Dr George Mountain Road Embankment Stabilisation

Revised 100% Design Report – Piled Wall

Bega Valley Shire Council

26 August 2022

→ The Power of Commitment

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1. Introduction

1.1 General

Bega Valley Shire Council (Council) engaged GHD to provide detailed design services for the remediation of roadside deformation and structural failure of a retaining wall at Dr. George Mountain Road, Tarraganda, located approximately 4.5 km east of Bega. The road section in question (the site) is approximately 50 m in length. Council engaged GHD based on a proposal dated 14 July 2021, entitled *Dr George Mountain Road Geotechnical assessment technical and fee proposal rev01, document ref 12554564.*

As part of the initial project engagement, the project was divided into two stages. Stage 1 comprises investigations and assessment to inform the 50% design works, while Stage 2 comprises the 100% detailed design with cost estimate. Following Stage 2, GHD was engaged for a third stage to incorporate guardrail and drainage into the design as variation works. Stage 3 would involve a revised 100% detailed design with cost estimate before proceeding to an IFC submission. A detailed list of the scope of works for each stage is provided in section 1.3.

GHD understands the project remedial works would be carried out under emergency funding by Council and Transport for New South Wales (TfNSW). Originally, Council had requested GHD deliver the project in a compressed timeframe to meet the requirements of the funding acquisition process. To facilitate a quicker turnaround time, Council and GHD agreed during the kick-off meeting on 30 July 2021 to develop one concept solution only for the 50% design. Several options were presented to Council during the kick-off meeting; however, it was agreed at the same meeting that slope stabilising piles will be the engineering solution to be developed for the 50% design.

During the 50% design stage, the design was modified to use a piled wall scheme to mitigate soil erosion and movement between piles. This was approved in principle by Council during the 50% Design Workshop dated 17 September 2021.

Following the workshop, GHD provided Council with a 50% Design Technical Memorandum dated 20 September 2021, with the subject '*Dr. George Mountain Road Geotechnical Assessment – 50% Design Technical Memorandum'*.

Subsequent to the 50% detailed design for a piled wall solution, the project proceeded to a 100% detailed design submission for both Council and TfNSW review on the 29 October 2021 as '*12554564-REP_Dr George Mtn Road_100 percent design report'*.

At that point, TfNSW the funding body for the proposed remedial works, requested further optioneering be carried out to support the selection of the piled wall solution as the preferred solution. In response GHD submitted a 50% detailed design for a soil nail solution, including an initial cost estimate of construction, which was submitted to Council/TfNSW on the 2 March 2022 as *'12554564-MEM_Dr George Mtn Road – 50 percent Design Technical Memo_Soil Nail Solution'*.

Subsequent to the submission of both the 100% detailed design for a piled wall solution and 50% detailed design for a soil nail solution, it was agreed GHD proceed to IFC with the piled wall solution. That design solution, this submission, however would include drainage remedial solutions (previously requested to be excluded from the design) and guard rail replacement (previously assumed existing would be reinstated and outside the design).

1.2 Background information

The road and embankment at the site were understood to have been formed by cut to fill on weathered granodiorite. The existing downslope embankment of the site is retained with steel piles and timber lagging, confirmed by Council to have been installed on site in 2010.

As part of the tendering process for the project, Council conducted a site walkover on site on Thursday 1 July 2021 with a GHD Technical Director – Civil Engineering, John Wearne, following reports of ground movement on site.

The following observations were made by GHD:

– Significant voids were observed behind the retaining wall lagging.
– Longitudinal tension cracks were present between the edge of bitumen and guardrail. The cracks were approximately 100 to 150 mm wide. This tension crack was apparent over an approximate 25 m length parallel to the road, although vegetation on site prevented more accurate observation of its extent.
– Longitudinal cracks observed on the pavement wearing course, which potentially indicate developing tension cracks.
– Two storm water pits located on the upslope side of the road. Each stormwater pit appears to be connected to a buried HDPE pipe that drains stormwater unto the downslope face. The pipe extends beyond the downslope face; hence no erosion protection structure was provided downstream of the pipe outlet.
– Surface erosion was evident on the eastern half of the retaining wall.
– Upslope of the road are rock cut exposures, indicating cut and fill nature of the embankment formation.
– The retaining wall was overgrown by vegetation, thick grass, and trees at the toe of the embankment.

Subsequent to the initial site walkover, GHD carried out geotechnical intrusive investigations and site survey to inform the geological model and basis of design. During those site investigation activities (as outlined in section 1.3 below), four separate retaining walls were observed. The length of the walls, from the westernmost to easternmost wall are approximately 1.0 m, 9.0 m, 1.2 m, and 7.0 m respectively. Nine (9) steel piles were observed, seven (7) of which are supporting portions of the retaining wall, with spacing interval ranging from approximately 1.4 m to 3.4 m. Two (2) additional piles were observed approximately 6.0 m east of the easternmost retaining wall.

Further details of the site inspection and investigation works can be found in the GHD report '*Dr. George Mountain Road Geotechnical Assessment – 50% Design Technical Memorandum*' (Reference: 12554564-MEM , dated 20 September 2021)

1.3 Scope of work

The project is divided into three stages of delivery, as detailed below:

Stage 1 – Site investigations, hydrology, and drainage assessment and 50% design

– Desktop review of publicly available information
– Field investigation which included the following
  - Slope risk assessment
  - Detailed site survey
  - Intrusive investigation including borehole drilling at two (2) locations, dynamic cone penetrometer (DCP) testing at three (3) locations, and hand auger drilling at one (1) location.
– Geotechnical laboratory testing
– Hydrology and drainage assessment
– Technical memorandum including the following
  - Field investigation information, including engineering logs of boreholes
  - Slope risk assessment
  - Hydrology and drainage assessment
  - Discussion on preliminary slope stability assessment
  - 50% design drawings
– Workshop with Council to present the 50% design works dated 17 September 2021. Based on this workshop, the 100% design works shall be progressed using a piled wall scheme.

Stage 2 – Piled Wall Scheme Detailed Design (100%).

– 100% design report and drawings

– Issued For Construction drawings – note this report included 100% Design Drawings for Council's review, prior to issuing the drawings.
– Cost estimate of the preferred solution – note the cost estimates will be provided minimum 1 week after submission of the 100% Design Drawings.

Stage 3 – Revised Pile Wall Scheme Detailed Design

– Additional site investigations including:
  - Site inspection to assess existing drainage conditions and damaged culvert
  - Additional site survey for the rock revetment on the slope (previously not identified)
– Revised 100% design report and drawings, updated to include:
  - Guardrail removal and replacement
  - Drainage solution to address surface water runoff, in particular areas adjacent to capping beam
  - Drainage solution for culvert outlets on to the subject slope
– Cost estimate of the revised 100% design solution
– Issued For Construction drawings – note this report included 100% Design Drawings for Council's review, prior to issuing the drawings.

1.4 Purpose of the report

The purpose of this report is to document and summarise the works carried out during the Stage 3 design works for the revised pile wall scheme. This report is to be read in conjunction with the IFC drawings and cost estimate of construction which are provide as Appendix F and Appendix G respectively.

1.5 Exclusions

The following are excluded from Stage 3 design works:

– Signage and line marking;
– Review and adjustment of existing road geometry;
– Road safety audit (RSA) or an external SiD (safety in design) workshop. SiD will be limited to an internal GHD review/risk register.
– Pavement design for the subject site area. Limited to advice regarding reinstatement behind the pile wall and beneath the guard rail system

1.6 Assumptions

The following assumptions have been considered in the development of the design:

– The removal of the existing timber retaining wall will not pose any design constraints to the proposed slope remedial solution. We note no Work As Existing drawings are available for the existing timber retaining wall, hence it was not identified whether any elements (i.e. tie-back anchors) will provide construction constraints.
– No water leakage occurs at the connection point of existing 750 mm culvert and HDPE pipe, albeit the collapsed section of the eastern culvert which will be replaced as part of the design.
– No changes on the design constraints identified in section 5.

1.7 Limitations

This report: has been prepared by GHD for Bega Valley Shire Council and may only be used and relied on by Bega Valley Shire Council for the purpose agreed between GHD and Bega Valley Shire Council as set out in section 1.4 of this report.

GHD otherwise disclaims responsibility to any person other than Bega Valley Shire Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

Any reports, drawings, memos, or other deliverables produced by GHD shall be produced in a traditional and generally accepted format. Accessible reports, drawings, memos, or other deliverables can be provided by GHD at an additional cost if necessary.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the site conditions, such as the location of buildings, services, and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

If the GHD document containing the disclaimer is to be included in another document, the entirety of GHD's report must be used (including the disclaimers contained herein), as opposed to reproductions or inclusions solely of sections of GHD's report.

GHD has prepared the preliminary cost estimate set out in section 5 of this report ("Cost Estimate") using information reasonably available to the GHD employee(s) who prepared this report; and based on assumptions and judgments made by GHD.

The Cost Estimate has been prepared for the purpose of assisting Council with the tendering process and must not be used for any other purpose.

The Cost Estimate is a preliminary estimate only. Actual prices, costs and other variables may be different to those used to prepare the Cost Estimate and may change. Unless as otherwise specified in this report, no detailed quotation has been obtained for actions identified in this report. GHD does not represent, warrant, or guarantee that the [works/project] can or will be undertaken at a cost which is the same or less than the Cost Estimate.

Where estimates of potential costs are provided with an indicated level of confidence, notwithstanding the conservatism of the level of confidence selected as the planning level, there remains a chance that the cost will be greater than the planning estimate, and any funding would not be adequate. The confidence level considered to be most appropriate for planning purposes will vary depending on the conservatism of the user and the nature of the project. The user should therefore select appropriate confidence levels to suit their particular risk profile.

GHD has prepared this report on the basis of information provided by Bega Valley Shire Council and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

This report should be read in conjunction with the General Notes included in Appendix A.

2. Reference material

2.1 Available information

The following available information were used in the development of this design report.

- Detailed site survey provided by Veris Australia; drawing name 202948 rev 0, dated 18 August 2021 based on GDA 2020 Zone 55.
- Detailed site survey provided by Veris Australia; drawing name 202948 rev 1, dated 30 June 2022 based on GDA 2020 Zone 55.
- LiDAR information obtained from ELVIS dated 6 September 2021.
- Regional geology map obtained from MinView (https://minview.geoscience.nsw.gov.au/) dated 27 August 2021.
- Rainfall information obtained from Bureau of Meteorology website (http://www.bom.gov.au/) dated 17 September 2021.
- Road chainage provided by Bega Valley Shire Council in an email dated 18 October 2021.
- GHD report *'Dr. George Mountain Road Geotechnical Assessment – 50% Design Technical Memorandum'*, Reference: 12554564-MEM, dated 20 September 2021.
- GHD report *'Dr. George Mountain Road Geotechnical Assessment – 100% Design Report'*, Reference: 12554564-REP, dated 29 October 2021.

There are no publicly available historical geotechnical investigation reports within the mountainous region where the site is located. In addition, there are no Work As Executed drawings of the existing timber and steel pile retaining wall on site.

2.2 Previous GHD deliverable

The reader is referred to the GHD report *Dr. George Mountain Road Geotechnical Assessment – 50% Design Technical Memorandum* (Reference 12554564-MEM), and GHD report *Dr. George Mountain Road Geotechnical Assessment – 100% Design Report* (Reference: 12554564-REP) for any information relating to the following items:

- Project setting, including:
  - Site observations during site visit in August 2021
  - Supporting information (discussion with residents, historic photos, and rainfall data)
  - Geological setting
- Geotechnical investigation, including discussions on:
  - Fieldwork
  - Laboratory testing
  - Results of geotechnical investigation
- Hydrology and drainage assessment
- Slope stability assessment
- Previous detailed design drawings
- Cost estimates of construction for the 100% design submission

For the purposes of this design report that information has not been reproduced, but instead captured in section 3 as the basis of design.

3. Basis of design

3.1 Slope risk assessment

A slope risk assessment was conducted on 10 to 12 August by a GHD engineering geologist, who is a qualified assessor to RMS Slope Risk Analysis (V 4.0). The results are provided in *Dr. George Mountain Road Geotechnical Assessment – 50% Design Technical Memorandum* – Appendix E.

TfNSW Technical Direction GTD 2018/001[(NOTE: 1)] provides a risk-based design guideline for the remediation of existing slopes and fill embankments.

For new infrastructure, TfNSW requires slopes and batters to achieve an ARL4 or better. For the remediation of existing slopes/embankments such as the site (i.e. more than 10 years old since the completion of construction), TfNSW accepts ARL3 or better in accordance with the Slope Asset Management Policy PN292.

It is noted that based on the slope risk assessment results, the site currently has an 'ARL2' classification. This classification supports the need to conduct a geotechnical investigation and to provide detailed design of embankment stabilisation solution.

3.2 Detailed site survey and LiDAR information

GHD engaged Veris Australia Pty Ltd (Veris) to carry out a detailed survey of the road reserve, area upslope of the road reserve, and the embankment fill downslope of the road on 10 to 12 August 2021. Survey works were carried out at the same time of the slope risk assessment discussed in section 3.1 and the geotechnical intrusive investigations outlined in section 1.3.

This information was supplemented with publicly available LiDAR information from Elvis, Elevation and Depth - Foundation Spatial Data (Reference: Elvis (fsdf.org.au)).

As part of the Stage 3 design works GHD re-engaged Veris to carry out further detailed site survey, with focus on the existing rock revetment on the subject slope that had previously not been captured due to thick grass cover. During the collation of the 100% detailed design report the rock revetment had been identified in a historic photo of emergency construction works that were carried out in 2010.

A second mobilisation to site by Veris was undertaken the 3 June 2022, following Councils attempts to clear the thick vegetation on the slope. While an attempt at vegetation clearance had been carried out to facilitate the site survey, the remaining vegetation cover was still too thick. As such the amount of additional survey points collected was limited. The additional survey points of the rock revetment were captured in a revised site survey plan that was presented to GHD on the 30 June 2022 and subsequently included in the revised detailed design drawings.

3.3 Hydrology and drainage assessment

Hydrology and drainage assessment of the site and its corresponding catchment area was conducted by a GHD Technical Director – Drainage. The results of the hydrology and drainage assessment are provided in *Dr. George Mountain Road Geotechnical Assessment – 50% Design Technical Memorandum* – Appendix G.

The following key findings of the hydrology and drainage assessment included:

– The hydrologic and hydraulic analysis had found that the western inlet capacity is the key constraint on drainage performance in the study area.
– The existing inlet has limited capacity as water is not able to pond above the inlet to gain additional inlet capacity. It is therefore suggested that the inlet pit be enlarged and that a bund 0.5 m high be constructed around the inlet to force additional water into the culvert.

[1] TfNSW (2018) *Technical Direction Geotechnology – GTD 2018/001 Geotechnical Design for Remediation of Existing Slopes and Embankments*, version 1, dated February 2019.

- The proposed upgrade options would reduce overflow from the western inlet to zero for both the 1% AEP and 10% AEP events with all captured flow conveyed in the culvert for these events. This would also reduce the flow in the eastern culvert and reduce road overflows to only 0.16 m^3/s in the 1% AEP event.
- While the western culvert has sufficient capacity to carry the 1% AEP flowrate, the inlet capacity is limited to 0.35 m^3/s compared to 0.91 m^3/s arriving. Inlet blockage by debris would further reduce the capture performance.
- It was found that by improving the performance of the western inlet the existing culvert can be utilised to convey the 1% AEP event without overflow and the eastern culvert will carry a large portion of the 1% AEP flow with only 0.16 m^3/s bypassing and flowing across the road and over the retaining wall in this event, compared to 0.71 m^3/s under the existing conditions.
- The downstream HDPE pipe batter chutes installed at the 750mm diameter pipe outlets are understood to be in good condition and functional and these should be retained subject to confirmation that the batter chutes are adequately anchored. The anchoring of these chutes has not been assessed in this investigation.

4. Geotechnical assessment

4.1 Geotechnical model

Interpreted geotechnical model cross sections representing site geometry (based on the survey results and the subsurface conditions identified in the geotechnical intrusive investigations) are presented below in Figure 1 and Figure 2.

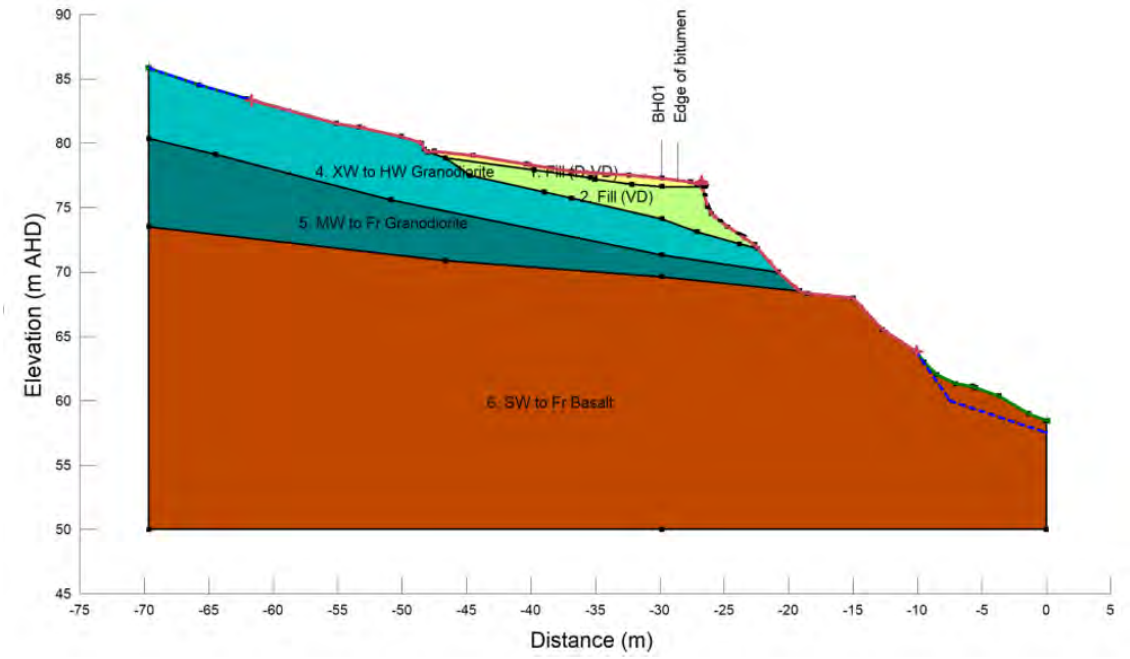


Figure 1 *Section A-A cross section geotechnical model, based on subsurface conditions encountered in BH01*

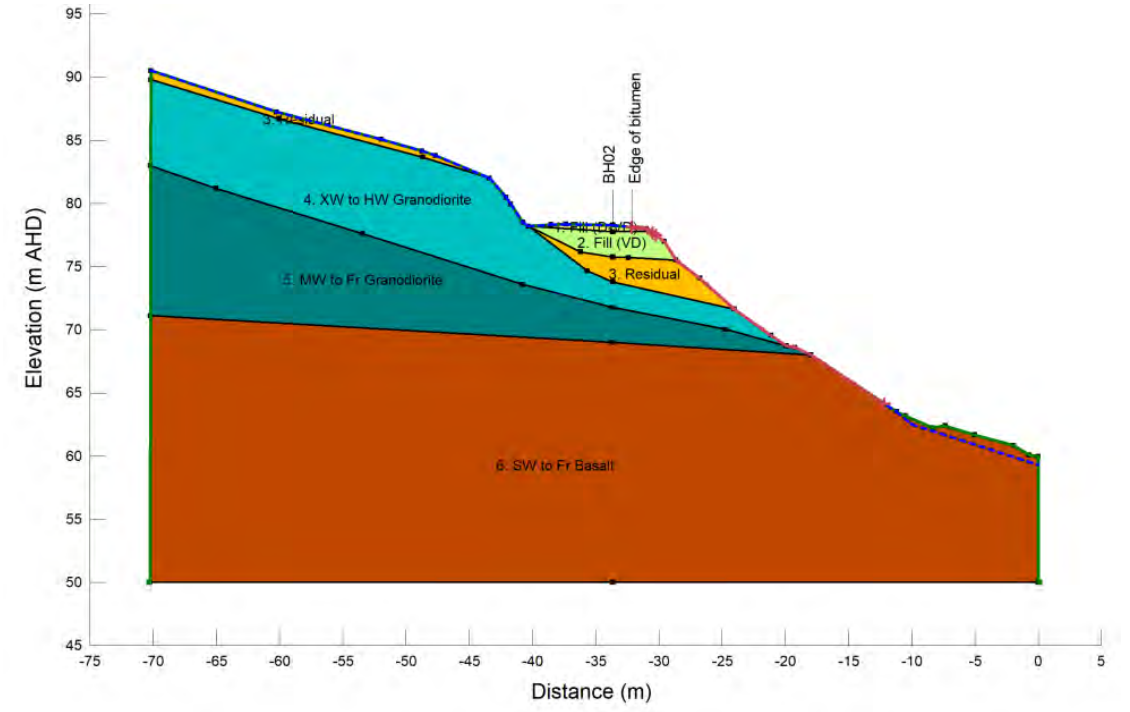


Figure 2 *Section B-B cross section geotechnical model, based on subsurface conditions encountered in BH02*

Considering the limited conducted geotechnical investigation, it should be noted that Section B-B is deemed applicable only up to the existing rock outcrop across the local access road.

4.2 Slope failure mechanisms

Two mechanisms have been identified as potential slope failure modes. Shallow and deep-seated landslide respectively. These are outlined in more detail below.

4.2.1 Shallow landslide

The site experienced significant rainfall events in May to June 2021. During the intense rainfall event, “break out” surface water flows occurred from the western portion of the site (portions of road in higher elevation), and from upslope of the site. That is, the flows were too significant to be effectively directed into the diversion drain on the upslope side of the road and out of the culvert. This resulted in surface flows occurring over the road. This is supported by the hydraulic modelling undertaken in the hydrology and drainage assessment conducted during Stage 1 – 50% Design works.

The surface water flows are thought to have progressively eroded and scoured the downslope road verge and batter of the embankment fill. This resulted in partial saturation of the embankment fill and loss of shear strength.

The instability has resulted in the observed scouring on site near the existing retaining wall and contributed to the development of tension cracks observed on the road formation on site. Given the geometry of the site and our understanding of the site history, the ongoing instability can be described as a developing shallow landslide, with the entry point likely to occur at the tension cracks observed on site.

4.2.2 Deep-seated landslide

There is an abrupt transition between the extremely weathered material (soil like) and high strength bedrock. This significant difference in shear strength of these two layers may result in a slip surface developing on the interface, hence there is also a potential for deep-seated slip surface/movement to occur underneath the road embankment. Checks on the global stability against deep seated (and including road and verge stability) were conducted, and detailed in section 4.5.

4.3 Back analysis of slope failure

Shear strength parameters for the fill, residual and extremely weathered materials were obtained by back analysis. The procedure allows input of the site failure mechanism into geotechnical modelling software SLOPE/W by varying the shear strength parameters of the materials and groundwater level behind the slope.

Key considerations and assumptions for the SLOPE/W modelling include:

– The existing retaining wall (timber logs and steel piles) are modelled using a failure through the piles ignoring the effect of the timber logs. This is a limitation of 2D modelling but is not deemed significant.
– The “Entry” point of the assessed slip circle was constrained to the road centreline up to the existing guardrails. This is consistent with observations of developing tensions cracks at these locations.
– The “Exit” point of the assessed slip circle was constrained on the fill batter, downslope of the road
– The slip failure is considered to propagate through the embankment fill to the underlying extremely weathered material. It is unlikely that the slip surface would occur into the underlying high strength bedrock.
– Fully saturated condition was used to represent groundwater level table to represent flood conditions during significant rainfall event.
– A Factor of Safety (FoS) near 1.0 has been targeted to simulate the slope being close to failure.

Extracts of the back analysis slope assessment are shown in Figure 3 and Figure 4 below.

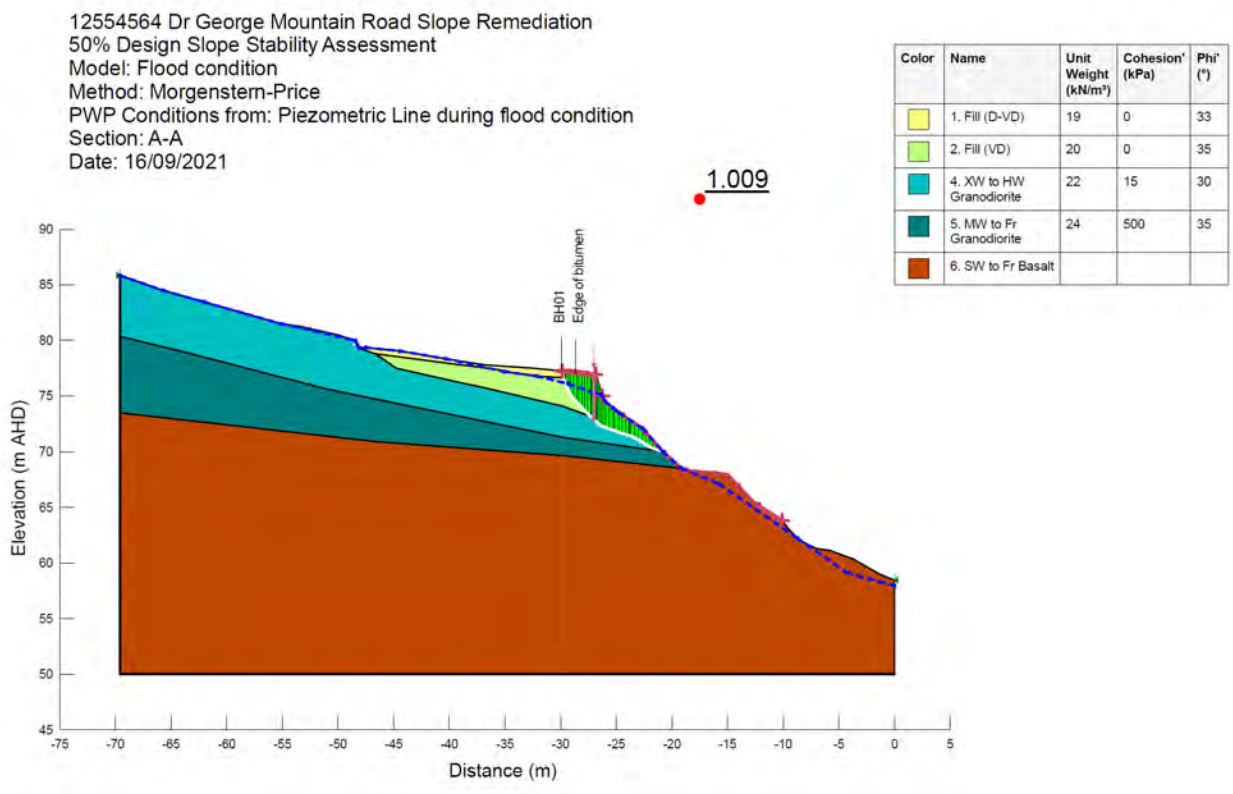


Figure 3 *Slope /W output on the back analysis of the slope at section A-A*

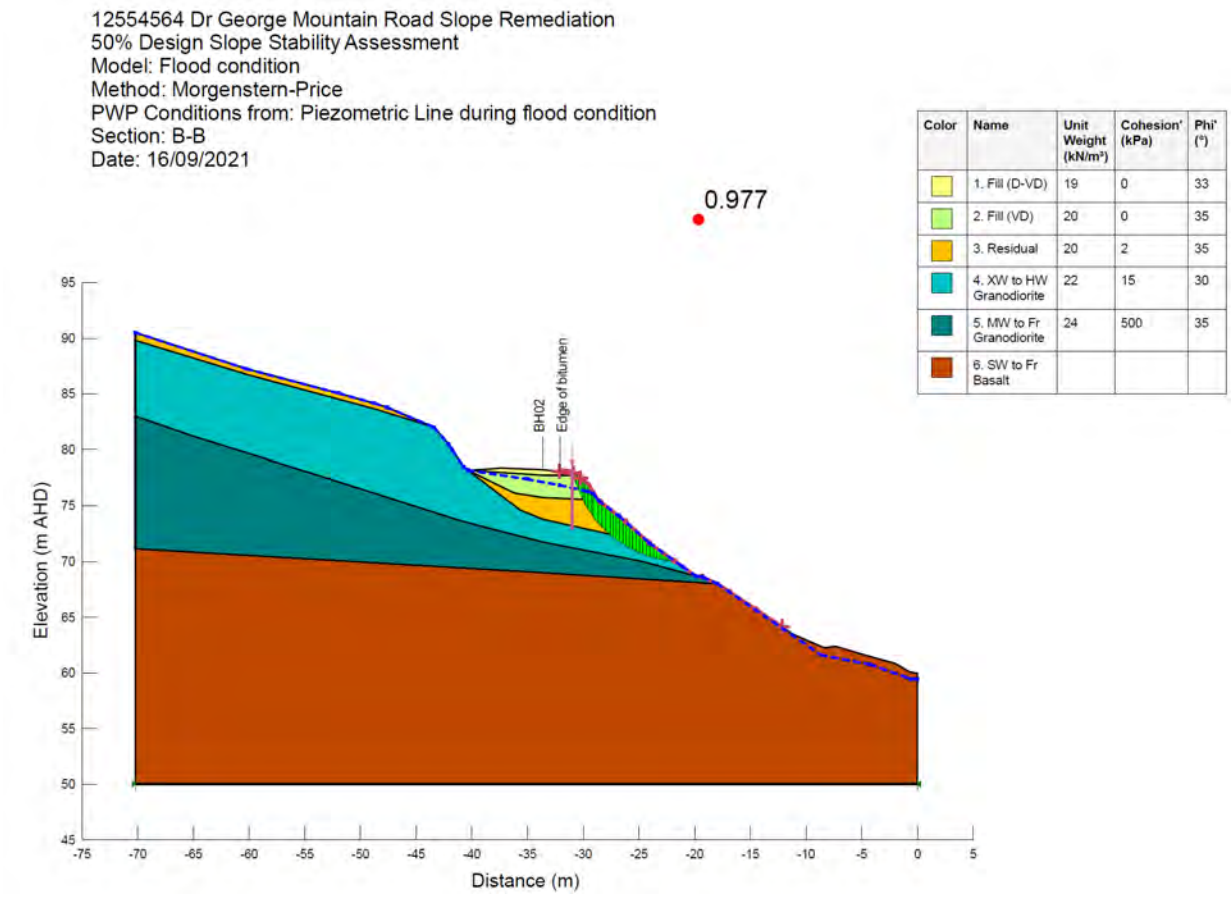


Figure 4 *Slope /W output on the back analysis of the slope at section B-B*

4.4 Geotechnical parameters

Table 1 outlines the soil parameters adopted in the geotechnical analysis based on back analysis (refer to section 4.3). Parameters for the moderately weathered to fresh bedrock were adopted based on engineering design experience, noting these have negligible influence on the outcomes of the geotechnical design.

Based on historic photos supplied by the client (2010-2013) during placement of the revetment, the rock revetment addition does not appear to be considerably contributing to the stability of the slope. Recent site photos (2021-2022) also do not reveal further details about how the current condition of the revetment is due to heavy vegetation covering the slope surface. It is not expected that the revetment has had a major contribution to the stability of the slope. Therefore, any potential minor contribution from the rock revetment has been excluded from the assessment.

Table 1 Summary of adopted geotechnical parameters

Unit	Description	Consistency/density (soil), or estimated strength (rock)	γ (kN/m3)	E (MPa)	c'_p (kPa)	φ'_p (º)
Fill	Gravelly SAND with boulders	Dense to very dense	19	18	0	33
Fill	Sandy GRAVEL	Very dense	20	25	0	35
Residual	Gravelly SAND	Very dense	20	19	2	35
Granodiorite	XW to HW Granodiorite	Extremely low to very low	22	75	15	30
	MW to Fr Granodiorite	Very high	24	500	500	35
Basalt	SW to Fr Basal	Extremely high	24	1000	500	35

Notes to Table 1: γ = unit weight, E = Young's modulus, c'_p = peak cohesion, φ'_p = peak friction angle
XW = extremely weathered, HW = highly weathered, MW = moderately weathered SW = slightly weathered, Fr = Fresh

4.5 Slope stability assessment

4.5.1 Existing site

Using the adopted design parameters in Table 1, a slope stability assessment of the existing site was performed for two cases – flood condition (high groundwater) and normal condition (lower groundwater). For each case, three failure modes were performed namely global stability (deep-seated failure), road stability (moderately deep failure) and road verge stability check (shallow failure).

A 20 kPa traffic load was applied on the normal condition, while no traffic load was applied on the flood condition.

Based on the slope risk assessment conducted on site, the consequence class for loss of life is C2 and the consequence class for property damage is C4. Hence, the site can be treated as having a consequence class of C2.

Based on Table 1 of TfNSW Technical Direction GTD 2018/001[(NOTE: 2)], the required minimum FoS for a consequence class of C2 is 1.40 for long term conditions and 1.25 for short term conditions.

A summary of the slope stability results is provided in Table 2.

[2] TfNSW (2018) *Technical Direction Geotechnology – GTD 2018/001 Geotechnical Design for Remediation of Existing Slopes and Embankments*, version 1, dated February 2019.

Table 2 Summary of slope stability assessment for existing conditions

Section	Condition	Stability Check	Factor of Safety (FoS)	Required minimum Factor of Safety	FoS > minimum required FoS?
A-A at BH01	Flood	Global	1.44	1.25	Yes
		Road	1.03		No
		Road verge	1.01		No
	Normal	Global	1.41	1.40	Yes
		Road	1.17		No
		Road verge	1.26		No
B-B at BH02	Flood	Global	0.98	1.25	No
		Road	0.96		No
		Road verge	0.98		No
	Normal	Global	1.02	1.40	No
		Road	1.02		No
		Road verge	1.03		No

As indicated in the results above, the critical case is at Section B-B, flood condition with the FoS slightly below 1 for all three stability cases. The critical cases for Section A-A were the road verge stability and road stability cases under flood conditions. Any of the cases at or below 1 have the potential to cause failure.

4.5.2 Stability assessment following remediation

Slope stability assessment of the site was conducted using site geometry, including the proposed embankment stabilisation. Geotechnical parameters were used as per Table 1.

The embankment stabilisation solution focuses on stabilisation of the road formation itself. Slip surfaces located downslope of the remedial solutions were not considered as the focus of the project is stabilising the embankment itself. The road verge stability case is not relevant given the piled wall will eliminate this failure mode.

Table 3 Summary of slope stability assessment with proposed remediation

Section	Condition	Stability Check	Factor of Safety (FoS)	Required minimum Factor of Safety	FoS > minimum required FoS?
A-A	Flood	Global	2.13	1.25	Yes
		Road	1.74		Yes
	Normal	Global	1.84	1.40	Yes
		Road	2.04		Yes
B-B	Flood	Global	1.29	1.25	Yes
		Road	1.40		Yes
	Normal	Global	1.40	1.40	Yes
		Road	1.41		Yes

The minimum factor of safety for slope stability has been achieved in all cases above once the remediation measures have been implement.

5. Design constraints and limitations

Several design constraints were identified while progressing from 50% design works to the 100% design works. These design constraints had significant effect on the resulting 100% design works.

5.1 Road geometry

We understand that Council requires the road geometry (including road centreline and edge of bitumen alignment) to remain, largely due to the narrow road corridor on this cut and fill road embankment. No earthworks (i.e. further cut on the upslope side of the road) were allowed for in the design except for excavations that may be required for the construction of the proposed piled wall scheme.

This limited the embankment stabilisation solutions to occur on the downslope side of the road verge of Dr. George Mountain Road and was the primary driver for the use of piled wall scheme.

5.2 Guardrail alignment and effect on design

Guardrails alignment is designed with full load transfer from guardrail post in case of vehicular impact.

Council requested GHD to consider typical maximum dynamic deflection (i.e. distance from guardrail post to edge of bank) for guardrails and take this into account on the initial proposed guardrail alignment. GHD considered a Thriebeam system which has a maximum dynamic deflection requirement of minimum 1.10 m.

For subsequent guardrail design and construction works, this may need to be considered by Council. However, we note the guardrail alignment should allow for the maximum dynamic deflection of the chosen guardrail type and consider any effect on the piled wall scheme.

Due to the maximum dynamic deflection requirement of a Thriebeam guardrail system, the proposed guardrail system width should be no more than 230mm, and post alignment is 0.730 m from the edge of the existing bitumen. This will allow sufficient horizontal clearance to install an SO gutter from the back of the post guardrail system and from the edge of the guardrail block out elements to the edge of road bitumen. The resulting capping beam geometry was designed to achieve 1.10 m.

5.3 Stormwater drainage (culvert)

Following the findings of the drainage assessment, Council instructed GHD to retain the existing two (2) 750 mm reinforced concrete pipe culverts on site. Hence the capping beam, piles and precast/insitu panels must be positioned such that they are acquiescent with the existing culvert pipes.

This resulted in the need for cast-in-situ panel at the perimeter of the culvert, with culvert penetration into the panel. Details for these portions are shown in the 100% design drawings in Appendix F.

No formal drainage design was undertaken as part of the scope for this project upon instruction from Council, however GHD recommends that formal kerb and gutter structure is formed on the downslope side (east bound side) of the road to divert water away from the piled wall scheme. Surface water management is critical in ensuring the effectiveness of the piled wall scheme throughout its design life.

Subsoil drainage behind the piled wall scheme was included in the 100% design works as this is an integral component of the piled wall scheme design.

5.4 Local access road

It is understood that the access through the existing local road to the east of the stabilisation area is to be maintained. Therefore, the proposed remediation was designed to keep the current access track. The length of the remediation was limited to the zone of the recent road failure and signs of instability and cracking.

6. Design of embankment stabilisation elements

6.1 General

The preferred design option is a piled wall scheme as discussed in section 1.1. The piled wall scheme primarily involves precast panels, except at the vicinity of the existing culverts where cast-in-situ wall will be used. The advantages of this option include less construction footprint and activities on site, and reduced construction time.

The geotechnical design included checks for overall slope stability (refer to section 4.5), piled wall stability check (ultimate limit state) and deformation check (serviceability limit state). The geotechnical design provided the maximum bending moment and shear force envelope for the different scenarios and construction stages (refer to section 6.4.4).

The structural elements were designed to provide capacities exceeding the maximum bending moment and shear forces identified in the geotechnical design. The design pile diameter, length and spacing were finalised once structural and geotechnical checks were completed.

6.2 Embankment stabilisation solution types

Three types of embankment stabilisation solution have been designed and are shown in the 100% design drawing sheet 211254564-C102. An overview of these types, excluding the drainage and guard rail design, is provided in Table 4.

The piles are the primary elements that stabilise the road embankment. The precast panels were only designed to retain soil in between piles, and eventually transfer all lateral loads to the pile.

Table 4 Summary of different types of embankment stabilisation solutions

Type	Structural elements	Approximate chainage	Comments
Type 1A	Piled wall using precast panels, capping beam	Ch. 740 to 780, except for portions covered by Type 1B	Provided at portions of the site where steep slopes from the top of bank and timber retaining walls are observed. This type of solution is presented on these areas where loss of soil materials between piles is likely to occur, hence the need for precast panels.
Type 1B	Piled wall using cast in-situ panels, capping beam	Ch. 755 to Ch. 757 Ch. 768 to Ch. 770	Similar to Type 1A solution, except cast in-situ panels are required to allow culvert penetration through the piled wall. Slope on this area is still steep, hence a “wall” (i.e., the cast in-situ panel) is required.
Type 2	Pile and capping beam only (no panels)	Ch. 730 to Ch. 740 Ch. 780 to Ch. 795	The distance from top of bank to edge of capping beam is greater than 750 mm on these portions of the site. In addition, the slopes are relatively gentler, hence ground movement in between piles is unlikely.

6.3 Design standards and criteria

AS4678 and AS3600 have been adopted for the geotechnical and structural design of the post and panel walls.

In addition, the following design criteria were used:

– The design life adopted is 100 years.
– For concrete structures, the following exposure classifications apply:
  - Climatic Zone: Temperate (AS5100.5-2017, Figure 4.3) – (Australian Standards, 2017b).
  - Members in contact with ground: B1.
  - Exterior members: B1 (industrial and temperate climatic zone).

– Maximum deflections adopted for the piled cantilever retaining wall as per AS4100-2020 Appendix B Table B1 (Australian Standards, 2020) limited to 1/125 of retaining wall height.

6.4 Design procedure

6.4.1 Adopted pile and wall properties

The proposed piled wall system comprises a 450 mm concrete bored pile spaced at 0.90 m c/c. A capping beam is positioned on top of the concrete piles. The wall will primarily be comprised of precast panels, except for cast-in-situ panels adjacent to culvert. Table 5 summarises the adopted engineering properties of the structural elements.

Table 5 Adopted engineering properties of structural elements

Structural element	Cross-sectional area (m^2)	Moment of inertia, I (m^4)	Young's modulus, E (MPa)
450 mm reinforced concrete bored pile	0.1590	0.00201	32800
Panels	0.175	0.00045	32800

6.4.2 Adopted geotechnical parameters

The geotechnical partial design factor shown in Table 6 have been adopted for the serviceability and ultimate limit states, consistent with the provisions of AS 4678 section 5.2.

Table 6 Geotechnical partial design factors based on AS 4678 Table 5.1

Unit	Description	Ultimate limit state (ULS)				Serviceability limit state (SLS)			
		$\Phi_{u\phi'}$	ϕ' (°)	$\Phi_{uc'}$	c'	$\Phi_{u\phi'}$	ϕ' (°)	$\Phi_{uc'}$	c'
FILL (reworked XW granodiorite)	Gravelly SAND	0.75	25.5	0.50	0	0.90	30.0	0.65	0
FILL (reworked weathered granodiorite)	Sandy GRAVEL	0.75	27.5	0.50	0	0.90	32.0	0.65	0
Residual	Gravelly SAND	0.85	30.5	0.70	0	1.00	35.0	0.85	0
Granodiorite	XW to HW	0.85	26.0	0.70	10.50	1.00	30.0	0.85	12.75
Granodiorite	MW to Fr	0.85	30.5	0.70	350.00	1.00	35.0	0.85	425.00
Basalt	SW to Fr Basalt	0.85	29.5	0.70	280.00	1.00	34.0	0.85	340.00

Notes: n/a = not applicable
$\Phi_{u\phi'}$ = uncertainty reduction factor on friction angle, $\Phi_{u\phi'}$ = uncertainty reduction factor on cohesion

Based on AS 4678 section 4.1 (a)(iii), a load factor of 1.25 of applied on the soil unit weight and 1.50 on live loads (i.e., traffic loads) for the ultimate limit state. A load factor of 1.0 is applied on both soil unit weight and live loads for the serviceability limit state.

6.4.3 Groundwater conditions

The site investigation work has been carried out in a dry condition. Groundwater (GW) has not been encountered in recently drilled boreholes. The area of the proposed retaining wall is subject to high groundwater level during significant rainfall events. The two groundwater levels have been adopted in the piled wall design is shown in Table 7.

Table 7 Summary of groundwater conditions considered in the piled wall design

Groundwater conditions	GW level – active side (m bgl)	GW level – passive side (m bgl)
High	1.50	3.50
Low	3.50	3.50

Note 1: Refer to section 6.4.4 for the design scenarios.

Groundwater is likely to fluctuate with local rainfall, and groundwater may be intercepted at shallower depths during construction. Hence, appropriate design and construction considerations should be made.

6.4.4 Design scenarios

Three design scenarios were considered in the piled wall design. A summary of the loads and groundwater conditions for each design scenario is provided in Table 8.

In the third design scenario, i.e. accidental lateral load case, a ULS lateral load equal to 300kN is considered to be applied horizontally to the guardrail based on Australian Standards AS5100.2: 2017 – Design Loads (Table 12.2.2 page 48). The load is selected based on barrier performance level of Regular and for Ultimate transverse outward load (F_T). It is assumed that the load will be distributed along 6m of guardrail reducing it to 50kN/m along the retaining wall. This horizontal load is then distributed along the pile depth as 4 point loads each equal to 12.64kN.

It should be noted that the distance between the piled wall and guardrail post and footing is 0.5m which is expected to attenuate and dissipate the accident energy. Therefore, the full lateral load due to design accident is not expected to be transferred to the retaining structure and distributed as outlined above.

Table 8 Summary of design scenarios

Design scenario	Load (ULS)	Load (SLS)	Groundwater condition
Regular	30 kPa (traffic load)	20 kPa (traffic load)	Low
Flood	20 kPa (traffic load)	10 kPa (traffic load)	High
Accidental lateral load case [NOTE 1]	12.64 kN (lateral load)	8.5 kN (lateral load)	Low

6.4.5 Design results – piles (typical)

The pile socket length was proportioned by checking the “overall stability” of the retaining wall under ultimate limit state (ULS) using WALLAP, a commercially available software used to design and analyse cantilever walls and soldier piles. The geotechnical model (see section 4.1), structural and soil parameters (see sections 6.4.1 to 6.4.2), groundwater conditions (see section 6.4.3) and design scenarios (see section 6.4.4) were incorporated into the WALLAP model. Pile is designed as a circular column wherein it is subjected to bending and shear forces. The design loads, and pile geometry (diameter, length and spacing) are presented in Table 9

The maximum bending moment and shear force envelopes at ULS, and deflection of the wall at SLS were used in the structural design on the reinforcements of the pile.

Table 9 100% design - pile geometry (typical)

Pile geometry	Value
Pile length	6.5 m, requiring minimum 2.0 m socket into low strength granodiorite or basalt
Pile diameter	450 mm
Pile spacing	900 mm
Maximum pile ULS shear force	149 kN
Maximum pile ULS bending moment	110 kN-m
Factor of safety for piled wall overall stability	1.13
Pile top SLS deflection (mm)	7 mm

Pile geometry	Value
General retained height (m)	1.50

6.4.6 Design results – piles near culvert

The typical spacing for the piled wall scheme is 900 mm, as shown in Table 9. However, this spacing was not achievable for the piles adjacent to the 750 mm culvert (P27, P28, P40 and P41). Similar design methodology was used as in section 6.4.5.

The maximum bending moment and shear force envelopes at ULS, and deflection of the wall at SLS were used in the structural design on the reinforcements of the pile and precast panel.

Table 10 100% design - pile geometry (near culvert)

Pile geometry	Value
Pile length	8.0 m, requiring minimum 1.5 m socket into high strength granodiorite or basalt
Pile diameter	450 mm
Pile spacing	1.80 m (spacing between piles on either side of the existing culvert)
Maximum pile ULS shear force	71 kN
Maximum pile ULS bending moment	180 kN-m
Factor of safety for piled wall overall stability	2.21
Pile top SLS deflection (mm)	5 mm
General retained height (m)	1.80

6.4.7 Design results –panels

The typical panels are proposed as precast panels. For the design of the panels, only the bending moment and shear force on the upper 1.5 m of the piled wall arrangement was considered. The resulting design geometry are as follows.

Table 11 100% design - pile geometry

Panel geometry	Value
Panel height	1.050 m
Panel length	1.800 m
Panel thickness	0.175 m
Maximum panel ULS shear force	46.6 kN
Maximum panel ULS bending moment	23.4 kN-m

However, panels in the culvert location are proposed to be cast-in-situ panels to allow for casting around the culvert opening. Similar design methodology is to typical panel design is used but additional consideration incorporated to enhance capacity to take into account the opening in wall for culvert..

7. Drainage design and considerations

7.1 Susceptibility of geotechnical measures

The geotechnical remedial options cannot be implemented effectively without addressing the deficiencies in the existing surface water drainage system and thus underlying causes of the instability. The geotechnical remedial systems outlined in this design report would be susceptible to potential damage and reduced performance as a result of ongoing surface water flows over the road.

A potential issue associated with lack of effective drainage at the site could be the potential for groundwater to develop behind the pile wall as a result of surface water ingress into the embankment. These increased pore pressures have the potential to cause punching shear and large-scale shotcrete failure in extreme cases. Whilst we have included subsurface drainage measures to reduce the likelihood of this mechanism, there is a need to direct flows away from the remedial treatment area.

7.2 Drainage design overview

The remedial stabilisation of the road embankment is to comprise a holistic geotechnical and civil design solution and thus one cannot be undertaken in isolation, without the other. Figure 5 below presents the output from drainage modelling in concept design phase which shows indicative stormwater overland flow paths and suggested remedial works.

For the design works captured in this design report, GHD has been asked by Council/TfNSW to limit the drainage design to include:

– Inspection of damage to site from recent rainfall
– Design to consider surface water runoff and propose kerb/dish drain adjacent to capping beam to protect backfill behind panels and ensure longevity of structure
– Design to consider an outlet structure for capture of surface water runoff

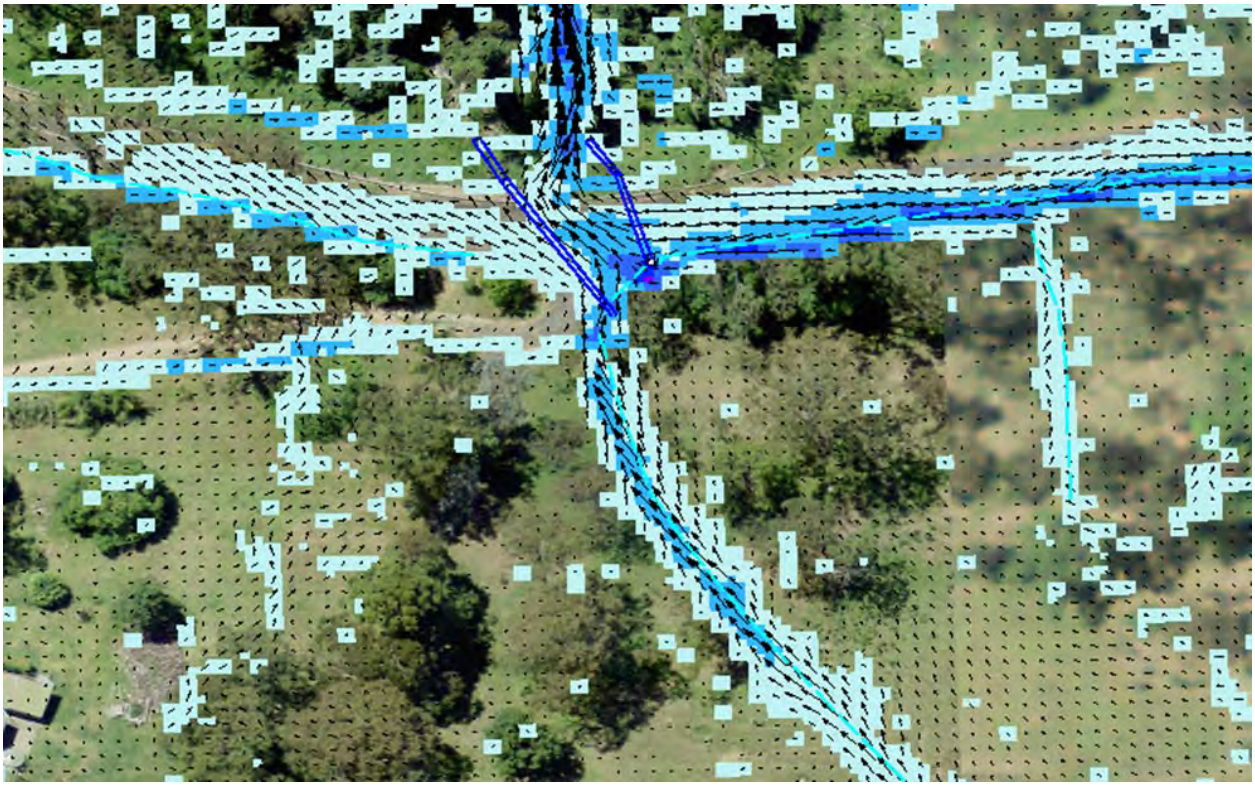


Figure 5 Drainage modelling output – resultant flow paths for fully blocked culverts

7.3 Supplementary site inspection

GHD conducted a supplementary site inspection on 24th and 25th May 2022. The purpose of this investigation was to review the concept design on site and to assess the existing drainage infrastructure and any additional design constraints. The following issues were noted:

– The property on the south side of Dr George Mountain Road has experienced erosion damage to the driveway. A drainage pipe under the existing property stone fence is recommended to direct flows to the existing concrete dish drain and western culvert.
– The existing HDPE culvert outlet pipes have no formal energy dissipation at their outlets and are not securely anchored. These could be replaced with gabion drop structures to dissipate energy.
– The downstream slope while heavily vegetated contains a riprap surface layer in parts.
– The eastern culvert inlet is an informal rock lined pit and can be replaced with a standard grated inlet pit.
– The presence of a property access gate to the east of the piled wall requiring realignment of the proposed wall and barrier.
– The last downstream segment of the eastern 750mm culvert has been dislodged and a small sinkhole has developed in the road verge above the pipe.

To address the issues observed on site, a markup of drainage recommendations was prepared and discussed with Council and TfNSW for inclusion in the detailed design as shown on Figure 6.

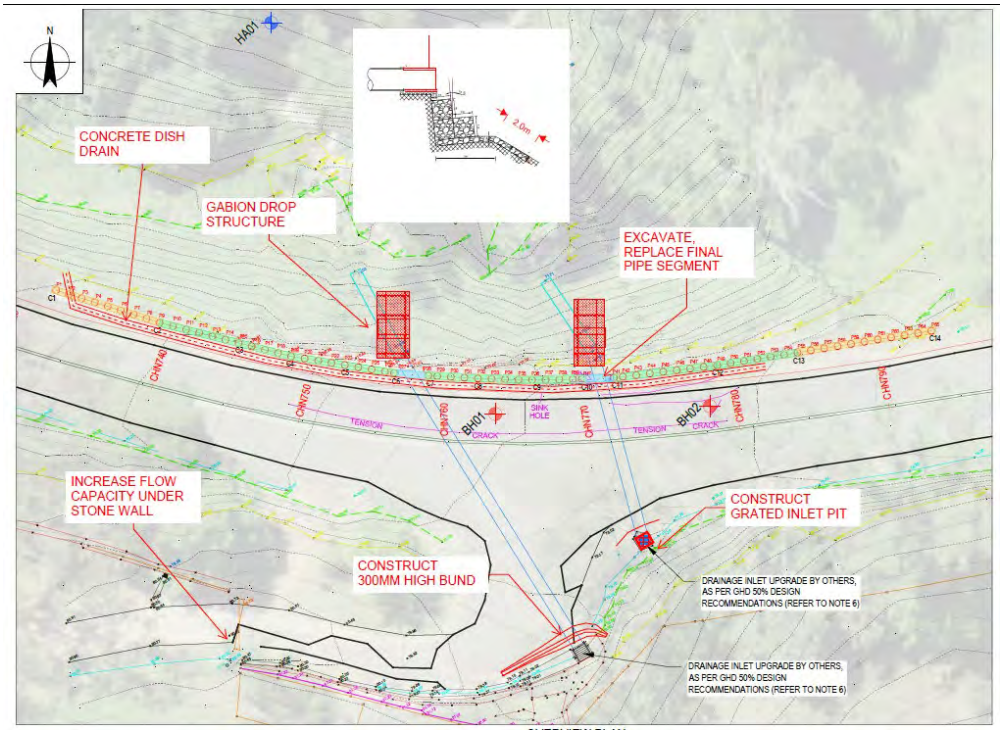


Figure 6 *Site visit recommendation markup*

7.4 Drainage design aspects

In response to the design requirements outlined by Council (section 7.2), the supplementary site inspection discussion (section 7.3) and the initial drainage (section 3.3) the following drainage remedial methods have been included into the detailed design:

- Inclusion of a 500 mm wide dish drain between new guard rail posts and capping beam, with rip rap scour protection at western end
- 300 mm high concrete bunding surrounding existing grate pit of the western culvert inlet. This included a 100 mm lowered overflow section to allow bypass of flows to the eastern culvert inlet.
- Replacement of rock armouring of the eastern culvert inlet, and replaced with a raised grate pit
- Replacement of the last section of the eastern culvert, where there has been collapse
- Gabion basket drop structures beneath each of the 2x culvert outlets & removal of existing HDPE pipe chutes
- Rip rap around gabion baskets to merge with existing revetment to stilling ponds
- Installation of surface drainage pipes (set in grout) beneath the rock wall of the upslope private property, to allow surface water drainage to pit drain and bund
- Refinements to the backfilling behind the piled wall panels and the inclusion of subsoil drainage behind the concrete panels that outlets through a concrete panel onto the rip rap material surrounding the gabion basket drop structures

A summary of the proposed drainage upgrade works for this project (highlighted green labels) is shown below in Figure 7.

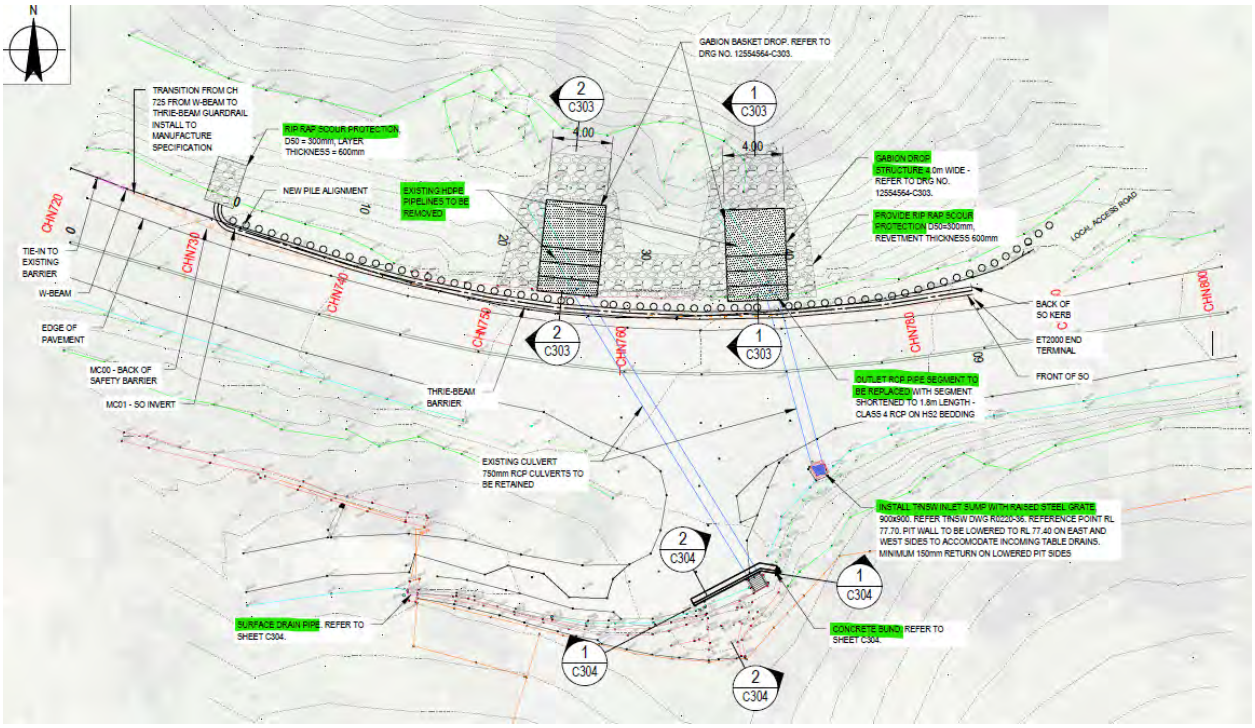


Figure 7 Overview plan – drainage remedial design features (highlighted green)

7.5 Road drainage

The road crossfall at the remedial works location is one way, falling outwards towards the downstream hill slope. A 500 mm wide dish drain can be accommodated between the proposed safety barrier and the capping beam to collect minor stormwater flows from the road and discharge these flows west of the proposed piled wall. This will prevent frequent overtopping of water over the piped wall. In major storm events some overtopping of the road and

piled wall is expected and for this reason riprap has been included at the base of the wall and on the downhill slope to provide embankment scour protection.

Stormwater flows collected in the two inlet pits and culverts will discharge onto a stepped gabion drop structure. During extreme events the water trajectory from the culverts will lengthen and water may skim over the drop structure and land on the slope beyond the gabions. Therefore, a reno mattress landing pad has been included in the design extending beyond the gabion baskets to minimise downstream embankment scour in such events. Further to this 600 mm thick riprap has also been included beyond the drop structure to provide additional scour protection.

8. Road design

The primary hazard identified at the site is situated along the northern side of Dr George Mountain Road (east bound lane) in the form of a steep embankment with failure at the top of the slope and near the existing guardrail in the form of slumping and longitudinal cracking in the pavement. This steep topography is aggravated by significant erosion caused by surface water run-off overtopping from Dr George Mountain Road requiring the need for this section of road to include an upgraded guardrail as part of the overall design works.

The scope of the civil works includes the replacement of existing guardrail with an upgraded unit and the proposed tie in at the extremities of the area of upgrade. Any assessment or upgrades to the current road geometry or pavement design were descoped by Council.

As such, the existing road geometry is to be maintained and any shape correction/pavement design or vertical and horizontal adjustments have not been undertaken. The posted speed of 80 km/hr is maintained on existing road alignment along the Dr George Mountain Road centreline and it serves only as a reference to determine the guardrail positioning and horizontal alignment.

The existing crossfalls are also maintained and extended to the capping beam structures and the gutter for the barrier system. There have been no sight distance checks undertaken and no signage and line-marking design, which have also been descoped by Council.

8.1 Guardrail Design

The guard rail design is intended to be a like-for-like replacement of the current barrier, as such, the point of need method, which is the traditional method to determine barrier length has not been applied.

A key element in selecting a barrier type is the dynamic deflection, which allows the barrier to safely deform, contain and redirect an errant vehicle. Generally, the dynamic deflection requires a support width behind the guardrail (see Figure 8) to allow for wheel contact. For the proposed MASH TL4 Thriebeam system a support width of 1.1 m is required. For this project a 1.1 m has been maintained through corrections to the alignment of the capping beam, even in areas where the road shoulder is not wide enough, and the road geometry cannot be changed.

It is noted the safety barrier's proposed containment post will be installed to manufacture's standards within the road shoulder and kerb & gutter arrangement are constructed behind the barrier system.

The barrier design parameters are referenced from Austroads: Guide to Road Design Part 6: Roadside Design, Safety and Barriers see Figure 8 below.

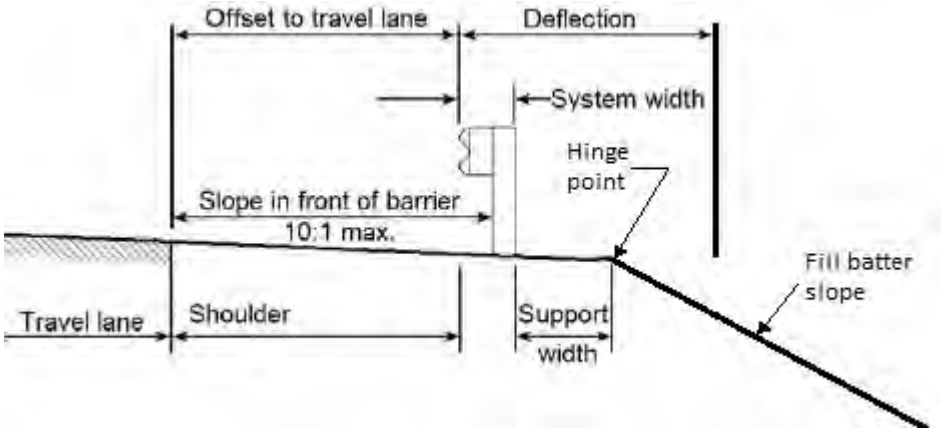


Figure 8 Typica Safety Barrier Considerations

The site is assessed in terms of available offset from the travel lane and available verge width, which are both constrained due to the existing site conditions. The offset of the guardrail alignment MC00 from the existing road edge of pavement of 730 mm to satisfy the minimum shoulder width, the dimensions required for the barrier system and the SO kerb gutter, to approximately 1.230 m. See Figure 9 below.

Austroads provides a guide to calculate the length of the barrier length to ensure that the extent of the hazard is adequately covered. However, for this project, the length calculation is not applicable, due to existing tie-in to exiting barrier system and local driveway access road. The length of the new barrier is directly determined by the length of the capping beam and the extents of the tie in lengths at both ends to the existing barrier system, which is approximately 60.0m in total.

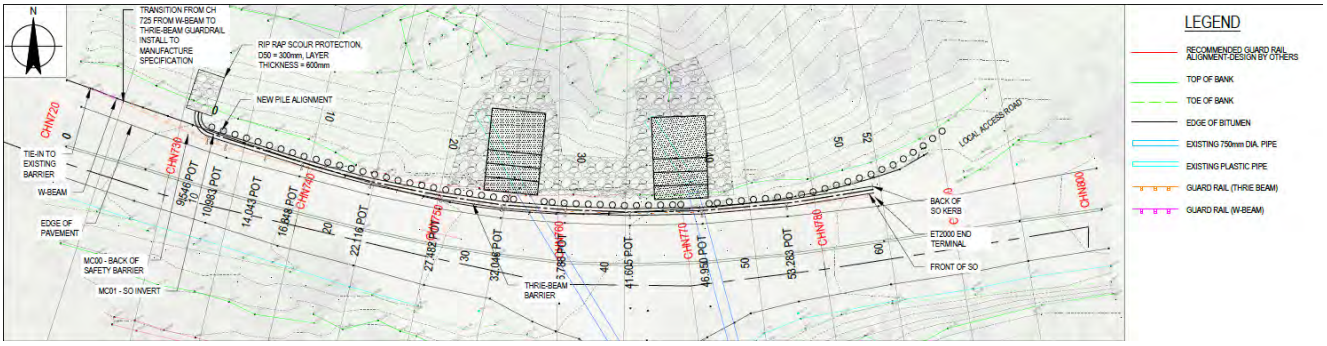


Figure 9 Overview Plan – giard rail design

The selected guardrail type is a Thriebeam Guardrail, which is embedded into road shoulder/pile wall backfill in front of the SO kerb and in turn the capping beam. See Figure 10 below for embedment with capping beam, pile and SO drain detail. See Figure 11 below for embedment with capping beam, pile, panel, SO drain and back reinstatement.

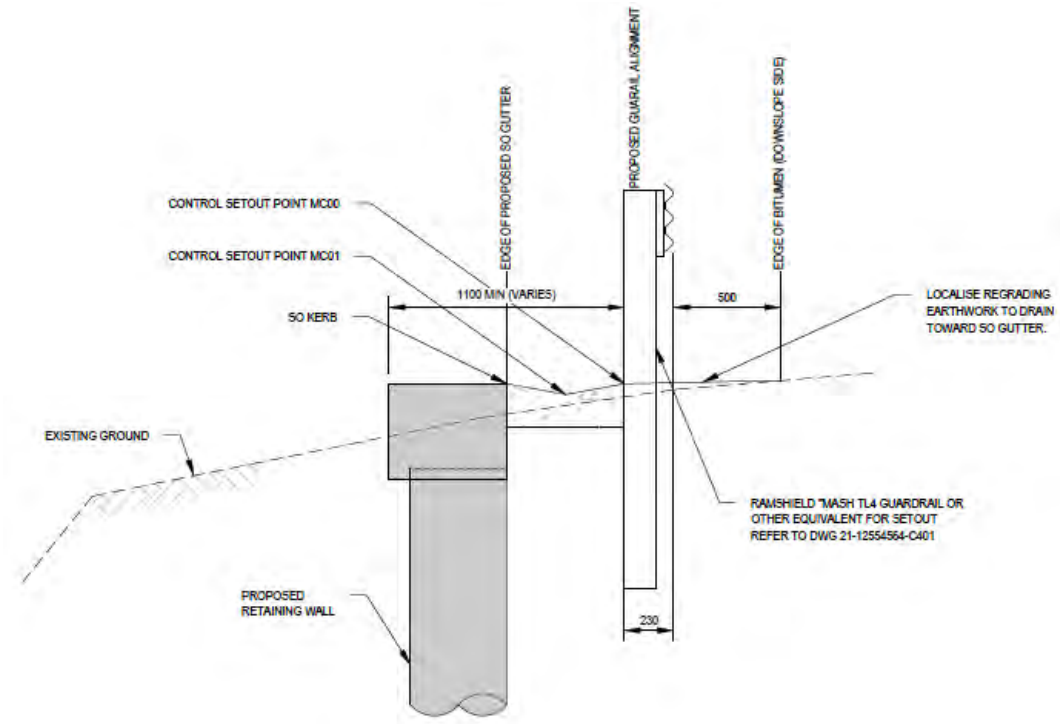


Figure 10 Section – guard rail, SO drain and capping beam detail

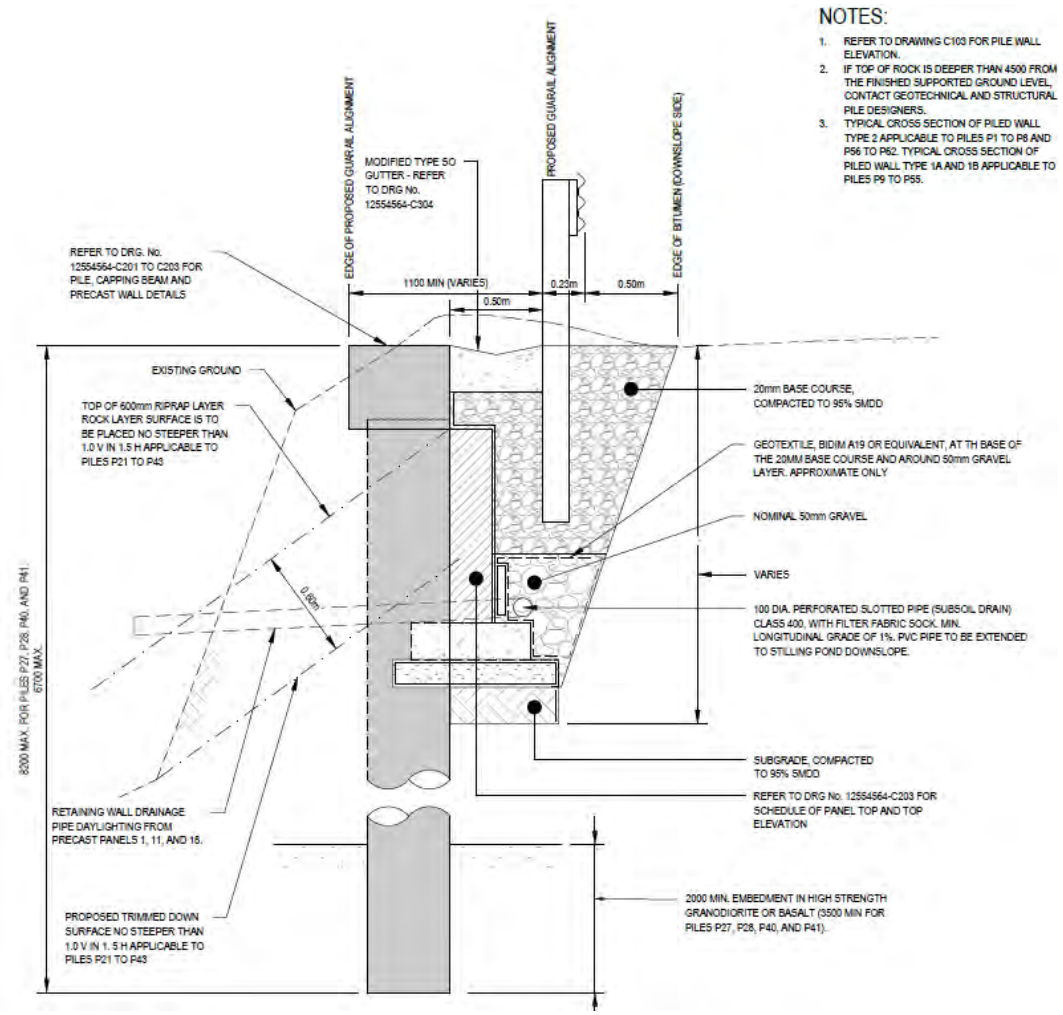


Figure 11 Section – guard rail, SO drain, capping beam, pile & panel and reinstatement detail

At the western end of the proposed guard rail replacement, the rail will transition into the existing W-beam guard rail system. At the eastern end of the proposed guard rial replacement a ET2000 end terminal is proposed.

9. Safety in design

9.1 Safety in design strategy

In compliance with legislative obligations and delivering industry leading safety in design (SiD) practices, GHD implements and carries out ongoing review of our Safety in Design Procedure to ensure our design teams are focused on delivering a service that considers project risk throughout the asset lifecycle.

Safety in design (SiD) is a strategy aimed at preventing injuries by considering hazards as early as possible in the planning and design process, enhancing safety through choices in the design process. A safety in design approach considers the safety of those who construct, operate, maintain, clean, repair and demolish an asset. Parties involved in the planning and design stage of a project are in a position to reduce the risks that arise during the life cycle of the asset.

GHD's approach to incorporating safety in design is achieved through designing in accordance Australian Standards and design guidelines (where applicable), and by undertaking team project hazard review and Safety in Design workshops.

9.2 Project roles and responsibilities

The key project roles and responsibilities associated with the project are:

- Client: Council
- Designer: GHD
- Construction Contractor: To Be Confirmed
- Operation and Maintenance: Council

9.3 Designers and stakeholders

At each design stage "designers" can make a significant contribution by identifying and eliminating hazards, or reducing likely risks from hazards where elimination is not possible. GHD has fulfilled the role of designer on the Harry Graham Drive, Area 6 Project. In this role, GHD has identified and mitigated a number of potential hazards within the limitations of our scope.

In addition to designers, project stakeholders can contribute much to the safety in design process. Major stakeholders in a construction project may be considered to be those who are:

- Connected with the design or construction process; or
- Parties that work where the end product is to be used, or could reasonably be expected to be used, either through inspection, operation, cleaning, maintenance or demolition.

For the Dr George Mountain Road detailed design, the list of stakeholders to consider includes:

- Design professionals, such as geotechnical, civil, structural, drainage engineer, project, heritage and environmental officers and drafters;
- Supplier / manufacturer of proprietary products such as traffic barriers;
- Contractors;
- Project managers;
- Asset owners;
- End users such as site / operations personnel;
- Quantity surveyors;
- Insurers;
- Quality assurance staff;
- Work health and safety professionals; and

– Project suppliers including manufacturers, importers and plant / equipment suppliers.

9.4 GHD SiD assessment

A Safety in Design Register (SiDR) has been created and can be found in Appendix E. This register is a risk matrix that aid in identification of design hazards, risks or issues with the proposed design, and appropriate controls to mitigate them. It is in accordance with relevant ASA/TfNSW standards.

A hierarchy of controls has been used to determine the appropriate control mitigation measures associated with an original hazard and risk to a level that is So far as is Reasonably Practical (SFAIRP). The risk criteria matrix and the hierarchy of controls used for the SiDR are provided below in Figure 12.

The intention for this SiDR is to be a live document that gets updated throughout the life of the project. The main objective of this is to address all issues associated with the project including those associated with design, construction, commissioning, and operation. Each item in the SiDR will be either closed out and the control implemented in the design, deferred to the constructor where appropriate, or deferred to the maintainer/operator where this is appropriate.

Once an appropriate level of detailed design has been reached, it is recommended a SiD workshop be carried out to review and update the SiDR prior construction works, with Council, contractors, TfNSW personal and/or other relevant key stakeholders. For the design works outlined in this report, no SiD workshop has been carried out between GHD, Council and/or other key stakeholders listed above.

The SiDR assessment considered general risks associated with the design, construction and ongoing monitoring and management of the slope stabilisation remedial works.

The following key risks were identified in the GHD SiD assessment:

– Interactions of works with traffic;
– Interaction of plant;
– Interaction with the public;
– Utilities; and,
– Environmental impacts

These risks along with their mitigation methods are discussed in the Risk Register in Appendix E. The register is used to document the hazards and risks, their controls and who is responsible for the controls, and also identifies residual risks to the site owner, in this instance Council. Items of safety that are directly related to or to be controlled by the design phase of the project have been considered in the development of the design. The register shall be maintained and updated throughout the lifecycle of the project.

Following review and input by Council into the SiD assessment, GHD will formally hand responsibilities of the residual risks relating to future aspects of this project to Council and their selected Contractor for further mitigation.

TfNSW Safety Risk Matrix

		Illness, first aid or injury not requiring medical treatment.	Illness or minor injuries requiring medical treatment	Single recoverable lost time injury or illness, alternate/restricted duties injury or short-term occupational illness.	1-10 major injuries requiring hospitalisation and numerous days lost, or medium-term occupational illness.	Single fatality and/or 10-20 major injuries/permanent disabilities/ chronic diseases.	Multiple Fatalities (and/or >20 major injuries/permanent disabilities / chronic diseases.	-
		Insignificant - C6	Minor - C5	Moderate - C4	Major - C3	Severe - C2	Catastrophic - C1	*[Drop-Down for zero risk (or not applicable or still to be scored)]*
10 times or more every gear. Expected to occur frequently during time of activity or project.	**Almost Certain - L1**	C	B	B	A	A	A	-
1 to 10 times every gear. Expected to occur occasionally during time of activity or project.	**Very Likely - L2**	C	C	B	B	A	A	-
Once each gear. More likely to occur than not occur during time of activity or project.	**Likely - L3**	D	C	C	B	B	A	-
Once every 1 to 10 gears. More likely not to occur than occur during time of activity or project	**Unlikely - L4**	D	D	C	C	B	B	-
Once every 10 to 100 gears. Not expected to occur during the time of activity or project	**Very Unlikely - L5**	D	D	D	C	C	B	-
Less than once every 100 gears. Not expected to occur during time of activity or project	**Almost Unprecedented - L6**	D	D	D	D	C	C	-
[Drop-Down for zero risk (or not applicable or still to be scored)]	-	-	-	-	-	-	-	-

	Likelihood - QUALITATIVE EXPECTATION	Likelihood - QUANTITATIVE FREQUENCY
Almost Certain - L1	Expected to occur frequently during time of activity or project.	**10 times or more every gear.**
Very Likely - L2	Expected to occur occasionally during time of activity or project.	**1 to 10 times every gear.**
Likely - L3	More likely to occur than not occur during time of activity or project.	**Once each gear.**
Unlikely - L4	More likely not to occur than occur during time of activity or project	**Once every 1 to 10 gears.**
Very Unlikely - L5	Not expected to occur during the time of activity or project	**Once every 10 to 100 gears.**
Almost Unprecedented - L6	Not expected to occur during time of activity or project	**Less than once every 100 gears.**

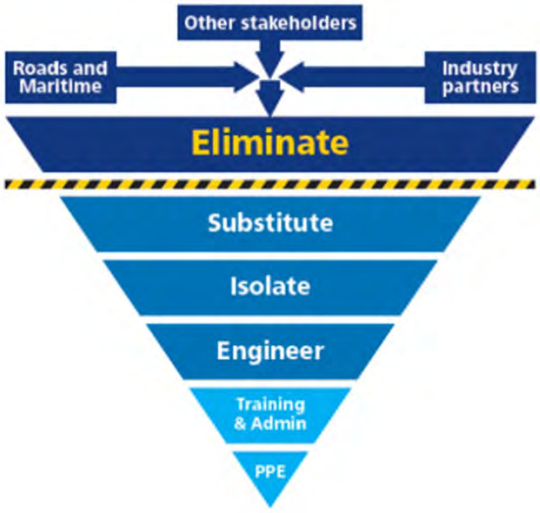


Figure 12 Risk Criteria and hierarchy of controls

10. Construction sequence

The assumed construction sequence for the different remediation solution types is indicated below. It is further assumed the tendering contractor will propose their own construction sequence as part of their tender submission.

10.1 Type 1A – Piled wall, precast panels, capping beam

- Drill boreholes for the bored piles. Refer to site remediation plan and pile schedule for the offset distances of bored piles from the existing edge of bitumen.
- Install bored piles and capping beam
- Remove existing timber retaining wall (where existing)
- Excavate ground in front of the piles as required for construction
- Excavate behind the piles, up to toe of precast panel footing. The excavation should be minimum 500 mm wide behind the pile. Refer to schedule for the toe of excavation.
- Install precast panels and related footing structures.
- Install subsoil drainage structures (cordrain, megaflo) and layout bidim and geotextile prior backfilling.
- Backfill the excavation and reinstate to original ground level.
- Install SO gutter
- Install guardrail post and Thrie-beam guardrail system.

10.2 Type 1B – Piled wall, insitu panels, capping beam

- Drill boreholes for the bored piles. Refer to site remediation plan and pile schedule for the offset distances of bored piles from the existing edge of bitumen.
- Install bored piles and capping beam
- Remove existing timber retaining wall (where existing)
- Excavate ground in front of the piles as required for construction
- Excavate behind the piles, up to toe of precast panel footing. The excavation should be minimum 500 mm wide behind the pile. Refer to schedule for the toe of excavation.
- Install cast in-situ panels and related footing structure around the culvert pipes.
- Install subsoil drainage structures (cordrain, megaflo) and layout bidim and geotextile prior backfilling.
- Backfill the excavation and reinstate to original ground level.
- Install SO gutter
- Install guardrail post & Thrie-beam guardrail system.

10.3 Type 2 – Pile and capping beam only

- Drill boreholes for the bored piles. Refer to site remediation plan and pile schedule for the offset distances of bored piles from the existing edge of bitumen.
- Install bored piles and capping beam
- Install SO gutter
- Install guardrail post and Thrie-beam guardrail system, including transitions to existing W-beam guard railed (western site end) and end terminal (eastern site end).

11. Cost estimate

A cost estimate collated by a quantity surveyor using the detailed design drawings and general notes has been collected to support Council's procurement process for the construction works of the proposed design.

It is acknowledged the quantities and assumed site conditions/variables in the detailed drawings and general notes may be different to those incurred during the construction phase e.g. the extent of vegetation clearance and tree removal based on actual positions of fence posts/fence segments.

The cost estimating for the proposed remedial works was carried out by a subcontracted quantity surveyor (De Waal Advisory Pty Ltd) and is presented in Appendix G of the detailed design report.

Design cost estimates were previously acquired for Council following the submission of the 100% design drawings. GHD notes a design cost estimate for the IFC design drawings and general notes will not be acquired. It is noted changes between the 100% and IFC design drawings will need to be considered during construction phase by Council and the appointed contractor

Copies of the cost estimate from the 100% and revised 100% design completion have been included in this submission of the detailed design report in Appendix G.

12. Closing remarks

This report presents the detailed design for Bega Valley Shire Council for the embankment stabilisation of a section of Dr George Mountain Road. These designs are based on assessments and our observations of geotechnical, hydraulic and other site features and assessment of hazards observable at the time of the fieldwork and design. Natural features will change and may deteriorate over time, which could change existing hazards or create new ones.

