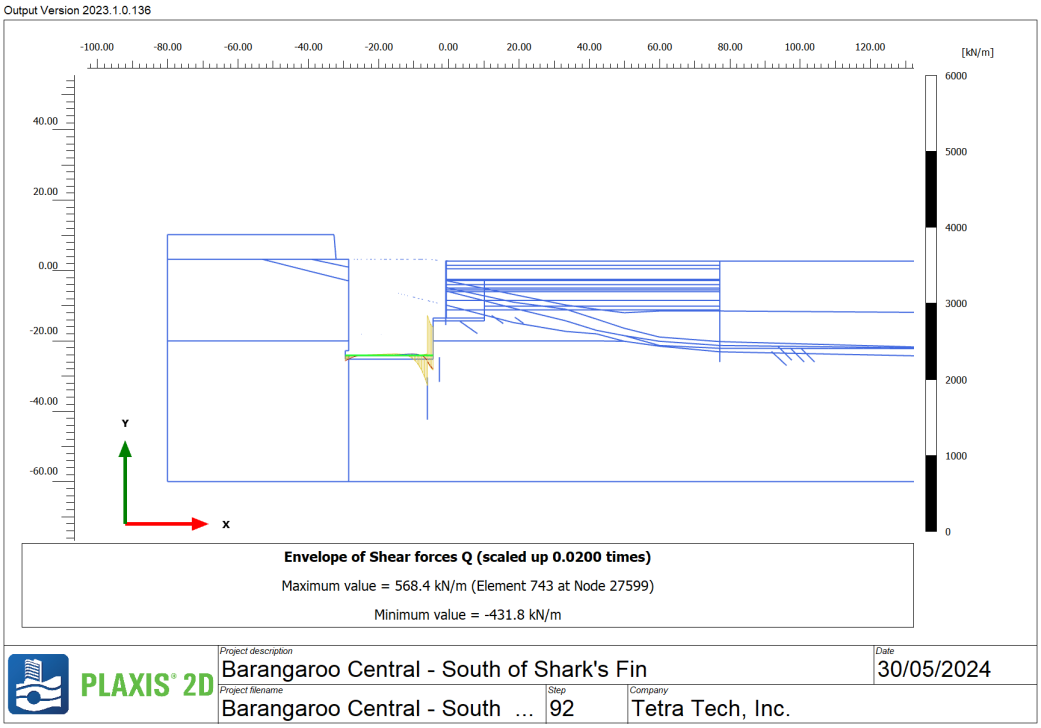
D. Base Slab



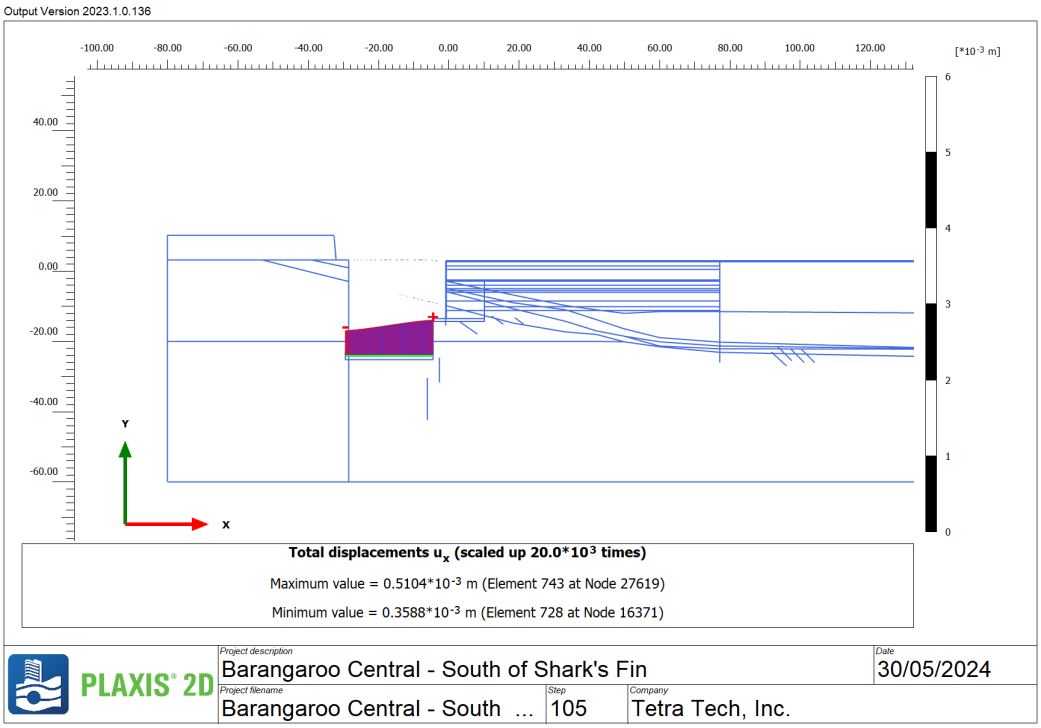
Lateral Displacement for Base Slab at Stage 19 – After installation of Station slabs and walls



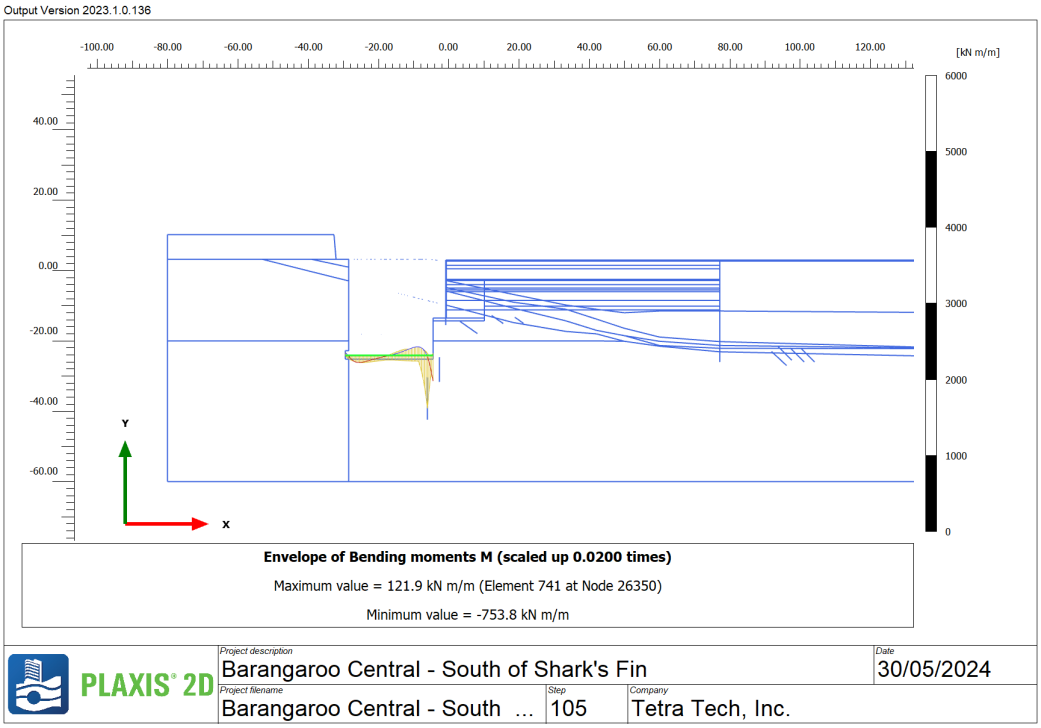
Bending Moment for Base Slab at Stage 19 – After installation of Station slabs and walls



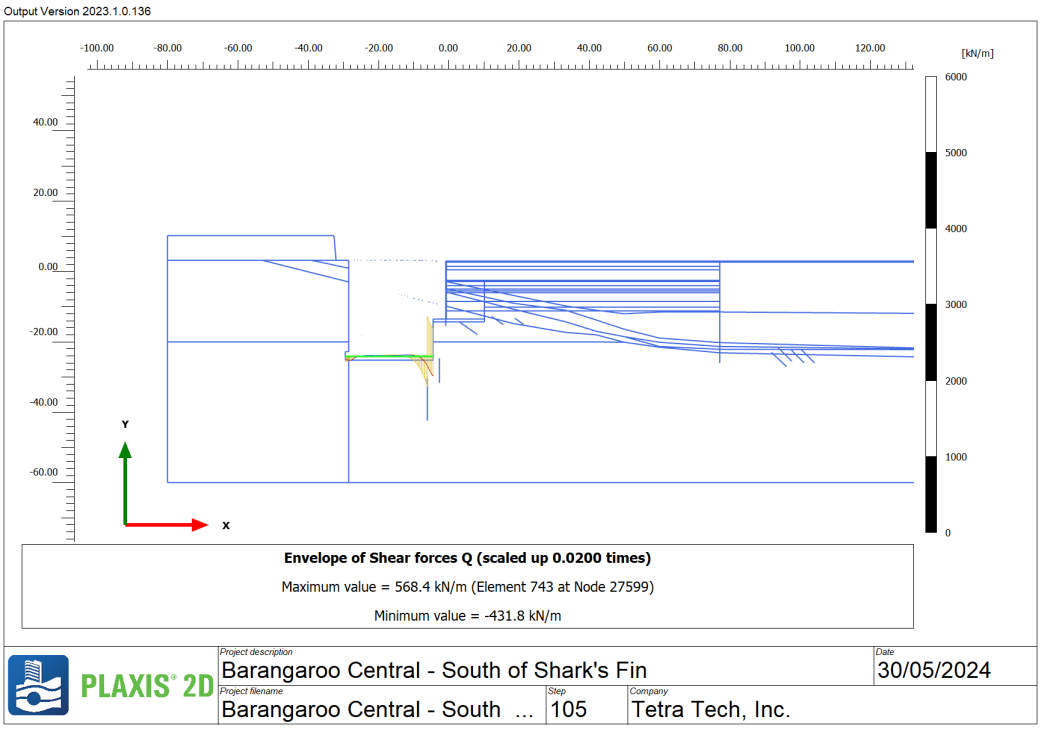
Shear Force for Base Slab at Stage 19 – After installation of Station slabs and walls



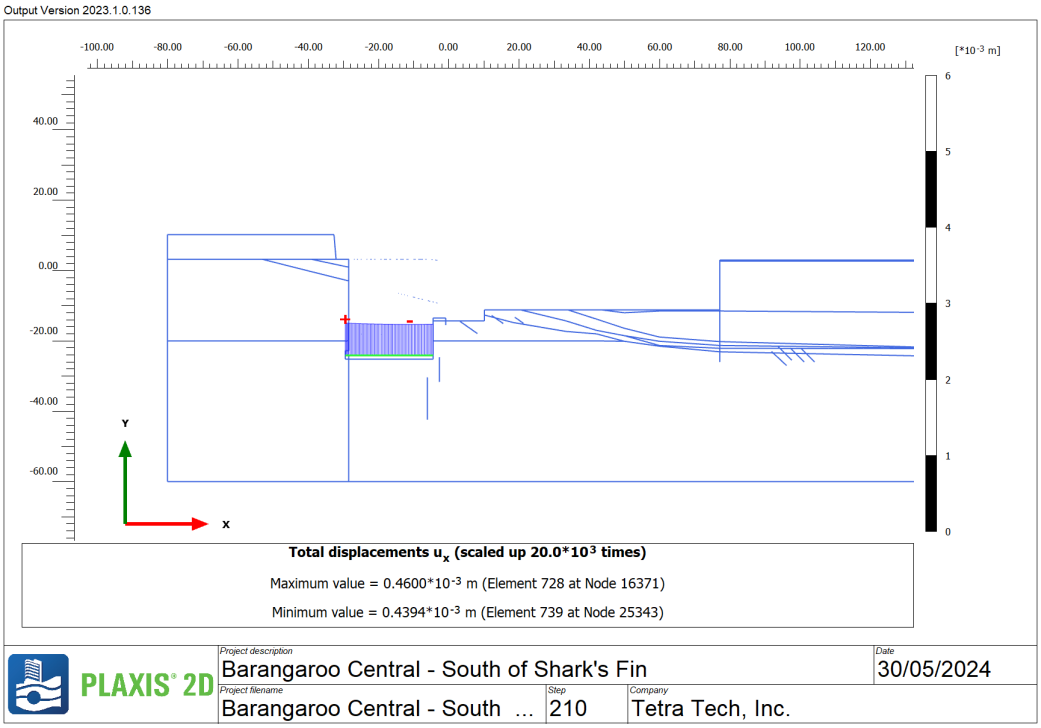
Lateral Displacement for Base Slab at Stage 20 – GWL at RL -15 for Station and RL -11 West of station



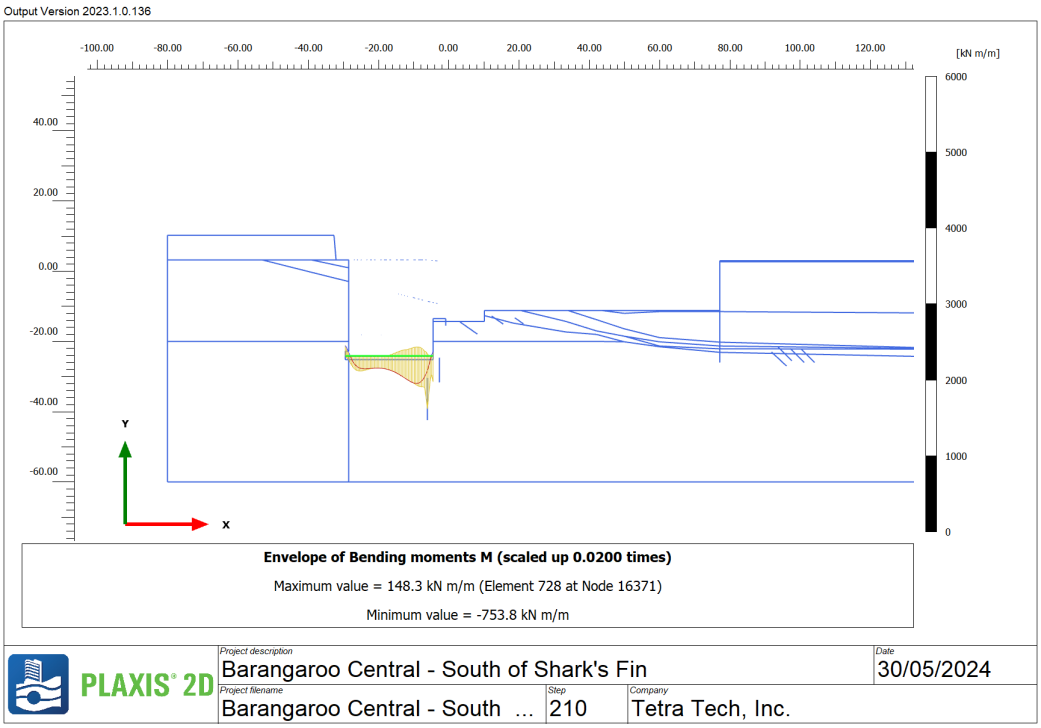
Bending Moment for Base Slab at Stage 20 – GWL at RL -15 for Station and RL -11 West of station



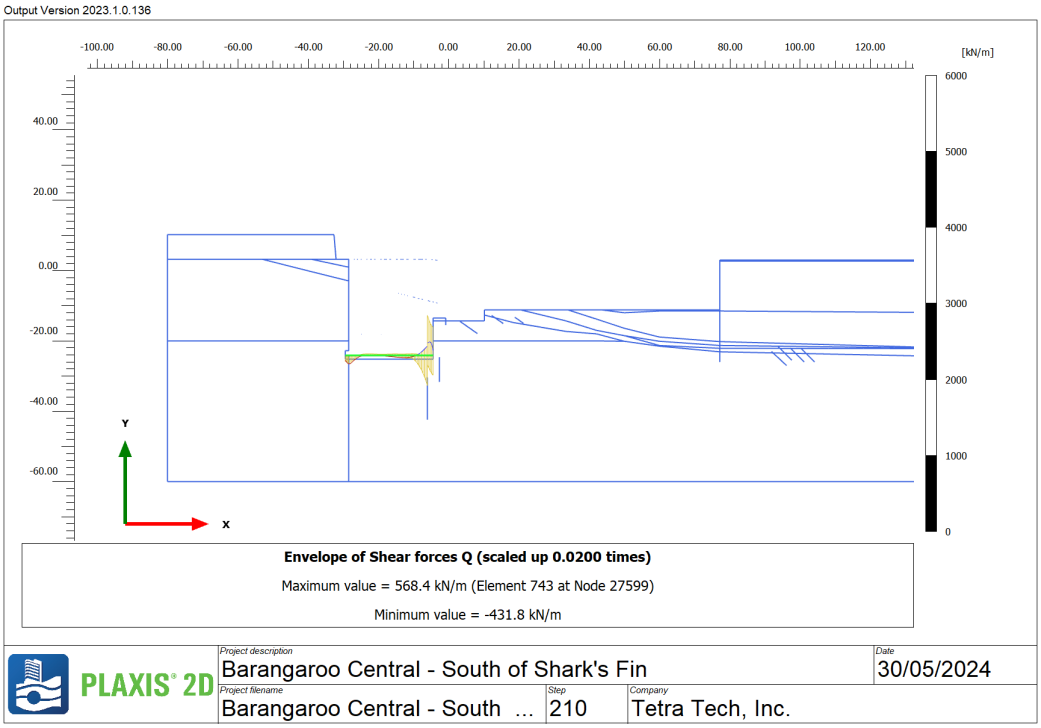
Shear Force for Base Slab at Stage 20 – GWL at RL -14.3 for Station and RL -11 West of station



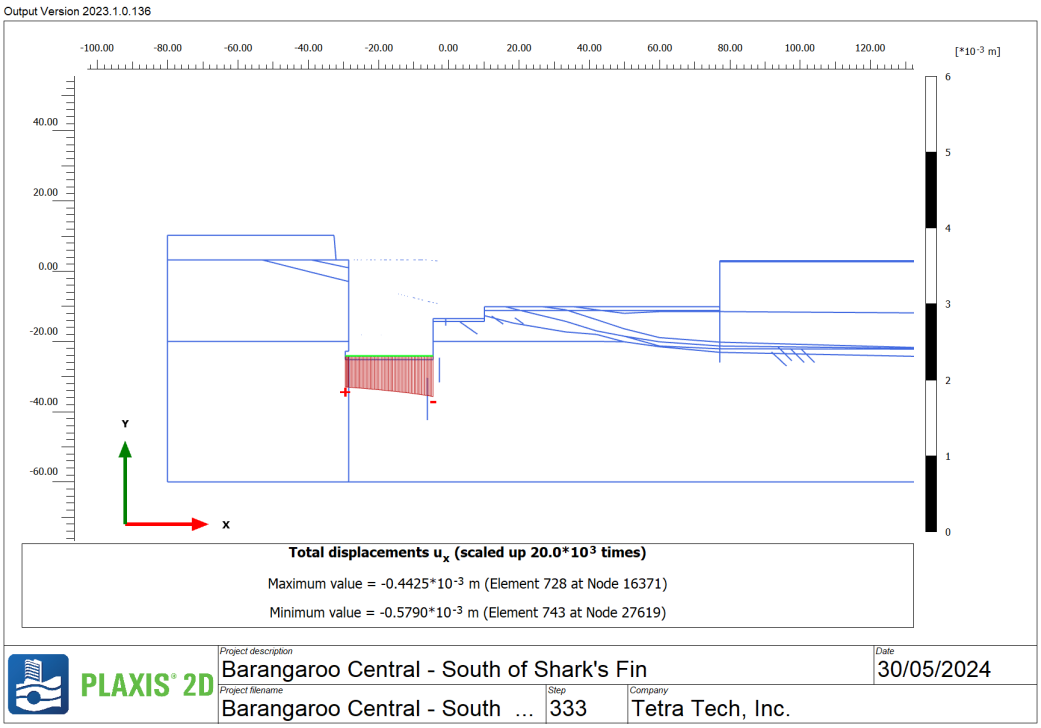
Lateral Displacement for Base Slab at Stage 33 – Excavate CBD to BEL at RL -14.3 and RL -11.2



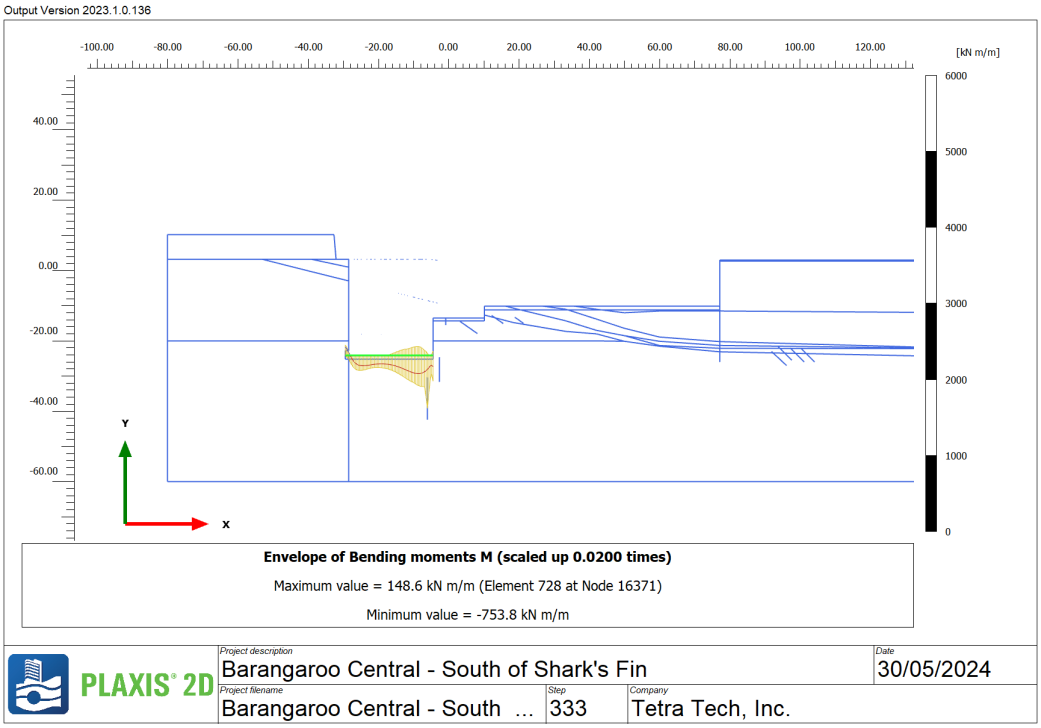
Bending Moment for Base Slab at Stage 33 – Excavate CBD to BEL at RL -14.3 and RL -11.2



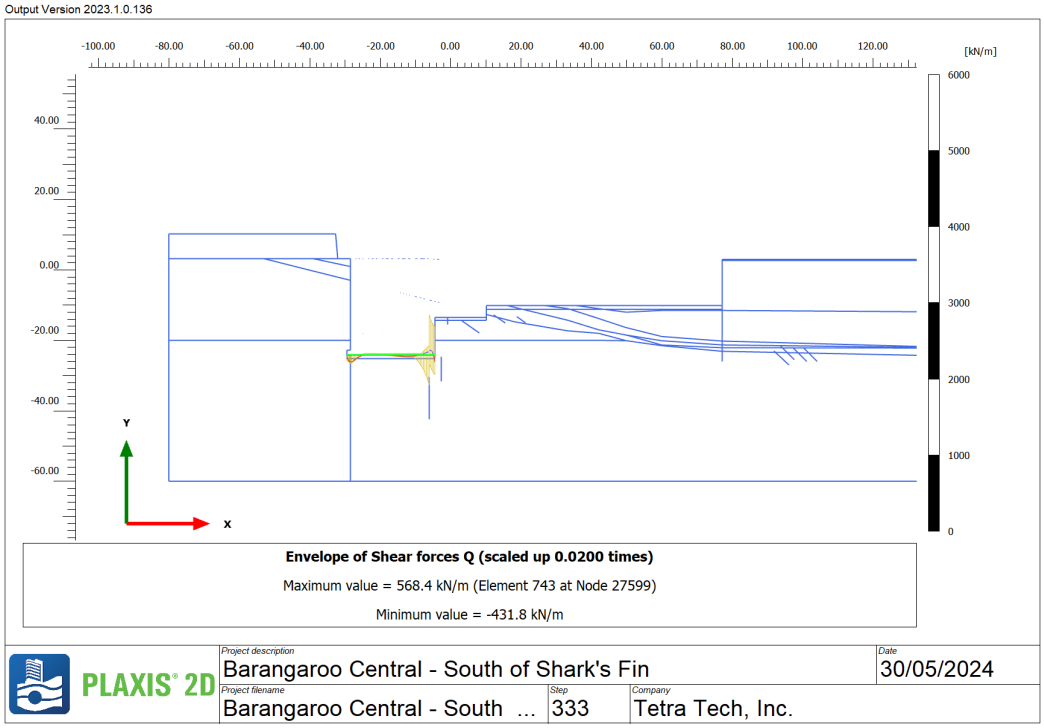
Shear Force for Base Slab at Stage 33 – Excavate CBD to BEL at RL -14.3 and RL -11.2



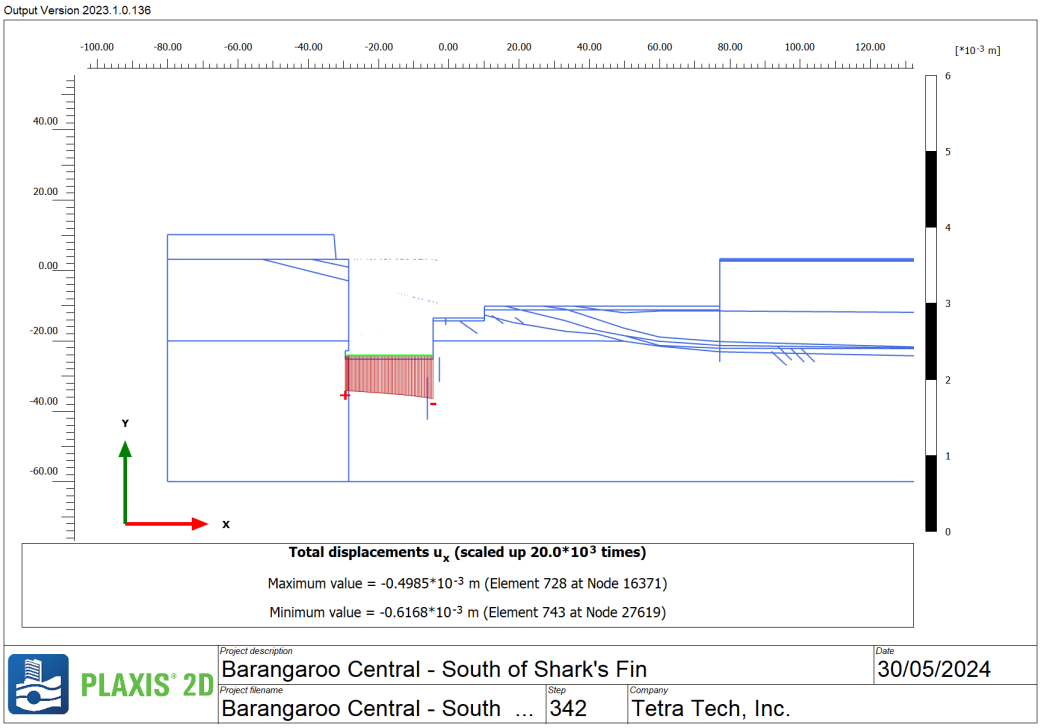
Lateral Displacement for Base Slab at Stage 36 – After Installation of CBD slabs and walls



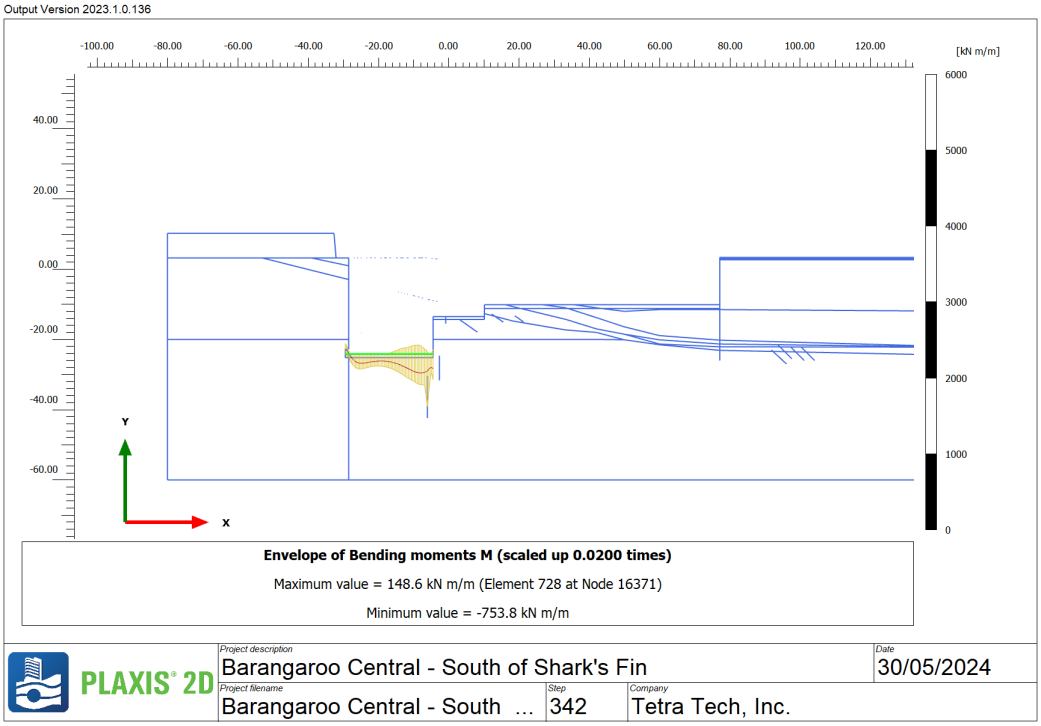
Bending Moment for Base Slab at Stage 36 – After Installation of CBD slabs and walls



Shear Force for Base Slab at Stage 36 – After Installation of CBD slabs and walls

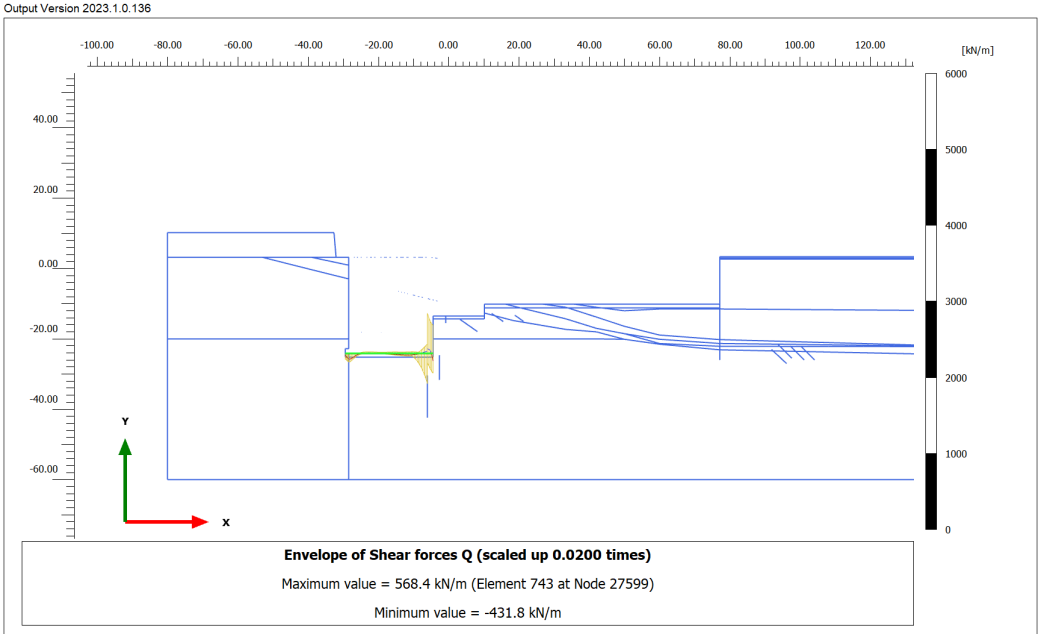


Lateral Displacement for Base Slab at Stage 37 – GWL at RL-10 for Station and RL -11.2 for CBD



Bending Moment for Base Slab at Stage 37 – GWL at RL-10 for Station and RL -11.2 for CBD

Output Version 2023.1.0.136

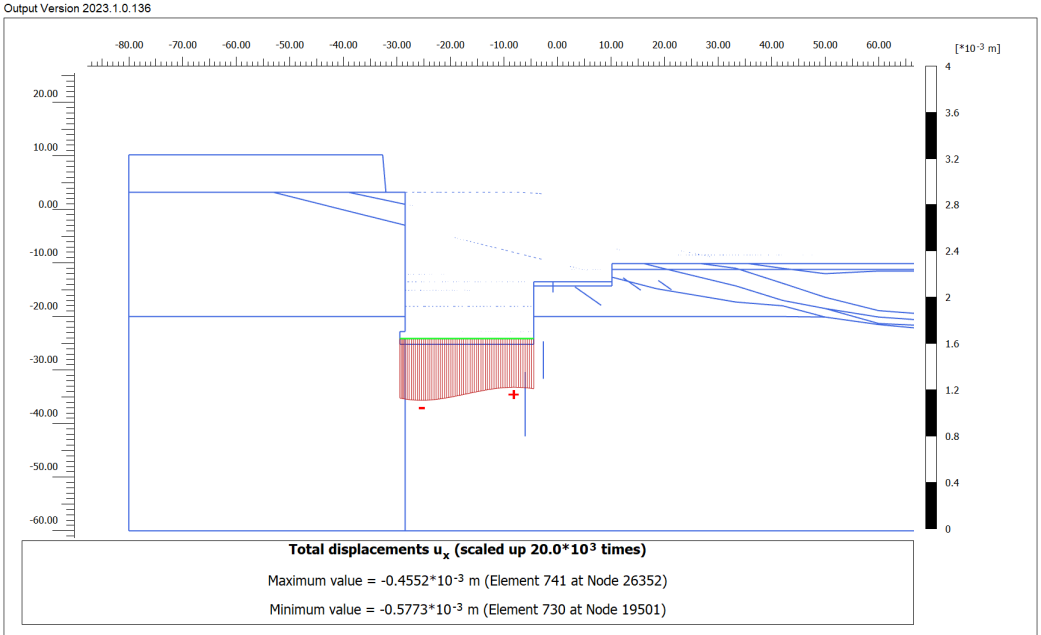


PLAXIS 2D

Project description		Date
Barangaroo Central - South of Shark's Fin		30/05/2024
Project filename	Step	Company
Barangaroo Central - South ...	342	Tetra Tech, Inc.

Shear Force for Base Slab at Stage 37 – GWL at RL-10 for Station and RL -11.2 for CBD

Output Version 2023.1.0.136

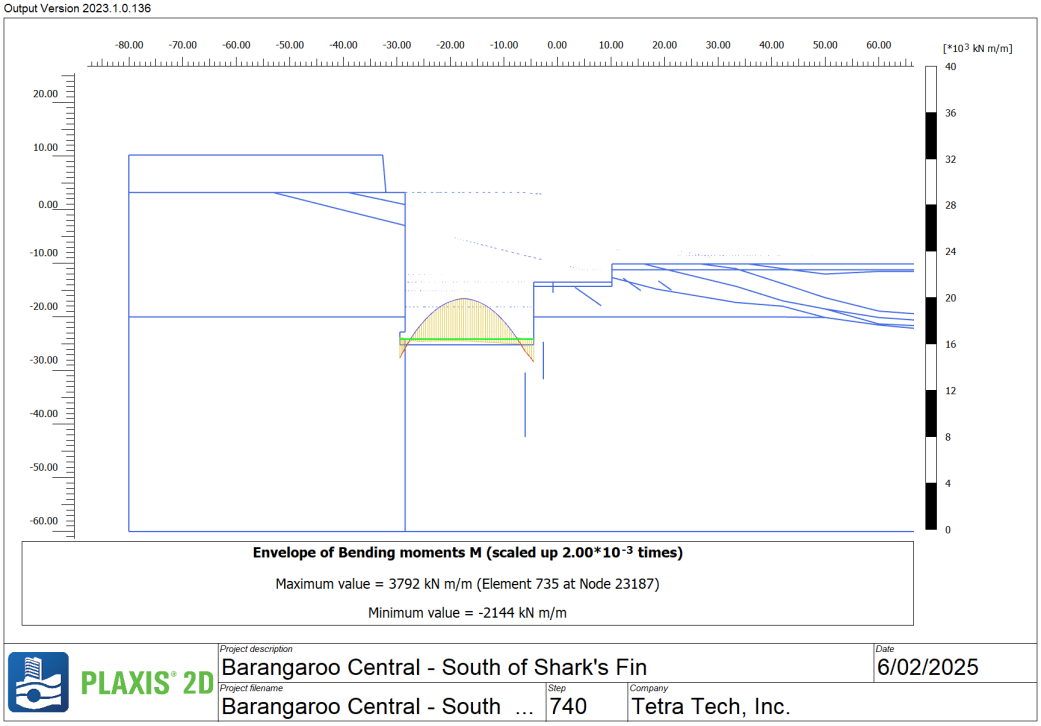


PLAXIS 2D

Project description		Date
Barangaroo Central - South of Shark's Fin		6/02/2025
Project filename	Step	Company
Barangaroo Central - South ...	740	Tetra Tech, Inc.

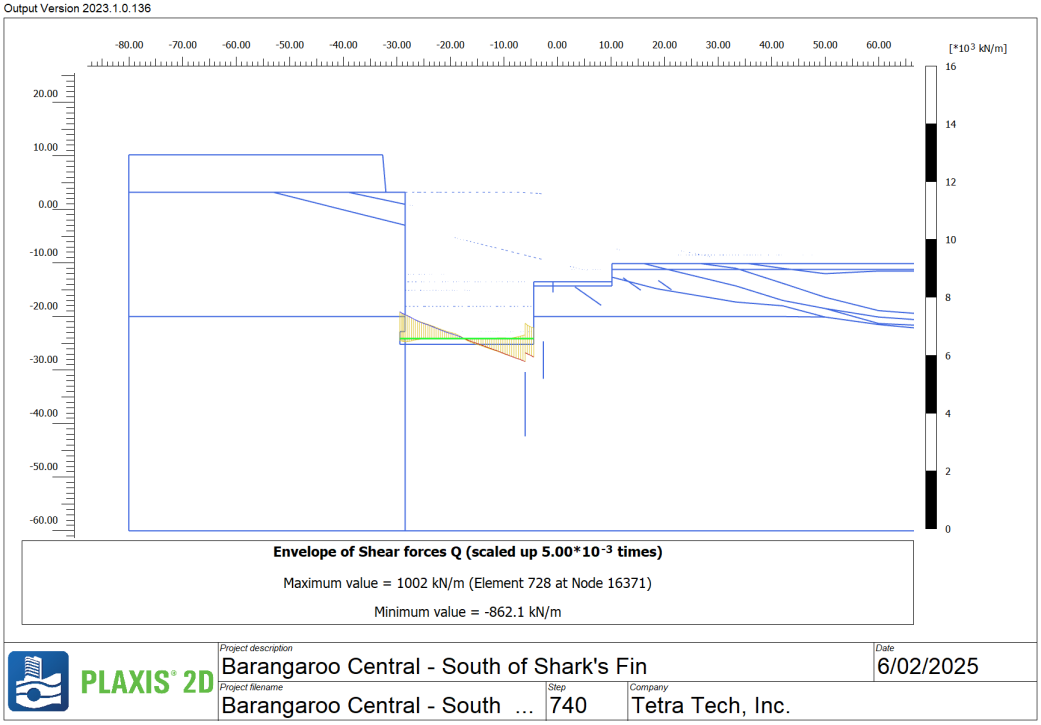
Lateral Displacement for Base Slab for GWL Case 1 - GWL at RL 1.5

Output Version 2023.1.0.136

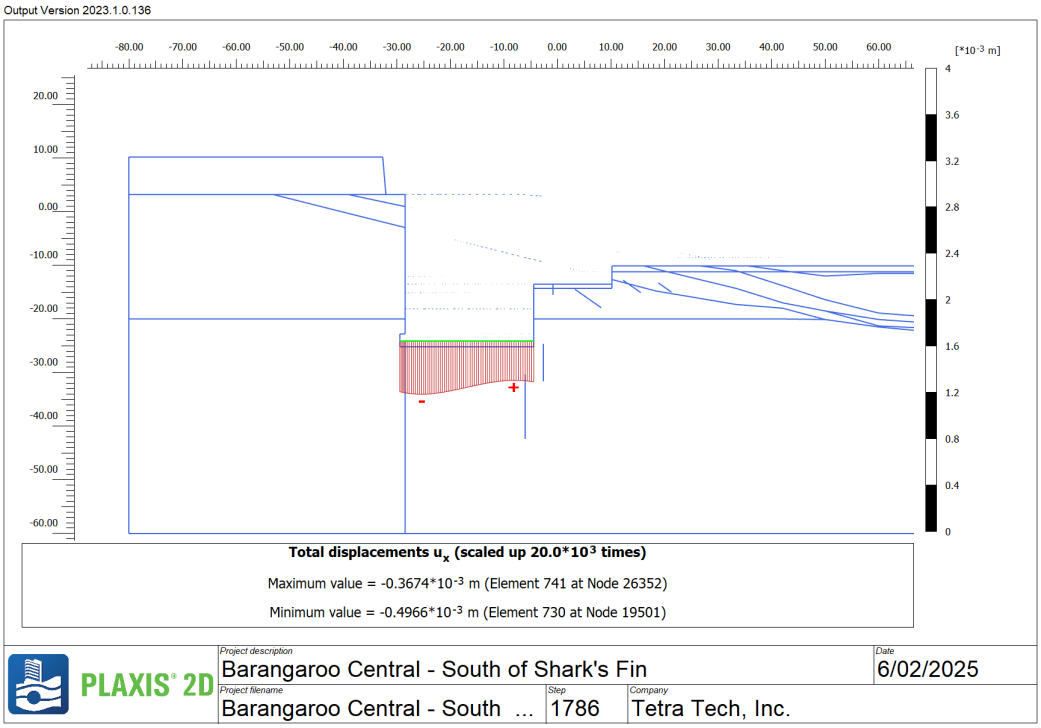


Bending Moment for Base Slab for GWL Case 1 - GWL at RL 1.5

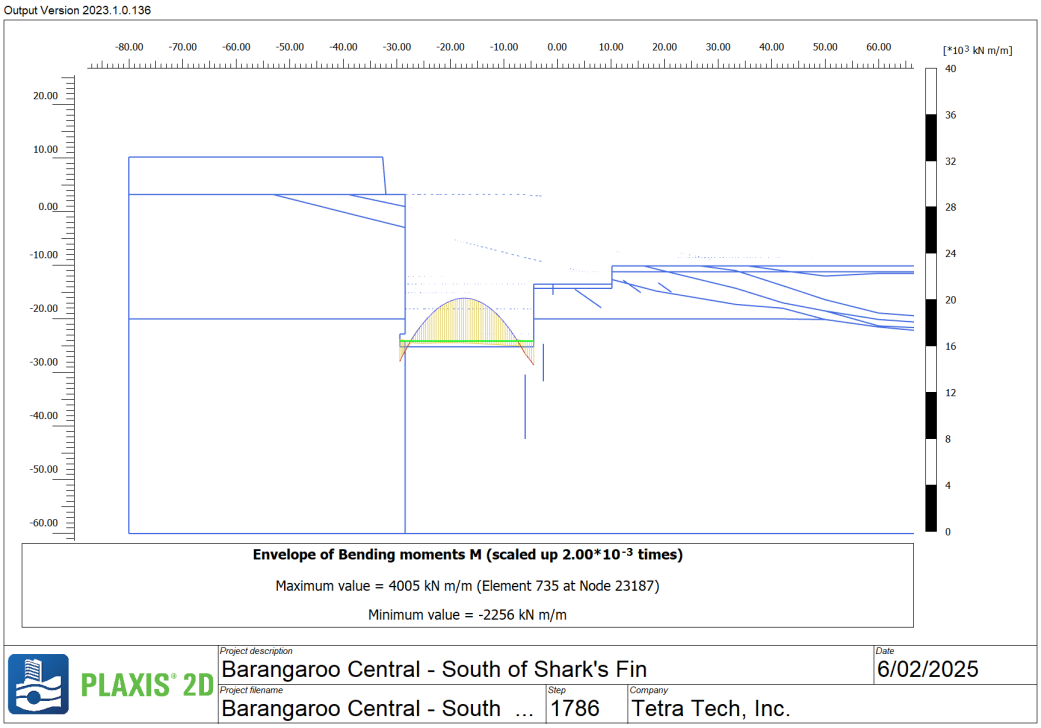
Output Version 2023.1.0.136



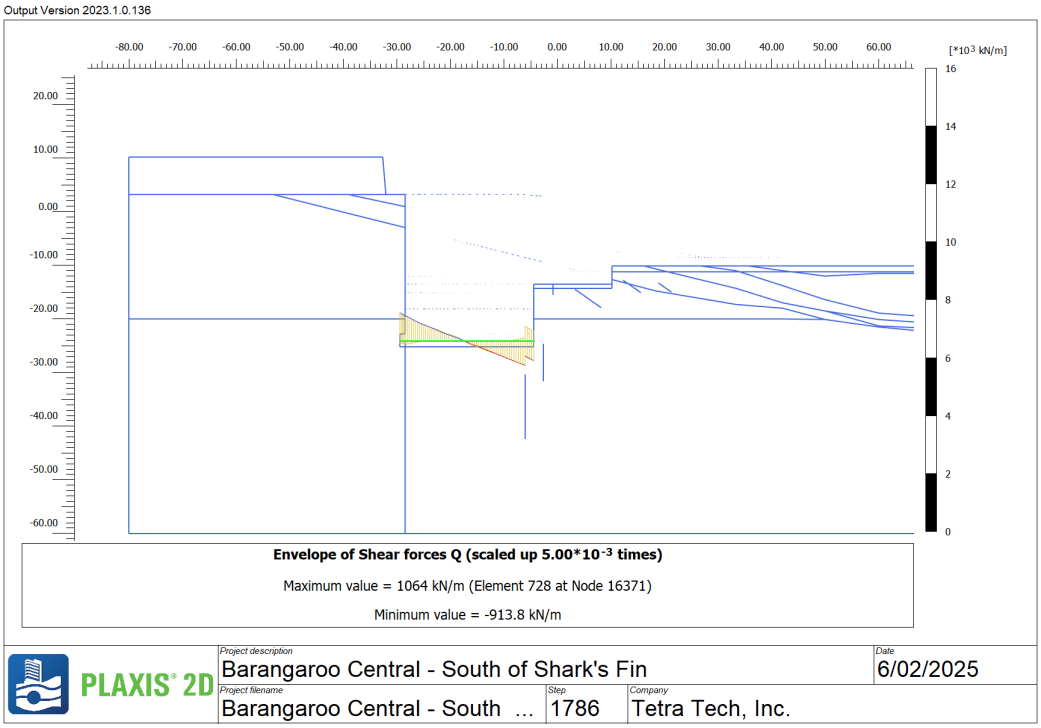
Shear Force for Base Slab for GWL Case 1 - GWL at RL 1.5



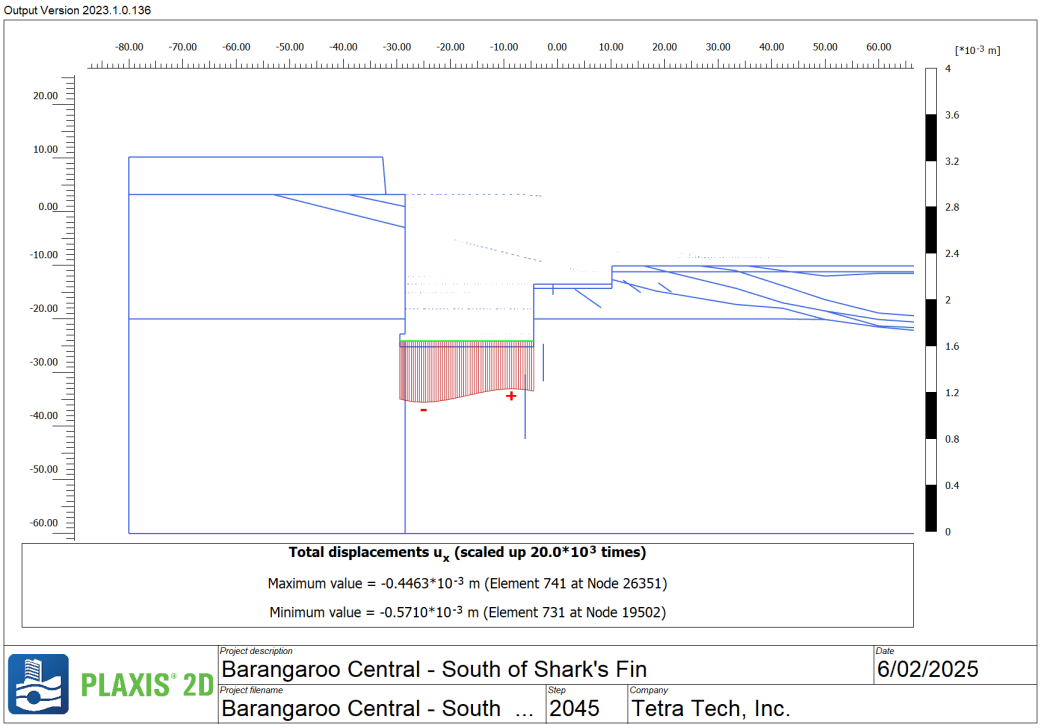
Lateral Displacement for Base Slab for GWL Case 2 - GWL at RL 1.5 at landward side and RL 0.5 at seaward side



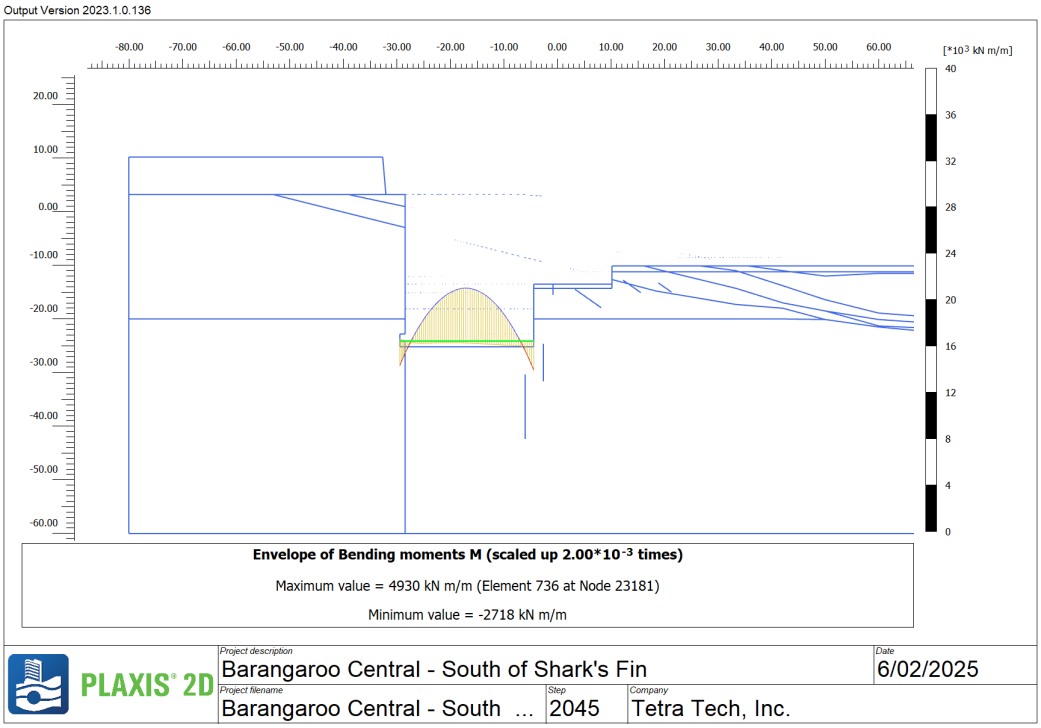
Bending Moment for Base Slab for GWL Case 2 - GWL at RL 1.5 at landward side and RL 0.5 at seaward side



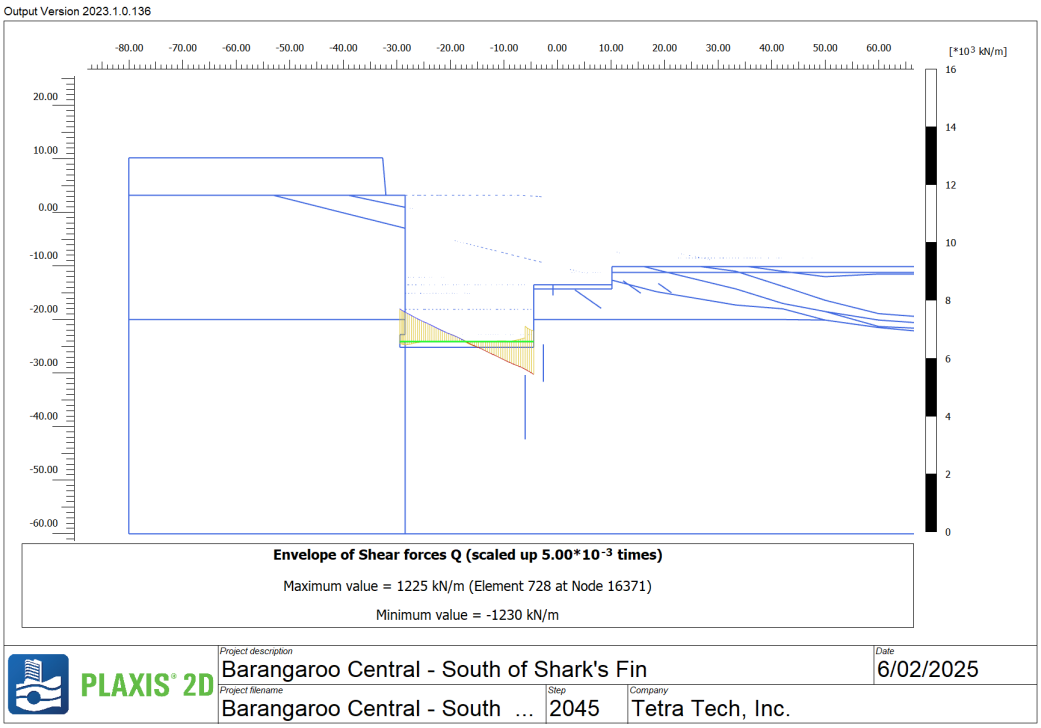
Shear Force for Base Slab for GWL Case 2 - GWL at RL 1.5 at landward side and RL 0.5 at seaward side



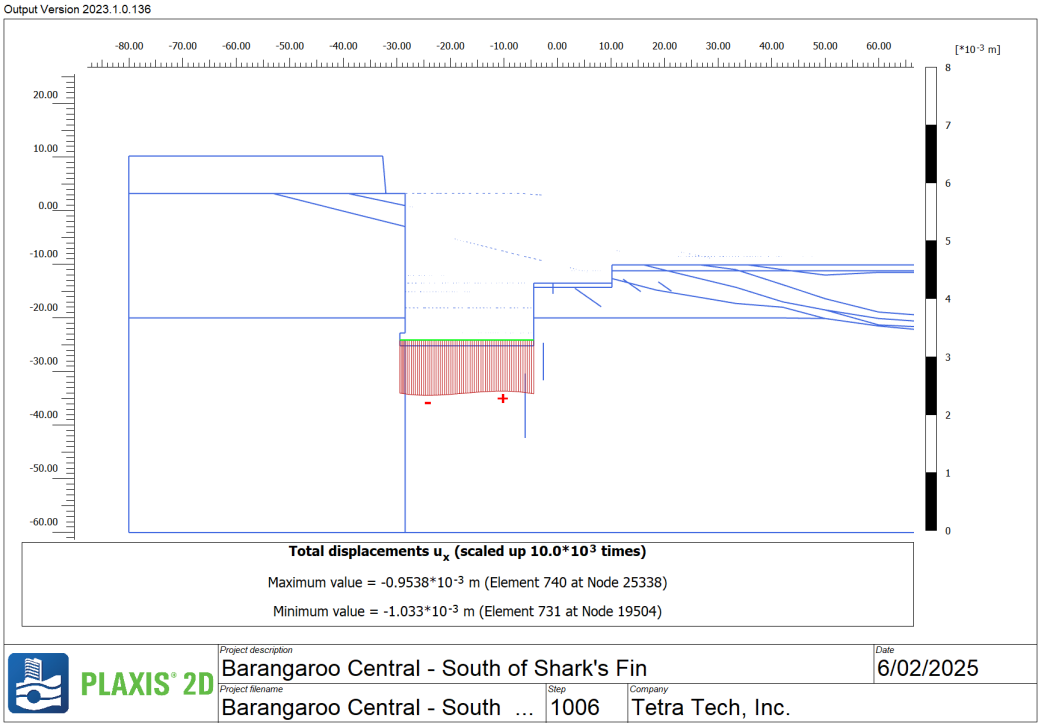
Lateral Displacement for Base Slab for GWL Case 3 - GWL at RL 2.575



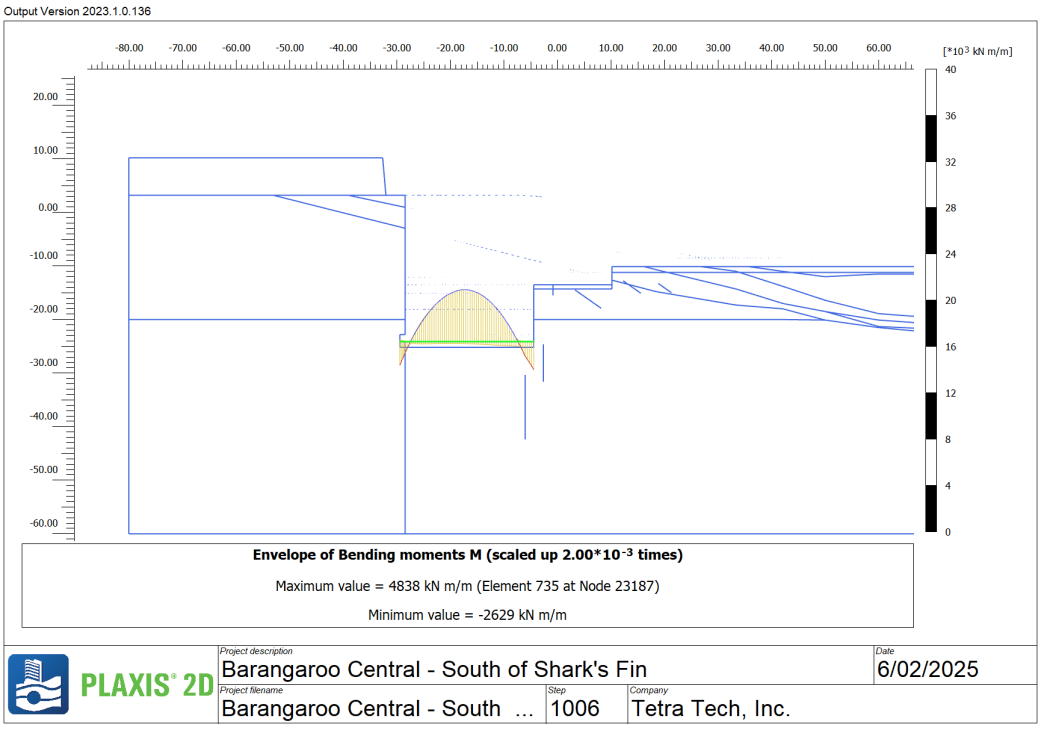
Bending Moment for Base Slab for GWL Case 3 - GWL at RL 2.575



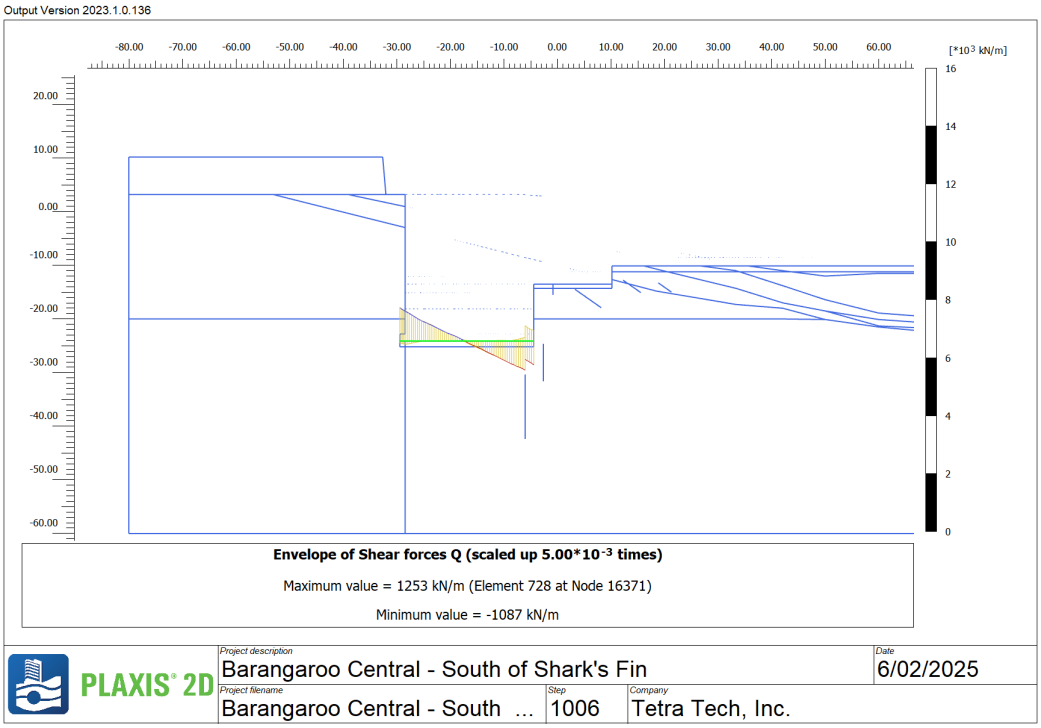
Shear Force for Base Slab for GWL Case 3 - GWL at RL 2.575



Lateral Displacement for Base Slab for GWL Case 4 - GWL at RL 2.575 at seaward side and RL 1.575 at landward side

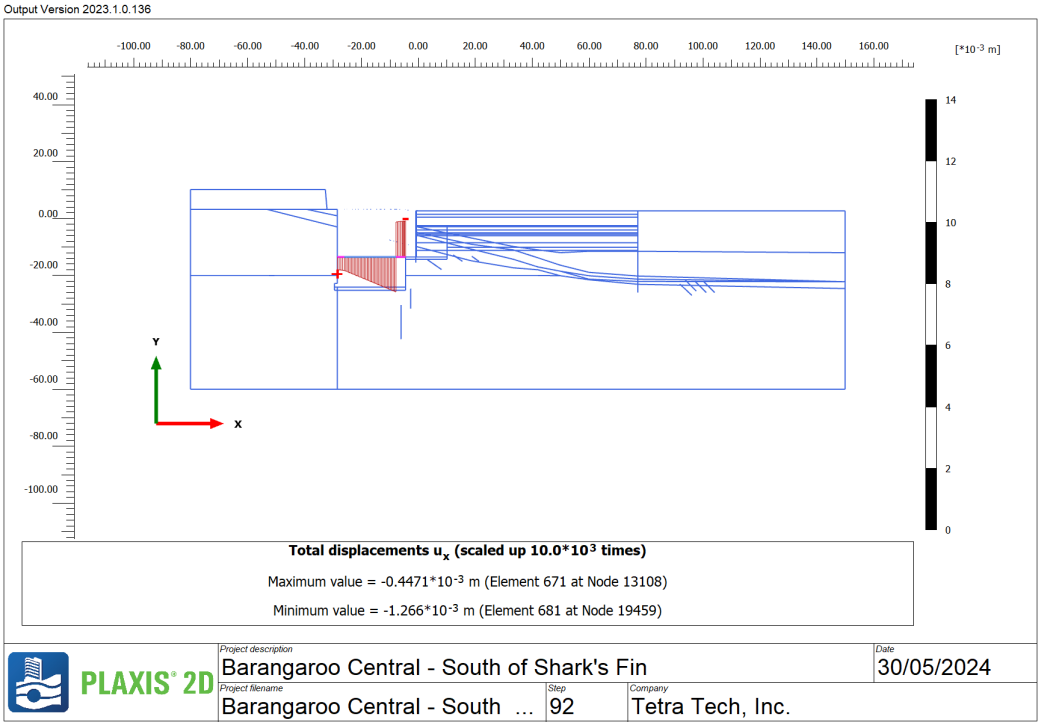


Bending Moment for Base Slab for GWL Case 4 - GWL at RL 2.575 at seaward side and RL 1.575 at landward side

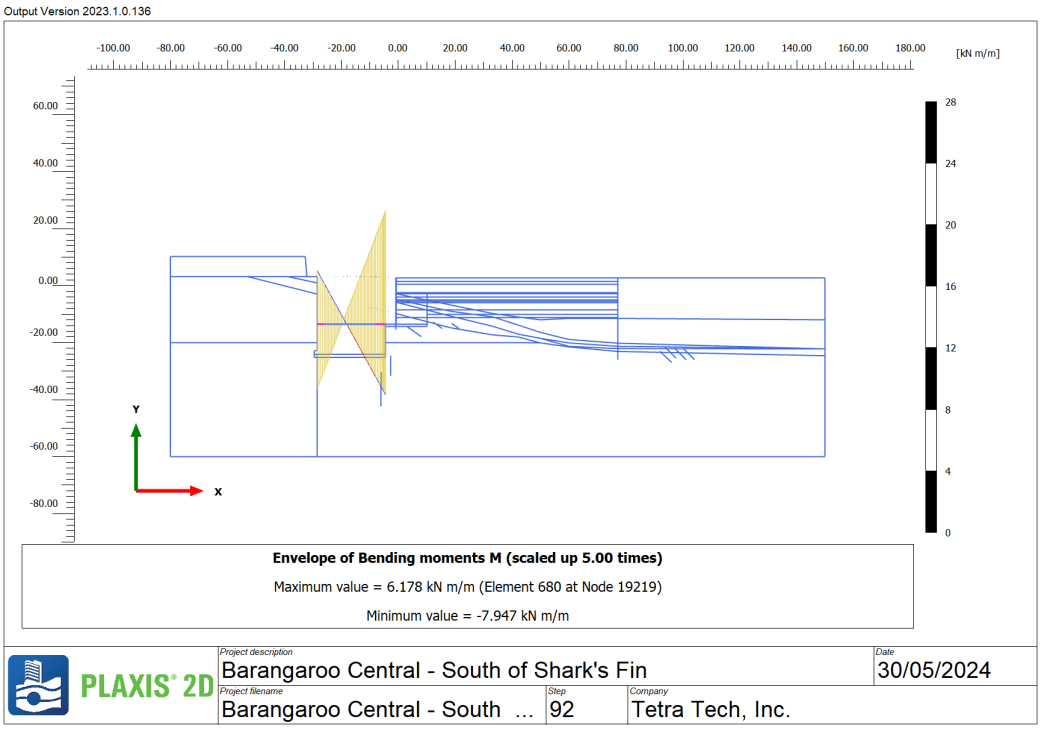


Shear Force for Base Slab for GWL Case 4 - GWL at RL 2.575 at seaward side and RL 1.575 at landward side

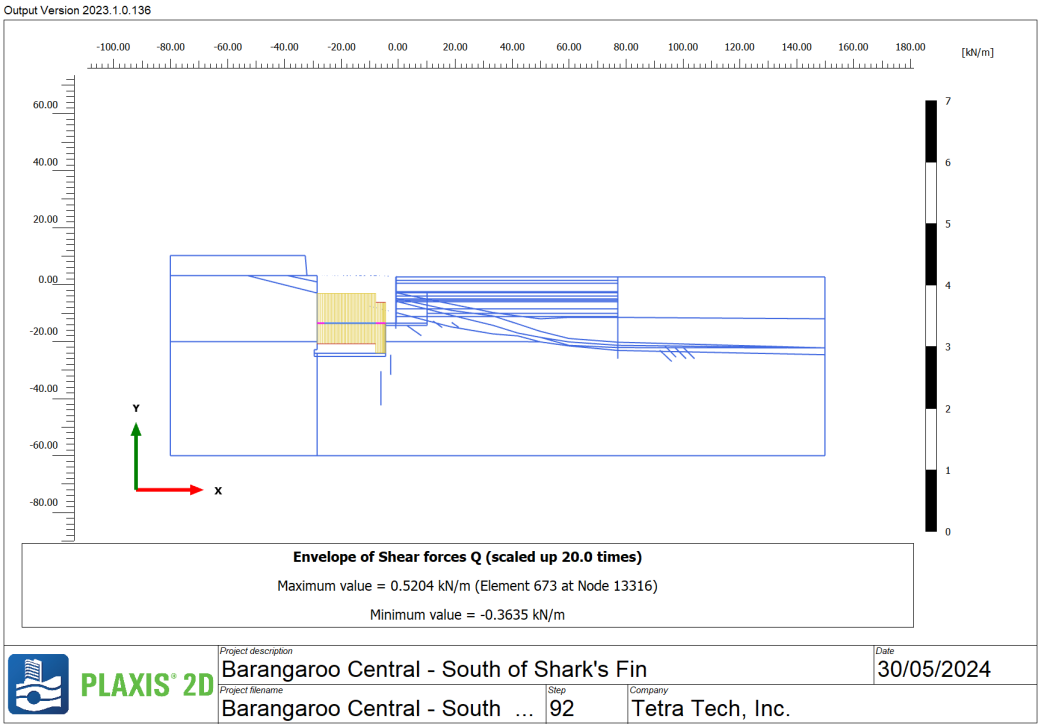
E. B3 (Concourse) Slab)



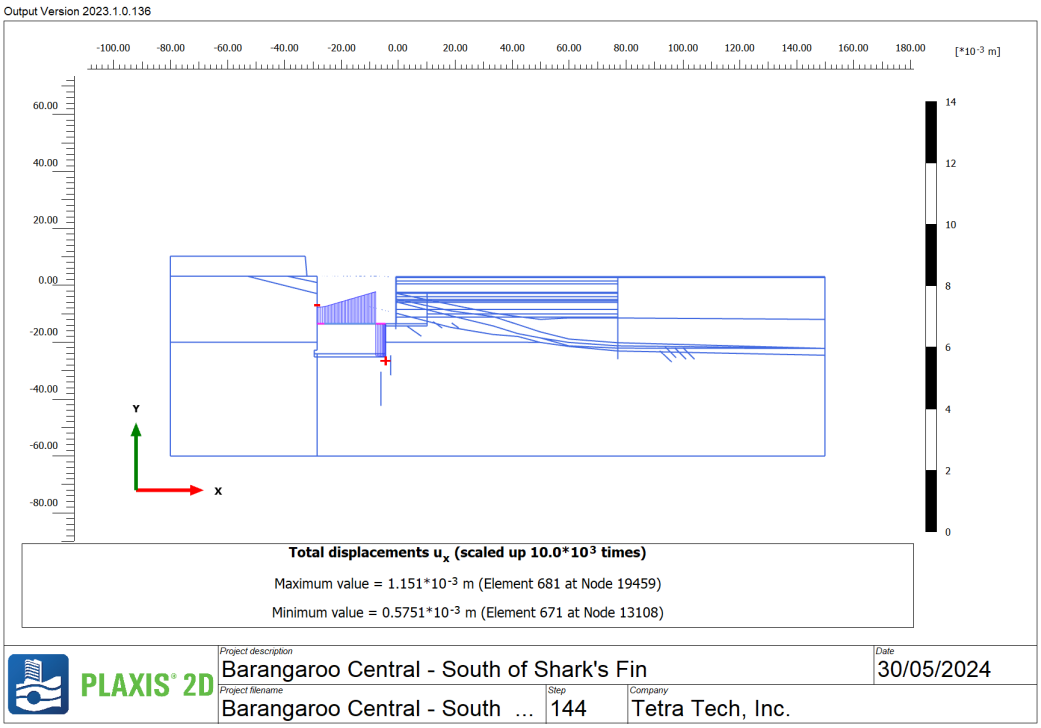
Lateral Displacement for B3 (Concourse) Slab at Stage 19 – After installation of Station slabs and walls



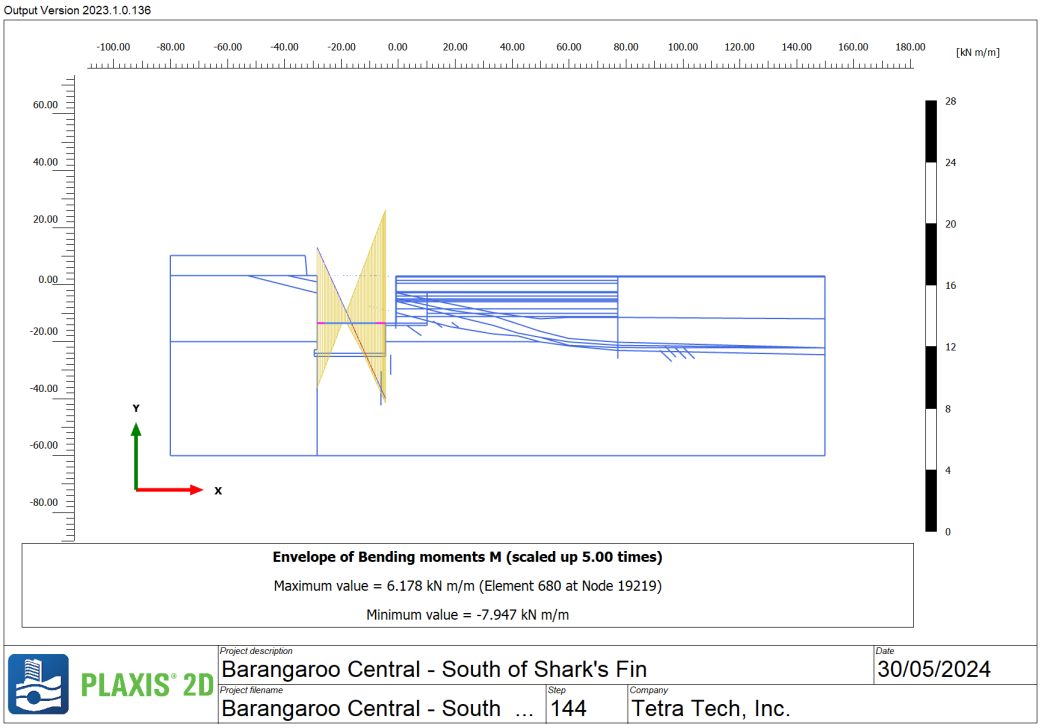
Bending Moment for B3 (Concourse) Slab at Stage 19 – After installation of Station slabs and walls



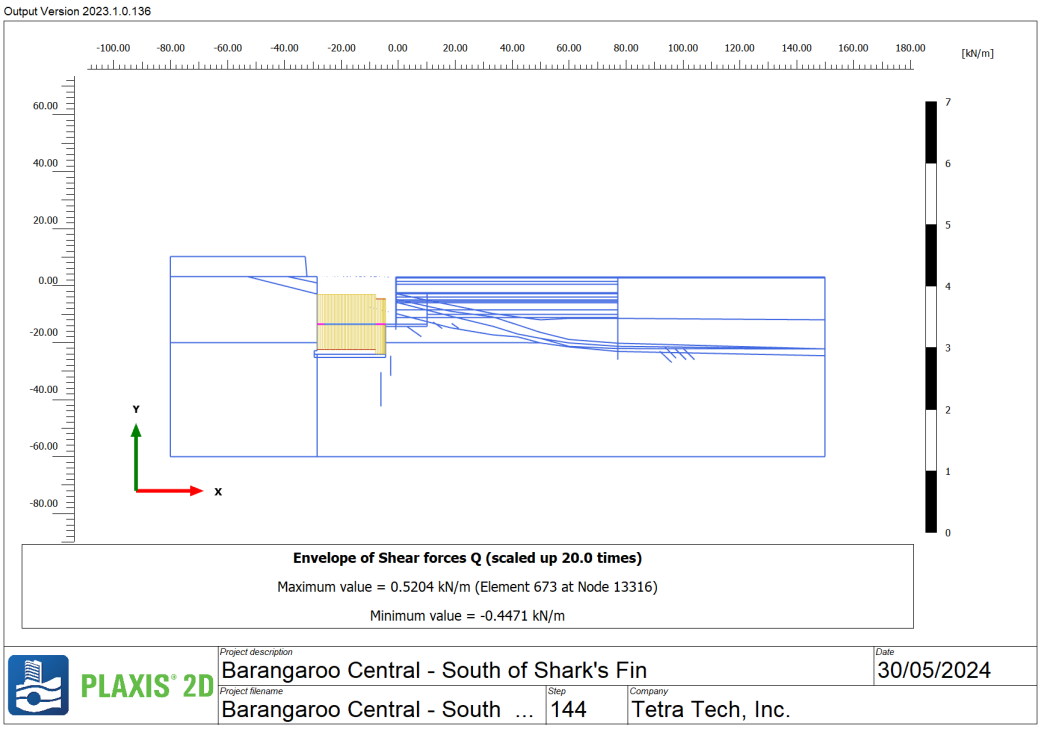
Shear Force for B3 (Concourse) Slab at Stage 19 – After installation of Station slabs and walls



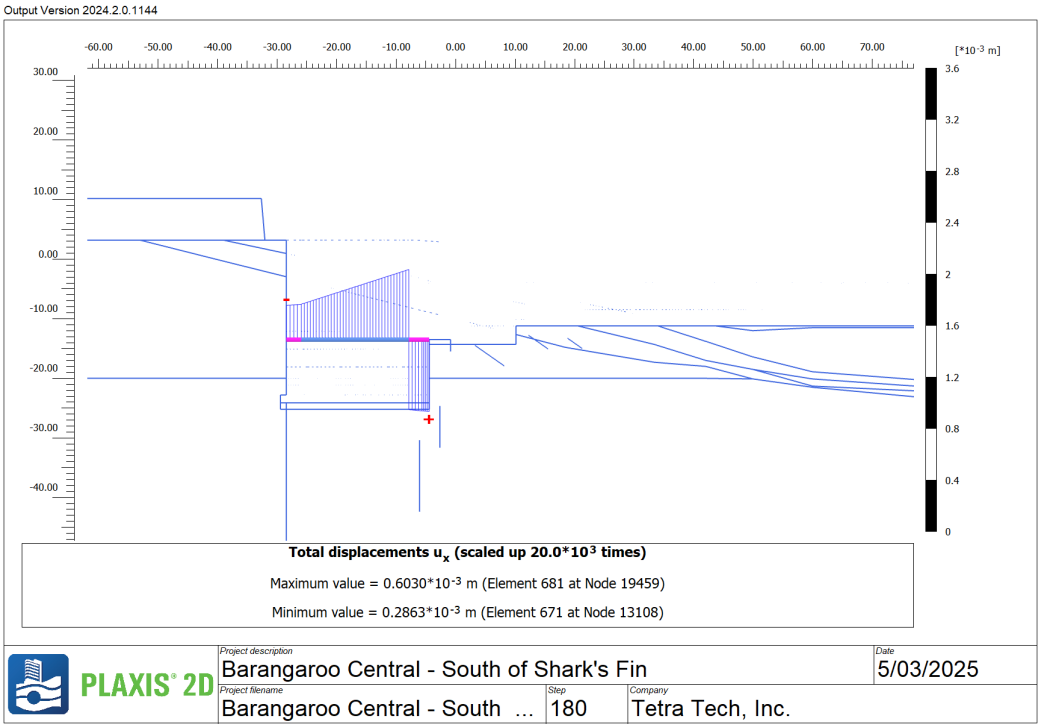
Lateral Displacement for B3 (Concourse) Slab at Stage 20 – GWL at RL -15 for Station and RL -11 West of station



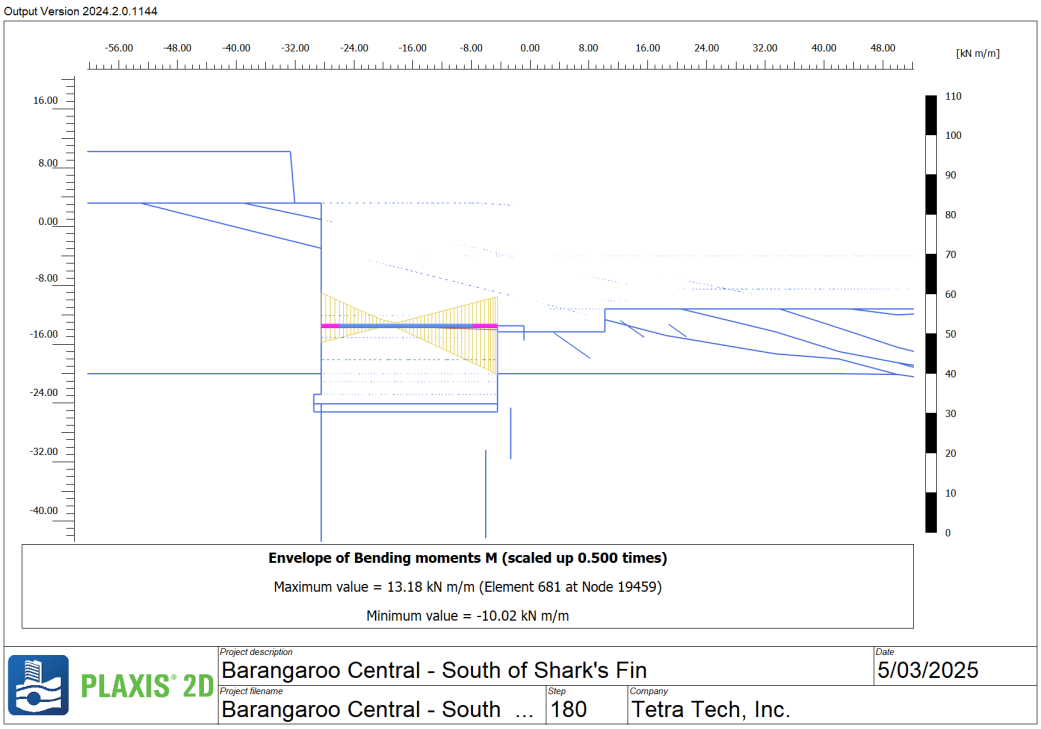
Bending Moment for B3 (Concourse) Slab at Stage 20 – GWL at RL -15 for Station and RL -11 West of station



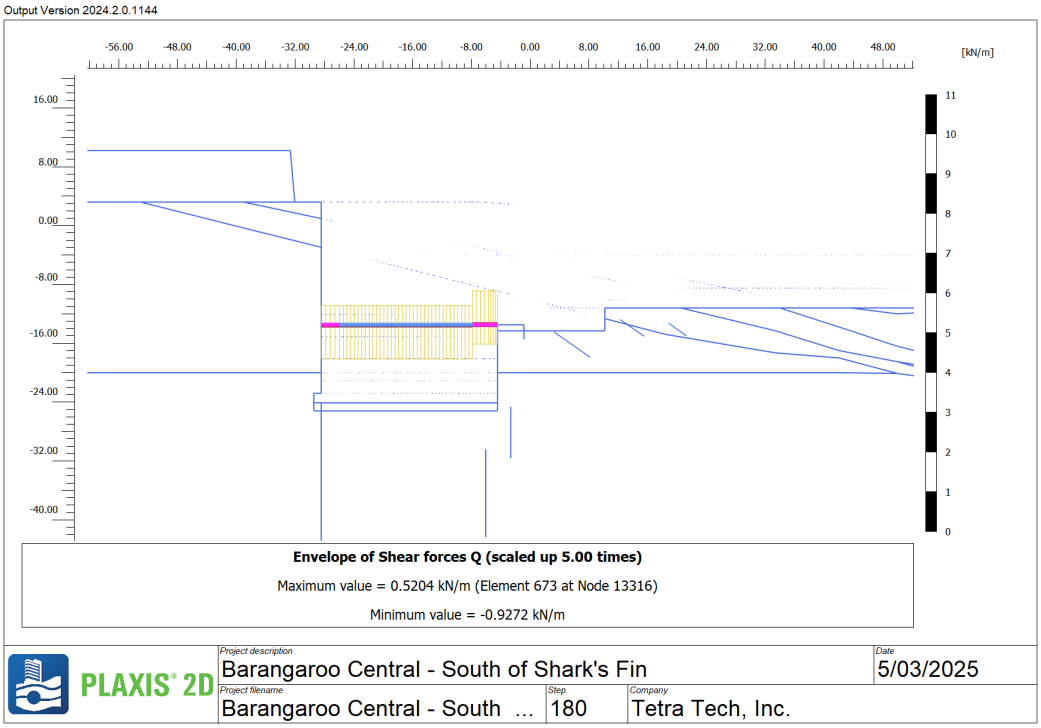
Shear Force for B3 (Concourse) Slab at Stage 20 – GWL at RL -15 for Station and RL -11 West of station



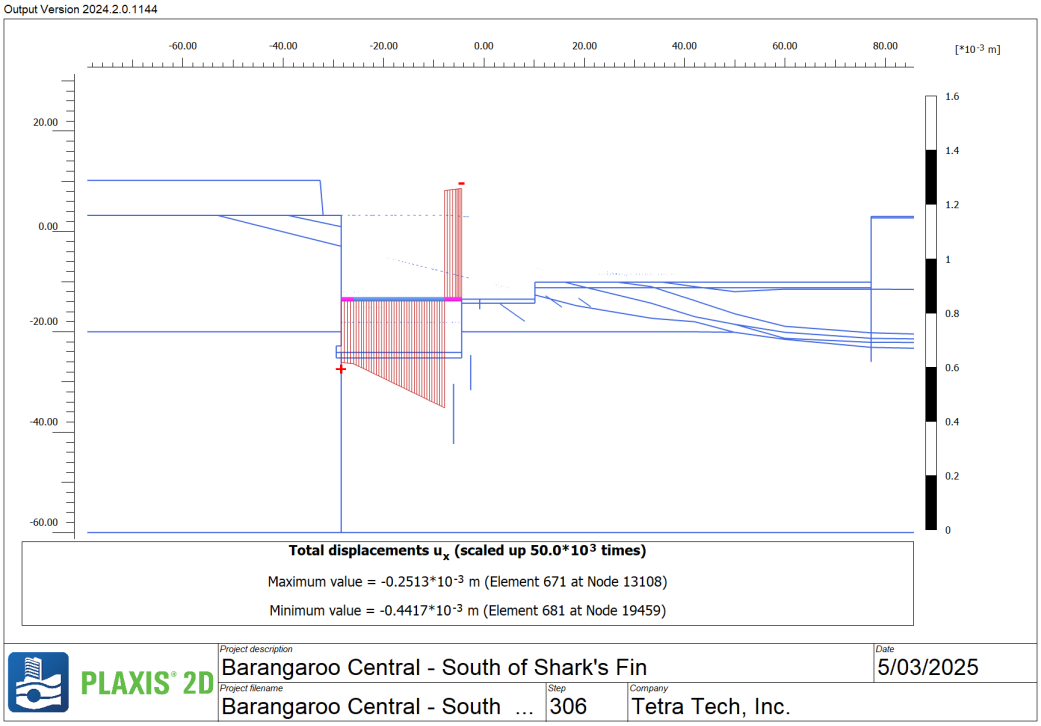
Lateral Displacement for B3 (Concourse) Slab at Stage 33 – Excavate CBD to BEL at RL -14.3 and RL -11.2



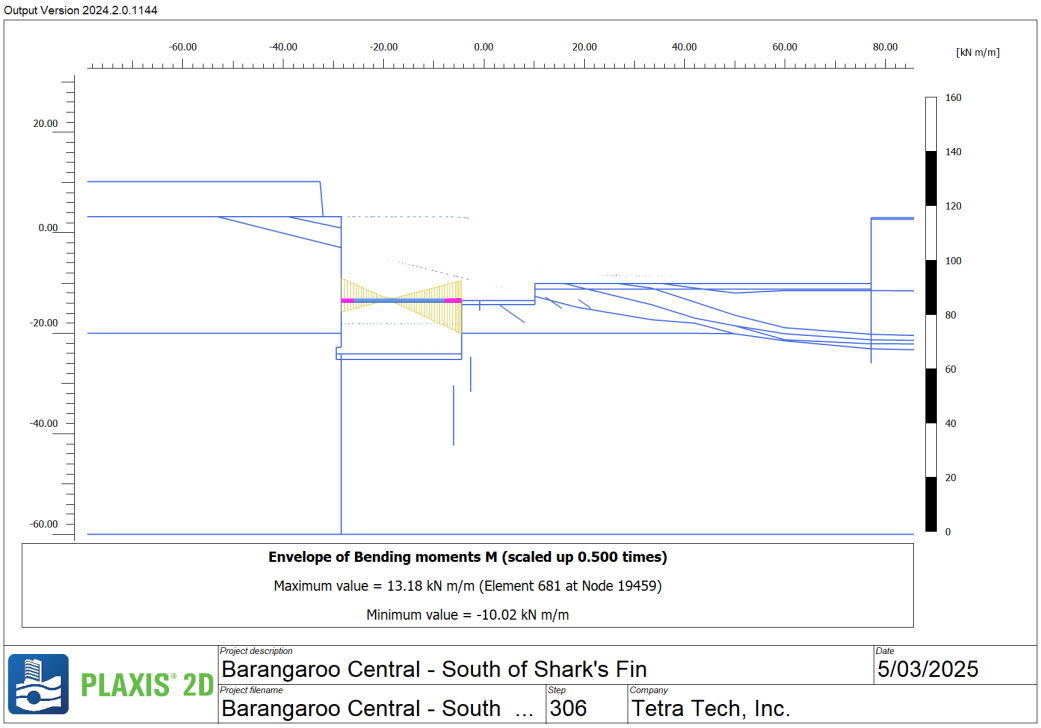
Bending Moment for B3 (Concourse) Slab at Stage 33 – Excavate CBD to BEL at RL -14.3 and RL -11.2



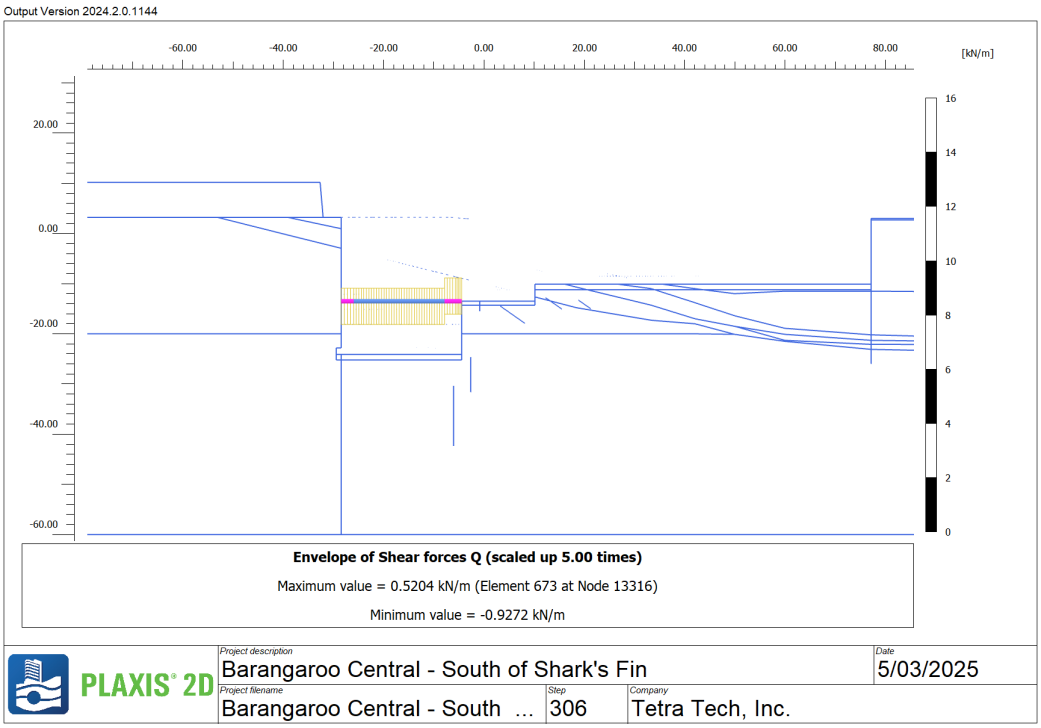
Shear Force for B3 (Concourse) Slab at Stage 33 – Excavate CBD to BEL at RL -14.3 and RL -11.2



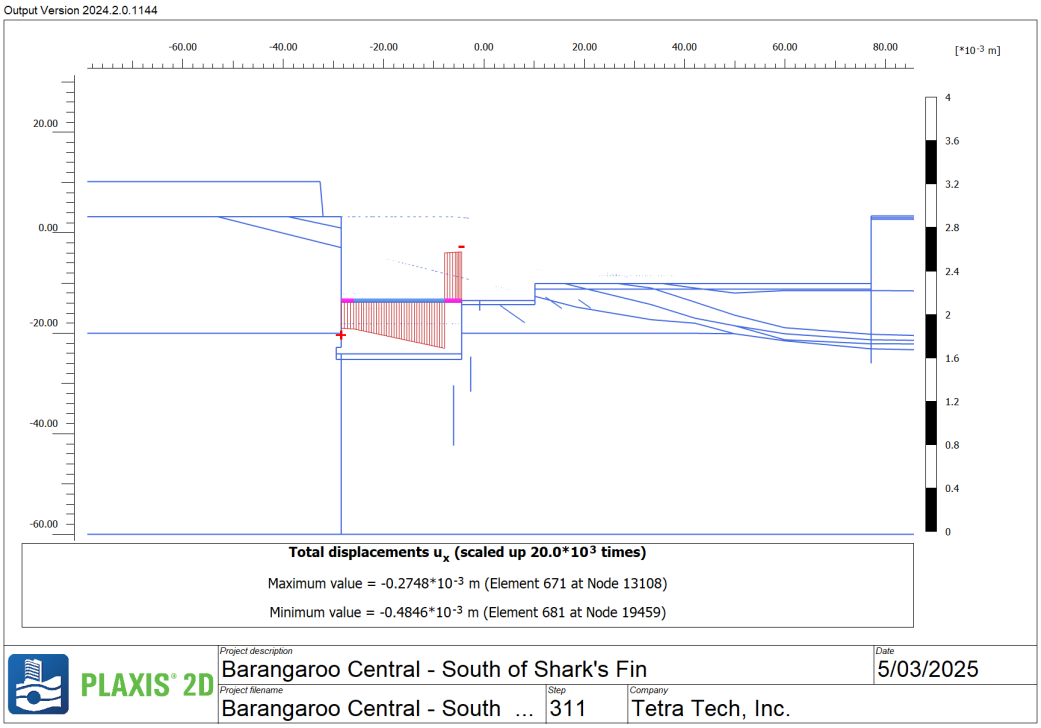
Lateral Displacement for B3 (Concourse) Slab at St age 36 – After Installation of CBD slabs and walls



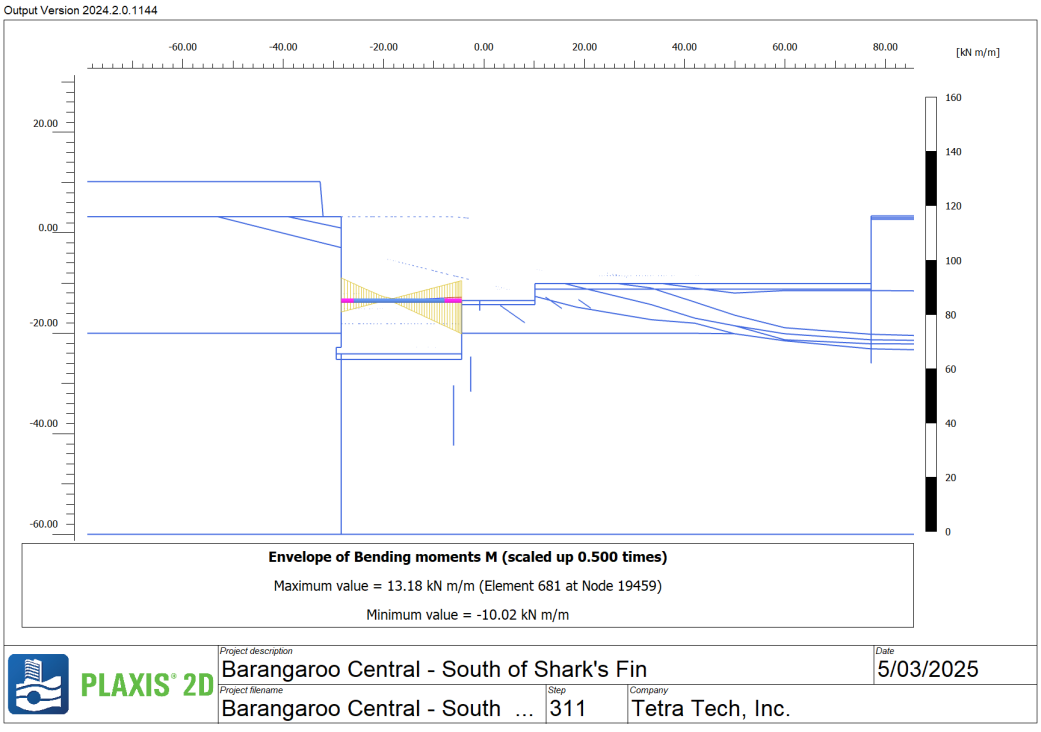
Bending Moment for B3 (Concourse) Slab at Stage 36 – After Installation of CBD slabs and walls



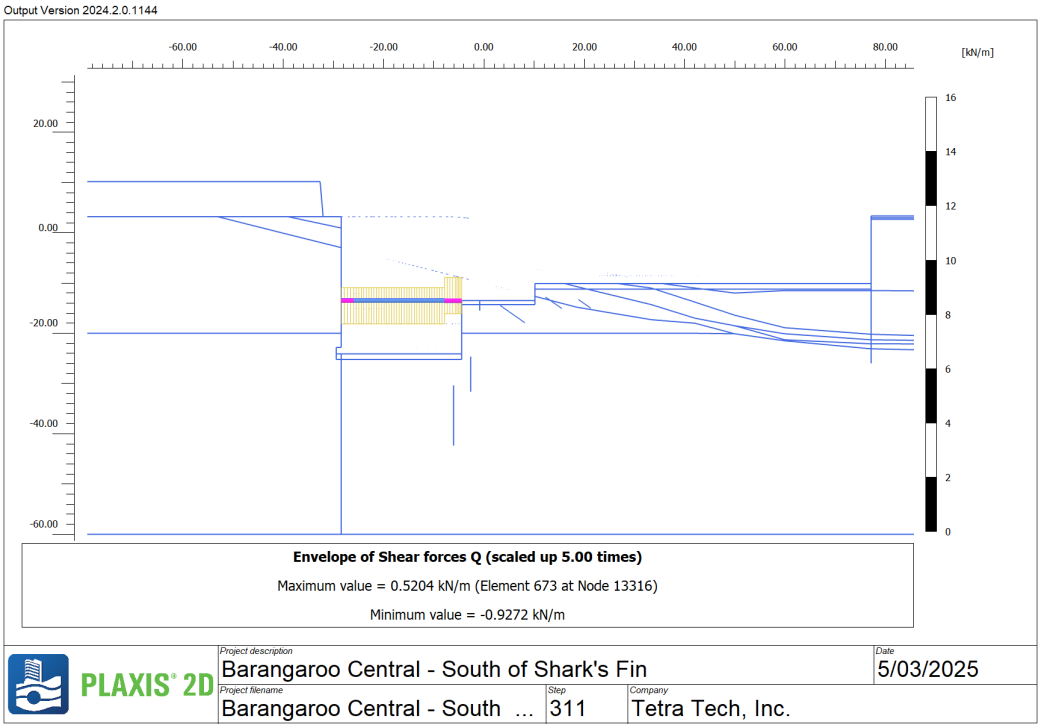
Shear Force for B3 (Concourse) Slab at Stage 36 – After Installation of CBD slabs and walls



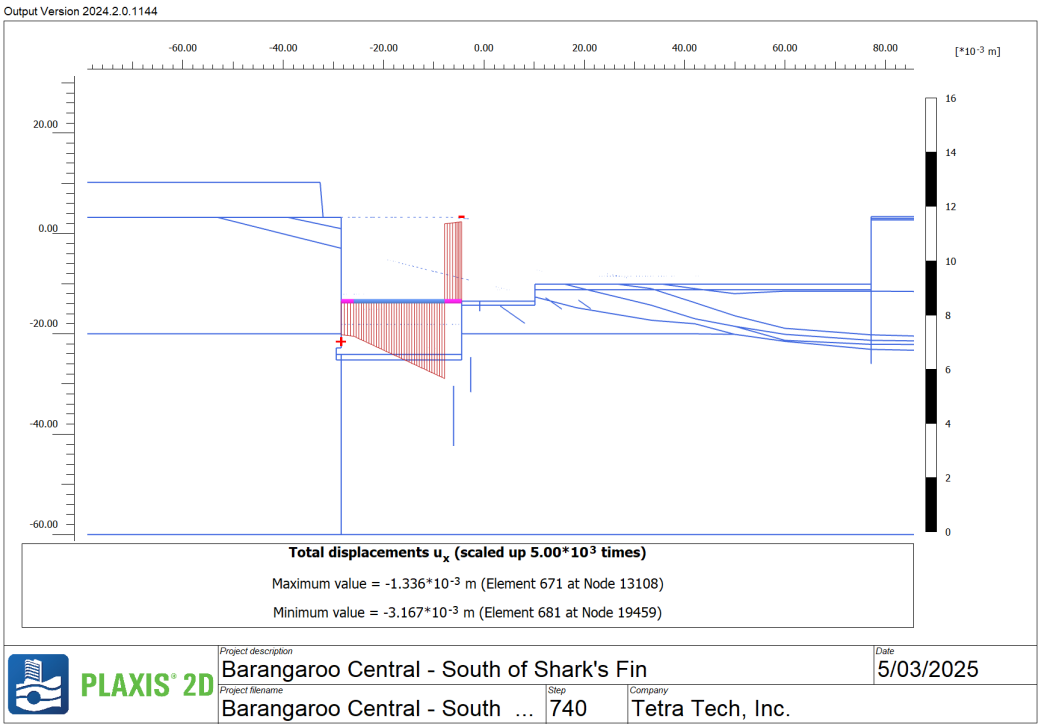
Lateral Displacement for B3 (Concourse) Slab at Stage 37 – GWL at RL-10 for Station and RL -11.2 for CBD



Bending Moment for B3 (Concourse) Slab at Stage 37 – GWL at RL-10 for Station and RL -11.2 for CBD

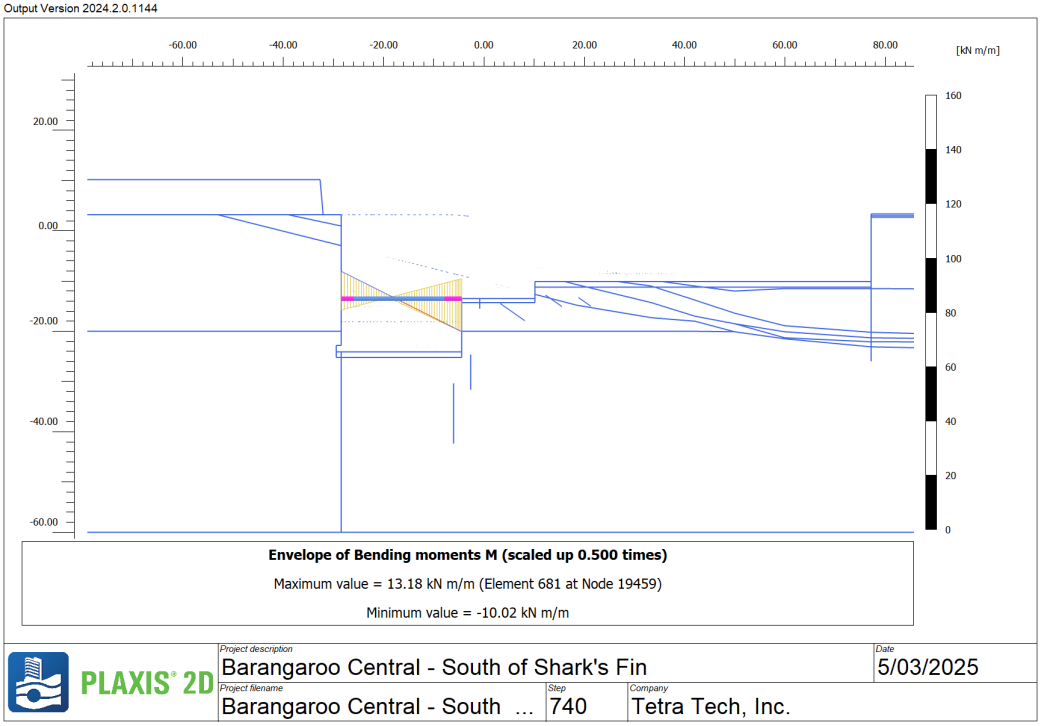


Shear Force for B3 (Concourse) Slab at Stage 37 – GWL at RL-10 for Station and RL -11.2 for CBD



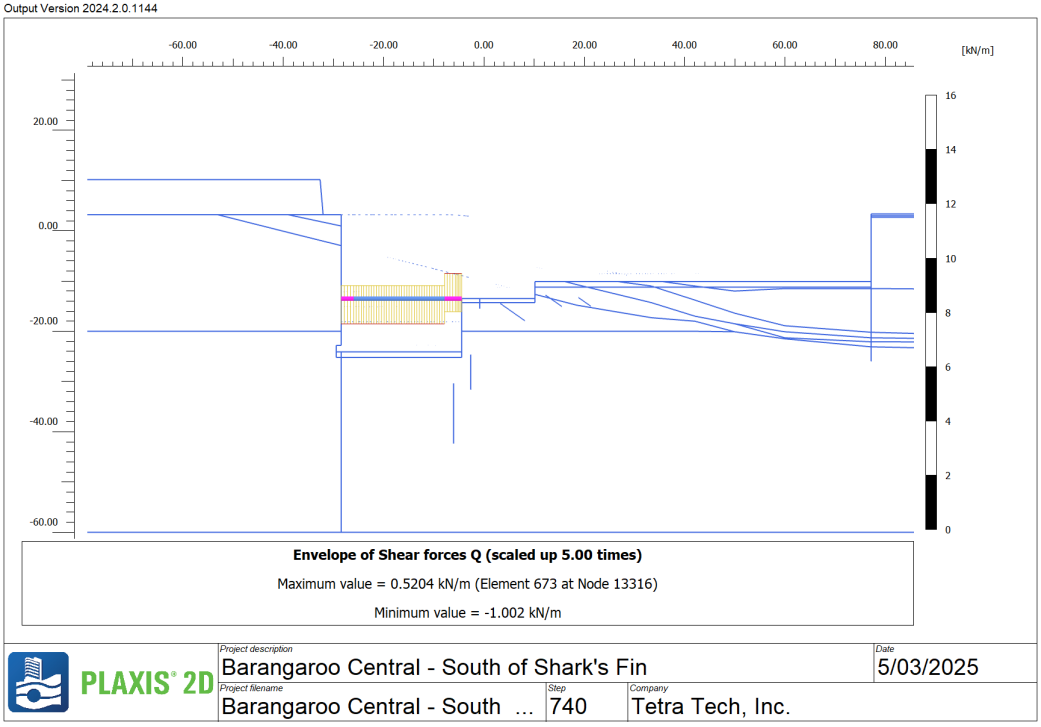
Lateral Displacement for B3 (Concourse) Slab for GWL Case 1 - GWL at RL 1.5

Output Version 2024.2.0.1144

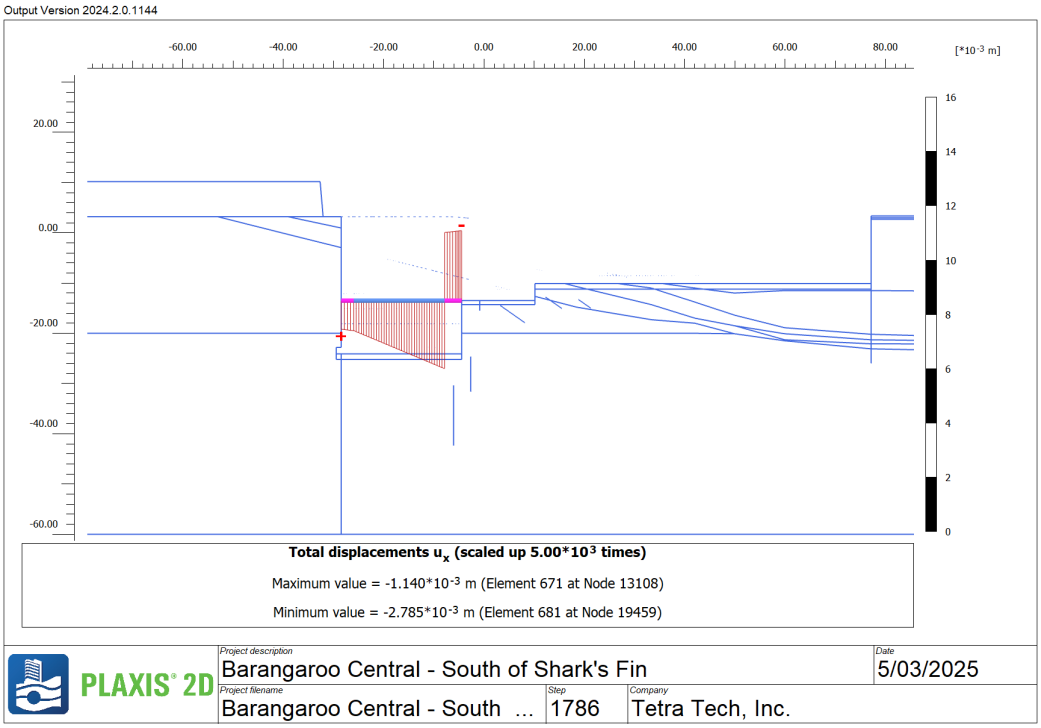


Bending Moment for B3 (Concourse) Slab for GWL Case 1 - GWL at RL 1.5

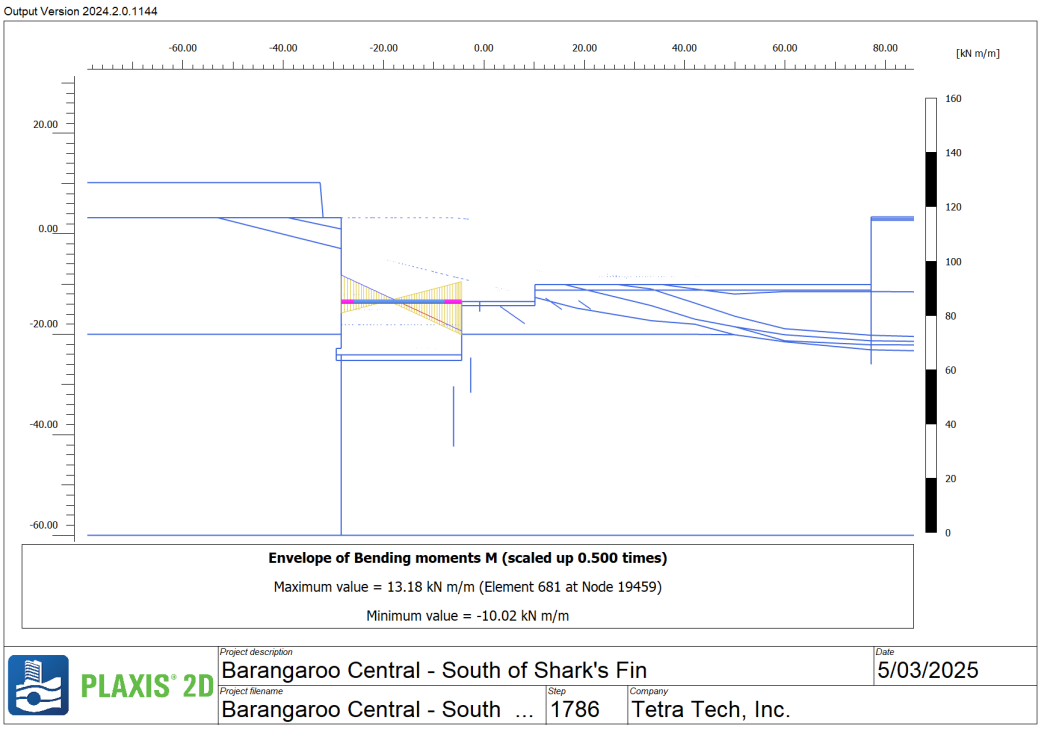
Output Version 2024.2.0.1144



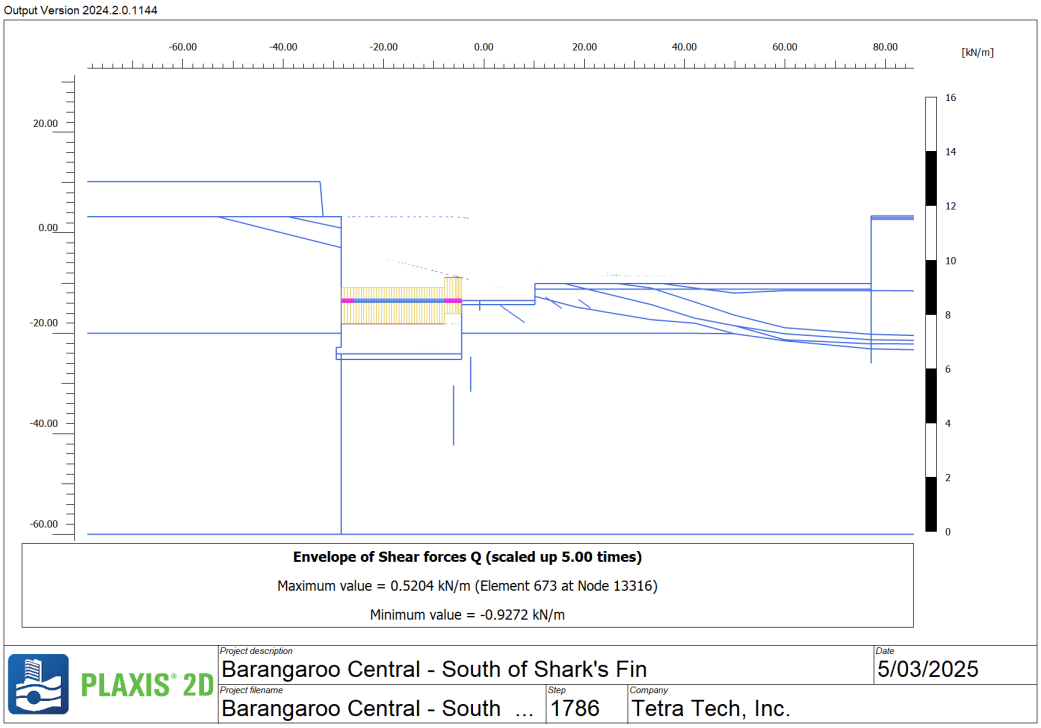
Shear Force for B3 (Concourse) Slab for GWL Case 1 - GWL at RL 1.5



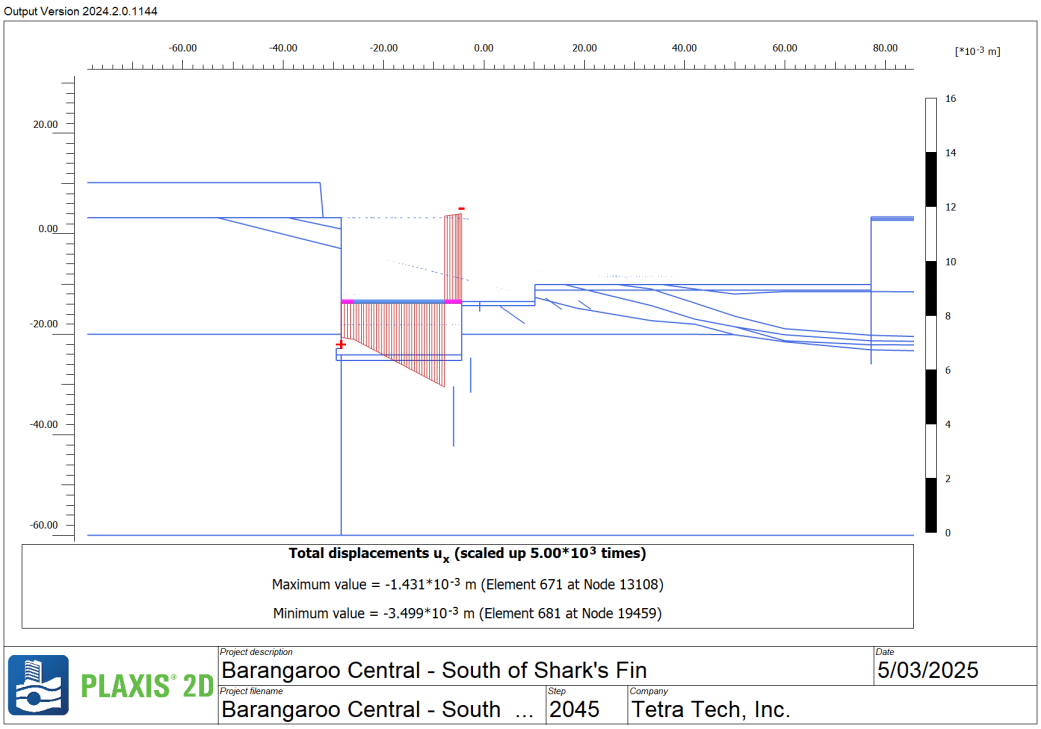
Lateral Displacement for B3 (Concourse) Slab for GWL Case 2 - GWL at RL 1.5 at landward side and RL 0.5 at seaward side



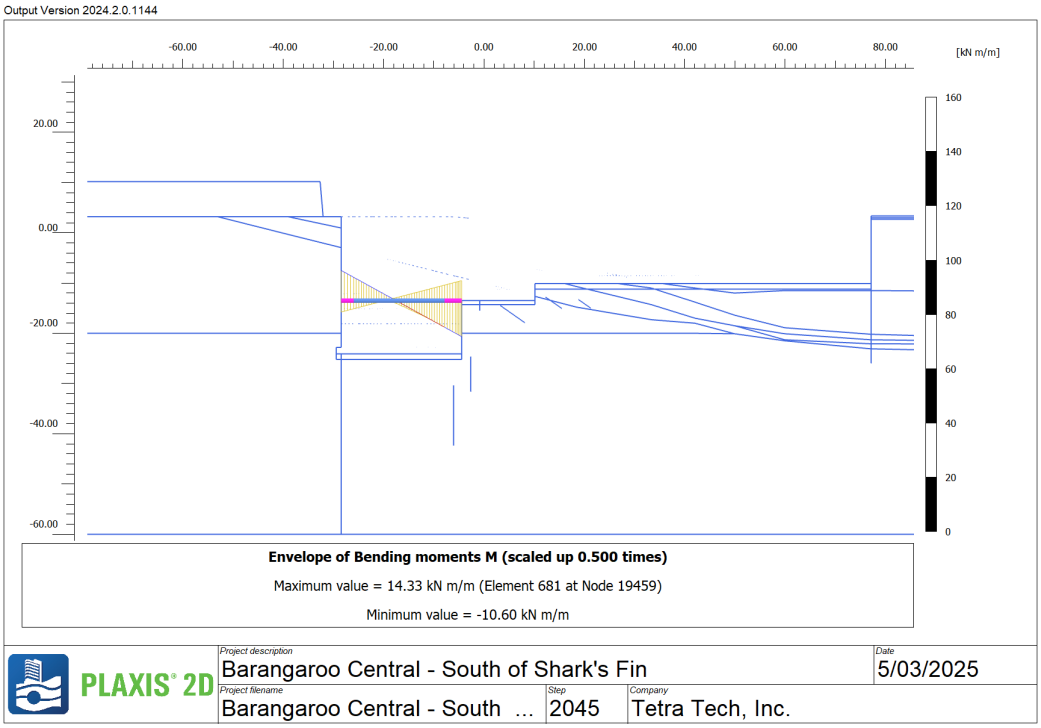
Bending Moment for B3 (Concourse) Slab for GWL Case 2 - GWL at RL 1.5 at landward side and RL 0.5 at seaward side



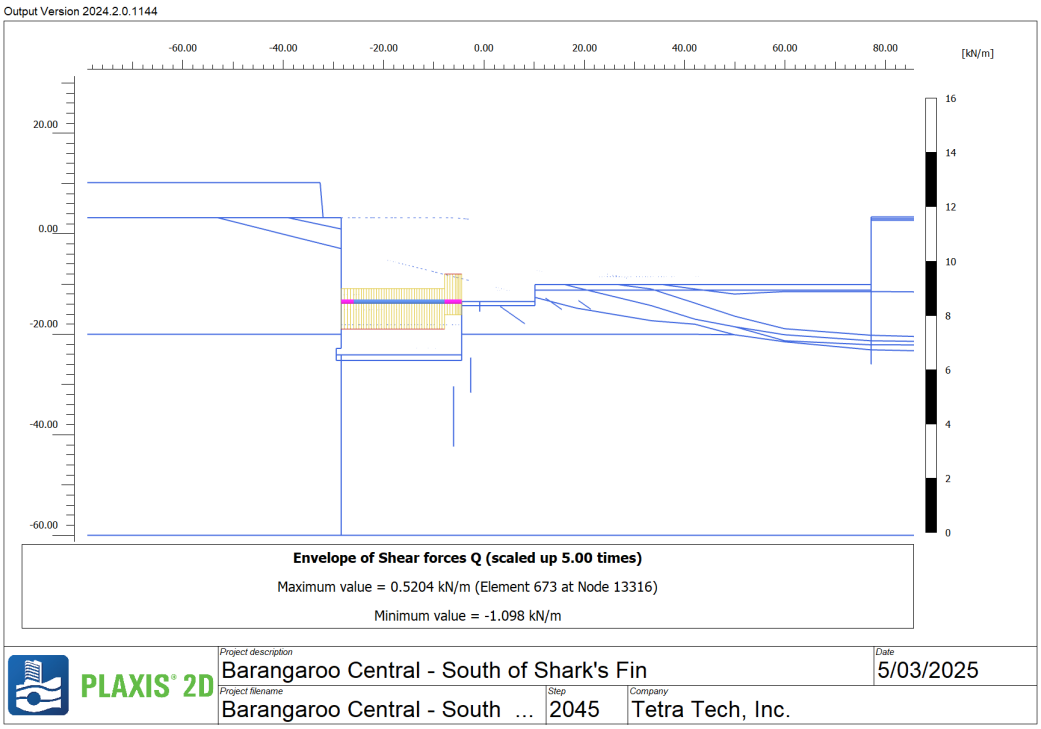
Shear Force for B3 (Concourse) Slab for GWL Case 2 - GWL at RL 1.5 at landward side and RL 0.5 at seaward side



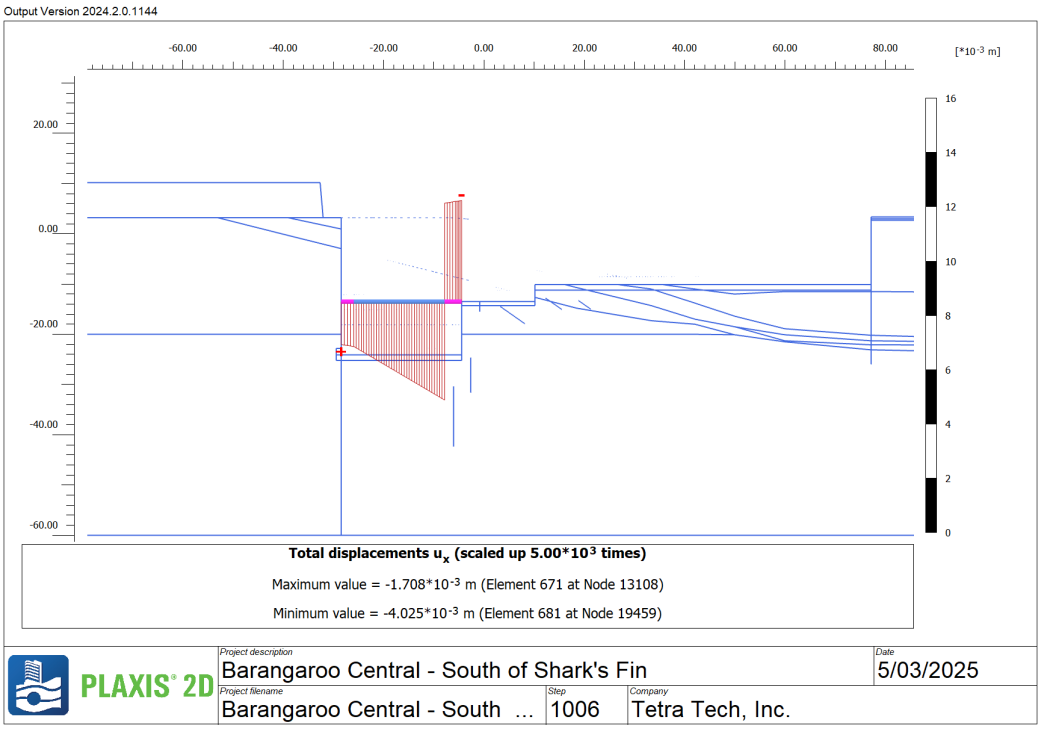
Lateral Displacement for B3 (Concourse) Slab for GWL Case 3 - GWL at RL 2.575



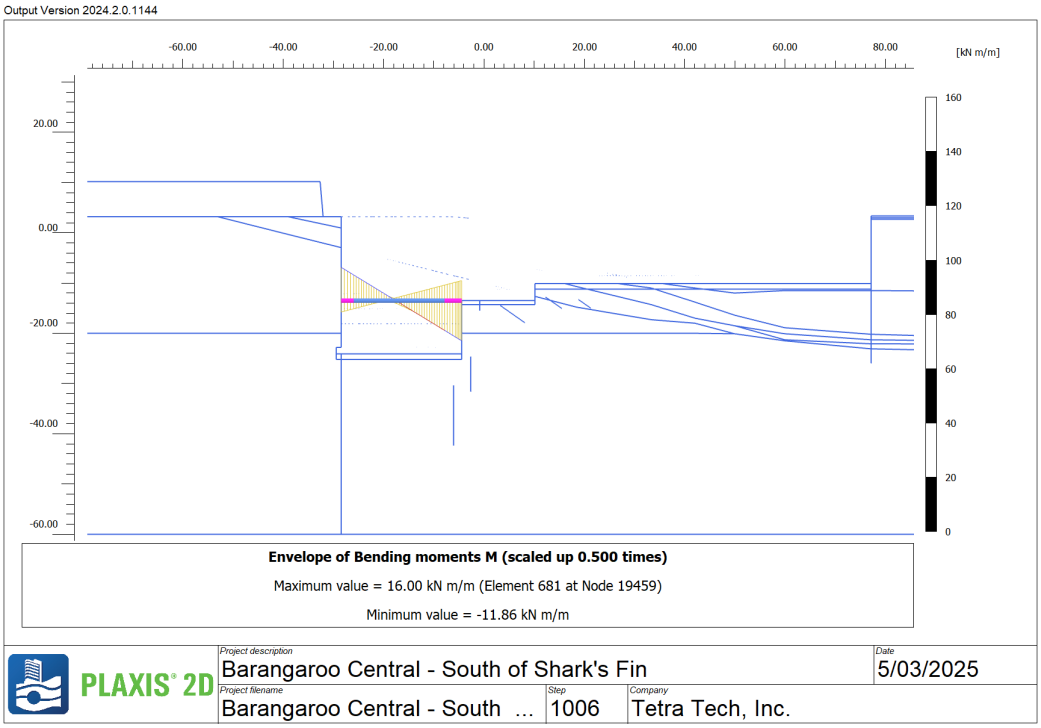
Bending Moment for B3 (Concourse) Slab for GWL Case 3 - GWL at RL 2.575



Shear Force for B3 (Concourse) Slab for GWL Case 3 - GWL at RL 2.575

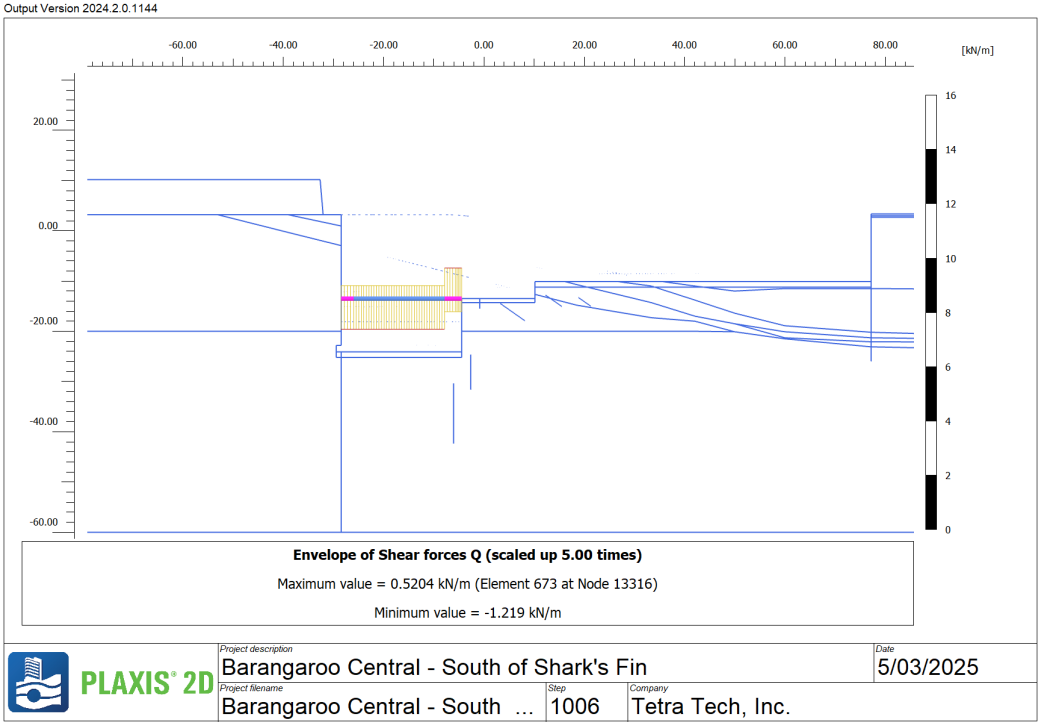


Lateral Displacement for B3 (Concourse) Slab for GWL Case 4 - GWL at RL 2.575 at seaward side and RL 1.575 at landward side



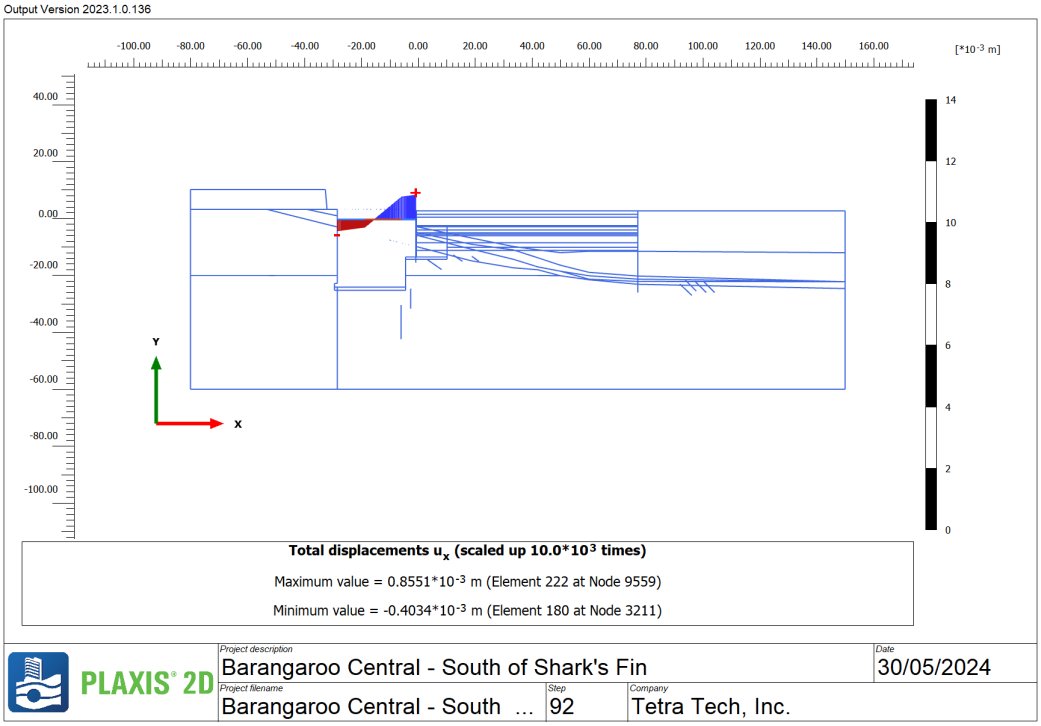
Bending Moment for B3 (Concourse) Slab for GWL Case 4 - GWL at RL 2.575 at seaward side and RL 1.575 at landward side

Output Version 2024.2.0.1144

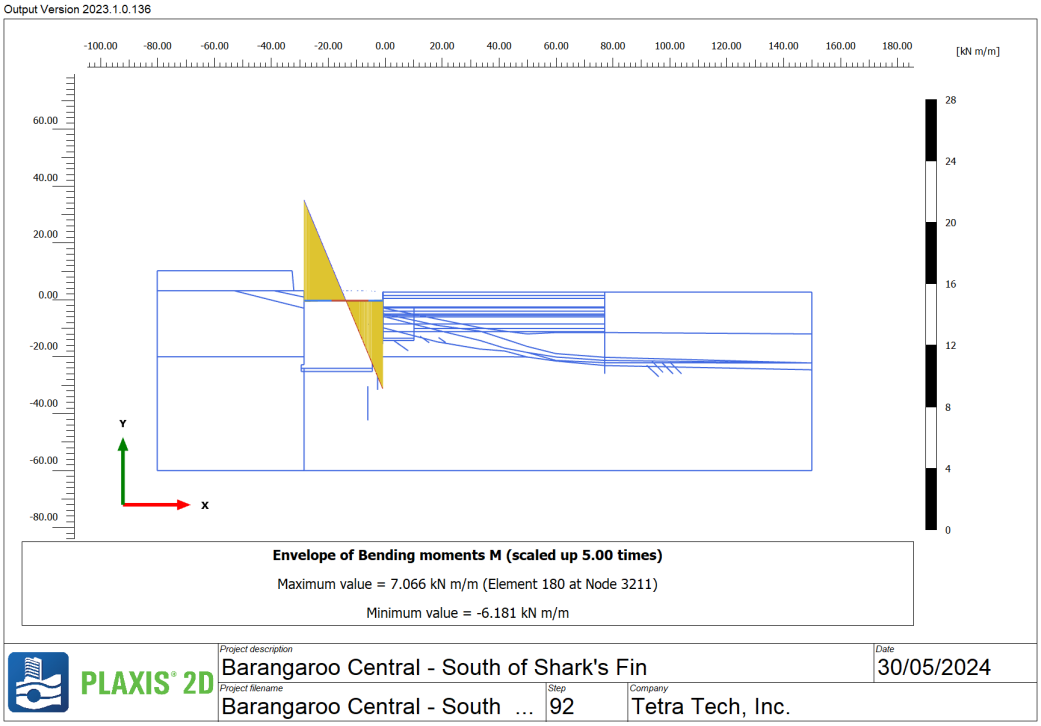


Shear Force for B3 (Concourse) Slab for GWL Case 4 - GWL at RL 2.575 at seaward side and RL 1.575 at landward side

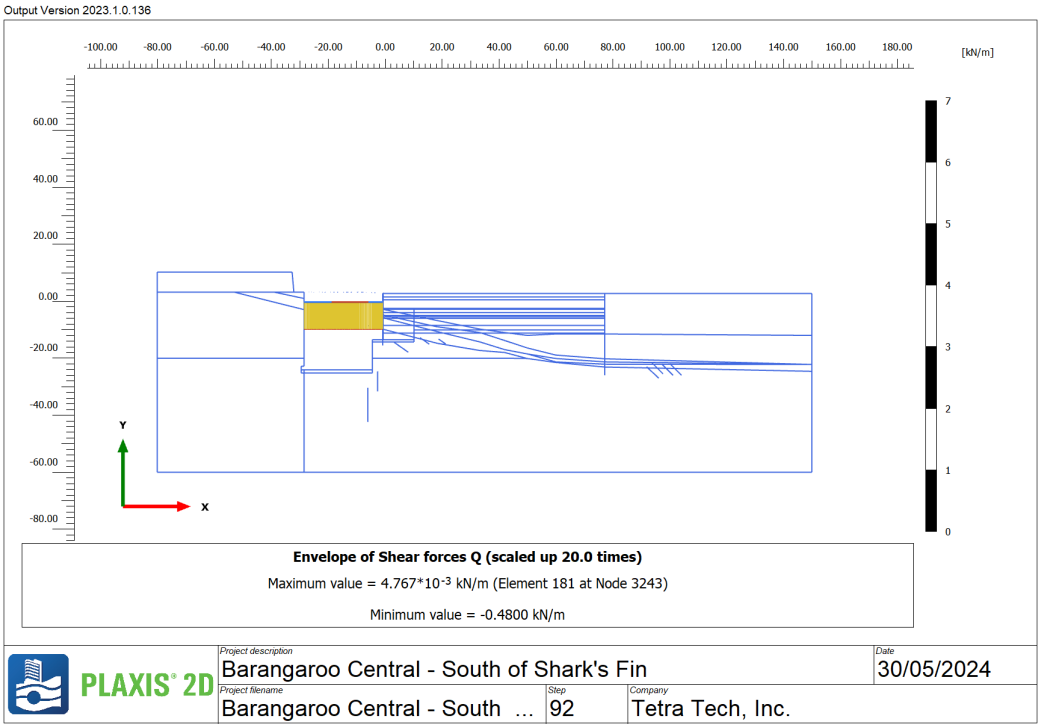
F. Top Slab



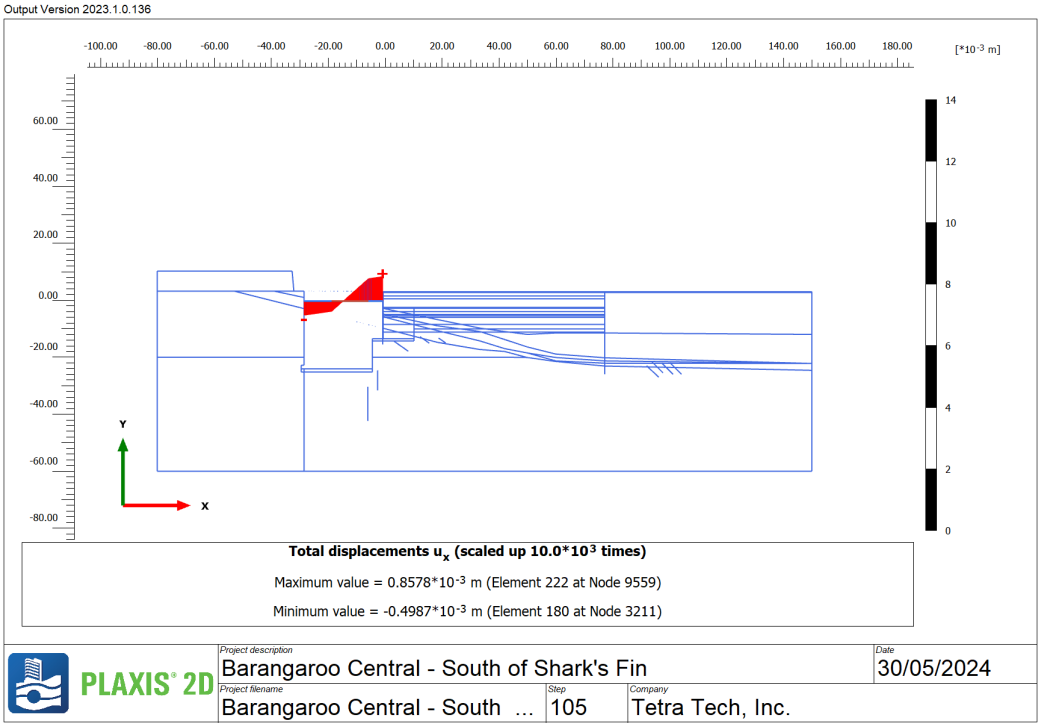
Lateral Displacement for Top Slab at Stage 19 – After installation of Station slabs and walls