Appendices

Appendix A

General notes

GENERAL NOTES

GHD
Specialist Services in Geotechnical Engineering, Geology, Field/Laboratory Testing and Hydrogeology
www.ghd.com/Geotechnical

The report contains the results of a geotechnical investigation or study conducted for a specific purpose and client. The results may not be used or relied on by other parties, or used for other purposes, as they may contain neither adequate nor appropriate information. In particular, the investigation does not cover contamination issues unless specifically required to do so by the client.

To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the report are excluded unless they are expressly stated to apply in the report.

TEST HOLE LOGGING

The information on the test hole logs (boreholes, test pits, exposures etc.) is based on a visual and tactile assessment, except at the discrete locations where test information is available (field and/or laboratory results). The test hole logs include both factual data and inferred information. Moreover, the location of test holes should be considered approximate, unless noted otherwise (refer report). Reference should also be made to the relevant standard sheets for the explanation of logging procedures (Soil and Rock Descriptions, Core Log Sheet Notes etc.).

GROUNDWATER

Unless otherwise indicated, the water depths presented on the test hole logs are the depths of free water or seepage in the test hole recorded at the given time of measuring. The actual groundwater depth may differ from this recorded depth depending on material permeabilities (i.e. depending on response time of the measuring instrument). Further, variations of this depth could occur with time due to such effects as seasonal, environmental and tidal fluctuations or construction activities such as a change is ground surface level. Confirmation of groundwater levels, phreatic surfaces or piezometric pressures can only be made by appropriate surveys, instrumentation techniques and monitoring programmes.

INTERPRETATION OF RESULTS

The discussion or recommendations contained within this report normally are based on a site evaluation from discrete test hole data, often with only approximate locations (e.g. GPS). Generalised, idealised or inferred subsurface conditions (including any geotechnical cross-sections) have been assumed or prepared by interpolation and/or extrapolation of these data. As such these conditions are an interpretation and must be considered as a guide only.

CHANGE IN CONDITIONS

Local variations or anomalies in ground conditions do occur in the natural environment, particularly between discrete test hole locations or available observation sites. Additionally, certain design or construction procedures may have been assumed in assessing the soil-structure interaction behaviour of the site. Furthermore, conditions may change at the site from those encountered at the time of the geotechnical investigation through construction activities and constantly changing natural processes.

Any change in design, in construction methods, or in ground conditions as noted during construction, from those assumed or reported should be referred to GHD for appropriate assessment and comment.

GEOTECHNICAL VERIFICATION

Verification of the geotechnical assumptions and/or model is an integral part of the design process - investigation, construction verification, and performance monitoring. Variability is a feature of the natural environment and, in many instances, verification of soil or rock quality, or foundation levels, is required. There may be a requirement to extend foundation depths, to modify a foundation system and/or to conduct monitoring as a result of this natural variability. Allowance for verification by appropriate geotechnical personnel must be recognised and programmed for construction.

FOUNDATIONS

Where referred to in the report, the soil or rock quality, or the recommended depth of any foundation (piles, caissons, footings etc.) is an engineering estimate. The estimate is influenced, and perhaps limited, by the fieldwork method and testing carried out in connection with the site investigation, and other pertinent information as has been made available. The material quality and/or foundation depth remains, however, an estimate and therefore liable to variation. Foundation drawings, designs and specifications should provide for variations in the final depth, depending upon the ground conditions at each point of support, and allow for geotechnical verification.

REPRODUCTION OF REPORTS

Where it is desired to reproduce the information contained in our geotechnical report, or other technical information, for the inclusion in contract documents or engineering specification of the subject development, such reproductions must include at least all of the relevant test hole and test data, together with the appropriate Standard Description sheets and remarks made in the written report of a factual or descriptive nature.

Ref: DS5.5.1 Issue 0 Date: 05/10/2018

Appendix B

Site photographs

Appendix B – Section 1

Photographs taken by GHD Engineering Geologist during site investigation (10-12 August 2021)

Photo 1: Looking west towards the site, note steep sloping embankment (dated 10 August 2021).

Photo 2: Looking east towards the site (dated 10 August 2021).

Photo 3 Looking northwest towards the westernmost portion of the site and surrounds (dated 10 August 2021).

Photo 4: Approximately 100 m west of the site looking east, note topographic grade (dated 12 August 2021).

Photo 5: Looking south towards natural valley upslope of the site (dated 10 August 2021).

Photo 6: Looking south towards the easternmost rock cut within the site vicinity (dated 10 August 2021).

Photo 7: Looking north from the base of the fill batter towards part of the retaining wall (dated 11 August 2021).

Photo 8: Standing on retaining wall looking down slope, note heavily vegetated fill batter (dated 10 August 2021).

Photo 9: Looking east towards the site, standing on access road built in 2010 for construction of the current retainment structure (dated 11 August 2021).

Photo 10: Close up shot of the area around culvert pipe outlet in the retaining wall (dated 10 August 2021).

Photo 11: Close up shot of decomposing logs hollowing out from the centre. Note material washout behind the timber logs and backfill material consisting of large granodiorite boulders (dated 10 August 2021).

Photo 12: Approximate chainage CH770. Not tension cracks forming in the eastbound lane (downslope side). Areas of the eastbound lane are also slightly depressed (dated 10 August 2021).

Photo 13: Looking east towards tension cracks in eastbound lane, nearby to the centreline (dated 10 August 2021).

Photo 14: Close up photo of hole in the road shoulder between the road and steel guardrail (dated 10 August 2021).

Photo 15: Looking east from the retaining wall, note holes and erosion in shoulder extending down behind the retaining structures (dated 10 August 2021).

Photo 16: Close up shot of inside the northernmost culvert pipe, note slight damage in the pipe connection of the first pipe segment (dated 10 August 2021).

Photo 17: Close up photo of the tension crack in the road shoulder, several deep holes up to 100 mm deep are present and in some areas a step 50 mm in height has formed (dated 27 July 2021).

Appendix B – Section 2

Historical photographs provided by private property owner through BVSC

Photo 18: Installation of the second road drain (dated 22 August 2013).

Photo 19: Looking down towards the construction of the filter dam adjacent to the road shoulder. Note the sloping embankment and erosion features below the steel guard rails (dated 19 August 2010).

Photo 20: Restored roadside and two culvert pipes (dated 21 May 2010).

Photo 21: Looking up towards the restored roadside and two culvert pipes. Note erosion below the retaining way structure (dated 21 May 2010).

Photo 22: Road collapse behind and around the steel guard rail, noting the steep sloping embankment (undated).

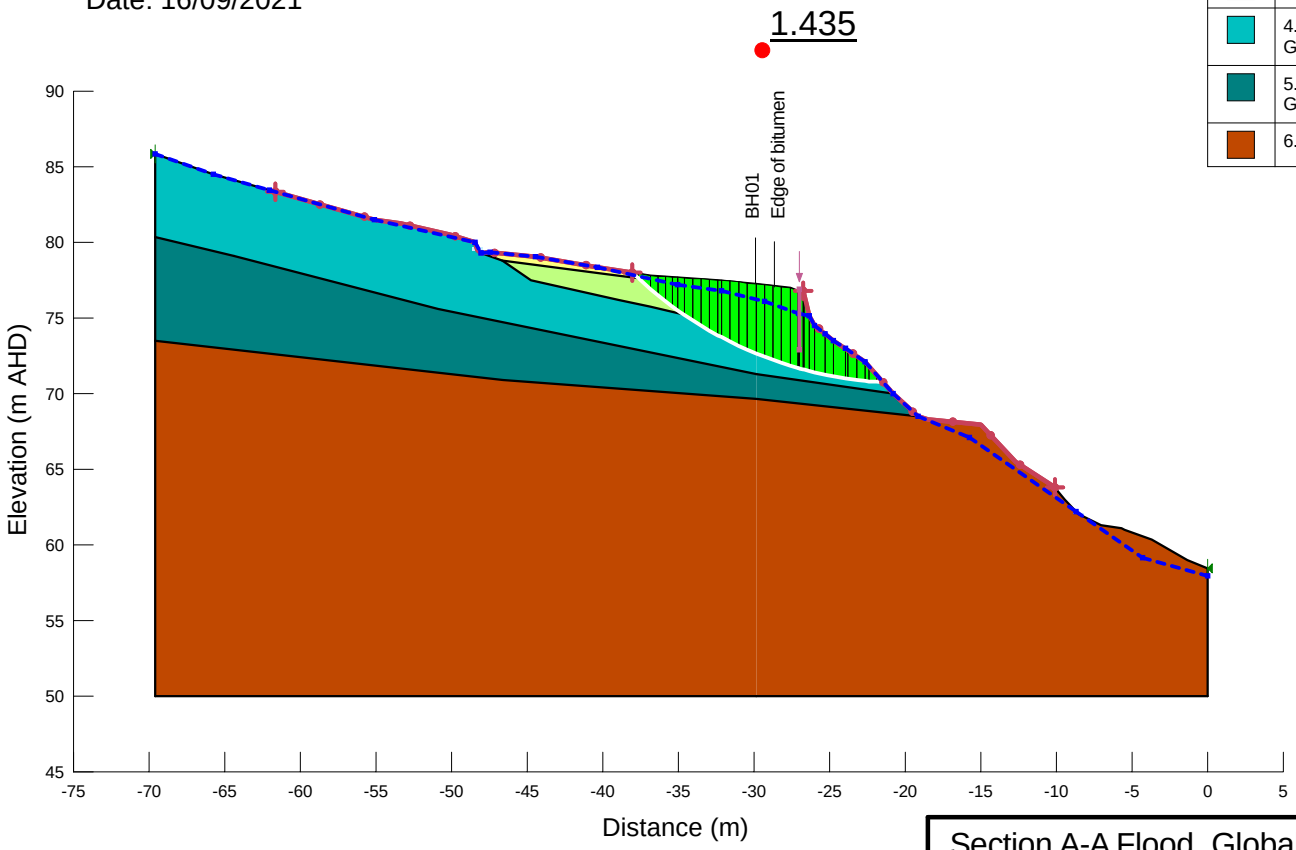
Photo 23: Rock filter dam at the base of the two culvert pipes (dated 21 May 2010).

Appendix C

Slope stability assessment

12554564 Dr George Mountain Road Slope Remediation
50% Design Slope Stability Assessment
Model: Flood condition
Method: Morgenstern-Price
PWP Conditions from: Piezometric Line during flood condition
Section: A-A
Date: 16/09/2021

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	1. Fill (D-VD)	19	0	33
	2. Fill (VD)	20	0	35
	4. XW to HW Granodiorite	22	15	30
	5. MW to Fr Granodiorite	24	500	35
	6. SW to Fr Basalt			



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Model: Flood condition
Method: Morgenstern-Price
PWP Conditions from: Piezometric Line during flood condition
Section: A-A
Date: 16/09/2021

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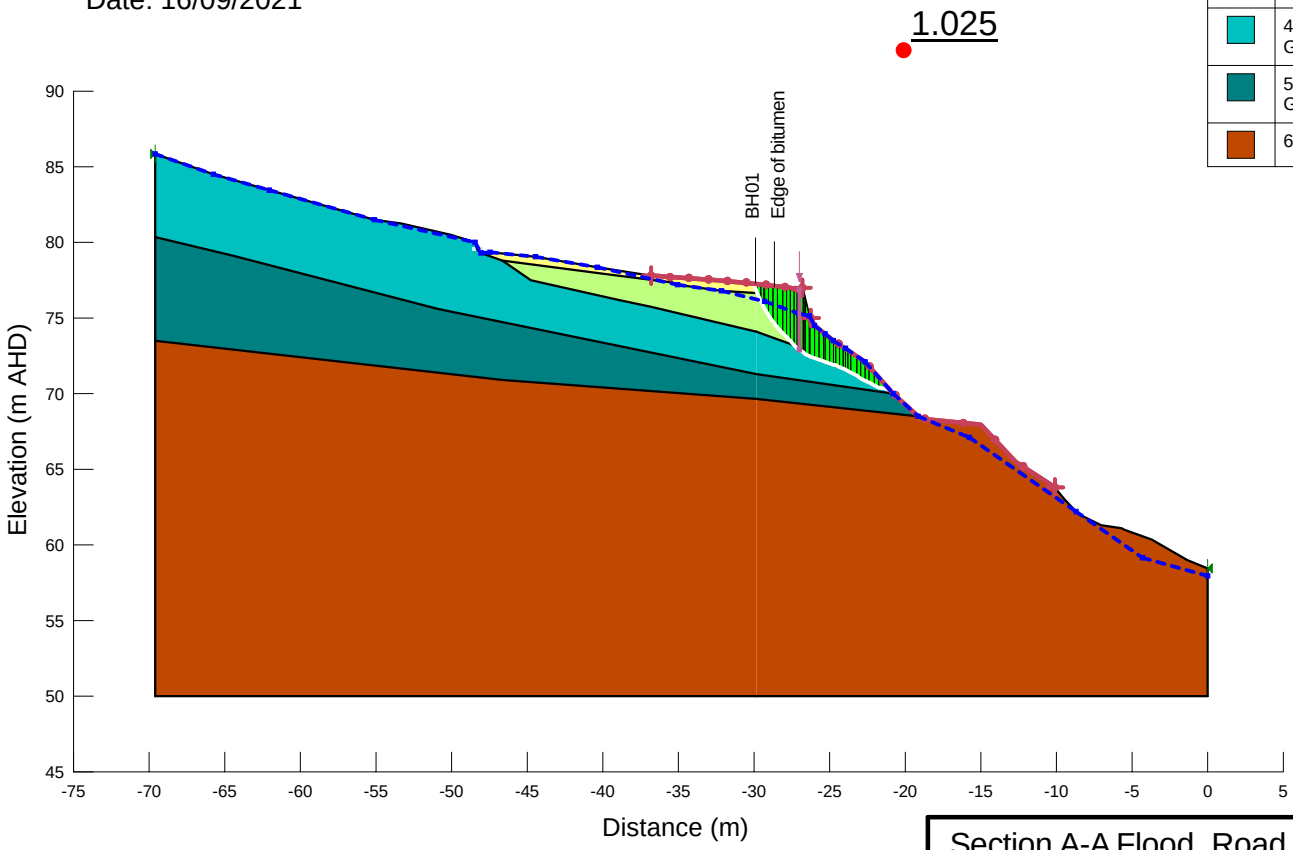

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Model: Flood condition
Method: Morgenstern-Price
PWP Conditions from: Piezometric Line during flood condition
Section: A-A
Date: 16/09/2021

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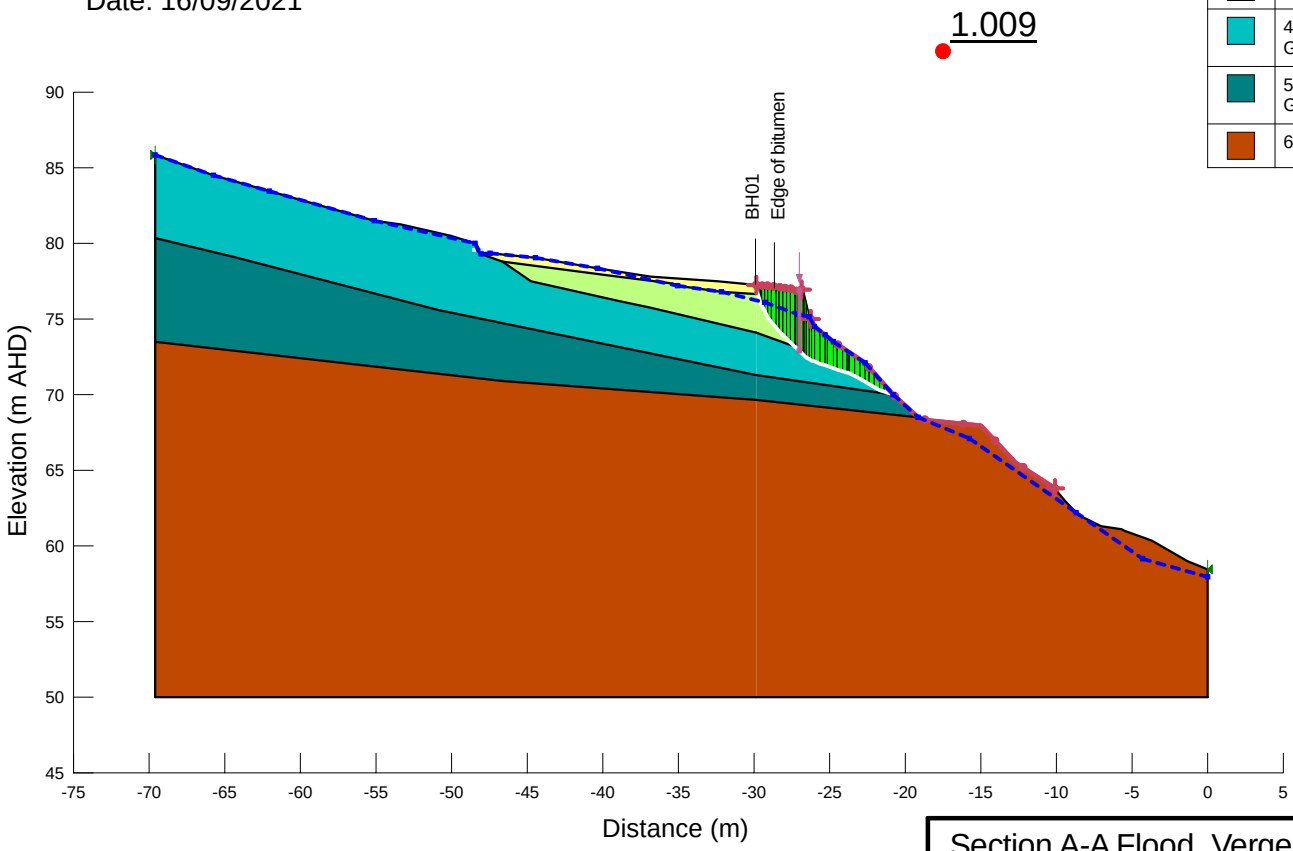

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Method: Morgenstern-Price
PWP Conditions from: Piezometric Line during normal condition
Section: A-A
Date: 16/09/2021

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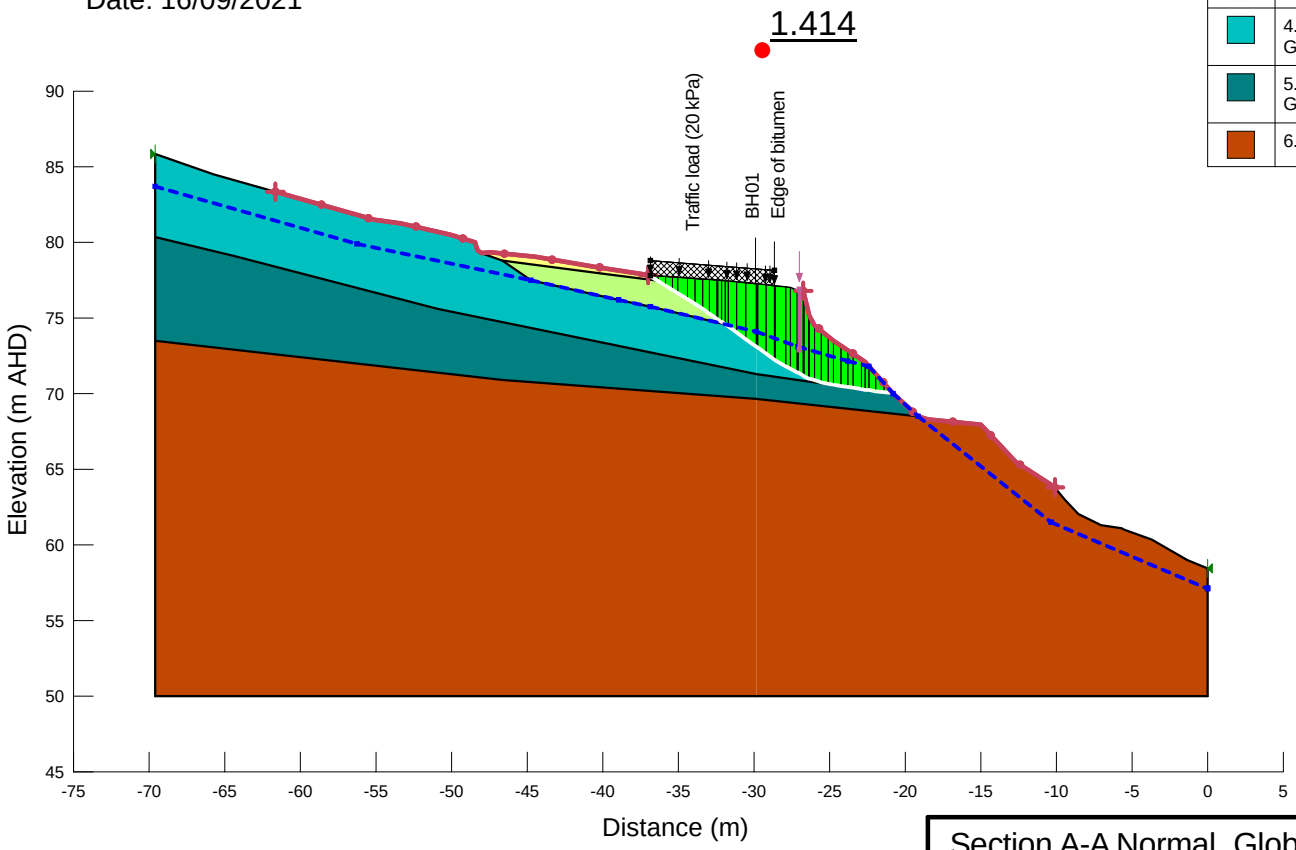

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Model: Normal condition
Method: Morgenstern-Price
PWP Conditions from: Piezometric Line during normal condition
Section: A-A
Date: 16/09/2021

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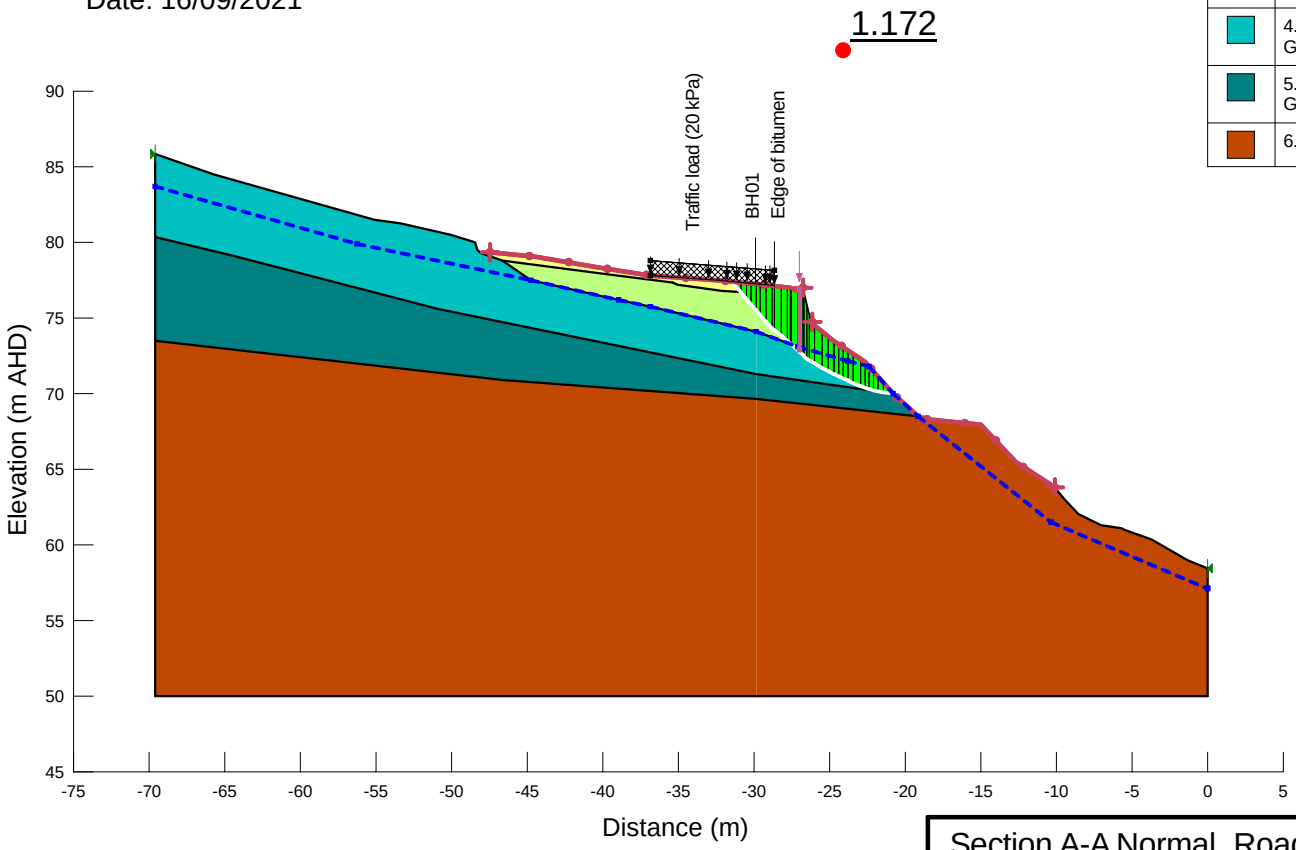

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Model: Normal condition
Method: Morgenstern-Price
PWP Conditions from: Piezometric Line during normal condition
Section: A-A
Date: 16/09/2021

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	5. MW to Fr Granodiorite	24	500	35
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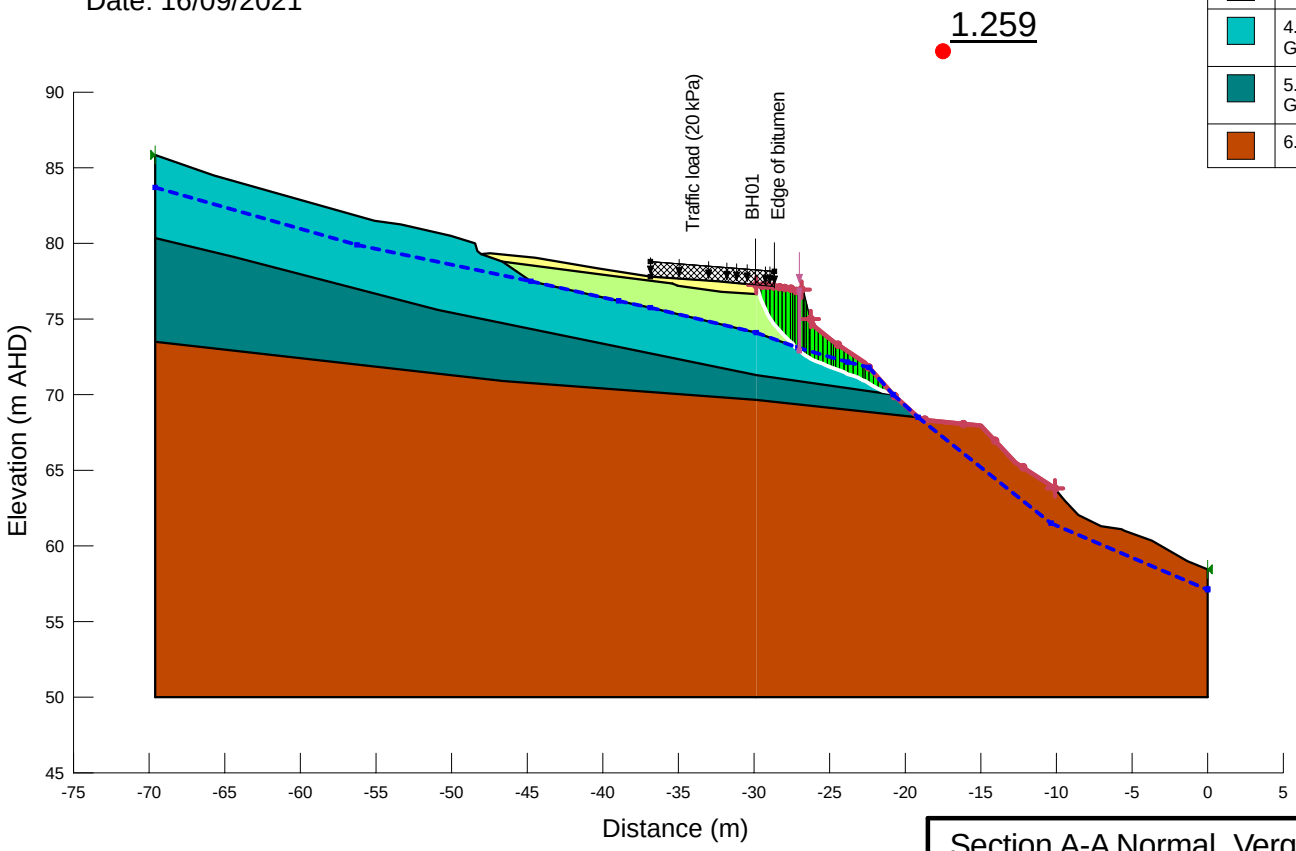

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12554564 Dr George Mountain Road Slope Remediation
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Model: Flood condition
Method: Morgenstern-Price
PWP Conditions from: Piezometric Line during flood condition
Section: B-B
Date: 16/09/2021

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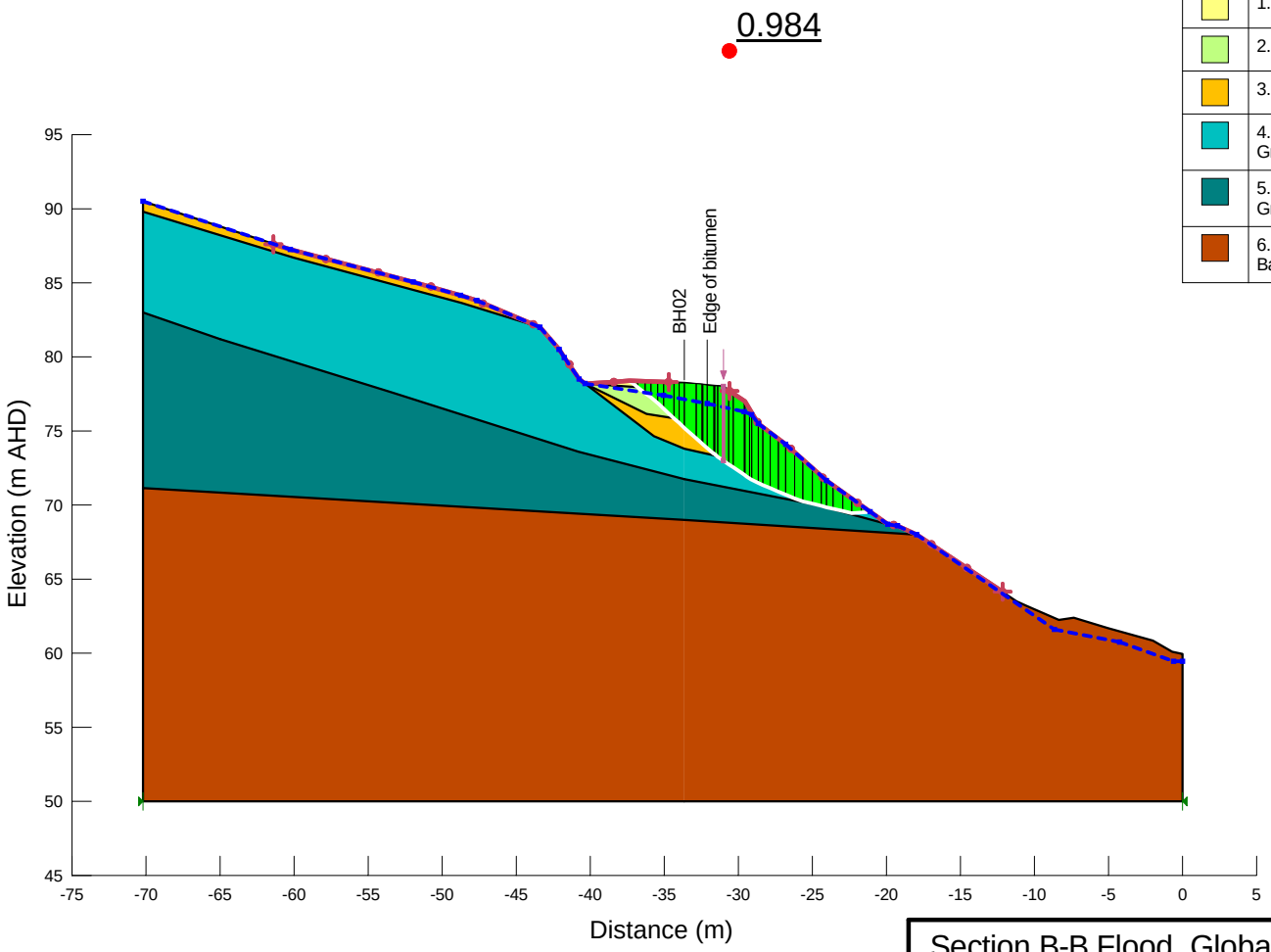

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Model: Flood condition
Method: Morgenstern-Price
PWP Conditions from: Piezometric Line during flood condition
Section: B-B
Date: 16/09/2021

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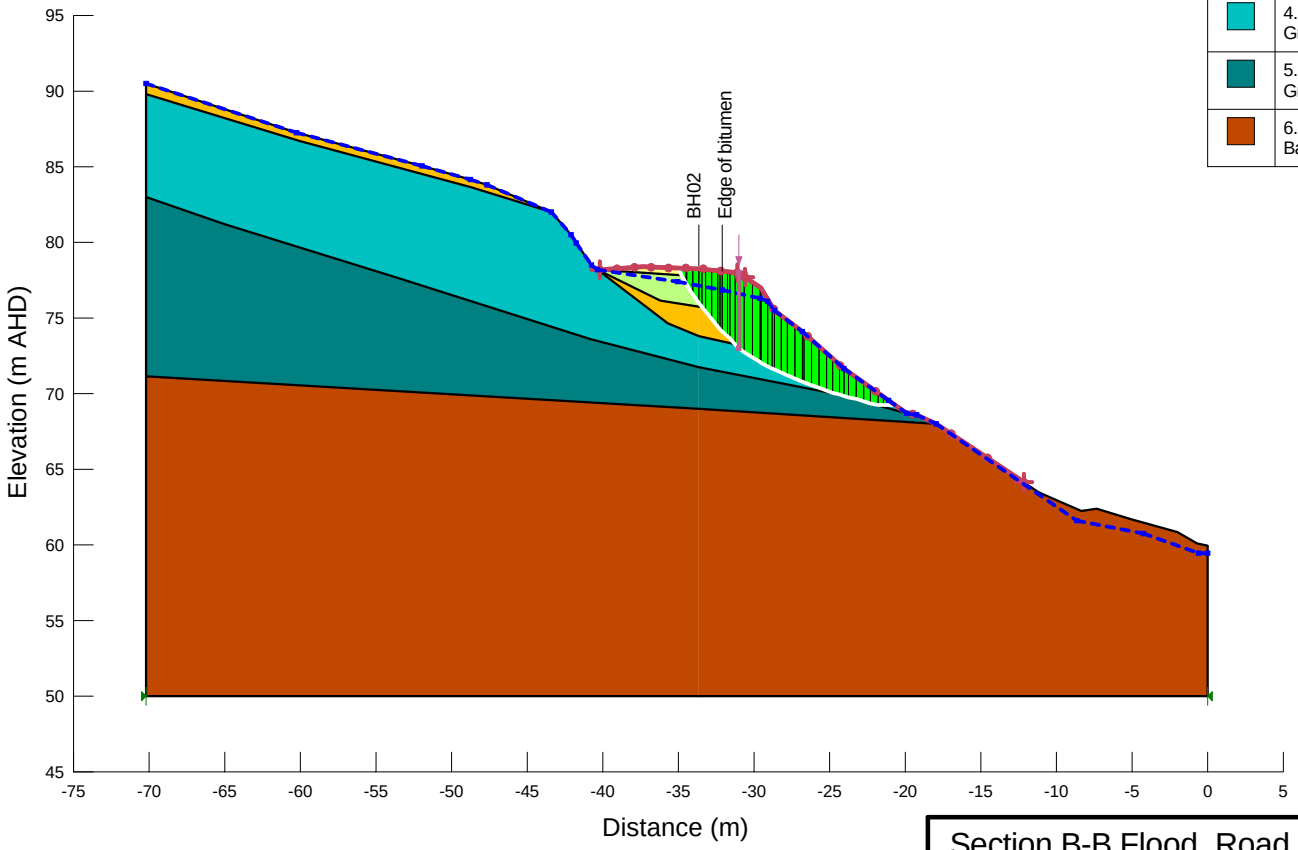

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50% Design Slope Stability Assessment
Model: Flood condition
Method: Morgenstern-Price
PWP Conditions from: Piezometric Line during flood condition
Section: B-B
Date: 16/09/2021

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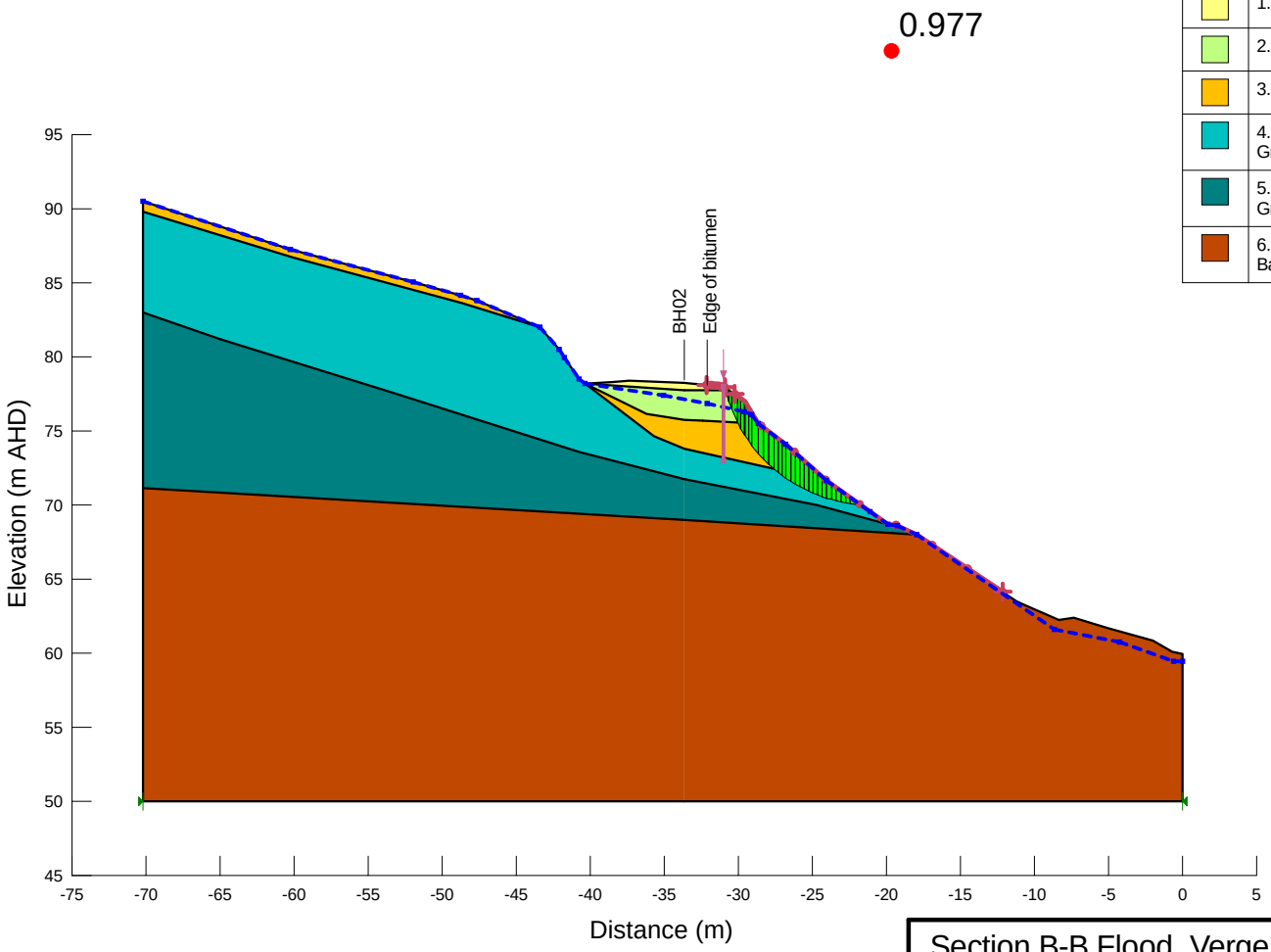

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50% Design Slope Stability Assessment
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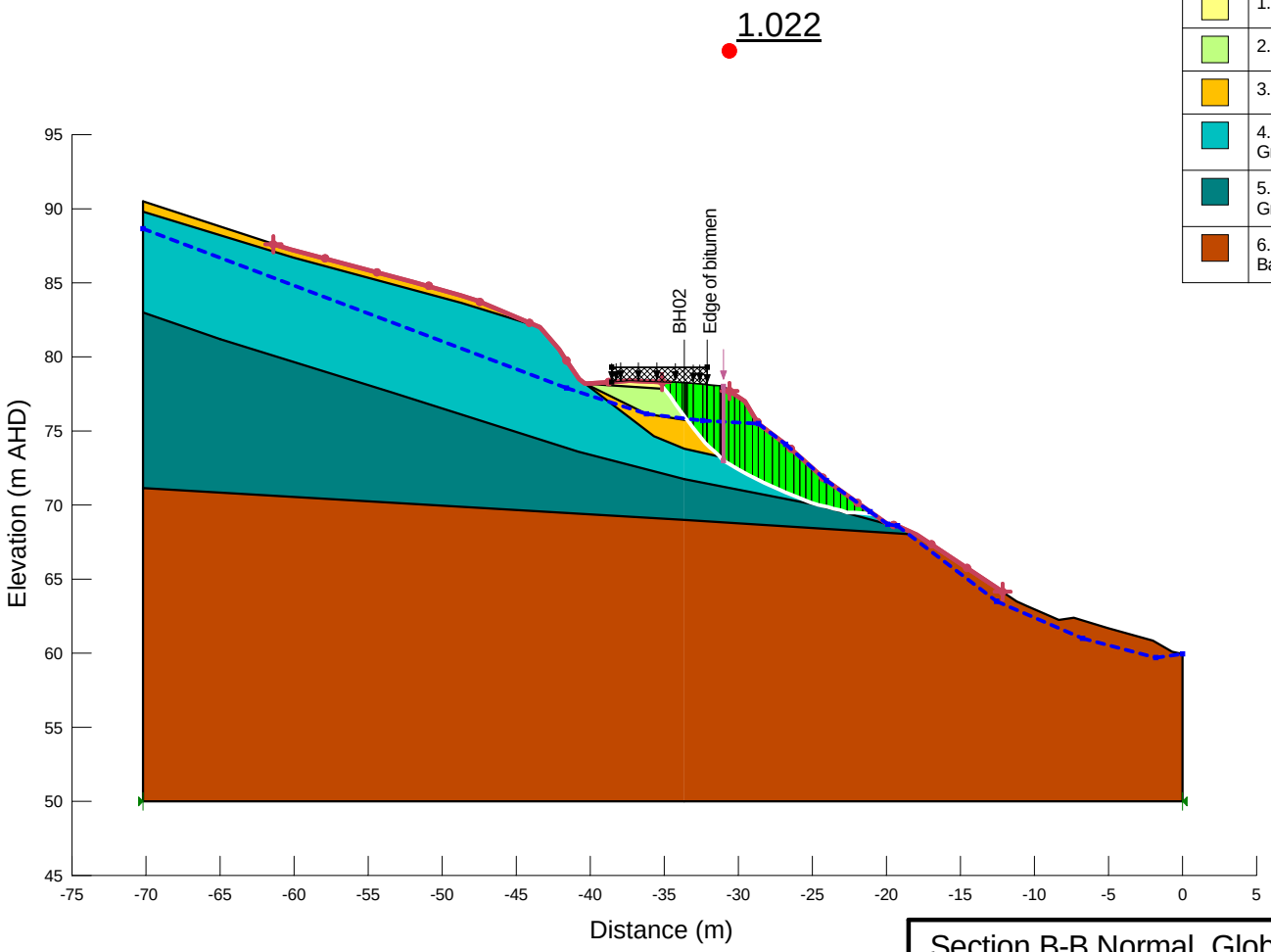

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50% Design Slope Stability Assessment
Model: Normal condition
Method: Morgenstern-Price
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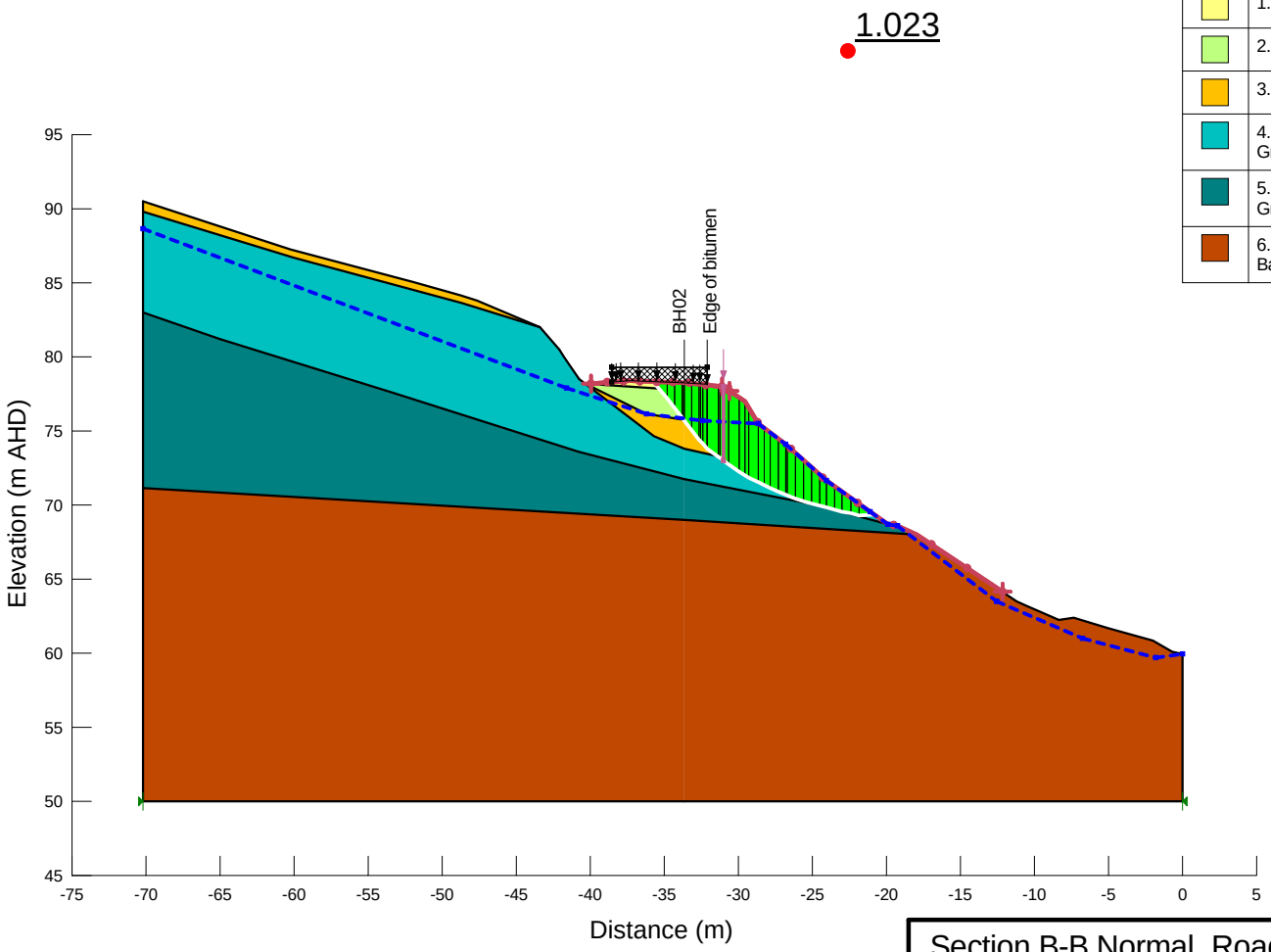

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50% Design Slope Stability Assessment
Model: Normal condition
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PWP Conditions from: Piezometric Line during normal condition
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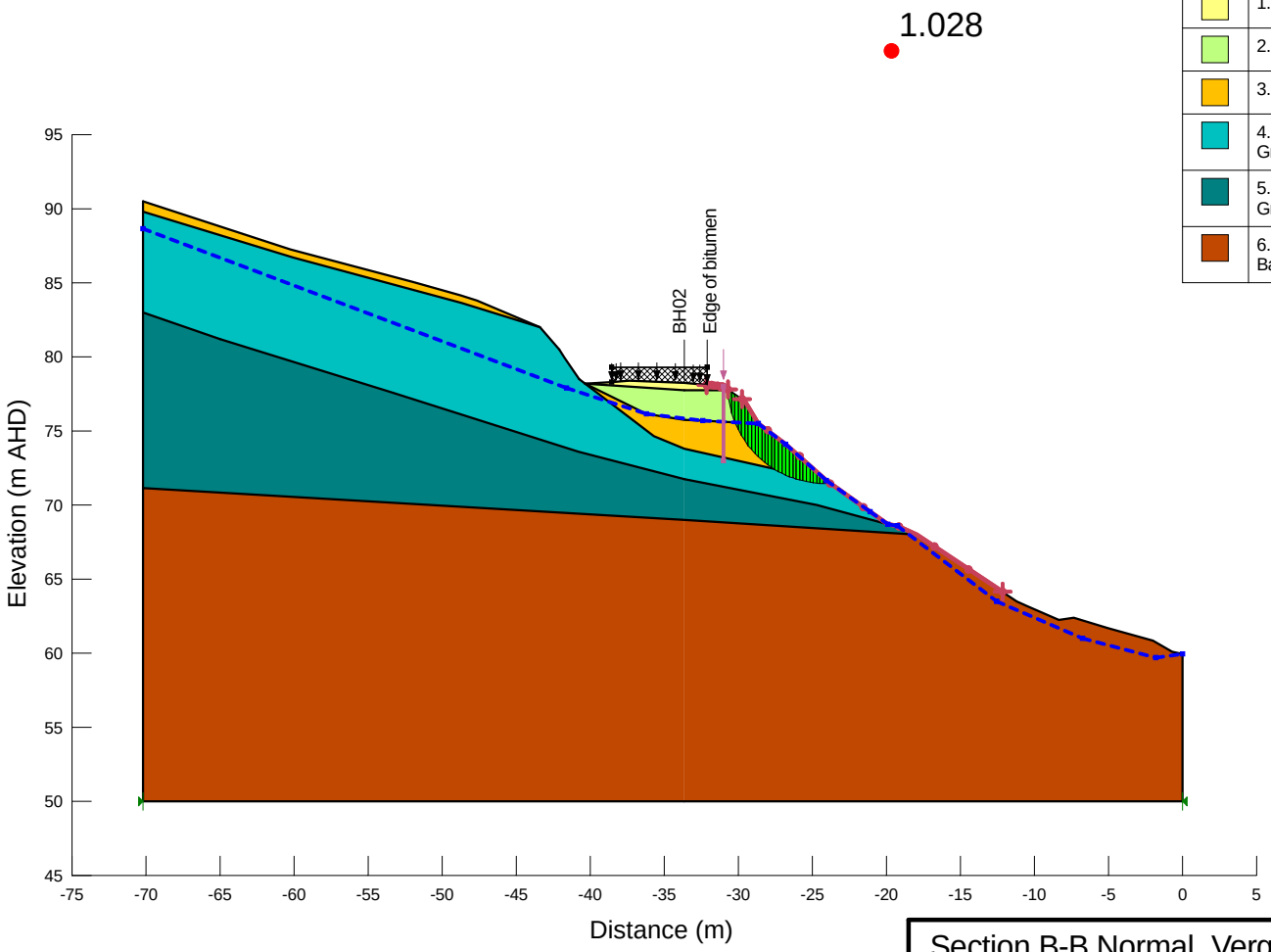

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50% Design Slope Stability Assessment
Model: Flood condition
Method: Morgenstern-Price
PWP Conditions from: Piezometric Line during flood condition
Section: A-A
Date: 26/10/2021

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
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	5. MW to Fr Granodiorite	24	500	35
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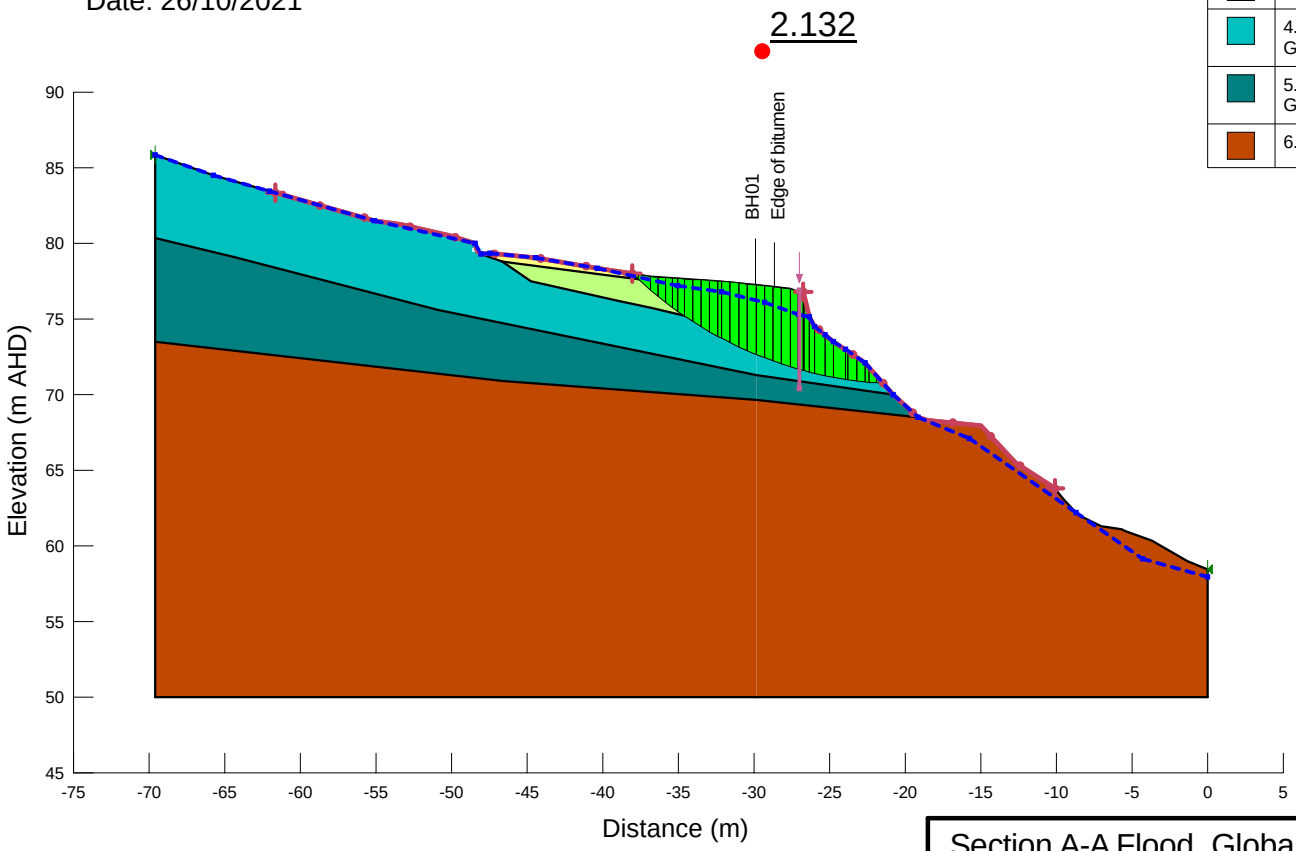

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12554564 Dr George Mountain Road Slope Remediation
50% Design Slope Stability Assessment
Model: Flood condition
Method: Morgenstern-Price
PWP Conditions from: Piezometric Line during flood condition
Section: A-A
Date: 26/10/2021

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
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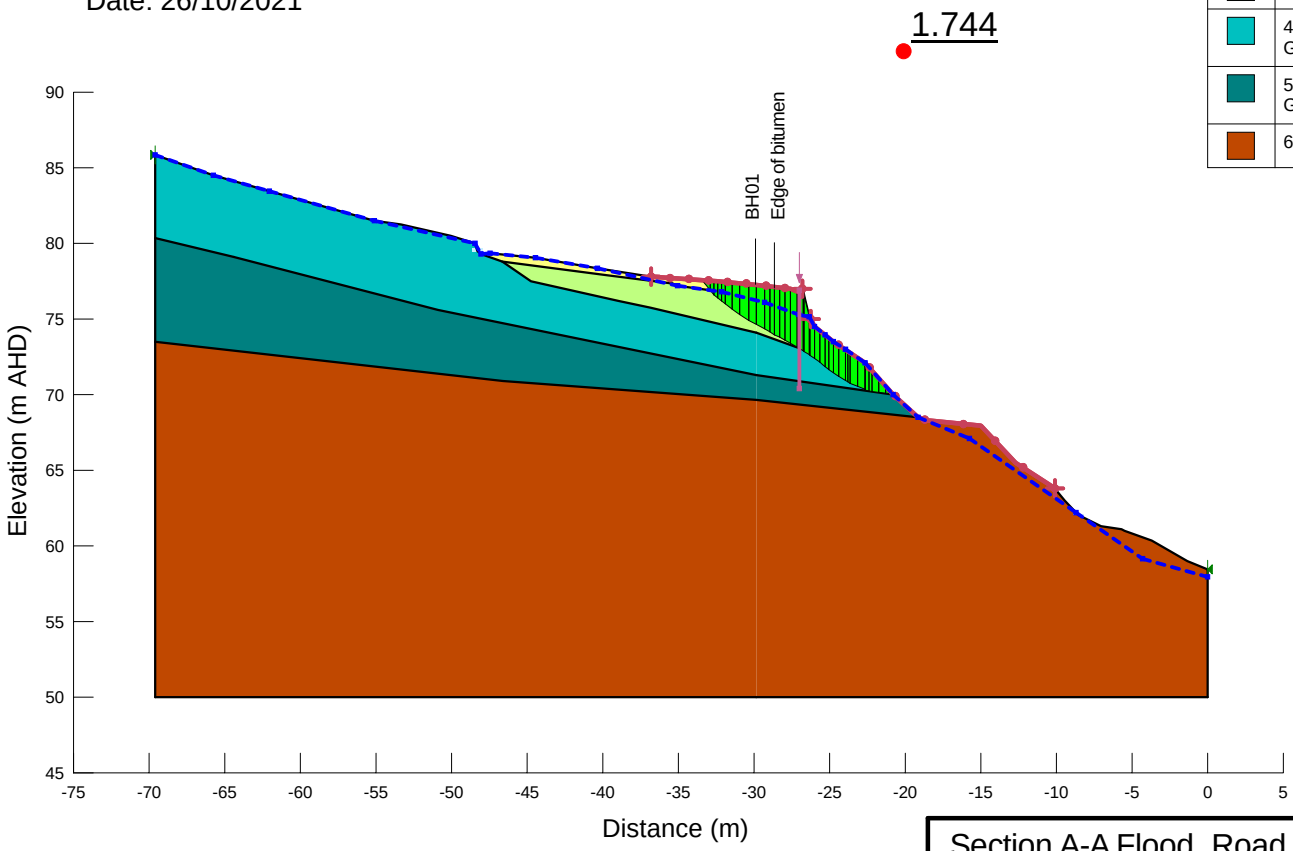

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Model: Normal condition
Method: Morgenstern-Price
PWP Conditions from: Piezometric Line during normal condition
Section: A-A
Date: 26/10/2021

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
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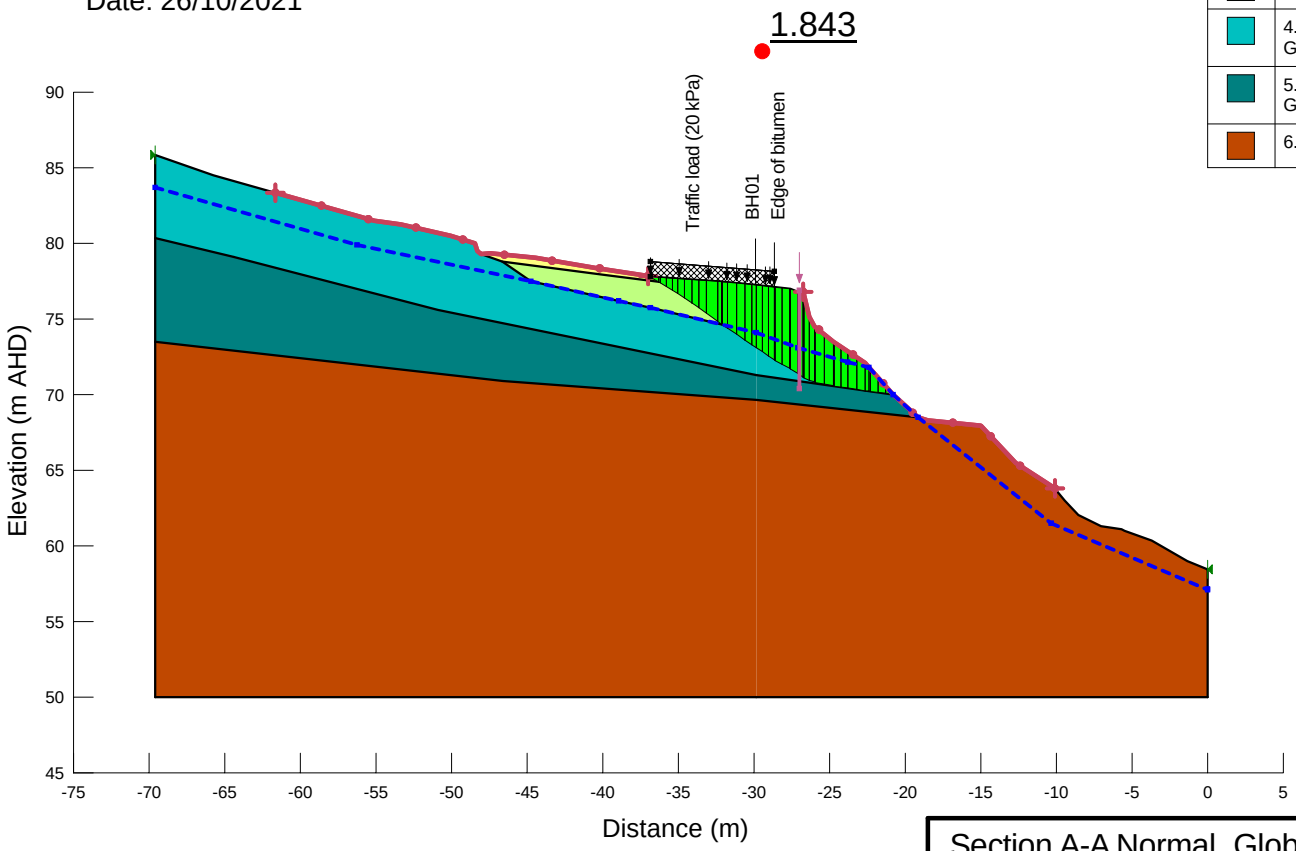


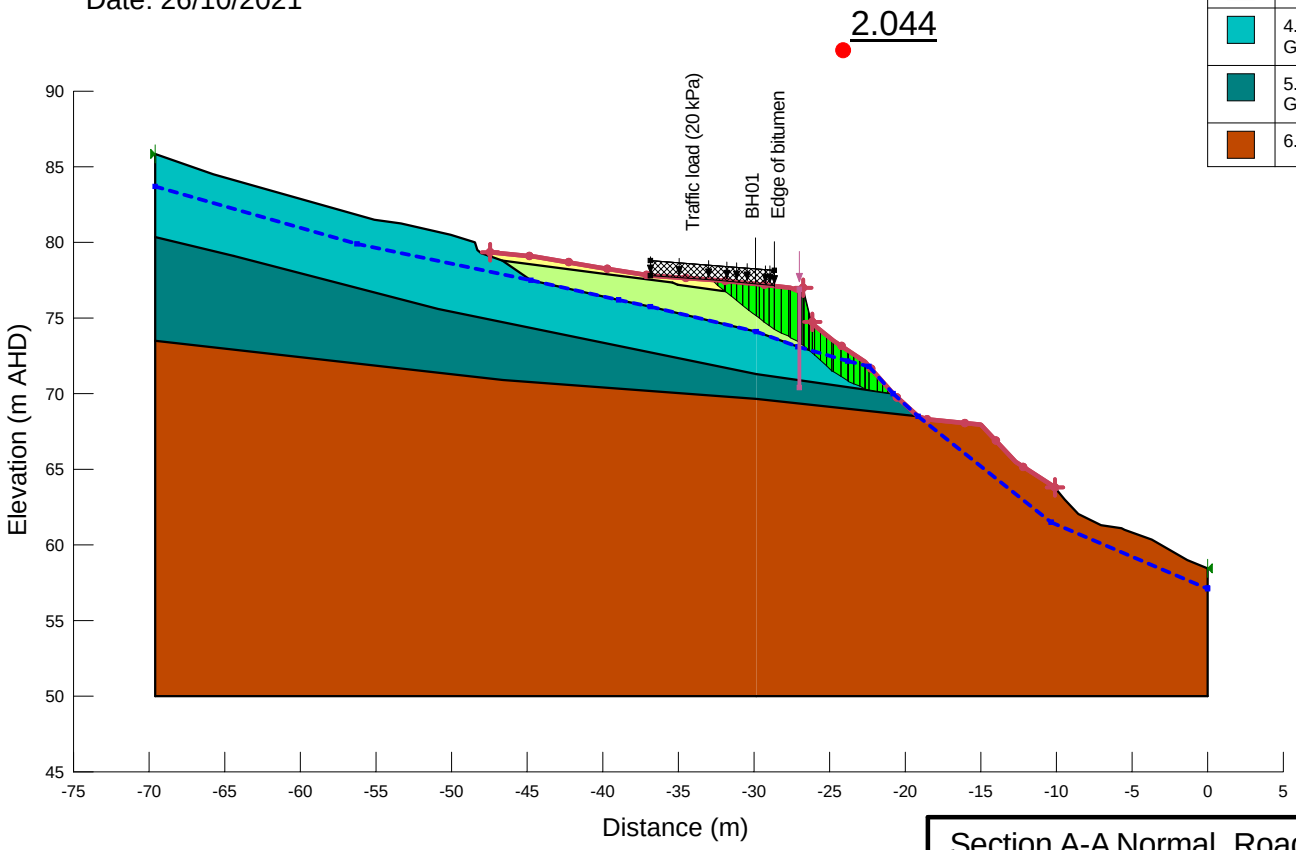
Section A-A Normal_Global Check

2021.10.26 - 100% Design Rev1.gsz

26/10/2021 1:500

12554564 Dr George Mountain Road Slope Remediation
50% Design Slope Stability Assessment
Model: Normal condition
Method: Morgenstern-Price
PWP Conditions from: Piezometric Line during normal condition
Section: A-A
Date: 26/10/2021

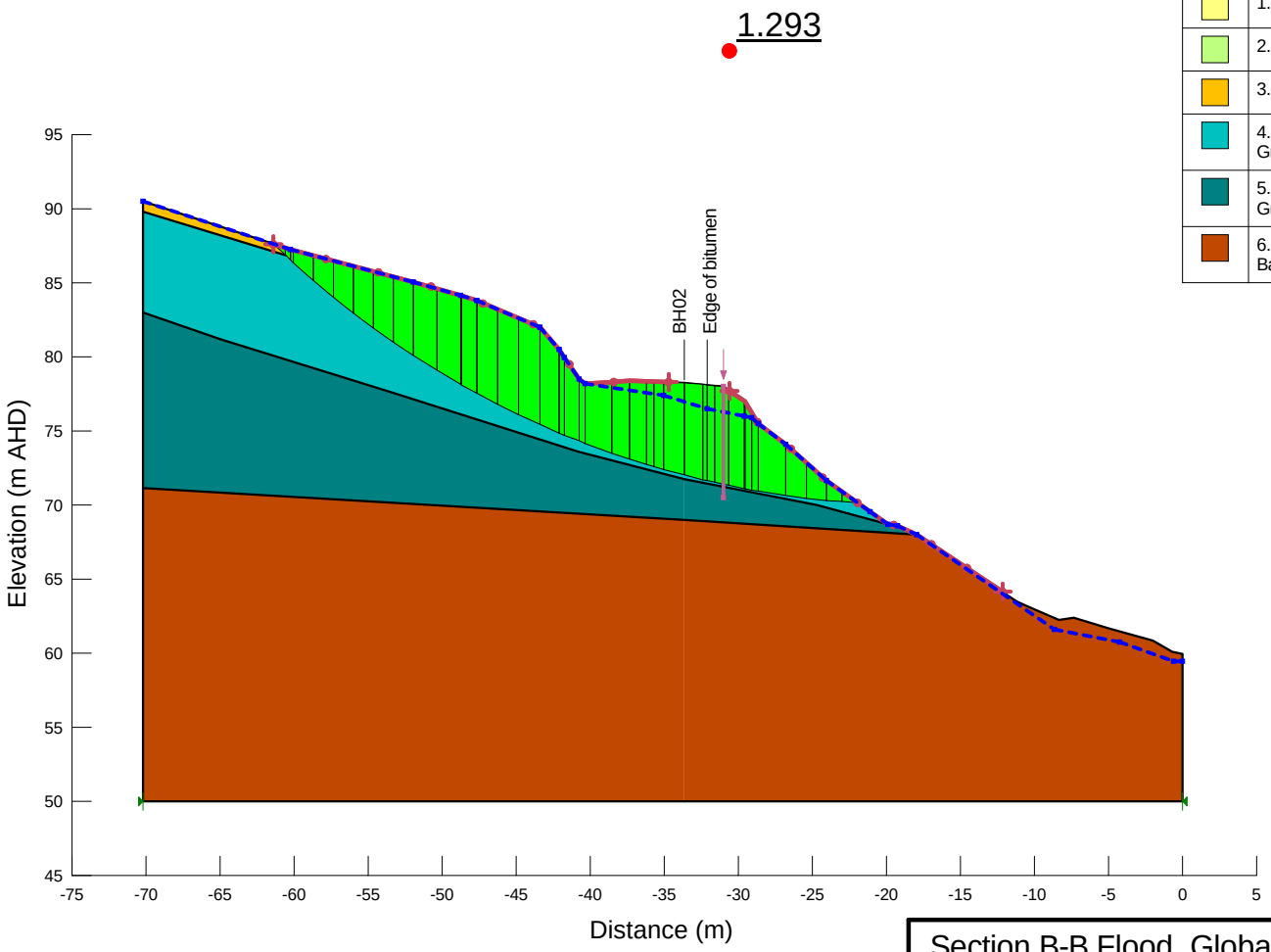
Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	1. Fill (D-VD)	19	0	33
	2. Fill (VD)	20	0	35
	4. XW to HW Granodiorite	22	15	30
	5. MW to Fr Granodiorite	24	500	35
	6. SW to Fr Basalt			



Section A-A Normal_Road Check
2021.10.26 - 100% Design Rev1.gsz
26/10/2021 1:500

12554564 Dr George Mountain Road Slope Remediation
50% Design Slope Stability Assessment
Model: Flood condition
Method: Morgenstern-Price
PWP Conditions from: Piezometric Line during flood condition
Section: B-B
Date: 26/10/2021

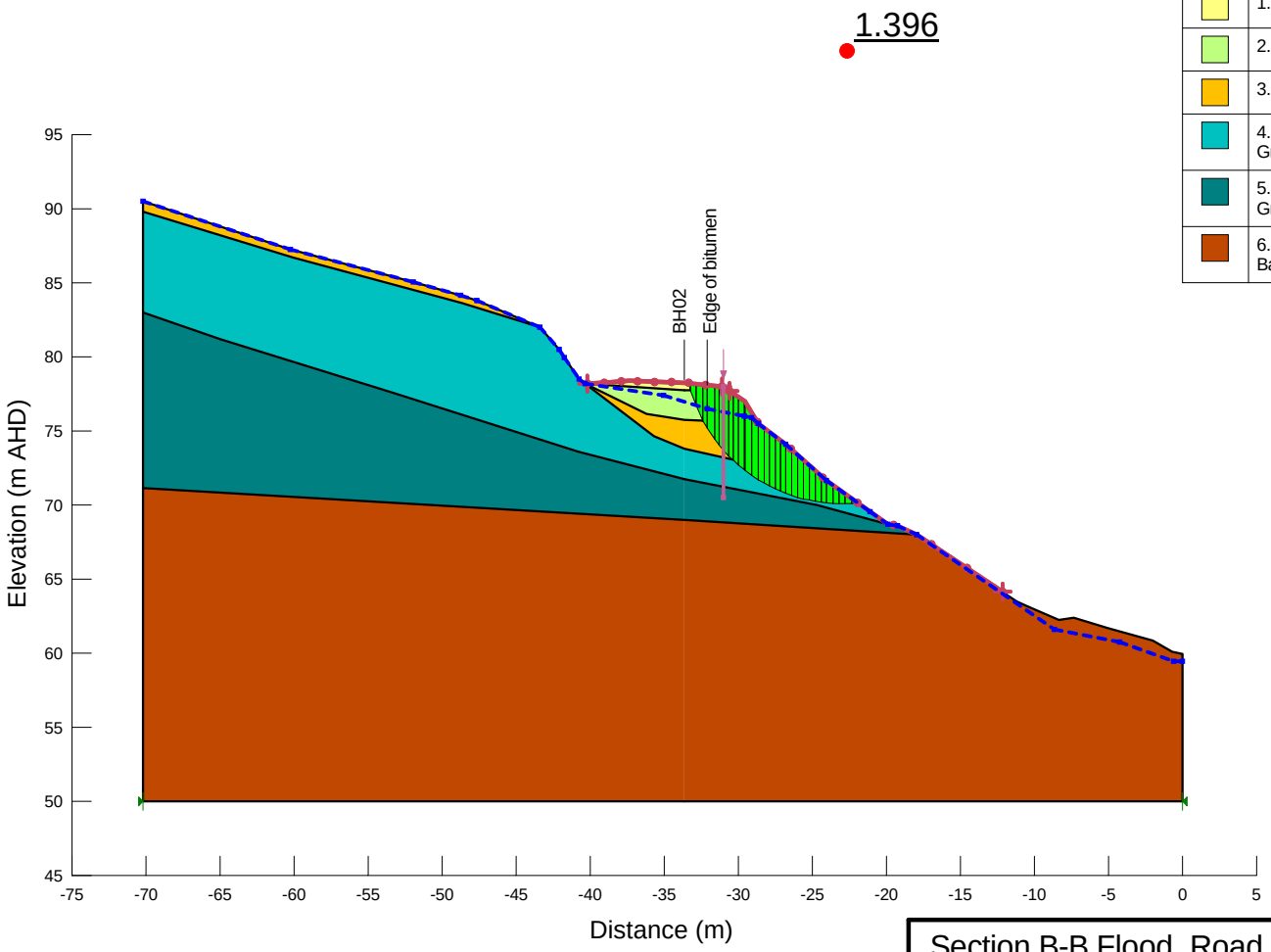
Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	1. Fill (D-VD)	19	0	33
	2. Fill (VD)	20	0	35
	3. Residual	20	2	35
	4. XW to HW Granodiorite	22	15	30
	5. MW to Fr Granodiorite	24	500	35
	6. SW to Fr Basalt			



Section B-B Flood_Global Check
2021.10.26 - 100% Design Rev1.gsz
26/10/2021 1:500

12554564 Dr George Mountain Road Slope Remediation
50% Design Slope Stability Assessment
Model: Flood condition
Method: Morgenstern-Price
PWP Conditions from: Piezometric Line during flood condition
Section: B-B
Date: 26/10/2021

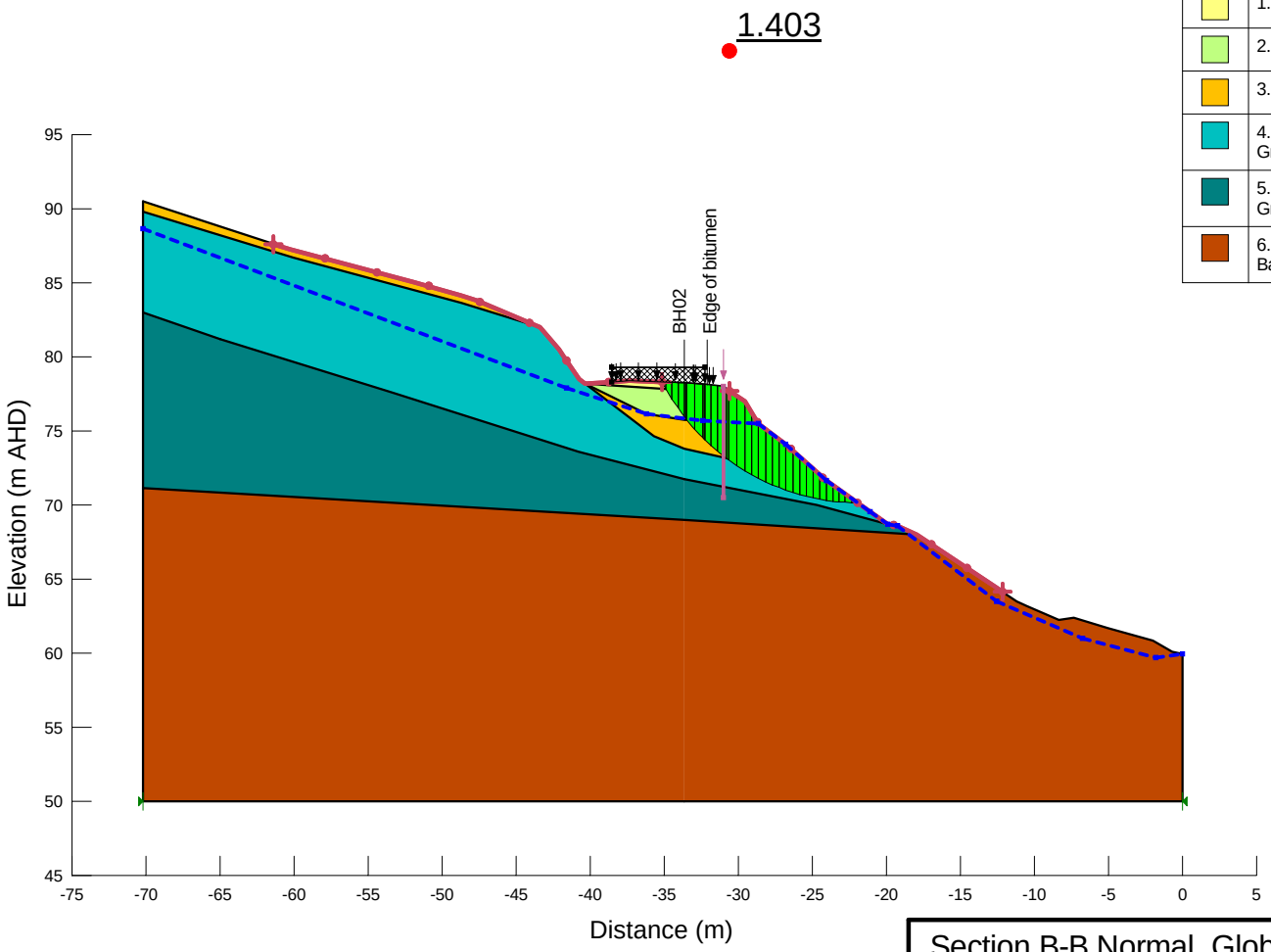
Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	1. Fill (D-VD)	19	0	33
	2. Fill (VD)	20	0	35
	3. Residual	20	2	35
	4. XW to HW Granodiorite	22	15	30
	5. MW to Fr Granodiorite	24	500	35
	6. SW to Fr Basalt			



Section B-B Flood_Road Check
2021.10.26 - 100% Design Rev1.gsz
26/10/2021 1:500

12554564 Dr George Mountain Road Slope Remediation
50% Design Slope Stability Assessment
Model: Normal condition
Method: Morgenstern-Price
PWP Conditions from: Piezometric Line during normal condition
Section: B-B
Date: 26/10/2021

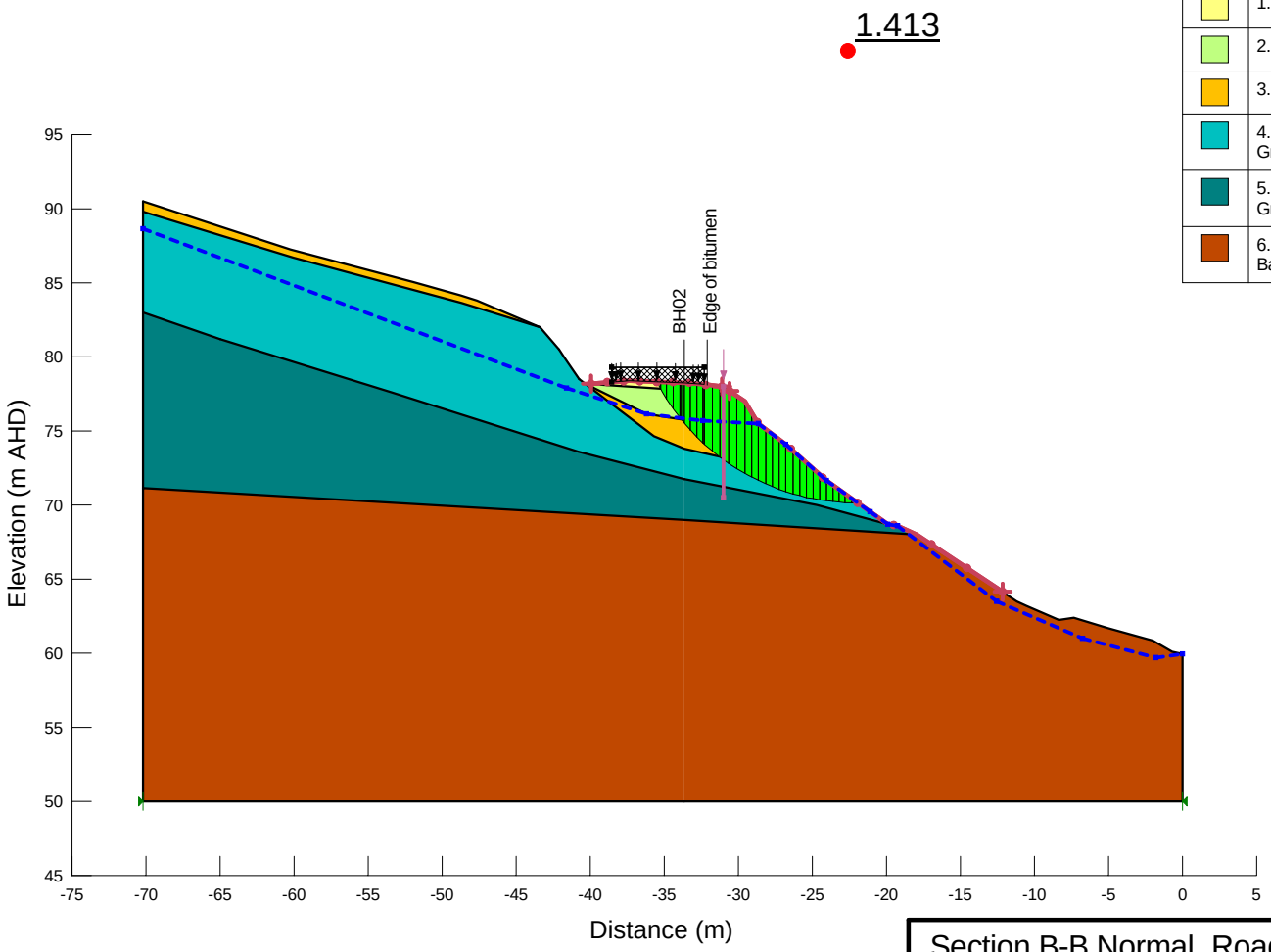
Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	1. Fill (D-VD)	19	0	33
	2. Fill (VD)	20	0	35
	3. Residual	20	2	35
	4. XW to HW Granodiorite	22	15	30
	5. MW to Fr Granodiorite	24	500	35
	6. SW to Fr Basalt			