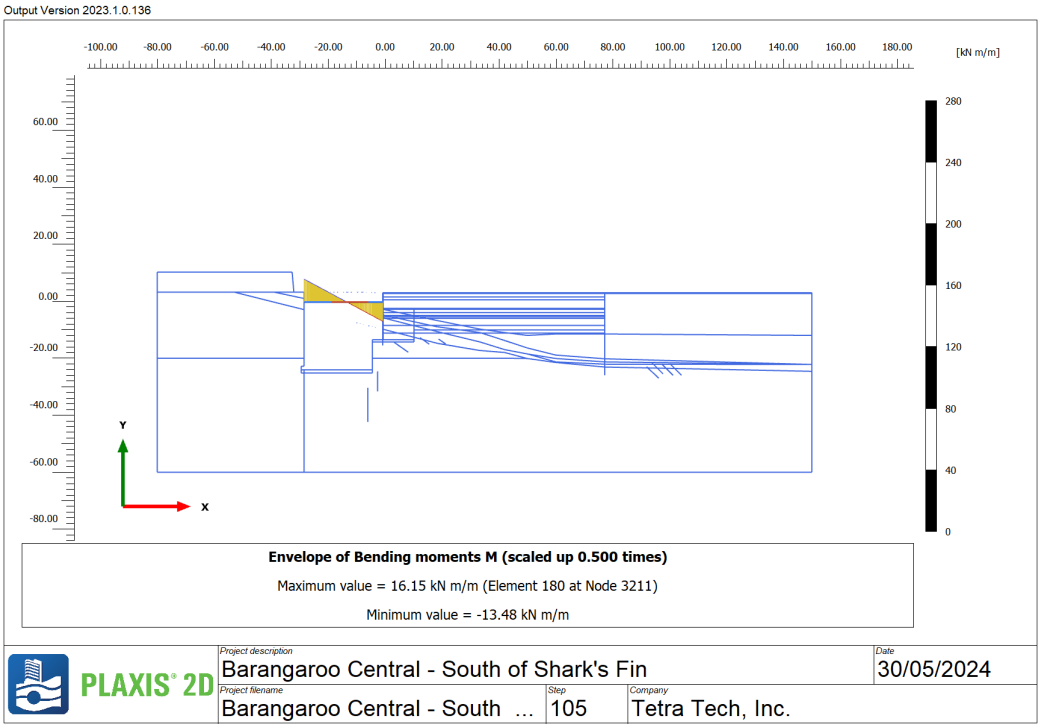
Bending Moment for Top Slab at Stage 19 – After installation of Station slabs and walls



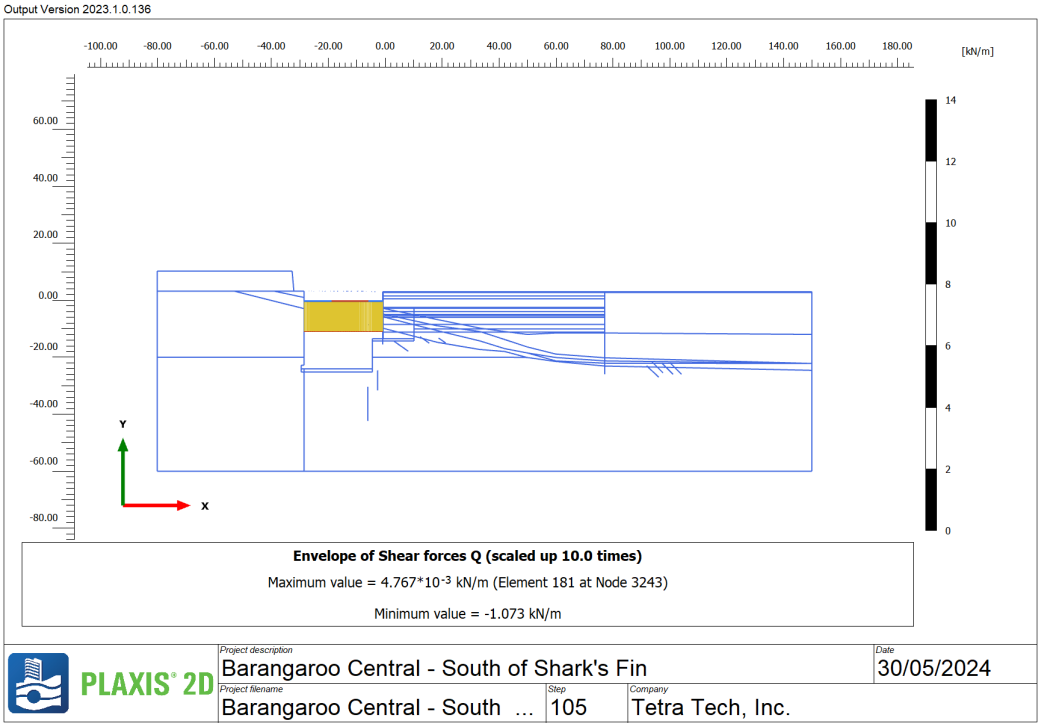
Shear Force for Top Slab at Stage 19 – After installation of Station slabs and walls



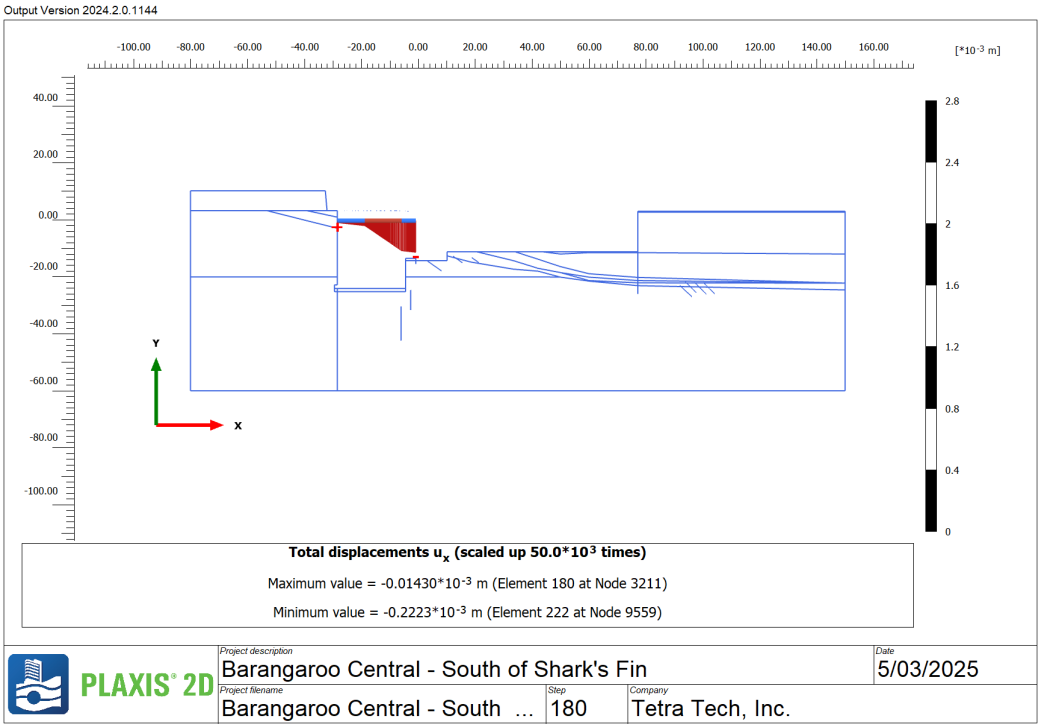
Lateral Displacement for Top Slab at Stage 20 – GWL at RL -15 for Station and RL -11 West of station



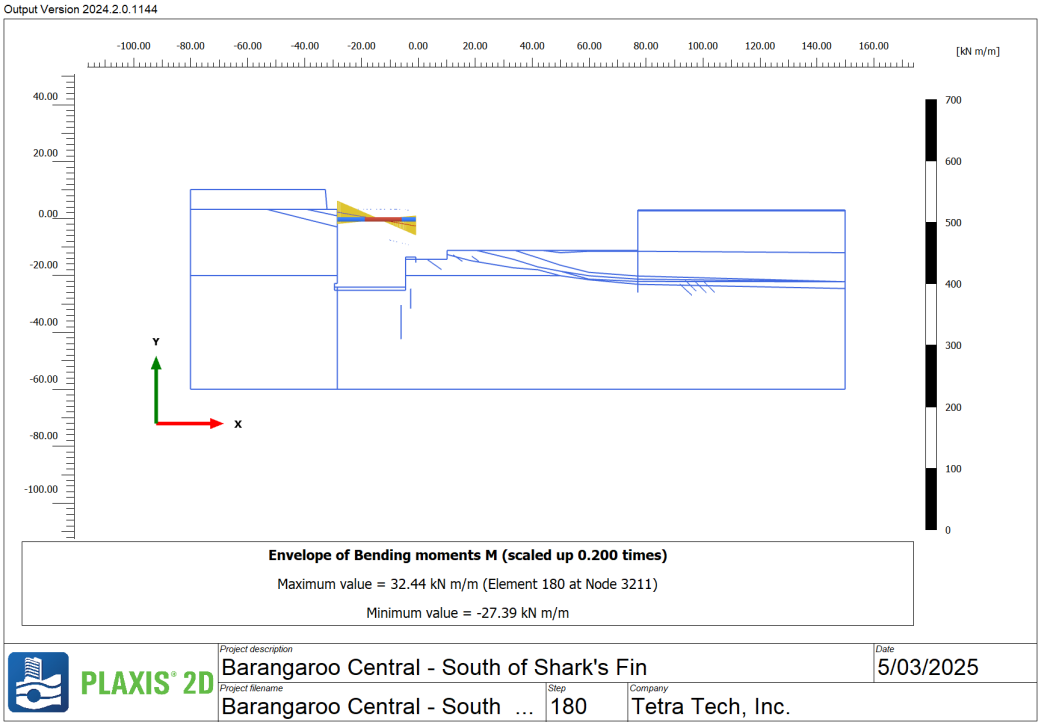
Bending Moment for Top Slab at Stage 20 – GWL at RL -15 for Station and RL -11 West of station



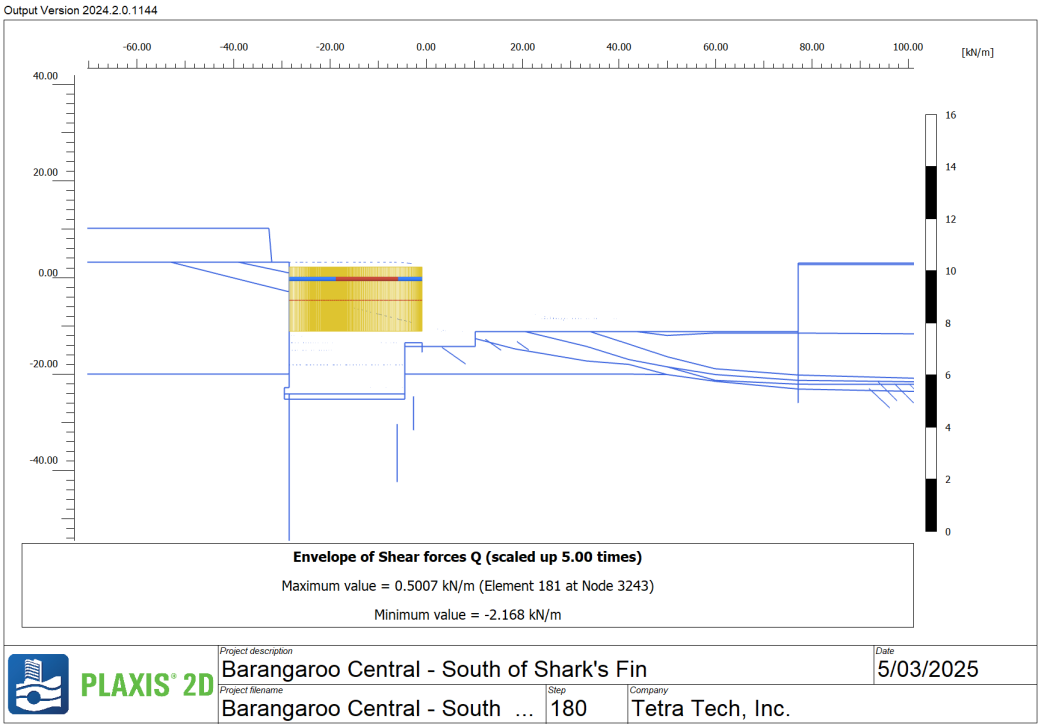
Shear Force for Top Slab at Stage 20 – GWL at RL -15 for Station and RL -11 West of station



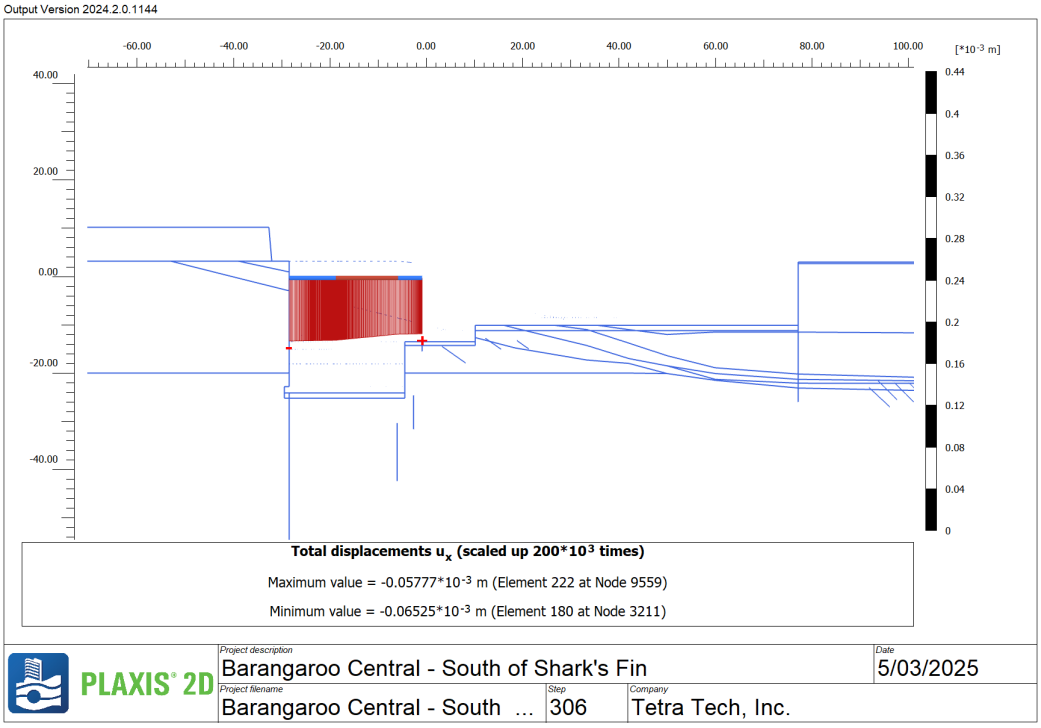
Lateral Displacement for Top Slab at Stage 33 – Excavate CBD to BEL at RL -14.3 and RL -11.2



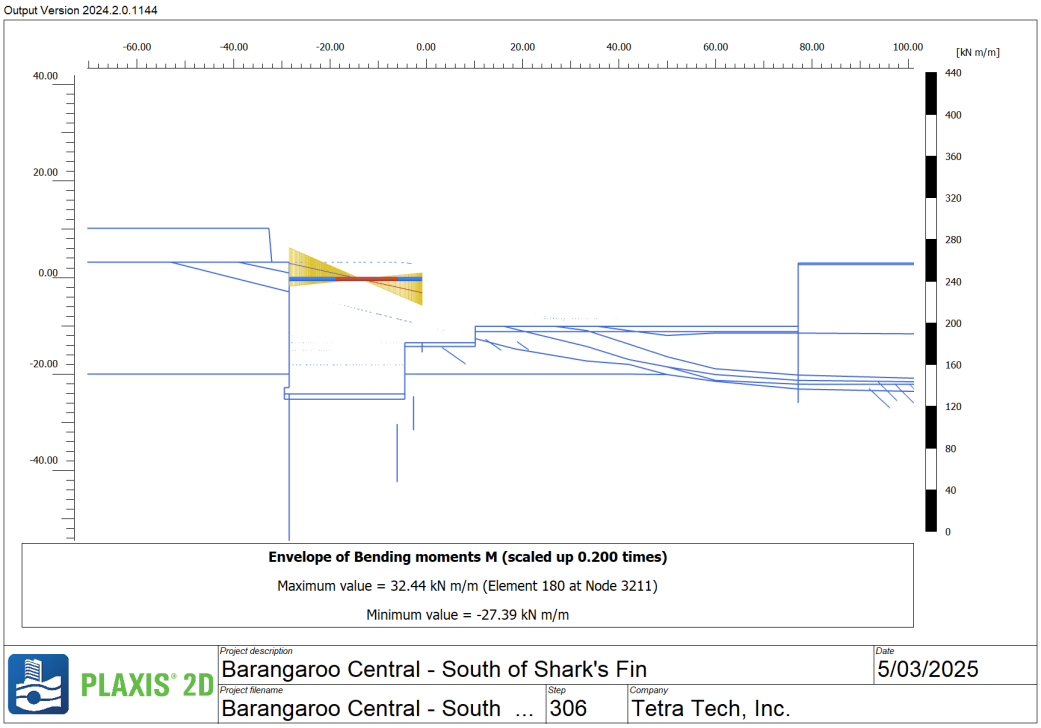
Bending Moment for Top Slab at Stage 33 – Excavate CBD to BEL at RL -14.3 and RL -11.2



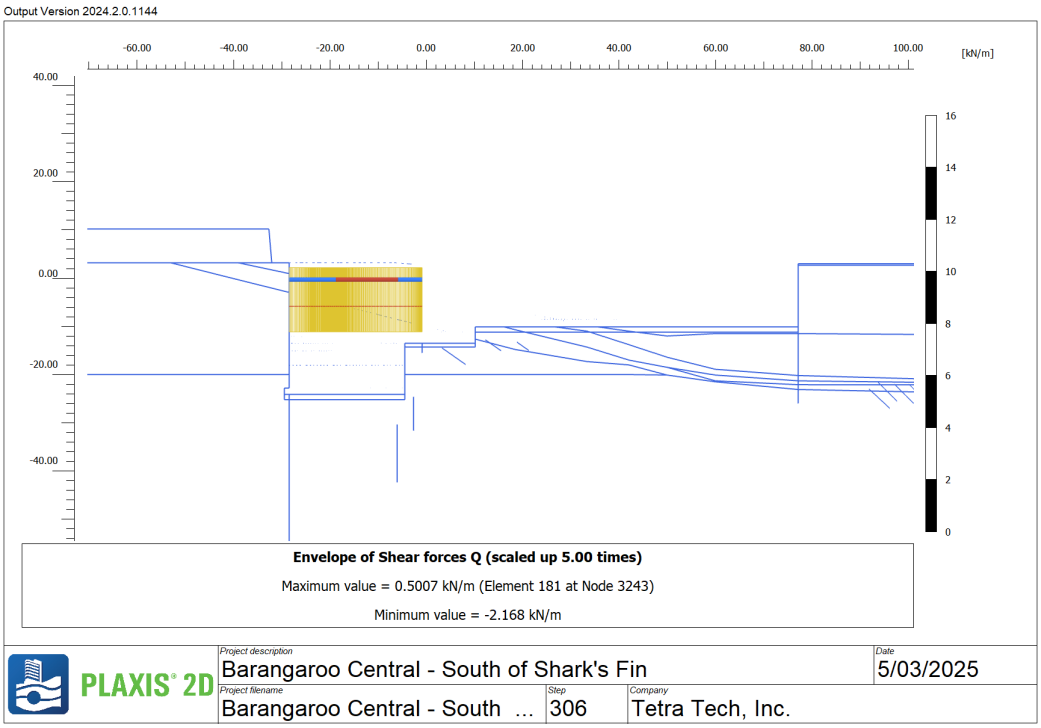
Shear Force for Top Slab at Stage 33 – Excavate CBD to BEL at RL -14.3 and RL -11.2



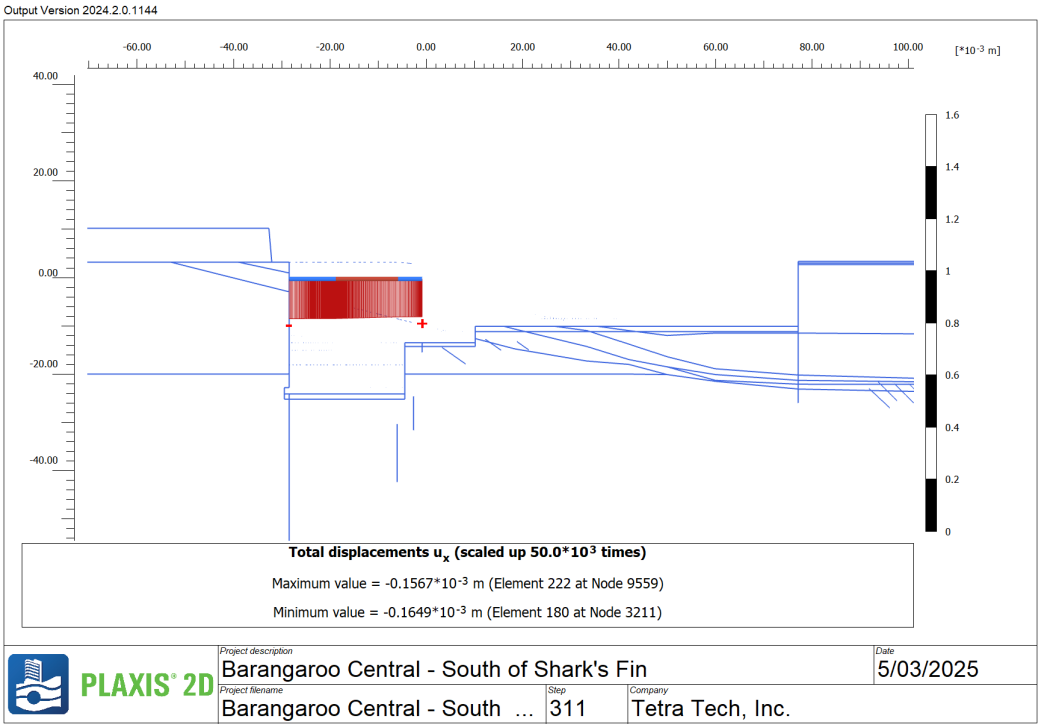
Lateral Displacement for Top Slab at Stage 36 – After Installation of CBD slabs and walls



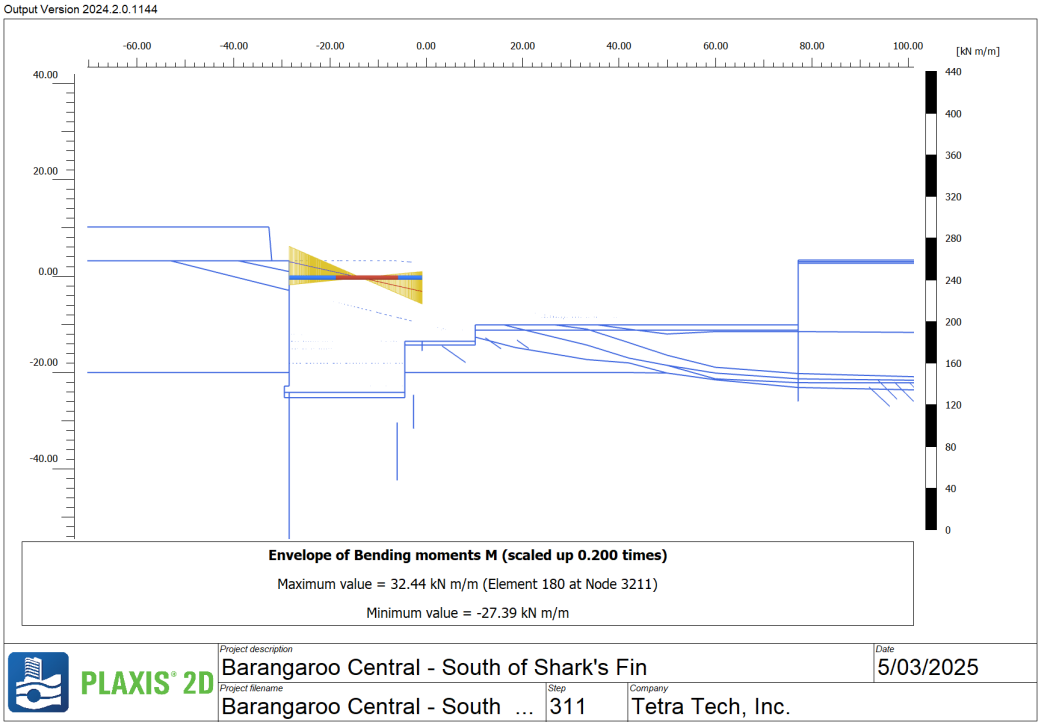
Bending Moment for Top Slab at Stage 36 – After Installation of CBD slabs and walls



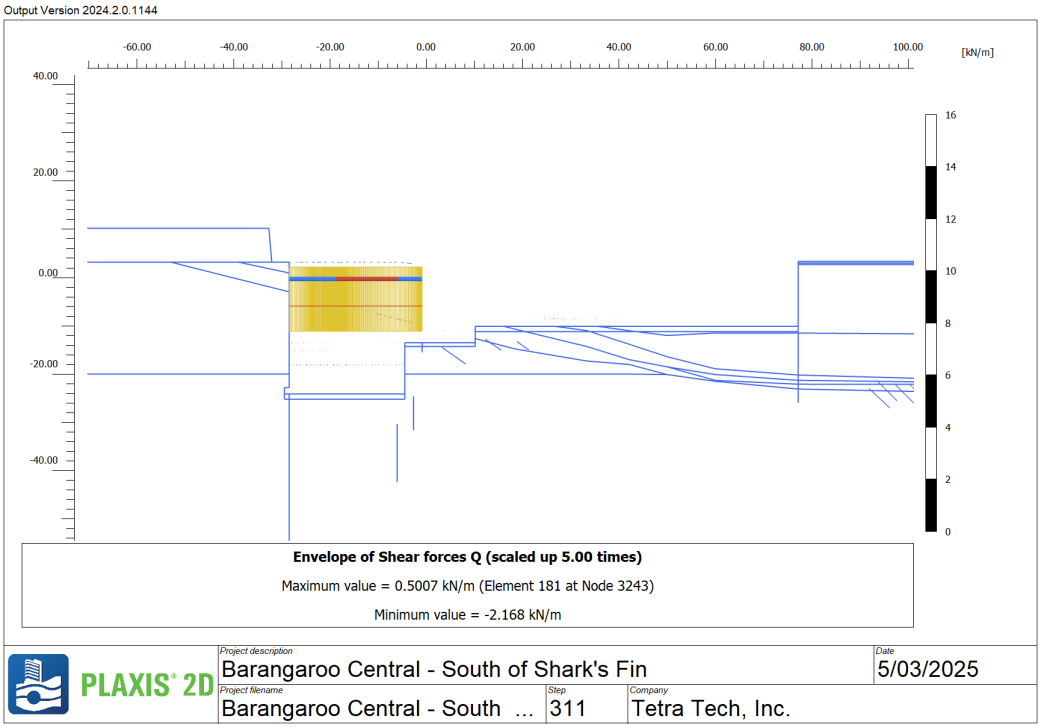
Shear Force for Top Slab at Stage 36 – After Installation of CBD slabs and walls



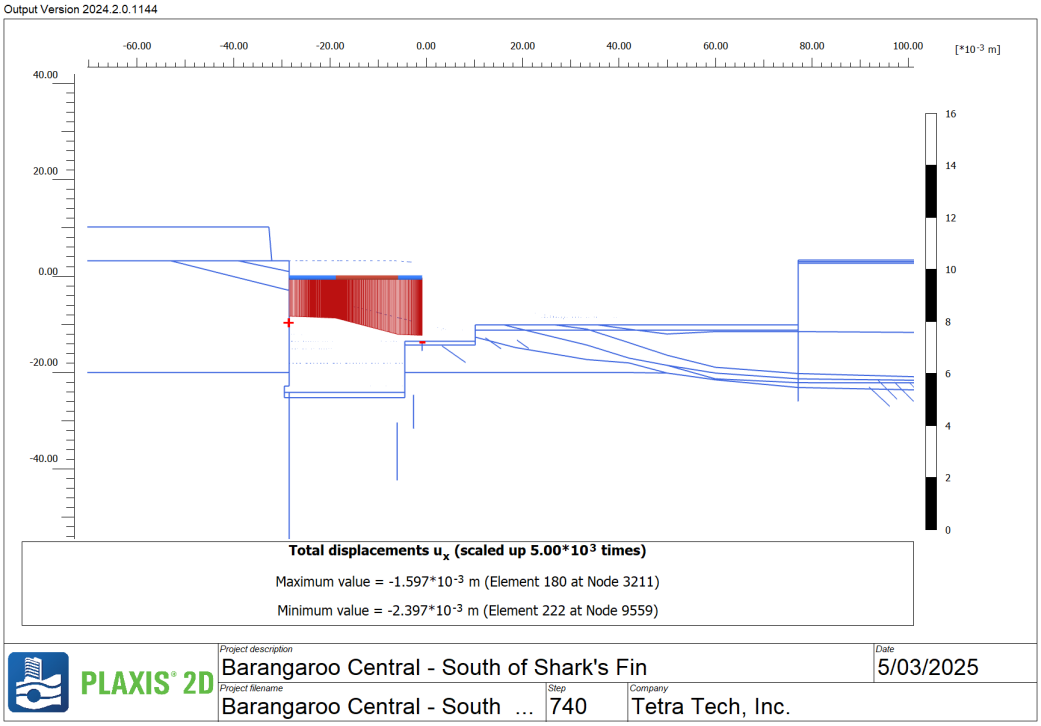
Lateral Displacement for Top Slab at Stage 37 – GWL at RL-10 for Station and RL -11.2 for CBD



Bending Moment for Top Slab at Stage 37 – GWL at RL-10 for Station and RL -11.2 for CBD

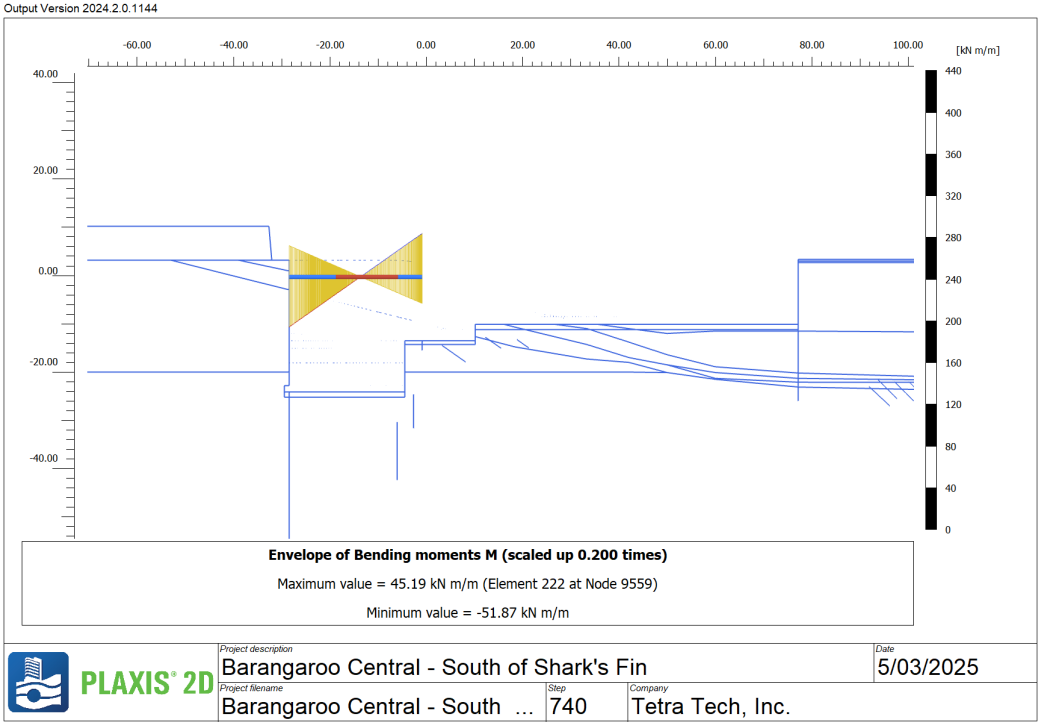


Shear Force for Top Slab at Stage 37 – GWL at RL-10 for Station and RL -11.2 for CBD



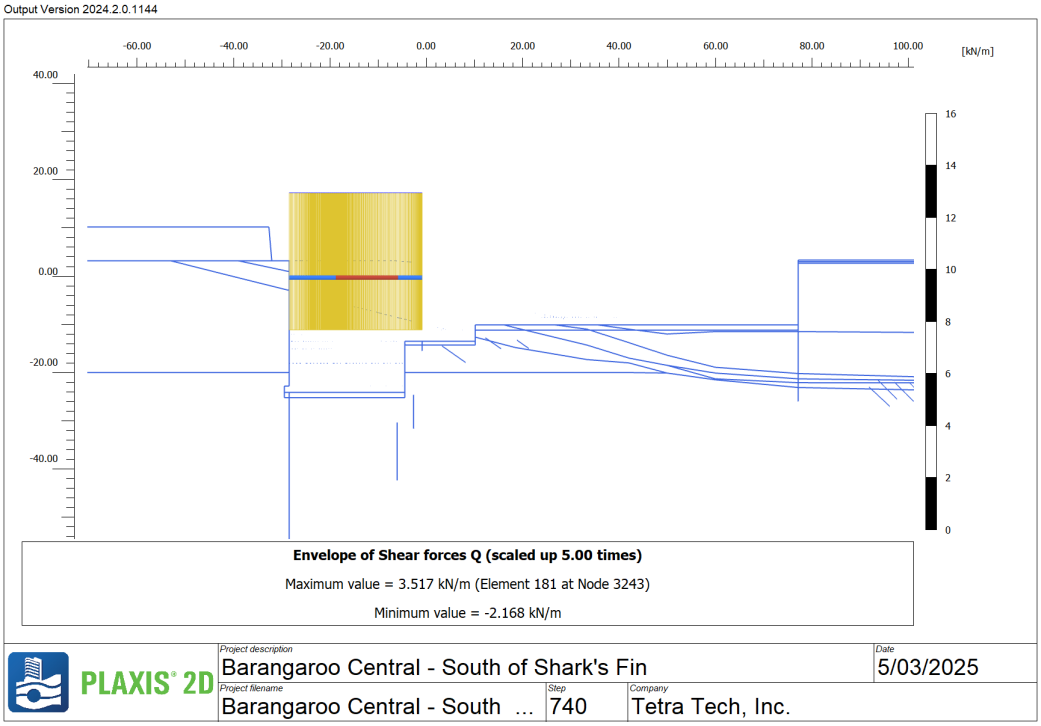
Lateral Displacement for Top Slab for GWL Case 1 - GWL at RL 1.5

Output Version 2024.2.0.1144

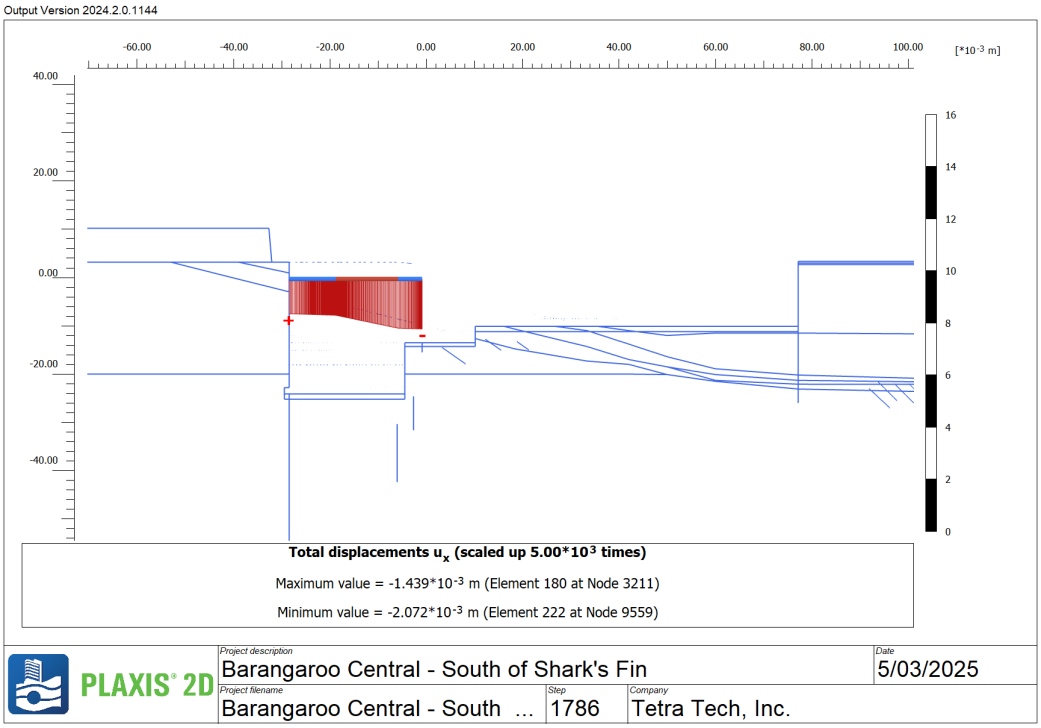


Bending Moment for Top Slab for GWL Case 1 - GWL at RL 1.5

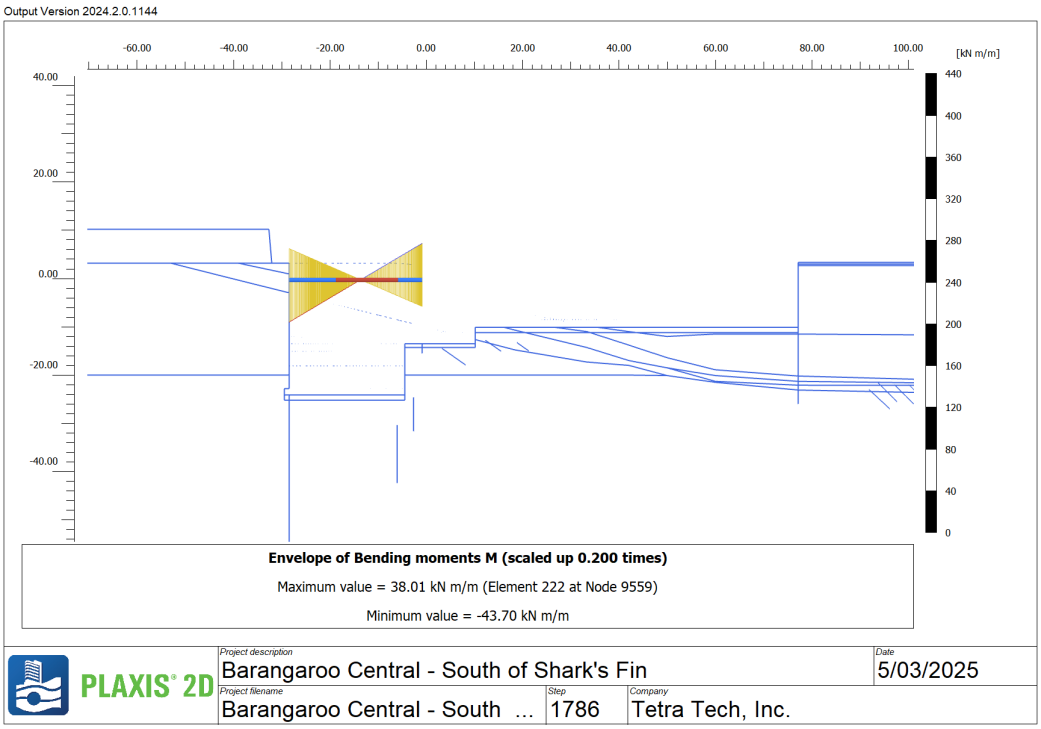
Output Version 2024.2.0.1144



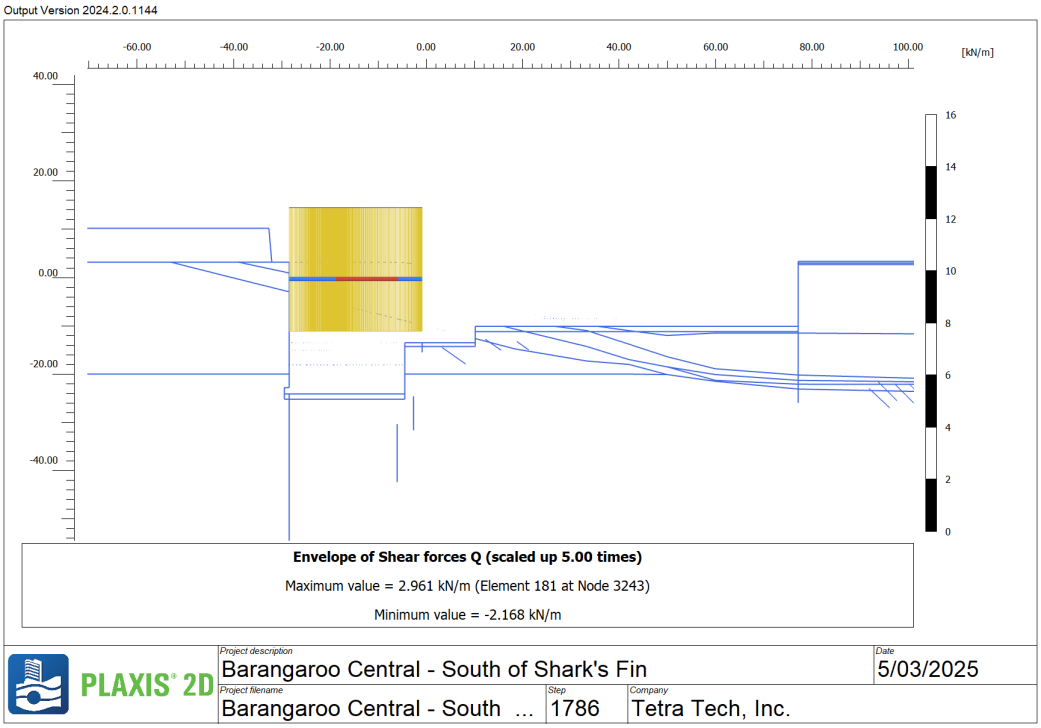
Shear Force for Top Slab for GWL Case 1 - GWL at RL 1.5



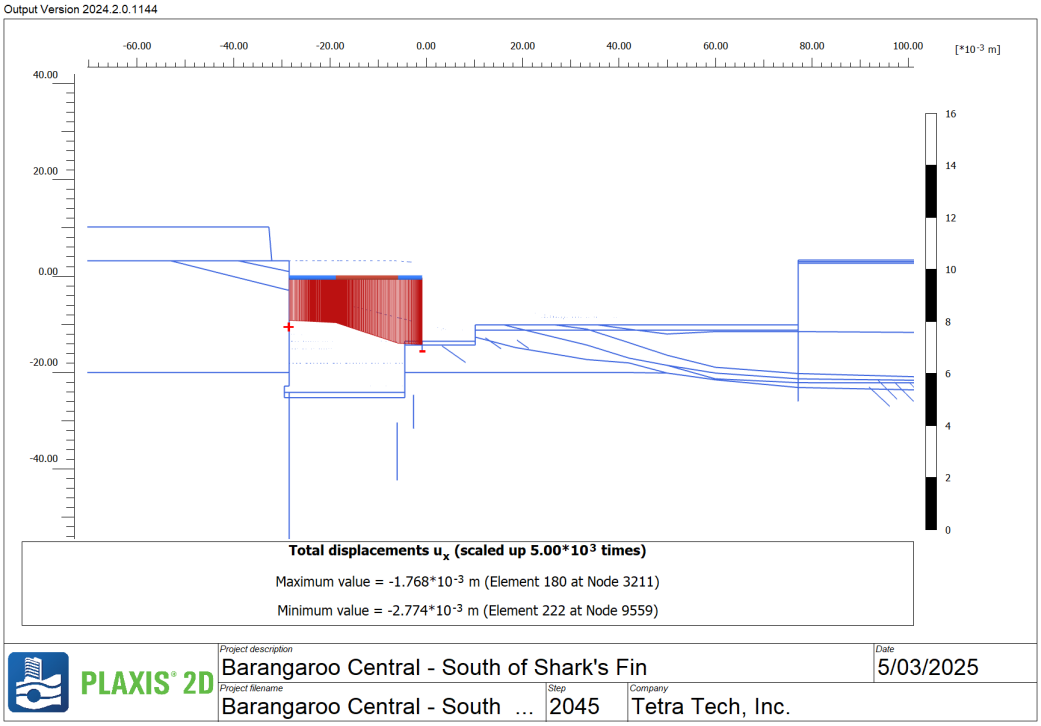
Lateral Displacement for Top Slab for GWL Case 2 - GWL at RL 1.5 at landward side and RL 0.5 at seaward side



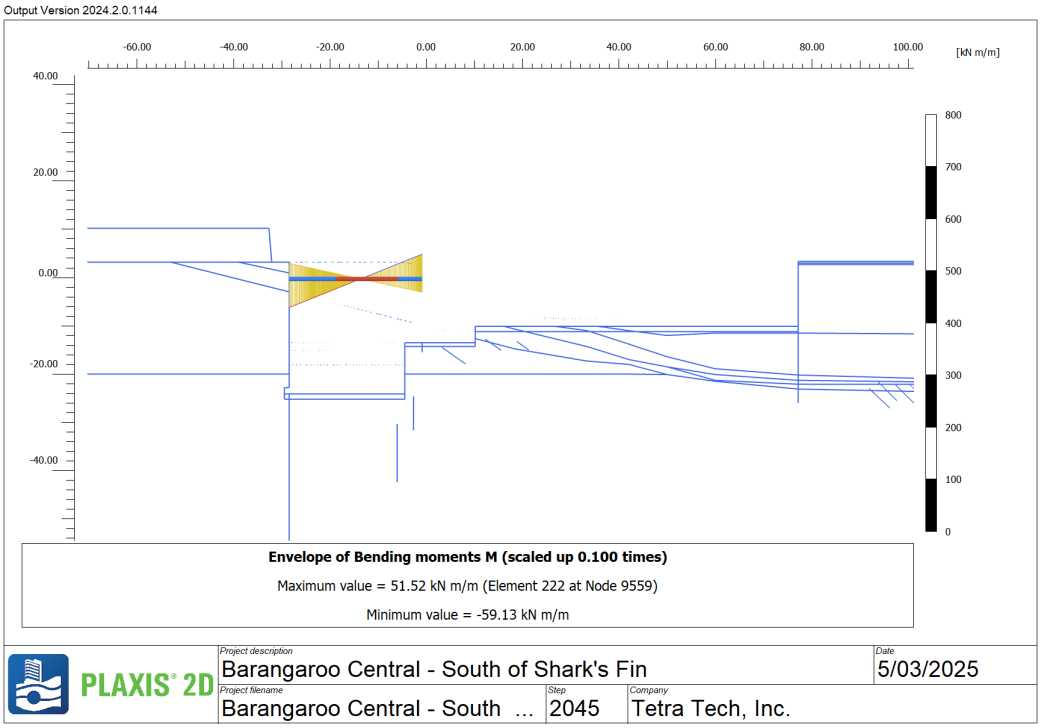
Bending Moment for Top Slab for GWL Case 2 - GWL at RL 1.5 at landward side and RL 0.5 at seaward side



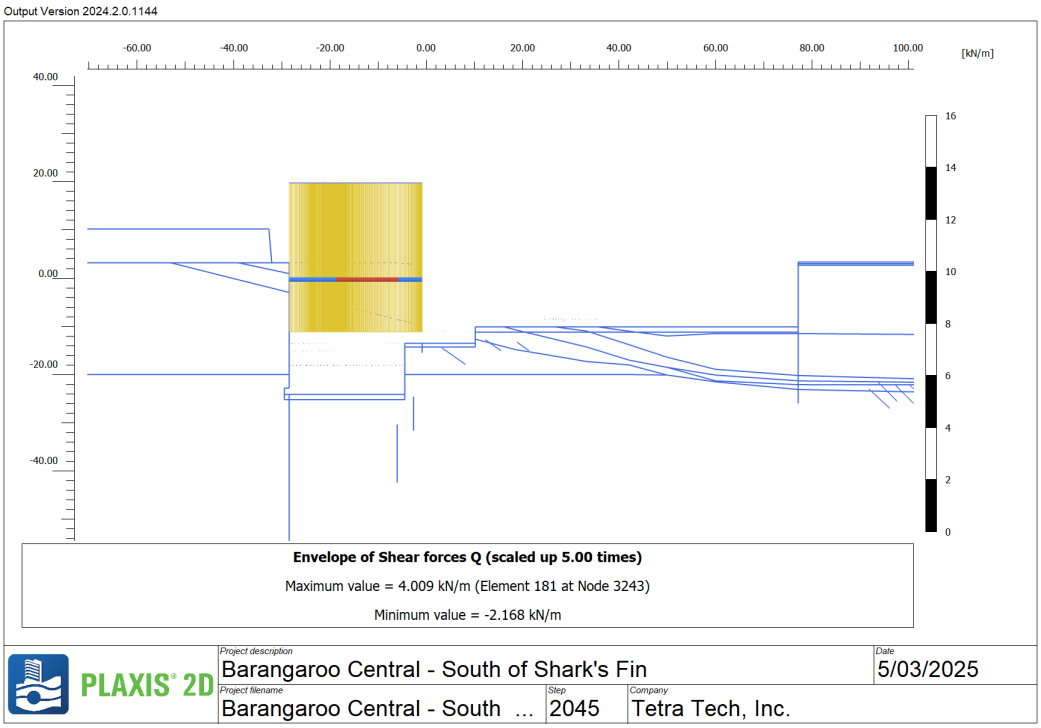
Shear Force for Top Slab for GWL Case 2 - GWL at RL 1.5 at landward side and RL 0.5 at seaward side



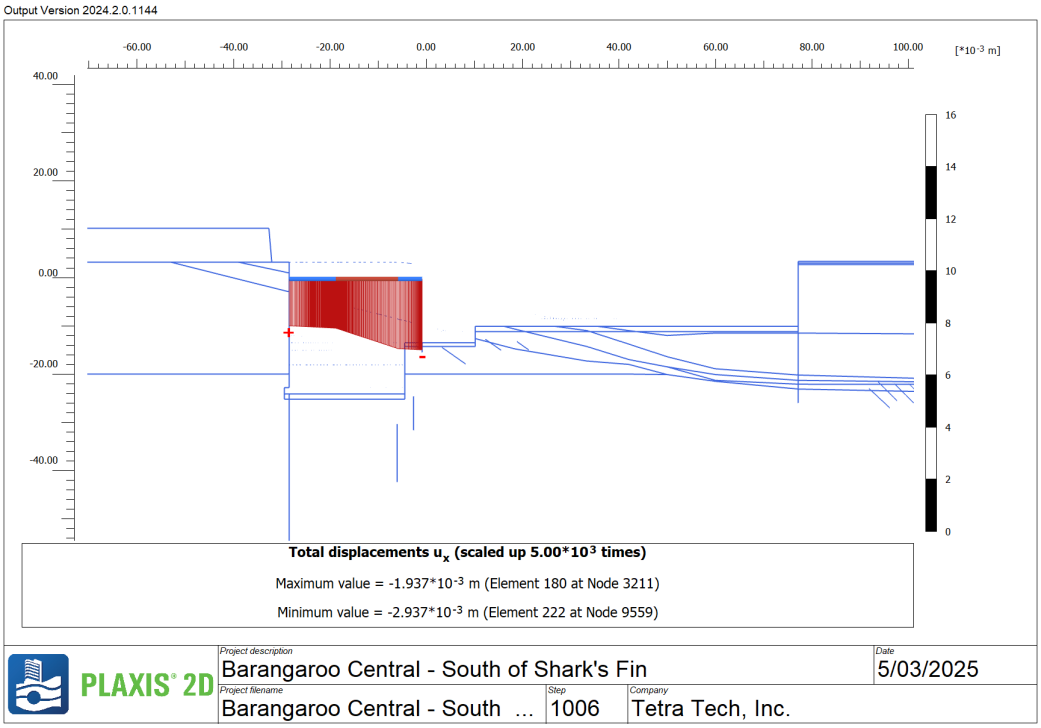
Lateral Displacement for Top Slab for GWL Case 3 - GWL at RL 2.575



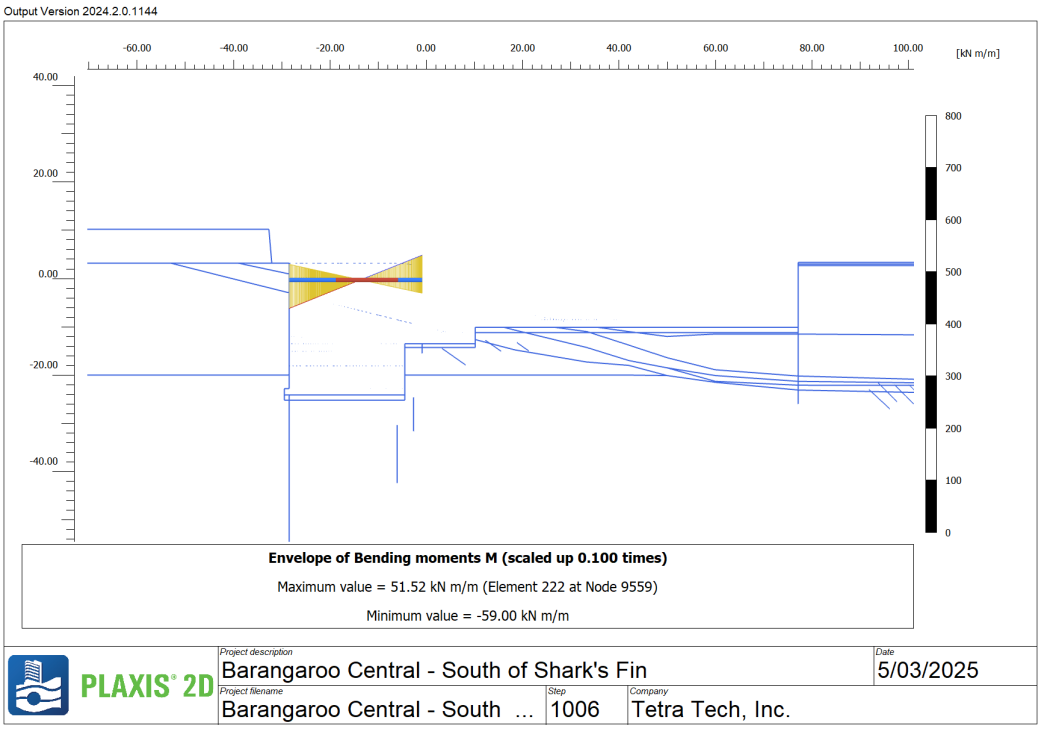
Bending Moment for Top Slab for GWL Case 3 - GWL at RL 2.575



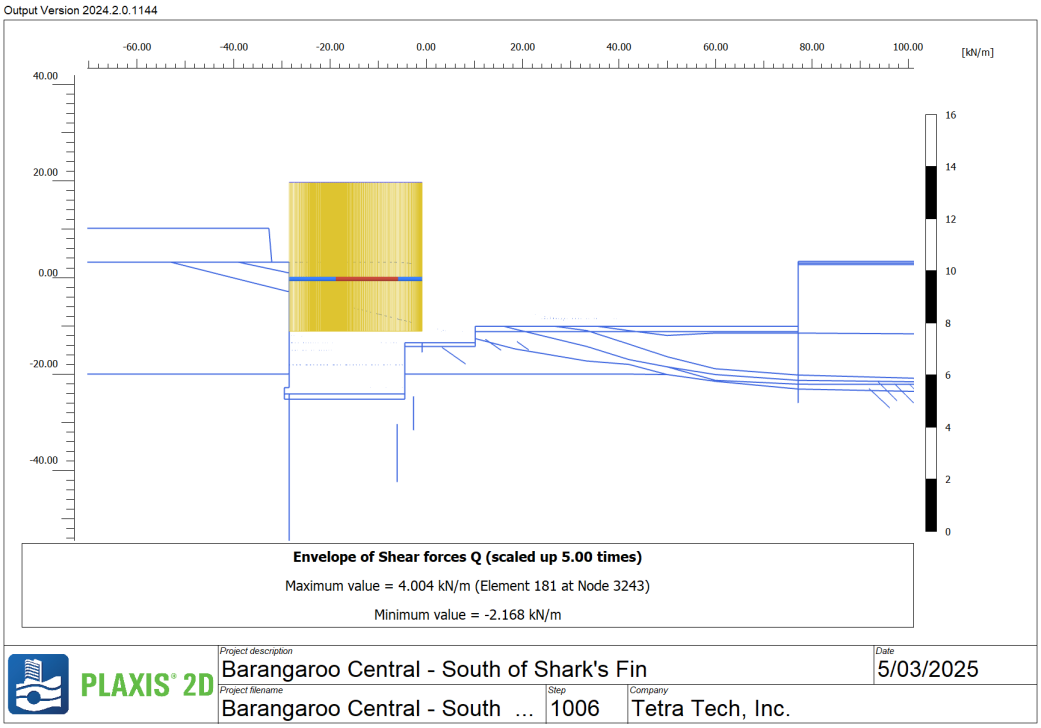
Shear Force for Top Slab for GWL Case 3 - GWL at RL 2.575



Lateral Displacement for Top Slab for GWL Case 4 - GWL at RL 2.575 at seaward side and RL 1.575 at landward side



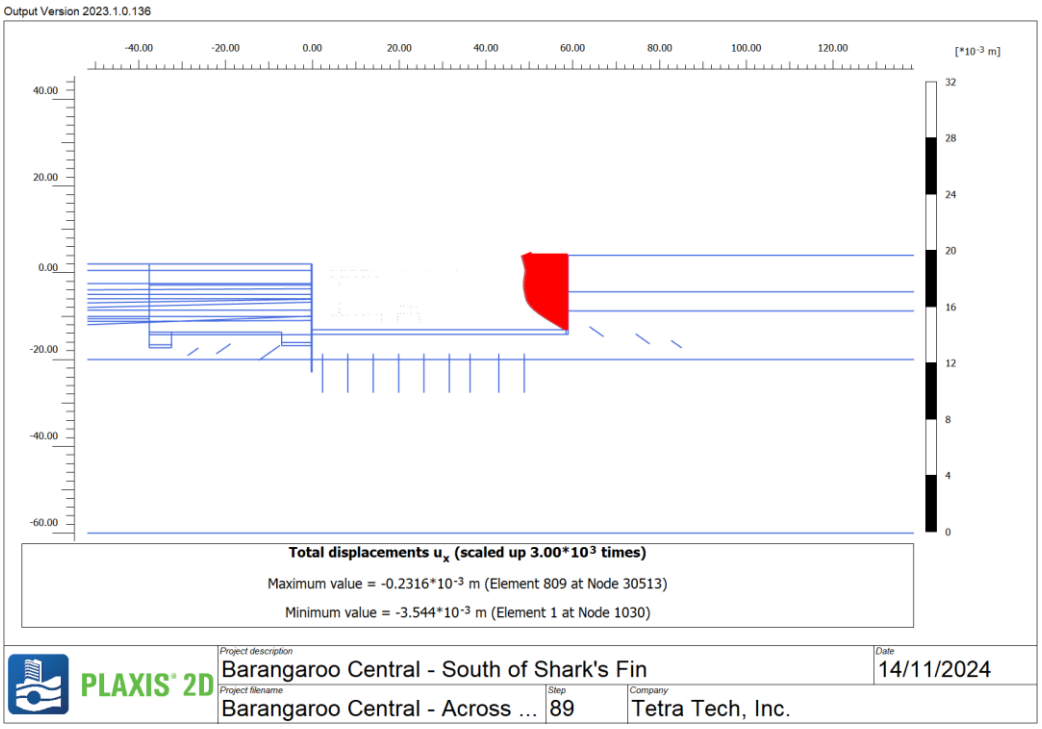
Bending Moment for Top Slab for GWL Case 4 - GWL at RL 2.575 at seaward side and RL 1.575 at landward side



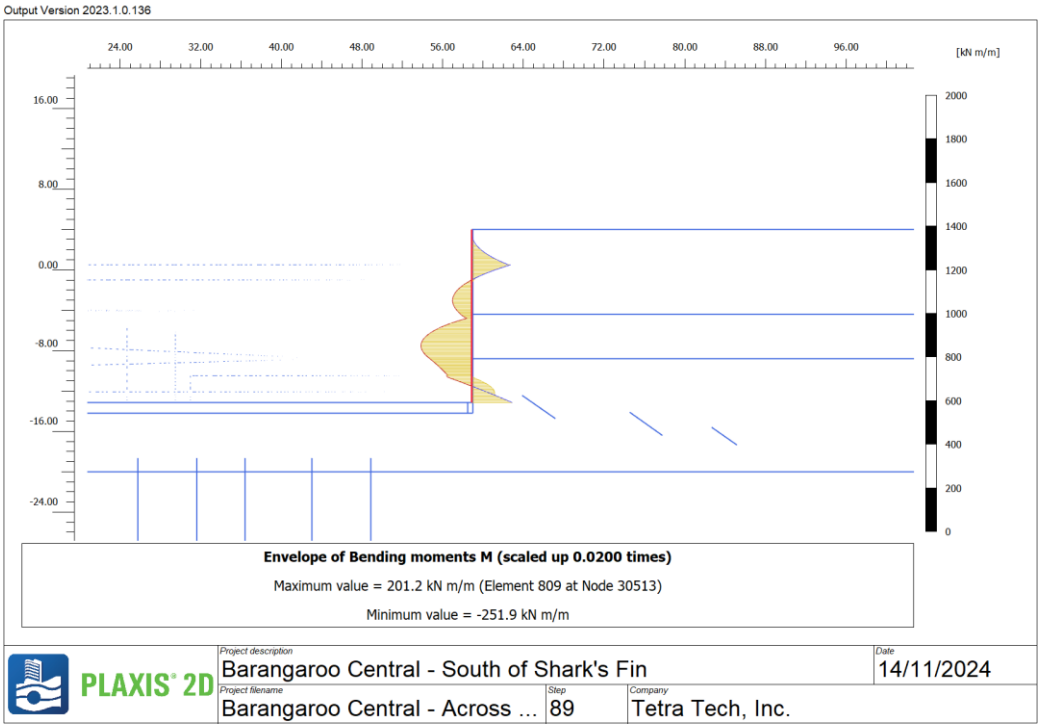
Shear Force for Top Slab for GWL Case 4 - GWL at RL 2.575 at seaward side and RL 1.575 at landward side

PLAXIS RESULTS – SECTION 2

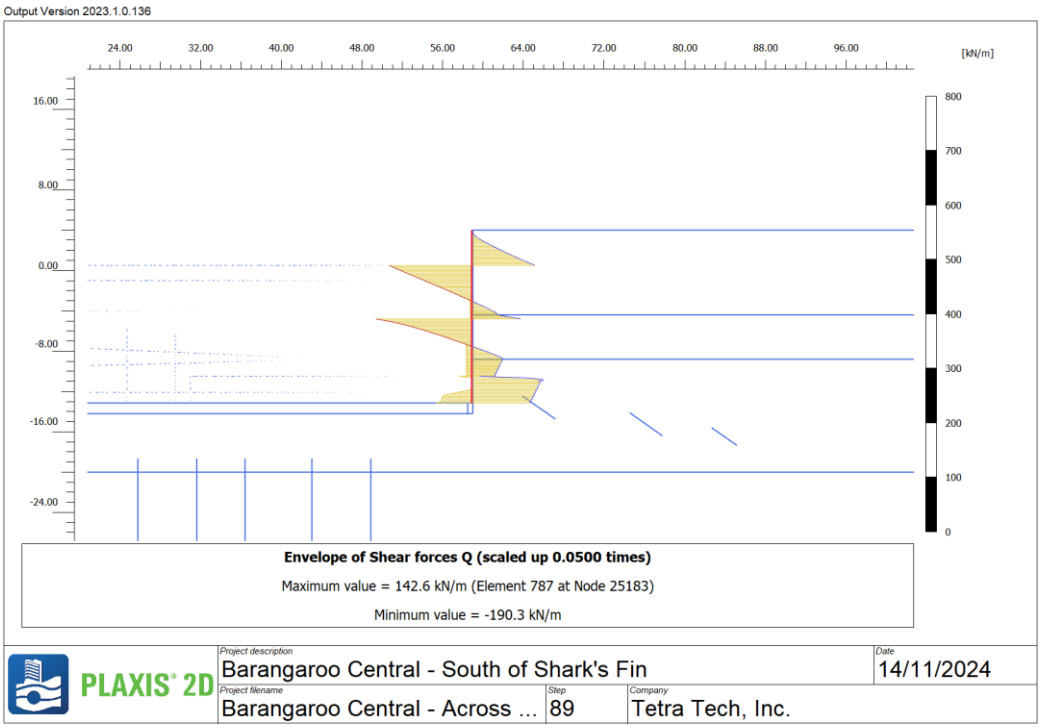
A. North Wall



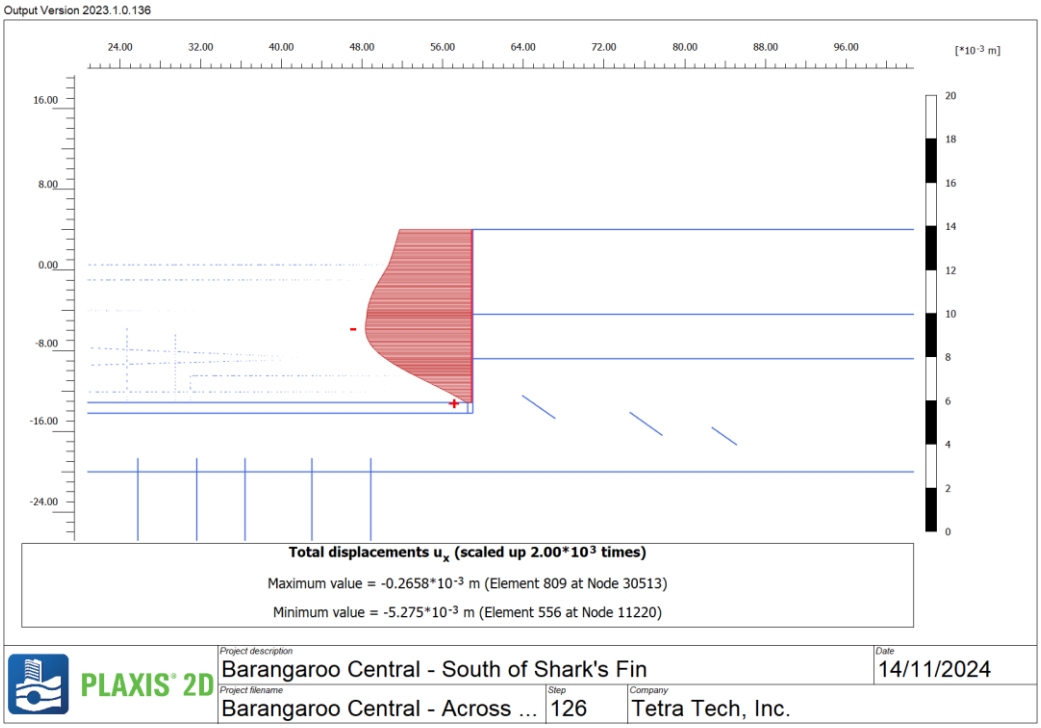
Lateral Displacement for North Wall at Stage 21 – After Installation of Shark Fin Slabs and Walls



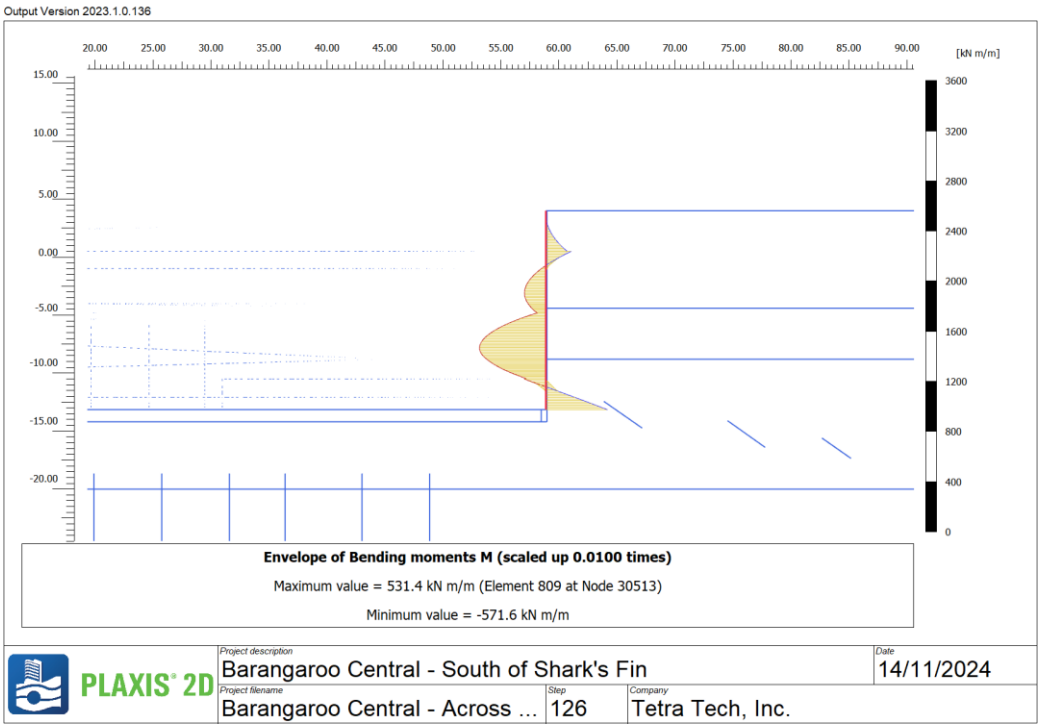
Bending Moment for North Wall at Stage 21 – After Installation of Shark Fin Slabs and Walls



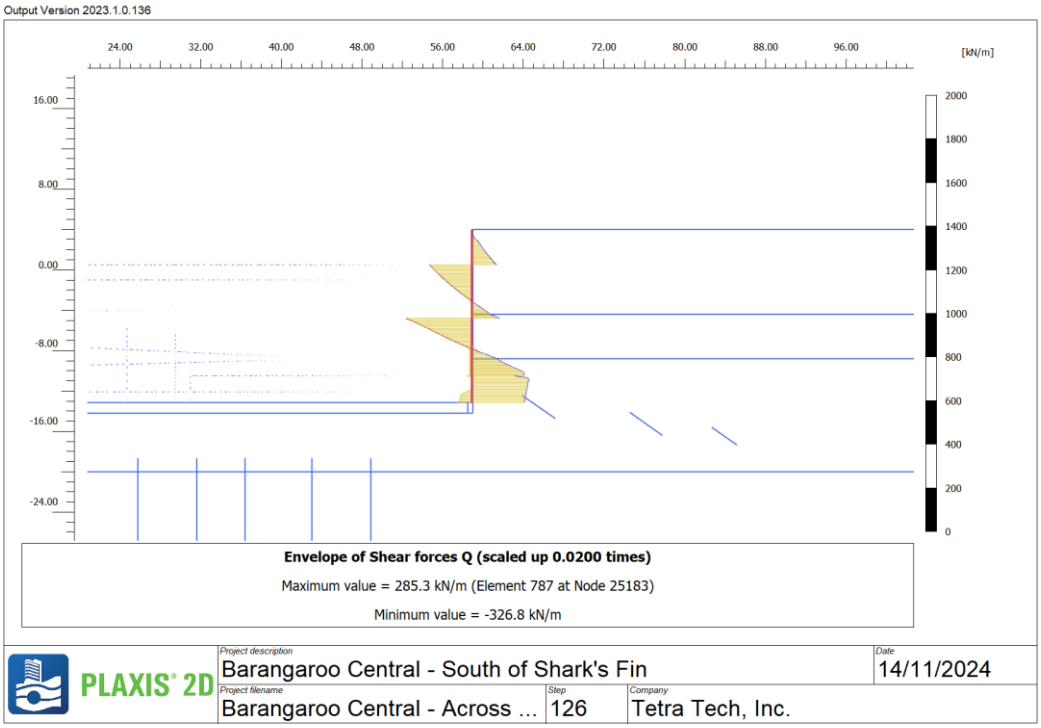
Shear Force for North Wall at Stage 21 – After Installation of Shark Fin Slabs and Walls



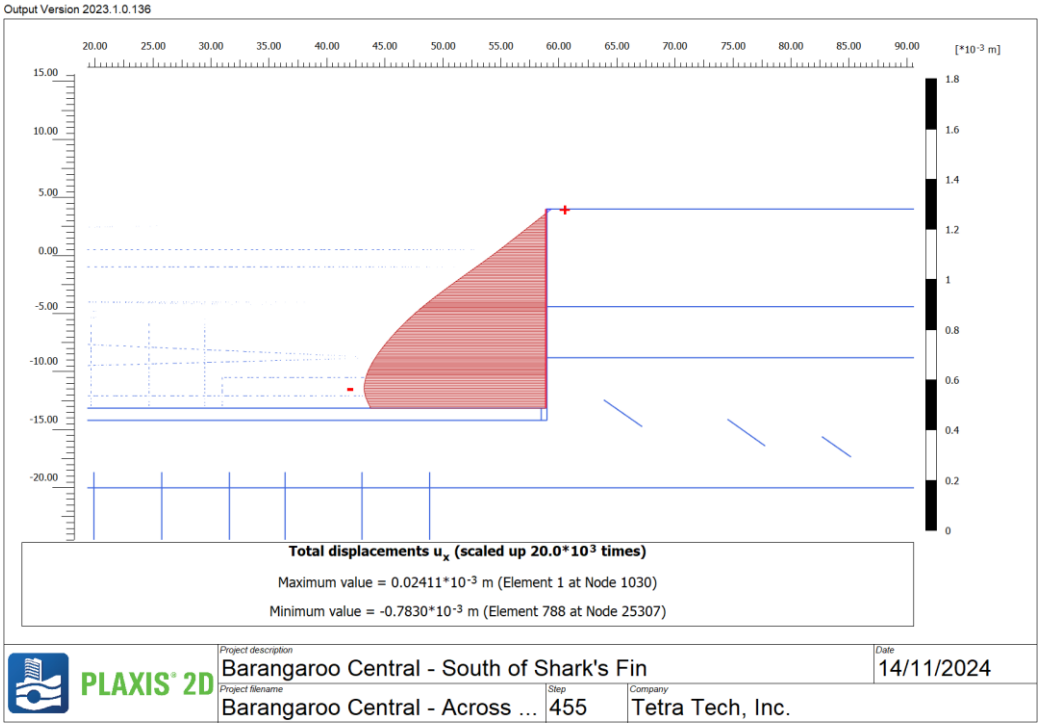
Lateral Displacement for North Wall at Stage 22 – GWL raise to RL1.5



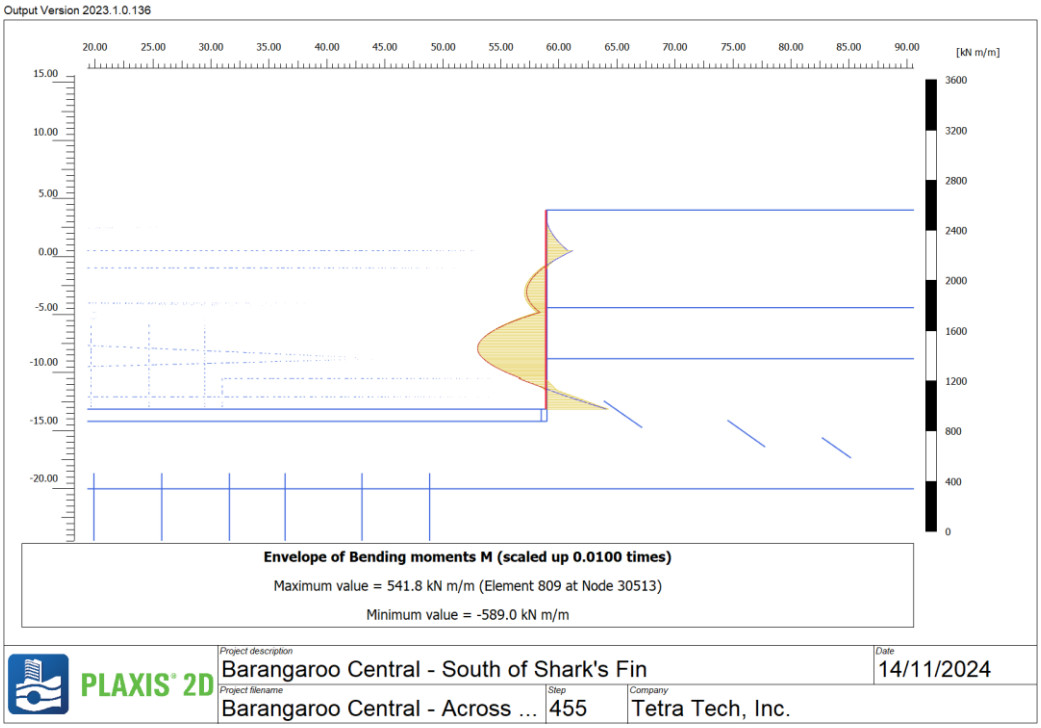
Bending Moment for North Wal l at Stage 22 – GWL raise to RL1.5



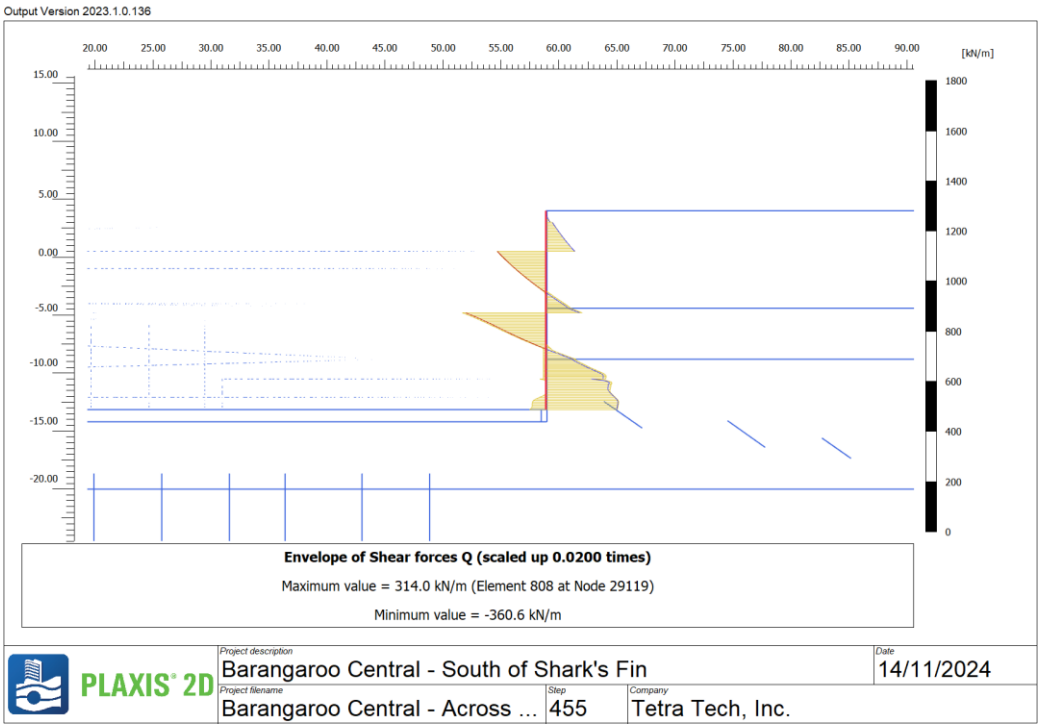
Shear Force for North Wall at Stage 22 – GWL raise to RL1.5



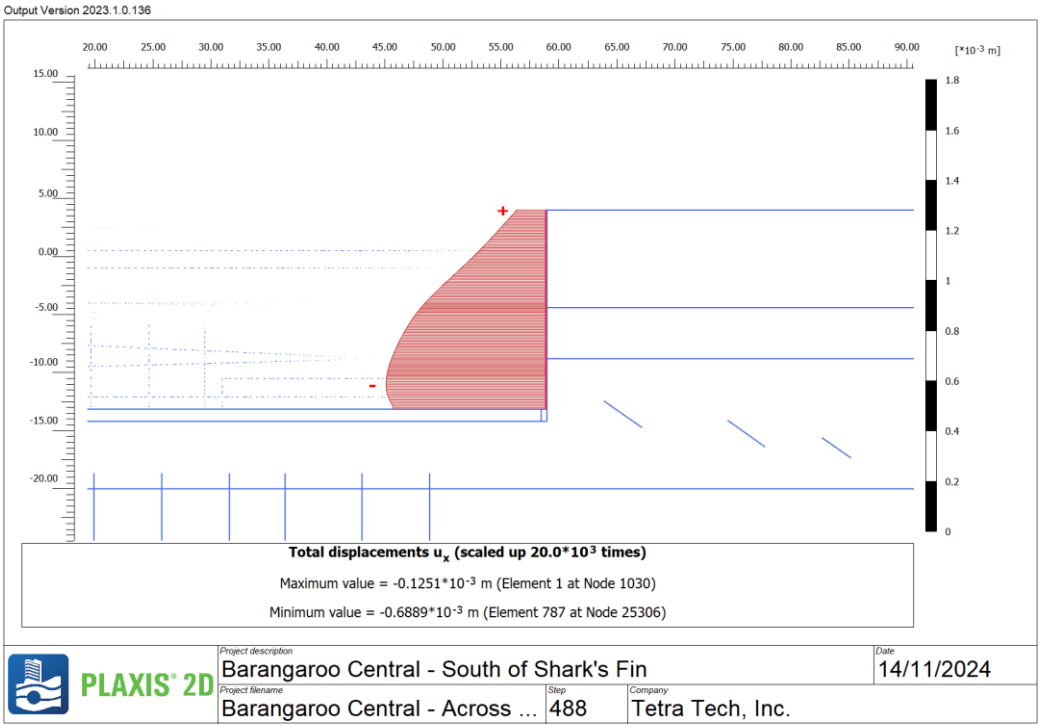
Lateral Displacement for North Wall at Stage 29 – Excavate Metro Interface to RL-14.3 and CBD at RL-11.2



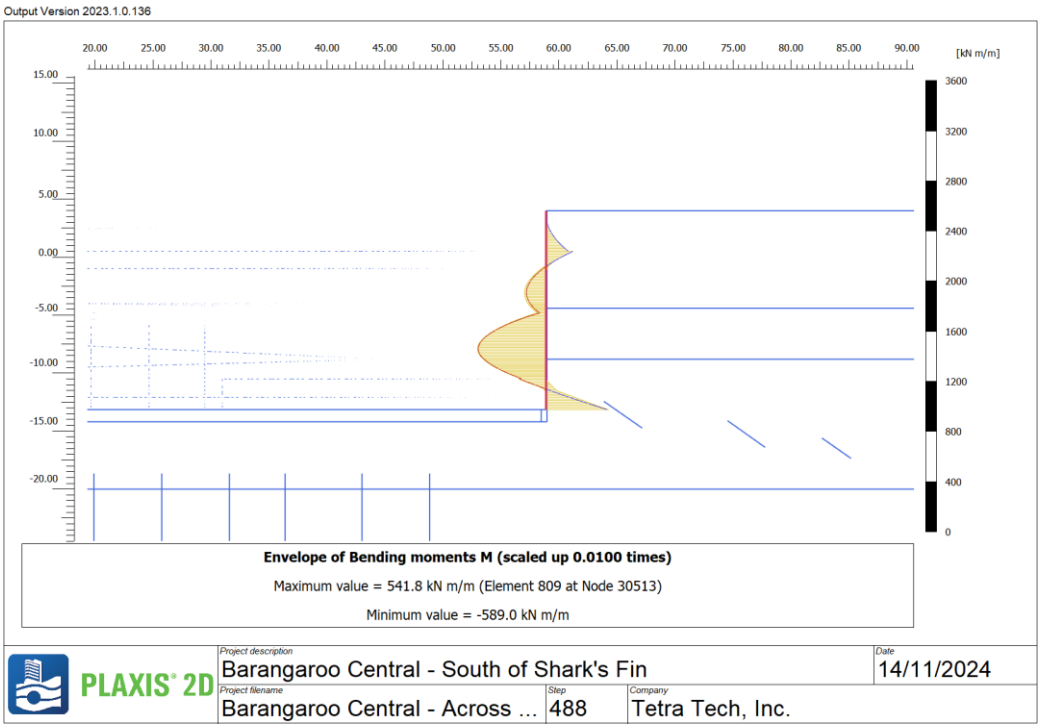
Bending Moment for North Wall at Stage 29 – Excavate Metro Interface to RL-14.3 and CBD at RL-11.2



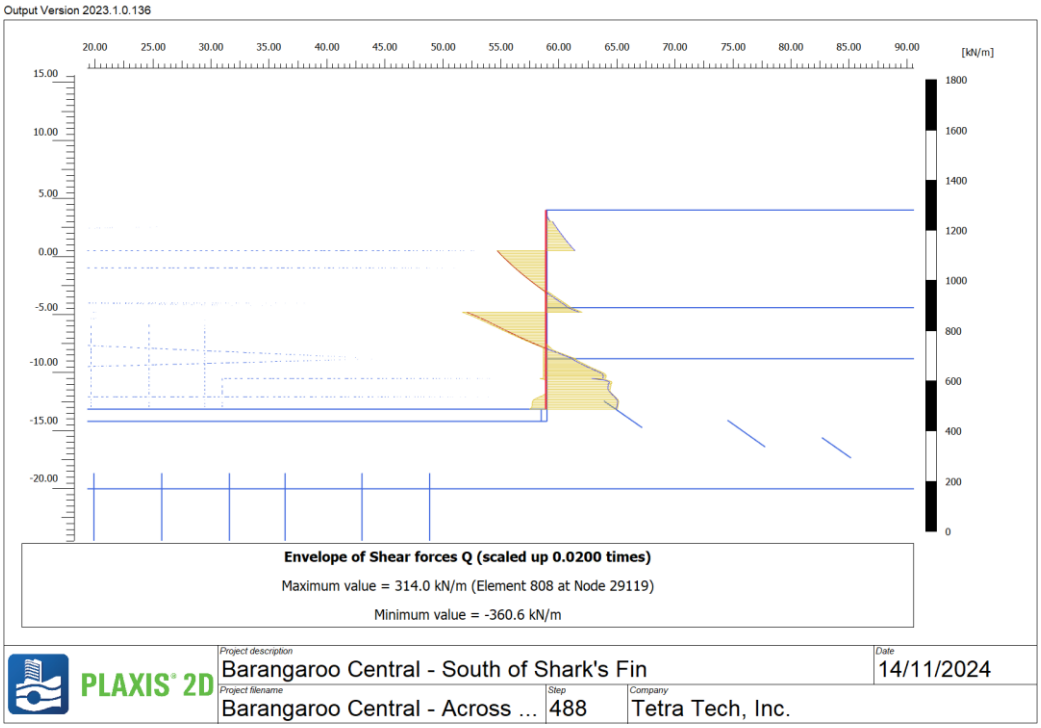
Shear Force for North Wall at Stage 29 – Excavate Metro Interface to RL-14.3 and CBD at RL-11.2



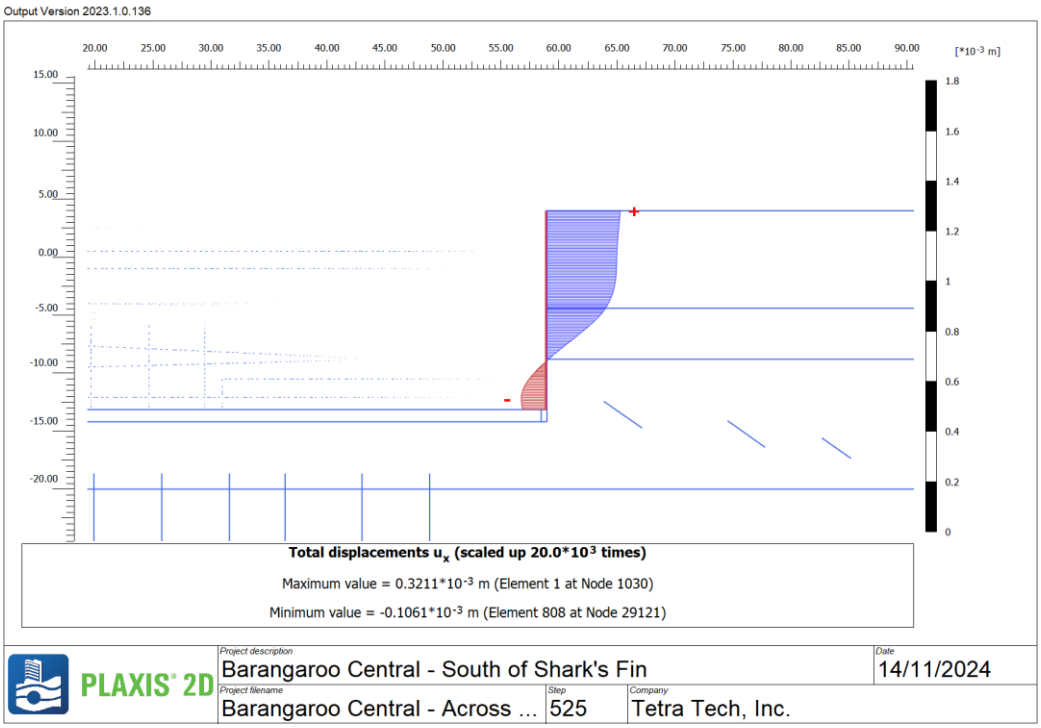
Lateral Displacement for North Wall at Stage 34 – After Installation of CBD slabs and walls



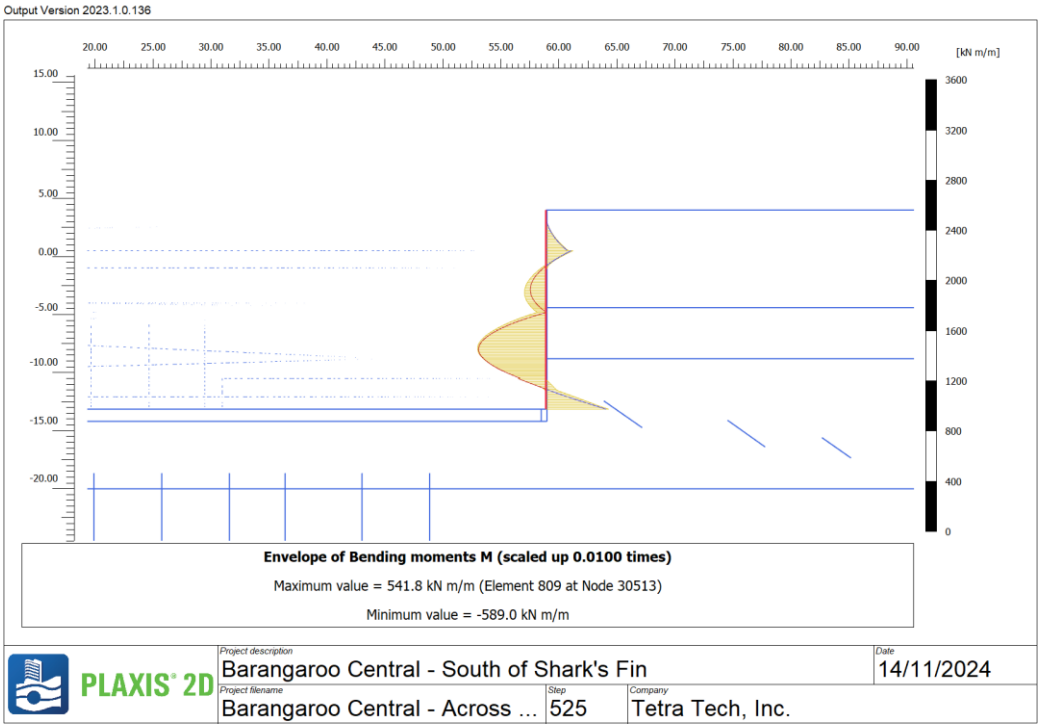
Bending Moment for North Wall at Stage 34 – After Installation of CBD slabs and walls



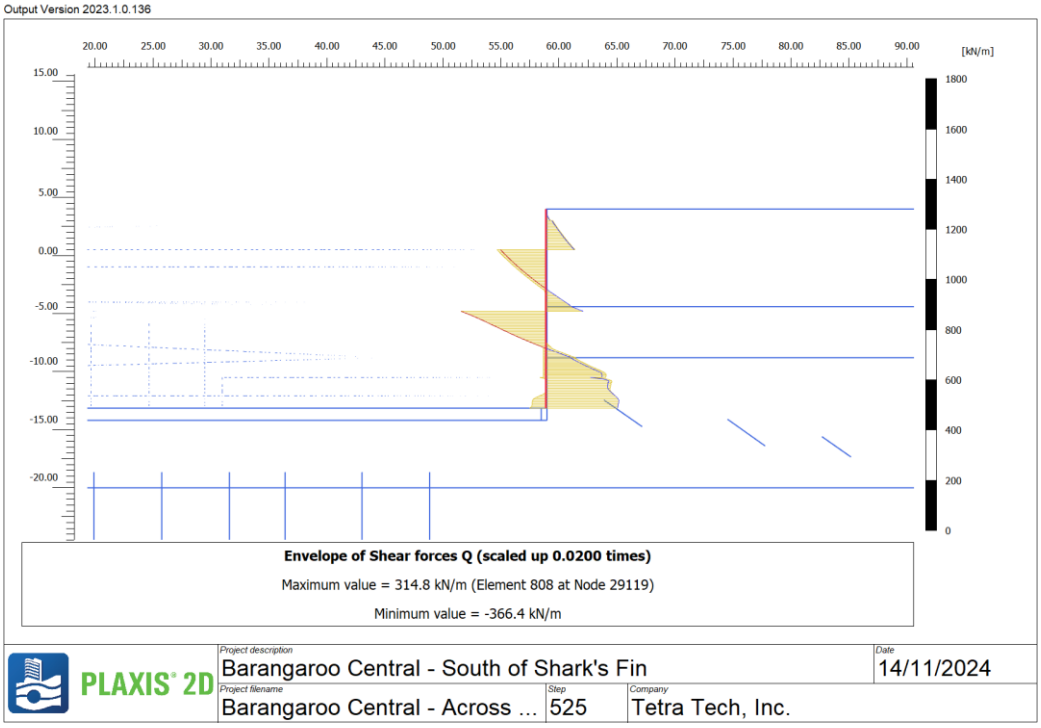
Shear Force for North Wall at Stage 34 – After Installation of CBD slabs and walls



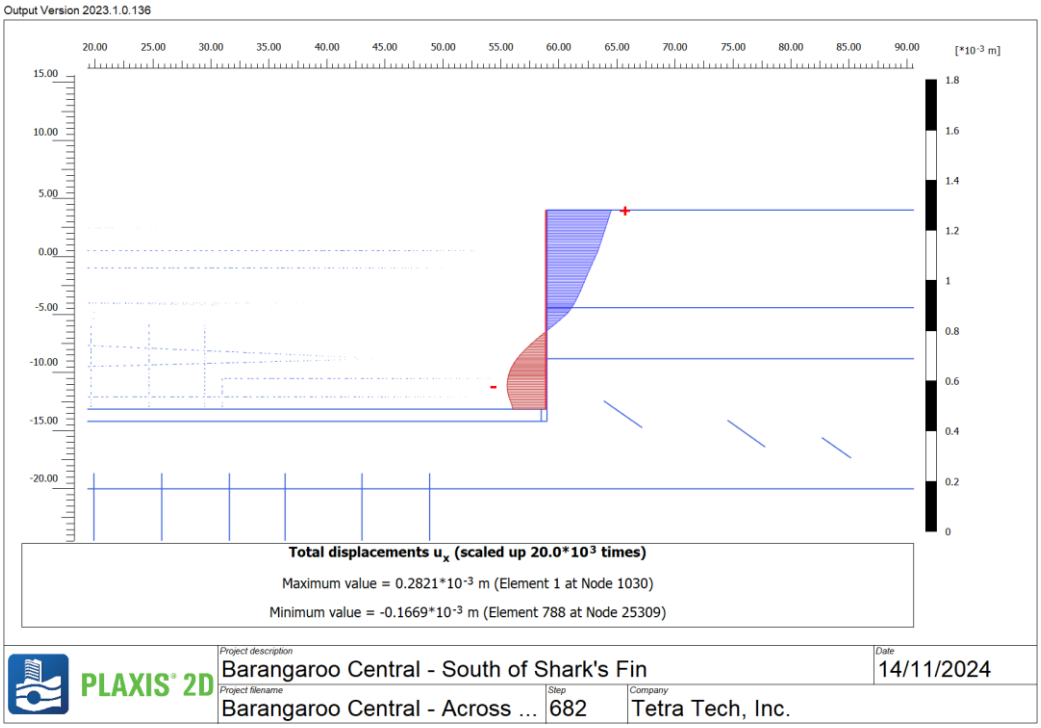
Lateral Displacement for North Wall for GWL Case 1 - GWL at RL 1.5



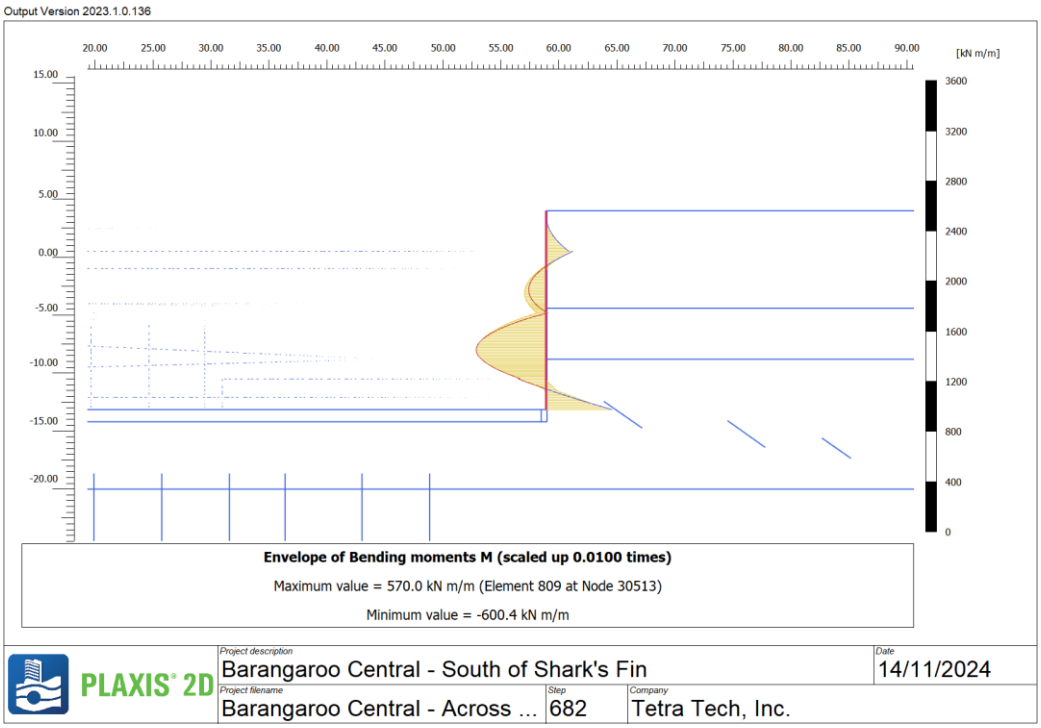
Bending Moment for North Wall for GWL Case 1 - GWL at RL 1.5



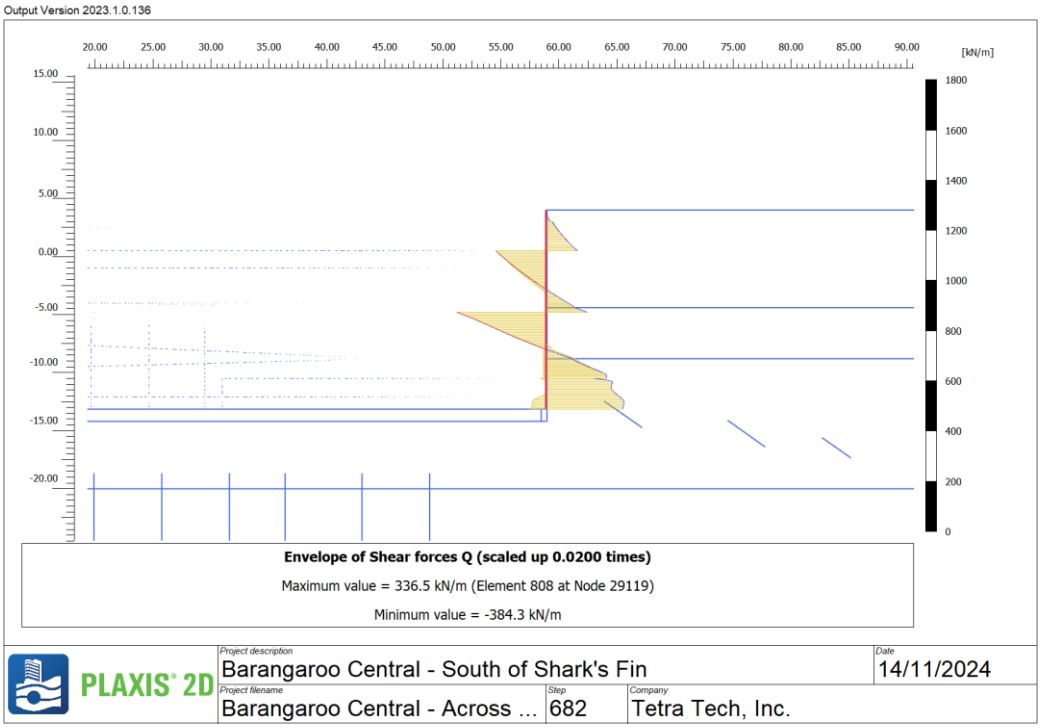
Shear Force for North Wall for GWL Case 1 - GWL at RL 1.5



Lateral Displacement for North Wall for GWL Case 3 - GWL at RL 2.575

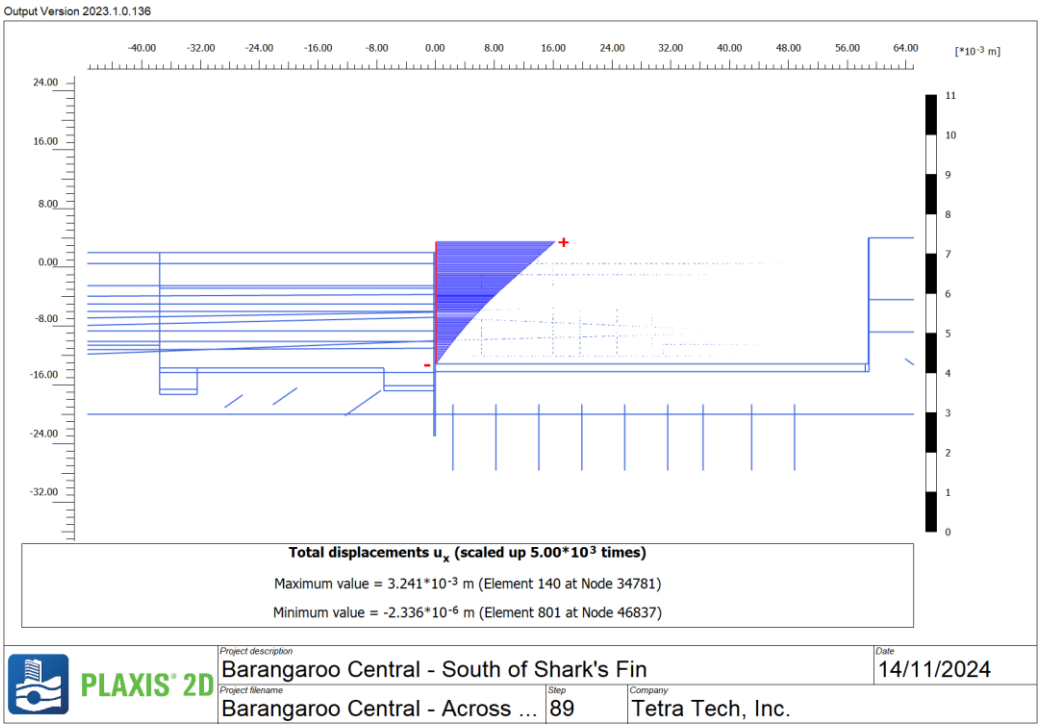


Bending Moment for North Wall for GWL Case 3 - GWL at RL 2.575

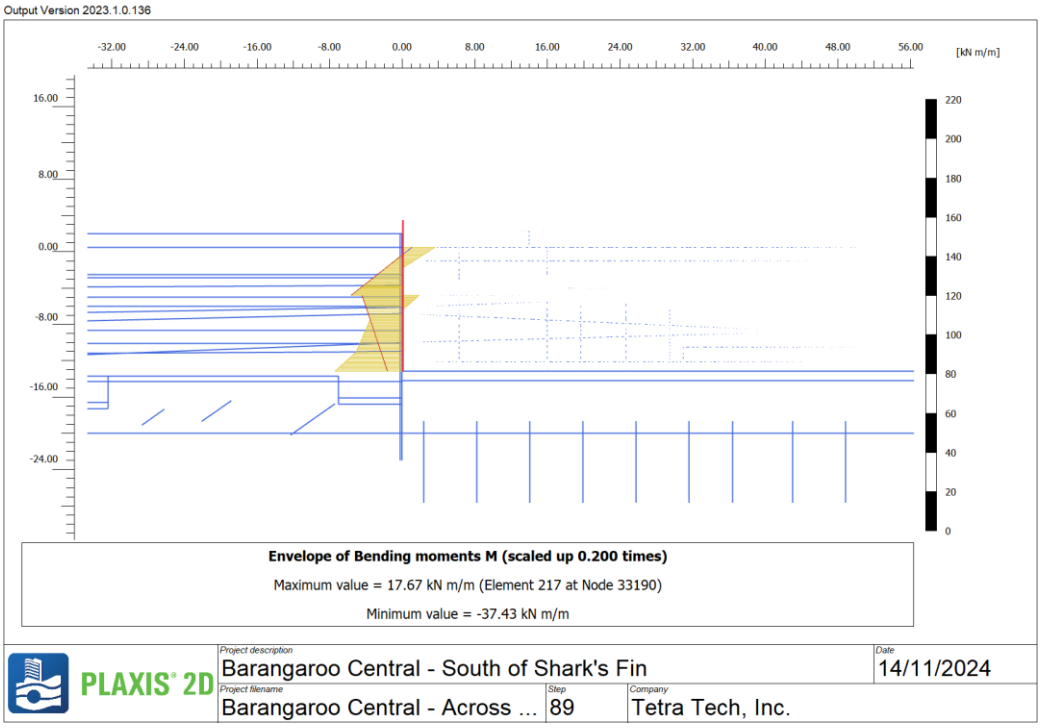


Shear Force for North Wall for GWL Case 3 - GWL at RL 2.575

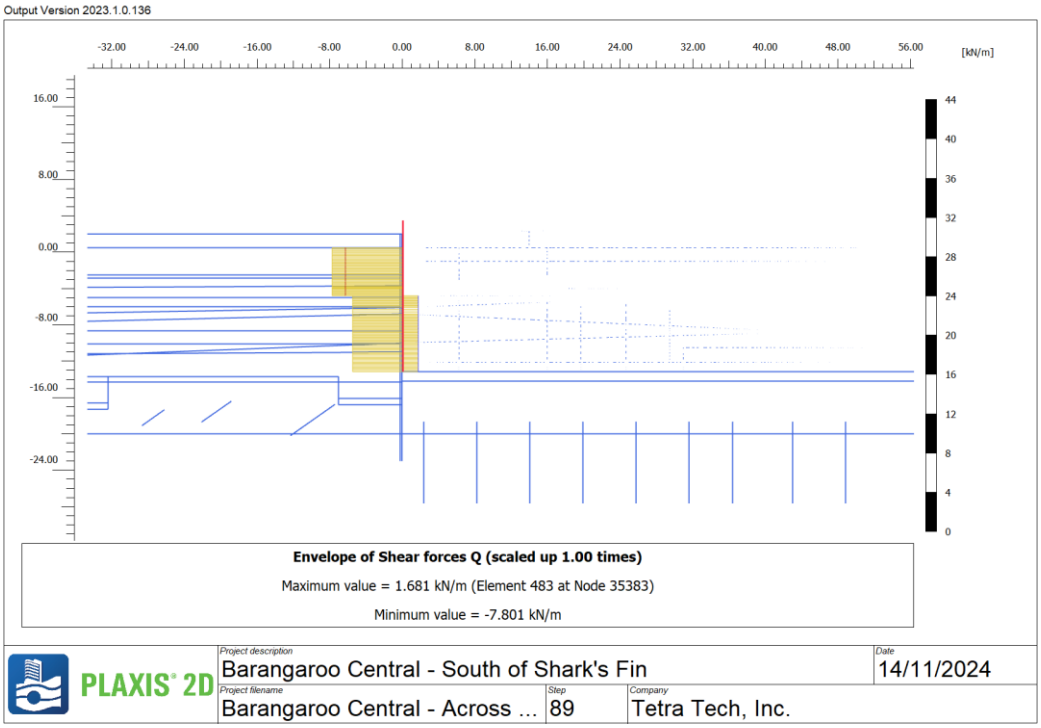
B. South Wall



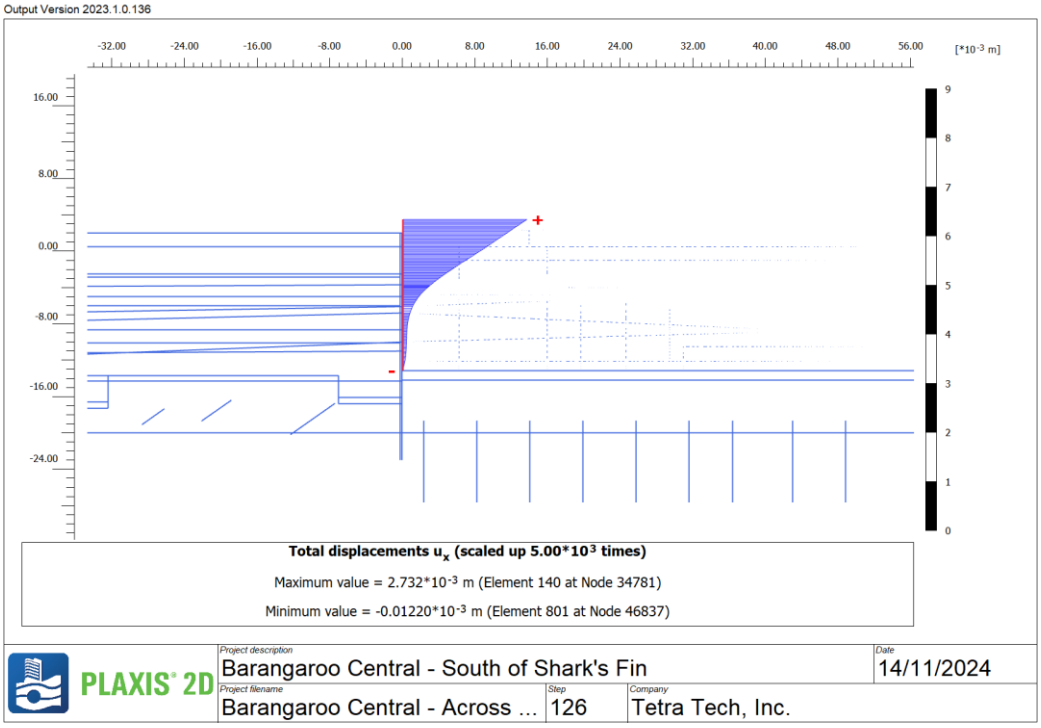
Lateral Displacement for South Wall at Stage 21 – After Installation of Shark Fin Excavation Slabs and Walls



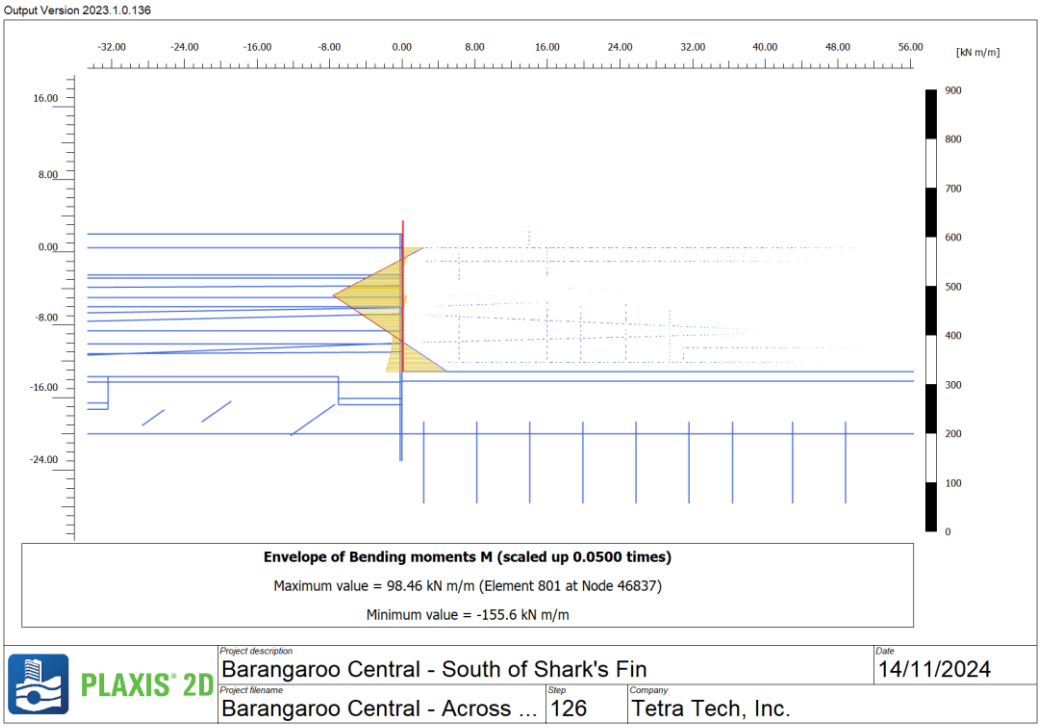
Bending Moment for South Wall at Stage 21 – After Installation of Shark Fin Excavation Slabs and Walls



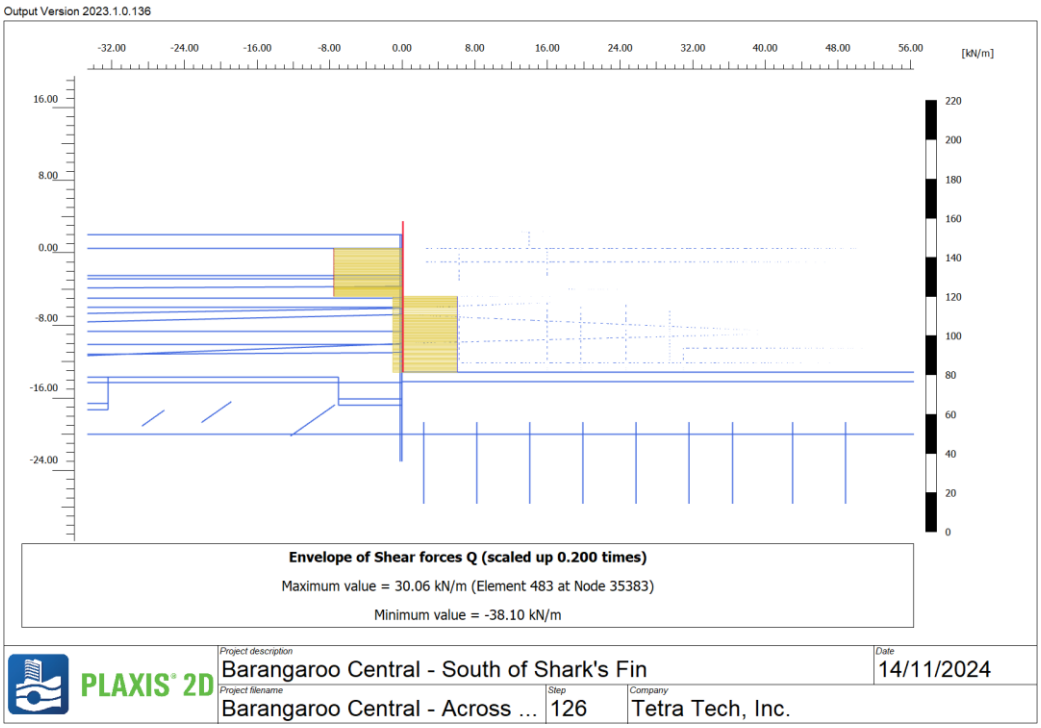
Shear Force for South Wall at Stage 21 – After Installation of Shark Fin Excavation Slabs and Walls



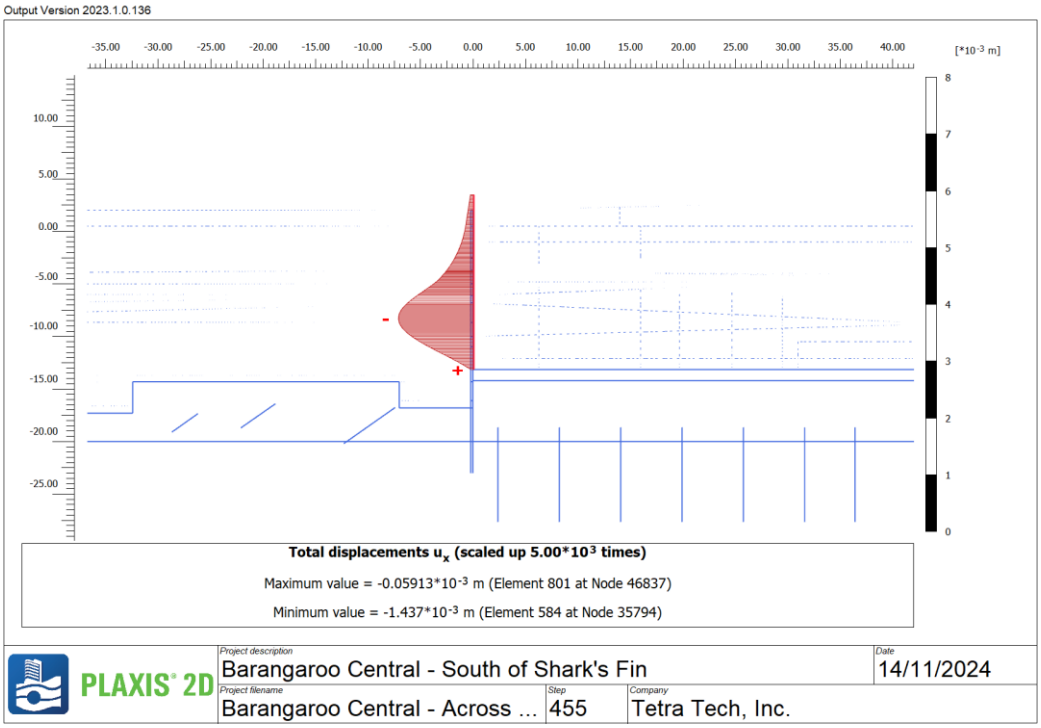
Lateral Displacement for South Wall at Stage 22 – GWL raise to RL1.5



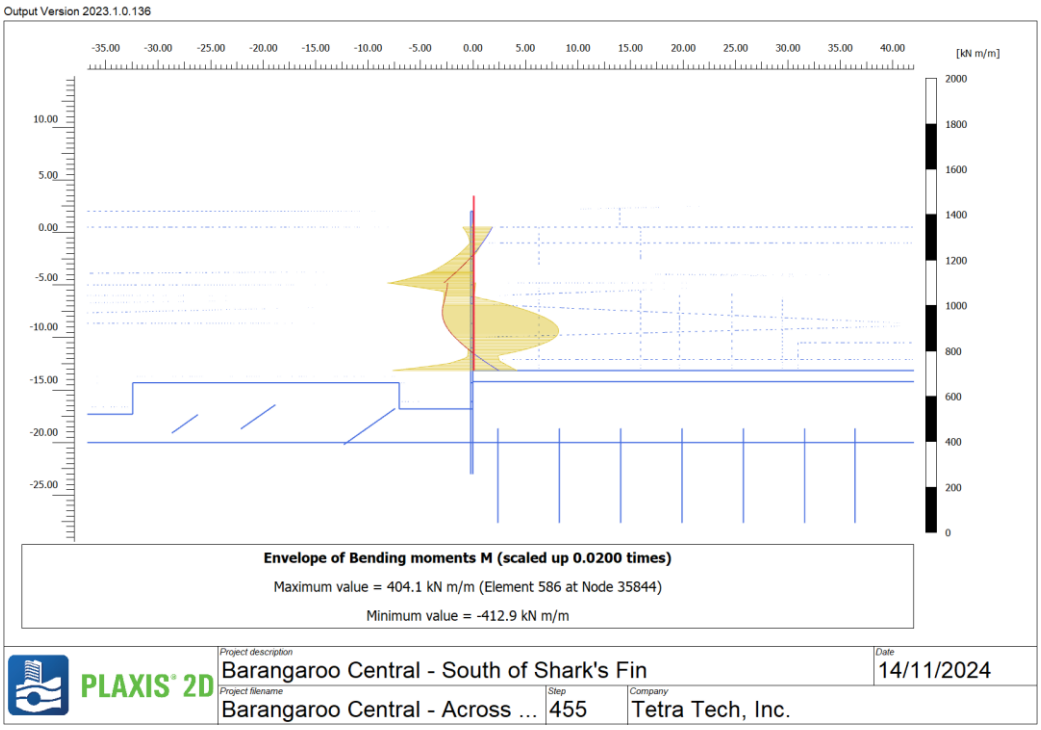
Bending Moment for South Wall at Stage 22 – GWL raise to RL1.5



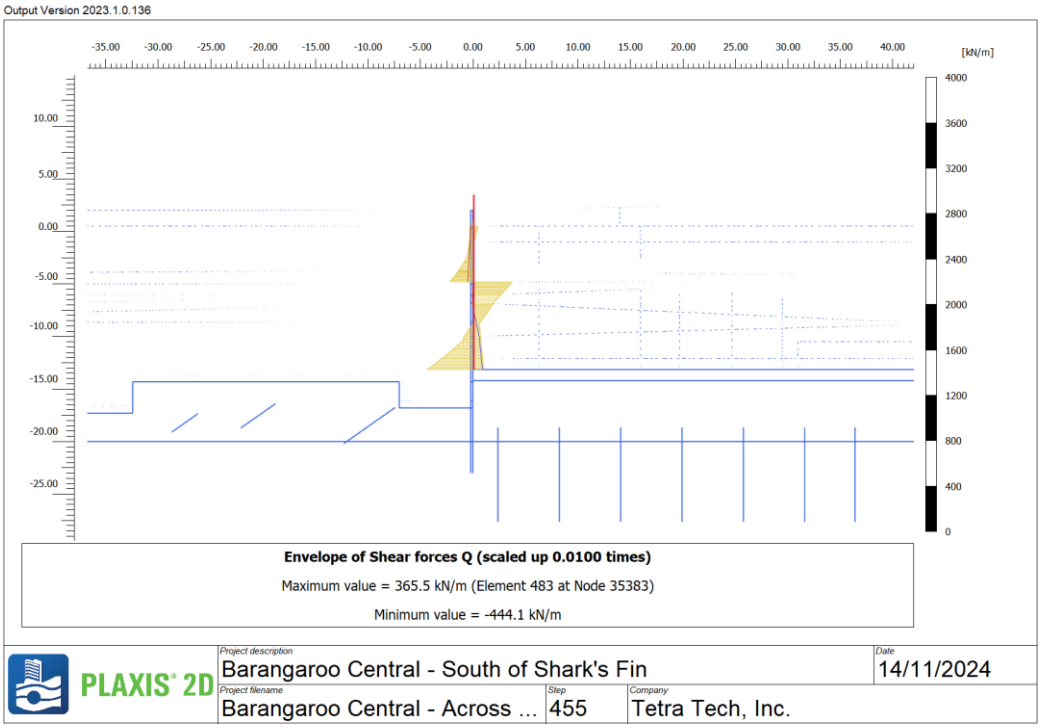
Shear Force for South Wall at Stage 22 – GWL raise to RL1.5



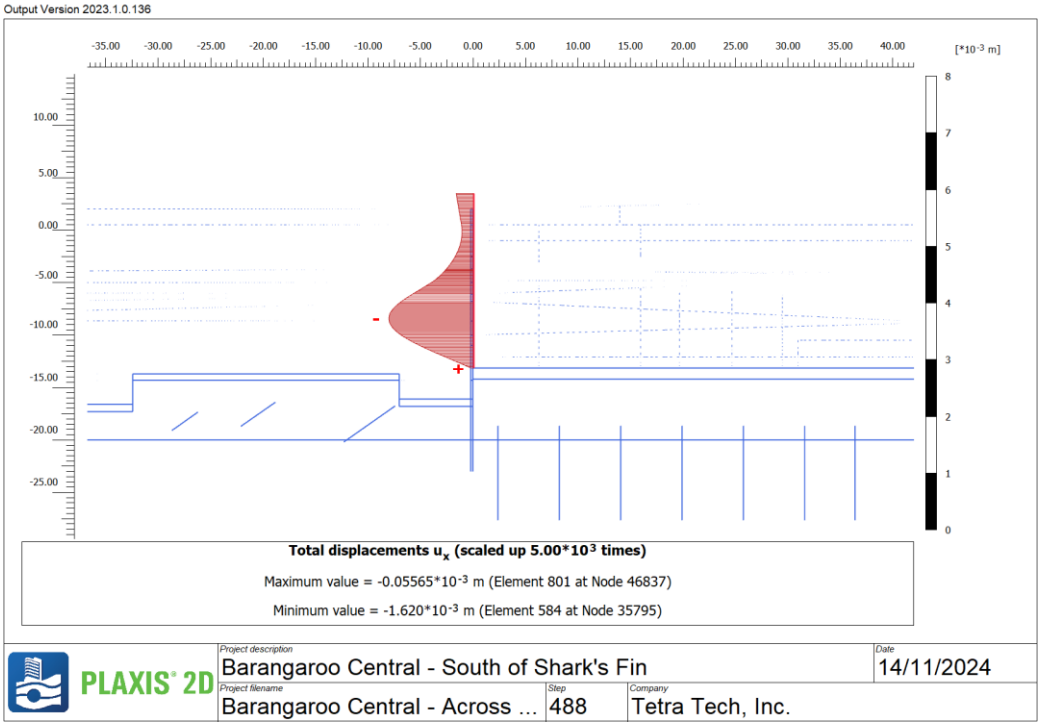
Lateral Displacement for South Wall at Stage 29 – Excavate Metro Interface to RL-14.3 and CBD at RL-11.2



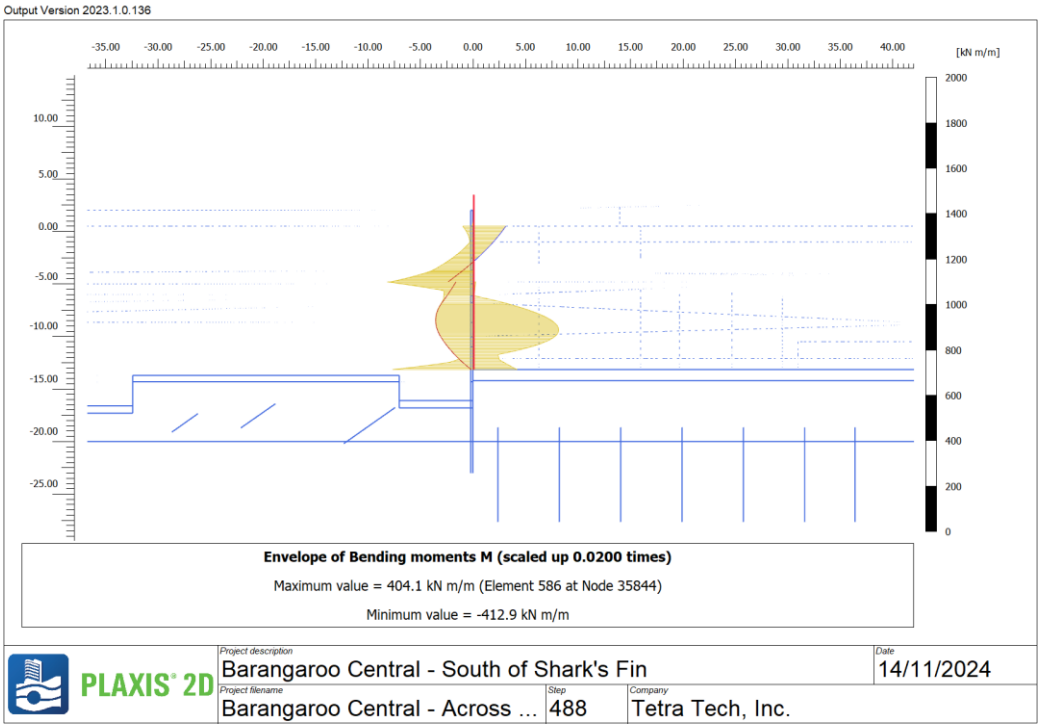
Bending Moment for South Wall at Stage 29 – Excavate Metro Interface to RL-14.3 and CBD at RL-11.2



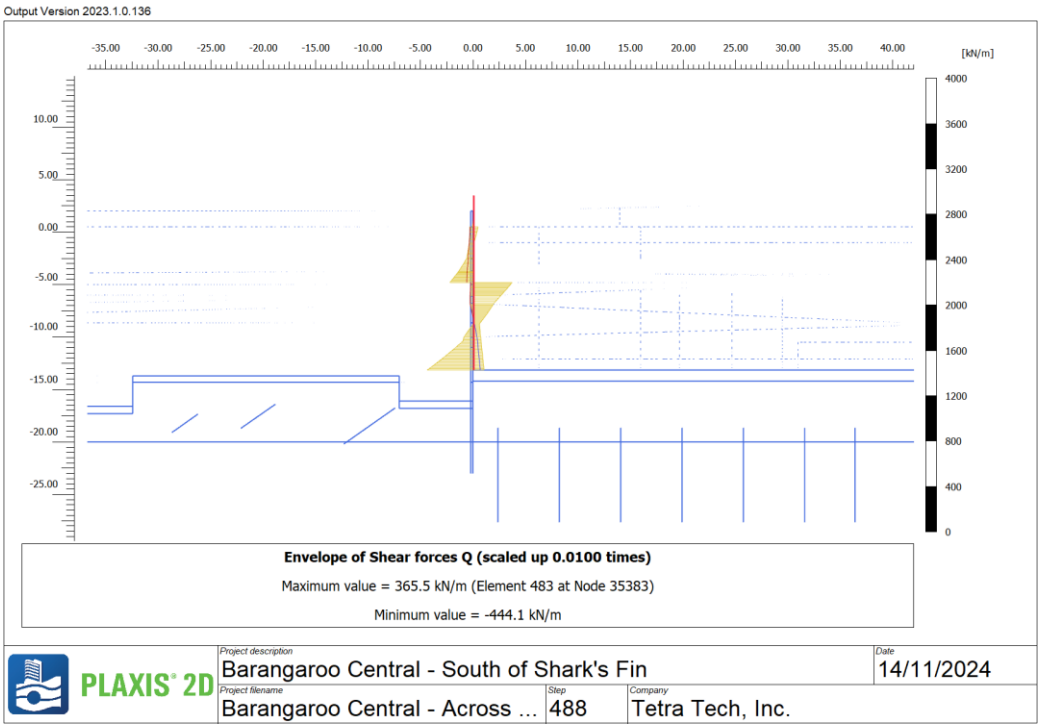
Shear Force for South Wall at Stage 29 – Excavate Metro Interface to RL-14.3 and CBD at RL-11.2



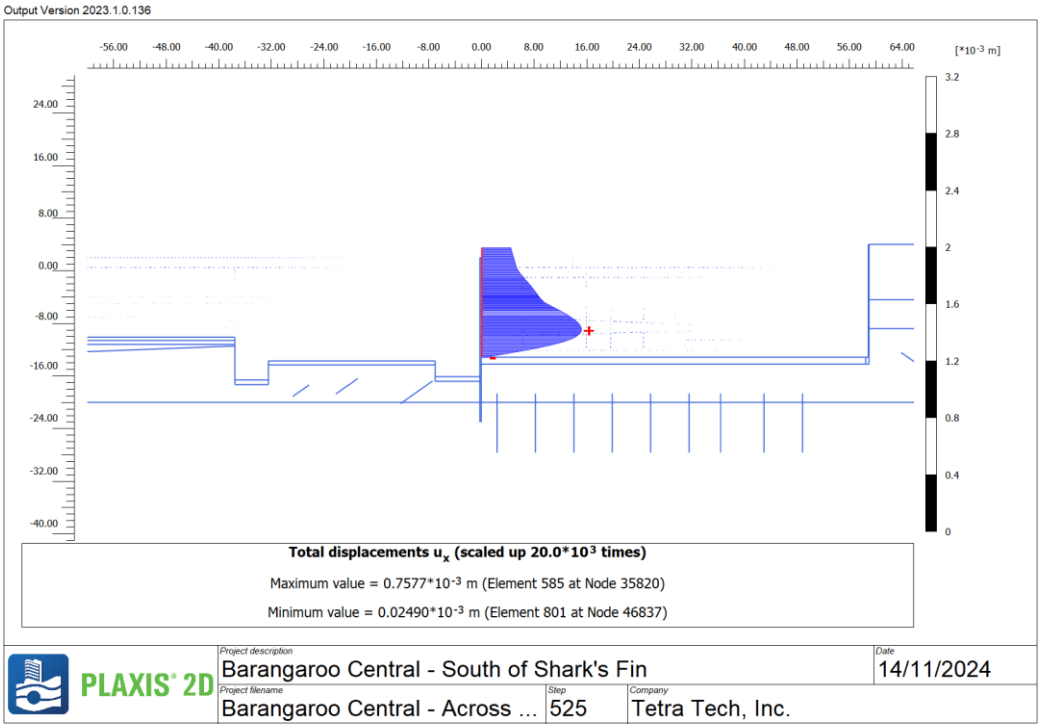
Lateral Displacement for South Wall at Stage 37 – After Installation of CBD slabs and walls



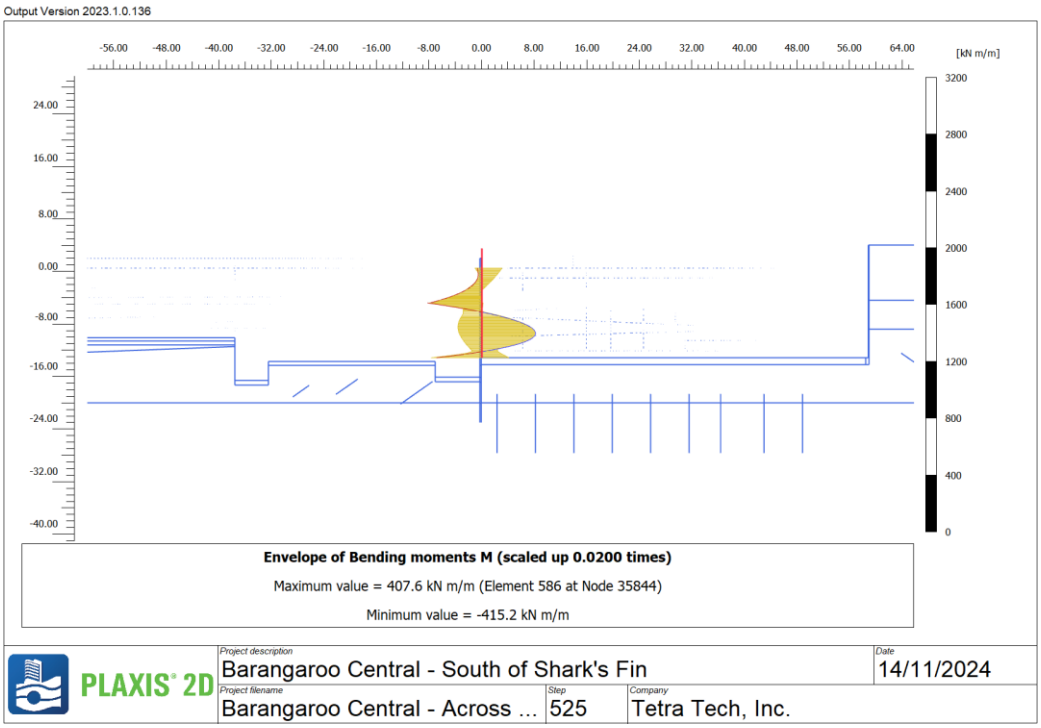
Bending Moment for South Wall at Stage 37 – After Installation of CBD slabs and walls