Section B-B Normal_Global Check
2021.10.26 - 100% Design Rev1.gsz
26/10/2021 1:500

12554564 Dr George Mountain Road Slope Remediation
50% Design Slope Stability Assessment
Model: Normal condition
Method: Morgenstern-Price
PWP Conditions from: Piezometric Line during normal condition
Section: B-B
Date: 26/10/2021

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	1. Fill (D-VD)	19	0	33
	2. Fill (VD)	20	0	35
	3. Residual	20	2	35
	4. XW to HW Granodiorite	22	15	30
	5. MW to Fr Granodiorite	24	500	35
	6. SW to Fr Basalt			



Section B-B Normal_Road Check
2021.10.26 - 100% Design Rev1.gsz
26/10/2021 1:500

Appendix D

Retaining wall assessment output (WALLAP)

Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	0.00	1 Fill (Dense)	1 Fill (Dense)
2	-0.50	2 Fill (very dense)	2 Fill (very dense)
3	-2.50	3 Residual	3 Residual
4	-4.55	4 Granodiorite (EL-VL)	4 Granodiorite (EL-VL)
5	-6.35	5 Granodiorite (VH)	5 Granodiorite (VH)
6	-7.60	6 Basalt	6 Basalt
7	-10.00	6 Basalt	6 Basalt

SOIL PROPERTIES

-- Soil type -- No.	Description (Datum elev.)	Bulk density kN/m3	Young's Modulus Eh,kN/m2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion kN/m2 (dc/dy)
1	Fill (Dense)	19.00a	18000	0.500	OC	0.283	4.369	
		20.00b			(0.200)	(0.000)	(0.000)	
2	Fill (very dense)	20.00a	25000	0.470	OC	0.260	4.964	
		21.00b			(0.200)	(0.000)	(0.000)	
3	Residual	20.00a	19000	0.430	OC	0.227	6.084	
		21.00b			(0.200)	(0.000)	(0.000)	
4	Granodiorite (EL-VL)	22.00a	75000	0.500	OC	0.337	3.442	10.50d
		23.00b			(0.300)	(1.360)	(5.007)	
5	Granodiorite (VH)	24.00a	150000	0.430	OC	0.227	6.084	350.0d
		25.00b			(0.200)	(1.104)	(7.261)	
6	Basalt	24.00a	130000	0.440	OC	0.237	4.236	280.0d
		25.00b			(0.200)	(1.131)	(5.720)	

Note: (a) and (b) are Bulk Densities above and below the water table

Additional soil parameters associated with Ka and Kp

------- Soil type ------- No.	Description	--- parameters for Ka --- Soil friction angle	Wall adhesion coeff.	Back-fill angle	--- parameters for Kp --- Soil friction angle	Wall adhesion coeff.	Back-fill angle
1	Fill (Dense)	30.00	0.667	0.00	30.00	0.500	0.00
2	Fill (very dense)	32.00	0.667	0.00	32.00	0.500	0.00
3	Residual	35.00	0.667	0.00	35.00	0.500	0.00
4	Granodiorite (EL-VL)	26.00	0.667	0.00	26.00	0.500	0.00
5	Granodiorite (VH)	35.00	0.667	0.00	35.00	0.500	0.00
6	Basalt	34.00	0.667	0.00	29.50	0.500	0.00

GROUND WATER CONDITIONS

Density of water = 10.00 kN/m3

	Left side	Right side
Initial water table elevation	-3.50	-3.50

Automatic water pressure balancing at toe of wall : No

Water press. profile no.	Left side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2	Right side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2
1	1	-3.50	-3.50	0.0	1	-3.50	-3.50	0.0
2	1	-1.50	-1.50	0.0	1	-3.50	-3.50	0.0

WALL PROPERTIES

```
                        Type of structure = Soldier Pile Wall
                     Soldier Pile width =  0.45 m
                   Soldier Pile spacing =  0.90 m
             Passive mobilisation factor =  3.00
                Elevation of toe of wall = -6.50
           Maximum finite element length =  0.40 m
                Youngs modulus of wall E = 3.0000E+07 kN/m2
             Moment of inertia of wall I = 2.2365E-03 m4/m run
                                         = 2.0129E-03 m4 per pile
                                     E.I = 67096 kN.m2/m run
                   Yield Moment of wall = Not defined
```

HORIZONTAL and MOMENT LOADS/RESTRAINTS

Load no.	Elevation	Horizontal load kN/m run	Moment load kN.m/m run	Moment restraint kN.m/m/rad	Partial factor (Category)
1	0.00	47.40	0	0	N/A
2	0.00	150.0	0	0	N/A
3	-0.50	8.500	0	0	N/A
4	-1.00	8.500	0	0	N/A
5	-1.50	8.500	0	0	N/A
6	-2.00	8.500	0	0	N/A

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge kN/m2 Near edge	Surcharge kN/m2 Far edge	Equiv. soil type	Partial factor/ Category
1	0.00	1.00(L)	60.00	7.00	20.00	=	N/A	N/A

Note: L = Left side, R = Right side

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Excavate to elevation -1.50 on RIGHT side Toe of berm at elevation -3.50 Width of top of berm = 0.50 Width of toe of berm = 3.00
2	Change EI of wall to 20000 kN.m2/m run From elevation 0.00 to -1.50 Yield moment not defined Allow wall to relax with new modulus value
3	Apply surcharge no.1 at elevation 0.00
4	Remove surcharge no.1 at elevation 0.00
5	Apply water pressure profile no.2
6	Change EI of wall to 30000 kN.m2/m run From elevation -1.50 to -6.50 Yield moment not defined Allow wall to relax with new modulus value

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
- Method of analysis - Strength Factor method
- Factor on soil strength for calculating wall depth = 1.00

Parameters for undrained strata:
- Minimum equivalent fluid density = 10.00 kN/m3
- Maximum depth of water filled tension crack = 0.00 m

Bending moment and displacement calculation:
- Method - Subgrade reaction model using Influence Coefficients
- Open Tension Crack analysis? - No
- Non-linear Modulus Parameter (L) = 3.000 m

Boundary conditions:
- Length of wall (normal to plane of analysis) = 50.00 m

- Width of excavation on Left side of wall = 20.00 m
- Width of excavation on Right side of wall = 20.00 m

- Distance to rigid boundary on Left side = 20.00 m

Distance to rigid boundary on Right side = 20.00 m

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement Bending mom. Shear force	Active, Passive pressures	Graph. output
1	Excav. to elev. -1.50 on RIGHT side	Yes	Yes	Yes
2	Change EI of wall to 20000kN.m2/m run	Yes	Yes	Yes
3	Apply surcharge no.1 at elev. 0.00	Yes	Yes	Yes
4	Remove surcharge no.1 at elev. 0.00	Yes	Yes	Yes
5	Apply water pressure profile no.2	Yes	Yes	Yes
6	Change EI of wall to 30000kN.m2/m run	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

Units: kN,m

Stage No. 1 Excavate to elevation -1.50 on RIGHT side
Toe of berm at elevation -3.50
Width of top of berm = 0.50
Width of toe of berm = 3.00

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = -6.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
1	0.00	-1.50	Cant.	1.664	-6.39	-3.73	2.23	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall
Analysis options
Soldier Pile width = 0.45m; spacing = 0.90m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	0.00	0.00	0.002	5.26E-04	0.0	0.0		67096
2	-0.25	1.35	0.002	5.26E-04	0.2	0.0		67096
3	-0.50	2.69	0.002	5.26E-04	0.7	0.1		67096
		2.47	0.002	5.26E-04	0.7	0.1		
4	-0.75	3.76	0.002	5.25E-04	1.5	0.4		67096
5	-1.00	5.06	0.001	5.23E-04	2.6	0.9		67096
6	-1.25	6.36	0.001	5.18E-04	4.0	1.7		67096
7	-1.50	7.66	0.001	5.10E-04	5.7	2.9		67096
8	-1.75	0.44	0.001	4.96E-04	6.7	4.5		67096
		3.07	0.001	4.96E-04	6.7	4.5		
9	-2.00	-1.52	0.001	4.76E-04	6.9	6.2		67096
		-0.99	0.001	4.76E-04	6.9	6.2		
10	-2.25	-5.32	0.001	4.50E-04	6.2	7.9		67096
		-5.97	0.001	4.50E-04	6.2	7.9		
11	-2.50	-10.51	0.001	4.18E-04	4.1	9.2		67096
		-9.51	0.001	4.18E-04	4.1	9.2		
12	-2.75	-8.57	0.001	3.82E-04	1.8	10.0		67096
13	-3.00	-6.37	0.001	3.45E-04	-0.0	10.2		67096
14	-3.25	-4.40	0.000	3.07E-04	-1.4	10.0		67096
15	-3.50	-2.65	0.000	2.71E-04	-2.3	9.5		67096
16	-3.75	-1.12	0.000	2.37E-04	-2.7	8.8		67096
17	-4.00	0.22	0.000	2.05E-04	-2.8	8.1		67096
18	-4.28	1.48	0.000	1.73E-04	-2.6	7.4		67096
19	-4.55	2.54	0.000	1.45E-04	-2.1	6.7		67096
		-8.50	0.000	1.45E-04	-2.1	6.7		
20	-4.88	-4.04	0.000	1.15E-04	-4.1	5.6		67096
21	-5.20	-0.50	0.000	9.21E-05	-4.8	4.0		67096
22	-5.60	2.97	0.000	7.40E-05	-4.3	2.1		67096
23	-5.97	5.72	0.000	6.65E-05	-2.7	0.6		67096
24	-6.35	8.30	0.000	6.47E-05	-0.1	0.0		67096
		-0.38	0.000	6.47E-05	-0.1	0.0		

(continued)

Stage No.1 Excavate to elevation -1.50 on RIGHT side
Toe of berm at elevation -3.50
Width of top of berm = 0.50
Width of toe of berm = 3.00

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
25	-6.50	1.48	0.000	6.47E-05	0.0	-0.0		---

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10470
2	-0.25	0.00	4.75	1.35	20.75	1.35	1.35a	10470
3	-0.50	0.00	9.50	2.69	41.51	2.69	2.69a	10470
		0.00	9.50	2.47	47.15	2.47	2.47a	14542
4	-0.75	0.00	14.50	3.76	71.97	3.76	3.76a	14542
5	-1.00	0.00	19.50	5.06	96.79	5.06	5.06a	14542
6	-1.25	0.00	24.50	6.36	121.61	6.36	6.36a	14542
7	-1.50	0.00	29.50	7.66	146.43	7.66	7.66a	14542
8	-1.75	0.00	34.50	8.96	171.24	8.96	8.96a	14542
9	-2.00	0.00	39.50	10.25	196.06	10.25	10.25a	14542
10	-2.25	0.00	44.50	11.55	220.88	11.55	11.55a	14542
11	-2.50	0.00	49.50	12.85	245.70	12.85	12.85a	14542
		0.00	49.50	11.23	301.16	12.89	12.89	11052
12	-2.75	0.00	54.50	12.37	331.58	16.15	16.15	11052
13	-3.00	0.00	59.50	13.50	362.01	19.31	19.31	11052
14	-3.25	0.00	64.50	14.64	392.43	22.36	22.36	11052
15	-3.50	0.00	69.50	15.77	422.85	25.31	25.31	11052
16	-3.75	2.50	72.25	16.39	439.58	27.19	29.69	11052
17	-4.00	5.00	75.00	17.02	456.31	28.98	33.98	11052
18	-4.28	7.75	78.03	17.70	474.71	30.86	38.61	11052
19	-4.55	10.50	81.05	18.39	493.12	32.65	43.15	11052
		10.50	81.05	13.02	331.57	30.84	41.34	48524
20	-4.88	13.75	85.28	14.44	346.12	35.00	48.75	48524
21	-5.20	17.00	89.50	15.87	360.66	38.74	55.74	48524
22	-5.60	21.00	94.70	17.62	378.56	42.93	63.93	48524
23	-5.97	24.75	99.57	19.26	395.34	46.64	71.39	48524
24	-6.35	28.50	104.45	20.90	412.12	50.27	78.77	48524
		28.50	104.45	0.00	3176.79	41.39	69.89	87250
25	-6.50	30.00	106.70	0.00	3190.48	43.21	73.21	87250

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	-0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	-0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	-1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	-1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	17290
8	-1.75	0.00	5.00	1.30	8.52b	8.52	8.52p	17290
		0.00	5.00	1.30	5.89b	5.89	5.89p	17290
9	-2.00	0.00	10.00	2.60	11.77b	11.77	11.77p	17290
		0.00	10.00	2.60	11.25b	11.25	11.25p	17290

(continued)

Stage No.1 Excavate to elevation -1.50 on RIGHT side
Toe of berm at elevation -3.50
Width of top of berm = 0.50
Width of toe of berm = 3.00

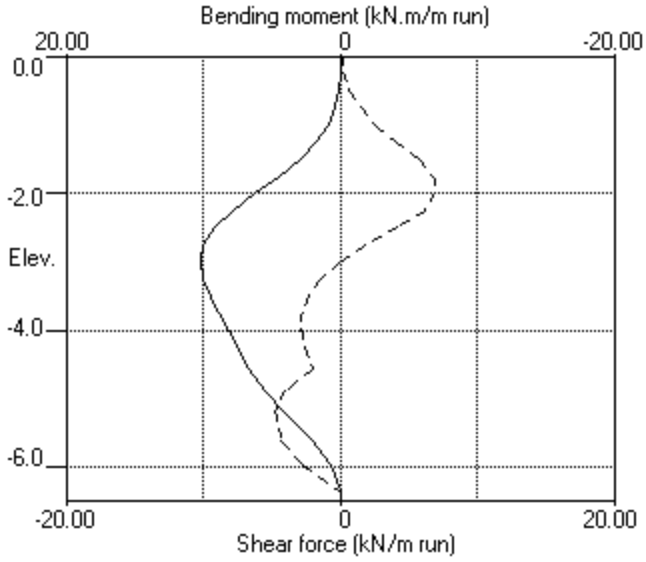
RIGHT side

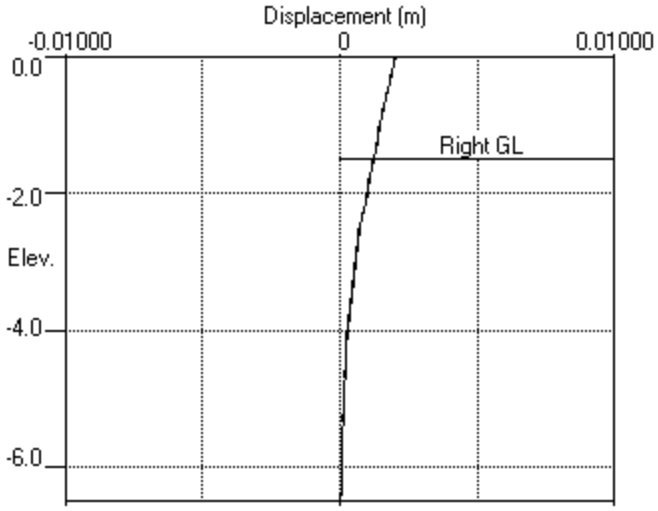
Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
10	-2.25	0.00	15.00	3.89	16.87b	16.87	16.87p	17290
		0.00	15.00	3.89	17.52b	17.52	17.52p	17290
11	-2.50	0.00	20.00	5.19	23.36b	23.36	23.36p	17290
		0.00	20.00	4.54	22.40b	22.40	22.40p	13141
12	-2.75	0.00	25.00	5.67	28.01b	24.72	24.72	13141
		0.00	25.00	5.67	29.38b	24.72	24.72	13141
13	-3.00	0.00	30.01	6.81	35.25b	25.68	25.68	13141
		0.00	30.01	6.81	37.48b	25.68	25.68	13141
14	-3.25	0.00	35.01	7.94	43.73b	26.76	26.76	13141
		0.00	35.01	7.94	46.98b	26.76	26.76	13141
15	-3.50	0.00	40.01	9.08	53.70b	27.96	27.96	13141
		0.00	40.01	9.08	38.90b	27.96	27.96	13141
16	-3.75	2.50	42.77	9.70	41.58b	28.31	30.81	13141
		2.50	42.77	9.70	55.23b	28.31	30.81	13141
17	-4.00	5.00	45.52	10.33	58.79b	28.76	33.76	13141
		5.00	45.52	10.33	72.22b	28.76	33.76	13141
18	-4.28	7.75	48.56	11.02	77.03b	29.38	37.13	13141
		7.75	48.56	11.02	90.26b	29.38	37.13	13141
19	-4.55	10.50	51.59	11.71	95.91b	30.11	40.61	13141
		10.50	51.59	3.10	140.34b	39.34	49.84	57299
20	-4.88	13.75	55.83	4.53	149.23b	39.04	52.79	57299
		13.75	55.83	4.53	135.42b	39.04	52.79	57299
21	-5.20	17.00	60.08	5.96	143.50b	39.24	56.24	57299
		17.00	60.08	5.96	150.53b	39.24	56.24	57299
22	-5.60	21.00	65.30	7.72	160.98b	39.97	60.97	57299
		21.00	65.30	7.72	168.08b	39.97	60.97	57299
23	-5.97	24.75	70.21	9.37	178.31b	40.92	65.67	57299
		24.75	70.21	9.37	184.78b	40.92	65.67	57299
24	-6.35	28.50	75.12	11.02	195.39b	41.97	70.47	57299
		28.50	75.12	0.00	2998.33	41.77	70.27	103741
25	-6.50	30.00	77.38	0.00	3012.11	41.73	71.73	103741

Note: 12.85a Soil pressure at active limit
22.40p Soil pressure at passive limit
195.39b Passive limit reduced because of berm

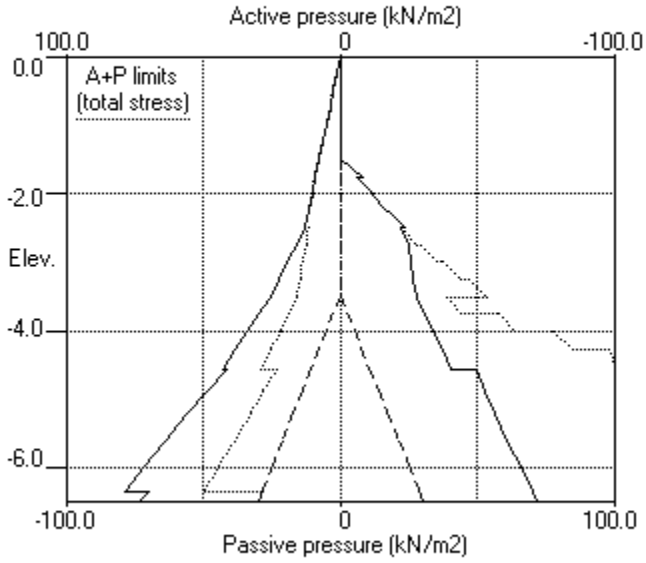
Units: kN,m

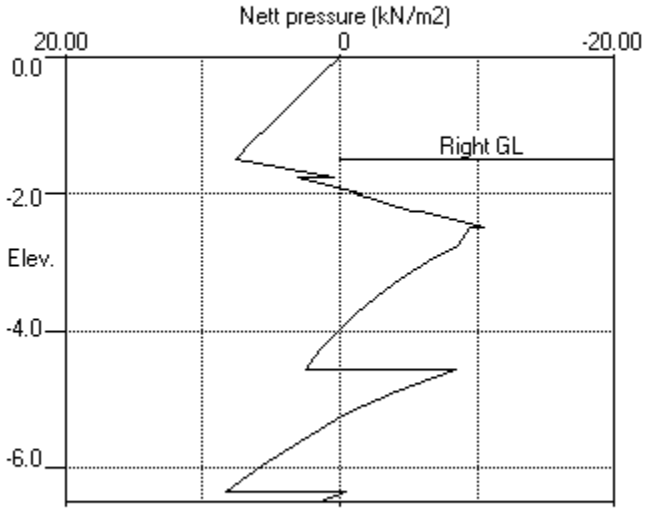
Stage No.1 Excav. to elev. -1.50 on RIGHT side





Stage No.1 Excav. to elev. -1.50 on RIGHT side





Units: kN,m

Stage No. 2 Change EI of wall to 20000 kN.m2/m run
From elevation 0.00 to -1.50
Yield moment not defined
Allow wall to relax with new modulus value

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = -6.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr-ation	Direction of failure
2	0.00	-1.50	Cant.	1.664	-6.39	-3.73	2.23	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall
Analysis options
Soldier Pile width = 0.45m; spacing = 0.90m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	0.00	0.00	0.002	5.66E-04	0.0	0.0		20000
2	-0.25	1.35	0.002	5.66E-04	0.2	0.0		20000
3	-0.50	2.69	0.002	5.65E-04	0.7	0.1		20000
		2.47	0.002	5.65E-04	0.7	0.1		
4	-0.75	3.76	0.002	5.62E-04	1.5	0.4		20000
5	-1.00	5.06	0.002	5.54E-04	2.6	0.9		20000
6	-1.25	6.36	0.001	5.38E-04	4.0	1.7		20000
7	-1.50	7.66	0.001	5.10E-04	5.7	2.9		67096
8	-1.75	0.44	0.001	4.96E-04	6.7	4.5		67096
		3.07	0.001	4.96E-04	6.7	4.5		
9	-2.00	-1.52	0.001	4.76E-04	6.9	6.2		67096
		-0.99	0.001	4.76E-04	6.9	6.2		
10	-2.25	-5.32	0.001	4.50E-04	6.2	7.9		67096
		-5.97	0.001	4.50E-04	6.2	7.9		
11	-2.50	-10.51	0.001	4.18E-04	4.1	9.2		67096
		-9.51	0.001	4.18E-04	4.1	9.2		
12	-2.75	-8.57	0.001	3.82E-04	1.8	10.0		67096
13	-3.00	-6.37	0.001	3.45E-04	-0.0	10.2		67096
14	-3.25	-4.40	0.000	3.07E-04	-1.4	10.0		67096
15	-3.50	-2.65	0.000	2.71E-04	-2.3	9.5		67096
16	-3.75	-1.12	0.000	2.37E-04	-2.7	8.8		67096
17	-4.00	0.22	0.000	2.05E-04	-2.8	8.1		67096
18	-4.28	1.48	0.000	1.73E-04	-2.6	7.4		67096
19	-4.55	2.54	0.000	1.45E-04	-2.1	6.7		67096
		-8.50	0.000	1.45E-04	-2.1	6.7		
20	-4.88	-4.04	0.000	1.15E-04	-4.1	5.6		67096
21	-5.20	-0.50	0.000	9.21E-05	-4.8	4.0		67096
22	-5.60	2.97	0.000	7.40E-05	-4.3	2.1		67096
23	-5.97	5.72	0.000	6.65E-05	-2.7	0.6		67096
24	-6.35	8.30	0.000	6.47E-05	-0.1	0.0		67096
		-0.38	0.000	6.47E-05	-0.1	0.0		

(continued)

Stage No.2 Change EI of wall to 20000 kN.m2/m run
From elevation 0.00 to -1.50
Yield moment not defined
Allow wall to relax with new modulus value

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
25	-6.50	1.48	0.000	6.47E-05	0.0	-0.0		---

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19984
2	-0.25	0.00	4.75	1.35	20.75	1.35	1.35a	19984
3	-0.50	0.00	9.50	2.69	41.51	2.69	2.69a	19984
		0.00	9.50	2.47	47.15	2.47	2.47a	27756
4	-0.75	0.00	14.50	3.76	71.97	3.76	3.76a	27756
5	-1.00	0.00	19.50	5.06	96.79	5.06	5.06a	27756
6	-1.25	0.00	24.50	6.36	121.61	6.36	6.36a	27756
7	-1.50	0.00	29.50	7.66	146.43	7.66	7.66a	13710
8	-1.75	0.00	34.50	8.96	171.24	8.96	8.96a	13710
9	-2.00	0.00	39.50	10.25	196.06	10.25	10.25a	13710
10	-2.25	0.00	44.50	11.55	220.88	11.55	11.55a	13710
11	-2.50	0.00	49.50	12.85	245.70	12.85	12.85a	13710
		0.00	49.50	11.23	301.16	12.89	12.89	10420
12	-2.75	0.00	54.50	12.37	331.58	16.15	16.15	10420
13	-3.00	0.00	59.50	13.50	362.01	19.31	19.31	10420
14	-3.25	0.00	64.50	14.64	392.43	22.36	22.36	10420
15	-3.50	0.00	69.50	15.77	422.85	25.31	25.31	10420
16	-3.75	2.50	72.25	16.39	439.58	27.19	29.69	10420
17	-4.00	5.00	75.00	17.02	456.31	28.98	33.98	10420
18	-4.28	7.75	78.03	17.70	474.71	30.86	38.61	10420
19	-4.55	10.50	81.05	18.39	493.12	32.65	43.15	10420
		10.50	81.05	13.02	331.57	30.84	41.34	45884
20	-4.88	13.75	85.28	14.44	346.12	35.00	48.75	45884
21	-5.20	17.00	89.50	15.87	360.66	38.74	55.74	45884
22	-5.60	21.00	94.70	17.62	378.56	42.93	63.93	45884
23	-5.97	24.75	99.57	19.26	395.34	46.64	71.39	125122
24	-6.35	28.50	104.45	20.90	412.12	50.27	78.77	125122
		28.50	104.45	0.00	3176.79	41.39	69.89	230349
25	-6.50	30.00	106.70	0.00	3190.48	43.21	73.21	230349

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	-0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	-0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	-1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	-1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	13710
8	-1.75	0.00	5.00	1.30	8.52b	8.52	8.52p	13710
		0.00	5.00	1.30	5.89b	5.89	5.89p	13710
9	-2.00	0.00	10.00	2.60	11.77b	11.77	11.77p	13710
		0.00	10.00	2.60	11.25b	11.25	11.25p	13710

(continued)

Stage No.2 Change EI of wall to 20000 kN.m2/m run
From elevation 0.00 to -1.50
Yield moment not defined
Allow wall to relax with new modulus value

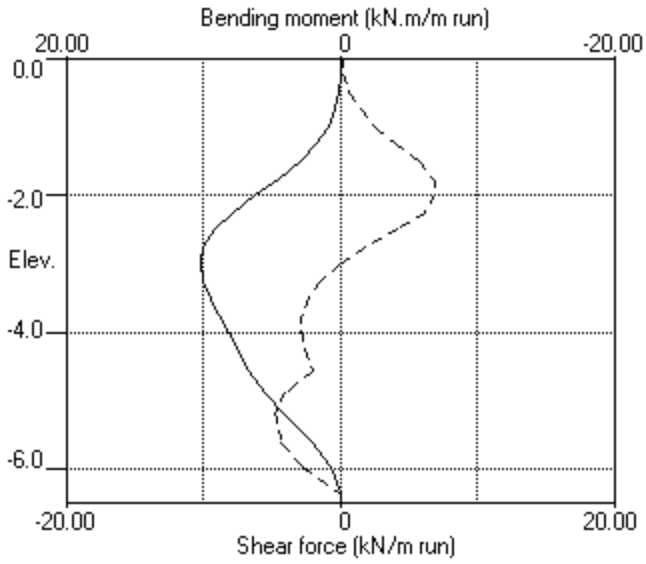
RIGHT side

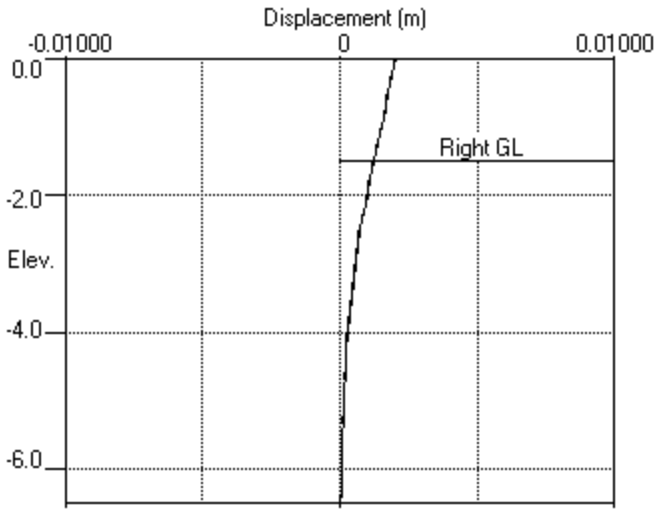
Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
10	-2.25	0.00	15.00	3.89	16.87b	16.87	16.87p	13710
		0.00	15.00	3.89	17.52b	17.52	17.52p	13710
11	-2.50	0.00	20.00	5.19	23.36b	23.36	23.36p	13710
		0.00	20.00	4.54	22.40b	22.40	22.40p	10420
12	-2.75	0.00	25.00	5.67	28.01b	24.72	24.72	10420
		0.00	25.00	5.67	29.38b	24.72	24.72	10420
13	-3.00	0.00	30.01	6.81	35.25b	25.68	25.68	10420
		0.00	30.01	6.81	37.48b	25.68	25.68	10420
14	-3.25	0.00	35.01	7.94	43.73b	26.76	26.76	10420
		0.00	35.01	7.94	46.98b	26.76	26.76	10420
15	-3.50	0.00	40.01	9.08	53.70b	27.96	27.96	10420
		0.00	40.01	9.08	38.90b	27.96	27.96	10420
16	-3.75	2.50	42.77	9.70	41.58b	28.31	30.81	10420
		2.50	42.77	9.70	55.23b	28.31	30.81	10420
17	-4.00	5.00	45.52	10.33	58.79b	28.76	33.76	10420
		5.00	45.52	10.33	72.22b	28.76	33.76	10420
18	-4.28	7.75	48.56	11.02	77.03b	29.38	37.13	10420
		7.75	48.56	11.02	90.26b	29.38	37.13	10420
19	-4.55	10.50	51.59	11.71	95.91b	30.11	40.61	10420
		10.50	51.59	3.10	140.34b	39.34	49.84	45884
20	-4.88	13.75	55.83	4.53	149.23b	39.04	52.79	45884
		13.75	55.83	4.53	135.42b	39.04	52.79	45884
21	-5.20	17.00	60.08	5.96	143.50b	39.24	56.24	45884
		17.00	60.08	5.96	150.53b	39.24	56.24	45884
22	-5.60	21.00	65.30	7.72	160.98b	39.97	60.97	45884
		21.00	65.30	7.72	168.08b	39.97	60.97	45884
23	-5.97	24.75	70.21	9.37	178.31b	40.92	65.67	125122
		24.75	70.21	9.37	184.78b	40.92	65.67	125122
24	-6.35	28.50	75.12	11.02	195.39b	41.97	70.47	125122
		28.50	75.12	0.00	2998.33	41.77	70.27	230349
25	-6.50	30.00	77.38	0.00	3012.11	41.73	71.73	230349

Note: 12.85a Soil pressure at active limit
22.40p Soil pressure at passive limit
195.39b Passive limit reduced because of berm

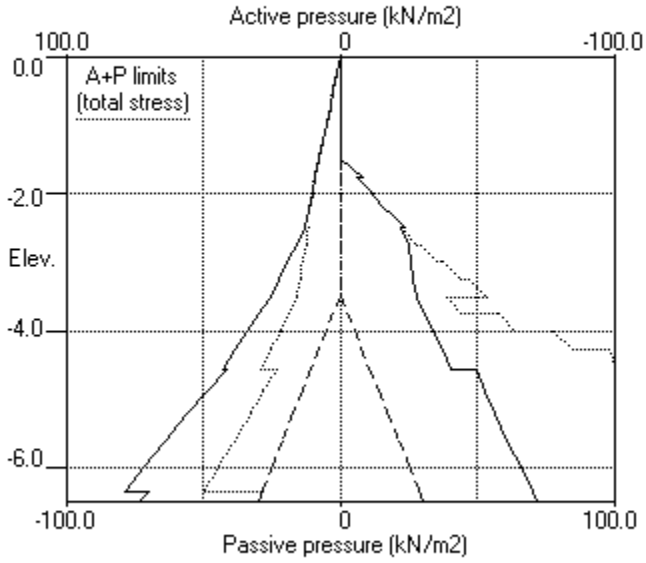
Units: kN,m

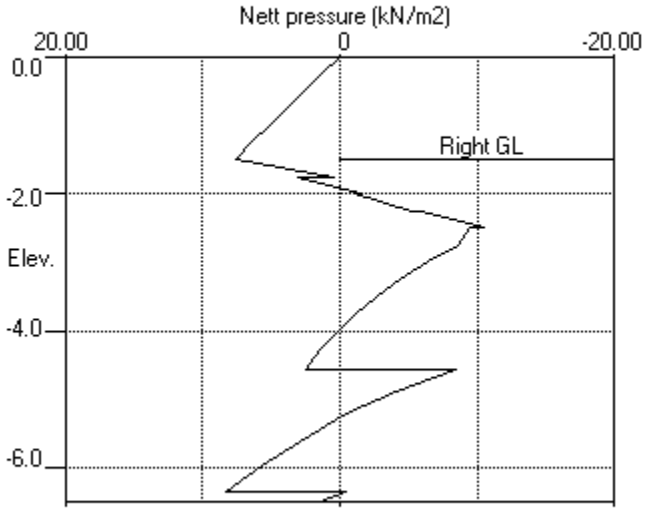
Stage No.2 Change EI of wall to 20000kN.m2/m run





Stage No.2 Change EI of wall to 20000kN.m2/m run





Units: kN,m

Stage No. 3 Apply surcharge no.1 at elevation 0.00

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = -6.50 Factor of Safety	FoS for toe elev. = -6.50 Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Toe elev. for FoS = 1.000 Wall Penetr-ation	Direction of failure
3	0.00	-1.50	Cant.	1.521	-6.40	-4.08	2.58	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall

Analysis options

Soldier Pile width = 0.45m; spacing = 0.90m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	0.00	0.00	0.003	7.89E-04	0.0	0.0		20000
2	-0.25	1.38	0.003	7.89E-04	0.2	0.0		20000
3	-0.50	2.92	0.003	7.88E-04	0.7	0.1		20000
		2.68	0.003	7.88E-04	0.7	0.1		
4	-0.75	4.30	0.002	7.85E-04	1.6	0.4		20000
5	-1.00	6.00	0.002	7.77E-04	2.9	0.9		20000
6	-1.25	7.70	0.002	7.59E-04	4.6	1.9		20000
7	-1.50	9.37	0.002	7.27E-04	6.7	3.3		67096
8	-1.75	2.47	0.002	7.11E-04	8.2	5.2		67096
		5.10	0.002	7.11E-04	8.2	5.2		
9	-2.00	0.79	0.001	6.88E-04	8.9	7.3		67096
		1.31	0.001	6.88E-04	8.9	7.3		
10	-2.25	-2.78	0.001	6.56E-04	8.7	9.6		67096
		-3.43	0.001	6.56E-04	8.7	9.6		
11	-2.50	-7.78	0.001	6.17E-04	7.3	11.6		67096
		-8.78	0.001	6.17E-04	7.3	11.6		
12	-2.75	-12.83	0.001	5.71E-04	4.6	13.2		67096
		-14.00	0.001	5.71E-04	4.6	13.2		
13	-3.00	-10.62	0.001	5.20E-04	1.6	14.0		67096
14	-3.25	-7.56	0.001	4.68E-04	-0.7	14.0		67096
15	-3.50	-4.84	0.001	4.16E-04	-2.3	13.6		67096
16	-3.75	-2.44	0.001	3.67E-04	-3.2	12.9		67096
17	-4.00	-0.33	0.000	3.21E-04	-3.5	12.0		67096
18	-4.28	1.66	0.000	2.73E-04	-3.3	11.1		67096
19	-4.55	3.35	0.000	2.30E-04	-2.6	10.2		67096
		-13.92	0.000	2.30E-04	-2.6	10.2		
20	-4.88	-6.88	0.000	1.84E-04	-6.0	8.6		67096
21	-5.20	-1.25	0.000	1.48E-04	-7.3	6.3		67096
22	-5.60	4.27	0.000	1.19E-04	-6.7	3.3		67096
23	-5.97	8.66	0.000	1.07E-04	-4.3	1.0		67096
24	-6.35	12.75	0.000	1.04E-04	-0.3	0.0		67096
		0.49	0.000	1.04E-04	-0.3	0.0		
25	-6.50	3.42	0.000	1.04E-04	0.0	0.0		---

(continued)

Stage No.3 Apply surcharge no.1 at elevation 0.00

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9998
2	-0.25	0.00	4.87	1.38	21.29	1.38	1.38a	9998
3	-0.50	0.00	10.31	2.92	45.04	2.92	2.92a	9998
		0.00	10.31	2.68	51.17	2.68	2.68a	13886
4	-0.75	0.00	16.57	4.30	82.27	4.30	4.30a	13886
5	-1.00	0.00	23.12	6.00	114.75	6.00	6.00a	13886
6	-1.25	0.00	29.67	7.70	147.25	7.70	7.70a	13886
7	-1.50	0.00	36.08	9.37	179.10	9.37	9.37a	13886
8	-1.75	0.00	42.32	10.99	210.06	10.99	10.99a	13886
9	-2.00	0.00	48.38	12.56	240.14	12.56	12.56a	13886
10	-2.25	0.00	54.28	14.09	269.41	14.09	14.09a	13886
11	-2.50	0.00	60.03	15.59	297.98	15.59	15.59a	13886
		0.00	60.03	13.62	365.24	13.62	13.62a	10553
12	-2.75	0.00	65.67	14.90	399.53	15.17	15.17	10553
13	-3.00	0.00	71.20	16.16	433.19	18.94	18.94	10553
14	-3.25	0.00	76.64	17.39	466.31	22.55	22.55	10553
15	-3.50	0.00	82.01	18.61	498.99	26.00	26.00	10553
16	-3.75	2.50	85.07	19.30	517.58	28.32	30.82	10553
17	-4.00	5.00	88.07	19.98	535.83	30.50	35.50	10553
18	-4.28	7.75	91.31	20.72	555.56	32.74	40.49	10553
19	-4.55	10.50	94.51	21.44	574.99	34.84	45.34	10553
		10.50	94.51	17.55	377.89	31.46	41.96	46441
20	-4.88	13.75	98.87	19.02	392.93	36.84	50.59	46441
21	-5.20	17.00	103.19	20.48	407.78	41.56	58.56	46441
22	-5.60	21.00	108.44	22.25	425.85	46.71	67.71	46441
23	-5.97	24.75	113.31	23.89	442.62	51.17	75.92	46441
24	-6.35	28.50	118.14	25.51	459.26	55.48	83.98	46441
		28.50	118.14	0.00	3260.11	43.64	72.14	83316
25	-6.50	30.00	120.37	0.00	3273.63	45.95	75.95	83316

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	-0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	-0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	-1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	-1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	16400
8	-1.75	0.00	5.00	1.30	8.52b	8.52	8.52p	16400
		0.00	5.00	1.30	5.89b	5.89	5.89p	16400
9	-2.00	0.00	10.00	2.60	11.77b	11.77	11.77p	16400
		0.00	10.00	2.60	11.25b	11.25	11.25p	16400
10	-2.25	0.00	15.00	3.89	16.87b	16.87	16.87p	16400
		0.00	15.00	3.89	17.52b	17.52	17.52p	16400
11	-2.50	0.00	20.00	5.19	23.36b	23.36	23.36p	16400
		0.00	20.00	4.54	22.40b	22.40	22.40p	12464
12	-2.75	0.00	25.00	5.67	28.01b	28.01	28.01p	12464
		0.00	25.00	5.67	29.38b	29.17	29.17	12464
13	-3.00	0.00	30.01	6.81	35.25b	29.56	29.56	12464
		0.00	30.01	6.81	37.48b	29.56	29.56	12464

(continued)

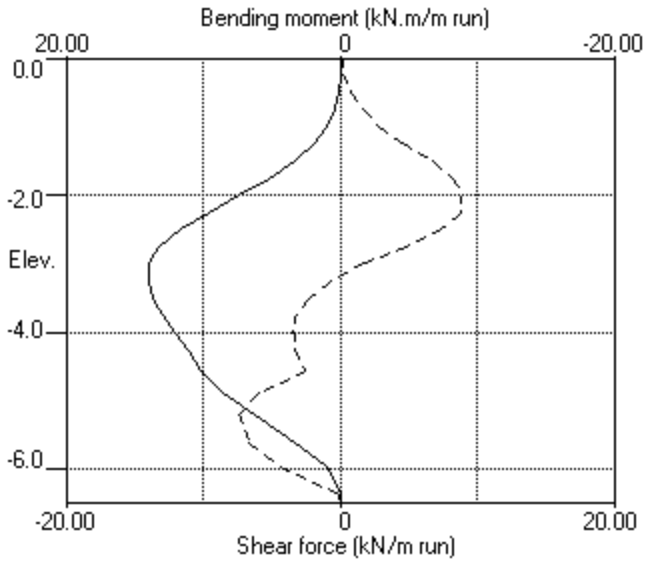
Stage No.3 Apply surcharge no.1 at elevation 0.00

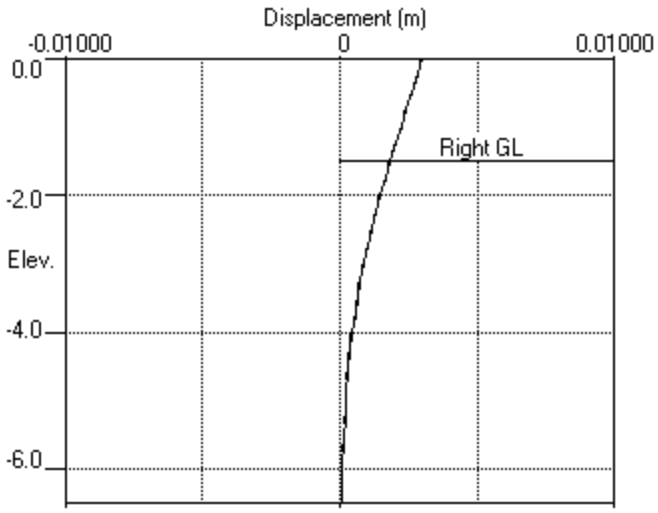
		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
14	-3.25	0.00	35.01	7.94	43.73b	30.11	30.11	12464
		0.00	35.01	7.94	46.98b	30.11	30.11	12464
15	-3.50	0.00	40.01	9.08	53.70b	30.84	30.84	12464
		0.00	40.01	9.08	38.90b	30.84	30.84	12464
16	-3.75	2.50	42.77	9.70	41.58b	30.76	33.26	12464
		2.50	42.77	9.70	55.23b	30.76	33.26	12464
17	-4.00	5.00	45.52	10.33	58.79b	30.83	35.83	12464
		5.00	45.52	10.33	72.22b	30.83	35.83	12464
18	-4.28	7.75	48.56	11.02	77.03b	31.08	38.83	12464
		7.75	48.56	11.02	90.26b	31.08	38.83	12464
19	-4.55	10.50	51.59	11.71	95.91b	31.49	41.99	12464
		10.50	51.59	3.10	140.34b	45.37	55.87	54452
20	-4.88	13.75	55.83	4.53	149.23b	43.71	57.46	54452
		13.75	55.83	4.53	135.42b	43.71	57.46	54452
21	-5.20	17.00	60.08	5.96	143.50b	42.81	59.81	54452
		17.00	60.08	5.96	150.53b	42.81	59.81	54452
22	-5.60	21.00	65.30	7.72	160.98b	42.44	63.44	54452
		21.00	65.30	7.72	168.08b	42.44	63.44	54452
23	-5.97	24.75	70.21	9.37	178.31b	42.51	67.26	54452
		24.75	70.21	9.37	184.78b	42.51	67.26	54452
24	-6.35	28.50	75.12	11.02	195.39b	42.73	71.23	54452
		28.50	75.12	0.00	2998.33	43.15	71.65	98401
25	-6.50	30.00	77.38	0.00	3012.11	42.53	72.53	98401

Note: 13.62a Soil pressure at active limit
28.01p Soil pressure at passive limit
195.39b Passive limit reduced because of berm

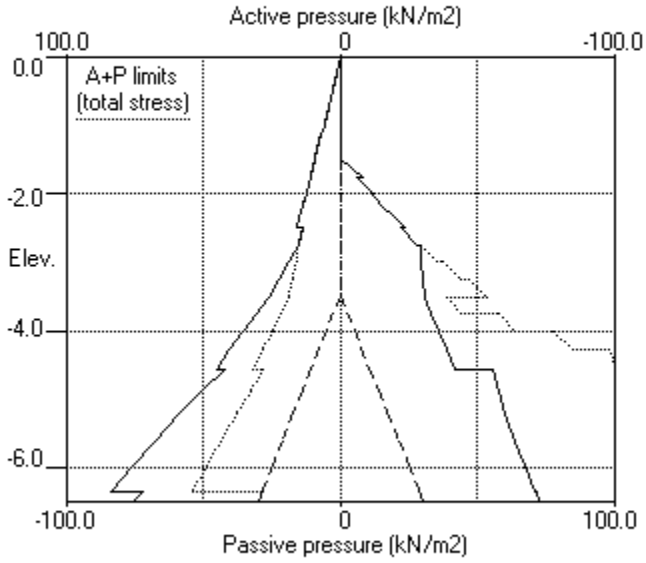
Units: kN,m

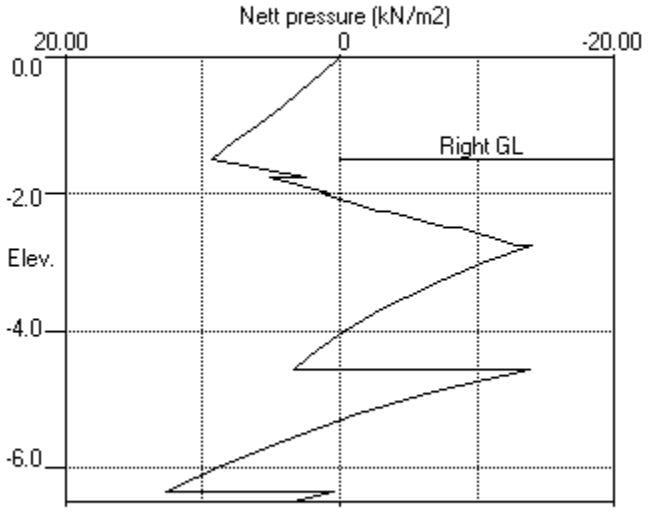
Stage No.3 Apply surcharge no.1 at elev. 0.00





Stage No.3 Apply surcharge no.1 at elev. 0.00





Units: kN,m

Stage No. 4 Remove surcharge no.1 at elevation 0.00

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = -6.50 Factor of Safety	FoS for toe elev. = -6.50 Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Toe elev. for FoS = 1.000 Wall Penetr-ation	Direction of failure
4	0.00	-1.50	Cant.	1.664	-6.39	-3.73	2.23	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall

Analysis options

Soldier Pile width = 0.45m; spacing = 0.90m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	0.00	0.00	0.003	8.19E-04	0.0	0.0		20000
2	-0.25	1.99	0.003	8.19E-04	0.2	0.0		20000
3	-0.50	3.41	0.003	8.18E-04	0.9	0.2		20000
		3.43	0.003	8.18E-04	0.9	0.2		
4	-0.75	4.81	0.002	8.14E-04	2.0	0.5		20000
5	-1.00	6.20	0.002	8.03E-04	3.3	1.2		20000
6	-1.25	7.57	0.002	7.82E-04	5.1	2.2		20000
7	-1.50	8.93	0.002	7.45E-04	7.1	3.7		67096
8	-1.75	3.11	0.002	7.28E-04	8.6	5.7		67096
		5.75	0.002	7.28E-04	8.6	5.7		
9	-2.00	1.25	0.001	7.02E-04	9.5	8.0		67096
		1.77	0.001	7.02E-04	9.5	8.0		
10	-2.25	-2.48	0.001	6.68E-04	9.4	10.4		67096
		-3.13	0.001	6.68E-04	9.4	10.4		
11	-2.50	-7.61	0.001	6.25E-04	8.1	12.6		67096
		-9.29	0.001	6.25E-04	8.1	12.6		
12	-2.75	-13.47	0.001	5.75E-04	5.2	14.4		67096
		-14.64	0.001	5.75E-04	5.2	14.4		
13	-3.00	-11.38	0.001	5.20E-04	2.0	15.2		67096
14	-3.25	-8.45	0.001	4.63E-04	-0.5	15.4		67096
15	-3.50	-5.85	0.001	4.07E-04	-2.3	15.0		67096
16	-3.75	-3.56	0.000	3.52E-04	-3.5	14.2		67096
17	-4.00	-1.59	0.000	3.01E-04	-4.1	13.2		67096
18	-4.28	0.26	0.000	2.50E-04	-4.3	12.0		67096
19	-4.55	1.80	0.000	2.03E-04	-4.0	10.9		67096
		-11.49	0.000	2.03E-04	-4.0	10.9		
20	-4.88	-5.15	0.000	1.55E-04	-6.7	8.9		67096
21	-5.20	-0.25	0.000	1.17E-04	-7.6	6.5		67096
22	-5.60	4.39	0.000	8.83E-05	-6.8	3.4		67096
23	-5.97	7.94	0.000	7.54E-05	-4.5	1.2		67096
24	-6.35	11.20	-0.000	7.18E-05	-0.9	0.1		67096
		4.62	-0.000	7.18E-05	-0.9	0.1		
25	-6.50	6.96	-0.000	7.17E-05	0.0	-0.0		---

(continued)

Stage No.4 Remove surcharge no.1 at elevation 0.00

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7014
2	-0.25	0.00	4.75	1.35	20.75	1.99	1.99	7014
3	-0.50	0.00	9.50	2.69	41.51	3.41	3.41	7014
		0.00	9.50	2.47	47.15	3.43	3.43	9742
4	-0.75	0.00	14.50	3.76	71.97	4.81	4.81	9742
5	-1.00	0.00	19.50	5.06	96.79	6.20	6.20	9742
6	-1.25	0.00	24.50	6.36	121.61	7.57	7.57	9742
7	-1.50	0.00	29.50	7.66	146.43	8.93	8.93	9742
8	-1.75	0.00	34.50	8.96	171.24	10.28	10.28	9742
9	-2.00	0.00	39.50	10.25	196.06	11.63	11.63	9742
10	-2.25	0.00	44.50	11.55	220.88	12.97	12.97	9742
11	-2.50	0.00	49.50	12.85	245.70	14.30	14.30	9742
		0.00	49.50	11.23	301.16	12.01	12.01	7404
12	-2.75	0.00	54.50	12.37	331.58	13.42	13.42	7404
13	-3.00	0.00	59.50	13.50	362.01	17.06	17.06	7404
14	-3.25	0.00	64.50	14.64	392.43	20.55	20.55	7404
15	-3.50	0.00	69.50	15.77	422.85	23.89	23.89	7404
16	-3.75	2.50	72.25	16.39	439.58	26.12	28.62	7404
17	-4.00	5.00	75.00	17.02	456.31	28.20	33.20	7404
18	-4.28	7.75	78.03	17.70	474.71	30.35	38.10	7404
19	-4.55	10.50	81.05	18.39	493.12	32.35	42.85	7404
		10.50	81.05	13.02	331.57	29.65	40.15	33632
20	-4.88	13.75	85.28	14.44	346.12	34.67	48.42	33632
21	-5.20	17.00	89.50	15.87	360.66	39.02	56.02	33632
22	-5.60	21.00	94.70	17.62	378.56	43.73	64.73	33632
23	-5.97	24.75	99.57	19.26	395.34	47.79	72.54	33632
24	-6.35	28.50	104.45	20.90	412.12	51.71	80.21	33632
		28.50	104.45	0.00	3176.79	43.86	72.36	58453
25	-6.50	30.00	106.70	0.00	3190.48	45.88	75.88	58453

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	-0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	-0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	-1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	-1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	10494
8	-1.75	0.00	5.00	1.30	8.52b	7.17	7.17	10494
		0.00	5.00	1.30	5.89b	4.54	4.54	10494
9	-2.00	0.00	10.00	2.60	11.77b	10.38	10.38	10494
		0.00	10.00	2.60	11.25b	9.86	9.86	10494
10	-2.25	0.00	15.00	3.89	16.87b	15.45	15.45	10494
		0.00	15.00	3.89	17.52b	16.10	16.10	10494
11	-2.50	0.00	20.00	5.19	23.36b	21.91	21.91	10494
		0.00	20.00	4.54	22.40b	21.30	21.30	7976
12	-2.75	0.00	25.00	5.67	28.01b	26.89	26.89	7976
		0.00	25.00	5.67	29.38b	28.06	28.06	7976
13	-3.00	0.00	30.01	6.81	35.25b	28.44	28.44	7976
		0.00	30.01	6.81	37.48b	28.44	28.44	7976

(continued)

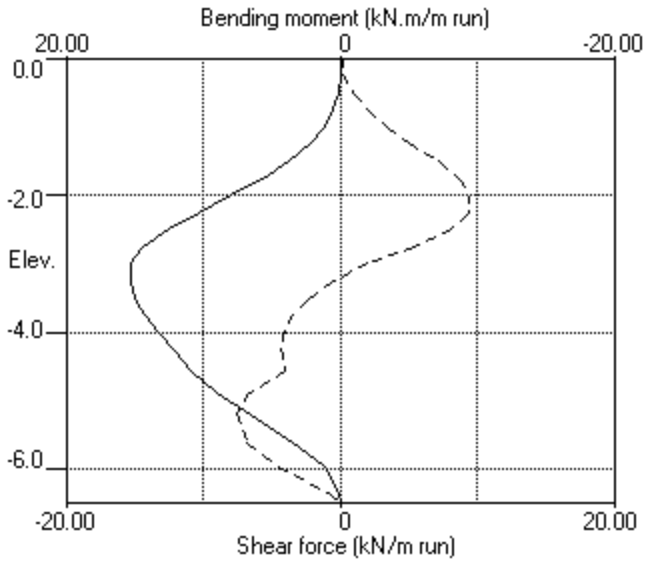
Stage No.4 Remove surcharge no.1 at elevation 0.00

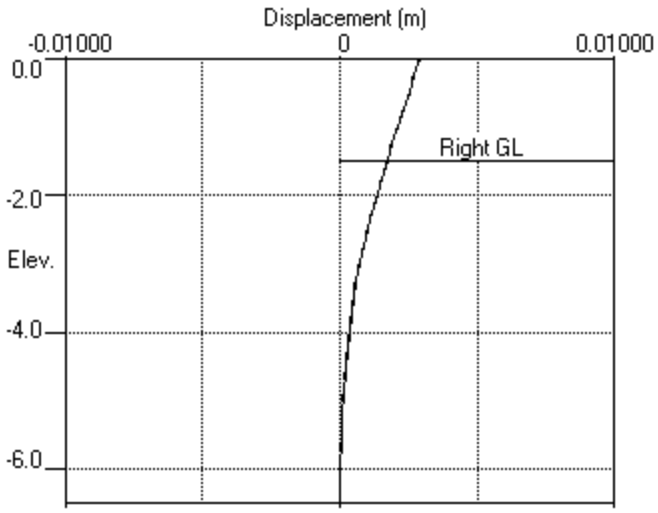
		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
14	-3.25	0.00	35.01	7.94	43.73b	29.00	29.00	7976
		0.00	35.01	7.94	46.98b	29.00	29.00	7976
15	-3.50	0.00	40.01	9.08	53.70b	29.74	29.74	7976
		0.00	40.01	9.08	38.90b	29.74	29.74	7976
16	-3.75	2.50	42.77	9.70	41.58b	29.68	32.18	7976
		2.50	42.77	9.70	55.23b	29.68	32.18	7976
17	-4.00	5.00	45.52	10.33	58.79b	29.79	34.79	7976
		5.00	45.52	10.33	72.22b	29.79	34.79	7976
18	-4.28	7.75	48.56	11.02	77.03b	30.09	37.84	7976
		7.75	48.56	11.02	90.26b	30.09	37.84	7976
19	-4.55	10.50	51.59	11.71	95.91b	30.55	41.05	7976
		10.50	51.59	3.10	140.34b	41.15	51.65	35856
20	-4.88	13.75	55.83	4.53	149.23b	39.82	53.57	35856
		13.75	55.83	4.53	135.42b	39.82	53.57	35856
21	-5.20	17.00	60.08	5.96	143.50b	39.26	56.26	35856
		17.00	60.08	5.96	150.53b	39.26	56.26	35856
22	-5.60	21.00	65.30	7.72	160.98b	39.34	60.34	35856
		21.00	65.30	7.72	168.08b	39.34	60.34	35856
23	-5.97	24.75	70.21	9.37	178.31b	39.84	64.59	35856
		24.75	70.21	9.37	184.78b	39.84	64.59	35856
24	-6.35	28.50	75.12	11.02	195.39b	40.50	69.00	35856
		28.50	75.12	0.00	2998.33	39.24	67.74	62966
25	-6.50	30.00	77.38	0.00	3012.11	38.92	68.92	62966

Note: 195.39b Passive limit reduced because of berm

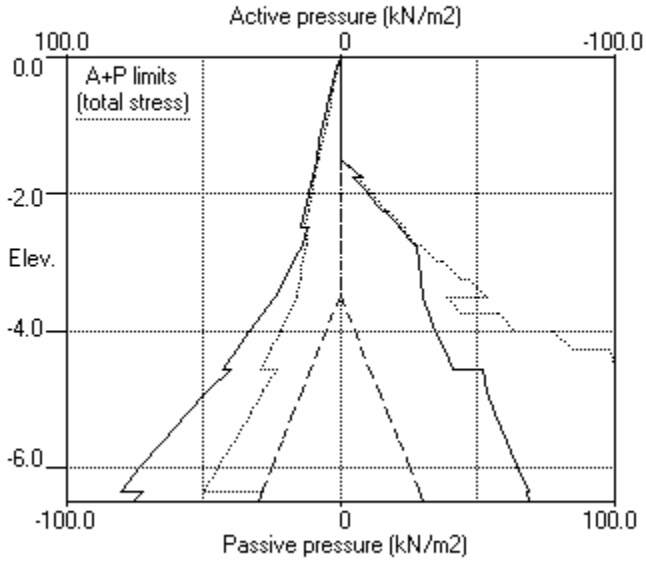
Units: kN,m

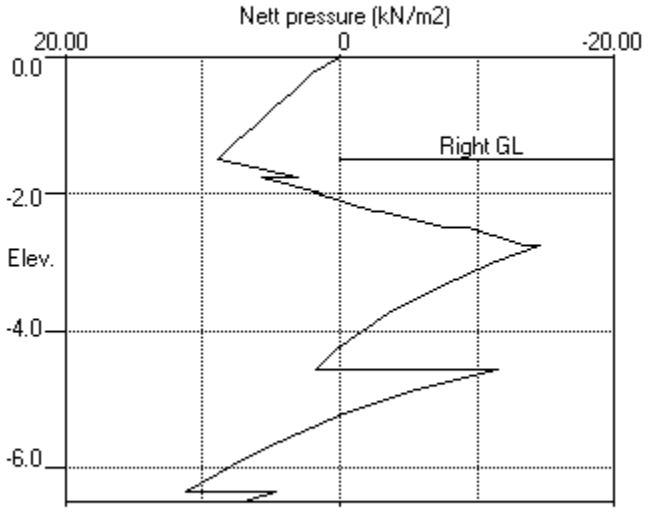
Stage No.4 Remove surcharge no.1 at elev. 0.00





Stage No.4 Remove surcharge no.1 at elev. 0.00





Units: kN,m

Stage No. 5 Apply water pressure profile no.2

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = -6.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr-ation	Direction of failure
5	0.00	-1.50	Cant.	1.428	-6.40	-4.56	3.06	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall

Analysis options

Soldier Pile width = 0.45m; spacing = 0.90m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	0.00	0.00	0.005	1.07E-03	0.0	0.0		20000
2	-0.25	1.35	0.004	1.07E-03	0.2	0.0		20000
3	-0.50	2.69	0.004	1.07E-03	0.7	0.1		20000
		2.47	0.004	1.07E-03	0.7	0.1		
4	-0.75	3.76	0.004	1.06E-03	1.5	0.4		20000
5	-1.00	5.06	0.004	1.06E-03	2.6	0.9		20000
6	-1.25	6.36	0.003	1.04E-03	4.0	1.7		20000
7	-1.50	7.66	0.003	1.01E-03	5.7	2.9		67096
8	-1.75	2.35	0.003	1.00E-03	7.0	4.5		67096
		4.99	0.003	1.00E-03	7.0	4.5		
9	-2.00	2.31	0.003	9.82E-04	7.9	6.4		67096
		2.84	0.003	9.82E-04	7.9	6.4		
10	-2.25	0.43	0.002	9.55E-04	8.3	8.4		67096
		-0.22	0.002	9.55E-04	8.3	8.4		
11	-2.50	-2.85	0.002	9.20E-04	7.9	10.4		67096
		-3.21	0.002	9.20E-04	7.9	10.4		
12	-2.75	-5.69	0.002	8.77E-04	6.8	12.4		67096
		-7.06	0.002	8.77E-04	6.8	12.4		
13	-3.00	-9.82	0.002	8.28E-04	4.7	13.8		67096
		-12.04	0.002	8.28E-04	4.7	13.8		
14	-3.25	-8.88	0.001	7.75E-04	2.1	14.7		67096
15	-3.50	-4.64	0.001	7.20E-04	0.4	15.0		67096
16	-3.75	-0.84	0.001	6.64E-04	-0.3	15.0		67096
17	-4.00	2.64	0.001	6.08E-04	-0.1	14.9		67096
18	-4.28	6.11	0.001	5.47E-04	1.1	15.0		67096
19	-4.55	9.20	0.001	4.84E-04	3.2	15.5		67096
		-33.22	0.001	4.84E-04	3.2	15.5		
20	-4.88	-21.13	0.000	4.10E-04	-5.6	15.1		67096
21	-5.20	-9.47	0.000	3.44E-04	-10.6	12.2		67096
22	-5.60	2.47	0.000	2.87E-04	-12.0	7.2		67096
23	-5.97	12.16	0.000	2.59E-04	-9.2	2.9		67096
24	-6.35	21.25	0.000	2.50E-04	-3.0	0.3		67096
		16.11	0.000	2.50E-04	-3.0	0.3		

(continued)

Stage No.5 Apply water pressure profile no.2

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
25	-6.50	23.22	-0.000	2.49E-04	0.0	-0.0		---

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8608
2	-0.25	0.00	4.75	1.35	20.75	1.35	1.35a	8608
3	-0.50	0.00	9.50	2.69	41.51	2.69	2.69a	8608
		0.00	9.50	2.47	47.15	2.47	2.47a	11955
4	-0.75	0.00	14.50	3.76	71.97	3.76	3.76a	11955
5	-1.00	0.00	19.50	5.06	96.79	5.06	5.06a	11955
6	-1.25	0.00	24.50	6.36	121.61	6.36	6.36a	11955
7	-1.50	0.00	29.50	7.66	146.43	7.66	7.66a	11955
8	-1.75	2.50	32.25	8.37	160.08	8.37	10.87a	11955
9	-2.00	5.00	35.00	9.09	173.73	9.09	14.09a	11955
10	-2.25	7.50	37.75	9.80	187.38	9.80	17.30a	11955
11	-2.50	10.00	40.50	10.51	201.03	10.51	20.51a	11955
		10.00	40.50	9.19	246.41	9.19	19.19a	9086
12	-2.75	12.50	43.25	9.81	263.14	9.81	22.31a	9086
13	-3.00	15.00	46.00	10.44	279.87	10.44	25.44a	9086
14	-3.25	17.50	48.75	11.06	296.60	11.06	28.56a	9086
15	-3.50	20.00	51.50	11.69	313.33	12.72	32.72	9086
16	-3.75	22.50	54.25	12.31	330.06	15.66	38.16	9086
17	-4.00	25.00	57.00	12.93	346.79	18.45	43.45	9086
18	-4.28	27.75	60.03	13.62	365.20	21.35	49.10	9086
19	-4.55	30.50	63.05	14.31	383.60	24.07	54.57	9086
		30.50	63.05	6.96	269.61	6.96	37.46a	40356
20	-4.88	33.75	67.28	8.38	284.16	13.71	47.46	40356
21	-5.20	37.00	71.50	9.80	298.70	21.23	58.23	40356
22	-5.60	41.00	76.70	11.56	316.60	29.36	70.36	40356
23	-5.97	44.75	81.57	13.20	333.38	36.29	81.04	40356
24	-6.35	48.50	86.45	14.84	350.16	42.94	91.44	40356
		48.50	86.45	0.00	3067.28	37.49	85.99	71731
25	-6.50	50.00	88.70	0.00	3080.97	41.74	91.74	508898

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	-0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	-0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	-1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	-1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	13684
8	-1.75	0.00	5.00	1.30	8.52b	8.52	8.52p	13684
		0.00	5.00	1.30	5.89b	5.89	5.89p	13684
9	-2.00	0.00	10.00	2.60	11.77b	11.77	11.77p	13684
		0.00	10.00	2.60	11.25b	11.25	11.25p	13684
10	-2.25	0.00	15.00	3.89	16.87b	16.87	16.87p	13684
		0.00	15.00	3.89	17.52b	17.52	17.52p	13684

(continued)

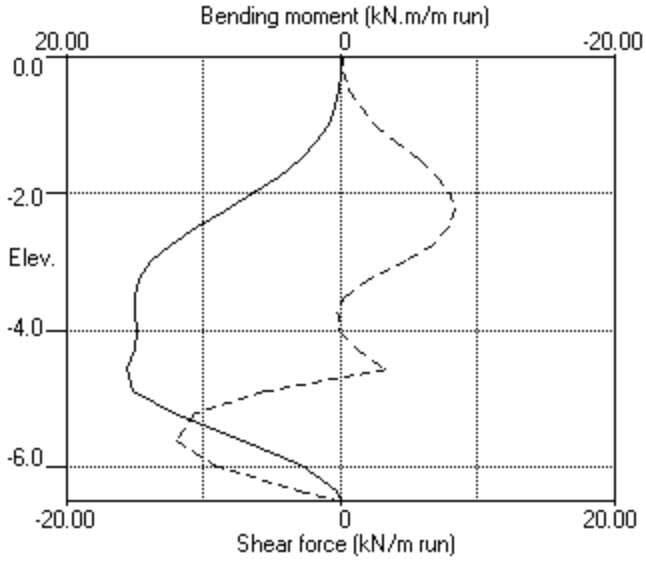
Stage No.5 Apply water pressure profile no.2

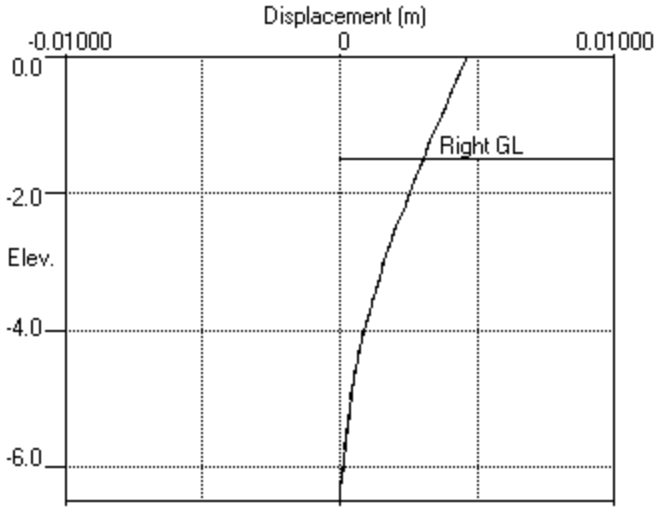
		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
11	-2.50	0.00	20.00	5.19	23.36b	23.36	23.36p	13684
		0.00	20.00	4.54	22.40b	22.40	22.40p	10400
12	-2.75	0.00	25.00	5.67	28.01b	28.01	28.01p	10400
		0.00	25.00	5.67	29.38b	29.38	29.38p	10400
13	-3.00	0.00	30.01	6.81	35.25b	35.25	35.25p	10400
		0.00	30.01	6.81	37.48b	37.48	37.48p	10400
14	-3.25	0.00	35.01	7.94	43.73b	37.44	37.44	10400
		0.00	35.01	7.94	46.98b	37.44	37.44	10400
15	-3.50	0.00	40.01	9.08	53.70b	37.37	37.37	10400
		0.00	40.01	9.08	38.90b	37.37	37.37	10400
16	-3.75	2.50	42.77	9.70	41.58b	36.50	39.00	10400
		2.50	42.77	9.70	55.23b	36.50	39.00	10400
17	-4.00	5.00	45.52	10.33	58.79b	35.80	40.80	10400
		5.00	45.52	10.33	72.22b	35.80	40.80	10400
18	-4.28	7.75	48.56	11.02	77.03b	35.23	42.98	10400
		7.75	48.56	11.02	90.26b	35.23	42.98	10400
19	-4.55	10.50	51.59	11.71	95.91b	34.87	45.37	10400
		10.50	51.59	3.10	140.34b	60.18	70.68	45800
20	-4.88	13.75	55.83	4.53	149.23b	54.84	68.59	45800
		13.75	55.83	4.53	135.42b	54.84	68.59	45800
21	-5.20	17.00	60.08	5.96	143.50b	50.70	67.70	45800
		17.00	60.08	5.96	150.53b	50.70	67.70	45800
22	-5.60	21.00	65.30	7.72	160.98b	46.89	67.89	45800
		21.00	65.30	7.72	168.08b	46.89	67.89	45800
23	-5.97	24.75	70.21	9.37	178.31b	44.13	68.88	45800
		24.75	70.21	9.37	184.78b	44.13	68.88	45800
24	-6.35	28.50	75.12	11.02	195.39b	41.69	70.19	45800
		28.50	75.12	0.00	2998.33	41.37	69.87	82102
25	-6.50	30.00	77.38	0.00	3012.11	38.51	68.51	584121

Note: 37.46a Soil pressure at active limit
37.48p Soil pressure at passive limit
195.39b Passive limit reduced because of berm

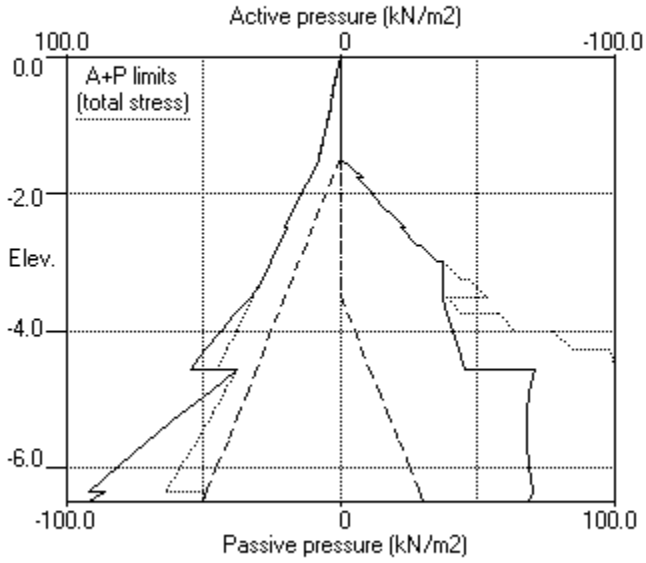
Units: kN,m

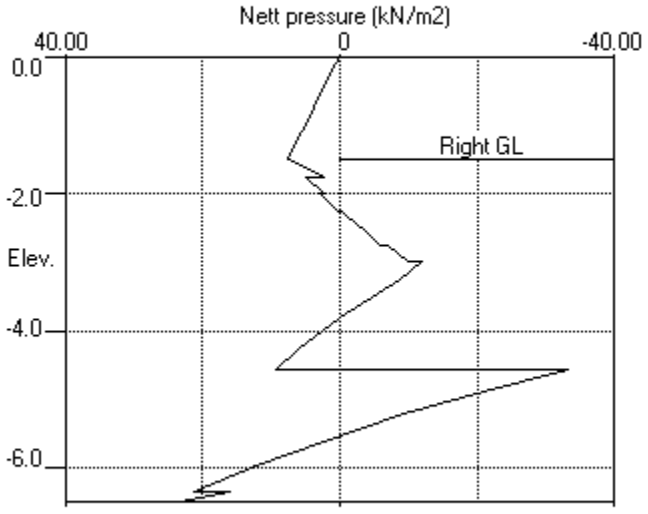
Stage No.5 Apply water pressure profile no.2





Stage No.5 Apply water pressure profile no.2





Units: kN,m

Stage No. 6 Change EI of wall to 30000 kN.m2/m run
From elevation -1.50 to -6.50
Yield moment not defined
Allow wall to relax with new modulus value

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = -6.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr-ation	Direction of failure
6	0.00	-1.50	Cant.	1.428	-6.40	-4.56	3.06	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall
Analysis options
Soldier Pile width = 0.45m; spacing = 0.90m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	0.00	0.00	0.007	1.75E-03	0.0	0.0		20000
2	-0.25	1.35	0.006	1.75E-03	0.2	0.0		20000
3	-0.50	2.69	0.006	1.75E-03	0.7	0.1		20000
		2.47	0.006	1.75E-03	0.7	0.1		
4	-0.75	3.76	0.006	1.75E-03	1.5	0.4		20000
5	-1.00	5.06	0.005	1.74E-03	2.6	0.9		20000
6	-1.25	6.36	0.005	1.72E-03	4.0	1.7		20000
7	-1.50	7.66	0.004	1.69E-03	5.7	2.9		30000
8	-1.75	2.35	0.004	1.66E-03	7.0	4.5		30000
		4.99	0.004	1.66E-03	7.0	4.5		
9	-2.00	2.31	0.003	1.62E-03	7.9	6.4		30000
		2.84	0.003	1.62E-03	7.9	6.4		
10	-2.25	0.43	0.003	1.56E-03	8.3	8.4		30000
		-0.22	0.003	1.56E-03	8.3	8.4		
11	-2.50	-2.85	0.003	1.48E-03	7.9	10.4		30000
		-3.21	0.003	1.48E-03	7.9	10.4		
12	-2.75	-5.69	0.002	1.38E-03	6.8	12.4		30000
		-7.06	0.002	1.38E-03	6.8	12.4		
13	-3.00	-9.82	0.002	1.27E-03	4.7	13.8		30000
		-12.04	0.002	1.27E-03	4.7	13.8		
14	-3.25	-12.90	0.002	1.16E-03	1.6	14.7		30000
15	-3.50	-8.32	0.001	1.03E-03	-1.1	14.9		30000
		-7.22	0.001	1.03E-03	-1.1	14.9		
16	-3.75	-3.51	0.001	9.16E-04	-2.4	14.6		30000
17	-4.00	1.51	0.001	8.00E-04	-2.7	14.1		30000
18	-4.28	6.20	0.001	6.78E-04	-1.6	13.7		30000
19	-4.55	10.09	0.001	5.61E-04	0.6	13.7		30000
		-29.34	0.001	5.61E-04	0.6	13.7		
20	-4.88	-15.40	0.000	4.29E-04	-6.6	12.9		30000
21	-5.20	-3.94	0.000	3.19E-04	-9.8	9.9		30000

(continued)

Stage No.6 Change EI of wall to 30000 kN.m2/m run
From elevation -1.50 to -6.50
Yield moment not defined
Allow wall to relax with new modulus value

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
22	-5.60	5.92	0.000	2.31E-04	-9.4	5.4		30000
23	-5.97	12.84	0.000	1.95E-04	-5.9	1.9		30000
24	-6.35	14.75	0.000	1.86E-04	-0.7	0.1		30000
		4.11	0.000	1.86E-04	-0.7	0.1		
25	-6.50	4.98	0.000	1.86E-04	0.0	-0.0		---

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11282
2	-0.25	0.00	4.75	1.35	20.75	1.35	1.35a	11282
3	-0.50	0.00	9.50	2.69	41.51	2.69	2.69a	11282
		0.00	9.50	2.47	47.15	2.47	2.47a	15669
4	-0.75	0.00	14.50	3.76	71.97	3.76	3.76a	15669
5	-1.00	0.00	19.50	5.06	96.79	5.06	5.06a	15669
6	-1.25	0.00	24.50	6.36	121.61	6.36	6.36a	15669
7	-1.50	0.00	29.50	7.66	146.43	7.66	7.66a	15669
8	-1.75	2.50	32.25	8.37	160.08	8.37	10.87a	15669
9	-2.00	5.00	35.00	9.09	173.73	9.09	14.09a	15669
10	-2.25	7.50	37.75	9.80	187.38	9.80	17.30a	15669
11	-2.50	10.00	40.50	10.51	201.03	10.51	20.51a	15669
		10.00	40.50	9.19	246.41	9.19	19.19a	11908
12	-2.75	12.50	43.25	9.81	263.14	9.81	22.31a	11908
13	-3.00	15.00	46.00	10.44	279.87	10.44	25.44a	11908
14	-3.25	17.50	48.75	11.06	296.60	11.06	28.56a	11908
15	-3.50	20.00	51.50	11.69	313.33	11.69	31.69a	11908
16	-3.75	22.50	54.25	12.31	330.06	14.51	37.01	11908
17	-4.00	25.00	57.00	12.93	346.79	17.96	42.96	11908
18	-4.28	27.75	60.03	13.62	365.20	21.39	49.14	14042
19	-4.55	30.50	63.05	14.31	383.60	24.52	55.02	14042
		30.50	63.05	6.96	269.61	8.89	39.39	61098
20	-4.88	33.75	67.28	8.38	284.16	16.58	50.33	61098
21	-5.20	37.00	71.50	9.80	298.70	24.00	61.00	61098
22	-5.60	41.00	76.70	11.56	316.60	31.09	72.09	61098
23	-5.97	44.75	81.57	13.20	333.38	36.63	81.38	61098
24	-6.35	48.50	86.45	14.84	350.16	39.69	88.19	177548
		48.50	86.45	0.00	3067.28	31.49	79.99	328168
25	-6.50	50.00	88.70	0.00	3080.97	32.61	82.61	328168

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	-0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	-0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	-1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	-1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	20711

(continued)

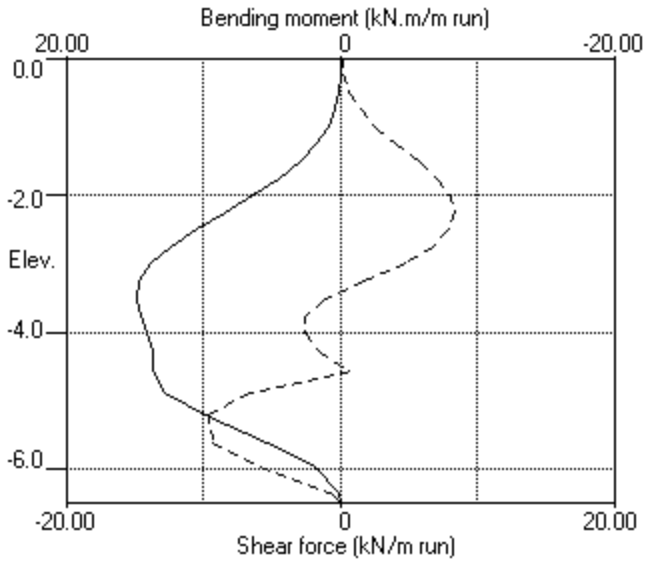
Stage No.6 Change EI of wall to 30000 kN.m2/m run
From elevation -1.50 to -6.50
Yield moment not defined
Allow wall to relax with new modulus value

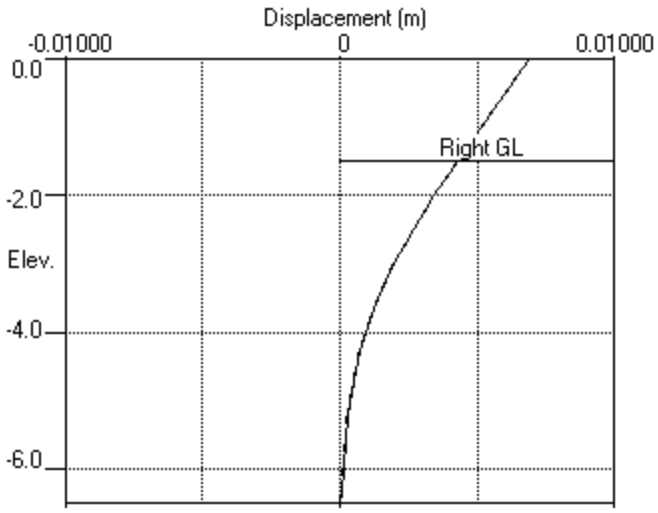
		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
8	-1.75	0.00	5.00	1.30	8.52b	8.52	8.52p	20711
		0.00	5.00	1.30	5.89b	5.89	5.89p	20711
9	-2.00	0.00	10.00	2.60	11.77b	11.77	11.77p	20711
		0.00	10.00	2.60	11.25b	11.25	11.25p	20711
10	-2.25	0.00	15.00	3.89	16.87b	16.87	16.87p	20711
		0.00	15.00	3.89	17.52b	17.52	17.52p	20711
11	-2.50	0.00	20.00	5.19	23.36b	23.36	23.36p	20711
		0.00	20.00	4.54	22.40b	22.40	22.40p	15740
12	-2.75	0.00	25.00	5.67	28.01b	28.01	28.01p	15740
		0.00	25.00	5.67	29.38b	29.38	29.38p	15740
13	-3.00	0.00	30.01	6.81	35.25b	35.25	35.25p	15740
		0.00	30.01	6.81	37.48b	37.48	37.48p	15740
14	-3.25	0.00	35.01	7.94	43.73b	41.46	41.46	15740
		0.00	35.01	7.94	46.98b	41.46	41.46	15740
15	-3.50	0.00	40.01	9.08	53.70b	40.01	40.01	15740
		0.00	40.01	9.08	38.90b	38.90	38.90p	15740
16	-3.75	2.50	42.77	9.70	41.58b	38.02	40.52	15740
		2.50	42.77	9.70	55.23b	38.02	40.52	15740
17	-4.00	5.00	45.52	10.33	58.79b	36.45	41.45	15740
		5.00	45.52	10.33	72.22b	36.45	41.45	15740
18	-4.28	7.75	48.56	11.02	77.03b	35.19	42.94	14042
		7.75	48.56	11.02	90.26b	35.19	42.94	14042
19	-4.55	10.50	51.59	11.71	95.91b	34.43	44.93	14042
		10.50	51.59	3.10	140.34b	58.24	68.74	61098
20	-4.88	13.75	55.83	4.53	149.23b	51.98	65.73	61098
		13.75	55.83	4.53	135.42b	51.98	65.73	61098
21	-5.20	17.00	60.08	5.96	143.50b	47.93	64.93	61098
		17.00	60.08	5.96	150.53b	47.93	64.93	61098
22	-5.60	21.00	65.30	7.72	160.98b	45.17	66.17	61098
		21.00	65.30	7.72	168.08b	45.17	66.17	61098
23	-5.97	24.75	70.21	9.37	178.31b	43.79	68.54	61098
		24.75	70.21	9.37	184.78b	43.79	68.54	61098
24	-6.35	28.50	75.12	11.02	195.39b	44.94	73.44	177548
		28.50	75.12	0.00	2998.33	47.38	75.88	328168
25	-6.50	30.00	77.38	0.00	3012.11	47.64	77.64	328168

Note: 31.69a Soil pressure at active limit
38.90p Soil pressure at passive limit
195.39b Passive limit reduced because of berm

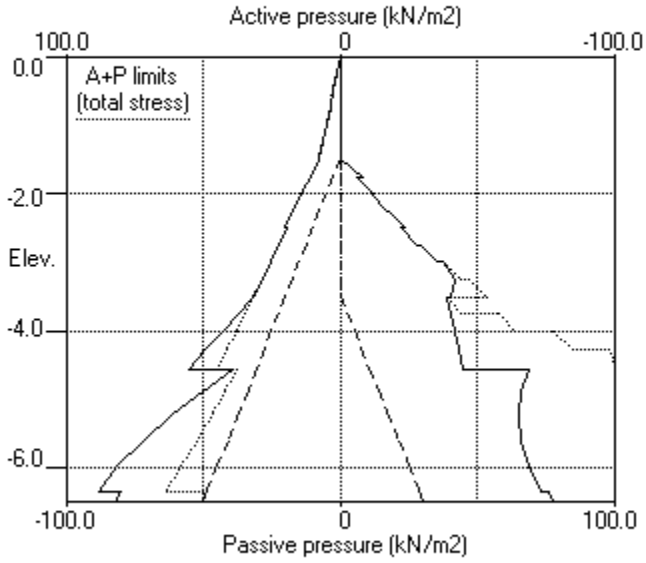
Units: kN,m

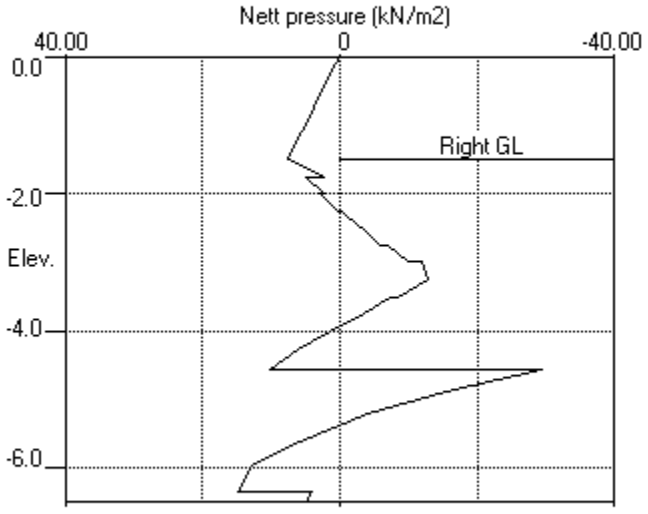
Stage No.6 Change EI of wall to 30000kN.m2/m run





Stage No.6 Change EI of wall to 30000kN.m2/m run





Units: kN,m

Summary of results

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = -6.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr-ation	Direction of failure
1	0.00	-1.50	Cant.	1.664	-6.39	-3.73	2.23	L to R
2	0.00	-1.50	Cant.	1.664	-6.39	-3.73	2.23	L to R
3	0.00	-1.50	Cant.	1.521	-6.40	-4.08	2.58	L to R
4	0.00	-1.50	Cant.	1.664	-6.39	-3.73	2.23	L to R
5	0.00	-1.50	Cant.	1.428	-6.40	-4.56	3.06	L to R
6	0.00	-1.50	Cant.	1.428	-6.40	-4.56	3.06	L to R

Units: kN,m

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall

Analysis options

Soldier Pile width = 0.45m; spacing = 0.90m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum	Displacement minimum	Bending moment maximum	Bending moment minimum	Shear force maximum	Shear force minimum
		m	m	kN.m/m	kN.m/m	kN/m	kN/m
1	0.00	0.007	0.000	0.0	0.0	0.0	0.0
2	-0.25	0.006	0.000	0.0	0.0	0.2	0.0
3	-0.50	0.006	0.000	0.2	0.0	0.9	0.0
4	-0.75	0.006	0.000	0.5	0.0	2.0	0.0
5	-1.00	0.005	0.000	1.2	0.0	3.3	0.0
6	-1.25	0.005	0.000	2.2	0.0	5.1	0.0
7	-1.50	0.004	0.000	3.7	0.0	7.1	0.0
8	-1.75	0.004	0.000	5.7	0.0	8.6	0.0
9	-2.00	0.003	0.000	8.0	0.0	9.5	0.0
10	-2.25	0.003	0.000	10.4	0.0	9.4	0.0
11	-2.50	0.003	0.000	12.6	0.0	8.1	0.0
12	-2.75	0.002	0.000	14.4	0.0	6.8	0.0
13	-3.00	0.002	0.000	15.2	0.0	4.7	-0.0
14	-3.25	0.002	0.000	15.4	0.0	2.1	-1.4
15	-3.50	0.001	0.000	15.0	0.0	0.4	-2.3
16	-3.75	0.001	0.000	15.0	0.0	0.0	-3.5
17	-4.00	0.001	0.000	14.9	0.0	0.0	-4.1
18	-4.28	0.001	0.000	15.0	0.0	1.1	-4.3
19	-4.55	0.001	0.000	15.5	0.0	3.2	-4.0
20	-4.88	0.000	0.000	15.1	0.0	0.0	-6.7
21	-5.20	0.000	0.000	12.2	0.0	0.0	-10.6
22	-5.60	0.000	0.000	7.2	0.0	0.0	-12.0
23	-5.97	0.000	0.000	2.9	0.0	0.0	-9.2
24	-6.35	0.000	-0.000	0.3	0.0	0.0	-3.0
25	-6.50	0.000	-0.000	0.0	-0.0	0.0	0.0

Maximum and minimum bending moment and shear force at each stage

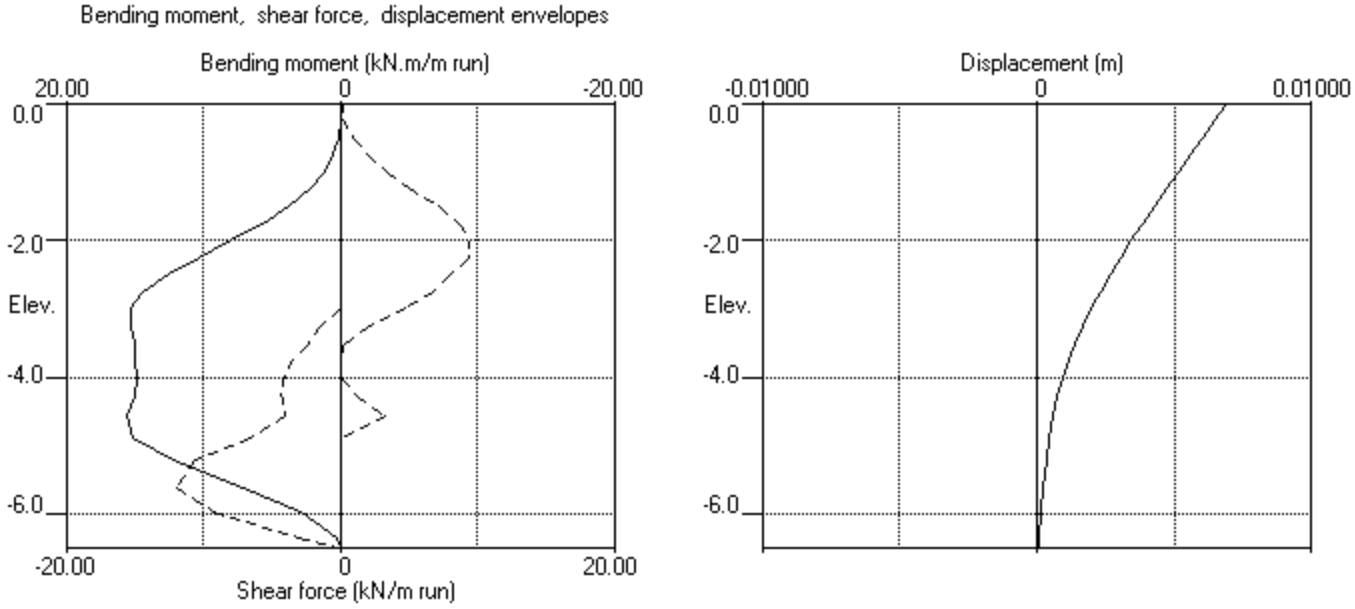
Stage no.	Bending moment maximum	Bending moment elev.	Bending moment minimum	Bending moment elev.	Shear force maximum	Shear force elev.	Shear force minimum	Shear force elev.
	kN.m/m		kN.m/m		kN/m		kN/m	
1	10.2	-3.00	-0.0	-6.50	6.9	-2.00	-4.8	-5.20
2	10.2	-3.00	-0.0	-6.50	6.9	-2.00	-4.8	-5.20
3	14.0	-3.25	0.0	0.00	8.9	-2.00	-7.3	-5.20
4	15.4	-3.25	-0.0	-6.50	9.5	-2.00	-7.6	-5.20
5	15.5	-4.55	-0.0	-6.50	8.3	-2.25	-12.0	-5.60
6	14.9	-3.50	-0.0	-6.50	8.3	-2.25	-9.8	-5.20

Summary of results (continued)

Maximum and minimum displacement at each stage

Stage no.	Displacement maximum	elev.	minimum	elev.	Stage description
	m		m		
1	0.002	0.00	0.000	0.00	Excav. to elev. -1.50 on RIGHT side
2	0.002	0.00	0.000	0.00	Change EI of wall to 20000kN.m2/m run
3	0.003	0.00	0.000	0.00	Apply surcharge no.1 at elev. 0.00
4	0.003	0.00	-0.000	-6.50	Remove surcharge no.1 at elev. 0.00
5	0.005	0.00	-0.000	-6.50	Apply water pressure profile no.2
6	0.007	0.00	0.000	0.00	Change EI of wall to 30000kN.m2/m run

Units: kN,m


Bending moment, shear force, displacement envelopes
Bending moment (kN.m/m run)
20.00
0
-20.00
0.0
-2.0
Elev.
-4.0
-6.0
-20.00
0
20.00
Shear force (kN/m run)
Displacement (m)
-0.01000
0
0.01000
0.0
-2.0
Elev.
-4.0
-6.0

Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Soil types Right side
1	0.00	1 Fill (Dense)	1 Fill (Dense)
2	-0.50	2 Fill (very dense)	2 Fill (very dense)
3	-2.50	3 Residual	3 Residual
4	-4.55	4 Granodiorite (EL-VL)	4 Granodiorite (EL-VL)
5	-6.35	5 Granodiorite (VH)	5 Granodiorite (VH)
6	-7.60	6 Basalt	6 Basalt
7	-10.00	6 Basalt	6 Basalt

SOIL PROPERTIES

-- Soil type -- No.	Description (Datum elev.)	Bulk density kN/m3	Young's Modulus Eh,kN/m2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion kN/m2 (dc/dy)
1	Fill	23.75a	18000	0.570	OC	0.344	3.346	
	(Dense)	24.00b			(0.200)	(0.000)	(0.000)	
2	Fill (very	25.00a	25000	0.540	OC	0.316	3.755	
	dense)	26.00b			(0.200)	(0.000)	(0.000)	
3	Residual	25.00a	19000	0.490	OC	0.277	4.508	
		26.00b			(0.200)	(0.000)	(0.000)	
4	Granodiori-	27.50a	75000	0.560	OC	0.337	3.442	10.50d
	te (EL-VL)	28.50b			(0.300)	(1.360)	(5.007)	
5	Granodiori-	30.00a	150000	0.490	OC	0.277	4.508	350.0d
	te (VH)	31.00b			(0.200)	(1.227)	(5.956)	
6	Basalt	30.00a	130000	0.510	OC	0.290	4.236	280.0d
		31.00b			(0.200)	(1.255)	(5.720)	

Note: (a) and (b) are Bulk Densities above and below the water table

Additional soil parameters associated with Ka and Kp

------- Soil type ------- No.	Description	--- parameters for Ka --- Soil friction angle	Wall adhesion coeff.	Back-fill angle	--- parameters for Kp --- Soil friction angle	Wall adhesion coeff.	Back-fill angle
1	Fill (Dense)	25.50	0.667	0.00	25.50	0.500	0.00
2	Fill (very dense)	27.50	0.667	0.00	27.50	0.500	0.00
3	Residual	30.50	0.667	0.00	30.50	0.500	0.00
4	Granodiorite (EL-VL)	26.00	0.667	0.00	26.00	0.500	0.00
5	Granodiorite (VH)	30.50	0.667	0.00	30.50	0.500	0.00
6	Basalt	29.50	0.667	0.00	29.50	0.500	0.00

GROUND WATER CONDITIONS

Density of water = 10.00 kN/m3

	Left side	Right side
Initial water table elevation	-3.50	-3.50

Automatic water pressure balancing at toe of wall : No

Water press. profile no.	Left side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2	Right side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2
1	1	-3.50	-3.50	0.0	1	-3.50	-3.50	0.0
2	1	-0.50	-0.50	0.0	1	-3.50	-3.50	0.0

WALL PROPERTIES

Type of structure = Soldier Pile Wall
Soldier Pile width = 0.45 m
Soldier Pile spacing = 0.90 m
Passive mobilisation factor = 3.00
Elevation of toe of wall = -6.50
Maximum finite element length = 0.40 m
Youngs modulus of wall E = 3.0000E+07 kN/m2
Moment of inertia of wall I = 2.2365E-03 m4/m run
= 2.0129E-03 m4 per pile
E.I = 67096 kN.m2/m run
Yield Moment of wall = Not defined

HORIZONTAL and MOMENT LOADS/RESTRAINTS

Load no.	Elevation	Horizontal load kN/m run	Moment load kN.m/m run	Moment restraint kN.m/m/rad	Partial factor (Category)
1	0.00	47.40	0	0	N/A
2	0.00	150.0	0	0	N/A
3	-0.50	12.64	0	0	N/A
4	-1.00	12.64	0	0	N/A
5	-1.50	12.64	0	0	N/A
6	-2.00	12.64	0	0	N/A

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge ----- kN/m2 ----- Near edge	Far edge	Equiv. soil type	Partial factor/ Category
1	0.00	1.00(L)	60.00	7.00	30.00	=	N/A	N/A

Note: L = Left side, R = Right side

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Excavate to elevation -1.50 on RIGHT side Toe of berm at elevation -3.50 Width of top of berm = 0.50 Width of toe of berm = 3.00
2	Change EI of wall to 20000 kN.m2/m run From elevation 0.00 to -1.50 Yield moment not defined Allow wall to relax with new modulus value
3	Apply surcharge no.1 at elevation 0.00
4	Apply water pressure profile no.2
5	Change EI of wall to 30000 kN.m2/m run From elevation -1.50 to -6.50 Yield moment not defined Allow wall to relax with new modulus value
6	Apply water pressure profile no.1
7	Remove surcharge no.1 at elevation 0.00
8	Apply load no.3 at elevation -0.50
9	Apply load no.4 at elevation -1.00
10	Apply load no.5 at elevation -1.50
11	Apply load no.6 at elevation -2.00

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
Method of analysis - Strength Factor method
Factor on soil strength for calculating wall depth = 1.00

Parameters for undrained strata:
Minimum equivalent fluid density = 10.00 kN/m3
Maximum depth of water filled tension crack = 0.00 m

Bending moment and displacement calculation:
Method - Subgrade reaction model using Influence Coefficients
Open Tension Crack analysis? - No
Non-linear Modulus Parameter (L) = 3.000 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 50.00 m

Width of excavation on Left side of wall = 20.00 m
Width of excavation on Right side of wall = 20.00 m

Distance to rigid boundary on Left side = 20.00 m
Distance to rigid boundary on Right side = 20.00 m

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Excav. to elev. -1.50 on RIGHT side	Yes	Yes	Yes
2	Change EI of wall to 20000kN.m2/m run	Yes	Yes	Yes
3	Apply surcharge no.1 at elev. 0.00	Yes	Yes	Yes
4	Apply water pressure profile no.2	Yes	Yes	Yes
5	Change EI of wall to 30000kN.m2/m run	Yes	Yes	Yes
6	Apply water pressure profile no.1	Yes	Yes	Yes
7	Remove surcharge no.1 at elev. 0.00	Yes	Yes	Yes
8	Apply load no.3 at elev. -0.50	No	No	No
9	Apply load no.4 at elev. -1.00	No	No	No
10	Apply load no.5 at elev. -1.50	No	No	No
11	Apply load no.6 at elev. -2.00	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

Units: kN,m

Stage No. 1 Excavate to elevation -1.50 on RIGHT side
Toe of berm at elevation -3.50
Width of top of berm = 0.50
Width of toe of berm = 3.00

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = -6.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr-ation	Direction of failure
1	0.00	-1.50	Cant.	1.506	-6.38	-4.59	3.09	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall
Analysis options
Soldier Pile width = 0.45m; spacing = 0.90m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	0.00	0.00	0.005	1.23E-03	0.0	0.0		67096
2	-0.25	2.04	0.004	1.23E-03	0.3	0.0		67096
3	-0.50	4.09	0.004	1.23E-03	1.0	0.2		67096
		3.75	0.004	1.23E-03	1.0	0.2		
4	-0.75	5.73	0.004	1.22E-03	2.2	0.6		67096
5	-1.00	7.70	0.004	1.22E-03	3.9	1.3		67096
6	-1.25	9.67	0.003	1.21E-03	6.1	2.5		67096
7	-1.50	11.65	0.003	1.20E-03	8.7	4.4		67096
8	-1.75	13.62	0.003	1.18E-03	11.9	6.9		67096
		9.32	0.003	1.18E-03	11.9	6.9		
9	-2.00	7.00	0.002	1.15E-03	13.9	10.2		67096
		4.12	0.002	1.15E-03	13.9	10.2		
10	-2.25	0.35	0.002	1.10E-03	14.5	13.8		67096
		-1.24	0.002	1.10E-03	14.5	13.8		
11	-2.50	-5.54	0.002	1.04E-03	13.6	17.3		67096
		-7.23	0.002	1.04E-03	13.6	17.3		
12	-2.75	-11.59	0.002	9.79E-04	11.3	20.4		67096
		-13.45	0.002	9.79E-04	11.3	20.4		
13	-3.00	-16.83	0.001	8.98E-04	7.5	22.9		67096
		-19.43	0.001	8.98E-04	7.5	22.9		
14	-3.25	-17.55	0.001	8.10E-04	2.9	24.4		67096
15	-3.50	-12.90	0.001	7.19E-04	-0.9	24.5		67096
		-10.37	0.001	7.19E-04	-0.9	24.5		
16	-3.75	-8.80	0.001	6.28E-04	-3.3	24.1		67096
17	-4.00	-5.24	0.001	5.41E-04	-5.1	23.0		67096
18	-4.28	-1.92	0.000	4.50E-04	-6.1	21.4		67096
19	-4.55	0.80	0.000	3.66E-04	-6.2	19.6		67096
		-20.96	0.000	3.66E-04	-6.2	19.6		
20	-4.88	-9.84	0.000	2.79E-04	-11.2	16.5		67096
21	-5.20	-1.46	0.000	2.09E-04	-13.1	12.3		67096

(continued)

Stage No.1 Excavate to elevation -1.50 on RIGHT side
Toe of berm at elevation -3.50
Width of top of berm = 0.50
Width of toe of berm = 3.00

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
22	-5.60	6.11	0.000	1.51E-04	-12.1	7.0		67096
23	-5.97	11.53	0.000	1.24E-04	-8.8	2.9		67096
24	-6.35	17.80	-0.000	1.15E-04	-3.3	0.4		67096
		12.93	-0.000	1.15E-04	-3.3	0.4		
25	-6.50	31.49	-0.000	1.14E-04	0.0	0.0		---

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10425
2	-0.25	0.00	5.94	2.04	19.86	2.04	2.04a	10425
3	-0.50	0.00	11.88	4.09	39.73	4.09	4.09a	10425
		0.00	11.88	3.75	44.60	3.75	3.75a	14480
4	-0.75	0.00	18.13	5.73	68.07	5.73	5.73a	14480
5	-1.00	0.00	24.38	7.70	91.54	7.70	7.70a	14480
6	-1.25	0.00	30.63	9.67	115.01	9.67	9.67a	14480
7	-1.50	0.00	36.88	11.65	138.48	11.65	11.65a	14480
8	-1.75	0.00	43.13	13.62	161.95	13.62	13.62a	14480
9	-2.00	0.00	49.38	15.60	185.42	15.60	15.60a	14480
10	-2.25	0.00	55.63	17.57	208.89	17.57	17.57a	14480
11	-2.50	0.00	61.88	19.55	232.36	19.55	19.55a	14480
		0.00	61.88	17.16	278.95	17.16	17.16a	11005
12	-2.75	0.00	68.13	18.89	307.13	18.89	18.89a	11005
13	-3.00	0.00	74.38	20.63	335.31	21.99	21.99	11005
14	-3.25	0.00	80.63	22.36	363.48	27.41	27.41	11005
15	-3.50	0.00	86.88	24.09	391.66	32.57	32.57	11005
16	-3.75	2.50	90.88	25.20	409.69	36.39	38.89	11005
17	-4.00	5.00	94.88	26.31	427.73	39.96	44.96	11005
18	-4.28	7.75	99.28	27.53	447.56	43.61	51.36	11005
19	-4.55	10.50	103.68	28.75	467.40	47.00	57.50	11005
		10.50	103.68	20.64	409.45	41.38	51.88	48328
20	-4.88	13.75	109.69	22.67	430.15	49.80	63.55	48328
21	-5.20	17.00	115.70	24.69	450.85	56.98	73.98	48328
22	-5.60	21.00	123.10	27.18	476.32	64.56	85.56	48328
23	-5.97	24.75	130.04	29.52	500.20	70.91	95.66	48328
24	-6.35	28.50	136.97	31.86	524.08	77.66	106.16	191827
		28.50	136.97	0.00	2702.16	68.84	97.34	344715
25	-6.50	30.00	140.13	0.00	2716.36	79.82	109.82	501589

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	-0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	-0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	-1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	-1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	17552

(continued)

Stage No.1 Excavate to elevation -1.50 on RIGHT side
Toe of berm at elevation -3.50
Width of top of berm = 0.50
Width of toe of berm = 3.00

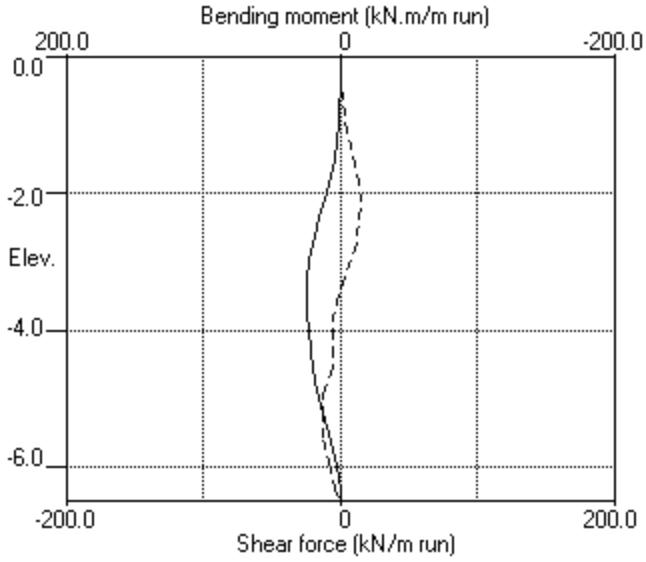
RIGHT side

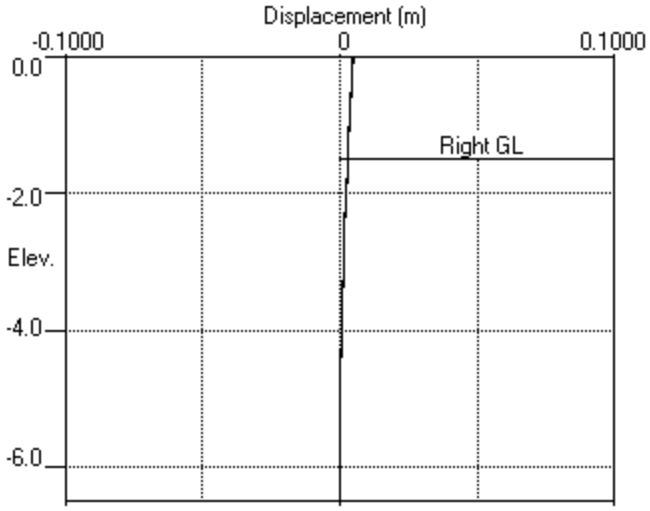
Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
8	-1.75	0.00	6.25	-0.01	0.00b	0.00	0.00p	17552
		0.00	6.25	1.97	4.30b	4.30	4.30p	17552
9	-2.00	0.00	12.50	3.95	8.60b	8.60	8.60p	17552
		0.00	12.50	3.95	11.48b	11.48	11.48p	17552
10	-2.25	0.00	18.75	5.92	17.22b	17.22	17.22p	17552
		0.00	18.75	5.92	18.81b	18.81	18.81p	17552
11	-2.50	0.00	25.00	7.90	25.08b	25.08	25.08p	17552
		0.00	25.00	6.93	24.39b	24.39	24.39p	13340
12	-2.75	0.00	31.25	8.67	30.49b	30.49	30.49p	13340
		0.00	31.25	8.67	32.35b	32.35	32.35p	13340
13	-3.00	0.00	37.51	10.40	38.82b	38.82	38.82p	13340
		0.00	37.51	10.40	41.42b	41.42	41.42p	13340
14	-3.25	0.00	43.76	12.14	48.32b	44.96	44.96	13340
		0.00	43.76	12.14	51.82b	44.96	44.96	13340
15	-3.50	0.00	50.02	13.87	59.23b	45.47	45.47	13340
		0.00	50.02	13.87	42.95b	42.95	42.95p	13340
16	-3.75	2.50	54.02	14.98	46.39b	45.18	47.68	13340
		2.50	54.02	14.98	60.49b	45.18	47.68	13340
17	-4.00	5.00	58.03	16.09	64.98b	45.19	50.19	13340
		5.00	58.03	16.09	78.72b	45.19	50.19	13340
18	-4.28	7.75	62.44	17.32	84.70b	45.54	53.29	13340
		7.75	62.44	17.32	98.13b	45.54	53.29	13340
19	-4.55	10.50	66.85	18.54	105.07b	46.20	56.70	13340
		10.50	66.85	8.24	196.71b	62.34	72.84	58138
20	-4.88	13.75	72.89	10.27	211.16b	59.64	73.39	58138
		13.75	72.89	10.27	169.07b	59.64	73.39	58138
21	-5.20	17.00	78.92	12.30	180.64b	58.43	75.43	58138
		17.00	78.92	12.30	190.52b	58.43	75.43	58138
22	-5.60	21.00	86.35	14.81	205.55b	58.45	79.45	58138
		21.00	86.35	14.81	215.44b	58.45	79.45	58138
23	-5.97	24.75	93.33	17.16	230.22b	59.39	84.14	58138
		24.75	93.33	17.16	239.16b	59.39	84.14	58138
24	-6.35	28.50	100.31	19.51	254.54b	59.86	88.36	226588
		28.50	100.31	0.00	2536.85	55.91	84.41	410073
25	-6.50	30.00	103.48	0.00	2551.14	48.34	78.34	501589

Note: 18.89a Soil pressure at active limit
42.95p Soil pressure at passive limit
254.54b Passive limit reduced because of berm

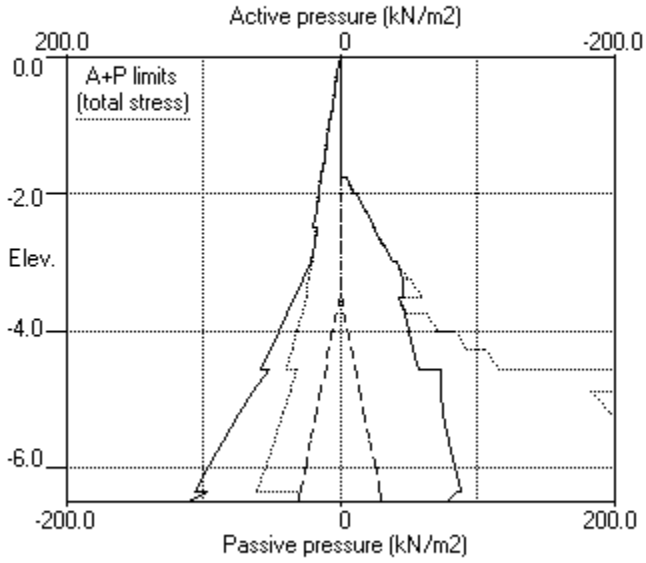
Units: kN,m

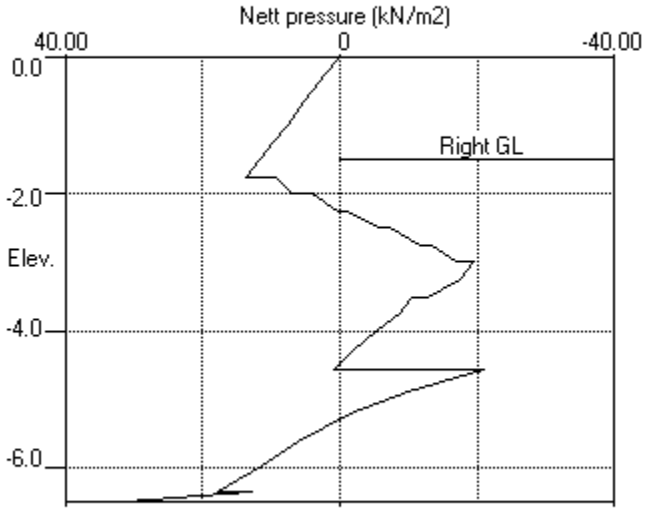
Stage No.1 Excav. to elev. -1.50 on RIGHT side





Stage No.1 Excav. to elev. -1.50 on RIGHT side





Units: kN,m

Stage No. 2 Change EI of wall to 20000 kN.m2/m run
From elevation 0.00 to -1.50
Yield moment not defined
Allow wall to relax with new modulus value

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = -6.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr-ation	Direction of failure
2	0.00	-1.50	Cant.	1.506	-6.38	-4.59	3.09	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall
Analysis options
Soldier Pile width = 0.45m; spacing = 0.90m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	0.00	0.00	0.005	1.29E-03	0.0	0.0		20000
2	-0.25	2.04	0.005	1.29E-03	0.3	0.0		20000
3	-0.50	4.09	0.004	1.28E-03	1.0	0.2		20000
		3.75	0.004	1.28E-03	1.0	0.2		
4	-0.75	5.73	0.004	1.28E-03	2.2	0.6		20000
5	-1.00	7.70	0.004	1.27E-03	3.9	1.3		20000
6	-1.25	9.67	0.003	1.24E-03	6.1	2.5		20000
7	-1.50	11.65	0.003	1.20E-03	8.7	4.4		67096
8	-1.75	13.62	0.003	1.18E-03	11.9	6.9		67096
		9.32	0.003	1.18E-03	11.9	6.9		
9	-2.00	7.00	0.002	1.15E-03	13.9	10.2		67096
		4.12	0.002	1.15E-03	13.9	10.2		
10	-2.25	0.35	0.002	1.10E-03	14.5	13.8		67096
		-1.24	0.002	1.10E-03	14.5	13.8		
11	-2.50	-5.54	0.002	1.04E-03	13.6	17.3		67096
		-7.23	0.002	1.04E-03	13.6	17.3		
12	-2.75	-11.59	0.002	9.79E-04	11.3	20.4		67096
		-13.45	0.002	9.79E-04	11.3	20.4		
13	-3.00	-16.83	0.001	8.98E-04	7.5	22.9		67096
		-19.43	0.001	8.98E-04	7.5	22.9		
14	-3.25	-17.55	0.001	8.10E-04	2.9	24.4		67096
15	-3.50	-12.90	0.001	7.19E-04	-0.9	24.5		67096
		-10.37	0.001	7.19E-04	-0.9	24.5		
16	-3.75	-8.80	0.001	6.28E-04	-3.3	24.1		67096
17	-4.00	-5.24	0.001	5.41E-04	-5.1	23.0		67096
18	-4.28	-1.92	0.000	4.50E-04	-6.1	21.4		67096
19	-4.55	0.80	0.000	3.66E-04	-6.2	19.6		67096
		-20.96	0.000	3.66E-04	-6.2	19.6		
20	-4.88	-9.84	0.000	2.79E-04	-11.2	16.5		67096
21	-5.20	-1.46	0.000	2.09E-04	-13.1	12.3		67096

(continued)

Stage No.2 Change EI of wall to 20000 kN.m2/m run
From elevation 0.00 to -1.50
Yield moment not defined
Allow wall to relax with new modulus value

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
22	-5.60	6.11	0.000	1.51E-04	-12.1	7.0		67096
23	-5.97	11.53	0.000	1.24E-04	-8.8	2.9		67096
24	-6.35	17.80	-0.000	1.15E-04	-3.3	0.4		67096
		12.93	-0.000	1.15E-04	-3.3	0.4		
25	-6.50	31.49	-0.000	1.14E-04	0.0	0.0		---

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19983
2	-0.25	0.00	5.94	2.04	19.86	2.04	2.04a	19983
3	-0.50	0.00	11.88	4.09	39.73	4.09	4.09a	19983
		0.00	11.88	3.75	44.60	3.75	3.75a	27755
4	-0.75	0.00	18.13	5.73	68.07	5.73	5.73a	27755
5	-1.00	0.00	24.38	7.70	91.54	7.70	7.70a	27755
6	-1.25	0.00	30.63	9.67	115.01	9.67	9.67a	27755
7	-1.50	0.00	36.88	11.65	138.48	11.65	11.65a	29054
8	-1.75	0.00	43.13	13.62	161.95	13.62	13.62a	29054
9	-2.00	0.00	49.38	15.60	185.42	15.60	15.60a	29054
10	-2.25	0.00	55.63	17.57	208.89	17.57	17.57a	29054
11	-2.50	0.00	61.88	19.55	232.36	19.55	19.55a	29054
		0.00	61.88	17.16	278.95	17.16	17.16a	22081
12	-2.75	0.00	68.13	18.89	307.13	18.89	18.89a	22081
13	-3.00	0.00	74.38	20.63	335.31	21.99	21.99	22081
14	-3.25	0.00	80.63	22.36	363.48	27.41	27.41	10678
15	-3.50	0.00	86.88	24.09	391.66	32.57	32.57	10678
16	-3.75	2.50	90.88	25.20	409.69	36.39	38.89	10678
17	-4.00	5.00	94.88	26.31	427.73	39.96	44.96	10678
18	-4.28	7.75	99.28	27.53	447.56	43.61	51.36	10678
19	-4.55	10.50	103.68	28.75	467.40	47.00	57.50	10678
		10.50	103.68	20.64	409.45	41.38	51.88	46960
20	-4.88	13.75	109.69	22.67	430.15	49.80	63.55	46960
21	-5.20	17.00	115.70	24.69	450.85	56.98	73.98	46960
22	-5.60	21.00	123.10	27.18	476.32	64.56	85.56	46960
23	-5.97	24.75	130.04	29.52	500.20	70.91	95.66	46960
24	-6.35	28.50	136.97	31.86	524.08	77.66	106.16	48576
		28.50	136.97	0.00	2702.16	68.84	97.34	87348
25	-6.50	30.00	140.13	0.00	2716.36	79.82	109.82	779935

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	-0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	-0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	-1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	-1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	29054

(continued)

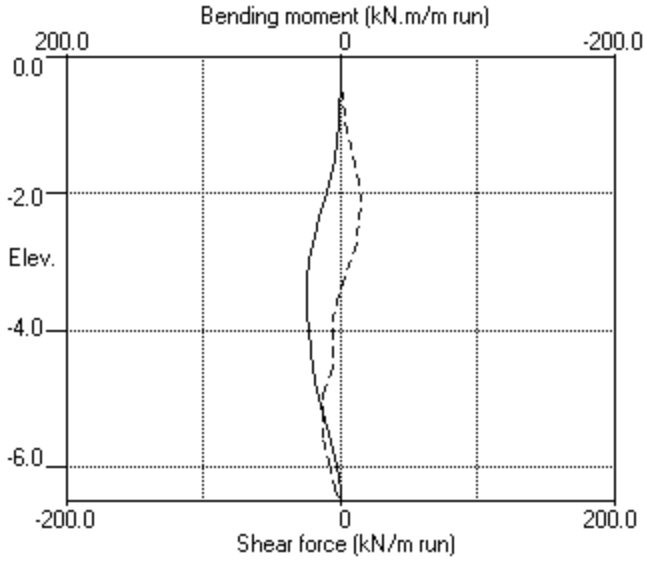
Stage No.2 Change EI of wall to 20000 kN.m2/m run
From elevation 0.00 to -1.50
Yield moment not defined
Allow wall to relax with new modulus value

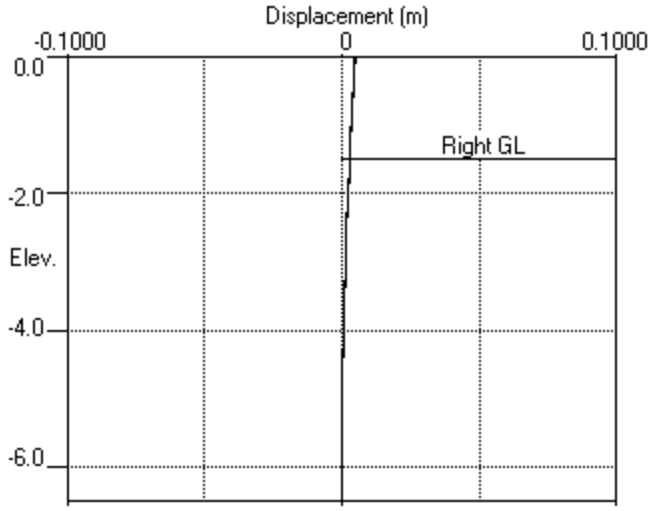
		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
8	-1.75	0.00	6.25	-0.01	0.00b	-0.00	-0.00p	29054
		0.00	6.25	1.97	4.30b	4.30	4.30p	29054
9	-2.00	0.00	12.50	3.95	8.60b	8.60	8.60p	29054
		0.00	12.50	3.95	11.48b	11.48	11.48p	29054
10	-2.25	0.00	18.75	5.92	17.22b	17.22	17.22p	29054
		0.00	18.75	5.92	18.81b	18.81	18.81p	29054
11	-2.50	0.00	25.00	7.90	25.08b	25.08	25.08p	29054
		0.00	25.00	6.93	24.39b	24.39	24.39p	22081
12	-2.75	0.00	31.25	8.67	30.49b	30.49	30.49p	22081
		0.00	31.25	8.67	32.35b	32.35	32.35p	22081
13	-3.00	0.00	37.51	10.40	38.82b	38.82	38.82p	22081
		0.00	37.51	10.40	41.42b	41.42	41.42p	22081
14	-3.25	0.00	43.76	12.14	48.32b	44.96	44.96	10678
		0.00	43.76	12.14	51.82b	44.96	44.96	10678
15	-3.50	0.00	50.02	13.87	59.23b	45.47	45.47	10678
		0.00	50.02	13.87	42.95b	42.95	42.95p	10678
16	-3.75	2.50	54.02	14.98	46.39b	45.18	47.68	10678
		2.50	54.02	14.98	60.49b	45.18	47.68	10678
17	-4.00	5.00	58.03	16.09	64.98b	45.19	50.19	10678
		5.00	58.03	16.09	78.72b	45.19	50.19	10678
18	-4.28	7.75	62.44	17.32	84.70b	45.54	53.29	10678
		7.75	62.44	17.32	98.13b	45.54	53.29	10678
19	-4.55	10.50	66.85	18.54	105.07b	46.20	56.70	10678
		10.50	66.85	8.24	196.71b	62.34	72.84	46960
20	-4.88	13.75	72.89	10.27	211.16b	59.64	73.39	46960
		13.75	72.89	10.27	169.07b	59.64	73.39	46960
21	-5.20	17.00	78.92	12.30	180.64b	58.43	75.43	46960
		17.00	78.92	12.30	190.52b	58.43	75.43	46960
22	-5.60	21.00	86.35	14.81	205.55b	58.45	79.45	46960
		21.00	86.35	14.81	215.44b	58.45	79.45	46960
23	-5.97	24.75	93.33	17.16	230.22b	59.39	84.14	46960
		24.75	93.33	17.16	239.16b	59.39	84.14	46960
24	-6.35	28.50	100.31	19.51	254.54b	59.86	88.36	48576
		28.50	100.31	0.00	2536.85	55.91	84.41	87348
25	-6.50	30.00	103.48	0.00	2551.14	48.34	78.34	779935

Note: 18.89a Soil pressure at active limit
42.95p Soil pressure at passive limit
254.54b Passive limit reduced because of berm

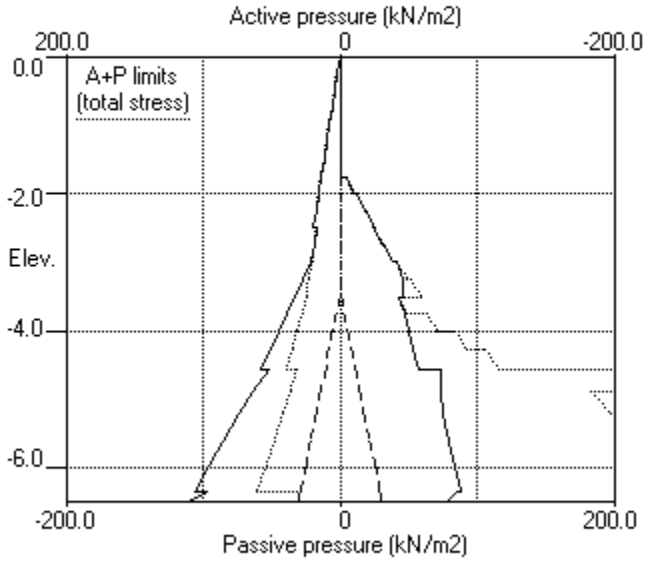
Units: kN,m

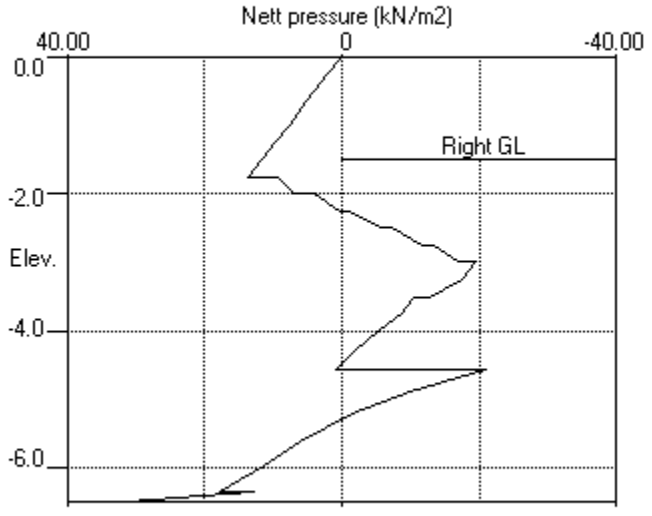
Stage No.2 Change EI of wall to 20000kN.m2/m run





Stage No.2 Change EI of wall to 20000kN.m2/m run





Units: kN,m

Stage No. 3 Apply surcharge no.1 at elevation 0.00

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = -6.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr-ation	Direction of failure
3	0.00	-1.50	Cant.	1.354	-6.38	-5.08	3.58	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall

Analysis options

Soldier Pile width = 0.45m; spacing = 0.90m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	0.00	0.00	0.008	2.00E-03	0.0	0.0		20000
2	-0.25	2.11	0.008	2.00E-03	0.3	0.0		20000
3	-0.50	4.50	0.007	2.00E-03	1.1	0.2		20000
		4.13	0.007	2.00E-03	1.1	0.2		
4	-0.75	6.71	0.007	1.99E-03	2.4	0.6		20000
5	-1.00	9.41	0.006	1.98E-03	4.5	1.5		20000
6	-1.25	12.12	0.006	1.95E-03	7.2	2.9		20000
7	-1.50	14.77	0.005	1.90E-03	10.5	5.1		67096
8	-1.75	17.33	0.005	1.88E-03	14.5	8.2		67096
		13.03	0.005	1.88E-03	14.5	8.2		
9	-2.00	11.20	0.004	1.84E-03	17.6	12.2		67096
		8.33	0.004	1.84E-03	17.6	12.2		
10	-2.25	4.98	0.004	1.79E-03	19.2	16.8		67096
		3.39	0.004	1.79E-03	19.2	16.8		
11	-2.50	-0.55	0.003	1.71E-03	19.6	21.7		67096
		-2.85	0.003	1.71E-03	19.6	21.7		
12	-2.75	-6.95	0.003	1.63E-03	18.3	26.5		67096
		-8.81	0.003	1.63E-03	18.3	26.5		
13	-3.00	-13.32	0.002	1.52E-03	15.6	30.9		67096
		-15.92	0.002	1.52E-03	15.6	30.9		
14	-3.25	-20.91	0.002	1.40E-03	11.0	34.4		67096
		-24.41	0.002	1.40E-03	11.0	34.4		
15	-3.50	-25.88	0.002	1.26E-03	4.7	36.4		67096
		-13.65	0.002	1.26E-03	4.7	36.4		
16	-3.75	-12.02	0.001	1.13E-03	1.5	37.3		67096
		-18.90	0.001	1.13E-03	1.5	37.3		
17	-4.00	-12.54	0.001	9.94E-04	-2.4	37.1		67096
18	-4.28	-6.50	0.001	8.44E-04	-5.1	35.9		67096
19	-4.55	-1.43	0.001	7.00E-04	-6.2	34.3		67096
		-44.26	0.001	7.00E-04	-6.2	34.3		
20	-4.88	-23.36	0.000	5.45E-04	-17.1	30.0		67096
21	-5.20	-7.30	0.000	4.16E-04	-22.1	23.2		67096
22	-5.60	7.42	0.000	3.06E-04	-22.1	13.7		67096

(continued)

Stage No.3 Apply surcharge no.1 at elevation 0.00

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
23	-5.97	18.03	0.000	2.51E-04	-17.3	6.0		67096
24	-6.35	35.04	-0.000	2.32E-04	-7.4	0.7		67096
		33.67	-0.000	2.32E-04	-7.4	0.7		
25	-6.50	64.65	-0.000	2.31E-04	0.0	0.0		---

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9836
2	-0.25	0.00	6.12	2.11	20.48	2.11	2.11a	9836
3	-0.50	0.00	13.09	4.50	43.79	4.50	4.50a	9836
		0.00	13.09	4.13	49.15	4.13	4.13a	13662
4	-0.75	0.00	21.24	6.71	79.75	6.71	6.71a	13662
5	-1.00	0.00	29.80	9.41	111.91	9.41	9.41a	13662
6	-1.25	0.00	38.37	12.12	144.11	12.12	12.12a	13662
7	-1.50	0.00	46.75	14.77	175.56	14.77	14.77a	13662
8	-1.75	0.00	54.86	17.33	206.01	17.33	17.33a	13662
9	-2.00	0.00	62.69	19.80	235.44	19.80	19.80a	13662
10	-2.25	0.00	70.29	22.20	263.96	22.20	22.20a	13662
11	-2.50	0.00	77.67	24.54	291.69	24.54	24.54a	13662
		0.00	77.67	21.54	350.17	21.54	21.54a	10383
12	-2.75	0.00	84.88	23.54	382.65	23.54	23.54a	10383
13	-3.00	0.00	91.92	25.49	414.42	25.49	25.49a	10383
14	-3.25	0.00	98.84	27.41	445.61	27.41	27.41a	10383
15	-3.50	0.00	105.65	29.30	476.29	29.30	29.30a	10383
16	-3.75	2.50	110.10	30.54	496.39	34.37	36.87	10383
17	-4.00	5.00	114.48	31.75	516.11	39.28	44.28	10383
18	-4.28	7.75	119.21	33.06	537.43	44.22	51.97	10383
19	-4.55	10.50	123.86	34.35	558.40	48.72	59.22	10383
		10.50	123.86	27.44	478.93	35.36	45.86	45730
20	-4.88	13.75	130.09	29.54	500.36	48.32	62.07	45730
21	-5.20	17.00	136.23	31.61	521.53	59.05	76.05	45730
22	-5.60	21.00	143.71	34.13	547.26	69.94	90.94	45730
23	-5.97	24.75	150.64	36.46	571.13	78.67	103.42	45730
24	-6.35	28.50	157.52	38.78	594.79	90.68	119.18	191316
		28.50	157.52	0.00	2794.76	81.77	110.27	353866
25	-6.50	30.00	160.62	0.00	2808.78	98.97	128.97	353866

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	-0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	-0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	-1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	-1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	16201
8	-1.75	0.00	6.25	-0.01	0.00b	0.00	0.00p	16201
		0.00	6.25	1.97	4.30b	4.30	4.30p	16201
9	-2.00	0.00	12.50	3.95	8.60b	8.60	8.60p	16201
		0.00	12.50	3.95	11.48b	11.48	11.48p	16201

(continued)

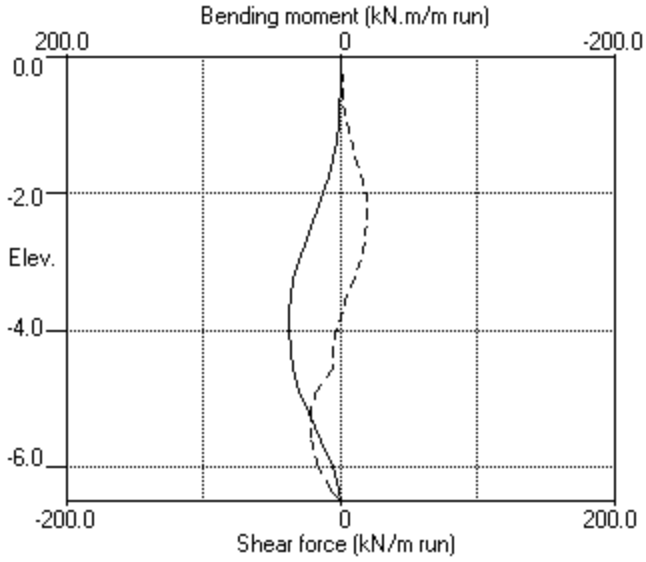
Stage No.3 Apply surcharge no.1 at elevation 0.00

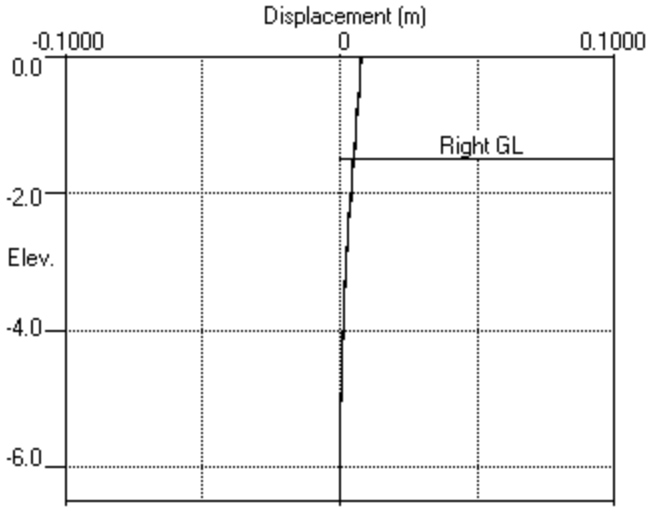
		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
10	-2.25	0.00	18.75	5.92	17.22b	17.22	17.22p	16201
		0.00	18.75	5.92	18.81b	18.81	18.81p	16201
11	-2.50	0.00	25.00	7.90	25.08b	25.08	25.08p	16201
		0.00	25.00	6.93	24.39b	24.39	24.39p	12313
12	-2.75	0.00	31.25	8.67	30.49b	30.49	30.49p	12313
		0.00	31.25	8.67	32.35b	32.35	32.35p	12313
13	-3.00	0.00	37.51	10.40	38.82b	38.82	38.82p	12313
		0.00	37.51	10.40	41.42b	41.42	41.42p	12313
14	-3.25	0.00	43.76	12.14	48.32b	48.32	48.32p	12313
		0.00	43.76	12.14	51.82b	51.82	51.82p	12313
15	-3.50	0.00	50.02	13.87	59.23b	55.18	55.18	12313
		0.00	50.02	13.87	42.95b	42.95	42.95p	12313
16	-3.75	2.50	54.02	14.98	46.39b	46.39	48.89p	12313
		2.50	54.02	14.98	60.49b	53.27	55.77	12313
17	-4.00	5.00	58.03	16.09	64.98b	51.81	56.81	12313
		5.00	58.03	16.09	78.72b	51.81	56.81	12313
18	-4.28	7.75	62.44	17.32	84.70b	50.72	58.47	12313
		7.75	62.44	17.32	98.13b	50.72	58.47	12313
19	-4.55	10.50	66.85	18.54	105.07b	50.15	60.65	12313
		10.50	66.85	8.24	196.71b	79.61	90.11	53815
20	-4.88	13.75	72.89	10.27	211.16b	71.67	85.42	53815
		13.75	72.89	10.27	169.07b	71.67	85.42	53815
21	-5.20	17.00	78.92	12.30	180.64b	66.35	83.35	53815
		17.00	78.92	12.30	190.52b	66.35	83.35	53815
22	-5.60	21.00	86.35	14.81	205.55b	62.52	83.52	53815
		21.00	86.35	14.81	215.44b	62.52	83.52	53815
23	-5.97	24.75	93.33	17.16	230.22b	60.64	85.39	53815
		24.75	93.33	17.16	239.16b	60.64	85.39	53815
24	-6.35	28.50	100.31	19.51	254.54b	55.64	84.14	191316
		28.50	100.31	0.00	2536.85	48.10	76.60	353866
25	-6.50	30.00	103.48	0.00	2551.14	34.32	64.32	353866

Note: 29.30a Soil pressure at active limit
48.89p Soil pressure at passive limit
254.54b Passive limit reduced because of berm

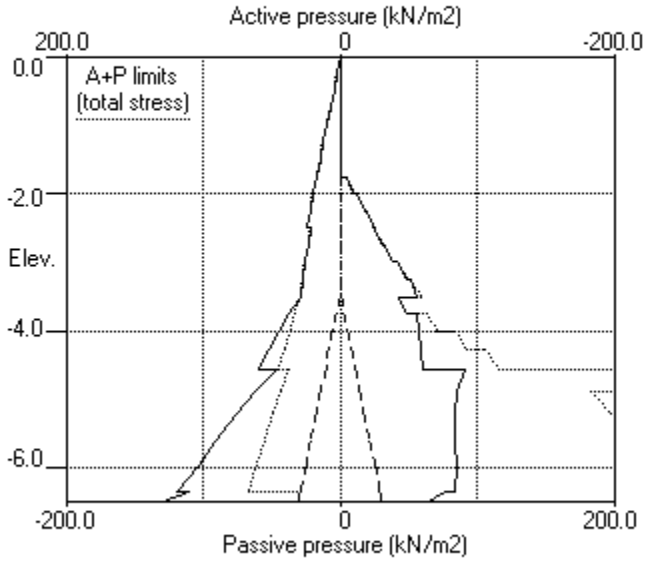
Units: kN,m

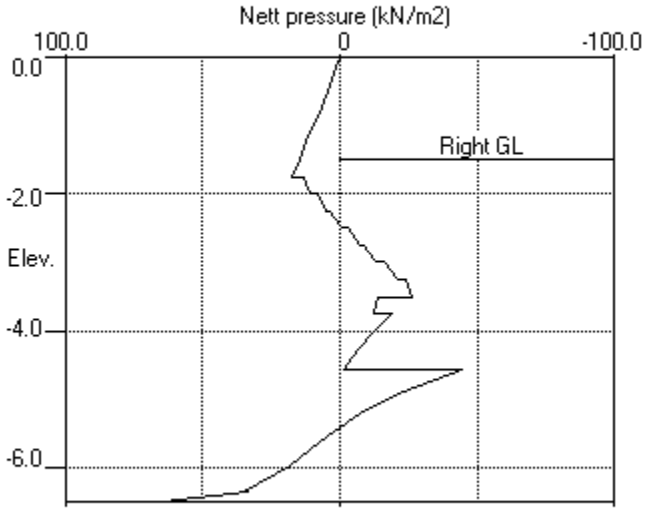
Stage No.3 Apply surcharge no.1 at elev. 0.00





Stage No.3 Apply surcharge no.1 at elev. 0.00





Units: kN,m

Stage No. 4 Apply water pressure profile no.2

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = -6.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr-ation	Direction of failure
4	0.00	-1.50	Cant.	1.109	-6.38	-6.22	4.72	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall

Analysis options

Soldier Pile width = 0.45m; spacing = 0.90m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	0.00	0.00	0.028	5.92E-03	0.0	0.0		20000
2	-0.25	2.11	0.026	5.92E-03	0.3	0.0		20000
3	-0.50	4.50	0.025	5.92E-03	1.1	0.2		20000
		4.13	0.025	5.92E-03	1.1	0.2		
4	-0.75	8.50	0.023	5.91E-03	2.7	0.6		20000
5	-1.00	12.99	0.022	5.90E-03	5.4	1.6		20000
6	-1.25	17.49	0.020	5.87E-03	9.2	3.4		20000
7	-1.50	21.92	0.019	5.81E-03	14.1	6.3		67096
8	-1.75	26.27	0.017	5.78E-03	20.1	10.5		67096
		21.97	0.017	5.78E-03	20.1	10.5		
9	-2.00	21.94	0.016	5.73E-03	25.6	16.2		67096
		19.06	0.016	5.73E-03	25.6	16.2		
10	-2.25	17.51	0.015	5.65E-03	30.2	23.2		67096
		15.92	0.015	5.65E-03	30.2	23.2		
11	-2.50	13.76	0.013	5.55E-03	33.9	31.2		67096
		12.16	0.013	5.55E-03	33.9	31.2		
12	-2.75	9.94	0.012	5.42E-03	36.6	40.1		67096
		8.08	0.012	5.42E-03	36.6	40.1		
13	-3.00	5.44	0.011	5.25E-03	38.3	49.6		67096
		2.84	0.011	5.25E-03	38.3	49.6		
14	-3.25	-0.27	0.009	5.05E-03	38.7	59.4		67096
		-3.77	0.009	5.05E-03	38.7	59.4		
15	-3.50	-7.42	0.008	4.81E-03	37.3	68.9		67096
		8.86	0.008	4.81E-03	37.3	68.9		
16	-3.75	6.66	0.007	4.54E-03	39.2	78.7		67096
		-7.44	0.007	4.54E-03	39.2	78.7		
17	-4.00	-10.72	0.006	4.23E-03	36.9	88.1		67096
		-24.46	0.006	4.23E-03	36.9	88.1		
18	-4.28	-29.13	0.005	3.85E-03	29.6	97.2		67096
		-37.71	0.005	3.85E-03	29.6	97.2		
19	-4.55	-26.82	0.004	3.43E-03	20.7	103.9		67096
		-148.37	0.004	3.43E-03	20.7	103.9		
20	-4.88	-126.51	0.003	2.93E-03	-24.0	104.7		67096
		-118.62	0.003	2.93E-03	-24.0	104.7		

(continued)

Stage No.4 Apply water pressure profile no.2

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
21	-5.20	-83.11	0.002	2.45E-03	-56.8	92.2		67096
22	-5.60	-34.26	0.001	1.99E-03	-80.2	63.5		67096
23	-5.97	31.48	0.000	1.72E-03	-80.8	31.0		67096
24	-6.35	167.77	-0.001	1.63E-03	-43.4	3.8		67096
		249.36	-0.001	1.63E-03	-43.4	3.8		
25	-6.50	329.26	-0.001	1.62E-03	0.0	-0.0		---

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9342
2	-0.25	0.00	6.12	2.11	20.48	2.11	2.11a	9342
3	-0.50	0.00	13.09	4.50	43.79	4.50	4.50a	9342
		0.00	13.09	4.13	49.15	4.13	4.13a	12975
4	-0.75	2.50	18.99	6.00	71.30	6.00	8.50a	12975
5	-1.00	5.00	25.30	7.99	95.02	7.99	12.99a	12975
6	-1.25	7.50	31.62	9.99	118.76	9.99	17.49a	12975
7	-1.50	10.00	37.75	11.92	141.76	11.92	21.92a	12975
8	-1.75	12.50	43.61	13.77	163.76	13.77	26.27a	12975
9	-2.00	15.00	49.19	15.54	184.74	15.54	30.54a	12975
10	-2.25	17.50	54.54	17.23	204.82	17.23	34.73a	12975
11	-2.50	20.00	59.67	18.85	224.09	18.85	38.85a	12975
		20.00	59.67	16.55	269.02	16.55	36.55a	9861
12	-2.75	22.50	64.63	17.92	291.35	17.92	40.42a	9861
13	-3.00	25.00	69.42	19.25	312.99	19.25	44.25a	9861
14	-3.25	27.50	74.09	20.55	334.03	20.55	48.05a	9861
15	-3.50	30.00	78.65	21.81	354.56	21.81	51.81a	9861
16	-3.75	32.50	83.10	23.05	374.66	23.05	55.55a	9861
17	-4.00	35.00	87.48	24.26	394.39	24.26	59.26a	9861
18	-4.28	37.75	92.21	25.57	415.70	25.57	63.32a	9861
19	-4.55	40.50	96.86	26.86	436.67	26.86	67.36a	9861
		40.50	96.86	18.35	385.99	18.35	58.85a	43558
20	-4.88	43.75	103.09	20.44	407.42	20.44	64.19a	43558
21	-5.20	47.00	109.23	22.51	428.58	22.51	69.51a	43558
22	-5.60	51.00	116.71	25.03	454.32	30.41	81.41	43558
23	-5.97	54.75	123.64	27.37	478.19	64.79	119.54	43558
24	-6.35	58.50	130.52	29.68	501.84	157.28	215.78	162132
		58.50	130.52	0.00	2673.03	219.36	277.86	299398
25	-6.50	60.00	133.62	0.00	2687.05	299.26	359.26	299398

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	-0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	-0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	-1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	-1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	15032
8	-1.75	0.00	6.25	-0.01	0.00b	0.00	0.00p	15032
		0.00	6.25	1.97	4.30b	4.30	4.30p	15032

(continued)

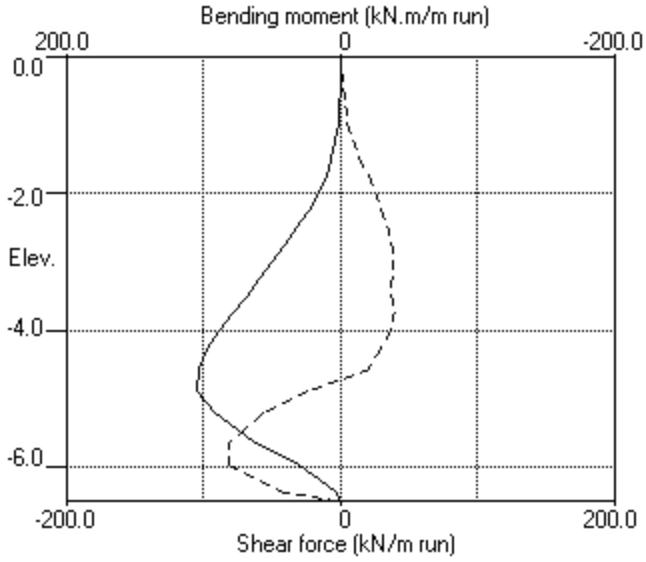
Stage No.4 Apply water pressure profile no.2

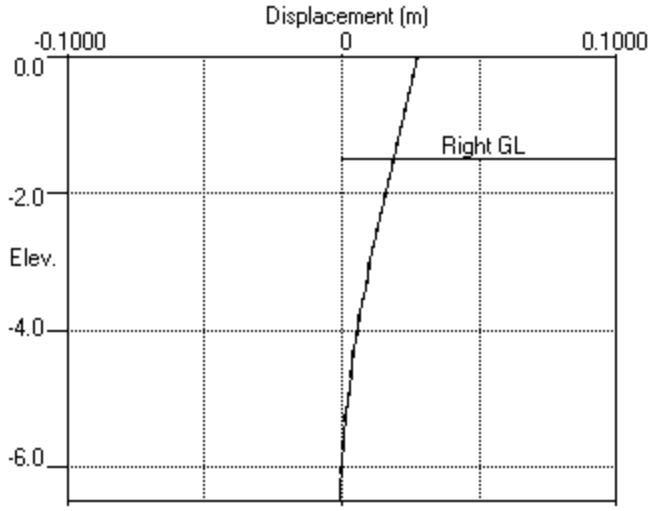
		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
9	-2.00	0.00	12.50	3.95	8.60b	8.60	8.60p	15032
		0.00	12.50	3.95	11.48b	11.48	11.48p	15032
10	-2.25	0.00	18.75	5.92	17.22b	17.22	17.22p	15032
		0.00	18.75	5.92	18.81b	18.81	18.81p	15032
11	-2.50	0.00	25.00	7.90	25.08b	25.08	25.08p	15032
		0.00	25.00	6.93	24.39b	24.39	24.39p	11424
12	-2.75	0.00	31.25	8.67	30.49b	30.49	30.49p	11424
		0.00	31.25	8.67	32.35b	32.35	32.35p	11424
13	-3.00	0.00	37.51	10.40	38.82b	38.82	38.82p	11424
		0.00	37.51	10.40	41.42b	41.42	41.42p	11424
14	-3.25	0.00	43.76	12.14	48.32b	48.32	48.32p	11424
		0.00	43.76	12.14	51.82b	51.82	51.82p	11424
15	-3.50	0.00	50.02	13.87	59.23b	59.23	59.23p	11424
		0.00	50.02	13.87	42.95b	42.95	42.95p	11424
16	-3.75	2.50	54.02	14.98	46.39b	46.39	48.89p	11424
		2.50	54.02	14.98	60.49b	60.49	62.99p	11424
17	-4.00	5.00	58.03	16.09	64.98b	64.98	69.98p	11424
		5.00	58.03	16.09	78.72b	78.72	83.72p	11424
18	-4.28	7.75	62.44	17.32	84.70b	84.70	92.45p	11424
		7.75	62.44	17.32	98.13b	93.29	101.04	11424
19	-4.55	10.50	66.85	18.54	105.07b	83.69	94.19	11424
		10.50	66.85	8.24	196.71b	196.71	207.21p	50086
20	-4.88	13.75	72.89	10.27	211.16b	176.95	190.70	50086
		13.75	72.89	10.27	169.07b	169.07	182.82p	50086
21	-5.20	17.00	78.92	12.30	180.64b	135.63	152.63	50086
		17.00	78.92	12.30	190.52b	135.63	152.63	50086
22	-5.60	21.00	86.35	14.81	205.55b	94.67	115.67	50086
		21.00	86.35	14.81	215.44b	94.67	115.67	50086
23	-5.97	24.75	93.33	17.16	230.22b	63.31	88.06	50086
		24.75	93.33	17.16	239.16b	63.31	88.06	50086
24	-6.35	28.50	100.31	19.51	254.54b	19.51	48.01a	162132
		28.50	100.31	0.00	2536.85	0.00	28.50a	299398
25	-6.50	30.00	103.48	0.00	2551.14	0.00	30.00a	299398

Note: 30.00a Soil pressure at active limit
182.82p Soil pressure at passive limit
254.54b Passive limit reduced because of berm

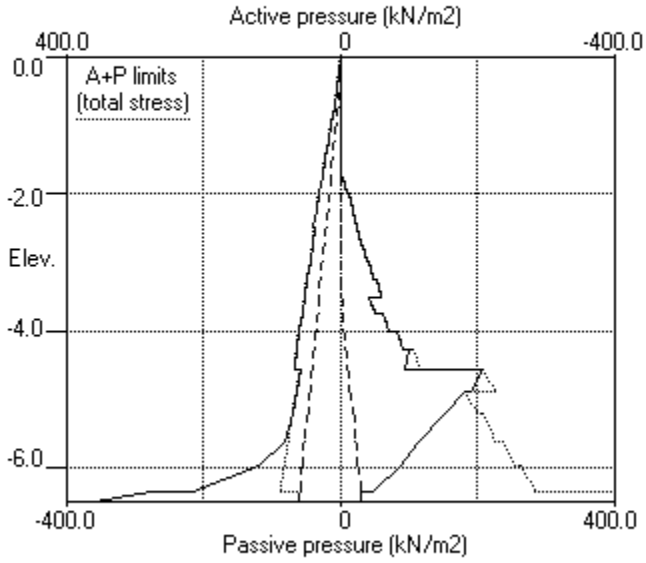
Units: kN,m

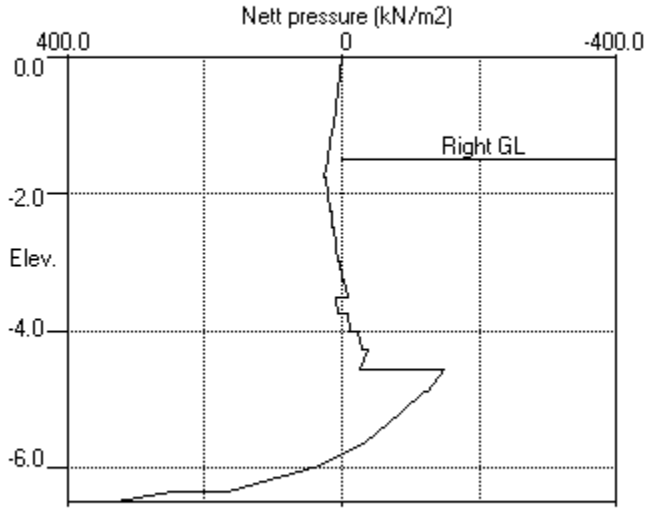
Stage No.4 Apply water pressure profile no.2





Stage No.4 Apply water pressure profile no.2





Units: kN,m

Stage No. 5 Change EI of wall to 30000 kN.m2/m run
From elevation -1.50 to -6.50
Yield moment not defined
Allow wall to relax with new modulus value

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = -6.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr-ation	Direction of failure
5	0.00	-1.50	Cant.	1.109	-6.38	-6.22	4.72	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall
Analysis options
Soldier Pile width = 0.45m; spacing = 0.90m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	0.00	0.00	0.047	1.06E-02	0.0	0.0		20000
2	-0.25	2.11	0.044	1.06E-02	0.3	0.0		20000
3	-0.50	4.50	0.042	1.06E-02	1.1	0.2		20000
		4.13	0.042	1.06E-02	1.1	0.2		
4	-0.75	8.50	0.039	1.06E-02	2.7	0.6		20000
5	-1.00	12.99	0.036	1.06E-02	5.4	1.6		20000
6	-1.25	17.49	0.034	1.06E-02	9.2	3.4		20000
7	-1.50	21.92	0.031	1.05E-02	14.1	6.3		30000
8	-1.75	26.27	0.029	1.04E-02	20.1	10.5		30000
		21.97	0.029	1.04E-02	20.1	10.5		
9	-2.00	21.94	0.026	1.03E-02	25.6	16.2		30000
		19.06	0.026	1.03E-02	25.6	16.2		
10	-2.25	17.51	0.023	1.02E-02	30.2	23.2		30000
		15.92	0.023	1.02E-02	30.2	23.2		
11	-2.50	13.76	0.021	9.97E-03	33.9	31.2		30000
		12.16	0.021	9.97E-03	33.9	31.2		
12	-2.75	9.94	0.018	9.67E-03	36.6	40.1		30000
		8.08	0.018	9.67E-03	36.6	40.1		
13	-3.00	5.44	0.016	9.30E-03	38.3	49.6		30000
		2.84	0.016	9.30E-03	38.3	49.6		
14	-3.25	-0.27	0.014	8.85E-03	38.7	59.4		30000
		-3.77	0.014	8.85E-03	38.7	59.4		
15	-3.50	-7.42	0.012	8.31E-03	37.3	68.9		30000
		8.86	0.012	8.31E-03	37.3	68.9		
16	-3.75	6.66	0.010	7.70E-03	39.2	78.7		30000
		-7.44	0.010	7.70E-03	39.2	78.7		
17	-4.00	-10.72	0.008	7.00E-03	36.9	88.1		30000
		-24.46	0.008	7.00E-03	36.9	88.1		
18	-4.28	-29.13	0.006	6.15E-03	29.6	97.2		30000
		-42.56	0.006	6.15E-03	29.6	97.2		

(continued)

Stage No.5 Change EI of wall to 30000 kN.m2/m run
From elevation -1.50 to -6.50
Yield moment not defined
Allow wall to relax with new modulus value

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
19	-4.55	-37.22	0.004	5.23E-03	18.6	103.8		30000
		-148.37	0.004	5.23E-03	18.6	103.8		
20	-4.88	-143.97	0.003	4.11E-03	-28.9	104.1		30000
		-118.62	0.003	4.11E-03	-28.9	104.1		
21	-5.20	-84.01	0.002	3.06E-03	-61.8	90.6		30000
22	-5.60	-14.80	0.001	2.07E-03	-81.6	60.6		30000
23	-5.97	45.94	0.000	1.53E-03	-75.8	28.6		30000
24	-6.35	159.83	-0.000	1.34E-03	-37.2	3.3		30000
		234.63	-0.000	1.34E-03	-37.2	3.3		
25	-6.50	261.11	-0.001	1.33E-03	0.0	-0.0		---

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10236
2	-0.25	0.00	6.12	2.11	20.48	2.11	2.11a	10236
3	-0.50	0.00	13.09	4.50	43.79	4.50	4.50a	10236
		0.00	13.09	4.13	49.15	4.13	4.13a	14216
4	-0.75	2.50	18.99	6.00	71.30	6.00	8.50a	14216
5	-1.00	5.00	25.30	7.99	95.02	7.99	12.99a	14216
6	-1.25	7.50	31.62	9.99	118.76	9.99	17.49a	14216
7	-1.50	10.00	37.75	11.92	141.76	11.92	21.92a	14216
8	-1.75	12.50	43.61	13.77	163.76	13.77	26.27a	14216
9	-2.00	15.00	49.19	15.54	184.74	15.54	30.54a	14216
10	-2.25	17.50	54.54	17.23	204.82	17.23	34.73a	14216
11	-2.50	20.00	59.67	18.85	224.09	18.85	38.85a	14216
		20.00	59.67	16.55	269.02	16.55	36.55a	10804
12	-2.75	22.50	64.63	17.92	291.35	17.92	40.42a	10804
13	-3.00	25.00	69.42	19.25	312.99	19.25	44.25a	10804
14	-3.25	27.50	74.09	20.55	334.03	20.55	48.05a	10804
15	-3.50	30.00	78.65	21.81	354.56	21.81	51.81a	10804
16	-3.75	32.50	83.10	23.05	374.66	23.05	55.55a	10804
17	-4.00	35.00	87.48	24.26	394.39	24.26	59.26a	10804
18	-4.28	37.75	92.21	25.57	415.70	25.57	63.32a	10804
19	-4.55	40.50	96.86	26.86	436.67	26.86	67.36a	10804
		40.50	96.86	18.35	385.99	18.35	58.85a	47490
20	-4.88	43.75	103.09	20.44	407.42	20.44	64.19a	47490
21	-5.20	47.00	109.23	22.51	428.58	22.51	69.51a	47490
22	-5.60	51.00	116.71	25.03	454.32	40.14	91.14	86073
23	-5.97	54.75	123.64	27.37	478.19	72.02	126.77	86073
24	-6.35	58.50	130.52	29.68	501.84	153.31	211.81	328375
		58.50	130.52	0.00	2673.03	211.99	270.49	609868
25	-6.50	60.00	133.62	0.00	2687.05	265.19	325.19	609868

(continued)

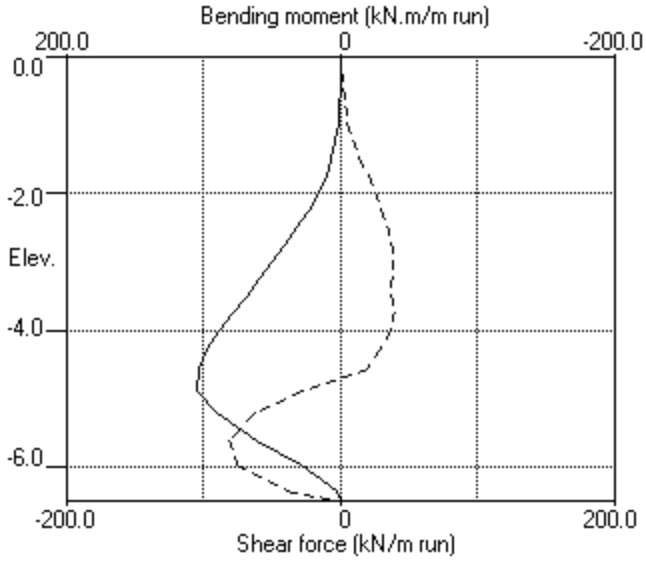
Stage No.5 Change EI of wall to 30000 kN.m2/m run
From elevation -1.50 to -6.50
Yield moment not defined
Allow wall to relax with new modulus value

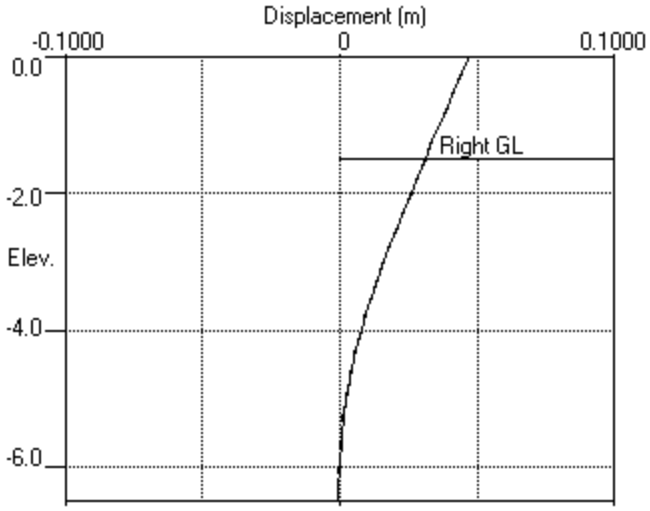
		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	-0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	-0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	-1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	-1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	17403
8	-1.75	0.00	6.25	-0.01	0.00b	0.00	0.00p	17403
		0.00	6.25	1.97	4.30b	4.30	4.30p	17403
9	-2.00	0.00	12.50	3.95	8.60b	8.60	8.60p	17403
		0.00	12.50	3.95	11.48b	11.48	11.48p	17403
10	-2.25	0.00	18.75	5.92	17.22b	17.22	17.22p	17403
		0.00	18.75	5.92	18.81b	18.81	18.81p	17403
11	-2.50	0.00	25.00	7.90	25.08b	25.08	25.08p	17403
		0.00	25.00	6.93	24.39b	24.39	24.39p	13226
12	-2.75	0.00	31.25	8.67	30.49b	30.49	30.49p	13226
		0.00	31.25	8.67	32.35b	32.35	32.35p	13226
13	-3.00	0.00	37.51	10.40	38.82b	38.82	38.82p	13226
		0.00	37.51	10.40	41.42b	41.42	41.42p	13226
14	-3.25	0.00	43.76	12.14	48.32b	48.32	48.32p	13226
		0.00	43.76	12.14	51.82b	51.82	51.82p	13226
15	-3.50	0.00	50.02	13.87	59.23b	59.23	59.23p	13226
		0.00	50.02	13.87	42.95b	42.95	42.95p	13226
16	-3.75	2.50	54.02	14.98	46.39b	46.39	48.89p	13226
		2.50	54.02	14.98	60.49b	60.49	62.99p	13226
17	-4.00	5.00	58.03	16.09	64.98b	64.98	69.98p	13226
		5.00	58.03	16.09	78.72b	78.72	83.72p	13226
18	-4.28	7.75	62.44	17.32	84.70b	84.70	92.45p	13226
		7.75	62.44	17.32	98.13b	98.13	105.88p	13226
19	-4.55	10.50	66.85	18.54	105.07b	94.09	104.59	13226
		10.50	66.85	8.24	196.71b	196.71	207.21p	57659
20	-4.88	13.75	72.89	10.27	211.16b	194.41	208.16	57659
		13.75	72.89	10.27	169.07b	169.07	182.82p	57659
21	-5.20	17.00	78.92	12.30	180.64b	136.53	153.53	57659
		17.00	78.92	12.30	190.52b	136.53	153.53	57659
22	-5.60	21.00	86.35	14.81	205.55b	84.93	105.93	86073
		21.00	86.35	14.81	215.44b	84.93	105.93	86073
23	-5.97	24.75	93.33	17.16	230.22b	56.07	80.82	86073
		24.75	93.33	17.16	239.16b	56.07	80.82	86073
24	-6.35	28.50	100.31	19.51	254.54b	23.48	51.98	328375
		28.50	100.31	0.00	2536.85	7.37	35.87	609868
25	-6.50	30.00	103.48	0.00	2551.14	34.08	64.08	609868

Note: 69.51a Soil pressure at active limit
182.82p Soil pressure at passive limit
254.54b Passive limit reduced because of berm