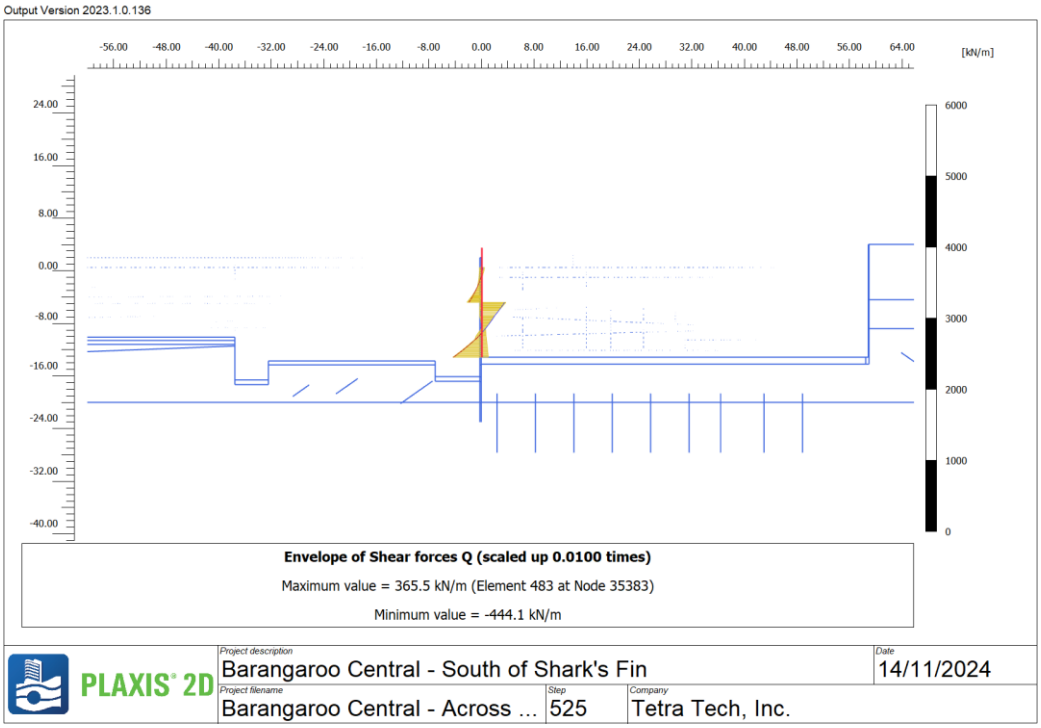
Shear Force for South Wall at Stage 37 – After Installation of CBD slabs and walls



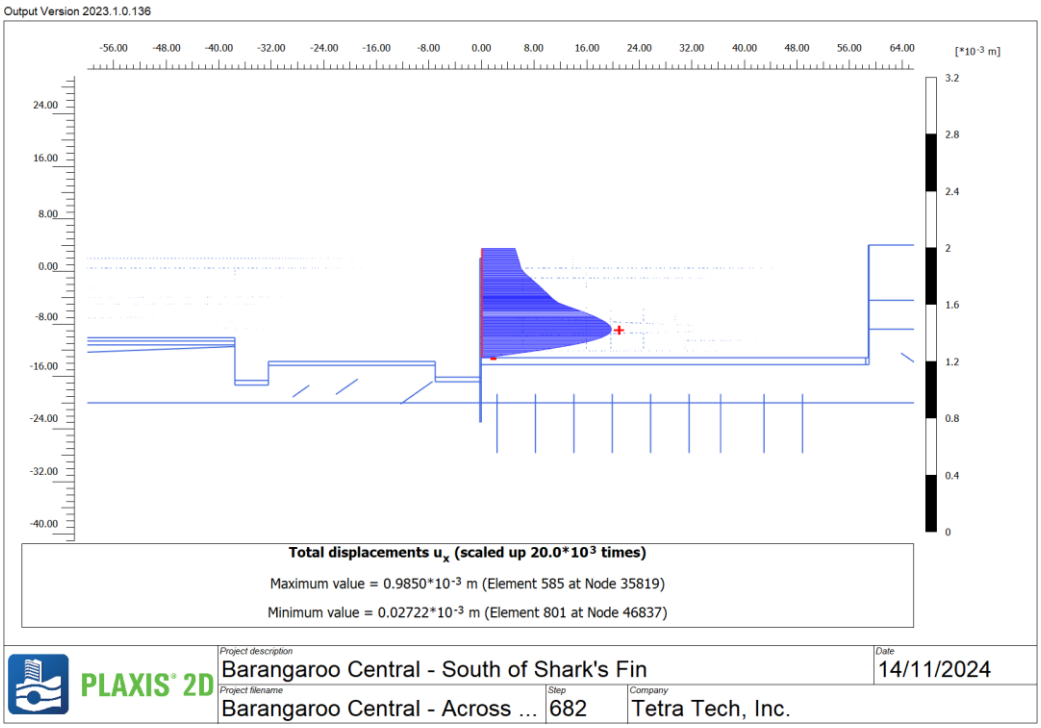
Lateral Displacement for South Wall for GWL Case 1 - GWL at RL 1.5



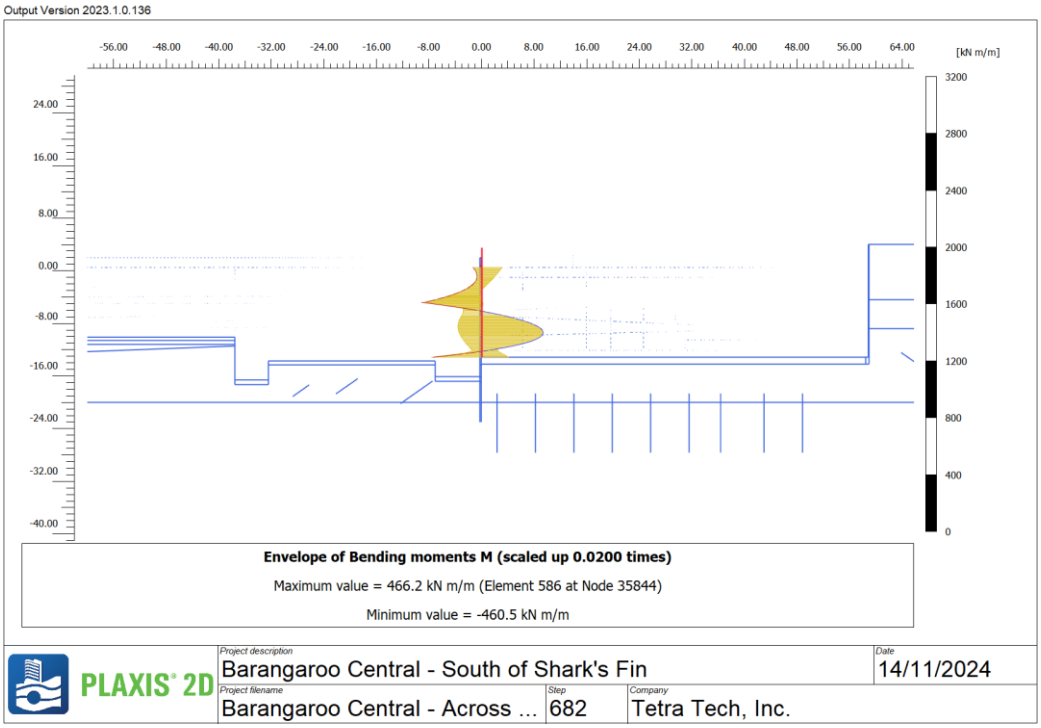
Bending Moment for South Wall for GWL Case 1 - GWL at RL 1.5



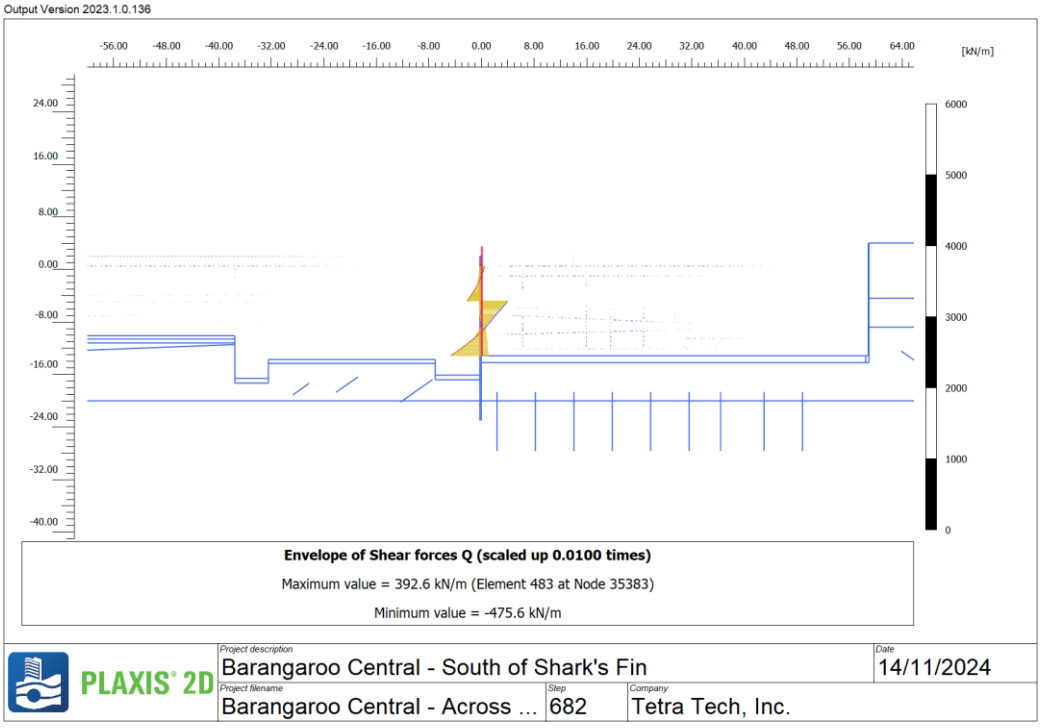
Shear Force for South Wall for GWL Case 1 - GWL at RL 1.5



Lateral Displacement for South Wall for GWL Case 3 - GWL at RL 2.575

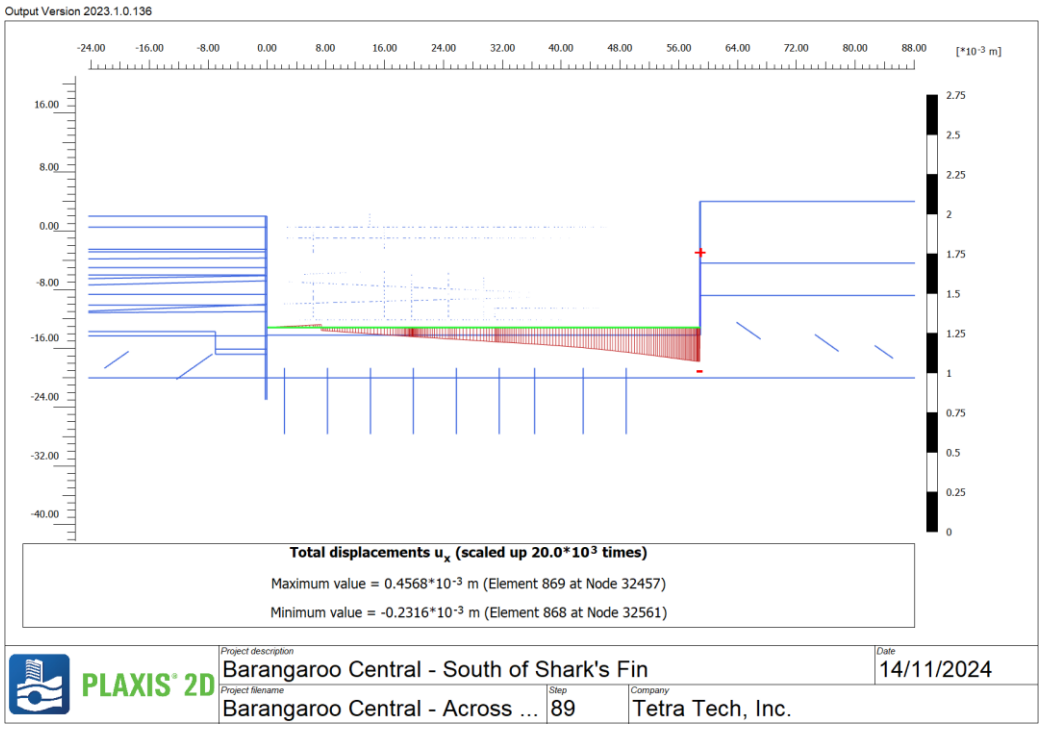


Bending Moment for South Wall for GWL Case 3 - GWL at RL 2.575

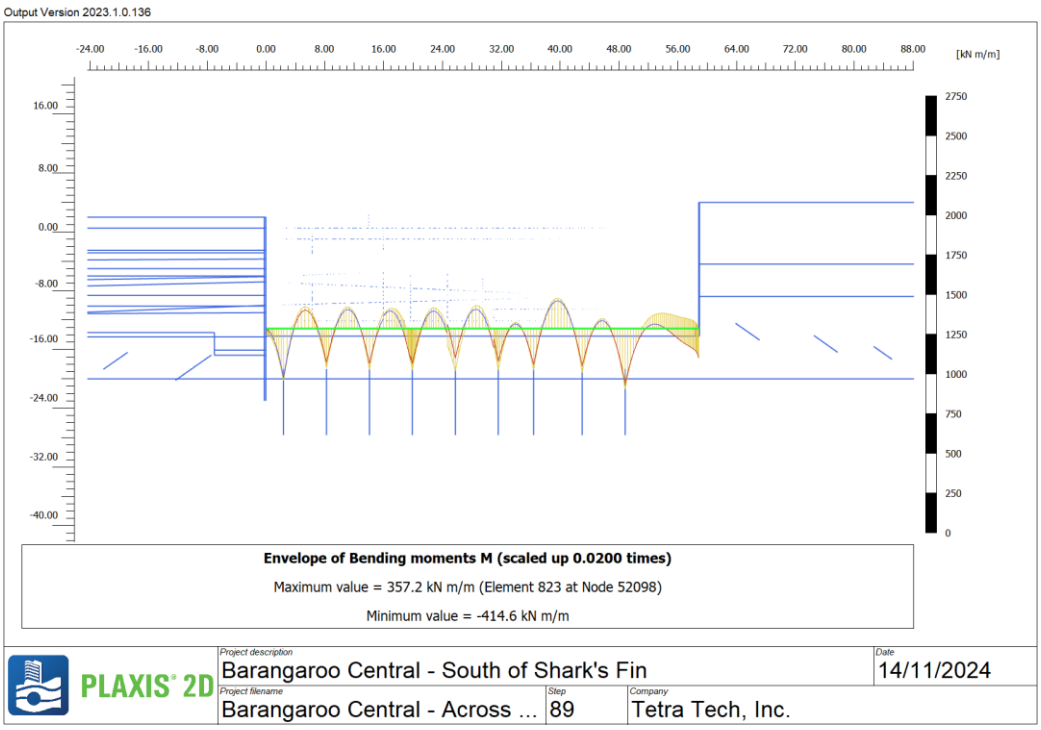


Shear Force for South Wall for GWL Case 3 - GWL at RL 2.575

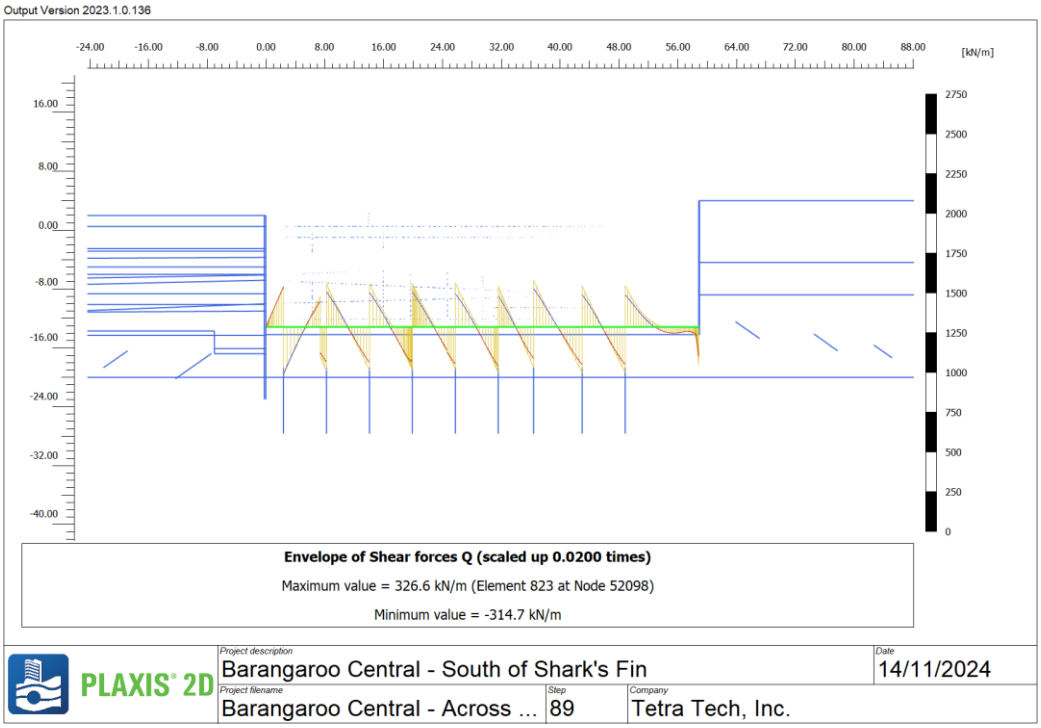
C. B3 (Concourse) Slab



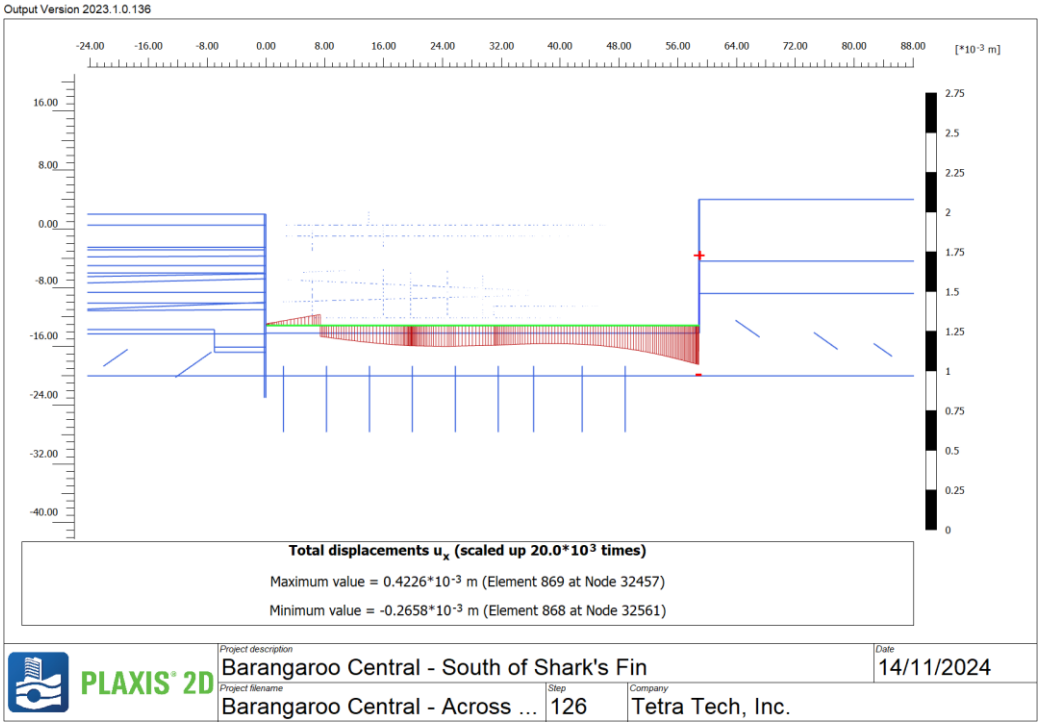
Lateral Displacement for B3 Slab at Stage 21 – After Installation of Shark Fin Slabs and Walls



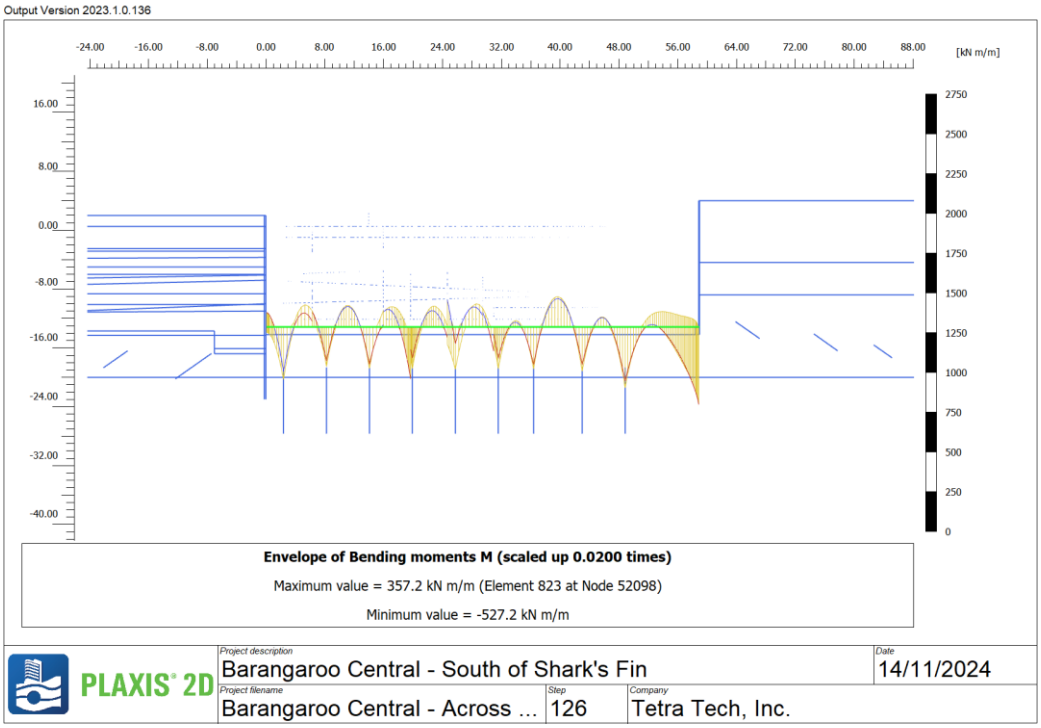
Bending Moment for B3 Slab at Stage 21 – After Installation of Shark Fin Slabs and Walls



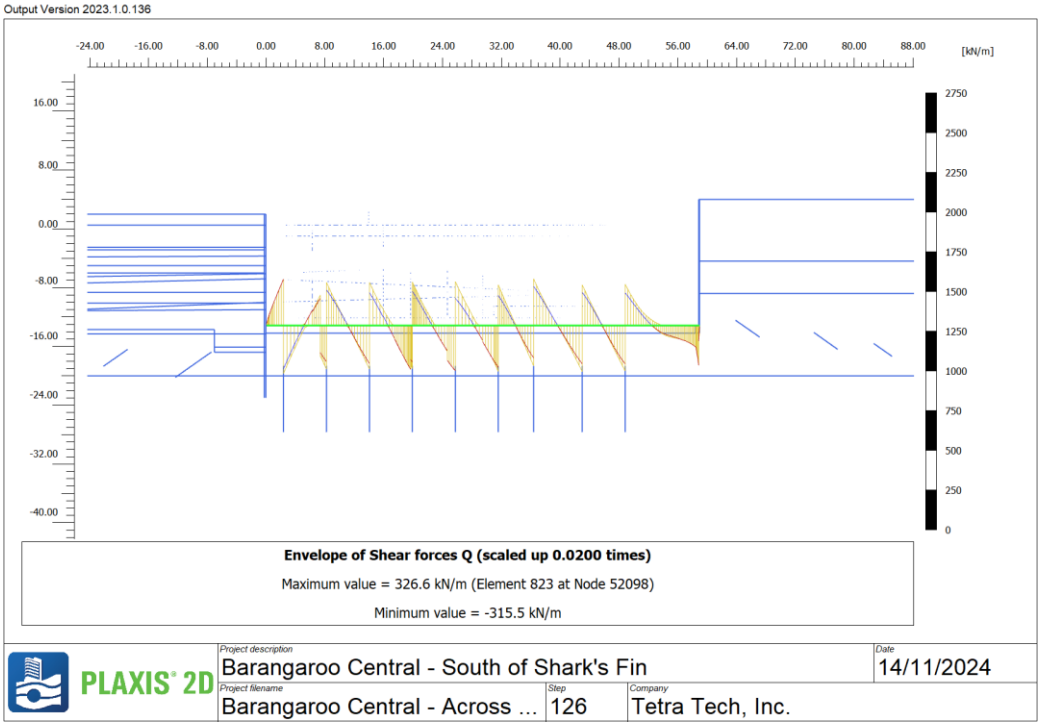
Shear Force for B3 Slab at Stage 21 – After Installation of Shark Fin Slabs and Walls



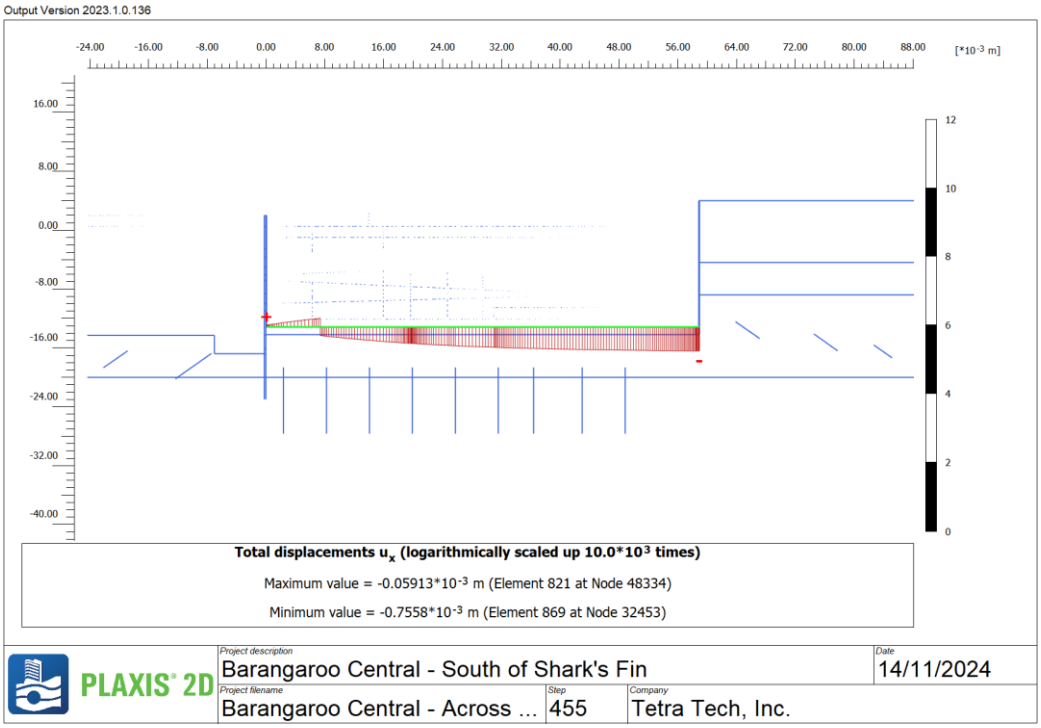
Lateral Displacement for B3 Slab at Stage 22 – GWL raise to RL1.5



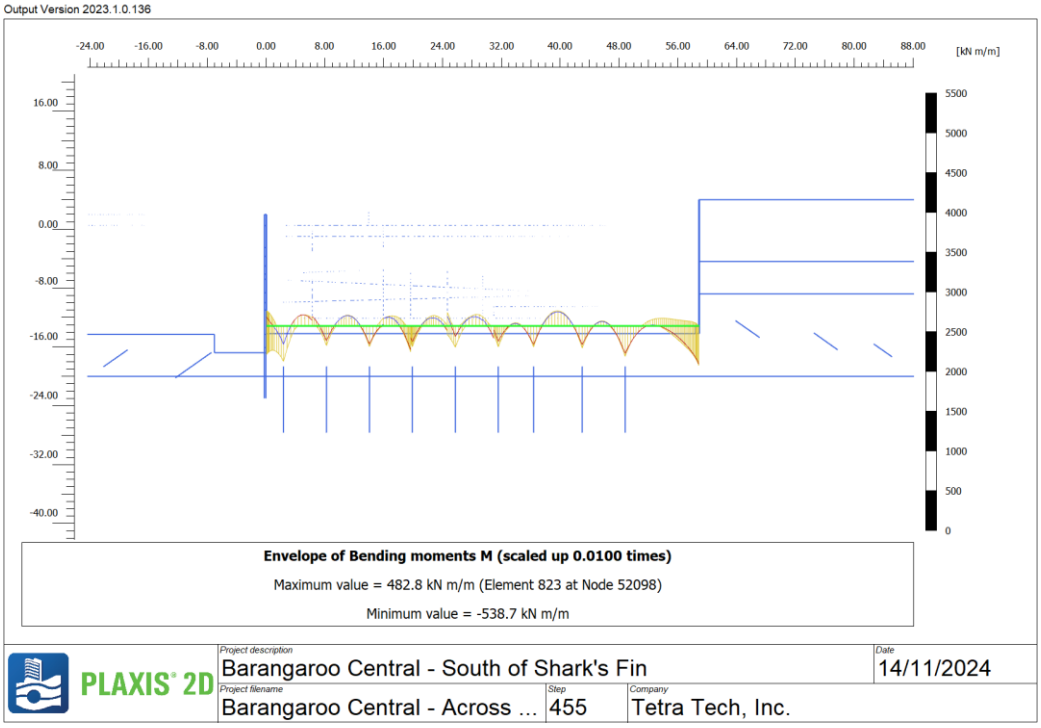
Bending Moment for B3 Slab at Stage 22 – GWL raise to RL1.5



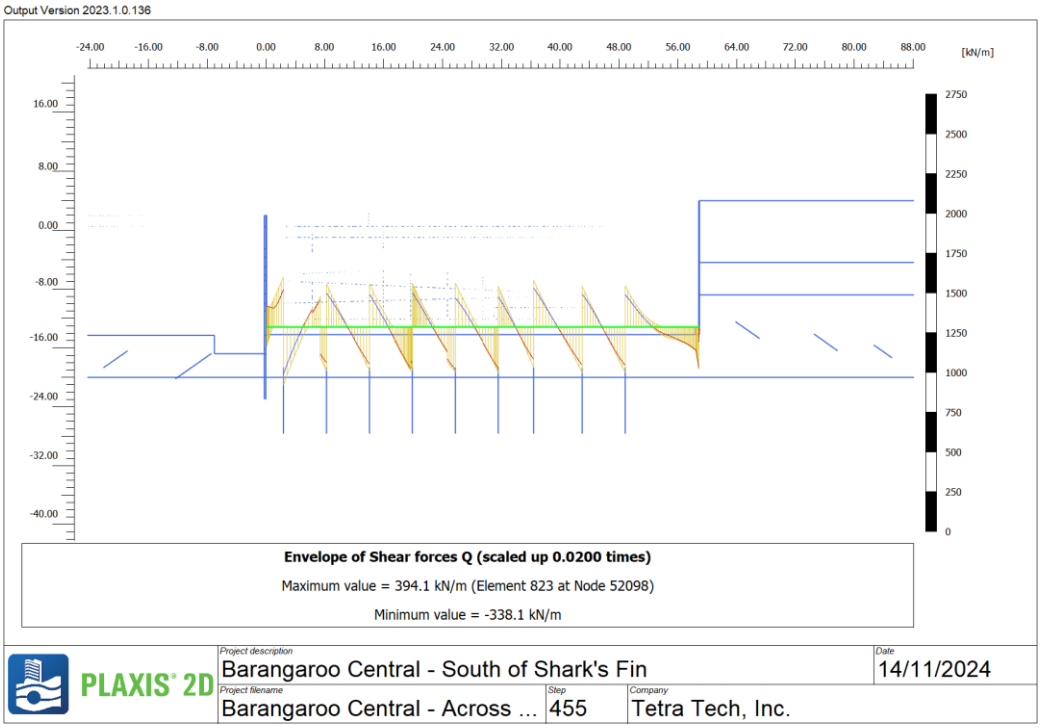
Shear Force for B3 Slab at Stage 22 – GWL raise to RL1.5



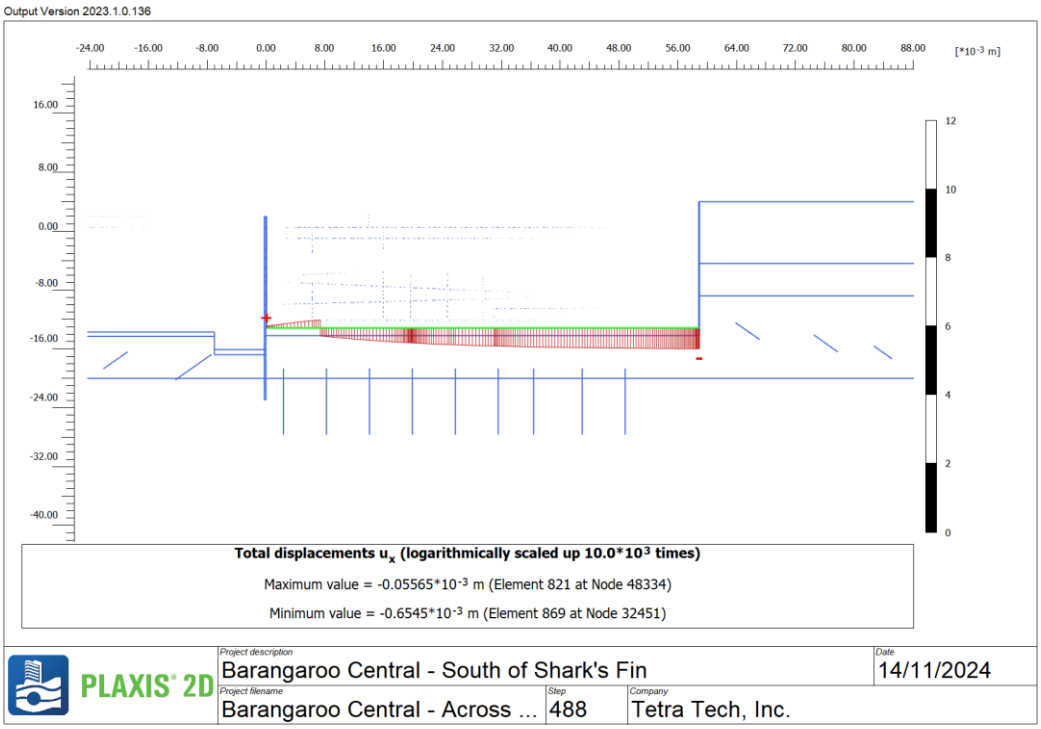
Lateral Displacement for B3 Slab at Stage 29 – Excavate Metro Interface to RL-14.3 and CBD at RL-11.2



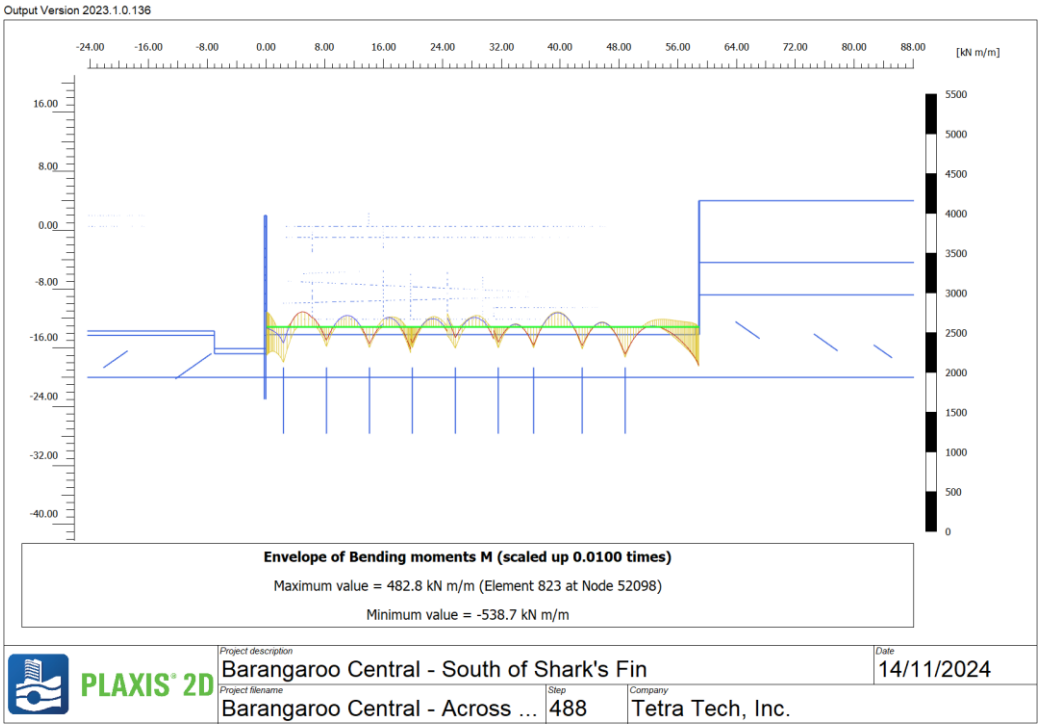
Bending Moment for B3 Slab at Stage 29 – Excavate Metro Interface to RL-14.3 and CBD at RL-11.2



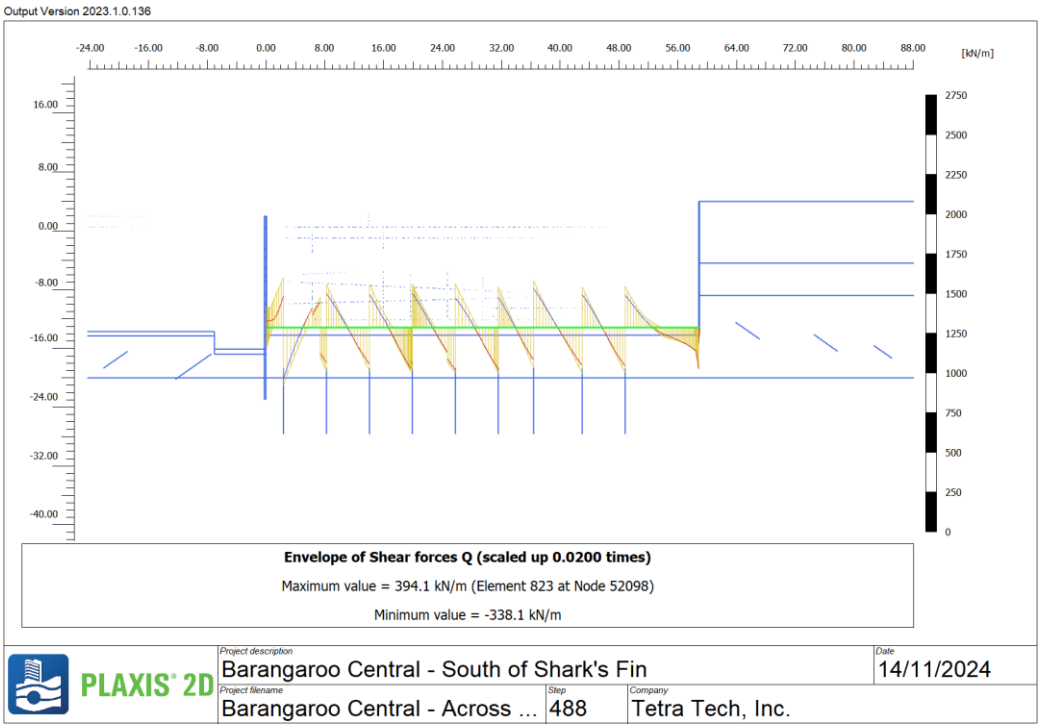
Shear Force for B3 Slab at Stage 29 – Excavate Metro Interface to RL-14.3 and CBD at RL-11.2



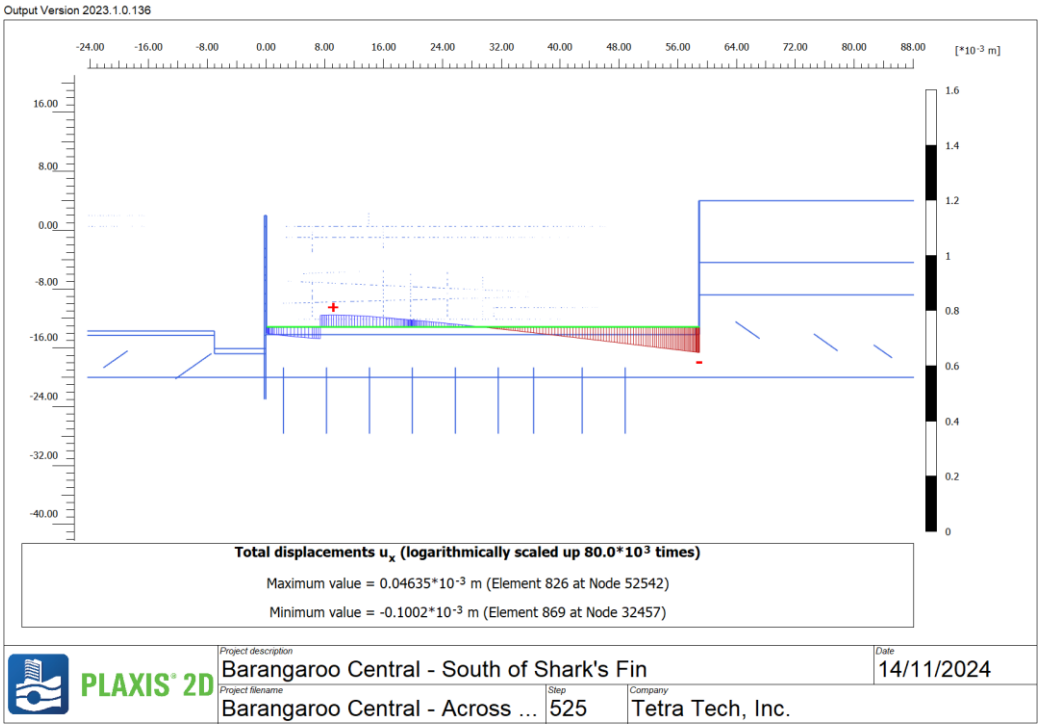
Lateral Displacement for B3 Slab at Stage 34 – After Installation of CBD slabs and walls



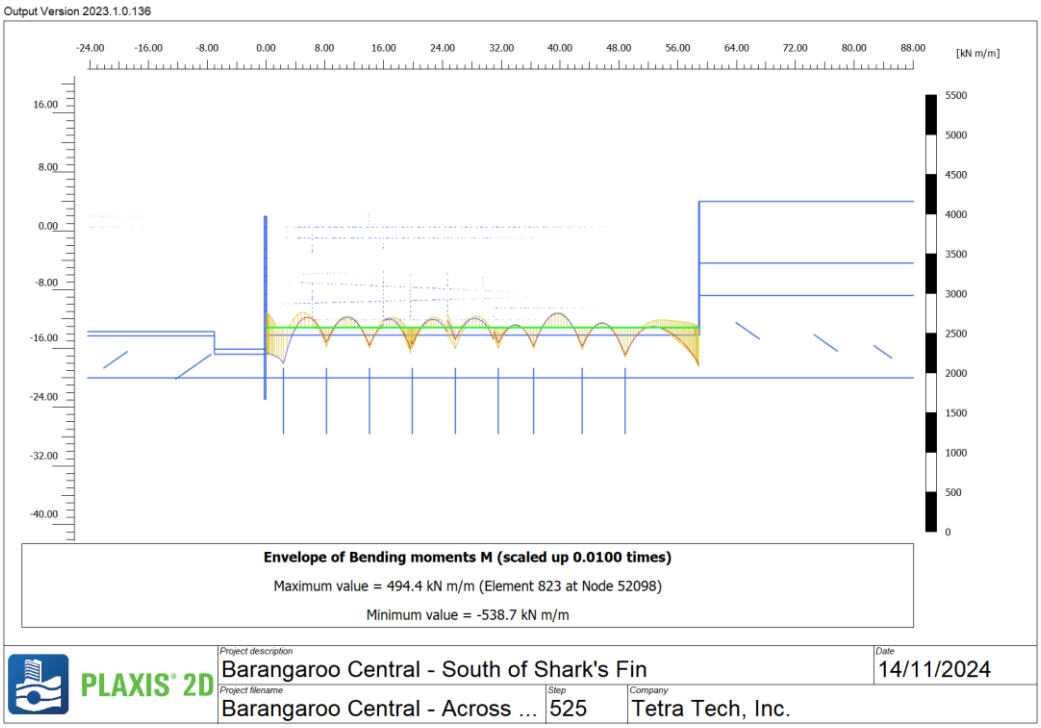
Bending Moment for B3 Slab at Stage 34 – After Installation of CBD slabs and walls



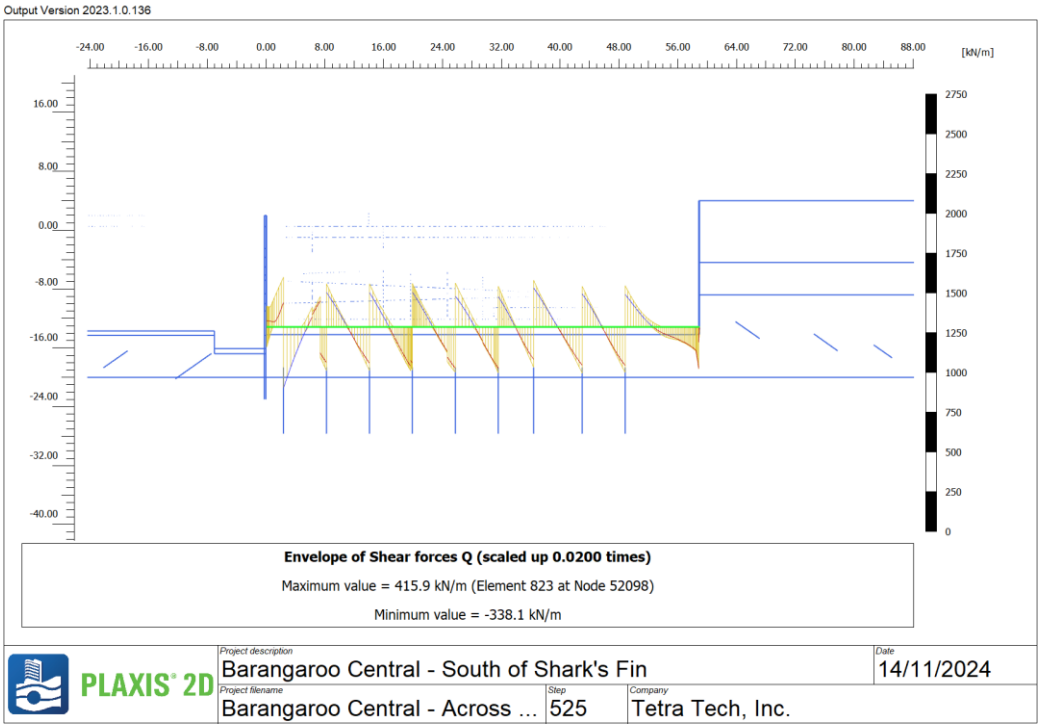
Shear Force for B3 Slab at Stage 37 – After Installation of CBD slabs and walls



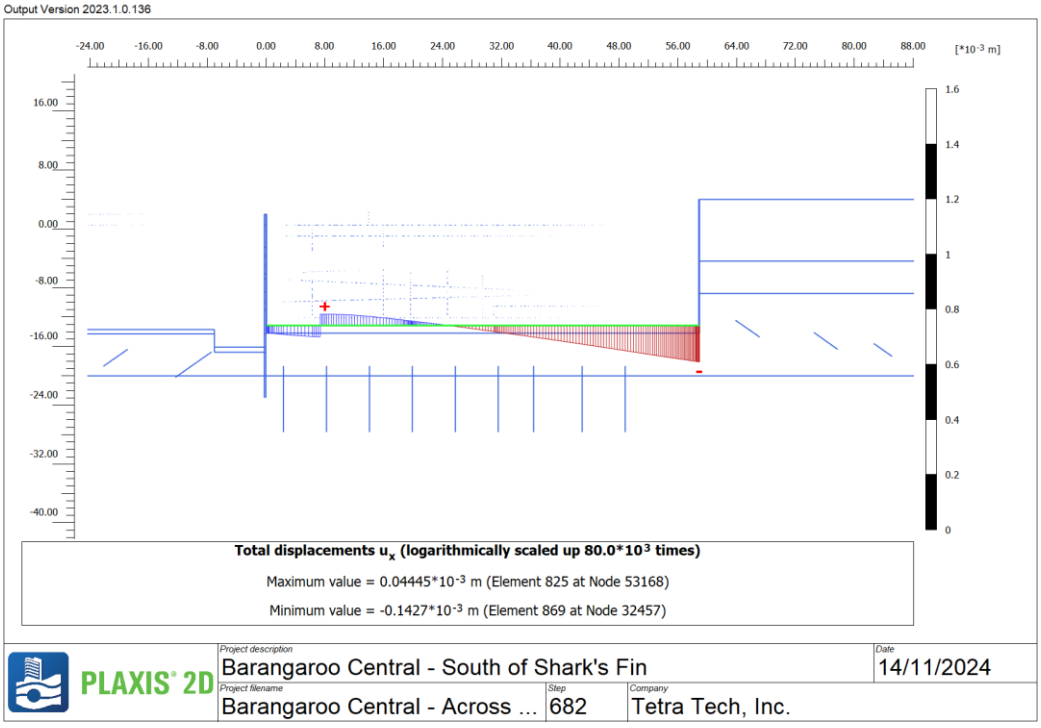
Lateral Displacement for B3 Slab for GWL Case 1 - GWL at RL 1.5



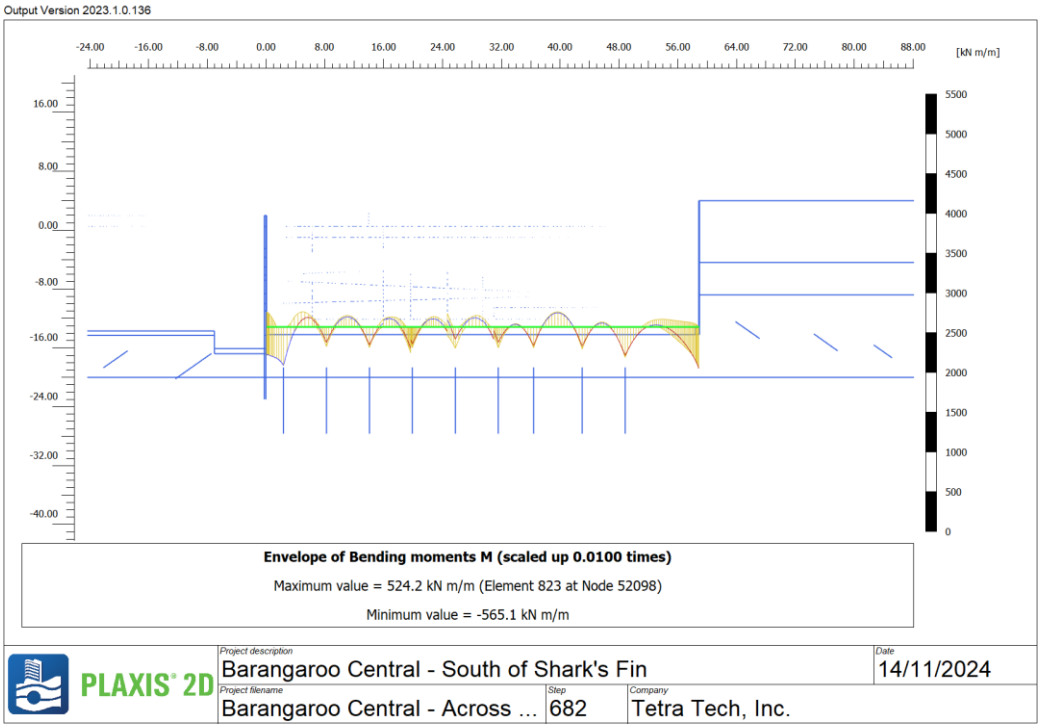
Bending Moment for B3 Slab for GWL Case 1 - GWL at RL 1.5



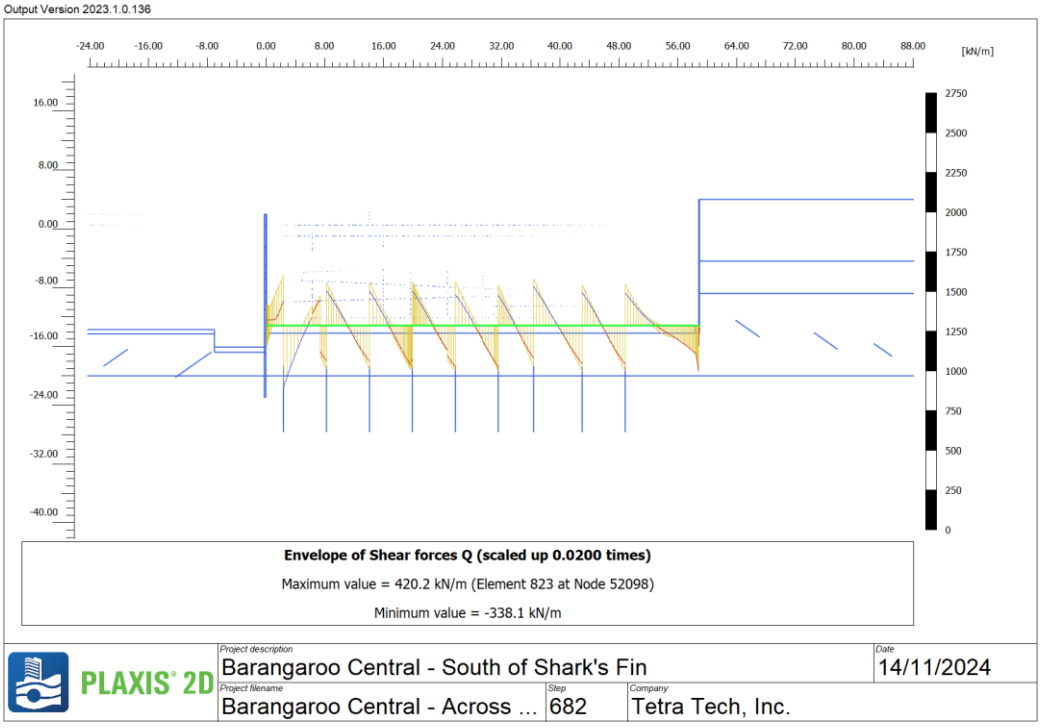
Shear Force for B3 Slab for GWL Case 1 - GWL at RL 1.5



Lateral Displacement for B3 Slab for GWL Case 3 - GWL at RL 2.575

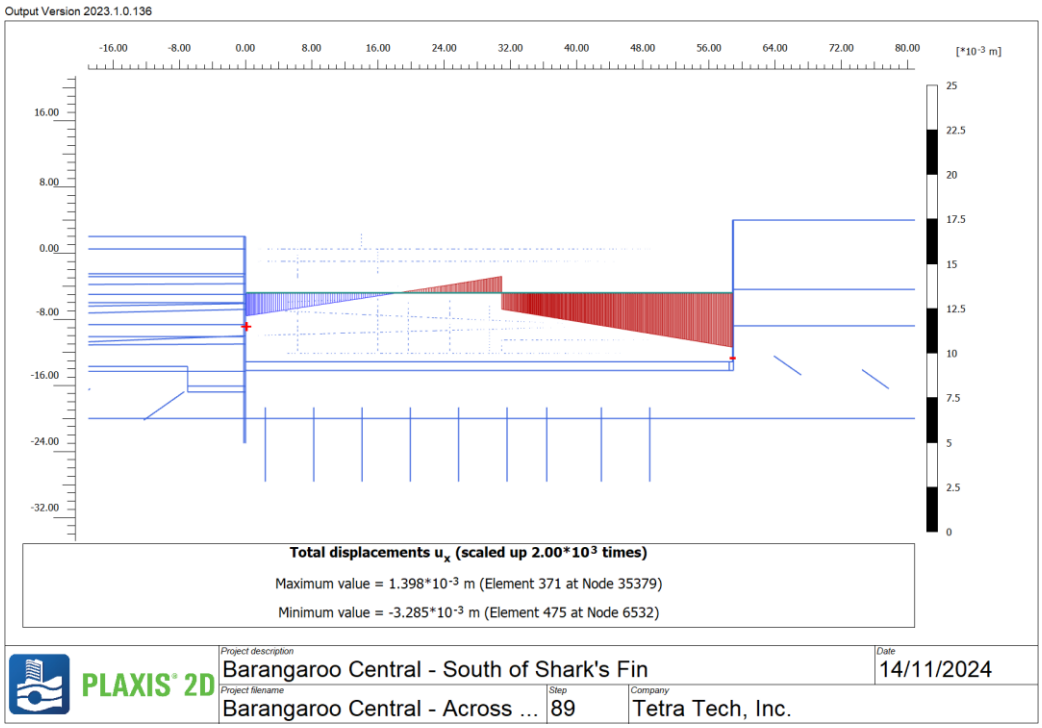


Bending Moment for B3 Slab for GWL Case 3 - GWL at RL 2.575

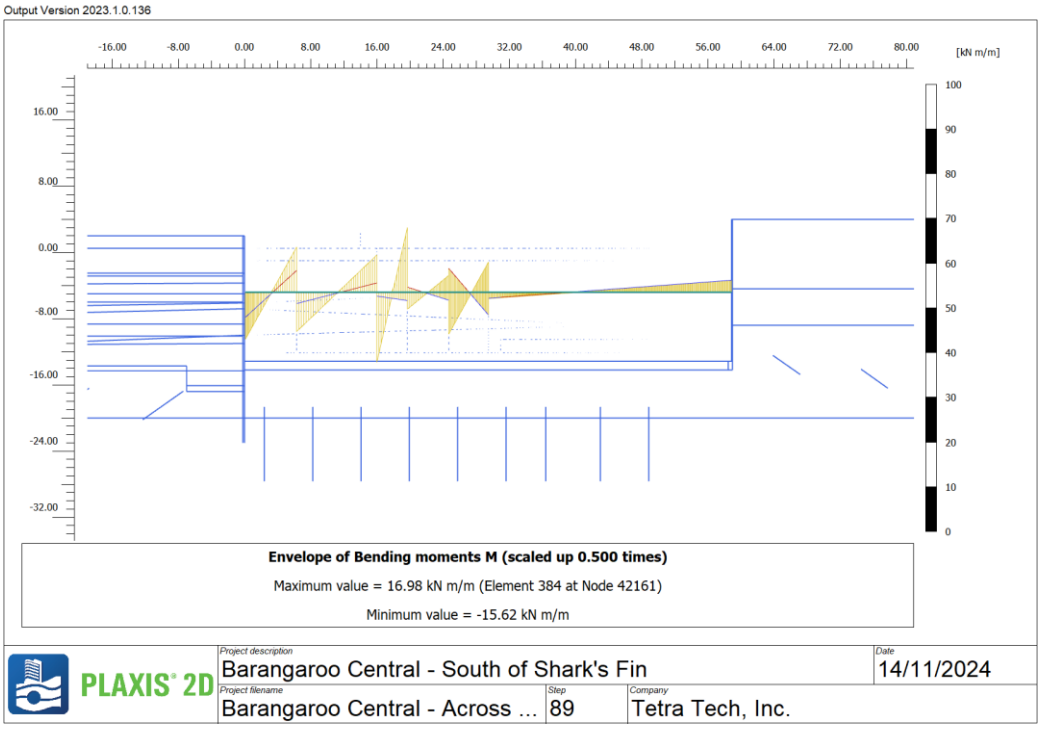


Shear Force Lateral Displacement for B3 Slab for GWL Case 3 - GWL at RL 2.575

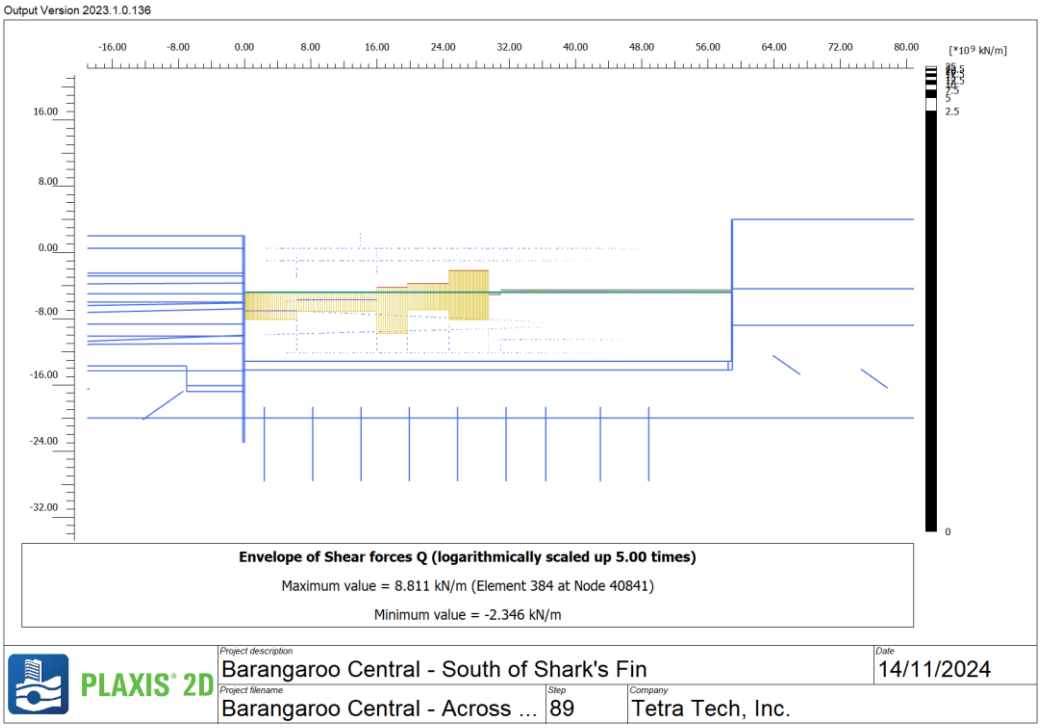
D. B1 Slab



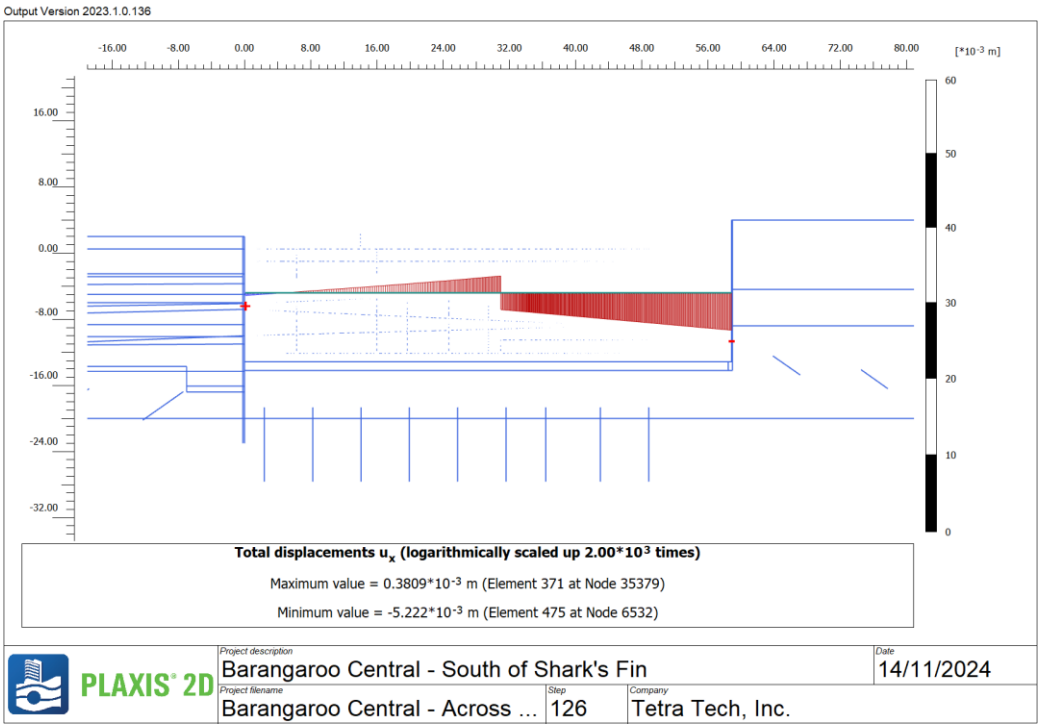
Lateral Displacement for B1 Slab at Stage 21 – After Installation of Shark Fin Excavation Slabs and Walls



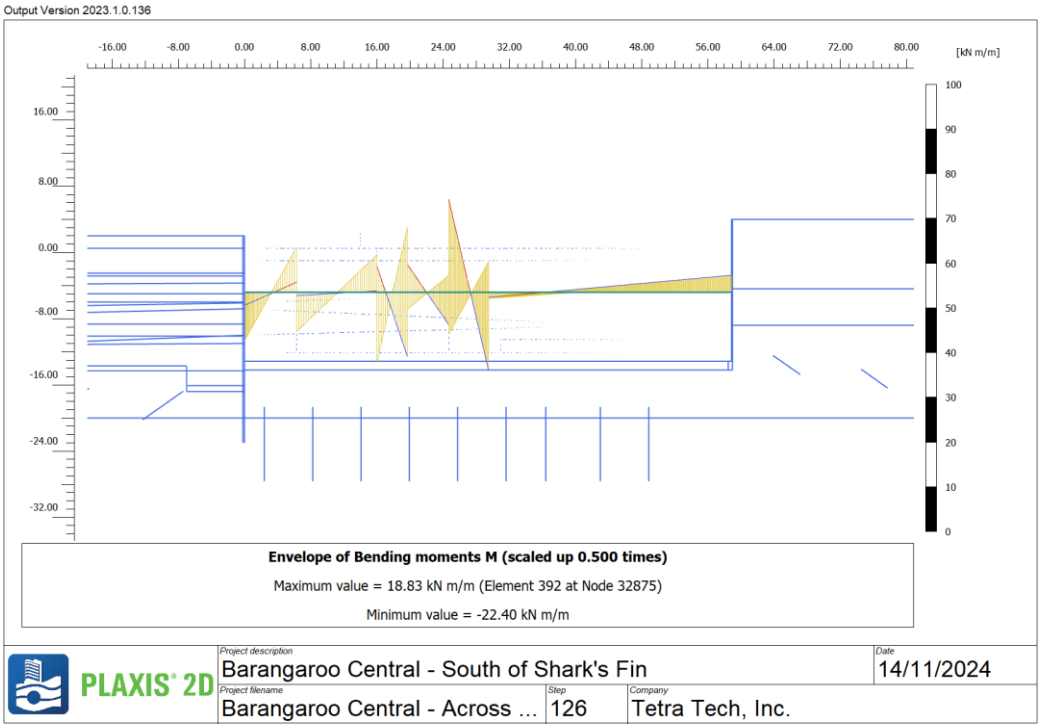
Bending Moment for B1 SLAB Slab at Stage 21 – After Installation of Shark Fin Excavation Slabs and Walls



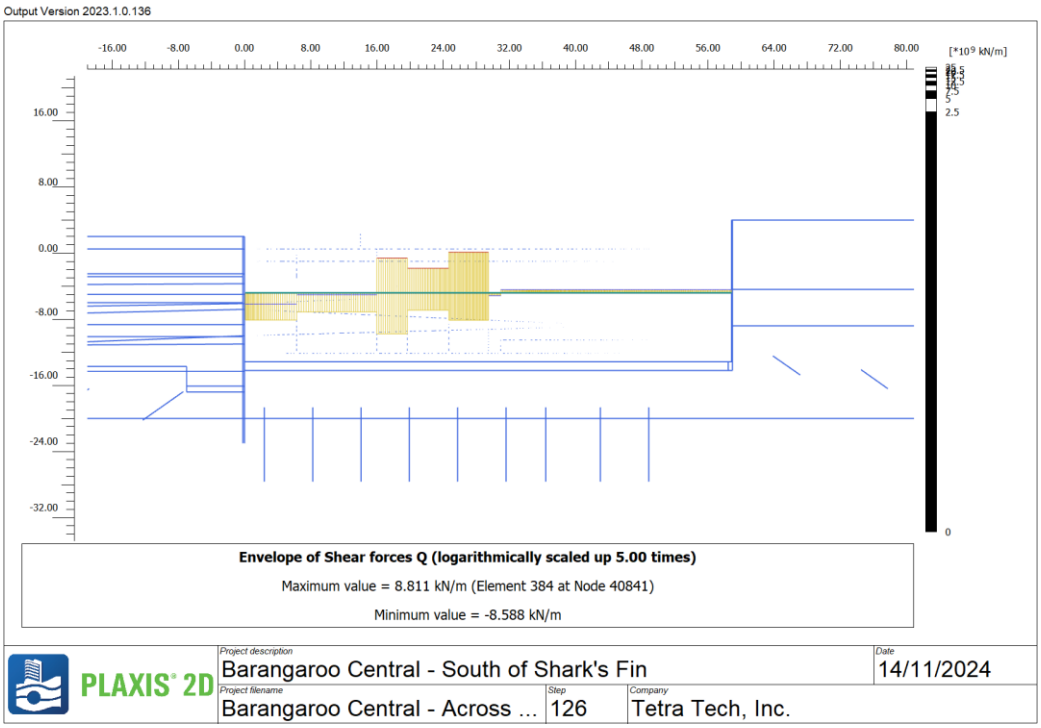
Shear Force for B1 SLAB Slab at Stage 21 – After Installation of Shark Fin Excavation Slabs and Walls



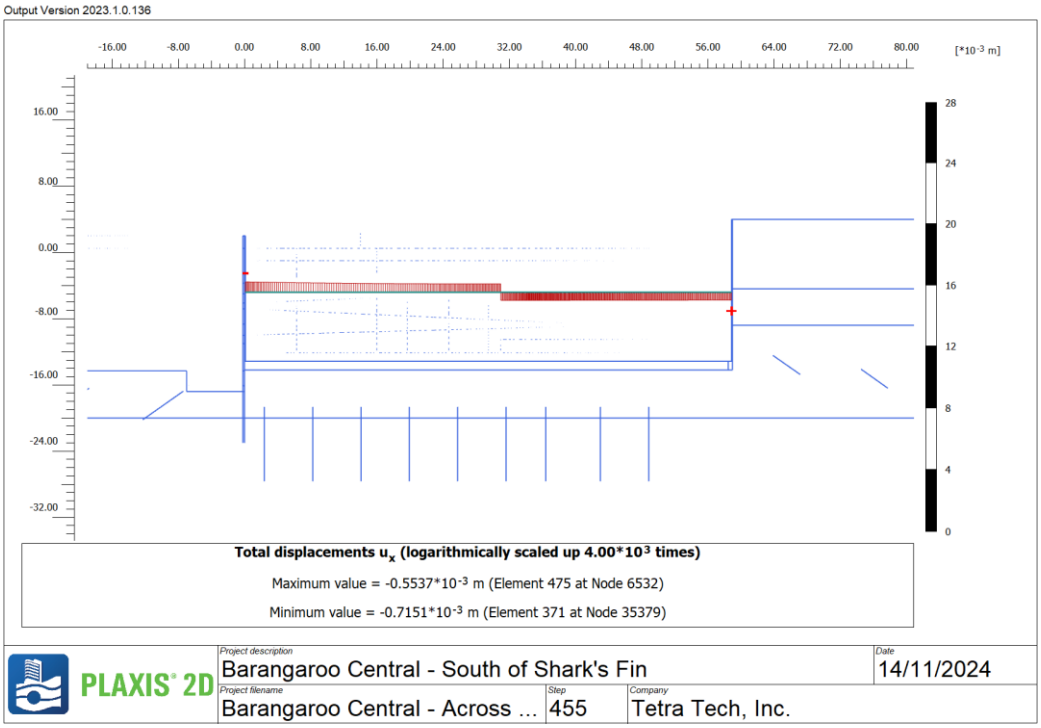
Lateral Displacement for B1 Slab at Stage 22 – GWL raise to RL1.5



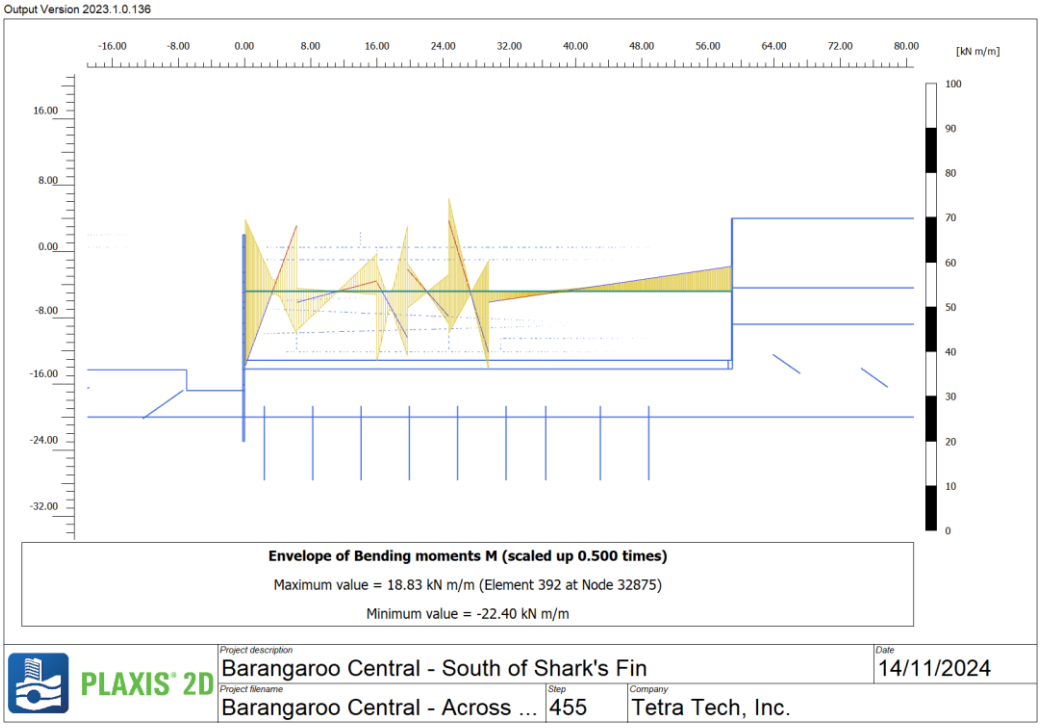
Bending Moment for B1 Slab at Stage 22 – GWL raise to RL1.5



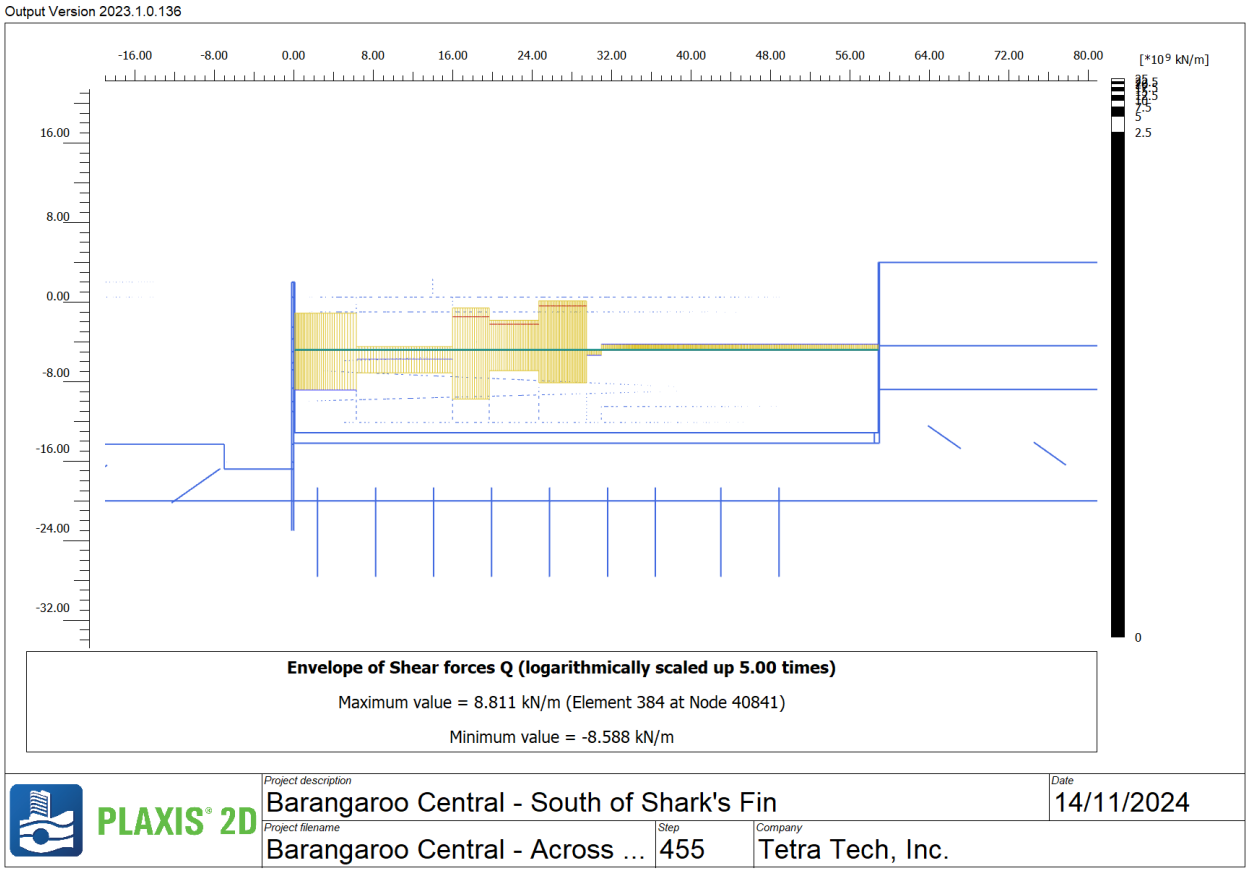
Shear Force for B1 Slab at Stage 22 – GWL raise to RL1.5



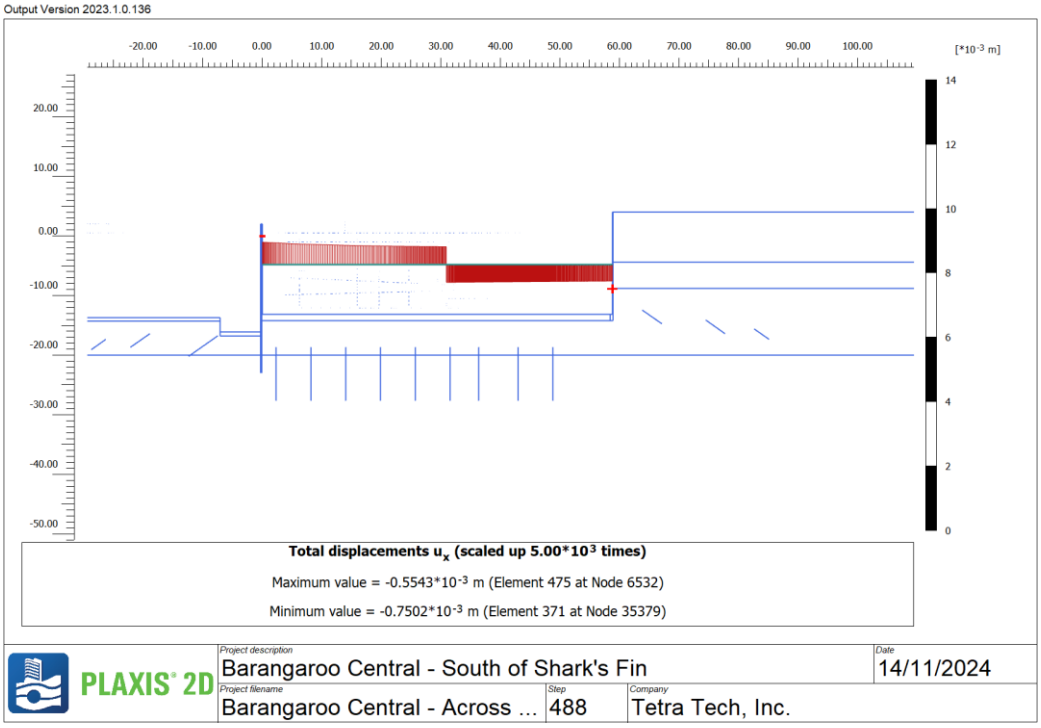
Lateral Displacement for B1 Slab at Stage 29 – Excavate Metro Interface to RL-14.3 and CBD at RL-11.2



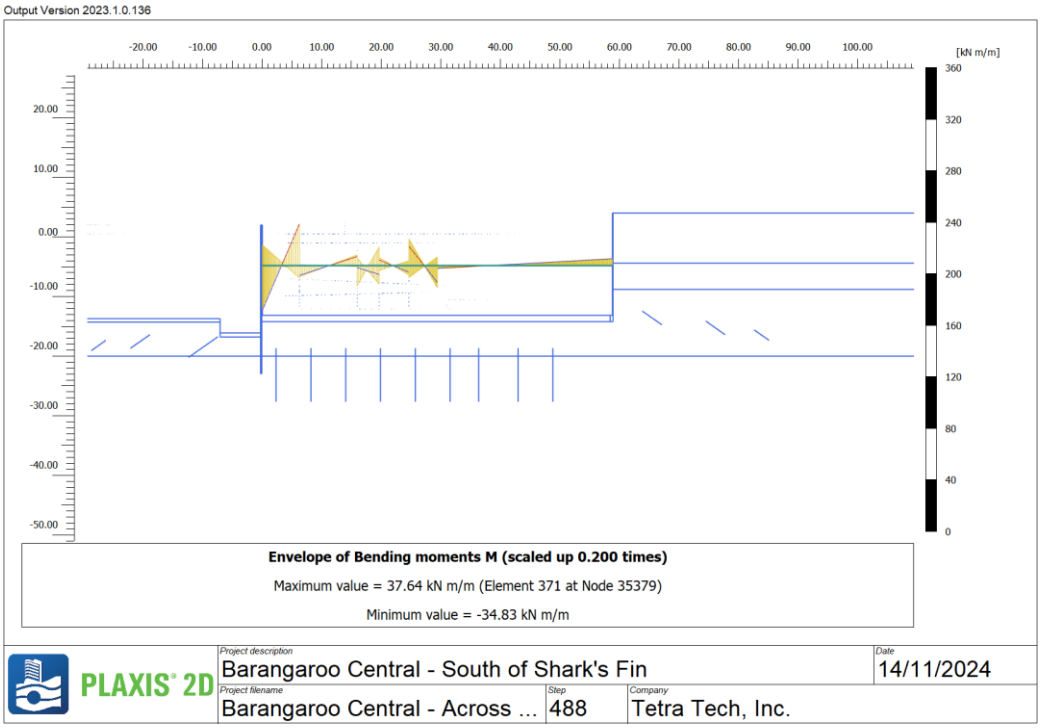
Bending Moment for B1 Slab at Stage 29 – Excavate Metro Interface to RL-14.3 and CBD at RL-11.2



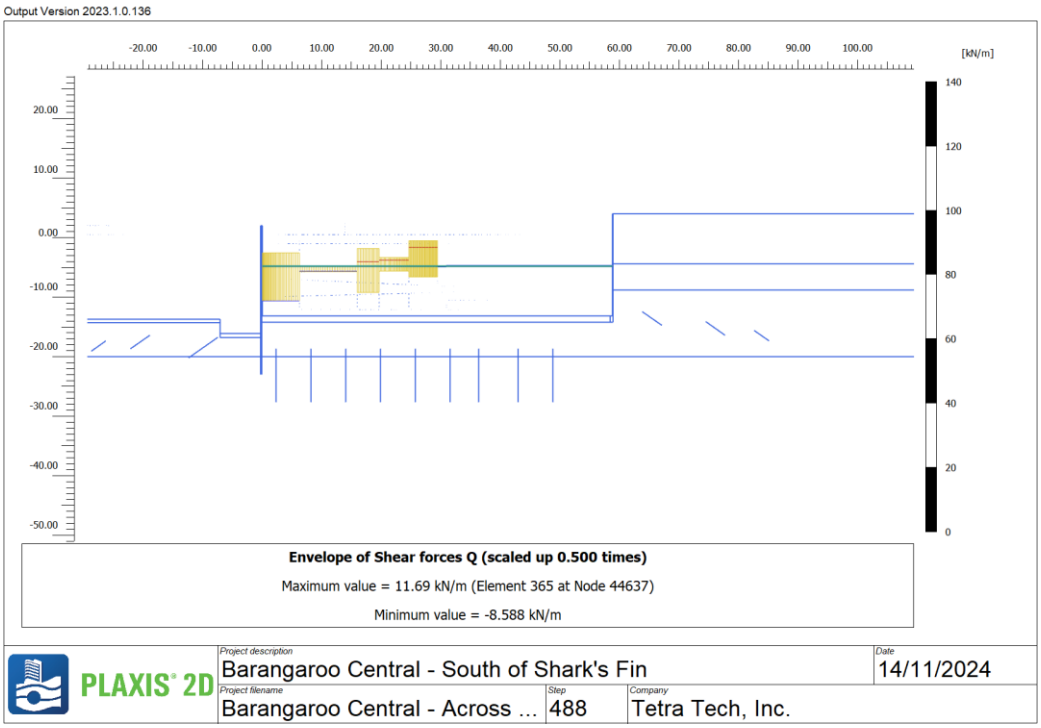
Shear Force for B1 Slab at Stage 29 – Excavate Metro Interface to RL-14.3 and CBD at RL-11.2



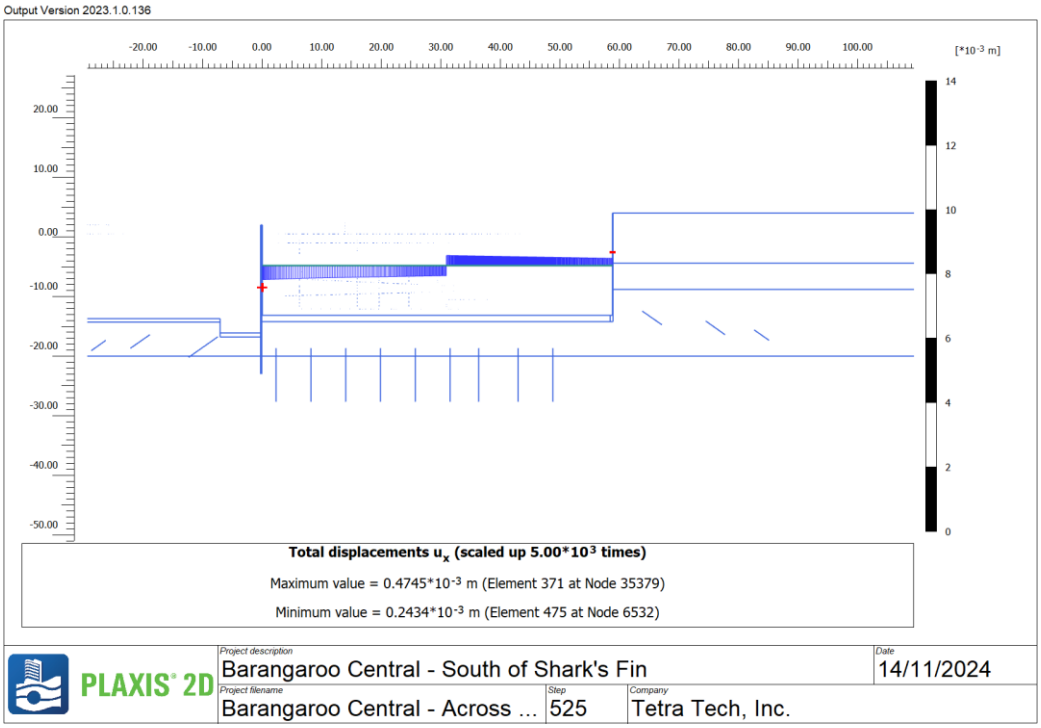
Lateral Displacement for B1 Slab at Stage 34 – After Installation of CBD slabs and walls



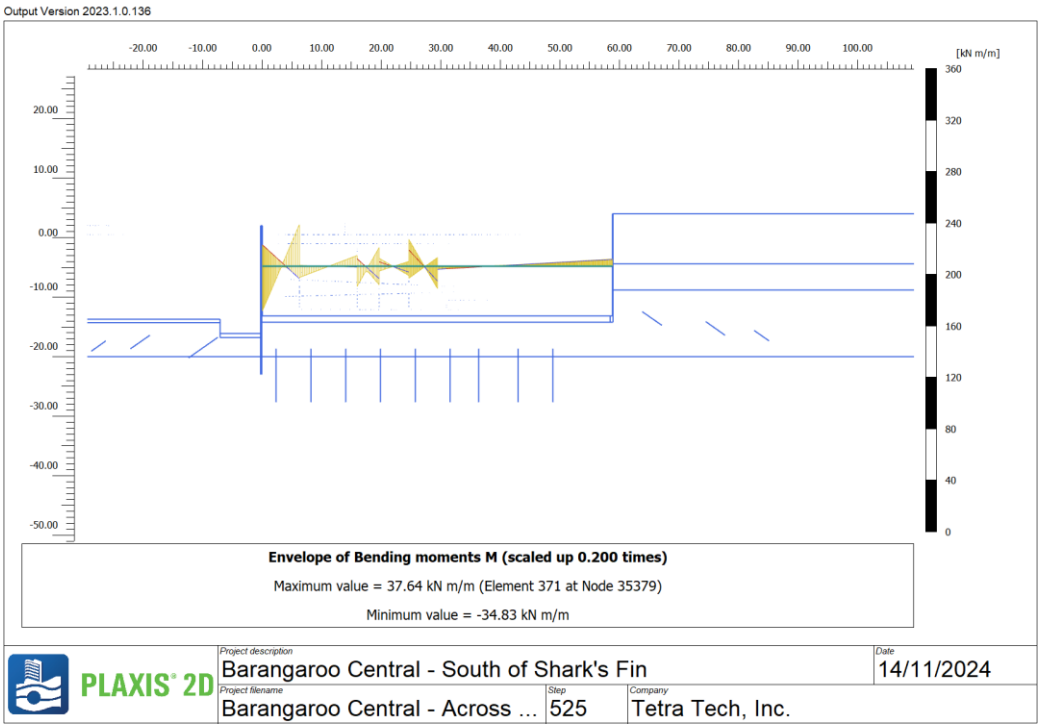
Bending Moment for B1 Slab at Stage 34 – After Installation of CBD slabs and walls



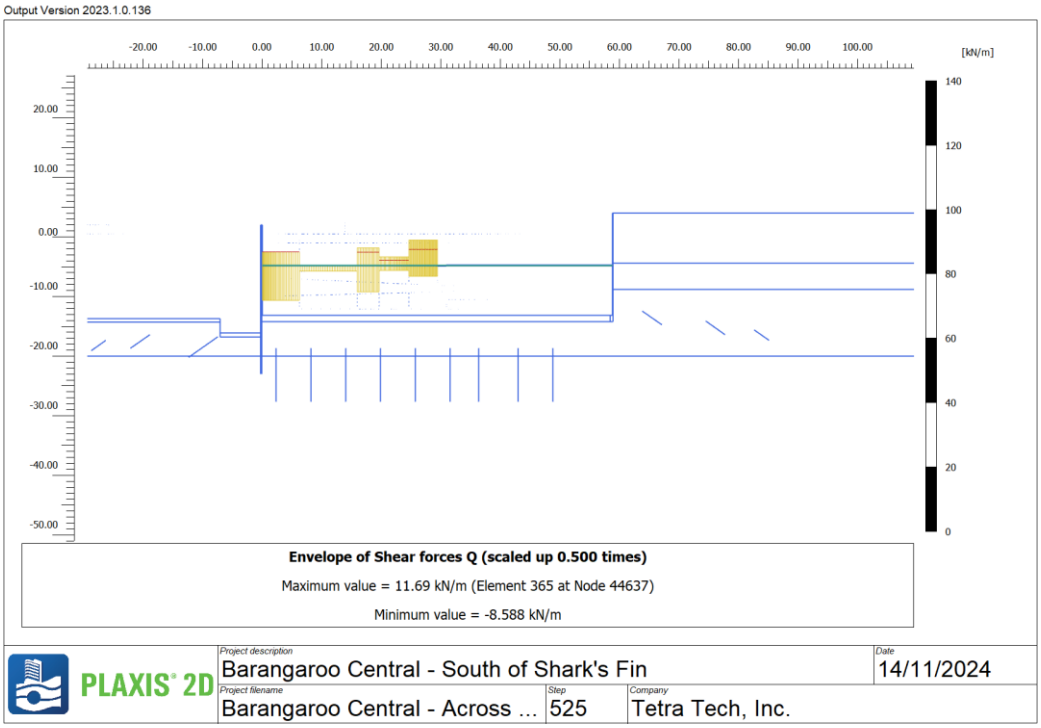
Shear Force for B1 Slab at Stage 34 – After Installation of CBD slabs and walls



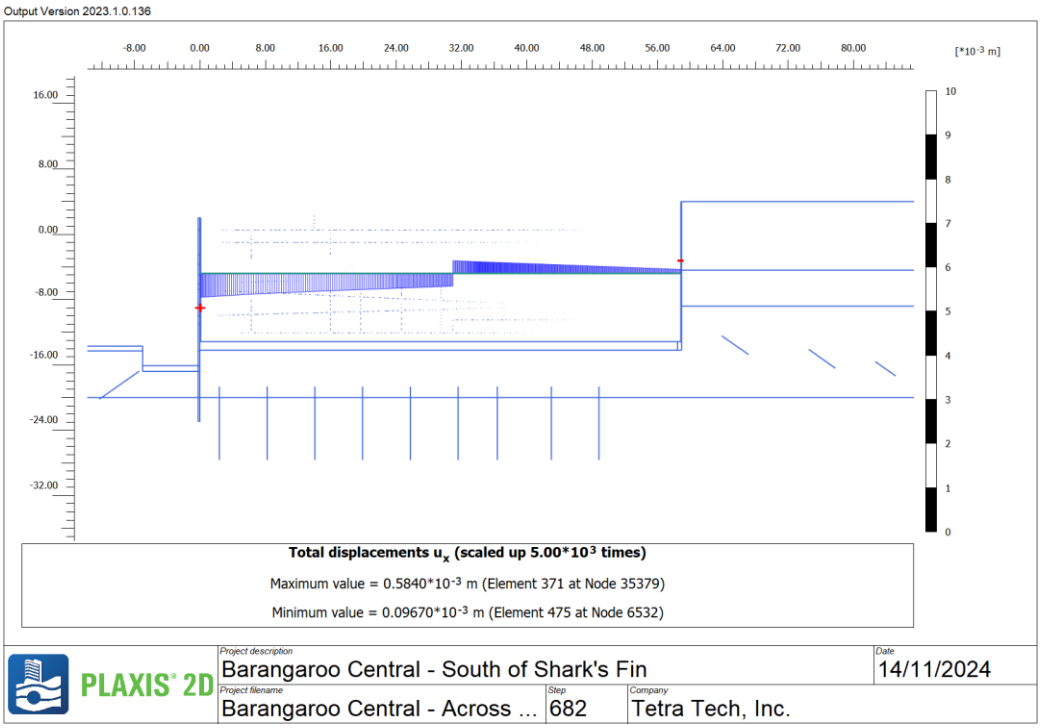
Lateral Displacement for B1 Slab for GWL Case 1 - GWL at RL 1.5



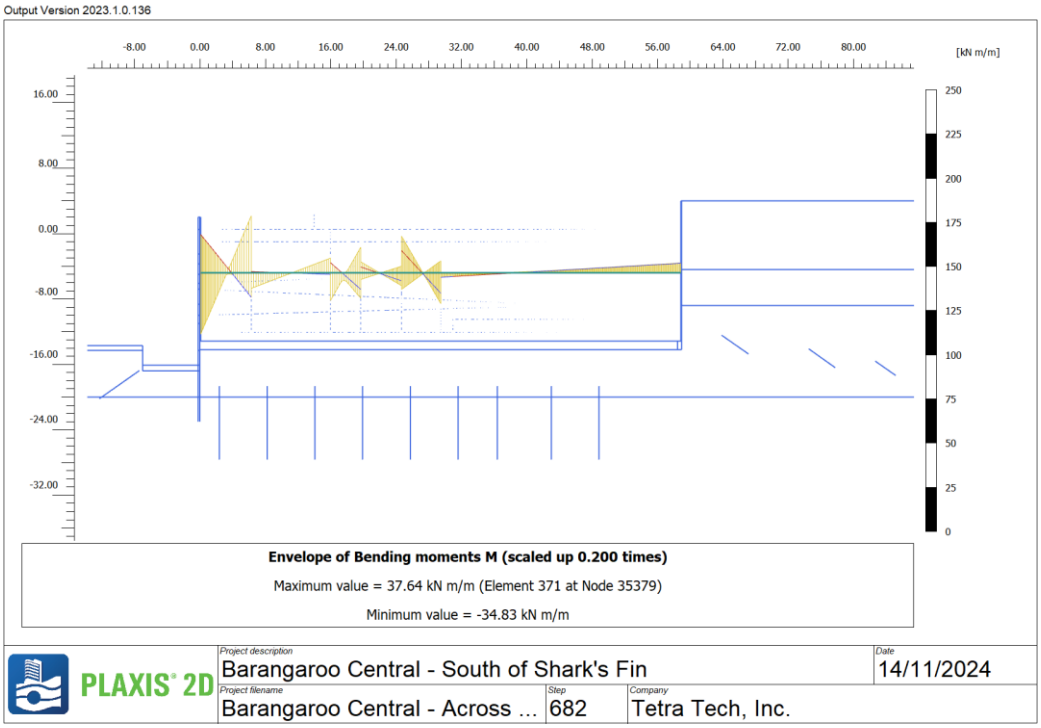
Bending Moment for B1 Slab for GWL Case 1 - GWL at RL 1.5



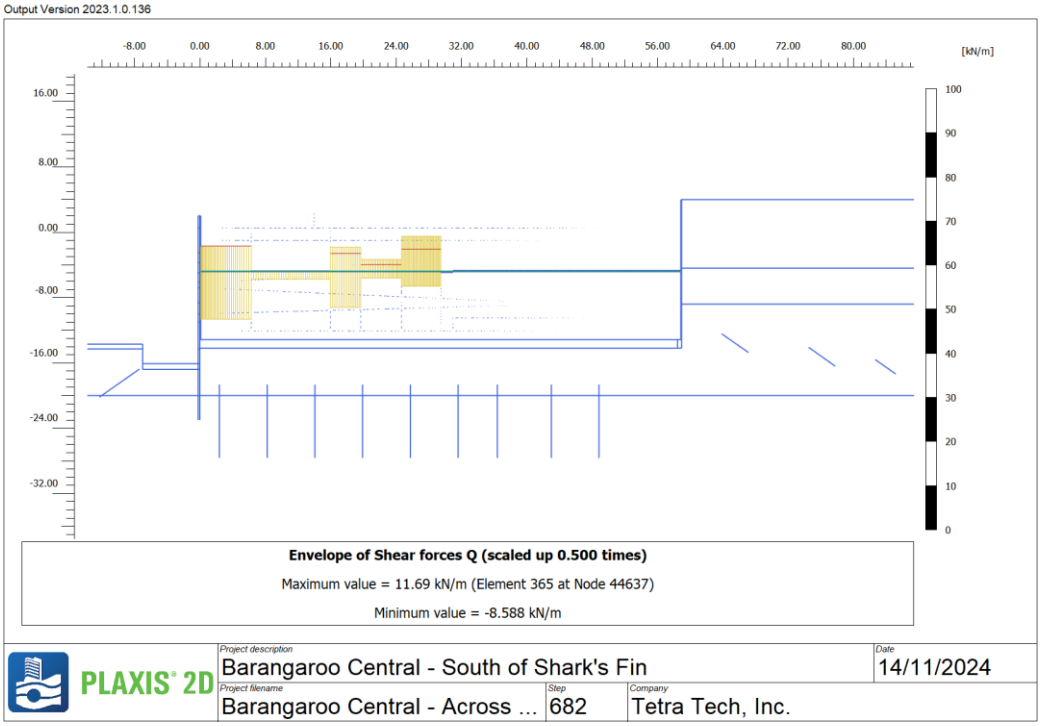
Shear Force for B1 Slab for GWL Case 1 - GWL at RL 1.5



Lateral Displacement for B1 Slab for GWL Case 3 - GWL at RL 2.575

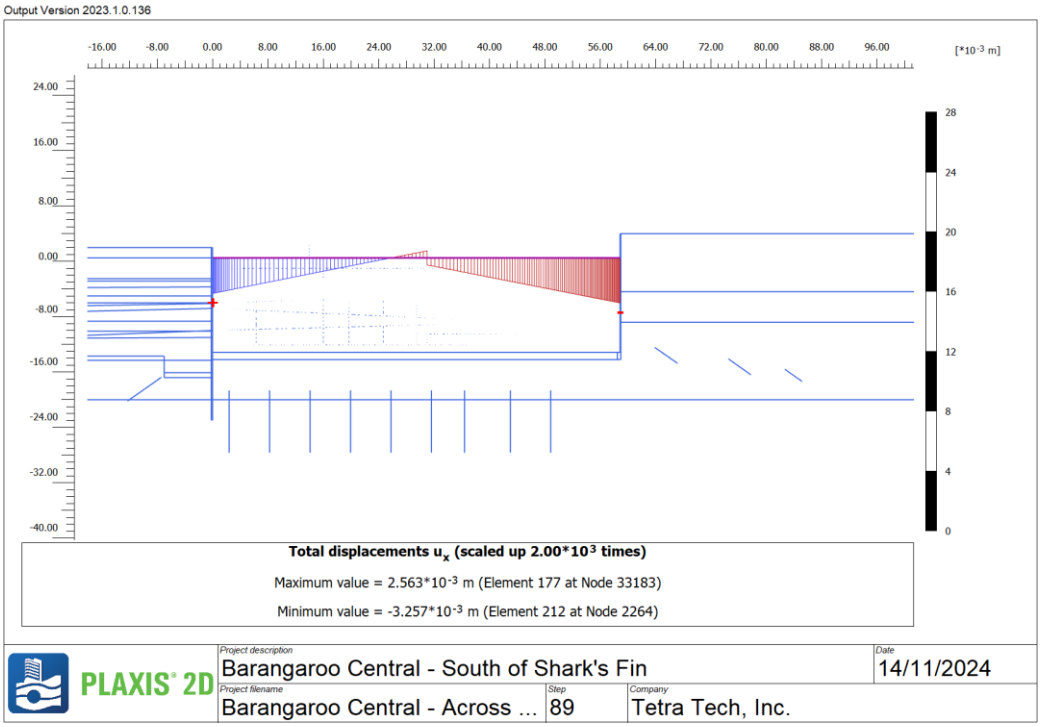


Bending Moment for B1 Slab for GWL Case 3 - GWL at RL 2.575

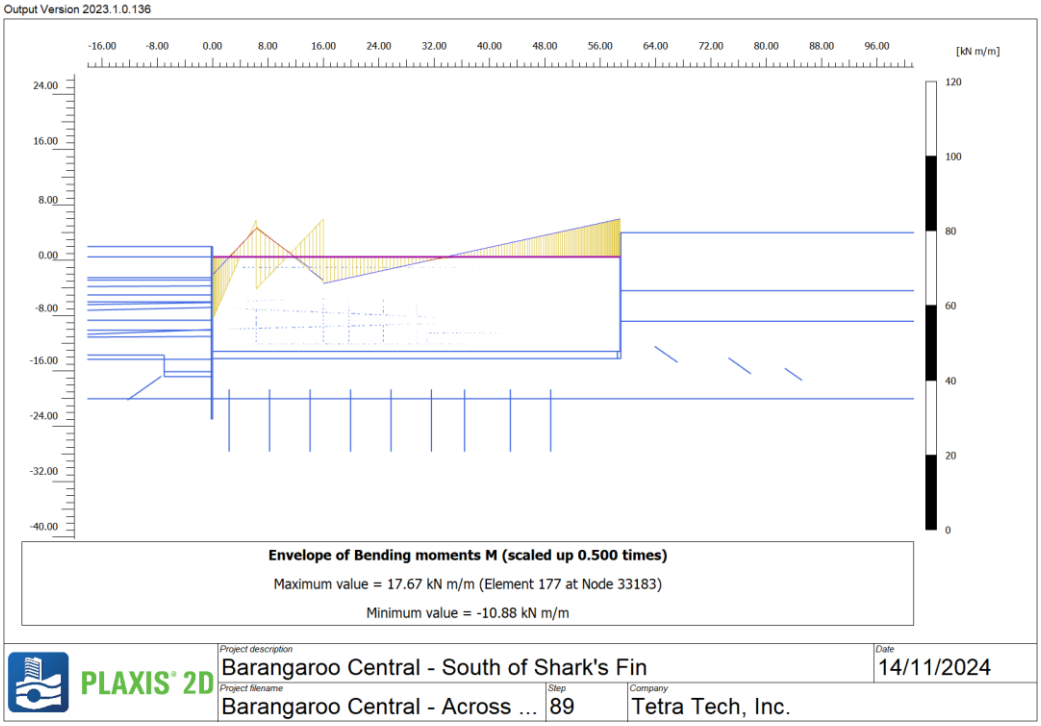


Shear Force for B1 Slab for GWL Case 3 - GWL at RL 2.575

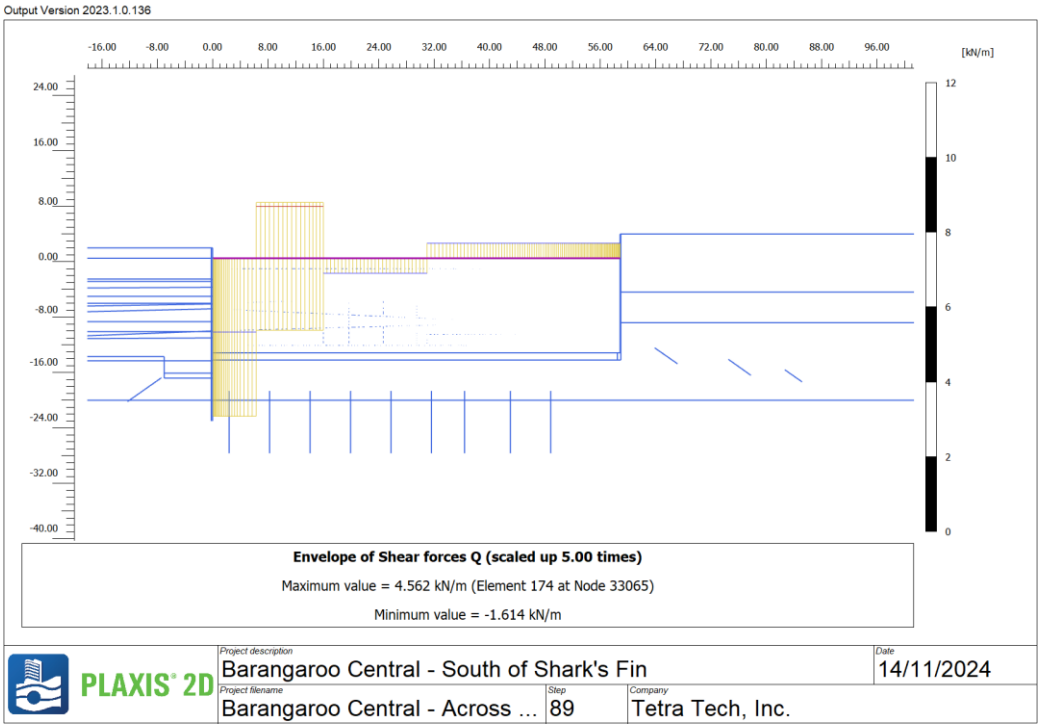
LG Slab



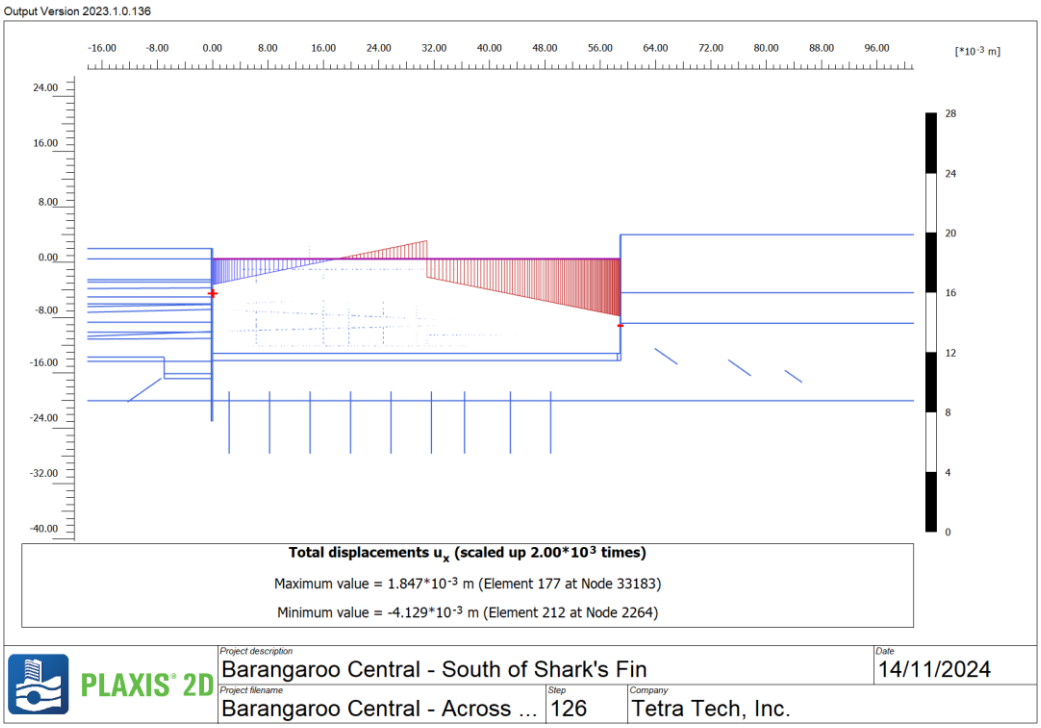
Lateral Displacement for LG Slab at Stage 21 – After Installation of Shark Fin Excavation Slabs and Walls



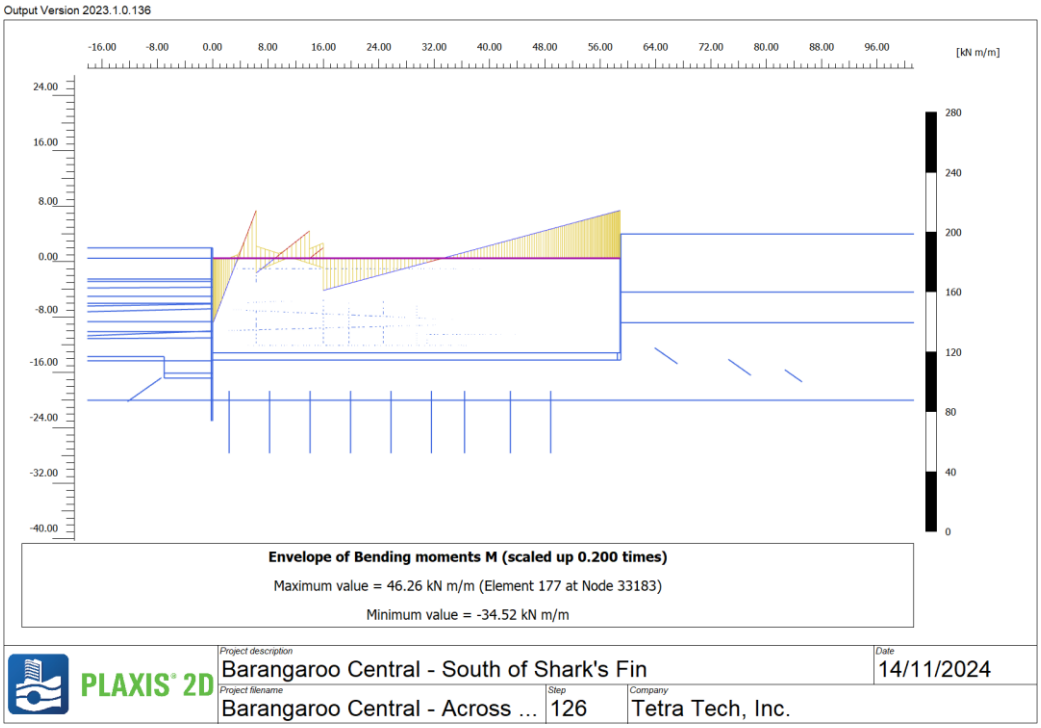
Bending Moment for LG SLAB Slab at Stage 21 – After Installation of Shark Fin Excavation Slabs and Walls



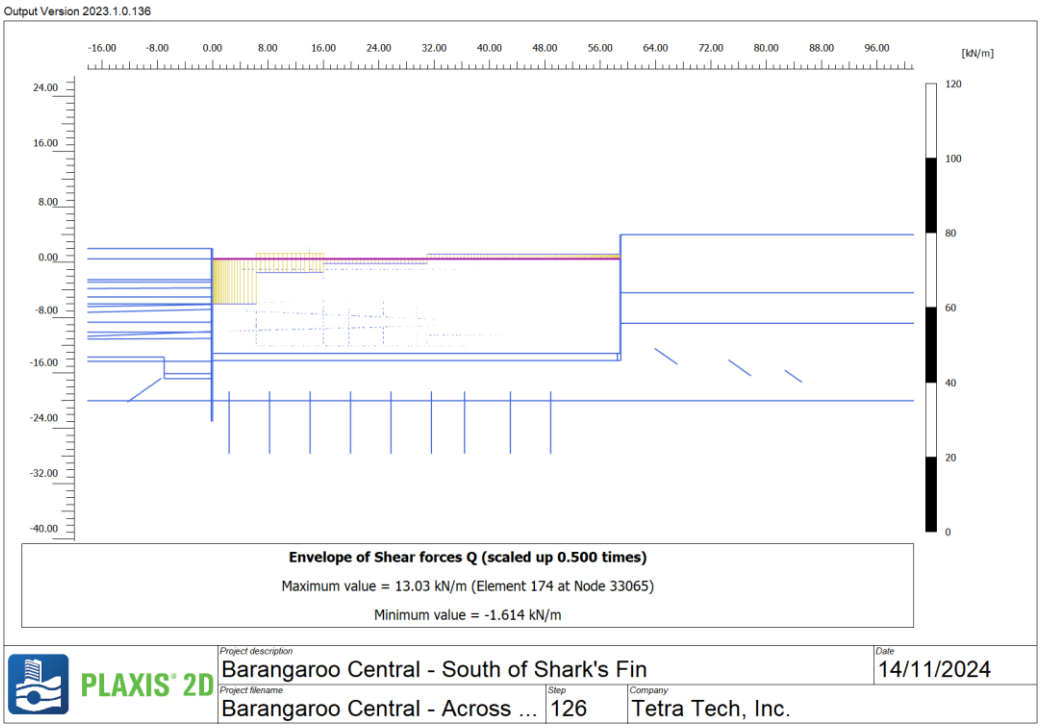
Shear Force for LG SLAB Slab at Stage 21 – After Installation of Shark Fin Excavation Slabs and Walls



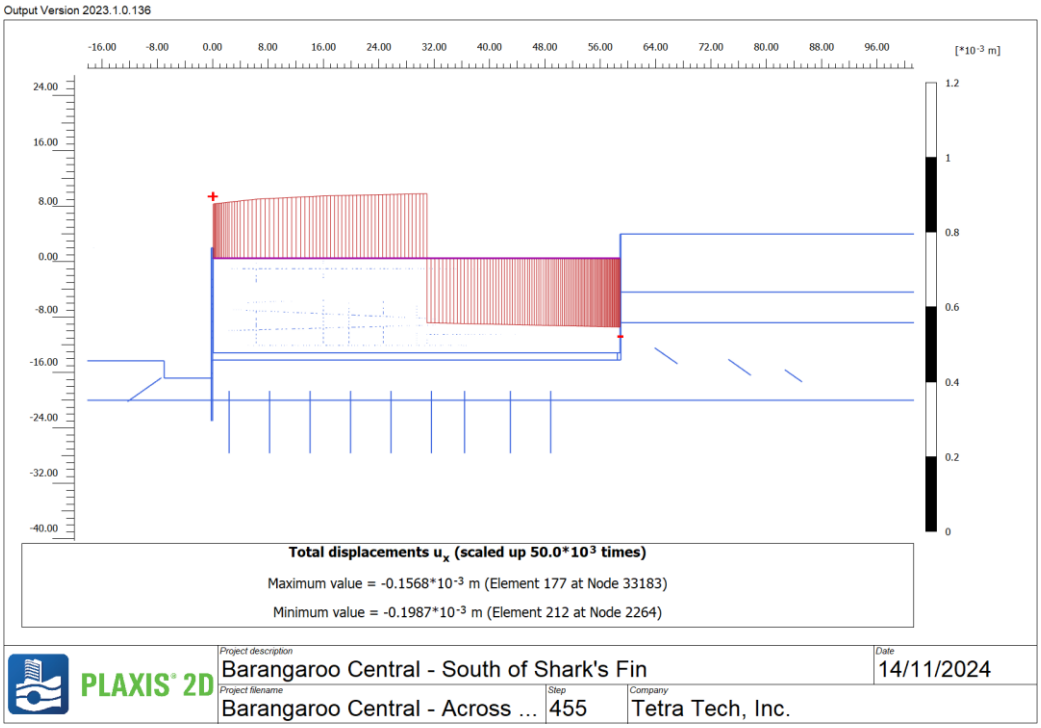
Lateral Displacement for LG Slab at Stage 22 – GWL raise to RL1.5



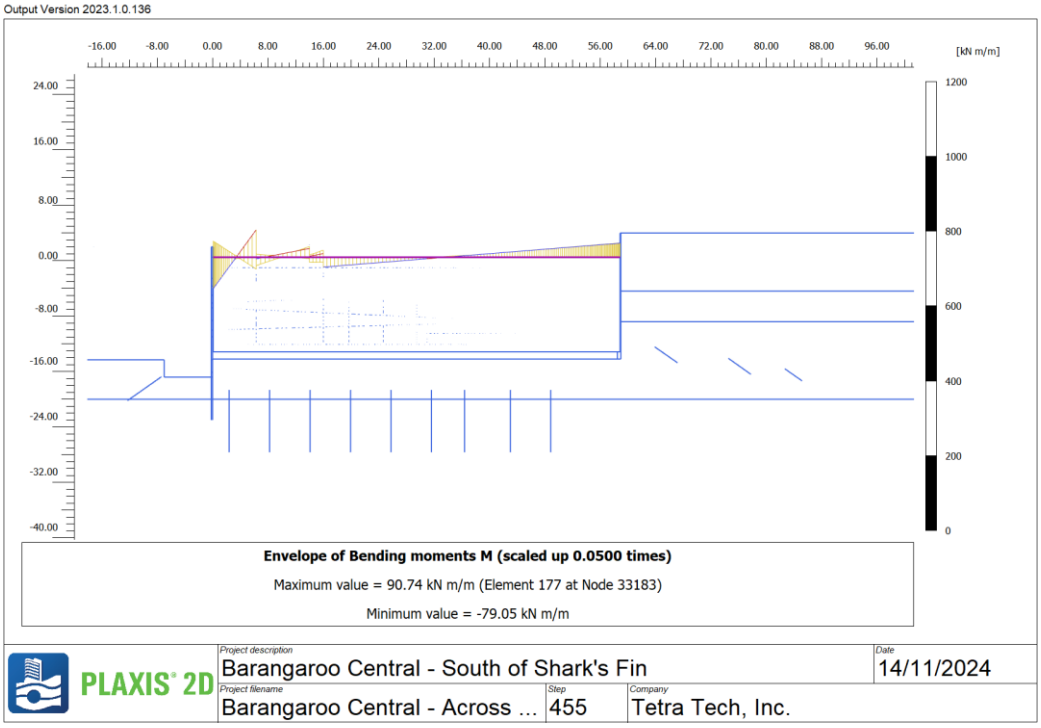
Bending Moment for LG Slab at Stage 22 – GWL raise to RL1.5



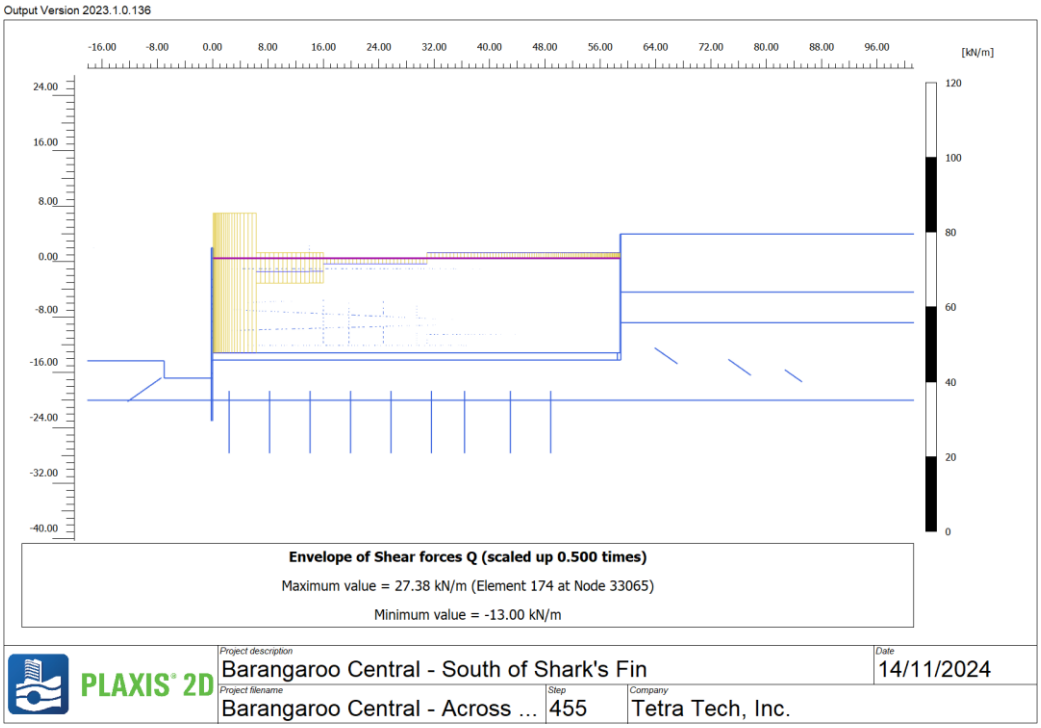
Shear Force for LG Slab at Stage 22 – GWL raise to RL1.5



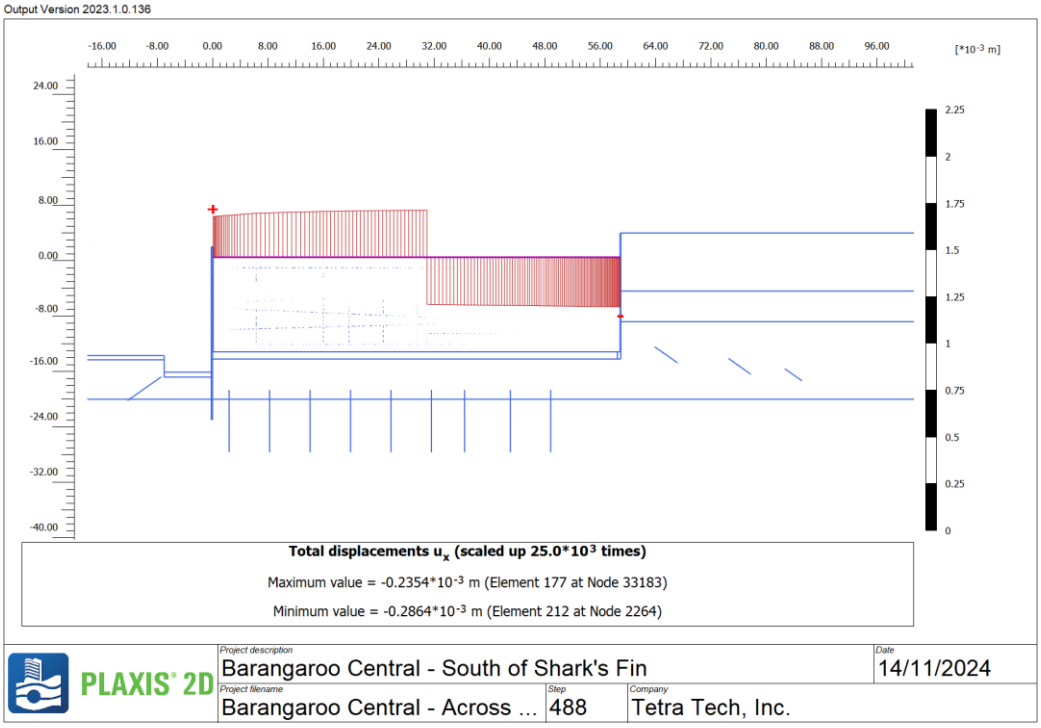
Lateral Displacement for LG Slab at Stage 29 – Excavate Metro Interface to RL-14.3 and CBD at RL-11.2



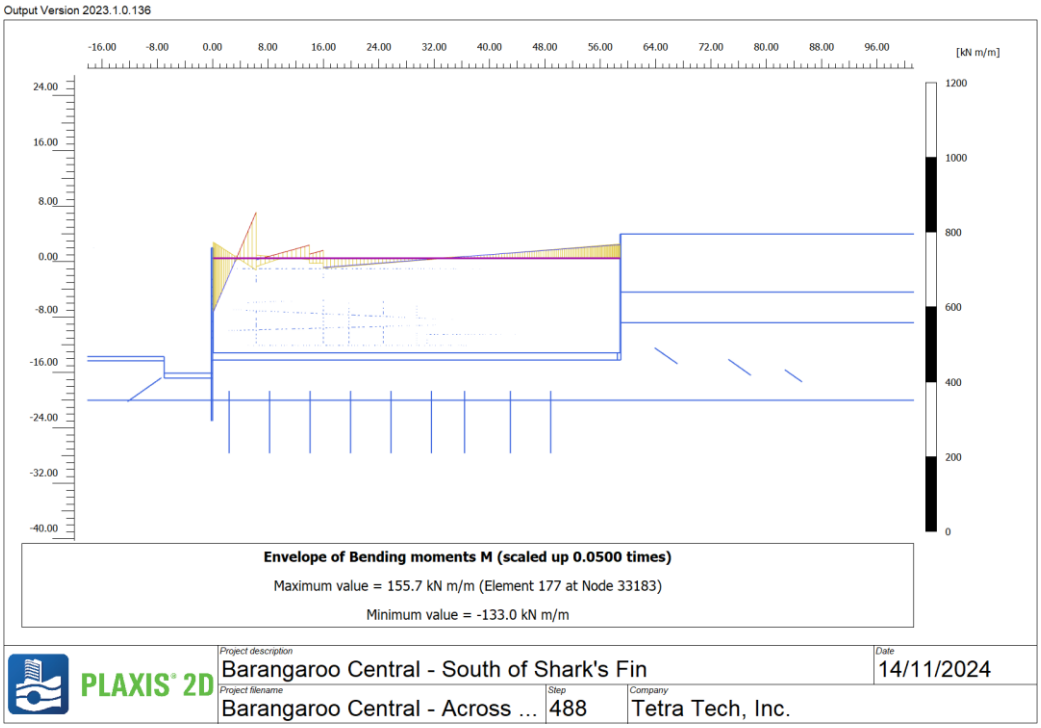
Bending Moment for LG Slab at Stage 29 – Excavate Metro Interface to RL-14.3 and CBD at RL-11.2



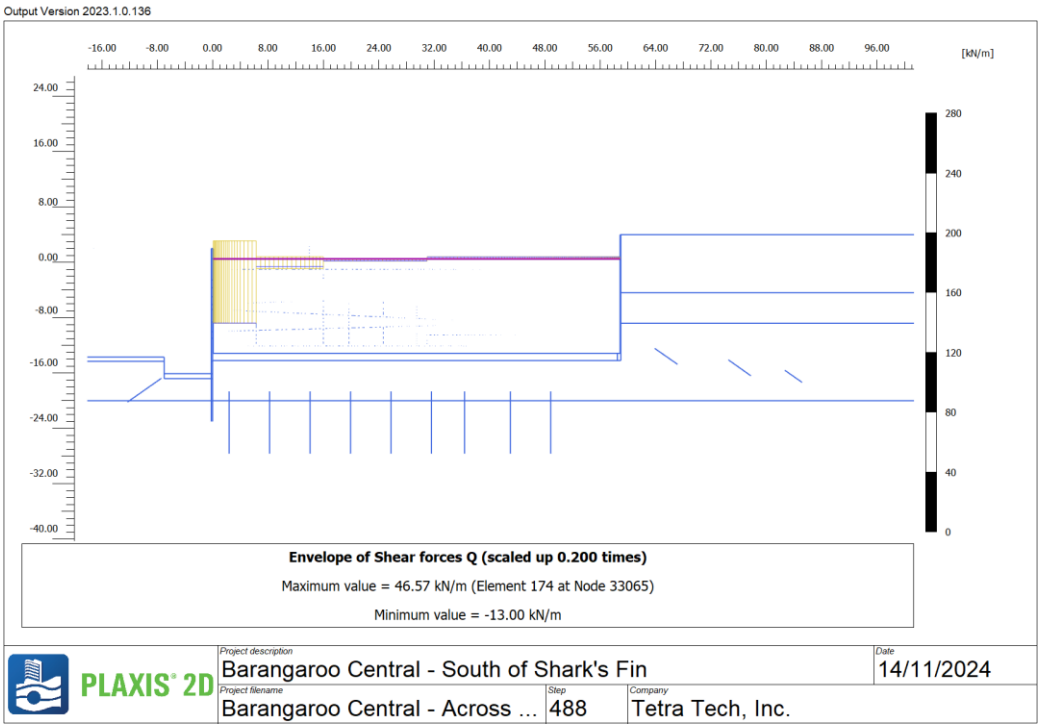
Shear Force for LG Slab at Stage 29 – Excavate Metro Interface to RL-14.3 and CBD at RL-11.2



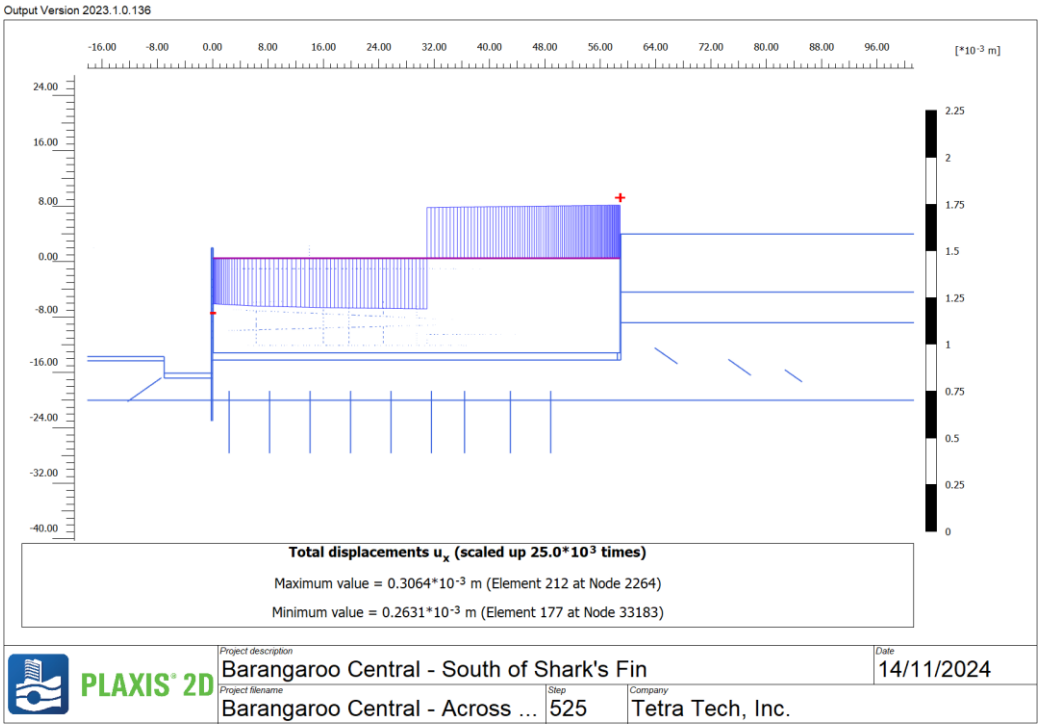
Lateral Displacement for LG Slab at Stage 34 – After Installation of CBD slabs and walls



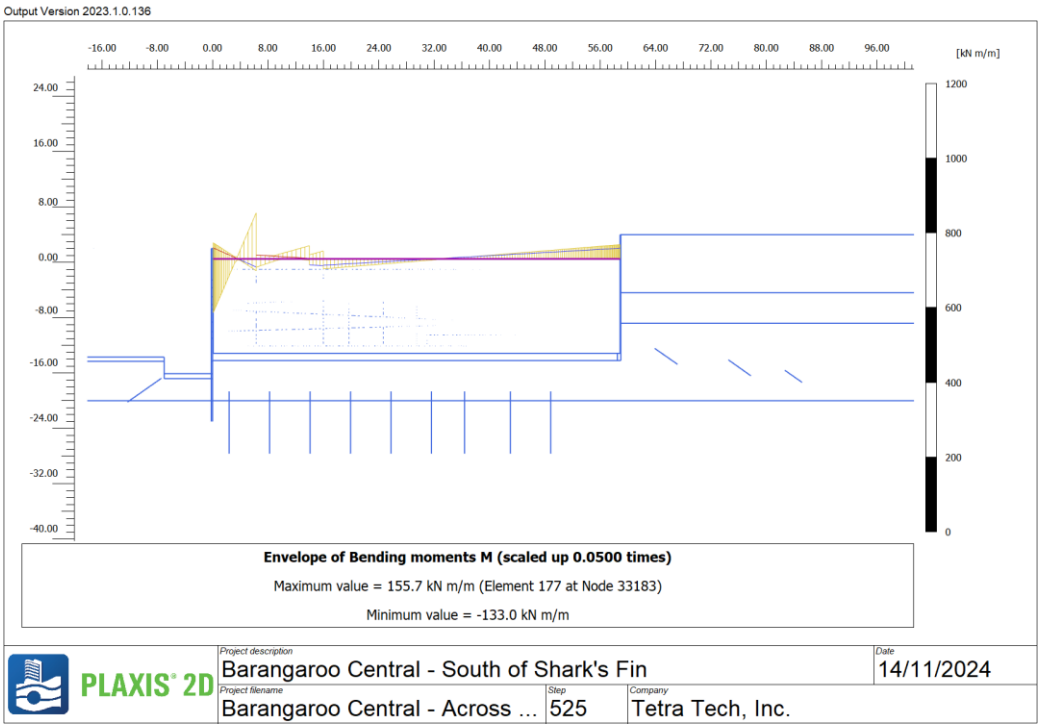
Bending Moment for LG Slab at Stage 34 – After Installation of CBD slabs and walls



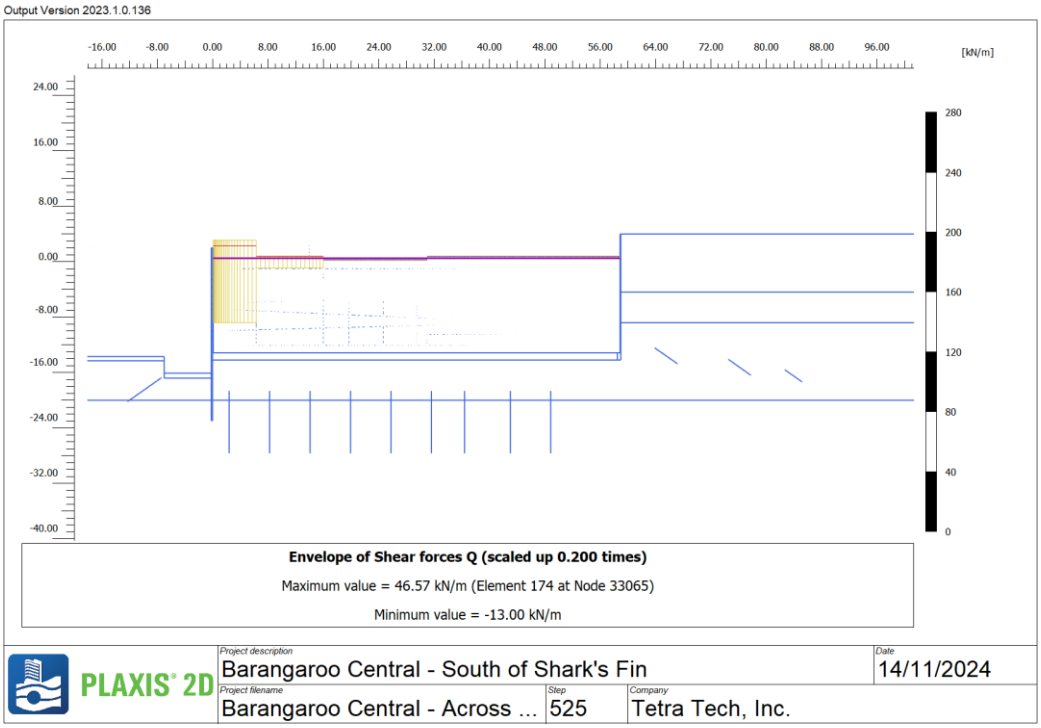
Shear Force for LG Slab at Stage 34 – After Installation of CBD slabs and walls



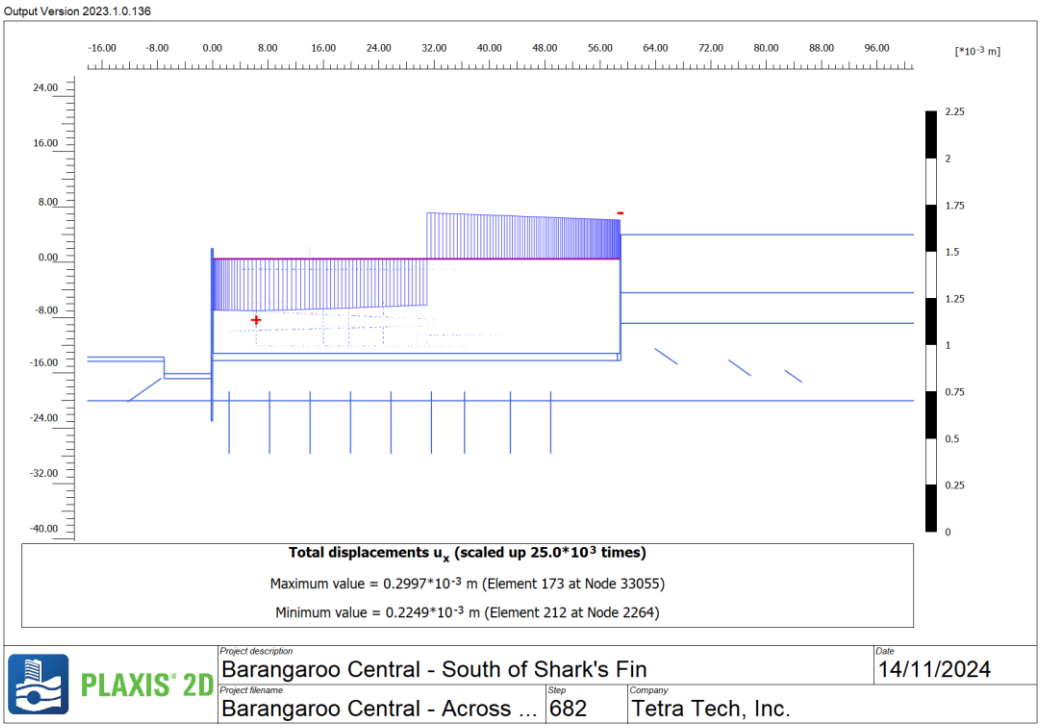
Lateral Displacement for LG Slab for GWL Case 1 - GWL at RL 1.5