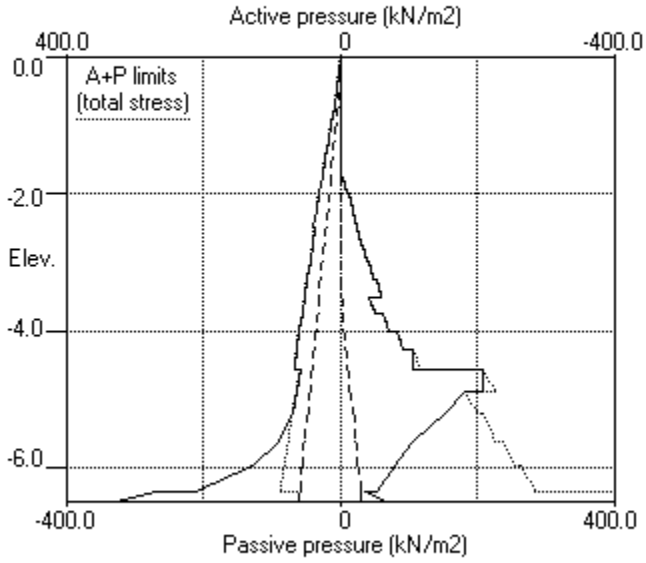
Units: kN,m

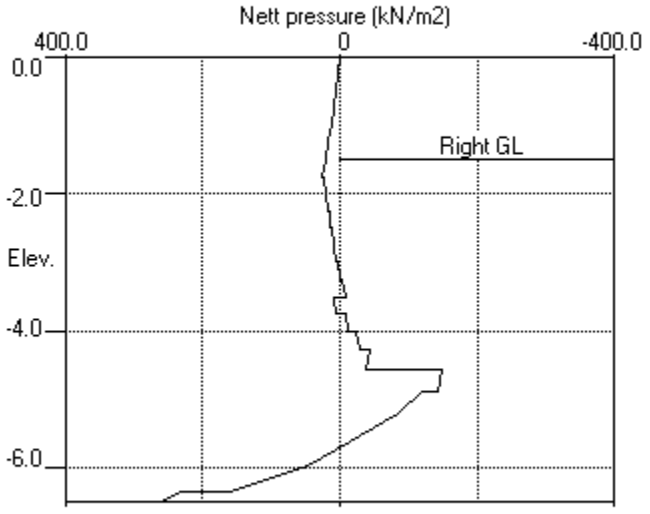
Stage No.5 Change EI of wall to 30000kN.m2/m run





Stage No.5 Change EI of wall to 30000kN.m2/m run





Units: kN,m

Stage No. 6 Apply water pressure profile no.1

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = -6.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr-ation	Direction of failure
6	0.00	-1.50	Cant.	1.354	-6.38	-5.08	3.58	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall

Analysis options

Soldier Pile width = 0.45m; spacing = 0.90m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	0.00	0.00	0.047	1.09E-02	0.0	0.0		20000
2	-0.25	4.55	0.044	1.09E-02	0.6	0.0		20000
3	-0.50	7.49	0.041	1.09E-02	2.1	0.3		20000
		8.28	0.041	1.09E-02	2.1	0.3		
4	-0.75	11.45	0.039	1.09E-02	4.5	1.1		20000
5	-1.00	14.73	0.036	1.09E-02	7.8	2.7		20000
6	-1.25	17.98	0.033	1.08E-02	11.9	5.1		20000
7	-1.50	21.11	0.031	1.07E-02	16.8	8.7		30000
8	-1.75	24.11	0.028	1.06E-02	22.4	13.5		30000
		22.12	0.028	1.06E-02	22.4	13.5		
9	-2.00	22.98	0.025	1.05E-02	28.1	19.8		30000
10	-2.25	21.43	0.023	1.03E-02	33.6	27.5		30000
		19.84	0.023	1.03E-02	33.6	27.5		
11	-2.50	16.44	0.020	1.00E-02	38.2	36.4		30000
		10.47	0.020	1.00E-02	38.2	36.4		
12	-2.75	6.65	0.018	9.73E-03	40.3	46.3		30000
		4.79	0.018	9.73E-03	40.3	46.3		
13	-3.00	0.34	0.015	9.30E-03	40.9	56.6		30000
		-2.26	0.015	9.30E-03	40.9	56.6		
14	-3.25	-7.42	0.013	8.79E-03	39.7	66.8		30000
		-10.92	0.013	8.79E-03	39.7	66.8		
15	-3.50	-16.87	0.011	8.19E-03	36.3	76.4		30000
		-0.59	0.011	8.19E-03	36.3	76.4		
16	-3.75	-3.42	0.009	7.52E-03	35.8	85.6		30000
		-17.52	0.009	7.52E-03	35.8	85.6		
17	-4.00	-21.66	0.007	6.77E-03	30.9	93.9		30000
		-35.40	0.007	6.77E-03	30.9	93.9		
18	-4.28	-41.25	0.005	5.88E-03	20.3	100.9		30000
		-54.68	0.005	5.88E-03	20.3	100.9		
19	-4.55	-50.67	0.004	4.93E-03	5.8	104.5		30000
		-122.91	0.004	4.93E-03	5.8	104.5		
20	-4.88	-125.66	0.002	3.82E-03	-34.6	102.0		30000
		-100.31	0.002	3.82E-03	-34.6	102.0		

(continued)

Stage No.6 Apply water pressure profile no.1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
21	-5.20	-72.38	0.001	2.80E-03	-62.6	87.6		30000
22	-5.60	-10.39	0.000	1.84E-03	-79.2	58.2		30000
23	-5.97	44.40	-0.000	1.32E-03	-72.8	27.5		30000
24	-6.35	150.87	-0.001	1.14E-03	-36.2	3.2		30000
		228.41	-0.001	1.14E-03	-36.2	3.2		
25	-6.50	254.02	-0.001	1.13E-03	0.0	-0.0		---

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7621
2	-0.25	0.00	6.12	2.11	20.48	4.55	4.55	7621
3	-0.50	0.00	13.09	4.50	43.79	7.49	7.49	7621
		0.00	13.09	4.13	49.15	8.28	8.28	10584
4	-0.75	0.00	21.24	6.71	79.75	11.45	11.45	10584
5	-1.00	0.00	29.80	9.41	111.91	14.73	14.73	10584
6	-1.25	0.00	38.37	12.12	144.11	17.98	17.98	10584
7	-1.50	0.00	46.75	14.77	175.56	21.11	21.11	10584
8	-1.75	0.00	54.86	17.33	206.01	24.10	24.10	10584
9	-2.00	0.00	62.69	19.80	235.44	26.93	26.93	10584
10	-2.25	0.00	70.29	22.20	263.96	29.61	29.61	10584
11	-2.50	0.00	77.67	24.54	291.69	32.12	32.12	10584
		0.00	77.67	21.54	350.17	27.72	27.72	8044
12	-2.75	0.00	84.88	23.54	382.65	29.82	29.82	8044
13	-3.00	0.00	91.92	25.49	414.42	31.77	31.77	8044
14	-3.25	0.00	98.84	27.41	445.61	33.57	33.57	8044
15	-3.50	0.00	105.65	29.30	476.29	35.22	35.22	8044
16	-3.75	2.50	110.10	30.54	496.39	36.15	38.65	8044
17	-4.00	5.00	114.48	31.75	516.11	36.95	41.95	8044
18	-4.28	7.75	119.21	33.06	537.43	37.70	45.45	8044
19	-4.55	10.50	123.86	34.35	558.40	38.35	48.85	8044
		10.50	123.86	27.44	478.93	51.18	61.68	36127
20	-4.88	13.75	130.09	29.54	500.36	49.81	63.56	36127
21	-5.20	17.00	136.23	31.61	521.53	48.65	65.65	36127
22	-5.60	21.00	143.71	34.13	547.26	62.77	83.77	36127
23	-5.97	24.75	150.64	36.46	571.13	91.77	116.52	36127
24	-6.35	28.50	157.52	38.78	594.79	170.38	198.88	36127
		28.50	157.52	0.00	2794.76	228.41	256.91	63505
25	-6.50	30.00	160.62	0.00	2808.78	279.74	309.74	63505

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	-0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	-0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	-1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	-1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	11345
8	-1.75	0.00	6.25	-0.01	0.00b	-0.01	-0.01a	11345
		0.00	6.25	1.97	4.30b	1.97	1.97a	11345

(continued)

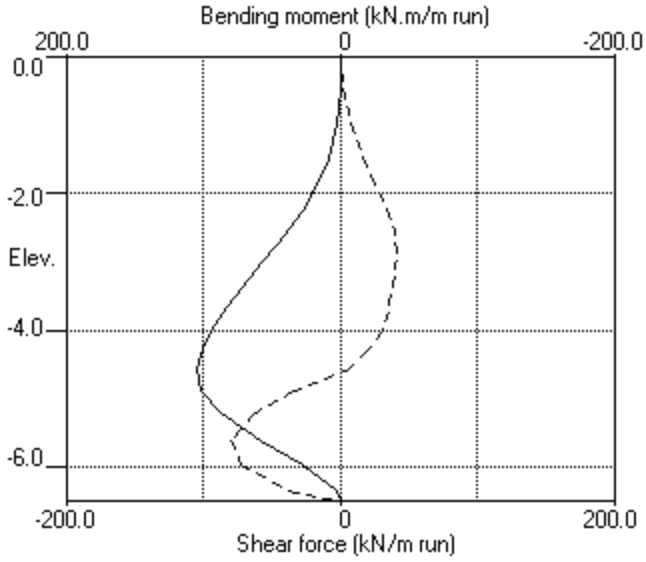
Stage No.6 Apply water pressure profile no.1

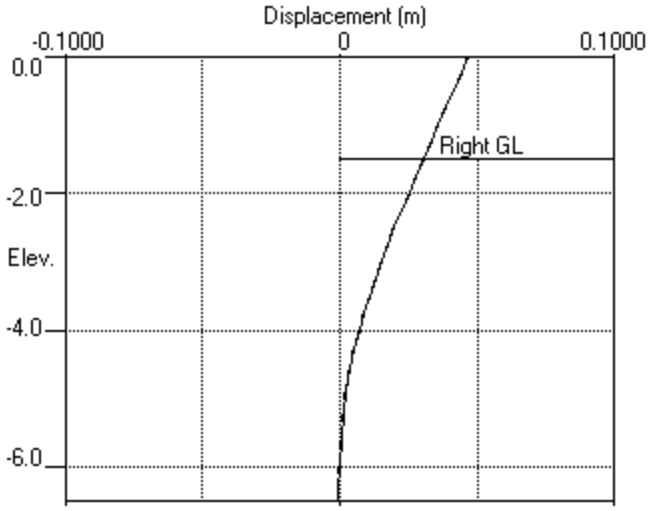
		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
9	-2.00	0.00	12.50	3.95	8.60b	3.95	3.95a	11345
		0.00	12.50	3.95	11.48b	3.95	3.95a	11345
10	-2.25	0.00	18.75	5.92	17.22b	8.17	8.17	11345
		0.00	18.75	5.92	18.81b	9.77	9.77	11345
11	-2.50	0.00	25.00	7.90	25.08b	15.68	15.68	11345
		0.00	25.00	6.93	24.39b	17.24	17.24	8622
12	-2.75	0.00	31.25	8.67	30.49b	23.17	23.17	8622
		0.00	31.25	8.67	32.35b	25.03	25.03	8622
13	-3.00	0.00	37.51	10.40	38.82b	31.43	31.43	8622
		0.00	37.51	10.40	41.42b	34.03	34.03	8622
14	-3.25	0.00	43.76	12.14	48.32b	40.99	40.99	8622
		0.00	43.76	12.14	51.82b	44.49	44.49	8622
15	-3.50	0.00	50.02	13.87	59.23b	52.09	52.09	8622
		0.00	50.02	13.87	42.95b	35.81	35.81	8622
16	-3.75	2.50	54.02	14.98	46.39b	39.58	42.08	8622
		2.50	54.02	14.98	60.49b	53.68	56.18	8622
17	-4.00	5.00	58.03	16.09	64.98b	58.61	63.61	8622
		5.00	58.03	16.09	78.72b	72.36	77.36	8622
18	-4.28	7.75	62.44	17.32	84.70b	78.95	86.70	8622
		7.75	62.44	17.32	98.13b	92.38	100.13	8622
19	-4.55	10.50	66.85	18.54	105.07b	89.01	99.51	8622
		10.50	66.85	8.24	196.71b	174.08	184.58	38457
20	-4.88	13.75	72.89	10.27	211.16b	175.47	189.22	38457
		13.75	72.89	10.27	169.07b	150.12	163.87	38457
21	-5.20	17.00	78.92	12.30	180.64b	121.03	138.03	38457
		17.00	78.92	12.30	190.52b	121.03	138.03	38457
22	-5.60	21.00	86.35	14.81	205.55b	73.16	94.16	38457
		21.00	86.35	14.81	215.44b	73.16	94.16	38457
23	-5.97	24.75	93.33	17.16	230.22b	47.37	72.12	38457
		24.75	93.33	17.16	239.16b	47.37	72.12	38457
24	-6.35	28.50	100.31	19.51	254.54b	19.51	48.01a	38457
		28.50	100.31	0.00	2536.85	0.00	28.50a	68068
25	-6.50	30.00	103.48	0.00	2551.14	25.72	55.72	68068

Note: 28.50a Soil pressure at active limit
123.45p Soil pressure at passive limit
254.54b Passive limit reduced because of berm

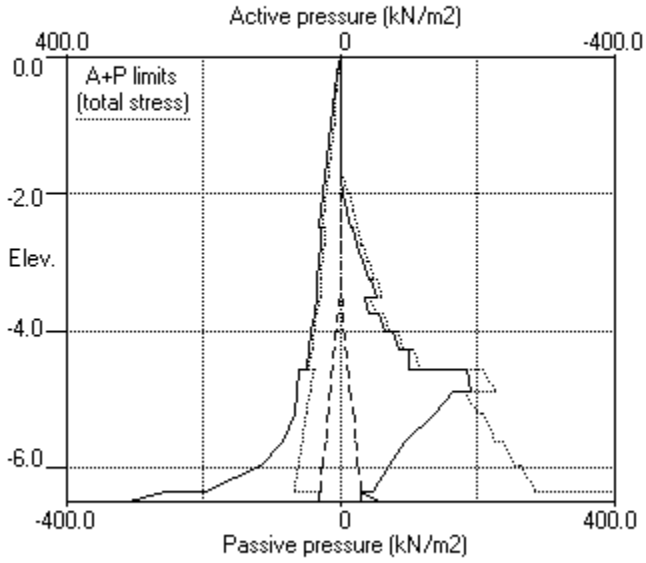
Units: kN,m

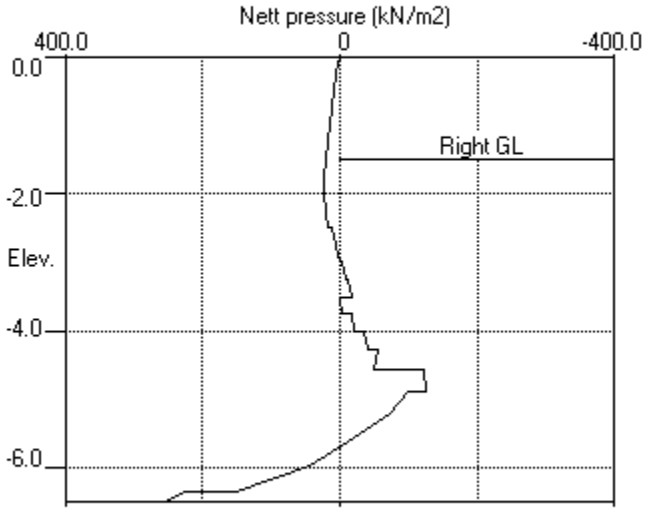
Stage No.6 Apply water pressure profile no.1





Stage No.6 Apply water pressure profile no.1





Units: kN,m

Stage No. 7 Remove surcharge no.1 at elevation 0.00

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = -6.50 Factor of Safety	FoS for toe elev. = -6.50 Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr-ation	Direction of failure
7	0.00	-1.50	Cant.	1.506	-6.38	-4.59	3.09	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall

Analysis options

Soldier Pile width = 0.45m; spacing = 0.90m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	0.00	0.00	0.047	1.10E-02	0.0	0.0		20000
2	-0.25	5.43	0.044	1.10E-02	0.7	0.0		20000
3	-0.50	8.22	0.041	1.10E-02	2.4	0.4		20000
		9.41	0.041	1.10E-02	2.4	0.4		
4	-0.75	12.26	0.039	1.09E-02	5.1	1.3		20000
5	-1.00	15.11	0.036	1.09E-02	8.5	3.0		20000
6	-1.25	17.91	0.033	1.09E-02	12.6	5.6		20000
7	-1.50	20.63	0.030	1.08E-02	17.5	9.3		30000
8	-1.75	23.27	0.028	1.07E-02	22.9	14.4		30000
		21.28	0.028	1.07E-02	22.9	14.4		
9	-2.00	21.83	0.025	1.05E-02	28.3	20.8		30000
10	-2.25	22.26	0.022	1.03E-02	33.8	28.4		30000
		20.84	0.022	1.03E-02	33.8	28.4		
11	-2.50	17.25	0.020	1.00E-02	38.6	37.5		30000
		10.14	0.020	1.00E-02	38.6	37.5		
12	-2.75	6.12	0.017	9.74E-03	40.6	47.4		30000
		4.26	0.017	9.74E-03	40.6	47.4		
13	-3.00	-0.38	0.015	9.30E-03	41.1	57.8		30000
		-2.98	0.015	9.30E-03	41.1	57.8		
14	-3.25	-8.35	0.013	8.77E-03	39.7	68.1		30000
		-11.85	0.013	8.77E-03	39.7	68.1		
15	-3.50	-18.01	0.011	8.17E-03	36.0	77.6		30000
		-1.73	0.011	8.17E-03	36.0	77.6		
16	-3.75	-4.79	0.009	7.48E-03	35.2	86.7		30000
		-18.89	0.009	7.48E-03	35.2	86.7		
17	-4.00	-23.28	0.007	6.73E-03	29.9	94.8		30000
		-37.02	0.007	6.73E-03	29.9	94.8		
18	-4.28	-43.14	0.005	5.83E-03	18.9	101.5		30000
		-56.57	0.005	5.83E-03	18.9	101.5		
19	-4.55	-52.84	0.004	4.88E-03	3.8	104.6		30000
		-118.59	0.004	4.88E-03	3.8	104.6		
20	-4.88	-122.62	0.002	3.77E-03	-35.4	101.7		30000
		-97.27	0.002	3.77E-03	-35.4	101.7		

(continued)

Stage No.7 Remove surcharge no.1 at elevation 0.00

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
21	-5.20	-70.52	0.001	2.75E-03	-62.6	87.2		30000
22	-5.60	-9.80	0.000	1.80E-03	-78.7	57.9		30000
23	-5.97	43.91	-0.000	1.28E-03	-72.3	27.4		30000
24	-6.35	145.59	-0.001	1.10E-03	-36.8	3.3		30000
		229.41	-0.001	1.10E-03	-36.8	3.3		
25	-6.50	260.91	-0.001	1.09E-03	0.0	-0.0		---

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7053
2	-0.25	0.00	5.94	2.04	19.86	5.43	5.43	7053
3	-0.50	0.00	11.88	4.09	39.73	8.22	8.22	7053
		0.00	11.88	3.75	44.60	9.41	9.41	9796
4	-0.75	0.00	18.13	5.73	68.07	12.26	12.26	9796
5	-1.00	0.00	24.38	7.70	91.54	15.11	15.11	9796
6	-1.25	0.00	30.63	9.67	115.01	17.91	17.91	9796
7	-1.50	0.00	36.88	11.65	138.48	20.63	20.63	9796
8	-1.75	0.00	43.13	13.62	161.95	23.26	23.26	9796
9	-2.00	0.00	49.38	15.60	185.42	25.78	25.78	9796
10	-2.25	0.00	55.63	17.57	208.89	28.18	28.18	9796
11	-2.50	0.00	61.88	19.55	232.36	30.46	30.46	9796
		0.00	61.88	17.16	278.95	25.51	25.51	7445
12	-2.75	0.00	68.13	18.89	307.13	27.39	27.39	7445
13	-3.00	0.00	74.38	20.63	335.31	29.15	29.15	7445
14	-3.25	0.00	80.63	22.36	363.48	30.76	30.76	7445
15	-3.50	0.00	86.88	24.09	391.66	32.24	32.24	7445
16	-3.75	2.50	90.88	25.20	409.69	33.00	35.50	7445
17	-4.00	5.00	94.88	26.31	427.73	33.63	38.63	7445
18	-4.28	7.75	99.28	27.53	447.56	34.20	41.95	7445
19	-4.55	10.50	103.68	28.75	467.40	34.68	45.18	7445
		10.50	103.68	20.64	409.45	48.80	59.30	33789
20	-4.88	13.75	109.69	22.67	430.15	46.77	60.52	33789
21	-5.20	17.00	115.70	24.69	450.85	45.00	62.00	33789
22	-5.60	21.00	123.10	27.18	476.32	58.49	79.49	33789
23	-5.97	24.75	130.04	29.52	500.20	86.97	111.72	33789
24	-6.35	28.50	136.97	31.86	524.08	165.10	193.60	33789
		28.50	136.97	0.00	2702.16	229.41	257.91	58779
25	-6.50	30.00	140.13	0.00	2716.36	280.39	310.39	58779

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	-0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	-0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	-1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	-1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	10566
8	-1.75	0.00	6.25	-0.01	0.00b	-0.01	-0.01a	10566
		0.00	6.25	1.97	4.30b	1.97	1.97a	10566

(continued)

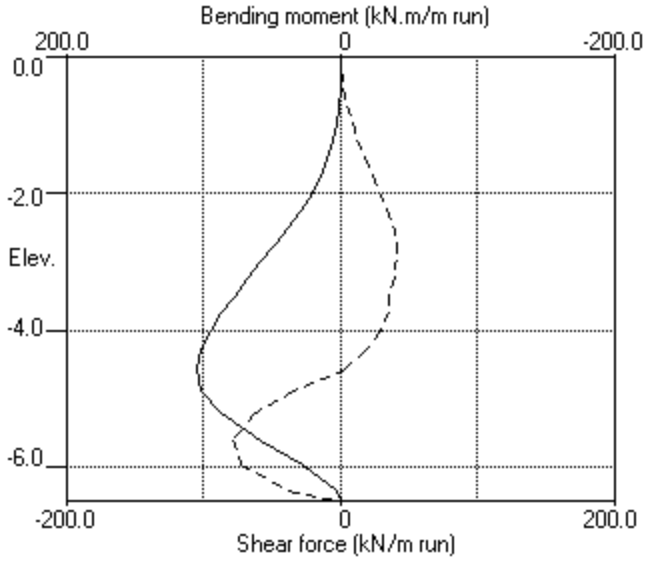
Stage No.7 Remove surcharge no.1 at elevation 0.00

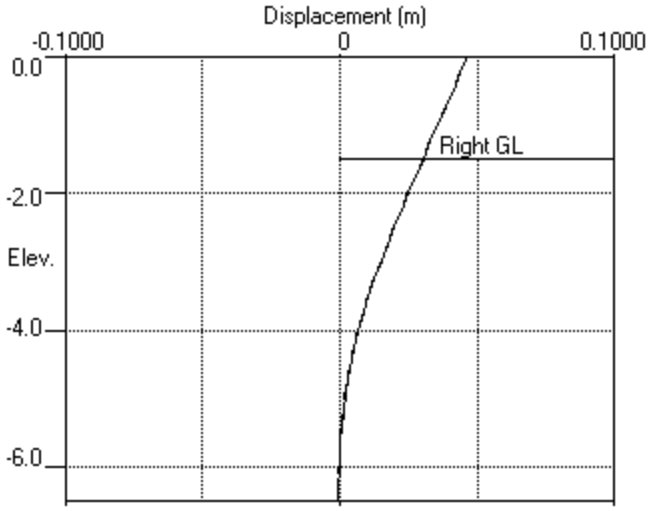
		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
9	-2.00	0.00	12.50	3.95	8.60b	3.95	3.95a	10566
		0.00	12.50	3.95	11.48b	3.95	3.95a	10566
10	-2.25	0.00	18.75	5.92	17.22b	5.92	5.92a	10566
		0.00	18.75	5.92	18.81b	7.35	7.35	10566
11	-2.50	0.00	25.00	7.90	25.08b	13.21	13.21	10566
		0.00	25.00	6.93	24.39b	15.37	15.37	8030
12	-2.75	0.00	31.25	8.67	30.49b	21.27	21.27	8030
		0.00	31.25	8.67	32.35b	23.13	23.13	8030
13	-3.00	0.00	37.51	10.40	38.82b	29.53	29.53	8030
		0.00	37.51	10.40	41.42b	32.13	32.13	8030
14	-3.25	0.00	43.76	12.14	48.32b	39.11	39.11	8030
		0.00	43.76	12.14	51.82b	42.61	42.61	8030
15	-3.50	0.00	50.02	13.87	59.23b	50.25	50.25	8030
		0.00	50.02	13.87	42.95b	33.97	33.97	8030
16	-3.75	2.50	54.02	14.98	46.39b	37.79	40.29	8030
		2.50	54.02	14.98	60.49b	51.90	54.40	8030
17	-4.00	5.00	58.03	16.09	64.98b	56.91	61.91	8030
		5.00	58.03	16.09	78.72b	70.65	75.65	8030
18	-4.28	7.75	62.44	17.32	84.70b	77.34	85.09	8030
		7.75	62.44	17.32	98.13b	90.77	98.52	8030
19	-4.55	10.50	66.85	18.54	105.07b	87.52	98.02	8030
		10.50	66.85	8.24	196.71b	167.39	177.89	36071
20	-4.88	13.75	72.89	10.27	211.16b	169.39	183.14	36071
		13.75	72.89	10.27	169.07b	144.04	157.79	36071
21	-5.20	17.00	78.92	12.30	180.64b	115.52	132.52	36071
		17.00	78.92	12.30	190.52b	115.52	132.52	36071
22	-5.60	21.00	86.35	14.81	205.55b	68.30	89.30	36071
		21.00	86.35	14.81	215.44b	68.30	89.30	36071
23	-5.97	24.75	93.33	17.16	230.22b	43.06	67.81	36071
		24.75	93.33	17.16	239.16b	43.06	67.81	36071
24	-6.35	28.50	100.31	19.51	254.54b	19.51	48.01a	36071
		28.50	100.31	0.00	2536.85	0.00	28.50a	63394
25	-6.50	30.00	103.48	0.00	2551.14	19.48	49.48	63394

Note: 28.50a Soil pressure at active limit
123.45p Soil pressure at passive limit
254.54b Passive limit reduced because of berm

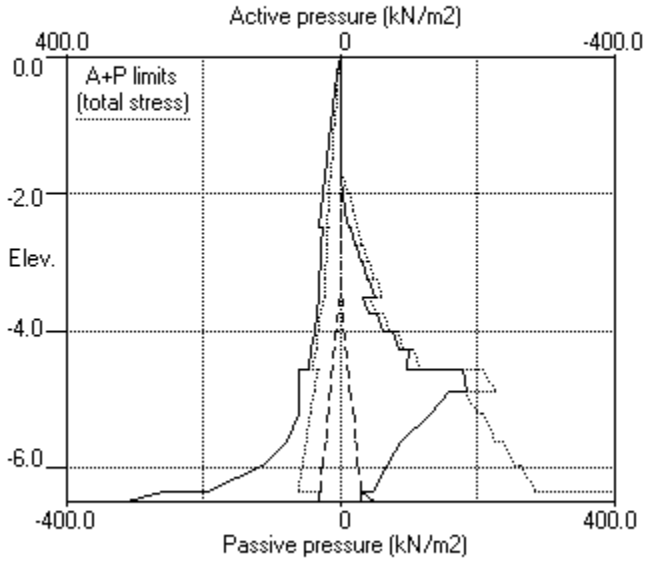
Units: kN,m

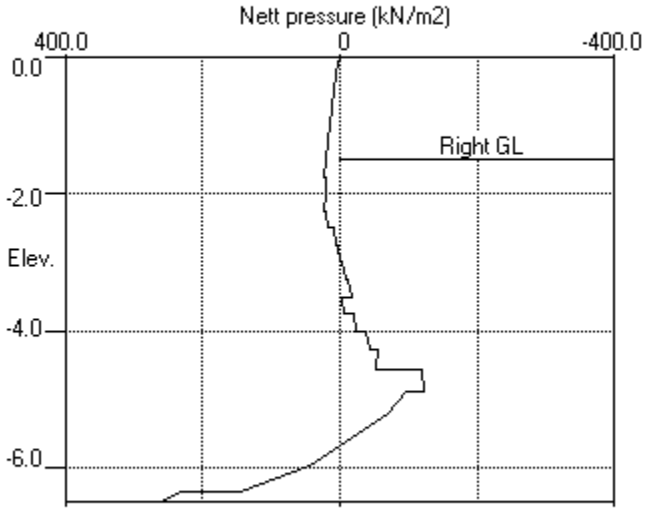
Stage No.7 Remove surcharge no.1 at elev. 0.00





Stage No.7 Remove surcharge no.1 at elev. 0.00





Units: kN,m

Stage No. 8 Apply load no.3 at elevation -0.50

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = -6.50 Factor of Safety	FoS for toe elev. = -6.50 Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr-ation	Direction of failure
8	0.00	-1.50	Cant.	1.375	-6.37	-5.36	3.86	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall

Analysis options

Soldier Pile width = 0.45m; spacing = 0.90m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	0.00	0.00	0.048	1.17E-02	0.0	0.0		20000
2	-0.25	2.04	0.045	1.17E-02	0.3	-0.0		20000
3	-0.50	4.09	0.042	1.17E-02	1.0	0.1	12.6	20000
		3.75	0.042	1.17E-02	13.7	0.1		
4	-0.75	5.73	0.039	1.16E-02	14.8	3.7		20000
5	-1.00	7.70	0.037	1.16E-02	16.5	7.6		20000
6	-1.25	9.67	0.034	1.14E-02	18.7	12.0		20000
7	-1.50	12.03	0.031	1.13E-02	21.4	17.0		30000
8	-1.75	17.00	0.028	1.11E-02	25.0	22.8		30000
		12.70	0.028	1.11E-02	25.0	22.8		
9	-2.00	12.91	0.025	1.09E-02	28.2	29.4		30000
		10.99	0.025	1.09E-02	28.2	29.4		
10	-2.25	15.56	0.022	1.06E-02	31.6	36.7		30000
		14.14	0.022	1.06E-02	31.6	36.7		
11	-2.50	13.80	0.020	1.03E-02	35.0	45.0		30000
		7.52	0.020	1.03E-02	35.0	45.0		
12	-2.75	5.36	0.017	9.90E-03	36.7	54.0		30000
		3.50	0.017	9.90E-03	36.7	54.0		
13	-3.00	-0.06	0.015	9.41E-03	37.1	63.3		30000
		-2.66	0.015	9.41E-03	37.1	63.3		
14	-3.25	-7.53	0.013	8.84E-03	35.8	72.6		30000
		-11.03	0.013	8.84E-03	35.8	72.6		
15	-3.50	-16.90	0.011	8.20E-03	32.3	81.2		30000
		-0.62	0.011	8.20E-03	32.3	81.2		
16	-3.75	-3.56	0.009	7.49E-03	31.8	89.4		30000
		-17.66	0.009	7.49E-03	31.8	89.4		
17	-4.00	-22.05	0.007	6.72E-03	26.8	96.7		30000
		-35.79	0.007	6.72E-03	26.8	96.7		
18	-4.28	-42.03	0.005	5.80E-03	16.1	102.6		30000
		-55.46	0.005	5.80E-03	16.1	102.6		
19	-4.55	-51.90	0.004	4.85E-03	1.4	105.0		30000
		-114.46	0.004	4.85E-03	1.4	105.0		
20	-4.88	-119.51	0.002	3.73E-03	-36.6	101.5		30000
		-94.16	0.002	3.73E-03	-36.6	101.5		

(continued)

Stage No.8 Apply load no.3 at elevation -0.50

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
21	-5.20	-68.37	0.001	2.72E-03	-63.1	86.7		30000
22	-5.60	-8.65	0.000	1.78E-03	-78.5	57.5		30000
23	-5.97	44.33	-0.000	1.27E-03	-71.8	27.1		30000
24	-6.35	144.63	-0.001	1.09E-03	-36.3	3.2		30000
		227.63	-0.001	1.09E-03	-36.3	3.2		
25	-6.50	256.92	-0.001	1.08E-03	0.0	-0.0		---

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14657
2	-0.25	0.00	5.94	2.04	19.86	2.04	2.04a	14657
3	-0.50	0.00	11.88	4.09	39.73	4.09	4.09a	14657
		0.00	11.88	3.75	44.60	3.75	3.75a	20357
4	-0.75	0.00	18.13	5.73	68.07	5.73	5.73a	20357
5	-1.00	0.00	24.38	7.70	91.54	7.70	7.70a	20357
6	-1.25	0.00	30.63	9.67	115.01	9.67	9.67a	20357
7	-1.50	0.00	36.88	11.65	138.48	12.03	12.03	20357
8	-1.75	0.00	43.13	13.62	161.95	17.00	17.00	20357
9	-2.00	0.00	49.38	15.60	185.42	21.51	21.51	20357
10	-2.25	0.00	55.63	17.57	208.89	25.54	25.54	20357
11	-2.50	0.00	61.88	19.55	232.36	29.10	29.10	20357
		0.00	61.88	17.16	278.95	24.47	24.47	15472
12	-2.75	0.00	68.13	18.89	307.13	27.09	27.09	15472
13	-3.00	0.00	74.38	20.63	335.31	29.31	29.31	11284
14	-3.25	0.00	80.63	22.36	363.48	31.17	31.17	11284
15	-3.50	0.00	86.88	24.09	391.66	32.79	32.79	11284
16	-3.75	2.50	90.88	25.20	409.69	33.62	36.12	11284
17	-4.00	5.00	94.88	26.31	427.73	34.24	39.24	11284
18	-4.28	7.75	99.28	27.53	447.56	34.76	42.51	11284
19	-4.55	10.50	103.68	28.75	467.40	35.15	45.65	11284
		10.50	103.68	20.64	409.45	50.86	61.36	49496
20	-4.88	13.75	109.69	22.67	430.15	48.32	62.07	49496
21	-5.20	17.00	115.70	24.69	450.85	46.08	63.08	49496
22	-5.60	21.00	123.10	27.18	476.32	59.07	80.07	49496
23	-5.97	24.75	130.04	29.52	500.20	87.18	111.93	49496
24	-6.35	28.50	136.97	31.86	524.08	164.62	193.12	255532
		28.50	136.97	0.00	2702.16	228.52	257.02	473775
25	-6.50	30.00	140.13	0.00	2716.36	278.40	308.40	473775

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	-0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	-0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	-1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	-1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	31334
8	-1.75	0.00	6.25	-0.01	0.00b	0.00	0.00p	31334
		0.00	6.25	1.97	4.30b	4.30	4.30p	31334

(continued)

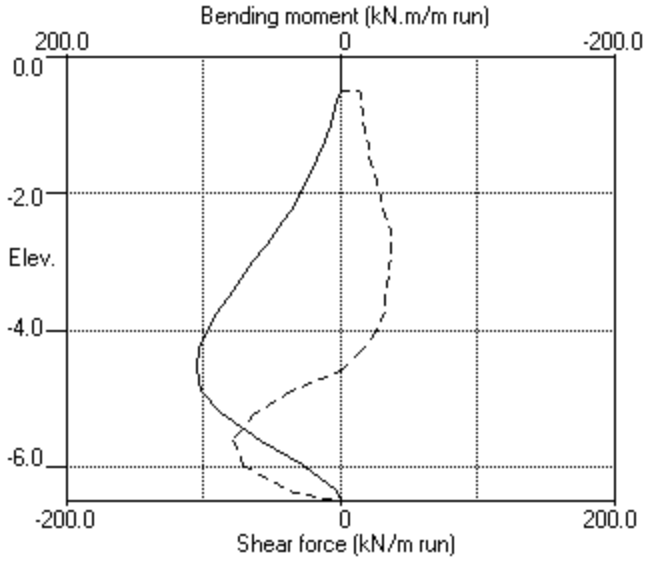
Stage No.8 Apply load no.3 at elevation -0.50

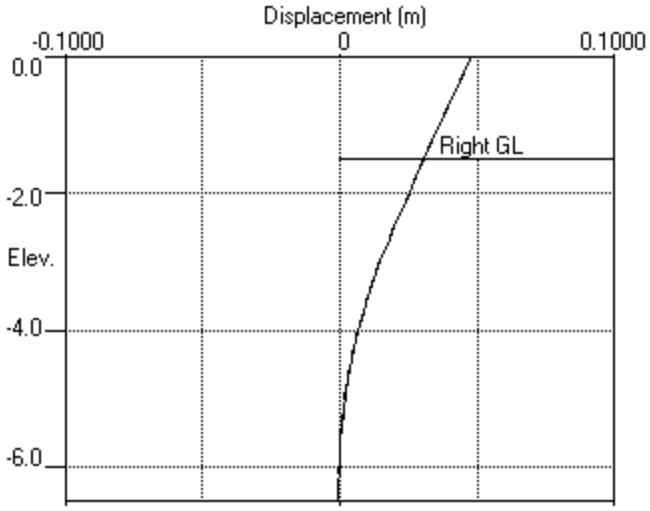
		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
9	-2.00	0.00	12.50	3.95	8.60b	8.60	8.60p	31334
		0.00	12.50	3.95	11.48b	10.52	10.52	31334
10	-2.25	0.00	18.75	5.92	17.22b	9.99	9.99	31334
		0.00	18.75	5.92	18.81b	11.41	11.41	31334
11	-2.50	0.00	25.00	7.90	25.08b	15.30	15.30	31334
		0.00	25.00	6.93	24.39b	16.96	16.96	23814
12	-2.75	0.00	31.25	8.67	30.49b	21.73	21.73	23814
		0.00	31.25	8.67	32.35b	23.59	23.59	23814
13	-3.00	0.00	37.51	10.40	38.82b	29.37	29.37	11284
		0.00	37.51	10.40	41.42b	31.97	31.97	11284
14	-3.25	0.00	43.76	12.14	48.32b	38.70	38.70	11284
		0.00	43.76	12.14	51.82b	42.20	42.20	11284
15	-3.50	0.00	50.02	13.87	59.23b	49.69	49.69	11284
		0.00	50.02	13.87	42.95b	33.41	33.41	11284
16	-3.75	2.50	54.02	14.98	46.39b	37.18	39.68	11284
		2.50	54.02	14.98	60.49b	51.28	53.78	11284
17	-4.00	5.00	58.03	16.09	64.98b	56.30	61.30	11284
		5.00	58.03	16.09	78.72b	70.04	75.04	11284
18	-4.28	7.75	62.44	17.32	84.70b	76.79	84.54	11284
		7.75	62.44	17.32	98.13b	90.22	97.97	11284
19	-4.55	10.50	66.85	18.54	105.07b	87.05	97.55	11284
		10.50	66.85	8.24	196.71b	165.32	175.82	49496
20	-4.88	13.75	72.89	10.27	211.16b	167.83	181.58	49496
		13.75	72.89	10.27	169.07b	142.48	156.23	49496
21	-5.20	17.00	78.92	12.30	180.64b	114.45	131.45	49496
		17.00	78.92	12.30	190.52b	114.45	131.45	49496
22	-5.60	21.00	86.35	14.81	205.55b	67.72	88.72	49496
		21.00	86.35	14.81	215.44b	67.72	88.72	49496
23	-5.97	24.75	93.33	17.16	230.22b	42.85	67.60	49496
		24.75	93.33	17.16	239.16b	42.85	67.60	49496
24	-6.35	28.50	100.31	19.51	254.54b	19.99	48.49	255532
		28.50	100.31	0.00	2536.85	0.89	29.39	473775
25	-6.50	30.00	103.48	0.00	2551.14	21.47	51.47	473775

Note: 9.67a Soil pressure at active limit
8.60p Soil pressure at passive limit
254.54b Passive limit reduced because of berm

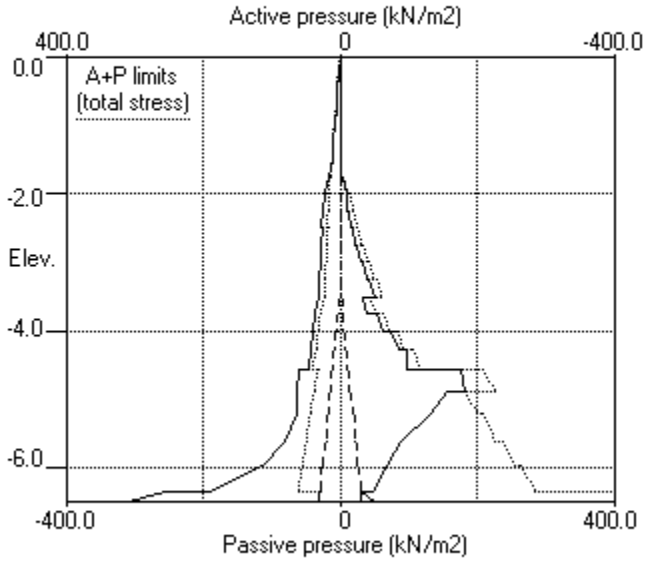
Units: kN,m

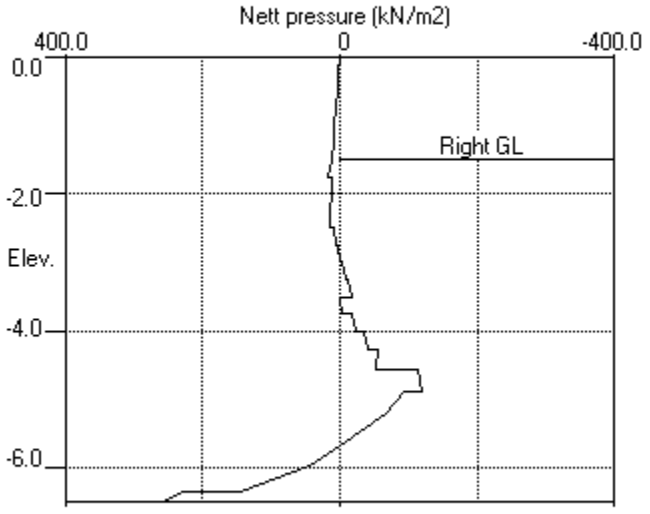
Stage No.8 Apply load no.3 at elev. -0.50





Stage No.8 Apply load no.3 at elev. -0.50





Units: kN,m

Stage No. 9 Apply load no.4 at elevation -1.00

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = -6.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr-ation	Direction of failure
9	0.00	-1.50	Cant.	1.274	-6.37	-5.78	4.28	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall

Analysis options

Soldier Pile width = 0.45m; spacing = 0.90m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	0.00	0.00	0.052	1.30E-02	0.0	0.0		20000
2	-0.25	2.04	0.049	1.30E-02	0.3	-0.0		20000
3	-0.50	4.09	0.046	1.30E-02	1.0	0.1	12.6	20000
		3.75	0.046	1.30E-02	13.7	0.1		
4	-0.75	5.73	0.042	1.30E-02	14.8	3.7		20000
5	-1.00	7.70	0.039	1.29E-02	16.5	7.6	12.6	20000
		7.70	0.039	1.29E-02	29.2	7.6		
6	-1.25	9.67	0.036	1.28E-02	31.3	15.1		20000
7	-1.50	11.65	0.033	1.26E-02	34.0	23.4		30000
8	-1.75	13.62	0.030	1.23E-02	37.2	32.2		30000
		9.32	0.030	1.23E-02	37.2	32.2		
9	-2.00	7.00	0.026	1.20E-02	39.2	41.7		30000
		4.12	0.026	1.20E-02	39.2	41.7		
10	-2.25	0.35	0.023	1.16E-02	39.8	51.5		30000
		-1.24	0.023	1.16E-02	39.8	51.5		
11	-2.50	-5.54	0.021	1.12E-02	38.9	61.3		30000
		-7.23	0.021	1.12E-02	38.9	61.3		
12	-2.75	-10.49	0.018	1.06E-02	36.7	70.8		30000
		-12.35	0.018	1.06E-02	36.7	70.8		
13	-3.00	-11.65	0.015	1.00E-02	33.7	79.8		30000
		-14.24	0.015	1.00E-02	33.7	79.8		
14	-3.25	-14.89	0.013	9.33E-03	30.1	87.9		30000
		-18.39	0.013	9.33E-03	30.1	87.9		
15	-3.50	-21.01	0.011	8.57E-03	25.1	94.8		30000
		-4.73	0.011	8.57E-03	25.1	94.8		
16	-3.75	-5.27	0.009	7.76E-03	23.9	101.0		30000
		-19.37	0.009	7.76E-03	23.9	101.0		
17	-4.00	-22.10	0.007	6.89E-03	18.7	106.3		30000
		-35.84	0.007	6.89E-03	18.7	106.3		
18	-4.28	-41.16	0.005	5.90E-03	8.1	110.0		30000
		-54.59	0.005	5.90E-03	8.1	110.0		
19	-4.55	-50.57	0.004	4.89E-03	-6.3	110.2		30000
		-108.67	0.004	4.89E-03	-6.3	110.2		

(continued)

Stage No.9 Apply load no.4 at elevation -1.00

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
20	-4.88	-113.17	0.002	3.73E-03	-42.4	104.5		30000
		-87.82	0.002	3.73E-03	-42.4	104.5		
21	-5.20	-62.65	0.001	2.69E-03	-66.8	88.2		30000
22	-5.60	-4.48	0.000	1.73E-03	-80.3	57.9		30000
23	-5.97	46.77	-0.000	1.22E-03	-72.3	27.2		30000
24	-6.35	145.30	-0.001	1.04E-03	-36.3	3.2		30000
		228.82	-0.001	1.04E-03	-36.3	3.2		
25	-6.50	255.65	-0.001	1.03E-03	0.0	-0.0		---

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12143
2	-0.25	0.00	5.94	2.04	19.86	2.04	2.04a	12143
3	-0.50	0.00	11.88	4.09	39.73	4.09	4.09a	12143
		0.00	11.88	3.75	44.60	3.75	3.75a	16866
4	-0.75	0.00	18.13	5.73	68.07	5.73	5.73a	16866
5	-1.00	0.00	24.38	7.70	91.54	7.70	7.70a	16866
6	-1.25	0.00	30.63	9.67	115.01	9.67	9.67a	16866
7	-1.50	0.00	36.88	11.65	138.48	11.65	11.65a	16866
8	-1.75	0.00	43.13	13.62	161.95	13.62	13.62a	16866
9	-2.00	0.00	49.38	15.60	185.42	15.60	15.60a	16866
10	-2.25	0.00	55.63	17.57	208.89	17.57	17.57a	16866
11	-2.50	0.00	61.88	19.55	232.36	19.55	19.55a	16866
		0.00	61.88	17.16	278.95	17.16	17.16a	12818
12	-2.75	0.00	68.13	18.89	307.13	19.99	19.99	12818
13	-3.00	0.00	74.38	20.63	335.31	24.43	24.43	12818
14	-3.25	0.00	80.63	22.36	363.48	28.07	28.07	12818
15	-3.50	0.00	86.88	24.09	391.66	31.06	31.06	12818
16	-3.75	2.50	90.88	25.20	409.69	32.90	35.40	12818
17	-4.00	5.00	94.88	26.31	427.73	34.22	39.22	12818
18	-4.28	7.75	99.28	27.53	447.56	35.19	42.94	12215
19	-4.55	10.50	103.68	28.75	467.40	35.82	46.32	12215
		10.50	103.68	20.64	409.45	53.76	64.26	53405
20	-4.88	13.75	109.69	22.67	430.15	51.49	65.24	53405
21	-5.20	17.00	115.70	24.69	450.85	48.94	65.94	53405
22	-5.60	21.00	123.10	27.18	476.32	61.15	82.15	53405
23	-5.97	24.75	130.04	29.52	500.20	88.40	113.15	53405
24	-6.35	28.50	136.97	31.86	524.08	164.95	193.45	53405
		28.50	136.97	0.00	2702.16	229.12	257.62	96435
25	-6.50	30.00	140.13	0.00	2716.36	277.76	307.76	1452926

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	-0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	-0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	-1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	-1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	23152

(continued)

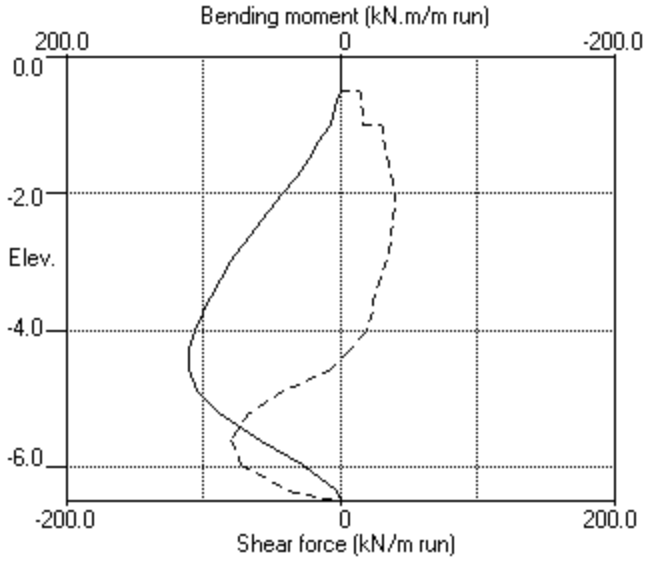
Stage No.9 Apply load no.4 at elevation -1.00

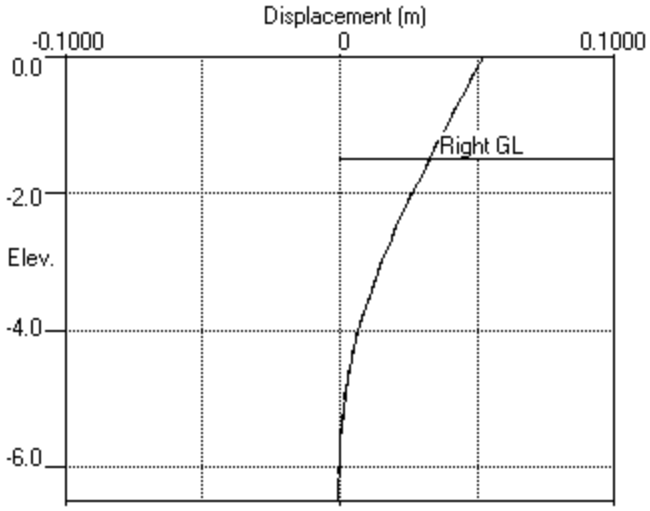
		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
8	-1.75	0.00	6.25	-0.01	0.00b	0.00	0.00p	23152
		0.00	6.25	1.97	4.30b	4.30	4.30p	23152
9	-2.00	0.00	12.50	3.95	8.60b	8.60	8.60p	23152
		0.00	12.50	3.95	11.48b	11.48	11.48p	23152
10	-2.25	0.00	18.75	5.92	17.22b	17.22	17.22p	23152
		0.00	18.75	5.92	18.81b	18.81	18.81p	23152
11	-2.50	0.00	25.00	7.90	25.08b	25.08	25.08p	23152
		0.00	25.00	6.93	24.39b	24.39	24.39p	17596
12	-2.75	0.00	31.25	8.67	30.49b	30.49	30.49p	17596
		0.00	31.25	8.67	32.35b	32.35	32.35p	17596
13	-3.00	0.00	37.51	10.40	38.82b	36.07	36.07	17596
		0.00	37.51	10.40	41.42b	38.67	38.67	17596
14	-3.25	0.00	43.76	12.14	48.32b	42.96	42.96	17596
		0.00	43.76	12.14	51.82b	46.46	46.46	17596
15	-3.50	0.00	50.02	13.87	59.23b	52.07	52.07	17596
		0.00	50.02	13.87	42.95b	35.79	35.79	17596
16	-3.75	2.50	54.02	14.98	46.39b	38.16	40.66	17596
		2.50	54.02	14.98	60.49b	52.27	54.77	17596
17	-4.00	5.00	58.03	16.09	64.98b	56.32	61.32	17596
		5.00	58.03	16.09	78.72b	70.06	75.06	17596
18	-4.28	7.75	62.44	17.32	84.70b	76.35	84.10	12215
		7.75	62.44	17.32	98.13b	89.78	97.53	12215
19	-4.55	10.50	66.85	18.54	105.07b	86.39	96.89	12215
		10.50	66.85	8.24	196.71b	162.42	172.92	53405
20	-4.88	13.75	72.89	10.27	211.16b	164.66	178.41	53405
		13.75	72.89	10.27	169.07b	139.31	153.06	53405
21	-5.20	17.00	78.92	12.30	180.64b	111.59	128.59	53405
		17.00	78.92	12.30	190.52b	111.59	128.59	53405
22	-5.60	21.00	86.35	14.81	205.55b	65.64	86.64	53405
		21.00	86.35	14.81	215.44b	65.64	86.64	53405
23	-5.97	24.75	93.33	17.16	230.22b	41.63	66.38	53405
		24.75	93.33	17.16	239.16b	41.63	66.38	53405
24	-6.35	28.50	100.31	19.51	254.54b	19.66	48.16	53405
		28.50	100.31	0.00	2536.85	0.29	28.79	96435
25	-6.50	30.00	103.48	0.00	2551.14	22.11	52.11	1452926

Note: 17.16a Soil pressure at active limit
32.35p Soil pressure at passive limit
254.54b Passive limit reduced because of berm

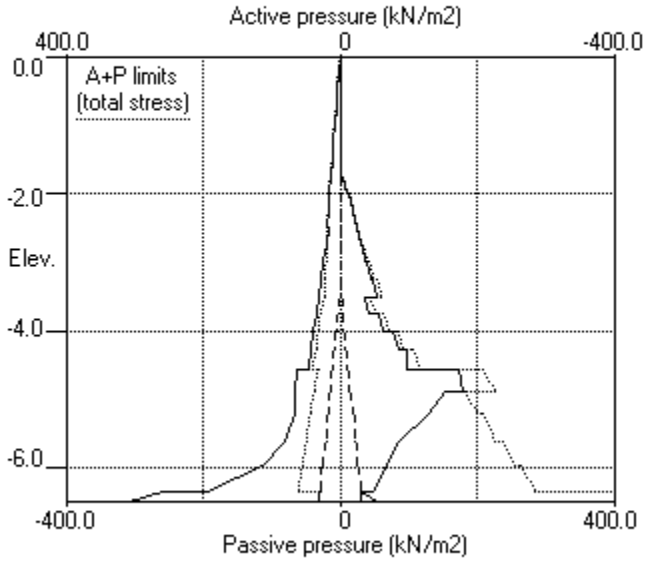
Units: kN,m

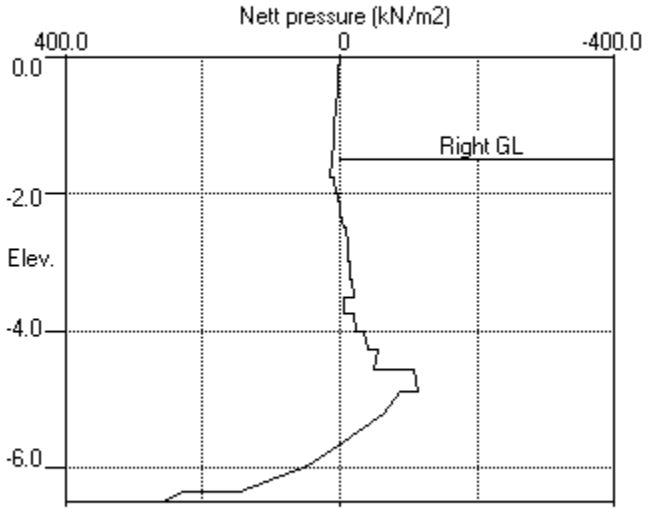
Stage No.9 Apply load no.4 at elev. -1.00





Stage No.9 Apply load no.4 at elev. -1.00





Units: kN,m

Stage No. 10 Apply load no.5 at elevation -1.50

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = -6.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr-ation	Direction of failure
10	0.00	-1.50	Cant.	1.194	-6.37	-6.12	4.62	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall

Analysis options

Soldier Pile width = 0.45m; spacing = 0.90m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	0.00	0.00	0.061	1.53E-02	0.0	0.0		20000
2	-0.25	2.04	0.057	1.53E-02	0.3	-0.0		20000
3	-0.50	4.09	0.053	1.53E-02	1.0	0.1	12.6	20000
		3.75	0.053	1.53E-02	13.7	0.1		
4	-0.75	5.73	0.049	1.53E-02	14.8	3.7		20000
5	-1.00	7.70	0.046	1.52E-02	16.5	7.6	12.6	20000
		7.70	0.046	1.52E-02	29.2	7.6		
6	-1.25	9.67	0.042	1.51E-02	31.3	15.1		20000
7	-1.50	11.65	0.038	1.48E-02	34.0	23.4	12.6	30000
		11.65	0.038	1.48E-02	46.6	23.4		
8	-1.75	13.62	0.034	1.46E-02	49.8	35.4		30000
		9.32	0.034	1.46E-02	49.8	35.4		
9	-2.00	7.00	0.031	1.43E-02	51.8	48.1		30000
		4.12	0.031	1.43E-02	51.8	48.1		
10	-2.25	0.35	0.027	1.38E-02	52.4	61.0		30000
		-1.24	0.027	1.38E-02	52.4	61.0		
11	-2.50	-5.54	0.024	1.32E-02	51.6	73.9		30000
		-7.23	0.024	1.32E-02	51.6	73.9		
12	-2.75	-11.59	0.021	1.26E-02	49.2	86.6		30000
		-13.45	0.021	1.26E-02	49.2	86.6		
13	-3.00	-18.19	0.017	1.18E-02	45.2	98.6		30000
		-20.79	0.017	1.18E-02	45.2	98.6		
14	-3.25	-25.96	0.015	1.09E-02	39.4	109.3		30000
		-29.46	0.015	1.09E-02	39.4	109.3		
15	-3.50	-35.13	0.012	1.00E-02	31.3	118.2		30000
		-18.85	0.012	1.00E-02	31.3	118.2		
16	-3.75	-21.18	0.010	9.01E-03	26.3	125.6		30000
		-35.29	0.010	9.01E-03	26.3	125.6		
17	-4.00	-38.66	0.007	7.94E-03	17.1	130.9		30000
		-52.41	0.007	7.94E-03	17.1	130.9		
18	-4.28	-52.58	0.005	6.73E-03	2.6	133.7		30000
		-66.01	0.005	6.73E-03	2.6	133.7		
19	-4.55	-57.02	0.004	5.51E-03	-14.3	132.0		30000
		-136.85	0.004	5.51E-03	-14.3	132.0		

(continued)

Stage No.10 Apply load no.5 at elevation -1.50

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
20	-4.88	-123.26	0.002	4.14E-03	-56.5	122.3		30000
		-97.92	0.002	4.14E-03	-56.5	122.3		
21	-5.20	-61.12	0.001	2.93E-03	-82.4	100.8		30000
22	-5.60	6.39	0.000	1.85E-03	-93.3	64.4		30000
23	-5.97	61.82	-0.000	1.28E-03	-80.5	29.5		30000
24	-6.35	154.18	-0.001	1.08E-03	-40.0	3.6		30000
		245.01	-0.001	1.08E-03	-40.0	3.6		
25	-6.50	288.93	-0.001	1.07E-03	0.0	-0.0		---

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10538
2	-0.25	0.00	5.94	2.04	19.86	2.04	2.04a	10538
3	-0.50	0.00	11.88	4.09	39.73	4.09	4.09a	10538
		0.00	11.88	3.75	44.60	3.75	3.75a	14636
4	-0.75	0.00	18.13	5.73	68.07	5.73	5.73a	14636
5	-1.00	0.00	24.38	7.70	91.54	7.70	7.70a	14636
6	-1.25	0.00	30.63	9.67	115.01	9.67	9.67a	14636
7	-1.50	0.00	36.88	11.65	138.48	11.65	11.65a	14636
8	-1.75	0.00	43.13	13.62	161.95	13.62	13.62a	14636
9	-2.00	0.00	49.38	15.60	185.42	15.60	15.60a	14636
10	-2.25	0.00	55.63	17.57	208.89	17.57	17.57a	14636
11	-2.50	0.00	61.88	19.55	232.36	19.55	19.55a	14636
		0.00	61.88	17.16	278.95	17.16	17.16a	11124
12	-2.75	0.00	68.13	18.89	307.13	18.89	18.89a	11124
13	-3.00	0.00	74.38	20.63	335.31	20.63	20.63a	11124
14	-3.25	0.00	80.63	22.36	363.48	22.36	22.36a	11124
15	-3.50	0.00	86.88	24.09	391.66	24.09	24.09a	11124
16	-3.75	2.50	90.88	25.20	409.69	25.20	27.70a	11124
17	-4.00	5.00	94.88	26.31	427.73	26.31	31.31a	11124
18	-4.28	7.75	99.28	27.53	447.56	30.12	37.87	11124
19	-4.55	10.50	103.68	28.75	467.40	32.95	43.45	11124
		10.50	103.68	20.64	409.45	41.18	51.68	48826
20	-4.88	13.75	109.69	22.67	430.15	46.99	60.74	48826
21	-5.20	17.00	115.70	24.69	450.85	49.70	66.70	68588
22	-5.60	21.00	123.10	27.18	476.32	66.59	87.59	68588
23	-5.97	24.75	130.04	29.52	500.20	95.93	120.68	68588
24	-6.35	28.50	136.97	31.86	524.08	173.68	202.18	68588
		28.50	136.97	0.00	2702.16	245.01	273.51	124863
25	-6.50	30.00	140.13	0.00	2716.36	294.40	324.40	124863

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	-0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	-0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	-1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	-1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	18312

(continued)

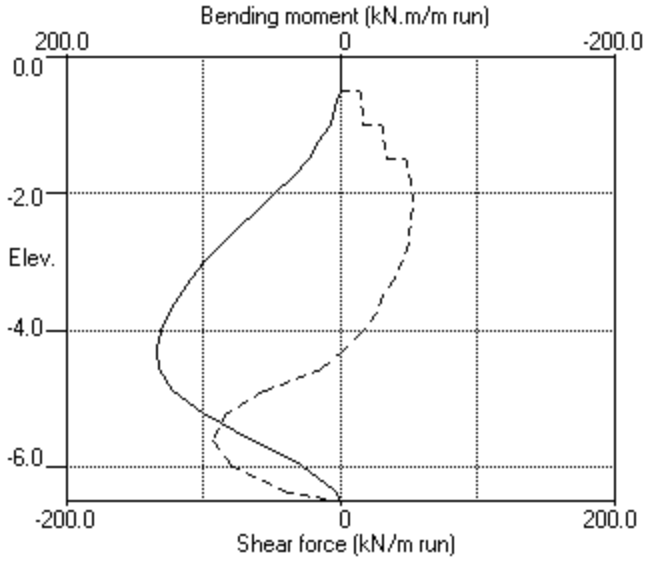
Stage No.10 Apply load no.5 at elevation -1.50

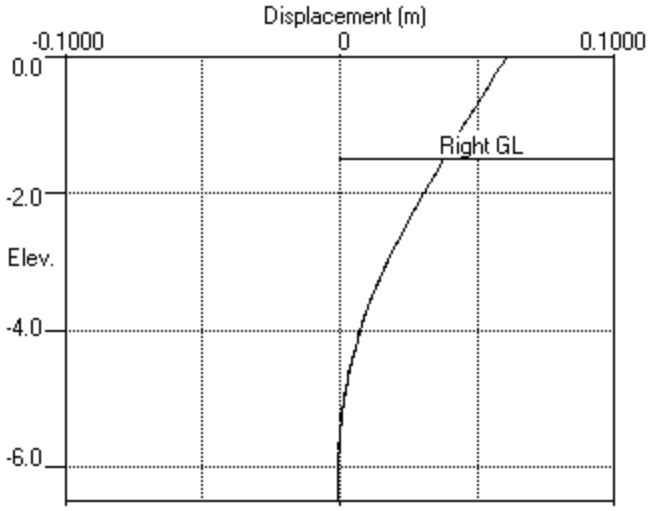
		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
8	-1.75	0.00	6.25	-0.01	0.00b	0.00	0.00p	18312
		0.00	6.25	1.97	4.30b	4.30	4.30p	18312
9	-2.00	0.00	12.50	3.95	8.60b	8.60	8.60p	18312
		0.00	12.50	3.95	11.48b	11.48	11.48p	18312
10	-2.25	0.00	18.75	5.92	17.22b	17.22	17.22p	18312
		0.00	18.75	5.92	18.81b	18.81	18.81p	18312
11	-2.50	0.00	25.00	7.90	25.08b	25.08	25.08p	18312
		0.00	25.00	6.93	24.39b	24.39	24.39p	13917
12	-2.75	0.00	31.25	8.67	30.49b	30.49	30.49p	13917
		0.00	31.25	8.67	32.35b	32.35	32.35p	13917
13	-3.00	0.00	37.51	10.40	38.82b	38.82	38.82p	13917
		0.00	37.51	10.40	41.42b	41.42	41.42p	13917
14	-3.25	0.00	43.76	12.14	48.32b	48.32	48.32p	13917
		0.00	43.76	12.14	51.82b	51.82	51.82p	13917
15	-3.50	0.00	50.02	13.87	59.23b	59.23	59.23p	13917
		0.00	50.02	13.87	42.95b	42.95	42.95p	13917
16	-3.75	2.50	54.02	14.98	46.39b	46.39	48.89p	13917
		2.50	54.02	14.98	60.49b	60.49	62.99p	13917
17	-4.00	5.00	58.03	16.09	64.98b	64.98	69.98p	13917
		5.00	58.03	16.09	78.72b	78.72	83.72p	13917
18	-4.28	7.75	62.44	17.32	84.70b	82.70	90.45	13917
		7.75	62.44	17.32	98.13b	96.13	103.88	13917
19	-4.55	10.50	66.85	18.54	105.07b	89.97	100.47	13917
		10.50	66.85	8.24	196.71b	178.03	188.53	60571
20	-4.88	13.75	72.89	10.27	211.16b	170.25	184.00	60571
		13.75	72.89	10.27	169.07b	144.90	158.65	60571
21	-5.20	17.00	78.92	12.30	180.64b	110.82	127.82	68588
		17.00	78.92	12.30	190.52b	110.82	127.82	68588
22	-5.60	21.00	86.35	14.81	205.55b	60.20	81.20	68588
		21.00	86.35	14.81	215.44b	60.20	81.20	68588
23	-5.97	24.75	93.33	17.16	230.22b	34.11	58.86	68588
		24.75	93.33	17.16	239.16b	34.11	58.86	68588
24	-6.35	28.50	100.31	19.51	254.54b	19.51	48.01a	68588
		28.50	100.31	0.00	2536.85	0.00	28.50a	124863
25	-6.50	30.00	103.48	0.00	2551.14	5.47	35.47	124863

Note: 28.50a Soil pressure at active limit
83.72p Soil pressure at passive limit
254.54b Passive limit reduced because of berm

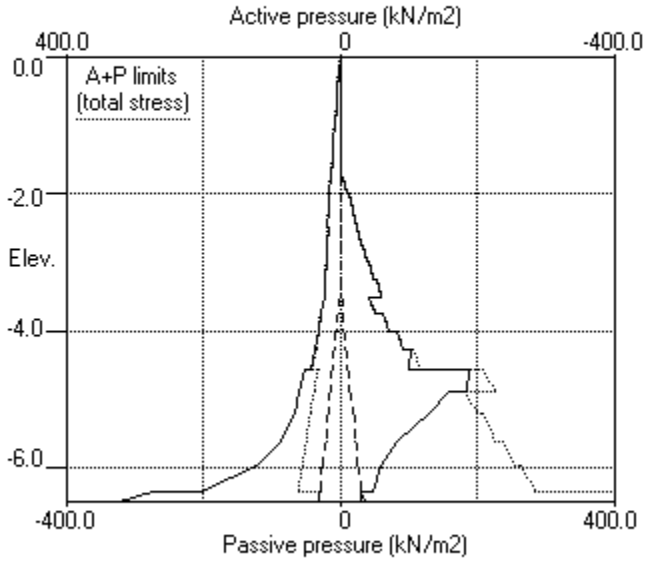
Units: kN,m

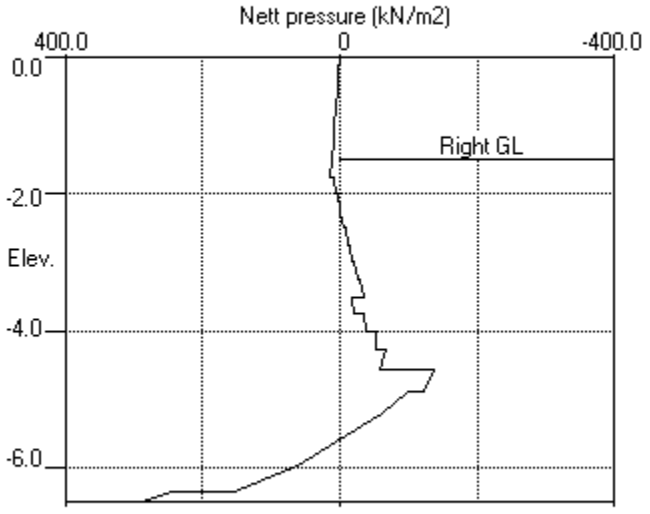
Stage No.10 Apply load no.5 at elev. -1.50





Stage No.10 Apply load no.5 at elev. -1.50





Units: kN,m

Stage No. 11 Apply load no.6 at elevation -2.00

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = -6.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr-ation	Direction of failure
11	0.00	-1.50	Cant.	1.131	-6.37	-6.36	4.86	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall

Analysis options

Soldier Pile width = 0.45m; spacing = 0.90m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	0.00	0.00	0.074	1.83E-02	0.0	0.0		20000
2	-0.25	2.04	0.070	1.83E-02	0.3	-0.0		20000
3	-0.50	4.09	0.065	1.83E-02	1.0	0.1	12.6	20000
		3.75	0.065	1.83E-02	13.7	0.1		
4	-0.75	5.73	0.061	1.83E-02	14.8	3.7		20000
5	-1.00	7.70	0.056	1.82E-02	16.5	7.6	12.6	20000
		7.70	0.056	1.82E-02	29.2	7.6		
6	-1.25	9.67	0.051	1.80E-02	31.3	15.1		20000
7	-1.50	11.65	0.047	1.78E-02	34.0	23.4	12.6	30000
		11.65	0.047	1.78E-02	46.6	23.4		
8	-1.75	13.62	0.043	1.76E-02	49.8	35.4		30000
		9.32	0.043	1.76E-02	49.8	35.4		
9	-2.00	7.00	0.038	1.72E-02	51.8	48.1	12.6	30000
		4.12	0.038	1.72E-02	64.5	48.1		
10	-2.25	0.35	0.034	1.67E-02	65.0	64.1		30000
		-1.24	0.034	1.67E-02	65.0	64.1		
11	-2.50	-5.54	0.030	1.61E-02	64.2	80.3		30000
		-7.23	0.030	1.61E-02	64.2	80.3		
12	-2.75	-11.59	0.026	1.54E-02	61.8	96.1		30000
		-13.45	0.026	1.54E-02	61.8	96.1		
13	-3.00	-18.19	0.022	1.45E-02	57.9	111.3		30000
		-20.79	0.022	1.45E-02	57.9	111.3		
14	-3.25	-25.96	0.019	1.36E-02	52.0	125.1		30000
		-29.46	0.019	1.36E-02	52.0	125.1		
15	-3.50	-35.13	0.015	1.25E-02	44.0	137.2		30000
		-18.85	0.015	1.25E-02	44.0	137.2		
16	-3.75	-21.18	0.012	1.13E-02	39.0	147.7		30000
		-35.29	0.012	1.13E-02	39.0	147.7		
17	-4.00	-38.66	0.010	1.00E-02	29.7	156.2		30000
		-52.41	0.010	1.00E-02	29.7	156.2		
18	-4.28	-57.17	0.007	8.59E-03	14.6	162.4		30000
		-70.60	0.007	8.59E-03	14.6	162.4		
19	-4.55	-75.29	0.005	7.10E-03	-5.4	163.8		30000
		-176.07	0.005	7.10E-03	-5.4	163.8		

(continued)

Stage No.11 Apply load no.6 at elevation -2.00

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
20	-4.88	-184.28	0.003	5.37E-03	-64.0	155.2		30000
		-146.40	0.003	5.37E-03	-64.0	155.2		
21	-5.20	-94.26	0.001	3.84E-03	-103.1	129.6		30000
22	-5.60	2.53	0.000	2.44E-03	-121.4	82.3		30000
23	-5.97	94.54	-0.001	1.72E-03	-103.2	36.6		30000
24	-6.35	187.13	-0.001	1.47E-03	-50.4	4.5		30000
		305.56	-0.001	1.47E-03	-50.4	4.5		
25	-6.50	366.55	-0.001	1.46E-03	0.0	-0.0		---

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9782
2	-0.25	0.00	5.94	2.04	19.86	2.04	2.04a	9782
3	-0.50	0.00	11.88	4.09	39.73	4.09	4.09a	9782
		0.00	11.88	3.75	44.60	3.75	3.75a	13587
4	-0.75	0.00	18.13	5.73	68.07	5.73	5.73a	13587
5	-1.00	0.00	24.38	7.70	91.54	7.70	7.70a	13587
6	-1.25	0.00	30.63	9.67	115.01	9.67	9.67a	13587
7	-1.50	0.00	36.88	11.65	138.48	11.65	11.65a	13587
8	-1.75	0.00	43.13	13.62	161.95	13.62	13.62a	13587
9	-2.00	0.00	49.38	15.60	185.42	15.60	15.60a	13587
10	-2.25	0.00	55.63	17.57	208.89	17.57	17.57a	13587
11	-2.50	0.00	61.88	19.55	232.36	19.55	19.55a	13587
		0.00	61.88	17.16	278.95	17.16	17.16a	10326
12	-2.75	0.00	68.13	18.89	307.13	18.89	18.89a	10326
13	-3.00	0.00	74.38	20.63	335.31	20.63	20.63a	10326
14	-3.25	0.00	80.63	22.36	363.48	22.36	22.36a	10326
15	-3.50	0.00	86.88	24.09	391.66	24.09	24.09a	10326
16	-3.75	2.50	90.88	25.20	409.69	25.20	27.70a	10326
17	-4.00	5.00	94.88	26.31	427.73	26.31	31.31a	10326
18	-4.28	7.75	99.28	27.53	447.56	27.53	35.28a	10326
19	-4.55	10.50	103.68	28.75	467.40	28.75	39.25a	10326
		10.50	103.68	20.64	409.45	20.64	31.14a	45493
20	-4.88	13.75	109.69	22.67	430.15	22.67	36.42a	45493
21	-5.20	17.00	115.70	24.69	450.85	34.54	51.54	45493
22	-5.60	21.00	123.10	27.18	476.32	64.83	85.83	45493
23	-5.97	24.75	130.04	29.52	500.20	112.29	137.04	109011
24	-6.35	28.50	136.97	31.86	524.08	206.64	235.14	109011
		28.50	136.97	0.00	2702.16	305.56	334.06	200298
25	-6.50	30.00	140.13	0.00	2716.36	366.55	396.55	200298

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	-0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	-0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	-1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	-1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	16246

(continued)

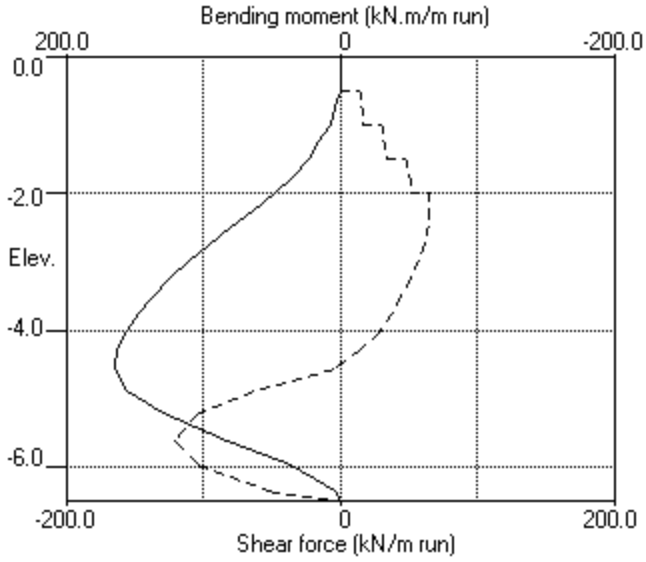
Stage No.11 Apply load no.6 at elevation -2.00

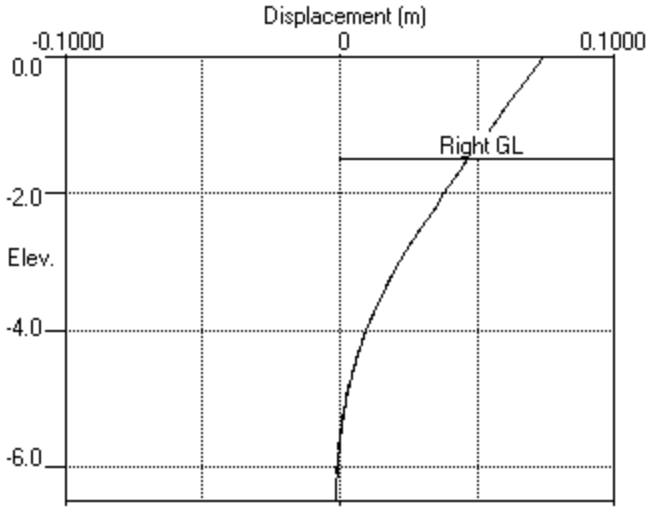
		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
8	-1.75	0.00	6.25	-0.01	0.00b	0.00	0.00p	16246
		0.00	6.25	1.97	4.30b	4.30	4.30p	16246
9	-2.00	0.00	12.50	3.95	8.60b	8.60	8.60p	16246
		0.00	12.50	3.95	11.48b	11.48	11.48p	16246
10	-2.25	0.00	18.75	5.92	17.22b	17.22	17.22p	16246
		0.00	18.75	5.92	18.81b	18.81	18.81p	16246
11	-2.50	0.00	25.00	7.90	25.08b	25.08	25.08p	16246
		0.00	25.00	6.93	24.39b	24.39	24.39p	12347
12	-2.75	0.00	31.25	8.67	30.49b	30.49	30.49p	12347
		0.00	31.25	8.67	32.35b	32.35	32.35p	12347
13	-3.00	0.00	37.51	10.40	38.82b	38.82	38.82p	12347
		0.00	37.51	10.40	41.42b	41.42	41.42p	12347
14	-3.25	0.00	43.76	12.14	48.32b	48.32	48.32p	12347
		0.00	43.76	12.14	51.82b	51.82	51.82p	12347
15	-3.50	0.00	50.02	13.87	59.23b	59.23	59.23p	12347
		0.00	50.02	13.87	42.95b	42.95	42.95p	12347
16	-3.75	2.50	54.02	14.98	46.39b	46.39	48.89p	12347
		2.50	54.02	14.98	60.49b	60.49	62.99p	12347
17	-4.00	5.00	58.03	16.09	64.98b	64.98	69.98p	12347
		5.00	58.03	16.09	78.72b	78.72	83.72p	12347
18	-4.28	7.75	62.44	17.32	84.70b	84.70	92.45p	12347
		7.75	62.44	17.32	98.13b	98.13	105.88p	12347
19	-4.55	10.50	66.85	18.54	105.07b	104.05	114.55	12347
		10.50	66.85	8.24	196.71b	196.71	207.21p	53959
20	-4.88	13.75	72.89	10.27	211.16b	206.95	220.70	53959
		13.75	72.89	10.27	169.07b	169.07	182.82p	53959
21	-5.20	17.00	78.92	12.30	180.64b	128.81	145.81	53959
		17.00	78.92	12.30	190.52b	128.81	145.81	53959
22	-5.60	21.00	86.35	14.81	205.55b	62.29	83.29	53959
		21.00	86.35	14.81	215.44b	62.29	83.29	53959
23	-5.97	24.75	93.33	17.16	230.22b	17.75	42.50	109011
		24.75	93.33	17.16	239.16b	17.75	42.50	109011
24	-6.35	28.50	100.31	19.51	254.54b	19.51	48.01a	109011
		28.50	100.31	0.00	2536.85	0.00	28.50a	200298
25	-6.50	30.00	103.48	0.00	2551.14	0.00	30.00a	200298

Note: 30.00a Soil pressure at active limit
182.82p Soil pressure at passive limit
254.54b Passive limit reduced because of berm

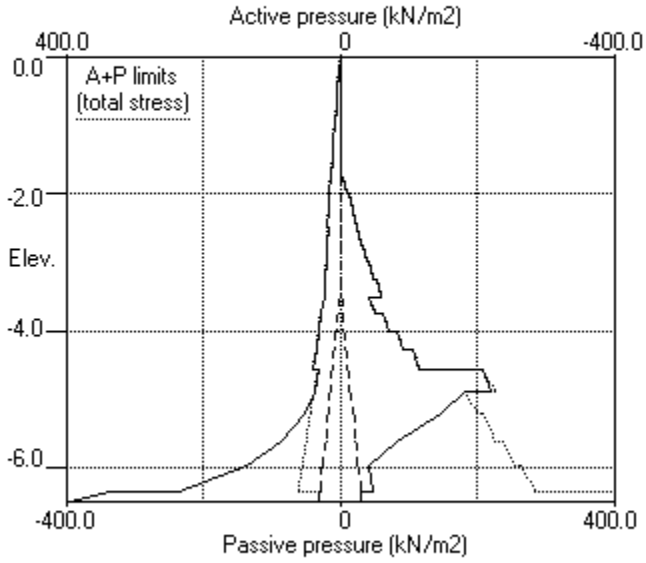
Units: kN,m

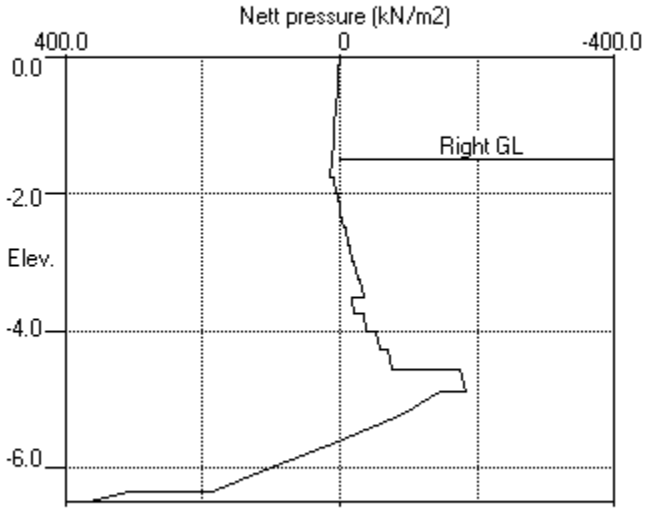
Stage No.11 Apply load no.6 at elev. -2.00





Stage No.11 Apply load no.6 at elev. -2.00





Units: kN,m

Summary of results

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = -6.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr-ation	Direction of failure
1	0.00	-1.50	Cant.	1.506	-6.38	-4.59	3.09	L to R
2	0.00	-1.50	Cant.	1.506	-6.38	-4.59	3.09	L to R
3	0.00	-1.50	Cant.	1.354	-6.38	-5.08	3.58	L to R
4	0.00	-1.50	Cant.	1.109	-6.38	-6.22	4.72	L to R
5	0.00	-1.50	Cant.	1.109	-6.38	-6.22	4.72	L to R
6	0.00	-1.50	Cant.	1.354	-6.38	-5.08	3.58	L to R
7	0.00	-1.50	Cant.	1.506	-6.38	-4.59	3.09	L to R
8	0.00	-1.50	Cant.	1.375	-6.37	-5.36	3.86	L to R
9	0.00	-1.50	Cant.	1.274	-6.37	-5.78	4.28	L to R
10	0.00	-1.50	Cant.	1.194	-6.37	-6.12	4.62	L to R
11	0.00	-1.50	Cant.	1.131	-6.37	-6.36	4.86	L to R

Units: kN,m

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall

Analysis options

Soldier Pile width = 0.45m; spacing = 0.90m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum	Displacement minimum	Bending moment maximum	Bending moment minimum	Shear force maximum	Shear force minimum
		m	m	kN.m/m	kN.m/m	kN/m	kN/m
1	0.00	0.074	0.000	0.0	0.0	0.0	0.0
2	-0.25	0.070	0.000	0.0	-0.0	0.7	0.0
3	-0.50	0.065	0.000	0.4	0.0	13.7	0.0
4	-0.75	0.061	0.000	3.7	0.0	14.8	0.0
5	-1.00	0.056	0.000	7.6	0.0	29.2	0.0
6	-1.25	0.051	0.000	15.1	0.0	31.3	0.0
7	-1.50	0.047	0.000	23.4	0.0	46.6	0.0
8	-1.75	0.043	0.000	35.4	0.0	49.8	0.0
9	-2.00	0.038	0.000	48.1	0.0	64.5	0.0
10	-2.25	0.034	0.000	64.1	0.0	65.0	0.0
11	-2.50	0.030	0.000	80.3	0.0	64.2	0.0
12	-2.75	0.026	0.000	96.1	0.0	61.8	0.0
13	-3.00	0.022	0.000	111.3	0.0	57.9	0.0
14	-3.25	0.019	0.000	125.1	0.0	52.0	0.0
15	-3.50	0.015	0.000	137.2	0.0	44.0	-0.9
16	-3.75	0.012	0.000	147.7	0.0	39.2	-3.3
17	-4.00	0.010	0.000	156.2	0.0	36.9	-5.1
18	-4.28	0.007	0.000	162.4	0.0	29.6	-6.1
19	-4.55	0.005	0.000	163.8	0.0	20.7	-14.3
20	-4.88	0.003	0.000	155.2	0.0	0.0	-64.0
21	-5.20	0.002	0.000	129.6	0.0	0.0	-103.1
22	-5.60	0.001	0.000	82.3	0.0	0.0	-121.4
23	-5.97	0.000	-0.001	36.6	0.0	0.0	-103.2
24	-6.35	0.000	-0.001	4.5	0.0	0.0	-50.4
25	-6.50	0.000	-0.001	0.0	-0.0	0.0	0.0

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum	Bending moment elev.	Bending moment minimum	Bending moment elev.	Shear force maximum	Shear force elev.	Shear force minimum	Shear force elev.
	kN.m/m		kN.m/m		kN/m		kN/m	
1	24.5	-3.50	0.0	0.00	14.5	-2.25	-13.1	-5.20
2	24.5	-3.50	0.0	0.00	14.5	-2.25	-13.1	-5.20
3	37.3	-3.75	0.0	0.00	19.6	-2.50	-22.1	-5.20
4	104.7	-4.88	-0.0	-6.50	39.2	-3.75	-80.8	-5.97
5	104.1	-4.88	-0.0	-6.50	39.2	-3.75	-81.6	-5.60
6	104.5	-4.55	-0.0	-6.50	40.9	-3.00	-79.2	-5.60
7	104.6	-4.55	-0.0	-6.50	41.1	-3.00	-78.7	-5.60
8	105.0	-4.55	-0.0	-0.25	37.1	-3.00	-78.5	-5.60
9	110.2	-4.55	-0.0	-0.25	39.8	-2.25	-80.3	-5.60
10	133.7	-4.28	-0.0	-0.25	52.4	-2.25	-93.3	-5.60
11	163.8	-4.55	-0.0	-0.25	65.0	-2.25	-121.4	-5.60

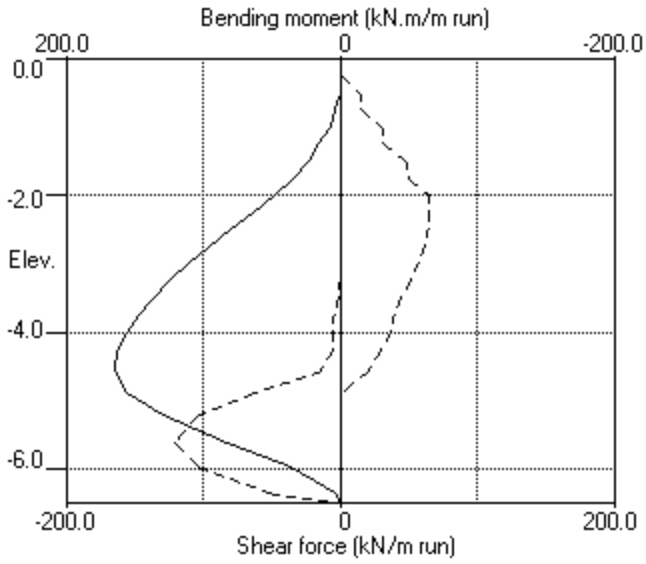
Summary of results (continued)

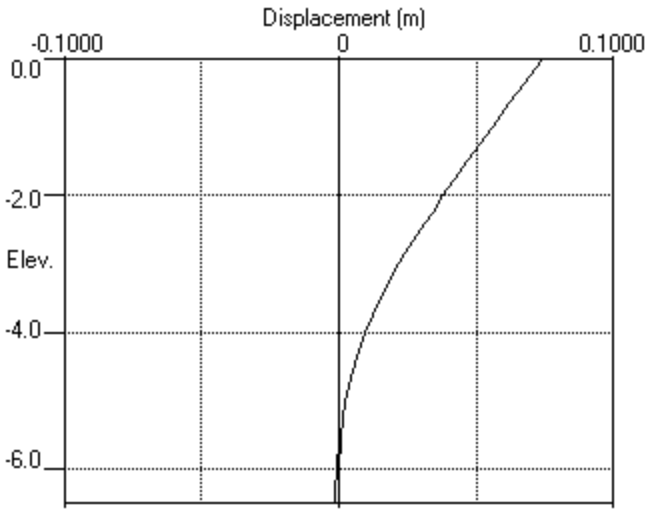
Maximum and minimum displacement at each stage

Stage no.	Displacement maximum m	elev.	minimum m	elev.	Stage description
1	0.005	0.00	-0.000	-6.50	Excav. to elev. -1.50 on RIGHT side
2	0.005	0.00	-0.000	-6.50	Change EI of wall to 20000kN.m2/m run
3	0.008	0.00	-0.000	-6.50	Apply surcharge no.1 at elev. 0.00
4	0.028	0.00	-0.001	-6.50	Apply water pressure profile no.2
5	0.047	0.00	-0.001	-6.50	Change EI of wall to 30000kN.m2/m run
6	0.047	0.00	-0.001	-6.50	Apply water pressure profile no.1
7	0.047	0.00	-0.001	-6.50	Remove surcharge no.1 at elev. 0.00
8	0.048	0.00	-0.001	-6.50	Apply load no.3 at elev. -0.50
9	0.052	0.00	-0.001	-6.50	Apply load no.4 at elev. -1.00
10	0.061	0.00	-0.001	-6.50	Apply load no.5 at elev. -1.50
11	0.074	0.00	-0.001	-6.50	Apply load no.6 at elev. -2.00

Units: kN,m

Bending moment, shear force, displacement envelopes





Appendix E

Safety in Design

Health and Safety in Design Risk Register

1 ID	WORK BREAKDOWN STRUCTURE		RISK IDENTIFICATION					RISK ASSESSMENT PRIOR TO TREATMENT *			HAZARD ELIMINATION / RISK MINIMISATION				RISK ASSESSMENT AFTER TREATMENT *			RESIDUAL RISK ALLOCATION *	20 SFAIRP CONSIDERATIONS / JUSTIFICATION	21 STATUS	22 Comments (& ownership if transferred)
	2 LIFE CYCLE STAGE	3 WHERE & WHAT Location Site featureInterface Design elementDrawing / reference	4 GUIDEWORD / DEVIATION* (if applicable / utilised)	5 HAZARD	6 CAUSES	7 CONSEQUENCES	8 PRE-ASSESSMENT ASSUMED HAZARD SAFEGUARD (e.g. observed speed limits, observed electrical safeguards)	9 Risk consequences (1-6)	10 Risk likelihood (1-6)	11 Risk level	12 Elimination practicable? Y / N	13 Justification ifElimination not practicable	14 Recommended Risk Minimisation: Safeguards / Action(s) / Controls State Hierarchy Of Control type foreach control & list controls in HOCorder (to be authorised)	15 Responsibility	16 Risk consequences (1-6)	17 Risk likelihood (1-6)	18 Risk level	19 Responsible person / due date			
1	CURRENT	Slope		Instability of slope, particularly during inclement weather events	• Unstable slope • Potential elevated phreatic surface during inclement weather • Ineffective surface drainage due to deformed ground profile	• Slope failure • Damage to infrastructure, • Damage to service road at toe of slope • Debris washout onto Dr. George Mt Road • Damage to Dr. George Mt Road inconveniencing road users	• Monitor slope • Install permanent stabilisation measure ASAP	C2	L1	A	Y		Recommended implementation of interim support measures to prevent slide debris from blocking the culvert or moving onto the road	Council	C2	L4	B	Council			Install permanent stabilisation measure ASAP
2	DESIGN	Retaining wall		Damage / collapse of structure	• Overload • Corrosion. • structural component failure. • geotechnical failure.	• Wall failure onto service road and potential spill over onto Dr. George Mt Road. • Damage to property and possible injury. • Reduced safety for road users on Dr. George Mt Road • Inconvenience to road users.					Y		• Engineer - Apply codes, appropriate corrosion allowance and detailing in the design. • Appropriately detailed wall for drainage provisions. • Necessitate pile installation inspection and documentation • Ensure design pile sockets are achieved on site	Designer	C2	L6	C	Designer			
3	CONSTRUCTION	Retaining wall		Disruption to traffic / road users on Dr. George Mt Road	• Construction works impacting traffic • Delivery of plant and equipment interfering with traffic flows	• Inconvenience to road users • Traffic accidents and injuries	Implement construction plan and traffic control measures	C4	L1	B	Y		• Adopt appropriate construction planning • Implement traffic management and control • Timing of works to coincide with non-peak traffic periods	Contractor	C4	L4	C	Contractor			
	OPERATION	Retaining wall		Disruption to local traffic	• Retaining wall alignment design	• Blocking local access road to north of the road and east of the alignment					Y		• Align piled wall in a way that maintains local accesses	Designer	C5	L5	D	Designer			
4	CONSTRUCTION	Retaining wall		Contamination of waterways	Poor ERSED control allowing escape of water, sediment and debris leaving construction site into drainage line and out onto Dr. George Mt Road	• Damage to the environment • Prosecution, penalties and infringement from EPA	Downslope gradient towards drainage line and Dr. George Mt Road	C4	L1	B	Y		• Implement appropriate ERSED control • Provide sedimentation basin or sump to capture water and sediment	Contractor	C4	L5	D	Contractor			
5	CONSTRUCTION	Retaining wall		Suspended loads, bored pile excavations, mobile equipment, construction activities	Working near suspended loads, open excavations and mobile equipment	Worker injury by collision with suspended load or other construction equipment leading to injury or death					Y		• Engineer - Limit wall component size toavoid lifting loads over adjacent roadways, etc. Adoption of post and panel design. • Implement standard	Contractor	C3	L5	C	Contractor			

Health and Safety in Design Risk Register

1 ID	WORK BREAKDOWN STRUCTURE		RISK IDENTIFICATION					RISK ASSESSMENT PRIOR TO TREATMENT *			HAZARD ELIMINATION / RISK MINIMISATION				RISK ASSESSMENT AFTER TREATMENT *			RESIDUAL RISK ALLOCATION *	20 SFAIRP CONSIDERATIONS / JUSTIFICATION	21 STATUS	22 Comments (& ownership if transferred)
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													construction procedures with regard to suspended loads, open excavations and mobile equipment. • Minimise site-based treatments (e.g. welding or cutting) • Provide hoarding and other barrier type prevention measure • Appropriate PPE for all construction workers and engineers to safeguard against the residual risk								
6	CONSTRUCTION	Retaining wall		Instability of temporaryworks	Inadequate design/temp support and construction issues	Collapse of temporary works/earthworks impacting workers, adjacent properties and construction equipment	• Unstable slope				Y		• Engineer - Aim to achieve batter slope and clearances that do not require temporary works, designs or structures • Do not mobilise equipment or plant on the existing unstable slope. • Do not construct temporary works platform or any other load bearing structures on the existing unstable slope • Undertake bearing capacity assessment accounting for the specific piling equipment that will be used on site	Contractor	C3	L4	C	Contractor			The use of the existing service road for establishment and setting up of equipment and pile rig, negating the need to mobilise equipment on the unstable slope and avoid temporary work platforms on existing unstable slope. Consider interaction with traffic barrier types
7	~~OPERATION~~	~~Retaining wall~~		~~Falling from height~~	~~No barrier along top of retaining wall of up to 4m high~~	~~Fall from height, seriousinjury to maintenance crews~~		~~C3~~	~~L3~~	~~B~~	~~Y~~		~~Eliminate - Ensure adequately designed~~ ~~• Install guardrail posts~~	~~Contractor~~	~~C3~~	~~L5~~	~~C~~	~~Contractor~~			
8	MAINTENANCE	Culvert Drain		Increased seepage into the retained slope and behind the retaining wall	Blockage from debris	Increase risk of slope instability and wall failure					Y		Routine inspection, clearing and maintenance	Council	C2	L5	C	Council			
9	MAINTENANCE	Horizontal drains and sub-surface ag drainage		Build-up in hydrostatic pressures behind retaining wall	Blocked horizontal drains	Increase risk of slope instability and wall failure					Y		Routine inspection, clearing and maintenance	Council	C2	L5	C	Council			

Health and Safety in Design Risk Register

1 ID	WORK BREAKDOWN STRUCTURE		RISK IDENTIFICATION					RISK ASSESSMENT PRIOR TO TREATMENT *			HAZARD ELIMINATION / RISK MINIMISATION				RISK ASSESSMENT AFTER TREATMENT *			RESIDUAL RISK ALLOCATION *	20 SFAIRP CONSIDERATIONS / JUSTIFICATION	21 STATUS	22 Comments (& ownership if transferred)
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10	CONSTRUCTION	Guard rail		Disruption to traffic / road users on Dr. George Mt Road	• Construction works impacting traffic • Installation of guard rail interfering with traffic flows	• Inconvenience to road users • Traffic accidents and injuries	Implement construction plan and traffic control measures	C4	L1	B	Y		• Adopt appropriate construction planning • Implement traffic management and control • Timing of works to coincide with non-peak traffic periods	Contractor	C4	L4		Contractor			
11	OPERATION	Guard rail		Damage to end terminal of guard rail system	Local driveway access vehicle hitting the guard rail	Traffic accidents and injuries		C4	L1	B	Y		• Apply appropriate end terminal and allowance off set away from driveway.	Designer	C2	L4	C	Designer			
12	OPERATION	Drainage		Aquaplaning of vehicles	Overtopping of stormwater pavement onto road carriageways	Traffic accidents and injuries		C3	L4	C	N		• Use V drain rather than kerb and gutter on downhill side of road to keep spread of flow outside carriageway • Maintain drainage system to minimise debris blockage risk	Designer	C3	L4	C	Designer/ Council			

Appendix F

Revised 100% Design drawings

DR GEORGE MOUNTAIN ROAD
EMBANKMENT STABILISATION
REVISED 100% DETAILED DESIGN - PILED WALL

LOCALITY PLAN

SCALE: 1:5000

REFERENCE: AERIAL IMAGERY (APRIL 2018) - DEPARTMENT OF CUSTOMER SERVICE 2021.

DRAWING LIST:

DRG NO:	DRAWING TITLE:
12554564-G001	COVER SHEET, LOCALITY PLAN AND DRAWING LIST
12554564-G002	GENERAL NOTES - SHEET 1 OF 4
12554564-G003	GENERAL NOTES - SHEET 2 OF 4
12554564-G004	GENERAL NOTES - SHEET 3 OF 4
12554564-G005	GENERAL NOTES - SHEET 4 OF 4
12554564-C101	EXISTING SITE PLAN
12554564-C102	SITE REMEDIATION OVERVIEW PLAN
12554564-C103	PILE WALL PLAN AND ELEVATION
12554564-C104	PILE SCHEDULE AND TYPICAL CROSS SECTIONS
12554564-C105	TYPICAL DETAILS
12554564-C201	DETAILS - CAPPING BEAM AND PILE - SHEET 1 OF 2
12554564-C202	DETAILS - CAPPING BEAM AND PILE - SHEET 2 OF 2
12554564-C203	DETAILS - PRECAST AND CAST IN-SITU PANEL
12554564-C301	GENERAL PLAN - DRAINAGE
12554564-C302	LONGITUDINAL SECTION
12554564-C303	DETAILS - DRAINAGE - SHEET 1
12554564-C304	DETAILS - DRAINAGE - SHEET 2
12554564-C401	GENERAL PLAN AND SETOUT - GUARD RAIL
12554564-C402	LONGITUDINAL SECTION
12554564-C403	CROSS SECTIONS - SHEET 1
12554564-C404	CROSS SECTIONS - SHEET 2
12554564-C405	TYPICAL DETAILS - GUARD RAILS

Rev	Description	Checked	Approved	Date
C	REVISED 100% DETAILED DESIGN	HA/MN/DB	DD	09.08.2022
B	100% DETAILED DESIGN	RM	DD	29.10.2021
A	50% DETAILED DESIGN	RM	DD	16.09.2021

Author: H WARR | Drafting Check: H WARR
Designer: H.A / F.K / D.B | Design Check: K.PINKERTON / M.NGO / D.BANNIGAN

0 50 100 150m
SCALE 1:5000 AT ORIGINAL SIZE

GHD
Level 11, Crown Tower
200 Crown Street Wollongong NSW 2500 Australia
P.O. Box 5047 Wollongong NSW 2520
T 61 2 4222 2300 F 61 2 4222 2301
E wolmail@ghd.com W www.ghd.com
www.ghd.com

Project No. 12554564

Client: BEGA VALLEY SHIRE COUNCIL
Project: DR GEORGE MOUNTAIN ROAD EMBANKMENT STABILISATION
Status: FOR REVIEW AND COMMENT | Status Code: S3

Drawing Title: COVER SHEET, LOCALITY PLAN AND DRAWING LIST
Size: A3
Drawing No.: 21-12554564-G001
Rev: C

Plot Date: 10 August 2022 - 8:18 PM | Plotted by: Archerry De Vera | File Name: \\ghdnet\ghd\AU\Wollongong\Projects\21\12554564\CADD\Drawings\Geotech\21-12554564-G001.dwg

GENERAL

G1. DEFINITIONS:
PRINCIPAL – THE PRINCIPAL IS IDENTIFIED AS BEGA VALLEY SHIRE COUNCIL
GEOTECHNICAL DESIGN REPRESENTATIVE- SUITABLY QUALIFIED GEOTECHNICAL ENGINEER APPOINTED BY THE PRINCIPAL TO PROVIDE ON-SITE VERIFICATION OF THE CONSTRUCTION.
CONTRACTOR – THE ENTITY UNDERTAKING THE CONSTRUCTION.

G2. **UNO** = UNLESS NOTED OTHERWISE
SLS = SERVICEABILITY LIMIT STATE
ULS = ULTIMATE LIMIT STATE
NSL = NATURAL SURFACE LEVEL
FSL = FINISHED SURFACE LEVEL

G3. READ THESE NOTES IN CONJUNCTION WITH THE 100% DESIGN REPORT, AND WITH SUCH OTHER WRITTEN INSTRUCTIONS ISSUED. REFER TO OTHER ENGINEERING DRAWINGS FOR SETTING OUT AND DETAIL DIMENSIONS. IN CASE OF DISCREPANCY, PRECEDENCE IS GIVEN TO DRAWINGS, THEN NOTES, THEN SPECIFICATION.

G4. CARRY OUT WORK IN A SAFE MANNER IN ACCORDANCE WITH APPLICABLE LEGISLATION, STATUTORY REGULATIONS, BY-LAWS OR RULES. CONTRACTOR IS RESPONSIBLE FOR OCCUPATIONAL HEALTH AND SAFETY OF SITE PERSONNEL AND GENERAL PUBLIC IN ACCORDANCE WITH ALL CURRENT WORK HEALTH AND SAFETY ACTS, LEGISLATIVE REQUIREMENTS, ASSOCIATED REGULATIONS AND CODES OF PRACTICE, INDUSTRIAL AGREEMENTS AND ACCEPTED INDUSTRY PRACTICE.

G5. REFER DISCREPANCIES TO SITE ENGINEER BEFORE PROCEEDING WITH WORK.

G6. SUBMIT DETAILS OF PROPOSED CHANGES TO SCOPE, WORK METHODS OR MATERIALS, SECTION SIZES, PROFILES etc FOR APPROVAL BEFORE PROCEEDING. APPROVAL DOES NOT AUTHORISE A VARIATION TO THE CONTRACT.

G7. SITE TO BE RETURNED TO ORIGINAL OR BETTER CONDITION AT THE COMPLETION OF THE WORK.

G8. NOMINATION OF PROPRIETARY ITEMS DOES NOT INDICATE EXCLUSIVE PREFERENCE BUT INDICATES REQUIRED PROPERTIES OF ITEM. SIMILAR ALTERNATIVES HAVING REQUIRED PROPERTIES MAY BE OFFERED FOR APPROVAL. APPROVAL DOES NOT AUTHORISE A VARIATION TO THE CONTRACT. INSTALL PROPRIETARY ITEMS IN ACCORDANCE WITH MANUFACTURER'S REQUIREMENTS AND RECOMMENDATIONS.

G9. OBTAIN NECESSARY PERMITS AND APPROVALS FROM RELEVANT AUTHORITIES BEFORE COMMENCING WORK ON SITE. NOTIFY RELEVANT SERVICE AUTHORITIES BEFORE COMMENCING WORK ON SITE.

G10. GIVE TWO WORKING DAYS (48 HOURS) NOTICE SO THAT INSPECTION MAY BE MADE OF CRITICAL STAGES OF WORK.

G11. ALLOW FOR INSPECTION BY DESIGNER AT LEAST AT FOLLOWING STAGES:
- FOUNDATION PREPARATION COMPLETE BEFORE PLACING CONCRETE
- REINFORCEMENT, DOWELS AND OTHER CAST-IN ITEMS IN PLACE BEFORE PLACING CONCRETE
- INSTALLATION OF PRE-FABRICATED ITEMS (PRECAST CONCRETE)
- SURFACE PREPARATION PRIOR TO APPLICATION OF COATINGS AND REPAIRS
- BEFORE STRUCTURAL WORK IS HIDDEN BY CLADDING OR LINING

G12. INSPECTIONS AND REVIEWS UNDERTAKEN BY CONTRACTOR OR OTHERS DO NOT RELIEVE CONTRACTOR OF RESPONSIBILITY FOR COMPLIANCE WITH DRAWINGS AND SPECIFICATIONS.

G13. DO NOT OBTAIN DIMENSIONS BY SCALING FROM DRAWINGS.

G14. DIMENSIONS ARE IN MILLIMETRES, LEVELS ARE IN METRES UNO, CHAINAGES ARE IN METRES UNO.

G15. DATUM FOR LEVELS IS AHD (AUSTRALIAN HEIGHT DATUM).
CO-ORDINATES ARE TO MGA94 (MAP GRID OF AUSTRALIA) AMG (AUSTRALIAN MAP GRID).

G16. HAVE SURVEY AND SETTING OUT UNDERTAKEN BY A REGISTERED SURVEYOR.

G17. TAKE CARE OF HAZARDS ASSOCIATED WITH BURIED, CONCEALED OR OVERHEAD SERVICES. CONTACT RELEVANT AUTHORITIES TO IDENTIFY PRESENCE OF SERVICES. TAKE PRECAUTIONS AND UNDERTAKE EXPLORATION TO ESTABLISH LOCATION OF AND PROTECT EXISTING SERVICES AT SITE. SERVICES SHOWN ON DRAWINGS ARE IN APPROXIMATE LOCATIONS ONLY. SERVICES OTHER THAN THOSE SHOWN MAY EXIST ON SITE. MARK LOCATIONS OF SERVICES CLEARLY ON SITE, AND ON AS-BUILT DRAWINGS. HAND EXCAVATE WITHIN ONE METRE OF IN-GROUND SERVICES.

G18. DISPOSE OF SURPLUS MATERIAL OFF SITE IN ACCORDANCE WITH LOCAL AUTHORITY WASTE REGULATIONS.

G19. IMPLEMENT SOIL AND WATER MANAGEMENT PROCEDURES TO AVOID EROSION, SOFTENING, SATURATION, CONTAMINATION AND SEDIMENTATION OF SITE, SURROUNDING AREAS AND DRAINAGE SYSTEMS.

G20. PROVIDE SITE WATER CONTROL MEASURES, WHICH MAY INCLUDE:
- CONSTRUCTION OF TEMPORARY DRAINS
- PUMPING AND/OR DEWATERING OF EXCAVATIONS
- DIVERSION OF CONCENTRATED FLOWS
- CONSTRUCTION AND MAINTENANCE OF SILT TRAPS
- STAGING OF EARTHWORKS
- PROGRESSIVE RESTORATION OF DISTURBED AREAS THROUGHOUT THE PROJECT.

G21. WORKMANSHIP AND MATERIALS TO COMPLY WITH REQUIREMENTS OF AUSTRALIAN STANDARDS, NATIONAL AND RELEVANT TRANSPORT FOR NSW STANDARDS.

G22. PROVIDE FOR TEMPORARY SUPPORT OF ADJOINING ELEMENTS DURING CONSTRUCTION. DRAWINGS DO NOT SHOW DETAILS OF ALL REQUIRED FIXTURES, INSERTS, SLEEVES, RECESSES OR OPENINGS etc.

G23. PROTECT EXISTING STRUCTURES FROM DAMAGE OR CRACKING. MAKE GOOD ANY DAMAGE TO EXISTING ELEMENTS AT COMPLETION OF WORKS OR AS DIRECTED BY CONTRACTOR.

G24. HAVE TESTING PERFORMED BY AN NATA (NATIONAL ASSOCIATION OF TESTING AUTHORITIES) ACCREDITED AUTHORITY AND PROVIDE TEST REPORTS TO CONTRACTOR.

G25. SUPPLY RELEVANT NOTES, DRAWINGS AND SPECIFICATIONS etc TO SUB-CONTRACTORS.

G26. BUILD, FABRICATE AND PROCURE ONLY FROM DRAWINGS 'ISSUED FOR CONSTRUCTION'.

G27. KEEP ON SITE A COMPLETE SET OF CONTRACT DOCUMENTS (INCLUDING DRAWINGS AND SPECIFICATIONS) AND SITE INSTRUCTIONS.

TEMPORARY WORKS

G28. THESE DRAWINGS DO NOT DETAIL TEMPORARY WORKS. CONSTRUCTION METHODS AND TEMPORARY WORKS ARE RESPONSIBILITY OF THE CONTRACTOR.

G29. PROVIDE SCAFFOLDING, BARRIERS, FALL RESTRAINT, HAND / MID RAILS AND TOE BOARDS FOR WORK AT HEIGHT. ERECT ACCESS STAIRS AT EARLIEST OPPORTUNITY TO REDUCE OPEN SHAFT HAZARDS AND FACILITATE ACCESS. MAINTAIN SAFETY MESH AND BARRIERS TO ALL OPENINGS AND ELEVATED EDGES.

G30. MAINTAIN STRUCTURE IN A STABLE CONDITION DURING CONSTRUCTION AND PROVIDE TEMPORARY BRACING AND / OR SUPPORT AS REQUIRED. SHOW TEMPORARY MEMBERS ON SHOP DRAWINGS. PROVIDE SPREADERS AT LOADS AND LIFTING POINTS WHERE REQUIRED. ENSURE NO PART IS OVERSTRESSED. DO NOT PLACE OR STORE BUILDING MATERIALS ON, SUPPORT FORMWORK ON OR PROP FROM STRUCTURAL MEMBERS WITHOUT CONTRACTOR'S APPROVAL. PROVIDE CALCULATIONS BY SUITABLY QUALIFIED STRUCTURAL ENGINEER TO PROVE ADEQUACY OF STRUCTURE FOR PROPOSED CONSTRUCTION SEQUENCE, METHODS AND LOADS INCLUDING PROPPING, CRANE LIFTS etc.

G31. PROVIDE TEMPORARY BRACING WHERE REQUIRED FOR STRUCTURAL ELEMENTS OR FRAMES STABILISED BY MASONRY, PRECAST CONCRETE OR OTHER ELEMENTS CONSTRUCTED AFTER ERECTION OF THE STRUCTURAL ELEMENT OR FRAME, AND SHOW ON SHOP DRAWINGS.

DESIGN ASSUMPTIONS

G32. ALL STRUCTURES TO HAVE A DESIGN WORKING LIFE OF 100 YEARS

G33. G1. STRUCTURAL WORK HAS BEEN DESIGNED FOR FOLLOWING LOADS:
- IMPOSED VERTICAL TRAFFIC LOAD ON GROUND 20 kPa
- IMPACT LOAD ON WBEAM GUARDRAIL AS PER AS 5100 TABLE 12.2.2 150 kN SPREAD ON 1.1 M CONTACT LENGTH (LOW BARRIER PERFORMANCE LEVEL). NOTE GUARDRAIL POST IS ISOLATED FROM THE PILED WALL SYSTEM.
- EARTH PRESSURE IN ACCORDANCE WITH AS 4678

DELIVERABLES

G34. RECORD ADOPTED CHANGES TO WORKING DRAWINGS AND SHOP DRAWINGS. ON COMPLETION OF WORKS SUBMIT A FULL SET OF 'AS CONSTRUCTED' DRAWINGS.

G35. SUPPLY APPROVED SHOP DRAWINGS TO THE CONTRACTOR. DO NOT VARY CONSTRUCTION FROM APPROVED SHOP DRAWINGS WITHOUT CONTRACTOR'S WRITTEN APPROVAL.

G36. REVIEW OF SHOP DRAWINGS AND CALCULATIONS IS OF GENERAL CONFORMANCE WITH DESIGN CONCEPT AND GENERAL COMPLIANCE WITH CONTRACT DOCUMENTS ONLY AND DOES NOT INCLUDE CHECKING OF DIMENSIONS. CONTRACTOR IS RESPONSIBLE FOR CONFIRMING AND CORRELATING QUANTITIES AND DIMENSIONS, SELECTING FABRICATION PROCEDURES AND CONSTRUCTION TECHNIQUES, AND PERFORMING WORK IN A SAFE MANNER. CORRECTIONS OR COMMENTS MADE ON SHOP DRAWINGS AND CALCULATIONS DO NOT RELIEVE CONTRACTOR FROM RESPONSIBILITY FOR COMPLIANCE WITH REQUIREMENTS OF CONTRACT DRAWINGS AND SPECIFICATION.

SAFETY IN DESIGN

SID1. THE SAFETY RISK MITIGATION ITEMS BELOW ARE BASED ON GHD'S DESIGN OFFICE EXPERIENCE AND DO NOT NECESSARILY ACCOUNT FOR ALL CONSTRUCTION, OPERATION, MAINTENANCE AND DEMOLITION SAFETY RISKS. BASED ON INFORMATION AVAILABLE WHEN THIS DRAWING WAS MADE, IN ITS CAPACITY AS DESIGNER ONLY, GHD HAS TRIED TO IDENTIFY SAFETY RISKS PERTAINING TO CONSTRUCTION, OPERATION, MAINTENANCE AND DEMOLITION PHASES OF THE ASSET. INCLUSION (OR NOT) OF ANY ITEM DOES NOT REDUCE OR LIMIT OBLIGATIONS OF CONSTRUCTOR, USER, MAINTAINER AND DEMOLISHER TO UNDERTAKE APPROPRIATE RISK MANAGEMENT ACTIVITIES TO REDUCE RISK AND IS NOT AN ADMISSION BY GHD THAT INCLUSION OF ANY ITEM IS DESIGNER'S RESPONSIBILITY.

SID2. CONSTRUCT BUILDING ELEMENTS THAT CONTRIBUTE TO SAFETY, SUCH AS HANDRAILS AND TOE BOARDS, FALL ARREST SYSTEMS, ACCESS STAIRS, etc AS EARLY AS POSSIBLE.

SID3. PROVIDE SAFETY BARRIERS AT EDGES OF OPENINGS AND ELEVATED AREAS. ENSURE EXCAVATIONS ARE ADEQUATELY FENCED, SECURE, WELL LIT AND SIGNED TO ENSURE PERSONNEL SAFETY.

SID4. REVIEW ADEQUACY OF WORKING SPACE AVAILABLE FOR CONSTRUCTION ACTIVITIES. ENSURE SEPARATION OF PLANT AND PERSONNEL ON SITE, INCLUDING MOVEMENTS OF BOTH.

SID5. LOCATE LIFTING SLEW AND LAY DOWN AREAS AWAY FROM REGULAR CONSTRUCTION TRAFFIC.

SID6. WRITTEN RISK ASSESSMENTS ARE RECOMMENDED FOR ACCESS TO OPEN EXCAVATIONS.

SID7. PROVIDE SAFE ACCESS AND EGRESS TO EXCAVATIONS APPROPRIATE IN CASE OF INUNDATION, COLLAPSE OR ENGULFMENT.

SID8. SEEK ADVICE FROM SUITABLY QUALIFIED GEOTECHNICAL OR STRUCTURAL ENGINEER PRIOR TO OPERATION OF HEAVY SURFACE PLANT AND EQUIPMENT OR STOCKPILING MATERIAL NEAR OPEN EXCAVATIONS OR EXISTING RETAINING STRUCTURES.

SID9. DO NOT STOCKPILE MATERIALS BEHIND OR EXCAVATE IN FRONT OF EXISTING RETAINING WALLS UNTIL WALL STABILITY HAS BEEN REVIEWED BY SUITABLY QUALIFIED STRUCTURAL ENGINEER.

SID10. HAVE LOAD CAPACITY OF STRUCTURES VERIFIED BY SUITABLY QUALIFIED STRUCTURAL ENGINEER BEFORE LOADING OR STORING MATERIALS ON EXISTING OR PARTIALLY COMPLETED STRUCTURAL ELEMENTS.

SID11. SEEK ADVICE FROM SUITABLY QUALIFIED STRUCTURAL ENGINEER IF PLANNING CRANE LIFTS OR HOIST INSTALLATION ON PARTIALLY ERECTED OR SUSPENDED STRUCTURES.

SID12. DEVELOP STEELWORK / PRECAST / TILT UP INSTALLATION SAFE WORK METHOD STATEMENT TO ELIMINATE AND MINIMISE INSTALLATION RISKS AND HAVE REVIEWED BY SUITABLY QUALIFIED STRUCTURAL ENGINEER PRIOR TO ERECTION.

SID13. MINIMISE SITE BASED TREATMENTS (eg WELDING, CUTTING, SPRAY PAINTING, GRIT BLASTING, etc). PROVIDE ADEQUATE PROTECTION, SCREENING AND VENTILATION TO MINIMISE HAZARDS TO PERSONNEL IF SITE BASED TREATMENT IS UNAVOIDABLE.

SID14. AVOID WORKING IN CONFINED SPACES WHENEVER POSSIBLE. IF CONFINED SPACES WORK CANNOT BE AVOIDED, PROVIDE SAFE WORK METHOD STATEMENT ADDRESSING MITIGATION OF RISKS. PROVIDE ADEQUATE SIGNAGE TO TEMPORARY AND PERMANENT CONFINED SPACES TO AS2865.

SID15. AVOID HOT WORKS ON SITE. HOT WORKS TO COMPLY WITH CLIENT PROCEDURES FOR APPLICABLE "HOT WORKS PERMITS".

SID16. SOME SITES IN AUSTRALIA AND EXTENSIVE REGIONS OF SE ASIA CONTAIN UNEXPLODED ORDNANCE (UXO) IN THE GROUND. UNDERTAKE DESKTOP REVIEWS FOR THE LIKELIHOOD OF UXO'S BEFORE COMMENCING ANY GROUND INVESTIGATION OR EXCAVATION IN THESE AREAS. SHOULD EVIDENCE INDICATE POTENTIAL UXO PRESENCE DO NOT COMMENCE GROUND WORKS UNTIL ENGAGING A SPECIALIST CONSULTANT WHO CAN HELP DEFINE ANY FUTURE CLEARANCE TASKS.

SID17. THERE ARE SIGNIFICANT SAFETY RISKS FOR PLACING LARGE PLANT AT THE CREST OF THE SLOPE IN ITS CURRENT CONDITION DUE TO POSSIBILITY OF FUTURE FAILURE. TEMPORARY WORK ASSESSMENTS TO FACILITATE SUITABLE ACCESS WOULD BE REQUIRED BY THE CONTRACTOR. THIS MAY INCLUDE LIMITING THE LOAD EXERTED BY PILING PLANT, RAMPED IN EXCAVATION OF A WORKING BENCH, OR SEQUENCED INSTALLATION OF PILES STARTING PRIOR TO THE UNSTABLE AREA TO ENABLE THE PLANT TO BE SUPPORTED BY THE INSTALLED PILES.

GEOTECHNICAL CONSIDERATIONS

GENERAL

GT1. THE GEOLOGICAL PROFILE AND GEOTECHNICAL CONDITIONS SHOWN ON THE DRAWINGS ARE INDICATIVE AND HAVE BEEN INTERPRETED BASED ON A SITE INVESTIGATION CONDUCTED IN AUGUST 2021. SHOULD THE ENCOUNTERED GEOLOGICAL PROFILE DIFFER FROM THAT SHOWN, THE DESIGN SHALL BE REVIEWED TO ENSURE SUITABILITY OF THE DESIGN TO THE ENCOUNTERED CONDITIONS.

GT2. THE GROUND CONDITIONS SHOULD BE VERIFIED BY A SUITABLY QUALIFIED GEOTECHNICAL ENGINEER PRESENT ON SITE DURING CONSTRUCTION. GROUND CONDITIONS AND DESIGN ASSUMPTIONS SHOULD BE VALIDATED DURING CONSTRUCTION.

GT3. THE ADOPTED GEOTECHNICAL PARAMETERS FOR THE ENCOUNTERED GEOTECHNICAL UNITS ARE PRESENTED BELOW IN TABLE GT1. NOTE REDUCTION FACTORS PER AS 4678 WERE APPLIED ON THESE PARAMETERS FOR THE DIFFERENT LIMIT STATES (ULTIMATE AND SERVICEABILITY).

TABLE GT1. GEOTECHNICAL PARAMETERS

GEOTECHNICAL UNIT	UNIT WEIGHT (kN/m3)	PEAK FRICTION ANGLE (DEG)	PEAK COHESION (TOTAL) (kPa)
FILL (REWORKED XW GRANODIORITE) – DENSE	19	0	33
FILL (REWORKED XW GRANODIORITE) – VERY DENSE	20	0	35
RESIDUAL – VERY DENSE	20	2	35
XW TO HW GRANODIORITE	22	15	30
MW TP FRESH GRANODIORITE	24	500	35
MW TO FR BASALT	24	400	34

GT4. THE PROPOSED PILED ELEMENTS ARE REQUIRED TO BE EMBEDDED MINIMUM 1.0 m INTO MODERATELY WEATHERED TO FRESH GRANODIORITE/BASALT. THE CONTRACT SHOULD ENSURE PROVISION OF APPROPRIATE DRILLING RIG TO INSTALL THE PILES TO THE REQUIRED EMBEDMENT.

GT5. IT MUST BE NOTED THAT THE PILED WALL IS DESIGNED TO PROVIDE DIRECT SUPPORT TO THE ROAD FORMATION AND DOES NOT SEEK TO IMPROVE THE STABILITY OF THE SLOPE FACE ITSELF. THE EXISTING VEGETATION ON THE SLOPE FACE IS EXPECTED TO PROVIDE STABILISING EFFECT. PROVISION OF STABILISING SOLUTIONS ON THE SLOPE FACE (I.E. GEOMATS) MUST BE CONSIDERED IN THE FUTURE WHERE LOCALISED FAILURES LIMITED TO THE SLOPE ARE OBSERVED.

EXISTING TIMBER RETAINING WALL AND CONSTRUCTION NOTES

GT6. THE EXISTING TIMBER RETAINING WALL AND STEEL PILES ARE TO BE REMOVED FROM THE SITE. NOTE THAT TIEBACK ANCHORS MAY POTENTIALLY BE PRESENT ON SITE. DUE TO LACK OF WORK AS EXISTING DRAWINGS, THIS COULD BE A RISK TO THE CONSTRUCTION OF THE PILED WALL SYSTEM (I.E. STEEL TIE BACK ANCHORS ON THE PILED WALL SYSTEM OR EXCAVATION FOOTPRINT).

GT7. PILES P14 TO P19 MAY POTENTIALLY BE LOCATED OUTSIDE OR AT THE EDGE OF THE EXISTING TIMBER RETAINING WALL. TEMPORARY WORKS MUST BE CONSIDERED ON THESE PARTICULAR LOCATIONS, ESPECIALLY IF DRILLING AT THE EDGE OF THE EXISTING BANK WILL BE PERFORMED.

SIMPLIFIED DESIGN CONSTRUCTION STAGING OF REMEDIATION WORKS

GT8. CONTRACTOR TO PROVIDE AND BE RESPONSOBLE FOR SEQUENCING OF CONSTRUCTION. A SIMPLIFIED CONSTRUCTION STAGING BY THE DESIGNER DESIGN ASSUMES:
- PREPARATON OF SLOPE SURFACES WITH REMOVAL OF VEGATION, DEBRIS AND LOOSE MATERIAL FOR OFF-SITE DISPOSAL
- DRILL BOREHOLES FOR THE BORED PILES. REFER TO SITE REMEDIATION PLAN AND PILE SCHEDULE FOR THE OFFSET DISTANCES OF BORED PILES FROM THE EXISTING EDGE OF BITUMEN
- INSTALL BORED PILES
- REMOVE CULVERT OUTLET PLASTIC PIPELINES AND EXISTING TIMBER WALL
- REMOVE EASTERN CULVERT DOWNSTREAM RCP PIPE SEGMENT, PREPARE BEDDING, REPLACE WITH SHORTENED SEGMENT AND BACKFILL
- EXCAVATE MIN 500 mm WIDE BEHIND THE PILE. REFER TO SCHEDULE FOR THE TOE OF EXCAVATION.
- INSTALL PRECAST PANELS AND RELATED FOOTING STRUCTURES
- INSTALL DRAINAGE STRUCTURES (CORDRAIN, MEGAFLO) AND LAYOUT
- BIDIM AND GEOTEXTILE PRIOR BACKFILLING
- BACKFILL THE EXCAVATION, AND REINSTATE TO ORIGINAL GROUND LEVEL
- DURING BACKFILLING WORKS, INSTALL CULVERT EXTENSION
- INSTALL GABION BASKET DROP AND RIPRAP TO DOWNSTREAM SLOPE
- INSTALL SO KERB
- INSTALL GUARDRAIL POSTS, THRIE BEAM GUARD RAIL (INCLUDING TRANSITION TO EXISTING W-BEAM), END TERMINAL
- REINSTATE EDGE OF BITUMEN/LINE MARKING, AS REQUIRED (DESIGN BY COUNCIL/OTHERS)
- INSTALL INLET SUMP WITH RAISED STEEL GRATE ON UPSLOPE SIDE OF THE ROAD
- INSTALL CONCRETE BUND ON UPSLOPE SIDE OF THE ROAD
- EXCAVATION AND INSTALL PVC PIPE & GROUT BENEATH UPSLOPE ROCK WALL ON UPSLOPE SIDE OF THE ROAD

EARTHWORKS, FOUNDATIONS AND FOOTINGS

EARTHWORKS

F1. EARTHWORKS TO BE TO IN ACCORDANCE WITH TfNSW R44.

F2. REMOVE TOPSOIL, MATERIAL CONTAINING GRASS ROOTS OR OTHER ORGANIC MATTER, REFUSE, PUTRESCIBLE AND FLAMMABLE MATERIAL, TIMBER, CONCRETE, RUBBLE AND / OR DEBRIS AND ALL UNSUITABLE MATERIAL BELOW SLABS AND FOOTINGS AND WHERE SHOWN ON DRAWINGS.

F3. STOCKPILE SUITABLE TOPSOIL FOR RE-USE TO 1500 mm MAXIMUM HEIGHT.

F4. DO NOT STOCKPILE MATERIAL AGAINST RETAINING WALLS, BUILDINGS, FENCES OR TREES etc. DO NOT OBSTRUCT THE FREE FLOW OF WATER.

F5. PROVIDE TEMPORARY SUPPORT TO FACES OF EXCAVATIONS AS REQUIRED.

F6. HAVE SAFETY OF PROPOSED EXCAVATIONS INCLUDING ANY TEMPORARY WORKS ASSESSED BY SUITABLY QUALIFIED GEOTECHNICAL / STRUCTURAL ENGINEER.

F7. SAMPLE AND TEST COMPACTION AS PER SPECIFICATION.

F8. PROTECT FINISHED EARTHWORKS FROM TRAFFIC, WEATHER AND EROSION AND KEEP WORKS FREE OF RUBBISH AND DEBRIS. REPAIR AND RE-ESTABLISH GRADES IN SETTLED, ERODED AND RUTTED AREAS. WHERE COMPLETED COMPACTED AREAS ARE DISTURBED BY SUBSEQUENT CONSTRUCTION OPERATIONS OR ADVERSE WEATHER, SCARIFY THE SURFACE, RESHAPE AND COMPACT TO THE REQUIRED DENSITY PRIOR TO FURTHER CONSTRUCTION.

FOUNDATIONS

F9. FOUNDATION LEVELS SHOWN ARE CONTRACT LEVELS. FINAL LEVELS TO BE AS DIRECTED BY CONTRACTOR.

F10. KEEP EXCAVATIONS FREE OF WATER. PROVIDE ADEQUATE DRAINAGE TO ENSURE FORMATION IS NOT AFFECTED BY MOISTURE. PREVENT FOUNDATION DRYING OUT DUE TO EXPOSURE. PLACE BLINDING, FOOTINGS, PILES AND BACKFILL AS SOON AS PRACTICABLE AFTER EXCAVATION.

F11. ENSURE EXCAVATIONS ARE STABLE AND PROTECT SURROUNDING PROPERTY AND SERVICES FROM ADVERSE EFFECTS OF GROUND WORKS. PROVIDE TEMPORARY WORKS AS REQUIRED. PROVIDE SHORING CERTIFIED BY SUITABLY QUALIFIED STRUCTURAL ENGINEER TO ALL DEEP EXCAVATIONS.

F12. DO NOT UNDERMINE EXISTING FOOTINGS.

Rev	Description	Checked	Approved	Date
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FOUNDATIONS CONT.

F13. DEEPEN FOOTINGS BY THICKENING BLINDING CONCRETE AS REQUIRED NEAR EXISTING SERVICE TRENCHES (EVEN IF BACKFILLED), EXCAVATIONS, BATTERS etc, SO INFLUENCE LINE (AT 30° TO HORIZONTAL) FROM FOOTING IS BELOW ADJACENT EXCAVATION.

F14. PROVIDE SAFETY MESH AND OTHER PROTECTION TO PREVENT EXPOSURE OF PERSONNEL TO EXCAVATIONS DURING FOUNDATION CONSTRUCTION.

F15. USE SUITABLE CONSTRUCTION TECHNIQUES AND EQUIPMENT FOR BACKFILLING ADJACENT TO STRUCTURES TO PREVENT OVERSTRESS AND DAMAGE. PROVIDE SUPPORT TO RETAINING WALLS IF CONSTRUCTION METHODS IMPOSE COMPACTION LOADS GREATER THAN ALLOWED (SEE DESIGN LOADS IN GENERAL NOTES). BACKFILL EVENLY TO AVOID DIFFERENTIAL SOIL PRESSURES ON STRUCTURES. BACKFILL AGAINST RETAINING WALLS ONLY AFTER SPECIFIED CONCRETE STRENGTH IS ACHIEVED, AND PERMANENT SUPPORTS INSTALLED.

F16. BACKFILL FOR RETAINING WALLS TO BE FREE DRAINING GRANULAR MATERIAL UNO. PROVIDE DRAINAGE BEHIND RETAINING WALLS COMPRISING CORDRAIN AND MEGAFLO SUBSOIL DRAINS, CONNECTED TO EXISTING STORMWATER SYSTEMS.

PILES

F17. PILING CONTRACTOR TO ALLOW FOR INFORMATION IN GEOTECHNICAL INVESTIGATION REPORT AND FOR SITE CONDITIONS.

F18. INSPECTION MAY BE MADE OF THE FOLLOWING: SETTING OUT, PILES AND PILING MATERIAL AFTER DELIVERY TO THE SITE AND BEFORE INSTALLATION, INSTALLATION OF PILING, PILE HEADS AFTER PREPARATION, PILE LOAD TESTS, REINFORCEMENT CAGES AFTER ASSEMBLY AND BEFORE INSTALLATION, EXCAVATED SHAFTS, INCLUDING CASINGS AND SOCKETS BEFORE PLACING REINFORCEMENT, REINFORCEMENT IN EXCAVATED SHAFTS BEFORE CONCRETING AND CONCRETING OF PILES.

F19. ED PILE CONSTRUCTION TECHNIQUES MUST CONSIDER EXCAVATION STABILITY AND NEED FOR DEWATERING. WORK PROCEDURES REQUIRING SUBMERGED CONSTRUCTION TECHNIQUES UTILISING BENTONITE SLURRY OR TREMIE CONCRETE PLACEMENT MUST BE APPROVED BY AN INDEPENDENT QUALIFIED GEOTECHNICAL ENGINEER.

F20. EXCAVATE PILE SOCKETS TO ENSURE SURFACES ARE FREE OF DEBRIS, CRUSHED ROCK AND SMEARED MATERIAL. USE CLEANING BUCKETS AND SIDE CLEANING TOOLS SUITABLE FOR THE PILE DIAMETER.

F21. ENSURE SIDE WALLS OF PILE SOCKETS ARE FREE OF SOIL AND CRUSHED ROCK OVER AT LEAST 80% OF SIDE WALL AREA. SIDE WALL ROUGHNESS TO BE CLASS R2 (GROOVES OF DEPTH TO 4 mm, WIDTH GREATER THAN 2 mm, SPACING BETWEEN 50 AND 200 mm).

F22. ENSURE BASE OF PILE SOCKETS ARE FREE OF DEBRIS, SOFT MATERIAL etc. EXPOSE COMPETENT BEDROCK AND ENSURE MINIMUM EMBEDMENT DEPTH INTO MW TO FR GRANODIORITE/BASAL IS ACHIEVED. PREVENT LOOSE MATERIAL FALLING INTO HOLE.

F23. SOCKET INSPECTIONS TO BE UNDERTAKEN BY SUITABLY QUALIFIED INDEPENDENT GEOTECHNICAL ENGINEER TO VERIFY SOCKET IS FOUNDED WHOLLY WITHIN CLASS OF ROCK SPECIFIED, MATERIAL UNDERLYING SOCKET BASE IS EQUIVALENT OR BETTER THAN ASSUMED BY DESIGN, SOCKET DIMENSIONS ARE AS SPECIFIED, SIDE WALL AND BASE CLEANLINESS IS AS SPECIFIED.

F24. REINFORCEMENT CAGES TO EXTEND OVER FULL DEPTH OF BORED PILES UNO.

F25. PLACE CONCRETE IN BORED PILES AS SOON AS PRACTICABLE, AND WITHIN 24 HOURS OF EXCAVATION.

F26. PILE SOCKET LENGTH / DEPTH MEASURED FROM BASE OF EXCAVATION. NO OVER EXCAVATION OF SOCKETED PILES IS PERMITTED.

F27. WHERE PILE CUT-OFF LEVEL IS ABOVE ADJACENT GROUND, FORM PILE ABOVE GROUND LEVEL.

F28. PEG POSITION OF EACH PILE AND ESTABLISH GRID OF RECOVERY PEGS TO ENABLE SETTING OUT TO BE CHECKED.

F29. DO NOT FOUND PILES HIGHER THAN LEVELS SHOWN.

F30. IF DAMAGE IS CAUSED TO ADJOINING PROPERTY, STOP PILING OPERATIONS AND ADVISE PRINCIPAL.

F31. PILE SETTING OUT DIMENSIONS ARE TO CENTRELINE OF PILE AT UNDERSIDE OF PILECAP. TOLERANCE ON POSITION OF PILES ± 50 mm. MAXIMUM DEVIATION OF PILE FROM SPECIFIED INCLINATION 1 in 50.

F32. INSTALLATION RECORDS TO BE PREPARED DURING PILE DRILLING INCLUDING THE FOLLOWING INFORMATION: PILE DIAMTER, PILE START AND TERMINATION DEPTH/RL, GROUND PROFILE ALONG PILE DEPTH, PILE SOCKET, GROUNDWATER CONDITIONS, PILE SKIN ROUGHNESS AND BASE CLEANNESS.

PILING DELIVERABLES

F33. SURVEY AS CONSTRUCTED PILE POSITIONS, GROUND LEVEL AT TIME OF INSTALLATION AND CUT-OFF LEVELS, AND SUBMIT RECORDS WITHIN ONE WEEK OF COMPLETION OF PILING.

CONCRETE

CONCRETE MIX

C1. WORKMANSHIP AND MATERIALS TO COMPLY WITH AS3600, AS3610, AS1379, AS1478, AS3582, AS3799, AS2758.1, AS2159.

C2. WET CONCRETE TO BE UNIFORM, DENSE, HOMOGENEOUS, COHESIVE AND ABLE TO WORK READILY INTO CORNERS AND AROUND REINFORCEMENT COMPLETELY FILLING FORMWORK WITHOUT SEGREGATION OF AGGREGATES AND / OR FIBRES, EXCESS FREE WATER ON SURFACE, LOSS OF MATERIAL, CONTAMINATION OR OTHER VISIBLE DEFECTS.

C3. CONCRETE TO HAVE GOOD DIMENSIONAL STABILITY AND ABLE TO RESIST PLASTIC SETTLEMENT CRACKING, THERMAL CRACKING AND SHRINKAGE CRACKING.

C4. FINISHED CONCRETE TO BE A DURABLE, DENSE, HOMOGENEOUS MASS COMPLETELY FILLING FORMWORK, EMBEDDING FIBRES, REINFORCEMENT AND TENDONS, AND FREE OF STONE POCKETS OR HONEYCOMBS, OF UNIFORM COLOUR AND TEXTURE, WITH LOW PERMEABILITY AND ADEQUATE BUT NOT EXCESSIVE STRENGTH FOR GRADE.

C5. CONCRETE BLEED TO BE LESS THAN 3% FOR FLOOR AND ROOF SLABS, LESS THAN 2% FOR WALLS.

C6. AIR ENTRAINMENT IS NOT PERMITTED UNLESS APPROVED IN WRITING BY CONTRACTOR.

C7. REVIEW LOCATION OF EMBEDDED ITEMS TO MINIMISE POSSIBLE ZONES OF POOR COMPACTION THAT MAY COMPROMISE STRUCTURAL INTEGRITY.

C8. QUALITY OF CONCRETE ELEMENTS TO BE AS FOLLOWS:

STRUCTURAL ELEMENT	BLINDING	PILE & CAPPING BEAM	PRECAST PANELS
EXPOSURE CLASSIFICATION	A2	A2	A2
STRENGTH GRADE (MPa)	N7	N40	S40
MINIMUM DENSITY (kg/m^3):	-	2350	2350
MAX. AGGREGATE SIZE (mm):	-	20	20
MAXIMUM / PEAK INSITU CONCRETE TEMPERATURE		65 ºC	65 ºC
CEMENT TYPE:	GB	GP/GB	GP/GB
MINIMUM CEMENTITIOUS CONTENT (kg/m^3):	100	320	330
MAXIMUM WATER: CEMENTITIOUS RATIO	-	0.50	0.50
MAXIMUM 56 DAY DRYING SHRINKAGE (MICROSTRAIN)	-	1000	750

C9. SUPPLEMENTARY CEMENTITIOUS MATERIALS INCLUDE AMORPHOUS SILICA FUME, FLY ASH, AND GROUND GRANULATED BLAST FURNACE SLAG (GGBFS OR SLAG) COMPLYING WITH AS3582.

C10. RHEOLOGY, WORKABILITY AND SLUMP TO BE AS REQUIRED FOR PLACEMENT (eg PUMPING, SPRAYING, CHUTE etc), COMPACTION AND FINISHING. USE SUPERPLASTICISERS AND HIGH RANGE WATER REDUCERS TO AS1478 TO ACHIEVE ADEQUATE WORKABILITY.

C11. MAXIMUM ACID SOLUBLE CHLORIDE ION CONTENT OF CONCRETE IS 0.4 kg/m^3 UNLESS WRITTEN APPROVAL TO USE 0.8 kg/m^3 TO AS1379 CLAUSE 2.7.3. DO NOT USE STRONGLY IONISED SALTS, CHLORINE SALTS OR ADMIXTURES CONTAINING MORE THAN 0.1% BY WEIGHT ACID SOLUBLE CHLORIDE. DO NOT ADD SALTS TO CONCRETE UNLESS PROVEN THEY DO NOT ADVERSELY AFFECT DURABILITY.

C12. MAXIMUM SULPHATE CONTENT (ACID SOLUBLE SO_3) TO BE LESS THAN 5% BY MASS OF TOTAL CEMENTITIOUS MATERIAL.

C13. TOTAL REACTIVE ALKALI CONTENT IN CONCRETE TO BE LESS THAN 2.8 kg/m^3 Na_2O_e (EQUIVALENT).

C14. USE CEMENTITIOUS MATERIALS LESS THAN SIX MONTHS OLD. USE BAGGED CEMENT IN ORDER OF RECEIPT.

C15. C1. FOR GENERAL BLENDED CEMENT (GB) CONTAINING ORDINARY PORTLAND CEMENT PLUS AT LEAST 5% SUPPLEMENTARY CEMENTITIOUS MATERIALS:

- SILICA FUME TO BE LESS THAN 10%, OR
- FLYASH TO BE LESS THAN 25%, OR
- GROUND GRANULATED BLAST FURNACE SLAG TO BE LESS THAN 40%.

FOR DOUBLE BLENDED CEMENT TOTAL SUPPLEMENTARY CEMENTITIOUS MATERIAL MUST BE LESS THAN SMALLER OF PERCENTAGES GIVEN ABOVE FOR CONSTITUENTS INCLUDED. FOR TRIPLE BLENDED CEMENT TOTAL SUPPLEMENTARY CEMENTITIOUS MATERIAL MUST BE LESS THAN 40%. CEMENTS MAY BE BLENDED AT CEMENT PLANT OR CONCRETE BATCHING PLANT. OTHER COMBINATIONS OF CEMENTITIOUS CONTENT MAY BE SUBMITTED IN WRITING FOR APPROVAL.

C16. TEST FINE AND COARSE AGGREGATES FOR POTENTIAL AGGREGATE ALKALI REACTIVITY (AAR) USING CSIRO ACCELERATED MORTAR BAR TEST. ALTERNATIVELY USE ASTM C1293 CONCRETE PRISM TEST. PETROGRAPHIC TESTING CAN PROVIDE ADDITIONAL AGGREGATE AAR RISK INFORMATION. TESTS MUST USE SAME CEMENT TYPE AS PROPOSED IN THE WORKS.

C17. ADMIXTURES TO COMPLY WITH AS1478. ADMIXTURES MUST NOT REDUCE STRENGTH OF CONCRETE BELOW SPECIFIED VALUE IN SHORT OR LONG TERM. ADMIXTURES MUST NOT CONTAIN CALCIUM CHLORIDE USE ADMIXTURES IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS. CONCRETE ADMIXTURES SHALL NOT CAUSE OR ACCELERATE CORROSION OF REINFORCEMENT, NOR BE DETRIMENTAL TO CONCRETE OR STEEL DURING EXPECTED LIFE OF STRUCTURE. DO NOT USE CHEMICAL ADMIXTURES OR OTHER MATERIALS WITHOUT CONTRACTOR'S WRITTEN APPROVAL.

C18. DO NOT ADD WATER TO CONCRETE AFTER TRUCK HAS LEFT BATCHING PLANT.

C19. MIX CONCRETE TO ENSURE UNIFORM DISTRIBUTION OF CONSTITUENTS.

CONCRETE TESTING

C20. TEST SLUMP OF EACH BATCH OF CONCRETE DELIVERED BEFORE PLACING CONCRETE FROM THAT DELIVERY. SLUMP MEASURED TO BE NO GREATER THAN TARGET SLUMP WITHIN TOLERANCES GIVEN IN AS1379 CLAUSE 5.2.3. CONCRETE OUTSIDE SLUMP TOLERANCE LIMITS IS LIABLE TO REJECTION. PROVIDE RECORDS OF ALL SLUMP TESTS.

C21. REGISTER PROJECT FOR DISSEMINATION OF CONCRETE PRODUCTION ASSESSMENT INFORMATION. MANUFACTURER TO CARRY OUT PRODUCTION ASSESSMENT OF CONCRETE FOR COMPLIANCE WITH REQUIREMENTS OF AS1379.

C22. CARRY OUT PROJECT ASSESSMENT OF CONCRETE TO AS1379 CLAUSE 6.4 AND 6.5. TAKE SAMPLES AT PROJECT SITE AT POINT OF DISCHARGE FROM AGITATOR. SPREAD SAMPLING EVENLY THROUGH POUR. SAMPLE CONCRETE FOR PROJECT ASSESSMENT CONCURRENTLY WITH EACH SAMPLE TAKEN FOR PRODUCTION ASSESSMENT AT PROJECT SITE. FOR EACH CONCRETE DESIGN MIX TAKE ONE SAMPLE FROM EACH 25 m^3 OF CONCRETE DELIVERED PER DAY, NOT LESS THAN FIVE SAMPLES TOTAL FOR EACH MIX DESIGN. EACH SAMPLE TO COMPRISE THREE CYLINDERS: TEST ONE AT 7 DAYS AND TWO AT 28 DAYS.

C23. NOTIFY CONTRACTOR WITHIN 2 WORKING DAYS IF 7-DAY CONCRETE TEST RESULTS INDICATE 28 DAY STRENGTHS ARE LIKELY TO BE BELOW SPECIFIED STRENGTH.

C24. CARRY OUT DRYING SHRINKAGE TESTING TO AS1012.13. FOR EACH CONCRETE DESIGN MIX TAKE ONE SAMPLE EVERY THREE MONTHS, OR FOR EVERY 1000 m^3 OF CONCRETE PLACED, MINIMUM OF ONE SAMPLEEACH SAMPLE TO COMPRISE THREE SPECIMENS. SAMPLE CONCRETE AT PROJECT SITE, DIRECTLY FROM DELIVERY VEHICLE. BASE ASSESSMENT ON AVERAGE OF THREE TEST RESULTS.

C25. CONCRETE SAMPLING AND TESTING TO BE BY AN APPROVED INDEPENDENT NATA REGISTERED LABORATORY.

FORMWORK

C26. RESPONSIBILITY FOR DESIGN, CERTIFICATION, CONSTRUCTION AND PERFORMANCE OF FORMWORK AND FALSEWORK LIES WITH CONTRACTOR.

C27. FORMWORK TO BE DESIGNED BY A SUITABLY QUALIFIED CHARTERED ENGINEER REGISTERED WITH NATIONAL ENGINEERING REGISTER (NER) OF ENGINEERS AUSTRALIA TO AS3600 AND AS3610, AND INDEPENDENTLY CERTIFIED BY A CHARTERED ENGINEER EXPERIENCED IN FORMWORK DESIGN AND REGISTERED WITH NATIONAL ENGINEERING REGISTER (NER) OF ENGINEERS AUSTRALIA. PROVIDE COPY OF DESIGN CALCULATIONS AND CERTIFICATION TO CONTRACTOR. DESIGN FORMWORK TO ACCOMMODATE DIMENSIONAL CHANGES AND MOVEMENTS RESULTING FROM IMPOSED ACTIONS, CONCRETE SHRINKAGE AND CREEP, TEMPERATURE CHANGES, PRESTRESSING FORCES, etc.

C28. FORMWORK TO BE MORTAR-TIGHT AND HAVE SUFFICIENT RIGIDITY TO PREVENT DISTORTION OR WARPING UNDER PRESSURE OF WET CONCRETE AND OTHER CONSTRUCTION LOADS, PARTICULARLY AT EDGES AND JOINTS.

C29. FORMWORK TO BE FREE OF DEFECTS THAT MIGHT AFFECT FINISHED CONCRETE SURFACE OR INTEGRITY OF THE STRUCTURE.

C30. FORMWORK MUST BE ABLE TO BE REMOVED WITHOUT CRACKING, DAMAGING, HAMMERING OR JARRING THE CONCRETE.

C31. DO NOT SUPPORT OR RESTRAIN FORMWORK ON PERMANENT WORKS OR REINFORCEMENT WITHOUT CONTRACTOR'S WRITTEN APPROVAL.

C32. CONSTRUCT FORMWORK TO COMPLY WITH AS3610 AND CLAUSE 17.6 OF AS3600 WHERE THIS IS MORE STRINGENT SO CONCRETE WILL HAVE LEVELS, DIMENSIONS, CONTOURS, SHAPE, LOCATION AND FINISH SPECIFIED.

C33. PROVIDE OPENINGS OR REMOVABLE PANELS IN FORMWORK FOR INSPECTION AND CLEANING.

C34. APPLY RELEASE AGENT COMPATIBLE WITH CONTACT SURFACES TO INTERIOR OF FORMWORK (EXCEPT WHERE CONCRETE IS TO RECEIVE AN APPLIED FINISH OR COATING FOR WHICH THERE IS NO COMPATIBLE RELEASE AGENT). WHERE NECESSARY CLEAN REINFORCEMENT TO REMOVE TRACES OF RELEASE AGENT.

C35. SEAL JOINTS BETWEEN FORMWORK PANELS, AND TO HARDENED CONCRETE WITH A FLEXIBLE RUBBER STRIP. SET OUT FORMWORK TO GIVE A REGULAR ARRANGEMENT OF PANELS, JOINTS, BOLT HOLES AND SIMILAR VISIBLE ELEMENTS IN FORMED SURFACE.

C36. DO NOT USE FORMWORK HARDWARE THAT FORMS A COMPLETE HOLE THROUGH CONCRETE ELEMENTS. DO NOT USE REINFORCEMENT TO SUPPORT FORMWORK.

C37. PROVIDE HOLES IN REBATE FORMERS, etc, AS REQUIRED TO PREVENT AIR ENTRAPMENT.

C38. DO NOT STRIP FORMWORK PRIOR TO 36 HOURS AFTER PLACEMENT.

C39. DO NOT STRIP FORMWORK UNTIL CONCRETE HAS HARDENED SUFFICIENTLY TO WITHSTAND MOVEMENT AND FORM REMOVAL WITHOUT DAMAGE AND CONCRETE STRENGTH IS AT LEAST 75% OF SPECIFIED'¢. MINIMUM STRIPPING TIMES TO BE AS PER AS3610 TABLE 5.4.1.

C40. STRIP FORMWORK TO AS3600 CLAUSE 17.6.

C41. REMOVE FORM TIE BOLTS WITHOUT DAMAGING CONCRETE. PARTS OF BOLTS LEFT IN CONCRETE MUST NOT INTRUDE INTO COVER CONCRETE. FLUSH FILL HOLES USING APPROVED PROPRIETARY PRE-MIXED NON-SHRINK CEMENTITIOUS REPAIR MORTAR MATCHING CONCRETE SURFACE COLOUR, STRENGTH AND DURABILITY AND ADEQUATE BOND. SUBMIT DETAILS OF PROPOSED REPAIR METHODS TO CONTRACTOR FOR APPROVAL.

C42. CONSTRUCTION TOLERANCES TO BE TO AS3610.

PLACING CONCRETE

C43. FORMWORK, REINFORCEMENT AND COVER, DOWELS, WATERSTOPS, CAST-IN ITEMS etc TO BE INSPECTED AND APPROVED BY SUITABLY QUALIFIED STRUCTURAL ENGINEER / CONTRACTOR / BUILDING SURVEYOR BEFORE CONCRETE IS PLACED.

C44. REMOVE FREE WATER, DUST AND DEBRIS, STAINS etc FROM FORMS, EXCAVATIONS etc BEFORE PLACING CONCRETE. IN HOT CONDITIONS DAMPEN FORMWORK AND / OR SUB-GRADE BEFORE PLACING CONCRETE.

C45. PLACE CONCRETE IN LAYERS LESS THAN 300 mm THICK FOR FIRST LAYER AND 75% OF IMMERSION VIBRATOR LENGTH FOR SUBSEQUENT LAYERS, AND VIBRATE EACH LAYER BEFORE PLACING NEXT.

C46. ELAPSED TIME BETWEEN WETTING OF MIX AND DISCHARGE OF CONCRETE AT SITE MUST BE AS SHORT AS POSSIBLE, AND MUST NOT EXCEED LIMITS GIVEN WITHOUT PRIOR WRITTEN CONSENT.

CONCRETE TEMPERATURE AT TIME OF DISCHARGE (C)	MAXIMUM ELAPSED TIME (HOURS)
10 – 32	1.50
> 32	NOT ACCEPTABLE

C47. ELAPSED TIME LIMITS MAY BE VARIED IF TRIALS DEMONSTRATE USE OF SET RETARDERS (TYPE Re OR WRRe TO AS1478) PROVIDE ADEQUATE RETENTION OF WORKABILITY FOR LONGER PERIODS AT REQUIRED TEMPERATURE. SLUMP LIMITS STILL APPLY. RE-TEMPERING BEYOND MAXIMUM ALLOWED DISCHARGE TIME USING WATER OR ADMIXTURES IS NOT ALLOWED.

C48. USE PLACEMENT METHODS THAT WILL MINIMISE PLASTIC SETTLEMENT AND SHRINKAGE CRACKING. LIMIT VERTICAL FREE FALL BY USE OF CHUTES, etc. KEEP CHUTES VERTICAL, FULL AND IMMERSED IN CONCRETE. PLACE CONCRETE IN LAYERS AND BLEND SUCCEEDING LAYERS BY COMPACTION. MAINTAIN CONCRETE EDGE IN A PLASTIC STATE. PROPERLY COMPACT CONCRETE USING MECHANICAL VIBRATORS (AND HAND METHODS IF REQUIRED AND APPROVED BY CONTRACTOR) TO REMOVE AIR BUBBLES AND GIVE MAXIMUM COMPACTION WITHOUT SEGREGATION OF CONCRETE. TAKE CARE TO AVOID CONTACT BETWEEN VIBRATORS AND PARTIALLY HARDENED CONCRETE, FORMWORK OR REINFORCEMENT. DO NOT USE VIBRATORS TO MOVE CONCRETE ALONG FORMS.

C49. PROVIDE AT LEAST ONE WORKING VIBRATOR FOR EVERY 7.5 CUBIC METRES OF CONCRETE PLACED PER HOUR, TWO MINIMUM.

C50. DO NOT DISTURB CONCRETE ONCE INITIAL SET HAS OCCURRED.

C51. OBTAIN CONTRACTORS WRITTEN APPROVAL OF PLACEMENT METHODS FOR CONCRETE ELEMENTS GREATER THAN 1500 mm HEIGHT.

C52. KEEP ON SITE A LOGBOOK RECORDING EACH PLACEMENT OF CONCRETE INCLUDING DATE, CLIMATIC CONDITIONS, PORTION OF WORK, SPECIFIED GRADE AND SOURCE OF CONCRETE, DELIVERY DOCKET DATA, METHODS OF PLACEMENT AND COMPACTION, PROJECT ASSESSMENT CARRIED OUT, SLUMP MEASUREMENTS, VOLUME AND OTHER NOTABLE MATTERS THAT MAY AFFECT PERFORMANCE OF CONCRETE.

C53. IN COLD WEATHER MAINTAIN TEMPERATURE OF FRESHLY MIXED CONCRETE WITHIN LIMITS SHOWN BELOW."OUTDOOR" AIR TEMPERATURE IS AIR TEMPERATURE AT TIME OF MIXING OR PREDICTED OR LIKELY AIR TEMPERATURE DURING NEXT 48 HOURS. BEFORE AND WHILE PLACING CONCRETE MAINTAIN TEMPERATURE OF FORMWORK AND REINFORCEMENT AT > 5°C. DO NOT USE CALCIUM CHLORIDE TO ACCELERATE SETTING TIME. DO NOT USE SALTS, CHEMICALS OR OTHER MATERIAL IN MIX TO LOWER THE FREEZING POINT OF CONCRETE. DO NOT ALLOW FROZEN MATERIALS TO ENTER MIXER. EVALUATE THE NEED FOR INSULATION OF CONCRETE SURFACES. DO NOT USE HIGH ALUMINA CEMENT.

C54. KEEP FORMS, MATERIALS, EQUIPMENT IN CONTACT WITH CONCRETE FREE OF FROST AND ICE. HEAT CONCRETE MATERIALS (OTHER THAN CEMENT) TO MINIMUM TEMPERATURE NECESSARY TO ENSURE TEMPERATURE OF PLACED CONCRETE IS WITHIN LIMITS SPECIFIED. MAXIMUM WATER TEMPERATURE: 60°C WHEN PLACED IN MIXER.

OUTDOOR AIR TEMPERATURE	TEMPERATURE OF CONCRETE	
	MINIMUM	MINIMUM
> 5°C	10°C	32°C
< 5°C	18°C	32°C

C55. IN HOT WEATHERPREVENT PREMATURE STIFFENING OF FRESH CONCRETE; REDUCE WATER ABSORPTION AND EVAPORATION LOSSES. MIX, TRANSPORT, PLACE AND COMPACT CONCRETE AS QUICKLY AS POSSIBLE. DURING PLACEMENT TEMPERATURE OF CONCRETE MUST NOT EXCEED TEMPERATURES BELOW:

CONCRETE ELEMENT	TEMPERATURE LIMIT
UNREINFORCED CONCRETE IN SECTIONS≥ 1 METRE EACH DIMENSION,	27 ºC
CONCRETE f_c ≥ 40 MPA IN SECTIONS≥ 500 MM THICKNESS	27 ºC
CONCRETE IN FOOTINGS, BEAMS, COLUMNS, WALLS AND SLABS f_c ≤ 32 MPA	32 ºC
ELSEWHERE	32 ºC

DO NOT MIX CONCRETE WHEN SURROUNDING OUTDOOR SHADE TEMPERATURE ≥ 38°C. MAINTAIN TEMPERATURE OF FORMWORK AND REINFORCEMENT AT≤ 32°C BEFORE AND DURING PLACING. COOL REINFORCEMENT AND FORMWORK AS REQUIRED. MAINTAIN SPECIFIED TEMPERATURE OF PLACED CONCRETE BY:

- PLACING CONCRETE WHEN AMBIENT TEMPERATURE IS LOW (AT NIGHT)
- COOL CONCRETE USING LIQUID NITROGEN INJECTION BEFORE PLACING, OR
- COVER CONTAINER IN WHICH CONCRETE IS TRANSPORTED TO FORMS, OR
- SHADING AND SPRAYING COARSE AGGREGATE USING COLD WATER, OR
- USE CHILLED MIXING WATER.

C56. PROTECT FRESH CONCRETE FROM PREMATURE DRYING (PARTICULARLY IN HOT, WINDY OR DRY CONDITIONS), EXCESSIVELY HOT OR COLD TEMPERATURES, SUN, RAIN, FROST, SNOW etc. PROVIDE WIND BREAKS. MAINTAIN CONCRETE AT A REASONABLY CONSTANT TEMPERATURE WITH MINIMUM MOISTURE LOSS FOR CURING PERIOD.

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PLACING CONCRETE CONT.

C57. FOR CONCRETE WITH WATER:CEMENT RATIO LESS THAN 0.5, IN HOT, WINDY OR DRY (LOW HUMIDITY) CONDITIONS SPRAY EXPOSED SURFACES OF FRESH CONCRETE WITH FOG SPRAY APPLICATION OF ALIPHATIC ALCOHOL RETARDANT IMMEDIATELY AFTER PLACEMENT TO REDUCE RISK OF PLASTIC SHRINKAGE CRACKING. IN SEVERE CLIMATIC CONDITIONS CONSIDER RE-VIBRATING CONCRETE BEFORE IT REACHES INITIAL SET.

C58. COMMENCE CURING OF CONCRETE TO AS3600 AS SOON AS POSSIBLE AFTER PLACING AND FINISHING OR STRIPPING, AND WITHIN ONE HOUR. ENSURE EXPOSED SURFACES ARE NOT STAINED. ACCEPTABLE METHODS OF CURING INCLUDE:

- RETENTION OF FORMWORK
- PONDING OR CONTINUOUS SPRINKLING WITH WATER (MOIST CURING)
- AN IMPERMEABLE MEMBRANE (USE CLEAR, WHITE OR LIGHT-COLOURED PLASTIC IN HOT CONDITIONS) SEALED AROUND EDGES
- AN ABSORPTIVE COVER KEPT CONTINUOUSLY WET AND COVERED BY IMPERMEABLE MEMBRANE
- STEAM CURING
- AN APPROVED CURING COMPOUND MAINTAINED INTACT (RESPRAY ANY DAMAGED AREAS). PROVIDE:
  - WAX-BASED (CLASS A), RESIN-BASED (CLASS B), OR WATER-BORNE (CLASS Z) CURING COMPOUND TO AS3799
  - EFFICIENCY INDEX MINIMUM 90%
  - CERTIFIED TEST RESULTS FOR WATER RETENTION TO AS3799 APPENDIX B
  - EVIDENCE THAT AN ACCEPTABLE FINAL SURFACE COLOUR WILL BE OBTAINED
  - EVIDENCE OF COMPATIBILITY WITH CONCRETE AND APPLIED FINISHES (IF ANY)
  - METHODS OF OBTAINING REQUIRED ADHESION FOR TOPPINGS, RENDER etc.
  - UNIFORM CONTINUOUS FLEXIBLE COATING WITHOUT VISIBLE BREAKS OR PINHOLES, WHICH REMAINS UNBROKEN FOR AT LEAST THE CURING PERIOD AFTER APPLICATION.

C59. DO NOT USE WAX-BASED OR CHLORINATED RUBBER-BASED CURING COMPOUNDS ON CONSTRUCTION JOINTS, SURFACES FORMING SUBSTRATES TO APPLIED FINISHES, CONCRETE TOPPINGS AND CEMENT BASED RENDER.

C60. C1. CURE CONTINUOUSLY UNTIL NUMBER OF DAYS DURING WHICH AIR TEMPERATURE IS ABOVE 10°C TOTALS:

- 3 DAYS FOR EXPOSURES CLASSIFICATION A1 AND A2
- 7 DAYS FOR EXPOSURE CLASSIFICATION B1, B2 AND C
- 14 DAYS FOR MIXES CONTAINING GB CEMENT AND SUPPLEMENTARY CEMENTITIOUS MATERIALS.

C61. PREVENT RAPID DRYING OUT AT END OF CURING PERIOD.

C62. FINISH CONCRETE SURFACES TO AS3610 AND AS SHOWN BELOW:

- FORMED SURFACES:
  - EXPOSED SURFACES 3C
  - HIDDEN SURFACES 5
- FINISHES AS LAID:
  - EXPOSED SURFACES STEEL TROWEL UNO
  - HIDDEN SURFACES WOOD FLOAT

C63. STEEL TROWEL FINISH: AFTER MACHINE FLOATING, USE POWER TROWELS TO PRODUCE SMOOTH SURFACES FREE OF DEFECTS. WHEN SURFACE HAS HARDENED SUFFICIENTLY, USE STEEL HAND TROWELS TO PRODUCE FINAL CONSOLIDATED FINISH FREE OF TROWEL MARKS, OF UNIFORM IN TEXTURE AND APPEARANCE, MAXIMUM DEVIATION FROM 3 m STRAIGHT EDGE IS LESS THAN 3 mm.

REINFORCEMENT COVER

C64. COVER IS CLEAR DISTANCE BETWEEN ANY REINFORCEMENT (INCLUDING LIGATURES, TIE WIRE etc) AND OUTSIDE SURFACE OF STRUCTURAL CONCRETE.

C65. COVER MUST NOT BE LESS THAN SPECIFIED. PROVIDE MINIMUM CLEAR COVER TO REINFORCEMENT AS SHOWN BELOW, EXCEPT WHERE SPECIFIED OTHERWISE:

LOCATION	COVER (mm)
PILES	75
PRECAST PANELS	40
CAPPING BEAM	40

DELIVERABLES

C66. SUBMIT NAMES AND CONTACT DETAILS OF PROPOSED CONCRETE SUBCONTRACTORS.

C67. AT LEAST ONE WEEK PRIOR TO CONCRETE PLACEMENT SUBMIT DETAILS OF PROPOSED READY MIXED CONCRETE SUPPLIER, NAME OF CONCRETE DELIVERY SUPERVISOR, LOCATION OF BATCHING PLANT, CONCRETE MIX DESIGNS, METHOD OF CONCRETE TEMPERATURE CONTROL, MIXING, HANDLING, TRANSPORT, PUMPING, PLACEMENT, COMPACTION, FINISHING, PROTECTION AND CURING, SEQUENCE AND TIMES FOR CONCRETE POURS. NOMINATE FOR EACH MIX DESIGN THE SOURCE, TYPE AND PROPORTIONS OF CONSTITUENTS, AGGREGATE GRADINGS AND SATURATED SURFACE-DRY DENSITIES, ADDITIVES AND ADMIXTURES, DESIGN WATER CONTENT AND MAXIMUM WATER: CEMENT RATIO, TARGET SLUMP, TARGET CHARACTERISTIC STRENGTH (fc), BLEED PROPERTIES AND TARGET DRYING SHRINKAGE.

C68. PROVIDE DOCUMENTARY EVIDENCE OF PREVIOUS PERFORMANCE AND RELEVANT TEST RESULTS OF MIX DESIGN TARGETS, AND 3, 7 AND 28 DAY COMPRESSIVE STRENGTHS, BATCHED MIX CONTENTS VERSUS MIX DESIGN, MEASURED SLUMP, BLEED, AIR CONTENT, PLACEMENT TEMPERATURE AND ADIABATIC TEMPERATURE RISE, DRYING SHRINKAGE, LIMITS OF SOLUBLE SALTS, CHLORIDE AND SULPHATE CONTENTS, AND ALKALI AGGREGATE REACTIVITY OF FINE AND COARSE AGGREGATES etc, BEING CERTIFIED TEST RESULTS MADE ON AT LEAST TWO SEPARATE SAMPLES FROM A NATA REGISTERED LABORATORY EITHER:

- ON CONCRETE OF SAME MIX DESIGN (IN RESPECT OF ALL DETAILS TO BE NOMINATED ABOVE) OF SAME GRADE MADE UNDER PRODUCTION CONDITIONS IN SAME PLANT WITHIN LAST SIX MONTHS, OR
- ON TESTS FROM LABORATORY OR PLANT TRIALS OF PROPOSED MIX.