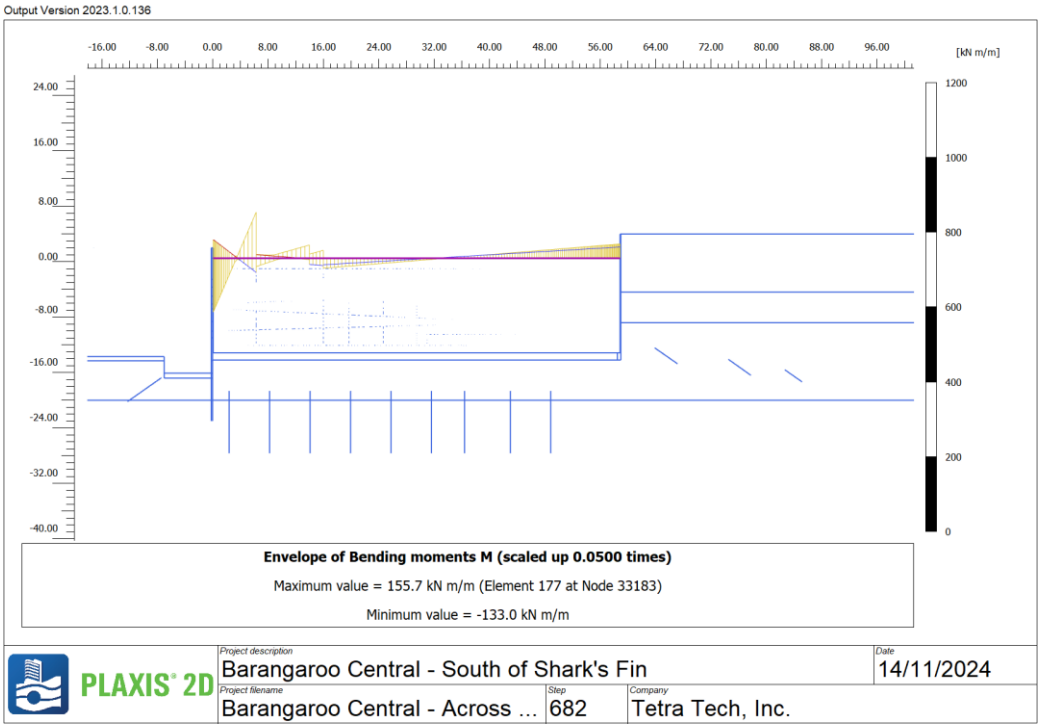
Bending Moment for LG Slab for GWL Case 1 - GWL at RL 1.5



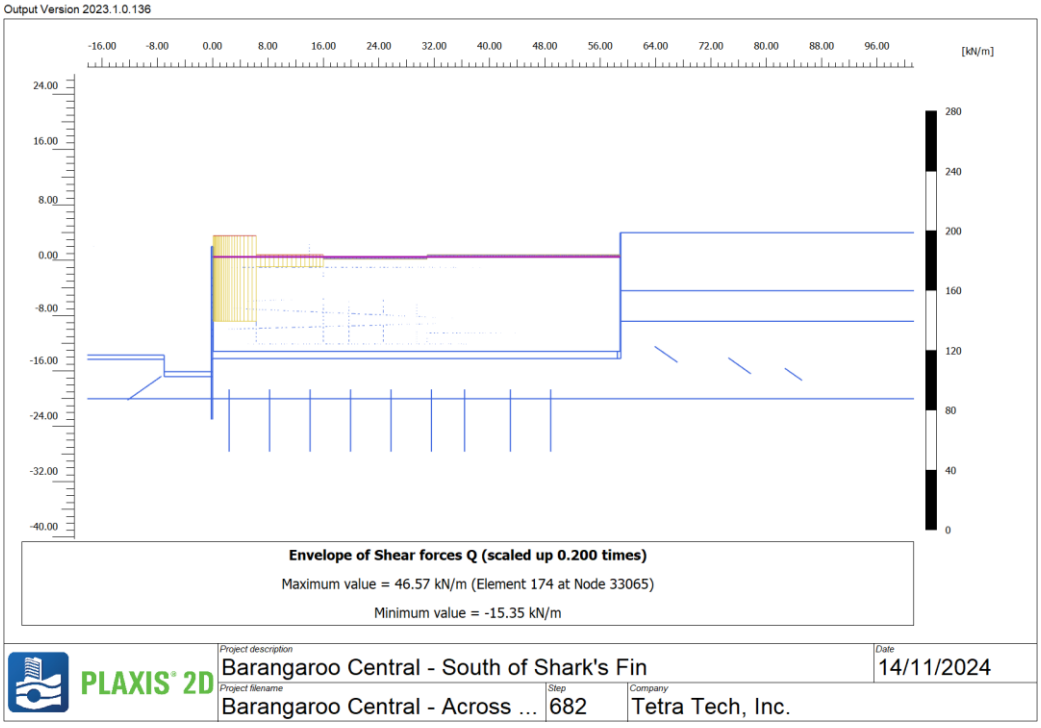
Shear Force for LG Slab for GWL Case 1 - GWL at RL 1.5



Lateral Displacement for LG Slab for GWL Case 3 - GWL at RL 2.575



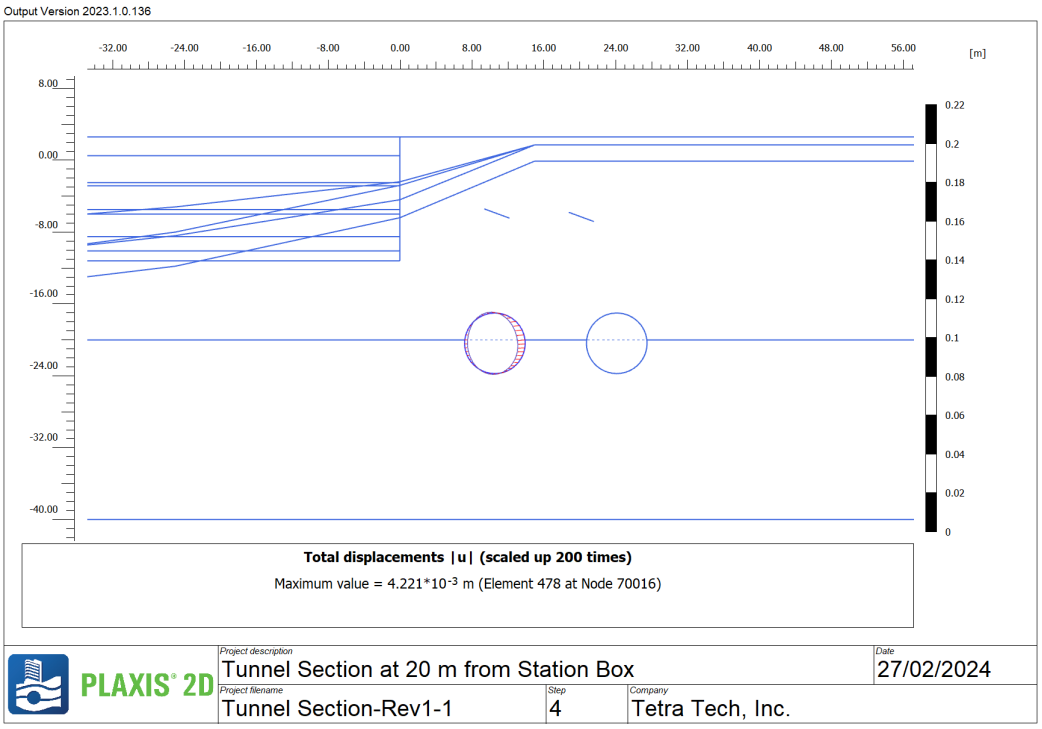
Bending Moment for LG Slab for GWL Case 3 - GWL at RL 2.575



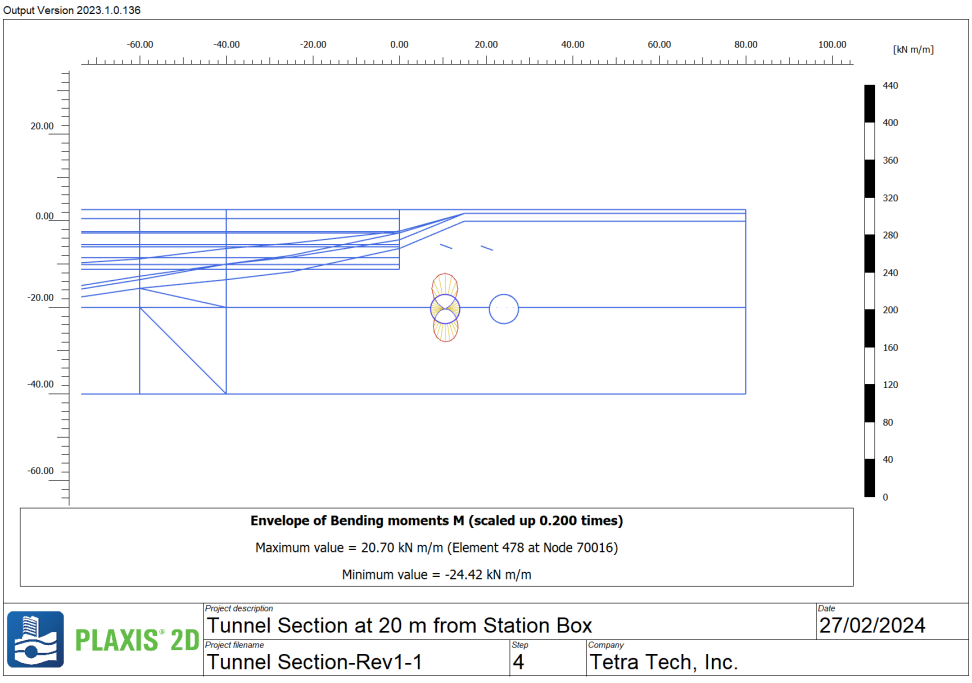
Shear Force for LG Slab for GWL Case 3 - GWL at RL 2.575

PLAXIS RESULTS – SECTION 3 – METRO TUNNELS

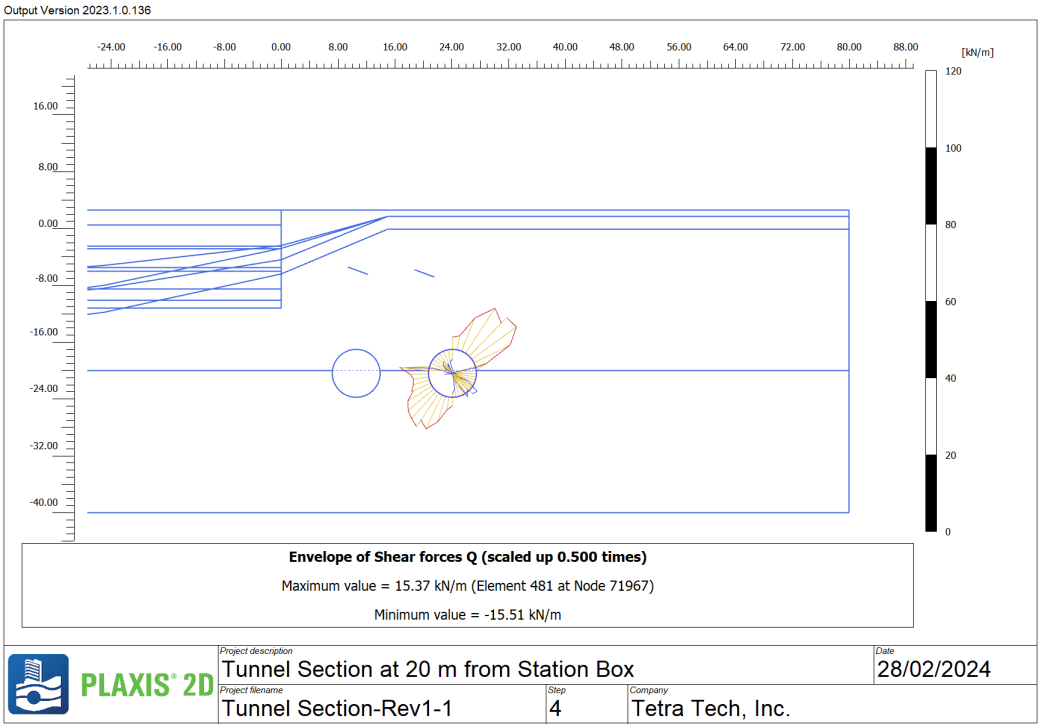
A. Westbound Tunnel



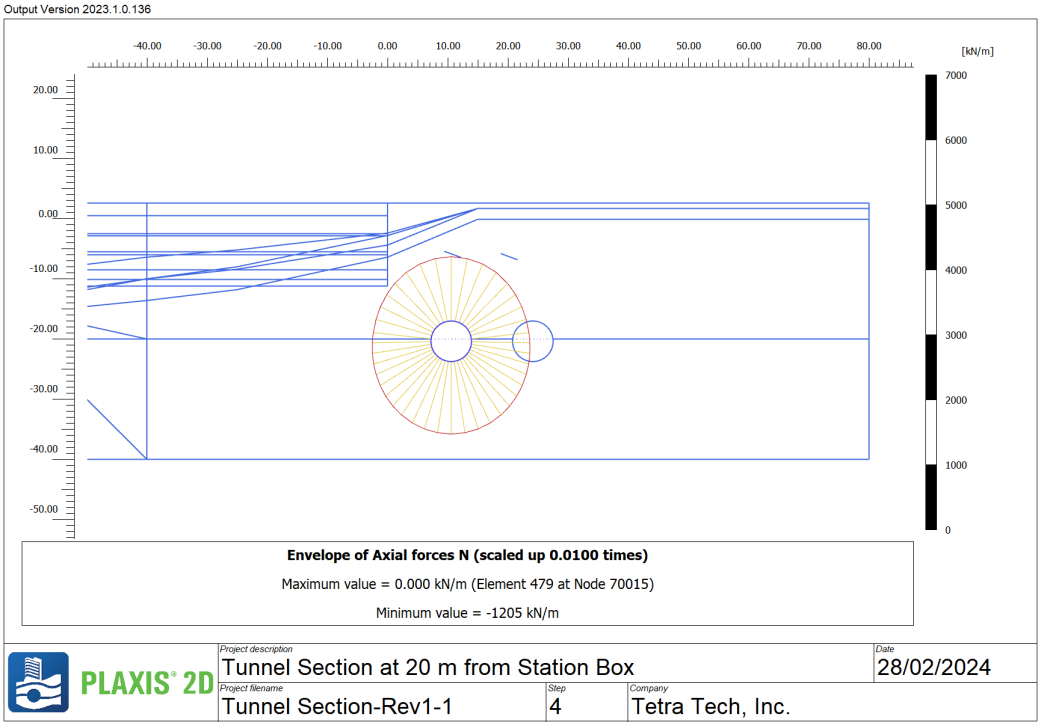
Total Displacement for Westbound Tunnel at Stage 3 – After Installation of Tunnel Liner



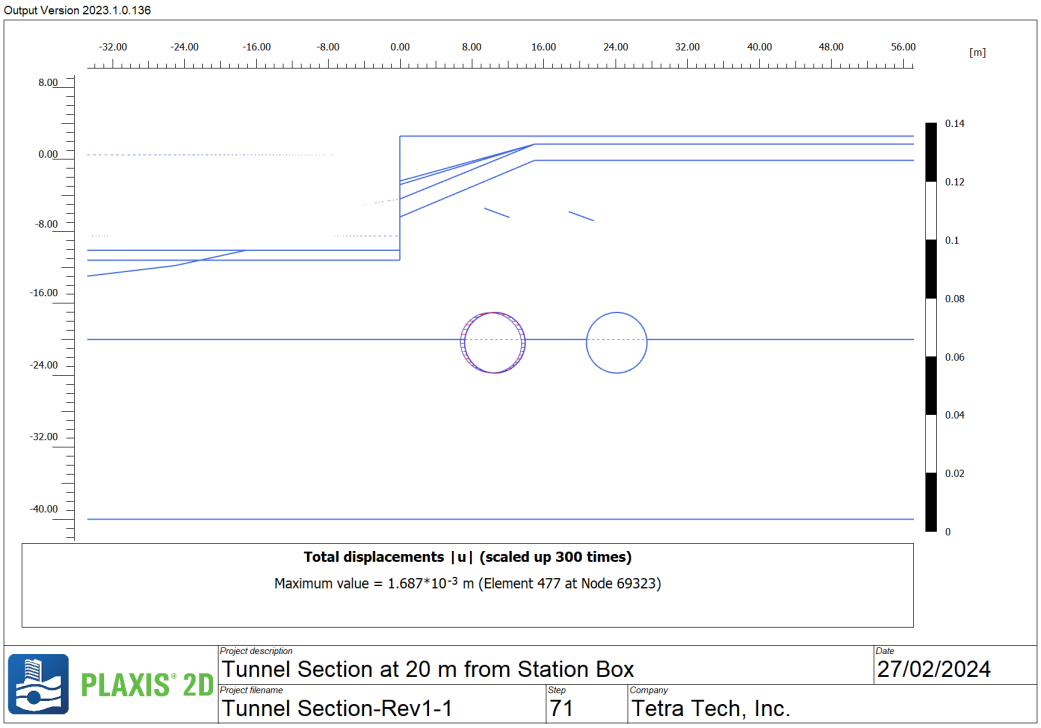
Bending Moment for Westbound Tunnel at Stage 3 – After Installation of Tunnel Liner



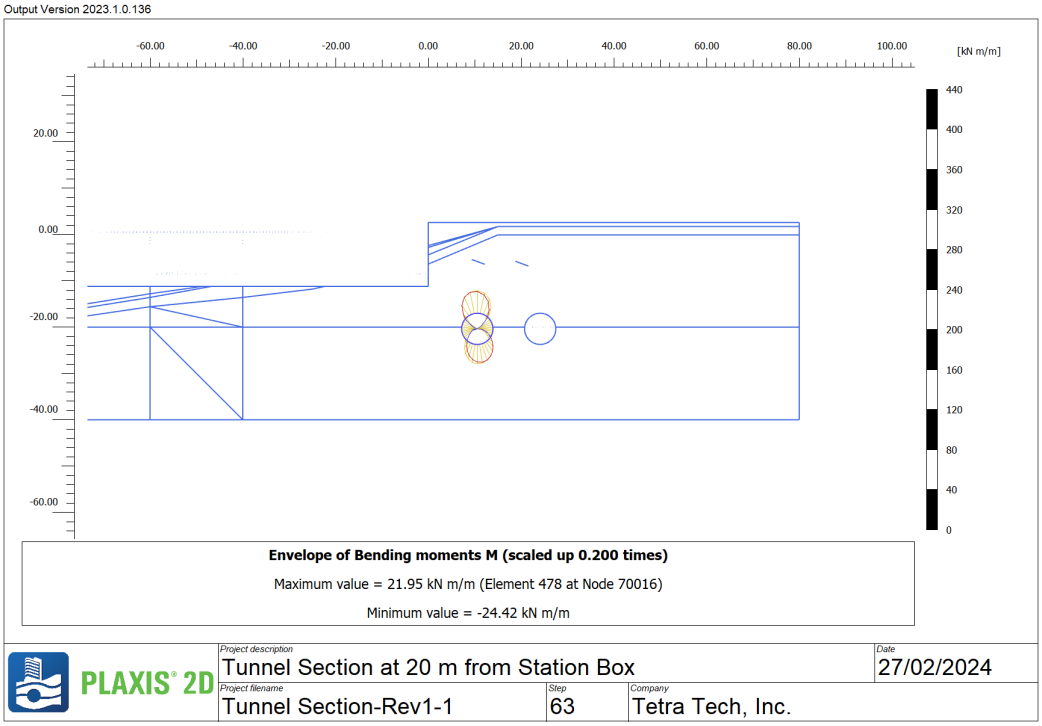
Shear Force for Westbound Tunnel at Stage 3 – After Installation of Tunnel Liner



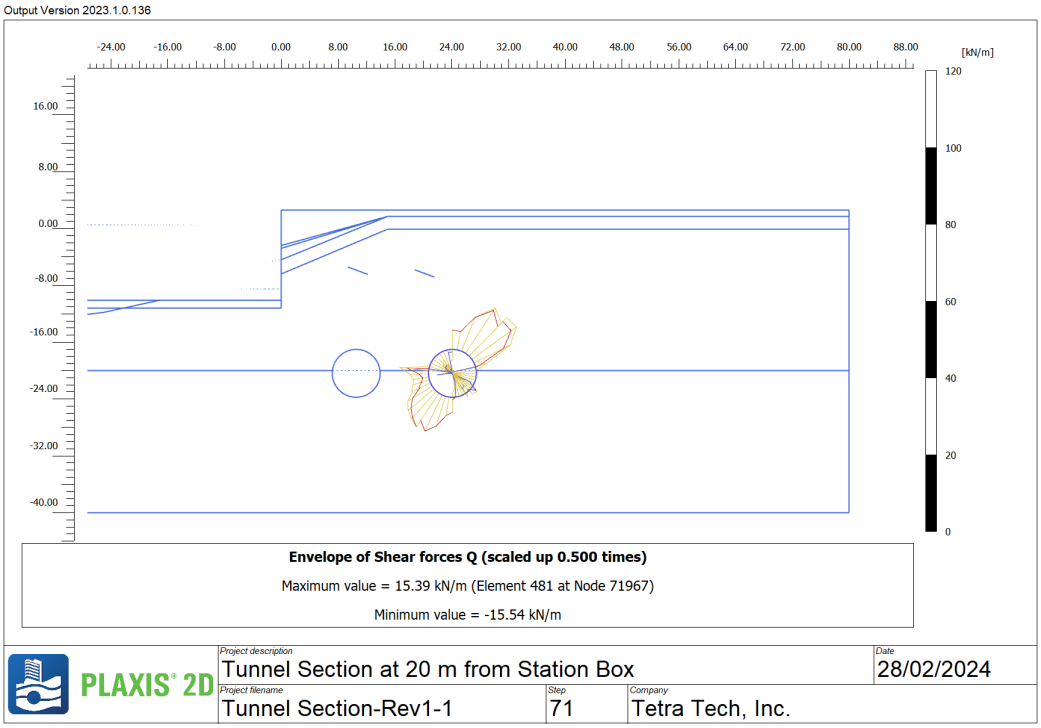
Axial Force for Westbound Tunnel at Stage 3 – After Installation of Tunnel Liner



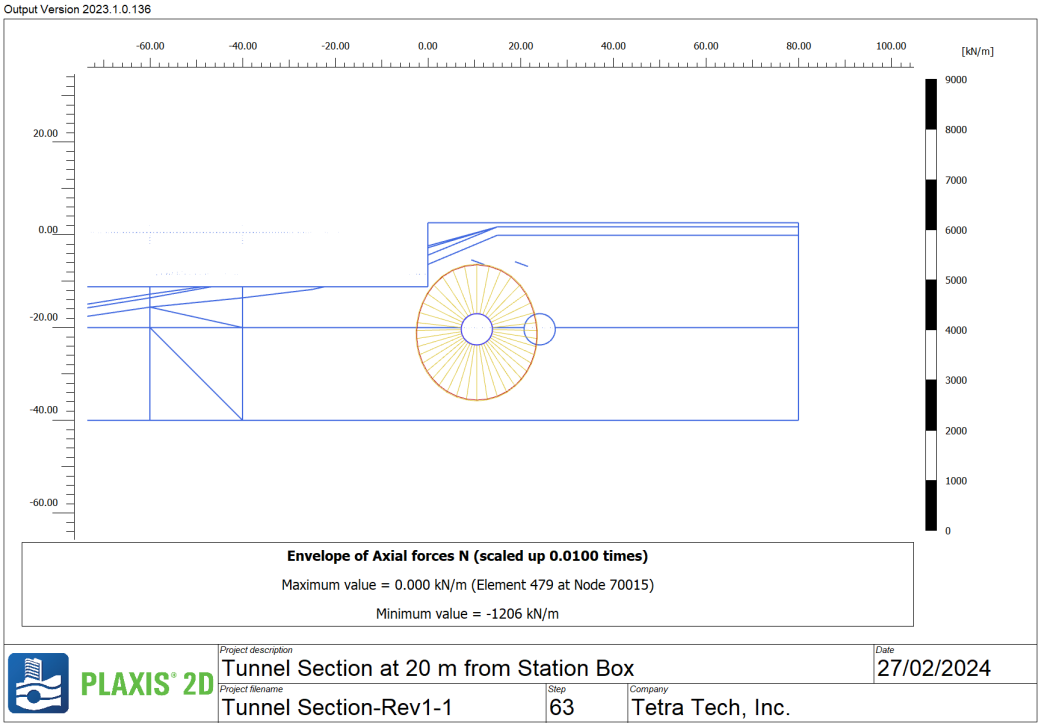
Total Displacement for Westbound Tunnel Liner at Stage 18 – After CBD Excavation to RL-11.2



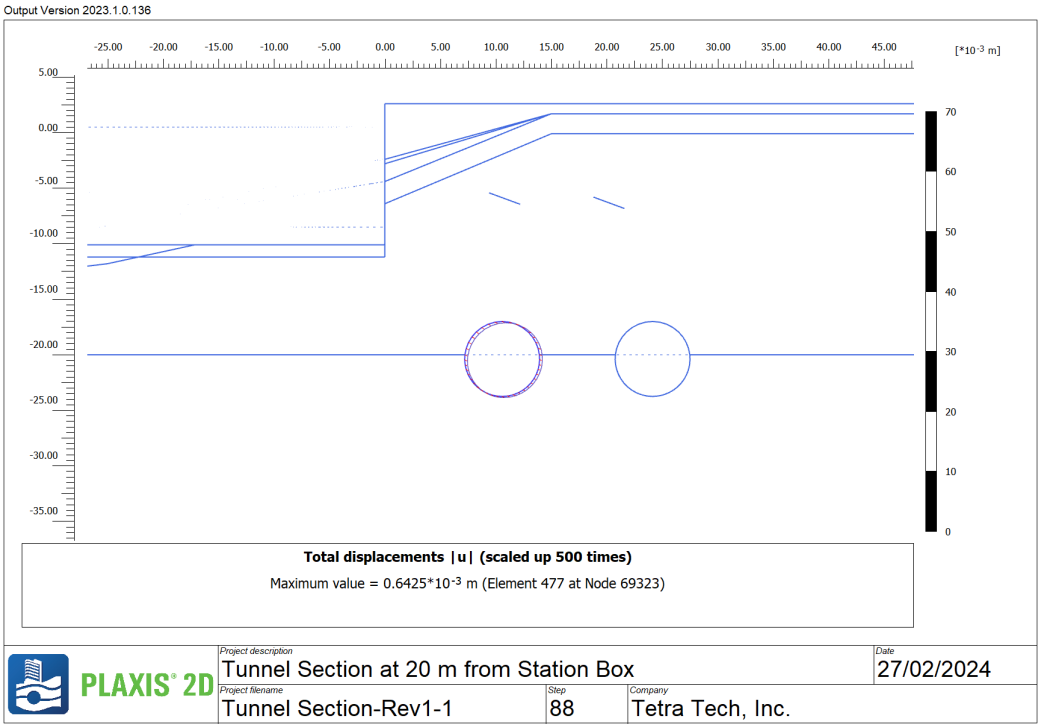
Bending Moment for Westbound Tunnel Liner at Stage 18 – After CBD Excavation to RL-11.2



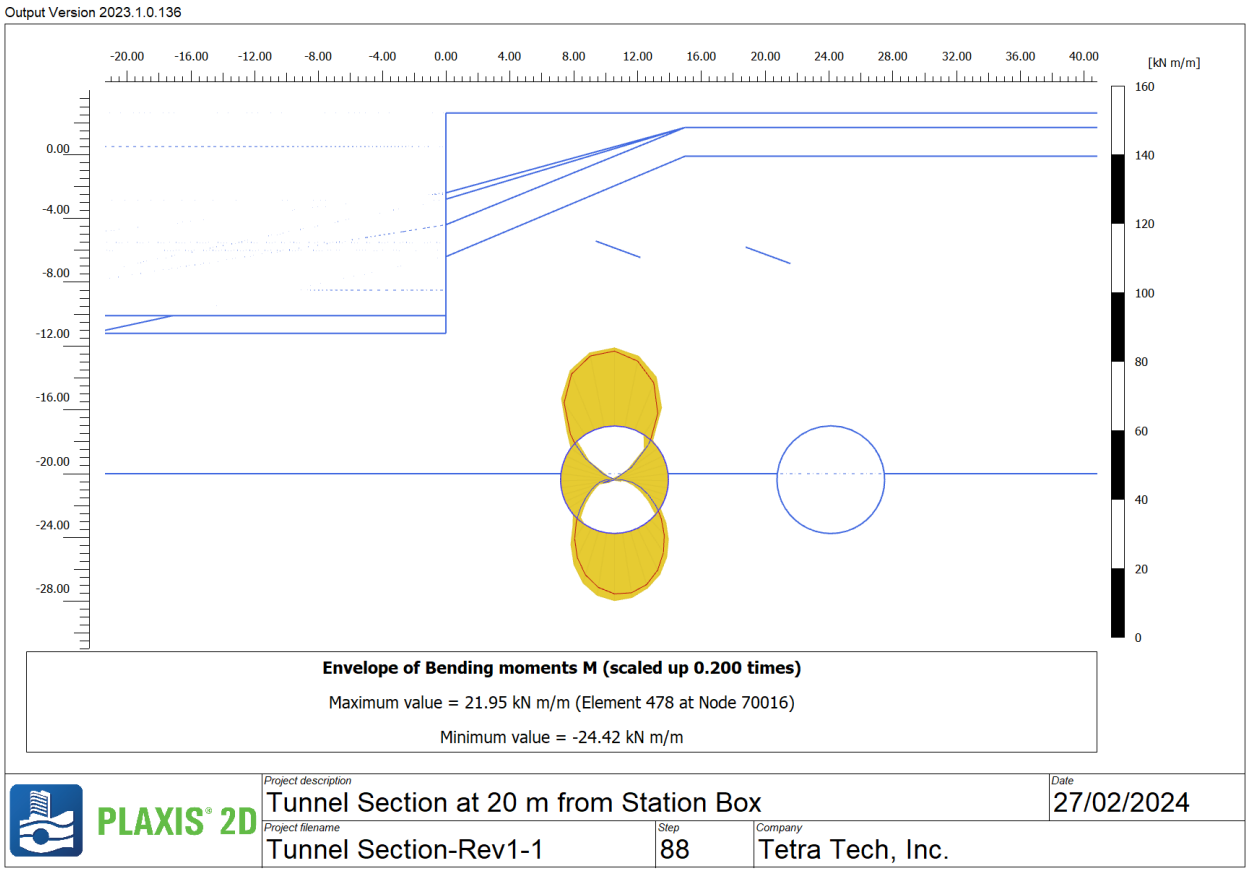
Shear Force for Westbound Tunnel Liner at Stage 18 – After CBD Excavation to RL-11.2



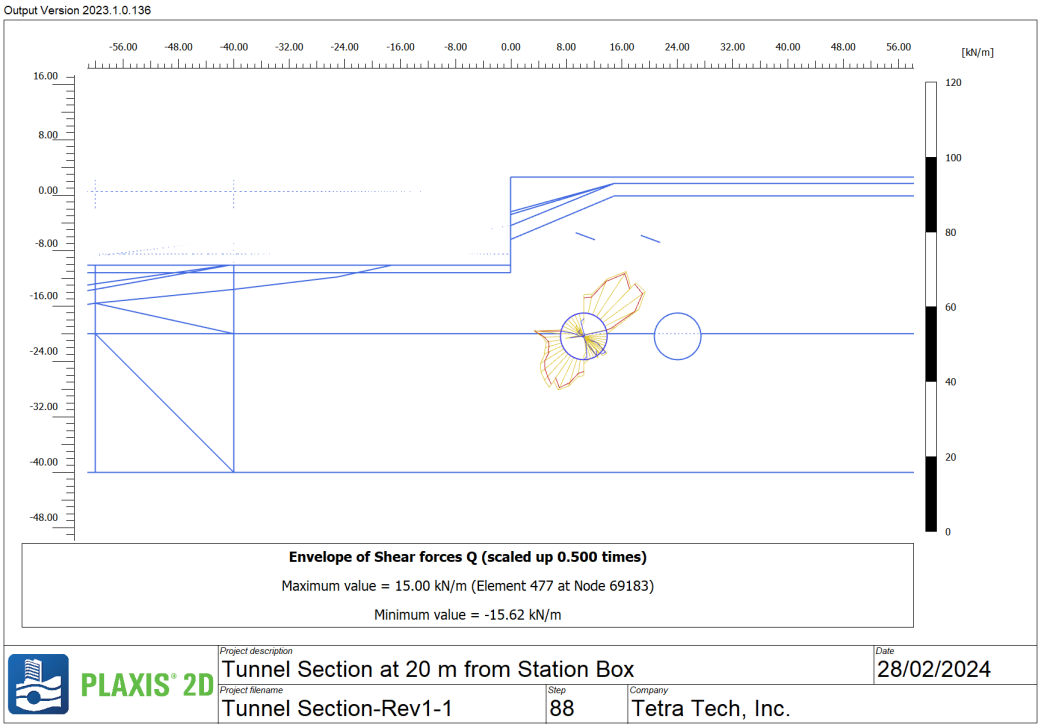
Axial Force for Westbound Tunnel Liner at Stage 18 – After CBD Excavation to RL-11.2



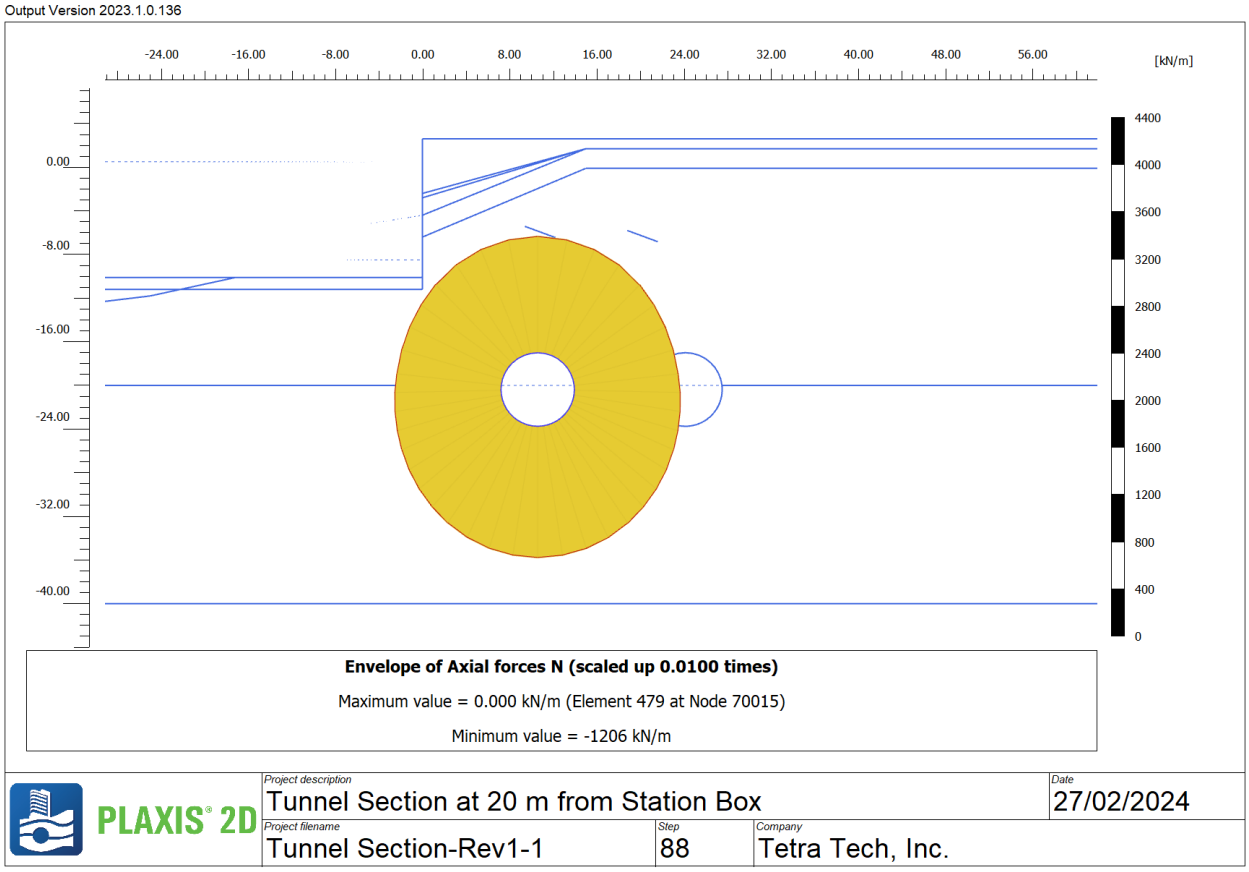
Total Displacement for Westbound Tunnel Liner at Stage 25 – After Installation of CBD slabs and walls



Bending Moment for Westbound Tunnel Liner at Stage 25 – After Installation of CBD slabs and walls

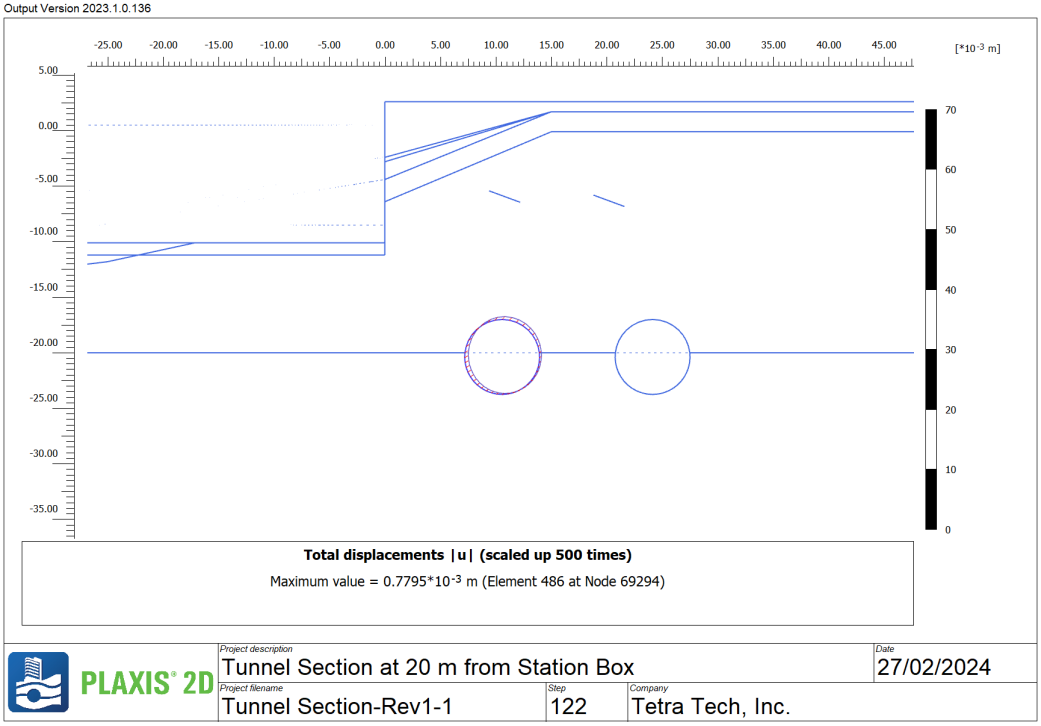


Shear Force for Westbound Tunnel Liner at Stage 25 – After Installation of CBD slabs and walls



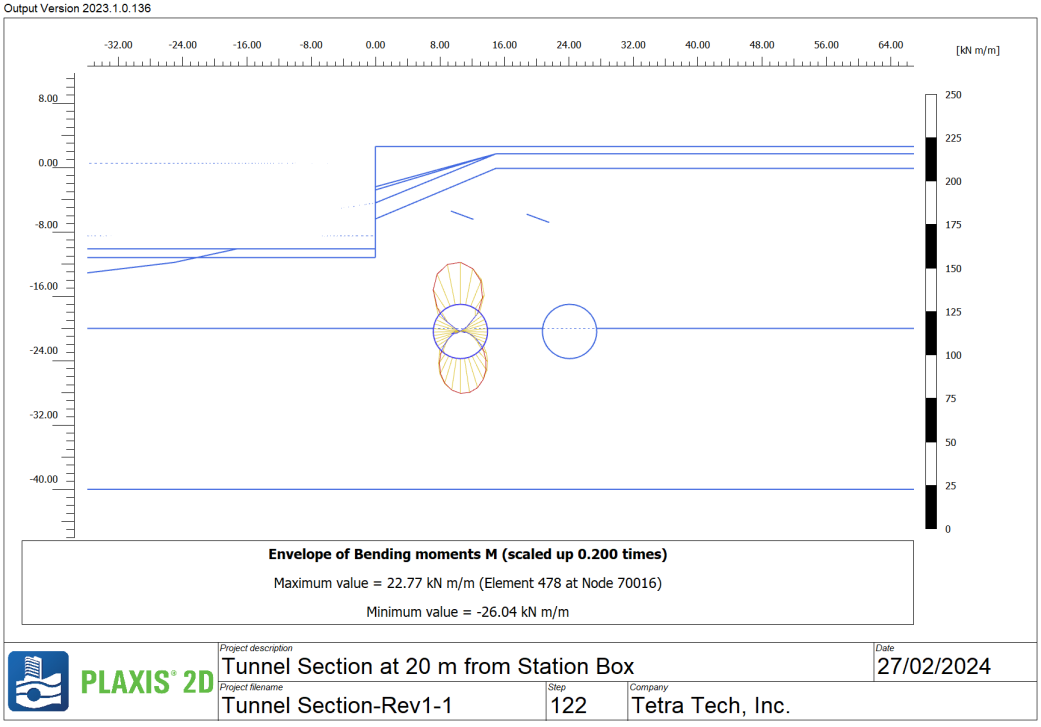
Axial Force for Westbound Tunnel Liner at Stage 25 – After Installation of CBD slabs and walls

Output Version 2023.1.0.136



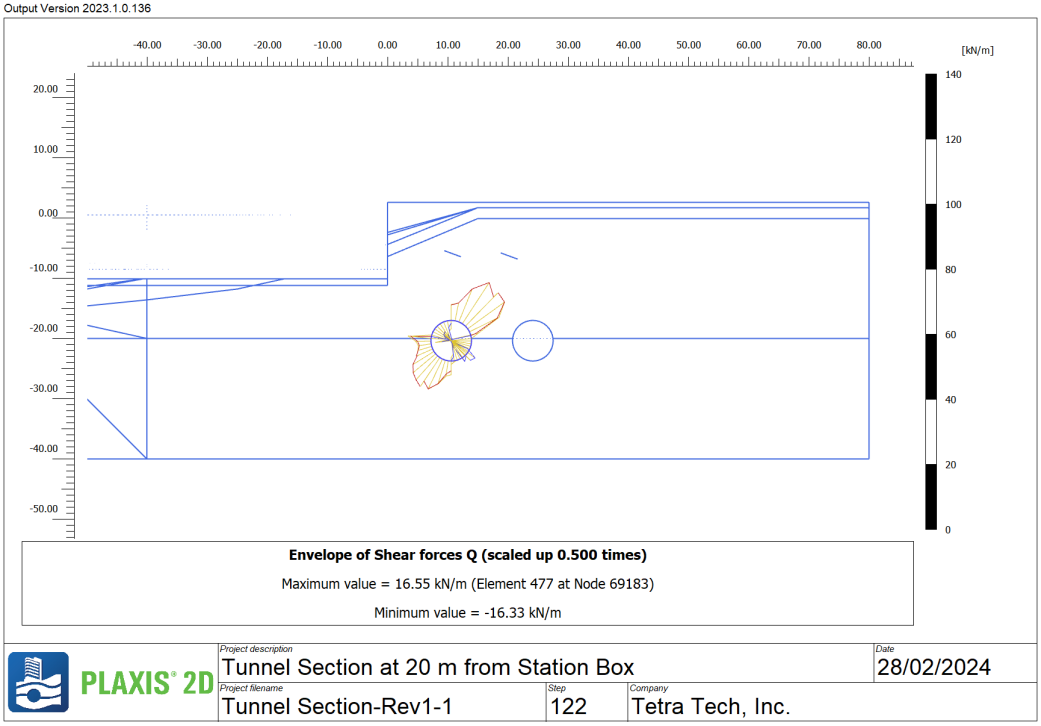
Total Displacement for Westbound Tunnel Liner for GWL Case 1 - GWL at RL 1.5

Output Version 2023.1.0.136



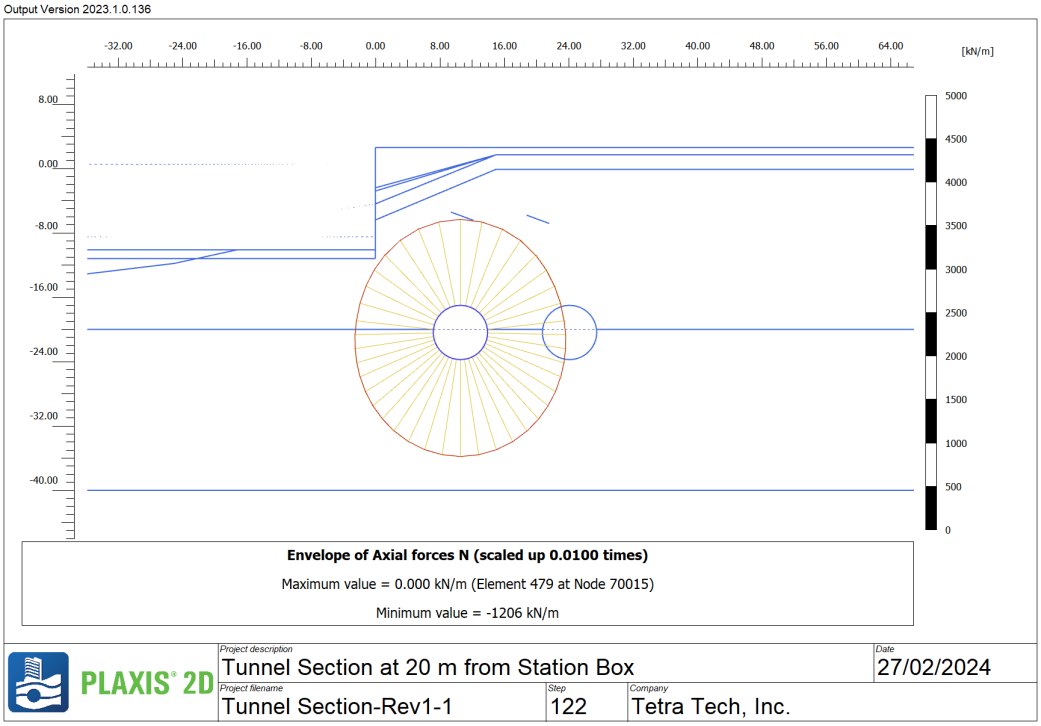
Bending Moment for Westbound Tunnel Liner for GWL Case 1 - GWL at RL 1.5

Output Version 2023.1.0.136

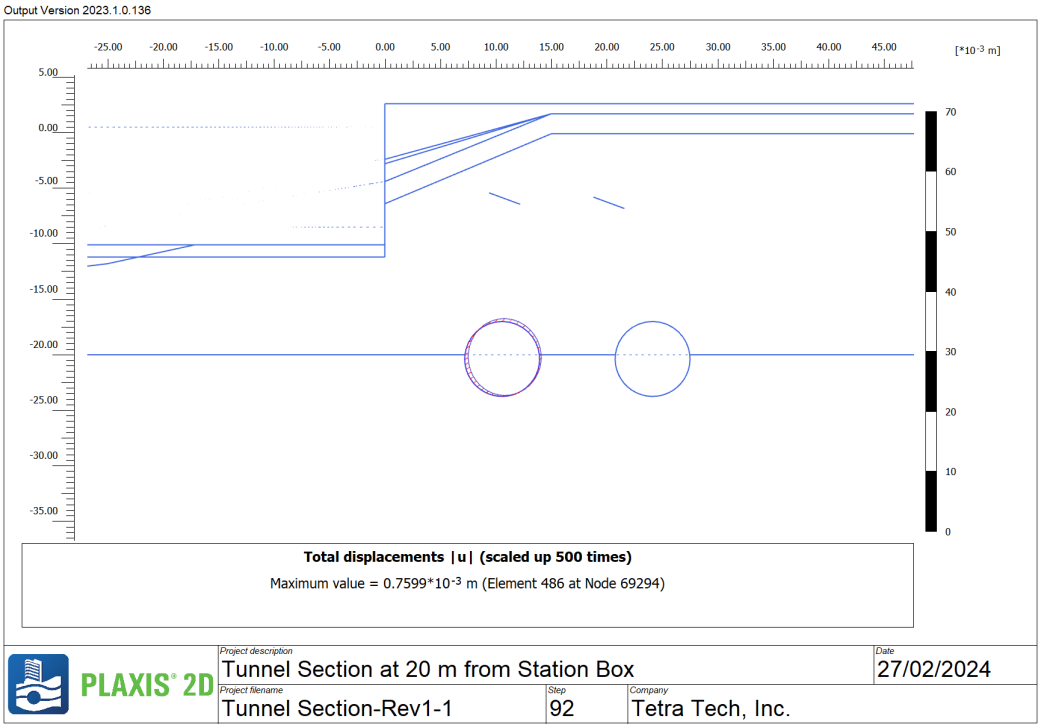


Shear Force for Westbound Tunnel Liner for GWL Case 1 - GWL at RL 1.5

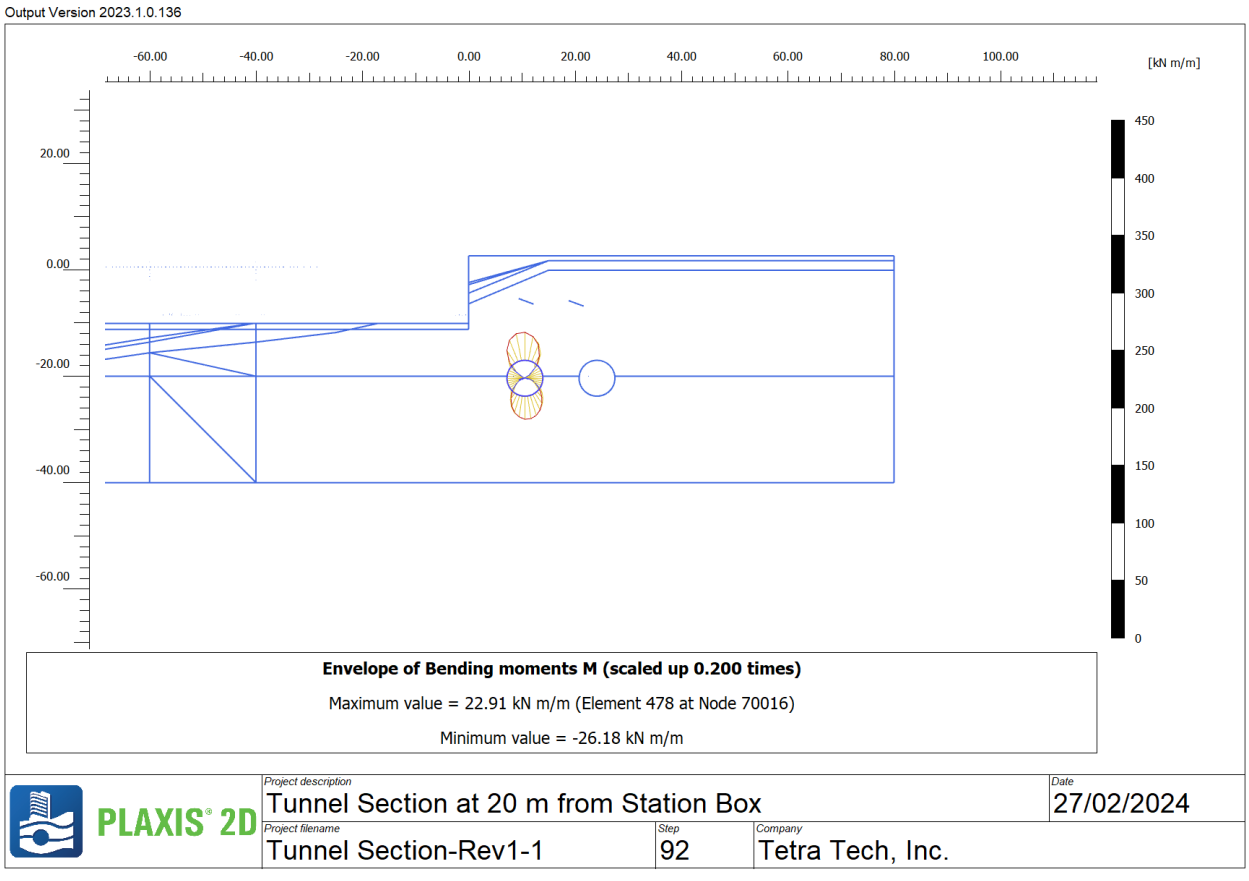
Output Version 2023.1.0.136



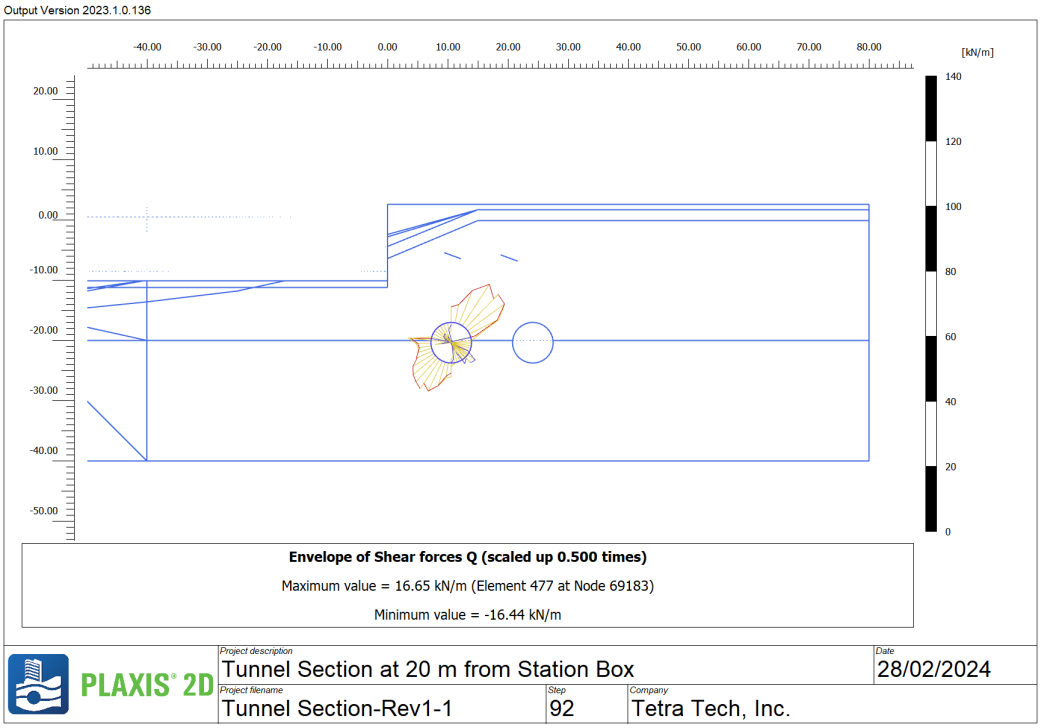
Axial Force for Westbound Tunnel Liner for GWL Case 1 - GWL at RL 1.5



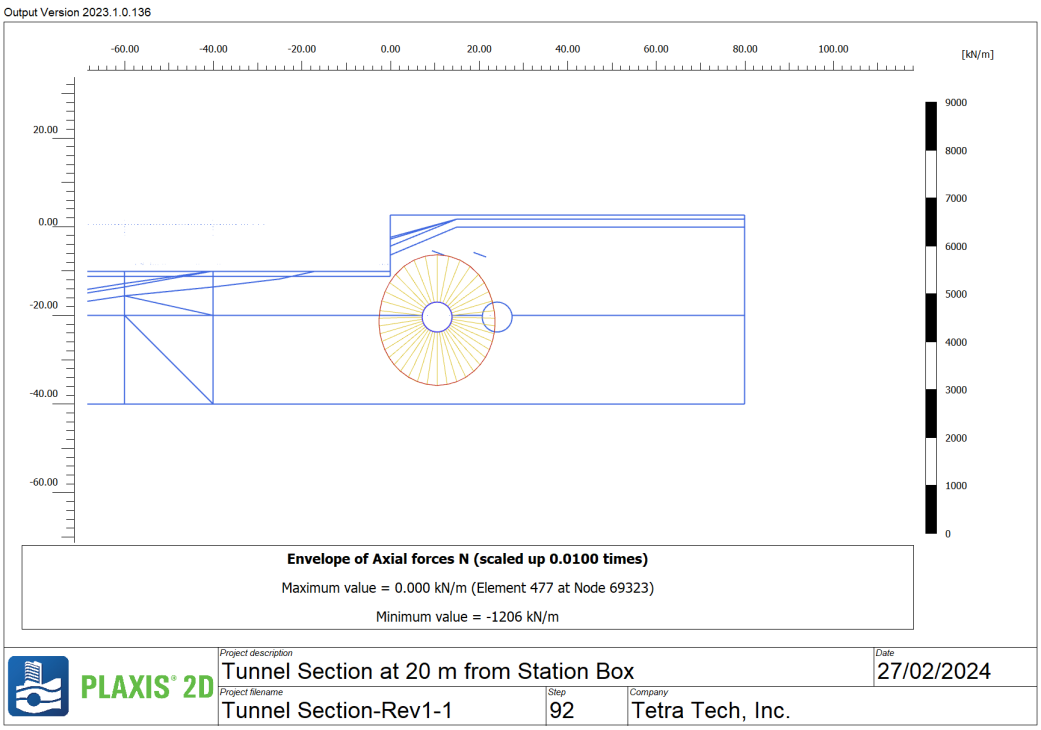
Total Displacement for Westbound Tunnel Liner for GWL Case 2 - GWL at RL 1.5 at landward side and RL 0.5 at seaward side



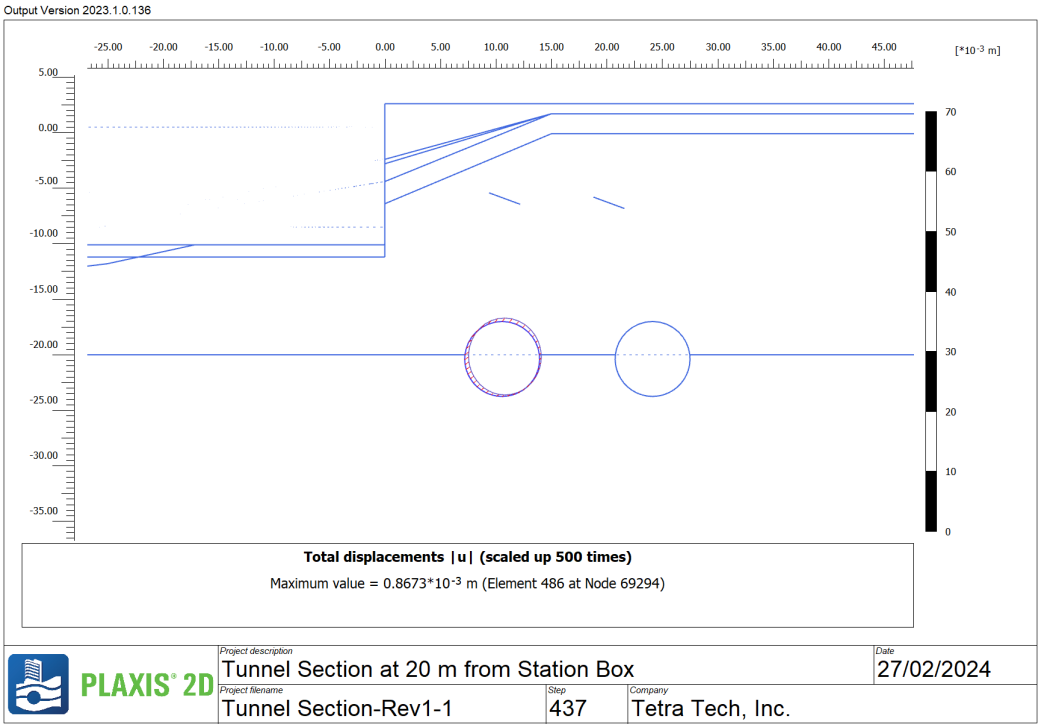
Bending Moment for Westbound Tunnel Liner for GWL Case 2 - GWL at RL 1.5 at landward side and RL 0.5 at seaward side



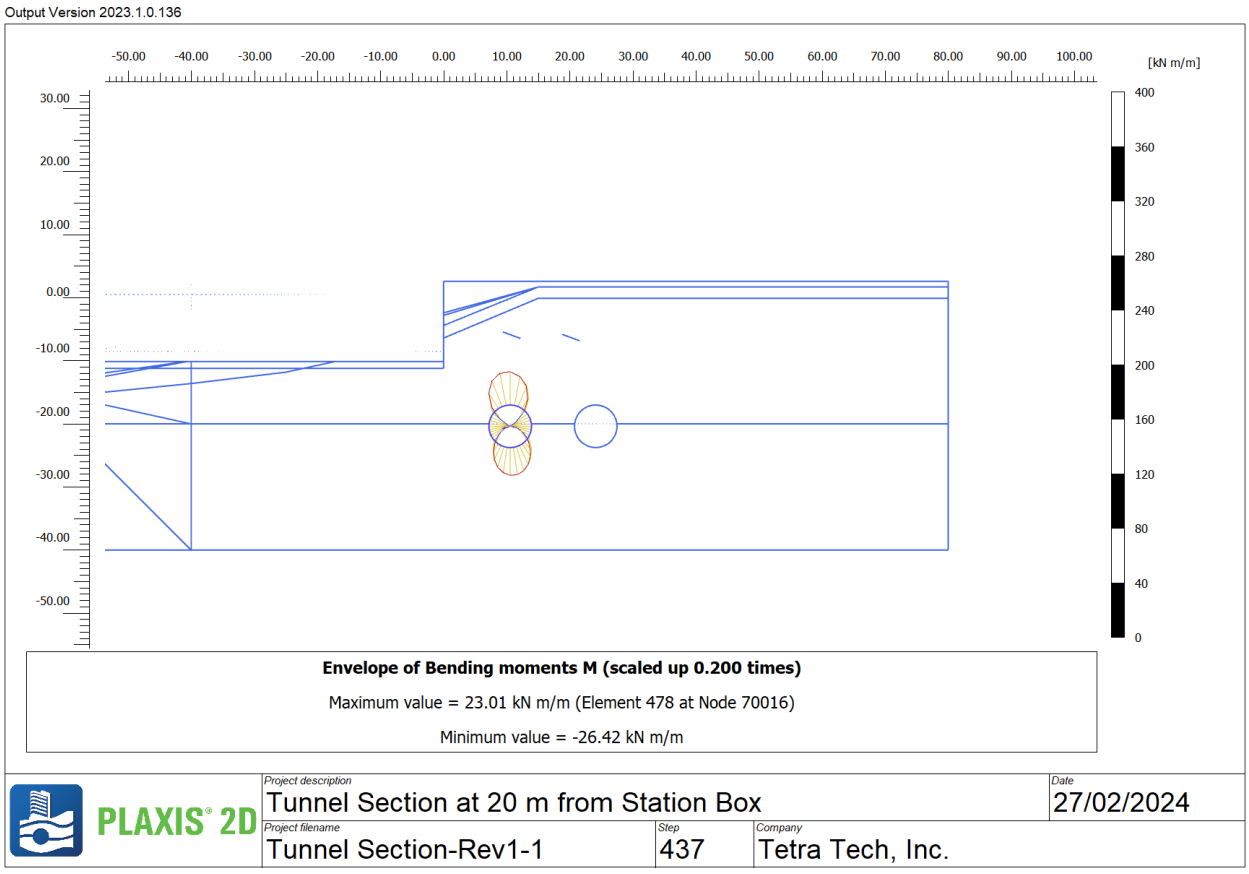
Shear Force for Westbound Tunnel Liner for GWL Case 2 - GWL at RL 1.5 at landward side and RL 0.5 at seaward side



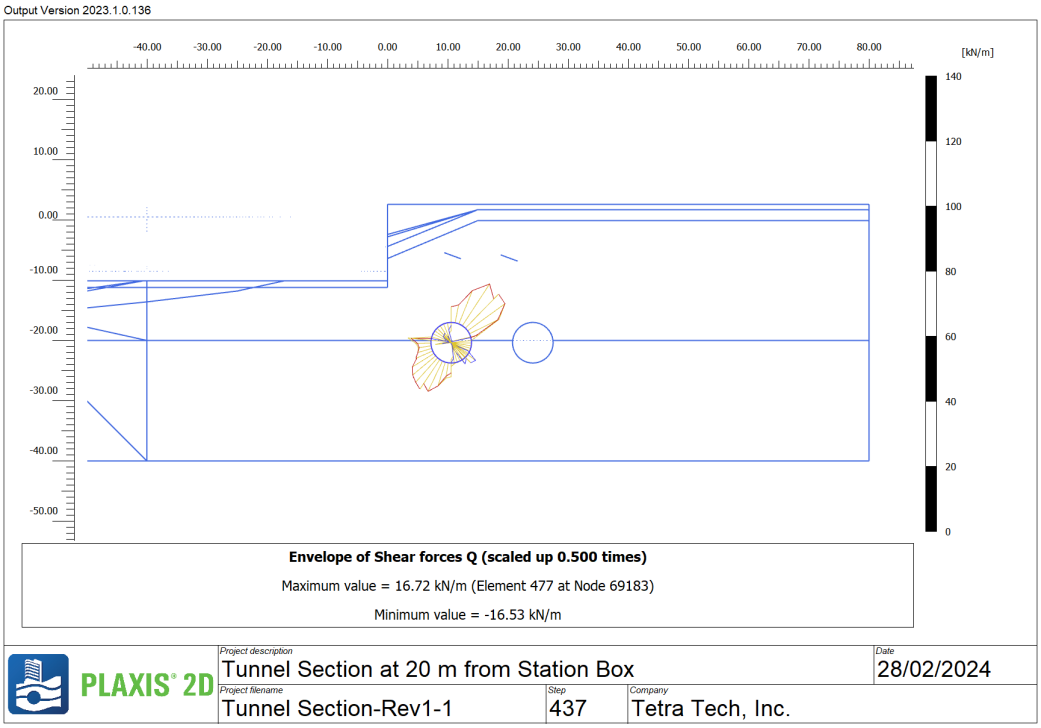
Axial Force for Westbound Tunnel Liner for GWL Case 2 - GWL at RL 1.5 at landward side and RL 0.5 at seaward side



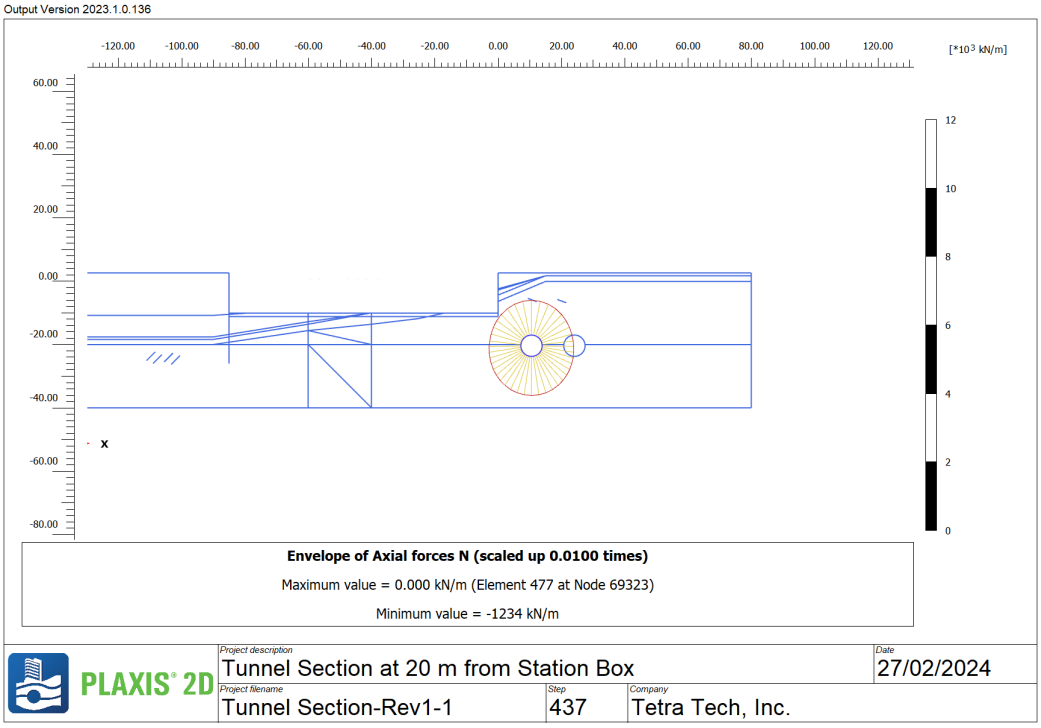
Total Displacement for Westbound Tunnel Liner for GWL Case 3 - GWL at RL 2.575



Bending Moment for Westbound Tunnel Liner for GWL Case 3 - GWL at RL 2.575

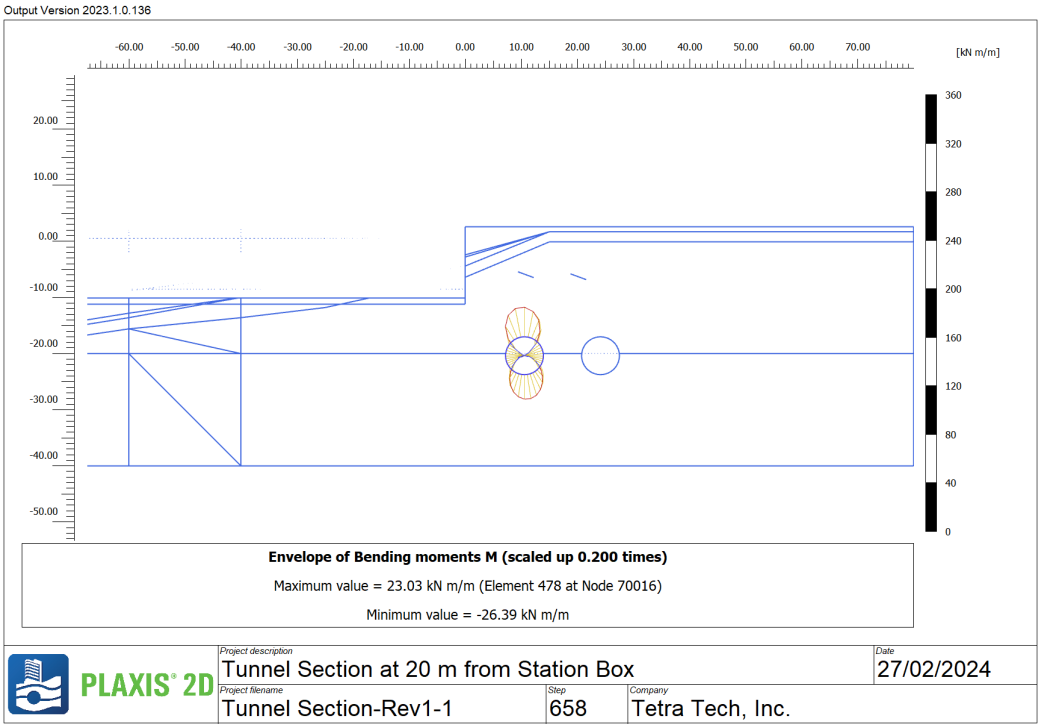


Shear Force for Westbound Tunnel Liner for GWL Case 3 - GWL at RL 2.575

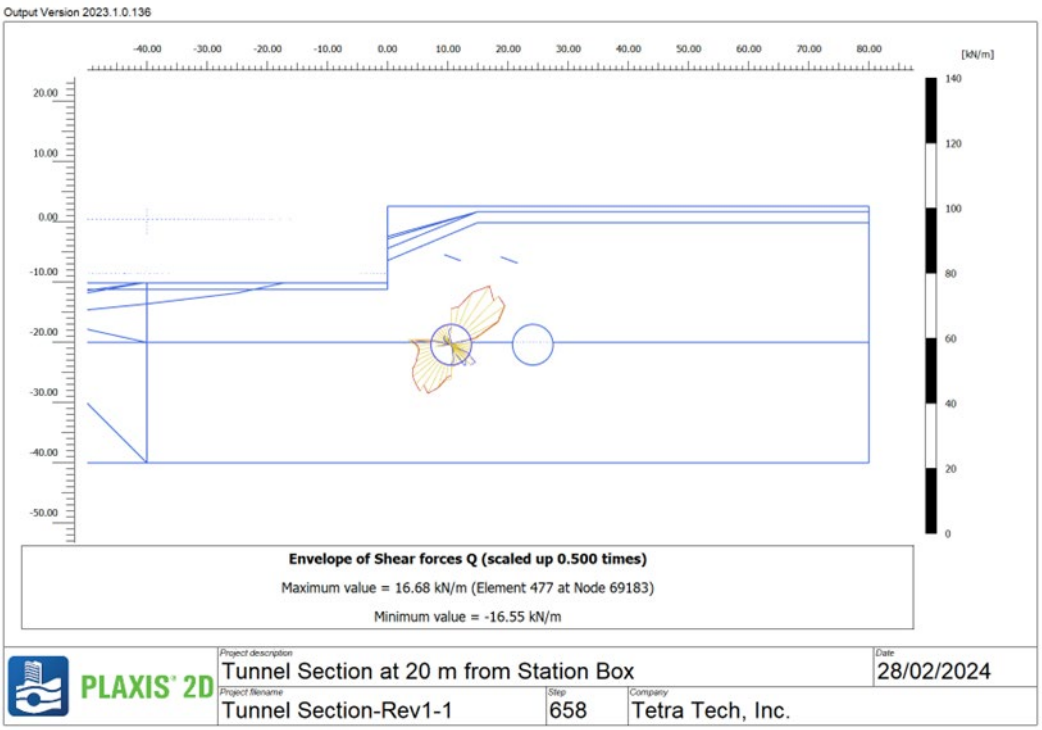


Axial Force for Westbound Tunnel Liner for GWL Case 3 - GWL at RL 2.575

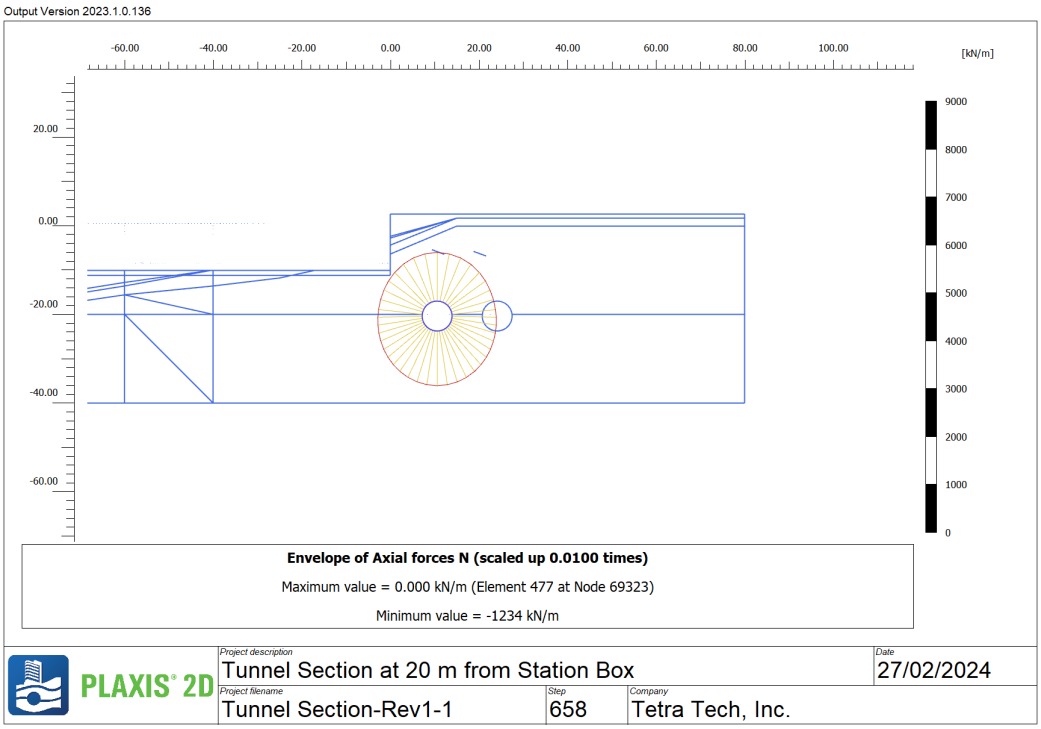
Total Displacement for Westbound Tunnel Liner for GWL Case 4 - GWL at RL 2.575 at seaward side and RL 1.575 at landward side



Bending Moment for Westbound Tunnel Liner for GWL Case 4 - GWL at RL 2.575 at seaward side and RL 1.575 at landward side

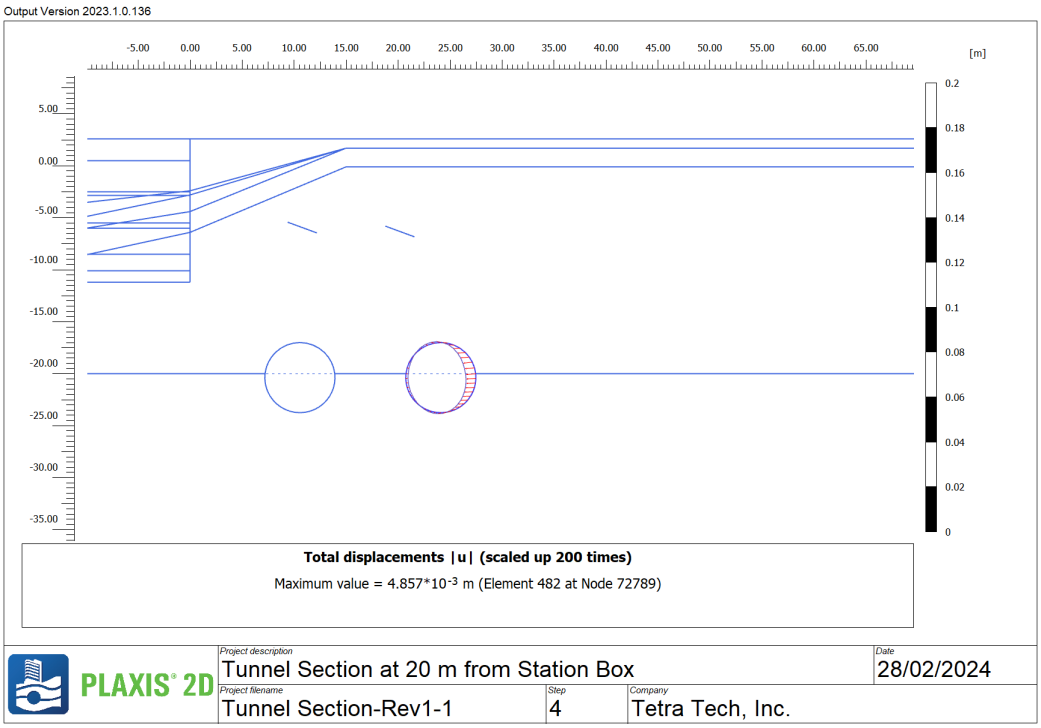


Shear Force for Westbound Tunnel Liner for GWL Case 4 - GWL at RL 2.575 at seaward side and RL 1.575 at landward side

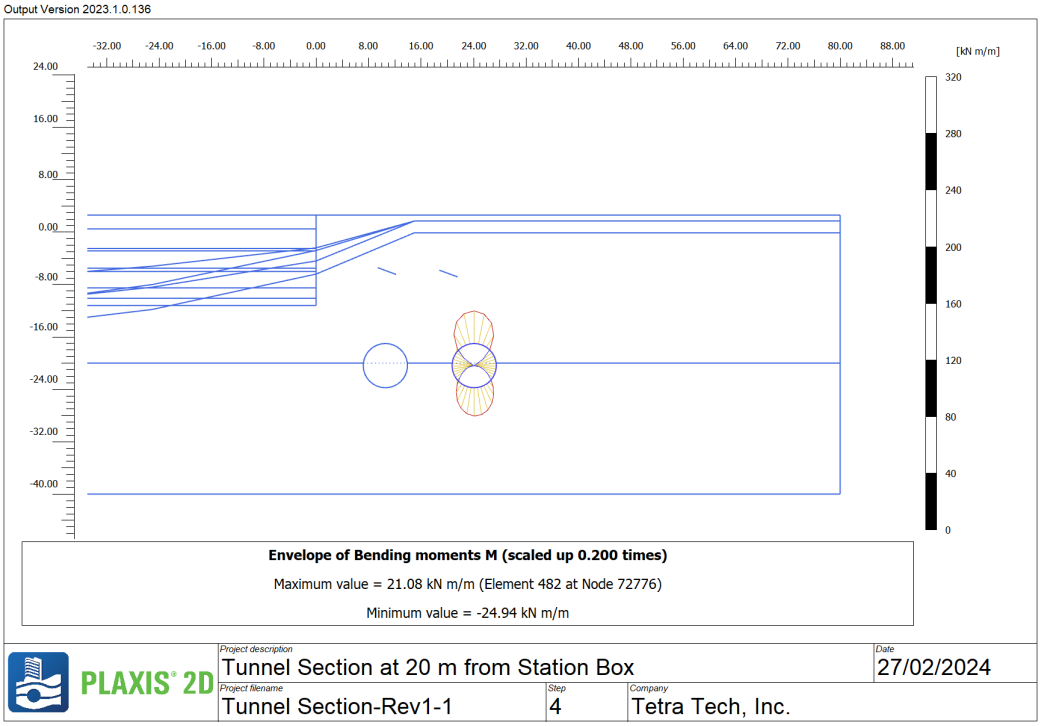


Axial Force for Westbound Tunnel Liner for GWL Case 4 - GWL at RL 2.575 at seaward side and RL 1.575 at landward side

B. Eastbound Tunnel

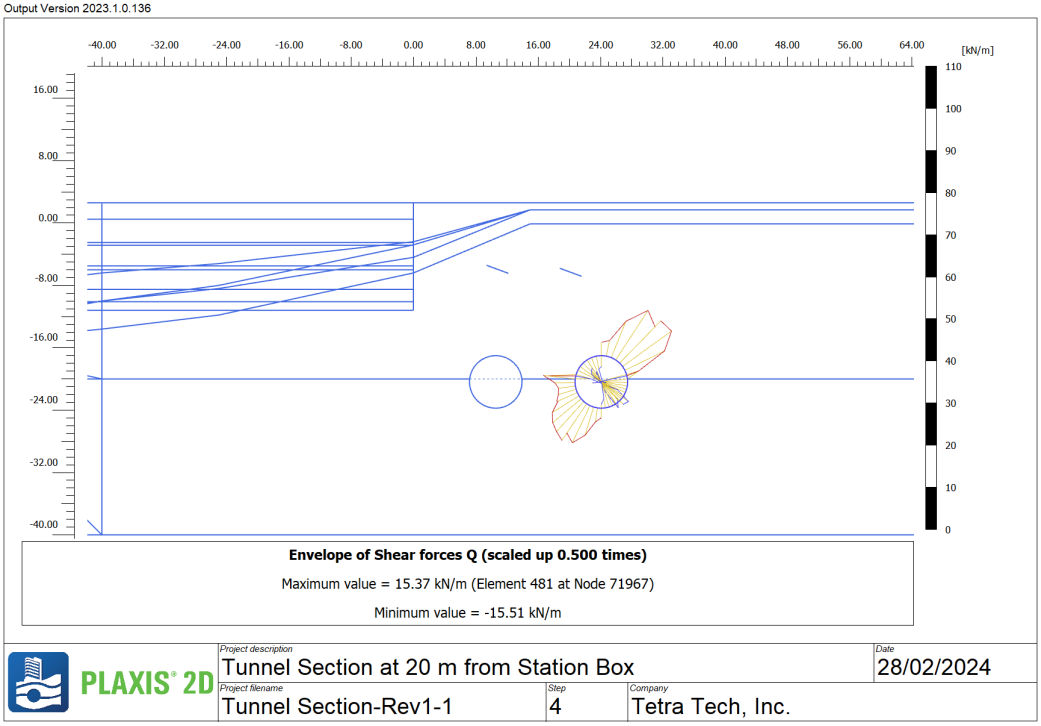


Total Displacement for Eastbound Tunnel at Stage 3 – After Installation of Tunnel Liner



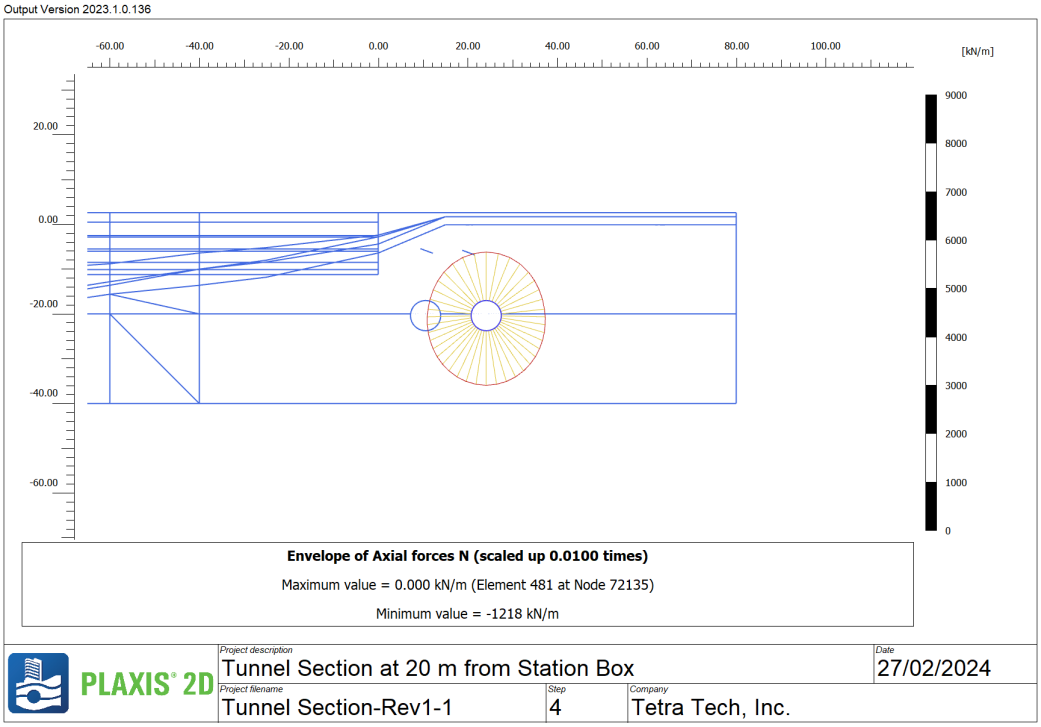
Bending Moment for Eastbound Tunnel at Stage 3 – After Installation of Tunnel Liner

Output Version 2023.1.0.136

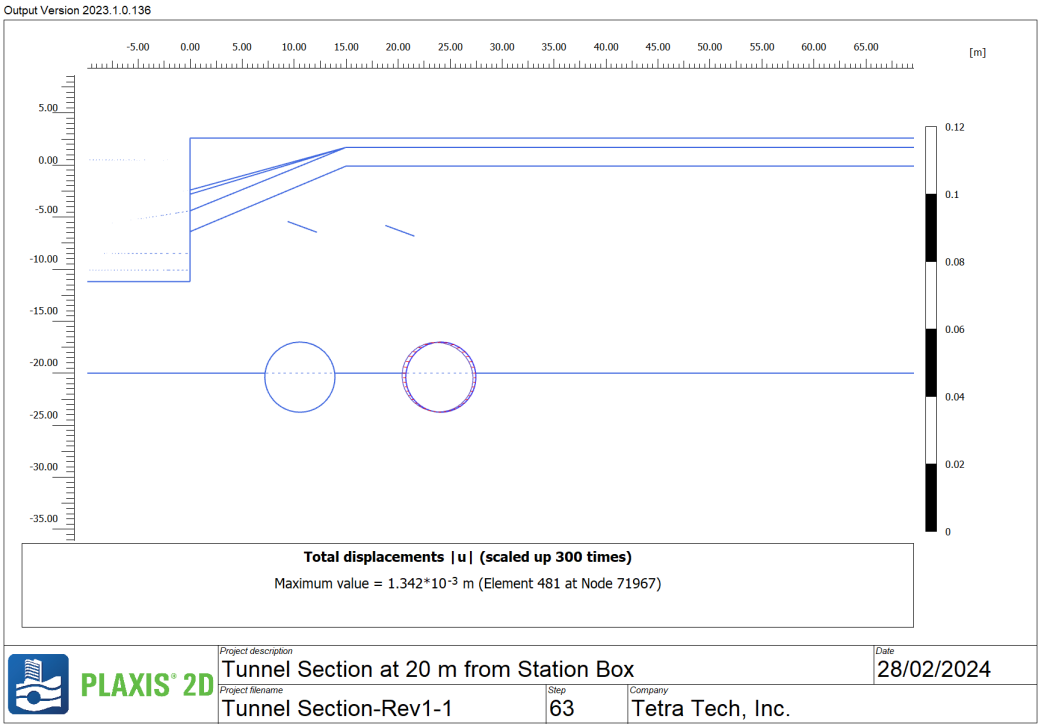


Shear Force for Eastbound Tunnel at Stage 3 – After Installation of Tunnel Liner

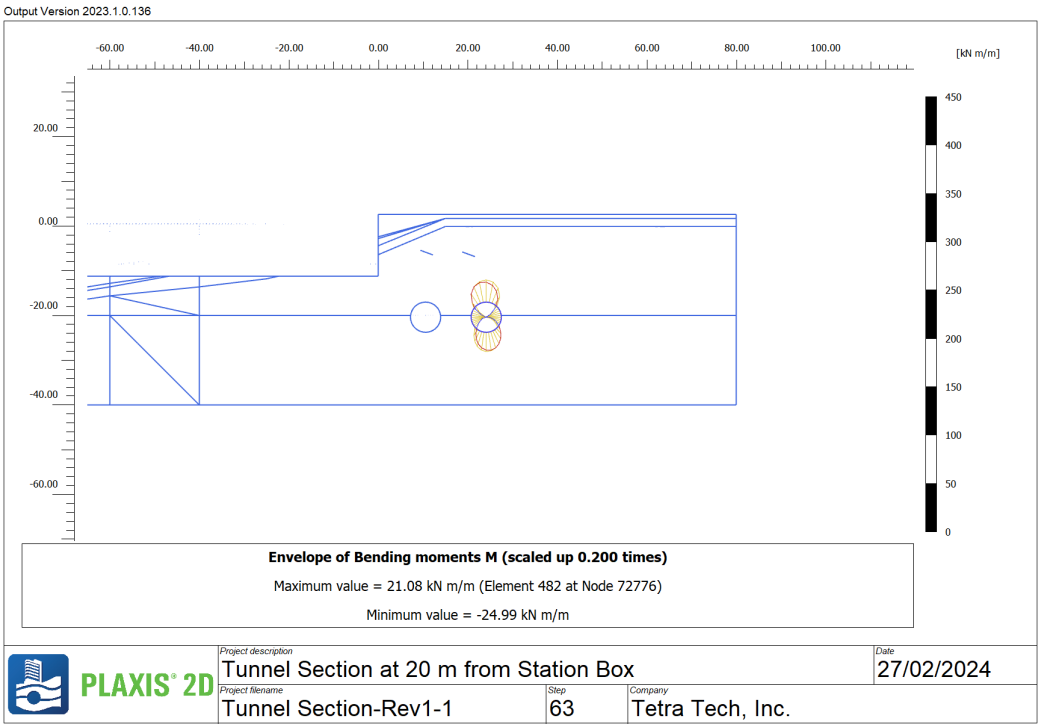
Output Version 2023.1.0.136



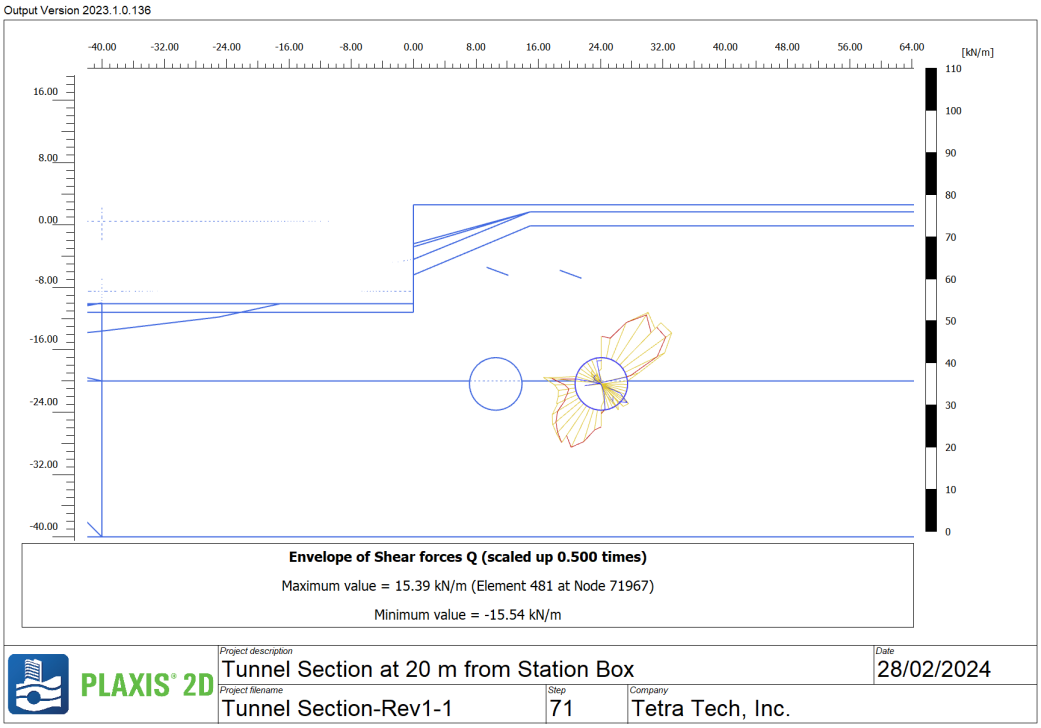
Axial Force for Eastbound Tunnel at Stage 3 – After Installation of Tunnel Liner



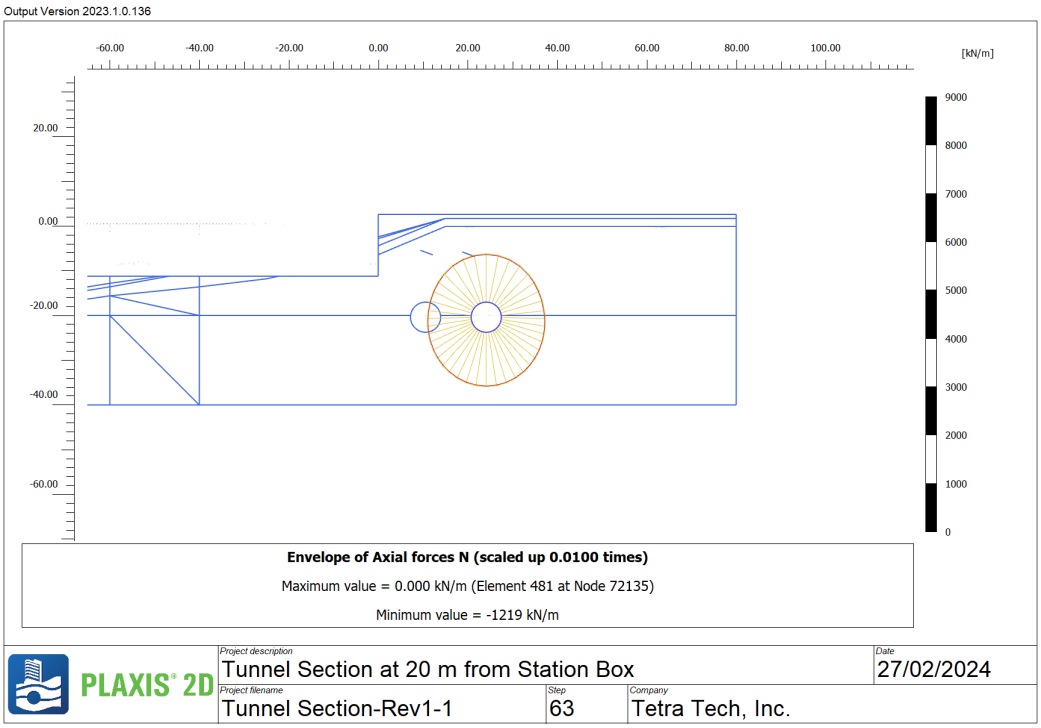
Total Displacement for Eastbound Tunnel Liner at Stage 18 – After CBD Excavation to RL-11.2



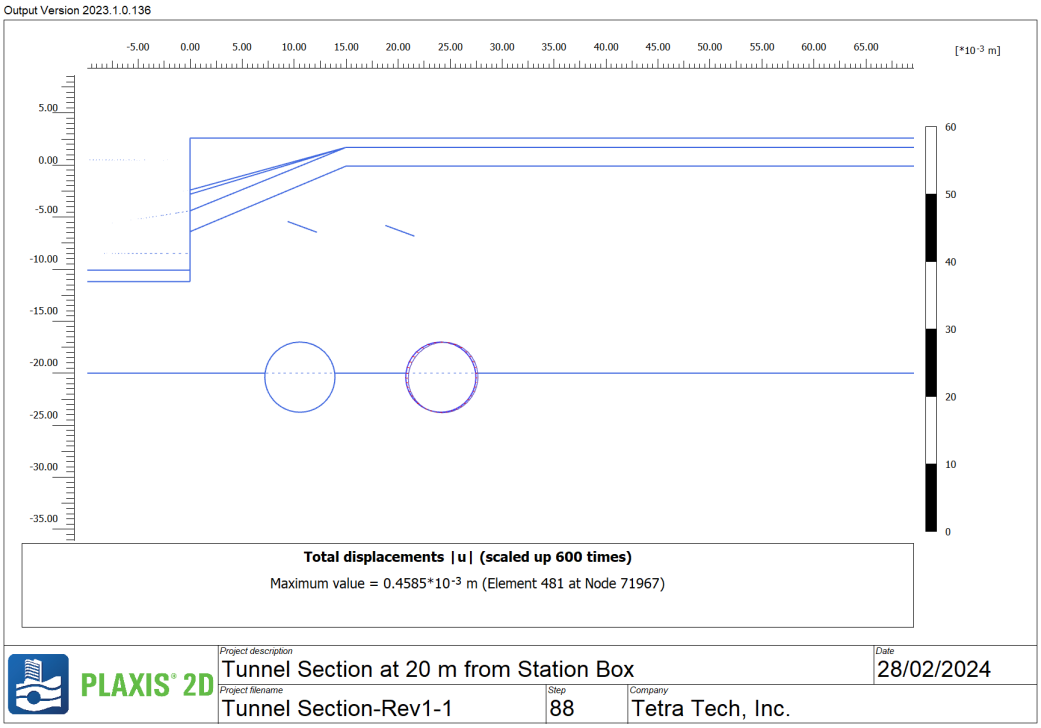
Bending Moment for Eastbound Tunnel Liner at Stage 18 – After CBD Excavation to RL-11.2



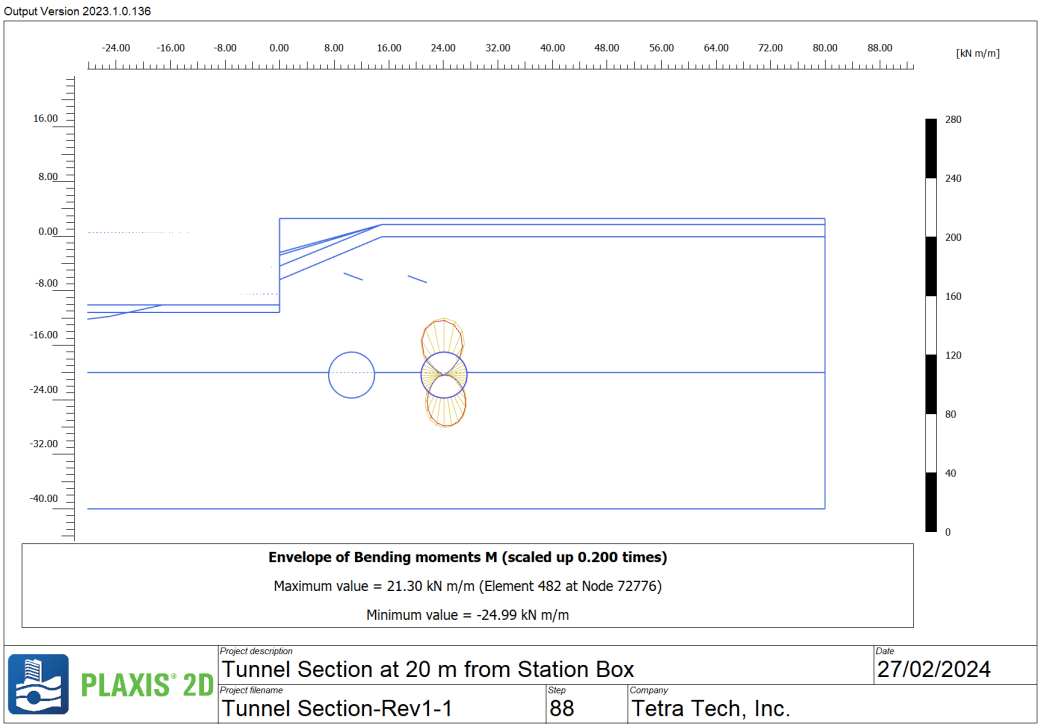
Shear Force for Eastbound Tunnel Liner at Stage 18 – After CBD Excavation to RL-11.2



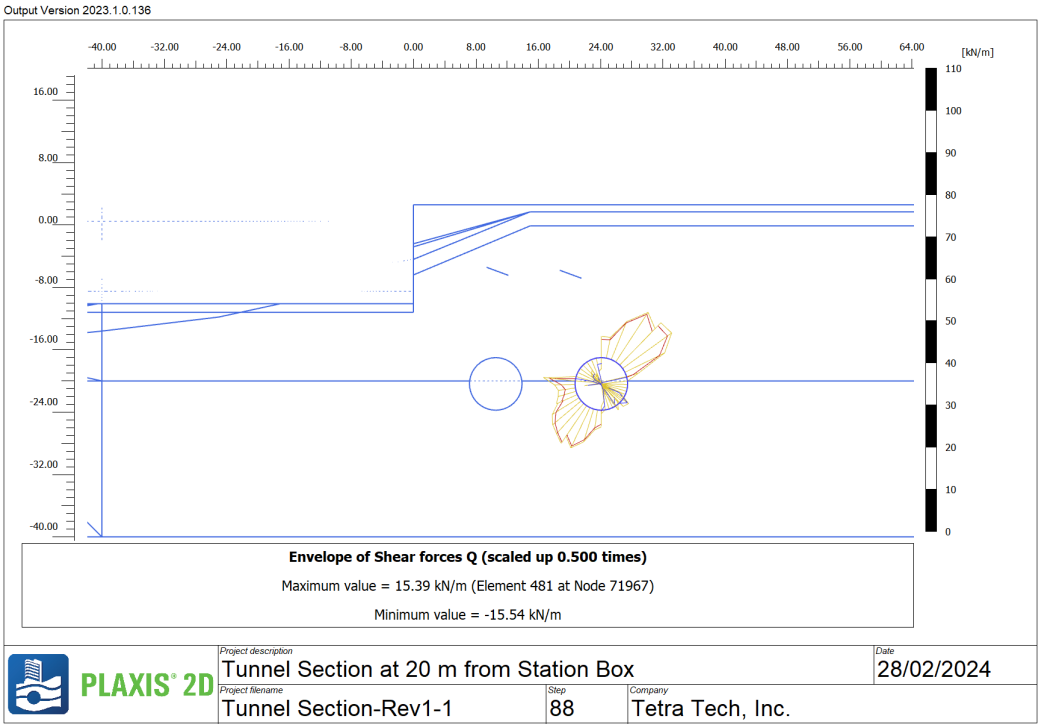
Axial Force for Eastbound Tunnel at Stage 18 – After CBD Excavation to RL-11.2



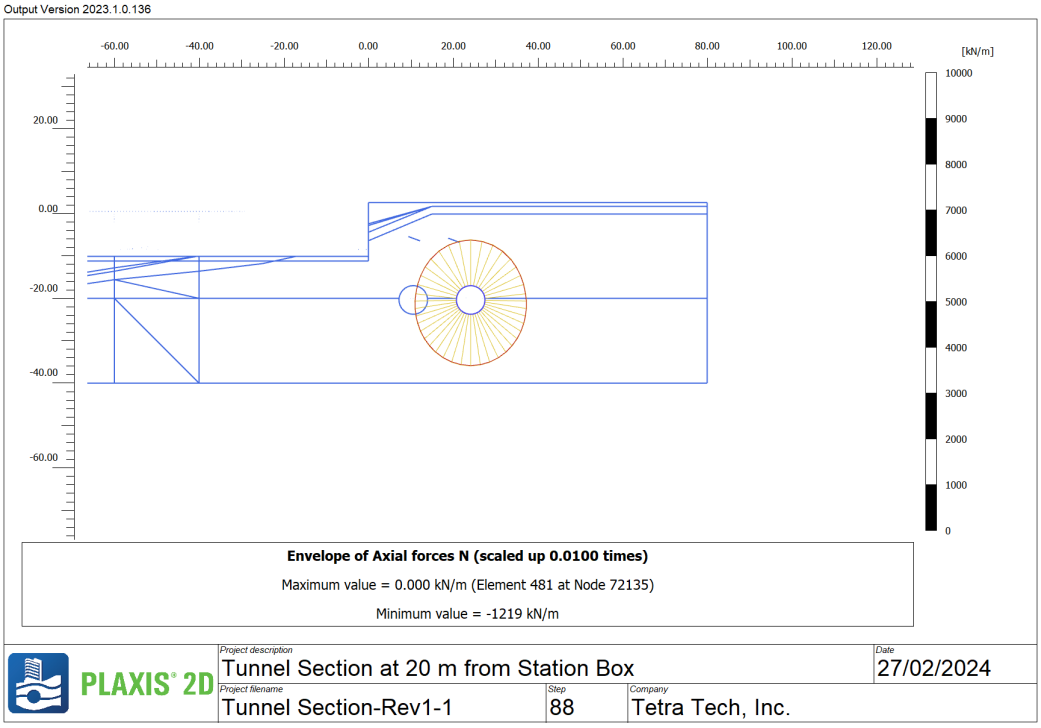
Total Displacement for Eastbound Tunnel Liner at Stage 25 – After Installation of CBD slabs and walls



Bending Moment for Eastbound Tunnel Liner at Stage 25 – After Installation of CBD slabs and walls

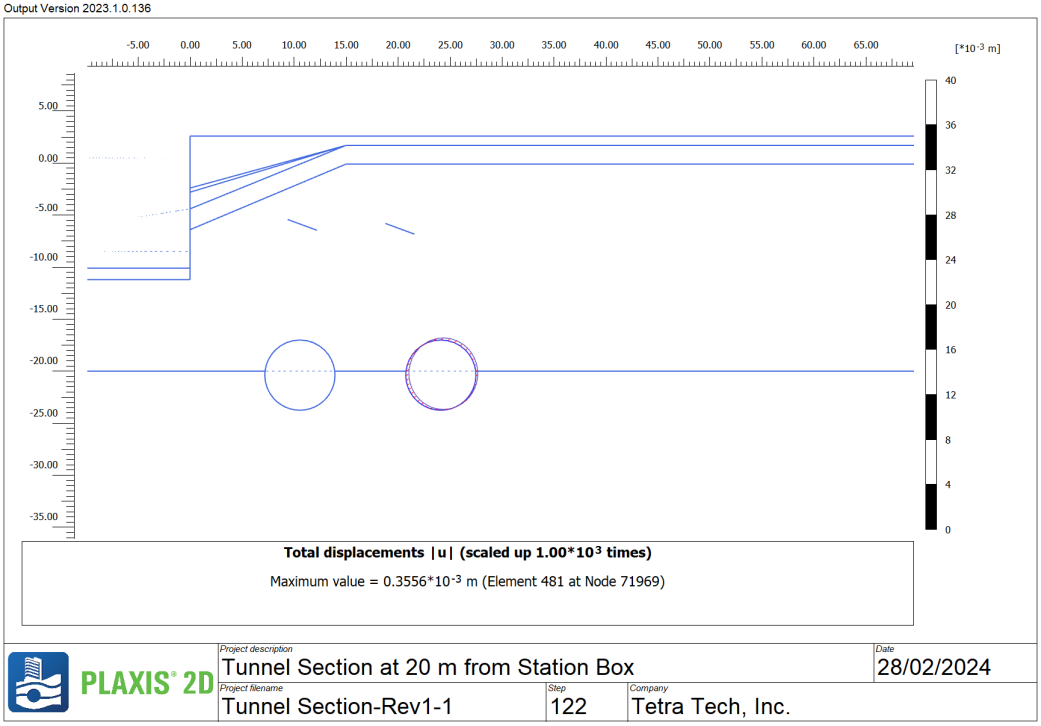


Shear Force for Eastbound Tunnel Liner at Stage 25 – After Installation of CBD slabs and walls



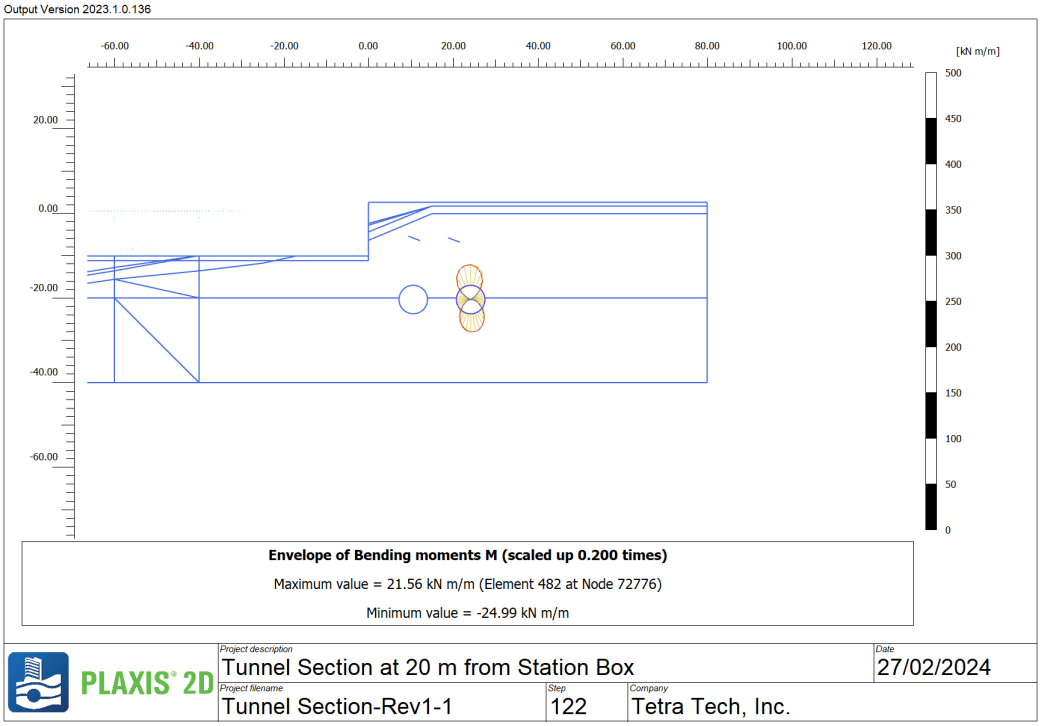
Axial Force for Eastbound Tunnel Liner at Stage 25 – After Installation of CBD slabs and walls

Output Version 2023.1.0.136

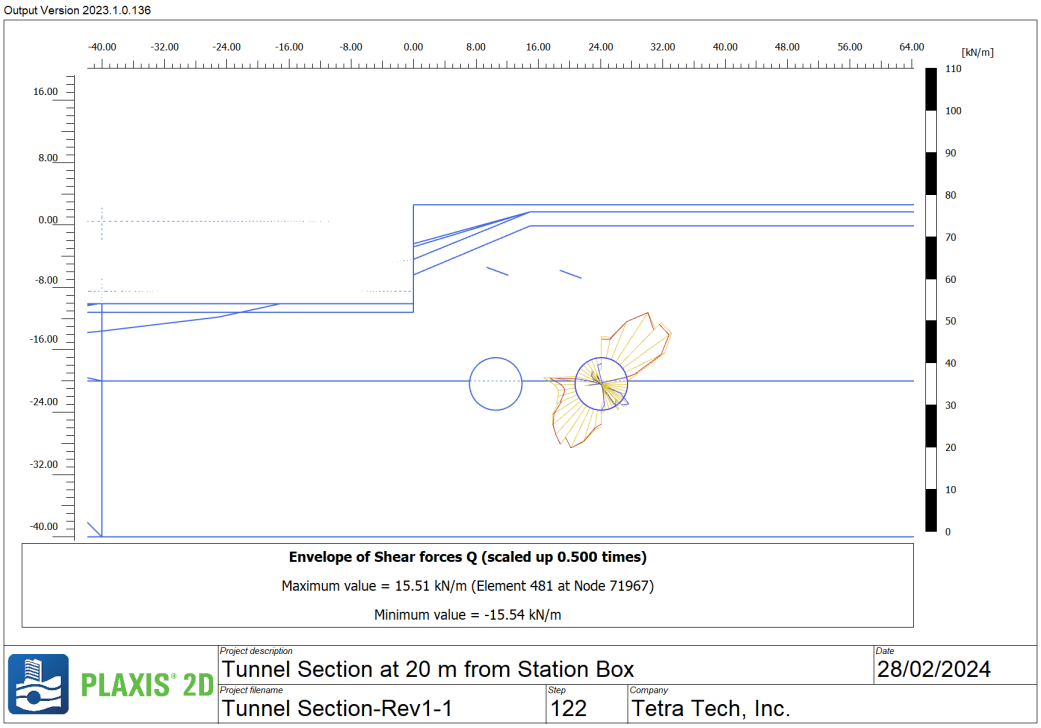


TotalDisplacement for Eastbound Tunnel Liner for GWL Case 1 - GWL at RL 1.5

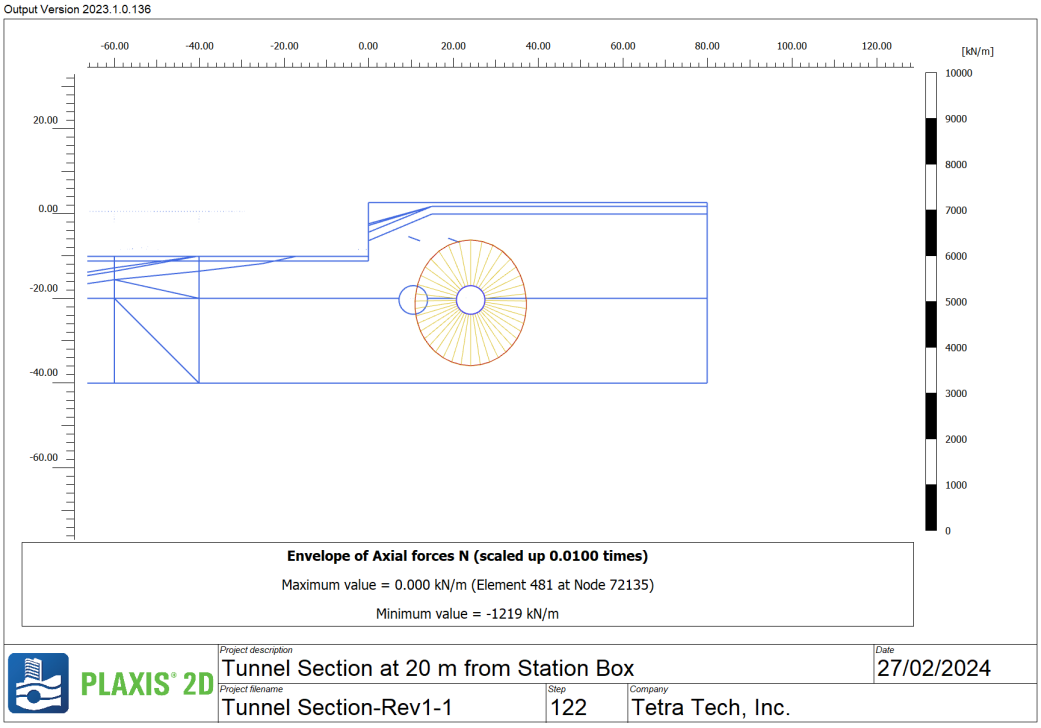
Output Version 2023.1.0.136



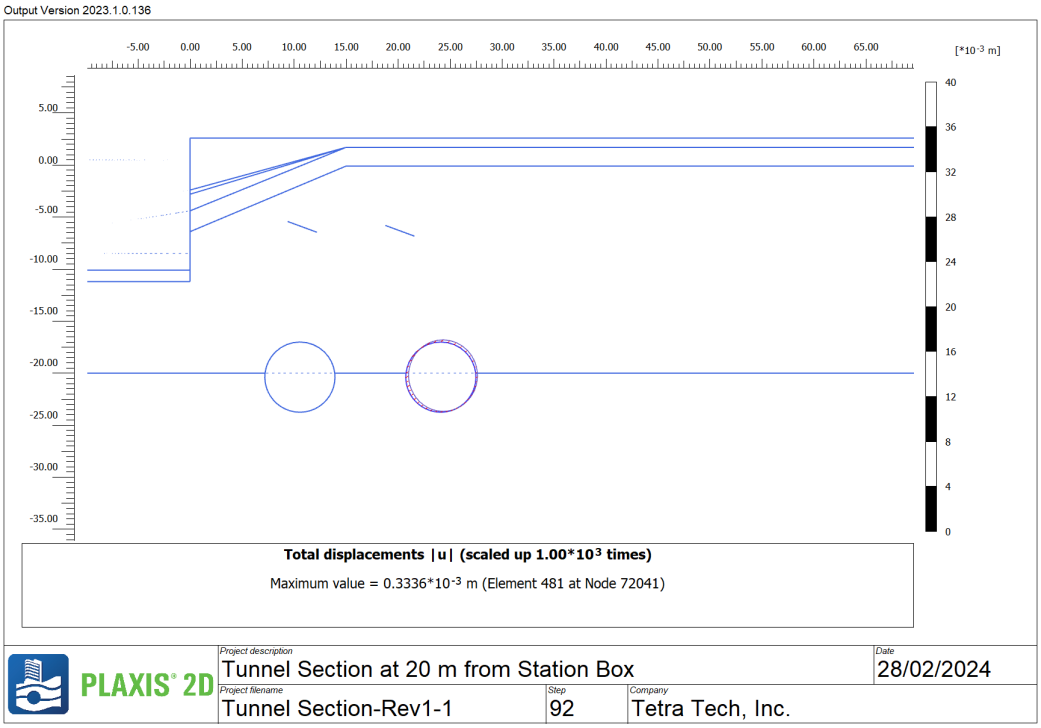
Bending Moment for Eastbound Tunnel Liner for GWL Case 1 - GWL at RL 1.5



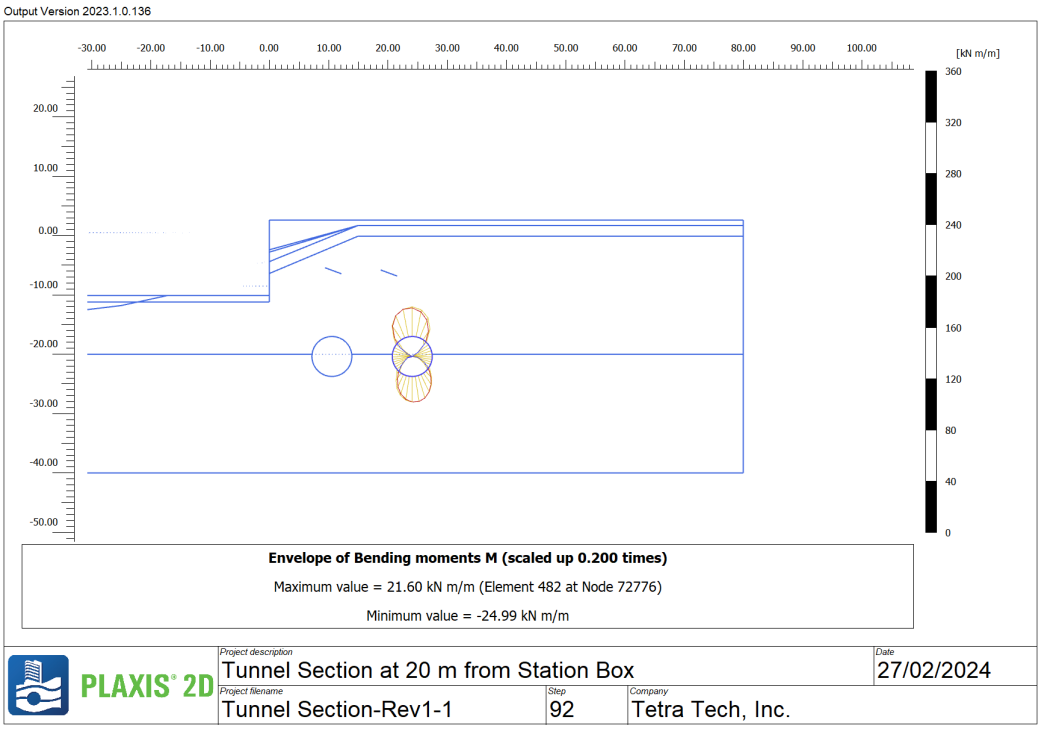
Shear Force for Eastbound Tunnel Liner for GWL Case 1 - GWL at RL 1.5



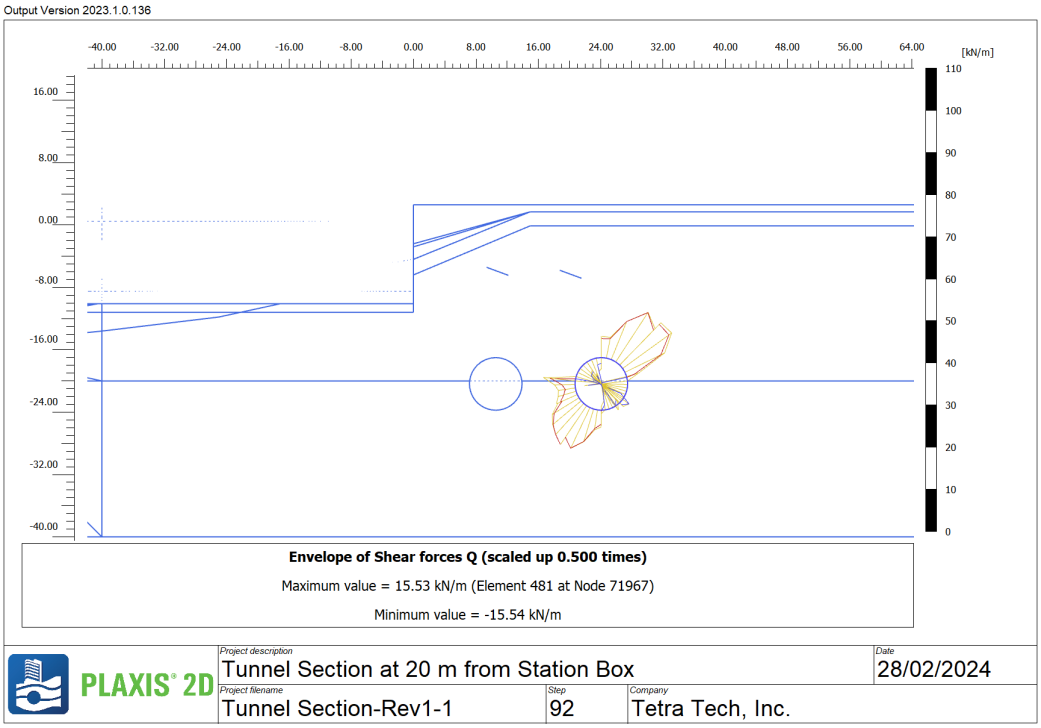
Axial Force for Eastbound Tunnel Liner for GWL Case 1 - GWL at RL 1.5



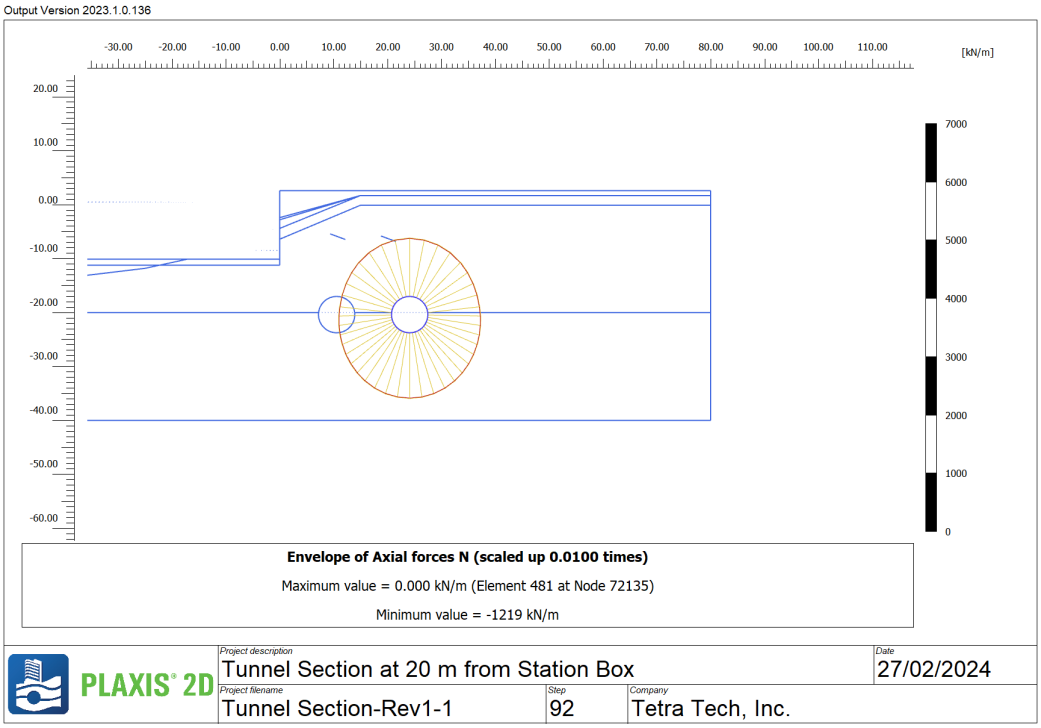
TotalDisplacement for Eastbound Tunnel Liner for GWL Case 2 - GWL at RL 1.5 at landward side and RL 0.5 at seaward side



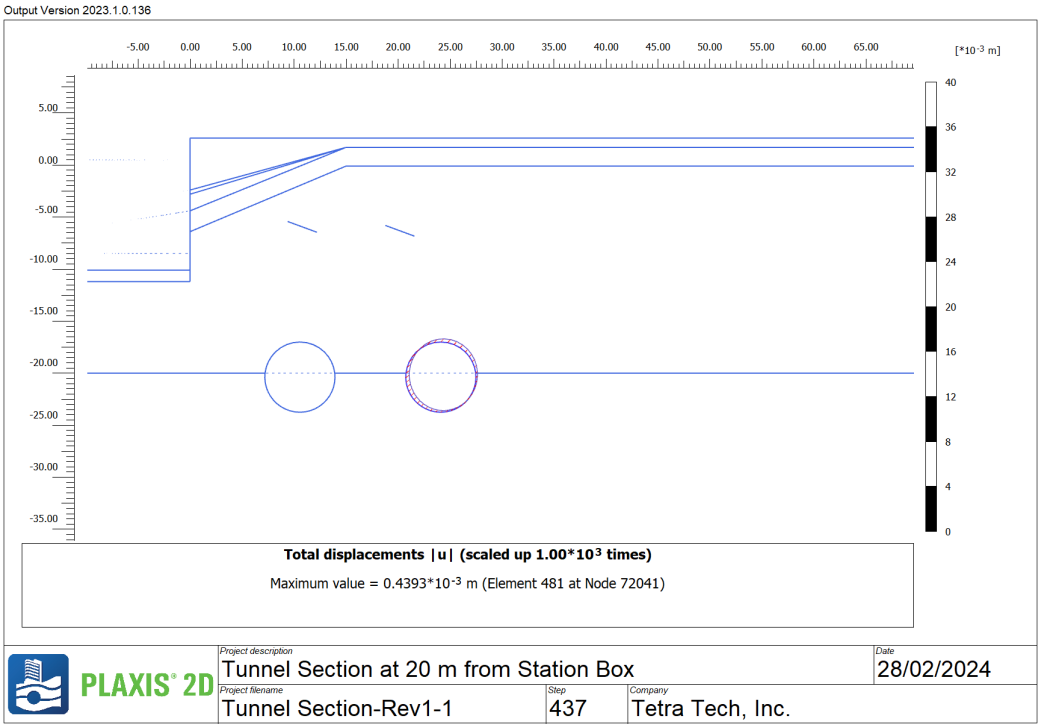
Bending Moment for Eastbound Tunnel Liner for GWL Case 2 - GWL at RL 1.5 at landward side and RL 0.5 at seaward side



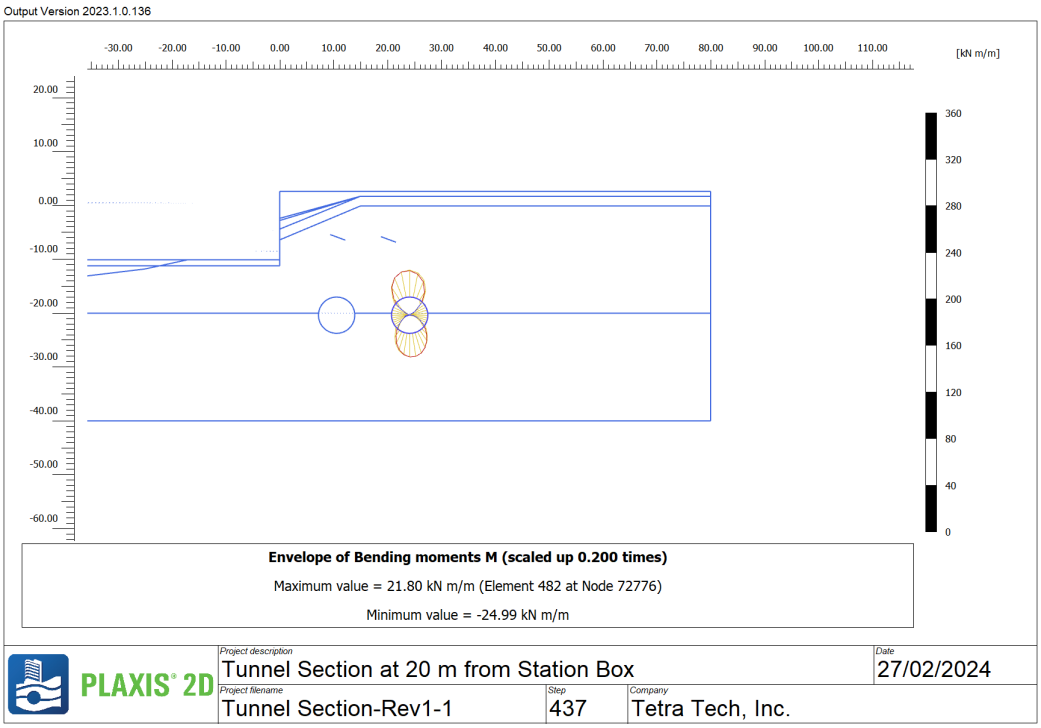
Shear Force for Eastbound Tunnel Liner for GWL Case 2 - GWL at RL 1.5 at landward side and RL 0.5 at seaward side



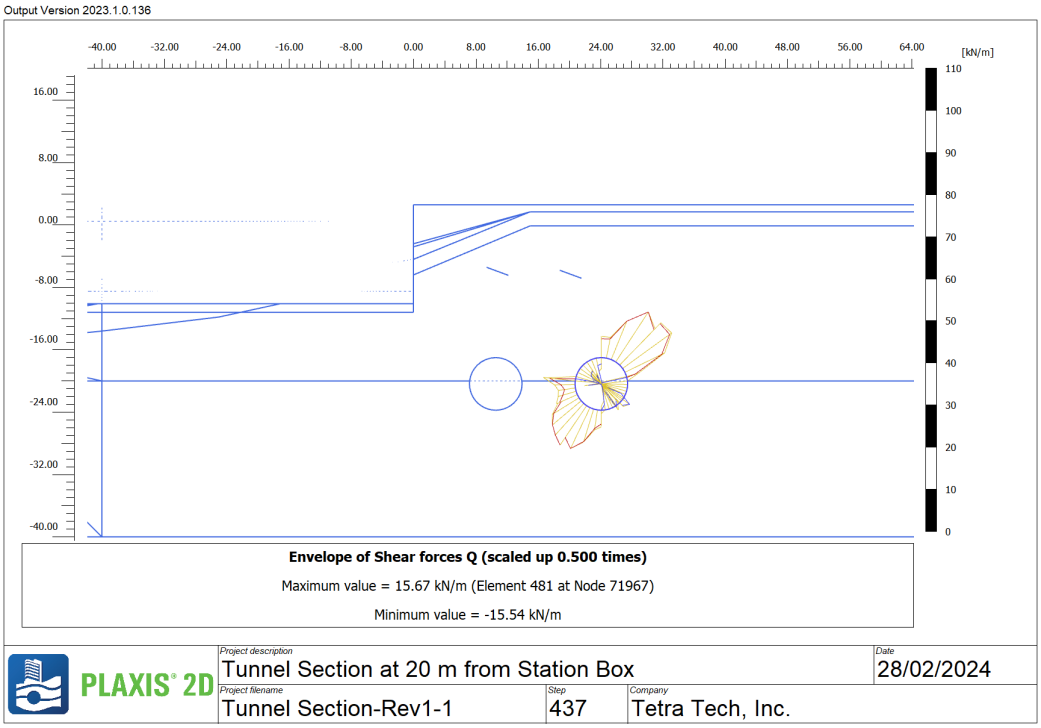
Axial Force for Eastbound Tunnel Liner for GWL Case 2 - GWL at RL 1.5 at landward side and RL 0.5 at seaward side



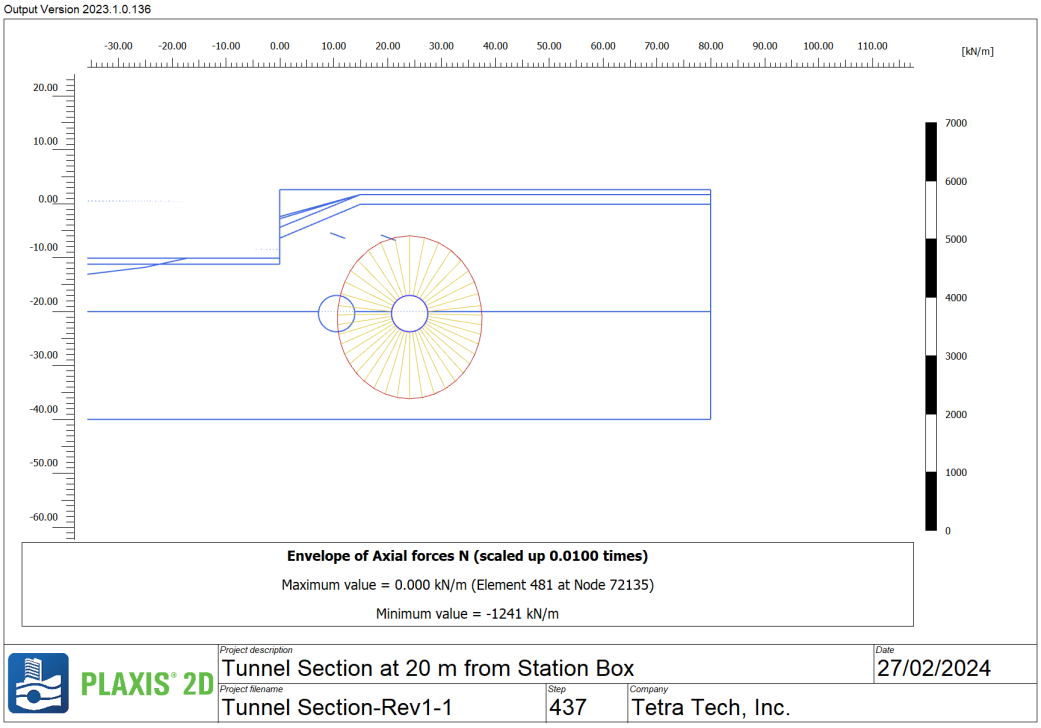
TotalDisplacement for Eastbound Tunnel Liner for GWL Case 3 - GWL at RL 2.575



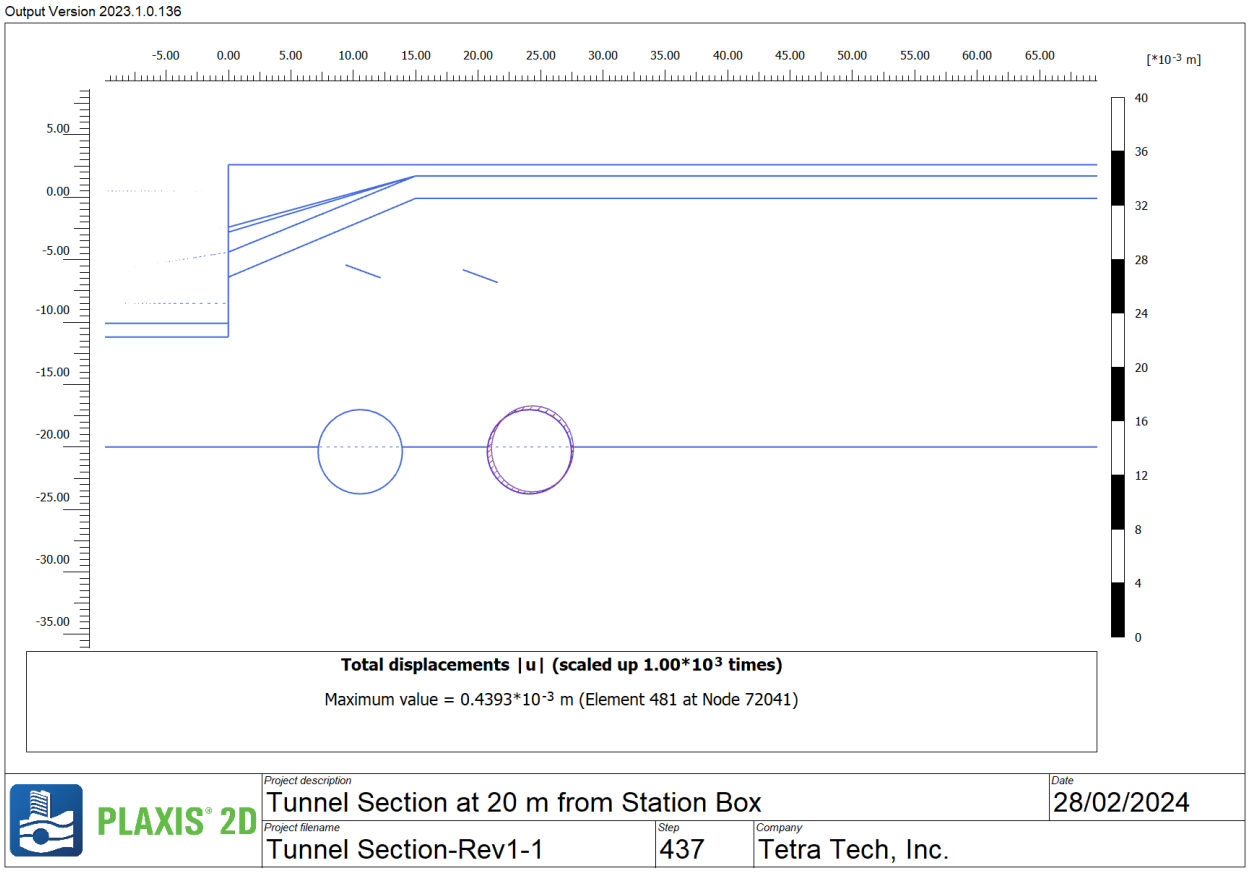
Bending Moment for Eastbound Tunnel Liner for GWL Case 3 - GWL at RL 2.575



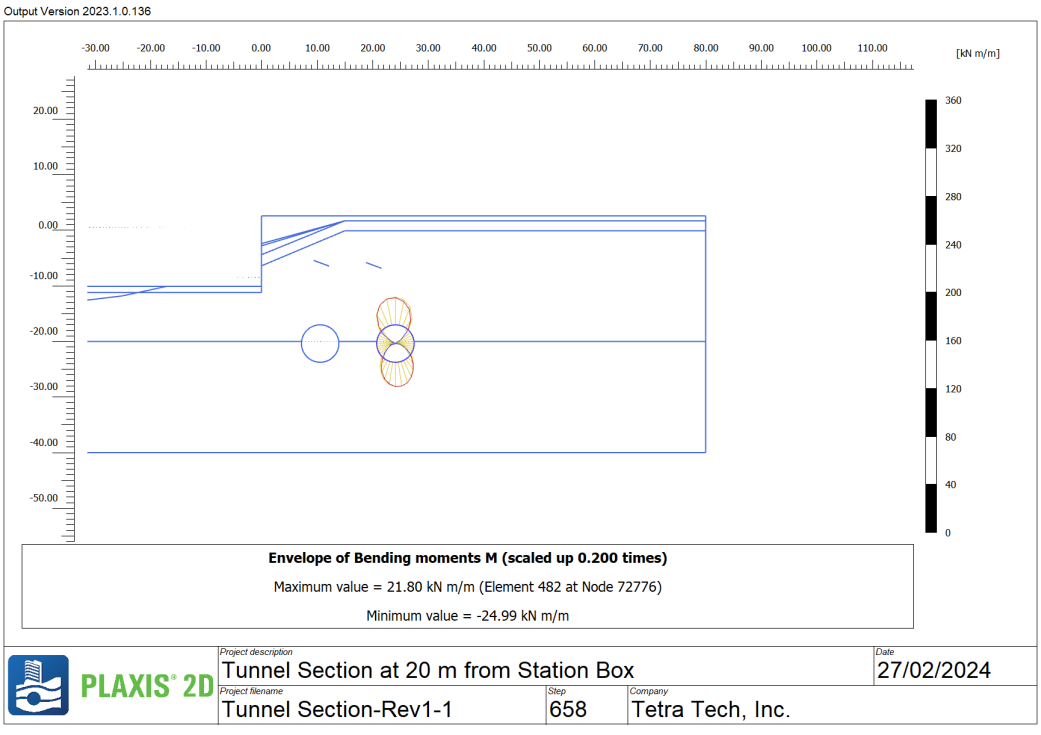
Shear Force for Eastbound Tunnel Liner for GWL Case 3 - GWL at RL 2.575



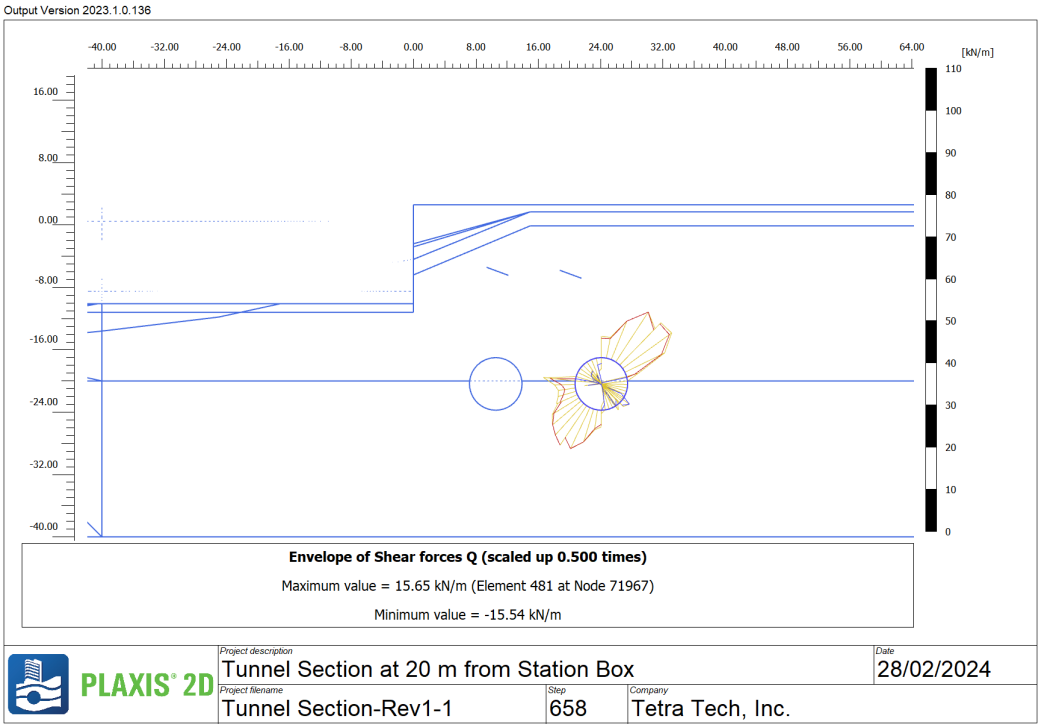
Axial Force for Eastbound Tunnel Liner for GWL Case 3 - GWL at RL 2.575



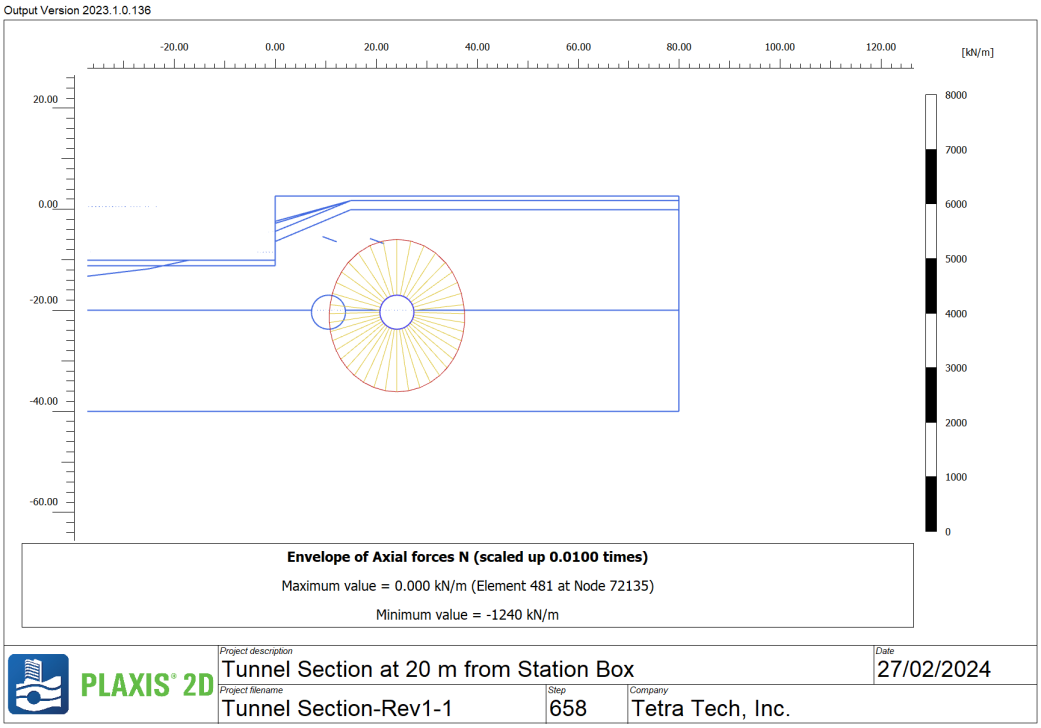
Total Displacement for Eastbound Tunnel Liner for GWL Case 4 - GWL at RL 2.575 at seaward side and RL 1.575 at landward side



Bending Moment for Eastbound Tunnel Liner for GWL Case 4 - GWL at RL 2.575 at seaward side and RL 1.575 at landward side



Shear Force for Eastbound Tunnel Liner for GWL Case 4 - GWL at RL 2.575 at seaward side and RL 1.575 at landward side



Axial Force for Eastbound Tunnel Liner for GWL Case 4 - GWL at RL 2.575 at seaward side and RL 1.575 at landward side

coffey
A TETRA TECH COMPANY

Computations

Client: AQL

Principal:

Project: Barangaroo Central

Location: Sydney Metro - Ground Anchor - Inverted Cone Failure Check

Project no: SYDGE287887

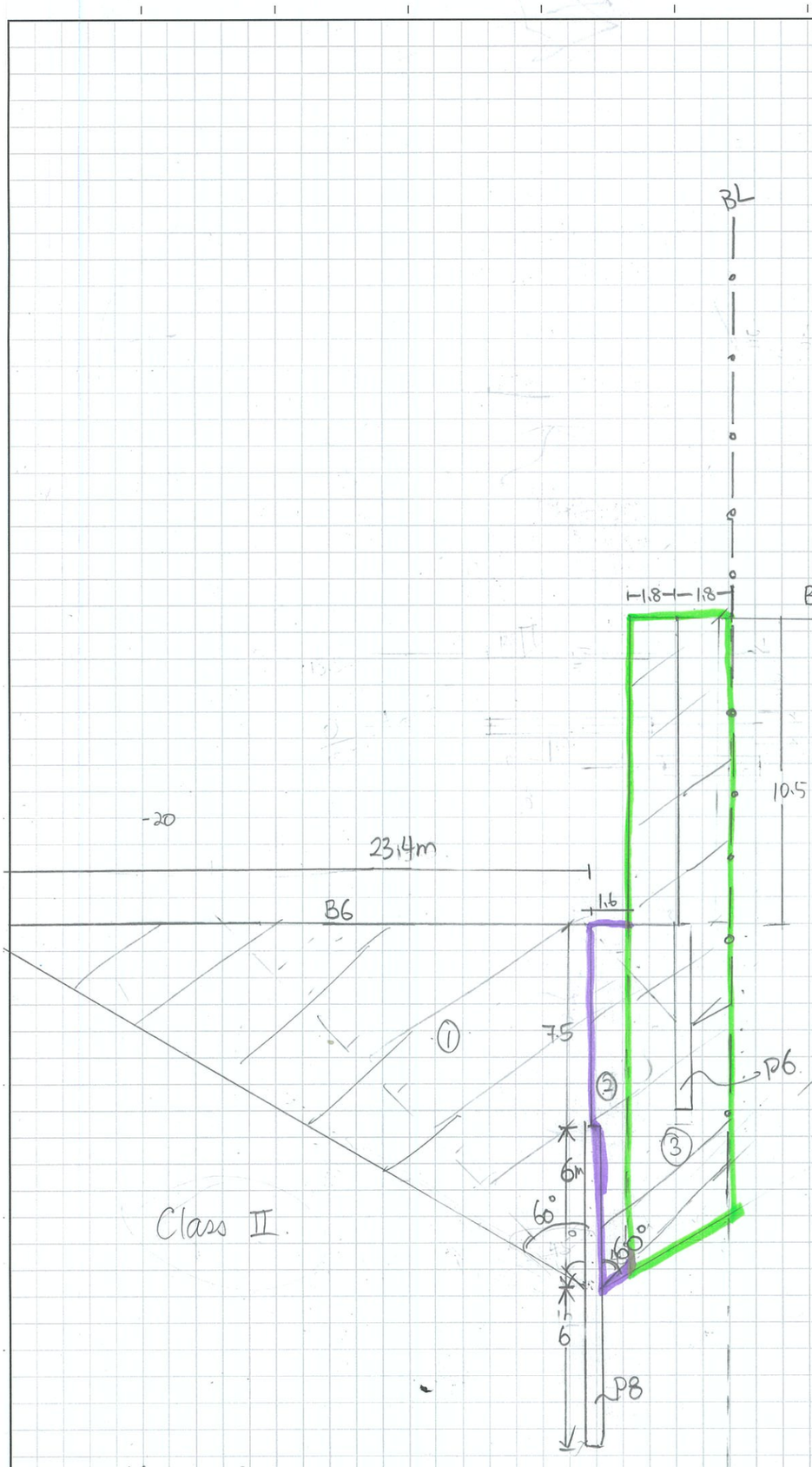
Office: CHATSWOOD

Date: 30 AUG 2024

By: HC

Checked: PKW

Sheet 1 Of 1



Class II.