C69. USE READY MIXED CONCRETE MIXED BY BATCH PRODUCTION PROCESS DELIVERED IN AGITATING TRUCKS. FOR EACH BATCH SUPPLY A DOCKET LISTING INFORMATION REQUIRED BY AS1379 CLAUSE 1.7.3 AND FOLLOWING:

- SERIAL NUMBER OF IDENTIFICATION CERTIFICATES OF EACH BATCH
- TIME OF BATCHING
- NAME OF CONCRETE DELIVERY SUPERVISOR
- ELEMENT FOR WHICH CONCRETE WAS ORDERED AND WHERE IT WAS PLACED
- METHOD OF PLACEMENT AND CLIMATIC CONDITIONS DURING POUR
- PROJECT ASSESSMENT CARRIED OUT
- TOTAL AMOUNT OF WATER REQUIRED BY MIX DESIGN
- ADMIXTURES TYPE AND QUANTITY
- ADDITIVES TYPE AND QUANTITY
- TOTAL AMOUNT OF WATER ADDED AT PLANT
- TOTAL WATER ADDED AFTER LEAVING BATCHING PLANT
- TOTAL FREE WATER IN CONCRETE.

CONTRACTOR MAY NOT REQUIRE CONCRETE TRIAL MIX TESTS SUBJECT TO REVIEW OF PRODUCTION TEST RESULTS.

C70. SUBMIT DETAILS OF ALL PROPOSED CONCRETE COATINGS FOR REVIEW.

C71. PROVIDE RECORD OF SLUMP TESTING.

C72. FORWARD CONCRETE PRODUCTION ASSESSMENT INFORMATION TO AS PER AS1379 CLAUSE 6.4 WHEN PRODUCTION ASSESSMENT IS UNDERTAKEN. REFER CONCRETE TESTING NOTES.

C73. FORWARD CONCRETE PROJECT ASSESSMENT INFORMATION TO CONTRACTOR AS PER AS1379 CLAUSE 6.3 WHEN PROJECT ASSESSMENT IS UNDERTAKEN. REFER CONCRETE TESTING NOTES.

C74. REPORT DRYING SHRINKAGE TESTING RESULTS. REFER CONCRETE TESTING NOTES.

C75. PROVIDE CONCRETE TEST RESULTS PROMPTLY, WITHIN SEVEN DAYS OF TESTING.

REINFORCEMENT

R1. SYMBOLS ON DRAWINGS FOR GRADE AND TYPE OF REINFORCEMENT ARE AS FOLLOWS:

- R: STRUCTURAL GRADE 250 PLAIN ROUND BAR TO AS/NZS4671
- N: HOT ROLLED GRADE 500 DEFORMED (RIBBED) BAR DUCTILITY CLASS N TO AS/NZS4671.

R2. MANUFACTURERS AND PROCESSORS OF STEEL REINFORCING AND PRE-STRESSING MATERIALS MUST HOLD A VALID CERTIFICATE OF APPROVAL ISSUED BY ACRS (AUSTRALASIAN CERTIFICATION AUTHORITY FOR REINFORCING AND STRUCTURAL STEELS). PROVIDE ACRS CERTIFICATION OF COMPLIANCE WITH AS/NZS4671, PRODUCT TAGS AND SUPPORTING DOCUMENTATION FOR ALL REINFORCEMENT. PROVIDE CERTIFICATION OF COMPLIANCE WITH AS/NZS4672.1 FOR ALL PRESTRESSING TENDONS.

R3. PROVIDE DOCUMENTATION TO SHOW THAT REINFORCEMENT SUPPLIER AND MILL COMPLY WITH AS/NZS4671.

R4. REINFORCEMENT MUST HAVE UNIQUE MARKS TO IDENTIFY SUPPLIER.

R5. DO NOT USE LOW DUCTILITY REINFORCEMENT (GRADE L) UNO.

R6. REINFORCEMENT TO BE CLEAN, FREE OF LOOSE MILL SCALE, RUST, OIL, GREASE, MUD OR OTHER MATERIAL THAT MIGHT REDUCE BOND BETWEEN REINFORCEMENT AND CONCRETE.

R7. SUBMIT PROPOSAL FOR CUTTING OR DISPLACING REINFORCEMENT. CLEAN AND PROTECT EXPOSED CUT ENDS OF REINFORCEMENT USING 6 mm APPROVED EPOXY. REFER TO CONCRETE REPAIR NOTES FOR TREATMENT OF NEWLY EXPOSED CONCRETE AND REINFORCEMENT SURFACES AT NEW PENETRATIONS OR AREAS OF DEMOLITION.

R8. DESIGNATION OF REINFORCEMENT BARS IS AS SHOWN:
eg 17 N20 - 350 EF

- 17: DENOTES No OF BARS AND TYPE IN GROUP
- N: DENOTES BAR GRADE AND DUCTILITY CLASS
- 20: DENOTES NOMINAL BAR DIAMETER IN mm
- 350: DENOTES SPACING IN mm
- EF: DENOTES LOCATION

R9. PROVIDE STANDARD COGS AND HOOKS TO AS3600. TERMINATE ENDS OF COLUMN AND BEAM LIGATURES IN A HOOK OF AT LEAST 135 DEGREES. PROVIDE FIRST LIGATURE WITHIN 50 mm OF FACE OF SUPPORT.

R10. PROVIDE ONE CONTINUOUS BAR PARALLEL TO (WITHIN 75 mm OF) CONCRETE EDGES.

R11. REINFORCEMENT IS REPRESENTED DIAGRAMMATICALLY AND IS NOT NECESSARILY IN TRUE PROJECTION. SET REINFORCEMENT OUT AT EQUAL CENTRES IF SPACING IS NOT NOMINATED. PLACE PARALLEL BARS IN THE SAME LAYER UNO.

R12. CAP STARTER BARS AND OTHER REINFORCEMENT TO REDUCE RISK OF IMPALEMENT AND LACERATIONS.

R13. ENSURE ALL LAID REINFORCING BARS ARE RESTRAINED BEFORE STOPPING WORK TO PREVENT BARS ROLLING UNDERFOOT.

R14. REINFORCEMENT TO BE SUPPLIED TO SITE PRE-BENT TO REQUIRED SHAPES.

R15. SECURE REINFORCEMENT IN POSITION AGAINST DISPLACEMENT AND MAINTAIN SPECIFIED CLEAR CONCRETE COVER TO REINFORCEMENT (INCLUDING FITMENTS) BY APPROVED CHAIRS, SPACERS, LIGATURES OR TIES AT 800 mm MAXIMUM CENTRES EACH WAY UNO. PROVIDE ADEQUATE SUPPORT TO PREVENT DISPLACEMENT OF REINFORCEMENT BY WORKMEN OR EQUIPMENT DURING CONCRETE PLACEMENT.

R16. SECURELY TIE REINFORCEMENT WITH WIRE TIES. TURN ENDS OF TIE WIRES INTO CONCRETE, CLEAR OF COVER ZONE.

R17. DO NOT PLACE OR MOVE REINFORCEMENT DURING OR AFTER CONCRETE PLACEMENT.

R18. ENSURE EMBEDDED ITEMS (INSERTS, THREADED SOCKETS, FERRULES, BOLTS, DISSIMILAR METAL ITEMS, etc) IN COVER CONCRETE OR EXPOSED TO AIR ARE NOT IN CONTACT WITH REINFORCEMENT. PROVIDE ISOLATION BETWEEN DISSIMILAR METALS, AND BETWEEN REINFORCEMENT AND EXPOSED ITEMS.

R19. OBTAIN APPROVAL OF INSERTS, FIXINGS AND OTHER ITEMS EMBEDDED IN COVER CONCRETE.

R20. SPLICE REINFORCEMENT ONLY AT LOCATIONS SHOWN ON DRAWINGS OR AS APPROVED BY CONTRACTOR.STAGGER LAPS WHERE POSSIBLE.LAPPED SPLICE LENGTHS TO COMPLY WITH AS3600.CLEAR SPACING BETWEEN LAPPED BARS TO BE LESS THAN THREE TIMES BAR DIAMETER. WHERE BAR SIZES VARY USE LAPPED SPLICE LENGTH FOR SMALLER BAR DIAMETER.

R21. LAPPED SPLICE LENGTHS FOR BARS SPACED A≥ 150 mm CENTRES TO COMPLY WITH THE FOLLOWING UNO:

COVER	f'c	N12	N16	N20	N24	N28	N32
≥ 25	≥ 20	590	890	1210	-	-	-
≥ 30	≥ 25	490	750	1040	1340	-	-
≥ 40	≥ 32	390	600	840	1110	1400	1710
≥ 50	≥ 40	350	480	690	920	1180	1450

DO NOT INTERPOLATE INTERMEDIATE VALUES OF SPLICE LENGTHS.
EPOXY COATED BARS, BARS IN LIGHTWEIGHT CONCRETE AND SLIP FORMED CONCRETE WILL REQUIRE LONGER SPLICE LENGTHS. REFER TO AS3600 OR CONTRACTOR.

R22. DO NOT WELD REINFORCEMENT, CAST-IN ITEMS etc UNLESS SHOWN ON DRAWINGS OR OTHERWISE APPROVED.

R23. DO NOT BEND OR STRAIN REINFORCEMENT IN A WAY THAT MAY CAUSE DAMAGE. BEND DIAMETERS TO BE TO AS3600. BARS TO BE BENT COLD UNO. GRADE 250 BARS MAY BE BENT AT TEMPERATURES UP TO 850°C. DO NOT COOL HEATED BARS BY QUENCHING.

R24. DO NOT CUT, BEND NOR HEAT REINFORCEMENT ON SITE WITHOUT CONTRACTORS PRIOR WRITTEN APPROVAL.

R25. ENSURE HOT BENDING OF REINFORCEMENT COMPLIES WITH AS3600 CLAUSE 17.2.3.1. DO NOT HEAT D500N REINFORCEMENT. USE TEMPERATURE INDICATOR PAINTS AND / OR CRAYONS TO ENSURE REINFORCEMENT TEMPERATURE DOES NOT EXCEED MANUFACTURERS RECOMMENDED LIMITS, 450 DEGREES MAXIMUM. REINFORCEMENT THAT CHANGED COLOUR DURING HEATING MUST BE DISCARDED.

R26. DO NOT BEND REINFORCEMENT AFTER GALVANIZING OR APPLICATION OF OTHER COATINGS.

R27. PERCUSSION ROTARY DRILL HOLES FOR GROUTED BARS AND THREADED RODS (NOTE: CORED HOLES MUST BE ROUGHENED). HOLE DIAMETER AND INSTALLATION TO BE IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS. EMBEDMENT LENGTHS AS PER DRAWINGS.

R28. ENSURE HOLES FOR GROUTED BARS AND THREADED RODS ARE DRY AND CLEANED THOROUGHLY BEFORE INSTALLING ANCHORS. WIRE BRUSH HOLES AND BLOW OUT WITH COMPRESSED AIR TO REMOVE DUST. FILL HOLE WITH ADHESIVE USING A CAULKING GUN FROM BOTTOM OF HOLE OUTWARDS. DISCARD ADHESIVE FROM FIRST TRIGGER PULL. PROVIDE BARS / THREADED RODS WITH CHAMFERED (CHISELLED) ENDS. BARS TO BE DEGREASED, AND FLAKY RUST REMOVED. ROTATE WHILE INSERTING TO ENSURE FULLY COATED AND PUSH FULLY INTO HOLE. PROTECT FROM DISTURBANCE DURING CURING. FOLLOW MANUFACTURERS RECOMMENDATIONS.

R29. USE RAMSET CHEMSET REO502 / EPCON C8 XTREME ADHESIVE IN ACCORDANCE MANUFACTURERS RECOMMENDATIONS UNO.

PRECAST CONCRETE

W1. COMPLY WITH REQUIREMENTS OF AS3850 PREFABRICATED CONCRETE ELEMENTS CODE, NATIONAL CONSTRUCTION CODE (NCC), CONCRETE NOTES AND SPECIFICATION.

W2. PRECAST CONCRETE UNITS HAVE BEEN DESIGNED FOR INSTALLED CONDITIONS ONLY.

W3. PRECAST UNITS AND CONNECTIONS HAVE NOT BEEN DESIGNED FOR VEHICLE IMPACT.

W4. PRECAST UNITS TO BE SUPPLIED BY A SPECIALIST SUB-CONTRACTOR.

W5. SUPPLIER TO DESIGN PRECAST CONCRETE UNITS, PROPS, CONNECTIONS, FIXING DETAILS AND JOINTS etc TO PROVIDE SATISFACTORY PERFORMANCE FOR STABILITY, FIRE RESISTANCE (WHERE REQUIRED AS NOTED IN DRAWINGS), SERVICEABILITY AND STRENGTH REQUIREMENTS DURING MANUFACTURE, STRIPPING, HANDLING, LIFTING, STACKING, TRANSPORT, ERECTION AND INSTALLATION OPERATIONS. PROVIDE TEMPORARY PROPPING AND ADDITIONAL REINFORCEMENT AS REQUIRED.

W6. USE FORMWORK BOND BREAKERS AND STRONG BACKS AS REQUIRED.

W7. DO NOT USE VENEERED CONSTRUCTION UNO.

W8. DO NOT APPLY ACID TREATMENTS TO PRECAST CONCRETE SURFACES UNO.

W9. LOCATE CONNECTIONS TO FACILITATE CONCRETE PLACEMENT, EASE OF ACCESS DURING INSTALLATION AND FINAL AESTHETICS.

W10. NOT USE REBARS OR STRESSING TENDONS AS LIFTING LOOPS. DO NOT USE FIXINGS FOR LIFTING. USE PROPRIETARY LIFTING INSERTS WITH PUBLISHED LOAD RATINGS. LIFT OR SUPPORT PRECAST UNITS ONLY AT SPECIFIED POINTS. LOCATE LIFTING POINTS TO SUIT CENTRE OF GRAVITY OF UNIT.

W11. PROVIDE THIN-WALLED GALVANIZED GROUT TUBES FOR TIE BARS AS SHOWN ON DRAWINGS.

W12. SUBMIT NAME, CONTACT DETAILS AND CREDENTIALS OF PROPOSED MANUFACTURER OF PRECAST UNITS.

W13. PROVIDE TEMPORARY BRACING TO AS3850 AND AS/NZS1170.2 AS REQUIRED TO ENSURE STABILITY DURING CONSTRUCTION.

W14. DO NOT PLACE LIFTING ATTACHMENTS, HOLES OR OTHER TEMPORARY FIXINGS etc ON VISIBLE FACES OF UNITS.

W15. ENSURE THAT PRECAST UNITS REMAIN UNCRACKED AND UNDAMAGED DURING MANUFACTURE, HANDLING, ERECTION AND INSTALLATION OPERATIONS. PROVIDE PROTECTION TO AVOID CRUSHING AND / OR CHAFING. PROTECT UNITS FROM STAINING, DISCOLOURATION AND OTHER DAMAGE.

W16. HOT DIP GALVANIZE CAST IN STEELWORK INCLUDING LIFTING INSERTS, FERRULES, DOWEL BARS, ANGLE CLEATS, BOLTS, NUTS WASHERS AND PACKERS etc. MINIMUM GALVANIZED COATING THICKNESS 600 g/m

W17. USE RIGID FORMWORK AND INTENSE COMPACTION, SUCH AS VIBRATING TABLES OR FORM VIBRATORS, TO AS3600.

W18. PRECAST UNIT TOLERANCES TO BE TO AS3600 EXCEPT WHERE VARIED BY SPECIFICATION.

W19. CAST UNITS WITH OUTER FACE OFF FORM.

W20. FINISH SURFACE OF PRECAST UNITS IN ACCORDANCE WITH SPECIFICATION.

W21. PROVIDE 15 mm x 45 DEGREES CHAMFERS OR FILLETS AT EDGES AND CORNERS OF PRECAST UNITS.

W22. EACH UNIT TO HAVE LEGIBLE MARKING (HIDDEN IN COMPLETED STRUCTURE) INCLUDING UNIT THICKNESS, REINFORCING SIZES AND SPACING, NUMBER OF STRANDS AND STRAND DIAMETER, CONCRETE COVER, DATE OF CASTING, CORRECT ORIENTATION OF UNIT AND WEIGHT, POSITION FOR TEMPORARY BEARING DURING STORAGE etc.

W23. SET ASIDE DAMAGED UNITS (CRACKED, SPALLED, INADEQUATE COVER) FOR INSPECTION BY CONTRACTOR. REPAIR OR RE-CAST AS INSTRUCTED.

W24. ALLOW FOR DEPARTMENT OF LABOUR OR OTHER REQUIREMENTS GOVERNING HANDLING, LIFTING, ROTATION OR TRANSPORT OF PRECAST UNITS.

W25. WHERE PRECAST UNITS ARE TO BE SUPPORTED BY CONCRETE MEMBERS, DO NOT ERECT UNITS UNTIL 28 DAY STRENGTH HAS BEEN ACHIEVED.

W26. USE 20 mm THICK HIGH-STRENGTH PVC OR FIBROUS CEMENT SHEET LEVELLING PADS x 150 mm LONG (MIN) AND PLACE CENTRAL UNDER WALL PANEL AND 300 mm FROM ENDS OF PRECAST UNITS. CHECK WITH SUITABLY QUALIFIED STRUCTURAL ENGINEER BEFORE USING ADDITIONAL SUPPORT POINTS. USE TWO LEVELLING PADS FOR EACH UNIT. DO NOT USE STEEL LEVELLING PADS. USE PACKERS OF SUITABLE THICKNESS SUCH THAT NOT MORE THAN THREE PACKERS ARE REQUIRED. PACKERS CAN REMAIN IN PLACE IF PROVIDED WITH 50 mm GROUT COVER UNO.

W27. PROVIDE COMPONENTS, MATERIALS, FASTENERS, BRACES, STRONGBACKS, SHIMS, JOINTING STRIPS, SEALANTS, FLASHING, GROUT AND MORTAR, BEARING PADS AND STRIPS, TIES, DOWELS, CLIPS, FIXINGS etc AS REQUIRED.

W28. RECESS LIFTING INSERTS, REMOVE TEMPORARY ATTACHMENTS AFTER ERECTION, MAKE GOOD AND SEAL.

W29. SEAL GAPS BEFORE GROUTING. USE NON-SHRINK NON-STAINING GROUT WITH 28 DAY CHARACTERISTIC STRENGTH OF 40 MPa. SUBMIT DETAILS FOR APPROVAL.

W30. JOINTS BETWEEN UNITS TO BE AS SPECIFIED ON DRAWINGS. TOLERANCE ON WIDTH +5, -0 mm. PROVIDE JOINTS IN WALL FINISHES AT JOINTS BETWEEN UNITS UNO. PLACE POLYSTYRENE IN JOINTS DURING CONSTRUCTION TO ENSURE HARD MATERIALS AND OTHER DEBRIS DOES NOT FALL INTO OR REMAIN IN JOINTS. REMOVE POLYSTYRENE PRIOR TO FILLING JOINTS, OR AT COMPLETION. MAINTAIN JOINTS FOR UNIFORM PLACEMENT OF SEALANTS.

W31. PROTECT, CLEAN AND MAINTAIN PERMANENT BEARINGS DURING CONSTRUCTION.

DELIVERABLES

W32. SUBMIT SHOP DRAWINGS AND DESIGN CALCULATIONS (PREPARED BY A SUITABLY QUALIFIED CHARTERED ENGINEER REGISTERED WITH NATIONAL ENGINEERING REGISTER (NER) OF ENGINEERS AUSTRALIA); REFER GENERAL DELIVERABLES NOTES. DRAWINGS TO SHOW PROPOSED DETAILS FOR DESIGN, MANUFACTURE, ASSEMBLY, TRANSPORT AND INSTALLATION OF PRECAST CONCRETE ELEMENTS, INCLUDING FOLLOWING: INFORMATION SPECIFIED IN AS3850.2 CLAUSE 2.10 AND APPENDIX A, PROJECT TITLE AND MANUFACTURERS NAME, MARKING PLANS AND ELEVATIONS WITH BUILDING GRID AND FLOORS LOCATING EACH UNIT, SHAPE AND PROFILE DRAWINGS INCLUDING WEIGHT OF UNITS, REINFORCEMENT DETAILS INCLUDING LOCATIONS, SIZES, MATERIALS, DUCTILITY AND STRESS GRADES, CAST IN ITEMS INCLUDING LOCATIONS, SIZES, DETAILS, MATERIALS, CORROSION PROTECTION AND GRADE OF FERRULES, PLATES, CUT-OUTS AND OPENINGS, ANCHORS, LIFTING DEVICES, PLUGS FOR SEALING RECESSES etc, CAULKING, MASTICS, BAFFLES, EQUIPMENT AND METHODS OF HANDLING. LIFTING, TRANSPORT INCLUDING LOCATION OF LIFTING POINTS, MAXIMUM LOADS ON LIFTING AND BRACING POINTS, EVIDENCE OF LOAD CAPACITY OF LIFTING AND BRACING INSERTS AND ATTACHMENTS IN FORM OF TEST REPORTS OR CALCULATIONS, CONCRETE MIX DESIGN, FORMWORK TYPE, SURFACE FINISH CLASS AND SURFACE TREATMENT, CURING AND PROTECTION METHODS, IDENTIFICATION MARKS, EQUIPMENT AND METHODS FOR HANDLING, TRANSPORT AND INSTALLATION, ERECTION AND INSTALLATION CONDITIONS.

W33. SUBMIT DETAILS OF PROPOSED METHODS TO ACHIEVE SELECTED COLOUR INCLUDING TYPE AND COLOUR OF CEMENT, SAND, AGGREGATES AND COLOURING OXIDE PIGMENTS AND STAINS.

W34. SUBMIT SAFE WORK METHOD STATEMENT SPECIFIC TO PROJECT FOR MANUFACTURE AND INSTALLATION OF UNITS. CARRY OUT WORK ONLY UNDER WIND AND TEMPERATURE CONDITIONS CONSISTENT WITH SAFE WORK METHOD STATEMENT AND STRUCTURAL CAPABILITY OF UNIT.

Rev	Description	Checked	Approved	Date
C	REVISED 100% DETAILED DESIGN	HA/MN/DB	DD	09.08.2022
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Project No. 12554564

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Project DR GEORGE MOUNTAIN ROAD EMBANKMENT STABILISATION

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Size A3

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ROAD GEOMETRY CONSTRAINTS AND GUARDRAIL POSTS

D1. THE GHD SCOPE OF WORK DESIGN IS LIMITED TO PROVISION OF DETAILED DRAWINGS FOR THE GEOTECHNICAL AND STRUCTURAL ELEMENTS IN THE PILED WALL SCHEME (INCLUDING SUBSOIL DRAINAGE). THE DESIGN DOES NOT INCLUDE EARTHWORKS AND ANY DESIGN ELEMENTS THAT WILL CHANGE THE ROAD GEOMETRY (INCLUDING EDGE OF BITUMEN).

D2. NOTE GUARDRAIL POST DESIGN TO BE DONE BY OTHERS.

D3. THE MAXIMUM DYNAMIC DEFLECTION ALLOWANCE OF 1.10 m PROVIDED IN THE DESIGN SHOULD BE MAINTAINED BETWEEN THE GUARDRAIL POST AND EDGE OF SLOPE/EDGE OF CAPPING BEAM. THIS IS EQUIVALENT TO THE MAXIMUM DYNAMIC DEFLECTION ALLOWED USING THRIEBEAM GUARDRAIL.

D4. GUARDRAIL DESIGNER TO SELECT APPROPRIATE GUARDRAIL PRODUCT THAT HAS A MAXIMUM DYNAMIC DEFLECTION LESS THAN OR EQUAL TO 1.10 m.

D5. GUARDRAIL POST DESIGNER (OTHERS) TO FINALISE THE GUARDRAIL ALIGNMENT.

DRAINAGE

D1. SETTING OUT DIMENSIONS SHOWN ON THE DRAWINGS MUST BE CONFIRMED BY THE PRINCIPAL ON SITE BEFORE CONSTRUCTION AND FABRICATION IS COMMENCED.

D2. PIPE INSTALLATION IS TO USE A TYPE HS3 SUPPORT AS PER TfNSW MODEL DRG R0240-01 U.N.O. IN CASES WHERE THE TRENCH CONDITION IS SATURATED THEN ALTERNATIVE BACKFILL MATERIAL TO BE PROPOSED FOR APPROVAL BY THE PRINCIPAL THAT ADHERE TO TfNSW TECHNICAL DIRECTION 2011 QUALITY ALERT No.8 - BACKFILL OF CULVERT IN WET CONDITIONS.

D3. REFER TO TfNSW STANDARD DRAWING 'STORMWATER DRAINAGE SERIES' FOR RELEVANT PIT DETAIL REFERENCED ON THE DRAWINGS. EXISTING STORMWATER DRAINAGE PIPES AND MANHOLES WITHIN THE LIMITS OF WORK MUST BE REMOVED OR MODIFIED AS SPECIFIED. ANY EXPOSED REINFORCEMENT TO BE PROTECTED IN ACCORDANCE WITH R53 REQUIREMENTS.

D4. ALL REINFORCEMENT MUST BE IN ACCORDANCE WITH AUSTRALIAN STANDARD 4671 GRADE D500L (FITMENT) AND D500N (TYPICAL).

D5. ALL GALVANISING TO BE IN ACCORDANCE WITH AUSTRALIAN STANDARD 2312 AND 4680. GALVANISING TO THE THREADED FASTENERS TO BE IN ACCORDANCE WITH THE AUSTRALIAN STANDARD 1214. MINIMUM GALVANISING 600g/sqm OTHER THAN ON FASTENERS.

D6. EQUIVALENT PRECAST HEADWALLS/PITS SUBJECT TO PRINCIPAL'S APPROVAL.

D7. ALL DRAINAGE PIPES MUST BE MINIMUM CLASS 4 REINFORCED CONCRETE PIPE CULVERT U.N.O. (REFER TO LONGITUDINAL SECTIONS). ALL DRAINAGE MUST BE RUBBER RING JOINTED AND INSTALLED IN ACCORDANCE WITH AS 3725 AND TfNSW QA SPECIFICATION R11 WITH TYPE HS3 SUPPORT.

D8. GEOTEXTILES TO CONFORM WITH TfNSW QA SPECIFICATION R63

D9. UNLESS NOTED OTHERWISE, ASSUMED FOUNDING MATERIAL IS STIFF CLAY OR BETTER. COHESIVE FOUNDING MATERIAL WITH AN UNDRAINED SHEAR STRENGTH OF LESS THAN 50kPa TO BE TREATED AS TfNSW QA SPECIFICATION R11 INADEQUATE FOUNDATION MATERIAL.

D10. CONNECTION BETWEEN PIPES AND STORMWATER PITS TO BE UNDERTAKEN IN ACCORDANCE WITH TfNSW QA SPECIFICATION R11. WHERE PRECAST PITS OR HEADWALLS ARE USED WITH AGREEMENT OF THE PRINCIPAL THE CONNECTION DETAILS MUST COMPLY WITH TfNSW QA SPECIFICATION B115. CONCRETE USED MUST COMPLY WITH TfNSW QA SPECIFICATION R53.

D11. INADEQUATE FOUNDATION MATERIAL FOR PIPES AND STRUCTURES MUST BE REMOVED OR IMPROVED IN ACCORDANCE WITH TfNSW QA SPECIFICATION R11.

D12. STEEL GRATES AND FRAMES ARE TO BE FABRICATED FROM MILD STEEL AND HOT DIP GALVANISED. ALL GRATES ARE TO BE CLASS D (U.N.O.). IN ACCORDANCE WITH AS 3996 U.N.O.

D13. THE LOCATION AND LEVEL OF ALL SERVICES CROSSING NEW STORMWATER LINES MUST BE OBTAINED BY YOU PRIOR TO CONSTRUCTION. ALL LEVELS MUST BE CHECKED BY YOU FOR CONFLICT WITH ANY SERVICES AND ANY CONFLICTS TO BE RESOLVED.

D14. THE GRADATION OF ROCK USED FOR RIP RAP MUST BE:

ROCK GRADATION
D50 = VARIES
D15 = 0.75 D50
D85 = 1.5 D50
D100 = 2.0 D50

D15. ACTUAL D50 MUST BE WITHIN 10% OF THE SPECIFIED NOMINAL DIAMETER. D85/D15 MUST FALL BETWEEN THE RANGE OF 1.5 MIN AND 2.5 MAX.

D16. RIP RAP MUST BE PLACED IN A MANNER THAT PREVENTS DAMAGE TO THE GEOTEXTILE.

D17. ROCK FILLED GABIONS AND MATTRESSES ARE TO BE SUPPLIED AND INSTALLED IN ACCORDANCE WITH TfNSW QA SPECIFICATION R55.

D18. ALL EXPOSED BATTER FACES AND DIVERSION DRAINS WILL REQUIRE STABILISATION WITH BIODEGRADABLE ORGANIC FIBRE MESH, HYDRO SEEDING AND ANIONIC BITUMEN EMULSION SPRAY AT A RATE OF 3 L/m2.

D19. USE WOVEN POLYPROPYLENE AND COTTON/GEOTEXTILE THREAD WITH A FLOW RATE OF 15 L/s/m2 TO AUSTRALIAN STANDARD AS 3706.9 AS THE FABRIC WHEN INSTALLING SEDIMENT FENCES.

D20. ALL BARRIER FENCES (PARAWEBBING) ARE TO BE INSTALLED BY CONTRACTOR TO AVOID SOIL DISTURBANCE OUTSIDE THE CONSTRUCTION AREA.

GABION

D21. GABION STRUCTURE IS NOT DESIGNED TO ACCOMMODATE ANY LOADS FROM THE PILED RETAINING WALL.

D22. GABIONS ARE TO BE INSTALLED AND CONSTRUCTED IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS AND SPECIFICATIONS COMPLYING WITH RMS SPECIFICATION R55.

D23. THE GABION FILL SHALL BE DENSE, HARD, DURABLE, CLEAN ROCK AND IN ACCORDANCE WITH AS 2758.4 - 2017. THE MINIMUM ROCK SIZE SHALL BE 100mm AND THE MAXIMUM ROCK SIZE SHALL BE 250mm.

D24. SEPARATOR GEOTEXTILE TO BE PLACED AT ALL MESH/SOIL/ROCK INTERFACE U.N.O. THE GEOTEXTILE MUST BE NON-WOVEN TYPE, MEETING THE REQUIREMENTS OF GEOTEXTILE STRENGTH CLASS C AND FILTRATION CLASS 2 IN ACCORDANCE WITH RMS SPECIFICATION R63.

D25. ALL WIRE SHALL MEET THE REQUIREMENTS OF ASTM B750-99.

GABION CONSTRUCTION SEQUENCE

THE FOLLOWING CONSTRUCTION SEQUENCE HAS BEEN TYPICALLY CONSIDERED FOR THE GABION WALL:

D26. STRIP THE TOPSOIL, FILL, AND LOOSE / WEATHERED MATERIAL TO REACH FOUNDING DEPTH EXPECTED TO BE RESIDUAL SOIL OR BEDROCK.

D27. PREPARE FOUNDATION IN ACCORDANCE WITH MANUFACTURER'S REQUIREMENTS AND STANDARD REQUIREMENTS. ALLOW FOR 100MM GAP BETWEEN GABIONS AND THE PILED WALL TO PREVENT THE RETAINING WALL IMPOSING ANY LATERAL EFFECTS ON GABIONS.

D28. THE DESIGNER'S SITE GEOTECHNICAL REPRESENTATIVE TO VERIFY FOUNDATION CONDITIONS AND RECOMMEND ANY GROUND TREATMENT WHERE REQUIRED.

D29. GEOTEXTILE SHALL BE PLACED ON PREPARED FOUNDATION PRIOR TO INSTALLATION OF GABION UNITS. A 100MM LAYER OF CONCRETE BLINDING IS PROPOSED TO BE POURED ON THE PREPARED FOUNDATION TO PROVIDE A FLAT SURFACE FOR GABIONS.

D30. INSTALL GABION UNITS IN ACCORDANCE WITH MANUFACTURER'S INSTALLATION INSTRUCTIONS AND STANDARD REQUIREMENTS.

D31. PLACE FILL BETWEEN GABIONS AND OVER EXCAVATED SIDE WALLS.

GABION GEOTECHNICAL NOTES:

D32. DURING CONSTRUCTION OF THE GABION WALL, THE FOUNDATION ASSUMPTIONS SHALL BE VALIDATED AND RECORDED ON SITE BY A COMPETENT GEOTECHNICAL ENGINEER.

D33. THE CONTRACTOR SHALL ENSURE THAT ANY NECESSARY FOUNDATION TREATMENT HAS BEEN COMPLETED AS PER SITE GEOTECHNICAL ENGINEER ADVICE PRIOR TO COMMENCEMENT OF GABION WALL CONSTRUCTION.

D34. THE INFERRED STRENGTH OF THE FOUNDING MATERIAL IS ACCORDING TO THE TABLE BELOW. ALLOWABLE BEARING CAPACITIES ARE BASED ON 2m X 2m GABION AREA.

DESCRIPTION	UNIT WEIGHT (KN/m^3)	FRICITION ANGLE (DEG)	COHESION (EFFECTIVE) (KPa)	ALLOWABLE BEARING CAPACITY (KPa)
RESIDUAL GRAVELLY SAND	20	35	2	200
XW TO HW GRANODIORITE OR BETTER	22	30	5	>500

D35. WHERE THERE HAS BEEN A DELAY OF MORE THAN 24 HOURS BETWEEN FOUNDATION PREPARATION AND INSTALLATION OF THE GABION BASKETS OR WHEN THE GABION FOUNDATION EXCAVATION HAS BEEN OBSERVED TO DETERIORATE SIGNIFICANTLY, THE FOUNDATION SHALL BE RE-CLEANED / COMPACTED AND RE-INSPECTED.

D36. THE SIDE OF THE EXCAVATIONS AND ANY TEMPORARY EARTHWORKS PROFILES ARE TO BE REGULARLY INSPECTED TO ENSURE THAT THEY REMAIN STABLE AND ARE NOT DETERIORATING THROUGH THE INGRESS OF WATER OR GROUND WATER SEEPAGE OR ANY OTHER MEANS AND THE WORKS CAN BE CONSTRUCTED SAFELY AT ALL TIMES.

D37. DO NOT ALLOW WATER TO INFILTRATE INTO THE GABION WALL FOUNDATION EXCAVATION AT ANY POINT DURING THE GABION WALL CONSTRUCTION.

D38. COMPACT SELECT BACKFILL AT THE BASE OF THE GABIONS IN ACCORDANCE WITH RMS SPECIFICATION R44.

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Project No. 12554564

Client BEGA VALLEY SHIRE COUNCIL
DR GEORGE MOUNTAIN ROAD
Project EMBANKMENT STABILISATION

Status FOR REVIEW AND COMMENT Status Code S3

Drawing Title GENERAL NOTES SHEET 4 OF 4

Size A3

Drawing No. 21-12554564-G005

Rev C

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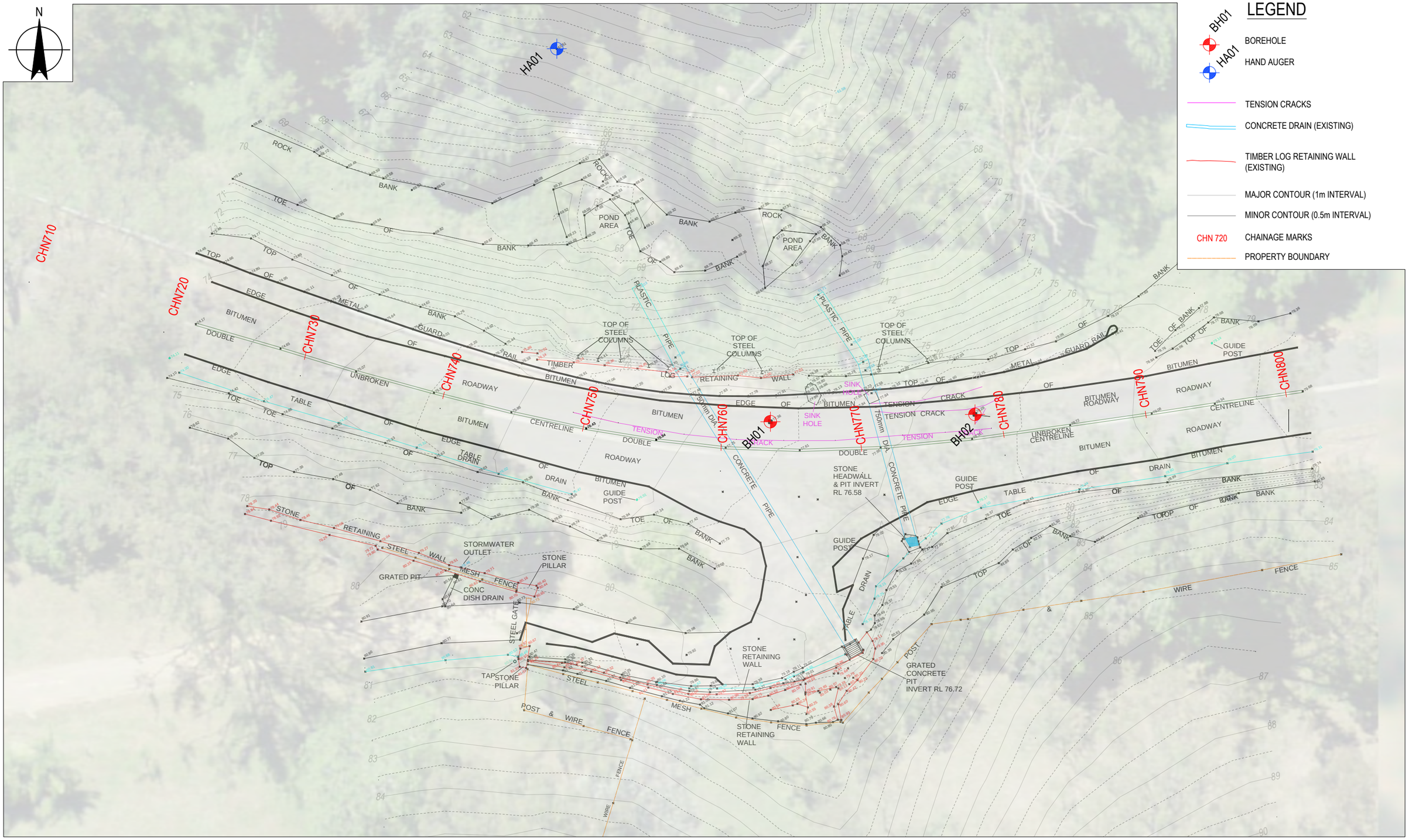

REFERENCE: SURVEY BY VERIS AUSTRALIA PTY LTD DWG 202948 REV 0 DATED 18/08/2021 BASED ON GDA2020 ZONE 55.
AERIAL IMAGERY (APRIL 2018) - DEPARTMENT OF CUSTOMER SERVICE 2021 (GDA2020/Z55).
LIDAR CONTOURS 1m ELVIS 2013 (GDA2020/Z55).

EXISTING SITE PLAN

SCALE 1:250

Rev	Description	Checked	Approved	Date
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Author H WARR | Drafting Check H WARR
Designer H.A / F.K / D.B | Design Check K.PINKERTON / M.NGO / D.BANNIGAN

0 2.5 5.0 7.5m
SCALE 1:250 AT ORIGINAL SIZE

NOTE:
ROAD CHANIAGE PROVIDED BY BEGA VALLEY SHIRE COUNCIL. CHAINAGE LOCALLY ADJUSTED TO MATCH ROAD CENTRELINE.

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Project No. 12554564

Client BEGA VALLEY SHIRE COUNCIL
DR GEORGE MOUNTAIN ROAD
Project EMBANKMENT STABILISATION

Status FOR REVIEW AND COMMENT | Status Code S3

Drawing Title EXISTING SITE PLAN

Size A3

Drawing No. 21-12554564-C101

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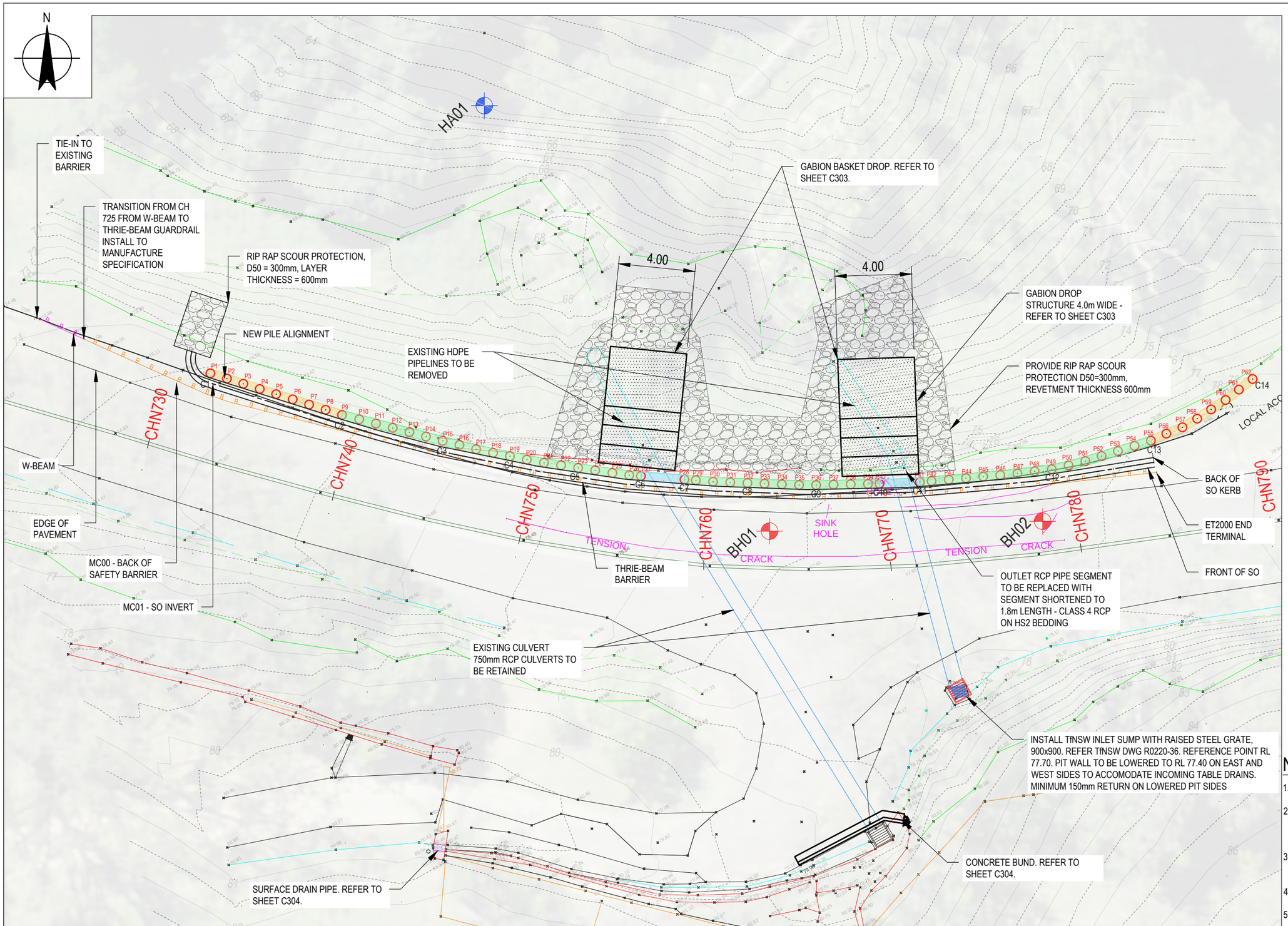

LEGEND

- BH01 — BOREHOLE
- HA01 — HAND AUGER
- TENSION CRACKS
- TIMBER LOG RETAINING WALL (EXISTING)
- MAJOR CONTOUR (1m INTERVAL)
- MINOR CONTOUR (0.5m INTERVAL)
- CHN 720 — CHAINAGE MARKS
- P1 — PILE NUMBERS AND POST
- C1 — CONTROL POINTS
- TYPE 1A - PILED WALL USING PRECAST PANEL
- TYPE 1B - PILED WALL USING CAST IN-SITU PANEL
- TYPE 2 - PILE ONLY
- TOP OF BANK
- TOE OF BANK
- EDGE OF BITUMEN
- EXISTING 750mm DIA. PIPE
- PROPERTY BOUNDARY
- GRATED CONCRETE PIT
- GRATED STEEL INLET SUMP

NOTES:

1. ROAD CHAINAGE PROVIDED BY BEGA VALLEY SHIRE COUNCIL. CHAINAGE LOCALLY ADJUSTED TO MATCH ROAD CENTRELINE.
2. PRECAST AND CAST IN-SITU PANELS NOT SHOWN FOR CLARITY. REFER TO DWG NO. 12554564-C104 FOR TYPICAL CROSS SECTIONS OF TYPE 1A, TYPE 1B AND TYPE 2 REMEDIAL SOLUTIONS.
3. GUARDRAIL DESIGN (INCLUDING FINAL ALIGNMENT) AND STORMWATER DRAINAGE DESIGN TO BE PROVIDED BY OTHERS.
4. REFER TO DWG No. 12554564-C103 FOR SETOUT POINTS AND ELEVATION OF PILE, CAPPING BEAM.
5. CONTRACTOR SHOULD PROVIDE CONSTRUCTION METHODOLOGY TO BE APPROVED BY PRINCIPAL FOR SAFE CONSTRUCTION OF SOLUTIONS CLOSE TO EXISTING TIMBER LOG RETAINING WALL, PARTICULARY FOR PILES P14 TO P20.

REFERENCE: SURVEY BY VERIS AUSTRALIA PTY LTD DWG 202948 REV 0 DATED 18/08/2021 BASED ON GDA2020 ZONE 55. AERIAL IMAGERY (APRIL 2018) - DEPARTMENT OF CUSTOMER SERVICE 2021.

OVERVIEW PLAN

SCALE 1:200

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Author H WARR — Drafting Check H WARR
Designer H.A / F.K / D.B — Design Check K.PINKERTON / M.NGO / D.BANNIGAN

0 2 4 6m
SCALE 1:200 AT ORIGINAL SIZE

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Project EMBANKMENT STABILISATION

Drawing Title SITE REMEDIATION OVERVIEW PLAN

Size A3

Status FOR REVIEW AND COMMENT — Status Code S3

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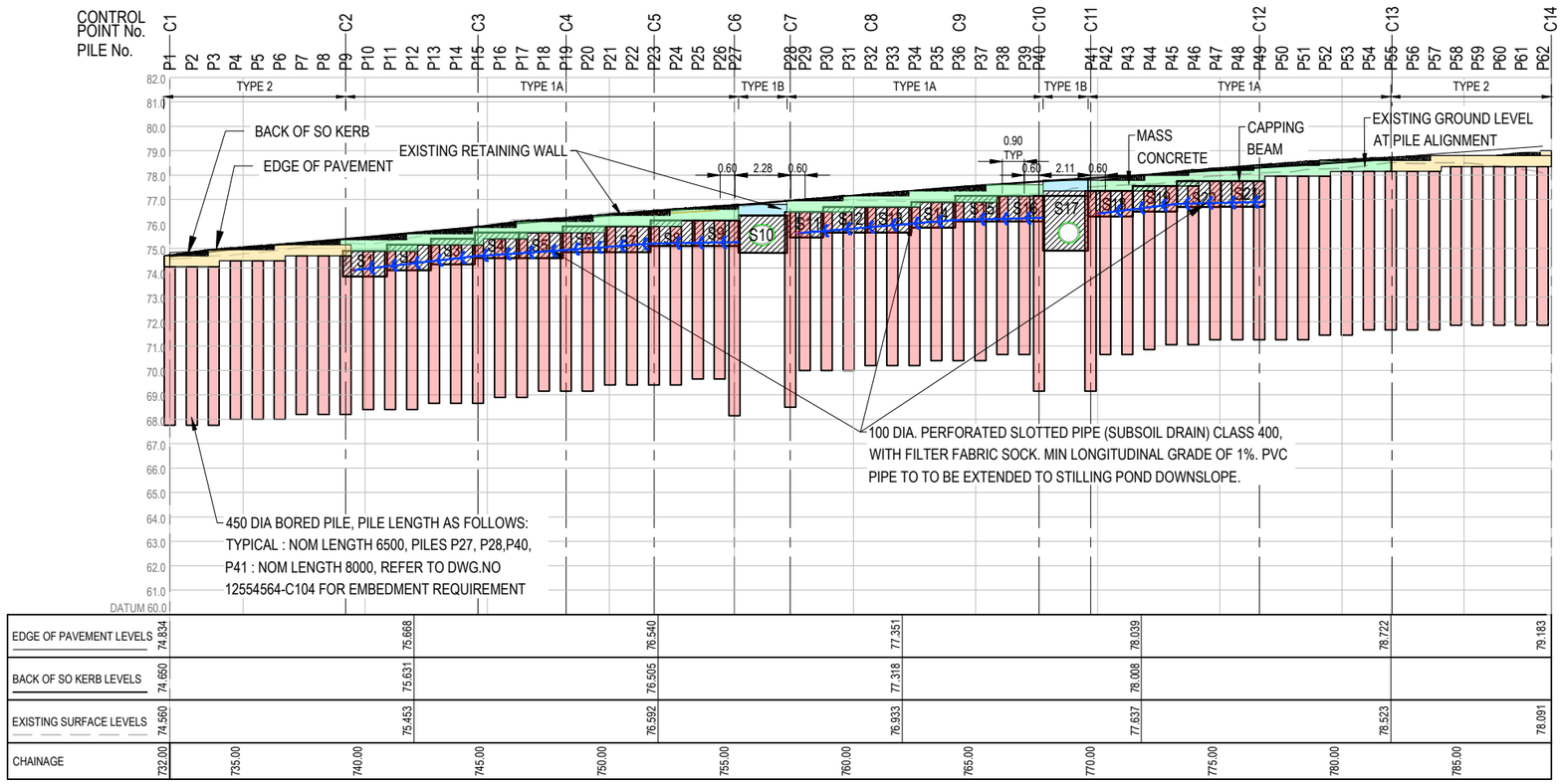
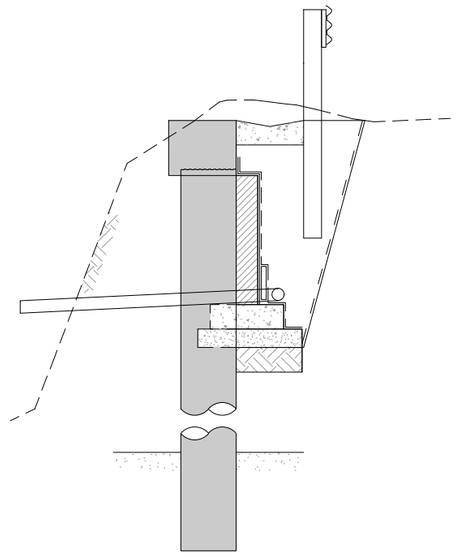


PILE WALL ELEVATION

SCALE 1:250

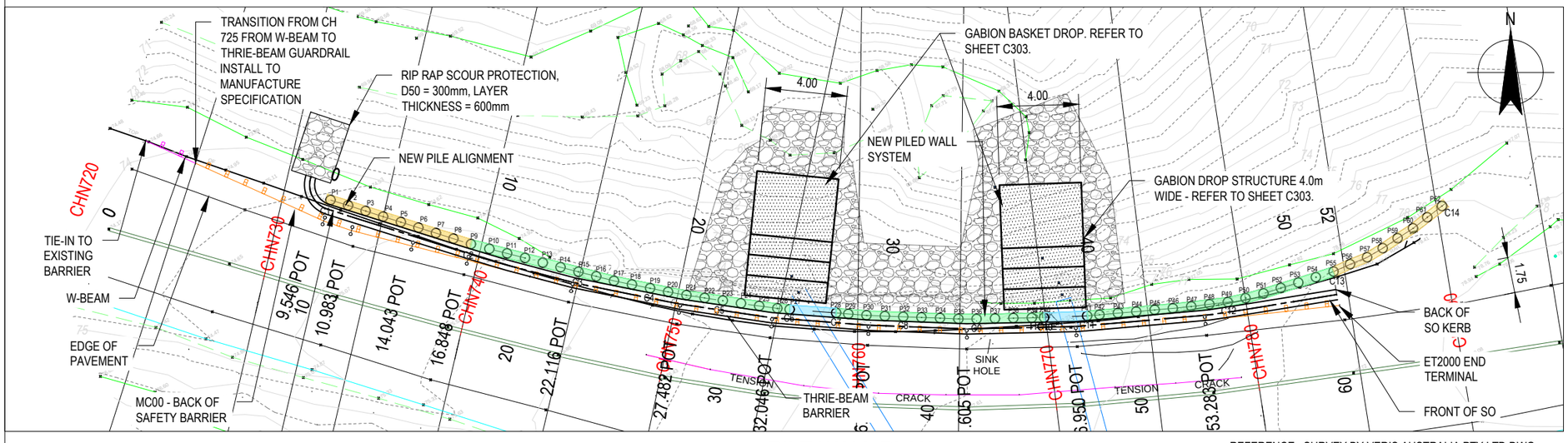
LEGEND

- P1 — PILE NUMBERS AND POST
- C1 — CONTROL POINTS
- TYPE 1A - PILED WALL USING PRECAST PANEL
- TYPE 1B - PILED WALL USING CAST IN-SITU PANEL
- TYPE 2 - PILE ONLY
- 100 DIA PERFORATED SLOTTED PIPE (SUBSOIL DRAIN) CLASS 400, WITH FILTER FABRIC SOCK.
- STEP IN CAPPING BEAM
- S1 — PRECAST CONCRETE PANEL WITH SUBSOIL DRAIN OUTLET



TYPICAL SECTION

SCALE 1:50



PILE WALL PLAN

SCALE 1:250

NOTES:

1. FOR GEOTECHNICAL DETAILS PLEASE REFER TO DRAWING C105.
2. FOR STRUCTURAL DETAILS PLEASE REFER TO DRAWING C202.
3. FOR DRAINAGE CROSS SECTION AND DETAILS PLEASE REFER TO C302.
4. FOR ROAD CROSS SECTION PLEASE REFER TO C405.

REFERENCE: SURVEY BY VERIS AUSTRALIA PTY LTD DWG 202948 REV 0 DATED 18/08/2021 BASED ON GDA2020 ZONE 55.

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Author: A. DE VERA — Drafting Check: H WARR
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0 2.5 5.0 7.5m
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Project No. 12554564

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Project: DR GEORGE MOUNTAIN ROAD EMBANKMENT STABILISATION
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PILE SCHEDULE									
PILE NO.	CONTROL POINT	DISTANCE FROM EDGE OF BITUMEN	EASTING MGA94	NORTHING MGA94	PILE TOE LEVEL	TOP OF PILE LEVEL	EXISTING GROUND LEVEL	MAX. PILE LENGTH	MIN. PILE SOCKET
P1	C1	1.75	757960.797	5938527.322	67.75	74.25	74.560	6.5	2
P2	-	-	757961.658	5938527.050	67.75	74.25	74.618	6.5	2
P3	-	-	757962.514	5938526.781	67.75	74.25	74.692	6.5	2
P4	-	-	757963.372	5938526.510	68	74.5	74.739	6.5	2
P5	-	-	757964.230	5938526.239	68	74.5	74.832	6.5	2
P6	-	-	757965.089	5938525.968	68	74.5	74.921	6.5	2
P7	-	-	757965.947	5938525.698	68.2	74.7	75.057	6.5	2
P8	-	-	757966.806	5938525.430	68.2	74.7	75.168	6.5	2
P9	C2	1.5	757967.664	5938525.157	68.2	74.7	75.206	6.5	2
P10	-	-	757968.560	5938524.928	68.4	74.9	75.159	6.5	2
P11	-	-	757969.432	5938524.706	68.4	74.9	75.317	6.5	2
P12	-	-	757970.304	5938524.483	68.4	74.9	75.442	6.5	2
P13	-	-	757971.174	5938524.255	68.65	75.15	75.581	6.5	2
P14	-	-	757972.045	5938524.032	68.65	75.15	75.770	6.5	2
P15	C3	1.5	757972.917	5938523.810	68.65	75.15	75.931	6.5	2
P16	-	-	757973.786	5938523.587	68.9	75.4	76.029	6.5	2
P17	-	-	757974.658	5938523.365	68.9	75.4	76.174	6.5	2
P18	-	-	757975.539	5938523.185	69.15	75.65	76.218	6.5	2
P19	C4	1.4	757976.420	5938523.008	69.15	75.65	76.278	6.5	2
P20	-	-	757977.301	5938522.830	69.15	75.65	76.384	6.5	2
P21	-	-	757978.198	5938522.661	69.4	75.9	76.464	6.5	2
P22	-	-	757979.087	5938522.529	69.4	75.9	76.560	6.5	2
P23	C5	1.4	757979.978	5938522.398	69.4	75.9	76.584	6.5	2
P24	-	-	757980.868	5938522.266	69.4	75.9	76.625	6.5	2
P25	-	-	757981.759	5938522.134	69.65	76.15	76.666	6.5	2
P26	-	-	757982.643	5938522.017	69.65	76.15	76.678	6.5	2
P27	C6	1.4	757983.248	5938521.971	68.15	76.15	76.673	8	3.5
P28	C7	1.4	757985.523	5938521.794	68.5	76.5	76.954	8	3.5
P29	-	-	757986.114	5938521.749	70	76.5	76.966	6.5	2
P30	-	-	757987.011	5938521.679	70	76.5	76.981	6.5	2
P31	-	-	757987.905	5938521.641	70	76.5	76.968	6.5	2
P32	C8	1.4	757988.804	5938521.608	70.2	76.7	76.954	6.5	2
P33	-	-	757989.698	5938521.574	70.2	76.7	76.939	6.5	2
P34	-	-	757990.602	5938521.541	70.2	76.7	76.925	6.5	2
P35	-	-	757991.502	5938521.507	70.4	76.9	76.889	6.5	2
P36	C9	1.4	757992.391	5938521.502	70.4	76.9	76.758	6.5	2
P37	-	-	757993.291	5938521.521	70.4	76.9	76.916	6.5	2
P38	-	-	757994.191	5938521.540	70.652	77.152	77.148	6.5	2
P39	-	-	757995.091	5938521.559	70.652	77.152	77.220	6.5	2
P40	C10	1.4	757995.689	5938521.571	69.152	77.152	77.240	8	3.5
P41	C11	1.5	757997.801	5938521.655	69.152	77.352	77.520	8.2	3.5
P42	-	-	757998.405	5938521.708	70.652	77.352	77.553	6.7	2
P43	-	-	757999.302	5938521.786	70.652	77.352	77.604	6.7	2
P44	-	-	758000.198	5938521.864	70.652	77.352	77.637	6.7	2
P45	-	-	758001.096	5938521.943	70.852	77.552	77.712	6.7	2
P46	-	-	758001.990	5938522.021	70.852	77.552	77.814	6.7	2
P47	-	-	758002.885	5938522.111	71.052	77.752	77.962	6.7	2
P48	-	-	758003.779	5938522.219	71.052	77.752	78.048	6.7	2
P49	C12	1.5	758004.675	5938522.327	71.052	77.752	78.093	6.7	2
P50	-	-	758005.550	5938522.523	71.252	77.952	78.130	6.7	2
P51	-	-	758006.421	5938522.748	71.252	77.952	78.214	6.7	2
P52	-	-	758007.270	5938523.011	71.452	77.952	78.257	6.5	2
P53	-	-	758008.130	5938523.279	71.452	78.152	78.283	6.7	2
P54	-	-	758008.989	5938523.546	71.652	78.152	78.405	6.5	2
P55	C13	2.1	758009.848	5938523.814	71.652	78.152	78.522	6.5	2
P56	-	-	758010.653	5938524.182	71.652	78.152	78.479	6.5	2
P57	-	-	758011.489	5938524.515	71.652	78.152	78.503	6.5	2
P58	-	-	758012.254	5938524.962	71.852	78.352	78.502	6.5	2
P59	-	-	758012.983	5938525.447	71.852	78.352	78.458	6.5	2
P60	-	-	758013.739	5938525.936	71.852	78.352	78.375	6.5	2
P61	-	-	758014.434	5938526.478	71.852	78.352	78.252	6.5	2
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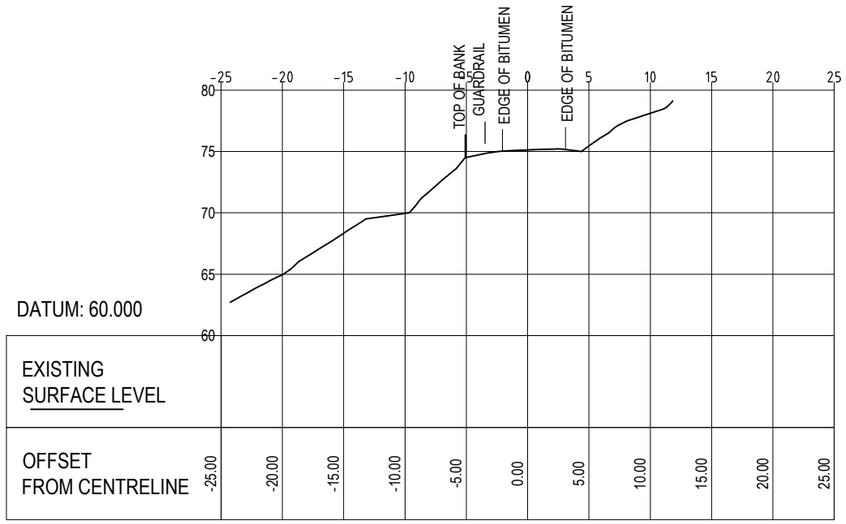
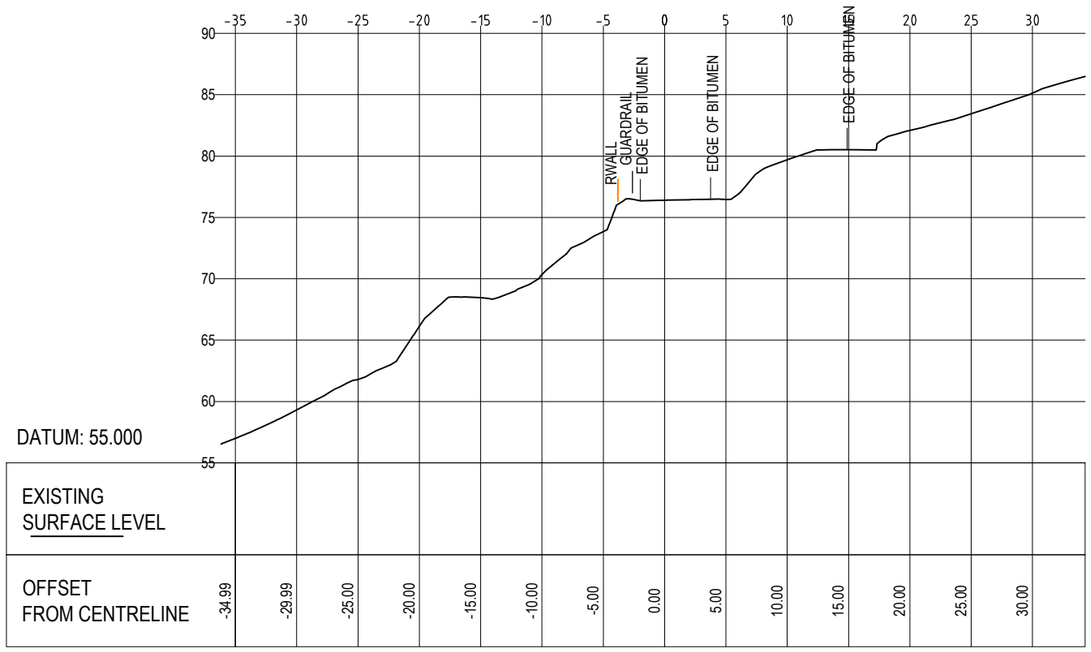


CROSS SECTION A-A' AT CHN 735
PILE AND CAPPING BEAM WITH PRECAST PANEL
TYPICAL DETAILS

SCALE 1:500



CROSS SECTION B-B' AT CHN 750
PILE AND CAPPING BEAM WITHOUT PRECAST PANEL
TYPICAL DETAILS

SCALE 1:500

REFERENCE: SURVEY BY VERIS AUSTRALIA PTY LTD DWG 202948 REV 0 DATED 18/08/2021 BASED ON GDA2020 ZONE 55.

Rev	Description	Checked	Approved	Date
B	REVISED 100% DETAILED DESIGN	HA/MN/DB	DD	09.08.2022
A	100% DETAIL DESIGN	RM	DD	29.10.2021

Author: A. DE VERA | Drafting Check: H WARR
Designer: H.A / F.K / D.B | Design Check: K.PINKERTON / M.NGO / D.BANNIGAN

0 5 10 15m
SCALE 1:500 AT ORIGINAL SIZE

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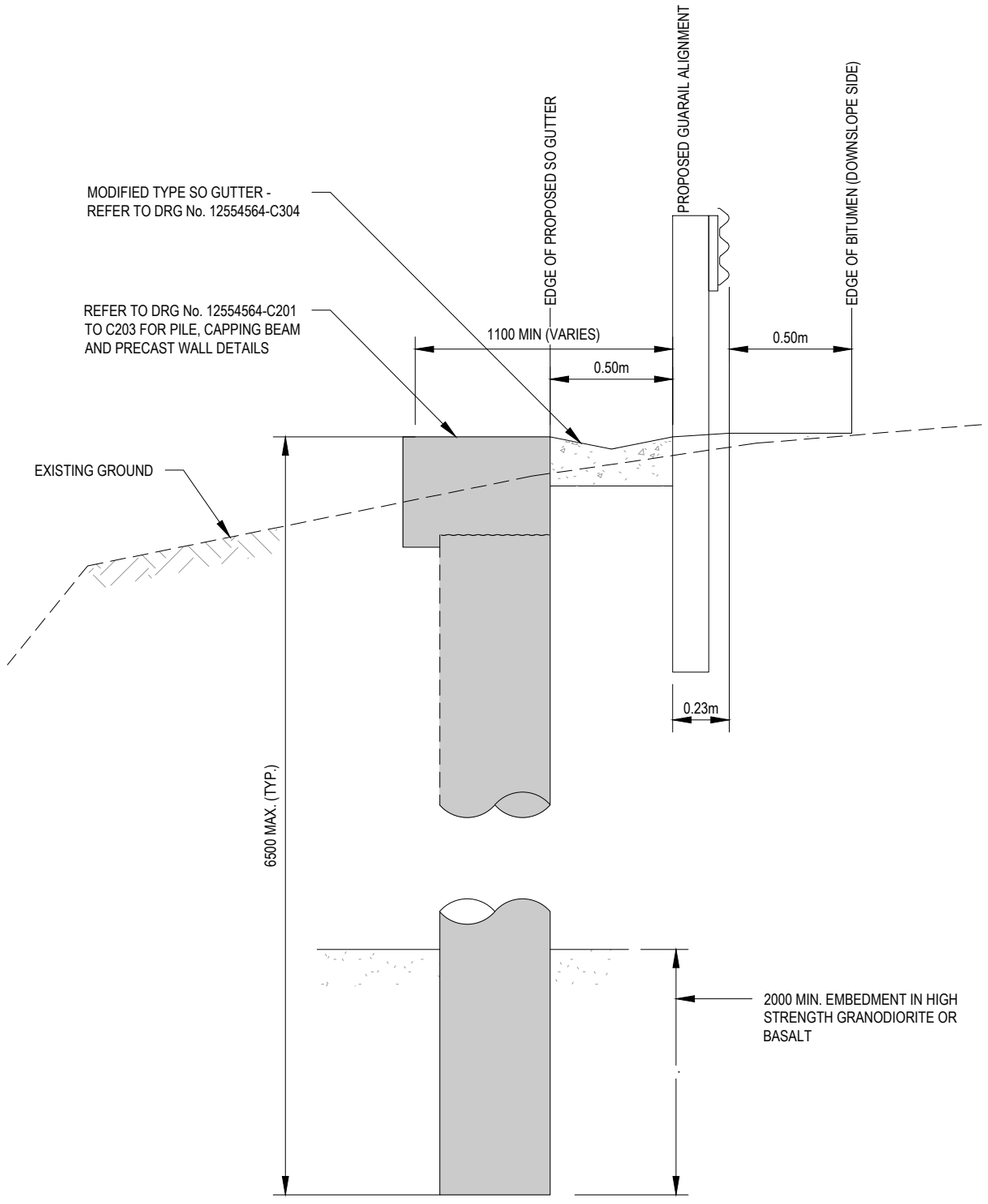
Project No. 12554564

Client: BEGA VALLEY SHIRE COUNCIL
DR GEORGE MOUNTAIN ROAD
Project: EMBANKMENT STABILISATION
Status: FOR REVIEW AND COMMENT | Status Code: S3

Drawing Title: PILE SCHEDULE AND TYPICAL CROSS SECTIONS
Size: A3
Drawing No.: 21-12554564-C104
Rev: B

Plot Date: 10 August 2022 - 8:05 PM | Plotted by: Archerry De Vera | File Name: \\ghdnet\ghd\AU\Wollongong\Projects\21\12554564\CADD\Drawings\Geotech\21-12554564-C104.dwg

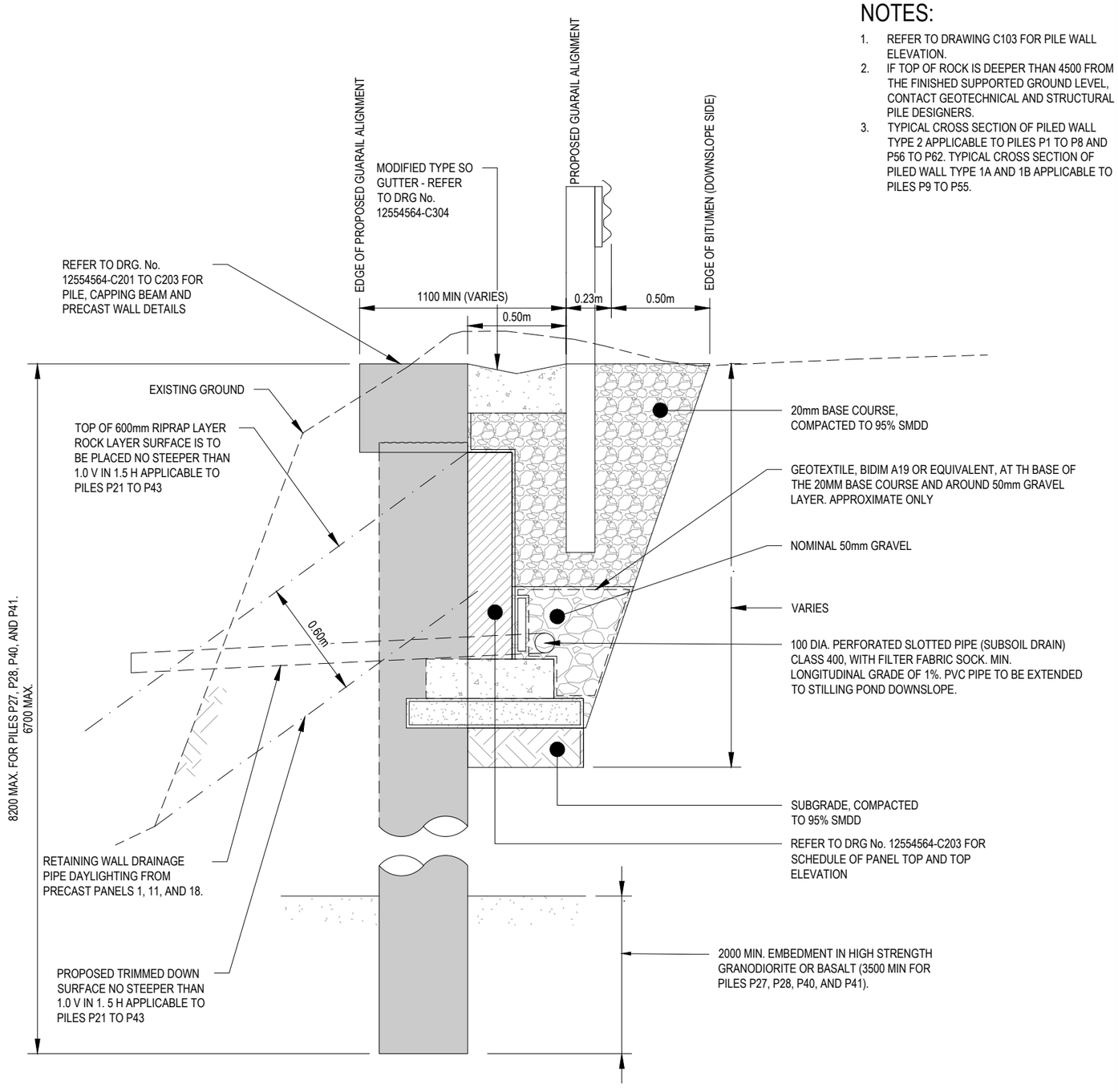


PILED WALL (TYPE 2) TYPICAL CROSS SECTION

SCALE 1:25

NOTES:

1. REFER TO DRAWING C103 FOR PILE WALL ELEVATION.
2. IF TOP OF ROCK IS DEEPER THAN 4500 FROM THE FINISHED SUPPORTED GROUND LEVEL, CONTACT GEOTECHNICAL AND STRUCTURAL PILE DESIGNERS.
3. TYPICAL CROSS SECTION OF PILED WALL TYPE 2 APPLICABLE TO PILES P1 TO P8 AND P56 TO P62. TYPICAL CROSS SECTION OF PILED WALL TYPE 1A AND 1B APPLICABLE TO PILES P9 TO P55.