Ultimate
Anchor capacity/m

P6 @ 4m
$= \frac{4000}{4} = 1000$ kN/m

P8 @ 2.484
$= \frac{5600}{2.484} = 2254$ kN/m

Vol. of Rock
Anchor P8 – spacing = 2.48 m

Area ① + ②

$\left[\frac{23.4 \times 13.5}{2} + \frac{(13.5+12.6) \times 1.6}{2}\right] = (158 + 21)m^2 = 3254$ kN/m
① ②
$= 179\ m^2 \times 14\ kN/m^3$
$= 2506$ kN/m

Total Ultimate anchor capacity : P6+P8

Anchor P6 – spacing = 4m

③

$\frac{[(12.6+10.5)+(10.5+10.5)] \times 3.6}{2} = 80\ m^2 \times 14\ kN/m^3 = 1111$ kN/m

TOTAL Rock Resistance = (2506 + 1111 kN/m) × 0.9.
= 3255 kN/m

APPENDIX E: BMIA SCHEDULE 3 & STRUCTURAL ADEQUACY REPORT & DYNAMIC LOADING

Robert Bird Group

Structural Adequacy Report

Central Barangaroo EWDA-2

Issue: 004

12th March 2025

Prepared For: Aqualand Projects Pty Ltd

Project No.: 22447

Document No.: 22447-RBG-ZZ-XX-RP-ST-TG001

bsi. ISO 9001 Quality Management

Report Amendment Register

Issue	Section & Page No.	Issue / Amendment Details	Author	Reviewer	Date
001	ALL	For Review	Sean Pollard	Mitchell Starkey	13/03/2024
002	ALL	For Review	Sean Pollard	Mitchell Starkey	22/03/24
003	1.1	For Review	Sean Pollard	Matthew Orford	12/03/25
004	1.2	For Review	Sean Pollard	Matthew Orford	12/03/25

ISSUE / AMENDMENT AUTHOR:

……..
Sean Pollard
Author of Issue / Amendment
Signing for and on behalf of
Robert Bird Group Pty Ltd

REVIEWER:

……..
Matthew Orford
Reviewer of Issue / Amendment
Signing for and on behalf of
Robert Bird Group Pty Ltd

Table of Contents

1.0 General 2
1.1 Introduction 2
1.2 Project Summary 2
1.3 The Site 4
2.0 Referenced Documents 6
2.1 Standards and Codes 6
2.2 Consultant Reports 6
3.0 Description of Site 7
4.0 Structural EWDA-2 Scheme Description 7

1.0 General

1.1 Introduction

Robert Bird Group (RBG) has been engaged by Aqualand to provide structural engineering advice for the proposed development of the Central Barangaroo development.

1.2 Project Summary

The proposed SSDA will seek approval for early works associated with the future mixed-use development of Central Barangaroo (set out under **MP06_0162**). The proposal sees to undertake bulk excavation and site establishment works for the installation of the perimeter retention wall, and conduct remediation and archaeological investigations within the site.

These works will facilitate the provision of future basements, consistent with the parameters set out under the approved Concept Plan for Barangaroo under MP06_0162.

The works subject of the SSDA include the following:

- Establish the site and installation of temporary plant and machinery, including dewatering and bentonite slurry plant and ancillary services,
- Construction of perimeter retention wall, including any required excavation, associated rock anchors and PRW capping beam construction,
- Associated remediation and Archaeological investigations in the area of excavation and works;
- Provision for future services,
- Associated “tie-in” works to Metro Interface Wall and the secant pile wall proposed by the applicant under SSD-39587022,
- De-stressing and removal of existing anchors supporting Sydney Metro pile wall,
- Bulk excavation for the provision of a future basement and associated rock anchors (including anchors to support the secant pile wall approved in SSD-39587022 ,
- Construction of foundation piling,
- Installation of waterproofing membrane,
- Construction of hydrostatic slab, and
- Structure and waterproofing for the Barangaroo Metro station southern entrance interface.

The proposal does not seek approval of any buildings, or the design, construct and use of the basement. These will be subject to future detailed SSDAs for Central Barangaroo, consistent with the outcomes of MP06_0162.

The intent of this document is to support the EWDA-2 submission and provide confirmation that the proposed basement envelope and EWDA-2 structural elements are structurally adequate and identify areas that will need to be revised and validated in future design stages. Key information for this document will include:

- Description of the current structural scheme and analysis completed to date.
- Key constraints identified for consideration in the structural design.
- Key structural parameters and performance indicators that will provide the basis of design for the structure.
- Areas of further work identified for future design stages.

Figures 1-3 below shows images of the proposed EWDA-2 plan

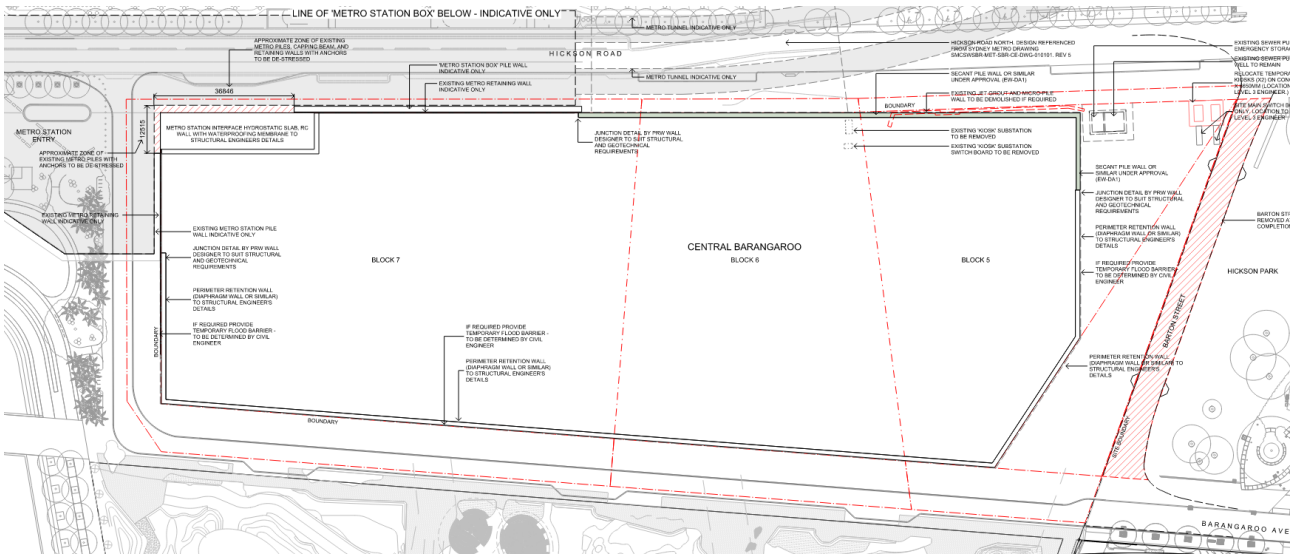


Figure 1 – Proposed EWDA-2 Plan

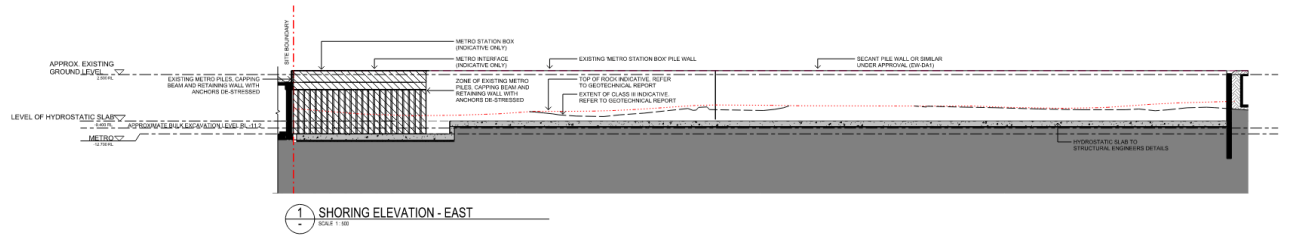


Figure 2 – Proposed EWDA-2 Section

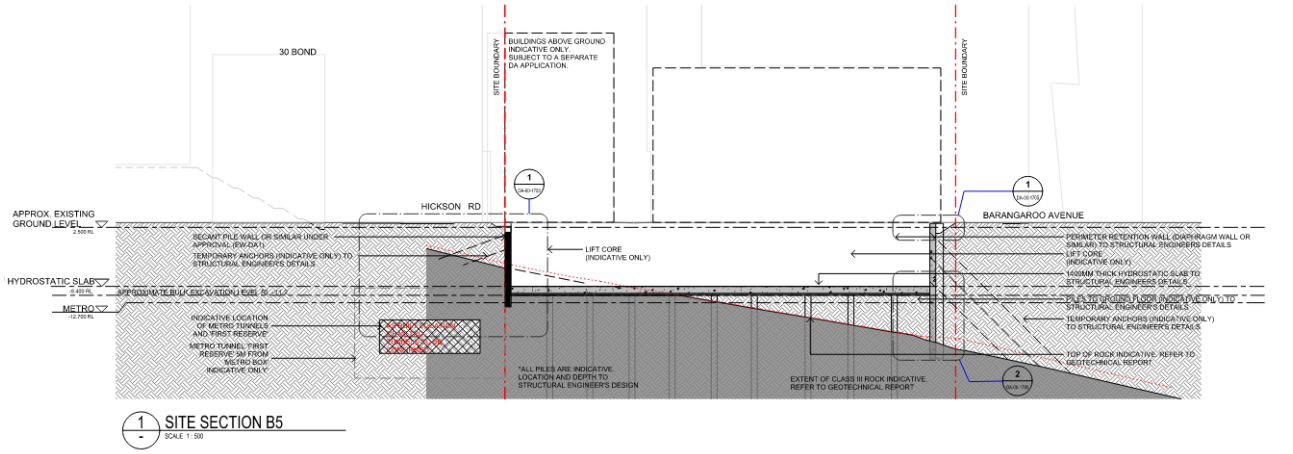


Figure 3 – Proposed EWDA-2 Section

1.3 The Site

The site is located in Central Barangaroo, which forms part of the wider Barangaroo Precinct comprising a total area of 22ha. It is located in the north-western edge of Sydney CBD and falls within City of Sydney Local Government Area (**LGA**). Barangaroo Precinct interfaces with Hickson Road in the east, the foreshore in the west, Walsh Bay to the north and Darling Harbour in the south.

The Precinct is divided into three distinct development areas, including:

- **Barangaroo South (approx. 7.5ha)** – Located at the southernmost end of Barangaroo Precinct. Progressively built over the last six years and includes mixed-use neighbourhood comprising commercial office buildings, mixed use buildings, shops, cafes, hotel and community uses.

- **Central Barangaroo (approx. 5.2ha and area subject of SSDA)** – Located between Barangaroo South and Barangaroo Reserve. Currently vacant and undergoing site preparation works to facilitate a mixed-use area with a focus on retail activation, residential and community uses.

- **Barangaroo Reserve (approve 6.1ha)** – Located in the northern end of the Precinct featuring Barangaroo Reserve. Featuring open space and lookout points to Sydney Harbour, Nawi Cove and Marrinawi Cove. Barangaroo Reserve features the Cutaway – a future arts and cultural entertainment space.

The above results in a total area of 18.8ha. The residual 3.2ha is represented by the reshaping of the former industrial headland into Barangaroo Reserve and the creation of Nawi Cove as a substantial water body within the Barangaroo site, forming the original 22ha.

A summary of the site is provided in **Table 1**.

Item	Description
Site Area	5.2ha (approx.) of the 22ha Barangaroo Precinct
Ownership	Infrastructure NSW
Legal Description	Lot 52 Deposited Plan 1213772

The area currently features a large concrete hardstand area/construction site that is occupied by temporary structures for site preparation works, machinery, materials and vehicle parking for site workers. Hoarding is currently erected around the Central Barangaroo site.

Background and Related Applications

Concept Application MP06_0162

The Barangaroo Concept Plan was approved on 9 February 2007 under Part 3A of the EP&A Act 1979. It has been modified several times since 2007.

The original Concept Plan was facilitated through an amendment to Schedule 3 of *State Environmental Planning Policy (Major Development) 2005* now consolidated into *State Environmental Planning Policy (Precincts – Eastern Harbour City) 2021* (**PEHC SEPP**). The SEPP establishes the land use, height, GFA and other provisions relating to the planning and development of Barangaroo.

The Approved Concept Plan

Following several modifications up to MOD 11, the approved Concept Plan that applies to Barangaroo currently is described in Condition A1 of the Instrument of Approval and is generally summarised to include the following key elements:

- A mixed use development with a maximum of 655,864m^2 of GFA comprised of:
    - A maximum 237,031m^2 of residential GFA of which a maximum 162,031m^2 will be in Barangaroo South,
    - A maximum 76,000m^2 of GFA for tourist uses of which a maximum 59,000m^2 will be in Barangaroo South,
    - A maximum 44,766m^2 of GFA for retail uses of which a maximum 30,000m^2 will be in Barangaroo South,
    - A maximum 5,000m^2 of GFA for active uses in the Public Recreation zone of which a maximum 3,500m^2 will be in Barangaroo South, and
    - A minimum of 14,800m^2 of GFA for community uses.

- Approximately 11 hectares of new public open space/public domain, with a range of formal and informal open spaces serving separate recreational functions and including an approximate 2.2km foreshore promenade.

Central Barangaroo Early Works Phase 1 SSDA-39587022

SSDA-39587022 was approved by the Independent Planning Commission on 29 January 2025 and includes:

- Partial demolition of an existing shoring wall capping beam along Hickson Road,
- Construction of a new secant pile retention wall (approx. 150m long),
- Excavation of land related to construction of the secant pile retention wall,
- Localised remediation related to the secant pile retention wall,
- Associated Archaeological Investigations in the area of excavation and works,
- Sydney Metro / Hickson Road interfaces – perimeter retention wall interface works, and Hickson Road public domain interface works, and
- Relocation of stormwater and other services to enable the permanent works outlined above.

2.0 Referenced Documents

2.1 Standards and Codes

All relevant Australian codes and standards will form the basis for the structural design, including:

NCC 2019	Building Code of Australia
AS/NZS 1170.0	Structural Design Actions – General Principles
AS/NZS 1170.1	Structural Design Actions – Permanent, Imposed, and other Actions
AS/NZS 1170.2	Structural Design Actions – Wind Actions
AS 1170.4	Structural Design Actions – Earthquake Actions in Australia
AS 1720	Timber Structures
AS 2159	Piling – Design and Installation
AS 2312	Guide to the Protection of Structural Steel Against Atmospheric Corrosion
AS/NZS 2327	Composite Structures - Composite Steel-concrete Construction in Buildings
AS 3600	Concrete Structures
AS 3700	Masonry Structures
AS 3735	Concrete Structures Retaining Liquids
AS 4100	Steel Structures
AS/NZS 4600	Cold-formed Steel Structures
AS 4678	Earth-retaining Structures
ISO 2631-2:2003	Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration — Part 2: Vibration in buildings (1 Hz to 80 Hz)

2.2 Consultant Reports

The following reports are to be used to obtain critical design information and provide guidance during structural design:

- Tetra Tech Coffey Geotechnical Impact Assessment Report: State Significant Development Application
- Tetra Tech Coffey and Robert Bird Group Sydney Metro Impact Assessment
- Tetra Tech Coffey and Robert Bird Group Specialist Engineering Assessment (SEA); Central Barangaroo Development – Pump Station SEA report
- Metron Barangaroo Station Protection Guidelines, report ref: SMCSWSBR-MET-SBR-ID-REP-000030 | Revision - P09 dated 11 February 2021
- Metron Structural Interface Report Barangaroo Station, report ref: NWRLSRT-MET-SBR-ST-REP-000032 | Revision - P08.1 dated 11 February 2021

3.0 Description of Site

The site is located at Central Barangaroo.

The site is bordered by Barangaroo South, Hickson Road, Barangaroo Metro Station and Barangaroo Headland Park.

Figure 2 - Site location

4.0 Structural EWDA-2 Scheme Description

The proposed structural scheme is based on the SJB drawings issued to RBG. The structural scheme selected is typical and appropriate for this type of development.

The proposed has the following key structural features:

- Columns will typically be supported on bored piers of 1.2m diameter, 50MPa concrete strength, with 75mm concrete cover to reinforcement. In the permanent mode these bored piers will be required to resist tension uplift forces due to the permanent buoyancy of the basement. As such these will be appropriately socketed into high strength sandstone.

- Where piles are founded within the geotechnical zone of influence these will be sleeved so as not to impose load on the station box. This is in accordance of Sydney Metro Structural Interface Report SMCSWSBR-MET-SBR-ST-REP-000032.

- Perimeter walls will typically be a Diaphragm Wall system that is temporary anchored during excavation, diaphragm walls are expected to be approximately 1000 thick, 50MPa concrete strength, with 75mm concrete cover. In other areas a secant pile wall will be used which will also be temporary anchored.

- The base slab will be a membraned hydrostatic slab capable of resisting large hydrostatic pressures and perform as a water tightness barrier. The hydrostatic slab will be in the order of 1400mm thick, 50MPa concrete strength and 75mm concrete cover.

It should be noted that whilst the station interfaces with the Central Barangaroo Metro Station there is no structural connection. The proposed Central Barangaroo development imposes no load on the station and conversely does not rely on the station for any structural support.

The “hard” piles of the secant pile wall will be constructed with a concrete strength notionally of f’c=50MPa and a minimum cover of 50mm. The “soft” piles are not reinforced. The capping beam for the secant pile wall will be constructed with a concrete strength notionally of f’c=50MPa and a minimum cover of 50mm.

Appendix 1 – Sydney Metro/Transport Comments on EWDA-1 Submission

Robert Bird Group
Member of the Surbana Jurong Group

Robert Bird Group Pty Ltd
ABN 67 010 580 248 | ACN 010 580 248

Reference: VL; MS CO/ST 22447

9 August 2023

Victor Kardash
Aqualand Projects Pty Ltd (ABN 73 169 346 810)
Level 37
264 George Street
SYDNEY NSW 2000

Dear Victor

RE: SYDNEY METRO/TRANSPORT COMMENTS ON EWDA-1 SUBMISSION

Further to our discussions and in response to the recent request for information provided by Sydney Metro regarding Aqualand's stage significant development application for EWDA-1.

RBG has prepared the below response in coordination with Tetra Tech Coffey.

RBG has reviewed the request for information and confirms the following:

- In the temporary condition the proposed secant pile wall will only receive minor vertical loads.
- In the permanent condition the basement will be structurally arranged such that all major vertical loads are directed away from the secant pile to inboard columns/walls resulting in the minor vertical loads on the secant pile wall.
- The "hard" piles of the secant pile wall will be constructed with a concrete strength notionally of f'c=50MPa and a minimum cover of 50mm. The "soft" piles are not reinforced.
- The capping beam for the secant pile wall will be constructed with a concrete strength notionally of f'c=50MPa and a minimum cover of 50mm.

Should you have any queries on the above please do not hesitate to contact the undersigned.

Yours faithfully

ROBERT BIRD GROUP PTY LTD

Mitchell Starkey
Buildings Lead

LEAD. CREATE. DELIVER. SUSTAIN

SYDNEY
Level 6
100 Pacific Highway
North Sydney NSW 2060 Australia
PO Box 6461, North Sydney NSW 2059
p: +61 (0)2 8246 3200 | w: robertbird.com

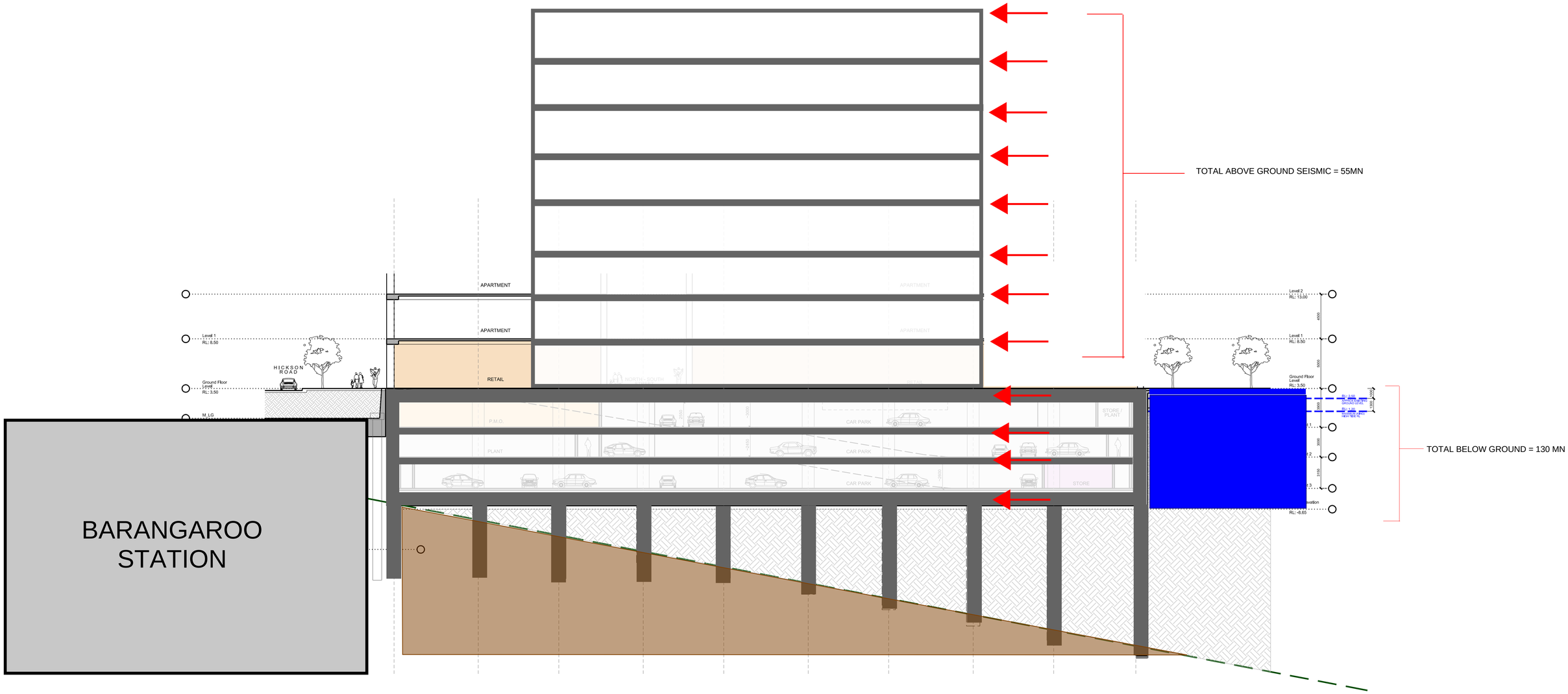
Sydney Office

Robert Bird Group Pty Ltd
ABN 67 010 580 248 ACN 010 580 248

Level 6, 100 Pacific Highway
North Sydney NSW 2060

Sydney South NSW 1235
Australia

P: +61 (0) 2 8246 3200
F: +61 (0) 2 8246 3201



TOTAL SEISMIC BASE SHEAR = 185 MN

ABOVE GROUND + BELOW GROUND.

CROSS SECTION - 02 (1:200 on A1)

(EAST - WEST)

OPTION 12CV8 - (3 Level Basement - Balanced Retail / Car Parking) - 12/10/23

AQUALAND

DWG-12CV8_06

SCHEDULE 3

Documentation

Part A - Documentation to be provided by BDA

Item.	Documentation required	When documentation is required
1.	Detailed survey information to confirm the property boundaries are consistent with the BDA Design Documentation.	Within 10 Business Days after the issuing of any Construction Certificate in respect of the Zone of Influence Works or the Southern Entrance Works (as applicable) and, in any event, before the commencement of any excavation or construction in connection with the Zone of Influence Works or the Southern Entrance Works.
2.	Plans, sections and details of Zone of Influence Works or the Southern Entrance Works, including: • their locations and dimensions; • the levels of the top and bottom of each structure; • loading, analysis and modelling calculations; • results and interpretations of investigations of subsurface conditions (which results must include suitable geotechnical information to enable assessment of any proposed excavations and structures); • a comprehensive engineering assessment in accordance with section 5 of the Infrastructure Protection Principles, including analysis and modelling necessary to quantify and measure the likely impact of the structures on the Sydney Metro and revisions to the calculations based on unexpected ground conditions.	At least 20 Business Days prior to the earlier of the commencement of: • any excavation; or • construction or installation of any structure, in connection with the Zone of Influence Works or the Southern Entrance Works.
3.	Reports from a Qualified Practising Geotechnical Engineer and a Qualified Practising Structural Engineer, which: • certifies that the Zone of Influence Works or the Southern Entrance Works, including the structural design of any excavations or structures in connection with those works, will comply with the TfNSW Design Requirements; and • include details of site investigations undertaken.	At least 20 Business Days prior to the commencement of: • any excavation; or • construction or installation of any structure, in connection with the Zone of Influence Works or the Southern Entrance Works.
4.	Reports from a Qualified Practising Geotechnical Engineer and a Qualified Practising Structural	Prior to the earlier of:

Item.	Documentation required	When documentation is required
	Engineer, which include: • detailed survey information for any excavation (including the location, vertical dimensions and diameter of each excavation, and the levels of the top and bottom of each hole excavated for any structures and in particular, each rock bolt and each rock anchor (including length and bearing) located in the Protection Zone), prepared by a registered surveyor; and • details of inspections and interpretation of any excavation faces, including geotechnical mapping of all excavations faces and identification of major geological features, such as fault zones.	• covering up of any excavation; or • 20 Business Days after the completion of construction or installation of any structure and the completion of any excavation, in connection with the Zone of Influence Works or the Southern Entrance Works.
5.	Reports prepared by a Qualified Practising Geotechnical Engineer and a Qualified Practising Structural Engineer, which: • certify that the Zone of Influence Works or the Southern Entrance Works, including the design and construction of the excavations and the design, construction and installation of all structures, complies with the Construction Method Statement and the TfNSW Design Requirements ; and • include as-built drawings of all structures and excavations.	Within 20 Business Days after each of: • the completion of the excavations; and • the completion of the construction and installation of all structures, in connection with the Zone of Influence Works or the Southern Entrance Works.

Part B - Documentation to be provided by TfNSW

Item	Documentation required	When documentation is required
1.	Detailed survey information to confirm the property boundaries are consistent with the TfNSW Design Documentation.	Within 10 Business Days after the issuing of any Construction Certificate (if applicable) in respect of the Station Works or the Hickson Road Works and, in any event, before the commencement of any excavation or construction in connection with the Station Works.
2.	Plans, sections and details of the Station Works or the Hickson Road Works, including: • their locations and dimensions; • the levels of the top and bottom of each structure; and	At least 20 Business Days prior to the earlier of the commencement of: • any excavation; or • construction or installation of any structure,

Item	Documentation required	When documentation is required
	• loading, analysis and modelling calculations; • results and interpretations of investigations of subsurface conditions (which results must include suitable geotechnical information to enable assessment of any proposed excavations and structures).	in connection with the Station Works.

APPENDIX F: GEOTECHNICAL INTERPRETATION REPORT (GIR)

Central Barangaroo Development (CBD)

Geotechnical Interpretative Report

Aqualand B Development Pty Ltd.

Reference: SYDGE287887-AN

15 November 2022

CENTRAL BARANGAROO DEVELOPEMNT

Geotechnical Interpretative Report

Report reference: SYDGE287887-AN
15 November 2022

PREPARED FOR

Aqualand B Development Pty Ltd
Level 37, Australia Square, 264 George Street,
Sydney NSW 2000
ABN 73 169 346 810

PREPARED BY

Tetra Tech Coffey
Level 19, Tower B, Citadel Tower,
799 Pacific Highway
Chatswood
NSW 2067 Australia
p: +61 2 9406 1000
f: +61 2 9415 1678
ABN 55 139 460 521

QUALITY INFORMATION

Revision history

Revision	Description	Date	Authors	Reviewer	Approver
0	First Draft	16 Sep. 2022	P. Mackenzie, R Turner	P Wong	P Sethi
1	Final Issue	15 Nov.2022	P. Mackenzie, R Turner	P Wong	P Sethi

Distribution

Report Status	No. of copies	Format	Distributed to	Date
Rev 0	1	PDF	Victor Kardash	16 Sep.2022
Rev 1	1	PDF	Victor Kardash	15 Nov.2022

CONTENTS

1 INTRODUCTION 1
1.1 The Project 1
1.2 DA-2 Early Works 1
1.3 Tetra Tech Coffey Commission 2
1.4 Scope 2
2 SITE SETTING 3
2.1 Local Geology 3
2.2 Site History 4
2.3 Typical Barangaroo Ground conditions 4
2.3.1 Fill 4
2.3.2 Estuarine & Alluvium Sediments 4
2.3.3 Hawkesbury Sandstone 5
2.3.4 Shale Interbeds and Breccia 5
2.3.5 Groundwater 6
3 GEOTECHNICAL INVESTIGATION METHODOLOGY 6
3.1 Stage 1 Desk Study & Initial Ground Model 6
3.2 Stage 2 Gap Analysis & Planning 7
3.3 Intrusive investigation 7
3.3.1 Borehole Drilling 7
3.3.2 Cone penetrometer testing 8
3.3.3 Standpipe Piezometers 8
4 LABORATORY TESTING 9
4.1 Particle size distribution 9
4.2 Atterberg limits 9
4.3 point load index testing 10
4.4 Uniaxial compressive strength and young's modulus testing 12
4.5 Chemical laboratory testing 13
5 GEOTECHNICAL GROUND MODEL 14
6 HYDROGEOLOGY 17
6.1 Groundwater levels 17
6.1.1 Groundwater monitoring 17
6.2 Aquifer Parameters 19
6.3 Groundwater chemistry 20

6.4 Predicted Groundwater Inflows 20
6.4.1 Sydney Metro Barangaroo Station depressurisation 20
6.4.2 Groundwater inflow originating from outside the excavation 21
6.4.3 Dewatering of fill material inside the excavation 21
6.5 Groundwater Drawdowns Outside Excavation 22
7 GEOTECHNICAL CONSIDERATIONS 22
7.1 Buried Sandstone Cliffs 22
7.2 Shale Interbeds and Breccia 22
7.3 Faults and Dykes 22
7.4 Fill 23
7.5 Estuarine Deposits 23
7.6 Ground Anchors 23
7.7 Regional Rock Stresses 24
7.8 Basement Considerations 25
7.8.1 Diaphragm Wall 26
7.8.2 Secant Pile Wall 26
7.8.3 Significance of Buried Cliff Lines 26
7.9 Ground Anchors 27
7.10 Excavation Support in rock 27
7.11 Excavation Induced Ground Movements 28
7.12 Aggressivity to Concrete and Steel 29
8 GEOTECHNICAL DESIGN MODEL & PARAMETERS 30
8.1 Retaining Walls 30
8.2 Foundations 31
8.2.1 Shallow and Piled Footings 31
8.2.2 Barrettes 32
8.3 Ground Anchors 32
8.4 Passive tension piles and interaction with Sydney Metro Station 33
34
9 EXCAVATION & EARTHWORKS 35
9.1 Excavation Conditions 35
9.2 Estimation of Material Volumes 36
9.3 Earthworks 36
9.3.1 Subgrade Preparation 36
9.3.2 Re-Use of Existing Fill 36

9.3.3 Subgrade preparation and Engineered Fill construction 36
9.3.4 Working Platforms 37
9.4 Seismic Design 38
9.5 Liquefaction potential of Fill and Alluvial Soils 38
10 REFERENCES 39
10.1 Ground Investigation Data 39
10.2 Sydney Metro Reports 40
10.3 Other Sources 40
11 LIMITATIONS 40

LIST OF TABLES

Table 1 Summary of UCS and Young's Modulus Testing 12
Table 2 Groundwater chemistry / Aggressivity test results 13
Table 3 Summary of 2017 Soil Aggressivity Results 14
Table 4 Geotechnical Ground Model Input Data 15
Table 5 Assessment of Rock Face Support Requirements 28
Table 6 Geotechnical Parameters for Soil 30
Table 7 Geotechnical Parameters for Rock 30
Table 8 Geotechnical Parameters for Rock Foundations 31
Table 9 Recommended Bond Stresses for Ground Anchors 33
Table 10 Estimated Total Volume of Central Barangaroo Site 36

LIST OF FIGURES

Figure 1 Central Barangaroo Development Concept and Footprint 1
Figure 2 Site Geology from NSW Seamless Geology and Och et al. 3
Figure 3 Particle Size Distribution – Unit 2 Alluvial Sediments 9
Figure 4 Atterberg Limit Tests 10
Figure 5 Point Load Index Results 11
Figure 6 Uniaxial Compressive Strength and Modulus versus depth below bedrock surface 13
Figure 7 Groundwater level monitoring at BH02 18
Figure 8 Groundwater level monitoring at BH04 18
Figure 9 Groundwater level monitoring at BH06 19
Figure 10 Proposed stress relationships for different values of rock mass stiffness (Oliveira & Parker) 25
Figure 11 Appendix L of the Structures Interface Report (SMCSWSBR-MET-SBR-ST-REP-000032.C.INF.C.02 dated 11 Feb 2021) Showing First and Second Reserves in Plan 34
Figure 12 Typical Section Showing First and Second Reserves (from Figure 3 Appendix D of the Sydney Metro Station Protection Guidelines (SMCSWSBR-MET-SBR-ID-REP-000030.01.AFC.01.02) ..34

APPENDICES

APPENDIX A. BORE HOLE LOCATION PLAN 41

APPENDIX B. BORE HOLE ENGINEERING LOGS & CORE PHOTOGRAPHS 42

APPENDIX C. CONE PENETRATION TESTS 43

APPENDIX D. LABORATORY TEST RESULTS 44

APPENDIX E. LEAP FROG CONTOUR PLANS AND CROSS SECTIONS 45

APPENDIX F. 3D VISUALISATION (LEAP FROG) 46

APPENDIX G. PRELIMINARY INFLOW AND DRAWDOWN ASSESSMENT 47

APPENDIX H. STANDPIPE PIEZOMETER INSTALLATION DETAILS 48

APPENDIX I. IMPORTANT INFORMATION 49

ACRONYMS/ABBREVIATIONS/DEFINITIONS

Abbreviations / Term	Definition
Geotechnical Ground Model	An interpretation of the ground conditions beneath a site, including stratigraphy, materials and characteristics, based on the outcomes of specific geotechnical investigation and other available geotechnical information.
Geotechnical Design Model	A characterisation of the Geotechnical Ground Model that identifies particular soil and/or rock units that have similar origin and material properties that can be assigned representative parameters for strength and deformation for geotechnical design purposes.

1 INTRODUCTION

1.1 THE PROJECT

Aqualand B Development Holding Pty Ltd. (Aqualand) is the developer for the Central Barangaroo Development (CBD). Central Barangaroo comprises the remaining development blocks 5, 6 and 7 (about 2.6 hectares) of the approved Barangaroo Concept Plan. The Central Barangaroo Project is located to the west of Hickson Road on the Sydney Harbour waterfront between Barangaroo Reserve at Millers Point and the Barangaroo South precinct. The north east quadrant of the precinct is adjacent to the Sydney Metro Barangaroo Station currently under construction beneath Hickson Road.

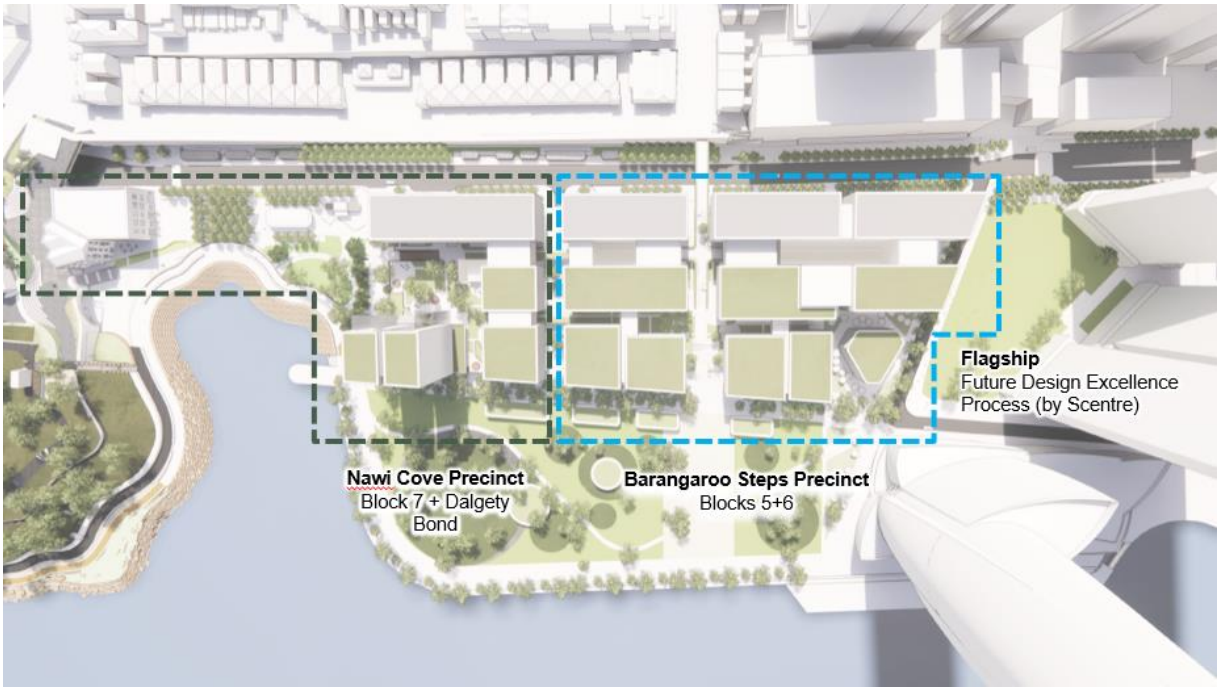


Figure 1 Central Barangaroo Development Concept and Footprint

1.2 DA-2 EARLY WORKS

This report relates to DA-2 Early Works – Additional Geotechnical Investigation for Geotechnical Design of Secant and Diaphragm walls for Basement Construction. The key components of the DA-2 Early Works consists of:

- Site establishment and construction of temporary working platform.
- Perimeter Retention Wall - Installation of secant pile and/or diaphragm walls.
- Bulk Excavation - Progressive bulk excavation and installation of temporary rock anchors and struts / and props, if required for basement construction.
- Remediation and Archaeological Investigations.
- Establish waterproof connection between DA1 Secant wall and Metro interface wall, as well as the waterproof connection between DA2 Diaphragm wall and the Metro interface north wall.
- De-watering.
- Rock bolting or other rock stabilization measures.

- Removal of the TSE piles at0 the Barangaroo Station / CBD interface.

For further details on the scope and staging of the works, reference should be made to the SSDA scoping document ref: P0038235, dated 01 July 2022.

1.3 TETRA TECH COFFEY COMMISSION

In June 2021 Tetra Tech Coffey (Coffey) submitted fee proposal reference SYDGE287887AA to provide initial desktop geotechnical design and groundwater assessments to support concept design and planning for the Central Barangaroo development. The work was planned as a staged approach as follows:

Stage 1: Desk Study - Using Coffey's local Barangaroo experience and existing site information by others, carry out initial geotechnical and hydrogeological design assessments to support design, planning and cost estimation works.

Stage 2: Additional Geotechnical Investigation - Using the Stage 1 assessments, design and conduct targeted geotechnical borehole and groundwater investigation to support detailed design and construction approvals process.

Stage 3: Detailed Design - Working closely with the project designers, carry out detailed geotechnical and hydrogeological design assessments to support final design and construction documentation.

The results of Stage 1 assessment were delivered in Coffey report reference SYDGE287887AB-Rev 1 dated 28 July 2022.

For Stage 2 geotechnical investigation, Coffey provided a budget fee (Coffey email of 10 February 2022) and issued a draft proposal for geotechnical investigations and preliminary geotechnical design of the diaphragm walls (refer to Aqualand Aconex correspondence ref: GCOR-000463, dated 24 May 2022). The scope was refined (at Aqualand's request for timing, access and current design status) by reducing the number of boreholes associated with foundation design but adding additional and/or deeper investigation for the site retention investigation. These amendments were incorporated into our fee proposal reference SYDGE287887AI-Rev2 dated 8 June 2022.

1.4 SCOPE

This Geotechnical Interpretative Report for Early Works DA-2 relates to Stage 2 investigation (refer Section 1.3) and involved the following:

- Gap Analysis - Identify gaps in the existing geotechnical information and provide advice on the scope, nature and costs of any additional geotechnical investigations required to undertake Diaphragm wall and foundation design.
- Additional geotechnical investigation works, and ground interpretation report based on the gap analysis. The targeted scope of additional investigations is 11 Boreholes and 3 Cone Penetration Test (CPTs).
- Update the existing Leap Frog Model following the completion of the additional site investigation and revise The Geotechnical Design Model.
- Prepare this geotechnical interpretative report and associated geotechnical recommendations for foundation and retaining wall design.

2 SITE SETTING

2.1 LOCAL GEOLOGY

The NSW Seamless Geology (Department of Planning, Industry and Environment, 2020) indicates the site is underlain by anthropogenic Fill, Recent and Quaternary sediments over Triassic age Hawkesbury Sandstone. Figure 2 displays the geology of the site and its surrounds.

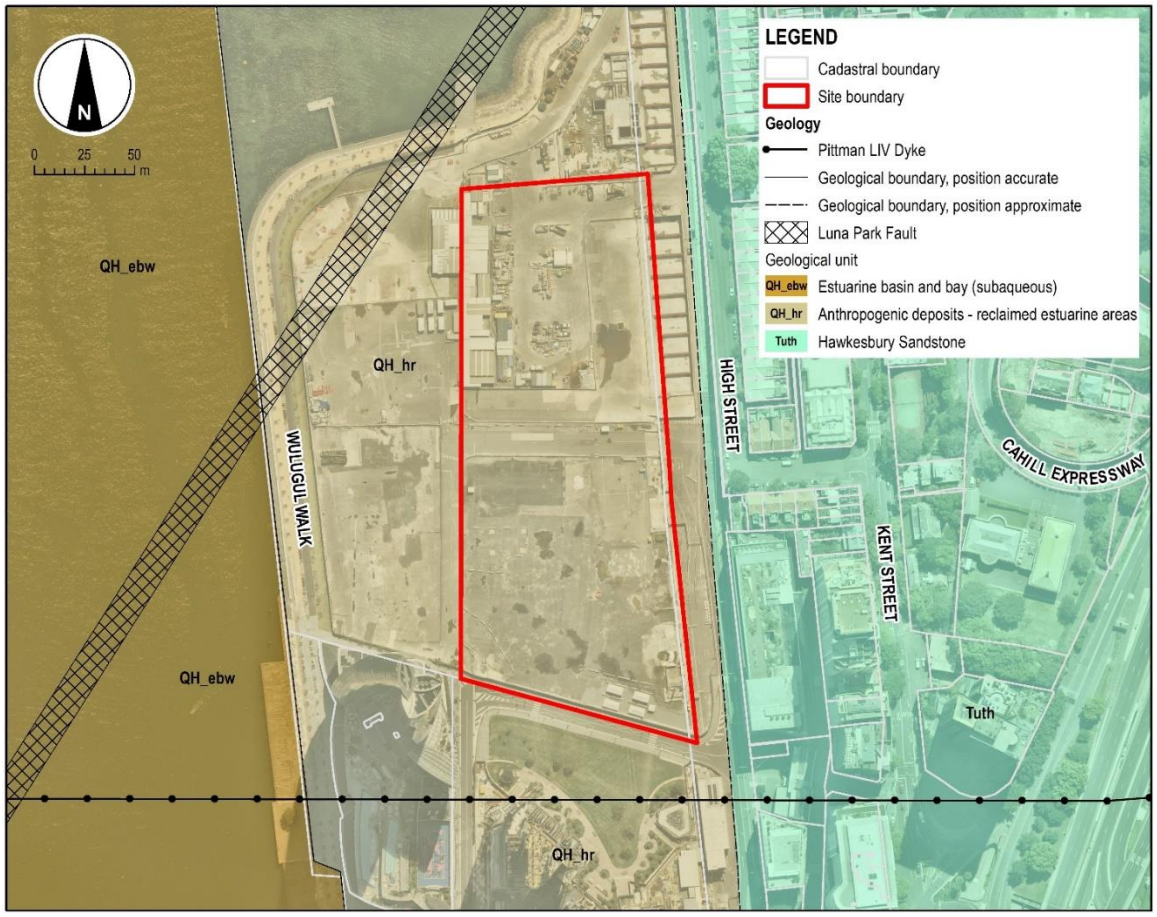


Figure 2 Site Geology from NSW Seamless Geology and Och et al.

The Jurassic age dolerite Pittman LIV dyke crosses in an east-west orientation to the south of Central Barangaroo. During excavation of Stage 1B, it was observed as an approximately 1.5 m wide subvertical extremely weathered dolerite dyke, dipping sub-vertically towards the south, with a smaller, possibly localised, 0.5 m wide stringer dyke roughly parallel to and south of the main dyke. The extremely weathered dolerite varied from very low in rock strength to soil strength. Jointed and iron-stained sandstone extended north of the dyke for about 2.5m.

The Luna Park Fault Zone is interpreted by Ochs et al (refer Section 2.3) to be aligned near the north-western corner of the harbour foreshore area. Within the Luna Park Fault Zone, sub-vertical joints spaced relatively closely (typically between 0.1m to 0.5m intervals) may be encountered. The sub-vertical joints may be clean, may be open 1 to 2 mm and contain clay infilling. The rock within the upper 15 m of the bedrock surface may be more weathered and lower strength than is typical of the surrounding rock. At depth, the rock may be more weathered than is typical of the surrounding rock. The fault zone is approximately 15 m wide.

Neither the Pittman LIV dyke nor Luna Park Fault Zone are expected to directly impact the Central Barangaroo basement, although secondary jointing and fracturing of the adjacent rock could potentially lead greater seepage inflow into the north-west corner of the site.

2.2 SITE HISTORY

The historical development of Central Barangaroo is mainly related to maritime industries and activities, the development and operation of which affected the physical form of the landform by reclamation and other changes to the shoreline and foreshore areas.

Most of the Central Barangaroo site was originally located below the water line, with the natural topography of the foreshore being very steep.

The nineteenth century development of this part of the harbour occurred around the northern and southern parts of the Barangaroo precinct. Whilst Central Barangaroo remained largely undeveloped, some shipyard development and wharf infrastructure extended into the central precinct.

By 1870, most of the foreshore between Dawes Point and Darling Harbour had been modified by quarrying, reclamation or the construction of seawalls, and the area was largely occupied by wharves, stores and commercial properties. Between 1880 and 1900, most of the wharves and other structures were demolished as part of the government resumption of the area.

Hickson Road was constructed c1912. These works included excavation of bedrock along the road alignment and major modification of the shoreline along the Central Barangaroo precinct.

The foreshore within the Central Barangaroo was partially reclaimed in the early twentieth century, and finger wharves were constructed c1912. By the 1950s, the finger wharves were obsolete. The areas between the wharves in the central and southern parts of the Barangaroo site were progressively infilled. Anecdotally, some of the historical timber wharves may remain within the fill.

2.3 TYPICAL BARANGAROO GROUND CONDITIONS

This section summarises generalised ground conditions that typically have been encountered in the Barangaroo foreshore locality.

2.3.1 Fill

Reclamation fill is highly variable in nature and thickness across the site and was placed during various phases of reclamation and filling that have occurred over the past 115 years. As a result, the fill material is heterogeneous, typically uncontrolled and difficult to characterise. The fill is known to contain deleterious materials, large hard inclusions such a boulders and rubble, and has a potential for near surface voids.

The Fill is generally continuous across the site.

2.3.2 Estuarine & Alluvium Sediments

Below the fill there is both alluvial and estuarine sediments occurring as pre-existing channel infills and coastal marine deposits around the pre-development Darling Harbour/Barangaroo foreshore area. The deeper Quaternary sediments are inferred to have been deposited during the last glacial period, or Pleistocene (approximately 120,000 years to 10,000 years ago) when sea level oscillation of between RL -20 m AHD and -120 m AHD occurred.

During periods of lower sea level, river systems incised into the underlying bedrock, and existing sediments became exposed and oxidised, causing Pleistocene sediments to exhibit red and orange hues. These

Pleistocene sediments are typically over consolidated and of higher density/consistency that the overlying Holocene sediments (from approximately 10,000 years ago).

By nature of the periodic deposition and erosion, both the Estuarine and Alluvium Sediments tend to be thinly layered and discontinuous across the Barangaroo Precinct.

Estuarine Sediments

Clay dominated deposits represent the broad lagoon/estuarine type environments associated with elevated sea levels, while the sand units represent higher energy fluvial deposits associated with lower sea levels.

During the following Holocene Epoch to the present, sea levels rose to the current level, submerging the eroded land surface and incised river valleys. These relatively recent sediments are generally normally consolidated, typically of soft/loose consistency/relative density and are often dark grey.

Where encountered in earlier Barangaroo stages, estuarine sediments are typically dark grey to black silty/sandy clays with subordinate clayey sands. They typically contain shells and shell fragments and organic material. Organic/peaty clay horizons may be present.

Alluvial Sediments

In addition to sediments deposited from the sea, there are sediments deposited from erosion of the neighbouring sandstone 'highland'. Where encountered in earlier Barangaroo stages, these soils are generally clayey sand with subordinate and interbedded silty clays and sandy clays, of medium dense to dense relative density and typically brown, orange brown, red brown and yellow.

2.3.3 Hawkesbury Sandstone

Due to the erosional deposition history of the overlying alluvial deposits, residual soil is generally absent and where present is typically less than 1 m thick.

The Hawkesbury Sandstone is typically a fine to coarse grained quartzose sandstone deposited in 1m to 5m thick beds and lenses that exhibit either massive or sheet facies. Shale breccia lenses and bands are common at the contacts between beds, with siltstone/shale interbeds forming a minor part of the unit. In some cases, these minor shale bands weather preferentially to form softer bands.

Structurally, there are two main joint sets within the Hawkesbury Sandstone in the Sydney CBD region: one set trending north-north-east and an orthogonal set trending west-north-west. The joints are typically sub-vertical, relatively widely spaced and may not be continuous through the sandstone beds. Vertical joints often terminate in shale bands. There are a number of sub-vertical fault zones (such as the Luna Park Fault to the north of the site) and joint swarms that have been identified trending roughly north east across the Sydney CBD that can result in more closely spaced jointing and may impact on excavation stability to a greater extent than the more widely spaced joints of the main joint sets.

The sub-horizontally bedded sandstone is inferred to step down towards Darling Harbour in a series of buried cliffs and possible overhangs paralleling the natural shoreline geometry. Quarried vertical sandstone faces also occur immediately east of Hickson Road, as noted in the site history below.

2.3.4 Shale Interbeds and Breccia

During the deposition of the Hawkesbury Sandstone, areas of overbank flooding and back swamps have resulted in present day discrete siltstone and shale bands within the sandstone beds. Often these beds are non-persistent, extending over relatively short lateral distances. Break up of these beds during consolidation has resulted in zones of mixed shale and sandstone (Shale Breccia). These zones can result in areas of higher strength bedrock, but also areas of poor resistance when exposed to the atmosphere.

2.3.5 Groundwater

In 2017, groundwater levels were measured at the site at elevations between 0.6 mAHD to -0.6 mAHD. Groundwater levels are expected to vary due to tidal influence. The Mean High Water Spring level is about 0.62 mAHD and the Mean Low Water Spring (MLWS) level is at -0.7 mAHD.

3 GEOTECHNICAL INVESTIGATION METHODOLOGY

3.1 STAGE 1 DESK STUDY & INITIAL GROUND MODEL

During Stage 1, Coffey prepared an initial geotechnical desk study and developed a preliminary 3D Leapfrog ground model. This was used to provide preliminary geotechnical design advice and identify data gaps in the existing site geotechnical information. The principal information sources for the initial Leapfrog model were:

1. Douglas Partners (2017) Geotechnical Investigation - Central Barangaroo - Block 7 Hickson Road Barangaroo – prepared for Grocon (CB) Developments Pty Ltd – Project 71723.18 August 2018. Block 7 occupies the northern third of Central Barangaroo. The investigation comprised:
    - 10 boreholes (BH1001 to BH1010) cored into rock, located mainly around the Block perimeter;
    - 5 cone penetration tests in the western half of the Block (3 near the central east-west axis and 1 at each of the northern and southern ends)
    - associated field and laboratory testing.
2. Golder/Douglas Borehole logs (2020) for boreholes SRT_BH070 to SRT_BH073, SRT_BH034, SRT_BH034 and SRT_BH077 and (2015) SRT_BH013 and SRT-BH014, located along the Sydney Metro alignment near Hickson Road in Millers Point. Of the provided borehole logs, BH013, BH072, BH035 and BH073 were located near Block 7.

The borehole and CPT data were reviewed and imported into Seequent's Leapfrog Works (V 2021.1.2) software to create a 3-dimensional model of the site. The data was rationalised to be consistent across the stages of investigations and checked for its geological sense. Boreholes were manually classified using the Pells et al rock classification[1] system. From this, preliminary unit boundary surfaces across the Central Barangaroo site were developed for the following geotechnical units:

- Fill;
- Sediments (Estuarine and Alluvium);
- Residual Soil;
- Sandstone Class V;
- Sandstone Class IV;
- Sandstone Class III;
- Sandstone Class II or better.

The outcomes were reported in Tetra Tech Coffey "Preliminary Desk Top Geotechnical Modelling Report" reference SYDGE287887AB-Rev 1 dated 28 July 2022.

In brief the model suggested that:

- Along the eastern (landside) boundary there was 2 to 6 m thickness of Fill extending from 3 mAHD to -3 mAHD, then thin layers of other Units, with top of sandstone encountered between -2 mAHD and -12 mAHD.

[1] Pells PJN, Mostyn G, Bertuzzi R, Wong PK (2019). Classification of sandstone and shales in the Sydney region: A Forty Year Review.

- Along the western (harbourside) boundary there was about 14 m thickness of Fill extending from about -2 mAHD to -12 mAHD, underlain by Unit 2 Sediments up to 10m thick, then thin layers of other Units, with top of Unit 4D sandstone encountered between -22 mAHD and -25 mAHD.
- Along the northern and southern boundaries, the thicknesses of Fill and Sediments increased from east to west, and RL of top of Unit 4D sandstone decreased from east to west.

3.2 STAGE 2 GAP ANALYSIS & PLANNING

During Gap Analysis, some amendments were made to the scope of work planned at issue of our fee proposal:

- It was noted that some boreholes used to develop the Stage 1 ground model did not extend deep enough to encounter Class II or better sandstone. Consequently, some planned boreholes were shifted and or deepened.
- Some boreholes were also shifted to avoid the Live Anchor Exclusion Zone around Barangaroo Station Box.
- The field investigation was amended to include cone penetrometer testing. This, together with the use of sonic drilling methods, provided improved assessment of soil type strength and deformation characteristics.
- The above reduced the need for laboratory classification testing of soils so these were omitted from the programme to offset costs.
- To optimise field investigation time, in particular the CPT testing in Alluvium, groundwater pressure (packer) testing was removed from the programme, since such testing had been conducted by Douglas for Block 7 and Coffey's significant past experience gained from the other Barangaroo precincts.

3.3 INTRUSIVE INVESTIGATION

3.3.1 Borehole Drilling

During July 2022, 11 boreholes were drilled vertically to depths ranging from 20.57 m to 45.5 m, and RL's ranging from -18.17 to -43.0 mAHD. Borehole locations are shown on in Appendix A.

Appendix B presents the engineering borehole logs and core photographs, together with soil and rock description explanation sheets.

Drilling rigs owned and operated by a specialist geotechnical drilling contractor were mobilised to the site for the drilling campaign. The boreholes were drilled using sonic equipment where the high frequency sonic head delivers vibration waves down the drill string to the bit, causing liquification of the soil/rock immediately around casing or drill string, and enabling entrapment of near continuous disturbed soil samples.

Engineering Geologists and Geotechnical Engineers from Coffey were in full time attendance on site during the drilling. The Coffey personnel were responsible for positioning of the boreholes, logging of the boreholes and direction of in-situ testing and sampling. Water levels were measured during the drilling process (where possible) and are presented on the borehole logs. This method allows near continuous disturbed sampling of the soil and rock penetrated.

Steel casing was installed through the soil profile to the surface of bedrock prior to coring to prevent the collapse of holes. All boreholes were drilled using town water and advanced through rock using triple barrel HQ sized drilling techniques.

Rock core was placed in purpose built steel boxes with one metre of core per row. The Coffey site representative logged and photographed the core on site. The engineering borehole logs were prepared using the commercially available gINT software, Edition 10.03.00.09 provided by gINT Software, Inc. California, USA.

Point Load Strength Index testing of rock core samples was undertaken at approximately 1m spacing, with both diametral and axial tests conducted where possible. The results of the point load strength index tests are presented on the engineering logs.

Three boreholes were completed as standpipe piezometers, sealed in a lockable flush mounted gatic cover. On completion of the drilling a concrete plug was placed at the surface of each of the boreholes, apart from those completed as standpipe piezometers.

3.3.2 Cone penetrometer testing

Four cone penetrometer tests (CPT) were conducted besides BH2, BH4, BH5 and BH7. The depths ranged from 18.89 m to 20.97 m. The CPT logs are provided in Appendix C.

Morooka MST-800VD track mounted CPT rig was used to undertake the CPT testing.

3.3.3 Standpipe Piezometers

BH2, BH4 and BH6 were completed as standpipe piezometers. 50mm diameter PVC standpipes were installed to varying depths with a 6m slotted section and gravel pack filter with an upper bentonite seal targeting specific strata of interest. All vertically drilled standpipes were constructed within the fill material. Standpipe piezometers were completed with a lockable 300mm diameter gatic cover.

Continuous water level loggers were installed in three piezometers (BH02, BH04 and BH06), with the instrumentation set to record levels at hourly intervals. Refer to Sections 4 and 6 of this report for geotechnical laboratory testing and groundwater monitoring results, respectively.

Soil samples and selected rock samples were dispatched for testing in NATA accredited geotechnical laboratories for the following tests to be undertaken:

- Uniaxial Compressive Strength Testing with Deformation Parameters
- Atterberg Limits
- Particle size distribution
- Water Aggressivity (pH, Cl, electrical conductivity and SO4)

Laboratory testing results and Standpipe Piezometer installation details are presented in Appendices D and H, respectively.

4 LABORATORY TESTING

The results of laboratory testing are presented in Appendix D and discussed in the following sections.

4.1 PARTICLE SIZE DISTRIBUTION

Four samples from Unit 2 alluvial sediments were subjected to Particle Size Distribution (PSD) testing during the investigation. The following Figure 3 presents the results of the current investigation PSD testing combined with the PSD results from the Douglas Partners 2017 investigation, with the 2017 results presented in black. The results typically fall within the boundaries of the previous PSD curves indicating the unit 2 material to be mainly a clayey sand.

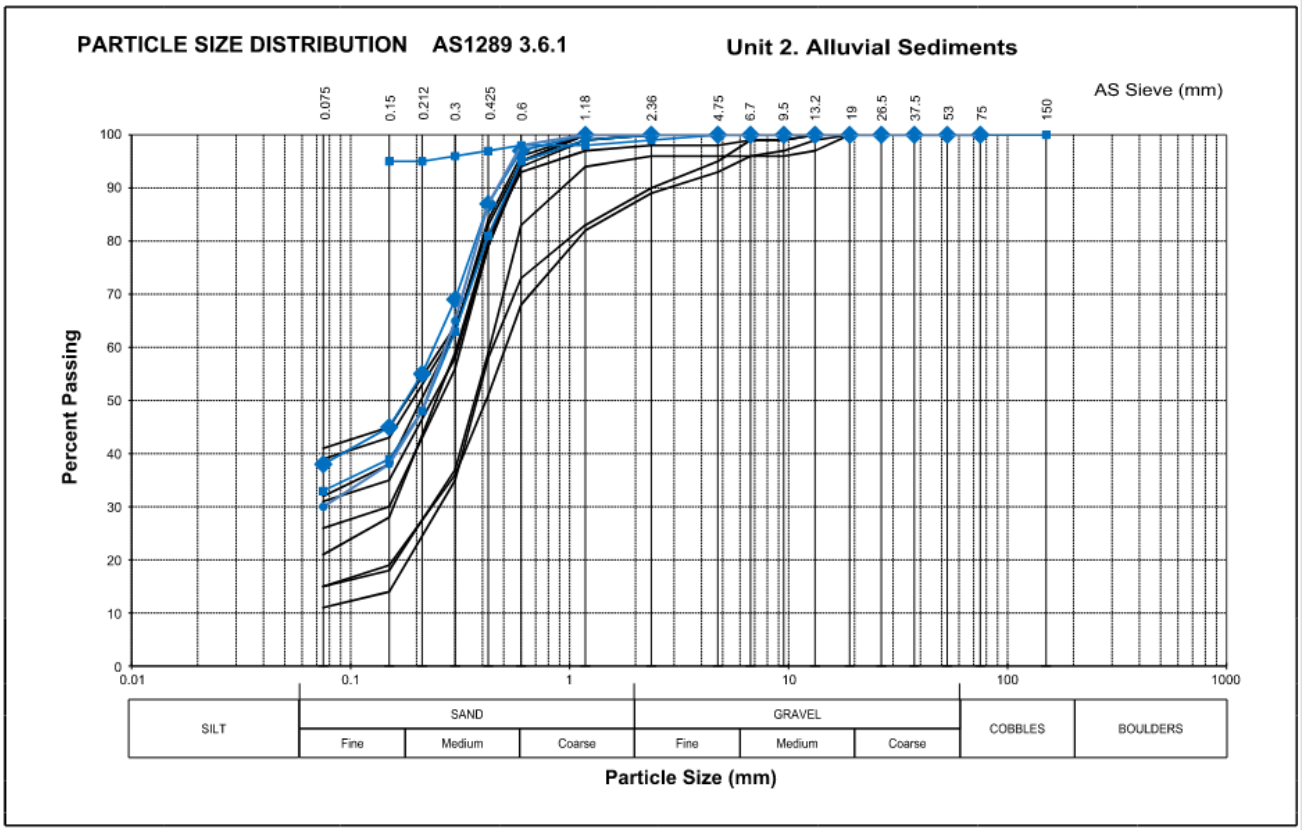


Figure 3 Particle Size Distribution – Unit 2 Alluvial Sediments

4.2 ATTERBERG LIMITS

A total of four Atterberg Limit tests were carried out on selected samples from the Unit 2 alluvial sediments. The results are presented on the Casagrande plasticity chart in Figure 3 below. Additionally, Figure 4 includes the Atterberg Limit tests for the Alluvial Sediments from the Douglas Partners 2017 investigation, the 2017 results are presented in black. The results show that the fines content of the alluvial sediments fall within the CL – CI classification, indicating they are of low to medium plasticity.

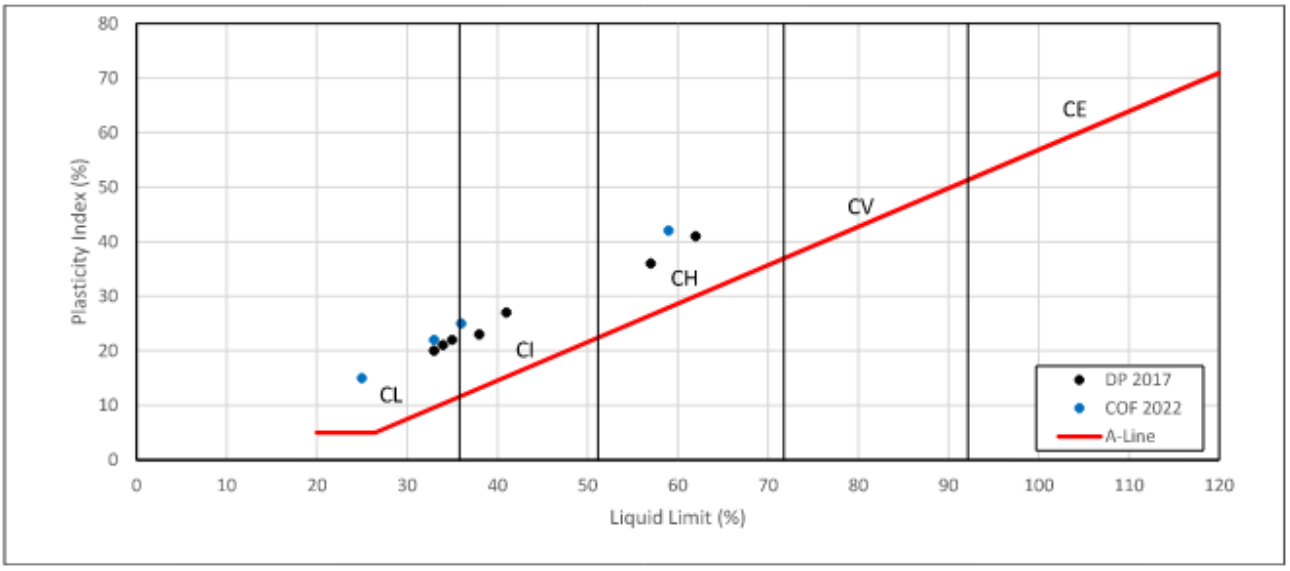


Figure 4 Atterberg Limit Tests

4.3 POINT LOAD INDEX TESTING

The following Figure 5 presents a review of the axial and diametral Point Load Strength Index test results on core samples recovered from the recent Coffey ground investigation campaign. The graph presents the results of the point load index testing below the top of bedrock. The test results indicate a general increase in strength of the sandstone from the bedrock surface, reaching a typical maximum value at approximately, 5 m.

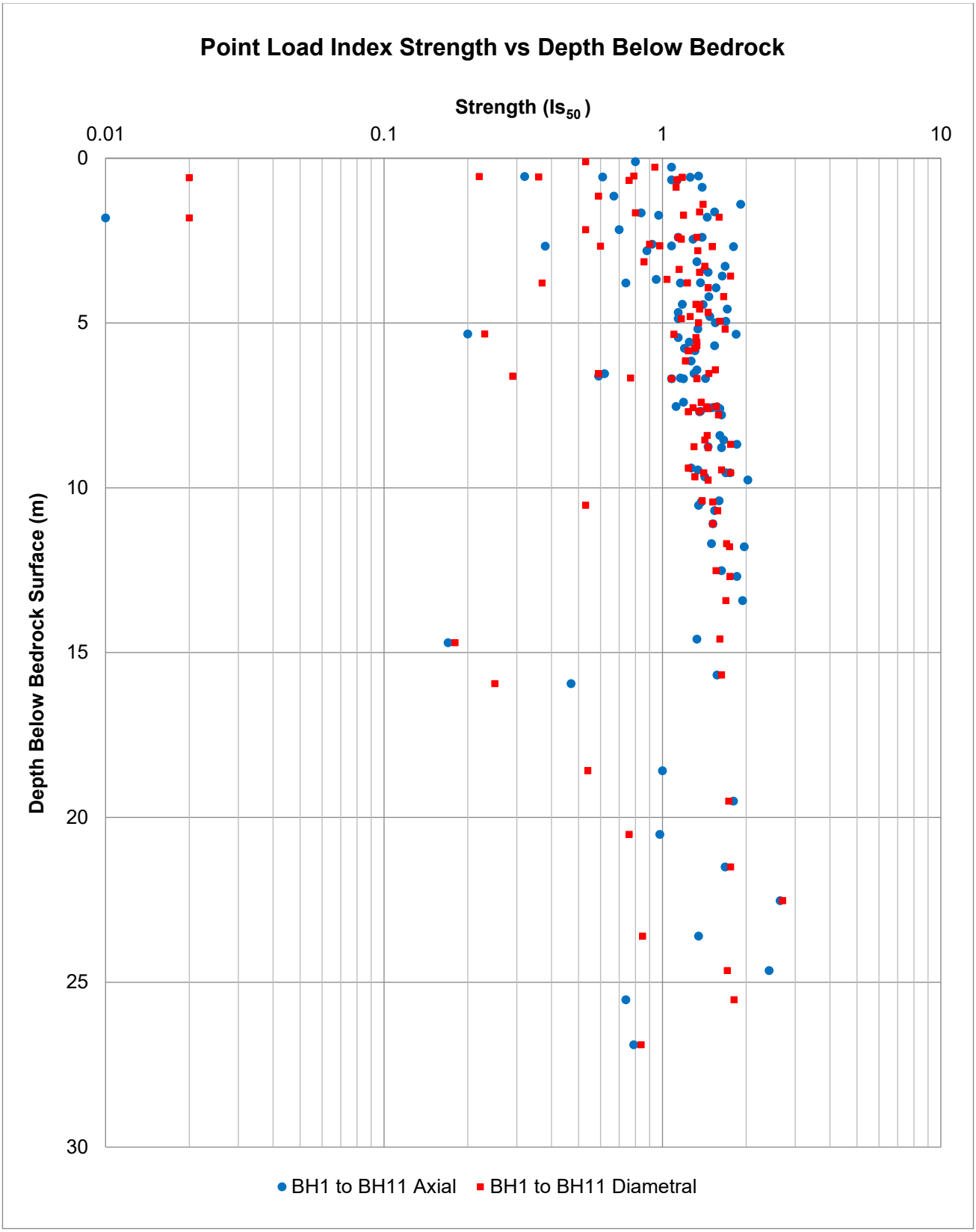


Figure 5 Point Load Index Results

4.4 UNIAXIAL COMPRESSIVE STRENGTH AND YOUNG'S MODULUS TESTING

During the recent Coffey investigations five samples of rock core were submitted for Uniaxial Compressive Strength (UCS) testing as well as an assessment of Young's Modulus.

Table 1 summarises the results of the UCS and Young's Modulus test results on intact rock samples. It should be pointed out that the rock mass modulus will be lower than the intact modulus due to the presence of defects within the rock mass.

Table 1 Summary of UCS and Young's Modulus Testing

Bore Hole	Depth (m)	Uniaxial compressive strength (MPa)	Tangent		Secant	
			Young's (GPa)	Poisson's ratio	Young's (GPa)	Poisson's ratio
BH 1	16.55 16.73	13	1.7	0.24	1.3	0.21
BH 4	23 – 23.22	16	3	0.14	1.3	0.12
BH 5	23.25 – 23.48	16	2.6	0.16	1.1	0.13
BH 6	24.8 – 25.0	23	5.1	0.13	2.4	0.11
BH 7	22.56 – 22.78	23	6.7	0.18	3.4	0.16

Figure 6 presents a graph of the UCS and Young's Modulus test results against depth below the bedrock surface.

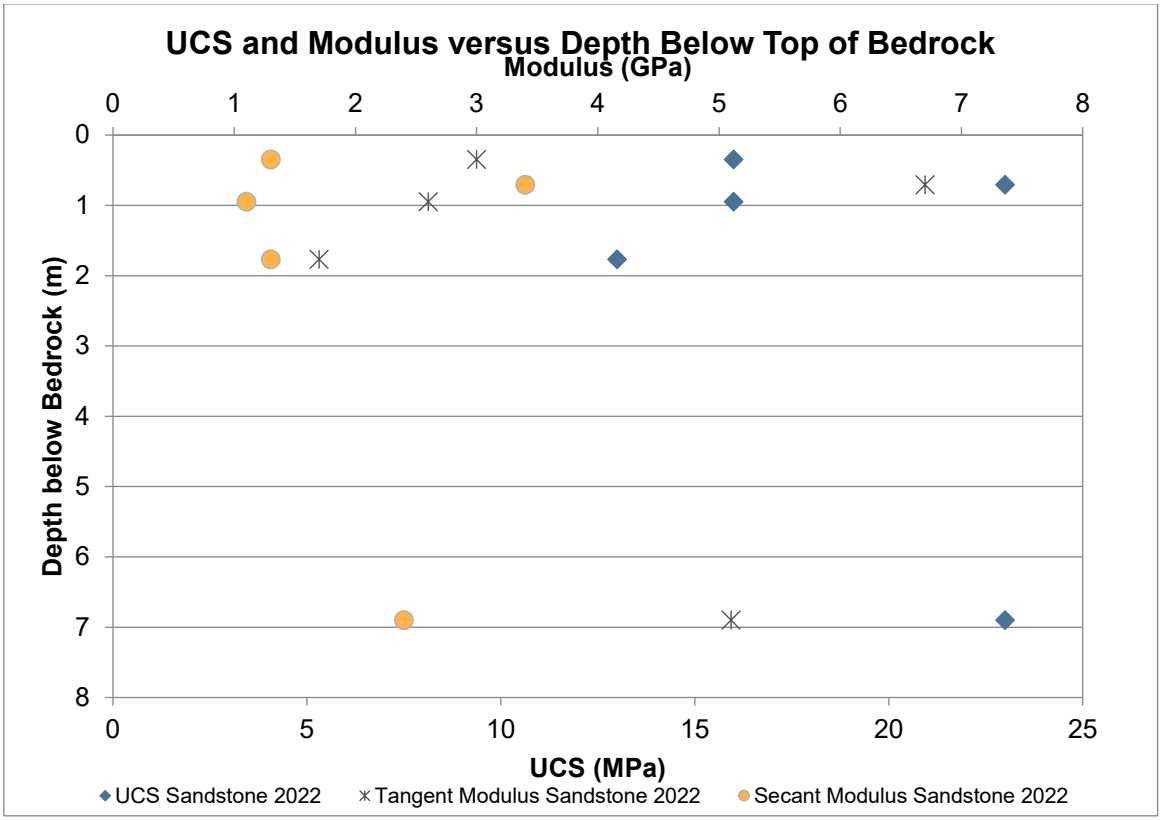


Figure 6 Uniaxial Compressive Strength and Modulus versus depth below bedrock surface

4.5 CHEMICAL LABORATORY TESTING

Water quality samples were taken on 7 September 2022 from BH2, BH4 and BH8. Water samples were sent to NATA accredited laboratory ALS, and tested for the following:

- pH
- Electrical conductivity (EC)
- Sulfate
- Chloride

The testing results are presented in Table 2 below.

Table 2 Groundwater chemistry / Aggressivity test results

Analyte / Test	Unit	Sample date	BH02	BH04	BH06
pH value	pH	7 September 2022	7.94	7.85	7.01
Electrical Conductivity	µS/cm	7 September 2022	8060	24600	17800
Sulfate	mg/L	7 September 2022	398	931	933
Chloride	mg/L	7 September 2022	2000	7950	5870

The Douglas Partners 2017 report included aggressivity tests conducted on eight soil samples from the Unit 2 alluvial sediments, these are summarised in Table 3 below and were included in the aggressivity assessments of the soil to buried structural elements. The results are summarised and presented including statistical analyses.

Table 3 Summary of 2017 Soil Aggressivity Results

Result	No. of Tests	pH	Sulphate, SO_4 (mg/kg)	Chloride, Cl (mg/kg)	Conductivity, EC (µS/cm)	Resistivity[1.] (ohm.cm)
Min – Max	8	5.3 – 8.9	83 – 470	720 – 2100	780 – 1700	588 – 1282
Average	8	7.6	216	1601	1423	751
+/- 1 SD[2.]	8	6.6 – 8.7	103 – 328	1114 –2088	1110 – 1735	528 – 974

Notes:

1. Resistivity values calculated from conductivity test results using the relationship that electrical conductivity is the reciprocal of electrical resistivity.
2. +/1 1SD, range calculated from the average minus 1 standard deviation to the average plus 1 standard deviation.

5 GEOTECHNICAL GROUND MODEL

The interpretation of the current site borehole and CPT data is summarised in Table 4 overleaf. The rock classifications assigned are interpretative based on review of rock core for Coffey boreholes and review of bore logs and core photographs for boreholes logged by others. In Table 4, **BH1 to BH11** are Coffey boreholes (2022), ***BH13, BH35, BH72*** and ***BH73*** are Golder/Douglas boreholes (2020) and ***BH1001*** to ***BH1010*** are Douglas Partner boreholes (2017).

From ground model information presented in Table 4, certain characteristics become evident:

- Estuarine soils in this locality are largely absent or occur as very thin layers. To simplify the geotechnical ground and design models, the Estuarine soils have been included in the Fill unit.
- Residual Soil and Class V Sandstone occur as discontinuous thin layers. Since these materials are similar in origin and characteristics, they have been incorporated into a single Unit for ground and design models.

The updated Stage 2 Leapfrog 3D geotechnical model reflects these amendments. The Stage 2 model has been used to generate interpreted contour levels for the top of various units and interpreted geotechnical sections along the various diaphragm wall alignments. This output is compiled in Appendix E.

The ground surface adopted in the Leapfrog model was generated from a LIDAR survey conducted prior to 2021. At this time, open excavations were present at the Barangaroo Metro Station, One Sydney Harbour and the remediation works near the sewage pump station located at the south-eastern corner of the CBD site. These excavations can be seen in the 3D visualisations included in Appendix F. These surfaces affect the generation of sections along the boundaries adjacent to the excavations. The sections presented in Appendix E have been corrected by either modifying the section line or manually in post-production where it was not possible to remove the excavation impacts. This has been noted to inform potential users of the digital Leapfrog data when importing into other models

Table 4 Geotechnical Ground Model Input Data

Unit	Material	Typical Description	Inferred Upper Surface of Material - RL (mAHD)													
			BH1	BH2	BH3	BH4	BH5	BH6	BH7	BH8	BH9	BH10	BH11	***BH013***	***BH072***	***BH035***	***BH073***
1	Fill	Variable soils, boulders, building rubble and timber	2.4	2.5	2.3	2.8	2.3	2.2	2.6	2.4	2.3	2.4	2.4	3.0	2.6	3.0	2.4
2	Estuarine	Variable soft clays/clayey sands and/or loose sands	NE Note 1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Alluvium	Stiff clays and loose to medium dense sands/clayey sands	-8.2	-12.5	-13.1	-10.5	-10.9	-11.7	-12.6	-6.6	-10.2	-11.4	-11.5	-2.3	NE	-2.3	-3.6
3	Residual Soil	Very stiff/hard clay and XW sandstone.	-11.3	-16.8	-31.1	-18.8	-20.0	NE	-18.7	-12.0	-12.0	-13.7	-14.4	NE	NE	NE	NE
4A	Sandstone Class V	XW and HW, very low strength, with clay seams	NE	NE	NE	NE	NE	NE	NE	NE	NE	-14.3	NE	NE	NE	NE	NE
4B	Sandstone Class IV	HW and MW, low or medium strength, often with closely spaced defects,	NE	NE	-32.0	NE	NE	NE	NE	NE	NE	NE	-15.5	-4.0	-2.6	-4.0	-5.3
4C	Sandstone Class III	MW to fresh, medium or high strength, with moderately spaced defects and/or shale breccia	-12.7 Note 2	-19.7	-33.7	-19.9	-20.4	-21.5	NE	-12.5 Note 3	-13.7	-16.3	NE	NE	-4.4	NE	-5.8
4D	Sandstone Class II or better	Slightly weathered to fresh, medium or high strength, with widely spaced defects	-18.6	-20.8	-35.1	-20.2	-22.7	-23.2	-19.5	-17.0	-14.3 Note 4	-19.1 Note 5	-17.0	-5.2	-5.4	-5.2	-7.4
-	Base of BH		-22.0	-26.8	-43.0	-28.2	-26.7	-28.0	-27.4	-18.2	-28.1	-30.9	-29.6	-28.4	-22.8	-28.4	-12.6

Notes:

1. NE = Not encountered in borehole
2. Includes medium strength shale breccia from-17.7 to -18.6 mAHD
3. Some sandstone in this unit is better than Class III in terms of strength and defects, but its engineering performance may be affected by medium strength shale breccia inclusions that occur between -16.2 and -17 mAHD.
4. Includes medium and high strength shale breccia and siltstone between -18.5 and -19.8 mAHD.
5. This unit includes about 1.1m of low/medium strength sandstone underlain by 1.7 m thickness of high strength sandstone with moderate defects underlain by 1.1 m thickness of medium strength shale breccia with moderate defects.

Table 4 Geotechnical Ground Model (Continued)

Unit	Material	Typical Description	Inferred Upper Surface of Material - RL (mAHD)									
			BH1001	*BH1002 A*	*BH1003*	*BH1004*	*BH1005*	*BH1006*	*BH1007*	*BH1008*	*BH1009*	*BH1010*
1	Fill	Variable soils, boulders, building rubble and timber	2.5	2.4	2.4	2.4	2.3	2.8	2.2	2.6	2.6	2.7
2	Estuarine	Variable soft clays/clayey sands and/or loose sands	-3.5	NE	NE	-3.1	NE	NE	-2.5	NE	-8.4	NE
	Alluvium	Stiff clays and loose to medium dense sands/clayey sands	NE	-11.3	-12.1	NE	-11.9	-12.7	-4.3	-11.6	-8.9	-11.7
3	Residual Soil	Very stiff/hard clay and XW sandstone.	-4.2	NE	NE	-4.6	-18.2	-16.2	NE	-15.2	NE	-12.6
4A	Sandstone Class V	XW and HW, very low strength, with clay seams	NE	-12.8	-19.5	-6.1	-19.7	NE	NE	-18.5	NE	NE
4B	Sandstone Class IV	HW and MW, low or medium strength, often with closely spaced defects,	-6.3	NE	-21.8	NE	NE	-17.7	NE	-19.1	NE	-16.8
4C	Sandstone Class III	MW to fresh, medium or high strength, with moderately spaced defects and/or shale breccia	-6.9	-16.5	NE	-6.7 Note 7	-20.2	NE	-5.3	-21.0	-11.1	-18.8
4D	Sandstone Class II or better	Slightly weathered to fresh, medium or high strength, with widely spaced defects	-10.0	-17.0	-25.8 Note 6	NE	-21.3	-19.2	-7.2	-22.4	-14.2	-20.3
-	Base of BH		-13.6	-22.8	-27.45	-13.1	-26.4	-32.8	-14.0	-26.0	-18.4	-25.2

Notes

6. High strength siltstone breccia/clasts between -25.2 to -25.8 mAHD
7. From about -7 mAHD, this borehole encountered mainly medium strength Class III Sandstone based on defect spacing, with high strength sandstone between -9.3 and -10.8 mAHD, and medium strength shale at -12.8 to -13.1 mAHD

6 HYDROGEOLOGY

The following reports provided by Aqualand provide information on previous hydrogeological conditions around the Central Barangaroo development site.

- Douglas Partners, “Report on Geotechnical Investigation, Central Barangaroo-Block 7, Hickson Road, 0Barangaroo”, dated August 2017 (Douglas 2017).
- Metron, “Geotechnical Interpretive Report System Wide, Stage 1 Design, Underground Station Design and Technical Services for Sydney Metro” dated 31 Jan 2018 (Metron 2018).

6.1 GROUNDWATER LEVELS

Douglas 2017 reported groundwater levels at the site at elevations between 0.65 mAHD to -0.61 mAHD with an average of about 0.2 mAHD. Given the close proximity to the harbour, groundwater levels are expected to vary due to tidal influence. The Mean High Water Spring (MHWS) level (or average high tide level) is at about 0.62 m AHD and the Mean Low Water Spring (MLWS) level is at -0.7 mAHD. It is anticipated that groundwater outside the development will fluctuate between approximately -1.0 m AHD to 2 mAHD during construction under the influence of tides and rainfall.

Metron 2018 reported groundwater levels in piezometers near Barangaroo Station had monitored groundwater levels during late 2016 to early 2017. The highest groundwater level of 1.9 mAHD was observed in piezometer SRT_BH080A, located to the immediate west of the station box, with the groundwater levels in that piezometer showing a strong tidal response.

Based on a report by Arup, *Climate Change and Sea Level Rise Report*, Dated June 2010, a long-term design groundwater level of RL 2.575 mAHD has been adopted. This is understood to include allowance for sea level rise, tide and storm surge effects, and is approximately equal to the ground surface at these locations.

6.1.1 Groundwater monitoring

Groundwater level monitoring equipment has been installed at monitoring piezometers BH2, BH4 and BH6. Figures 7 to 9 present the results of groundwater level monitoring at these piezometers during August and early September 2022.

To illustrate the tidal response in groundwater levels at BH4 and BH6, tidal predictions for Fort Dennison in Sydney Harbour are included for 12 August to 22 August (source: Bureau of Meteorology).

Groundwater levels in BH04, approximately 115 m from the harbour, moved within a range having a magnitude of approximately 9% of the magnitude of the corresponding tidal water level range at Fort Dennison on 12 August 2022. This percentage may be named a ‘tidal efficiency’. For BH6, approximately 40 m from the harbour, the tidal efficiency was approximately 44% and 55% of tidal water levels at Fort Dennison on 12 August 2022 and 19 August 2022 respectively.

There is negligible tidal response evident at BH2. A decrease in the groundwater level of approximately 0.8 m between 1 August and 7 September observed at this location indicates the potential influence of groundwater drawdown to nearby underground structures such as basement carparks and the current dewatering associated with construction of the Sydney Metro Barangaroo Station.

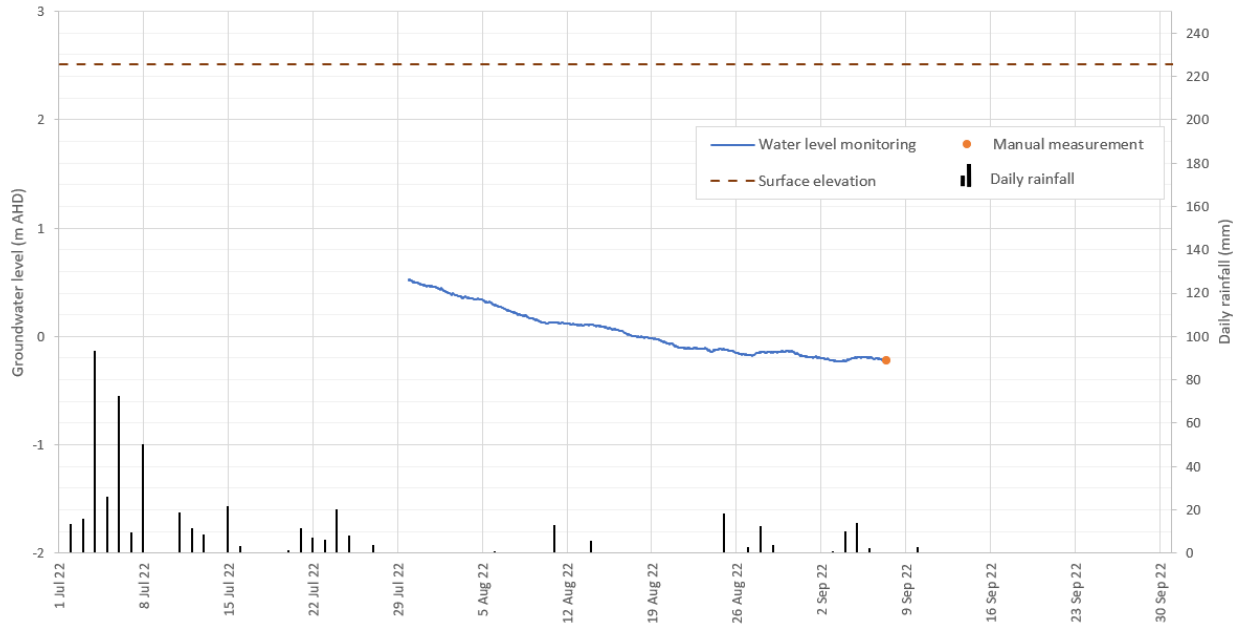


Figure 7 Groundwater level monitoring at BH02

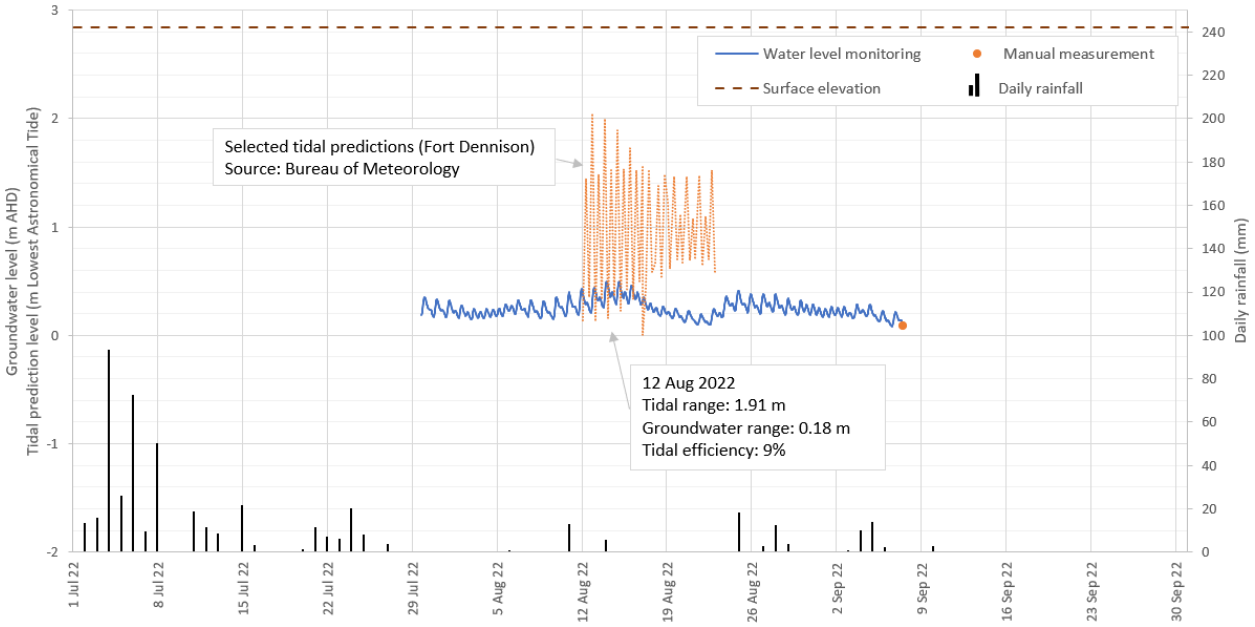


Figure 8 Groundwater level monitoring at BH04

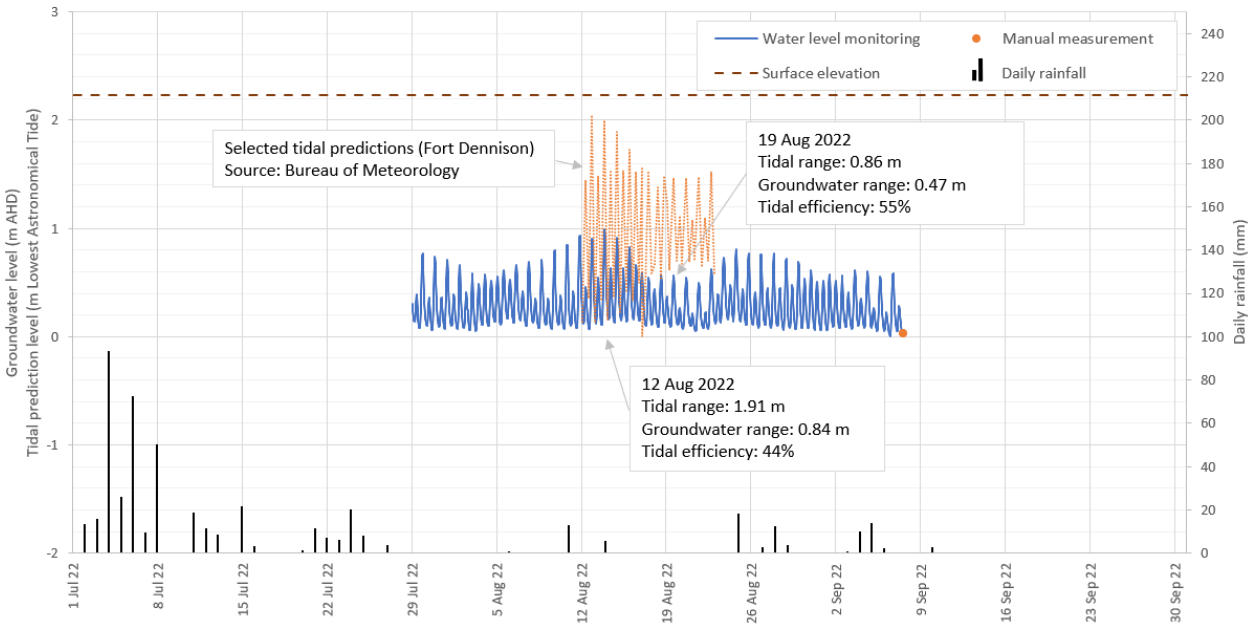


Figure 9 Groundwater level monitoring at BH06

6.2 AQUIFER PARAMETERS

Groundwater monitoring at Coffey boreholes, BH04 and BH06, as described in Section 6.1.1, indicates tidal response in groundwater levels at both of these boreholes, with a tidal efficiency of approximately 9% at BH04 (115 m from the harbour) and a tidal efficiency of approximately 50% at BH06 (40 m from the harbour).

For homogeneous aquifers with horizontal extent much larger than vertical extent, it has been shown by Edelman (1972) that tidal efficiency in groundwater decreases exponentially with distance from the tidal source. The discussion presented by Edelman (1972) Section 5.2.1 can be used to derive a hydraulic conductivity value from the observations of tidal efficiency in groundwater at BH04 and BH06 as follows:

$$Tidal\ efficiency = e^{ax}\ (dimensionless)$$

where:

x	$Distance\ from\ tidal\ source\ (m)$
$a = \sqrt{0.5\ S_S\ \omega\ k^{-1}}$	$Tidal\ efficiency\ distance\ factor\ (m^{-1})$
Ss	$Specific\ storage\ of\ aquifer\ (m^{-1})$
$\omega = \frac{2\pi}{44700}$	$Tidal\ circular\ frequency\ (s^{-1})$
k	$Horizontal\ hydraulic\ conductivity\ (m/s)$

The observations at BH04 and BH06 result in tidal efficiency distance factors of a = 0.02 at BH04 and a = 0.017 at BH06. Taking the average of these, a = 0.0185, and assuming a specific storage of the fill aquifer of 1 x 10^{-4} m^{-1} the assessed hydraulic conductivity of the fill material using this method is approximately 2 x 10^{-5} m/s.

Note that the above assessment assumes the fill material is confined between low permeability layers. If the fill material is unconfined, the storage parameter is replaced by the specific yield and the hydraulic conductivity is replaced by the aquifer transmissivity in the equation for (a) above. This would result in a higher assessed hydraulic conductivity as the specific yield of an aquifer is generally significantly larger than the specific storage of the aquifer.

It is relevant to note that groundwater monitoring reported by Metron for piezometer SRT_BH080A, located to the immediate west of the station box and screened in the upper 3 m of fill, also shows a strong tidal response in groundwater levels in this piezometer.

Douglas 2018 reported the following results:

- Four falling head test results for the alluvial and estuarine deposits. These had assessed permeability between 4.9 x 10^{-5} m/s and 4.1 x 10^{-7} m/s. Particle size distribution test results showed fines contents generally above 15% for tests carried out on samples of the alluvial and estuarine deposits, including for samples logged as sands.

  Borehole water pressure (packer) tests carried out in the sandstone bedrock yielded interpreted hydraulic conductivity ranging from less than 1.0 x 10^{-9} m/s to 1.5 x 10^{-6} m/s. The median Lugeon Value interpreted was 0.29 uL, corresponding to a hydraulic conductivity of 2.9 x 10^{-8} m/s. Douglas reported that hydraulic conductivity across Block 7 likely vary from 1 x 10^{-8} m/s to 1 x 10^{-7} m/s.

The median packer test result for other previous developments on this precinct ranged between 3.2 uL and was 2.2 uL. This is somewhat higher than reviews of larger numbers of packer test results across Sydney reported by Burgess et al (1987) and Best and Parker (2005) in Hawkesbury Sandstone, which report median packer test values of 0.4 uL and 0.6 uL respectively.

6.3 GROUNDWATER CHEMISTRY

Water quality samples were taken on 7 September 2022 from BH2, BH4 and BH8. Water samples were sent to NATA accredited laboratory ALS, and tested for the following:

- pH
- Electrical conductivity (EC)
- Sulfate
- Chloride

Laboratory results can be found in Section 4 of this report.

6.4 PREDICTED GROUNDWATER INFLOWS

A preliminary construction stage groundwater inflow assessment for the Central Barangaroo Development excavation has been prepared by Coffey (Coffey ref: SYDGE287887AD, dated 4 November 2021) and is included for reference in Appendix G.

For the purpose of the inflow assessment the groundwater profile was approximated using interpreted profiles for the northern and southern boundaries, and across the central part of the site. The assessment was made using analytical methods for flow under a cut-off wall presented by Polubarinova-Kochina (1952) together with flow net analysis.

6.4.1 Sydney Metro Barangaroo Station depressurisation

To prevent the occurrence of out-of-balance groundwater loads between the east and west walls of the Sydney Metro Barangaroo Station box during construction dewatering of the adjacent Central Barangaroo Development, a depressurisation system has been developed by Sydney Metro to equalise the hydrostatic water pressure across the station. The design approach of the depressurization system was described in the Appendix P of the Design Package: DP-S-240 Barangaroo Station Structure (Ref: SMCSWTSE-JAB-SBR-ST-RPT-030018 AFC(B6-B3)).

Dewatering of the adjacent Sydney Metro Barangaroo Station excavation depressurisation system is assumed to be operated and managed by others. It should be noted, however, that there is potential that the temporary depressurisation system around the Sydney Metro Barangaroo Station may result in a greater zone of influence for groundwater inflow to the Central Barangaroo site.

6.4.2 Groundwater inflow originating from outside the excavation

The total assessed construction stage inflow to the Central Barangaroo Development is 2.8 L/s.

This includes an assessed steady-state inflow to the Central Barangaroo Development excavation of 1.3 L/s or 112 m^3/day and allowance for an additional 1.5 L/s inflow to account for potential increase in zone of influence due to the Sydney Metro Barangaroo Station excavation depressurisation system discussed above. Note that 1.5 L/s was reported as a typical design inflow for sizing drainage components for the depressurisation system (refer to Appendix P of the Design Package: DP-S-240 Barangaroo Station Structure (Ref: SMCSWTSE-JAB-SBR-ST-RPT-030018 AFC(B6-B3)). Combining the inflow assessments in this way is considered conservative but appropriate prior to construction.

The inflow assessment for the Central Barangaroo Development excavation is based on the following assumptions:

- Groundwater level to remain at -16 mAHD (or higher) inside the excavation. Groundwater level in the fill outside the excavation to remain at 1.5 mAHD during construction due to the influence from the nearby harbour.
- Impermeable cut off walls will enclose the site, stopping lateral groundwater inflow to the excavation from soil units. Seepage may occur from the floor of the excavation and/or from exposed sandstone walls where these are present around the excavation.
- A sandstone permeability of 1 x 10^{-7} m/s was adopted.
- The effects of individual high permeability features were not taken into account (inflows associated with such features, if present, would be additional).
- It is assumed that there will be no groundwater flow in rock at depths of over 30 m below the base of the excavation.
- Inflows to the north eastern parts of the site, adjacent the Sydney Metro Barangaroo Station excavation, were not treated explicitly except to include an allowance of an additional 1.5 L/s for the presence of the perimeter drainage system for the Metro Station.
- Drawdowns around the Sydney Metro Barangaroo Station excavation were not considered in this inflow assessment. These would result in lower assessed inflow rates.

This assessment is based on pre-construction site investigation data and as such contains significant uncertainty. For this reason, the sandstone permeability for the inflow assessment (1 x 10^{-7} m/s) was adopted conservatively based on Coffey's previous experience of dewatering of deep excavations in Sydney sandstone.

Please refer to Central Barangaroo Development – Preliminary groundwater inflow assessment (Coffey ref: SYDGE287887AD, dated 4 November 2021) which is included in Appendix G for further details on the preliminary inflow assessment.

6.4.3 Dewatering of fill material inside the excavation

In addition to the rate nominated above, the volume of water which would need to be removed from the fill materials within the excavation is assessed to be a volume of 37 ML (allowing an area of 2.6 ha within the cut off wall, an average saturated soil thickness of 9.5 m and a specific yield of 0.15 for the saturated soil).

If dewatering is carried out over a period of two months an additional dewatering rate of 7.1 L/s would be required.

6.5 GROUNDWATER DRAWDOWNS OUTSIDE EXCAVATION

As reported in Central Barangaroo Development – Preliminary groundwater inflow assessment (Coffey ref: SYDGE287887AD, dated 4 November 2021), groundwater drawdown is expected to be up to 11 m within the rock immediately adjacent to the CBD excavation/basement walls, reducing to negligible at distances of approximately 250 m of the site.

There is expected to be limited to negligible drawdown within the fill material.

Note that drawdown in the vicinity of Sydney Metro Barangaroo Station due to the Central Barangaroo Development is unlikely to exceed that which is expected to occur due to the Sydney Metro Barangaroo Station excavation depressurisation system.

The assessment of potential settlements is beyond the scope of this report but will need to be considered separately.

7 GEOTECHNICAL CONSIDERATIONS

The following factors or considerations may considerably impact on the design, construction and performance of the Central Barangaroo development

7.1 BURIED SANDSTONE CLIFFS

Notwithstanding the interpreted profile from the 3D ground model, the sub-horizontally bedded sandstone is inferred to step down towards Darling Harbour in a series of buried cliffs and possible overhangs, paralleling the natural shoreline geometry. Exposed quarried vertical sandstone faces may also occur immediately east of Hickson Road. Such buried cliff lines and quarry faces have been problematic in earlier stages of Barangaroo development.

The cliff lines are likely to impact on:

- Excavation and temporary batters;
- The type of retention system and anchoring / bracing system adopted;
- Requirements for rock bolting, grouting and other such excavation support; and
- Downgrading of footing end bearing pressures due to the proximity to the cliff lines.
- If buried cliff lines are present close to the toe of the retention wall, there is a risk of reduced toe support and/or local increase in water inflow.

7.2 SHALE INTERBEDS AND BRECCIA

Testing of the shale breccia during earlier developments on this precinct indicated that shale breccia generally the exhibits similar axial strength to the surrounding sandstone, however, in places the material has a much lower diametral strength, possibly due to the fissile nature of the shale inclusions. This could lead to higher than expected bit wear during excavating this material.

7.3 FAULTS AND DYKES

Neither the Pittman LIV dyke nor Luna Park Fault Zone are expected to directly impact the Central Barangaroo basement, although secondary jointing and fracturing of the adjacent rock could potentially lead greater seepage inflow into the north-west corner of the site.

7.4 FILL

The fill across the Barangaroo site is known to contain inclusions such as wood, timber, steel, sandstone boulders and other building rubble. Large voids have been encountered during earlier development episodes. The presence of inclusions, and associated voids, will have a significant impact on the constructability and hence choice in foundation type and water management programme.

Timber piles related to former Hickson Road wharves have been encountered during earlier development episodes and may be encountered during the excavation works for Central Barangaroo basement construction.

Within the western portion of the site, there is a deep fill profile with thick underlying alluvial deposits. The upper natural sediment surface is assessed as being highly disturbed or remoulded. Such soil would provide limited lateral support for a deep foundation system.

In addition, the consistency of the fill is highly variable and the soft/loose parts may undergo settlement both during dewatering and over time resulting in negative skin friction impacting on the foundations. Similarly, the alluvial/estuarine sediments may contain compressible clays and organic/peaty horizons.

Excavation equipment, piling rigs and cranes will need a suitable working platform to reduce the risk of bearing capacity failures or differential settlement, both of which could lead to overturning or toppling of such plant.

7.5 ESTUARINE DEPOSITS

Although expected to be limited in occurrence, sediments may be acid sulphate bearing due to their assumed depositional environment and may be more aggressive to buried steel and concrete elements. Acid sulphate soils are a problem if allowed to oxidise following sub-aerial exposure and hence should acid sulphate soils be present, the treatment of natural sediment spoil would need to be considered

7.6 GROUND ANCHORS

The Central Barangaroo basement will likely be constructed through bottom-up methodology, with the basement excavation undertaken in stages and the retaining walls progressively supported by temporary lateral supports in the form of active ground anchors or strutting. Installation of ground anchors beyond the site boundaries will require careful consideration, particularly near the existing development with associated live anchors.

Strutting is normally preferred where there is reduced opportunity to install temporary ground anchors beyond the site boundary or where there are existing in ground structures behind the proposed retaining walls. Strutting is more expensive than conventional anchoring and makes plant movement and sequencing and co-ordination of works more challenging.

Anchors for wall construction are likely to be temporarily anchors, to be destressed following basement construction. Tie-down anchors required below the basement slab are likely to be permanent features, requiring ongoing management and maintenance. Permanent tie-down anchors will require appropriate corrosion protection for all anchor elements. A typical maintenance programme would comprise periodic inspection of the anchor head annually and lift off testing every 5 to 10 years. Access to the anchor heads to perform such a maintenance programme will be required. Alternatively, the use of permanent passive tension piles may be incorporated in the foundation design of the basement structure as discussed further in Section 8.4.

Sufficient length of the anchor tendons should be left above the anchor head and be protected by a grease filled stainless steel cap to enable long term inspection and re-stressing of anchors if required.

Due to the relatively high groundwater levels, water is likely to flow into the excavation at the head of wall anchors. Consideration needs to be given to providing water management systems, such as sealing of anchor heads, control of groundwater inflow in the contact zone of the base of retention structures, seepage collection systems and the disposal options.

Temporary anchors were extensively employed to support the retention systems associated with the previous Barangaroo phases. However, the stepped profile of sandstone down to the west will present challenges to the temporary anchor design. The depth to rock and the stepped profile will require relatively long anchors, with free anchor lengths being approximately 40 m (assuming 45 degrees installation angle), followed by the bond lengths. Consequently, the total anchor lengths could be in the order of 50 m. Similar length anchors were employed during the earlier Barangaroo phases, thus providing some assurance on the feasibility of this temporary support methodology. Steeper angles of inclination could be considered to reduce the anchor free lengths but the anchors will be less effective.

As the temporary anchors will be installed below the water table, specialist advice should be sought from suitably competent and experienced anchoring contractors.

7.7 REGIONAL ROCK STRESSES

There are significant horizontal virgin stress field within the relatively shallow Triassic rocks of the Sydney Basin, which need to be considered in basement design. Enever *et al.* (1990) described the direction of the principal horizontal stresses within the depth of the likely built environment as:

- Major horizontal stress (σ_1) = 2.5 x overburden pressure; orientation 28^o magnetic
- Minor horizontal stress (σ_2) = 1.5 x overburden pressure; orientation 118^o magnetic

Since then there have been modifications to the above formula (e.g. Pells 2002) to account more specifically for the Sydney CBD, as more information became progressively available. Collation of stress data for Hawkesbury Sandstone from Sydney CBD, North West Rail Link and CBD Metro projects has led to the following generalised formula. The following generalised stress regime for Sandstone (Class IV or better) has been interpolated from the reasonably variable results:

$\sigma_1 = \sigma_{h(N\text{-}S)} = 1.5MPa + 2\sigma_v$
$\sigma_2 = \sigma_{h(E\text{-}W)} = 1.0MPa + 1.2\sigma_v$
$\sigma_3 = \sigma_v$

Where σ_1 and σ_3 are major and minor principal horizontal stresses, σ_2 is the intermediate principal stress
z = depth below ground surface (m)

Variability in situ stress magnitudes and directions can be due to the local topography (e.g. stress relief may occur at incised valley locations) and built environment (e.g. quarrying or adjacent basements) or local geological features such as faults and dykes. The harbour front location of Central Barangaroo, its previous development history and the proximity to local geological structures may mean that stress fields may vary at different parts of the site. Because of this uncertainty, a range of design values is suggested below to assess the sensitivity of the various in-ground design elements. More recently, Oliveira and Parker (2014) considered the need to account for interrelationship between ground conditions (rock mass quality – fracturing, strength and stiffness) and the in situ stresses and presented a different approach for assessing the in situ stresses in Sydney. Their presented approach is based on considering interdependency between the Principal and mean stress. The proposed stress relationships for different values of rock mass stiffness present better compatibility of tectonic strain that is established by accounting for different rock mass qualities. Consequently this approach is recommended for preliminary designs. Figure 10 below shows the charts proposed by Oliveira and Parker (2015) for typical proposed stress relationships for different values of rock mass stiffness.

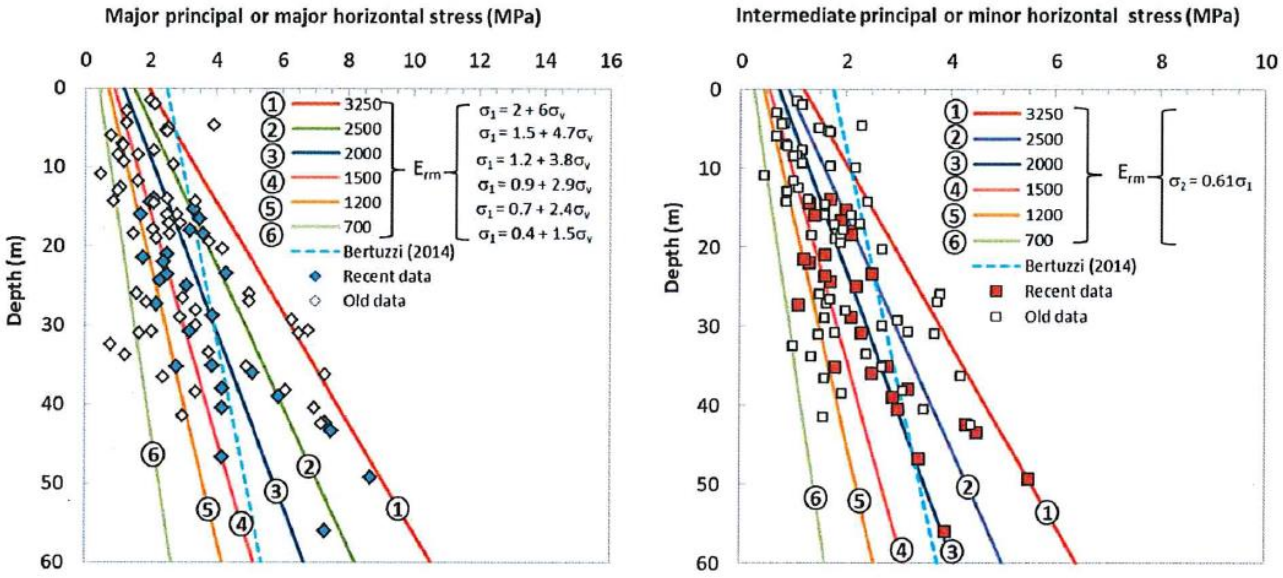


Figure 10 Proposed stress relationships for different values of rock mass stiffness (Oliveira & Parker)

7.8 BASEMENT CONSIDERATIONS

At present, the basement construction is understood to include the construction of a secant wall (along Hickson Road) and diaphragm perimeter wall for the remainder of the perimeter. In assessing a suitable retention system, the following geotechnical issues should be considered:

- Interaction with the Barangaroo metro Station
- Obstructions within the fill.
- Permeability of the soils (and risk of 'loss' of bentonite during construction).
- Excavation of high strength bands within the sandstone.
- Voids within the fill resulting in larger than expected concrete volumes.
- Water tightness.
- Depth of excavation.
- Stiffness of the retention system.
- Increasing depth to rock towards the harbour (westerly direction).
- Temporary lateral support in the form of anchors.
- Design and installation of temporary anchors, particularly along the western boundary.
- Dewatering.

The depth of fill and alluvial units as well as depth to rock increases towards the harbour, i.e. in the westerly direction. The rock elevation (Class III sandstone) along the eastern boundary of CBD (along Hickson Road) is approximately -5 mAHD i.e. at 8m to 9m depth and the anticipated bulk excavation level is -14 mAHD, approximately. The rock elevation appears to have a stepped profile with the rock elevation to dropping to as low as -22 mAHD along the western CBD boundary.

Where there are high groundwater levels and hydraulic connection with the harbour, together with a stepped rock profile and deep soil strength materials, it is expected that a diaphragm wall system would be most suitable. There may be a scope for adopting a secant pile wall where rock elevation is higher along the eastern boundary and eastern end of the southern boundary.

7.8.1 Diaphragm Wall

Coffey understands that the intention is to incorporate the retention system into the permanent works with the principal considerations being watertightness and stiffness of the retention system.

Compared to other embedded wall systems such as contiguous or secant piled walls, diaphragm walls are:

- Stiffer, since they are more continuous and have higher moment inertia for the same wall thickness as the pile diameter.
- More watertight due to fewer joints or discontinuities in the wall. Diaphragm walling techniques can achieve tighter verticality (construction tolerances), reducing the potential for disengagement of the panel joints.

Diaphragm walls offer practical advantages, such as the facility to:

- incorporate anchor conduits.
- incorporate block outs for couplers to facilitate structural connection between permanent slabs and diaphragm wall.
- omit the need to temporary steel walers (depending anchor loads) as the diaphragm wall can be designed to have “built in walers” at the temporary anchor elevations.

Diaphragm walls require specialist equipment and large plant set up to house bentonite batching and treatment silos. Consequently, mobilisation and operating costs are high.

7.8.2 Secant Pile Wall

Secant pile construction may be less effected by obstructions within the fill, where piles are less than approximately 10 m to 15 m in length. From our experience with these walls, when they extend over depth of say 15m, there is an issue with the verticality of each of the piles. The verticality issue will be compounded by inclusions within the fill. Due to the anticipated bedrock level along the Hickson Road boundary a secant pile wall may be suitable, however, construction quality control within the western side of the site may be problematic. As with the diaphragm wall, there may be significant loss of bentonite and/or concrete due to large voids within the fill, however due to the relative localised nature of the pile excavations there is lower risk of significant loss of material.

The key risks associated with secant pile walls are:

- Achieving adequate construction tolerances to provide acceptable watertightness.
- Ability to maintain adequate overlapping of hard and soft piles for the full depth.

Consideration should be given to cased secant piling (CSP) method, which can achieve better verticality compared to the traditional secant wall construction techniques.

Some additional measure may also be required if secant walls are to be incorporated into permanent works. These may include structural shotcrete wall on secant wall face.

The secant walls tend to be more cost effective compared to diaphragm walls but are less reliable in terms of watertightness as compared to diaphragm walls.

7.8.3 Significance of Buried Cliff Lines

The presence of buried cliff lines across the Barangaroo site has been discussed earlier within this report, and encountered during previous developments on this precinct. Of particular interest is the potential presence of cliff lines located perpendicular to the northern and southern boundaries. Where the edge of buried cliff lines is present close to the toe of the retention wall there may be a risk of reduced toe support, together with a

local increase in water inflow. Potential methods of managing the impacts of the buried cliff lines within the basement include:

- Inclusion of vertical steel pipes within the wall reinforcement to provide access to the toe of the retaining wall should, subsequent grouting or toe pins be required.
- Extension of the wall units to a level below possible cliff lines.

7.9 GROUND ANCHORS

Temporary ground anchors are likely to be installed during conventional basement construction to provide lateral restraint to the basement wall. It is anticipated that anchors required for wall construction will consist of temporarily stressed units, to be destressed following basement construction

Due to the relatively high water table within the site soils, due to tidal fluctuations, water is likely to flow into the excavation at the head of wall anchors. Consideration needs to be given to providing water management systems, such as sealing of anchor heads, control of groundwater inflow in the contact zone of the base of retention structures, seepage collection systems and the disposal options.

Installation of ground anchors beyond the site boundaries will require careful consideration, particularly along the eastern site boundary. It is considered that conventional temporary ground anchors (e.g. pre-stressed multi-strand steel anchors) may be installed for wall retention, which will be de-stressed after construction of the permanent wall support.

7.10 EXCAVATION SUPPORT IN ROCK

Excavations below the retention system, where required are likely to consist of Class III or better sandstone. Vertical excavations should be feasible in the Class III or better sandstone below the retention system. However, some support in the form of shotcreting and rock bolting is likely to be required and specific support requirements can only be assessed during excavation. An experienced geotechnical engineer/engineering geologist should carry out regular inspections as excavation progresses (at least every 2 m depth of excavation). For estimating purposes, we recommend allowance for the support presented in Table 5.

Table 5 Assessment of Rock Face Support Requirements

Rock Class	Support
Class IV Sandstone	• Shoring Wall comprising soldier piles and shotcrete infill panels **OR** • Mesh supported by 0.5m long dowels and shotcrete (minimum 75 mm thick) or fibre reinforced shotcrete. • Pattern rock bolting of fractured zones.
Class III Sandstone	• Localised pattern bolting in fractured zones. • Mesh supported by 0.5m long dowels and shotcrete (minimum 75 mm thick) or fibre reinforced shotcrete of fractured zones. • Isolated bolting of potential wedges.
Class II or better Sandstone	• Isolated bolting of potential wedges.
Shale breccia/bands	• Shale breccia zones and isolated beds will require excavation of a minimum of 100mm from the face and replacement with shotcrete or dental concrete.

Where the toe of the retention system panels/piles lie in close proximity to the edge of an excavation there is a risk of blocks falling out and removing support before the rock can be inspected. The rock should be inspected once the excavation has extended not greater than 1m below the base of retention system to assess whether adverse jointing requires bolting.

Where long-term support is required below the site retention system rock bolts must be provided with a high level of corrosion protection if they cannot be maintained (i.e. inspected and replaced, if necessary). Multiple layers of corrosion protection such as encapsulating bolts in both grout and PVC sheaths may be required. Proprietary products such as 'CT' rock bolts or equivalent should be suitable for bolting the rock faces. Such bolts have a mechanical anchor to allow a nominal tension to be applied and are then fully cement grouted to act as a dowel.

7.11 EXCAVATION INDUCED GROUND MOVEMENTS

Adjacent ground movements are likely to occur due to the proposed excavation. Within the retained fill and extremely weathered rock profile the magnitude of adjacent ground movements will depend upon the ground conditions, design lateral pressures, stiffness of the retention system, sequence of construction, and workmanship. Lateral movements of the adjacent ground surface due to the fill, soils and extremely weathered rock profile would be expected to be of the order of 0.1% to 0.5% of the retained depth providing good workmanship is employed.

Within an unsupported rock excavation, additional lateral movement will occur due to relief of *in situ* horizontal stresses. Relatively high natural horizontal stresses can occur within the Hawkesbury Sandstone.

Stress redistribution measurements associated with excavations within the Sydney CBD have been made at distances of up to 1.5 times basement depth. These measurements show, typically, that at a distance approximately equal to the depth of basement, movements are likely to be about 30% of the displacement around the perimeter of the excavation. However, this approximation will be affected by local geological structures and should only be used as a rough guide.

Based on past experience of deep basements in Hawkesbury Sandstone in the Sydney CBD, typical lateral movements are of the order of 0.5mm to 2mm per metre of excavation, depending on rock quality and

presence of bedding seams. Stress relief movements on the east and west site boundaries are likely to be lower due to lower lock-in stresses in the rock in this direction, compared to the north and south site boundaries given the major locked-in stress is in the north-south direction.

An assessment of the potential ground movements, particularly within the sandstone bedrock, will be required to assess the potential effects on the Sydney Metro and One Sydney Harbour basement as the excavation for the Central Barangaroo Development proceeds.

Structures and buried services are likely to be present close to the Hickson Road boundary. Excavation of a deep basement within the CBD site may result in ground movements which affect the services and structures, with potential damage ranging from cosmetic cracking to structural impacts. Adequate allowance should be made for repair of such damage after construction. A dilapidation survey should be carried out on all adjacent structures prior to commencement of excavation and analysis of deformation due to excavation is recommended to assess impacts on nearby structures. Settlement tolerances of buried services are dependent on the age, material, and asset owner. Liaison with the individual asset owners should be undertaken to assess the likelihood of damage to nearby buried services.

7.12 AGGRESSIVITY TO CONCRETE AND STEEL

The aggressivity data obtained from laboratory testing of both Unit 2 soils and water have been used to assess durability classifications for buried structural elements in accordance with AS2159-2009 and AS3600-2018. The exposure classifications are determined using Soil Condition A, this considers high permeability soils which are in groundwater. This soil condition definition is consistent for both AS2159-2009 and AS3600-2018.

For buried concrete structures (Hydrostatic slabs, capping beams etc.) and concrete piles in soil:

- Exposure Classification – Moderate, from criteria set out in AS2159-2009 Table 6.4.2(C).
- Exposure Classification – A2, from criteria set out in AS3600-2018 Tables 4.3(1c) and 4.8.1.

For Steel piles in soil:

- Exposure Classification – Severe, from criteria set out in AS2159-2009 Table 6.5.2(C). The selection of this classification was determined using the resistivity data from soil testing.

Consideration should be given to the potential effects of soil contamination, known to be present in previously developed Barangaroo sites. Neither contamination, nor acid sulphate soil assessment was included in the Coffey scope of works. It is Coffey's understanding that an environmental consultant is conducting additional site investigation with reporting of these items.

8 GEOTECHNICAL DESIGN MODEL & PARAMETERS

8.1 RETAINING WALLS

The design of retention systems is geotechnically complex, and best carried out using soil-structure interaction analysis methods. For preliminary design, the parameters in Tables 6 and 7 may be used.

Table 6 Geotechnical Parameters for Soil

Unit	Description	Bulk Unit Weight (kN/m^3)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Undrained Shear Strength (kPa)	Elastic Modulus (MPa)	Poisson's Ratio	'At Rest' Earth Pressure Coefficient. K_0(1)
1	Fill	18-20	0	30	-	5-15	0.35	0.5
2	Alluvium	19	2	30	-	20	0.3	0.5
3	Residual Soil & Class V Sandstone	20	5	25	75	60	0.35	0.5

Table 7 Geotechnical Parameters for Rock

Unit	Sandstone Class	Bulk Unit Weight (kN/m^3)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Elastic Modulus (MPa)	Poisson's Ratio	Earth Pressure Coefficient. K_0(1)
4B	Class IV	23	200	35	400	0.3	0.5
4C	Class III	24	300	35	1000	0.3	0.5
4D	Class II or Better	24	500	50	1800	0.3	0.5

Note 1: Values provided assume a lateral movement of the wall of about 0.2% of the wall height is allowed to occur. *In situ* 'at rest' earth pressure coefficient may be significantly higher

For the design of retaining walls the impacts of the potential occurrence of large scale, low strength and adversely oriented defects should be considered. The potential for such conditions to occur locally will need to be carefully assessed by experienced geotechnical personnel during construction and the design reviewed and modified (if necessary) to suit the site conditions.

The following additional pressures need to be considered:

- Since the retention structure is likely to provide a groundwater cut off into the underlying bedrock, systems should be designed for hydrostatic pressures.
- Allowance for regional in situ rock stresses as outlined in Section 7.7
- Applicable surcharge loads should be added to earth pressures.
- Additional out of balance forces in the east-west direction, as assessed and advised by the structural engineers.

8.2 FOUNDATIONS

8.2.1 Shallow and Piled Footings

Based on the site conditions suitable foundation options for the proposed development include shallow footings where rock is exposed in the bulk excavation and piles founded on the sandstone rock elsewhere. Bored piles will require casing through Fill and natural soils.

As a guide, strip/pad footings or bored piles founded on sandstone bedrock may be designed in accordance with the limit state design parameters in the Table 8.

Table 8 Geotechnical Parameters for Rock Foundations

Sandstone Rock Class	Buoyant Bulk Unit Weight (kN/m^3)	Ultimate Shaft Resistance (kPa)		Ultimate End Bearing Pressure (kPa)	Young's Modulus (Vertical) (MPa)	Young's Modulus (Horizontal) (MPa)	Ultimate Lateral Bearing Pressure (kPa)
		Compression	Tension	Compression	Axial Response	Lateral Response	Lateral Response
IV	13	400	280	6,000	400	280	1,500[A] / 3,000[B]
III	14	1000	700	35,000	1000	700	8,750[A] / 17,500[B]
II or better	14	1800	1260	80,000	1800	1260	20,000[A] / 40,000[B]

Notes:

(1) Rock classification according to Pells et al (1998). These are generalised rock classification for the purpose of foundation design only and should not be used for assessment of rock excavatability or pile drillability.
(2) Ultimate limit state design stress level of concrete may govern pile capacity when founded on Class II or better Sandstone
(3) For uplift capacity, the shaft adhesion values should be factored by 0.7.
(4) [A] – Value applicable to the upper 1m
(5) [B] – Values applicable below upper 1m depth

The above bearing pressure values assume a minimum embedment of 0.5m or 1 pile diameter (whichever is the greater) into the relevant bearing stratum. Bearing pressure values are dependent on the level of assessment carried out during construction. Bearing pressures may need to be downgraded where footings are close to excavations or (buried) cliff lines unless the entire base of the footing lies outside a line projected upwards at 45^o from the toe of the base of the excavation/cliff.

The design values for Class IV Sandstone may be adopted for relatively lightly loaded footings or piles. For heavily loaded structures we recommend that footings be taken to the Class III or better Sandstone to obtain the benefit of higher end bearing and shaft adhesion values.

The nominated modulus values are applicable at the anticipated working stress values. Non-linear effects should be considered depending on operating stress levels

Base of piles or shallow footings should be cleaned of debris prior to concrete pouring. A clean pile socket of roughness category R2 (defined as grooves of depth 1 mm to 4 mm and width greater than 2mm at spacing of 50 mm to 200 mm) or better is required to achieve the values provided above. Shaft adhesion values may have to be reduced if rock sockets are smeared or polish is present.

For limit state design, the design ultimate geotechnical pile capacity is derived by applying a geotechnical strength reduction factor (ϕ_g) to the ultimate geotechnical pile capacity assessed using the ultimate shaft resistance and end bearing values shown in Table 8.

ϕ_g is dependent on an Average Risk Rating (ARR) which takes into account various geotechnical uncertainties, foundation system redundancy, construction supervision, quantity and type of pile testing. Testing may provide more assurance to achieve a higher ϕ_g and more economical design.

For uplift capacity the ultimate shaft resistance values in Table 8 should be multiplied by 0.7 as well as the geotechnical reduction factor. In addition to shaft adhesion, uplift capacity should be checked for cone pull-out failure mode. A cone angle of 60° in soil and 90° in rock, considering the submerged weight and adopting a factor of safety of 1 against pull-out. Uplift capacity for groups of piles should take into account interaction between piles which will lead to lower individual pile capacities.

Limit state design also requires assessment of the serviceability performance of the foundation system, including pile group interaction effects. For footings on rock the settlement characteristics of the footing rather than ultimate load capacity often governs the design. The serviceability limit state should be assessed using the elastic modulus values presented in Table 8. This should be carried out by experienced geotechnical professional using well-established and soundly based methods. The modulus values given in Table 6 can be used, though the accuracy of settlement prediction is dependent on construction methods as well as material stiffness, both of which can involve considerable uncertainty. Settlement predictions can have a large margin for error, and in some cases serviceability pile load testing should be completed when foundation settlement is critical to the structure's performance.

8.2.2 Barrettes

Barrettes are rectangular 'piles' of 2.4 m or 3.6 m horizontal length (depending on equipment size) formed in a slurry supported excavation up to 1500 mm in width. Barrettes can be rectangular or T-shaped or H-shaped, can carry very large loads and have high resistance to horizontal stress and bending moments.

Barrette construction may be favoured at certain locations within the site, such as the areas of tower cores. Principles for barrette design are similar to that of piled footings, but construction methods need to consider the methods available to achieve the necessary bedrock socket side roughness.

Pile shaft adhesion values in Table 6 may be appropriate for barrette design where a similar 'R2' roughness can be achieved, that is grooves of depth 1 mm to 4 mm and width greater than 2mm at spacing of 50 mm to 200 mm. This requirement may prove difficult to construct and/or measure during installation. Where such side roughness cannot be achieved the shaft adhesion values should be downgraded.

The methods and frequency of barrette testing should reflect those adopted for pile testing to achieve the required design confidence.

8.3 GROUND ANCHORS

Where conventional basement construction methods are adopted internal strutting of the retention walls is likely to be impractical. Single or multiple anchors may be required for basement wall construction. Furthermore, we understand that the basement structure may require vertical, multi-strand anchors or tension piles to be installed to resist the uplift forces.

Basement wall anchoring may include high capacity soil anchors (such as post-grouted anchors or Single Bore Multi-Anchor systems) as they offer the potential to reduce anchor lengths. However, care must be taken to fully support the saturated soil materials during drilling and installation of the anchors to avoid loss of ground and consequential surface settlement.

Inclined anchors at approximately 1.5 m spacing were installed in much of the diaphragm wall construction for previous stages, anchored into the underlying sandstone, drilled from above the mean high tide level.

For the preliminary design of anchors, the ultimate bond stresses in Table 9 are recommended:

Table 9 Recommended Bond Stresses for Ground Anchors

Unit	Ultimate Bond Stress (kPa)(1)
4B Class IV Sandstone	500
4C Class III Sandstone	1200
4D Class II or better sandstone	2000

Note: 1) For bond lengths not less than 3m and not more than 7m (except for a single bore multi-anchor system)

A geotechnical reduction factor of 0.5 should be applied to the ultimate values within Table 9 to calculate allowable bond stress for ground anchors and soil nails. The recommended values are given on the provision that each anchor is proof loaded to 1.3 times maximum working load for temporary anchors, and to 1.5 times maximum working load for permanent anchors, prior to locking off at the required working load. Where multiple anchors are installed in close proximity to each other the overall anchor capacity may require reduction to allow for group effects. Anchors should be checked for anchor pull-out failure mechanism assuming a 45^{o} failure cone in addition to bond strength.

8.4 PASSIVE TENSION PILES AND INTERACTION WITH SYDNEY METRO STATION

The use of passive tension piles in lieu of permanent tie-down ground anchors and their interaction with Sydney Metro Barangaroo Station has been assessed in our draft report SYDGE287887AC dated 15 October 2021. Such piles will be used for carrying compression loads as well as hydrostatic uplift loads, thus providing an efficient and cost-effective system.

Based on a hydrostatic uplift of approximately, 193 kPa which includes the effect of long-term climate change corresponding to a design long-term groundwater level of 2.575 mAHD, we have assessed the required thickness of buoyant rock mass to resist this uplift pressure below the base of the B5 slab to be approximately 1.3 m of B5 slab, 1 m of Class IV Sandstone, 2 m of Class III Sandstone and 8.5 m of Class II Sandstone, giving a total rock socket length of 11.5 m. This will need to be confirmed in the detailed foundation design phase of the project in order to optimise the foundation design.

Currently, the Sydney Metro protection guidelines require piles located within the second reserve (see Figure 11 and 12 below) to be sleeved below the base of the second reserve.

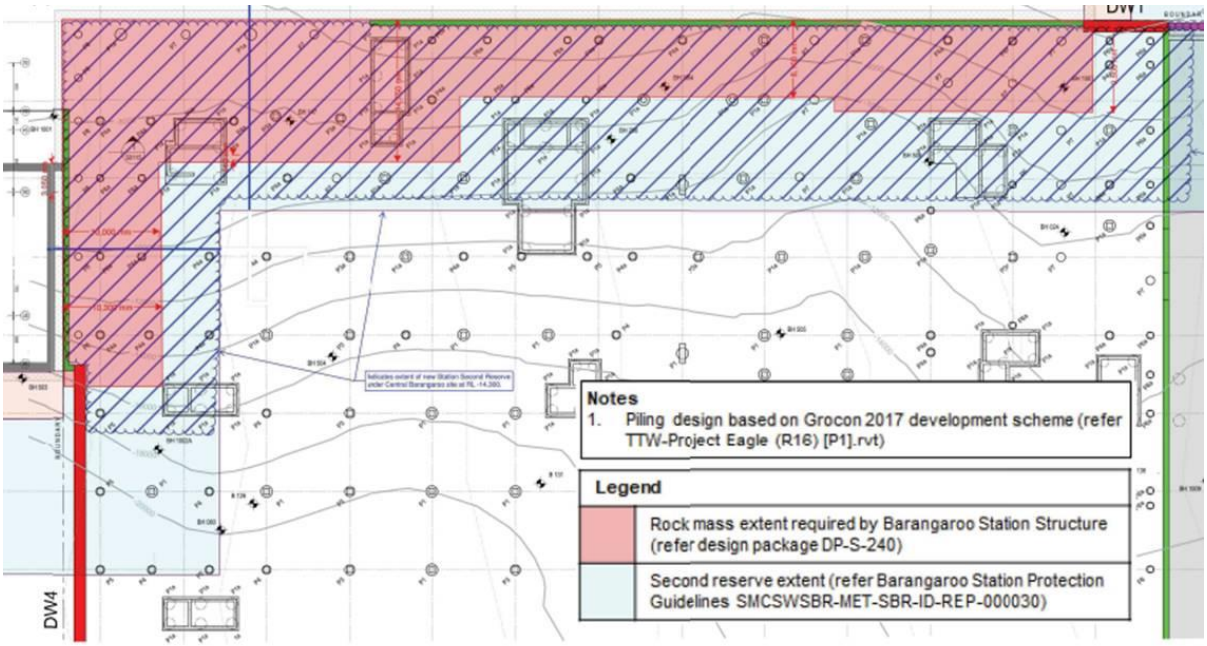


Figure 11 Appendix L of the Structures Interface Report (SMCSWSBR-MET-SBR-ST-REP-000032.C.INF.C.02 dated 11 Feb 2021) Showing First and Second Reserves in Plan

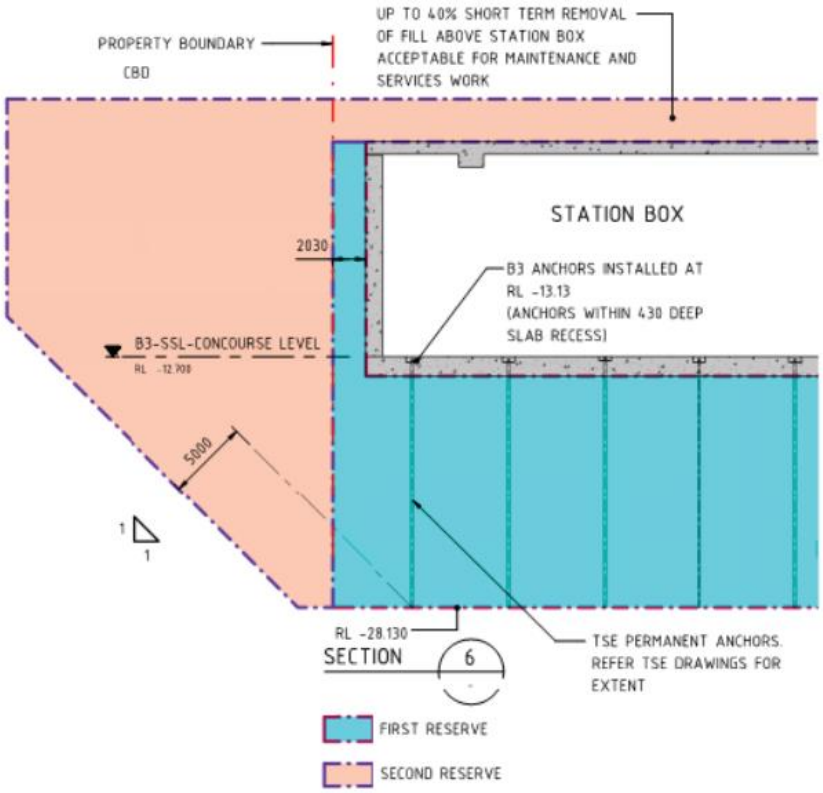


Figure 12 Typical Section Showing First and Second Reserves (from Figure 3 Appendix D of the Sydney Metro Station Protection Guidelines (SMCSWSBR-MET-SBR-ID-REP-000030.01.AFC.01.02)

We are of the opinion that it may be possible to delete the need for sleeving based on the following reasons:

- The assessment of the inverted cone pull-out mechanism for the Sydney Metro project was based on a 90^{o} included angle, whereas an included angle of 120^{o} may be used in good quality, horizontally bedded rock as discussed in our report SYDGE287887AC. This means that a much larger rock mass is available to resist the hydrostatic uplift.
- The “rock slab” (currently assessed to be 11.5 m thick) in which the passive tension piles will be installed, will have a net weight downwards against the buoyancy. Therefore, any compression loading from the building transferred via shaft friction within the second reserve will only add to the resisting load against buoyancy of the Sydney Metro Barangaroo Station box.

Therefore, we suggest initially discussing the opportunity to delete the requirement for sleeving the pile shaft within the second reserve with Sydney Metro Authority, and if they are receptive to this idea, carry out more detailed analyses in the detailed foundation design phase to demonstrate this to their satisfaction.

9 EXCAVATION & EARTHWORKS

9.1 EXCAVATION CONDITIONS

The proposed basement excavation would generally involve excavating Unit 1 (Fill), Unit 2 (Estuarine & Alluvium Deposits) and Unit 4 (Sandstone Bedrock), with minor quantities of Unit 3.

Soil strength materials should be able to be excavated using a hydraulic excavator or bulldozer blade and bucket. Ripping may be required if less weathered and higher strength bands are encountered near the soil / rock interface. Saturated soil layers are expected to exist within the excavation, with wet and poor trafficability expected for machinery.

The excavation of Class III or better sandstone may require the use of heavy ripping, such as with a Caterpillar D11 or Komatsu 475 or equivalent, or use of a hydraulic breaker. Use of an impact ripper would significantly improve productivity. Along the edges and at the corners of the proposed excavations, the use of a rock saw or rock line drilling should be considered to reduce overbreak and to form a clean excavated face that requires less temporary support.

The excavation sandstone may require the use of heavy ripping, equipment, or use of a hydraulic breaker. Along the edges and at the corners of the proposed excavations, the use of a rock saw or rock line drilling should be considered to reduce overbreak and to form a clean excavated face that requires less temporary support.

Use of impact hammers may result in vibrations that could damage nearby structures/infrastructure. A rock saw could be used to reduce the lateral transfer of vibrations. Dilapidation surveys and vibration monitoring should be carried out if vibration sensitive structures lie within close proximity to excavations.

Contractors associated with all forms of excavation on the Central Barangaroo Site, such as bulk earthworks, wall contractors and piling contractors should be required to examine the engineering logs and rock cores to make their own assessment of plant, equipment, and production rates.

9.2 ESTIMATION OF MATERIAL VOLUMES

Based on the current 3D Geological model, the preliminary estimated total material volumes within the Central Barangaroo site boundary with a basement excavation level of -14 mAHD are presented in Table 10.

Table 10 Estimated Total Volume of Central Barangaroo Site

Material Type	Preliminary Volume Estimate (m^3)
Fill	228,100
Alluvium	64,700
Residual Soil / Class V Sandstone	11,300
Class IV Sandstone	5,700
Class III Sandstone	19,800
Class II or better Sandstone	24,600

Please note that the above-mentioned material types are primarily to estimate the material volumes.

9.3 EARTHWORKS

9.3.1 Subgrade Preparation

To prepare existing Fill for construction of relatively thin temporary pavements, fill embankments and working platforms:

- Proof roll the exposed surface using a minimum 10 tonne smooth drum roller in non-vibratory mode. The surface should be rolled a minimum of six times with the last two passes observed by an experienced geotechnical practitioner to detect any soft or wet zones.
- Heaving materials identified during proof rolling should be removed and/or treated (e.g. geosynthetics, crushed rock bridging layers).

9.3.2 Re-Use of Existing Fill

Excavated Filling on-site may be geotechnically suitable for re-use as Filling, provided a geotechnical practitioner confirms its suitability. An environmental engineer should be consulted as to waste classification of excavated materials and appropriateness for re-use.

For re-use, fill should not contain deleterious materials, vegetation, large cobbles or boulders, or similar sized building rubble (bricks, concrete). From a moisture conditioning perspective, it is likely that only Fill from above the groundwater level would be potentially suitable.

Caution will be required when using compaction or tracked plant around and over existing buried services or nearby structures. In particular, vibratory rollers should only be used after an assessment of the sensitivity of any existing services or structures, such as the stormwater culverts and the Barangaroo Station box.

9.3.3 Subgrade preparation and Engineered Fill construction

Preparation of the subgrade prior to filling and Engineered fill construction should be planned and specified for purpose by a geotechnical practitioner, who should also instruct compliance monitoring requirements. Compliance monitoring should be conducted by an appropriate Geotechnical Inspection and Testing Authority.

9.3.4 Working Platforms

a) General

Excavation equipment, piling rigs and cranes will need a suitable (and adequately maintained) working platform to reduce the risk of bearing failures or excessive differential settlement, both of which could lead to overturning or toppling of plant. Design for working platforms should be conducted by a suitably qualified and experienced geotechnical engineer on a case by case basis for the specific equipment being used. The design (thickness and stiffness) of working platforms will be dependent on:

- the equipment dimensions and maximum applied track pressures of equipment that will be used;
- the nature of the subgrade on which the platform will be founded
- the depth to the water table, and
- the proximity to the edge of batters, service trenches, culverts or retention structures.

Prior to construction of working platforms, the subgrade should be proof rolled as directed by the working platform design engineer. Typically, the preparation for a foundation for the working platform construction would involve:

- Testing the foundation to at least 2 m depth with dynamic cone penetrometer testing to assess ground conditions are feasible for working platform construction.
- Gaining good understanding of the groundwater level, within the upper 2 m to 3 m.
- Proof rolling the exposed surface using a minimum 10 tonne smooth drum roller in non-vibratory mode. The surface should be rolled a minimum of six times with the last two passes observed by an experienced geotechnical practitioner to detect any soft or wet zones
- Heaving materials identified during proof rolling should be removed and replaced with more suitable fill, and treatment with geosynthetics and/or crushed rock bridging layers may be needed

The working platform would then be placed in layers of appropriate thickness (maximum 300 mm loose thickness) for the compaction plant and compacted to at least 98% Standard Maximum dry density ratio, with compliance testing of each layer as specified by the working platform designer.

Platform materials would typically consist of well-graded recycled concrete, DGB material or a well graded material with a maximum particle size of 70 mm and contain less than 5% fines.

b) Opportunities

Depending on the size, and loading of the construction plants, there is also an opportunity to utilise the existing hardstand as a suitable working platform subject to site specific testing and proof loading with a similar size plant. This method (incorporating a program of plate bearing tests, Benkelman beam testing, proof loading using a large size crawler crane, and before and after proof rolling surveys of the ground level) was successfully implemented in Barangaroo South Stage 1a for the diaphragm wall rigs and foundation piling rigs for construction of bored piles prior to basement excavation without the need for a piling platform. Soft areas identified during the testing program were bridged over using heavy steel road plates.

9.4 SEISMIC DESIGN

Selection of seismic parameters for design of soil retention and underground structures should follow the requirements of:

- AS 4678-2002 Earth Retaining Structures
- AS 1170.4-2007 Structural Design Actions – Part 4: Earthquake Action in Australia

The probability factor (k_p) for the annual probability of exceedance shall be selected in accordance with Section 3 of AS1170.4 as appropriate for the limit state under consideration. A hazard factor (Z) of 0.08 is appropriate for the Barangaroo site. Based on the findings of the geotechnical investigations carried out at Barangaroo, conditions are considered to resemble the site sub-soil Class Ce most closely, as defined in Section 4 of AS 1170.4. The Ce classification is also considered appropriate for the proposed Harbour Heat Rejection structure located near BH3 which encountered stiff and stiff to very stiff sandy clay alluvium to 34 m depth.

9.5 LIQUEFACTION POTENTIAL OF FILL AND ALLUVIAL SOILS

Although, Australia is considered a stable continental region, geological conditions exist that are susceptible to liquefaction under earthquake ground motion. Geologically young or relatively loose sands and non-plastic silts are considered susceptible to liquefaction.

Liquefaction occurs when pore water pressures within the soil are increased to an extent that the effective stress approaches zero, resulting in negligible shear strength in frictional (granular) soils. The tendency for loose soils to contract under strain results in a temporary increase in pore pressure. Under rapid cyclic loading (such as earthquake induced seismic loading), these pore pressures may build up at a rate which exceeds the capacity of the soil to dissipate the pore pressures and liquefaction may occur. This leads to a rapid decrease in shear strength and stiffness of the liquefied soil. Liquefaction is commonly associated with loose or very loose saturated sand deposits; however liquefaction of soils with appreciable fines content can occur.

Cohesive soils tend to develop lower pore pressures under undrained cyclic loading and do not reach zero effective stress which is the condition for liquefaction.

The proposed 5 level basement results in an excavation level of approximately -14 mAHD for most of the site with a local deepening of the excavation to -15 mAHD adjacent to the Barangaroo Metro Station. The geological model suggests up to 50% of the excavation, including the lower -15 mAHD portion of the basement will expose bedrock at excavation level. The remaining portion of the excavation will expose Unit 2 alluvium with the possibility of thin layers of filling, less than 2 m being present.

For foundation pile design preliminary assessment indicates the Unit 2 soils observed under the B5 basement level are unlikely to be subject to liquefaction under an assumed possible earthquake event. If the design bulk excavation level was to change, this assessment will require amendment.

However, for the retaining wall design the presence of loose sands within the fill deposits poses a potential risk of liquefaction. Therefore, the potential for the site soils at CBD to liquefy under design earthquake events should be assessed.

Specific consideration may also be required at the Harbour Heat Rejection structure pending final design.

Where liquefaction assessment is undertaken, the impact of dynamic water pressure should be included in the design of retaining wall structures. Australian Standard AS 4678 Earth-retaining structures provides guidance regarding this design requirement.

Liquefaction analysis requires the determination of both the peak ground acceleration and magnitude of potential earthquake events for the subject site. AS1170.4 provides methods to calculate the appropriate

maximum acceleration levels but does not provide commentary regarding the determination of a representative earthquake magnitude.

A paper by Mote and Dismuke provides three models for the estimation of design magnitude for earthquakes in Australia with reference to the hazard maps presented in AS1170.4. These methods are:

1. Approximate Deaggregation, allowing for determination of magnitude for various return periods.
2. Maximum Magnitude for Stable Continental Regions. This method provides magnitudes that generally correspond to design return periods greater than 2500 years which may be considered too large for designs using 500 – 2500 year return periods.
3. Maximum Magnitude Derived from AS1170.4. This method provides maximum magnitudes for the source zones used in the Australian national hazard model. These magnitudes can be considered the maximum credible earthquake (MCE) for each zone.

For liquefaction analysis, Coffey suggests adopting the following design magnitudes (M) from Figure 8 and Table 1 presented by Mote and Dismuke were the site lies in Zone 22 (Sydney). Method 2 has not been included as it considers return periods that fall outside of those considered by AS1170.4.

1. Construction Duration: 500 year return period, M=5.0.
2. Structure Life Cycle: 2500 year return period, M=5.3.
3. MCE: M=6.1 (AS1170.4)

The maximum accelerations for the three design cases listed above were determined in accordance with methods outlined in AS1170.4. The MCE liquefaction analysis was conducted using acceleration data for a 2500 year return period in the absence of any specific data. AS1170.4 defines the maximum acceleration as the product of the factors kp and Z where.

- kp is taken from Table 3.1 based on the annual probability of exceedance (P).
- Z is the hazard factor from Table 3.2.

An annual probability of exceedance of 1/500 for the construction duration is considered appropriate whereas 1/2500 is considered appropriate for the structure life cycle and MCE, Z = 0.08 for Sydney (table 3.2). This results in the following maximum acceleration values where g = acceleration due to gravity, the design case earthquake magnitudes are included for clarity.

- Construction Duration, 0.08g (kp = 0.75, Z = 1.0) & M=5.0
- Structure Life, 0.14g (kp = 1.8, Z = 0.08) & M=5.3
- MCE, 0.14g (kp = 1.8g, Z = 0.08) & M=6.1

10 REFERENCES

10.1 GROUND INVESTIGATION DATA

1. Douglas Partners (2017) Geotechnical Investigation - Central Barangaroo - Block 7 Hickson Road Barangaroo – prepared for Grocon (CB) Developments Pty Ltd – Project 71723.18 August 2018.
2. Sydney Metro - Golder/Douglas Borehole logs (2020) for boreholes SRT_BH070 to SRT_BH073, SR T_BH034, SRT_BH034 and SRT_BH077 and (2015) SRT_BH013 and SRT-BH014,

10.2 SYDNEY METRO REPORTS

3. Barangaroo Station Protection Guidelines (Underground Stations Design and Technical Services - SMCWSBR-MET-SBR-ID-REP-000030 Rev P09, dated 11 February 2021.
4. Structural Interface Report Barangaroo Station (Stage 3 Detail Design) SMCWSBR-MET-SBR-ST-REP-000032 Rev P03, dated 11 February 2021.
5. Geotechnical Interpretive Report System Wide (Stage 1 Design) – NWRLSRT-MET-SRT-GE-REP-000001, Rev P03, dated 31 January 2018.

10.3 OTHER SOURCES

6. D.J. Och, Offler, R., Zwingmann, H., Braybrooke, J., & Graham, I. T. (2009). Timing of brittle faulting and thermal events, Sydney region: association with the early stages of extension of East Gondwana. Australian Journal of Earth Sciences(56), 873-887.
7. Department of Planning, Industry and Environment. (2020). NSW Seamless Geology. Retrieved from MinView: https://minview.geoscience.nsw.gov.au/.
8. Enever, J.R., Walton, R.J., & Windsor, C.R. (1990). Stress regime in the Sydney basin and its implications for excavation design and construction. Inst. Of Eng. Aust. VII Tunnelling Conf. Sydney pp49-59.
9. Godden Mackay Logan. (2012). Central Barangaroo Waterfront Promenade and Interim Public Domain Archaeological Assessment. Sydney.
10. Jeffery and Katauskas Pty Ltd (J&K). (2006). Report to Sydney Harbour Foreshore Authority on Geotechnical Investigation for Proposed Redevelopment of Wharves 3-8 at Hickson Road, Darling Harbour East, NSW.
11. NSW Government - Spatial Services. (2020, May). Retrieved from ELVIS - Elevation and Depth - Foundation Spatial Data: elevation.fsdf.org.au
12. Burgess, P.J., Hosking, L.A. and Mirkov, P. (1987), Geotechnical Investigations for Urban Road Tunnels in Sydney. 6th Australian Tunnelling Conference, Melbourne, March 1987.
13. Best, R.J. and Parker, C.J. (2005), Groundwater in Sydney-Tunnel Inflows and Settlement-Theory and Experience, 12th Australian Tunnelling Conference, March 2005.
14. Polubarubiva-Kochina (1952), Theory of Motion of Groundwater, Gostekhhizdat, Moskow.
15. Edelman, J.H. (1972) Groundwater hydraulics of extensive aquifers, ILRI, Wageningen, The Netherlands.
16. Oliveira, D.A.F, Parker, C.J (2014) An alternative Approach for Assessing In Situ Stresses in Sydney, 15th Australasian Tunnelling Conference, September 2014.
17. Mote and Dismuke (2011) Screening-Level Liquefaction Hazard Maps for Australia. Australian Earthquake Engineering Society 2011 Conference, Nov 19-20, Barossa Valley, South Australia City
18.

11 LIMITATIONS

The assessments provided herein are based on discrete/specific geotechnical data. In addition, subsurface conditions can change over relatively short distances and the subsurface conditions encountered at the test locations may not be representative of subsurface conditions across the site.

This report must not be reproduced except in full and must be read in conjunction with the attached ‘Important information about your Tetra Tech Coffey report’.

APPENDIX A. BORE HOLE LOCATION PLAN

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE	AW	PM	07-11-2022

LEGEND

- BASEMENT FOOTPRINT
- BOREHOLE LOCATION
- CPT LOCATION

MAP PROJECTION: GDA2020 MGA ZONE 56

10 0 10 30 50

Scale (metres) 1:1000

AERIAL IMAGERY COPYRIGHT: ©Nearmap (2/08/2022)
SOURCED FROM WEBSITE: https://www.nearmap.com/au/en

drawn	PM / AW
approved	PM
date	07-11-2022
scale	AS SHOWN
original size	A3

TETRA TECH COFFEY

client: AQUALAND

project: CENTRAL BARANGAROO DEVELOPMENT
BARANGAROO, NSW

title: INVESTIGATION LOCATION PLAN

project no: 754-SYDGE287887-AN | figure no: FIGURE 1 | rev: A

PLOT DATE: 7/11/2022 4:56:03 PM DWG FILE: \\TT.LOCAL\COFS\779\R1. PROJECTS\4. SYD-GEOTECHNICS\12. SYDGE280000\SYDGE287887 BARANGAROO CENTRAL AQUALAND\12. CAD\754-SYDGE287887-AN.DWG

APPENDIX B. BORE HOLE ENGINEERING LOGS & CORE PHOTOGRAPHS

SOIL DESCRIPTION EXPLANATION SHEET

DEFINITION:

In engineering terms soil includes every type of uncemented or partially cemented inorganic or organic material found in the ground. In practice, if the material can be remoulded or disaggregated by hand in its field condition or in water it is described as a soil. Other materials are described using rock description terms.

CLASSIFICATION SYMBOL & SOIL NAME

Soils are described in accordance with AS 1726:2017 as shown in the table on Sheet 2.

PARTICLE SIZE DEFINITIONS

Components	Subdivision	Size (mm)
Boulders Cobbles		>200 63 - 200
Gravel	Coarse Medium Fine	19 - 63 6.7 - 19 2.36 - 6.7
Sand	Coarse Medium Fine	0.6 - 2.36 0.210 - 0.6 0.075 - 0.21
Silt Clay		0.002 – 0.075 < 0.002

MOISTURE CONDITION

Coarse Grained Soil

Dry (D)	Non-cohesive and free-running
Moist (M)	Soil feels cool, darked in colour. Soil tends to stick together.
Wet (W)	As for moist, with free water forming when handled.

Fine Grained Soil

Moist, dry of plastic limit ($w<W_P$)	Hard and friable or powdery
Moist, near plastic limit ($w\approx W_P$)	Can be moulded at a moisture content approximately equal to the plastic limit.
Moist, wet of plastic limit ($w>W_P$)	Soils usually weakened and free water forms on hands when handling.
Wet, near liquid limit ($w\approx W_L$)	Near liquid limit.
Wet, wet of liquid limit ($w>W_L$)	Wet of liquid limit.

CONSISTENCY OF COHESIVE SOILS

Term (Abbreviation)	Indicative undrained shear strength s_u (kPa)	Field guide
Very Soft (VS)	<12	Soil exudes between fingers when squeezed in hand.
Soft (S)	12 – 25	Soil can be moulded by light finger pressure.
Firm (F)	25 – 50	Soil can be moulded by strong finger pressure.
Stiff (St)	50 – 100	Soil cannot be moulded by fingers.
Very Stiff (VSt)	100 – 200	Soil can be indented by thumb nail.
Hard (H)	>200	Soil can be indented with difficulty by thumb nail.
Friable (Fb)	–	Soil can be easily crumbled or broken into small pieces by hand.

RELATIVE DENSITY OF NON-COHESIVE SOILS

Term (Abbreviation)	Density index (%)
Very Loose (VL)	Less than 15
Loose (L)	15 – 35
Medium Dense (MD)	35 – 65
Dense (D)	65 – 85
Very Dense (VD)	Greater than 85

MINOR COMPONENTS

Term	Assessment Guide	Proportion of minor component in:
Trace	Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component.	Coarse grained soils: Fines - <5%, Accessory coarse fraction - <15% Fine grained soils: sand/gravel <15%
With	Presence easily detected by feel or eye, soil properties little different to general properties of primary component.	Coarse grained soils: Fines - 5 to 12%, Accessory coarse fraction – 15 to 30% Fine grained soils: sand/gravel 15 to 30%

SOIL STRUCTURE AND CEMENTATION

Zoning		Cementation	
Layer	Zone is continuous across exposure or sample.	Weakly cemented	Easily disaggregated by hand in air or water.
Lense	Discontinuous layer of different material, with lenticular shape.	Moderately cemented	Effort is required to disaggregate the soil by hand in air or water.
Pocket	Irregular inclusion of different material.		

GEOLOGICAL ORIGIN

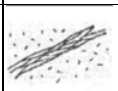
Residual soil	Structure and fabric of parent rock not visible.
Extremely weathered material	Structure and/or fabric of parent rock is visible.
Alluvial soil	Deposited by streams and rivers.
Estuarine soil	Deposited in coastal estuaries, including sediments carried by inflowing rivers and streams, or tidal currents.
Marine soil	Deposited in a marine environment
Lacustrine soil	Deposited in freshwater lakes
Aeolian soil	Carried and deposited by wind
Colluvial soil	Deposited on slopes (transported downslope by gravity, with or without assistance of water).
Topsoil	Mantle of surface or near surface material, often defined by high levels of organic material.
Fill	Any material which has been placed by anthropogenic processes. Fill may be significantly more variable between tested locations than naturally occurring soils.

SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 63 mm and basing fractions on estimated mass)							GROUP SYMBOL	SOIL NAME
COARSE GRAINED SOIL More than 65% of materials less than 63 mm is larger than 0.075 mm	(A 0.075 mm particle is about the smallest particle visible to the naked eye)	GRAVEL More than half of coarse fraction is larger than 2.36 mm	CLEAN GRAVEL (Fines less than 5%)	Wide range in grain size and substantial amounts of all intermediate particle sizes, not enough fines to bind coarse grains, no dry strength.			GW	GRAVEL
				Predominantly one size or a range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength.			GP	GRAVEL
			GRAVEL with FINES (Fines greater than 12%)	'Dirty' materials with excess of non-plastic fines (for identification procedures see ML below).			GM	Silty GRAVEL
				'Dirty' materials with excess of plastic fines (for identification procedures see CL below).			GC	Clayey GRAVEL
		SAND More than half of coarse fraction is smaller than 2.36	CLEAN SAND (Fines less than 5%)	Wide range in grain sizes and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength.			SW	SAND
				Predominantly one size or a range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength.			SP	SAND
			SAND with FINES (Fines greater than 12%r)	'Dirty' materials with excess of non-plastic fines (for identification procedures see ML below).			SM	Silty SAND
				'Dirty' materials with excess of plastic fines (for identification procedures see CL below).			SC	Clayey SAND
FINE GRAINED SOIL More than 35% of material less than 63 mm is smaller than 0.075 mm			IDENTIFICATION PROCEDURES ON FRACTIONS <0.2 mm					
		SILT & CLAY Liquid limit less	DRY STRENGTH	DILATANCY	TOUGHNESS			
			None to low	Slow to rapid	Low		ML	SILT
			Medium to high	None to slow	Medium		CL, CI	CLAY
			Low to medium	Slow	Low		OL	Organic SILT
		SILT & CLAY Liquid limit	Low to medium	None to slow	Low to medium		MH	SILT
			High to very high	None	High		CH	CLAY
			Medium to high	None to very slow	Low to medium		OH	Organic CLAY
HIGHLY ORGANIC SOILS			Readily identified by colour, odour, spongy feel and frequently by fibrous texture.				PT	Peat

● Low plasticity – Liquid Limit W_L less than 35%. ● Medium plasticity –W_L between 35% and 50%. ● High plasticity – W_L greater than 50%.

COMMON DEFECTS IN SOIL

TERM	DEFINITION	DIAGRAM
Parting	A surface or crack across which the soil has little or no tensile strength. Parallel or sub parallel to layering (e g. bedding). May be open or closed.	
Fissure	A surface or crack across which the soil has little or no tensile strength but which is not parallel or sub parallel to layering. May be open or closed. May include desiccation cracks.	
Sheared Seam	Zone in clayey soil with roughly parallel near planar, curved or undulating boundaries containing closely spaced, smooth or slickensided, curved intersecting joints which divide the mass into lenticular or wedge shaped blocks.	
Sheared Surface	A near planar curved or undulating, smooth, polished or slickensided surface in clayey soil. The polished or slickensided surface indicates that movement (in many cases very little) has occurred along the defect	

TERM	DEFINITION	DIAGRAM
Softened Zone	A zone in clayey soil, usually adjacent to a defect in which the soil has a higher moisture content than elsewhere	
Tube	Tubular cavity. May occur singly or as one of a large number of separate or interconnected tubes. Walls often coated with clay or strengthened by denser packing of grains. May contain organic matter. Origins include root holes, animal burrows, tunnel erosion.	
Tube cast	An infilled tube. The infill may be uncemented or weakly cemented soil or have rock properties.	
Infilled Seam	Sheet or wall like body of soil substance or mass with roughly planar to irregular near parallel boundaries which cuts through a soil mass. Formed by infilling of open defects.	

ROCK DESCRIPTION EXPLANATION SHEET

The descriptive terms used by Tetra Tech Coffey are given below. They are broadly consistent with Australian Standard AS1726:2017.

DEFINITIONS: Rock material, defect, structure and rock mass are defined as follows:

Rock material	In engineering terms rock material is any naturally occurring aggregate of minerals and/or organic materials that cannot be disaggregated by hand in air or water without prior soaking. Rock material is intact rock that is bounded by defects. Material which can be disaggregated or remoulded should be described as a soil.
Defect	Discontinuity, fracture, break or void in the material or materials across which there is little or no tensile strength.
Structure	Nature and configuration of the different defects within the rock mass and their relationship with each other.
Rock mass	It is the entirety of the system formed by all of the rock material and all of the defects. That is, it is a body of material which is not effectively homogeneous.

MATERIAL DESCRIPTIVE TERMS:

Rock name	Simple rock names are used rather than precise geological classification.
Particle size	Grain size terms for sandstone are:
Coarse grained	Mainly 0.6mm to 2mm
Medium grained	Mainly 0.2mm to 0.6mm
Fine grained	Mainly 0.06mm (just visible) to 0.2mm
Fabric	When grains show an alignment, a preferred orientation or a layering (e.g. bedding or lamination for sedimentary rocks, and foliation or cleavage for metamorphic rocks) the terms used are:
Massive	No layering or penetrative fabric.
Indistinct	Layering or fabric just visible. Little effect on strength properties.
Distinct	Layering or fabric is easily visible. Rock may break more easily parallel to the fabric.

CLASSIFICATION OF MATERIAL WEATHERING

Term	Abbreviation	Definition
Residual Soil	**RS**	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible. Soil has not been significantly transported.
Extremely Weathered	**XW**	Material is weathered to such an extent that it has soil properties, i.e. it either disaggregates or can be remoulded in water. Mass structure and material texture and fabric of original rock are still visible.
Highly Weathered[1]	**HW**	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching or may be decreased due to the deposition of weathering products in pores.
Moderately Weathered[1]	**MW**	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is no longer recognisable. Little or no change of strength from fresh rock.
Slightly Weathered	**SW**	Rock is partially discoloured with staining or bleaching adjacent to defects, but shows little or no change of strength from fresh rock.
Fresh	**FR**	Rock shows no sign of decomposition of individual minerals or colour changes.

Notes on Weathering:

1. The term 'Distinctly Weathered' (DW) may be used where it is not practicable (or it is judged that there is no advantage in making such a distinction) to distinguish between 'Highly Weathered' and 'Moderately Weathered'. 'Distinctly Weathered' is defined as follows: 'Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores'.
2. Where physical and chemical changes of the rock material are caused by hot gases or liquids at depth (process called alteration) the term 'altered' may be substituted for 'weathering' to give the abbreviations XA, HA, MA, SA and DA.

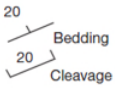
ROCK MATERIAL STRENGTH TERMS

Term (Abbreviation)	Guide to Strength: Point Load Strength Index, $I_{s(50)}$ (MPa)	Guide to Strength: Field Assessment
Very Low (VL)	0.03 - 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with a knife; too hard to cut a triaxial sample by hand; pieces up to 30mm thick can be broken by finger pressure.
Low (L)	0.1 - 0.3	Easily scored with a knife; indentations 1mm to 3mm show with firm bows of a pick point; has a dull sound under hammer. A piece of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium (M)	0.3 to 1.0	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High (H)	1 to 3	A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High (VH)	3 to 10	Hand specimen breaks after more than one blow; rock rings under hammer.
Extremely High (EH)	More than 10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Notes on Rock Material Strength:

1. Material with strength less than 'Very Low' should be described using soil characteristics.
2. The method of measuring the $I_{s(50)}$ should be in accordance with AS 4133.4.2.
3. The rock strength should be determined perpendicular to any anisotropy in the rock. High strength anisotropic rocks may readily break parallel to the planar anisotropy.
4. Although AS1726:2017 provides a basis for rock strength terms based on Unconfined Compressive Strength (UCS), the ratio between UCS and $I_{s(50)}$ may vary from less than 10 to over 30 depending on the rock type and overall strength. The UCS/$I_{s(50)}$ strength ratio should be determined for each rock material.
5. The rock strength classification using $I_{s(50)}$ above should be considered indicative only. The rock strength classified in accordance with AS1726:2017 may be higher or lower if UCS results are available.

COMMON ROCK DEFECT TYPES

Term	Definition	Diagram	Map Symbol	Graphic Log (Note 1)
Parting	A surface or crack across which the rock has little or no tensile strength. Parallel or sub-parallel to layering (e.g. bedding) or a planar anisotropy in the rock material (e.g. cleavage). May be open or closed.			(Note 2)
Joint	A surface or crack with no apparent shear displacement and across which the rock has little or no tensile strength, but which is not parallel or sub-parallel to layering or to planar anisotropy in the rock material. May be open or closed.			(Note 2)
Sheared Zone/Seam (Note 3)	Zone of rock material with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge shaped blocks.			
Sheared Surface (Note 3)	A near planar, curved or undulating surface which is usually smooth, polished or slickensided and which shows evidence of shear displacement.			
Crushed Seam (Note 3)	Seam of soil material with roughly parallel almost planar boundaries, composed of disoriented, usually angular fragments of the host rock material which may be more weathered than the host rock. The seam has soil properties.			
Infilled Seam	Seam of soil material usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint, infilled seams up to 1mm thick may be described as veneer or coating on a joint surface.			
Extremely Weathered Seam	Seam of soil material, often with gradational boundaries. Formed by weathering of the rock material in place.			

Notes on Defects:

1. Usually borehole logs show the true dip of defects, and face sketches and sections show the apparent dip.
2. Partings and joints are not usually shown on the graphic log unless considered significant.
3. Sheared zones/seams, sheared surfaces and crushed seams are generally faults in geological terms.

DEFECT SHAPE TERMS

Planar	The defect does not vary in orientation
Curved	The defect has a gradual change in orientation
Undulating	The defect has a wavy surface
Stepped	The defect has one or more well defined steps
Irregular	The defect has many sharp changes of orientation

Note: The assessment of defect shape is partly influenced by the scale of the observation.

DEFECT ROUGHNESS TERMS

Very Rough	Many large surface irregularities (amplitude generally more than 1mm). Feels like, or coarser than very coarse sand paper.
Rough	Many small surface irregularities (amplitude generally less than 1mm). Feels like fine to coarse sand paper.
Smooth	Smooth to touch. Few or no surface irregularities.
Polished	Shiny smooth surface.
Slickensided	Grooved or striated surface, usually polished.

DEFECT COATING TERMS

Clean	No visible coating.
Stained	No visible coating but surfaces are discoloured.
Veneer	A visible coating of soil or mineral, too thin to measure; may be patchy.
Coating	A visible coating up to 1mm thick. Thicker soil material should be described using appropriate defect terms (e g. infilled seam). Thicker rock strength material should be described as a vein.

DIMENSION OF DEFECTS

Spacing, length, openness and thickness

The spacing, length, aperture (openness), and seam thickness should generally be described directly in millimetres or metres.

Block Shape

Where it is considered significant, block shape (e.g. tabular, prismatic, columnar) should be described using the terms in Table 23 of AS 1726:2017.

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	**BH1**
sheet:	1 of 5
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**22 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**22 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,696.86; N: 6,251,708.44 (GDA94 Zone 56) surface elevation: 2.42 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa)	soil origin, structure and additional observations
SONIC / C	1 2 3	▶		2				**ROAD SURFACE: ASPHALTIC CONCRETE**: dark grey, 50mm.	D			**PAVEMENT**
								FILL: Sandy GRAVEL: fine to medium, sub-angular basalt gravel, grey to dark grey, fine to medium grained sand.	<Wp			**FILL**
									D			
				1	1.0			**FILL: Sandy CLAY**: low plasticity, pale brown, fine to coarse grained sand, with fine to coarse, angular to sub-angular sandstone and basalt gravel, trace pale grey clay pockets.				
								FILL: Gravelly SAND: fine to medium grained, pale brown to pale yellow-brown, fine to coarse angular to sub-rounded sandstone and basalt gravel, trace brick fragments to 10mm, trace fines.				
				0	2.0							
					3.0			**FILL: Gravelly CLAY**: low to medium plasticity, pale grey mottled red-brown and yellow-brown, with fine to coarse sub-angular and elongated sandstone and basalt gravel, trace fine to medium grained sand.	<Wp			
				-1	4.0							
				-2	5.0							
				-3	6.0			**FILL: MIXTURE OF COBBLES(85%) AND SOIL (15%)**: sub-rounded to sub-angular sandstone cobbles, fine to medium grained, orange. Soil is Sandy CLAY, low to medium plasticity, yellow-brown and orange, fine to medium grained sand.	M			
				-4					>Wp			
								FILL: CLAY: low plasticity, brown, trace silt, trace fine to medium grained sand.				
					7.0			**FILL: Clayey GRAVEL**: fine to coarse, angular to sub-angular basalt gravel, grey-brown and dark grey, trace medium to coarse sub-angular sandstone gravel, trace sub-rounded sandstone cobbles.	W			
				-5					>Wp			
								FILL: CLAY: medium plasticity, red-orange mottled pale grey and yellow-brown, trace fine to medium,				

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud N nil
C casing

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remoulded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	***BH1***
sheet:	2 of 5
project no.	***754-SYDGE287887***
client:	***Aqualand Projects Pty Ltd***
date started:	***22 Jul 2022***
principal:	***Aqualand Projects Pty Ltd***
date completed:	***22 Jul 2022***
project:	***Central Barangaroo Development***
logged by:	***RAS***
location:	***39 Hickson Road, Sydney NSW 2000***
checked by:	***RT***

position: E: 333,696.86; N: 6,251,708.44 (GDA94 Zone 56) surface elevation: 2.42 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa)	soil origin, structure and additional observations
SONIC, C				-6				sub-angular iron indurated gravel.	>Wp			**FILL**
					9.0			**FILL: Sandy CLAY**: low to medium plasticity, yellow-brown, medium to coarse grained sand, with medium to coarse, sub-angular sandstone gravel, trace sub-angular sandstone cobbles.				
				-7				**FILL: Sandy CLAY**: low to medium plasticity, pale yellow-brown and orange-red, medium to coarse grained sand, with fine to coarse sub-angular sandstone gravel.				
					10.0			**FILL: Sandy CLAY**: medium plasticity, yellow-brown, fine to medium grained sand, with medium to coarse sub-angular sandstone gravel, trace sandstone cobbles.				
				-8				**FILL: Silty CLAY**: low plasticity, dark grey, trace wood pieces to 5mm, trace shell and shell fragments to 10mm, and fine sub-angular granite gravel.	W			
							CI-CH	**FILL: SAND**: fine to medium grained, dark grey, with silt, trace shell and wood fragments to 50mm, and trace medium sub-angular granite gravel.	>Wp	St - VSt	HP 200 kPa HP 220 kPa HP 250 kPa	**ALLUVIUM**
					11.0			**Sandy CLAY**: medium to high plasticity, orange mottled pale grey and yellow-brown, fine to medium grained sand.			HP 260 kPa HP 290 kPa	
				-9						VSt - H	HP 330 kPa HP 400 kPa	
					12.0						HP 410 kPa	
				-10							HP 390 kPa HP 415 kPa	
					13.0						HP 430 kPa	
				-11							HP 450 kPa	
					14.0		CI-CH	**Sandy CLAY**: medium to high plasticity, orange to orange-red, fine to medium grained sand, relict rock fabric visible, laminated 10-20mm, extremely weathered. 14.2 m: becoming pale grey From 14.4m: becoming red-brown and pale grey		H	HP 450 kPa	**EXTREMELY WEATHERED MATERIAL**
				-12								
					15.0			Borehole BH1 continued as cored hole				
				-13								

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud N nil
C casing

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remoulded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TETRA TECH COFFEY

Engineering Log - Cored Borehole

Borehole ID.	**BH1**
sheet:	3 of 5
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**22 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**22 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,696.86; N: 6,251,708.44 (GDA94 Zone 56) surface elevation: 2.42 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information				material substance						rock mass defects			
method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular	general
		-6	9.0									
		-7	10.0									
		-8	11.0									
		-9	12.0									
		-10	13.0									
		-11	14.0									
		-12			started coring at 14.78m							
HQ3	100% Water return	-13	15.0		**SANDSTONE**: fine to medium grained, pale grey with bands of orange-red, cross-bedded at 0-5°.	XW HW			53%		From 14.78m to 22m: strong petrol/coal tar odour. After 22m slight petrol/coal tar odour. Possible contamination into rock.	
					SANDSTONE: medium to coarse grained, red-brown to orange with bands of pale grey, indistinctly cross-bedded at 5-20°, 1% siltstone flecks and clasts to 5mm, heavily iron stained.			a=1.13 d=0.76	95%		PT, 5 - 30°, UN, Fe and coal tar SN, tight	

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:41

TETRA TECH COFFEY

Engineering Log - Cored Borehole

Borehole ID.	**BH1**
sheet:	4 of 5
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**22 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**22 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,696.86; N: 6,251,708.44 (GDA94 Zone 56) surface elevation: 2.42 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
HQ3	95% Water return	-14		From 16.0m: scattered sub-rounded to rounded quartz and siltstone clasts to 10mm, 15% voids up to 10mm	HW					
				NO CORE: 0.08 m	MW		a=0.84 d=0.80			PT, 0 - 5°, PL, RO, Fe SN XW SM, 0 - 15°, IR, clay with sand, 2-5mm PT, 10°, ST, RO, Coal tar SN
		-15	17.0	**SANDSTONE**: medium to coarse grained, red-brown and orange, indistinctly cross-bedded at 0-15°, heavily iron stained, some defect surfaces contain a dark grey possible coal tar staining or veneer. 16.82 to 17.07 m: possible petrol/coal tar impregnated into rock matrix, with dark grey zones up to 100mm 16.83 to 16.90 m: sub-angular fine to medium quartz gravel	FR		a=1.29 d=1.17	95%		JT, 40 - 85°, UN, VR, CN, (17.39m-17.97m)
		-16	18.0	**SANDSTONE**: medium to coarse grained, pale grey, indistinctly to distinctly cross-bedded at 5-20°, 2% siltstone laminations and flecks. From 17.8m: occasional dark grey, sub-rounded to elongated siltstone clasts up to 20mm From 18.43: 2% voids up to 10mm 18.54 to 18.70 m: dark grey coal tar staining	SW FR		a=1.42 d=1.15			JT, 25 - 50°, ST, tight JT, 5 - 55°, ST, RO, Fe and coal tar SN
		-17	19.0	19.50 to 19.55 m: dark grey wavy siltstone laminations up to 5mm			a=1.18 d=1.32			
		-18	20.0	**SHALE BRECCIA**: sub-rounded to irregularly shaped, dark grey siltstone clasts and beds up to 70mm in a pale grey, medium to coarse grained sandstone matrix. 2% sub-rounded to sub-angular quartz clasts. Matrix supported. Siltstone beds are laminated at 5-15°.			a=0.20 d=0.23	99%		JT, 40 - 55°, ST, VR, CN
	95-100% Water return	-19	21.0	**SANDSTONE**: medium to coarse grained, pale grey, distinctly cross-bedded at 5-20°, 5-30mm typical spacing, well developed bedding, 1% dark grey siltstone flecks.			a=1.16 d=0.77			
		-20	22.0	22.24 to 22.28 m: dark grey siltstone laminations				100%		
		-21	23.0				a=1.85 d=1.76			PT, 10°, PL, RO, Clay VN PT x2, 15°, PL, Clay VN, tight

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:41

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

coating
CN clean
SN stained
VN veneer
CO coating

TETRA TECH COFFEY

Engineering Log - Cored Borehole

Borehole ID.	***BH1***
sheet:	5 of 5
project no.	***754-SYDGE287887***
date started:	***22 Jul 2022***
date completed:	***22 Jul 2022***
logged by:	***RAS***
checked by:	***RT***

client: ***Aqualand Projects Pty Ltd***

principal: ***Aqualand Projects Pty Ltd***

project: ***Central Barangaroo Development***

location: ***39 Hickson Road, Sydney NSW 2000***

position: E: 333,696.86; N: 6,251,708.44 (GDA94 Zone 56) surface elevation: 2.42 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information				material substance					rock mass defects		
method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
HQ3		-22	25.0		From 23.87m: becoming indistinctly cross-bedded From 24.27m: disturbed bedding	FR		a=1.34 d=1.63	100%		
		-23	26.0		Borehole BH1 terminated at 24.38 m Target depth						
		-24	27.0								
		-25	28.0								
		-26	29.0								
		-27	30.0								
		-28	31.0								
		-29									

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:41

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

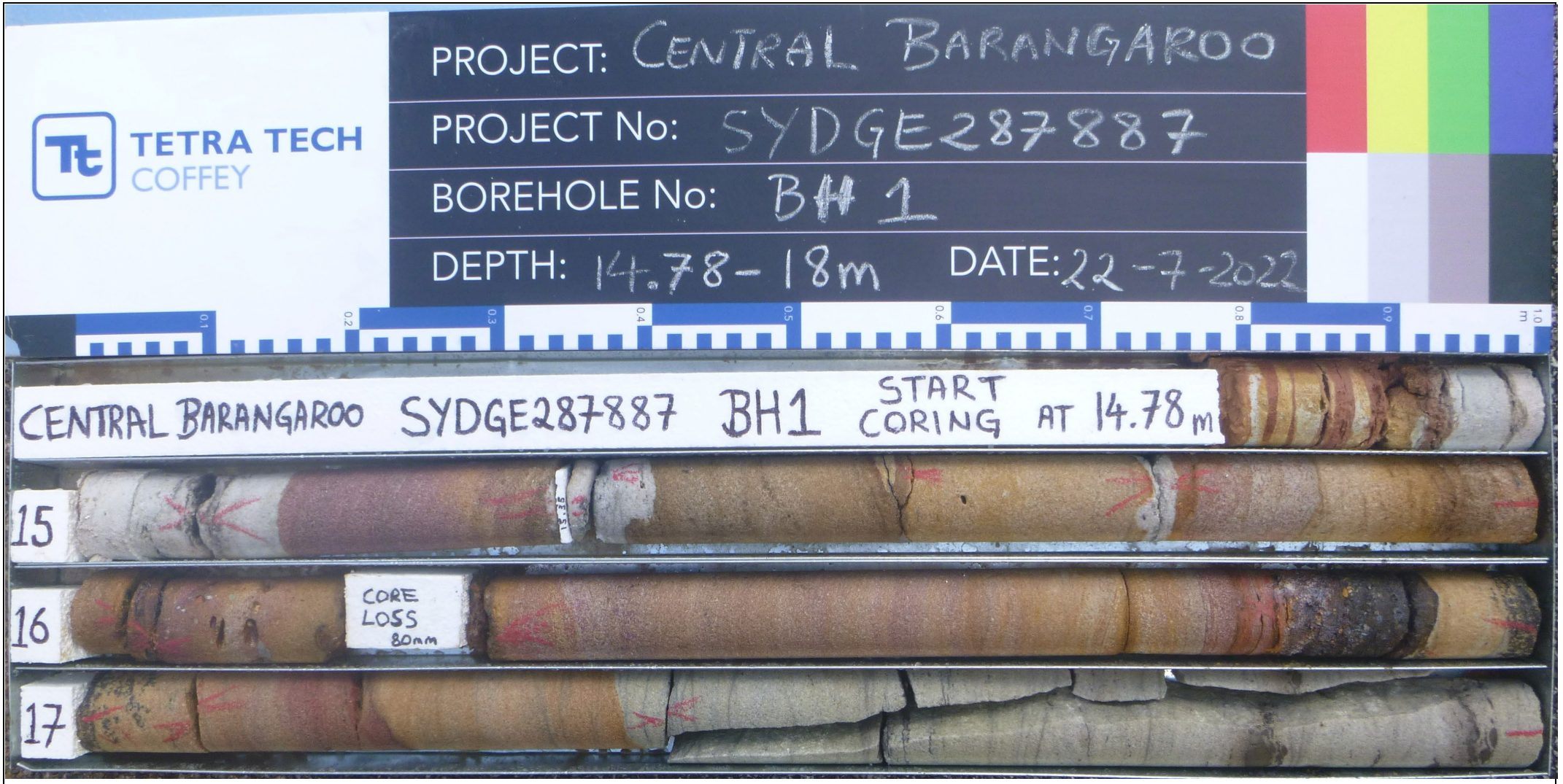
strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

coating
CN clean
SN stained
VN veneer
CO coating



drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project :	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH1**
scale	**N/A**		project no: **754-SYDGE287887**	**Figure 1**
original	**A4**			

drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project :	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH1**
scale	**N/A**			
original	**A4**		project no: **754-SYDGE287887**	**Figure 2**

drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project :	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH1**
scale	**N/A**			
original	**A4**		project no: **754-SYDGE287887**	**Figure 3**

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	**BH2**
sheet:	1 of 5
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**05 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**06 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,664.26; N: 6,251,721.52 (GDA94 Zone 56) surface elevation: 2.51 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa)	soil origin, structure and additional observations
SONIC / C		▶		2				**ROAD SURFACE: ASPHALTIC CONCRETE**: dark grey, 50mm.	D			**PAVEMENT**
								FILL: Sandy GRAVEL: pale brown, medium to coarse sub-angular to sub-rounded sandstone gravel, fine to medium grained sand.				**FILL**
				1	1.0			**FILL: Gravelly SAND**: fine to medium grained, dark grey to grey, medium to coarse sub-rounded to sub-angular basalt and sandstone gravel, trace brick fragments to 5mm. From 0.65m: becoming brown.				
								FILL: GRAVEL: fine to medium, sub-angular and platy basalt gravel, dark grey, trace fine to medium grained sand.	<Wp			
								FILL: MIXTURE OF BRICKS (65%) AND SOIL (35%): Brick fragments to 30mm, orange. Soil is Clayey SAND, fine to medium grained, brown to dark brown with fine to medium, sub-angular basalt gravel.	D			
				0	2.0			**FILL: CONCRETE**: grey, 200mm.				
								FILL: Sandy CLAY: low plasticity, dark brown to grey, fine to medium grained sand, with medium to coarse, sub-angular basalt gravel, with brick fragments up to 50mm.	W			
				-1	3.0			**FILL: SAND**: fine to coarse grained, grey and brown, trace brick fragments to 5mm, becoming grey-brown with depth. From 3.4m: with medium to coarse, sub-angular sandstone gravel, trace terracotta fragments to 80mm.				At 3.0m: 2 pieces of bonded ACM, 5 to 15mm.
								FILL: Gravelly SAND: medium to coarse grained, grey and yellow-brown, fine to coarse, sub-angular sandstone and basalt gravel, trace brick and terracotta fragments to 70mm, trace fines.				
				-2	4.0							
				-3	5.0							
				-4	6.0							
				-5	7.0			**FILL: Sandy GRAVEL**: fine to coarse, sub-angular to sub-rounded sandstone gravel, grey and yellow-brown, medium to coarse grained sand, with fine to medium, sub-angular basalt gravel.				

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud
C casing
N nil

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remoulded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TETRA TECH COFFEY

Engineering Log - Borehole

		Borehole ID.	**BH2**
		sheet:	2 of 5
		project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**	date started:	**05 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**	date completed:	**06 Jul 2022**
project:	**Central Barangaroo Development**	logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**	checked by:	**RT**

position: E: 333,664.26; N: 6,251,721.52 (GDA94 Zone 56) surface elevation: 2.51 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (**SOIL NAME**: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa)	soil origin, structure and additional observations
SONIC C				-6	9.0			**FILL: SAND**: medium to coarse grained, grey and yellow-brown, with medium to coarse, sub-angular to sub-rounded sandstone gravel, trace clay and sandstone cobbles.	W			**FILL**
				-7	10.0							From 10.0m: Hydrocarbon odour.
				-8	11.0			**FILL: SAND**: fine to coarse grained, yellow-brown to brown, with medium to coarse, sub-angular and sub-rounded sandstone gravel, trace sandstone cobbles, trace tile and brick fragments to 50mm.				
				-9	12.0			**FILL: Sandy CLAY**: low plasticity, dark grey, fine to medium grained sand. From 11.6m: with medium to coarse, sub-rounded to sub-angular sandstone gravel, trace sub-rounded sandstone cobbles and trace metal strips up to 90mm.	>Wp W			From 12.0m: Slight hydrocarbon odour.
				-10	13.0			**FILL: MIXTURE OF REFUSE (80%) AND SOIL (20%)**: Refuse includes wood pieces up to 150mm (possible old wooden sleepers), copper wire, one metallic cylinder 110mm in length and several pieces of hard and soft plastic up to 50mm. Soil is SAND, fine to medium grained, grey.				
				-11	14.0							
				-12	15.0		CL-CI	**Sandy CLAY**: low to medium plasticity, red-brown mottled yellow-brown and pale grey, fine to medium grained sand, trace dark grey carbonaceous lenses. Sand grading to coarse with depth.	>Wp	St - VSt	×	**ALLUVIUM** From 15.0m: Hydrocarbon odour HP 130 kPa HP 200 kPa HP 270 kPa HP 250 kPa
				-13								

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud N nil
C casing

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remoulded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TETRA TECH COFFEY

Engineering Log - Borehole

		Borehole ID.	**BH2**
		sheet:	3 of 5
		project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**	date started:	**05 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**	date completed:	**06 Jul 2022**
project:	**Central Barangaroo Development**	logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**	checked by:	**RT**

position: E: 333,664.26; N: 6,251,721.52 (GDA94 Zone 56) surface elevation: 2.51 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	soil origin, structure and additional observations
SONIC, C				-14	17.0		CL-CI	**Sandy CLAY**: low to medium plasticity, red-brown mottled yellow-brown and pale grey, fine to medium grained sand, trace dark grey carbonaceous lenses. Sand grading to coarse with depth. *(continued)*	>Wp	St - VSt		**ALLUVIUM**
				-15							HP 240 kPa	
											HP 220 kPa	
								17.6 to 17.8 m: dark grey mottled orange-brown.				
					18.0		CI	**Sandy CLAY**: medium plasticity, pale grey mottled orange-brown, coarse grained sand.		VSt	HP 260 kPa	
				-16			SC	**CLAYEY SAND**: medium to coarse grained, dark grey to grey mottled yellow-brown, interbedded with low plasticity sandy clay layers up to 100mm thick.	W			
					19.0			From 19.0m: red-brown and pale grey.				
				-17			CI-CH	**Sandy CLAY**: medium to high plasticity, pale grey mottled orange-brown, medium to coarse grained sand, relict rock fabric visible, thinly laminated (5-10mm), extremely weathered.		H		**EXTREMELY WEATHERED MATERIAL**
					20.0			**SANDSTONE**: medium to coarse grained, red-brown becoming orange-brown, inferred very low to low strength, highly weathered.				From 19.3m: No hydrocarbon odour **HAWKESBURY SANDSTONE**
				-18								
					21.0			From 21.0m: with extremely weathered seams, becoming pale-brown and orange.				
				-19								
					22.0			**SANDSTONE**: medium to coarse grained, pale grey and orange, ironstained, inferred low to medium strength, highly to moderately weathered.				
				-20				Borehole BH2 continued as cored hole				
					23.0							
				-21								

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud
C casing
N nil

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remoulded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TETRA TECH COFFEY

Engineering Log - Cored Borehole

Borehole ID.	***BH2***
sheet:	4 of 5
project no.	***754-SYDGE287887***
client:	***Aqualand Projects Pty Ltd***
date started:	***05 Jul 2022***
principal:	***Aqualand Projects Pty Ltd***
date completed:	***06 Jul 2022***
project:	***Central Barangaroo Development***
logged by:	***RAS***
location:	***39 Hickson Road, Sydney NSW 2000***
checked by:	***RT***

position: E: 333,664.26; N: 6,251,721.52 (GDA94 Zone 56) surface elevation: 2.51 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		-14	17.0								
		-15	18.0								
		-16	19.0								
		-17	20.0								
		-18	21.0								
		-19	22.0		started coring at 22.16m						
HQ3	100% Water return	-20	23.0		**SANDSTONE**: medium to coarse grained, orange and pale grey, cross-bedded at 10-15°, iron stained.	MW					
		-21			**SANDSTONE**: medium to coarse grained, pale grey, indistinctly to distinctly cross-bedded at 5-25°, 2% dark grey siltstone flecks.	FR		a=0.88 d=1.34	100%		PT, 10°, PL, closed
					23.67 to 23.74 m: dark grey carbonaceous laminations and flecks			a=1.37 d=1.23			PT, 5 - 10°, UN, RO, Clay VN

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:41

TETRA TECH COFFEY

Engineering Log - Cored Borehole

Borehole ID.	**BH2**
sheet:	5 of 5
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**05 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**06 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,664.26; N: 6,251,721.52 (GDA94 Zone 56) surface elevation: 2.51 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
HQ3	100% Water return	-22			**SANDSTONE**: medium to coarse grained, pale grey, distinctly cross-bedded at 15-25°, 10-50mm typical spacing, well developed bedding. *(continued)*	FR		a=1.48 d=1.26	100%		PT, 15°, PL, Clay VN, tight
			25.0		**SANDSTONE**: medium to coarse grained, pale grey, indistinctly becoming distinctly cross-bedded at 10-20° with depth, 15 - 100mm typical spacing.			a=1.54 d=1.33			
		-23							100%		
			26.0		**SANDSTONE**: medium to coarse grained, pale grey, indistinct and irregular cross-bedding, 1% dark grey carbonaceous flecks. 26.39 to 26.58 m: wavy bedding			a=1.19 d=1.33			PT, 0 - 10°, UN, RO, Clay CO, possible DB
		-24									
			27.0					a=1.63 d=1.59			
		-25			27.57 to 27.65 m: wavy bedding						
			28.0								PT x2, 5°, PL, Clay VN, tight
		-26						a=1.63 d=1.46	98%		
			29.0		28.84 to 28.99 m: scattered dark grey, sub-rounded and elongated siltstone clasts up to 40mm			a=1.69 d=1.41			PT, 5 - 10°, PL, Clay VN, tight PT, 10°, PL, Clay VN, tight
		-27			**SANDSTONE**: medium to coarse grained, pale grey, indistinctly cross-bedded at 5-15°.						
			30.0		Borehole BH2 terminated at 29.30 m Target depth Standpipe Installed						
		-28									
			31.0								
		-29									

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:41

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

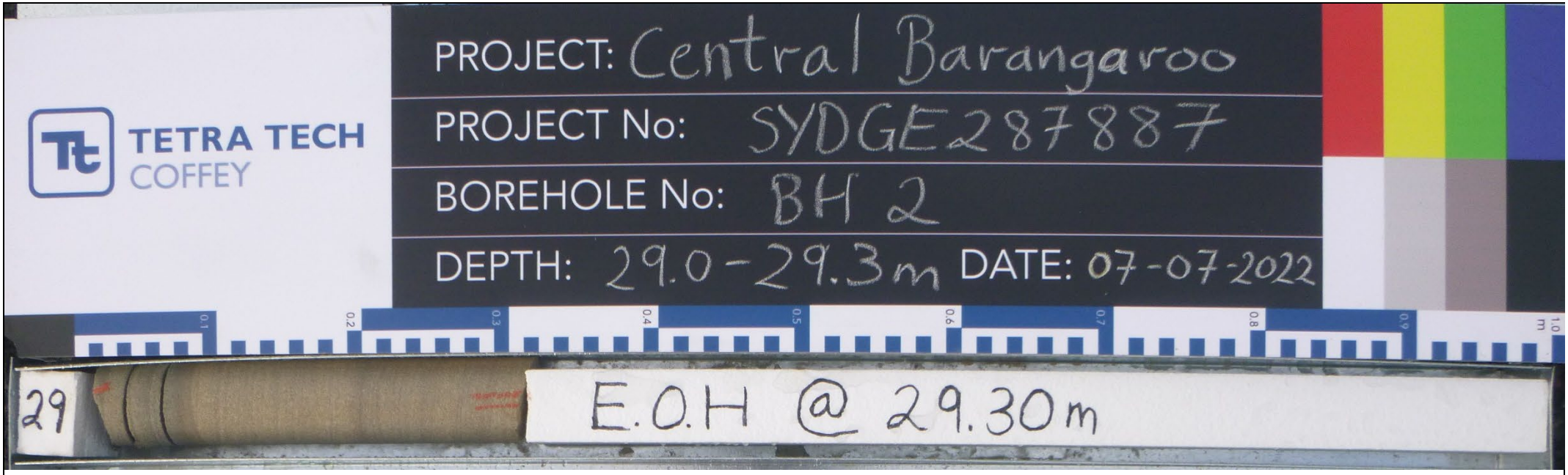
roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

coating
CN clean
SN stained
VN veneer
CO coating

drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project :	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH2**
scale	**N/A**			
original	**A4**		project no: **754-SYDGE287887**	**Figure 1**

drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project :	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH2**
scale	**N/A**			
original	**A4**		project no: **754-SYDGE287887**	**Figure 2**



drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project :	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH2**
scale	**N/A**			
original	**A4**		project no: **754-SYDGE287887**	**Figure 3**

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	**BH3**
sheet:	1 of 7
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**25 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**26 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,568.79; N: 6,251,769.03 (GDA94 Zone 56) surface elevation: 2.32 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa)	soil origin, structure and additional observations
SONIC / C	1 2 3	▶		2				**ROAD SURFACE: ASPHALTIC CONCRETE**: dark grey, 90mm.	<Wp			**PAVEMENT**
								FILL: Gravelly CLAY: low plasticity, grey, fine to coarse sub-angular basalt gravel, trace fine to medium sub-angular sandstone gravel, trace fine to medium grained sand.	D			**FILL**
									>Wp			**PAVEMENT**
					1.0			**ROAD SURFACE: ASPHALTIC CONCRETE**: grey, 250mm.				**FILL**
				1				**FILL: Sandy CLAY**: low plasticity, pale brown and pale grey, fine to coarse grained sand with fine to coarse, sub-angular basalt and sandstone gravel, trace sandstone cobbles.	W			
					2.0			**FILL: MIXTURE OF COBBLES (70%) AND SOIL (30%)**: Sub-angular to sub-rounded pale grey sandstone and dark grey siltstone cobbles. Soil is Gravelly SAND, fine to medium grained, pale brown, fine to coarse sub-angular to rounded sandstone and siltstone gravel.				
				0				**FILL: Sandy CLAY**: low plasticity, pale grey and pale brown, fine to coarse grained sand, with fine to coarse sub-angular sandstone gravel, trace sub-rounded to angular sandstone cobbles.	>Wp			
					3.0			**FILL: Sandy CLAY**: low to medium plasticity, pale grey to grey, medium to coarse grained sand, with fine to coarse sub-angular sandstone gravel, trace sub-rounded to angular sandstone cobbles.				
				-1								
					4.0							
				-2								
					5.0			From 5.0m: becoming pale -brown, with dark grey silty sand lenses				
				-3								
					6.0			**FILL: Gravelly Sandy CLAY**: low plasticity, dark grey to grey, fine to medium grained sand, fine to coarse sub-angular to angular sandstone and basalt gravel, metal wires to 80mm length.	W			
				-4				**FILL: Gravelly SAND**: fine to coarse grained, pale yellow-brown, fine to coarse, sub-angular to angular and platy basalt and sandstone gravel, trace fines.				
					7.0							
				-5								

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud N nil
C casing

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remoulded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	**BH3**
sheet:	2 of 7
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**25 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**26 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,568.79; N: 6,251,769.03 (GDA94 Zone 56) surface elevation: 2.32 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

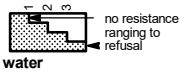
method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	soil origin, structure and additional observations
SONIC C				-6					W			**FILL**
								FILL: Sandy CLAY: low to medium plasticity, grey, fine to coarse grained sand, with fine to coarse sub-angular to angular sandstone gravel, trace sub-rounded sandstone cobbles, copper wires up to 120mm in length.	>Wp			
					9.0			**FILL: SAND**: fine to coarse grained, pale yellow-brown, fine to medium sub-angular basalt and sandstone gravel, trace fine sub-angular quartz gravel, trace brick fragments to 5mm.	W			
				-7					>Wp			
								FILL: Sandy CLAY: low plasticity, grey to pale grey, fine to medium grained sand, with fine to coarse sub-angular sandstone gravel, trace sandstone cobbles.				
					10.0							
				-8								
					11.0							
				-9								
					12.0			**FILL: Sandy CLAY**: medium plasticity, pale grey and orange, fine to medium grained sand, rock fabric visible.				
				-10				**FILL: Sandy CLAY**: low to medium plasticity, pale grey, fine to medium grained sand, with fine to coarse sub-angular to angular sandstone gravel, trace sandstone cobbles. From 12.6m: yellow-brown				
					13.0							
				-11								
					14.0			**FILL: Silty CLAY**: low plasticity, dark grey with grey bands, trace fine to medium grained sand, trace shells and shell fragments to 30mm, trace root fibres. At 13.85m: 1 x sub-angular sandstone cobble				**DISTURBED SOIL / FILL**
				-12								
					15.0							
				-13								
							Cl	**CLAY**: medium plasticity, pale grey mottled orange-red and yellow-brown, trace fine to medium sub-angular iron indurated gravel.		F - St		**ALLUVIUM** HP 100 kPa HP 110 kPa

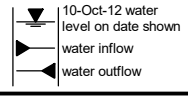
CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud N nil
C casing

penetration


water


samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remoulded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	***BH3***
sheet:	3 of 7
project no.	***754-SYDGE287887***
client:	***Aqualand Projects Pty Ltd***
date started:	***25 Jul 2022***
principal:	***Aqualand Projects Pty Ltd***
date completed:	***26 Jul 2022***
project:	***Central Barangaroo Development***
logged by:	***RAS***
location:	***39 Hickson Road, Sydney NSW 2000***
checked by:	***RT***

position: E: 333,568.79; N: 6,251,769.03 (GDA94 Zone 56) surface elevation: 2.32 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (**SOIL NAME**: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa)	soil origin, structure and additional observations
SONIC C				-14	17.0		CI	**CLAY**: medium plasticity, pale grey mottled orange-red and yellow-brown, trace fine to medium sub-angular iron indurated gravel. *(continued)*	>Wp	F - St	HP 140 kPa	**ALLUVIUM**
											HP 190 kPa	
											HP 170 kPa	
				-15							HP 220 kPa	
							CH	**CLAY**: high plasticity, grey mottled yellow-brown, trace fine to medium grained sand.		St - VSt	HP 200 kPa	
					18.0						HP 240 kPa	
				-16							HP 275 kPa	
											HP 310 kPa	
											HP 290 kPa	
					19.0						HP 300 kPa	
				-17			CI-CH	**Sandy CLAY**: medium to high plasticity, grey, fine to medium grained sand.		F - St	HP 50 kPa	
											HP 90 kPa	
							CH	**CLAY**: high plasticity, grey to pale grey mottled yellow-brown, with fine to medium grained sand.		VSt	HP 150 kPa	
					20.0						HP 190 kPa	
				-18							HP 230 kPa	
											HP 250 kPa	
											HP 280 kPa	
											HP 310 kPa	
					21.0		CH	**CLAY**: high plasticity, grey mottled red-orange and yellow-brown, trace fine to medium grained sand.			HP 200 kPa	
				-19							HP 120 kPa	
											HP 140 kPa	
							CI-CH	**CLAY**: medium to high plasticity, grey, with fine grained sand.		St - VSt	HP 180 kPa	
											HP 180 kPa	
											HP 200 kPa	
					22.0						HP 210 kPa	
				-20			CL-CI	**Sandy CLAY**: low to medium plasticity, grey to dark grey, fine to medium grained sand.			HP 120 kPa	
											HP 150 kPa	
											HP 180 kPa	
					23.0						HP 210 kPa	
				-21							HP 190 kPa	
											HP 230 kPa	

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud
C casing
N nil

penetration
1 2 3
no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remoulded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	**BH3**
sheet:	4 of 7
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**25 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**26 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,568.79; N: 6,251,769.03 (GDA94 Zone 56) surface elevation: 2.32 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description **SOIL NAME**: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency / relative density	hand penetrometer (kPa)	soil origin, structure and additional observations
SONIC C				-22			CL	**Sandy CLAY**: low plasticity, pale grey, fine to medium grained, trace dark grey silty lenses.	>Wp	F - St	HP 50 kPa HP 90 kPa HP 140 kPa	**ALLUVIUM**
					25.0		CI-CH	**CLAY**: medium to high plasticity, pale grey to grey, with fine to medium grained sand.		St - VSt	HP 150 kPa HP 190 kPa	
				-23			CI-CH	**Sandy CLAY**: medium to high plasticity, pale grey, fine to medium grained sand.			HP 220 kPa HP 200 kPa HP 240 kPa	
					26.0							
				-24							HP 220 kPa HP 280 kPa HP 300 kPa	
					27.0		SC	**CLAYEY SAND**: fine to medium grained, pale grey, interbedded with medium plasticity sandy clay layers up to 150mm.	W			
				-25			CL-CH	**Sandy CLAY**: low to medium plasticity, pale grey, fine to medium grained sand.	>Wp	St	HP 120 kPa HP 180 kPa	
					28.0		CI-CH	**CLAY**: medium to high plasticity, pale grey.		VSt	HP 160 kPa HP 280 kPa HP 300 kPa	
				-26			CH	**CLAY**: high plasticity, pale grey mottled red-orange and yellow-brown, trace fine to medium sub-angular iron indurated gravel.			HP 270 kPa HP 290 kPa	
					29.0							
				-27							HP 310 kPa HP 300 kPa HP 320 kPa HP 350 kPa	
					30.0		CI	**Sandy CLAY**: medium plasticity, grey mottled red-brown and yellow-brown, fine to medium grained sand.		St - VSt	HP 140 kPa	
				-28							HP 170 kPa HP 200 kPa	
					31.0						HP 210 kPa	
				-29							HP 200 kPa HP 240 kPa HP 220 kPa	

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud N nil
C casing

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remoulded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	**BH3**
sheet:	5 of 7
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**25 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**26 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,568.79; N: 6,251,769.03 (GDA94 Zone 56) surface elevation: 2.32 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	soil origin, structure and additional observations
SONIC C				-30			CI	**Sandy CLAY**: medium plasticity, grey mottled red-brown and yellow-brown, fine to medium grained sand. *(continued)* From 32.0m: yellow-brown to brown and pale grey	>Wp	St - VSt	HP 250 kPa HP 230 kPa HP 240 kPa HP 250 kPa HP 220 kPa HP 250 kPa HP 250 kPa	**ALLUVIUM**
				-31	33.0		CI-CH	**Sandy CLAY**: medium to high plasticity, pale grey, fine to medium grained sand, rock fabric visible, laminated to bedded (10-40mm), extremely weathered.		H		**EXTREMELY WEATHERED MATERIAL**
				-32	34.0			Borehole BH3 continued as cored hole				
				-33	35.0							
				-34	36.0							
				-35	37.0							
				-36	38.0							
				-37	39.0							

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
- DT diatube
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- RR rock roller

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

soil group symbol & material description based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

TETRA TECH COFFEY

Engineering Log - Cored Borehole

Borehole ID.	**BH3**
sheet:	6 of 7
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**25 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**26 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,568.79; N: 6,251,769.03 (GDA94 Zone 56) surface elevation: 2.32 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		-30									
			33.0								
		-31									
			34.0		started coring at 34.28m						
HQ3	100% Water return	-32			**SANDSTONE**: medium to coarse grained, pale grey banded orange, indistinctly cross-bedded at 5°. 34.56 m: dark grey siltstone clast, 25mm	MW		a=0.17 d=0.18			XW SM, 0 - 30°, PL, clay with sand, 15mm JT, 45°, PL, VR, Clay CO
			35.0			XW					XW SM, 0 - 30°, PL, sandy clay, 140mm
		-33			**SANDSTONE**: fine grained, pale grey with red-brown bands, orange iron staining around defects, indistinctly cross-bedded at 0-10°, 2% dark grey siltstone flecks.	HW SW		a=0.47 d=0.25	64%		PT, 5°, PL, tight PT, 5 - 10°, PL, tight PT, 0°, PL, tight JT, 0 - 45°, ST, Fe SN, tight CS, 10 - 45°, ST, sandy clay and fine gravel, 50mm JT, 30 - 60°, ST, Fe SN, tight JT, 5 - 20°, ST, RO, Fe SN JT, 20 - 30°, ST, Fe SN, tight JT, 40°, PL, Clay VN, tight JT, 15 - 60°, ST, RO, Sandy clay CO XW SM, 5°, PL, Sandy clay, 5mm JT, 5 - 35°, ST, RO, Fe SN PT, 15°, PL, Fe SN, closed PT, 15°, PL, RO, Fe Clay VN JT, 0 - 25°, ST, RO, CN
			36.0		From 35.89m: becoming distinctly cross-bedded at 5-15°, 5-10mm typical spacing, 15% dark grey siltstone laminations	SW					
		-34						a=1.00 d=0.54			
			37.0		36.64 to 36.75 m: Interlaminated sandstone (60%) and siltstone (40%): sandstone is pale grey to grey, fine grained, indistinctly cross-bedded at 0-5°, siltstone is dark grey From 36.75m: indistinctly cross-bedded at 0-5°	FR					XW SM, 0 - 5°, PL, sandy clay, 40mm
		-35			**SANDSTONE**: medium to coarse grained, pale grey, indistinctly cross-bedded at 5-20°, 2% dark grey siltstone flecks and laminations.			a=1.80 d=1.73			
			38.0						90%		SZ, 5 - 40°, ST, fine to medium sub-angular gravel, 50mm Sheared SM, 5 - 10°, PL, sandy clay, 5mm JT, 55 - 85°, ST, VR, CN, (37.97m-38.16m) XW SM, 0 - 5°, PL, sandy clay, 5mm JT, 0 - 20°, UN, Clay VN, closed
		-36						a=0.98 d=0.76			
			39.0								XW SM, 10 - 15°, PL, sandy clay, 2-4mm PT x2, 5 - 35°, UN, Clay VN, closed PT, 5 - 15°, ST, Clay VN, closed PT, 5 - 10°, PL, Clay VN, closed XW SM, 0 - 20°, ST, sandy clay, 10-15mm
		-37						a=1.68 d=1.76	99%		

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:41

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

TETRA TECH COFFEY

Engineering Log - Cored Borehole

Borehole ID.	**BH3**
sheet:	7 of 7
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**25 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**26 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,568.79; N: 6,251,769.03 (GDA94 Zone 56) surface elevation: 2.32 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
HQ3	100% Water return	-38			**SANDSTONE**: medium to coarse grained, pale grey, indistinctly cross-bedded at 5-20°, 2% dark grey siltstone flecks and laminations. *(continued)* 40.20 m: dark grey siltstone clast, sub-rounded, 1-5mm	FR		a=2.65 d=2.70			PT, 25°, PL, RO, CN
			41.0		40.84 to 41.27 m: well developed cross-bedding at 10-25°						PT x2, 10 - 15°, Clay VN, tight
		-39			fine to medium grained, grey sandstone bed, cross-bedded at 0-5°, 5% dark grey siltstone flecks			a=1.35 d=0.85	99%		XW SM, 0°, PL, sandy clay, 15mm JT, 0 - 5°, UN, tight
			42.0		**SANDSTONE**: medium to coarse grained, pale grey, distinctly cross-bedded at 15-30°, 10-40mm typical spacing, well developed bedding, 2% dark grey siltstone flecks and lenticles. From 41.47m: scattered fine sub-angular quartz gravel						PT, 25°, PL, VR, Clay VN
		-40						a=2.42 d=1.71			PT, 15 - 25°, UN, Clay VN, tight PT, 15 - 30°, ST, tight
		-41	43.0					a=0.74 d=1.81			
					43.63 to 43.65 m: dark grey carbonaceous laminations				89%		XW SM, 0 - 5°, PL, sandy clay, 20mm PT x2, 5 - 10°, PL, Clay VN, tight JT, 20 - 30°, ST, Clay VN, tight PT, 15°, PL, RO, Clay VN
		-42	44.0		**SANDSTONE**: fine to medium grained, pale grey, indistinctly cross-bedded at 0-5°.						PT, 5°, PL, Clay VN, tight JT, 65 - 80°, ST, Clay CO, closed, (44.2m-44.54m) JT, 40 - 90°, ST, Clay CO, tight, (44.32m-44.57m)
			45.0		**SANDSTONE**: medium to coarse grained, pale grey, indistinctly to distinctly cross-bedded at 5-15°, <1% dark grey siltstone flecks.			a=0.79 d=0.84			JT, 50 - 75°, UN, Clay VN, closed, (44.38m-44.72m) JT, 35 - 80°, UN, Clay VN, closed, (44.56m-44.85m) PT, 5°, PL, Clay VN, tight JT, 30°, PL, Clay VN, tight JT, 20°, PL, Clay VN, tight
		-43			Borehole BH3 terminated at 45.30 m Target depth						
			46.0								
		-44									
			47.0								
		-45									

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:41

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

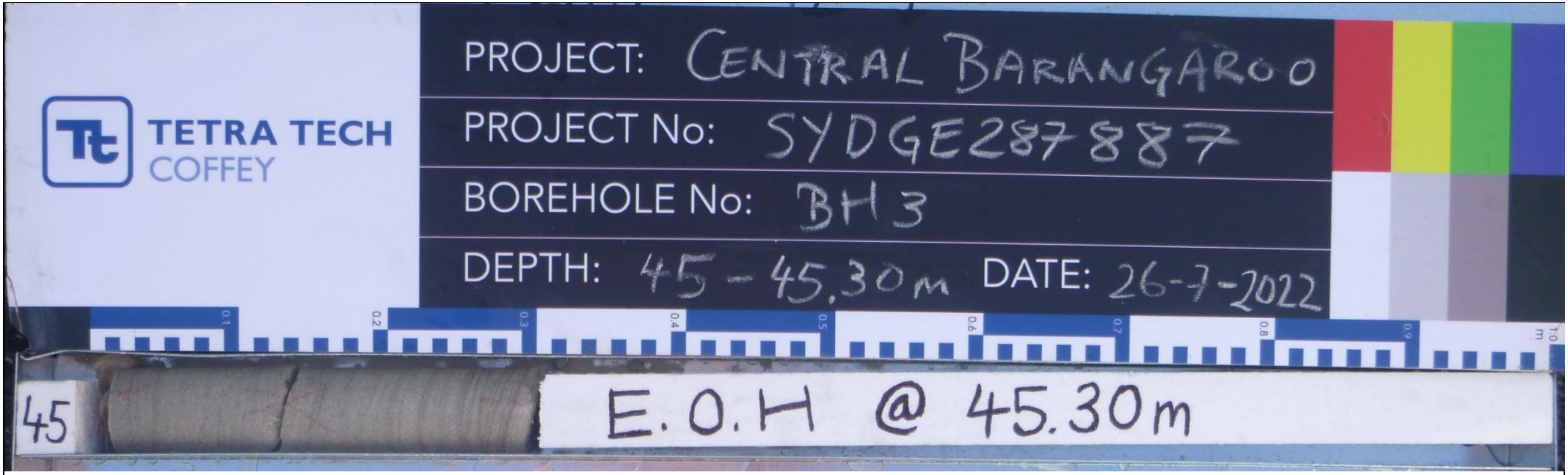
planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

coating
CN clean
SN stained
VN veneer
CO coating

drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project :	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH3**
scale	**N/A**			
original	**A4**		project no: **754-SYDGE287887**	**Figure 1**

drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project :	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH3**
scale	**N/A**			
original	**A4**		project no: **754-SYDGE287887**	**Figure 2**

drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project :	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH3**
scale	**N/A**		project no: **754-SYDGE287887**	**Figure 3**
original	**A4**			



drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project :	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH3**
scale	**N/A**		project no: **754-SYDGE287887**	**Figure 4**
original	**A4**			

TETRA TECH COFFEY

Engineering Log - Borehole

		Borehole ID.	**BH4**
		sheet:	1 of 5
		project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**	date started:	**07 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**	date completed:	**08 Jul 2022**
project:	**Central Barangaroo Development**	logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**	checked by:	**RT**

position: E: 333,641.82; N: 6,251,794.24 (GDA94 Zone 56) surface elevation: 2.84 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	soil origin, structure and additional observations
SONIC, C				2				**ROAD SURFACE: ASPHALTIC CONCRETE**: dark grey, 50mm.	D			**PAVEMENT**
								FILL: SAND: medium to coarse grained, grey, with fine to medium sub-rounded to angular sandstone and basalt gravel, trace metal fragments to 2mm, trace glass fragments to 5mm. From 0.5m: becoming brown				**FILL**
				1	1.0			**FILL: CLAYEY SAND**: fine to medium grained, brown, with fine to coarse, sub-rounded to sub-angular sandstone gravel, trace clay pockets, trace fine to coarse, sub-angular siltstone gravel.				
								FILL: SAND: fine to medium grained, dark brown, with fine to medium, sub-angular to angular sandstone gravel, with brick and glass fragments to 20mm, trace fines.				
				0	2.0			**FILL: SANDSTONE**: medium to coarse grained, pale grey.				
					3.0			**FILL: Sandy GRAVEL**: fine to coarse, sub-rounded to angular sandstone gravel, pale grey and brown, medium grained sand, trace rounded sandstone cobbles.				
		▶		-1	4.0			**FILL: Sandy CLAY**: low plasticity, grey to dark grey, fine to medium grained sand, trace pockets of pale grey clay, trace soft plastic and rubber inclusions.	>Wp			
				-2	5.0			**FILL: GRAVEL**: fine to coarse, sub-angular to angular sandstone and basalt gravel, grey, with fine to medium grained sand, with brick fragments to 140mm.	W			
				-3	6.0			**FILL: SAND**: medium to coarse grained, grey-brown, with fine to coarse, sub-rounded to angular sandstone gravel, with sandstone cobbles, with brick fragments 5-80mm, trace rubber inclusions to 100mm.				
				-4	7.0							
				-5								

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud
C casing
N nil

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remoulded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	**BH4**
sheet:	2 of 5
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**07 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**08 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,641.82; N: 6,251,794.24 (GDA94 Zone 56) surface elevation: 2.84 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	soil origin, structure and additional observations
SONIC C				-6	9.0			**FILL: Sandy GRAVEL**: medium to coarse, sub-angular sandstone gravel, grey to pale grey, fine to medium grained sand.	W			**FILL**
								FILL: CLAYEY SAND: medium to coarse grained, yellow-brown, with medium to coarse, sub-rounded to sub-angular sandstone gravel.				
				-7	10.0			**FILL: Sandy CLAY**: low to medium plasticity, orange, fine to medium grained sand, trace sandstone cobbles.	>Wp			
				-8	11.0			**FILL: Sandy GRAVEL**: fine to medium, sub-angular sandstone gravel, ,fine to medium grained sand, with brick fragments to 50mm, trace sandstone cobbles.	W			
				-9	12.0			**FILL: Sandy CLAY**: low plasticity, dark grey, fine to medium grained sand, with medium to coarse sub-angular sandstone gravel.	>Wp			
				-10	13.0			**FILL: Gravelly SAND**: medium to coarse grained, brown, fine to coarse, sub-rounded to sub-angular sandstone gravel, trace sandstone cobbles.	W			
								FILL: Sandy CLAY: low to medium plasticity, dark grey, fine to medium grained sand, trace metal fragments to 20mm.	>Wp			From 13m: slight sulphur odour
				-11	14.0		CI	**Sandy CLAY**: medium plasticity, grey mottled orange-brown and yellow-brown, medium to coarse grained sand.		F to St		**ALLUVIUM**
							CI-CH	**CLAY**: medium to high plasticity, grey mottled orange-red, with medium to coarse grained sand.				
				-12	15.0		CI-CH	**CLAY**: medium to high plasticity, pale grey mottled orange-red and yellow-brown, with silt, trace fine to medium grained sand, becoming pale grey with depth.		St		
							SP	**SAND**: medium to coarse grained, pale grey mottled orange-brown.	W			
				-13			SC	**CLAYEY SAND**: fine to medium grained, pale grey mottled orange-brown, with sandy clay lenses.				

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud
C casing
N nil

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	**BH4**
sheet:	3 of 5
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**07 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**08 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,641.82; N: 6,251,794.24 (GDA94 Zone 56) surface elevation: 2.84 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description **SOIL NAME**: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	soil origin, structure and additional observations
SONIC, C							SC	**CLAYEY SAND**: fine to medium grained, pale grey mottled orange-brown, with sandy clay lenses. *(continued)*	W			**ALLUVIUM**
				-14	17.0		CI-CH	**Sandy CLAY**: medium to high plasticity, orange-red mottled yellow-brown and pale grey, fine to medium grained sand, trace root fibres.	>Wp	VSt		
				-15	18.0		CH	**Sandy CLAY**: high plasticity, brown-orange mottled pale grey and yellow-brown, medium to coarse grained sand.		VSt to H		
				-16	19.0			From 20.0m: pale grey mottled orange and red-brown				
				-17	20.0		CH	**Sandy CLAY**: high plasticity, orange mottled red-brown, medium to coarse grained sand.				
				-18	21.0			From 20.0m: red-brown mottled yellow-brown and pale grey				
				-19	22.0		CH	**Sandy CLAY**: high plasticity, yellow-brown mottled pale grey, medium to coarse grained sand, relict rock fabric faintly visible, extremely weathered.		H		**EXTREMELY WEATHERED MATERIAL**
				-20	23.0			Borehole BH4 continued as cored hole				
				-21								

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud
C casing
N nil

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TETRA TECH COFFEY

Engineering Log - Cored Borehole

Borehole ID.	***BH4***
sheet:	4 of 5
project no.	***754-SYDGE287887***
client:	***Aqualand Projects Pty Ltd***
date started:	***07 Jul 2022***
principal:	***Aqualand Projects Pty Ltd***
date completed:	***08 Jul 2022***
project:	***Central Barangaroo Development***
logged by:	***RAS***
location:	***39 Hickson Road, Sydney NSW 2000***
checked by:	***RT***

position: E: 333,641.82; N: 6,251,794.24 (GDA94 Zone 56) surface elevation: 2.84 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		-14	17.0								
		-15	18.0								
		-16	19.0								
		-17	20.0								
		-18	21.0								
		-19	22.0								
					started coring at 22.65m						
HQ3	100% Water return	-20	23.0		**SANDSTONE**: medium to coarse grained, orange, indistinctly cross-bedded, iron stained.	MW FR		a=0.80 d=0.53			
		-21			**SANDSTONE**: medium to coarse grained, pale grey, indistinctly cross-bedded at 5-15°, <5% dark grey carbonaceous flecks and laminations.	SW FR		a=1.39 d=1.12	86%		PT, 5 - 15°, ST, RO, Fe SN PT, 10°, PL, RO, Fe SN Infilled SM, 0 - 10°, PL, sandy clay, 20mm PT, 5 - 10°, PL, tight PT, 5°, PL, tight

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:41

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

TETRA TECH COFFEY

Engineering Log - Cored Borehole

Borehole ID.	**BH4**
sheet:	5 of 5
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**07 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**08 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,641.82; N: 6,251,794.24 (GDA94 Zone 56) surface elevation: 2.84 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
HQ3	95% Water return	-22	25.0		**SANDSTONE**: medium to coarse grained, pale grey, indistinctly cross-bedded at 5-15°, <5% dark grey carbonaceous flecks and laminations. *(continued)*	FR		a=0.97 d=1.19	86%		
		-23	26.0		**SANDSTONE**: medium to coarse grained, pale grey, massive, <1% dark grey siltstone flecks.			a=1.08 d=0.98	99%		PT x2, 10°, PL, RO, Clay VN
		-24	27.0					a=1.16 d=1.23			
	100% Water return	-25	28.0					a=1.14 d=1.17			PT, 15°, PL, Clay VN, tight
		-26	29.0					a=1.20 d=1.31	98%		
		-27	30.0		**SANDSTONE**: medium to coarse grained, pale grey, indistinctly cross-bedded at 5-15°, 2% dark grey siltstone flecks and laminations. 29.35 to 29.42 m: cross-bedded at 5° 29.58 to 29.90 m: brown to pale grey 29.89 m: elongated, dark grey siltstone clast, 5mm			a=1.08 d=1.08 a=1.51 d=1.29			PT x2, 0°, PL, Clay CO JT, 15°, PL, RO, Clay VN, tight Sheared SM, 5°, PL, Sandy clay, 10mm JT, 5 - 20°, UN, RO, CN
		-28	31.0		Borehole BH4 terminated at 30.40 m Target depth Standpipe Installed						
		-29									

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:41

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

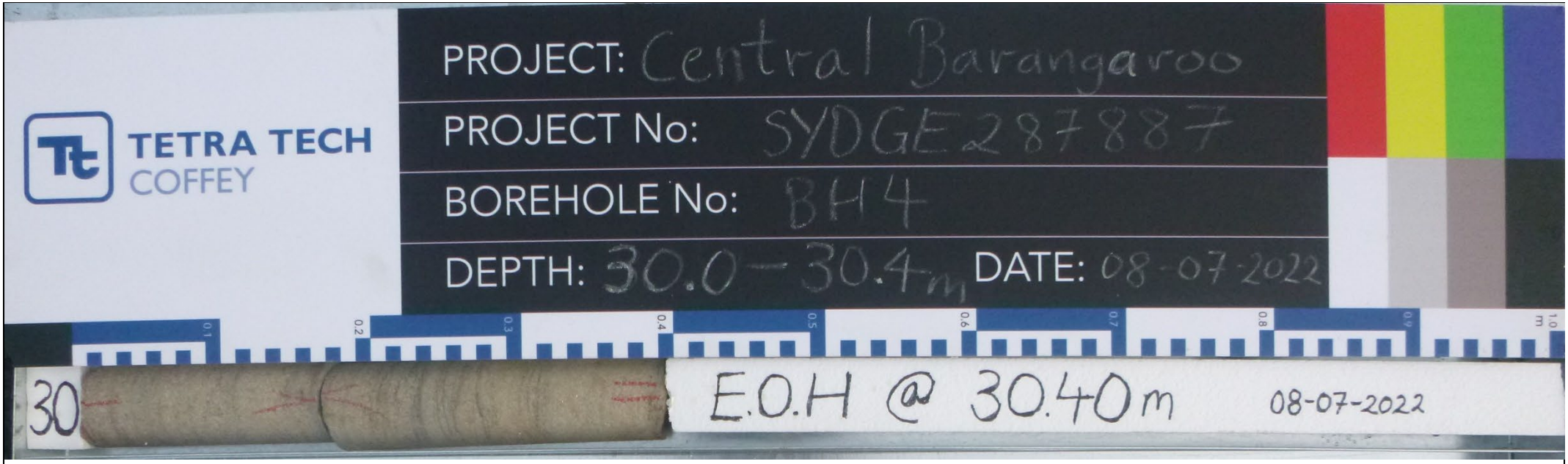
roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

coating
CN clean
SN stained
VN veneer
CO coating

drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project :	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH4**
scale	**N/A**			
original	**A4**		project no: **754-SYDGE287887**	**Figure 1**

drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project :	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH4**
scale	**N/A**		project no: **754-SYDGE287887**	**Figure 2**
original	**A4**			



drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project :	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH4**
scale	**N/A**			
original	**A4**		project no: **754-SYDGE287887**	**Figure 3**

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	**BH5**
sheet:	1 of 5
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**09 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**09 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**PJM/RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,622.24; N: 6,251,857.73 (GDA94 Zone 56) surface elevation: 2.33 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa)	soil origin, structure and additional observations
SONIC / C	1 2 3	▶		2 / 1.0 / 1 / 2.0 / 0 / 3.0 / -1 / 4.0 / -2 / 5.0 / -3 / 6.0 / -4 / 7.0 / -5				**ROAD SURFACE: ASPHALTIC CONCRETE**: dark grey, 40mm.	D		100 200 300 400	**PAVEMENT**
								FILL: Gravelly SAND: fine to medium grained, grey-brown, medium to coarse, sub-rounded to sub-angular sandstone gravel.				**FILL**
								FILL: SAND: fine to coarse grained, brown, trace fine to medium, sub-angular to angular basalt and sandstone gravel, trace concrete fragments to 40mm.	<Wp			
								FILL: Sandy CLAY: low to medium plasticity, pale grey and orange-brown, fine to medium grained sand, trace brick , tile and concrete fragments to 30mm, trace sandstone cobbles, trace soft plastic pieces to 40mm, becoming brown with depth.				
								FILL: Gravelly SAND: medium to coarse grained, dark grey, fine to coarse, sub-angular to angular sandstone gravel, trace wood pieces to 60mm.	D			
								FILL: Sandy GRAVEL: fine to coarse, sub-rounded to angular sandstone gravel, dark grey, medium to coarse grained sand, with tile, brick and soft plastic fragments to 40mm, trace sandstone cobbles.				
								From 5.4m: becoming brown, trace wood fibres	W			

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud N nil
C casing

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remoulded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	**BH5**
sheet:	2 of 5
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**09 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**09 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**PJM/RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,622.24; N: 6,251,857.73 (GDA94 Zone 56) surface elevation: 2.33 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	soil origin, structure and additional observations
SONIC C				-6				**FILL: Sandy GRAVEL**: fine to coarse, sub-rounded to angular sandstone gravel, dark grey, medium to coarse grained sand, with tile, brick and soft plastic fragments to 40mm, trace sandstone cobbles. *(continued)*	W			**FILL**
				-7	9.0			**FILL: SAND**: medium to coarse grained, dark brown, with brick and ceramic fragments to 40mm, with fine to coarse sub-angular sandstone and siltstone gravel.				
				-8	10.0							
				-9	11.0							
				-10	12.0			**FILL: SAND**: medium to coarse grained, grey, trace fine to medium, sub-angular sandstone gravel.				
				-11	13.0			**CLAY**: low plasticity, dark grey, with fine to medium grained sand lenses.	>Wp			**DISTURBED SOIL / FILL**
				-12	14.0			At 14.9m: 1 x cobble size piece of rubble				
				-13	15.0		CL-Cl	**CLAY**: low to medium plasticity, grey.	W	S - F		**ESTUARINE ALLUVIUM**
							SP	**SAND**: medium to coarse grained, grey, trace clay.				
							CL-Cl	**Sandy CLAY**: low to medium plasticity, orange-brown and grey, fine to medium grained sand.	>Wp	F - St		

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud
C casing
N nil

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	**BH5**
sheet:	3 of 5
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**09 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**09 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**PJM/RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,622.24; N: 6,251,857.73 (GDA94 Zone 56) surface elevation: 2.33 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	soil origin, structure and additional observations
SONIC, C				-14	17.0		CL-CI	**Sandy CLAY**: low to medium plasticity, orange-brown and grey, fine to medium grained sand. *(continued)*	>Wp	F - St		**ALLUVIUM**
				-15	18.0		CI	**CLAY**: medium plasticity, grey-brown mottled orange-brown.		St		
				-16	19.0		CL-CI	**Sandy CLAY**: low to medium plasticity, grey, fine to medium grained sand.				
				-17			CL	**CLAY**: low plasticity, dark grey.				
					20.0		CL-CI	**Sandy CLAY**: low to medium plasticity, grey and brown, fine to medium grained sand.				
				-18			CL-CI	**CLAY**: low to medium plasticity, dark grey.				
							SP	**SAND**: medium to coarse grained, grey, trace clay.	W			
				-19	21.0		CI	**Sandy CLAY**: medium plasticity, grey, medium grained sand.	>Wp	St - VSt		
							SC	**CLAYEY SAND**: medium grained, orange-brown.	W			
				-20	22.0		CI-CH	**Sandy CLAY**: medium to high plasticity, orange-brown and grey, medium to coarse grained sand.	>Wp	VSt - H		**RESIDUAL SOIL**
								SANDSTONE: medium to coarse grained, grey and orange-brown, inferred very low to low strength, extremely to highly weathered.				**HAWKESBURY SANDSTONE**
				-21	23.0			Borehole BH5 continued as cored hole				

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud
C casing
N nil

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TETRA TECH COFFEY

Engineering Log - Cored Borehole

Borehole ID.	**BH5**
sheet:	4 of 5
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**09 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**09 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**PJM/RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,622.24; N: 6,251,857.73 (GDA94 Zone 56) surface elevation: 2.33 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information				material substance						rock mass defects		
method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular	general
		-14										
			17.0									
		-15										
			18.0									
		-16										
			19.0									
		-17										
			20.0									
		-18										
			21.0									
		-19										
			22.0									
		-20			started coring at 22.65m							
HQ3	97-100% Water return	-21	23.0		**SANDSTONE**: medium to coarse grained, orange and red-brown, becoming distinctly cross-bedded at 5-20° with depth, 1% dark grey siltstone flecks.	MW		a=0.61 d=0.36 a=0.67 d=0.59	99%		PT, 5°, PL, Clay VN, tight	

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:41

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

coating
CN clean
SN stained
VN veneer
CO coating

TETRA TECH COFFEY

Engineering Log - Cored Borehole

Borehole ID.	**BH5**
sheet:	5 of 5
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**09 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**09 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**PJM/RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,622.24; N: 6,251,857.73 (GDA94 Zone 56) surface elevation: 2.33 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
HQ3	97-100% Water return	-22	25.0		**SANDSTONE**: medium to coarse grained, orange and red-brown, becoming distinctly cross-bedded at 5-20° with depth, 1% dark grey siltstone flecks. *(continued)*	MW		a=0.70 d=0.53	99%		JT, 45 - 60°, UN, closed, Fe cemented, (24.34m-24.54m) JT, 55°, PL, closed, (24.61m-24.73m) JT, 45°, PL, closed, Fe cemented, (24.64m-24.74m) JT, 55°, PL, closed, incipient, (24.64m-24.72m) JT, 45 - 55°, ST, VR, Fe SN
		-23						a=1.33 d=0.86			
		-24	26.0		**SANDSTONE**: medium to coarse grained, pale grey, distinctly cross-bedded at 5-15°, <5% dark grey siltstone laminations and flecks. 26.41 to 26.56 m: brown-orange	SW FR		a=1.56 d=1.46	97%		JT, 40 - 45°, PL, VR, Fe SN PT, 15°, PL, Clay CO, tight
		-25	27.0					a=1.69 d=1.61			
		-26	28.0		From 28.03m: well developed bedding, 10-50mm typical bed spacing 28.20 to 28.26 m: dark grey, lustrous coal lenticles			a=1.27 d=1.21	99%		XW SM, 5 - 20°, PL, sandy clay, 10mm
		-27	29.0		Borehole BH5 terminated at 29.00 m Target depth						
		-28	30.0								
		-29	31.0								

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:41

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

coating
CN clean
SN stained
VN veneer
CO coating

drawn	RAS	TETRA TECH COFFEY	client:	Aqualand Projects Pty Ltd
approved	RT		project :	Central Barangaroo Development
date	09/11/22		title:	CORE PHOTOGRAPH BH5
scale	N/A		project no: 754-SYDGE287887	Figure 1
original	A4			

drawn	RAS	TETRA TECH COFFEY	client:	Aqualand Projects Pty Ltd
approved	RT		project :	Central Barangaroo Development
date	09/11/22		title:	CORE PHOTOGRAPH BH5
scale	N/A		project no: 754-SYDGE287887	Figure 2
original	A4			

TETRA TECH COFFEY

Engineering Log - Borehole

		Borehole ID.	**BH6**
		sheet:	1 of 5
		project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**	date started:	**12 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**	date completed:	**13 Jul 2022**
project:	**Central Barangaroo Development**	logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**	checked by:	**RT**

position: E: 333,615.20; N: 6,251,929.14 (GDA94 Zone 56) surface elevation: 2.23 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa)	soil origin, structure and additional observations
SONIC; C	1 2 3			2				**ROAD SURFACE: CONCRETE**: grey, 70mm.	D			**PAVEMENT**
								FILL: Gravelly SAND: fine to medium grained, grey, fine to medium sub-angular basalt gravel, trace fine to medium sub-angular sandstone gravel, trace clay.				**FILL**
				1	1.0			**FILL: CLAYEY SAND**: fine to medium grained, brown to pale brown, fine to medium sub-angular basalt and sandstone gravel. From 1.0m: becoming orange-brown and pale grey				
								FILL: Sandy GRAVEL: fine to coarse, sub-angular to angular basalt and sandstone gravel, grey, fine to coarse grained sand, trace concrete fragments to 30mm.				
				0	2.0			**FILL: SAND**: medium to coarse grained, orange-brown and pale grey, with fine to coarse sub-angular sandstone gravel, trace sandstone cobbles and clay.				
					3.0			**FILL: Sandy CLAY**: low plasticity, orange-brown and pale grey, medium to coarse grained sand, with fine to medium sub-angular sandstone gravel, trace sandstone cobbles.	<Wp			
				-1				**FILL: Sandy CLAY**: low plasticity, grey and brown, fine to medium grained sand, with fine to medium sub-angular sandstone gravel.				
					4.0			**FILL: Sandy CLAY**: low to medium plasticity, brown and orange-brown, fine to coarse grained sand, with medium to coarse angular sandstone gravel, trace sandstone cobbles. 4.5 to 4.6 m: sandstone cobbles				
				-2	5.0			**FILL: Sandy CLAY**: low to medium plasticity, pale grey and brown, fine to medium grained sand, with fine to coarse sub-angular to angular sandstone gravel, trace sandstone cobbles, trace wire fragments to 8mm.				
				-3				**FILL: Sandy CLAY**: low to medium plasticity, brown-grey to yellow-brown, fine to medium grained sand, with fine to medium sub-angular to angular sandstone gravel, trace sandstone cobbles, trace copper wire lengths to 120mm.				
				-4	6.0							
				-5	7.0							

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud
C casing
N nil

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	**BH6**
sheet:	2 of 5
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**12 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**13 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,615.20; N: 6,251,929.14 (GDA94 Zone 56) surface elevation: 2.23 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	soil origin, structure and additional observations
SONIC C		▶		-6				**FILL: Sandy CLAY**: low to medium plasticity, brown-grey to yellow-brown, fine to medium grained sand, with fine to medium sub-angular to angular sandstone gravel, trace sandstone cobbles, trace copper wire lengths to 120mm. *(continued)*	<Wp			**FILL**
				-7	9.0				>Wp			
								FILL: SAND: fine to medium grained, yellow-brown, with fine to medium sub-angular sandstone gravel, trace sandstone cobbles.	W			
				-8	10.0			**FILL: Sandy CLAY**: low plasticity, yellow-brown, fine to coarse grained sand, with fine to coarse sub-angular sandstone gravel, with sandstone cobbles.	>Wp			
				-9	11.0			11.3 to 11.4 m: fine to medium grained yellow-brown sand				
				-10	12.0			**FILL: SAND**: medium to coarse grained, brown-grey, fine to medium, sub-angular sandstone gravel, trace clay.	W			
								FILL: Sandy GRAVEL: fine to coarse, sub-rounded to sub-angular sandstone gravel, dark grey to grey, fine to medium grained sand.				
				-11	13.0			**FILL: SAND**: fine to medium grained, pale grey to grey, with fine to coarse sub-angular to angular sandstone gravel, trace brick fragments to 60mm, trace sandstone cobbles, trace clay pockets.				
				-12	14.0		CI	**FILL: CLAY**: low to medium plasticity, dark grey, trace medium sub-angular sandstone gravel, with shell and shell fragments to 25mm.	>Wp	F to St		**ALLUVIUM**
							CL-CI	**Sandy CLAY**: medium plasticity, pale grey, medium to coarse grained sand.				
								Sandy CLAY: low to medium plasticity, yellow-brown and pale grey, medium to coarse grained sand, interbedded with clayey sand layers.				
				-13	15.0		CI	**Sandy CLAY**: medium plasticity, pale grey mottled yellow-brown and orange-red, medium to coarse grained sand.				
							CI-CH					

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud
C casing
N nil

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	**BH6**
sheet:	3 of 5
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**12 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**13 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,615.20; N: 6,251,929.14 (GDA94 Zone 56) surface elevation: 2.23 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description **SOIL NAME**: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency / relative density	hand penetrometer (kPa)	soil origin, structure and additional observations
SONIC C	1 2 3			-14 -15 -16 -17 -18 -19 -20 -21	17.0 18.0 19.0 20.0 21.0 22.0 23.0		CI-CH	**Sandy CLAY**: medium to high plasticity, orange-red mottled pale grey and yellow-brown, medium to coarse grained sand. *(continued)*	>Wp	F to St	100 200 300 400	**ALLUVIUM**
							CL-CI	**Sandy CLAY**: low to medium plasticity, orange mottled yellow-brown, fine to medium grained sand.				
							SC	**CLAYEY SAND**: medium to coarse grained, pale grey to grey, with pockets of clay.	W			
							SP	**SAND**: fine to medium grained, grey and brown, trace fines. 21.4 to 21.5 m: orange				
							CL-CI	**Silty CLAY**: low to medium plasticity, dark grey.	>Wp	S to F		
							CI	**Sandy CLAY**: medium plasticity, pale grey, fine to medium grained sand.		F to St		
							CI-CH	**Sandy CLAY**: medium to high plasticity, pale grey mottled orange-red, medium to coarse grained sand.		St to VSt		
							CI	**Sandy CLAY**: medium plasticity, pale grey and pale brown, medium to coarse grained sand		H		**EXTREMELY WEATHERED MATERIAL**

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud
C casing
N nil

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

TETRA TECH COFFEY

Engineering Log - Cored Borehole

Borehole ID.	**BH6**
sheet:	4 of 5
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**12 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**13 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,615.20; N: 6,251,929.14 (GDA94 Zone 56) surface elevation: 2.23 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information				material substance					rock mass defects			
method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general

-14 -15 -16 -17 -18 -20 -21

17.0 18.0 19.0 20.0 21.0 22.0 23.0

Borehole continued as a cored hole from 23.90m

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

coating
CN clean
SN stained
VN veneer
CO coating

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:41

TETRA TECH COFFEY

Engineering Log - Cored Borehole

Borehole ID.	**BH6**
sheet:	5 of 5
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**12 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**13 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,615.20; N: 6,251,929.14 (GDA94 Zone 56) surface elevation: 2.23 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
HQ3	95-100% Water return	-22			**SANDSTONE**: medium to coarse grained, orange and red-brown, indistinctly cross-bedded, iron stained. *(continued)*	MW		a=0.62 d=0.59	71%		JT, 50 - 85°, UN, closed, Fe cemented, (23.93m-24.45m) JT, 15 - 80°, IR, closed, Fe cemented, (24.13m-24.63m)
			25.0		From 24.62: becoming indistinctly cross-bedded at 5-20°						
		-23			**SANDSTONE**: medium to coarse grained, pale grey, indistinctly cross-bedded at 5-20°, 2% dark grey siltstone flecks and laminations.	FR		a=1.57 d=1.44	97%		
		-24	26.0					a=1.66 d=1.42			
			27.0		26.97 to 27.43 m: pale grey to brown			a=1.75 d=1.76			
		-25			From 27.63m: well developed cross-bedding 10-20°, 5-100mm typical spacing						
			28.0					a=1.35 d=0.53			PT, 10°, PL, RO, Clay VN PT x2, 5°, PL, tight
		-26							99%		
		-27	29.0					a=1.97 d=1.74			
			30.0								
		-28			Borehole BH6 terminated at 30.23 m Target depth Standpipe Installed						
			31.0								
		-29									

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

coating
CN clean
SN stained
VN veneer
CO coating

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:41

drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project:	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH6**
scale	**N/A**		project no: **754-SYDGE287887**	**Figure 1**
original	**A4**			

drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project:	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH6**
scale	**N/A**		project no: **754-SYDGE287887**	**Figure 2**
original	**A4**			

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	**BH7**
sheet:	1 of 5
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**14 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**15 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,667.99; N: 6,251,925.12 (GDA94 Zone 56) surface elevation: 2.55 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa)	soil origin, structure and additional observations
SONIC					0.0			**ROAD SURFACE: CONCRETE**: grey, 250mm.				**PAVEMENT**
				2				**FILL: SAND**: fine to medium grained, dark grey and brown, with fine to medium sub-angular sandstone and basalt gravel.	D			**FILL**
				1	1.0			**FILL: SAND**: fine to coarse grained, brown, with fine to coarse sub-angular to angular sandstone and basalt gravel, with brick, glass and terracotta fragments to 100mm, trace fines. 1.5 to 2.5 m: brown and orange				
				0	2.0			From 2.5m: with concrete fragments to 40mm, trace sandstone cobbles				
		▶		-1	3.0				W			
				-2	4.0			**FILL: CLAYEY SAND**: fine to medium grained, dark grey to grey, with fine to coarse sub-angular to angular sandstone gravel, trace brick fragments to 120mm, trace concrete fragments to 30mm.				
				-3	5.0			**SAND**: fine to medium grained, brown and grey, with fine to coarse sub-angular sandstone gravel, trace sandstone cobbles.	>Wp			
								FILL: Sandy CLAY: low plasticity, grey-brown, fine to coarse grained sand, with fine to coarse sub-angular to angular sandstone gravel, cloth rags.				
				-4	6.0			**FILL: Gravelly SAND**: fine to medium grained, dark grey, fine to coarse sub-angular sandstone gravel, trace fine to medium sub-angular basalt gravel, trace fines and brick fragments to 5mm, trace sandstone cobbles.	W			5.8-6.8m: slight hydrocarbon odour
				-5	7.0			**FILL: Sandy CLAY**: low plasticity, brown, fine to coarse grained sand, with fine to coarse sub-angular to angular sandstone gravel, trace sandstone cobbles. From 7.2m: dark grey, with silt	>Wp			

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
- DT diatube
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- RR rock roller

* bit shown by suffix e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration: no resistance ranging to refusal

water: 10-Oct-12 water level on date shown; water inflow; water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remoulded (kPa)
- R refusal
- HB hammer bouncing

soil group symbol & material description based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	***BH7***
sheet:	2 of 5
project no.	***754-SYDGE287887***
client:	***Aqualand Projects Pty Ltd***
date started:	***14 Jul 2022***
principal:	***Aqualand Projects Pty Ltd***
date completed:	***15 Jul 2022***
project:	***Central Barangaroo Development***
logged by:	***RAS***
location:	***39 Hickson Road, Sydney NSW 2000***
checked by:	***RT***

position: E: 333,667.99; N: 6,251,925.12 (GDA94 Zone 56) surface elevation: 2.55 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (**SOIL NAME**: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	soil origin, structure and additional observations
SONIC				-6				**FILL: Sandy CLAY**: low to medium plasticity, brown to red-brown, fine to medium grained sand, with fine to coarse sub-angular sandstone gravel, trace sandstone cobbles. *(continued)* 8.5 to 8.7 m: yellow-brown to orange	>Wp			**FILL**
				-7	9.0			**FILL: SAND**: fine to medium grained, grey, trace brick fragments to 5mm.	W			
				-8	10.0			**FILL: Sandy GRAVEL**: fine to medium, sub-angular basalt gravel, grey-brown, fine to coarse grained sand, trace tile, ceramic and brick fragments to 60mm, trace sandstone cobbles.				
				-9	11.0			**FILL: Gravelly SAND**: fine to medium grained, dark grey to grey, fine to coarse, angular to sub-angular sandstone gravel, trace tile fragments to 50mm, trace sandstone cobbles, trace fines.				
				-10	12.0			**FILL: SANDSTONE**: medium to coarse grained, pale grey.				
				-11	13.0			**FILL: SAND**: fine to coarse grained, dark grey, with silt, trace fine to medium sub-angular sandstone gravel, trace brick fragments to 70mm.				
				-12	14.0							
				-13	15.0		CL-CI	**Sandy CLAY**: low to medium plasticity, grey and brown, fine to medium grained sand.	>Wp	VSt - H		At 15.0m: several metal circular discs, 100mm diameter, 1mm thick **ALLUVIUM**
							SC	**CLAYEY SAND**: fine to medium grained, orange-brown.	W			

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud
C casing
N nil

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	***BH7***
sheet:	3 of 5
project no.	***754-SYDGE287887***
client:	***Aqualand Projects Pty Ltd***
date started:	***14 Jul 2022***
principal:	***Aqualand Projects Pty Ltd***
date completed:	***15 Jul 2022***
project:	***Central Barangaroo Development***
logged by:	***RAS***
location:	***39 Hickson Road, Sydney NSW 2000***
checked by:	***RT***

position: E: 333,667.99; N: 6,251,925.12 (GDA94 Zone 56) surface elevation: 2.55 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description **SOIL NAME**: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	soil origin, structure and additional observations
SONIC				-14			SP	**SAND**: fine to medium grained, brown.	W			**ALLUVIUM**
					17.0		CI	**Sandy CLAY**: medium plasticity, orange-brown mottled pale grey, medium grained sand.	>Wp	F - St		
				-15			CL-CI	**Sandy CLAY**: low to medium plasticity, orange-brown mottled yellow-brown and red-brown, fine to medium grained sand.				
					18.0			From 18.0m: becoming yellow-brown mottled pale grey				
				-16			SC	**CLAYEY SAND**: medium to coarse grained, pale yellow-brown mottled pale grey, with dark grey low plasticity clay lenses.	W			
				-17	19.0		CI	**Sandy CLAY**: medium plasticity, yellow-brown mottled red-brown and orange, medium to coarse grained sand, with fine to medium sub-angular iron indurated gravel, trace iron indurated cobbles.	>Wp	F - St		
					20.0		CI-CH	**Sandy CLAY**: medium to high plasticity, red-brown mottled yellow-brown and orange, medium to coarse grained sand, with medium to coarse sub-angular iron indurated gravel.		St		
				-18								
					21.0		CH	**Sandy CLAY**: high plasticity, pale grey mottled yellow-brown, fine to medium grained sand, relict rock fabric visible, laminated (5-35mm), extremely weathered.		H		**EXTREMELY WEATHERED MATERIAL**
				-19								
					22.0			**SANDSTONE**: medium grained, red-brown, highly weathered, inferred low strength.				**HAWKESBURY SANDSTONE**
				-20				**SANDSTONE**: medium grained, pale grey, moderately weathered, inferred low to medium strength.				
					23.0			Borehole BH7 continued as cored hole				
				-21								

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud
C casing
N nil

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TETRA TECH COFFEY

Engineering Log - Cored Borehole

		Borehole ID.	**BH7**
		sheet:	4 of 5
		project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**	date started:	**14 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**	date completed:	**15 Jul 2022**
project:	**Central Barangaroo Development**	logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**	checked by:	**RT**

position: E: 333,667.99; N: 6,251,925.12 (GDA94 Zone 56) surface elevation: 2.55 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information				material substance						rock mass defects		
method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 X = axial; O = diametral VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		-14									
			17.0								
		-15									
			18.0								
		-16									
			19.0								
		-17									
			20.0								
		-18									
			21.0								
		-19									
			22.0		started coring at 22.15m						
HQ3	100% Water return	-20			**SANDSTONE**: medium to coarse grained, pale grey, massive, 1% siltstone flecks.	FR		a=1.26 d=1.18	100%		
			23.0		23.03 to 23.08 m: elongated and sub-rounded siltstone clasts to 5mm						
		-21			**SHALE BRECCIA**: elongated, irregular shaped and sub-rounded siltstone clasts up to 50mm, in a medium to coarse grained, pale grey sandstone matrix. Matrix supported. 1% siltstone flecks.			a=1.45 d=1.60			

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:41

TETRA TECH COFFEY

Engineering Log - Cored Borehole

Borehole ID.	***BH7***
sheet:	5 of 5
project no.	***754-SYDGE287887***
client:	***Aqualand Projects Pty Ltd***
date started:	***14 Jul 2022***
principal:	***Aqualand Projects Pty Ltd***
date completed:	***15 Jul 2022***
project:	***Central Barangaroo Development***
logged by:	***RAS***
location:	***39 Hickson Road, Sydney NSW 2000***
checked by:	***RT***

position: E: 333,667.99; N: 6,251,925.12 (GDA94 Zone 56) surface elevation: 2.55 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
HQ3	100% Water return	-22	25.0		**SANDSTONE**: medium to coarse grained, pale grey, indistinctly becoming distinctly cross-bedded at 10-30°, 2% dark grey siltstone laminations and flecks.	FR		a=1.80 d=1.51	100%		
		-23						a=1.64 d=1.76			
			26.0		From 25.94m: well developed bedding, 10-20mm typical spacing				100%		PT, 10°, PL, RO, Clay CO PT, 15 - 30°, ST, RO, CN
		-24						a=1.71 d=1.36			
			27.0		27.22 m: dark grey, coal lenticle, lustrous, 5mm						
	90% Water return	-25						a=1.25 d=1.33			
			28.0		27.86 m: irregularly shaped siltstone inclusion, 40mm From 27.92m: scattered sub-rounded to sub-angular, fine to medium quartz gravel				100%		
		-26			**SILTY SANDSTONE**: fine grained, grey, indistinctly cross-bedded at 0-10°, 5% dark grey siltstone laminations.			a=0.59 d=0.29			
	95% Water return		29.0		**SHALE BRECCIA**: elongated, irregular shaped and sub-rounded siltstone clasts and beds up to 90mm, in a medium to coarse grained, pale grey sandstone matrix. Matrix supported. Siltstone beds indistinctly laminated at 5-15°, 5% pale grey fine grained sandstone laminations.				100%		
		-27						a=1.61 d=1.46			
			30.0		**SANDSTONE**: medium to coarse grained, pale grey, distinctly cross-bedded at 15-25°, 5-30mm typical spacing, 2% dark grey siltstone flecks and clasts to 5mm. 29.34 to 29.89 m: cross-bedded at 5-10°						
		-28			Borehole BH7 terminated at 30.04 m Target depth						
			31.0								
		-29									

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:41

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

coating
CN clean
SN stained
VN veneer
CO coating

drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project:	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH7**
scale	**N/A**		project no: **754-SYDGE287887**	**Figure 1**
original	**A4**			

drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project :	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH7**
scale	**N/A**		project no: **754-SYDGE287887**	**Figure 2**
original	**A4**			

drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project :	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH7**
scale	**N/A**			
original	**A4**		project no: **754-SYDGE287887**	**Figure 3**

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	***BH8***
sheet:	1 of 4
project no.	***754-SYDGE287887***
client:	***Aqualand Projects Pty Ltd***
date started:	***15 Jul 2022***
principal:	***Aqualand Projects Pty Ltd***
date completed:	***15 Jul 2022***
project:	***Central Barangaroo Development***
logged by:	***RAS***
location:	***39 Hickson Road, Sydney NSW 2000***
checked by:	***RT***

position: E: 333,697.98; N: 6,251,907.36 (GDA94 Zone 56) surface elevation: 2.43 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa)	soil origin, structure and additional observations
SONIC / C				2				**ROAD SURFACE: CONCRETE**: grey, 200mm.				**PAVEMENT**
								FILL: Gravelly SAND: fine to medium grained, grey-brown, fine to coarse, sub-angular to angular basalt and sandstone gravel, trace fines, trace concrete fragments to 20mm.	D <Wp			**FILL**
				1	1.0			**FILL: Sandy CLAY**: low to medium plasticity, pale grey and brown, fine to medium grained sand, with medium to coarse, sub-angular basalt and sandstone gravel, trace brick fragments to 5mm, trace sandstone cobbles.				
				0	2.0			**FILL: Sandy CLAY**: medium to high plasticity, pale grey mottled yellow-brown and orange, fine to medium grained sand, trace medium to coarse, sub-angular iron indurated and sandstone gravel.				
								From 2.5m: becoming brown mottled pale grey				
				-1	3.0			**FILL: CLAYEY SAND**: medium to coarse grained, yellow-brown, medium to coarse, sub-angular to angular sandstone and basalt gravel, trace sandstone cobbles.	D <Wp			
				-2	4.0			**FILL: Sandy CLAY**: medium plasticity, pale grey and grey-brown, fine to coarse grained sand, with fine to coarse sub-angular sandstone gravel, with sandstone cobbles, trace brick fragments to 50mm.				
				-3	5.0			**FILL: SAND**: medium to coarse grained, yellow-brown, with medium to coarse, sub-rounded sandstone gravel, trace brick fragments to 5mm, trace sandstone cobbles.	M W			
				-4	6.0							
				-5	7.0							

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud N nil
C casing

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remoulded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	**BH8**
sheet:	2 of 4
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**15 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**15 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,697.98; N: 6,251,907.36 (GDA94 Zone 56) surface elevation: 2.43 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description **SOIL NAME**: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	soil origin, structure and additional observations
SONIC C				-6				**FILL: CLAYEY SAND**: fine to coarse grained, dark brown to grey-brown, with sandstone cobbles, trace fine to medium sub-angular sandstone gravel. *(continued)*	W			**FILL**
					9.0		CL-CI	**Sandy CLAY**: low to medium plasticity, pale grey mottled yellow-brown and brown, medium to coarse grained sand.	>Wp	F		**ALLUVIUM**
				-7								
					10.0							
				-8			CH	**CLAY**: high plasticity, pale grey mottled orange-red and yellow-brown, with medium to coarse grained sand.		F - St		
							CL-CI	**Sandy CLAY**: low to medium plasticity, orange-brown, medium to coarse grained sand, interbedded with clayey sand layers up to 100mm thick.		St - VSt		
					11.0							
				-9			SP	**SAND**: medium to coarse grained, yellow-brown, with pockets of medium plasticity clay.	W			
					12.0							
				-10			CI	**Sandy CLAY**: medium plasticity, orange-brown, medium to coarse grained sand interbedded with clayey sand layers.	>Wp	St		
							CI-CH	**Sandy CLAY**: medium to high plasticity, yellow-brown mottled pale grey and orange, medium to coarse grained sand.		St - VSt		
					13.0							
				-11			CI-CH	**Sandy CLAY**: medium to high plasticity, pale grey mottled yellow-brown and red-brown, medium to coarse grained sand, trace fine to medium sub-angular iron indurated gravel.		VSt		
					14.0							
							CI-CH	**Sandy CLAY**: medium to high plasticity, pale grey mottled orange-red, becoming pale grey at depth, medium to coarse grained sand.				
				-12			CH	**Sandy CLAY**: high plasticity, red-brown mottled pale grey and yellow-brown, relict rock fabric visible, laminated (5-20mm), extremely weathered.		H		**EXTREMELY WEATHERED MATERIAL**
					15.0			**SANDSTONE**: medium to coarse grained, pale grey and pale red-brown, with iron staining, inferred low strength, highly weathered.				**HAWKESBURY SANDSTONE**
				-13				Borehole BH8 continued as cored hole				

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud N nil
C casing

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remoulded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TETRA TECH COFFEY

Engineering Log - Cored Borehole

Borehole ID.	**BH8**
sheet:	3 of 4
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**15 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**15 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,697.98; N: 6,251,907.36 (GDA94 Zone 56) surface elevation: 2.43 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information				material substance					rock mass defects		
method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		-6	9.0								
		-7	10.0								
		-8	11.0								
		-9	12.0								
		-10	13.0								
		-11	14.0								
		-12			started coring at 14.85m						
HQ3	97% Water return	-13	15.0		**SANDSTONE**: medium to coarse grained, orange to orange-red with pale grey with bands, distinctly cross-bedded at 15-25°, 10-50mm typical spacing, iron stained.	MW	O	a=1.35 d=0.79 a=1.08 d=1.13	98%		14.88m: JT, 75, PL, VR, CN, discontinuous PT, 20°, PL, VR, Fe Clay VN

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:42

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

TETRA TECH COFFEY

Engineering Log - Cored Borehole

Borehole ID.	***BH8***
sheet:	4 of 4
project no.	***754-SYDGE287887***
client:	***Aqualand Projects Pty Ltd***
date started:	***15 Jul 2022***
principal:	***Aqualand Projects Pty Ltd***
date completed:	***15 Jul 2022***
project:	***Central Barangaroo Development***
logged by:	***RAS***
location:	***39 Hickson Road, Sydney NSW 2000***
checked by:	***RT***

position: E: 333,697.98; N: 6,251,907.36 (GDA94 Zone 56) surface elevation: 2.43 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
HQ3	97% Water return	-14	17.0		From 16.0m: indistinctly cross-bedded at 5-15°	MW					PT, 5 - 20°, ST, RO, Clay VN PT, 0 - 10°, UN, RO, Fe SN PT, 5 - 10°, UN, closed
					16.27 m: dark grey, lustrous coal lenticle 1-3mm	FR					
					SANDSTONE: medium to coarse grained, pale grey, indistinctly cross-bedded at 5-15°, 1% dark grey siltstone flecks. 16.85 m: coal lenticle, dark grey and lustrous, 2-4mm				98%		
		-15			From 17.51m: becoming more massive			a=0.92 d=0.90			
			18.0		**SANDSTONE**: medium to coarse grained, pale grey, massive, 2% dark grey siltstone flecks and clasts. 17.70 to 17.74 m: sub-rounded to irregularly shaped dark grey siltstone clasts 10-30mm						
		-16			**SILTSTONE**: dark grey, indistinctly laminated at 0-10°, 15% fine grained, pale grey sandstone laminations. From 18.85m: disturbed bedding, irregular and wavy sandstone laminations 19.00 to 19.22 m: irregular quartz inclusions			a=0.74 d=0.37	100%		
			19.0		**SANDSTONE**: medium to coarse grained, pale grey, indistinctly cross-bedded at 5-15°, 1% dark grey siltstone flecks. 19.31 to 19.36 m: concentration of dark grey carbonaceous flecks rounded to sub-rounded, dark grey siltstone clasts up to 35mm At 20.1m, 20.4m and 20.57m: sub-rounded, dark grey siltstone clasts 5-20mm			a=1.55 d=1.35 a=1.84 d=1.10	96%		PT, 10°, PL, RO, CN, possible DB CS, 0 - 20°, UN, sandy clay and fine sub-angular gravel, 3-5mm
		-17									
		-18	20.0		Borehole BH8 terminated at 20.57 m Terminated at 20.57m depth, at Client's request						
		-19	21.0								
		-20	22.0								
		-21	23.0								

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:42

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

coating
CN clean
SN stained
VN veneer
CO coating

drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project :	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH8**
scale	**N/A**		project no: **754-SYDGE287887**	**Figure 1**
original	**A4**			

drawn	RAS	TETRA TECH COFFEY	client:	Aqualand Projects Pty Ltd
approved	RT		project :	Central Barangaroo Development
date	09/11/22		title:	CORE PHOTOGRAPH BH8
scale	N/A		project no: 754-SYDGE287887	Figure 2
original	A4			

TETRA TECH COFFEY

Engineering Log - Borehole

		Borehole ID.	**BH9**
		sheet:	1 of 5
		project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**	date started:	**20 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**	date completed:	**20 Jul 2022**
project:	**Central Barangaroo Development**	logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**	checked by:	**RT**

position: E: 333,699.79; N: 6,251,797.84 (GDA94 Zone 56) surface elevation: 2.25 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa)	soil origin, structure and additional observations
SONIC / C	1 2 3	▶		2 1 0 -1 -2 -3 -4 -5	1.0 2.0 3.0 4.0 5.0 6.0 7.0			**ROAD SURFACE: ASPHALTIC CONCRETE**: dark grey, 40mm.	D		100 200 300 400	**PAVEMENT**
								FILL: Sandy GRAVEL: fine to coarse, sub-angular to angular basalt gravel, grey and dark brown, fine to medium grained sand, trace fines.	<Wp			**FILL** At 0.2m: 1 x cloth rag, 110mm in length
								FILL: Sandy CLAY: low plasticity, brown and grey, fine to coarse grained sand, with fine to coarse sub-angular to angular sandstone gravel, trace brick fragments to 50mm, trace sub-rounded to sub-angular sandstone cobbles.				
								FILL: SAND: medium to coarse grained, pale brown, trace brick fragments to 5mm.	W			
								FILL: MIXTURE OF COBBLES (90%) AND SOIL (10%): Medium to coarse grained, orange and pale grey sandstone cobbles, sub-angular. Soil is SAND, medium to coarse grained, pale brown, with fine to coarse sub-angular sandstone gravel.				