PILED WALL (TYPE 1A AND 1B) TYPICAL CROSS SECTION

SCALE 1:25

Rev	Description	Checked	Approved	Date
B	REVISED 100% DETAILED DESIGN	HA/MN/DB	DD	09.08.2022
A	100% DETAILED DESIGN	RM	DD	29.10.2021

Author A. DE VERA **Drafting Check** H WARR
Designer H.A / F.K / D.B **Design Check** K.PINKERTON / M.NGO / D.BANNIGAN

0 0.25 0.5 0.75m
SCALE 1:25 AT ORIGINAL SIZE

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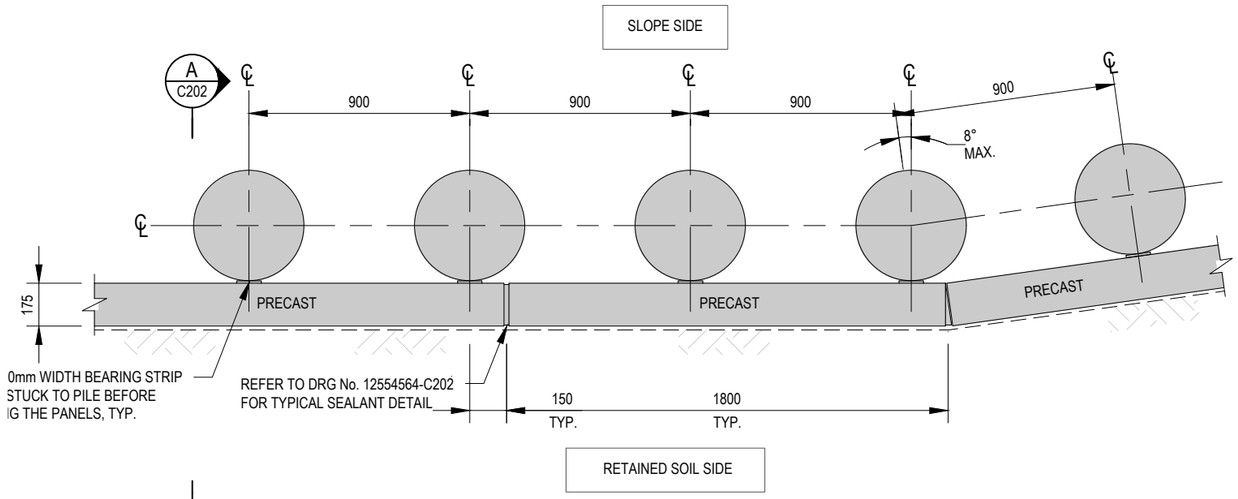
GHD Pty Ltd

Project No. 12554564

Client: BEGA VALLEY SHIRE COUNCIL
Project: DR GEORGE MOUNTAIN ROAD EMBANKMENT STABILISATION
Status: FOR REVIEW AND COMMENT Status Code: S3

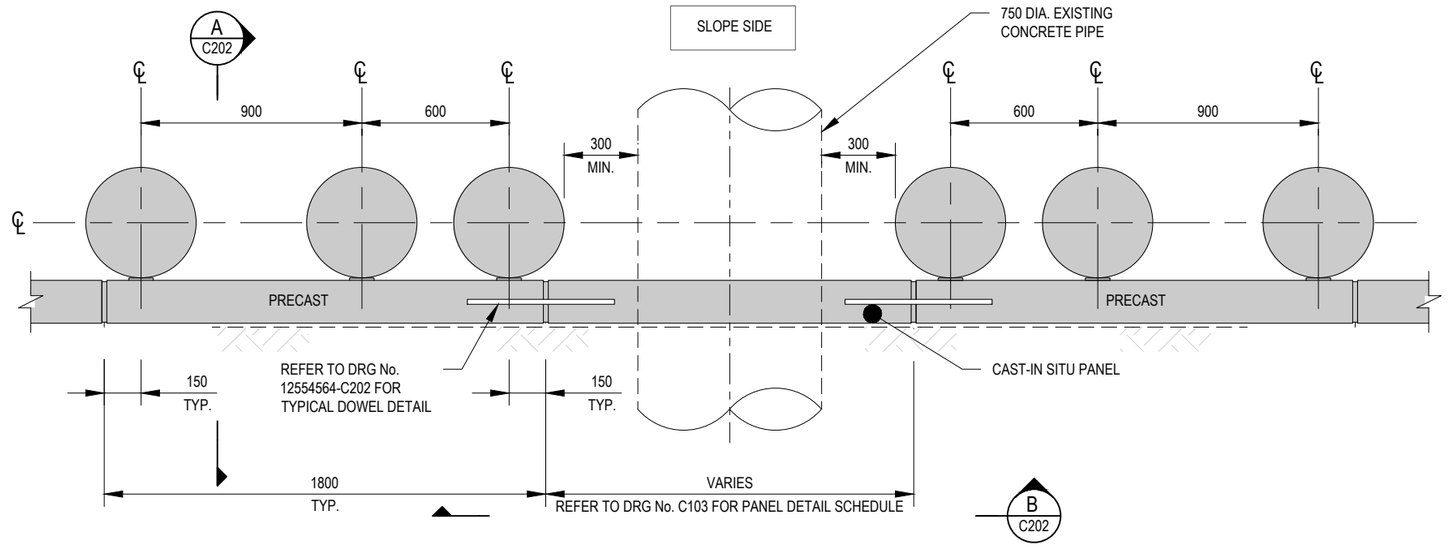
Drawing Title: TYPICAL CROSS SECTIONS
Size: A3
Drawing No.: 21-12554564-C105
Rev: B

Plot Date: 10 August 2022 - 8:04 PM Plotted by: Archerry De Vera File Name: \\ghdnet\ghd\AU\Wollongong\Projects\21\12554564\CADD\Drawings\Geotech\21-12554564-C105.dwg



PILED WALL ARRANGEMENT PLAN - TYPE 1A

SCALE 1 : 25



PILED WALL ARRANGEMENT PLAN - TYPE 1B

SCALE 1 : 25

Rev	Description	Checked	Approved	Date
B	REVISED 100% DETAILED DESIGN	HA/MN/DB	DD	09.08.2022
A	100% DETAILED DESIGN	RM	DD	29.10.2021

Author	H WARR	Drafting Check	H WARR
Designer	H.A / F.K / D.B	Design Check	K.PINKERTON / M.NGO / D.BANNIGAN

0 250 500 750 mm
SCALE 125 AT ORIGINAL SIZE

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Project No. 12554564

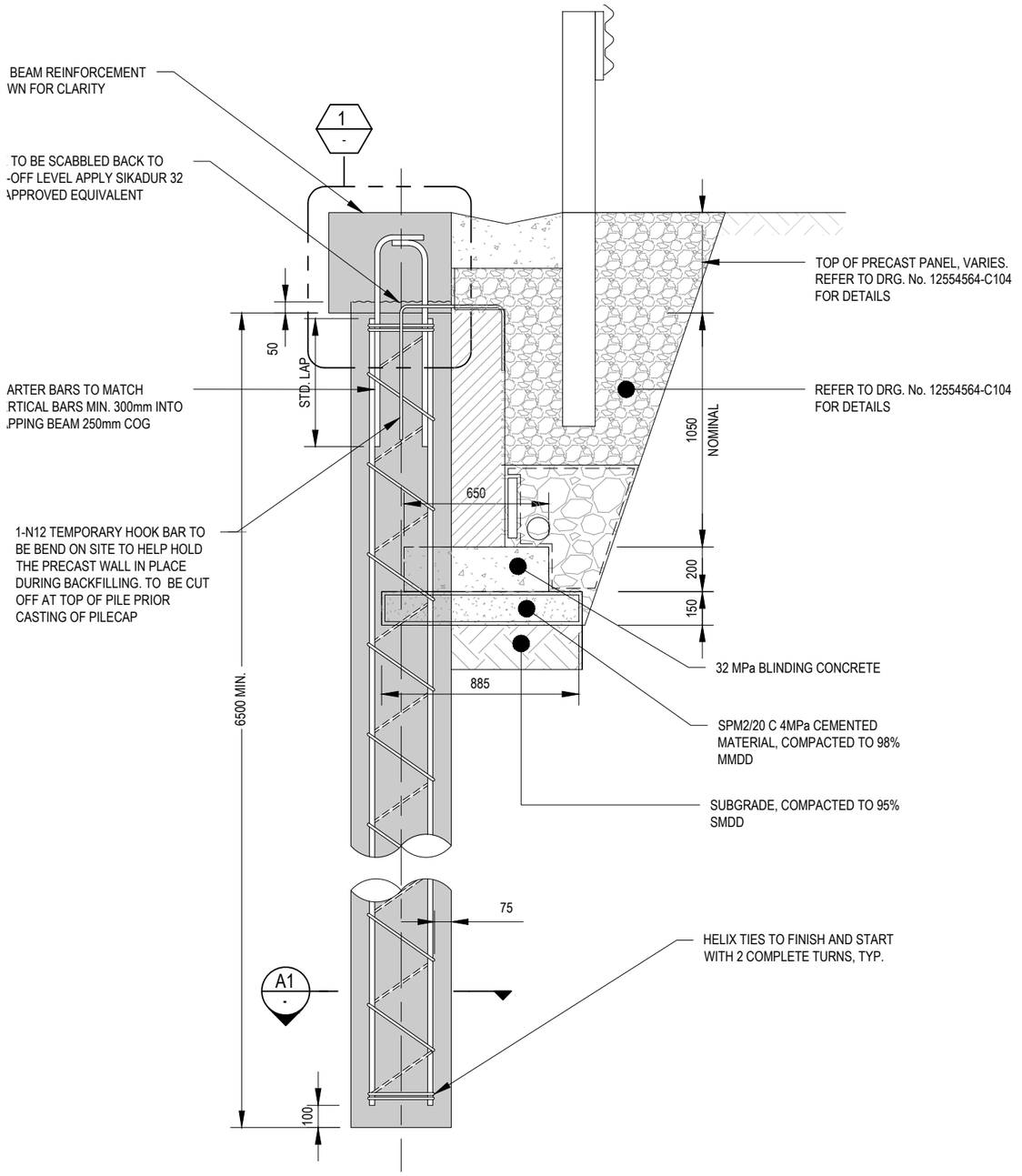
Client: BEGA VALLEY SHIRE COUNCIL
DR GEORGE MOUNTAIN ROAD
Project: EMBANKMENT STABILISATION

Status: FOR REVIEW AND COMMENT
Status Code: S3

Drawing Title: DETAILS - CAPPING BEAM AND PILE - SHEET 1 OF 2

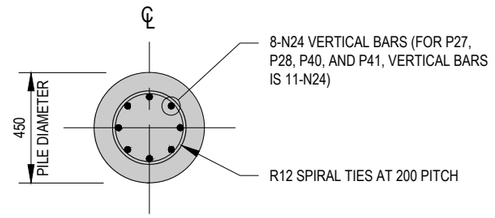
Size: A3
Drawing No.: 21-12554564-C201
Rev: B

Plot Date: 10 August 2022 - 7:59 PM Plotted by: Archerry De Vera File Name: \\ghdnet\ghd\AU\Wollongong\Projects\21\12554564\CADD\Drawings\Structural\21-12554564-C201.dwg



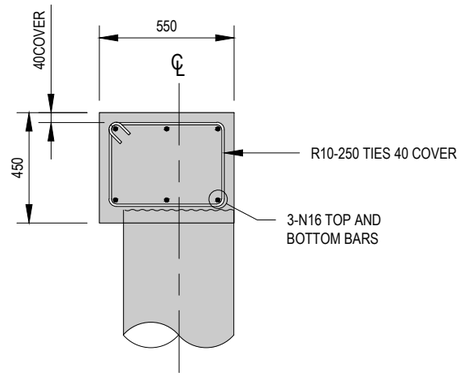
NOTE:
PILE DETAILS SIMILAR TO TYPE 2

A / C201 SECTION
SCALE 1 : 25



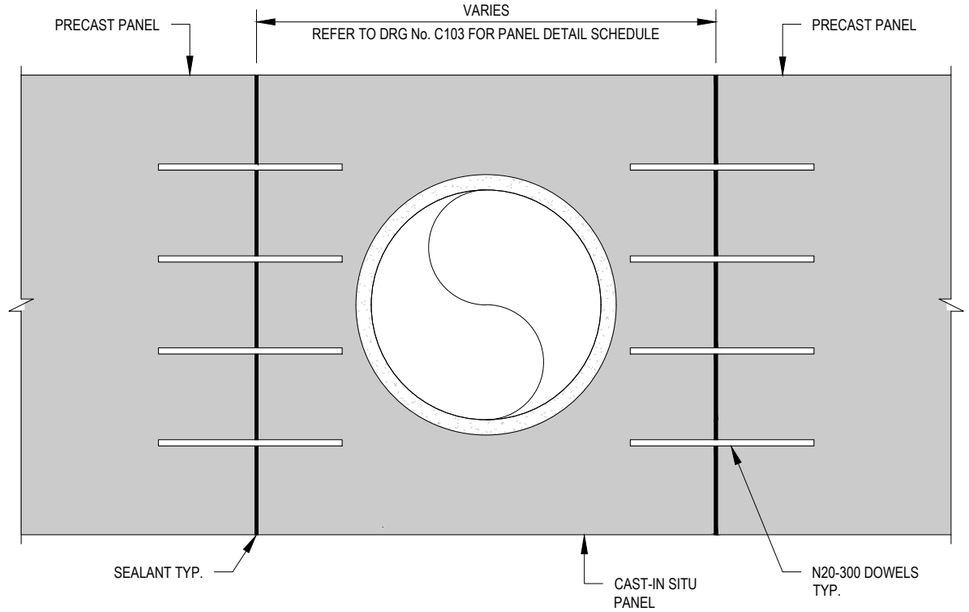
PILE DETAIL

A1 / — SECTION
SCALE 1 : 25



CAPPING BEAM DETAIL

1 / - DETAIL
SCALE 1 : 25



B / C201 SECTION
SCALE 1 : 20

Rev	Description	Checked	Approved	Date
B	REVISED 100% DETAILED DESIGN	HA/MN/DB	DD	09.08.2022
A	100% DETAILED DESIGN	RM	DD	29.10.2021

Author H WARR | Drafting Check H WARR
Designer H.A / F.K / D.B | Design Check K.PINKERTON / M.NGO / D.BANNIGAN

0 250 500 750 mm
SCALE 125 AT ORIGINAL SIZE

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GHD Pty Ltd

Project No. 12554564

Client BEGA VALLEY SHIRE COUNCIL
DR GEORGE MOUNTAIN ROAD
Project EMBANKMENT STABILISATION

Status FOR REVIEW AND COMMENT | Status Code S3

Drawing Title DETAILS - CAPPING BEAM AND PILE - SHEET 2 OF 2

Size A3

Drawing No. 21-12554564-C202 | Rev B

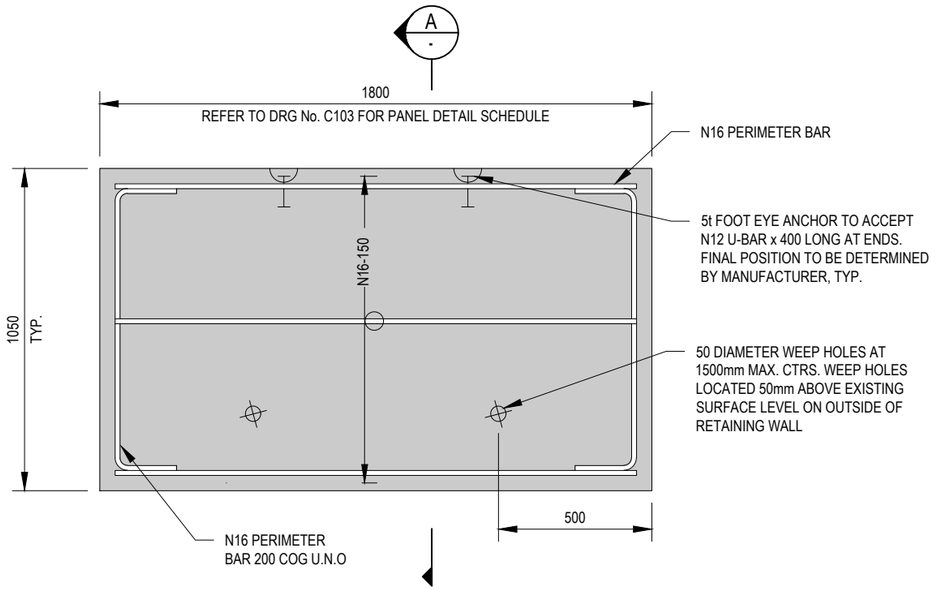
Plot Date: 10 August 2022 - 10:31 AM Plotted by: Eldegardo Perez

File Name: \\ghdnet\ghd\AU\Wollongong\Projects\21\12554564\CADD\Drawings\Structural\21-12554564-C202.dwg

PANEL SCHEDULE																					
PANEL MARK	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21
PANEL TYPE	PRECAST									IN-SITU	PRECAST						IN-SITU	PRECAST			
LENGTH (mm)	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	NOTE 1	1.5	1.8	1.8	1.8	1.8	1.8	NOTE 1	1.8	1.8	1.8	1.8
PANEL HEIGHT (mm)	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	NOTE 1	1.05	1.05	1.05	1.05	1.05	1.05	NOTE 1	1.05	1.05	1.05	1.05
PANEL TOE LEVEL	73.850	74.100	74.350	74.600	74.600	74.850	74.850	75.100	75.100	75.333	75.450	75.650	75.650	75.850	76.102	76.102	75.783	76.102	76.302	76.502	76.502
TOP OF PANEL LEVEL	74.900	75.150	75.400	75.650	75.650	75.900	75.900	76.150	76.150	76.800	76.500	76.700	76.700	76.900	77.152	77.152	77.245	77.352	77.552	77.752	77.752

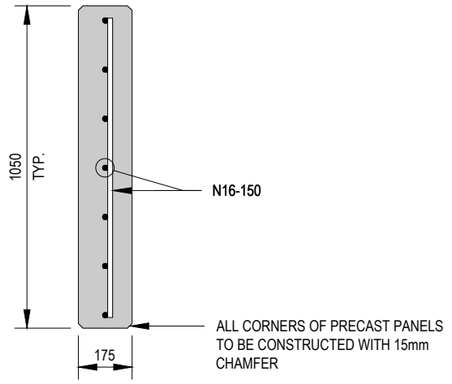
NOTES:

1. ACTUAL IN-SITU LENGTH AND HEIGHT TO BE CONFIRMED ON SITE.
2. ACTUAL PIPE DIAMETER AT PENETRATION TO BE CONFIRMED ON SITE.



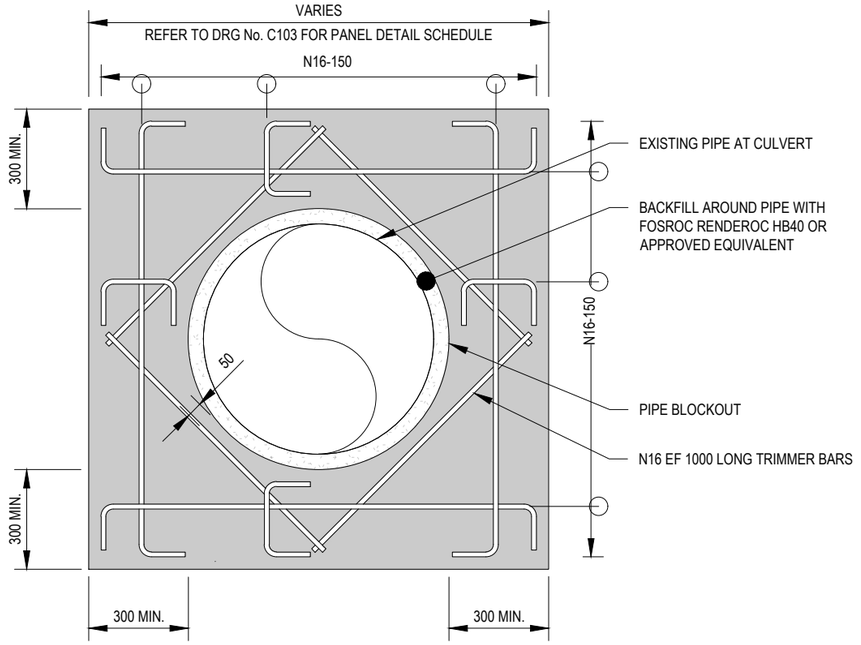
TYPICAL PRECAST PANEL DETAIL

SCALE 1 : 20



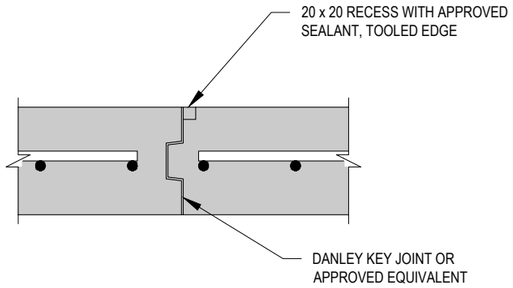
A — SECTION

SCALE 1 : 20



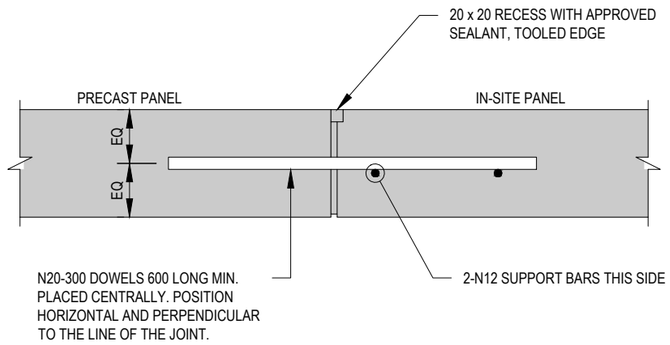
CAST-IN SITU PANEL AT PENETRATION DETAIL

SCALE 1 : 20



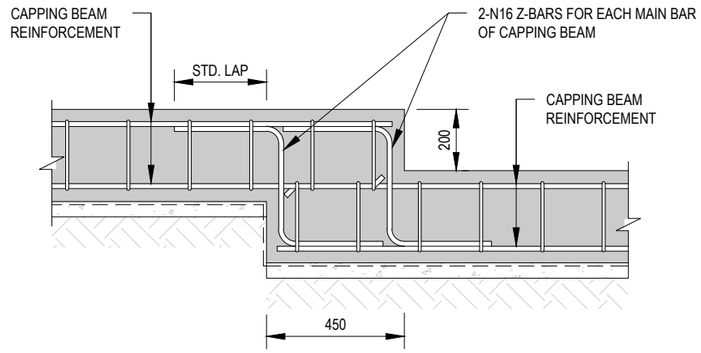
TYPICAL SEALANT DETAIL

SCALE 1 : 10



TYPICAL DOWEL DETAIL

SCALE 1 : 10



TYPICAL CAPPING BEAM STEP DETAIL

SCALE 1 : 20

Rev	Description	Checked	Approved	Date
B	REVISED 100% DETAILED DESIGN	HA/MN/DB	DD	09.08.2022
A	100% DETAILED DESIGN	RM	DD	29.10.2021

Author H WARR Drafting Check H WARR
Designer H.A / F.K / D.B Design Check K.PINKERTON / M.NGO / D.BANNIGAN

0 100 200 300 mm
SCALE 1:10 AT ORIGINAL SIZE
0 200 400 600 mm
SCALE 1:20 AT ORIGINAL SIZE

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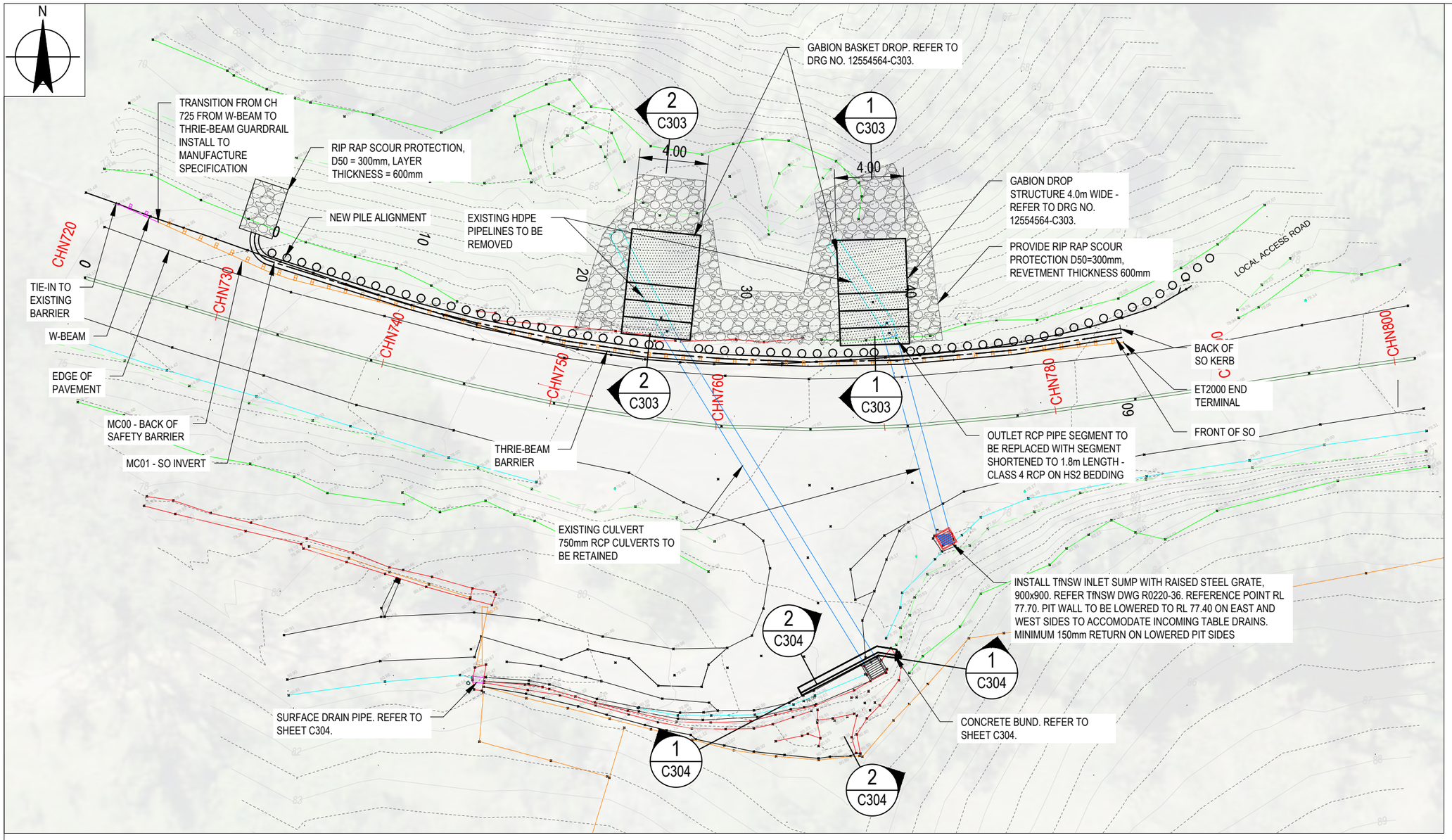
GHD Pty Ltd

Project No. 12554564

Client BEGA VALLEY SHIRE COUNCIL
Project DR GEORGE MOUNTAIN ROAD EMBANKMENT STABILISATION
Status FOR REVIEW AND COMMENT Status Code S3

Drawing Title DETAILS - PRECAST AND CAST-IN SITU PANEL
Drawing No. 21-12554564-C203
Size A3
Rev B

Plot Date: 10 August 2022 - 7:56 PM Plotted by: Archerry De Vera File Name: \\ghdnet\ghd\AU\Wollongong\Projects\21\12554564\CADD\Drawings\Structural\21-12554564-C203.dwg



GENERAL PLAN

SCALE 1:200

REFERENCE: SURVEY BY VERIS AUSTRALIA PTY LTD DWG 202948 REV 0 DATED 18/08/2021 BASED ON GDA2020 ZONE 55. AERIAL IMAGERY (APRIL 2018) - DEPARTMENT OF CUSTOMER SERVICE 2021.

Rev	Description	Checked	Approved	Date
A	REVISED 100% DETAILED DESIGN	HA/MN/DB	DD	09.08.2022

Author	H WARR	Drafting Check	H WARR
Designer	H.A / F.K / D.B	Design Check	K.PINKERTON / M.NGO / D.BANNIGAN

0 2 4 6m
SCALE 1:200 AT ORIGINAL SIZE

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Project No. 12554564

Client: BEGA VALLEY SHIRE COUNCIL
DR GEORGE MOUNTAIN ROAD
Project: EMBANKMENT STABILISATION

Status: FOR REVIEW AND COMMENT
Status Code: S3

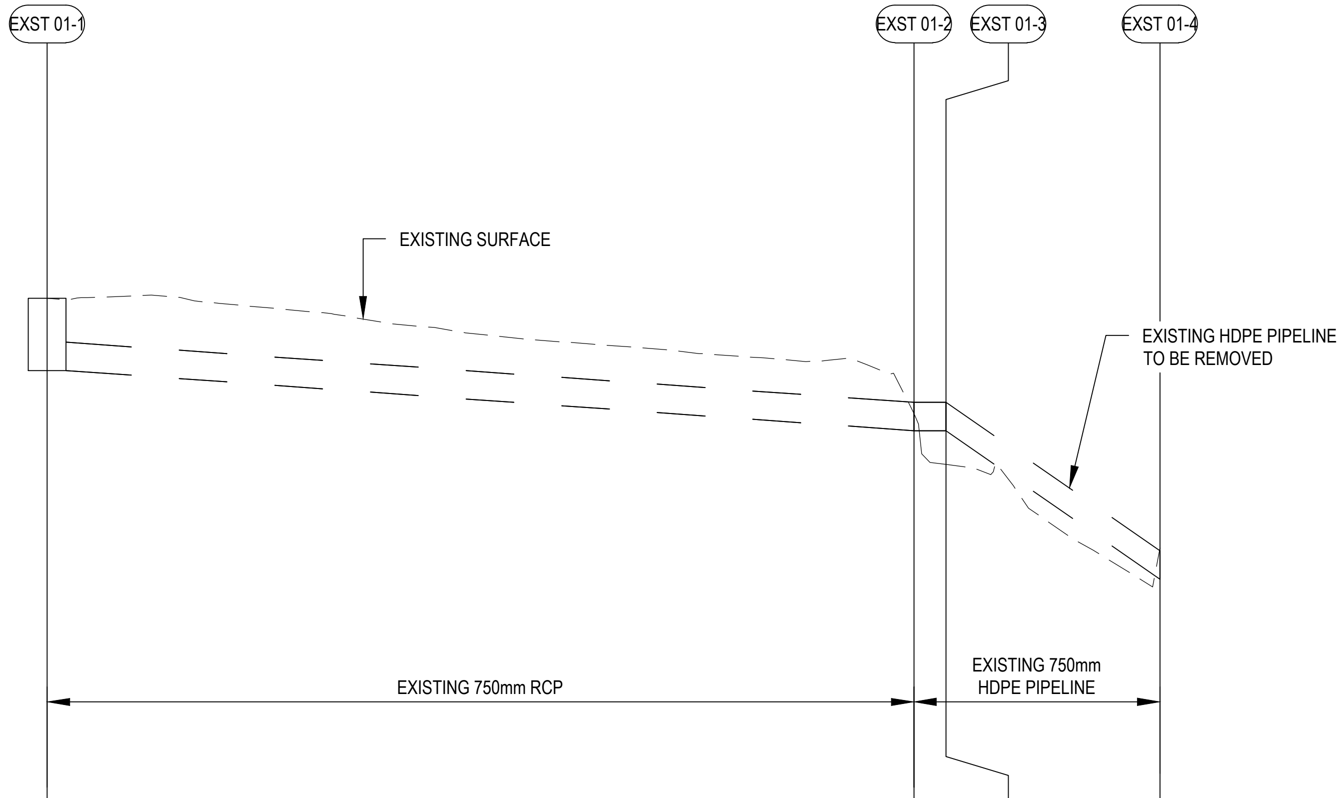
Drawing Title: GENERAL PLAN
DRAINAGE

Size: A3

Drawing No. 21-12554564-C301

Rev: A

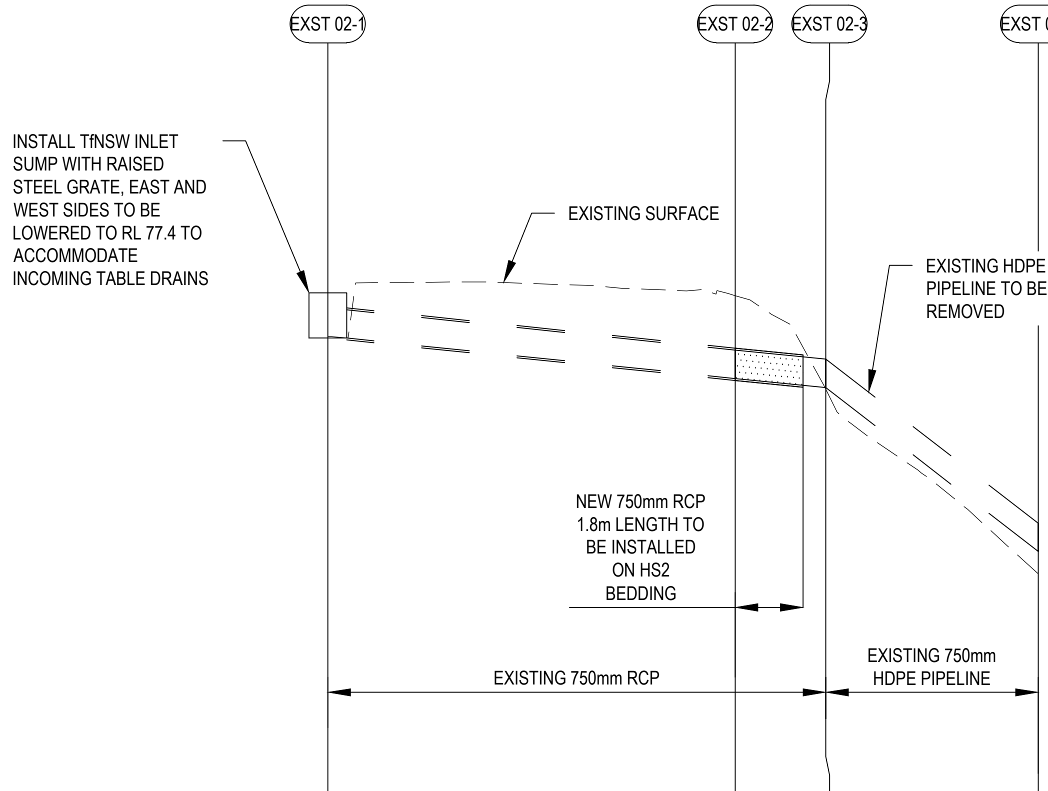
Plot Date: 10 August 2022 - 8:11 PM Plotted by: Archerry De Vera File Name: \\ghdnet\ghd\AU\Wollongong\Projects\21\12554564\CADD\Drawings\Geotech\21-12554564-C301.dwg



DATUM R.L. 56.00	EXST 01-1		EXST 01-2		EXST 01-3		EXST 01-4
DEPTH TO INVERT FROM DESIGN SURFACE	1.911		0.750 0.750		0.750 0.750		0.750 0.750
INVERT LEVEL	76.720		75.125 75.125		75.125 75.125		71.195 71.195
DESIGN SURFACE LEVEL	78.631		75.875		75.875		71.945
EXISTING SURFACE LEVEL	78.631		75.584		74.234		72.018
CHAINAGE	0.000	22.967	22.967	0.852	23.819	5.665	29.484

WESTERN CULVERT LONGITUDINAL SECTION

SCALE 1:2000



DATUM R.L. 55.00	EXST 02-1		EXST 02-2		EXST 02-3		EXST 02-4
DEPTH TO INVERT FROM DESIGN SURFACE	1.120		0.750 0.750		0.750 0.750		0.750 0.750
INVERT LEVEL	76.580		75.508 75.508		75.269 75.269		70.929 70.929
DESIGN SURFACE LEVEL	77.700		76.258		76.019		71.679
EXISTING SURFACE LEVEL	76.621		77.704		75.228		70.333
CHAINAGE	0.000	10.790	10.790	2.400	13.190	5.625	18.816

EASTERN CULVERT LONGITUDINAL SECTION

SCALE 1:2000

REFERENCE: SURVEY BY VERIS AUSTRALIA PTY LTD DWG 202948 REV 0 DATED 18/08/2021 BASED ON GDA2020 ZONE 55.

Rev	Description	Checked	Approved	Date
A	REVISED 100% DETAILED DESIGN	HA/MN/DB	DD	09.08.2022

Author H WARR Drafting Check H WARR
Designer H.A / F.K / D.B Design Check K.PINKERTON / M.NGO / D.BANNIGAN

0 20 40 60m
SCALE 1:2000 AT ORIGINAL SIZE

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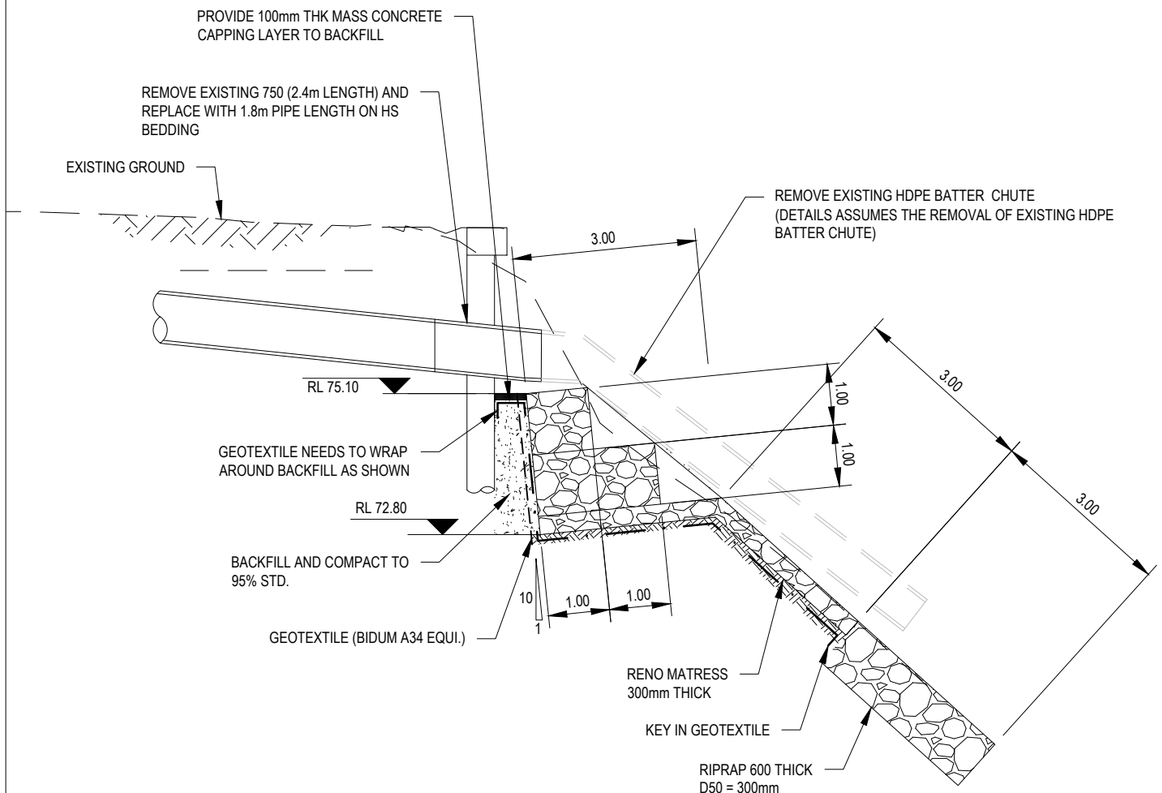
Project No. 12554564

Client BEGA VALLEY SHIRE COUNCIL
DR GEORGE MOUNTAIN ROAD
Project EMBANKMENT STABILISATION
Status FOR REVIEW AND COMMENT Status Code S3

Drawing Title LONGITUDINAL SECTION DRAINAGE

Size A3
Drawing No. 21-12554564-C302
Rev A

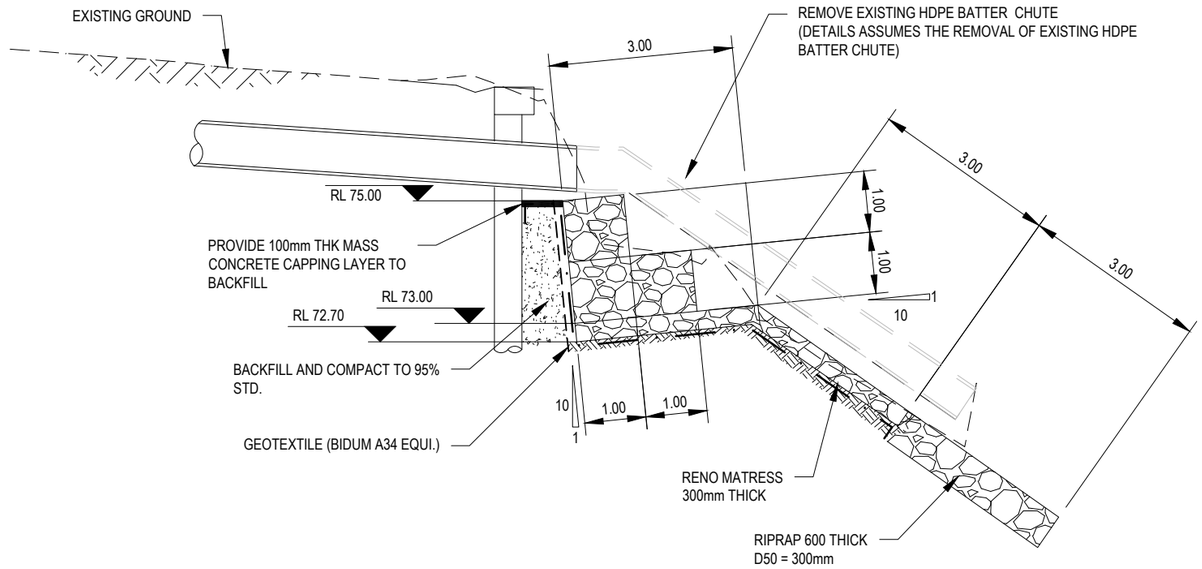
Plot Date: 10 August 2022 - 11:40 AM Plotted by: Eldegardo Perez File Name: \\ghdnet\ghd\AU\Wollongong\Projects\21\12554564\CADD\Drawings\Geotech\21-12554564-C302.dwg



EASTERN OUTLET DROP STRUCTURE

1 C301 SECTION

SCALE 1 : 1000



WESTERN OUTLET DROP STRUCTURE

2 C301 SECTION

SCALE 1 : 1000

Rev	Description	Checked	Approved	Date
A	REVISED 100% DETAILED DESIGN	HA/MN/DB	DD	09.08.2022

Author	H WARR	Drafting Check	H WARR
Designer	H.A / F.K / D.B	Design Check	K.PINKERTON / M.NGO / D.BANNIGAN

0 10 20 30m

SCALE 1:1000 AT ORIGINAL SIZE

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www.ghd.com

Project No. 12554564

Client: BEGA VALLEY SHIRE COUNCIL
DR GEORGE MOUNTAIN ROAD

Project: EMBANKMENT STABILISATION

Status: FOR REVIEW AND COMMENT — Status Code: S3

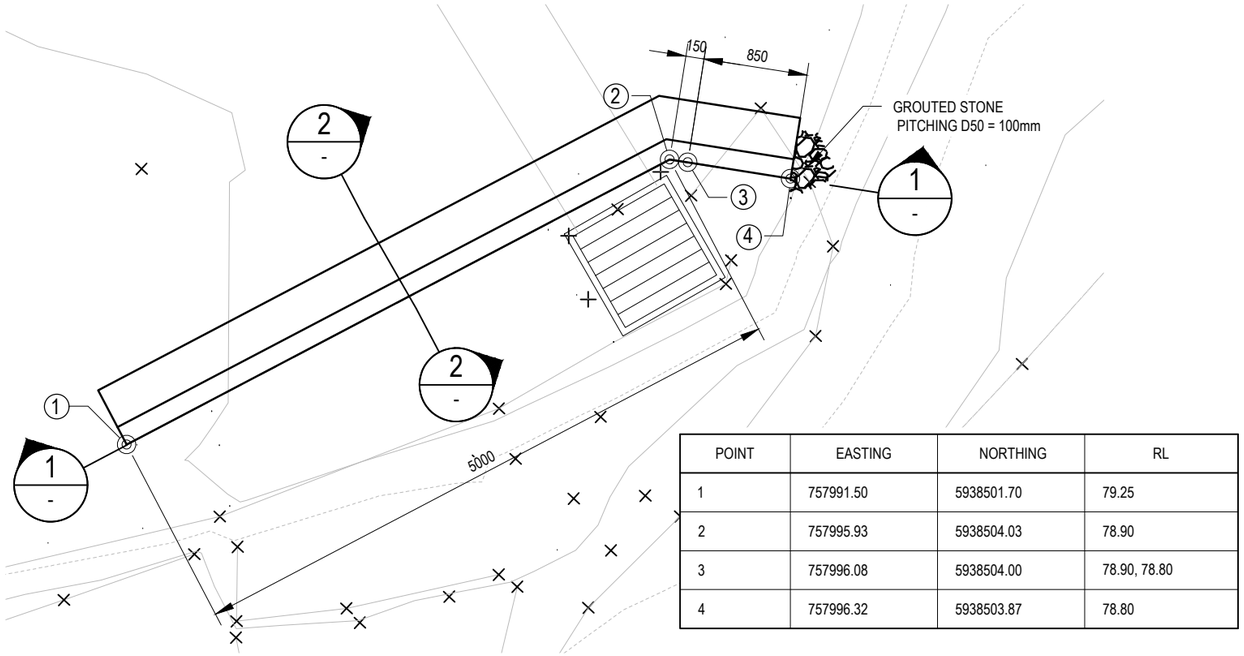
Drawing Title: DETAILS - DRAINAGE SHEET 1 OF 2

Size: A3

Drawing No.: 21-12554564-C303

Rev: A

Plot Date: 10 August 2022 - 8:17 PM Plotted by: Archerry De Vera File Name: \\ghdnet\ghd\AU\Wollongong\Projects\21\12554564\CADD\Drawings\Geotech\21-12554564-C303.dwg

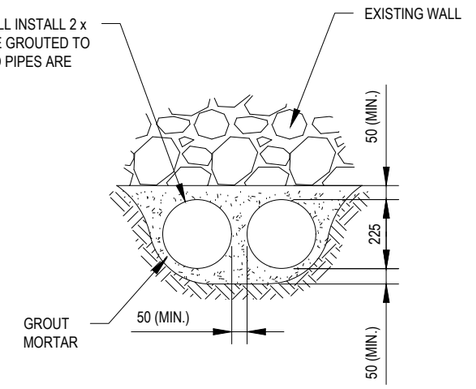


POINT	EASTING	NORTHING	RL
1	757991.50	5938501.70	79.25
2	757995.93	5938504.03	78.90
3	757996.08	5938504.00	78.90, 78.80
4	757996.32	5938503.87	78.80

CONCRETE DIVERSION WALL PLAN

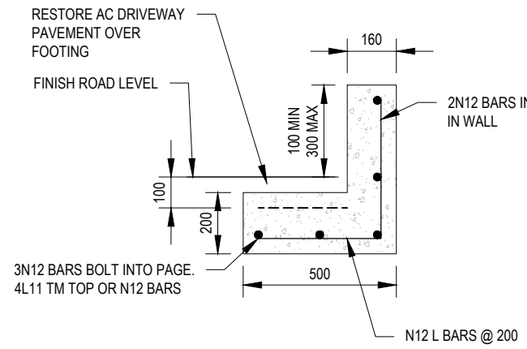
SCALE 1:50

EXCAVATE BENEATH EXISTING ROCK WALL INSTALL 2 x 225Ø PVCu PIPES, 500 LONG. PIPES TO BE GROUTED TO ENSURE WALL IS FULLY SUPPORTED AND PIPES ARE FULLY ENCASED IN GROUT



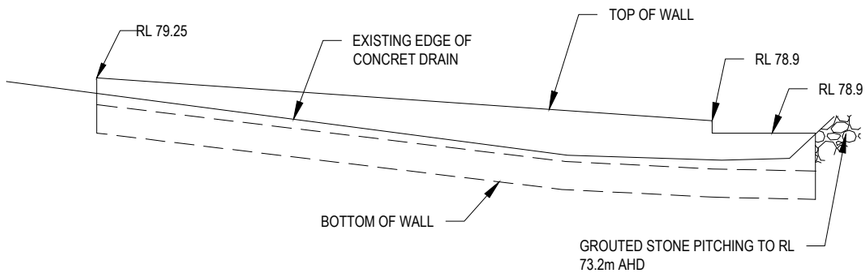
CONCRETE DIVERSION WALL - CROSS SECTION 2

SCALE 1:20



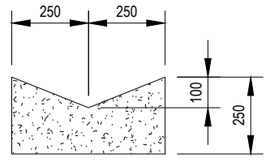
2 - SECTION

SCALE 1 : 20



1 - SECTION

SCALE 1 : 50



MODIFIED SO DISH DRAIN DETAIL

SCALE 1:20

Rev	Description	Checked	Approved	Date
A	REVISED 100% DETAILED DESIGN	HA/MN/DB	DD	09.08.2022

Author A. DE VERA Drafting Check H WARR

Designer H.A / F.K / D.B Design Check K.PINKERTON / M.NGO / D.BANNIGAN

0 0.5 1.0 1.5m
SCALE 1:50 AT ORIGINAL SIZE

0 0.2 0.4 0.6m
SCALE 1:20 AT ORIGINAL SIZE

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Project No. 12554564

Client BEGA VALLEY SHIRE COUNCIL
DR GEORGE MOUNTAIN ROAD

Project EMBANKMENT STABILISATION

Status FOR REVIEW AND COMMENT Status Code S3

Drawing Title DETAILS - DRAINAGE
SHEET 2 OF 2

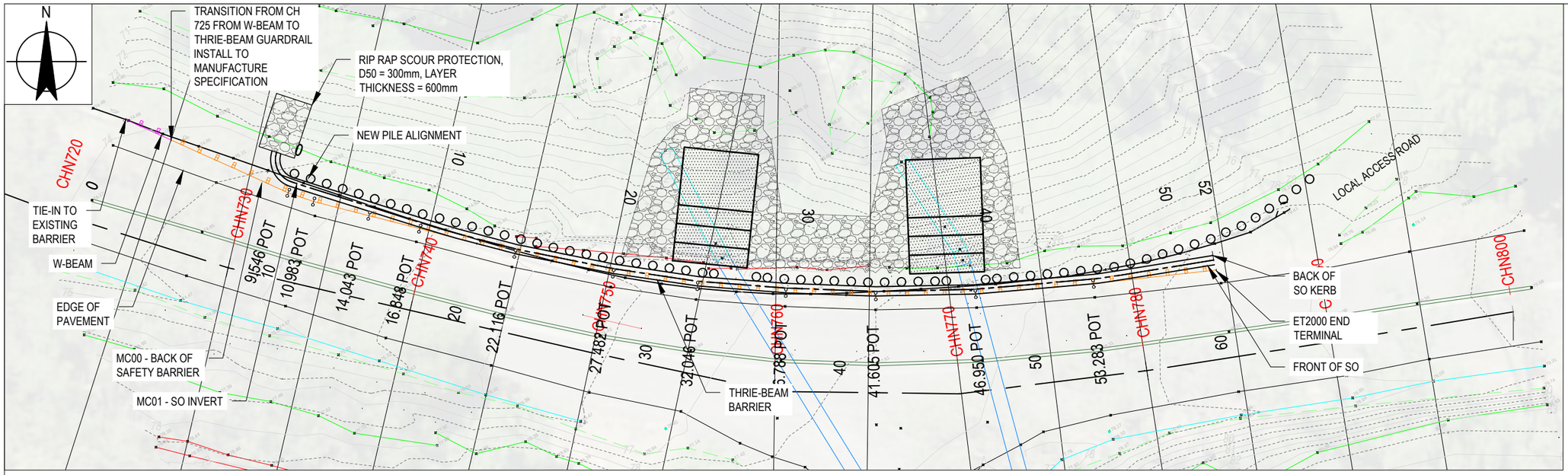
Size A3

Drawing No. 21-12554564-C304

Rev A

Plot Date: 10 August 2022 - 12:58 PM Plotted by: Eldegardo Perez

File Name: \\ghdnet\ghd\AU\Wollongong\Projects\21\12554564\CADD\Drawings\Geotech\21-12554564-C304.dwg



LEGEND

- RECOMMENDED GUARD RAIL ALIGNMENT-DESIGN BY OTHERS
- TOP OF BANK
- TOE OF BANK
- EDGE OF BITUMEN
- EXISTING 750mm DIA. PIPE
- EXISTING PLASTIC PIPE
- GUARD RAIL (THRIE BEAM)
- GUARD RAIL (W-BEAM)

GUARD RAIL PLAN

SCALE 1:200

HORIZONTAL ALIGNMENT REPORT - MC00						
POINT	CHAINAGE	EASTING	NORTHING	ELEMENT	LENGTH	BEARING
START	0	757951.753	5938530.215			
				STRAIGHT	9.546	114°13'23"
HIP	9.546	757960.458	5938526.299			
				STRAIGHT	1.438	109°12'50"
HIP	10.983	757961.816	5938525.826			
				STRAIGHT	3.06	104°16'58"
HIP	14.043	757964.781	5938525.071			
				STRAIGHT	2.805	104°17'49"
HIP	16.848	757967.499	5938524.378			
				STRAIGHT	5.268	104°43'56"
HIP	22.116	757972.594	5938523.039			
				STRAIGHT	5.366	101°23'15"
HIP	27.482	757977.854	5938521.979			
				STRAIGHT	4.564	98°25'12"
HIP	32.046	757982.369	5938521.311			
				STRAIGHT	4.742	94°25'06"
HIP	36.788	757987.097	5938520.946			
				STRAIGHT	4.817	92°07'36"
HIP	41.605	757991.91	5938520.767			
				STRAIGHT	5.345	88°47'46"
HIP	46.950	757997.254	5938520.879			
				STRAIGHT	6.334	84°59'54"
HIP	53.283	758003.564	5938521.431			
				STRAIGHT	6.622	83°36'52"
END	59.905	758010.145	5938522.168			

HORIZONTAL ALIGNMENT REPORT - SO INVERT MC01						
POINT	CHAINAGE	EASTING	NORTHING	ELEMENT	LENGTH	BEARING
START	0	757959.831	5938528.458			198°19'10"
CC		757961.017	5938528.065	R = -1.250	1.982	
CT	1.982	757960.642	5938526.873			107°29'36"
				STRAIGHT	7.256	107°29'36"
HIP	9.237	757967.562	5938524.692			
				STRAIGHT	0.621	107°10'29"
HIP	9.858	757968.155	5938524.508			
				STRAIGHT	0.542	106°46'20"
HIP	10.4	757968.674	5938524.352			
				STRAIGHT	0.853	106°17'08"
HIP	11.254	757969.493	5938524.112			
				STRAIGHT	3.21	104°43'56"
HIP	14.464	757972.598	5938523.296			
				STRAIGHT	0.061	104°20'00"
HIP	14.525	757972.657	5938523.281			
				STRAIGHT	5.333	101°23'15"
HIP	19.858	757977.885	5938522.228			
				STRAIGHT	4.552	98°25'40"
HIP	24.411	757982.389	5938521.561			
				STRAIGHT	3.543	94°25'41"
HIP	27.953	757985.921	5938521.287			
				STRAIGHT	1.216	94°22'40"
HIP	29.169	757987.133	5938521.194			
				STRAIGHT	4.257	92°07'36"
HIP	33.426	757991.387	5938521.036			
				STRAIGHT	0.533	92°04'52"
HIP	33.959	757991.919	5938521.017			
				STRAIGHT	5.259	88°47'46"
HIP	39.218	757997.177	5938521.128			
				STRAIGHT	0.072	88°21'27"
HIP	39.289	757997.249	5938521.13			
				STRAIGHT	6.317	84°59'51"
HIP	45.607	758003.542	5938521.68			
				STRAIGHT	0.278	83°42'34"
HIP	45.885	758003.818	5938521.711			
				STRAIGHT	0.513	81°49'57"
HIP	46.397	758004.326	5938521.784			
				STRAIGHT	0.683	81°25'07"
HIP	47.08	758005.001	5938521.886			
				STRAIGHT	1.288	80°52'53"
HIP	48.368	758006.273	5938522.09			
				STRAIGHT	3.775	80°47'55"
END	52.144	758009.999	5938522.693			

REFERENCE: SURVEY BY VERIS AUSTRALIA PTY LTD DWG 202948 REV 0 DATED 18/08/2021 BASED ON GDA2020 ZONE 55. AERIAL IMAGERY (APRIL 2018) - DEPARTMENT OF CUSTOMER SERVICE 2021.

Rev	Description	Checked	Approved	Date
A	100% DETAILED DESIGN	HA/MN/DB	DD	09.08.2022

Author A. DE VERA Drafting Check H WARR
Designer H.A / F.K / D.B Design Check K.PINKERTON / M.NGO / D.BANNIGAN

0 2 4 6m
SCALE 1:200 AT ORIGINAL SIZE

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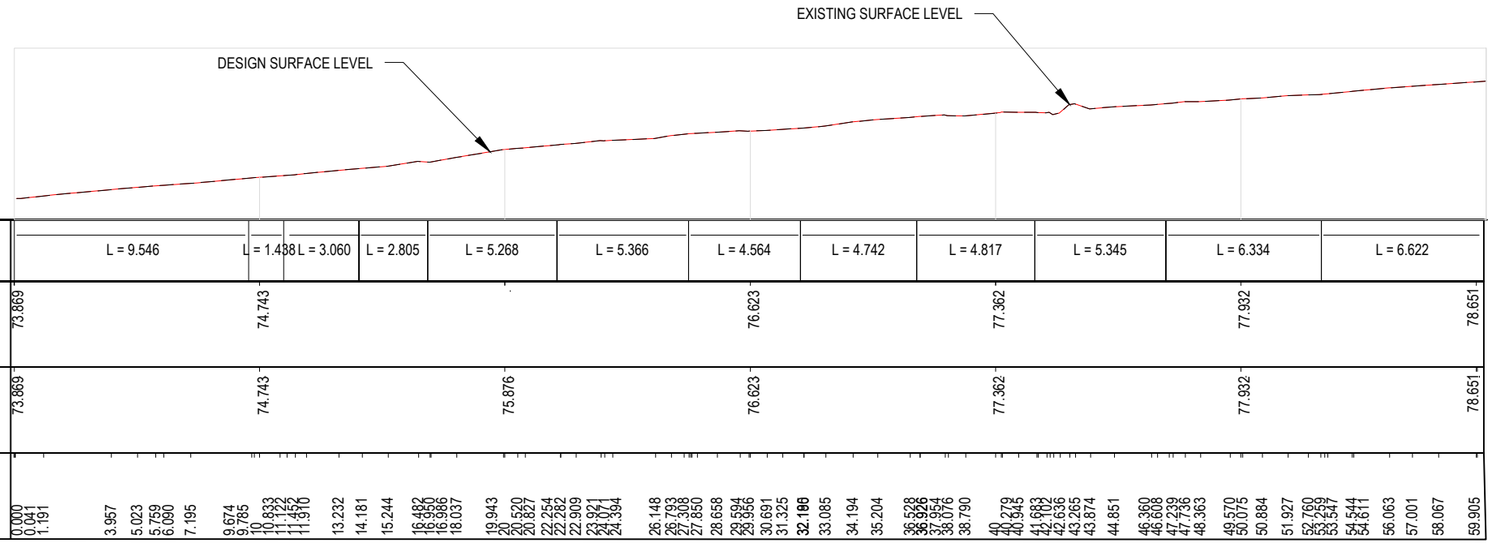
www.ghd.com

Project No. 12554564

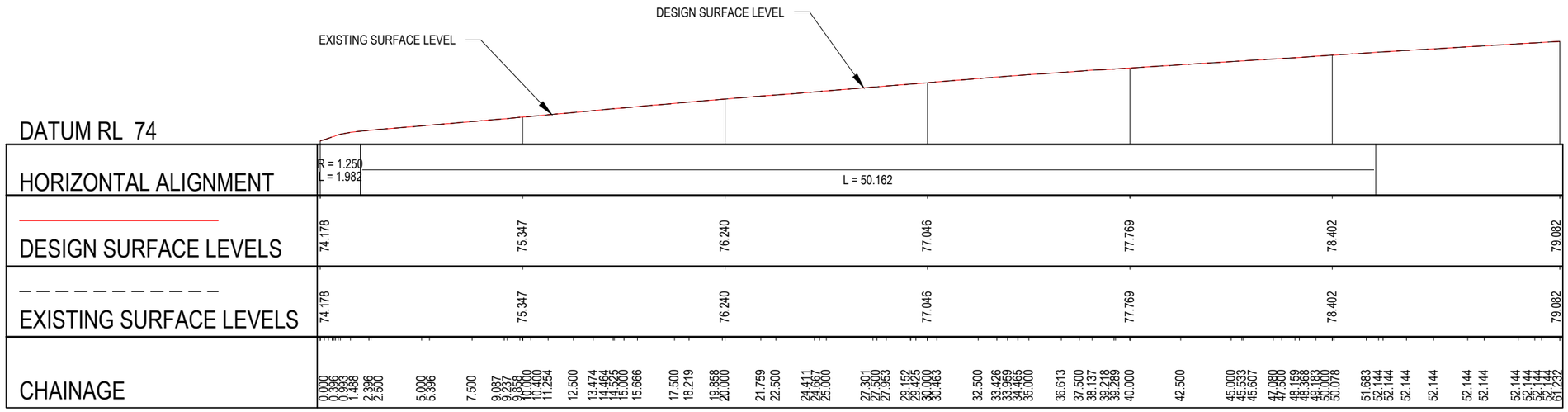
Client BEGA VALLEY SHIRE COUNCIL
Project DR GEORGE MOUNTAIN ROAD EMBANKMENT STABILISATION
Drawing Title GENERAL PLAN AND SET-OUT - GUARD RAILS
Status FOR REVIEW AND COMMENT
Status Code S3
Size A3
Drawing No. 21-12554564-C401
Rev A

Plot Date: 10 August 2022 - 10:19 AM Plotted by: Archerry De Vera File Name: \\ghdnet\ghd\AU\Wollongong\Projects\21\12554564\CADD\Drawings\Geotech\21-12554564-C401.dwg



LONGITUDINAL SECTION - GUARD RAIL - MC00

SCALE 1:250



LONGITUDINAL SECTION - SO INVERT - MC01

SCALE 1:250

REFERENCE: SURVEY BY VERIS AUSTRALIA PTY LTD DWG 202948 REV 0 DATED 18/08/2021 BASED ON GDA2020 ZONE 55.

Rev	Description	Checked	Approved	Date
A	REVISED 100% DETAILED DESIGN	HA/MN/DB	DD	09.08.2022

Author: A. DE VERA — Drafting Check: H WARR
Designer: H.A / F.K / D.B — Design Check: K.PINKERTON / M.NGO / D.BANNIGAN

0 2.5 5.0 7.5m
SCALE 1:250 AT ORIGINAL SIZE

bega valley shire council

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Project No. 12554564

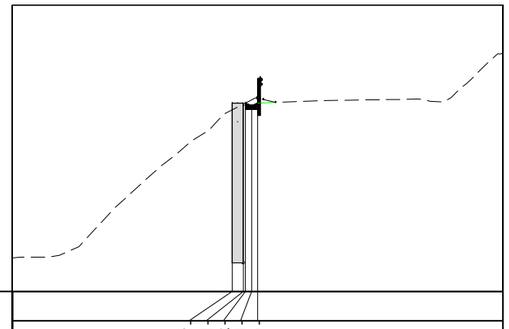
Client: BEGA VALLEY SHIRE COUNCIL
DR GEORGE MOUNTAIN ROAD
Project: EMBANKMENT STABILISATION

Drawing Title: LONGITUDINAL SECTION

Status: FOR REVIEW AND COMMENT — Status Code: S3

Size: A3
Drawing No.: 21-12554564-C402
Rev: A

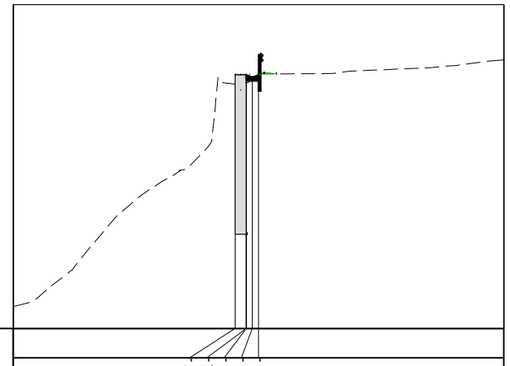
Plot Date: 9 August 2022 - 5:35 PM — Plotted by: Archerry De Vera — File Name: \\ghdnet\ghd\AU\Wollongong\Projects\21\12554564\CADD\Drawings\Geotech\21-12554564-C402.dwg



R.L. 68	W-T	W-T1	CB-R	MC01	MC00
DESIGN FEATURES					
DESIGN LEVELS	75.666	75.666	75.666	75.566	75.876
EXISTING LEVELS	75.399	75.629	75.675	75.804	75.876
DESIGN OFFSETS	-1.040	-0.590	-0.500	-0.250	-0.000

MC00 20.00

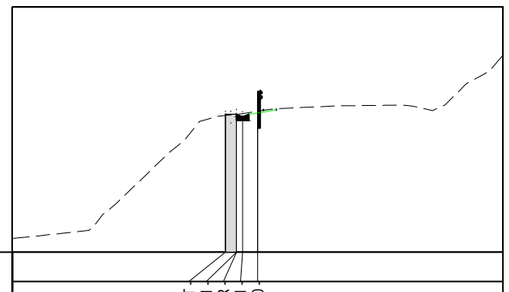
SCALE 1:250



R.L. 67	W-T	CB-R	W-T1	MC01	MC00
DESIGN FEATURES					
DESIGN LEVELS	77.336	77.336	77.336	77.236	77.362
EXISTING LEVELS	76.953	76.995	76.995	77.158	77.362
DESIGN OFFSETS	-0.950	-0.500	-0.500	-0.250	-0.000

MC00 40.00

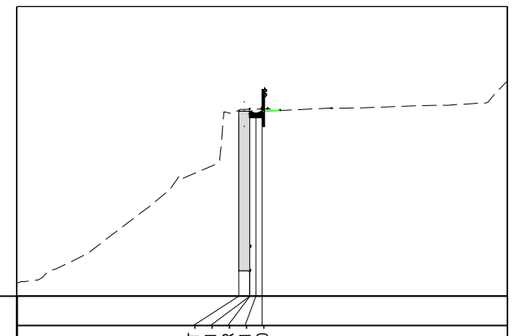
SCALE 1:250



R.L. 69	W-T	W-T1	CB-R	MC01	MC00
DESIGN FEATURES					
DESIGN LEVELS	74.617	74.616	74.616	74.515	74.743
EXISTING LEVELS	74.565	74.616	74.616	74.645	74.743
DESIGN OFFSETS	-1.317	-0.866	-0.866	-0.616	-0.000

MC00 10.00

SCALE 1:250



R.L. 69	W-T	W-T1	CB-R	MC01	MC00
DESIGN FEATURES					
DESIGN LEVELS	76.529	76.529	76.529	76.429	76.623
EXISTING LEVELS	76.571	76.612	76.612	76.618	76.623
DESIGN OFFSETS	-0.950	-0.500	-0.500	-0.250	0.000

MC00 30.00

SCALE 1:250

REFERENCE: SURVEY BY VERIS AUSTRALIA PTY LTD DWG 202948 REV 0 DATED 18/08/2021 BASED ON GDA2020 ZONE 55.

Rev	Description	Checked	Approved	Date
A	REVISED 100% DETAILED DESIGN	HA/MN/DB	DD	09.08.2022

Author A. DE VERA Drafting Check H WARR

Designer H.A / F.K / D.B Design Check K.PINKERTON / M.NGO / D.BANNIGAN

0 5 10 15m

SCALE 1:500 AT ORIGINAL SIZE

bega valley shire council

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Project No. 12554564

Client BEGA VALLEY SHIRE COUNCIL

Project DR GEORGE MOUNTAIN ROAD EMBANKMENT STABILISATION

Status FOR REVIEW AND COMMENT Status Code S3

Drawing Title CROSS SECTIONS SHEET 1 OF 2

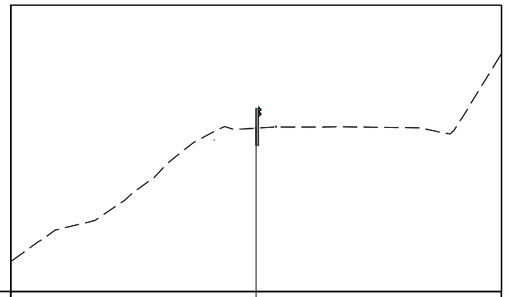
Size A3

Drawing No. 21-12554564-C403

Rev A

Plot Date: 9 August 2022 - 5:33 PM Plotted by: Archerry De Vera

File Name: \\ghdnet\ghd\AU\Wollongong\Projects\21\12554564\CADD\Drawings\Geotech\21-12554564-C403.dwg

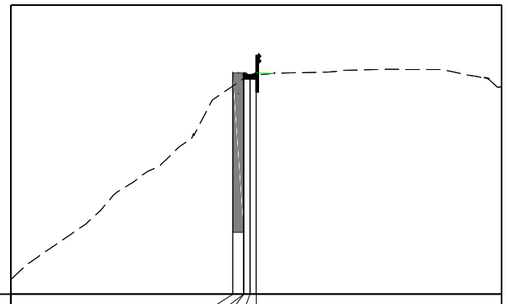


R.L. 72

DESIGN FEATURES	MC00
DESIGN LEVELS	78.651
EXISTING LEVELS	78.651
DESIGN OFFSETS	-0.000

MC00 59.905

SCALE 1:250



R.L. 68

DESIGN FEATURES	W-T	CB-R	MC01	CF-R	MC00
DESIGN LEVELS	78.016	78.016	78.016	77.916	77.932
EXISTING LEVELS	77.482	77.793	77.793	77.908	77.932
DESIGN OFFSETS	-0.949	-0.500	-0.499	-0.250	0.000

MC00 50.00

SCALE 1:250

REFERENCE: SURVEY BY VERIS AUSTRALIA PTY LTD DWG 202948 REV 0 DATED 18/08/2021 BASED ON GDA2020 ZONE 55.

Rev	Description	Checked	Approved	Date
A	REVISED 100% DETAILED DESIGN	HA/MN/DB	DD	09.08.2022

Author A. DE VERA Drafting Check H WARR

Designer H.A / F.K / D.B Design Check K.PINKERTON / M.NGO / D.BANNIGAN

0 5 10 15m

SCALE 1:500 AT ORIGINAL SIZE

bega valley shire council

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Project No. 12554564

Client BEGA VALLEY SHIRE COUNCIL
DR GEORGE MOUNTAIN ROAD

Project EMBANKMENT STABILISATION

Status FOR REVIEW AND COMMENT Status Code S3

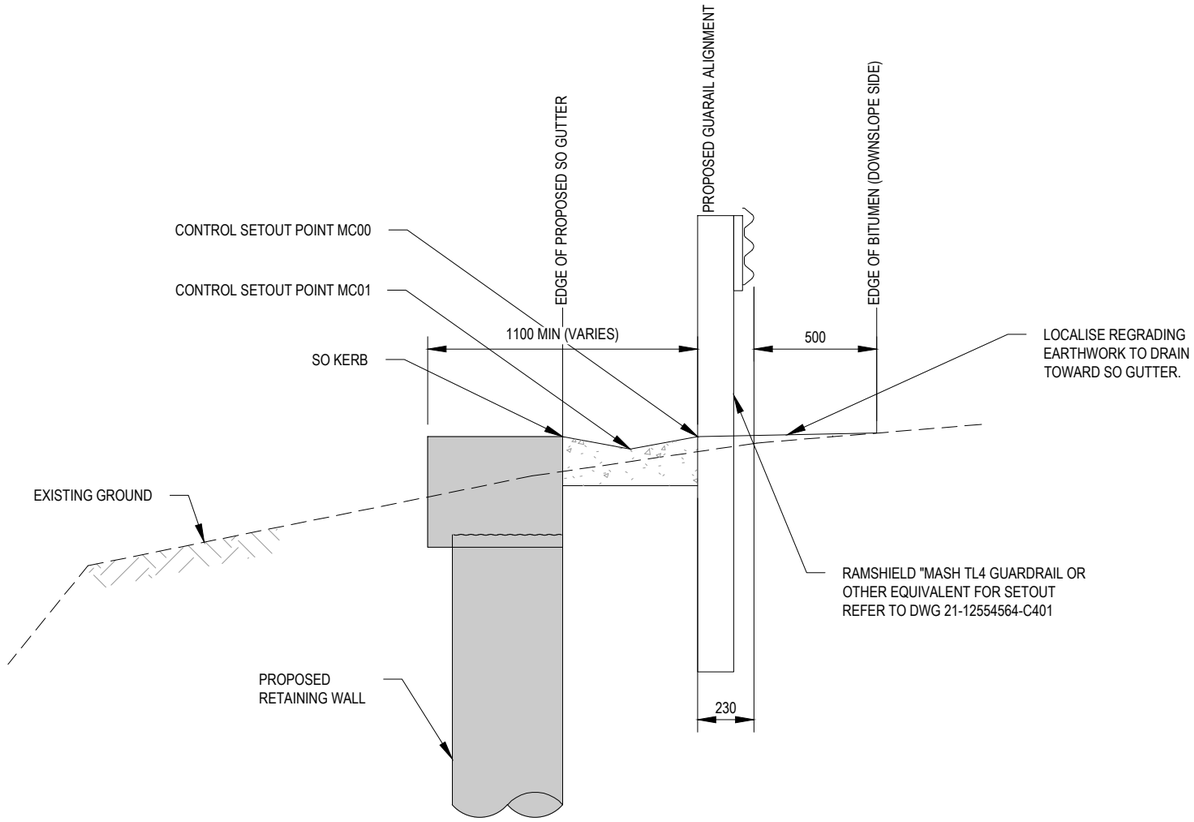
Drawing Title CROSS SECTIONS
SHEET 2 OF 2

Size A3

Drawing No. 21-12554564-C404

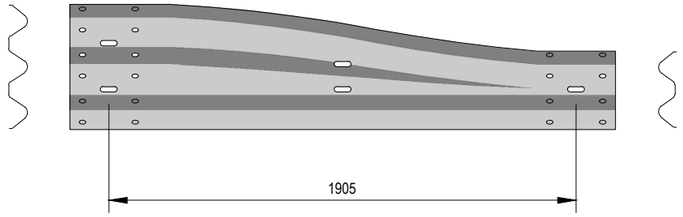
Rev A

Plot Date: 9 August 2022 - 5:31 PM Plotted by: Archerry De Vera File Name: \\ghdnet\ghd\AU\Wollongong\Projects\21\12554564\CADD\Drawings\Geotech\21-12554564-C404.dwg



TYPICAL DETAIL

SCALE 1:25



TRANSITION TO W-BEAM

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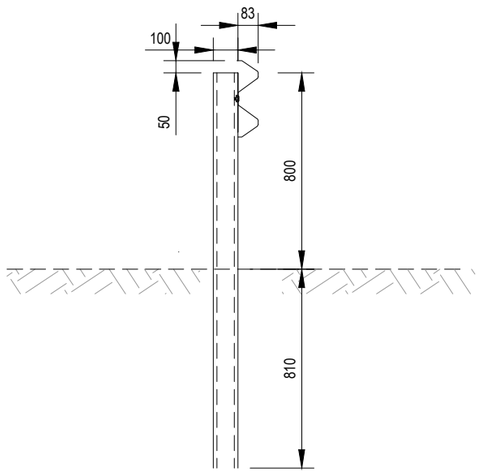
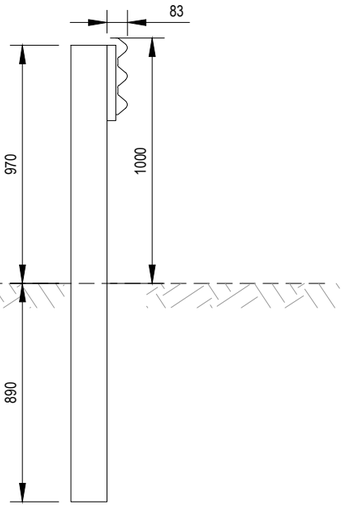


W-BEAM TYPICAL DETAIL

SCALE 1:25



THRIE-BEAM TYPICAL DETAIL

SCALE 1:25

Rev	Description	Checked	Approved	Date
A	REVISED 100% DETAILED DESIGN	HA/MN/DB	DD	09.08.2022

Author	A. DE VERA	Drafting Check	H WARR
Designer	H.A / F.K / D.B	Design Check	K.PINKERTON / M.NGO / D.BANNIGAN

0 0.25 0.5 0.75m

SCALE 1:25 AT ORIGINAL SIZE

bega valley shire council

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Project No. 12554564

Client: BEGA VALLEY SHIRE COUNCIL
Project: DR GEORGE MOUNTAIN ROAD EMBANKMENT STABILISATION

Status: FOR REVIEW AND COMMENT — Status Code: S3

Drawing Title: TYPICAL DETAILS GUARD RAILS

Size: A3

Drawing No.: 21-12554564-C405

Rev: A

Plot Date: 10 August 2022 - 1:02 PM Plotted by: Archerry De Vera File Name: \\ghdnet\ghd\AU\Wollongong\Projects\21\12554564\CADD\Drawings\Geotech\21-12554564-C405.dwg

Appendix G

Revised 100% Design cost estimate

De Waal Advisory
trust + verify

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23 August 2022

GHD
Level 11, 200 Crown Street
WOLLONGONG NSW 2500

For the attention of: Daniel Deen
Team Leader – Geotechnical Services

Dear Daniel

BEGA VALLEY SHIRE COUNCIL: DR GEORGE MOUNTAIN ROAD EMBANKMENT STABILISATION COST ESTIMATE OF 100% DESIGN DOCUMENTATION
REVISION 3 UPDATE

Our opinion of the construction cost of the embankment stabilisation is as follows:

Cost Centre	Current Estimate ($)	Jan 2022 Estimate ($)
Stabilisation construction contract	927,000	769,000
Client costs including internal fees, contract supervision and approval costs	65,000	54,000
Escalation allowance to receipt of tenders	17,000	11,000
Location allowance, COVID impact and contingencies	298,000	285,000
ANTICIPATED OUT-TURN COST	**1,307,000**	**1,119,000**

GST is excluded from all figures

This estimate is issued for the purposes of establishing the likely cost of the project based on GHD's updated documentation of August 2022 and is issued subject to the limitations statement noted on the estimate.

Trusting that the above meets your requirements.

Yours sincerely
for and on behalf of De Waal Advisory

A. E. deWaal

Adré de Waal, Principal
MRICS MAIQS CQS MAIPM

Code	Description	Total	Jan 21 Estimate	Variance
	BEGA VALLEY SHIRE COUNCIL			
	DR GEORGE MOUNTAIN ROAD EMBANKMENT STABILISATION			
	DETERMINISTIC COST ESTIMATE			
	REV 3, 22 AUGUST 2022			
	PREAMBLES			
	The lead consultant is GHD, Wollongong			
	The estimate is based on GHD's 100% design report and Revision A drawings of 9 August 2022, which now includes stormwater treatment, gutters, barriers, etc to represent a completed project			
	COST ESTIMATE			
	Direct Construction Costs			
1	Preliminaries, Site Establishment and Management Costs	198,000	185,000	13,000
2	Traffic Management Costs	124,000	117,000	7,000
3	Direct Construction Costs	506,000	385,000	121,000
4	Contractor's Margin (12%)	99,000	82,000	17,000
	ESTIMATED CONSTRUCTION CONTRACT	**927,000**	**769,000**	**158,000**
	Client Costs			
5	Internal project management fee (2.5%)	23,000	19,000	4,000
6	Allowance for PAP services (4%)	37,000	31,000	6,000
7	Land acquisition and property cost			
8	Design Fees (0%)			
9	Construction Certificate Fees (0.45%)	5,000	4,000	1,000
	PROJECT BASE COST	**992,000**	**823,000**	**169,000**
	Contingency Allowances			
10	Escalation allowance for 6 months to RFT at 3.5% per annum	17,000	11,000	6,000
11	Location allowance / COVID supply chain issues (5%)	50,000	38,000	12,000
12	Contingent risk allowance (25%)	248,000	247,000	1,000
	ANTICIPATED OUT-TURN COST EXCL GST	**1,307,000**	**1,119,000**	**188,000**
	CLARIFICATIONS			
	De Waal Advisory has prepared this document in accordance with the instructions of their client for their sole and specific use for the purposes stated in this report. De Waal Advisory otherwise disclaims any responsibility or liability to any other party, and this includes the exclusion of implied warranties and conditions to the extent it is legal to do so			
	This estimate has been prepared in accordance with generally accepted consulting practices and no other warranty, expressed or implied, is made as to the professional advice included in this proposal. Where we form opinions, draw conclusions, or make recommendations those are based on the information contained in this report or on information provided by others and the assumption is that all relevant information has been supplied by them; and we have used that information without further independent verification. De Waal Advisory disclaims any liability from any of those opinions, conclusions or recommendations being found incorrect after the fact			

Code	Description	Quantity	Unit	Rate	Total	Change on Jan21 Estimate
1	**Preliminaries, Site Establishment and Management Costs**					
	PRELIMINARIES, SITE ESTABLISHMENT AND MANAGEMENT COSTS					
	Preambles					
	This being a small project, the superintendent when on site, will share with the contractor		note			
	Temporary site fencing and barriers are allowed with traffic management		note			
	It is not anticipated that there are any existing services to be relocated		note			
	Project Duration Estimate					
	Site establishment and TTM arrangements	1.0	wks			
	Excavate and site preparation, scaffold	2.0	wks			
	Bored piers	1.5	wks			
	RC capping beam, curing and stripping formwork	2.0	wks			
	PC wall	1.0	wks			
	RC in-situ components	1.0	wks			
	Backfill behind wall, guard rail, etc	2.0	wks			
	Road repairs	0.5	wks			
	Dis-establishment	0.5	wks			
	Total	11.5	wks			
	General requirements					
1.1	Site Establishment	1	ls	18,075.00	18,075	
1.2	Site office	1	ls	4,225.00	4,225	
1.3	Supervision of works (PM 50%, SM full time)	12	wks	5,019.23	57,721	7,529
1.4	Insurances, bonds, etc, managing the GC21 contract	1	ls	9,500.00	9,500	
1.5	Crane/plant hire, materials handling, etc	12	wks	1,200.00	13,800	1,800
1.6	Project Signs	2	no	1,750.00	3,500	
1.7	Coordination with Utility Authorities	1	ls	1,500.00	1,500	
1.8	Liaison and coordination with Principal's surveyor for setout information	1	ls	4,500.00	4,500	
1.9	Liaison and coordination with Principal's Geotechnical Engineer for classifications and inspections	1	ls	3,500.00	3,500	
1.10	Liaison and coordination with Principal's Cultural Heritage Consultant	1	ls	2,500.00	2,500	
1.11	Surveyor setout and WAE documentation	12	wks	1,600.00	18,400	2,400
	Quality Construction					
1.12	Quality system documents and records	1	ls	4,750.00	4,750	
1.13	Quality verification and control – Additional testing of soil samples and concrete	1	ls	8,775.00	8,775	
1.14	Preparation of WAE documentation and submission	75	hrs	250.00	18,750	
	Control of Erosion and Sedimentation					

Code	Description	Quantity	Unit	Rate	Total	Change on Jan21 Estimate
1	**Preliminaries, Site Establishment and Management Costs**					*(Continued)*
1.15	Establishment of silt fences, filter areas and the like	1	ls	2,675.00	2,675	
1.16	Maintenance for the contract duration (one day per week)	12	wks	600.00	6,900	900
1.17	Disestablishment	1	ls	3,000.00	3,000	
1.18	Dept of Fisheries permit	1	ls	600.00	600	
	Fall Protection					
1.19	Install and ultimately remove 65m single rise scaffold and fall protection on steep down-slope portion of the works	1	item	9,000.00	9,000	
1.20	Scaffold hire	6	weeks	925.00	5,550	
	Preliminaries, Site Establishment and Management Costs				**197,221**	**12,629**

Code	Description	Quantity	Unit	Rate	Total	Change on Jan21 Estimate
2	**Traffic Management Costs**					
	TRAFFIC MANAGEMENT COSTS					
	Preambles					
	The methodology is to provide portable traffic lights generally but bring physical traffic controllers onto site when concrete pours or large deliveries or hoisting are scheduled		note			
	Traffic Management Measures					
2.1	Control of traffic (2 people for 3 days per week) for half the contract period	6	wks	3,600.00	20,700	2,700
2.2	Portable Traffic signals	12	wks	1,250.00	14,375	1,875
2.3	Temporary lighting	12	wks	450.00	5,175	675
2.4	Variable message signs	12	wks	1,750.00	20,125	2,625
2.5	Temporary concrete barriers	75	m	181.33	13,600.00	
2.6	Shift concrete barriers, one instance	1	no	5,000.00	5,000.00	
2.7	Risk management allowance for traffic management	1	item	45,000.00	45,000	
	Traffic Management Costs				**123,975**	**7,875**

Code	Description	Quantity	Unit	Rate	Total	Change on Jan21 Estimate
3	**Direct Construction Costs**					
	DIRECT CONSTRUCTION COSTS					
	Preambles					
	The estimated costs take into account the construction sequence which GHD proposes in their 100% Design Report dated 29 October 2021		note			
	The lower access road leading to the existing filter ponds is overgrown and probably too far below the road level to provide useful access the proposed work area, therefore the estimate allows for all works to occur from road level		note			
	The estimate allows for the following construction methodology					
	Site establishment (probably) on land borrowed from neighbours, comprising a fenced compound, shed and ablutions		note			
	Erection of traffic barriers to slow and redirect traffic through a single lane on the up-slope side of the works, including mobile traffic lights and VMS boards		note			
	Remove existing guardrail to allow access to the work site		note			
	Excavate for working space up to road shoulder and to down-slope run-out to proposed base level of new precast wall panels		note			
	Remove existing steel post and timber log retaining wall, and stabilise disturbed areas as required		note			
	Install scaffold and fall protection on down-slope		note			
	Setup and construct bored piers		note			
	Form and construct capping beam		note			
	Set up base and install precast panels		note			
	Form and construct in-situ wall segments		note			
	Install subsoil drainage and membrane, and backfill up to shoulder of road, pour channel		note			
	Install gabion boxes and rip rap		note			
	On the down-slope side of the retaining wall, backfill and reform slope, stabilise slope and seed		note			
	Install guardrail		note			
	Repair damage to existing road, which is anticipated due to heavy construction vehicles twisting and turning over road surface and road edge		note			
	Dis-establish site and remediate any damage to site compound area and any swales disturbed during construction operations		note			
	Remove temporary traffic management arrangements		note			
	Site Preparation					
3.1	Remove existing metal guard rail and posts, set aside for re-use	4	m/days	720.00	2,880	

Code	Description	Quantity	Unit	Rate	Total	Change on Jan21 Estimate
3	**Direct Construction Costs**					*(Continued)*
3.2	Remove existing timber and steel retaining wall and dispose of material	1	item	12,320.00	12,320	
3.3	Excavate for working space	183	m3	31.09	5,690	-1,150
3.4	Cart spoil off site, dumping for free (say 3hr return trip)	183	m3	58.50	10,706	-2,165
	Bored Piers					
3.5	Mobilisation and demobilisation of piling plant	1	item	17,500.00	17,500	
3.6	450mm Dia piers including drilling, concrete and temporary sockets if needed in unstable embankment	411	m	375.00	154,125	14,050
3.7	Extra for socketing into rock	124	m	150.00	18,600	3,900
3.8	Labour only cleaning bottom of pile hole	62	no	150.00	9,300	-450
3.9	Labour only trimming top of pier	62	no	125.00	7,750	-375
3.10	Rebar in piers at 150kg/m3	9.90	t	3,250.00	32,175	12,025
3.11	Attendance of Geotechnical Engineer during pile drilling	12	hrs	210.00	2,520	
3.12	Allowance for pile testing	2	no	350.00	700	
	Capping Beam & In-situ Walls					
3.13	Reinforced concrete in capping beam including placing and pumping	13	m3	424.75	5,522	-1,274
3.14	Rebar in capping beam	1.6	t	3,250.00	5,200	-975
3.15	Formwork to sides and soffits of capping beam	74	m2	145.00	10,730	-2,030
3.16	In-situ wall panels including small quantities penalty	8	m2	892.74	7,142	628
	Precast Panels					
3.17	Supply precast panels	45	m2	500.00	22,500	900
3.18	Transport to site (25t)	3	trips	1,260.00	3,780	
3.19	Crane hire	4	days	1,800.00	7,200	
3.20	Installation	16	m/days	760.00	12,160	
3.21	Cement stabilised base	35	m2	100.00	3,500	-100
3.22	32MPa Blinding layer including placing and pumping	35	m2	133.78	4,682	-134
3.23	Miscellaneous fixings, bond breaker, etc	1	item	2,000.00	2,000	
	Backfilling and Sub-soil Drainage					
3.24	Agi line in drainage material wrapped in geotextile	51	m	65.00	3,315	-650
3.25	Backfill behind retaining wall, including compaction, etc	132	m3	75.00	9,900	-2,025
3.26	Fill in front of retaining wall and stabilise re-created slope with jute matting and grass seeding	152	m2	100.53	15,281	-3,117
	Guardrail					
3.27	Thriebeam guard rail	58	m	325.00	18,850	18,850
3.28	Tie to W beam and small extension to existing rail	1	no	3,500.00	3,500	3,500
3.29	ET2000 End terminal	1	no	2,500.00	2,500	2,500
	Stormwater Items					

Code	Description	Quantity	Unit	Rate	Total	Change on Jan21 Estimate
3	**Direct Construction Costs**					*(Continued)*
3.30	New inlet sump and grate connected into existing 750mm pipeline including excavation, backfilling and reinstatement of existing surfaces to fall towards the sump	1	no	6,240.00	6,240	6,240
3.31	1.8m 750mm Extension to existing pipeline	1	no	1,635.00	1,635	1,635
3.32	Concrete bund wall	7	m	798.57	5,590	5,590
3.33	Drain below existing rock wall per dwg C304	1	item	1,000.00	1,000	1,000
	Miscellaneous Items					
	Due to small quantities the stone items have been priced from first principles rather than standard industry rates		note			
3.34	Gabion cages	24	m	688.33	16,520	16,520
3.35	300mm Reno mattresses	25	m2	373.20	9,330	9,330
3.36	600mm Rip rap	99	m2	228.15	22,587	22,587
3.37	Miscellaneous backfill behind gabions in excess of other allowances, and some concrete capping layers	2	no	2,500.00	5,000	5,000
3.38	SO Kerb	53	m	95.00	5,035	-2,565
3.39	7mm Seal to re-instate road surface	421	m2	36.00	15,156	10,156
3.40	Allowance for line marking and minor road furniture	1	item	5,000.00	5,000	5,000
	Direct Construction Costs				**505,120**	**120,902**

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