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:28

method

DT	diatube
AD	auger drilling*
AS	auger screwing*
HA	hand auger
W	washbore
RR	rock roller
*	bit shown by suffix
e.g.	AD/T
B	blank bit
T	TC bit
V	V bit

support

M	mud
C	casing
N	nil

penetration

1 2 3 — no resistance ranging to refusal

water

10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests

B	bulk disturbed sample
D	disturbed sample
E	environmental sample
SS	split spoon sample
U##	undisturbed sample ##mm diameter
HP	hand penetrometer (kPa)
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
VS	vane shear; peak/remoulded (kPa)
R	refusal
HB	hammer bouncing

soil group symbol & material description based on AS 1726:2017

moisture condition

D	dry
M	moist
W	wet
Wp	plastic limit
Wl	liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

TETRA TECH COFFEY

Engineering Log - Borehole

		Borehole ID.	**BH9**
		sheet:	2 of 5
		project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**	date started:	**20 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**	date completed:	**20 Jul 2022**
project:	**Central Barangaroo Development**	logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**	checked by:	**RT**

position: E: 333,699.79; N: 6,251,797.84 (GDA94 Zone 56) surface elevation: 2.25 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	soil origin, structure and additional observations
SONIC C				-6					W			**FILL**
					9.0			**FILL: MIXTURE OF COBBLES (65%) AND SOIL (35%)**: Medium to coarse grained, orange sandstone cobbles, sub-angular and up to 100mm. Soil is Clayey SAND, fine to coarse grained, grey-brown, with fine to medium sub-angular sandstone gravel, trace brick fragments to 5mm.				
				-7	10.0							
				-8								
					11.0							
				-9								
					12.0			**FILL: Sandy CLAY**: low plasticity, grey, with fine to medium grained sand, with medium to coarse sub-angular sandstone gravel, trace sub-rounded to sub-angular sandstone cobbles.	>Wp			
				-10				**FILL: Sandy CLAY**: low to medium plasticity, yellow-brown, fine to medium grained sand, with fine to medium sub-angular sandstone gravel, trace sandstone cobbles.	W	H		**ALLUVIUM**
							SP CI	**FILL: Silty CLAY**: low plasticity, dark grey, trace sandstone cobbles.				**EXTREMELY WEATHERED MATERIAL**
				-11	13.0			**SAND**: medium to coarse grained, grey-brown, with silt and shell fragments to 10mm.				
								Sandy CLAY: medium plasticity, orange and pale brown, medium to coarse grained sand, rock fabric faintly visible, extremely weathered.				
				-12	14.0		CI-CH	**Sandy CLAY**: medium to high plasticity, orange mottled red-brown and pale grey, medium grained sand, relict rock fabric visible, laminated (5-20mm), extremely weathered.				
					15.0			From 15.0m: pale grey mottled dark red-brown, trace fine to medium sub-rounded iron indurated gravel, becoming orange at depth				
				-13								

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:28

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud N nil
C casing

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remoulded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	***BH9***
sheet:	3 of 5
project no.	***754-SYDGE287887***
client:	***Aqualand Projects Pty Ltd***
date started:	***20 Jul 2022***
principal:	***Aqualand Projects Pty Ltd***
date completed:	***20 Jul 2022***
project:	***Central Barangaroo Development***
logged by:	***RAS***
location:	***39 Hickson Road, Sydney NSW 2000***
checked by:	***RT***

position: E: 333,699.79; N: 6,251,797.84 (GDA94 Zone 56) surface elevation: 2.25 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description **SOIL NAME**: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	soil origin, structure and additional observations
				-14				Borehole BH9 continued as cored hole				
					17.0							
				-15								
					18.0							
				-16								
					19.0							
				-17								
					20.0							
				-18								
					21.0							
				-19								
					22.0							
				-20								
					23.0							
				-21								

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:28

method

DT	diatube
AD	auger drilling*
AS	auger screwing*
HA	hand auger
W	washbore
RR	rock roller
*	bit shown by suffix
e.g.	AD/T
B	blank bit
T	TC bit
V	V bit

support

M	mud
C	casing
N	nil

penetration

1 2 3 — no resistance ranging to refusal

water

10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests

B	bulk disturbed sample
D	disturbed sample
E	environmental sample
SS	split spoon sample
U##	undisturbed sample ##mm diameter
HP	hand penetrometer (kPa)
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
VS	vane shear; peak/remouded (kPa)
R	refusal
HB	hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition

D	dry
M	moist
W	wet
Wp	plastic limit
Wl	liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

TETRA TECH COFFEY

Engineering Log - Cored Borehole

Borehole ID.	**BH9**
sheet:	4 of 5
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**20 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**20 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,699.79; N: 6,251,797.84 (GDA94 Zone 56) surface elevation: 2.25 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
HQ3	95-100% Water return	-14			started coring at 16.05m						
					SANDSTONE: medium grained, orange, indistinctly cross-bedded at 0-5°, iron stained, 1% dark grey sub-rounded siltstone clasts and voids up to 5mm. From 16.28m: pale grey and no longer iron stained	MW / FR		a=1.08 d=0.94			16.05m-16.28m: slight coal tar odour and dark grey spot staining; XW SM, 0 - 10°, PL, Sandy clay, 20mm
		-15	17.0		**SANDSTONE**: medium to coarse grained, pale grey, indistinctly and distinctly cross-bedded at 5-20°, 5% dark grey siltstone flecks and clasts. 16.58 to 16.61 m: sub-rounded to elongated dark grey siltstone clasts to 5mm			a=1.91 d=1.40	98%		
		-16	18.0					a=1.39 d=1.33			
		-17	19.0		18.91m-19.0m and 19.14m-19.16m: carbonaceous laminations			a=1.68 d=1.42			PT, 15°, PL, Clay VN, tight
		-18	20.0		19.43 to 19.49 m: dark grey, coal lenticle, lustrous, 2-5mm. 19.45 to 19.54 m: elongated and sub-rounded, dark grey siltstone and quartz clasts up to 15mm and coal lenticles			a=1.47 d=1.66	100%		
		-19	21.0		**SANDSTONE**: medium to coarse grained, pale grey, massive becoming indistinctly cross-bedded at 5-10 with depth, 2% dark grey siltstone flecks. 19.92 m: dark grey siltstone laminations. From 20.17m: occasional dark grey, sub-rounded and elongated siltstone clasts and bands up to 20mm. 20.29 m: dark grey siltstone lenticle			a=1.34 d=1.68			
		-20	22.0		**SHALE BRECCIA**: Sub-rounded to irregularly shaped, dark grey siltstone clasts up to 60mm and beds up to 250mm in a pale grey, medium to coarse grained sandstone matrix. 1% sub-angular quartz clasts up to 15mm. Matrix supported. Siltstone beds are laminated at 10-25°. From 21.04m: wavy bedding, 10% pale grey fine grained sandstone laminations			a=1.33 d=1.55	100%		JT, 30°, PL, SL, CN, tight
		-21	23.0		**SILTSTONE**: dark grey, indistinctly laminated at 0-5°, <2% pale grey fine grained sandstone laminations. From 21.88m: medium to coarse grained, pale grey sandstone clasts and inclusions up to 45mm						
					SANDSTONE: medium to coarse grained, pale grey, massive, 2% dark grey siltstone flecks and clasts up to 3mm.			a=1.19 d=1.38			

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:42

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

coating
CN clean
SN stained
VN veneer
CO coating

TETRA TECH COFFEY

Engineering Log - Cored Borehole

Borehole ID.	**BH9**
sheet:	5 of 5
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**20 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**20 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,699.79; N: 6,251,797.84 (GDA94 Zone 56) surface elevation: 2.25 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information				material substance					rock mass defects		
method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
HQ3	95-100% Water return	-22	25.0		**SANDSTONE**: medium to coarse grained, pale grey, massive, 2% dark grey siltstone flecks and clasts up to 3mm. *(continued)*	FR		a=1.61 d=1.45	100%		
		-23						a=1.27 d=1.24			PT, 10°, PL, Clay VN, tight PT x2, 0 - 10°, PL, Clay VN, tight PT, 10°, PL, Clay VN, tight Sheared SM, 5 - 15°, PL, Sandy clay, 20mm
		-24	26.0		**SANDSTONE**: medium to coarse grained, pale grey, distinctly cross-bedded at 5-15°, 5-60mm typical spacing, 2% dark grey siltstone laminations. From 26.14m: well developed bedding			a=1.60 d=1.39	98%		
		-25	27.0		From 27.03m: distinctly cross-bedded at 10-25°, 5-100mm typical spacing						PT, 10°, PL, Clay VN, tight
		-26	28.0		From 28.44m: becoming indistinctly cross-bedded almost massive						PT, 10°, PL, RO, CN PT, 15°, PL, Clay VN, tight
		-27	29.0						100%		
		-28	30.0		**SANDSTONE**: medium to coarse grained, pale grey, massive, <1% dark grey siltstone flecks.						
		-29	31.0		Borehole BH9 terminated at 30.42 m Target depth						

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:42

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

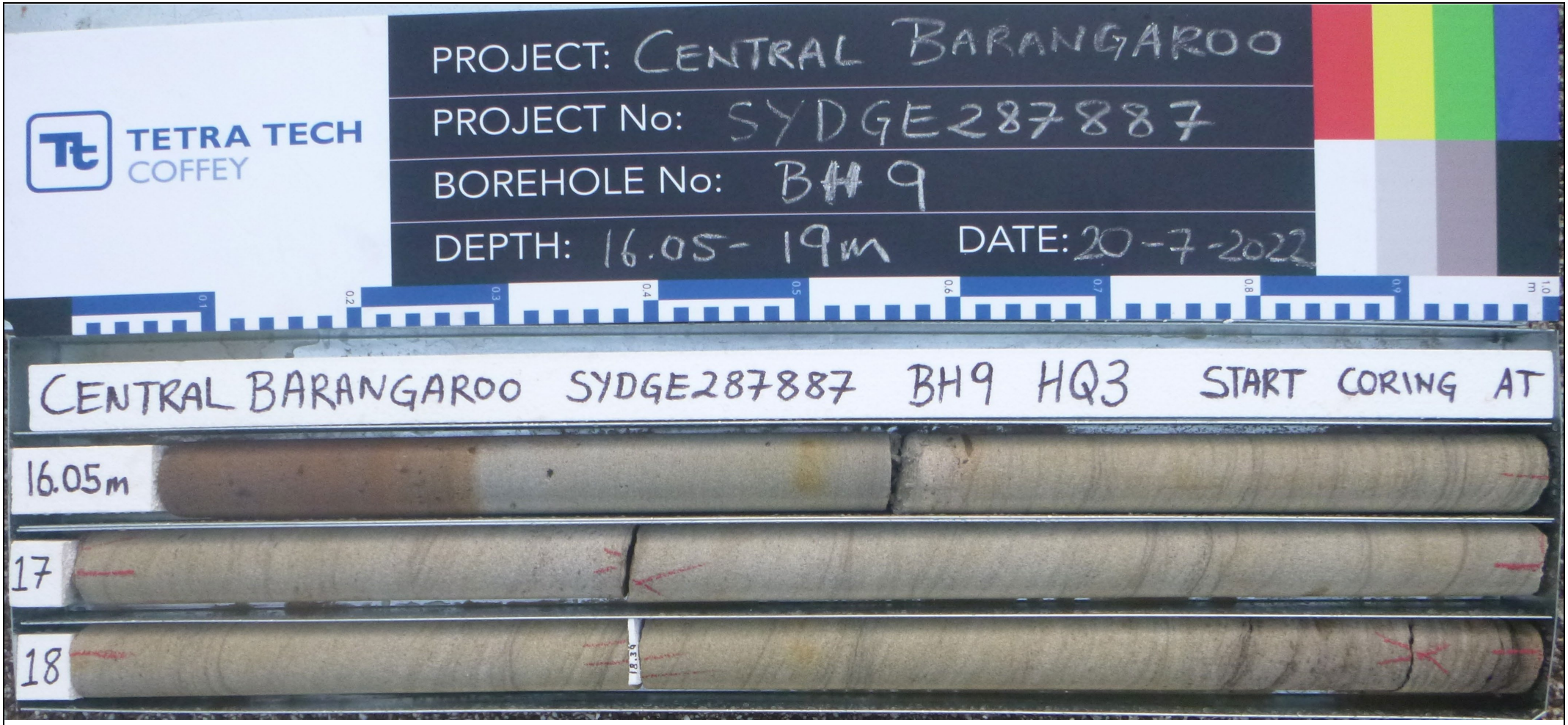
strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

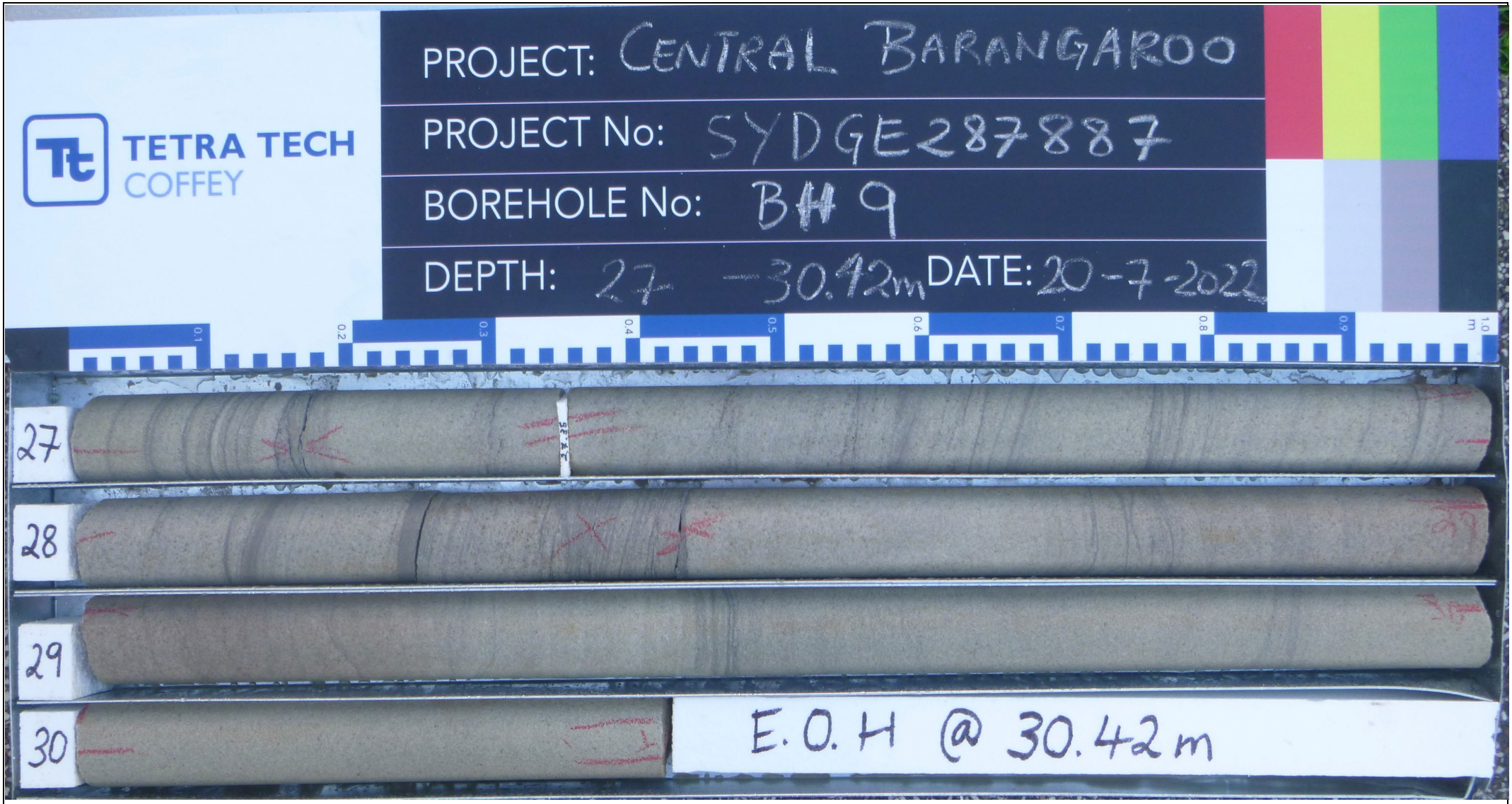
coating
CN clean
SN stained
VN veneer
CO coating



drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project :	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH9**
scale	**N/A**			
original	**A4**		project no: **754-SYDGE287887**	**Figure 1**

drawn	RAS	TETRA TECH COFFEY	client:	Aqualand Projects Pty Ltd
approved	RT		project :	Central Barangaroo Development
date	09/11/22		title:	CORE PHOTOGRAPH BH9
scale	N/A		project no: 754-SYDGE287887	Figure 2
original	A4			

drawn	RAS	TETRA TECH COFFEY	client:	Aqualand Projects Pty Ltd
approved	RT		project :	Central Barangaroo Development
date	09/11/22		title:	CORE PHOTOGRAPH BH9
scale	N/A		project no: 754-SYDGE287887	Figure 3
original	A4			



drawn	RAS	TETRA TECH COFFEY	client:	Aqualand Projects Pty Ltd
approved	RT		project :	Central Barangaroo Development
date	09/11/22		title:	CORE PHOTOGRAPH BH9
scale	N/A		project no: 754-SYDGE287887	Figure 4
original	A4			

TETRA TECH COFFEY

Engineering Log - Borehole

		Borehole ID.	**BH10**
		sheet:	1 of 6
		project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**	date started:	**18 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**	date completed:	**19 Jul 2022**
project:	**Central Barangaroo Development**	logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**	checked by:	**RT**

position: E: 333,683.33; N: 6,251,876.19 (GDA94 Zone 56) surface elevation: 2.44 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa)	soil origin, structure and additional observations
SONIC / C								**ROAD SURFACE: CONCRETE**: grey, 200mm.				**PAVEMENT**
				2				**FILL: Sandy CLAY**: low to medium plasticity, orange-brown, medium to coarse grained sand, with fine to coarse, sub-angular to angular sandstone gravel.	<Wp			**FILL**
									D			
				1	1.0			**FILL: SAND**: fine to medium grained, dark grey, with fine to coarse, sub-angular to angular sandstone and basalt gravel, trace fines.				
								FILL: CLAYEY SAND: fine to medium grained, brown and orange, with medium to coarse, sub-angular to sub-rounded sandstone gravel.				
				0	2.0							
								FILL: SANDSTONE: medium to coarse grained, pale grey, (recovered mainly as gravel size fragments).	<Wp			
								FILL: Sandy CLAY: low to medium plasticity, pale brown and pale grey, fine to medium grained sand, trace medium to coarse sub-angular sandstone gravel.				
				-1	3.0			**FILL: Sandy CLAY**: low plasticity, dark grey to grey, fine to coarse grained sand, with medium to coarse, sub-angular sandstone gravel, trace brick fragments and bricks to 120mm, trace wood pieces to 60mm, trace sandstone cobbles.				
				-2	4.0							
					5.0			**FILL: CLAYEY SAND**: medium to coarse grained, grey to grey-brown, with fine to medium sub-angular to angular sandstone gravel, trace angular sandstone cobbles, metal wires to 100mm.	D			
				-3					M			
		▶			6.0			**FILL: SAND**: fine to coarse grained, grey to dark grey, with fines, trace fine to medium sub-angular basalt gravel. From 5.6m: pale grey	>Wp			
				-4				**FILL: Sandy CLAY**: low plasticity, grey and pale grey, fine to medium grained sand, with fine to coarse sub-angular to angular sandstone and basalt gravel, trace sub-rounded sandstone cobbles.				
					7.0							
				-5				**FILL: Sandy CLAY**: low plasticity, grey-brown and orange, coarse grained sand.				

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud
C casing
N nil

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

TETRA TECH COFFEY

Engineering Log - Borehole

		Borehole ID.	**BH10**
		sheet:	2 of 6
		project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**	date started:	**18 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**	date completed:	**19 Jul 2022**
project:	**Central Barangaroo Development**	logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**	checked by:	**RT**

position: E: 333,683.33; N: 6,251,876.19 (GDA94 Zone 56) surface elevation: 2.44 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa)	soil origin, structure and additional observations
SONIC, C				-6				**FILL: Sandy CLAY**: low plasticity, grey-brown and orange, coarse grained sand. *(continued)*	>Wp			**FILL**
					9.0			**FILL: SAND**: medium to coarse grained, grey-brown, with fine to coarse sub-angular to sub-rounded sandstone gravel, trace clay, trace sandstone cobbles, trace brick fragments to 5mm.	W			
				-7				From 9.5m: sandy clay lenses				
					10.0			**FILL: Sandy CLAY**: low plasticity, grey, fine to coarse grained sand with fine to coarse, sub-angular sandstone gravel, trace sub-angular sandstone cobbles, trace concrete fragments 15mm.	>Wp			
				-8								
					11.0							
				-9				**FILL: SANDSTONE**: medium to coarse grained, pale grey, (recovered as medium to coarse gravel).	>Wp			
								FILL: Sandy CLAY: low plasticity, grey-brown, fine to medium grained sand trace sub-angular to sub-rounded sandstone cobbles.	W			
					12.0			**FILL: SAND**: medium to coarse grained, grey, with fine to coarse sub-angular sandstone gravel, trace sub-angular sandstone cobbles, trace glass fragments to 50mm.				
				-10				**FILL: Silty CLAY**: low plasticity, dark grey, with fine to medium grained sand, trace shells to 10mm.	>Wp			
					13.0			**FILL: Sandy CLAY**: medium plasticity, orange and yellow-brown, medium to coarse grained sand, relict rock fabric visible in some materials..				
				-11				**FILL: Sandy CLAY**: low to medium plasticity, dark grey, fine to coarse grained sand, trace fines.	W			**ALLUVIUM/POSSIBLE FIILL**
							CI	**FILL: Sandy CLAY**: medium to high plasticity, pale grey, fine to medium grained sand, relict rock fabric visible in some materials.	>Wp	St - VSt		**ALLUVIUM**
					14.0			**FILL: SAND**: fine to medium grained, yellow-brown, fine to medium grained sand, with low to medium plasticity sandy clay lenses.				
				-12				**Sandy CLAY**: medium plasticity, yellow-brown mottled orange and pale grey, fine to medium grained sand.				
					15.0			13.9 m: becoming orange-red mottled yellow-brown and pale grey				
				-13			CI-CH	From 15.0m: pale grey spotted orange-red		VSt		
								Sandy CLAY: medium to high plasticity, yellow-brown mottled orange and pale grey, medium to coarse grained sand.				

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud
C casing
N nil

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remoulded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	***BH10***
sheet:	3 of 6
project no.	***754-SYDGE287887***
client:	***Aqualand Projects Pty Ltd***
date started:	***18 Jul 2022***
principal:	***Aqualand Projects Pty Ltd***
date completed:	***19 Jul 2022***
project:	***Central Barangaroo Development***
logged by:	***RAS***
location:	***39 Hickson Road, Sydney NSW 2000***
checked by:	***RT***

position: E: 333,683.33; N: 6,251,876.19 (GDA94 Zone 56) surface elevation: 2.44 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description **SOIL NAME**: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	soil origin, structure and additional observations
SONIC C							CI-CH	From 16.0m: yellow-brown	>Wp	VSt		**ALLUVIUM**
				-14			CI-CH	**Sandy CLAY**: medium to high plasticity, pale grey mottled yellow-brown and orange, medium to coarse grained sand, relict rock fabric visible, laminated (10-40mm), extremely weathered.		H		**EXTREMELY WEATHERED MATERIAL**
					17.0			Borehole BH10 continued as cored hole				
				-15								
					18.0							
				-16								
					19.0							
				-17								
					20.0							
				-18								
					21.0							
				-19								
					22.0							
				-20								
					23.0							
				-21								

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
- DT diatube
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- RR rock roller

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remoulded (kPa)
- R refusal
- HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

TETRA TECH COFFEY

Engineering Log - Cored Borehole

Borehole ID.	**BH10**
sheet:	4 of 6
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**18 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**19 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,683.33; N: 6,251,876.19 (GDA94 Zone 56) surface elevation: 2.44 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	material description (ROCK TYPE: grain characterisics, colour, structure, minor components)	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral)	samples, field tests & Is(50) (MPa) (a = axial; d = diametral)	core run & RQD	defect spacing (mm)	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		-14		started coring at 16.75m						
HQ3	90% Water return	-15	17.0	**SANDSTONE**: medium to coarse grained, pale grey and orange-red.	XW					
				NO CORE: 0.12 m	XW					
				SANDSTONE: medium to coarse grained, mottled red-brown and pale grey, with occasional medium to coarse, sub-angular iron indurated gravel and bands.			a=0.00 d=0.02	0%		
		-16	18.0	18.16 to 18.20 m: iron indurated band, 40mm						
				SILTSTONE: grey to pale grey, with red-brown iron indurated clasts and bands to 20mm.			a=0.01 d=0.02			XW SM, 0 - 20°, UN, sandy clay, 80mm
		-17	19.0	**SANDSTONE**: medium to coarse grained, brown-red and orange, indistinctly cross-bedded at 5-15°, scattered fine sub-rounded to sub-angular quartz gravel.	HW					PT, 10 - 15°, PL, VR, Fe SN
				19.43 to 19.60 m: orange and dark brown			a=0.38 d=0.60			
				19.83 m: dark grey, siltstone clast, 3mm	FR			84%		
		-18	20.0	**SANDSTONE**: medium to coarse grained, pale grey, cross-bedded at 5-20°, 2% dark grey siltstone flecks and laminations.						PT, 10°, PL, RO, Clay CO, tight
							a=0.95 d=1.04			
	95-97% Water return	-19	21.0	From 21.15m: occasioinal dark grey, siltstone clasts, sub-rounded to sub-angular, up to 25mm						PT, 20°, PL, RO, CN
				From 21.39m: becoming indistinctly bedded to massive			a=1.14 d=1.46			
		-20	22.0	**SHALE BRECCIA**: elongated, irregular and sub-rounded siltstone clasts and beds up to 100mm, in a medium to coarse grained, pale grey sandstone matrix. Matrix supported. Siltstone beds laminated at 5-20°, 10% fine grained pale grey sandstone laminations.						JT, 25°, PL, SO, CN
				SANDSTONE: medium to coarse grained, pale grey, indistinctly cross-bedded at 5-20°, 1% dark grey siltstone and flecks.			a=1.31 d=1.24	98%		CS, 10 - 40°, CU, RO, sandy clay and medium to coarse gravel, 50mm
		-21	23.0				a=1.43 d=1.33			

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:41

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

coating
CN clean
SN stained
VN veneer
CO coating

TETRA TECH COFFEY

Engineering Log - Cored Borehole

Borehole ID.	**BH10**
sheet:	5 of 6
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**18 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**19 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,683.33; N: 6,251,876.19 (GDA94 Zone 56) surface elevation: 2.44 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
HQ3	95-97% Water return	-22	25.0		**SANDSTONE**: medium to coarse grained, pale grey, indistinctly cross-bedded at 5-20°, 1% dark grey siltstone and flecks. *(continued)*	FR		a=1.36 d=1.24	98%		
		-23			25.24 to 25.44 m: pale grey to grey			a=1.46 d=1.30			PT x2, 5°, PL, Clay CO, tight
		-24	26.0		25.79 to 26.61 m: distinctly cross-bedded at 10-20°, 10-60mm typical spacing			a=1.42 d=1.31	100%		
		-25	27.0		**SANDSTONE**: medium to coarse grained, pale grey, massive, 1% dark grey siltstone flecks.			a=1.54 d=1.58			
		-26	28.0		28.11 to 30.14 m: indistinctly cross-bedded at 0-10°, grading to massive			a=1.50 d=1.70	100%		
		-27	29.0					a=1.85 d=1.75			
		-28	30.0								
		-29	31.0		31.58 to 31.77 m: grey to grey-brown			a=1.33 d=1.61	99%		PT, 5°, PL, RO, Clay VN, tight PT, 10°, PL, closed PT, 15°, PL, RO, Clay VN, tight

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:41

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

TETRA TECH COFFEY

Engineering Log - Cored Borehole

Borehole ID.	***BH10***
sheet:	6 of 6
project no.	***754-SYDGE287887***
client:	***Aqualand Projects Pty Ltd***
date started:	***18 Jul 2022***
principal:	***Aqualand Projects Pty Ltd***
date completed:	***19 Jul 2022***
project:	***Central Barangaroo Development***
logged by:	***RAS***
location:	***39 Hickson Road, Sydney NSW 2000***
checked by:	***RT***

position: E: 333,683.33; N: 6,251,876.19 (GDA94 Zone 56) surface elevation: 2.44 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information				material substance					rock mass defects		
method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
HQ3	95-97% Water return	-30	33.0		**SANDSTONE**: medium to coarse grained, pale grey, indistinctly to distinctly cross-bedded at 5-15°, 2% dark grey siltstone flecks and laminations. *(continued)* 32.27 to 32.37 m: sub-rounded to sub-angular and elongated dark grey siltstone and quartz clasts up to 30mm 32.95 m: dark grey, carbonaceous laminations	FR		a=1.57 d=1.63	99%		
		-31			Borehole BH10 terminated at 33.34 m Target depth						
		-32	34.0								
		-33	35.0								
		-34	36.0								
		-35	37.0								
		-36	38.0								
		-37	39.0								

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:41

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

coating
CN clean
SN stained
VN veneer
CO coating

drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project :	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH10**
scale	**N/A**			
original	**A4**		project no: **754-SYDGE287887**	**Figure 1**

drawn	RAS	TETRA TECH COFFEY	client:	Aqualand Projects Pty Ltd
approved	RT		project :	Central Barangaroo Development
date	09/11/22		title:	CORE PHOTOGRAPH BH10
scale	N/A		project no: 754-SYDGE287887	Figure 2
original	A4			

drawn	RAS	TETRA TECH COFFEY	client:	Aqualand Projects Pty Ltd
approved	RT		project :	Central Barangaroo Development
date	09/11/22		title:	CORE PHOTOGRAPH BH10
scale	N/A		project no: 754-SYDGE287887	Figure 3
original	A4			

drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project :	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH10**
scale	**N/A**			
original	**A4**		project no: **754-SYDGE287887**	**Figure 4**

drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project :	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH10**
scale	**N/A**			
original	**A4**		project no: **754-SYDGE287887**	**Figure 5**

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	***BH11***
sheet:	1 of 5
project no.	***754-SYDGE287887***
client:	***Aqualand Projects Pty Ltd***
date started:	***21 Jul 2022***
principal:	***Aqualand Projects Pty Ltd***
date completed:	***21 Jul 2022***
project:	***Central Barangaroo Development***
logged by:	***RAS***
location:	***39 Hickson Road, Sydney NSW 2000***
checked by:	***RT***

position: E: 333,675.59; N: 6,251,773.51 (GDA94 Zone 56) surface elevation: 2.44 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa)	soil origin, structure and additional observations
SONIC / C				2				**ROAD SURFACE: ASPHALTIC CONCRETE**: dark grey, 40mm.	D			**PAVEMENT**
								FILL: Sandy GRAVEL: fine to coarse, angular to sub-angular basalt gravel, grey, fine to coarse grained sand.	<Wp			**FILL**
				1	1.0			**FILL: Sandy CLAY**: low plasticity, brown to pale brown, fine to medium grained sand, with fine to coarse sub-angular to sub-rounded sandstone gravel.				
								FILL: Sandy CLAY: low to medium plasticity, brown, fine to medium grained sand, with fine to coarse sub-angular to angular sandstone gravel, trace glass fragments to 50mm, trace sandstone cobbles.				
				0	2.0			**FILL: SAND**: fine to medium grained, red-brown, with fine to coarse sub-angular to sub-rounded sandstone gravel, trace brick fragments to 100mm, trace fines.	D			
					3.0			**FILL: Sandy CLAY**: low plasticity, brown and grey, fine to medium grained, with fine to medium, sub-angular sandstone gravel, trace ceramic and brick fragments to 10mm, with sandstone cobbles, trace fines.	<Wp			
				-1	4.0							
				-2	5.0			**FILL: CONCRETE**: grey, 400mm.				
				-3	6.0			**FILL: Sandy CLAY**: low to medium plasticity, grey to dark grey, fine to medium grained sand, with fine to coarse sub-angular sandstone gravel, trace sandstone and basalt cobbles, trace brick fragments to 20mm.	<Wp / >Wp			
				-4	7.0			**FILL: Sandy CLAY**: low plasticity, grey, with fine to medium sub-angular sandstone gravel, trace sandstone cobbles, trace brick fragments to 60mm.				
				-5								

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud
C casing
N nil

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remoulded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

TETRA TECH COFFEY

Engineering Log - Borehole

		Borehole ID.	**BH11**
		sheet:	2 of 5
		project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**	date started:	**21 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**	date completed:	**21 Jul 2022**
project:	**Central Barangaroo Development**	logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**	checked by:	**RT**

position: E: 333,675.59; N: 6,251,773.51 (GDA94 Zone 56) surface elevation: 2.44 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	soil origin, structure and additional observations
SONIC C				-6					>Wp			**FILL**
								FILL: Sandy CLAY: low to medium plasticity, brown to pale brown, medium to coarse grained sand, with medium to coarse sub-angular sandstone and basalt gravel, trace sandstone cobbles.	W			
					9.0			**FILL: SAND**: medium to coarse grained, pale grey, with medium to coarse sub-angular sandstone gravel, trace sandstone cobbles.				
				-7				**FILL: SAND**: medium to coarse grained, grey-brown, trace fine to medium sub-angular basalt gravel, trace brick fragments to 5mm.				
					10.0							
				-8				**FILL: MIXTURE OF COBBLES (90%) AND SOIL (10%)**: Medium to coarse grained, pale grey sandstone cobbles, sub-angular. Soil is SAND, fine to coarse grained, grey-brown to brown, with fine to coarse sub-angular to angular sandstone and basalt gravel.				
					11.0							
				-9								
					12.0							
				-10								
					13.0			**FILL: SAND**: medium to coarse grained, brown to grey-brown, with fine to coarse sub-angular sandstone gravel, trace brick and ceramic fragments to 40mm, trace silt.				
				-11								
								FILL: Silty CLAY: low plasticity, dark grey to grey, trace fine sub-angular siltstone gravel.	>Wp			
					14.0		CL-CI	**Sandy CLAY**: low to medium plasticity, orange mottled pale grey and yellow-brown, fine to medium grained sand, trace fine sub-angular iron indurated gravel.		F - St		**ALLUVIUM**
				-12			CI-CH	**Sandy CLAY**: medium to high plasticity, pale grey with orange and yellow-brown bands, medium to coarse grained sand.		St - VSt		
					15.0							
				-13								

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
DT diatube
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
RR rock roller

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud N nil
C casing

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

soil group symbol & material description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TETRA TECH COFFEY

Engineering Log - Borehole

Borehole ID.	***BH11***
sheet:	3 of 5
project no.	***754-SYDGE287887***
client:	***Aqualand Projects Pty Ltd***
date started:	***21 Jul 2022***
principal:	***Aqualand Projects Pty Ltd***
date completed:	***21 Jul 2022***
project:	***Central Barangaroo Development***
logged by:	***RAS***
location:	***39 Hickson Road, Sydney NSW 2000***
checked by:	***RT***

position: E: 333,675.59; N: 6,251,773.51 (GDA94 Zone 56) surface elevation: 2.44 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description **SOIL NAME**: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	soil origin, structure and additional observations
SONIC C				-14			CI-CH	**Sandy CLAY**: medium to high plasticity, orange-red mottled yellow-brown and pale grey, fine to medium grained sand.	>Wp	VSt		**ALLUVIUM**
				-15	17.0		CH	From 16.8m: becoming pale grey and red-brown, high plasticity **Sandy CLAY**: high plasticity, red-brown and orange, with iron indurated bands, fine to medium grained sand, relict rock fabric visible, laminated (2-10mm), extremely weathered. 17.6 m: pale grey and red-brown		H		**EXTREMELY WEATHERED MATERIAL**
				-16	18.0			Borehole BH11 continued as cored hole				
				-17	19.0							
				-18	20.0							
				-19	21.0							
				-20	22.0							
				-21	23.0							

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:27

method
- DT diatube
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- RR rock roller

* bit shown by suffix e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

soil group symbol & material description based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

TETRA TECH COFFEY

Engineering Log - Cored Borehole

Borehole ID.	***BH11***
sheet:	4 of 5
project no.	***754-SYDGE287887***
client:	***Aqualand Projects Pty Ltd***
date started:	***21 Jul 2022***
principal:	***Aqualand Projects Pty Ltd***
date completed:	***21 Jul 2022***
project:	***Central Barangaroo Development***
logged by:	***RAS***
location:	***39 Hickson Road, Sydney NSW 2000***
checked by:	***RT***

position: E: 333,675.59; N: 6,251,773.51 (GDA94 Zone 56) surface elevation: 2.44 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		-14			started coring at 17.90m						
			17.0								
		-15									
HQ3	100% Water return		18.0		**SANDSTONE**: medium to coarse grained, orange to orange-brown, indistinctly cross-bedded at 5-15°, 1% dark grey siltstone flecks and laminations.	HW		a=0.32 d=0.22	100%		PT, 15°, PL, RO, Fe SN
		-16			18.80 to 19.13 m: iron indurated bands up to 40mm, red-brown and pale grey	XW					Infilled SM, 0 - 5°, PL, yellow-brown and pale grey sandy clay, 20mm XW SM, 5 - 30°, PL, sandy clay, 50mm
			19.0		From 19.2m: pale grey, iron stained along defects only	MW SW					XW SM, 5 - 15°, UN, sandy clay, 40mm
	93% Water return	-17			**SANDSTONE**: medium to coarse grained, pale grey, massive to indistinctly cross- bedded, 1% dark grey siltstone flecks.	FR		a=1.54 d=1.36	84%		XW SM, 10°, PL, sandy clay, 120mm PT, 10 - 15°, UN, RO, Fe SN, Open, 1mm PT, 0 - 10°, UN, RO, Fe SN JT, 35°, PL, RO, Fe SN, partially closed JT, 10 - 65°, ST, RO, Fe SN, partially closed XW SM, 5 - 10°, PL, sandy clay, 30mm
			20.0		19.42 m: sub-rounded, dark grey siltstone clast, 10-15mm 20.04 to 20.12 m: subrounded to elongated, dark grey siltstone clasts						
		-18						a=1.14 d=1.14			
			21.0		**SANDSTONE**: medium to coarse grained, pale grey, distinctly cross-bedded at 5-15°, 10-40mm typical spacing, 1% dark grey siltstone flecks.	XW FR					Infilled SM, 0 - 20°, PL, orange sandy clay, 20mm XW SM, 0 - 5°, PL, sandy clay, 50mm
		-19						a=1.46 d=1.36			
			22.0								
	97-100% Water return	-20			**SANDSTONE**: medium to coarse grained, pale grey, massive, <1% dark grey siltstone flecks.			a=1.40 d=1.36	100%		
			23.0		**SANDSTONE**: medium to coarse grained, pale grey, indistinctly to distinctly cross-bedded at 0-10°, 10-100mm, typical spacing.						PT, 5°, PL, RO, Clay VN, tight
		-21						a=1.14 d=1.32			PT, 5°, PL, Clay VN, tight

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

coating
CN clean
SN stained
VN veneer
CO coating

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:41

TETRA TECH COFFEY

Engineering Log - Cored Borehole

Borehole ID.	**BH11**
sheet:	5 of 5
project no.	**754-SYDGE287887**
client:	**Aqualand Projects Pty Ltd**
date started:	**21 Jul 2022**
principal:	**Aqualand Projects Pty Ltd**
date completed:	**21 Jul 2022**
project:	**Central Barangaroo Development**
logged by:	**RAS**
location:	**39 Hickson Road, Sydney NSW 2000**
checked by:	**RT**

position: E: 333,675.59; N: 6,251,773.51 (GDA94 Zone 56) surface elevation: 2.44 m (AHD) angle from horizontal: 90°

drill model: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
HQ3	97-100% Water return	-22	25.0		**SANDSTONE**: medium to coarse grained, pale grey, massive, <1% dark grey siltstone flecks.	FR		a=1.30 d=1.47	100%		
		-23						a=1.12 d=1.56	99%		XW SM, 0 - 5°, PL, clay with sand, 25mm PT, 10°, PL, Clay CO
		-24	26.0		**SANDSTONE**: medium to coarse grained, pale grey, indistinctly becoming distinctly cross-bedded at 5-25°. Where distinctly cross-bedded typical bed spacing 5-120mm, 1% dark grey siltstone flecks.						PT, 15 - 20°, PL, RO, Clay VN
		-25	27.0								PT, 20°, PL, RO, Clay VN
		-26	28.0		**SANDSTONE**: medium to coarse grained, pale grey, wavy and disturbed bedding. 28.40 to 28.55 m: cross-bedded at 5-20°			a=2.03 d=1.46 a=1.38 d=1.52			PT, 25°, PL, RO, Clay VN
		-27	29.0		**SANDSTONE**: medium to coarse grained, pale grey, indistinctly cross-bedded at 10-25°, <1% dark grey siltstone flecks. **SANDSTONE**: medium to coarse grained, pale grey, massive, <1% dark grey siltstone flecks.			a=1.52 d=1.52	100%		
		-28	30.0								
		-29	31.0		**SANDSTONE**: medium to coarse grained, pale grey, indistinctly cross-bedded at 5-15°, 1% dark grey siltstone flecks and laminations. 30.50 to 30.53 m: pale grey to grey 30.68 m: dark grey coal lenticle			a=1.63 d=1.56 a=1.94 d=1.69	100%		PT, 15°, PL, RO, Clay VN
					Borehole BH11 terminated at 31.97 m Target depth						

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: CORED 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 11:41

method
DT diatube
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
RR rock roller

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS sheared surface
SZ sheared zone
CO contact
CS crushed seam
SM seam

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

coating
CN clean
SN stained
VN veneer
CO coating

drawn	RAS	TETRA TECH COFFEY	client:	Aqualand Projects Pty Ltd
approved	RT		project :	Central Barangaroo Development
date	09/11/22		title:	CORE PHOTOGRAPH BH11
scale	N/A		project no: 754-SYDGE287887	Figure 1
original	A4			

drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project :	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH11**
scale	**N/A**		project no: **754-SYDGE287887**	**Figure 2**
original	**A4**			

drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project :	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH11**
scale	**N/A**		project no: **754-SYDGE287887**	**Figure 3**
original	**A4**			

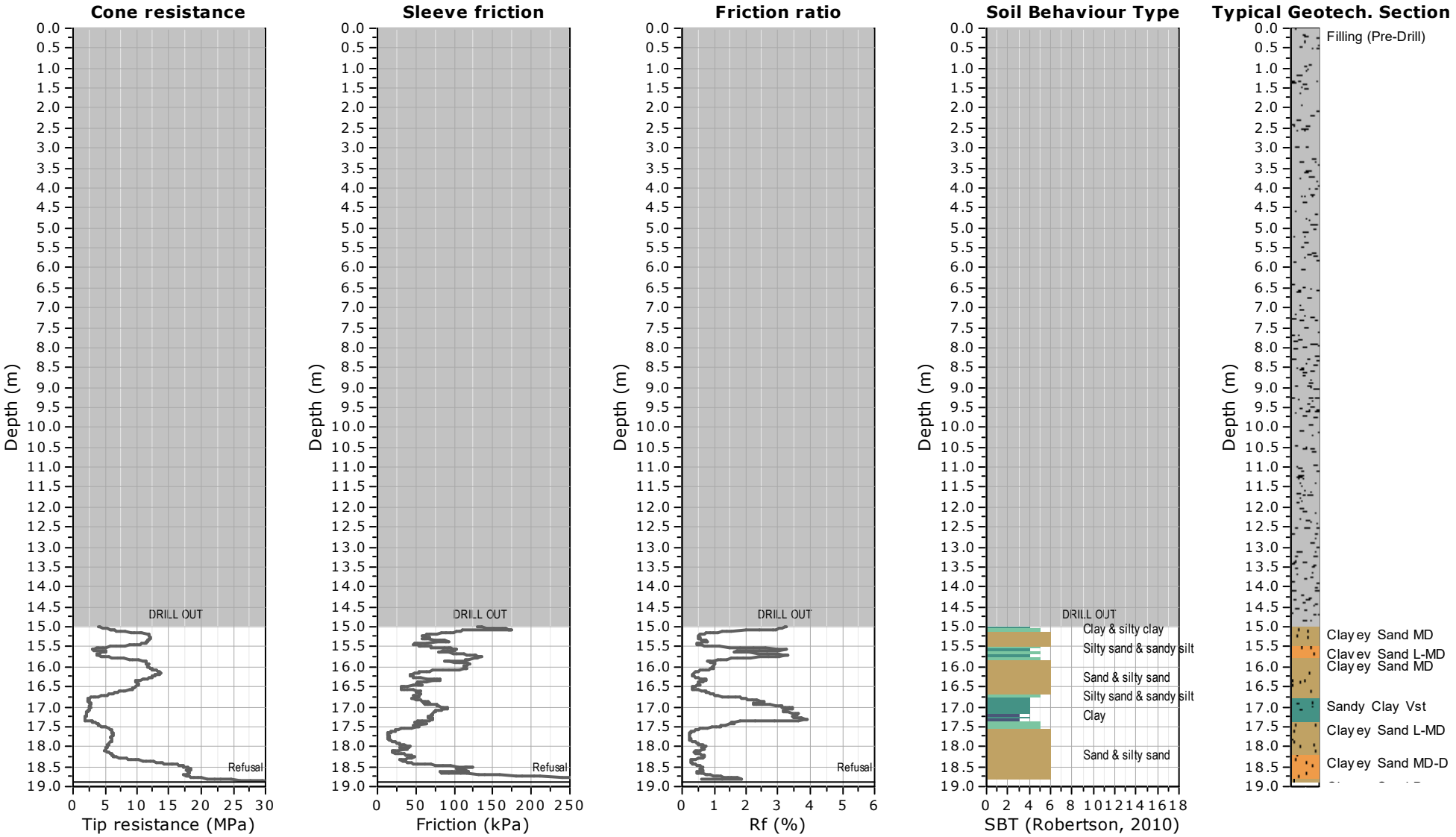
drawn	**RAS**	TETRA TECH COFFEY	client:	**Aqualand Projects Pty Ltd**
approved	**RT**		project :	**Central Barangaroo Development**
date	**09/11/22**		title:	**CORE PHOTOGRAPH BH11**
scale	**N/A**			
original	**A4**		project no: **754-SYDGE287887**	**Figure 4**

APPENDIX C. CONE PENETRATION TESTS

TETRA TECH COFFEY
Project ID: SYDGE287887
Office: Level 19, 799 Pacific Highway, Chastwood NSW 2067
Web: tetratechcoffey.com

CPT: CPT-BH02
Total depth: 18.89 m, Date: 20/07/2022
Surface Elevation: 3.30 m
Coords: N 6251724.8, E 333664.4
Cone Type: Pre-Drilled to 15m
Cone Operator: Coffey

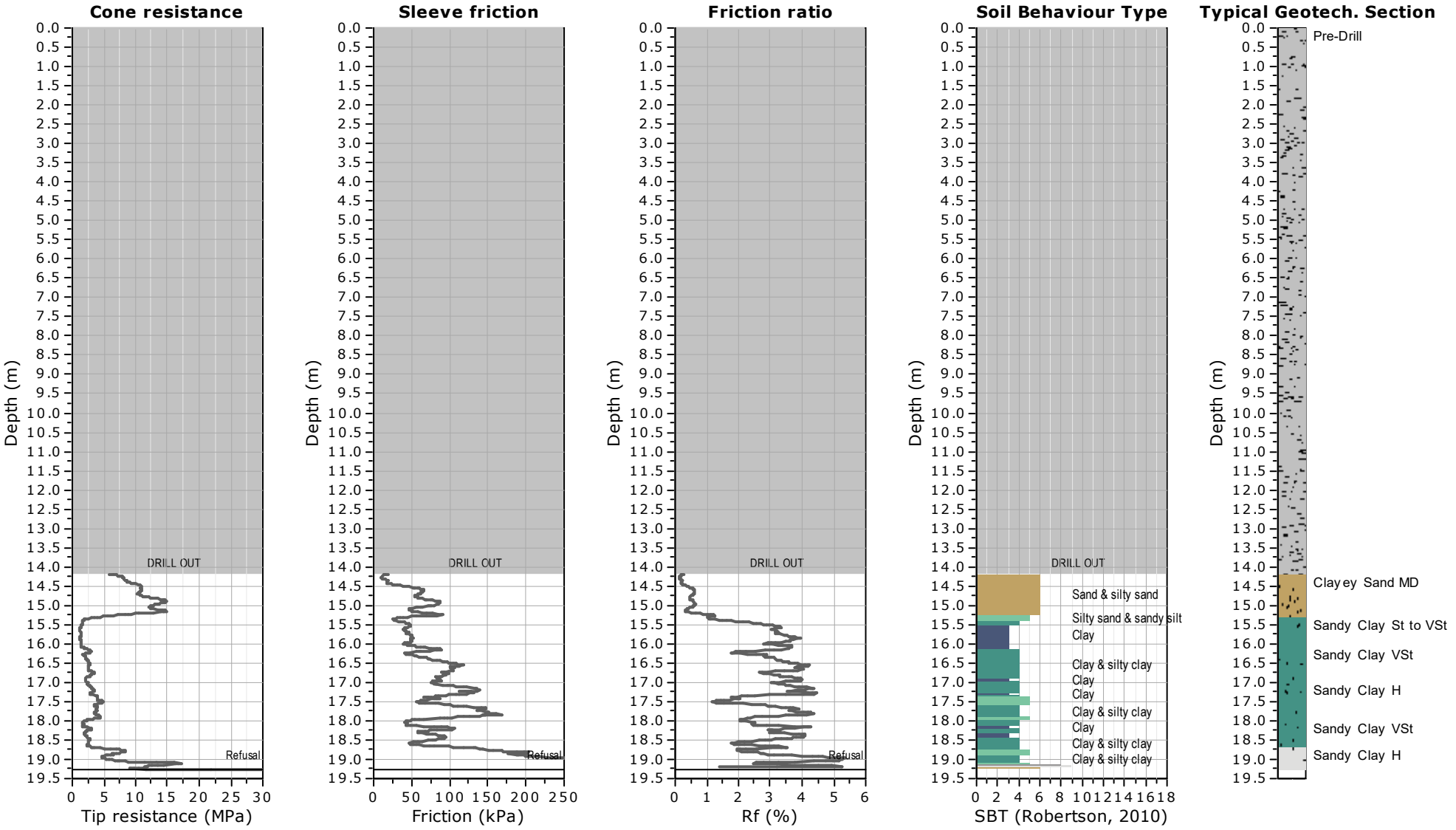
Project: Central Barangaroo Development
Location: Hickson Road, Sydney NSW



TETRA TECH COFFEY
Project ID: SYDGE287887
Office: Level 19, 799 Pacific Highway, Chastwood NSW 2067
Web: tetratechcoffey.com

CPT: CPT-BH04
Total depth: 19.28 m, Date: 20/07/2022
Surface Elevation: 2.90 m
Coords: N 6251798.8, E 333641.8
Cone Type: Pre-Drilled to 14.2m
Cone Operator: Coffey

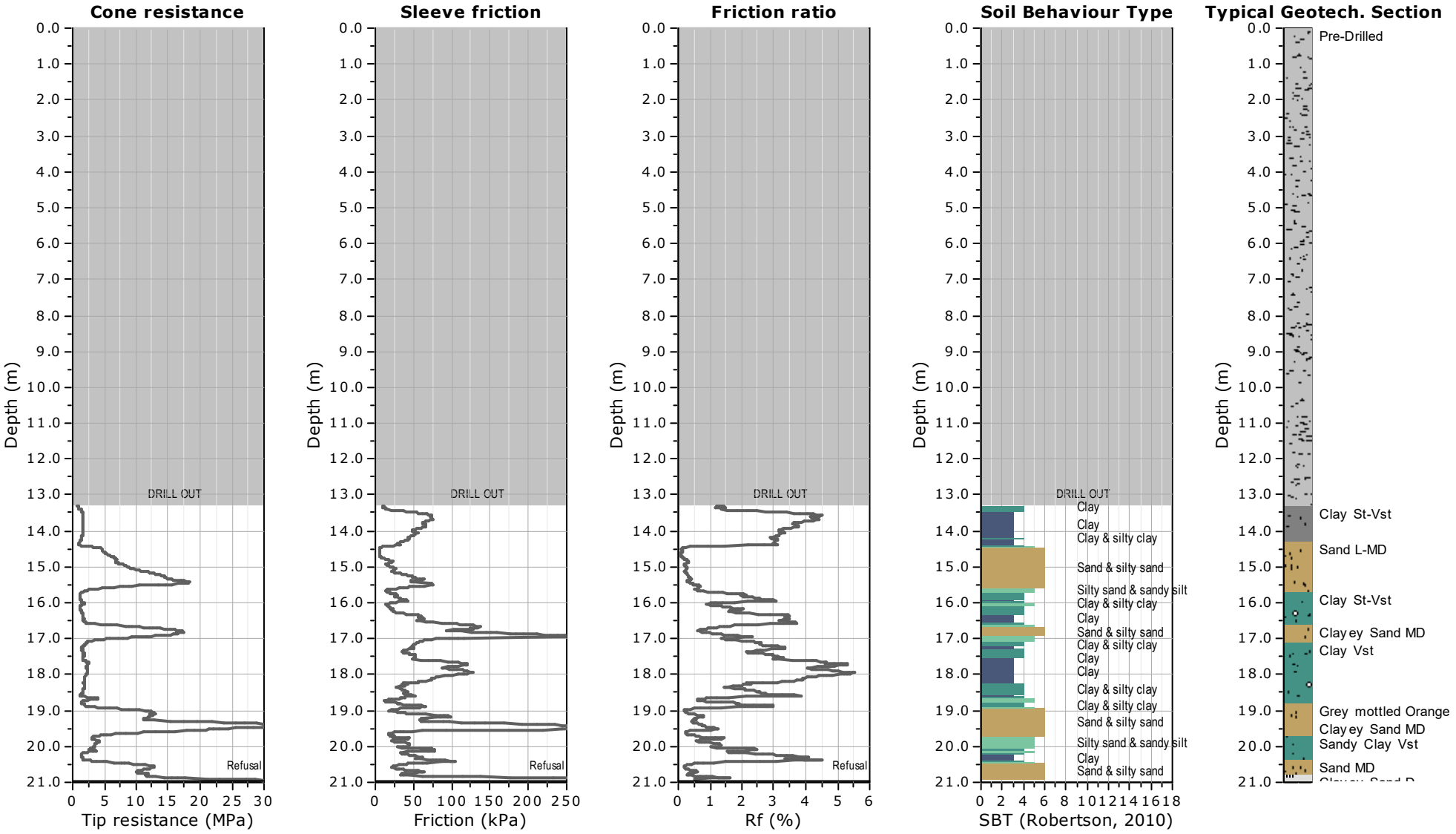
Project: Central Barangaroo Development
Location: Hickson Road, Sydney NSW



TETRA TECH COFFEY
Project ID: SYDGE287887
Office: Level 19, 799 Pacific Highway, Chastwood NSW 2067
Web: tetratechcoffey.com

CPT: CPT-BH05
Total depth: 20.97 m, Date: 20/07/2022
Surface Elevation: 2.30 m
Coords: N 6251854.4, E 333622.4
Cone Type: Pre-Drilled to 13.3m
Cone Operator: Coffey

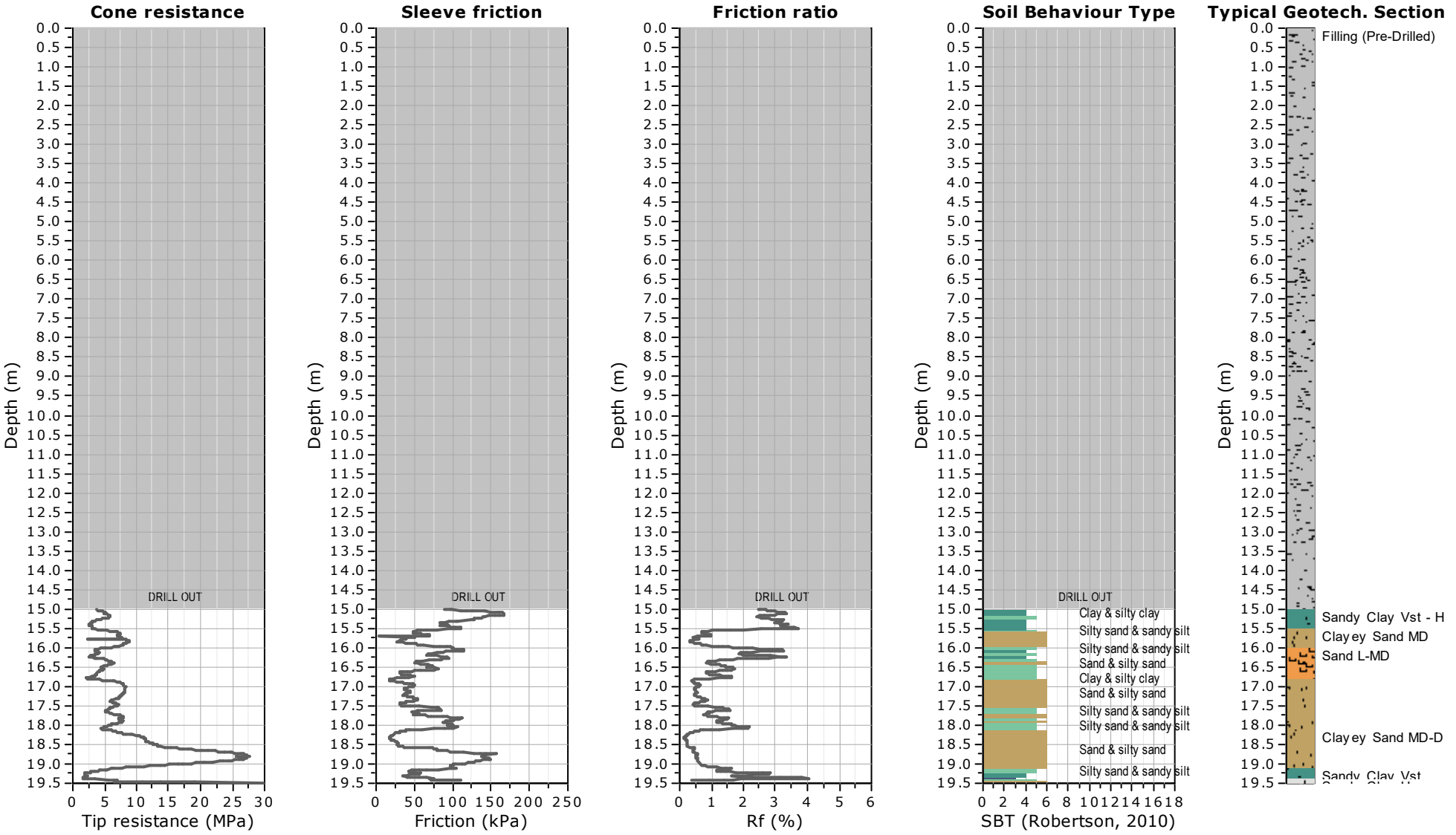
Project: Central Barangaroo Development
Location: Hickson Road, Sydney NSW



TETRA TECH COFFEY
Project ID: SYDGE287887
Office: Level 19, 799 Pacific Highway, Chastwood NSW 2067
Web: tetratechcoffey.com

CPT: CPT-BH07
Total depth: 19.50 m, Date: 20/07/2022
Surface Elevation: 2.50 m
Coords: N 6251925.4, E 333665.3
Cone Type: Pre-Drilled to 15m
Cone Operator: Coffey

Project: Central Barangaroo Development
Location: Hickson Road, Sydney NSW



APPENDIX D. LABORATORY TEST RESULTS

SOIL CLASSIFICATION REPORT

Client	Tetra Tech Coffey	**Source**	BH3_22.8-23.0 m
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Sample Description**	Silty Sandy CLAY
Project	Central Barangaroo Development (754-SYDGE287887)	**Report No.**	S80371-PI
Job No.	S22038-2	**Lab No.**	S80371

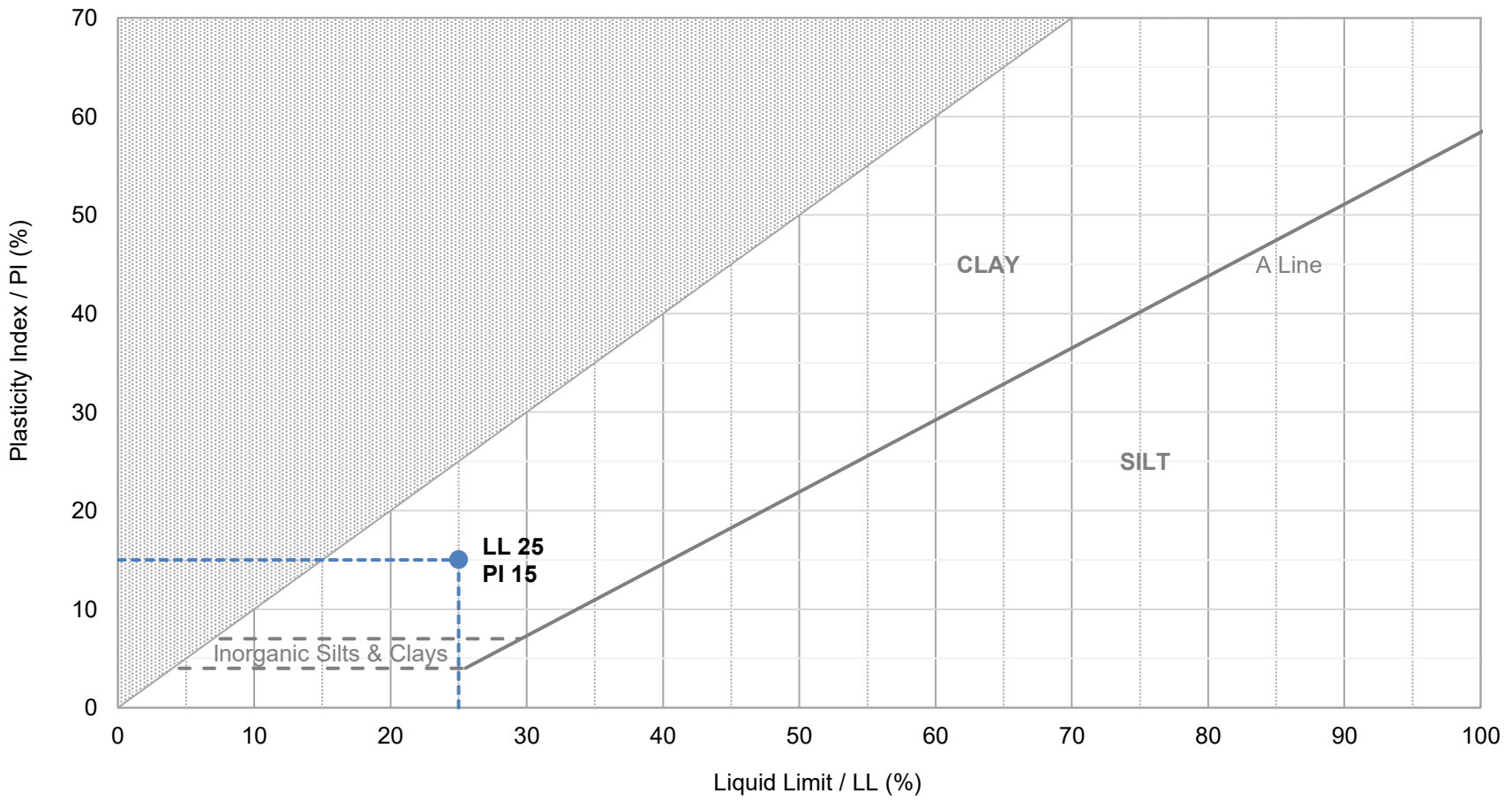
Test Procedure

- ☑ AS1289 3.1.1 Liquid Limit - Four point Casagrande method
- ☐ AS1289 3.1.2 Liquid Limit - One point Casagrande method
- ☑ AS1289 3.2.1 Plastic Limit - Standard method
- ☑ AS1289 3.3.1 Calculation of the Plasticity Index
- ☐ AS1289 3.4.1 Linear Shrinkage - Standard method

Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	7/09/2022
Preparation	Prepared in accordance with the test method	**Date Tested**	5/10/2022

Plasticity Chart for Classification of Fine-Grained Soils

AS 1726:2017 Clause 6.1.6 (Figure 5)



Preparation		Results	
Method of Preparation	**Dry Sieved**	Liquid Limit / LL (%)	**25**
History of the Sample	**Air Dried**	Plastic Limit (%)	**10**
		Plasticity Index / PI (%)	**15**
		Linear Shrinkage (%)	**-**
		Condition upon Drying	**N/A**

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. This document shall not be reproduced, except in full. Results relate only to the samples tested.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

6/10/2022

Date:

Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

SOIL CLASSIFICATION REPORT

Client	Tetra Tech Coffey	**Source**	BH3_25.7-26.0 m
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Sample Description**	Clayey SAND
Project	Central Barangaroo Development (754-SYDGE287887)	**Report No.**	S80372-PI
Job No.	S22038-2	**Lab No.**	S80372

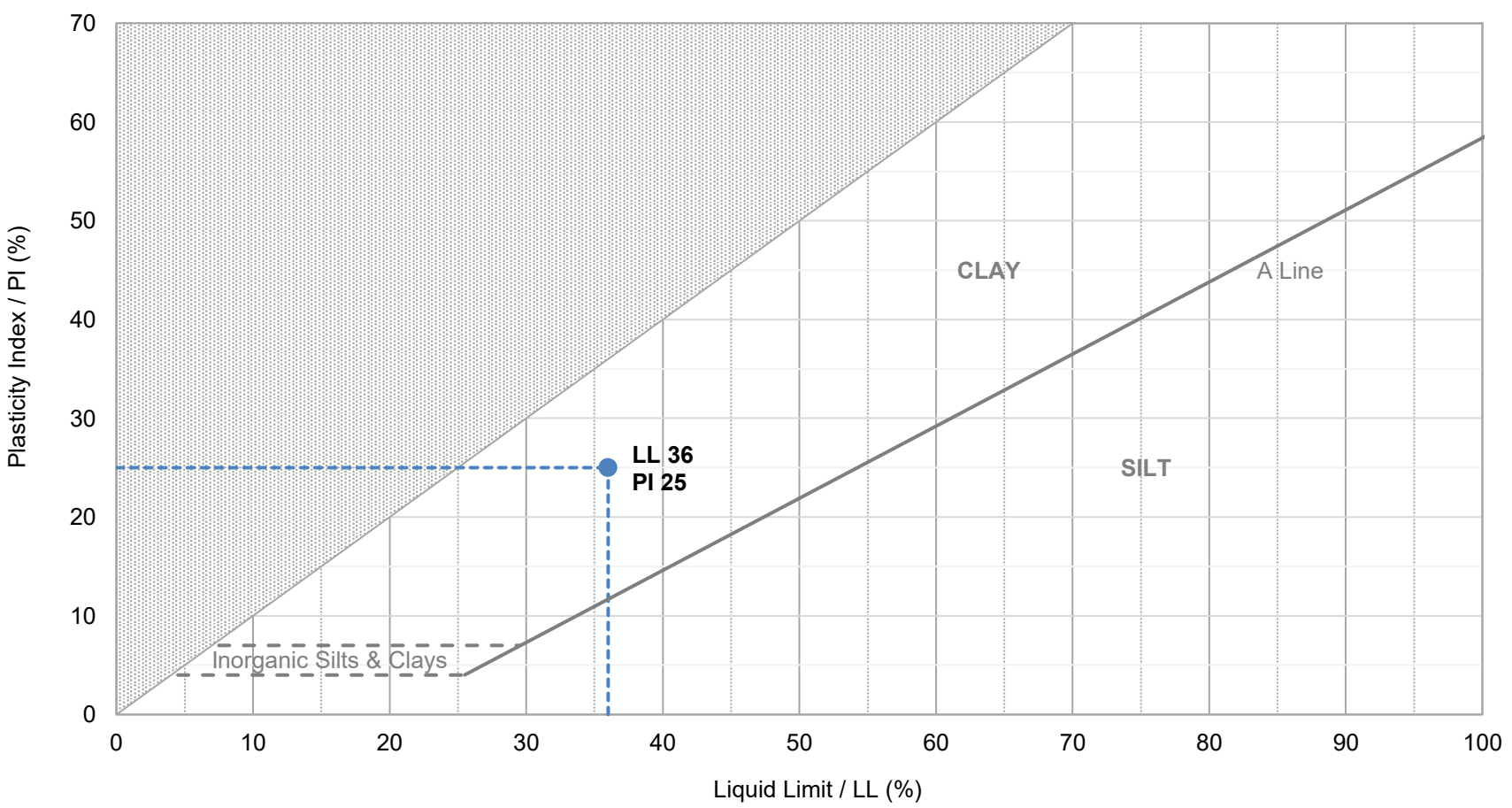
Test Procedure

- ☑ AS1289 3.1.1 Liquid Limit - Four point Casagrande method
- ☐ AS1289 3.1.2 Liquid Limit - One point Casagrande method
- ☑ AS1289 3.2.1 Plastic Limit - Standard method
- ☑ AS1289 3.3.1 Calculation of the Plasticity Index
- ☐ AS1289 3.4.1 Linear Shrinkage - Standard method

Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	7/09/2022
Preparation	Prepared in accordance with the test method	**Date Tested**	4/10/2022

Plasticity Chart for Classification of Fine-Grained Soils

AS 1726:2017 Clause 6.1.6 (Figure 5)



Preparation		**Results**	
Method of Preparation	**Dry Sieved**	Liquid Limit / LL (%)	**36**
History of the Sample	**Air Dried**	Plastic Limit (%)	**11**
		Plasticity Index / PI (%)	**25**
		Linear Shrinkage (%)	**-**
		Condition upon Drying	**N/A**

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. This document shall not be reproduced, except in full. Results relate only to the samples tested.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

5/10/2022

Date:

Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

SOIL CLASSIFICATION REPORT

Client	Tetra Tech Coffey	**Source**	BH3_28.7-29.0 m
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Sample Description**	Silty CLAY, trace of Sand
Project	Central Barangaroo Development (754-SYDGE287887)	**Report No.**	S80373-PI
Job No.	S22038-2	**Lab No.**	S80373

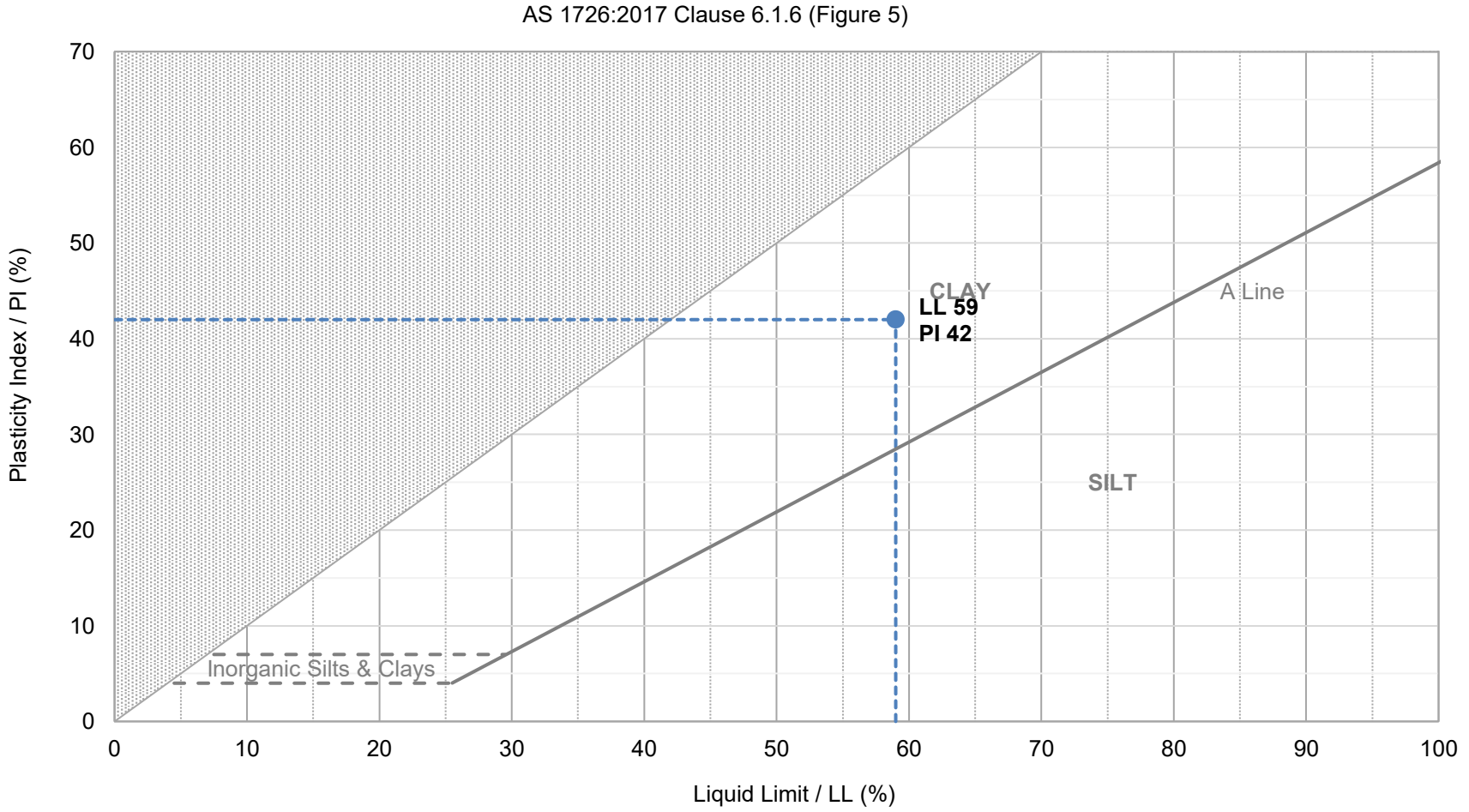
Test Procedure

- ☑ AS1289 3.1.1 Liquid Limit - Four point Casagrande method
- ☐ AS1289 3.1.2 Liquid Limit - One point Casagrande method
- ☑ AS1289 3.2.1 Plastic Limit - Standard method
- ☑ AS1289 3.3.1 Calculation of the Plasticity Index
- ☐ AS1289 3.4.1 Linear Shrinkage - Standard method

Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	7/09/2022
Preparation	Prepared in accordance with the test method	**Date Tested**	5/10/2022

Plasticity Chart for Classification of Fine-Grained Soils

AS 1726:2017 Clause 6.1.6 (Figure 5)



Preparation		**Results**	
Method of Preparation	**Dry Sieved**	Liquid Limit / LL (%)	**59**
History of the Sample	**Air Dried**	Plastic Limit (%)	**17**
		Plasticity Index / PI (%)	**42**
		Linear Shrinkage (%)	**-**
		Condition upon Drying	**N/A**

Notes

NATA

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. This document shall not be reproduced, except in full. Results relate only to the samples tested.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

6/10/2022

Date:

MACQUARIE GEOTECH

Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

SOIL CLASSIFICATION REPORT

Client	Tetra Tech Coffey	**Source**	BH3_32.8-32.9 m
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Sample Description**	Clayey SAND
Project	Central Barangaroo Development (754-SYDGE287887)	**Report No.**	S80374-PI
Job No.	S22038-2	**Lab No.**	S80374

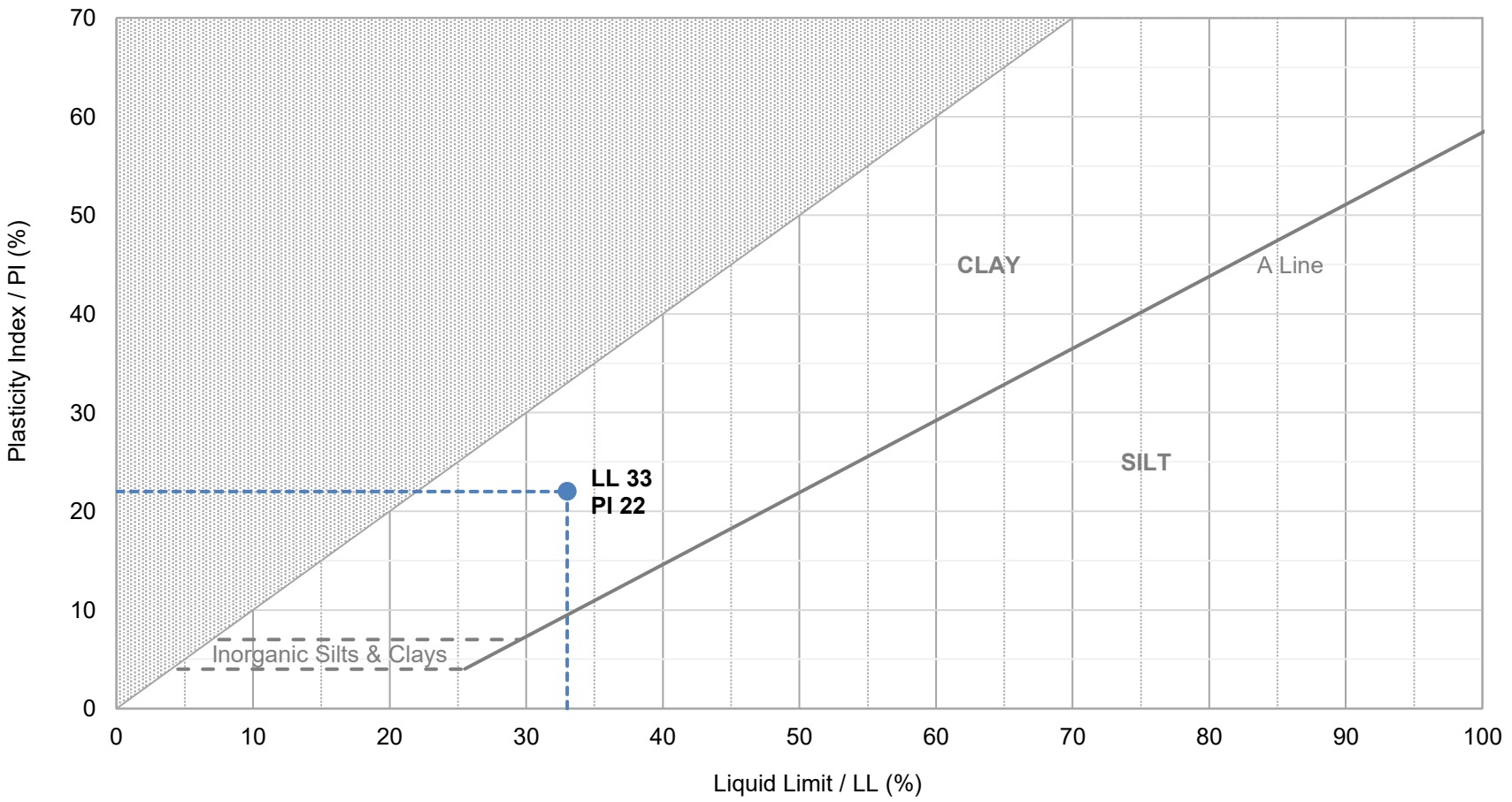
Test Procedure

- ☑ AS1289 3.1.1 Liquid Limit - Four point Casagrande method
- ☐ AS1289 3.1.2 Liquid Limit - One point Casagrande method
- ☑ AS1289 3.2.1 Plastic Limit - Standard method
- ☑ AS1289 3.3.1 Calculation of the Plasticity Index
- ☐ AS1289 3.4.1 Linear Shrinkage - Standard method

Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	7/09/2022
Preparation	Prepared in accordance with the test method	**Date Tested**	5/10/2022

Plasticity Chart for Classification of Fine-Grained Soils

AS 1726:2017 Clause 6.1.6 (Figure 5)



Preparation		**Results**	
Method of Preparation	**Dry Sieved**	Liquid Limit / LL (%)	**33**
History of the Sample	**Air Dried**	Plastic Limit (%)	**11**
		Plasticity Index / PI (%)	**22**
		Linear Shrinkage (%)	**-**
		Condition upon Drying	**N/A**

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. This document shall not be reproduced, except in full. Results relate only to the samples tested.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

6/10/2022

Date:

Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

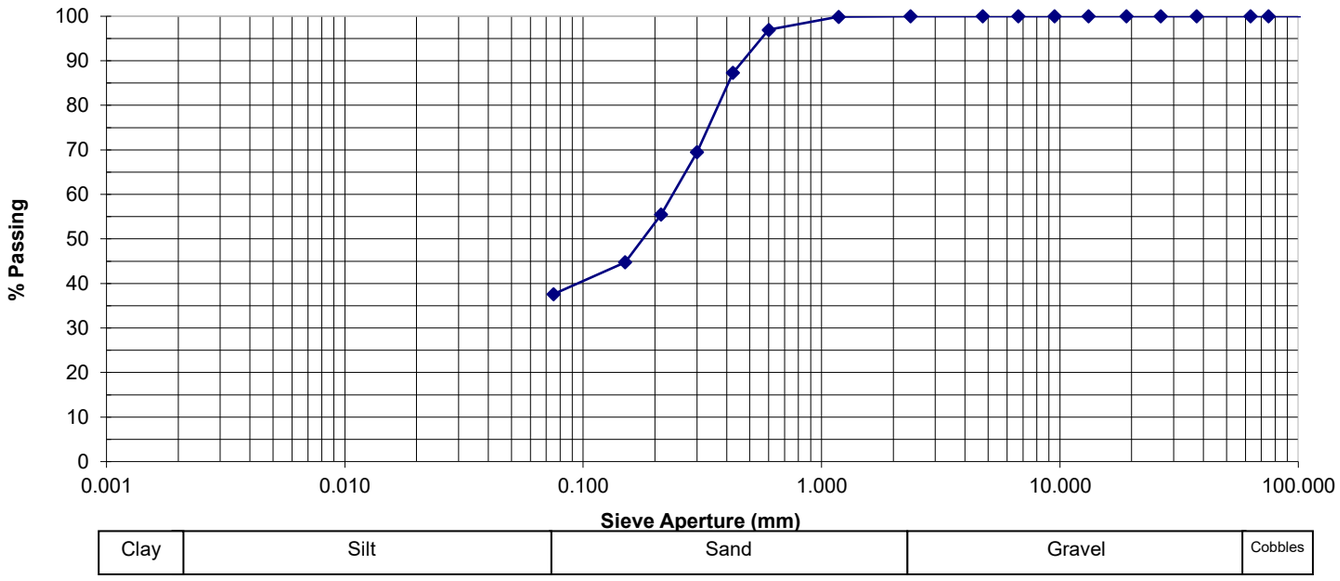
Particle Size Distribution Report

Client	Tetra Tech Coffey	**Source**	BH3_22.8-23.0 m
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Sample Description**	Silty Sandy CLAY
Project	Central Barangaroo Development (754-SYDGE287887)	**Report No**	S80371-PSD
Job No	S22038-2	**Lab No**	S80371

Test Procedure AS 1289.3.6.1 - Particle size distribution of a soil

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 7/09/2022

Preparation Prepared in accordance with the test method **Date Tested** 28/09/2022



Sieve Aperture: (mm)	% Passing	Specification (..) Envelope	Sieve Aperture: (mm)	% Passing	Specification (..) Envelope
200	100		4.75	100	
75	100		2.36	100	
63	100		1.18	100	
37.5	100		0.600	97	
26.5	100		0.425	87	
19	100		0.300	69	
13.2	100		0.212	55	
9.5	100		0.150	45	
6.7	100		0.075	38	

Notes

NATA

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. This document shall not be reproduced, except in full. Results relate only to the samples tested.

NATA Accredited Laboratory Number: 14874

Authorised Signatory: Date:

29/09/2022

Chris Lloyd

MACQUARIE GEOTECH

Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

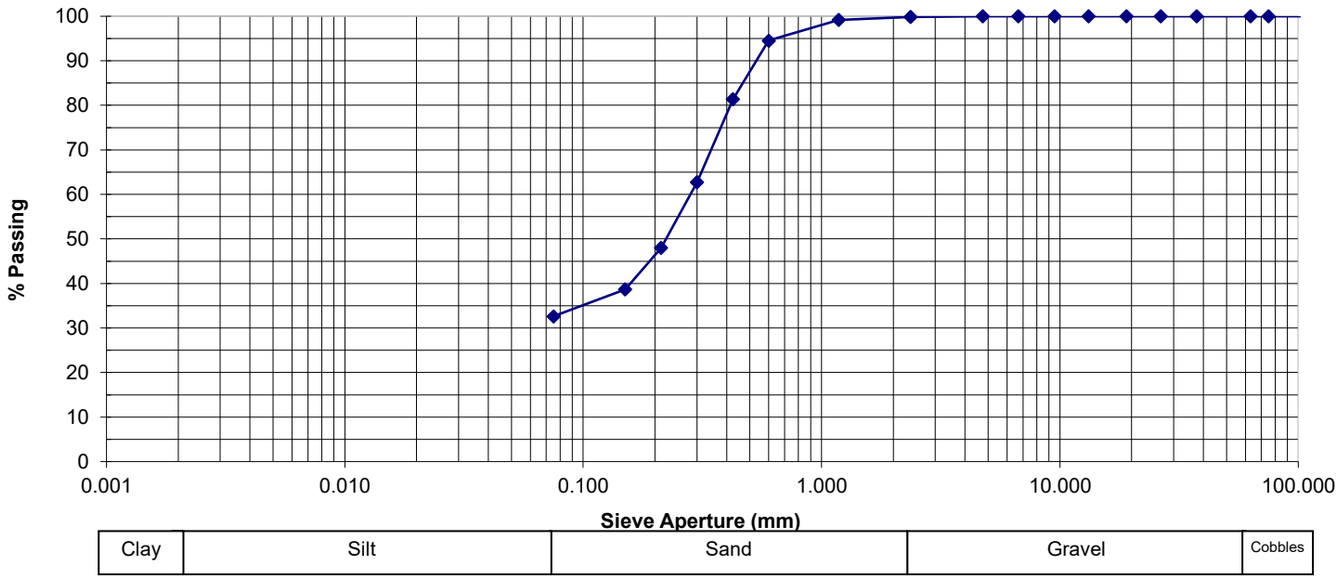
Particle Size Distribution Report

Client	Tetra Tech Coffey	**Source**	BH3_25.7-26.0 m
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Sample Description**	Clayey SAND
Project	Central Barangaroo Development (754-SYDGE287887)	**Report No**	S80372-PSD
Job No	S22038-2	**Lab No**	S80372

Test Procedure AS 1289.3.6.1 - Particle size distribution of a soil

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 7/09/2022

Preparation Prepared in accordance with the test method **Date Tested** 28/09/2022



Sieve Aperture: (mm)	% Passing	Specification (..) Envelope	Sieve Aperture: (mm)	% Passing	Specification (..) Envelope
200	100		4.75	100	
75	100		2.36	100	
63	100		1.18	99	
37.5	100		0.600	95	
26.5	100		0.425	81	
19	100		0.300	63	
13.2	100		0.212	48	
9.5	100		0.150	39	
6.7	100		0.075	33	

Notes

NATA

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.

NATA Accredited Laboratory Number: 14874

Authorised Signatory: Date:

29/09/2022

Chris Lloyd

MACQUARIE GEOTECH

Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

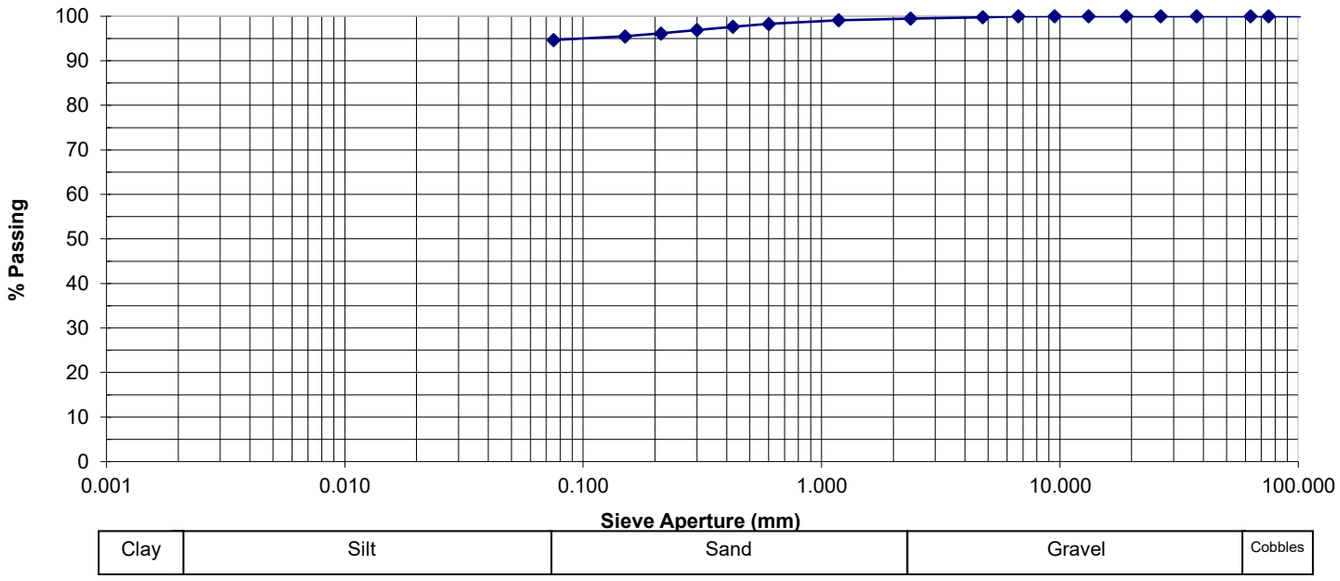
Particle Size Distribution Report

Client	Tetra Tech Coffey	**Source**	BH3_28.7-29.0 m
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Sample Description**	Silty CLAY, trace of Sand
Project	Central Barangaroo Development (754-SYDGE287887)	**Report No**	S80373-PSD
Job No	S22038-2	**Lab No**	S80373

Test Procedure AS 1289.3.6.1 - Particle size distribution of a soil

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 7/09/2022

Preparation Prepared in accordance with the test method **Date Tested** 28/09/2022



Sieve Aperture: (mm)	% Passing	Specification (..) Envelope	Sieve Aperture: (mm)	% Passing	Specification (..) Envelope
200	100		4.75	100	
75	100		2.36	100	
63	100		1.18	99	
37.5	100		0.600	98	
26.5	100		0.425	98	
19	100		0.300	97	
13.2	100		0.212	96	
9.5	100		0.150	95	
6.7	100		0.075	95	

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.

NATA Accredited Laboratory Number: 14874

Authorised Signatory: Date:

28/09/2022

Chris Lloyd

Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

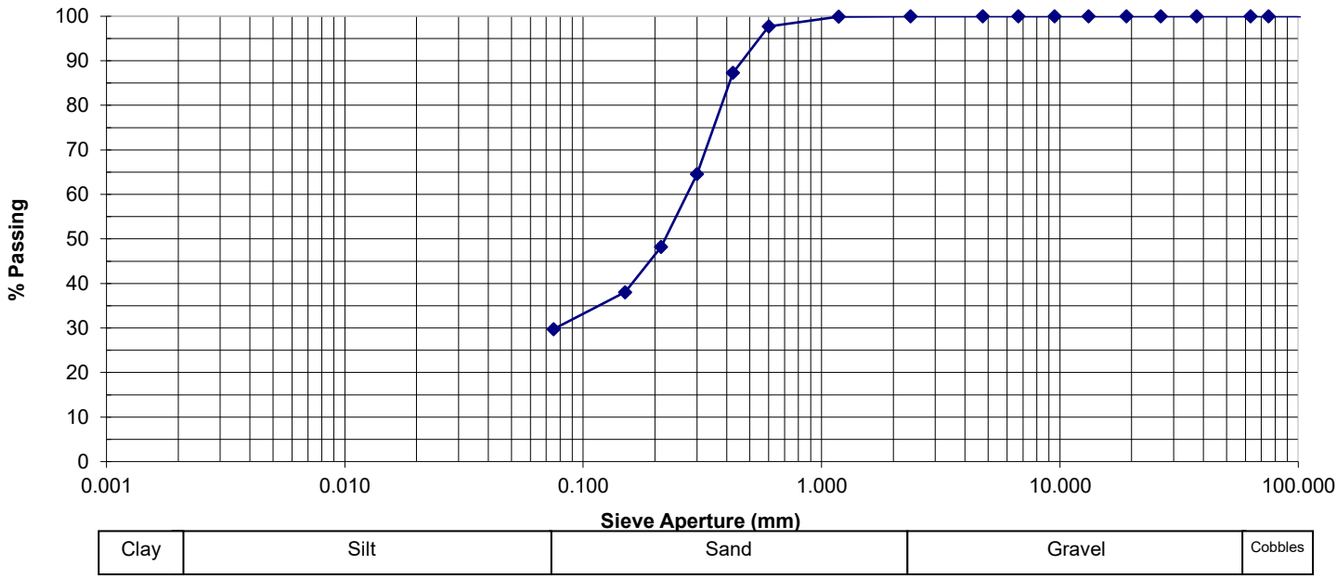
Particle Size Distribution Report

Client	Tetra Tech Coffey	**Source**	BH3_32.8-32.9 m
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Sample Description**	Clayey SAND
Project	Central Barangaroo Development (754-SYDGE287887)	**Report No**	S80374-PSD
Job No	S22038-2	**Lab No**	S80374

Test Procedure AS 1289.3.6.1 - Particle size distribution of a soil

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 7/09/2022

Preparation Prepared in accordance with the test method **Date Tested** 28/09/2022



Sieve Aperture: (mm)	% Passing	Specification (..) Envelope	Sieve Aperture: (mm)	% Passing	Specification (..) Envelope
200	100		4.75	100	
75	100		2.36	100	
63	100		1.18	100	
37.5	100		0.600	98	
26.5	100		0.425	87	
19	100		0.300	65	
13.2	100		0.212	48	
9.5	100		0.150	38	
6.7	100		0.075	30	

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. This document shall not be reproduced, except in full. Results relate only to the samples tested.

NATA Accredited Laboratory Number: 14874

Authorised Signatory: Date:

29/09/2022

Chris Lloyd

MACQUARIE GEOTECH

Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2232116**	Page	: 1 of 2
Client	: **TETRA TECH COFFEY PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: PHIL MACKENZIE	Contact	: Khaleda Ataei
Address	: LEVEL 19, TOWER B- CITADEL TOWER 799 PACIFIC HIGHWAY CHATSWOOD NSW, AUSTRALIA 2067	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: + 61 2 8784 8555
Project	: SYDGE287887 Central Barangaroo Development	Date Samples Received	: 07-Sep-2022 17:00
Order number	: ----	Date Analysis Commenced	: 07-Sep-2022
C-O-C number	: ----	Issue Date	: 08-Sep-2022 18:49
Sampler	: Richard Sanchez		
Site	:		
Quote number	: EN/222		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Sample ID	**BH2**	**BH4**	**BH6**	**----**	**----**
			Sampling date / time	07-Sep-2022 00:00	07-Sep-2022 00:00	07-Sep-2022 00:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES2232116-001**	**ES2232116-002**	**ES2232116-003**	**--------**	**--------**
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.94**	**7.85**	**7.01**	**----**	**----**
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**8060**	**24600**	**17800**	**----**	**----**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**398**	**931**	**933**	**----**	**----**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**2000**	**7950**	**5870**	**----**	**----**

POINT LOAD STRENGTH INDEX REPORT

Client	Tetra Tech Coffey	**Moisture Content Condition**	As received
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Storage History**	Core boxes
Project	Central Barangaroo Development (754-SYDGE287887)	**Report #**	S79333-PL
Job #	S21729-1	**Test Date**	18-19/08/2022

Test Procedure ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 22/07/2022

Preparation Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S79333	BH1 15.46-15.56m	Sandstone	Diametral	-	59.0	2.47	0.71	0.76	1
			Axial	60.9	45.0	3.67	1.05	1.13	1
S79334	BH1 16.45-16.55m	Sandstone	Diametral	-	58.0	2.53	0.75	0.80	1
			Axial	60.8	39.0	2.42	0.80	0.84	1
S79335	BH1 17.25-17.35m	Sandstone	Diametral	-	58.0	3.68	1.09	1.17	1
			Axial	60.9	44.0	4.11	1.20	1.29	1
S79336	BH1 18.16-18.26m	Sandstone	Diametral	-	59.0	3.73	1.07	1.15	1
			Axial	60.9	50.0	4.98	1.28	1.42	1
S79337	BH1 19.22-19.31m	Sandstone	Diametral	-	59.0	4.27	1.23	1.32	1
			Axial	60.9	45.0	3.83	1.10	1.18	1
S79338	BH1 20.12-20.22m	Siltstone	Diametral	-	59.0	0.75	0.22	0.23	1
			Axial	60.7	42.0	0.61	0.19	0.20	4
S79339	BH1 21.46-21.50m	Sandstone	Diametral	-	58.0	2.41	0.72	0.77	1
			Axial	61.1	46.0	3.83	1.07	1.16	1
S79340	BH1 22.47-22.57-m	Sandstone	Diametral	-	59.0	4.40	1.26	1.36	1
			Axial	61.0	44.0	4.35	1.27	1.37	1
S79341	BH1 23.47-23.57-m	Sandstone	Diametral	-	58.0	5.53	1.64	1.76	1
			Axial	61.0	45.0	6.00	1.72	1.85	1
S79342	BH1 24.25-24.35m	Sandstone	Diametral	-	58.0	5.13	1.52	1.63	1
			Axial	60.9	42.0	4.10	1.26	1.34	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

22/08/2022

Date

Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

POINT LOAD STRENGTH INDEX REPORT

Client	Tetra Tech Coffey	**Moisture Content Condition**	As received
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Storage History**	Core boxes
Project	Central Barangaroo Development (754-SYDGE287887)	**Report #**	S79343-PL
Job #	S21729-1	**Test Date**	18-19/08/2022

Test Procedure ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 7/07/2022

Preparation Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S79343	BH2 22.47-22.59m	Sandstone	Diametral	-	59.0	4.33	1.24	1.34	1
			Axial	61.0	44.0	2.79	0.82	0.88	1
S79344	BH2 23.44-23.55m	Sandstone	Diametral	-	58.0	3.86	1.15	1.23	1
			Axial	61.0	41.0	4.13	1.30	1.37	1
S79345	BH2 24.46-24.56m	Sandstone	Diametral	-	59.0	4.07	1.17	1.26	1
			Axial	60.8	46.0	4.87	1.37	1.48	1
S79346	BH2 25.35-25.44m	Sandstone	Diametral	-	59.0	4.29	1.23	1.33	1
			Axial	60.9	49.0	5.34	1.41	1.54	1
S79347	BH2 26.35-26.45m	Sandstone	Diametral	-	59.0	4.30	1.24	1.33	1
			Axial	61.0	35.0	3.18	1.17	1.19	1
S79348	BH2 27.45-27.55m	Sandstone	Diametral	-	59.0	5.15	1.48	1.59	1
			Axial	60.8	41.0	4.90	1.54	1.63	1
S79349	BH2 28.44-28.54m	Sandstone	Diametral	-	58.0	4.58	1.36	1.46	1
			Axial	60.9	49.0	5.63	1.48	1.63	1
S79350	BH2 29.20-29.30m	Sandstone	Diametral	-	58.0	4.44	1.32	1.41	1
			Axial	60.8	38.0	4.78	1.62	1.69	1
S79351	BH3 34.36-34.45m	Sandstone	Diametral	-	58.0	0.56	0.17	0.18	1
			Axial	60.5	48.0	0.59	0.16	0.17	1
S79352	BH3 35.60-35.68m	Sandstone	Diametral	-	59.0	0.81	0.23	0.25	1
			Axial	60.7	42.0	1.43	0.44	0.47	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

22/08/2022

Date

MACQUARIE GEOTECH
Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

POINT LOAD STRENGTH INDEX REPORT

Client	Tetra Tech Coffey	**Moisture Content Condition**	As received
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Storage History**	Core boxes
Project	Central Barangaroo Development (754-SYDGE287887)	**Report #**	S79353-PL
Job #	S21729-1	**Test Date**	18-19/08/2022

Test Procedure ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 26/07/2022

Preparation Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S79353	BH3 36.49-36.57m	Sandstone	Diametral	-	59.0	1.73	0.50	0.54	1
			Axial	61.0	44.0	3.19	0.93	1.00	1
S79354	BH3 37.41-37.53m	Sandstone	Diametral	-	59.0	5.59	1.61	1.73	1
			Axial	61.1	43.0	5.64	1.69	1.80	1
S79355	BH3 38.42-38.52m	Sandstone	Diametral	-	58.0	2.38	0.71	0.76	1
			Axial	60.9	44.0	3.11	0.91	0.98	1
S79356	BH3 39.41-39.52m	Sandstone	Diametral	-	58.0	5.55	1.65	1.76	1
			Axial	60.9	41.0	5.07	1.59	1.68	1
S79357	BH3 40.43-40.54m	Sandstone	Diametral	-	58.0	8.50	2.53	2.70	1
			Axial	60.7	40.0	7.81	2.53	2.65	1
S79358	BH3 41.51-41.64m	Sandstone	Diametral	-	59.0	2.74	0.79	0.85	1
			Axial	61.1	50.0	4.75	1.22	1.35	1
S79359	BH3 42.55-42.63m	Sandstone	Diametral	-	59.0	5.51	1.58	1.71	1
			Axial	61.0	43.0	7.56	2.26	2.42	1
S79360	BH3 43.44-43.53m	Sandstone	Diametral	-	59.0	5.86	1.68	1.81	1
			Axial	60.9	40.0	2.19	0.71	0.74	1
S79361	BH3 44.80-44.90m	Sandstone	Diametral	-	58.0	2.65	0.79	0.84	1
			Axial	60.9	40.0	2.32	0.75	0.79	1
S79362	BH4 22.77-22.86m	Sandstone	Diametral	-	58.0	1.67	0.50	0.53	1
			Axial	60.8	45.0	2.60	0.75	0.80	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

22/08/2022

Date

Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

POINT LOAD STRENGTH INDEX REPORT

Client	Tetra Tech Coffey	**Moisture Content Condition**	As received
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Storage History**	Core boxes
Project	Central Barangaroo Development (754-SYDGE287887)	**Report #**	S79363-PL
Job #	S21729-1	**Test Date**	18-19/08/2022

Test Procedure ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 8/07/2022

Preparation Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S79363	BH4 23.54-23.64m	Sandstone	Diametral	-	58.0	3.53	1.05	1.12	1
			Axial	60.8	40.0	4.09	1.32	1.39	1
S79364	BH4 24.39-24.49m	Sandstone	Diametral	-	58.0	3.76	1.12	1.19	1
			Axial	60.8	40.0	2.85	0.92	0.97	1
S79365	BH4 25.32-25.42m	Sandstone	Diametral	-	59.0	3.18	0.91	0.98	1
			Axial	60.9	44.0	3.45	1.01	1.08	1
S79366	BH4 26.45-26.55m	Sandstone	Diametral	-	58.0	3.88	1.15	1.23	1
			Axial	60.9	50.0	4.08	1.05	1.16	1
S79367	BH4 27.53-27.65m	Sandstone	Diametral	-	58.0	3.68	1.09	1.17	1
			Axial	60.9	43.0	3.55	1.06	1.14	1
S79368	BH4 28.43-28.55m	Sandstone	Diametral	-	58.0	4.12	1.22	1.31	1
			Axial	60.9	44.0	3.81	1.12	1.20	1
S79369	BH4 29.35-29.45m	Sandstone	Diametral	-	59.0	3.50	1.01	1.08	1
			Axial	61.0	47.0	3.63	0.99	1.08	1
S79370	BH4 30.23-30.33m	Sandstone	Diametral	-	59.0	4.17	1.20	1.29	1
			Axial	60.9	50.0	5.29	1.36	1.51	1
S79371	BH5 22.88-22.97m	Sandstone	Diametral	-	58.0	1.12	0.33	0.36	1
			Axial	60.7	45.0	1.98	0.57	0.61	1
S79372	BH5 23.46-23.56m	Sandstone	Diametral	-	59.0	1.92	0.55	0.59	1
			Axial	60.8	44.0	2.12	0.62	0.67	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

22/08/2022

Date

Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

POINT LOAD STRENGTH INDEX REPORT

Client	Tetra Tech Coffey	**Moisture Content Condition**	As received
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Storage History**	Core boxes
Project	Central Barangaroo Development (754-SYDGE287887)	**Report #**	S79373-PL
Job #	S21729-1	**Test Date**	18-19/08/2022

Test Procedure ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 9/07/2022

Preparation Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S79373	BH5 24.48-24.58m	Sandstone	Diametral	-	59.0	1.70	0.49	0.53	1
			Axial	60.8	44.0	2.22	0.65	0.70	1
S79374	BH5 25.45-25.55m	Sandstone	Diametral	-	59.0	2.77	0.80	0.86	1
			Axial	61.0	42.0	4.10	1.26	1.33	1
S79375	BH5 26.24-26.34m	Sandstone	Diametral	-	58.0	4.60	1.37	1.46	1
			Axial	60.9	45.0	5.05	1.45	1.56	1
S79376	BH5 27.26-27.36m	Sandstone	Diametral	-	59.0	5.19	1.49	1.61	1
			Axial	61.0	41.0	5.11	1.60	1.69	1
S79377	BH5 28.46-28.56m	Sandstone	Diametral	-	58.0	3.81	1.13	1.21	1
			Axial	60.9	42.0	3.90	1.20	1.27	1
S79378	BH6 24.45-24.56m	Sandstone	Diametral	-	58.0	1.85	0.55	0.59	1
			Axial	60.9	47.0	2.09	0.57	0.62	1
S79379	BH6 25.45-25.56m	Sandstone	Diametral	-	59.0	4.66	1.34	1.44	1
			Axial	60.9	49.0	5.43	1.43	1.57	1
S79380	BH6 26.46-26.59m	Sandstone	Diametral	-	59.0	4.58	1.32	1.42	1
			Axial	60.8	46.0	5.47	1.54	1.66	1
S79381	BH6 27.45-27.55m	Sandstone	Diametral	-	58.0	5.54	1.65	1.76	1
			Axial	60.8	46.0	5.74	1.61	1.75	1
S79382	BH6 28.44-28.55m	Sandstone	Diametral	-	59.0	1.71	0.49	0.53	1
			Axial	60.9	49.0	4.66	1.23	1.35	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

22/08/2022

Date

Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

POINT LOAD STRENGTH INDEX REPORT

Client	Tetra Tech Coffey	**Moisture Content Condition**	As received
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Storage History**	Core boxes
Project	Central Barangaroo Development (754-SYDGE287887)	**Report #**	S79383-PL
Job #	S21729-1	**Test Date**	18-19/08/2022

Test Procedure ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 14/07/2022

Preparation Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S79383	BH6 29.70-29.80m	Sandstone	Diametral	-	58.0	5.46	1.62	1.74	1
			Axial	60.9	46.0	6.48	1.82	1.97	1
S79384	BH7 22.44-22.55m	Sandstone	Diametral	-	59.0	3.81	1.09	1.18	1
			Axial	60.9	50.0	4.42	1.14	1.26	1
S79385	BH7 23.65-23.75m	Sandstone	Diametral	-	58.0	5.02	1.49	1.60	1
			Axial	60.9	46.0	4.79	1.34	1.45	1
S79386	BH7 24.54-24.65m	Sandstone	Diametral	-	58.0	4.74	1.41	1.51	1
			Axial	60.9	48.0	6.11	1.64	1.80	1
S79387	BH7 25.44-25.55m	Sandstone	Diametral	-	59.0	5.69	1.63	1.76	1
			Axial	61.0	41.0	4.95	1.55	1.64	1
S79388	BH7 26.44-26.55m	Sandstone	Diametral	-	58.0	4.29	1.28	1.36	1
			Axial	60.9	41.0	5.16	1.62	1.71	1
S79389	BH7 27.44-27.55m	Sandstone	Diametral	-	58.0	4.19	1.25	1.33	1
			Axial	60.9	46.0	4.11	1.15	1.25	1
S79390	BH7 28.47-28.58m	Sandstone	Diametral	-	59.0	0.93	0.27	0.29	1
			Axial	60.8	31.0	1.44	0.60	0.59	1
S79391	BH7 29.46-29.56m	Sandstone	Diametral	-	59.0	4.71	1.35	1.46	1
			Axial	61.0	45.0	5.22	1.49	1.61	1
S79392	BH8 15.35-15.45m	Sandstone	Diametral	-	59.0	2.56	0.74	0.79	1
			Axial	60.8	42.0	4.13	1.27	1.35	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

22/08/2022

Date

Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

POINT LOAD STRENGTH INDEX REPORT

Client	Tetra Tech Coffey	**Moisture Content Condition**	As received
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Storage History**	Core boxes
Project	Central Barangaroo Development (754-SYDGE287887)	**Report #**	S79393-PL
Job #	S21729-1	**Test Date**	18-19/08/2022

Test Procedure ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 19/07/2022

Preparation Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S79393	BH8 15.47-15.57m	Sandstone	Diametral	-	59.0	3.65	1.05	1.13	1
			Axial	60.9	44.0	3.42	1.00	1.08	1
S79394	BH8 17.42-17.52m	Sandstone	Diametral	-	59.0	2.90	0.83	0.90	1
			Axial	60.8	44.0	2.91	0.85	0.92	1
S79395	BH8 18.60-18.70m	Siltstone	Diametral	-	59.0	1.18	0.34	0.37	1
			Axial	61.0	44.0	2.36	0.69	0.74	4
S79396	BH8 19.80-19.90m	Sandstone	Diametral	-	59.0	4.37	1.26	1.35	1
			Axial	61.1	48.0	5.29	1.42	1.55	1
S79397	BH8 20.15-20.25m	Sandstone	Diametral	-	59.0	3.54	1.02	1.10	1
			Axial	60.9	42.0	5.64	1.73	1.84	1
S79398	BH9 16.33-16.44m	Sandstone	Diametral	-	58.0	2.97	0.88	0.94	1
			Axial	60.7	36.0	2.92	1.05	1.08	1
S79399	BH9 17.46-17.57m	Sandstone	Diametral	-	58.0	4.42	1.31	1.40	1
			Axial	60.8	42.0	5.86	1.80	1.91	1
S79400	BH9 18.46-18.57m	Sandstone	Diametral	-	58.0	4.20	1.25	1.33	1
			Axial	60.9	36.0	3.78	1.35	1.39	1
S79401	BH9 19.34-19.45m	Sandstone	Diametral	-	59.0	4.60	1.32	1.42	1
			Axial	60.9	46.0	5.54	1.55	1.68	1
S79402	BH9 20.26-20.37m	Sandstone	Diametral	-	58.0	5.22	1.55	1.66	1
			Axial	60.9	46.0	4.84	1.36	1.47	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

22/08/2022

Date

Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

POINT LOAD STRENGTH INDEX REPORT

Client	Tetra Tech Coffey	**Moisture Content Condition**	As received
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Storage History**	Core boxes
Project	Central Barangaroo Development (754-SYDGE287887)	**Report #**	S79403-PL
Job #	S21729-1	**Test Date**	18-19/08/2022

Test Procedure ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 20/07/2022

Preparation Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S79403	BH9 21.24-21.36m	Sandstone	Diametral	-	58.0	5.29	1.57	1.68	1
			Axial	60.8	45.0	4.33	1.24	1.34	1
S79404	BH9 22.48-22.59m	Sandstone	Diametral	-	59.0	5.01	1.44	1.55	1
			Axial	61.0	46.0	4.38	1.23	1.33	1
S79405	BH9 23.46-23.58m	Sandstone	Diametral	-	59.0	4.46	1.28	1.38	1
			Axial	61.0	45.0	3.86	1.10	1.19	1
S79406	BH9 24.47-24.58m	Sandstone	Diametral	-	59.0	4.68	1.34	1.45	1
			Axial	60.9	49.0	5.58	1.47	1.61	1
S79407	BH9 25.46-25.57m	Sandstone	Diametral	-	59.0	4.00	1.15	1.24	1
			Axial	61.0	50.0	4.46	1.15	1.27	1
S79408	BH9 26.45-26.56m	Sandstone	Diametral	-	58.0	4.36	1.30	1.39	1
			Axial	61.0	42.0	4.93	1.51	1.60	1
S79409	BH10 17.35-17.45m	Sandstone	Diametral	-	43.0	0.04	0.02	0.02	1
			Axial	60.7	26.0	0.01	0.00	0.00	1
S79410	BH10 18.57-18.66m	Sandstone	Diametral	-	45.0	0.04	0.02	0.02	1
			Axial	58.9	31.0	0.03	0.01	0.01	1
S79411	BH10 19.43-19.53m	Sandstone	Diametral	-	59.0	1.95	0.56	0.60	1
			Axial	60.9	39.0	1.11	0.37	0.38	1
S79412	BH10 20.44-20.54m	Sandstone	Diametral	-	59.0	3.37	0.97	1.04	1
			Axial	61.0	42.0	2.92	0.90	0.95	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

22/08/2022

Date

Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

POINT LOAD STRENGTH INDEX REPORT

Client	Tetra Tech Coffey	**Moisture Content Condition**	As received
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Storage History**	Core boxes
Project	Central Barangaroo Development (754-SYDGE287887)	**Report #**	S79413-PL
Job #	S21729-1	**Test Date**	18-19/08/2022

Test Procedure ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 19/07/2022

Preparation Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S79413	BH10 21.44-21.54m	Sandstone	Diametral	-	59.0	4.73	1.36	1.46	1
			Axial	61.1	41.0	3.43	1.08	1.14	1
S79414	BH10 22.60-22.70m	Sandstone	Diametral	-	59.0	4.00	1.15	1.24	1
			Axial	61.0	54.0	4.88	1.16	1.31	1
S79415	BH10 23.44-23.55m	Sandstone	Diametral	-	58.0	4.17	1.24	1.33	1
			Axial	60.8	41.0	4.31	1.36	1.43	1
S79416	BH10 24.45-24.55m	Sandstone	Diametral	-	58.0	3.90	1.16	1.24	1
			Axial	60.9	45.0	4.41	1.26	1.36	1
S79417	BH10 25.51-25.61m	Sandstone	Diametral	-	58.0	4.08	1.21	1.30	1
			Axial	60.9	45.0	4.72	1.35	1.46	1
S79418	BH10 26.43-26.54m	Sandstone	Diametral	-	59.0	4.23	1.22	1.31	1
			Axial	61.0	46.0	4.69	1.31	1.42	1
S79419	BH10 27.45-27.55m	Sandstone	Diametral	-	58.0	4.96	1.47	1.58	1
			Axial	60.8	49.0	5.33	1.41	1.54	1
S79420	BH10 28.45-28.55m	Sandstone	Diametral	-	58.0	5.34	1.59	1.70	1
			Axial	60.9	50.0	5.28	1.36	1.50	1
S79421	BH10 29.45-29.55m	Sandstone	Diametral	-	58.0	5.51	1.64	1.75	1
			Axial	61.0	50.0	6.52	1.68	1.85	1
S79422	BH10 31.35-31.46m	Sandstone	Diametral	-	58.0	5.07	1.51	1.61	1
			Axial	60.9	44.0	4.22	1.24	1.33	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

22/08/2022

Date

Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

POINT LOAD STRENGTH INDEX REPORT

Client	Tetra Tech Coffey	**Moisture Content Condition**	As received
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Storage History**	Core boxes
Project	Central Barangaroo Development (754-SYDGE287887)	**Report #**	S79423-PL
Job #	S21729-1	**Test Date**	18-19/08/2022

Test Procedure ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 19/07/2022

Preparation Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S79423	BH10 32.44-32.56m	Sandstone	Diametral	-	58.0	5.12	1.52	1.63	1
			Axial	60.9	40.0	4.63	1.49	1.57	1
S79424	BH11 18.47-18.58m	Sandstone	Diametral	-	58.0	0.70	0.21	0.22	1
			Axial	60.7	40.0	0.94	0.30	0.32	1
S79425	BH11 19.54-19.64m	Sandstone	Diametral	-	59.0	4.40	1.26	1.36	1
			Axial	61.0	46.0	5.07	1.42	1.54	1
S79426	BH11 20.31-20.43m	Sandstone	Diametral	-	59.0	3.67	1.05	1.14	1
			Axial	61.0	48.0	3.89	1.04	1.14	1
S79427	BH11 21.37-21.47m	Sandstone	Diametral	-	58.0	4.29	1.28	1.36	1
			Axial	60.9	39.0	4.24	1.40	1.46	1
S79428	BH11 22.35-22.46m	Sandstone	Diametral	-	58.0	4.28	1.27	1.36	1
			Axial	60.9	45.0	4.54	1.30	1.40	1
S79429	BH11 23.35-23.43m	Sandstone	Diametral	-	57.0	4.03	1.24	1.32	1
			Axial	60.9	47.0	3.81	1.05	1.14	1
S79430	BH11 24.44-24.55m	Sandstone	Diametral	-	58.0	4.63	1.38	1.47	1
			Axial	60.9	44.0	4.14	1.21	1.30	1
S79431	BH11 25.44-25.55m	Sandstone	Diametral	-	58.0	4.91	1.46	1.56	1
			Axial	60.9	45.0	3.64	1.04	1.12	1
S79432	BH11 27.67-27.76m	Sandstone	Diametral	-	59.0	4.73	1.36	1.46	1
			Axial	61.0	42.0	6.25	1.92	2.03	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

22/08/2022

Date

Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

POINT LOAD STRENGTH INDEX REPORT

Client	Tetra Tech Coffey	**Moisture Content Condition**	As received
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Storage History**	Core boxes
Project	Central Barangaroo Development (754-SYDGE287887)	**Report #**	S79433-PL
Job #	S21729-1	**Test Date**	18-19/08/2022

Test Procedure ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 21/07/2022

Preparation Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S79433	BH11 28.34-28.44m	Sandstone	Diametral	-	59.0	4.92	1.41	1.52	1
			Axial	61.1	41.0	4.17	1.31	1.38	1
S79434	BH11 29-45-29.56m	Sandstone	Diametral	-	59.0	4.92	1.41	1.52	1
			Axial	60.9	44.0	4.84	1.42	1.52	1
S79435	BH11 30.42-30.52m	Sandstone	Diametral	-	58.0	4.92	1.46	1.56	1
			Axial	60.9	45.0	5.29	1.52	1.63	1
S79436	BH11 31.33-31.46m	Sandstone	Diametral	-	59.0	5.45	1.57	1.69	1
			Axial	60.9	43.0	6.06	1.82	1.94	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

22/08/2022

Date

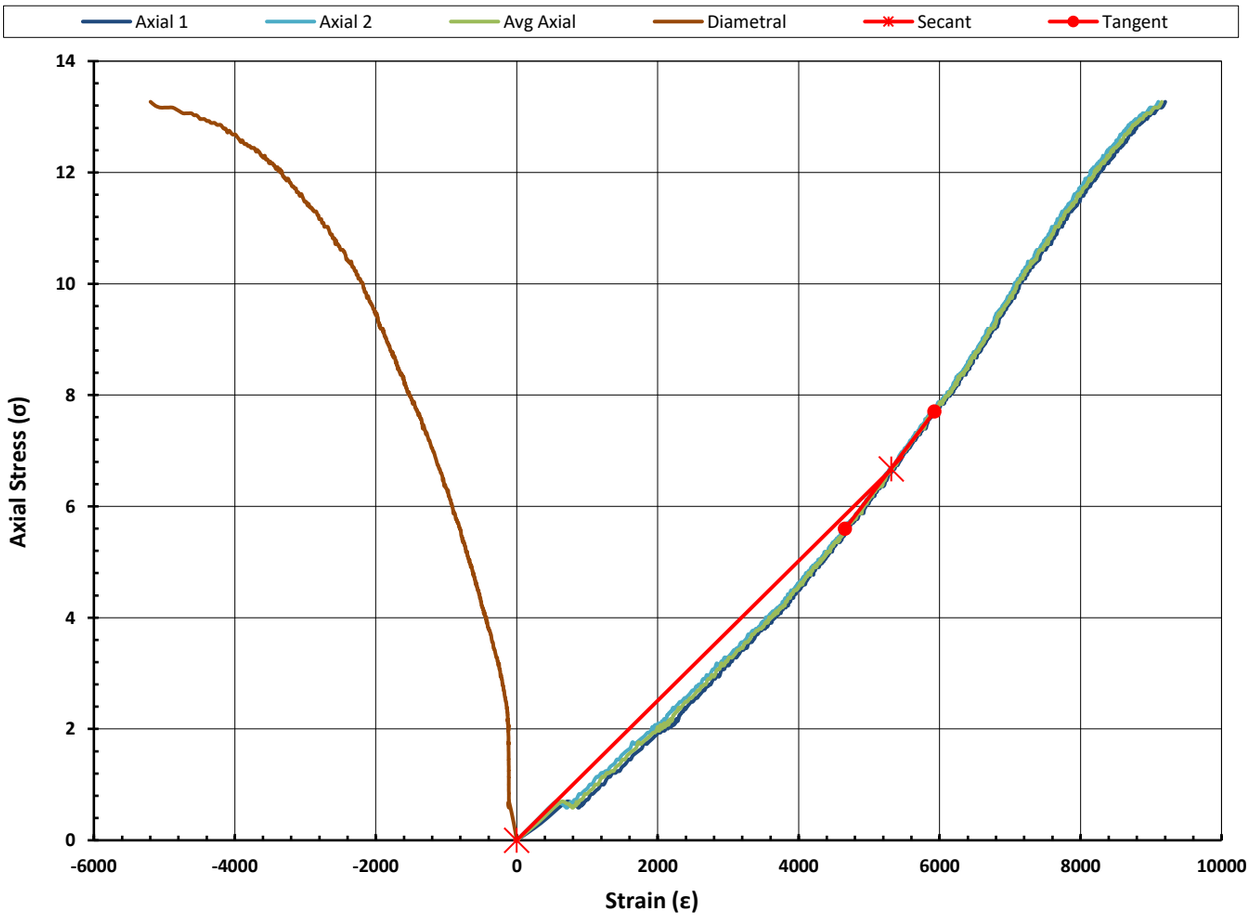
MACQUARIE GEOTECH
Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

Deformability of Rock Materials in Uniaxial Compression

Client	Tetra Tech Coffey	**Sample Source**	BH1 16.55-16.73m
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Sample Description**	Sandstone
Project	Central Barangaroo Development (754-SYDGE287887)	**Report #**	S80324-MOD
Job #	S22038-1	**Sample #**	S80324

Test Procedure	AS 4133.4.3.2 Deformability of rock materials in uniaxial compression-Rock strength less than 50 MPa		
Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	Unknown
Storage History	Core Box	**Storage Environment**	Sealed at as received moisture condition

Axial Stress vs Strain Plots



Uniaxial Compressive Strength **13** **MPa**

	Young's Modulus	Poisson's Ratio	
Tangent	1.7 GPa	0.24	from 42 % to 58 % of Max UCS
Secant	1.3 GPa	0.21	from 0 % to 50 % of Max UCS

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.
NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Jacob Lloyd

Date: 13/09/2022

MACQUARIE GEOTECH
Macquarie Geotechnical
14 Carter Street
Lidcombe NSW 2141

Deformability of Rock Materials in Uniaxial Compression

Client	Tetra Tech Coffey	**Sample Source**	BH1 16.55-16.73m
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Sample Description**	Sandstone
Project	Central Barangaroo Development (754-SYDGE287887)	**Report #**	S80324-MOD
Job #	S22038-1	**Sample #**	S80324

Test Procedure	AS 4133.4.3.2 Deformability of rock materials in uniaxial compression-Rock strength less than 50 MPa		
Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	Unknown
Storage History	Core Box	**Storage Environment**	Sealed at as received moisture condition

Average Specimen Diameter (mm)	60.7	**Moisture Content (%)**	7.9
Average Specimen Height (mm)	168.7	**Wet Density (t/m^3)**	2.35
Length to Diameter Ratio	2.8	**Dry Density (t/m^3)**	2.18
Duration of Test (min)	10.59	**Rate of Displacement (mm/min):**	< 0.1
Date of Test:	12/9/22	**Specimen Curing**	-
Mode of Failure	Single shear plane	**Test Apparatus**	Matest Compression Machine with Axial and Circumferential Extensometers.

Before Test

After Test

Uniaxial Compressive Strength **13** **MPa**

	Young's Modulus	Poisson's Ratio	
Tangent	1.7 GPa	0.24	from 42 % to 58 % of Max UCS
Secant	1.3 GPa	0.21	from 0 % to 50 % of Max UCS

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.
NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Jacob Lloyd

Date: 13/09/2022

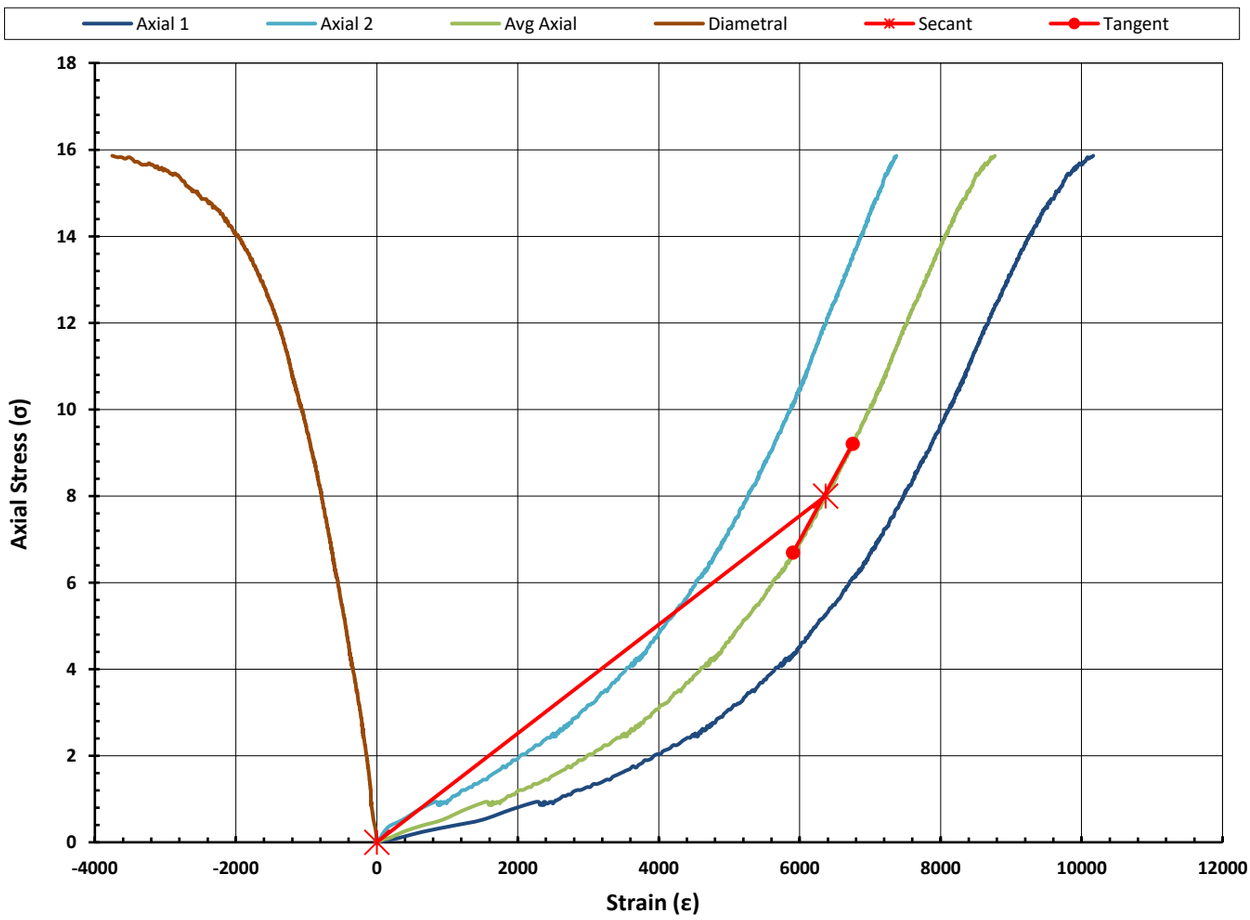
MACQUARIE GEOTECH
Macquarie Geotechnical
14 Carter Street
Lidcombe NSW 2141

Deformability of Rock Materials in Uniaxial Compression

Client	Tetra Tech Coffey	**Sample Source**	BH4 23.00-23.22m
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Sample Description**	Sandstone
Project	Central Barangaroo Development (754-SYDGE287887)	**Report #**	S80325-MOD
Job #	S22038-1	**Sample #**	S80325

Test Procedure	AS 4133.4.3.2 Deformability of rock materials in uniaxial compression-Rock strength less than 50 MPa		
Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	Unknown
Storage History	Core Box	**Storage Environment**	Sealed at as received moisture condition

Axial Stress vs Strain Plots



Uniaxial Compressive Strength **16** **MPa**

	Young's Modulus	Poisson's Ratio	
Tangent	3.0 GPa	0.14	from 42 % to 58 % of Max UCS
Secant	1.3 GPa	0.12	from 0 % to 50 % of Max UCS

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.
NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Jacob Lloyd

Date: 13/09/2022

Macquarie Geotechnical
14 Carter Street
Lidcombe NSW 2141

Deformability of Rock Materials in Uniaxial Compression

Client	Tetra Tech Coffey	**Sample Source**	BH4 23.00-23.22m
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Sample Description**	Sandstone
Project	Central Barangaroo Development (754-SYDGE287887)	**Report #**	S80325-MOD
Job #	S22038-1	**Sample #**	S80325

Test Procedure	AS 4133.4.3.2 Deformability of rock materials in uniaxial compression-Rock strength less than 50 MPa		
Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	Unknown
Storage History	Core Box	**Storage Environment**	Sealed at as received moisture condition

Average Specimen Diameter (mm)	60.8	**Moisture Content (%)**	8.3
Average Specimen Height (mm)	175.2	**Wet Density (t/m^3)**	2.29
Length to Diameter Ratio	2.9	**Dry Density (t/m^3)**	2.11
Duration of Test (min)	10.35	**Rate of Displacement (mm/min):**	< 0.1
Date of Test:	12/9/22	**Specimen Curing**	-
Mode of Failure	Mixed mode	**Test Apparatus**	Matest Compression Machine with Axial and Circumferential Extensometers.

Before Test

After Test

Uniaxial Compressive Strength **16** **MPa**

	Young's Modulus	Poisson's Ratio	
Tangent	3.0 GPa	0.14	from 42 % to 58 % of Max UCS
Secant	1.3 GPa	0.12	from 0 % to 50 % of Max UCS

NATA

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.
NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Jacob Lloyd

Date: 13/09/2022

MACQUARIE GEOTECH

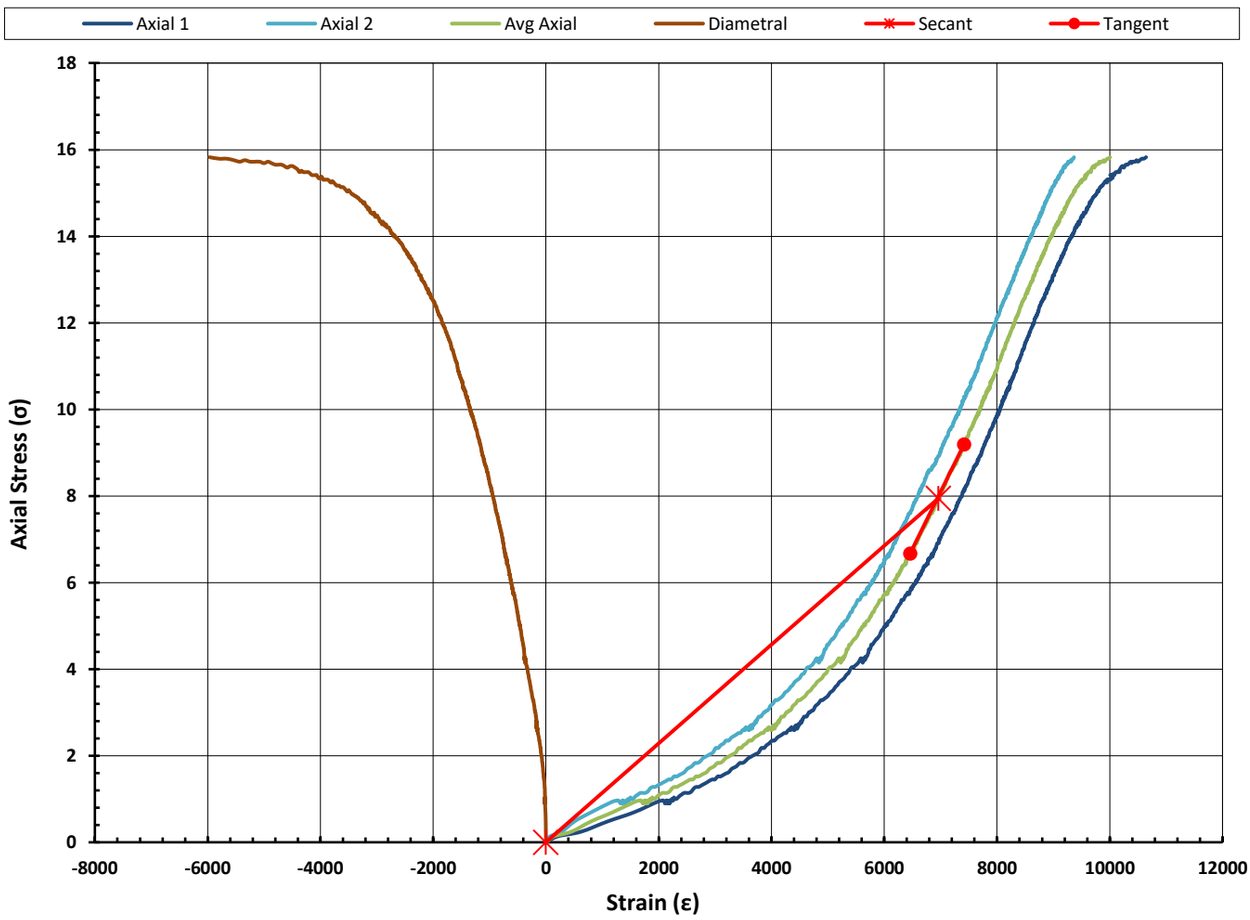
Macquarie Geotechnical
14 Carter Street
Lidcombe NSW 2141

Deformability of Rock Materials in Uniaxial Compression

Client	Tetra Tech Coffey	**Sample Source**	BH5 23.25-23.48m
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Sample Description**	Sandstone
Project	Central Barangaroo Development (754-SYDGE287887)	**Report #**	S80326-MOD
Job #	S22038-1	**Sample #**	S80326

Test Procedure	AS 4133.4.3.2 Deformability of rock materials in uniaxial compression-Rock strength less than 50 MPa		
Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	Unknown
Storage History	Core Box	**Storage Environment**	Sealed at as received moisture condition

Axial Stress vs Strain Plots



Uniaxial Compressive Strength		**16**	**MPa**

	Young's Modulus	**Poisson's Ratio**	
Tangent	2.6 GPa	0.16	from 42 % to 58 % of Max UCS
Secant	1.1 GPa	0.13	from 0 % to 50 % of Max UCS

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.
NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Jacob Lloyd

Date: 13/09/2022

Macquarie Geotechnical
14 Carter Street
Lidcombe NSW 2141

Deformability of Rock Materials in Uniaxial Compression

Client	Tetra Tech Coffey	**Sample Source**	BH5 23.25-23.48m
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Sample Description**	Sandstone
Project	Central Barangaroo Development (754-SYDGE287887)	**Report #**	S80326-MOD
Job #	S22038-1	**Sample #**	S80326

Test Procedure	AS 4133.4.3.2 Deformability of rock materials in uniaxial compression-Rock strength less than 50 MPa		
Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	Unknown
Storage History	Core Box	**Storage Environment**	Sealed at as received moisture condition

Average Specimen Diameter (mm)	60.7	**Moisture Content (%)**	7.7
Average Specimen Height (mm)	175.1	**Wet Density (t/m^3)**	2.30
Length to Diameter Ratio	2.9	**Dry Density (t/m^3)**	2.14
Duration of Test (min)	10.39	**Rate of Displacement (mm/min):**	< 0.1
Date of Test:	12/9/22	**Specimen Curing**	-
Mode of Failure	Single shear plane	**Test Apparatus**	Matest Compression Machine with Axial and Circumferential Extensometers.

Before Test

After Test

Uniaxial Compressive Strength **16** **MPa**

	Young's Modulus	Poisson's Ratio	
Tangent	2.6 GPa	0.16	from 42 % to 58 % of Max UCS
Secant	1.1 GPa	0.13	from 0 % to 50 % of Max UCS

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.
NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Jacob Lloyd

Date: 13/09/2022

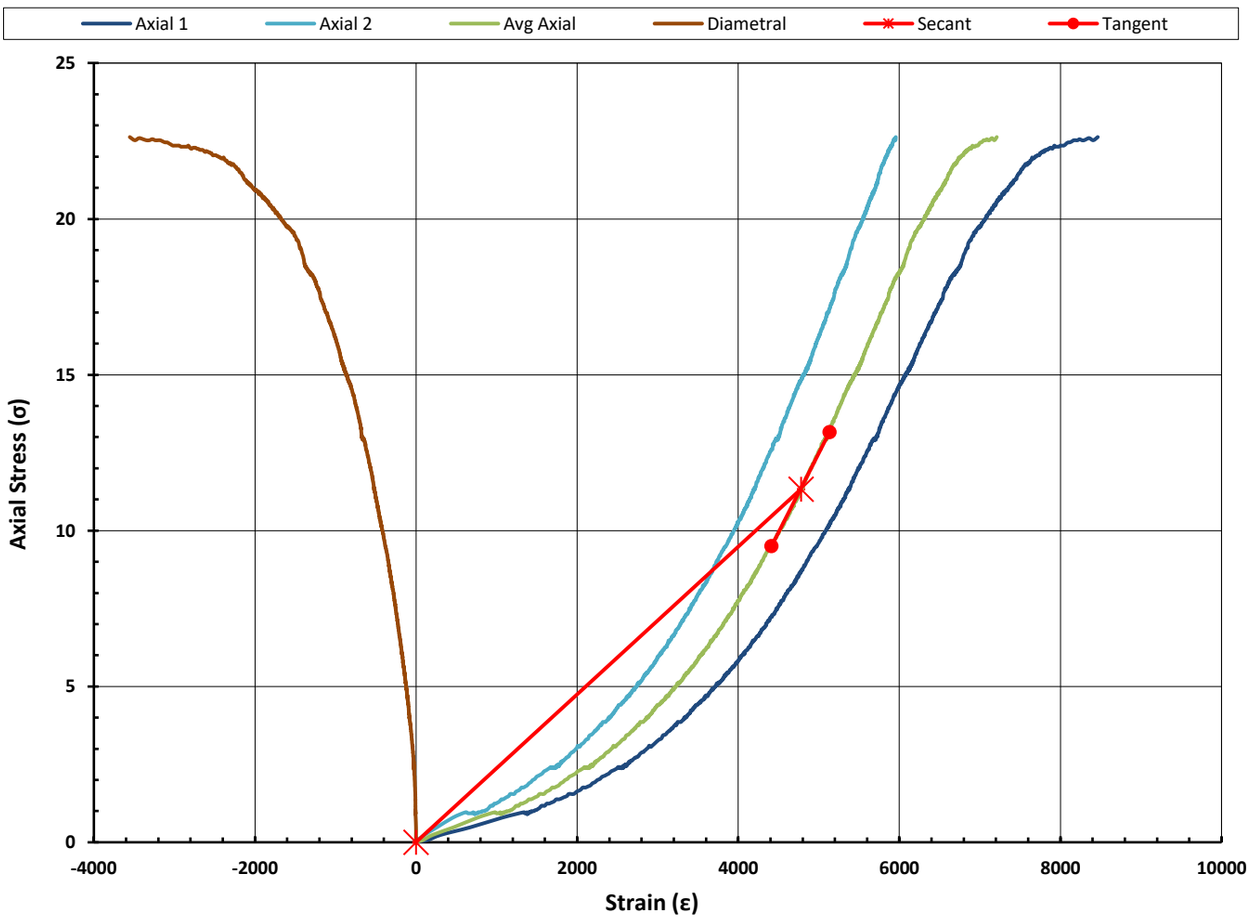
MACQUARIE GEOTECH
Macquarie Geotechnical
14 Carter Street
Lidcombe NSW 2141

Deformability of Rock Materials in Uniaxial Compression

Client	Tetra Tech Coffey	**Sample Source**	BH6 24.80-25.00m
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Sample Description**	Sandstone
Project	Central Barangaroo Development (754-SYDGE287887)	**Report #**	S80327-MOD
Job #	S22038-1	**Sample #**	S80327

Test Procedure	AS 4133.4.3.2 Deformability of rock materials in uniaxial compression-Rock strength less than 50 MPa		
Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	Unknown
Storage History	Core Box	**Storage Environment**	Sealed at as received moisture condition

Axial Stress vs Strain Plots



Uniaxial Compressive Strength		**23**	**MPa**

	Young's Modulus	Poisson's Ratio	
Tangent	5.1 GPa	0.13	from 42 % to 58 % of Max UCS
Secant	2.4 GPa	0.11	from 0 % to 50 % of Max UCS

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.
NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Jacob Lloyd

Date: 13/09/2022

Macquarie Geotechnical
14 Carter Street
Lidcombe NSW 2141

Deformability of Rock Materials in Uniaxial Compression

Client	Tetra Tech Coffey	**Sample Source**	BH6 24.80-25.00m
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Sample Description**	Sandstone
Project	Central Barangaroo Development (754-SYDGE287887)	**Report #**	S80327-MOD
Job #	S22038-1	**Sample #**	S80327

Test Procedure	AS 4133.4.3.2 Deformability of rock materials in uniaxial compression-Rock strength less than 50 MPa		
Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	Unknown
Storage History	Core Box	**Storage Environment**	Sealed at as received moisture condition

Average Specimen Diameter (mm)	60.8	**Moisture Content (%)**	7.8
Average Specimen Height (mm)	176.1	**Wet Density (t/m^3)**	2.35
Length to Diameter Ratio	2.9	**Dry Density (t/m^3)**	2.18
Duration of Test (min)	10.62	**Rate of Displacement (mm/min):**	< 0.1
Date of Test:	12/9/22	**Specimen Curing**	-
Mode of Failure	Mixed mode	**Test Apparatus**	Matest Compression Machine with Axial and Circumferential Extensometers.

Before Test

After Test

Uniaxial Compressive Strength **23** **MPa**

	Young's Modulus	Poisson's Ratio	
Tangent	5.1 GPa	0.13	from 42 % to 58 % of Max UCS
Secant	2.4 GPa	0.11	from 0 % to 50 % of Max UCS

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.
NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Jacob Lloyd

Date: 13/09/2022

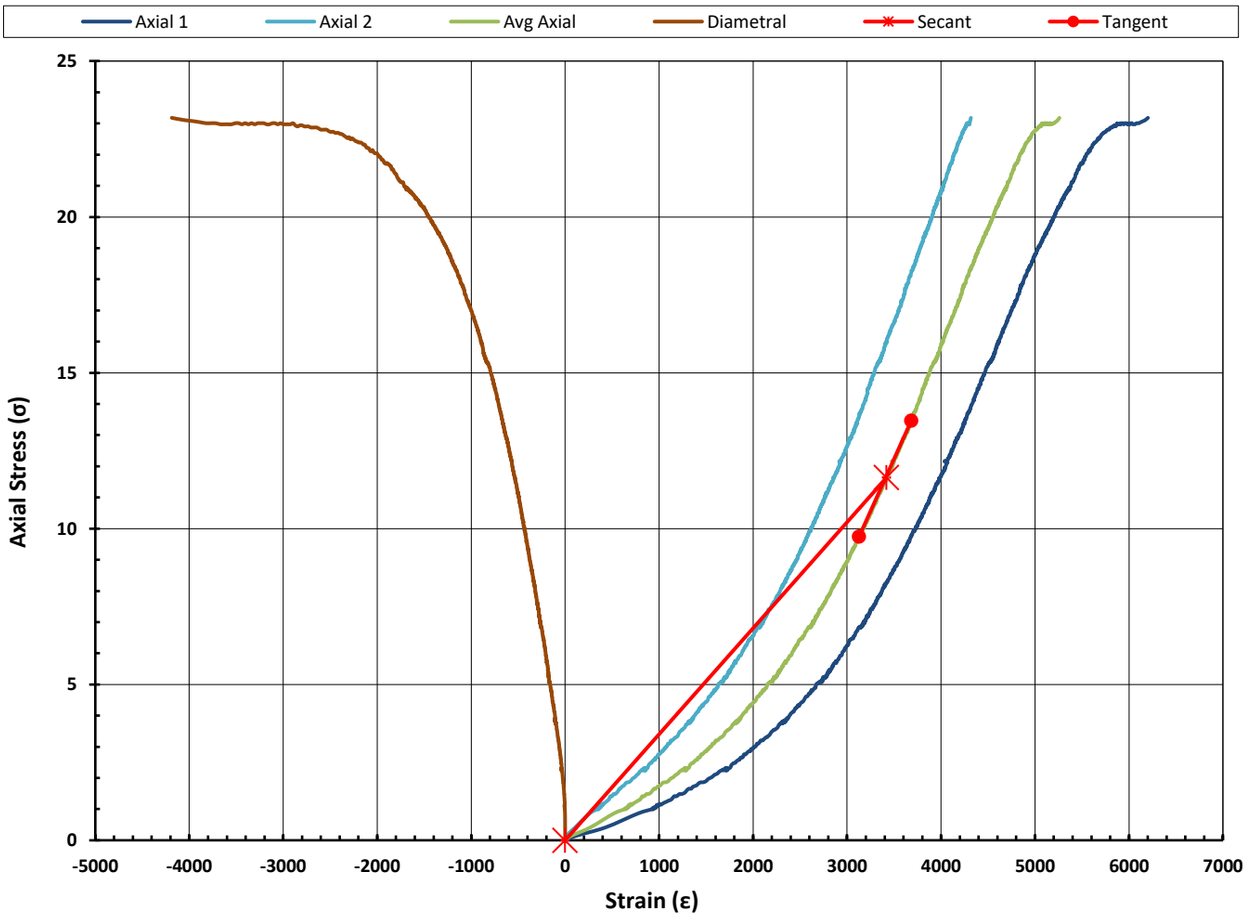
Macquarie Geotechnical
14 Carter Street
Lidcombe NSW 2141

Deformability of Rock Materials in Uniaxial Compression

Client	Tetra Tech Coffey	**Sample Source**	BH7 22.56-22.78m
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Sample Description**	Sandstone
Project	Central Barangaroo Development (754-SYDGE287887)	**Report #**	S80328-MOD
Job #	S22038-1	**Sample #**	S80328

Test Procedure	AS 4133.4.3.2 Deformability of rock materials in uniaxial compression-Rock strength less than 50 MPa		
Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	Unknown
Storage History	Core Box	**Storage Environment**	Sealed at as received moisture condition

Axial Stress vs Strain Plots



Uniaxial Compressive Strength		**23**	**MPa**

	Young's Modulus	**Poisson's Ratio**	
Tangent	6.7 GPa	0.18	from 42 % to 58 % of Max UCS
Secant	3.4 GPa	0.16	from 0 % to 50 % of Max UCS

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.
NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Jacob Lloyd

Date: 13/09/2022

MACQUARIE GEOTECH
Macquarie Geotechnical
14 Carter Street
Lidcombe NSW 2141

Deformability of Rock Materials in Uniaxial Compression

Client	Tetra Tech Coffey	**Sample Source**	BH7 22.56-22.78m
Address	Citadel Tower, Level 19, Tower B/799 Pacific Hwy, Chatswood NSW 2067	**Sample Description**	Sandstone
Project	Central Barangaroo Development (754-SYDGE287887)	**Report #**	S80328-MOD
Job #	S22038-1	**Sample #**	S80328

Test Procedure	AS 4133.4.3.2 Deformability of rock materials in uniaxial compression-Rock strength less than 50 MPa		
Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	Unknown
Storage History	Core Box	**Storage Environment**	Sealed at as received moisture condition

Average Specimen Diameter (mm)	60.8	**Moisture Content (%)**	6.3
Average Specimen Height (mm)	174.6	**Wet Density (t/m^3)**	2.31
Length to Diameter Ratio	2.9	**Dry Density (t/m^3)**	2.17
Duration of Test (min)	10.82	**Rate of Displacement (mm/min):**	< 0.1
Date of Test:	12/9/22	**Specimen Curing**	-
Mode of Failure	Mixed mode	**Test Apparatus**	Matest Compression Machine with Axial and Circumferential Extensometers.

Before Test

After Test

Uniaxial Compressive Strength **23** **MPa**

	Young's Modulus	Poisson's Ratio	
Tangent	6.7 GPa	0.18	from 42 % to 58 % of Max UCS
Secant	3.4 GPa	0.16	from 0 % to 50 % of Max UCS

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.
NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Jacob Lloyd

Date: 13/09/2022

Macquarie Geotechnical
14 Carter Street
Lidcombe NSW 2141

APPENDIX E. LEAP FROG CONTOUR PLANS AND CROSS SECTIONS

LEGEND

- Contour - Base of Fill / Top of Alluvium (mAHD)
- Cadastral boundary
- Basement footprint

NOTE
Surface contours will be updated on receipt of updated survey or LiDAR. Contours are similar to the northern and southern part of the station box.

SOURCE
Footprint and contours from Tetra Tech Coffey.
Cadastral boundaries from DFSI.
Aerial imagery from Nearmap (capture date 02-08-2022).

N

0 25 50 m

SCALE **1:1,250**
PAGE SIZE: **A3**
PROJECTION: **GDA 1994 MGA Zone 56**

AQUALAND

BARANGAROO CENTRAL

FIGURE 1

Base of Fill / Top of Alluvium

TETRA TECH COFFEY

DATE: **12.09.22** PROJECT: **754-SYDGE287887** FILE: **287887_01_F001_GIS_REVD**

DISCLAIMER: THIS FIGURE HAS BEEN PRODUCED FOR INTERNAL REVIEW ONLY AND MAY CONTAIN INCONSISTENCIES OR OMISSIONS. IT IS NOT INTENDED FOR PUBLICATION.

DOC REFERENCE: \\TTLOCAL\COFS772\S\GIS\287887_SYDGE_AQUALAND_BARANGAROOCENTRAL\AQUALAND_BARANGAROOCENTRAL_GIS\MXD\287887_01\REVD\287887_01_GIS002_REVD.MXD_2
SAVED BY: EAMMON.MARHA 12.09.22 12:36:43 PM

LEGEND

- Contour - Top of Residual Soil (mAHD)
- Cadastral boundary
- Basement footprint

NOTE 1
No residual encountered in the boreholes in these areas.
The material in this area is inferred to be residual, or better.
NOTE 2
Surface contours will be updated on receipt of updated survey or LiDAR. Contours are similar to the northern and southern part of the station box.
SOURCE
Footprint and contours from Tetra Tech Coffey.
Cadastral boundaries from DFSI.
Aerial imagery from Nearmap (capture date 02-08-2022).

0 25 50 m

SCALE **1:1,250**
PAGE SIZE: **A3**
PROJECTION: **GDA 1994 MGA Zone 56**

AQUALAND

BARANGAROO CENTRAL

FIGURE 2

Top of Residual Soil

TETRA TECH COFFEY

DATE: **09.11.22** PROJECT: **754-SYDGE287887** FILE: **287887_01_F002_GIS_REVD**

DISCLAIMER: THIS FIGURE HAS BEEN PRODUCED FOR INTERNAL REVIEW ONLY AND MAY CONTAIN INCONSISTENCIES OR OMISSIONS. IT IS NOT INTENDED FOR PUBLICATION.

SAVED BY: EAMMON.MARHA 09.11.22 10:48:09 AM
DOC REFERENCE: \\TTLOCAL\COFS772\S\GIS\287887_SYDGE_AQUALAND_BARANGAROOCENTRAL\AQUALAND_BARANGAROOCENTRAL_GIS\MXD\287887_01\REVD\287887_01_GIS003_REVD.MXD_2

LEGEND

- Contour - Top of Class IV (mAHD)
- Cadastral boundary
- Basement footprint

NOTE 1
No class IV sandstone encountered in the boreholes in these areas. The rock in this area is inferred to be class III sandstone, or better.
NOTE 2
Surface contours will be updated on receipt of updated survey or LiDAR. Contours are similar to the northern and southern part of the station box.
Footprint and contours from Tetra Tech Coffey.
Cadastral boundaries from DFSI.
Aerial imagery from Nearmap (capture date 02-08-2022).

N

0 25 50 m

SCALE **1:1,250**
PAGE SIZE: **A3**
PROJECTION: **GDA 1994 MGA Zone 56**

AQUALAND

BARANGAROO CENTRAL

FIGURE 3

Top of Class IV

TETRA TECH COFFEY

DATE: **09.11.22** PROJECT: **754-SYDGE287887** FILE: **287887_01_F003_GIS_REVD**

DISCLAIMER: THIS FIGURE HAS BEEN PRODUCED FOR INTERNAL REVIEW ONLY AND MAY CONTAIN INCONSISTENCIES OR OMISSIONS. IT IS NOT INTENDED FOR PUBLICATION.

SAVED BY: EAMMON.MARHA 09.11.22 10:03:54 AM
DOC REFERENCE: \\TTLOCAL\COFS772\S\GIS\287887_SYDGE_AQUALAND_BARANGAROOCENTRAL\AQUALAND_BARANGAROOCENTRAL_GIS\MXD\287887_01\REVD\287887_01_GIS005_REVD.MXD_2

SAVED BY: EAMMON.MARHA 12.09.22 12:51:46 PM

DOC REFERENCE: \\TTLOCAL\COFS772\SIS\GIS\287887_SYDGE_AQUALAND_BARANGAROOCENTRAL\AQUALAND_BARANGAROOCENTRAL_GIS\MXD\287887_01REVD\287887_01_GISI006_REVD.MXD_2

333,500 333,550 333,600 333,650 333,700 333,750 333,800 333,850

6,251,950 6,251,900 6,251,850 6,251,800 6,251,750 6,251,700 6,251,650

SEE NOTE

Extent of excavation in rock for basement construction

WULUGUL WALK

HIGH STREET

HIGH LANE

KENT STREET

BARANGAROO AVENUE

-22 -21 -20 -19 -18 -17 -16 -15 -14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4

LEGEND

- Contour - Top of Class III (mAHD)
- Cadastral boundary
- Basement footprint

NOTE
Surface contours will be updated on receipt of updated survey or LiDAR. Contours are similar to the northern and southern part of the station box.

SOURCE
Footprint and contours from Tetra Tech Coffey.
Cadastral boundaries from DFSI.
Aerial imagery from Nearmap (capture date 02-08-2022).

N

0 25 50 m

SCALE **1:1,250**
PAGE SIZE: **A3**
PROJECTION: **GDA 1994 MGA Zone 56**

AQUALAND

BARANGAROO CENTRAL

FIGURE 4

Top of Class III

TETRA TECH COFFEY

DATE: **12.09.22** PROJECT: **754-SYDGE287887** FILE: **287887_01_F004_GIS_REVD**

DISCLAIMER: THIS FIGURE HAS BEEN PRODUCED FOR INTERNAL REVIEW ONLY AND MAY CONTAIN INCONSISTENCIES OR OMISSIONS. IT IS NOT INTENDED FOR PUBLICATION.

LEGEND

- Contour - Top of Class II or Better Sandstone (mAHD)
- Cadastral boundary
- Basement footprint

NOTE
Surface contours will be updated on receipt of updated survey or LiDAR. Contours are similar to the northern and southern part of the station box.

SOURCE
Footprint and contours from Tetra Tech Coffey.
Cadastral boundaries from DFSI.
Aerial imagery from Nearmap (capture date 02-08-2022).

0 25 50 m

SCALE **1:1,250**
PAGE SIZE: **A3**
PROJECTION: **GDA 1994 MGA Zone 56**

AQUALAND

BARANGAROO CENTRAL

FIGURE 5

Top of Class II or Better Sandstone

TETRA TECH COFFEY

DATE: **12.09.22** PROJECT: **754-SYDGE287887** FILE: **287887_01_F005_GIS_REVD**

DISCLAIMER: THIS FIGURE HAS BEEN PRODUCED FOR INTERNAL REVIEW ONLY AND MAY CONTAIN INCONSISTENCIES OR OMISSIONS. IT IS NOT INTENDED FOR PUBLICATION.

DOC REFERENCE: \\TTLOCAL\COFS772\SIS\GIS287887_SYDGE_AQUALAND_BARANGAROOCENTRAL\AQUALAND_BARANGAROOCENTRAL_GIS\MXD\287887_01\REVD\287887_01_GIS007_REVD.MXD_3
SAVED BY: EAMMON.MARHA 12.09.22 1:02:37 PM

LEGEND

- Geotechnical cross section
- Cadastral boundary
- Basement footprint

SOURCE
Cross sections and footprint from Tetra Tech Coffey.
Cadastral boundaries from DFSI.
Aerial imagery from Nearmap (capture date 02-08-2022).

0 25 50 m

SCALE **1:1,250**
PAGE SIZE: **A3**
PROJECTION: **GDA 1994 MGA Zone 56**

AQUALAND

BARANGAROO CENTRAL

FIGURE 6

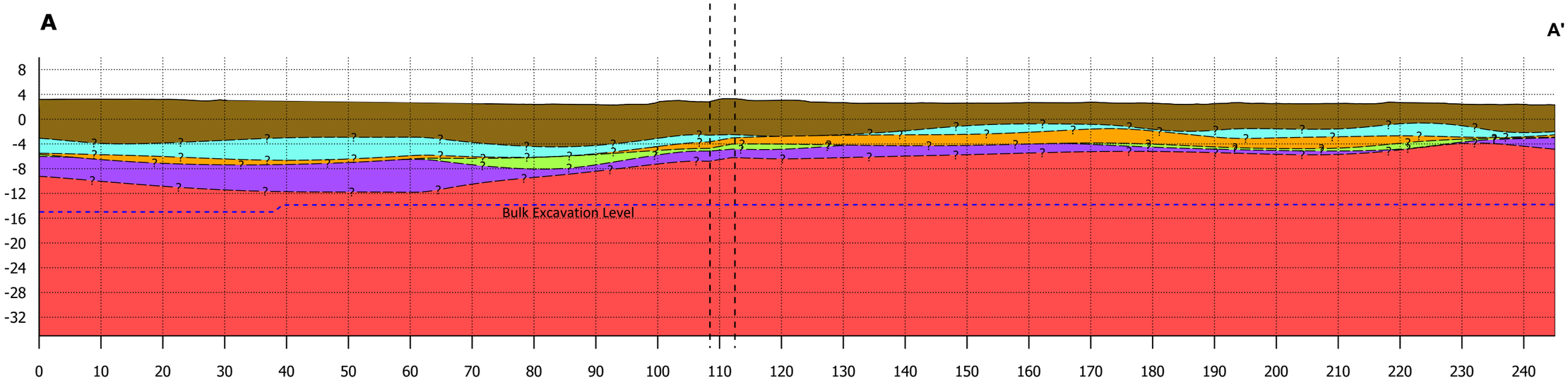
Geotechnical Cross Sections

TETRA TECH COFFEY

DATE: **09.11.22** PROJECT: **754-SYDGE287887** FILE: **287887_01_F006_GIS_REVC**

DISCLAIMER: THIS FIGURE HAS BEEN PRODUCED FOR INTERNAL REVIEW ONLY AND MAY CONTAIN INCONSISTENCIES OR OMISSIONS. IT IS NOT INTENDED FOR PUBLICATION.

DOC REFERENCE: \\TTLOCAL\COFS772\GIS\GIS287887_SYDGE_AQUALAND_BARANGAROOCENTRAL\AQUALAND_BARANGAROOCENTRAL_GIS\MXD\287887_01_REVD\287887_011REVD287887_01_GISI008_REVD.MXD_3
SAVED BY: EAMMON.MARHA 09.11.22 10:12:07 AM



Legend

- Grouped_Units: Alluvium/Estuarine
- Grouped_Units: Fill
- Class: Class II/I Sandstone
- Class: Class III Sandstone
- Class: Class IV Sandstone
- Grouped_Units: Residual Soil

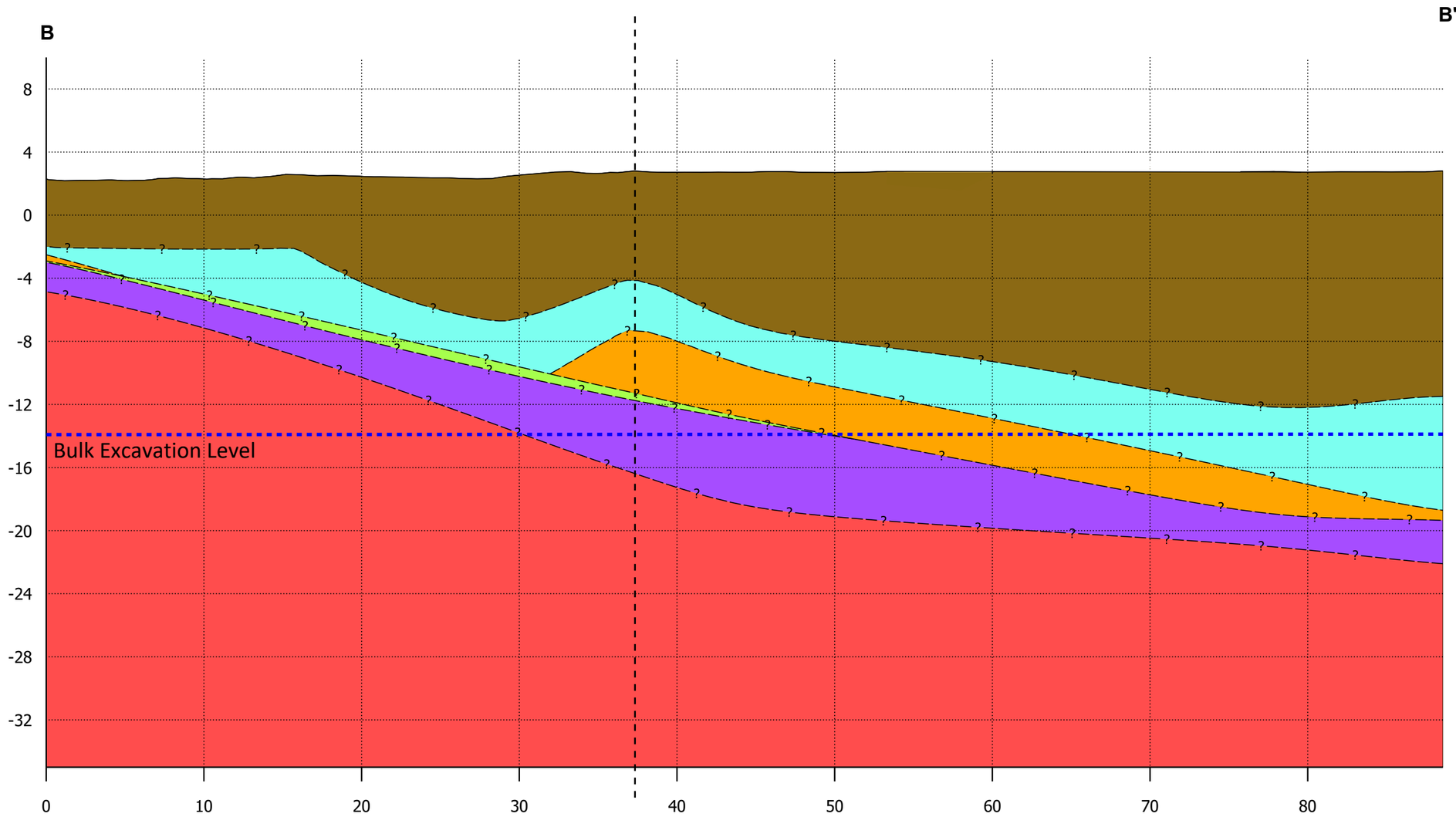
Revision	No.	Description	Drawn	Approved	Date
	1	DRAFT	L S	P M	13.09.22

Scale: 1:700
Vertical exaggeration: 1x
0m 25m

Drawn	L 5
Approved	PM
Date	13.09.22
Scale	1:400
Original Size	A3

TETRA TECH COFFEY

Client:	Aqualand
Project:	Central Barangaroo Development
Title:	East Wall
Project No:	SYDGE287887
Figure No:	7
REV:	2



Legend

- Grouped_Units: Alluvium/Estuarine
- Grouped_Units: Fill
- Class: Class II/I Sandstone
- Class: Class III Sandstone
- Class: Class IV Sandstone
- Grouped_Units: Residual Soil

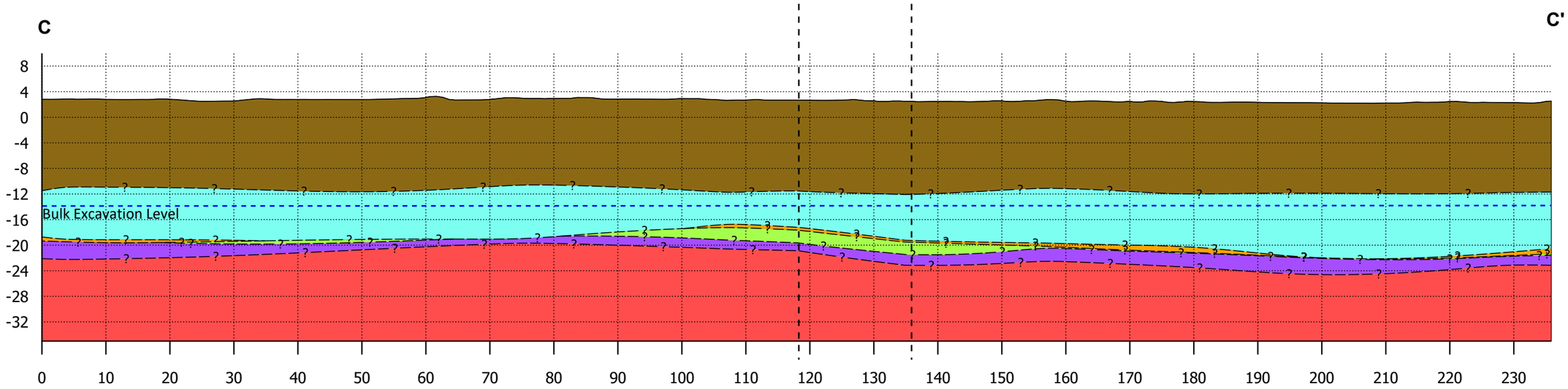
Revision	No.	Description	Drawn	Approved	Date
	1	DRAFT	L S	P M	13.09.22

Scale: 1:300
Vertical exaggeration: 1x
0m 15m

Drawn	L 5
Approved	PM
Date	13.09.22
Scale	1:400
Original Size	A3

TETRA TECH COFFEY

Client:	Aqualand
Project:	Central Barangaroo Development
Title:	South Wall
Project No:	SYDGE287887
Figure No:	8
REV:	2



Legend

- Grouped_Units: Alluvium/Estuarine
- Grouped_Units: Fill
- Class: Class II/I Sandstone
- Class: Class III Sandstone
- Class: Class IV Sandstone
- Grouped_Units: Residual Soil

Revision	No.	Description	Drawn	Approved	Date
	1	DRAFT	L S	P M	13.09.22

Scale: 1:700

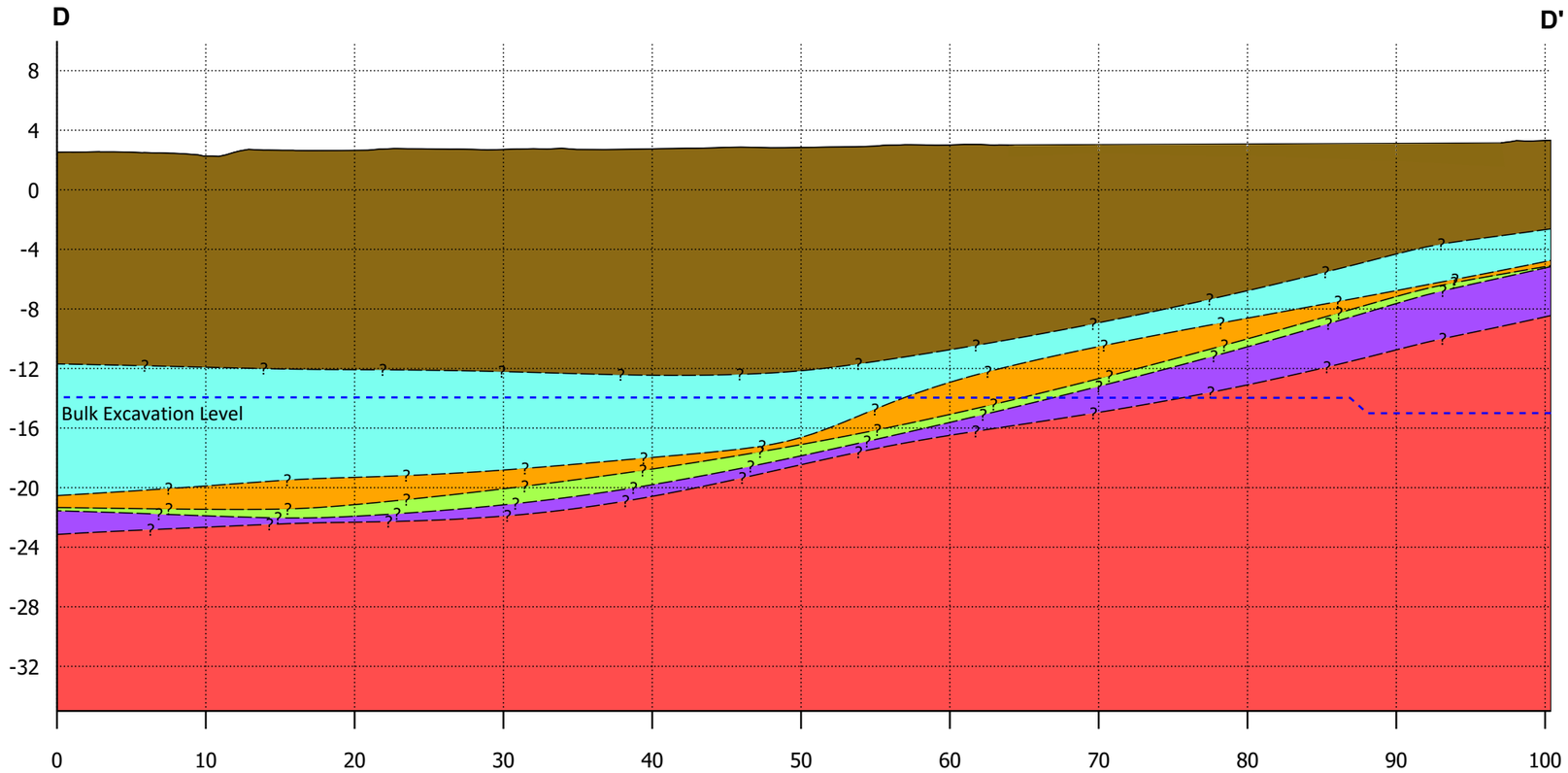
Vertical exaggeration: 1x

0m 25m

Drawn	L 5
Approved	PM
Date	13.09.22
Scale	1:400
Original Size	A3

TETRA TECH COFFEY

Client:	Aqualand
Project:	Central Barangaroo Development
Title:	West Wall
Project No:	SYDGE287887
Figure No:	9
REV:	2



Legend

- Grouped_Units: Alluvium/Estuarine
- Grouped_Units: Fill
- Class: Class II/I Sandstone
- Class: Class III Sandstone
- Class: Class IV Sandstone
- Grouped_Units: Residual Soil

Revision	No.	Description	Drawn	Approved	Date
	1	DRAFT	L S	P M	13.09.22

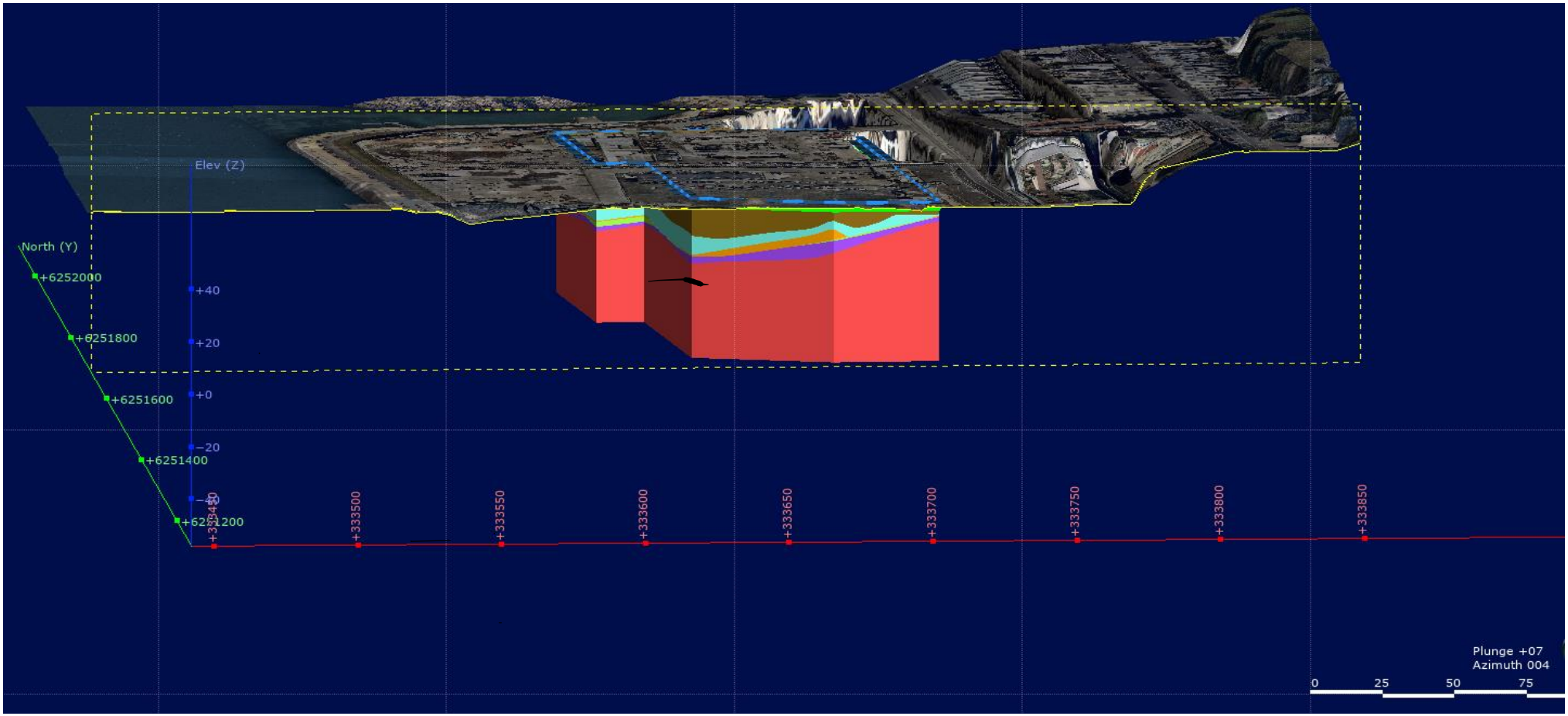
Scale: 1:400
Vertical exaggeration: 1x
0m 25m

Drawn	L 5
Approved	PM
Date	13.09.22
Scale	1:400
Original Size	A3

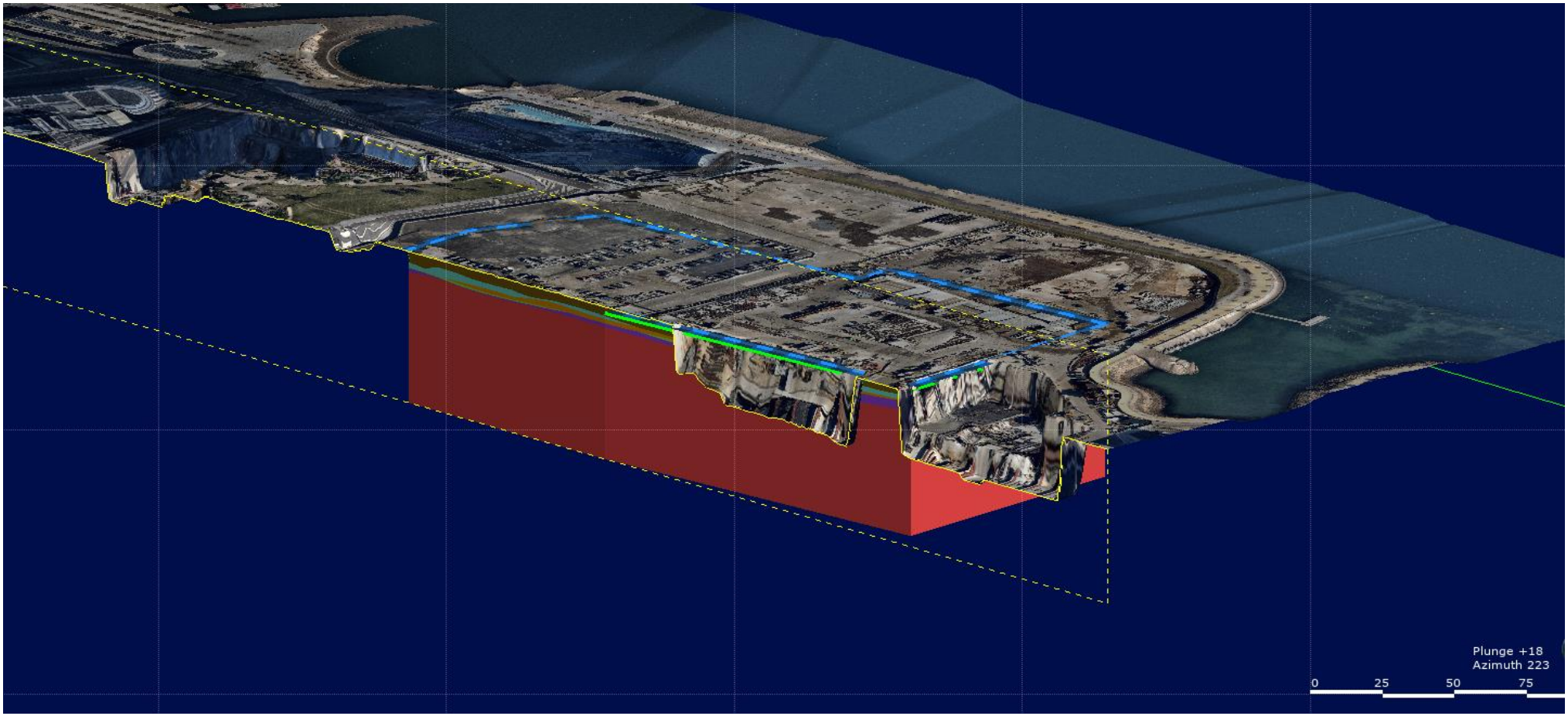
TETRA TECH COFFEY

Client:	Aqualand
Project:	Central Barangaroo Development
Title:	North Wall
Project No:	SYDGE287887
Figure No:	10
REV:	2

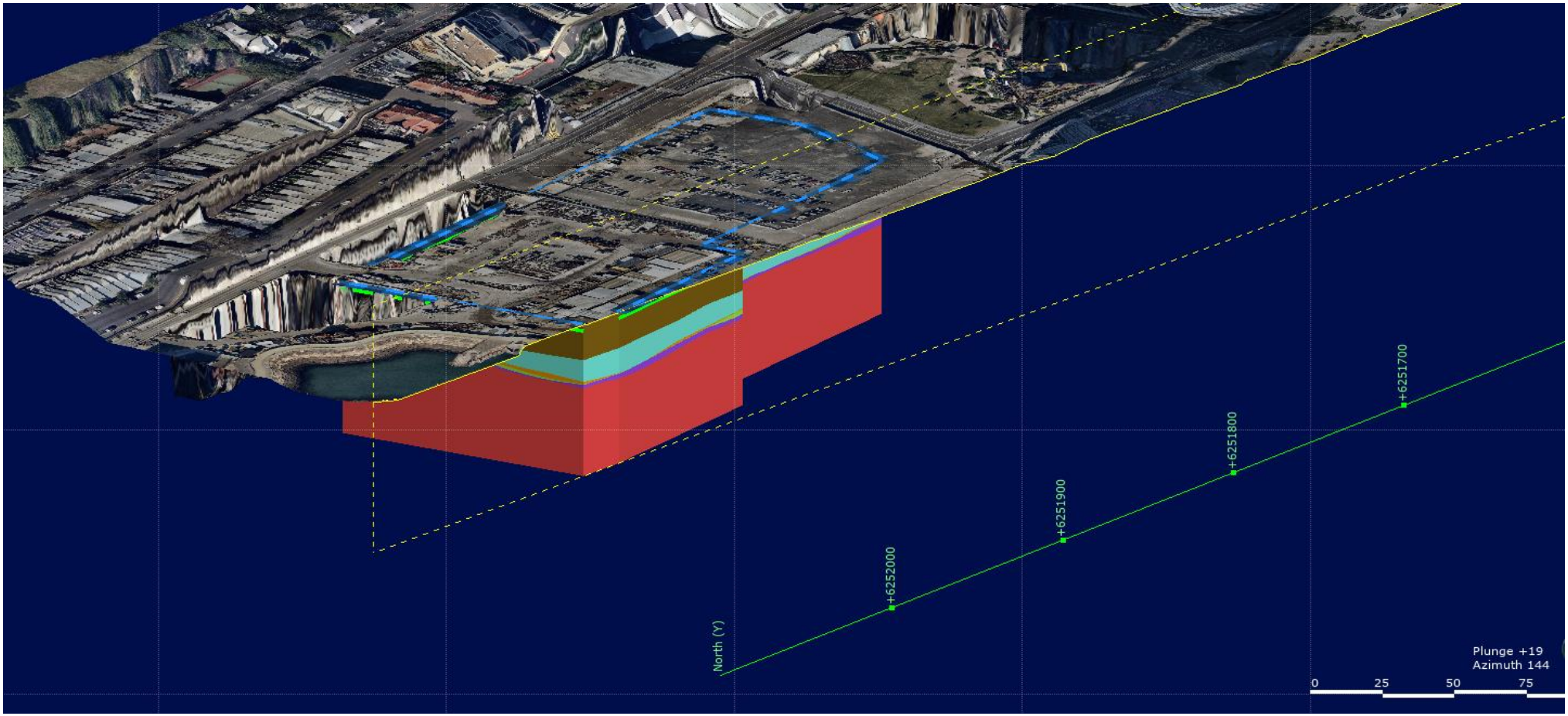
APPENDIX F. 3D VISUALISATION (LEAP FROG)



drawn	LS	TETRA TECH COFFEY	client:	AQUALAND
approved	PJM		project:	CENTRAL BARANGAROO
date	13/09/2022		title:	3D Model – Viewing towards North
scale	-		project no: 754-SYDGE287887	figure no: 1
original size	A4			



drawn	LS	TETRA TECH COFFEY	client:	AQUALAND
approved	PJM		project:	CENTRAL BARANGAROO
date	13/09/2022		title:	3D Model – Viewing towards South West
scale	-		project no: 754-SYDGE287887	figure no: 2
original size	A4			



drawn	LS	TETRA TECH COFFEY	client:	AQUALAND
approved	PJM		project:	CENTRAL BARANGAROO
date	13/09/2022		title:	3D Model – Viewing towards South East
scale	-		project no: 754-SYDGE287887	figure no: 3
original size	A4			

APPENDIX G. PRELIMINARY INFLOW AND DRAWDOWN ASSESSMENT

TETRA TECH COFFEY

Level 19, Tower B, Citadel Tower, 799 Pacific Highway
Chatswood
NSW 2067 Australia

t: +61 2 9406 1000
f: +61 2 9415 1678
tetratechcoffey.com

4 November 2021

Our ref: SYDGE287887AD

Aqualand
Level 47, Tower 1,
100 Barangaroo Avenue
Barangaroo NSW 2000

Attention: Sam Jenkins

Quality information

Revision history

Revision	Description	Date	Originator	Reviewer	Approver
Final	Preliminary Inflow and Drawdown Assessment	4/11/2021	Peter Sun	Ross Best	Ross Best

Distribution

Report Status	No. of copies	Format	Distributed to	Date
Final	1	PDF	Sam Jenkins	4/11/2021

PRELIMINARY ADVICE ONLY

TABLE OF CONTENTS

1. INTRODUCTION 3

2. PROPOSED DEVELOPMENT 3

2.1 Setting 3

2.2 Proposed excavation and drainage 4

2.3 Existing metro station 5

3. HYDROGEOLOGICAL CONDITIONS 5

3.1 Available information 5

3.2 Stratigraphy 6

3.3 Groundwater levels 7

3.4 Aquifer properties 7

3.5 Experience during Stage 1A and 1B 9

4. INTERACTION WITH SYDNEY METRO BARANGAROO STATION 10

4.1 Sydney Metro protection zones 10

4.2 Interaction of groundwater inflow 10

5. ASSESSMENT OF GROUNDWATER INFLOWS AND DRAWDOWN 12

6. SUMMARY AND RECOMMENDATIONS 13

7. LIMITATIONS 14

8. REFERENCES 14

APPENDICES

APPENDIX A: CENTRAL BARANGAROO GA SECTION(AA)

APPENDIX B: GROUNDWATER INFLOW AND DRAWDOWN CALCULATION

PRELIMINARY ADVICE ONLY

1. INTRODUCTION

Tetra Tech Coffey Pty Ltd (Coffey) has been requested by Aqualand Pty Ltd (Aqualand) to provide preliminary construction stage groundwater inflow and potential drawdown assessment for the proposed 5 level basement for the Central Barangaroo Development (CBD) and early estimate of interaction with the adjacent Metro station excavation.

This report addresses Item 6 of our fee proposal SYDGE287887 dated 1 June 2021 and provides preliminary groundwater advice in relation to the proposed construction stage of the development.

2. PROPOSED DEVELOPMENT

2.1 SETTING

We understand that the proposed CBD consists of three development blocks, i.e., Blocks 5 to 7 and the foreshore areas, with a total area approximately 2. Hectares. The proposed development site is adjacent or close to:

- On the east - Barangaroo Station box which has a general base level of approximately -25.7 m AHD,
- On the west – Darling Harbour,
- On the north – Headland Park,
- On the South – Barangaroo Stage 1B basement level approximately -13.4 m AHD (at this stage we have allowed for -14 m AHD).

The location of the proposed development is shown in Figure 1.

PRELIMINARY ADVICE ONLY

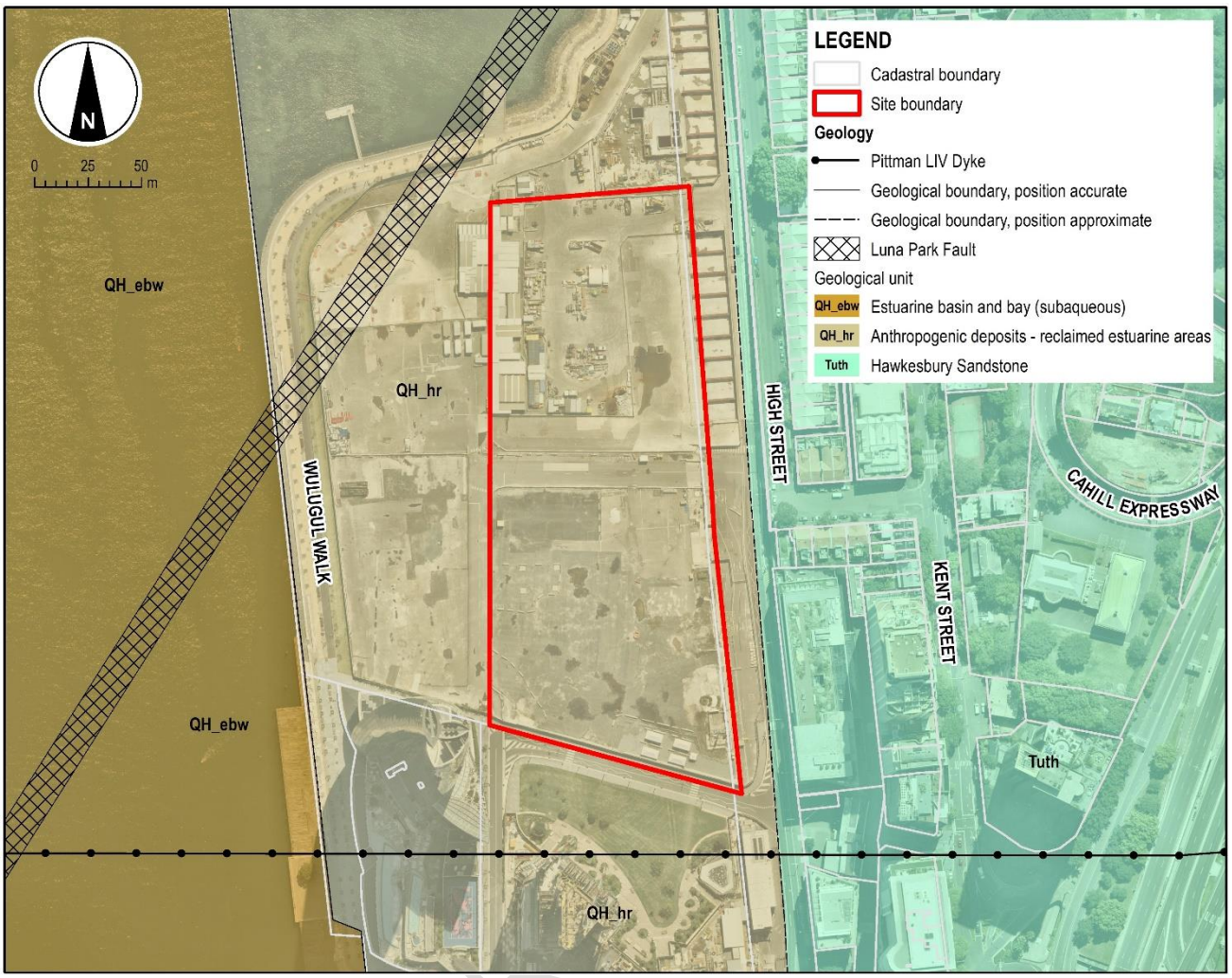


Figure 1 – Location of Central Barangaroo Development

2.2 PROPOSED EXCAVATION AND DRAINAGE

We understand the proposed structure is largely 7 storeys with one 20 storey Tower and 5 levels below-ground basement. The Webber Executive Architecture (Webber) drawing ES-S00-06501 Rev P02 “GA Section (AA)”, dated 13 May 2021 (see Appendix A) shows that the top of the B5 (lowest basement) slab is at a level of -11.5 m AHD. The existing ground level is approximately 2.5 m AHD and the anticipated bulk excavation level is approximately -13.4 m AHD. The basement area foot print is approximately 26,000 m^2.

Coffey understands that the intention is to incorporate retention system into the permanent works and the principal considerations being watertightness and stiffness of the retention system. In this regard the most suitable system for the retention of the proposed CBD basement would appear to be a diaphragm wall. Consideration could be given to the use of secant pile wall where the rock elevations are high enough to suit this type of wall system. Based on the review of the rock levels for the CBD, secant piled option maybe feasible at eastern boundary and a portion (about 20 m) of south east alignment.

Temporary dewatering within the construction excavation is proposed to remove the groundwater during the bulk excavation and until the end of hydrostatic slab construction and until structure to L00 is completed. The temporary dewatering is expected to comprise dewatering spears initially and transition to drainage channels and sumps with pumps when the excavation is below -3 m AHD.

PRELIMINARY

2.3 EXISTING METRO STATION

The existing Barangaroo Station is adjacent to the proposed site as shown in Figure 1. The Barangaroo Station structure is an underground structure located below and alongside Hickson Road between Munn Street and High Steps, Barangaroo. The excavation for the station structure is typically rectangular in plan and the proposed excavation level is at -25.7 m AHD with station concourse level at -12.6 m AHD. Barangaroo Station has been designed as an undrained structure. A depressurisation system has been developed to equalise the hydrostatic water pressure across the station. The design approach of the depressurization system was described in the Appendix P of the Design Package: DP-S-240 Barangaroo Station Structure (Ref: SMCSWTSE-JAB-SBR-ST-RPT-030018 AFC(B6-B3)). The dimensions of the Barangaroo Station bulk excavation geometry is shown in Figure 2 which is extracted from PSM's design memorandum on Barangaroo Station groundwater depressurisation contained within document DP-S-240 Barangaroo Station Structure.

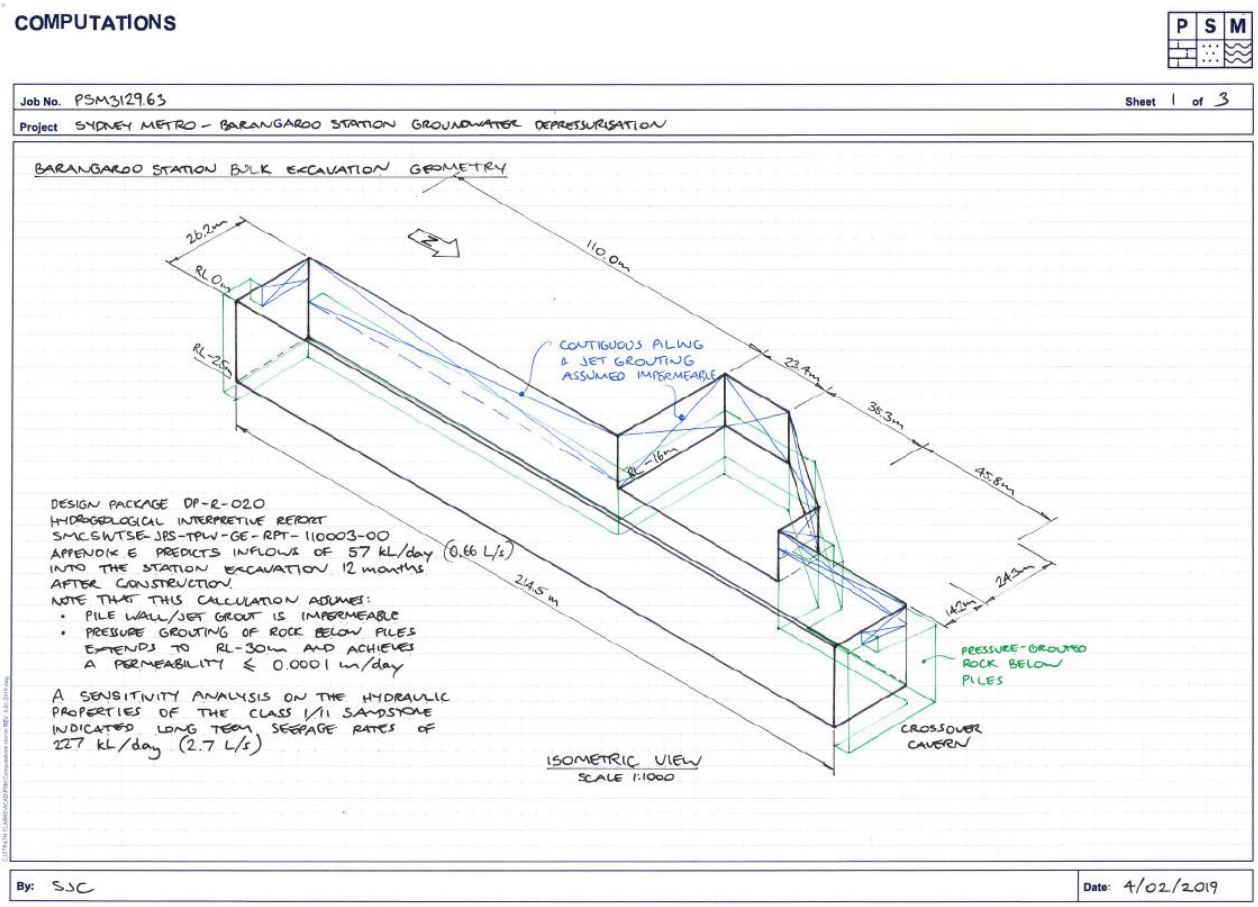


Figure 2 – Barangaroo Station bulk excavation geometry.

3. HYDROGEOLOGICAL CONDITIONS

3.1 AVAILABLE INFORMATION

The following reports provided to Coffey by Aqualand set out background, which was used to develop this report.

- Douglas Partners, "Report on Geotechnical Investigation, Central Barangaroo-Block 7, Hickson Road, Barangaroo".

- Metron, “Geotechnical Interpretive Report System Wide, Stage 1 Design, Underground Station Design and Technical Services for Sydney Metro”.
- Sydney Metro City and Southwest-TSE, “Design Package: DP-S-240, Barangaroo Station Structure, SMCSWTSE-JAB-SBR-ST-RPT-030018 AFC(B6-B3)”
- Metron, “Barangaroo Station Protection Guidelines, Underground Stations Design and Technical Services for Transport for New South Wales, TfNSW, SMCSWSBR-MET-SBR-ID-REP-000030.”

3.2 STRATIGRAPHY

Douglas Partners Pty Ltd (DP) undertook geotechnical investigation at the site in June 2017, including drilling 11 boreholes.

DP assessed ground conditions at the site to generally comprise pavements, fill, and alluvial and estuarine deposits that grade into weathered sandstone bedrock. The surface weathered sandstone rock profile appears to fall across the site stepping down at the western and north-western corner of the site.

- Pavements: Typically bitumen, underlain by road base gravel and sands.
- The fill extends to depths generally between -3.5 m AHD to -12.9 m AHD. Fill encountered by DP consists of compacted crushed sandstone, sand, gravelly sand, clayey sand, sandy clay, sandy gravel filling with sandstone cobbles, boulders and building rubble including concrete, timber, bricks and steel. The maximum thickness of fill is 15.5 m.
- Base of alluvial and estuarine deposits varies from -5.3 m AHD to -19.7 m AHD. The sediments reported by DP generally includes firm to still clay with interbedded sand and clayey sand layers, loose to medium dense sand, silty clay and silt, with shell fragments found in three boreholes close to the harbour. The maximum thickness of the sediments is 7.8 m.
- Bedrock: Typically extremely low and very low strength sandstone with some clay seams, overlying medium to high strength weathered then fresh sandstone (extremely low to low strength, medium strength and high strength). Top of medium strength sandstone was encountered at depths ranging from -5.3 m AHD to -21.8 m AHD. A minor shale lens was observed in some borehole across the site. The maximum thickness of low strength sandstone and shale lens is 3.1 m and 0.3 m respectively.

Figure 3 shows the approximate locations of boreholes described in DP reports.

PRELIMINARY ADVICE ONLY

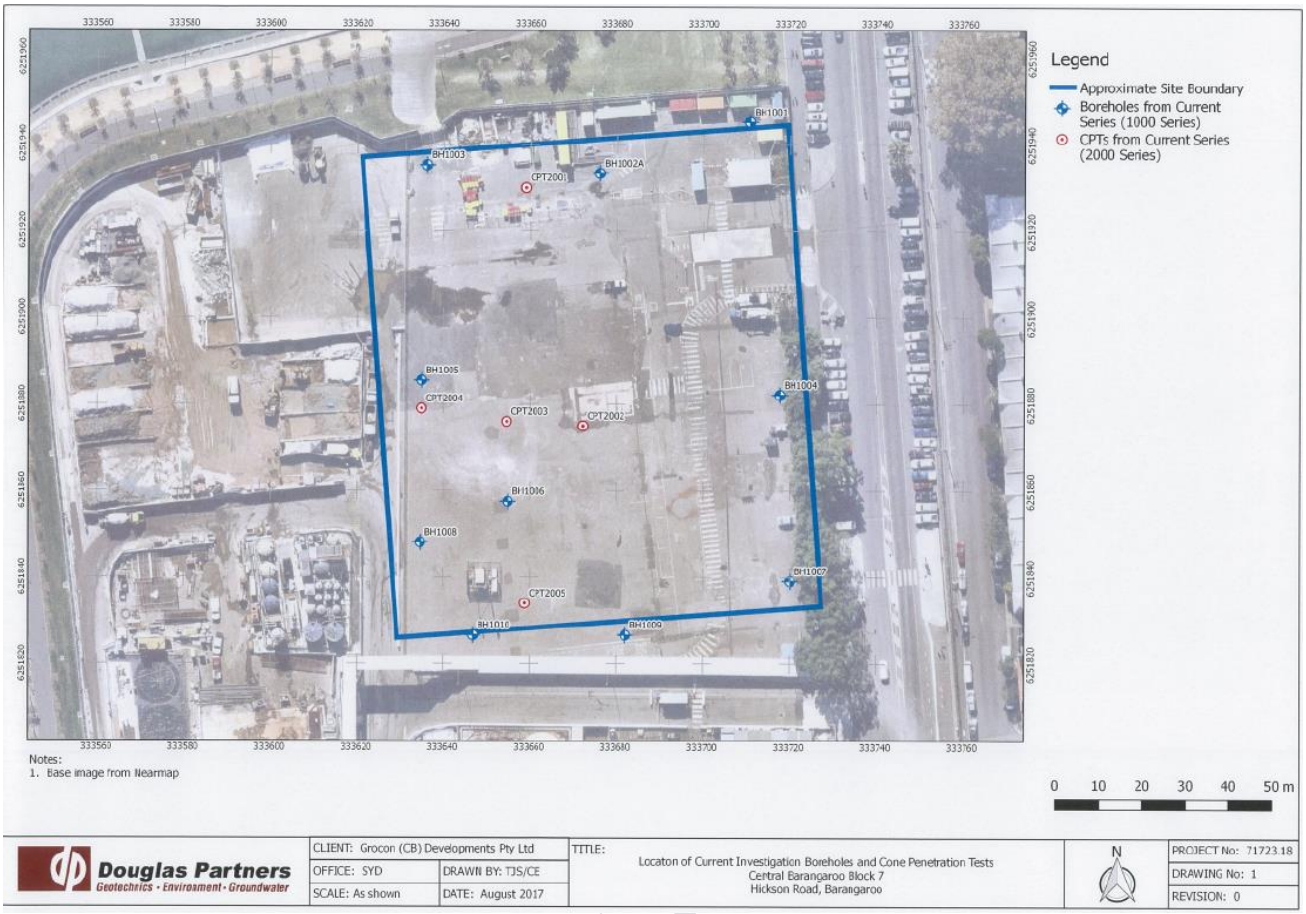


Figure 3 – Locations of boreholes by Douglas Partners

3.3 GROUNDWATER LEVELS

DP measured the groundwater levels at the site and reported that the groundwater levels varied from 0.65 m AHD to -0.61 m AHD with an average of about 0.2 m AHD. Given the close proximity to the Sydney Harbour, groundwater levels are expected to vary due to tidal influence. The Mean High Water Spring (MHWS) level, which is the average high tide level, is at about 0.62 m AHD and the Mean Low Water Spring (MLWS) level is at -0.7 m AHD. It is anticipated that groundwater outside the development will fluctuate between approximately -1.0 m AHD to 2 m AHD during construction under the influence of tide and rainfall.

Metron reported that in the vicinity of Barangaroo Station, a number of piezometers have monitored groundwater levels in later 2016 to early 2017. The highest groundwater level of 1.9 m AHD was observed in piezometer SRT_BH080A, located to the immediate west of the station box. It is reported the groundwater levels in this piezometer show a strong tidal response.

For the Barangaroo South projects (Stage 1A Commercial and Stage 1B Residential), a long-term design groundwater level of RL 2.575 mAHD was adopted (with allowance for climate change[1]). This is understood to include allowance for sea level rise, tide and storm surge effects.

3.4 AQUIFER PROPERTIES

Permeability testing was carried out by DP using falling head tests within the soil layers. The results from the falling head tests are summarised in Table 1. The result of the falling head tests provide a range of interpreted hydraulic conductivity values from 1.7 x 10^{-7} m/s to 6.1 x 10^{-3} m/s.

[1] Arup Report, Climate Change and Sea Level Rise Report, dated June 2010.

Table 1: Summary of falling head tests on soils by DP

Bore	Base of Test (m)	Interval (m)	Hydraulic Conductivity (k) (m/s)	Material Description
BH1001	6.5	0	4.9×10^{-5}	Sandy Silt/Silty Sand with trace clay& shells (alluvial/estuarine)
BH1002A	15.0	1.8	1.9×10^{-7}	Sandy Clay and Clayey Sand (residual)
BH1003	17.0	0	5.9×10^{-6}	Clayey Sand (alluvial/estuarine)
BH1004	4.2	0	9.7×10^{-6}	Crushed Sandstone (filling)
BH1005	14.5	0	6.1×10^{-3}*	Sand with some silt and a trace of clay (alluvial)
BH1006	17.5	0.5	4.1×10^{-7}	Sandy clay and Clayey Sand (alluvial/estuarine/possible residual)
BH1007	5.5	0	2.2×10^{-5}	Silt with some sand, clay and shells (alluvial/estuarine)
BH1008	20.6	0	3.5×10^{-7}	Sand and Clayey Sand (possible residual)
BH1010	13.5	0.4	1.7×10^{-7}	Sandy Clay (filling/possible alluvial/estuarine)

*Potential leaking of the seal at the base of the test

Water pressure tests were carried out by DP in the sandstone rock using packer tests and the results are summarised in Table 2. The interpreted hydraulic conductivity values range from $<1.0 \times 10^{-9}$ m/s to 1.5×10^{-6} m/s.

PRELIMINARY ADVICE ONLY

Table 2: Summary of water pressure tests on sandstone by DP

Bore	From (m)	To (m)	Interval (m)	Lugeon Value[1](l/m/min at 1000kPa)	Hydraulic Conductivity (k)[1](m/s)	Comment
BH1001	12.4	16.1	3.7	0.29	2.9×10^{-8}	Low k-increasing in permeability due to the opening up of fractures
BH1002A	21.6	25.2	3.8	10.32	1.0×10^{-6}	Mod k-decreasing in permeability with blocking of fractures
BH1003	25.7	29.5	3.8	0.38	3.8×10^{-8}	Low k-laminar flow after some washout of fractures
BH1004	11.0	15.5	4.5	1.47	1.5×10^{-7}	Low k-laminar flow after some infill of fractures
BH1005	25.0	28.8	3.8	0.02	2.0×10^{-9}	Low k-tight fractures
BH1006	23.1	26.6	3.5	<0.01	$< 1.0 \times 10^{-9}$	Low k-very tight fractures
BH1006	26.6	29.6	3.0	<0.01	$< 1.0 \times 10^{-9}$	Low k-very tight fractures
BH1006	29.6	35.6	6.0	0.28	2.8×10^{-8}	Low k-laminar flow after some infill of fractures
BH1007	11.1	16.3	5.2	<0.01	$< 1.0 \times 10^{-9}$	Low k-very tight fractures
BH1008	23.4	28.6	5.2	<0.01	$< 1.0 \times 10^{-9}$	Low k-very tight fractures
BH1009	15.4	21.1	5.7	15.26	1.5×10^{-6}	Mod k-laminar flow after some infill of fractures
BH1010	23.6	27.9	4.3	<0.01	$< 1.0 \times 10^{-9}$	Low k-very tight fractures

[1] Hydraulic conductivity is based on: 1 Lugeon=~1.0×10^{-7} m/s

The median Lugeon Value interpreted from the packer tests is 0.285 uL corresponding to a hydraulic conductivity of 2.85×10^{-8} m/s (0.0025 m/d) for sandstone. DP reported that the hydraulic conductivity values across the general area likely varies from 1×10^{-8} m/s to 1×10^{-7} m/s, with some localised higher inflows.

3.5 EXPERIENCE DURING STAGE 1A AND 1B

Geotechnical site investigation for State 1B site confirmed the presence of a Pittman LIV dyke within the stage 1B site, representing a near vertical structure approximately 3m wide, generally orientated in an east-west direction. Coffey (2014) reported that 63 water pressure (packer) tests were conducted in boreholes in Areas 1A to 1C. Of these, were interpreted to be representative of the dyke, with the rest being representative of the sandstone. It is reported the median result for the stage 1B site was 3.2 uL compared with 2.2 uL for the stage 1A site. The median permeability value for the dyke is higher than for the permeability results for the stage 1B site as a whole (4.7 uL compared with 3.2 uL). The median packer test value from the 63 test results is about 4 uL. About 30% of results are in the high category or greater. This is somewhat higher than reviews of packer test results reported by Burgess et al (1987) and Best and Parker (2005) in Hawkesbury Sandstone. In their assessment of the probability distribution of permeability testing results for Hawkesbury Sandstone in the Central Sydney Region, Burgess et al (1987) indicated a median packer test results of 0.4 uL. The more

PRELIMINARY - NOT FOR CONSTRUCTION

recent review by Best and Parker (2006) for Hawkesbury Sandstone in the Sydney area (wider than the CBD) indicated a median packer test result of 0.6 uL.

4. INTERACTION WITH SYDNEY METRO BARANGAROO STATION

4.1 SYDNEY METRO PROTECTION ZONES

The specific reserve (protection) zones of the Sydney Metro Barangaroo Station are shown in Figure 3 Appendix D of the Sydney Metro Station Protection Guidelines (SMCSWSBR-MET-SBR-ID-REP-000030.01.AFC.01.01), and this figure is reproduced as Figure 4.

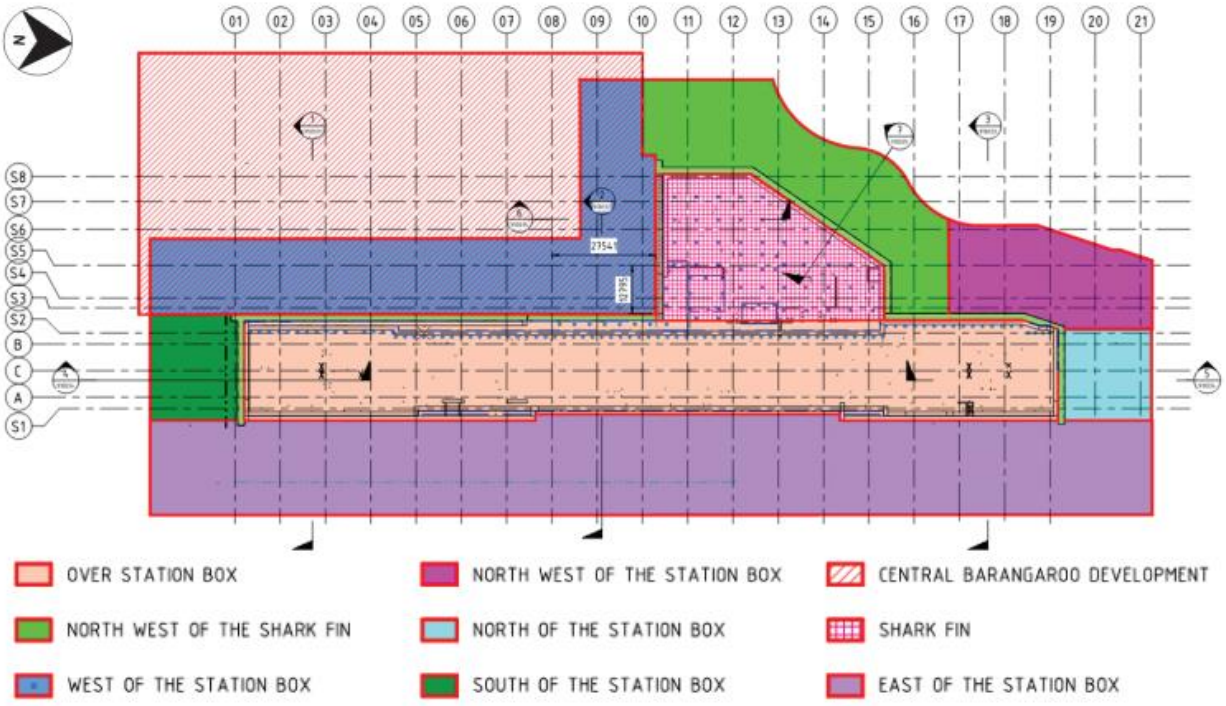


Figure 4 – Specific reserve zones from Figure 3 Appendix D of the Sydney Metro Station Protection Guidelines (SMCSWSBR-MET-SBR-ID-REP-000030.01.AFC.01.02 dated 11 Feb 2021)

The blue area marked as “WEST OF THE STATION BOX” is where interaction between the Central Barangaroo Development and the Sydney Metro Barangaroo Station will be relevant.

4.2 INTERACTION OF GROUNDWATER INFLOW

Out-of-balance groundwater loads could occur between the east and west walls of the Metro Station due to dewatering during development of the adjacent Central Barangaroo. In order to prevent the occurrence of this out-of-balance groundwater loads, a depressurisation system has been developed to equalise the hydrostatic water pressure across the station. The design approach of the depressurization system was described in the Appendix P of the Design Package: DP-S-240 Barangaroo Station Structure (Ref: SMCSWTSE-JAB-SBR-ST-RPT-030018 AFC(B6-B3)). The design concept is shown in Figure 5. The system consists of a depressurisation pipe running from the northern end of the station along the east side towards south, across the southern end and then stretching along the west side to the Central Barangaroo Development interface. The pipe connects a system of vertical and horizontal strip drains with a discharge point at the holding tank

located at the Central Barangaroo Development interface. Flushing points are incorporated into the depressurisation for monitoring and maintenance purposes.

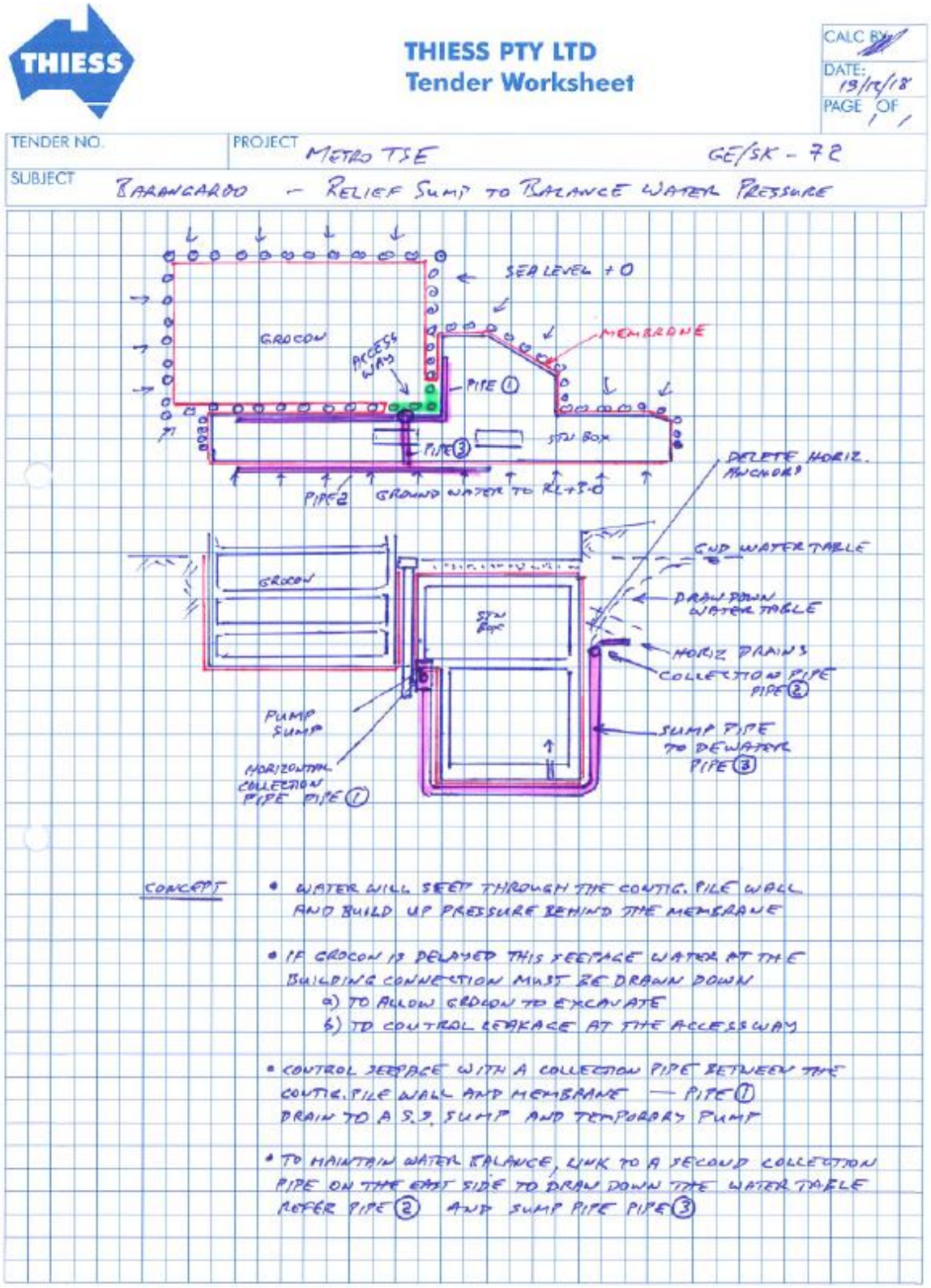


Figure 5 – Design concept of Barangaroo Station groundwater depressurisation/relief system.

The depressurisation system allows the water on the eastern side of the Barangaroo Station box to be lowered (to similar level as the Central Barangaroo Development basement level) to prevent out of balance water pressures building on the western wall of the station box, before the basement excavation for the Central Barangaroo Development commences. The inflow assessment for Central Barangaroo Development will need to treat the area around the Metro station as being hydraulically connected and this will increase the inflows during construction of the Barangaroo Central and increase the extent of the drawdown impact.

5. ASSESSMENT OF GROUNDWATER INFLOWS AND DRAWDOWN

Initially, an assessment of inflow to the Central Barangaroo Development excavation during construction was undertaken without considering the interaction with Barangaroo Station. Then a combined inflow was obtained by adding the assessed inflow for Barangaroo Station to the assessed inflow for Central Barangaroo Development. The calculation is presented in Appendix B.

A hydraulic conductivity value of 1 x 10^{-7} m/s was adopted for sandstone based on Coffey's experience and available packer tests data over the area, which is considered to be conservative. The following assumptions apply to the assessment:

- Impermeable cut off walls enclose the site and penetrate at least 0.5 m into sandstone, therefore, seepage into the excavation would be limited to seepage from the sandstone rock;
- The effects of individual high permeability features are not taken into account (inflows associated with such features, if present, would be additional);
- Sandstone permeability 1 x10^{-7} m/s;
- Hydraulic connection is present between the sandstone and the waters of Darling Harbour; and
- Groundwater levels outside the wall are taken as 1.5 m AHD.

The above assumptions are considered reasonable based on the information available but it must be recognised that groundwater inflow prediction is strongly dependent on ground conditions. As a result, inflows may depart significantly from the assessment presented herein.

For the purpose of the assessment the groundwater profile is approximated using interpreted profiles for the northern and southern boundaries, and across the central part of the site. The assessment was made using analytical methods presented by Polubarubiva-Kochina (Theory of Motion of Groundwater, Gostekhhizdat, Moscow, 1952) together with flow net analysis.

For the Barangaroo Station, the Design Package DP-R-020 Hydrogeological Interpretive Report (SMCSWTSE-JPS-TPW-GE-RPT-110003-00 Appendix E) predicts long term seepage rate to the station (i.e. prior to construction of the permanent structure and waterproofing) was approximately 0.66 L/s (57kL/d), with a peak rate of 1.2 L/s. Sensitivity analysis on the hydraulic properties of the Class I/II sandstone indicated seepage rates of up to 2.7 L/s. The assessment was based on the assumptions:

- Pile wall/Jet grout is impermeable over the depth of the soil profile
- Pressure grouting of rock below piles extends to -30 m AHD and achieves a permeability ≤ 0.0001 m/d.

PSM reassessed the seepage inflow for Barangaroo Station and adopted a typical design inflow of 1.5 L/s for sizing the drainage components (SMCSWTSE-JPS-TPW-GE-DAN-502254-A Design Advise Note-Barangaroo Station-Groundwater Depressurisation/Relief System Advice dated 5th February 2019).

In this assessment, it is assumed hydraulic connectivity is present between the Barangaroo Station and Central Barangaroo Development and the PSM assessed seepage inflow of 1.5 L/s is added to the assessed inflow for Barangaroo Central for considering the interaction of these two sites.

PRELIMINARY ADVICE ONLY

The results of the assessments above are summarised in Table 3.

Table 3: Seepage inflow assessment for Central Barangaroo Development during construction

Source	Inflow (L/s)*
Sandstone beneath Barangaroo Central Perimeter Cutoff wall	1.34
Inflow to Barangaroo Station	1.5
TOTAL	2.84

*Inflows through localised high permeability features are not included and would be additional to the values nominated above.

In addition to the rate nominated above the volume of water which would need to be removed from the fill materials within the proposed perimeter cut off wall to achieve dewatering to -16 m AHD is assessed to be a volume of 37 ML (allowing an area of 2.6 ha within the cut off wall, an average saturated soil thickness of 9.5 m and a specific yield of 0.15 for the saturated soil). If dewatering is carried out over a period of two months an additional dewatering rate of 7.9 L/s would be required.

Initial dewatering would be achieved using a combination of production bores and vacuum spear points. As excavation to sandstone will be carried out over much of the site it will not be possible to achieve complete dewatering of the overlying fill and natural soil using production bores and spear points. Trenches and sumps will be required to collect seepage in the later stages of excavation.

An assessment of drawdown profile (Attachment B) was undertaken for long term inflow to the CBD excavation assuming an extensive unsaturated aquifer under uniform infiltration, which was made using the analytical method presented by Edelman (1972). Groundwater drawdown outside of eastern wall of CBD is expected to be up to 11 m within the rock based on the above assumptions and with little drawdown within the fill horizon. Due to CBD excavation, the extent of groundwater drawdown in the sandstone in vicinity of the eastern boundary of the Barangaroo Station is expected to be up to 6 m. The groundwater level adjacent to the eastern boundary of the Barangaroo Station is assessed to be approximately -6 m AHD with rock surface adopted as 0 m AHD. It is reported in the Appendix P of the Design Package: DP-S-240 Barangaroo Station Structure that the depressurization system is intended to draw down the groundwater level around the station to -14 m AHD. Therefore, the drawdown is unlikely to exceed that is occurring during the Barangaroo Station development. The drawdown in the east of CBD excavation is expected to be negligible beyond about 250 m from the CBD excavation.

6. SUMMARY AND RECOMMENDATIONS

Our assessment findings and recommendations are as follows:

- Groundwater seepage to the proposed development is expected to be up to 89.6 ML/year (2.84 L/s) considering the interaction of Barangaroo Station.
- Groundwater drawdown is expected to be up to 11 m within the rock immediately adjacent to the CBD excavation/basement walls, reducing to negligible at about 250 m of the site and with little drawdown within in the fill horizon. The drawdown is unlikely to exceed that is occurring during the Barangaroo Station development.
- The volume of water which would need to be removed from the fill materials within the proposed perimeter cut off wall is expected to be up to 37 ML.
- Dewatering would be achieved using a combination of production bores and vacuum spear points. Trenches and sumps will be required to collect seepage in the later stages of excavation.

PRELIMINARY ADVICE ONLY

- Groundwater quality or potential contamination is not addressed in this report.
- It is recommended the implementation of continuous groundwater level monitoring during cut-off wall construction and during dewatering to check if unfavourable conditions such as defects in wall construction or unexpected adverse ground conditions are affecting the performance of the cut-off wall. Monitoring should be reviewed at monthly intervals.

7. LIMITATIONS

The preliminary advice contained in this report is based on a desk study of available existing geotechnical data. The advice is subject to change when further geotechnical investigations become available.

This report must not be reproduced except in full and must be read in conjunction with the attached 'Important information about your Tetra Tech Coffey Report'.

8. REFERENCES

Coffey (2014), Lend Lease Building Pty Ltd Barangaroo South Pittman LIV Dyke Hydraulic Testing Report. Ref: GEOTLCOV24015AO-BPr1.

Burgess, P.J., Hosking, L.A. and Mirkov, P. (1987), Geotechnical Investigations for Urban Road Tunnels in Sydney. 6th Australian Tunnelling Conference, Melbourne, March 1987.

Best, R.J. and Parker, C.J. (2005), Groundwater in Sydney-Tunnel Inflows and Settlement-Theory and Experience, 12th Australian Tunnelling Conference, March 2005.

Polubarubiva-Kochina (1952), Theory of Motion of Groundwater, Gostekhhizdat, Moskow.

Edelman, J.H. (1972), Groundwater Hydraulics of Extensive Aquifers, International Institute for Land Reclamation and Improvement, Wageningen.

For and on behalf of Tetra Tech Coffey

Ross Best
Senior Principal

PRELIMINARY ADVICE ONLY

Important information about your Tetra Tech Coffey Report

These notes have been prepared by Tetra Tech Coffey to help you to interpret and understand the limitations of this report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Tetra Tech Coffey and applies only to this project and site. Project criteria typically include the general nature of the project; its size and configuration; the location of any structural elements on site; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Tetra Tech Coffey to assess how factors that changed subsequent to the date of the inspection or report affect the report's recommendations. Tetra Tech Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Reliance on external data

External data is often relied upon for Tetra Tech Coffey to generate our reports. This data includes items such as survey data, drawings, reports and geotechnical data. It is the responsibility of the client to ensure that all relevant data is provided to Tetra Tech Coffey. We are not able to independently verify external data and therefore cannot accept responsibility for problems due to the accuracy of external data.

Your report is prepared for specific purposes and persons

This report has been prepared by Tetra Tech Coffey for the Client and may only be used and relied on by the Client for the purpose as set out in proposal and within this report.

To avoid misuse of the information contained in your report, it is recommended that you confer with Tetra Tech Coffey before passing your report on to another party. Your report should not be applied to any project other than that originally specified at the time the report was issued.

The conclusions and recommendations in this report are based on the conditions and other information available to Tetra Tech Coffey at the time of preparing this report. Tetra Tech Coffey has no responsibility or obligation to update this report due to and subsequent change to these conditions or information.

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Tetra Tech Coffey to work with other project design professionals who are affected by this report. Tetra Tech Coffey can explain the report implications to the design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report

This report as a whole presents the findings of our investigation or design and the report should not be copied in part or altered in any way. Figures, tables, drawings, etc/ are customarily included in our report and are developed by our engineers based on their interpretation of input data. Information should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Rely on Tetra Tech Coffey for additional services

Tetra Tech Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from concept to operation. It is common that not all approaches will be necessarily dealt with at the time of this report due to the project status. As the project progresses through design towards construction, speak with Tetra Tech Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

PRELIMINARY ADVICE ONLY

APPENDIX B: GROUNDWATER INFLOW AND DRAWDOWN CALCULATION

PRELIMINARY ADVICE ONLY

LEGEND

- Geotechnical cross section
- Cadastral boundary
- Site boundary

SOURCE
Site boundary and cross sections from Tetra Tech Coffey.
Cadastral boundaries from DFSI.
Aerial imagery from Nearmap (capture date 04-10-2021).

N

0 25 50 m

SCALE **1:1,250**
PAGE SIZE: **A3**
PROJECTION: **GDA 1994 MGA Zone 56**

AQUALAND

BARANGAROO CENTRAL

FIGURE 12 DRAFT

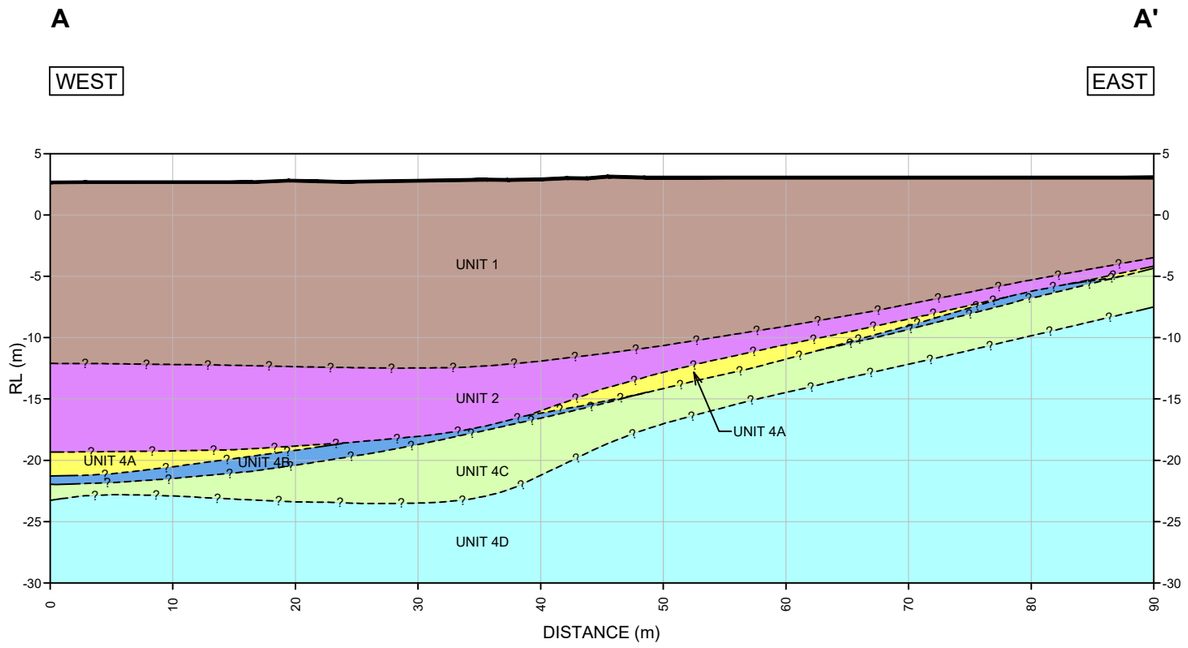
Geotechnical Cross Sections

TETRA TECH COFFEY

DATE: **26.10.21** PROJECT: **754-SYDGE287887** FILE: **287887_01_F008_GIS_REVB**

DISCLAIMER: THIS FIGURE HAS BEEN PRODUCED FOR INTERNAL REVIEW ONLY AND MAY CONTAIN INCONSISTENCIES OR OMISSIONS. IT IS NOT INTENDED FOR PUBLICATION.

DOC REFERENCE: C:\USERS\GREG.HANTON\DOCUMENTS\GIS\287887_SYDGE_AQUALAND_BARANGAROOCENTRAL\AQUALAND_BARANGAROOCENTRAL_GIS\MXD\287887_01\REVB\287887_01_GIS\008_REVB.MXD_2
SAVED BY: GREG.HANTON 26.10.21 1:10:26 PM



UNIT LEGEND

- UNIT 1 - FILL
- UNIT 2 - ALLUVIUM / ESTUARINE
- UNIT 3 - RESIDUAL SOIL
- UNIT 4A - CLASS V SANDSTONE
- UNIT 4B - CLASS IV SANDSTONE
- UNIT 4C - CLASS III SANDSTONE
- UNIT 4D - CLASS II SANDSTONE OR BETTER

SECTION LEGEND

- EXISTING GROUND SURFACE
- INFERRED GEOLOGICAL BOUNDARY

DRAFT

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE			

5 0 5 15 25
Horizontal Scale (metres) 1:500

5 0 5 15 25
Vertical Scale (metres) 1:500

drawn	AM / AW
approved	-
date	25-10-2021
scale	AS SHOWN
original size	A3

TETRA TECH COFFEY

client: AQUALAND

project: CENTRAL BARANGAROO
CENTRAL BARANGAROO, SYDNEY, NSW

title: NORTHERN WALL

project no: 754-SYDGE287887-AB | figure no: CROSS SECTION 1 | rev: A

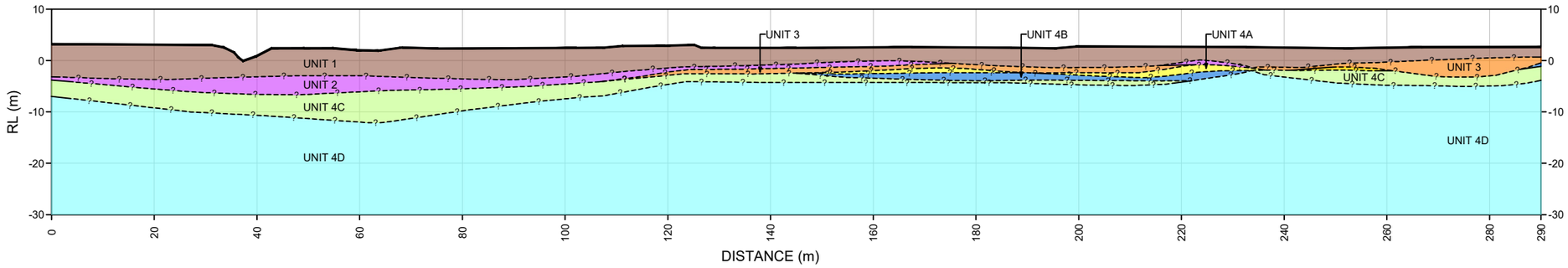
PLOT DATE: 25/10/2021 3:31:12 PM DWG FILE: \\TTS779FS1.TTLOCAL\DATA\1. PROJECTS\54. SYD-GEOTECHNICS\12. SYDGE280000\SYDGE287887 BARANGAROO CENTRAL AQUALAND\12. CAD\754-SYDGE287887-AB-500.DWG

B

NORTH

B'

SOUTH



UNIT LEGEND

- UNIT 1 - FILL
- UNIT 2 - ALLUVIUM / ESTUARINE
- UNIT 3 - RESIDUAL SOIL
- UNIT 4A - CLASS V SANDSTONE
- UNIT 4B - CLASS IV SANDSTONE
- UNIT 4C - CLASS III SANDSTONE
- UNIT 4D - CLASS II SANDSTONE OR BETTER

SECTION LEGEND

- EXISTING GROUND SURFACE
- INFERRED GEOLOGICAL BOUNDARY

DRAFT

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE			

10 0 10 30 50
Horizontal Scale (metres) 1:1000

5 0 5 15 25
Vertical Scale (metres) 1:1000

drawn	AM / AW
approved	-
date	25-10-2021
scale	AS SHOWN
original size	A3

TETRA TECH COFFEY

client: AQUALAND

project: CENTRAL BARANGAROO
CENTRAL BARANGAROO, SYDNEY, NSW

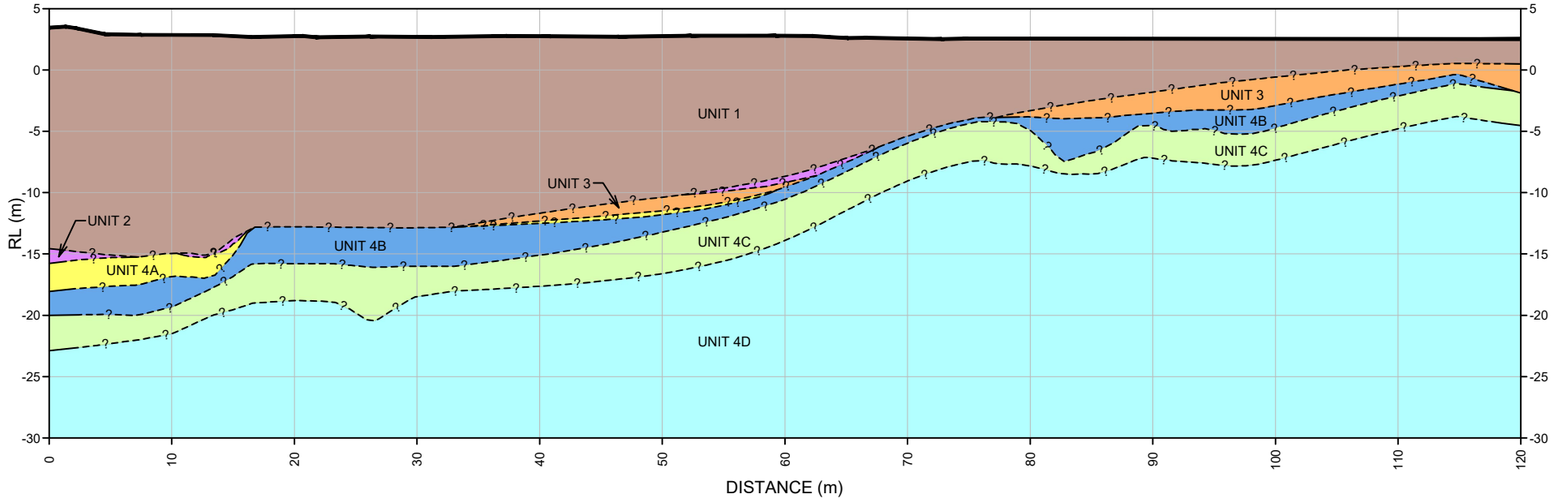
title: EASTERN WALL

project no: 754-SYDGE287887-AB | figure no: CROSS SECTION 2 | rev: A

PLOT DATE: 25/10/2021 3:28:46 PM DWG FILE: \\TTS779FS1.TT.LOCAL\DATA\1. PROJECTS\54. SYD-GEOTECHNICS\12. SYDGE280000\SYDGE287887 BARANGAROO CENTRAL AQUALAND\12. CAD\754-SYDGE287887-AB-1000.DWG

C **C'**

WEST EAST



UNIT LEGEND

- UNIT 1 - FILL
- UNIT 2 - ALLUVIUM / ESTUARINE
- UNIT 3 - RESIDUAL SOIL
- UNIT 4A - CLASS V SANDSTONE
- UNIT 4B - CLASS IV SANDSTONE
- UNIT 4C - CLASS III SANDSTONE
- UNIT 4D - CLASS II SANDSTONE OR BETTER

SECTION LEGEND

- EXISTING GROUND SURFACE
- INFERRED GEOLOGICAL BOUNDARY

DRAFT

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE			

5 0 5 15 25
Horizontal Scale (metres) 1:500

5 0 5 15 25
Vertical Scale (metres) 1:500

drawn	AM / AW
approved	-
date	25-10-2021
scale	AS SHOWN
original size	A3

TETRA TECH COFFEY

client: AQUALAND

project: CENTRAL BARANGAROO
CENTRAL BARANGAROO, SYDNEY, NSW

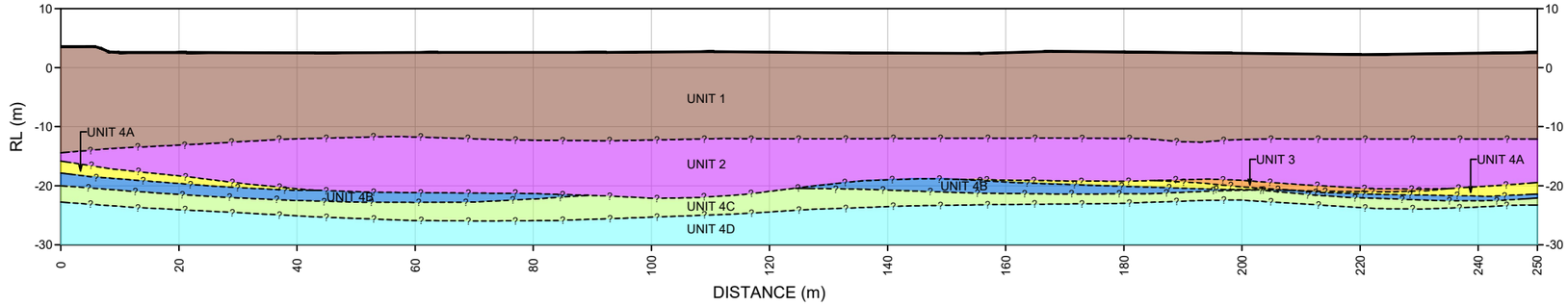
title: SOUTHERN WALL

project no: 754-SYDGE287887-AB | figure no: CROSS SECTION 3 | rev: A

PLOT DATE: 25/10/2021 3:30:45 PM DWG FILE: \\TTS779FS1.TTL.LOCAL\DATA\1. PROJECTS\4. SYD-GEOTECHNICS\12. SYDGE280000\SYDGE287887 BARANGAROO CENTRAL AQUALAND\12. CAD\754-SYDGE287887-AB-500.DWG

D **D'**

NORTH SOUTH



UNIT LEGEND

- UNIT 1 - FILL
- UNIT 2 - ALLUVIUM / ESTUARINE
- UNIT 3 - RESIDUAL SOIL
- UNIT 4A - CLASS V SANDSTONE
- UNIT 4B - CLASS IV SANDSTONE
- UNIT 4C - CLASS III SANDSTONE
- UNIT 4D - CLASS II SANDSTONE OR BETTER

SECTION LEGEND

- EXISTING GROUND SURFACE
- INFERRED GEOLOGICAL BOUNDARY

DRAFT

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE			

10 0 10 30 50
Horizontal Scale (metres) 1:1000

5 0 5 15 25
Vertical Scale (metres) 1:1000

drawn	AM / AW
approved	-
date	25-10-2021
scale	AS SHOWN
original size	A3

TETRA TECH COFFEY

client: AQUALAND

project: CENTRAL BARANGAROO
CENTRAL BARANGAROO, SYDNEY, NSW

title: WESTERN WALL

project no: 754-SYDGE287887-AB | figure no: CROSS SECTION 4 | rev: A

PLOT DATE: 25/10/2021 3:28:22 PM DWG FILE: \\TTS779FS1.TT.LOCAL\DATA\1. PROJECTS\54. SYD-GEOTECHNICS\12. SYDGE280000\SYDGE287887 BARANGAROO CENTRAL AQUALAND\12. CAD\754-SYDGE287887-AB-1000.DWG

(800mm) (900Φ @ 1.4c/s)
D-WALL OR SECANT

APPX. TOE LEVEL -7.0m AHD.

SAME AS EAST BOUNDARY

VARYING TOE LEVELS (REFER TO TABLE 5 OF GOFFEY REPORT)

SECANT 900Φ piles @ 1.4c/s OR D-WALL 800mm thick (MIN)

D-WALL 1200mm Thick (MIN) ACTUAL THICKNESS TO BE CONFIRMED

PRELIMINARY WALL TYPES

NOTES

This drawing is copyright and the property of WEBBER Australia and must not be used without written authorisation.

Do not scale this drawing.

All dimensions are to be verified on site and any discrepancies reported before commencement of any work or shop drawing.

KEY

NORTH

REV	DATE	DESCRIPTION
P13	24/9/21	Revised Stair to Core 1A,4
P12	2/9/21	Issued for Costing
P11	27/8/21	Issued for Coordination
P10	6/8/21	Issued for Coordination
P09	28/7/21	Issued for RLB
P08	2/7/21	Issued for Coordination
P07	18/6/21	Issued for Coordination
P06	14/6/21	Revised GFA
P05	3/6/21	Cores note added
P04	3/6/21	Revised Ramp, D-wall and Escalators
P03	13/5/21	ISSUED FOR SCENTRE DISCUSSION
P02	22/4/21	Issued for Coordination
P01	7/4/21	Issued for Comment

WEBBER
EXECUTIVE ARCHITECTURE
Level 6, 95 York Street, Sydney, NSW, 2000 (T) +61 2 8067 0688
Nominated Architect: Colin Dibb NSW 9950 www.webberaustralia.com.au

CLIENT
AQUALAND
Tower One, Level 47, 100 Barangaroo Avenue Sydney NSW 2000

PROJECT
CENTRAL BARANGAROO
39 Hickson Road
Sydney, NSW, 2000

TITLE
GA FLOOR PLAN - BASEMENT 05

ISSUED STATUS			
FOR INFORMATION			
SCALE @ A1	DRAWN	APPROVED	FIRST ISSUE DATE
1:500	CD	MB	7/4/21
PROJECT CODE	SHEET NUMBER		REVISION
20200	EA-BAS-01002		P13

Date Printed: 24/9/21

coffey

Computations

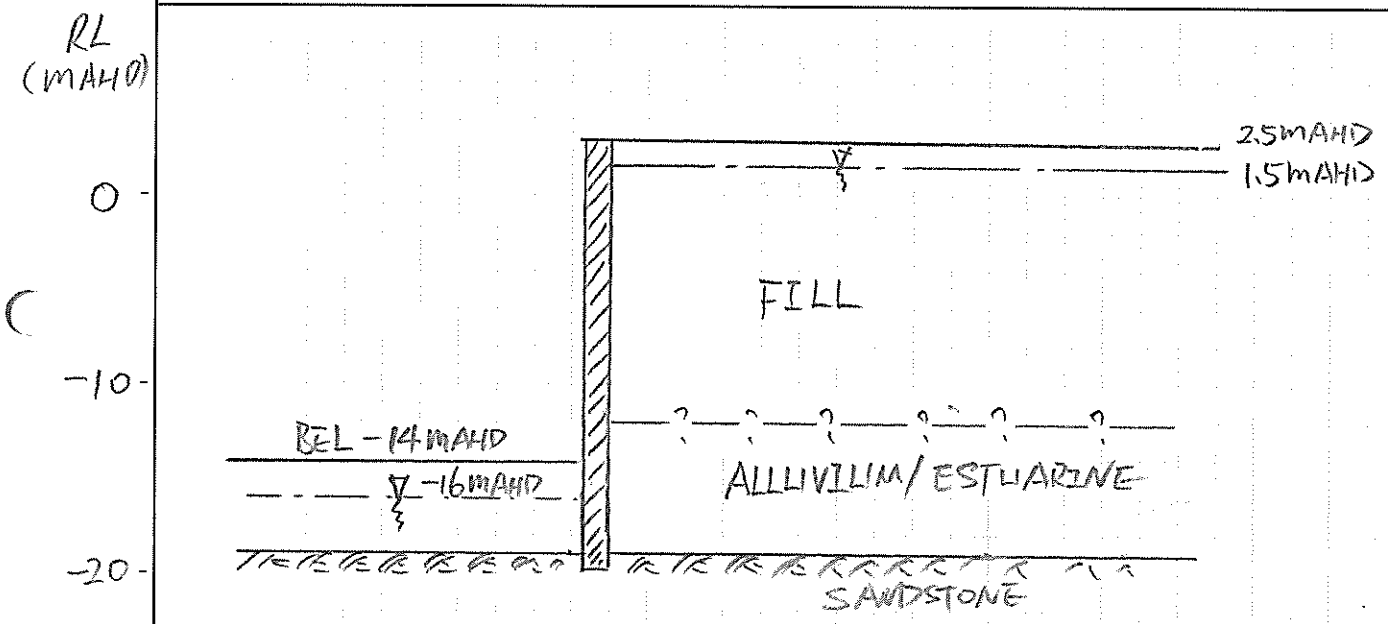
Project No: 754-SYDGE28788 Sheet 1 of 5

Client: AQUALAND Office: CHATSWOOD

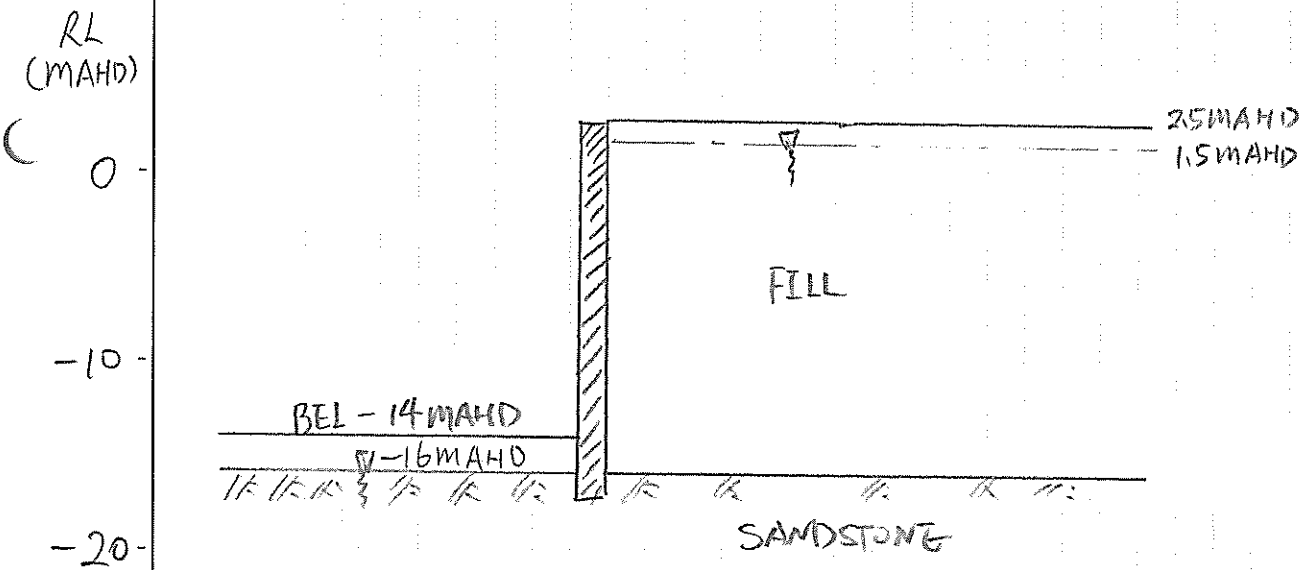
Principal: Date: 30/10/2021

Project: CENTRAL BARANGAROO DEVELOPMENT By: Peter Sun.

Location: Checked:



CASE A - WESTERN END OF NORTHERN BOUNDARY AND WESTERN BOUNDARY (LENGTH ~ 301 m)

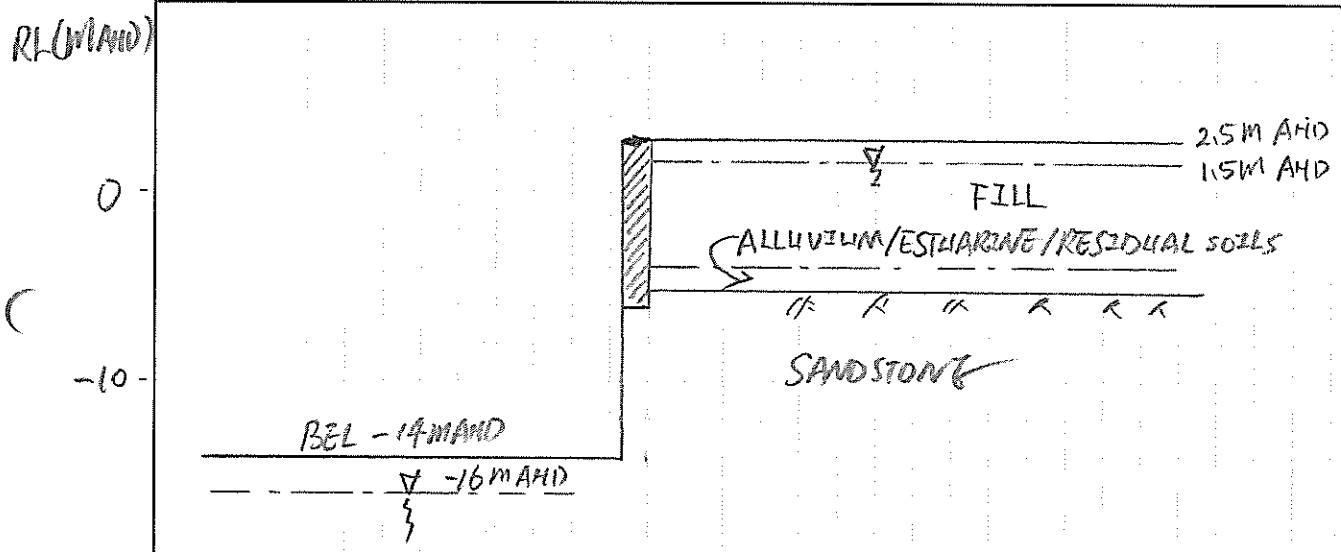


CASE B - WESTERN END OF SOUTHERN BOUNDARY (LENGTH ~ 60m)

coffey

Computations Project No: Sheet 2 of 5

Client:	Office:
Principal:	Date:
Project:	By:
Location:	Checked:



CASE C – EASTERN END OF SOUTHERN BOUNDARY AND SOUTHERN END OF EASTERN BOUNDARY (LENGTH ~ 242m)

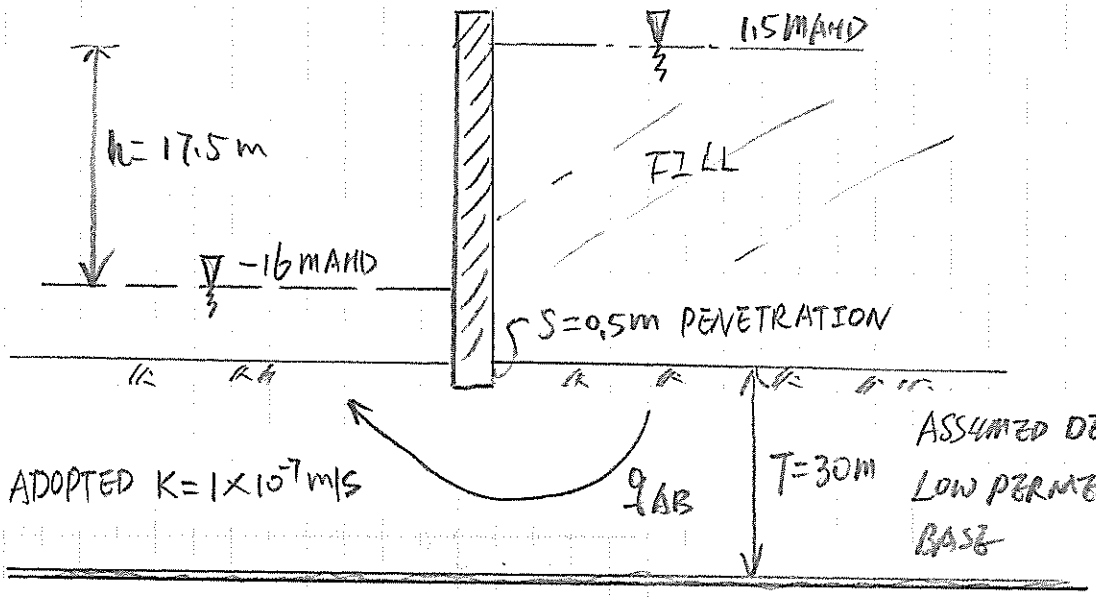
BASED ON THE EXPERIENCE DURING STAGE 1A AND 1B AND THE AVAILABLE PACKER TESTS DATA OVER THE AREA, THE ADOPTED HYDRAULIC CONDUCTIVITY FOR SANDSTONE IS 1×10^{-7} m/s. THIS IS CONSIDERED TO BE CONSERVATIVE.

coffey

Computations Project No: Sheet 3 of 5

Client:	Office:
Principal:	Date:
Project:	By:
Location:	Checked:

CASE A AND B



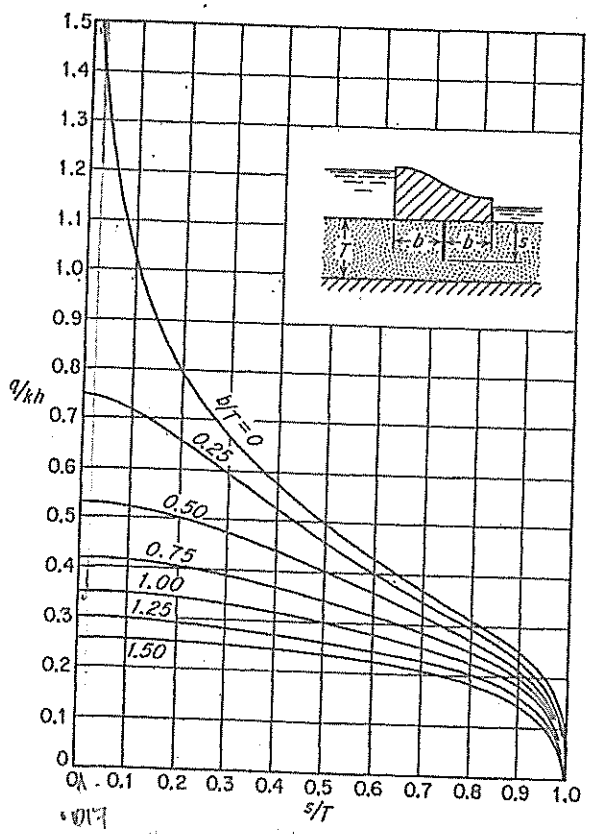


FIG. 5-17. (*After Polubarinova-Kochina* [116].)

FIGURE FROM WORK:
GROUNDWATER AND SEEPAGE
MCGRAW HILL 1962

$$S/T = \frac{0.5}{30} = 0.017$$

$$\Rightarrow \frac{q_{AB}}{kh} = 1.5$$

$$\Rightarrow q_{AB} = 1.5 \times 1 \times 10^{-7} \times 17.5 \ m^3/s/m$$

$$= 0.0026 \ L/s/m$$

64200 / 04-14

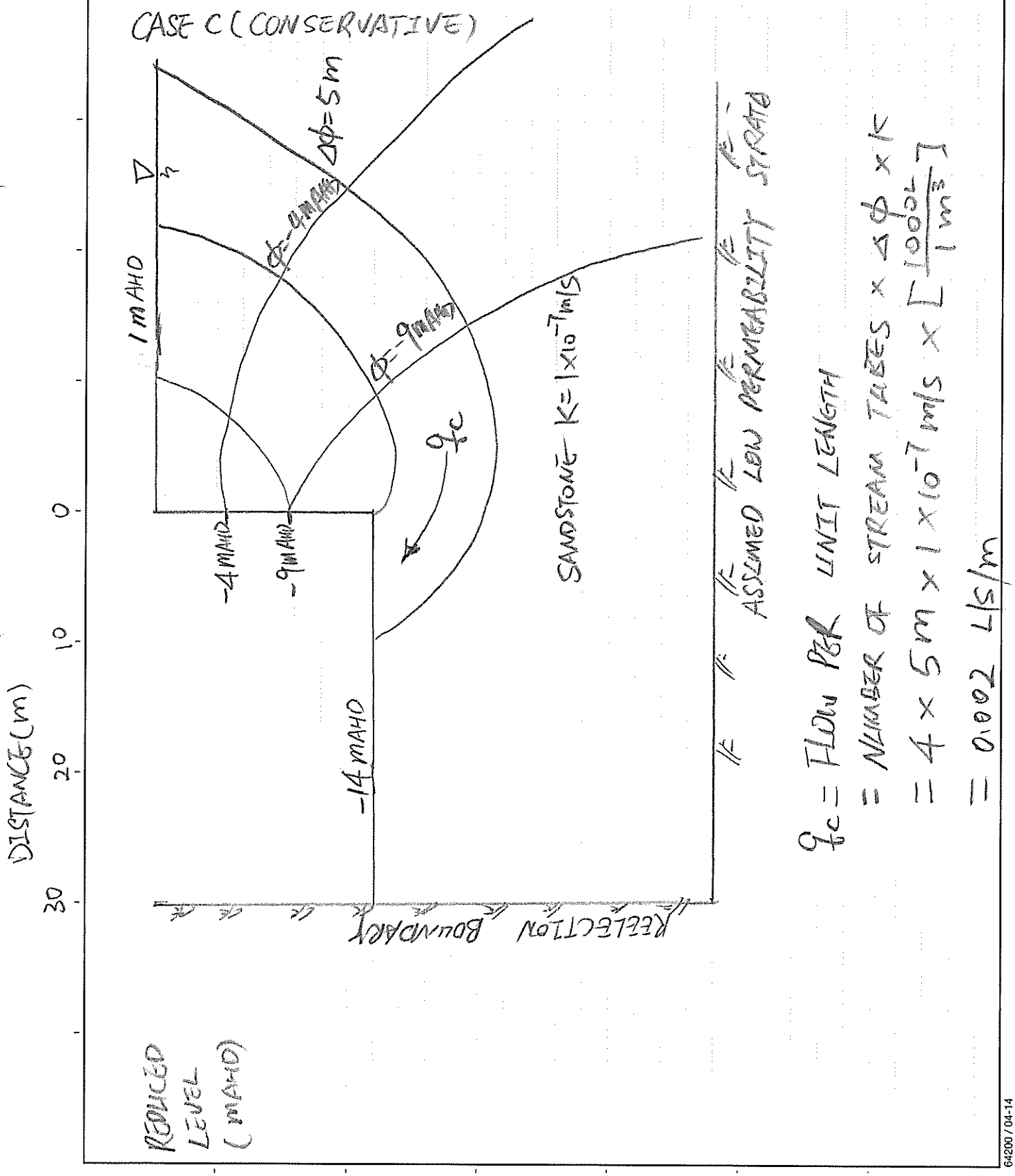
coffey

Computations

Project No:

Sheet 4 of 5

Client:	Office:
Principal:	Date:
Project:	By:
Location:	Checked:



q_c = FLOW PER UNIT LENGTH

= NUMBER OF STREAM TUBES × Δφ × K

= 4 × 5m × 1 × 10^{-7} m/s × $\left[\frac{1000L}{1m^3}\right]$

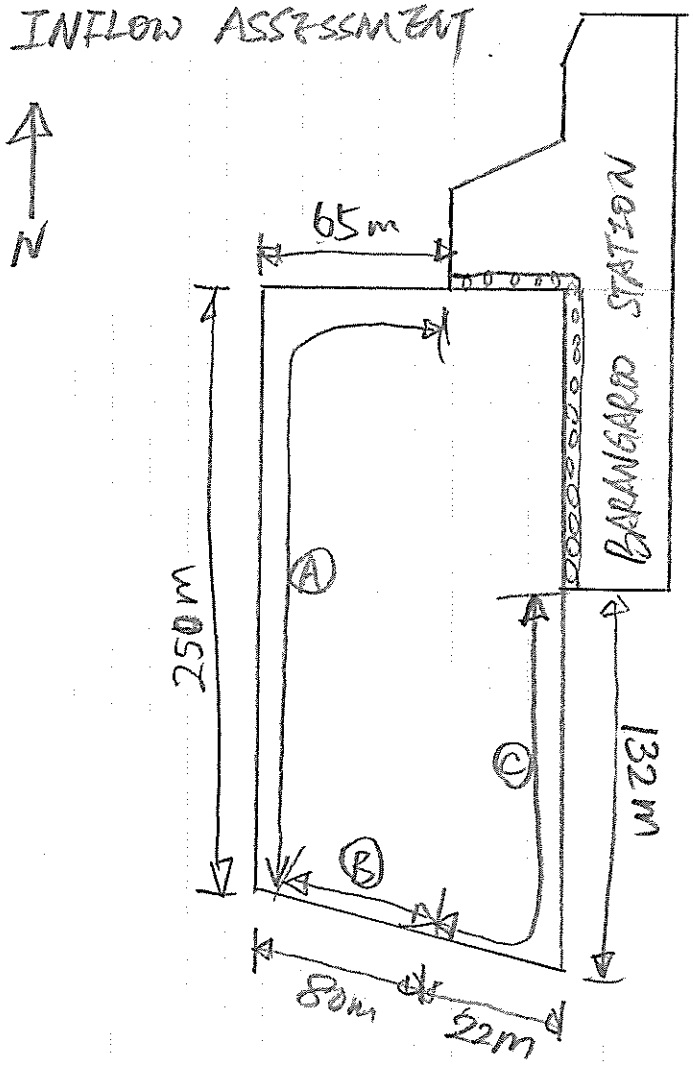
= 0.002 L/s/m

coffey

Computations Project No: Sheet 5 of 5

Client:	Office:
Principal:	Date:
Project:	By:
Location:	Checked:

INFLOW ASSESSMENT



INFLOW TO BARANGAROO STATION:

BASED ON PSM'S ASSESSMENT A TYPICAL DESIGN INFLOW OF 1.5 L/S WAS ADOPTED (SMCSWTSE-JPS-TPW-GE-OAN-502254-A DESIGN ADVICE NOTE – BARANGAROO STATION – GROUNDWATER DEPRESSURISATION / RELIEF SYSTEM ADVICE DATED 5TH FEBRUARY 2019)

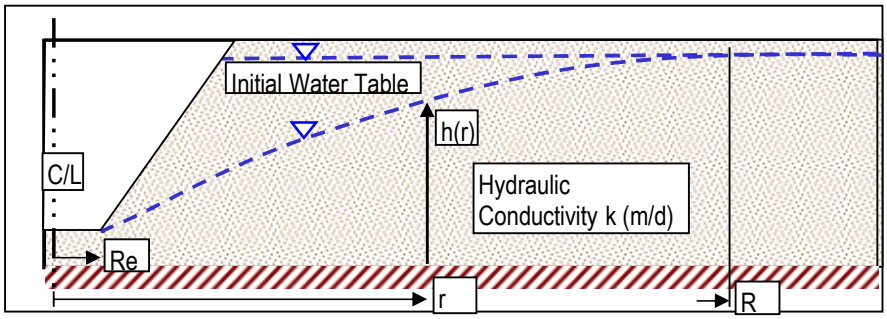
$$Q = q_{AB}L_A + q_{AB}L_B + q_cL_c + \text{STATION INFLOW}$$

$$= 0.0026\ \text{L/s/m} \times (250\text{m} + 65\text{m}) + 0.0026\ \text{L/s/m} \times 80\text{m} + 0.002\ \text{L/s/m} \times (132\text{m} + 22\text{m}) + \text{STATION INFLOW}$$

$$= 0.819\ \text{L/S} + 0.208\ \text{L/S} + 0.308\ \text{L/S} + \text{STATION INFLOW}$$

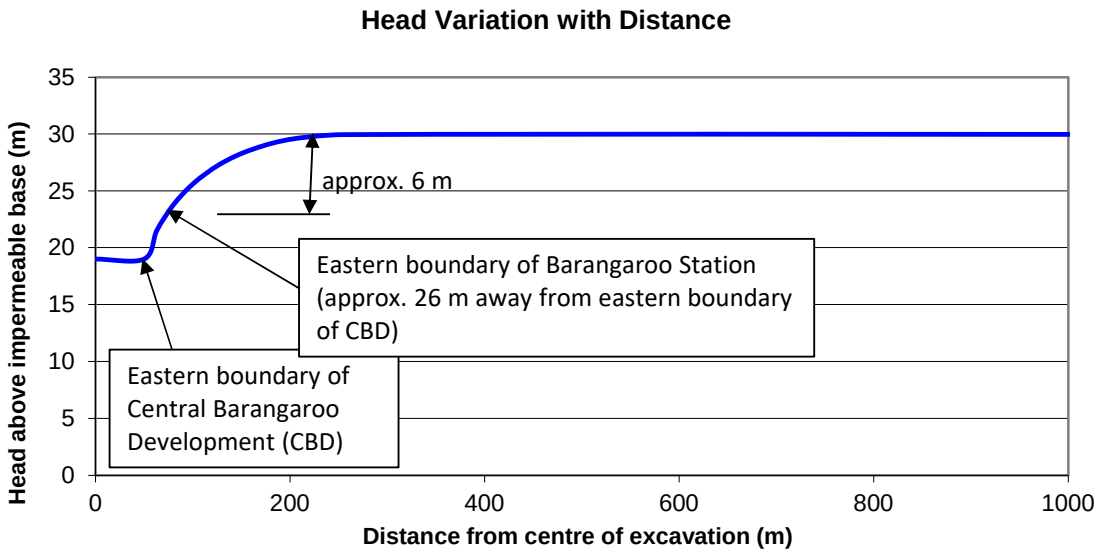
$$= 1.34\ \text{L/S} + 1.5\ \text{L/S}$$

$$= 2.84\ \text{L/S}$$



Input Parameters	
Radius of Excavation (m)	50
Hydraulic Conductivity (m/d)	0.00864
Initial Saturated Thickness h(R) (r	30
Sat Thickness in Excavation h(Re	19
Infiltration Rate (m/d)	0.00006

Calculated Parameters	
Radius of Influence (m)	258



Assessment of inflow rate and drawdwon profile for long term inflow to an excavation within an extensive unsaturated aquifer under uniform infil

Reference: JH Edelman 'Groundwater Hydraulics of Extensive Aquifers', International Institute for Land Reclaimation and Improvement, Wagen

drawn	PS	TETRA TECH COFFEY	client:	Aqualand
approved	RJB		project:	Central Barangaroo Development Groundwater Assessment
date	30-10-21		title:	Assessment of groundwater drawdown around CBD excavation
scale	N/A		project no:	754-SYDGE287887
original	A4		figure no:	

C:\Users\Peter.sun\Desktop\Projects\Barangaroo Central\Calculations\[Radial Drawdown Infinite Aquifer-Barangaroo Central .xls]Drawdown

APPENDIX H. STANDPIPE PIEZOMETER INSTALLATION DETAILS

TETRA TECH COFFEY

Piezometer Installation Log

		Hole ID.	***BH2***
		sheet:	1 of 1
		project no.	***754-SYDGE287887***
client:	***Aqualand Projects Pty Ltd***	date started:	***05 Jul 2022***
principal:	***Aqualand Projects Pty Ltd***	date completed:	***06 Jul 2022***
project:	***Central Barangaroo Development***	logged by:	***RAS***
location:	***39 Hickson Road, Sydney NSW 2000***	checked by:	***RT***

position: E: 333,664.26; N: 6,251,721.52 (GDA94 Zone 56) surface elevation: 2.51 m (AHD) angle from horizontal: 90°

equipment type: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

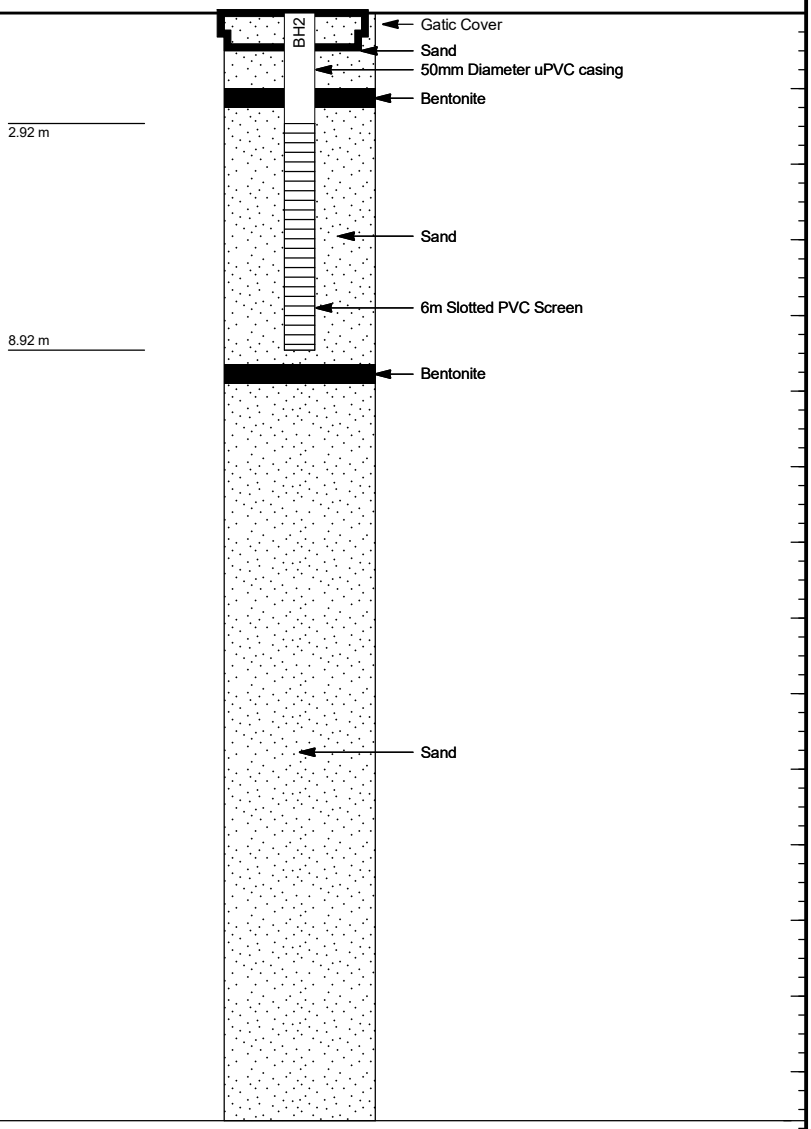
drilling information | **material substance** | **piezometer construction details**

method & support	water	RL (m)	depth (m)	graphic log	material description (refer to engineering log for full description)
		0	4		**PAVEMENT**
					FILL
		-4	8		
		-8	12		
		-12	16		**ALLUVIUM**
		-16	20		**EXTREMELY WEATHERED MATERIAL**
					HAWKESBURY SANDSTONE
		-20	24		
		-24	28		
		-28			

SONIC — C — HQ3 — Water

completion details: Gatic Cover
pvc type:
sand type:
grout type:

bore construction license:
drilling company: Terratest Pty Ltd
driller: KB
driller's permit no.:



method & support
see engineering log for details

water
- 10-Oct-12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
- core recovered (graphic symbols indicate material)
- no core recovered

ID	type	installation date	development date	stickup (m)	tip depth (m)	water level (m)	Relative Levels (AHD) stickup	tip	water level
BH2	standpipe piezometer				8.92 m			-6.41	

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF PIEZOMETER ONE PAGE SUMMARY 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 13:26

TETRA TECH COFFEY

Piezometer Installation Log

		Hole ID.	***BH4***
		sheet:	1 of 1
		project no.	***754-SYDGE287887***
client:	***Aqualand Projects Pty Ltd***	date started:	***07 Jul 2022***
principal:	***Aqualand Projects Pty Ltd***	date completed:	***08 Jul 2022***
project:	***Central Barangaroo Development***	logged by:	***RAS***
location:	***39 Hickson Road, Sydney NSW 2000***	checked by:	***RT***

position: E: 333,641.82; N: 6,251,794.24 (GDA94 Zone 56) surface elevation: 2.84 m (AHD) angle from horizontal: 90°

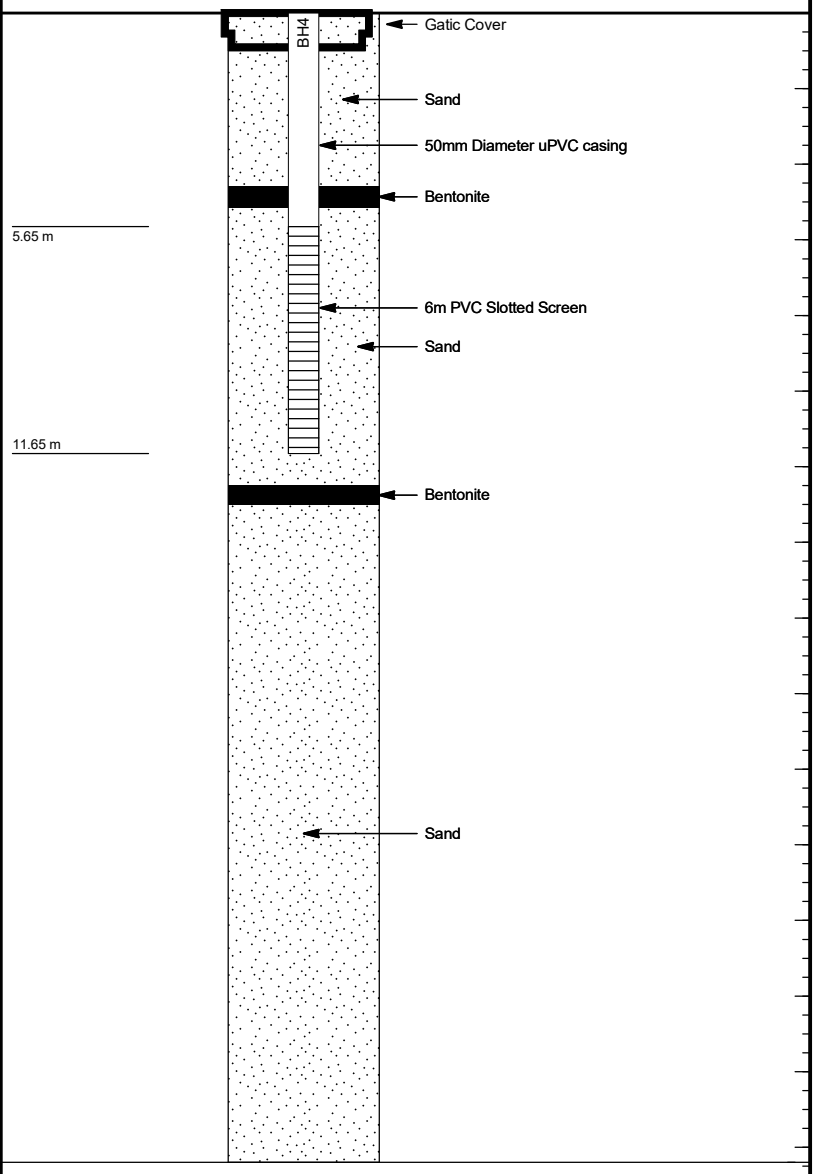
equipment type: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance** | **piezometer construction details**

completion details: Gatic Cover
pvc type:
sand type:
grout type:

bore construction license:
drilling company: Terratest Pty Ltd
driller: KB
driller's permit no.:

method & support	water	RL (m)	depth (m)	graphic log	material description (refer to engineering log for full description)
SONIC		0	4		PAVEMENT
					FILL
		-4	8		
		-8	12		ALLUVIUM
		-12	16		
		-16	20		EXTREMELY WEATHERED MATERIAL
HQ3	Water	-20	24		
	Water	-24	28		
	Water	-28			



CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF PIEZOMETER ONE PAGE SUMMARY 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 13:26

method & support
see engineering log for details

water
- 10-Oct-12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
- core recovered (graphic symbols indicate material)
- no core recovered

ID	type	installation date	development date	stickup (m)	tip depth (m)	water level (m)	Relative Levels (AHD) stickup	tip	water level
BH4	standpipe piezometer				11.65 m			-8.81	

TETRA TECH COFFEY

Piezometer Installation Log

		Hole ID.	***BH6***
		sheet:	1 of 1
		project no.	***754-SYDGE287887***
client:	***Aqualand Projects Pty Ltd***	date started:	***12 Jul 2022***
principal:	***Aqualand Projects Pty Ltd***	date completed:	***13 Jul 2022***
project:	***Central Barangaroo Development***	logged by:	***RAS***
location:	***39 Hickson Road, Sydney NSW 2000***	checked by:	***RT***

position: E: 333,615.20; N: 6,251,929.14 (GDA94 Zone 56) surface elevation: 2.23 m (AHD) angle from horizontal: 90°

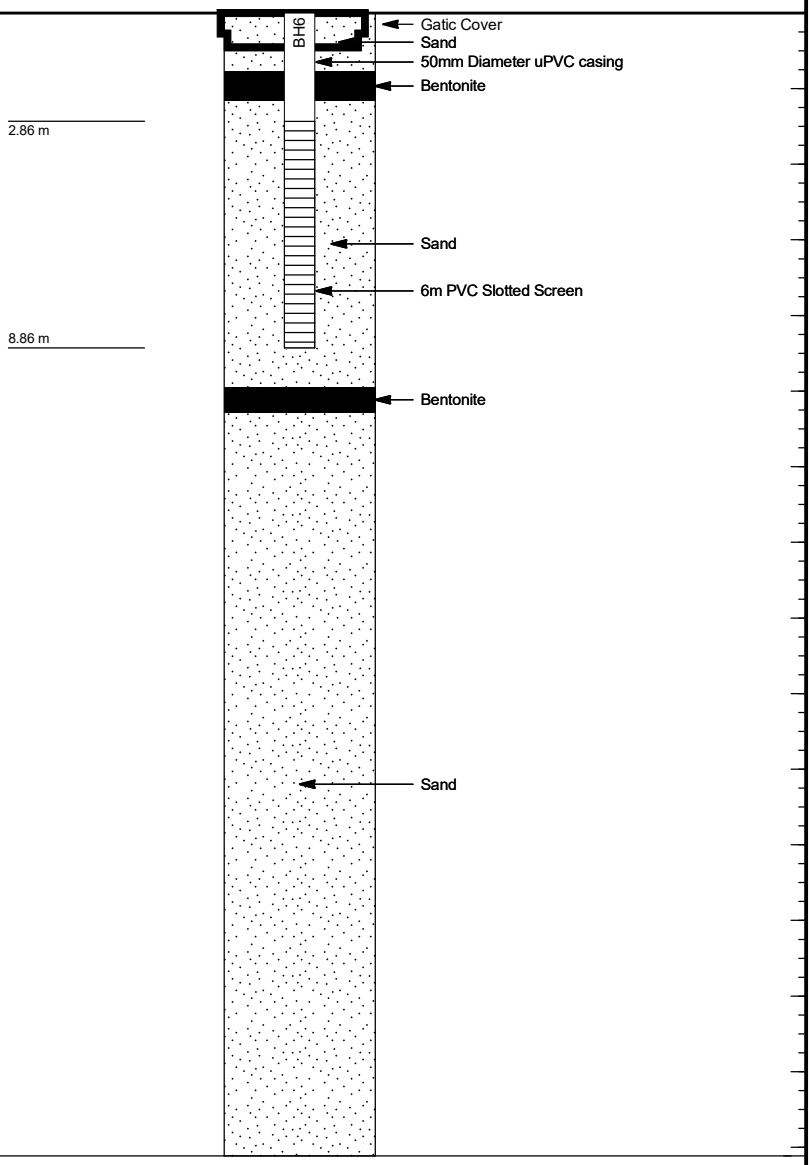
equipment type: Comacchio 450P, Track mounted drilling fluid: Water hole diameter : 96/130

drilling information | **material substance** | **piezometer construction details**

method & support	water	RL (m)	depth (m)	graphic log	material description (refer to engineering log for full description)
SONIC, C		0	0		
		-4	4		**PAVEMENT**
		-8	8		**FILL**
		-12	12		**ALLUVIUM**
		-16	16		
		-20	20		
HQ3	Water	-24	24		**EXTREMELY WEATHERED MATERIAL**
		-28	28		

completion details: Gatic Cover
pvc type:
sand type:
grout type:

bore construction license:
drilling company: Terratest Pty Ltd
driller: KB
driller's permit no.:



method & support
see engineering log for details

water
- 10-Oct-12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
- core recovered (graphic symbols indicate material)
- no core recovered

ID	type	installation date	development date	stickup (m)	tip depth (m)	water level (m)	Relative Levels (AHD) stickup	tip	water level
BH6	standpipe				8.86 m			-6.63	

CDF_0_10_00.4_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log COF PIEZOMETER ONE PAGE SUMMARY 754-SYDGE287887.GPJ <<DrawingFile>> 10-11-2022 13:26

APPENDIX I. IMPORTANT INFORMATION

IMPORTANT INFORMATION ABOUT YOUR TETRA TECH COFFEY REPORT

As a client of Tetra Tech Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Tetra Tech Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Tetra Tech Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Tetra Tech Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Tetra Tech Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Tetra Tech Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Tetra Tech Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Tetra Tech Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Tetra Tech Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Tetra Tech Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Tetra Tech Coffey to work with other project design professionals who are affected by the report. Have Tetra Tech Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Tetra Tech Coffey for information relating to geoenvironmental issues.

Rely on Tetra Tech Coffey for additional assistance

Tetra Tech Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Tetra Tech Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Tetra Tech Coffey to other parties but are included to identify where Tetra Tech Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Tetra Tech Coffey closely and do not hesitate to ask any questions you may have.