GOLDER
MEMBER OF WSP

22 June 2021 Reference No. 20139217-006-L-Rev0

Josef Casilla
City of Norwood Payneham and St Peters
175 The Parade
NORWOOD SA 5067

ST PETERS BILLABONG, INPUT TO ENGINEERED SOLUTIONS
OUTLINE DESIGNS AND INDICATIVE ESTIMATES OF POSSIBLE CONSTRUCTION COST RANGES

Dear Josef,

1.0 INTRODUCTION

City of Norwood, Payneham and St Peters (Council) has engaged Golder Associates Pty Ltd (Golder) to undertake an assessment of the riverbank slopes and cliffs at St Peters Billabong located adjacent River Street and Eighth Avenue, St Peters. Golder undertook a visual assessment of the riverbank slopes and soil cliffs with the findings of our assessment presented in our report 20139217-002-L-Rev2 dated 24 November 2020. Our report included commentary on possible options for engineering solutions to assist with the management of erosion and slope instability.

Golder has also previously provided Council with preliminary concept drawings and budget costing for installation of erosion control matting at the site (Golder reference no. 20139217-003-L-Rev1, dated 15 September 2020).

This letter provides further guidance on each of the possible options presented in our initial report, including a summary of an outline design for each of the options, associated commentary and assumptions, and indicative estimates of a possible range of construction costs.

2.0 SITE DESCRIPTION AND EXISTING GEOMETRY

The site is located on the east side of the St Peters Billabong and covers a length of approximately 200 m, between the River Park Carpark (at the northern end) and the boundary between 12 Eighth Avenue and Cliff Goodwin Reserve (at the southern end).

An aerial image of the site, showing the approximate location of the area assessed is provided in Figure 1 below.

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Figure 1: Site Location

Council provided the following information to assist in our initial assessment:

- Coffey Report titled '*Slope Stability Assessment, St Peters Urban Wetland*' (reference A3256/1-AF dated 14 December 2000).

It has been assumed that the topographical survey provided in that report is still applicable for the site. Typical sections have been considered based on those adopted previously for the erosion control matting preliminary concept (refer Golder report 20139217-003-L-Rev1, dated 15 September 2020) and site observations made as part of our initial geotechnical assessment (refer Golder report 20139217-002-L-Rev2, dated 24 November 2020).

A general description of the geometry of the site is provided below.

- Generally, the slopes in the area assessed were between approximately 10 m and 12 m in total height. The geometry of the slopes varies largely depending on whether comprise near vertical soil cliffs and/or battered slopes.

- The soil cliffs were present behind properties located at 12 Eighth Avenue and between 15 and 19 River Street. The soil cliffs are near vertical from the crest with a height of between 3 m and 5 m. The area below the vertical sections was battered at an angle of approximately 45 degrees.
- The battered slopes were present behind the remaining properties and had an overall slope angle of approximately 45°, with some localised steeper sections where erosion and localised slumping has occurred.
- Residential properties are typically located at the crest of the slope with fence boundaries located at the crest to approximately 10 m away from the crest. The St Peters Billabong is located at the toe of the slope.

Reference should be made to our initial geotechnical assessment report for further information, including site observations and photographs.

3.0 OUTLINE DESIGNS AND BUDGET COSTINGS

Table 1 presents a summary of outline designs for each of the following engineering solution options:

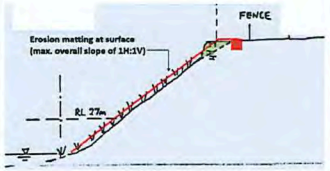
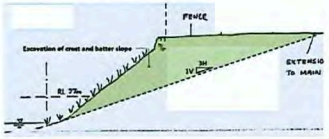
- Erosion protection matting
- Earthworks solution
- Piled wall (embedded)
- Soil nails
- Gabion/crib wall.

The engineering solution types are based on those presented in our geotechnical assessment report (20139217-002-L-Rev2) as possible options to assist with the management of erosion and slope instability. That report should be referred to for further comment on the applicability and suitability of these options. For each of the outline design options we have provided a budget estimate of costs for construction and/or supply and installation. The costs have been calculated based on a per linear metre of riverbank.

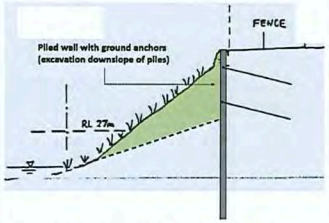
Commentary has also been provided on whether the risks of erosion and global instability has been addressed; and other assumptions and construction related considerations.

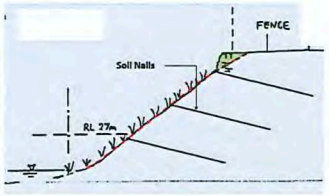
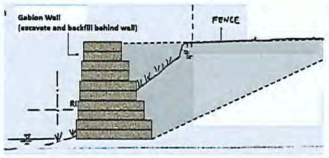
Rough sketches have been provided in Table 1 to help visualise the outline designs described. These are not drawn to scale and are for information purposes only. They have not been provided as design drawings.

Table 1: Option Assessment

Option no.	Engineering solution type	Outline design	Indicative range of construction costs (per linear metre)	Erosion and global stability impacts	Construction and other considerations / assumptions
1	**Erosion protection matting**	Soil cliff (at crest of slope) to be excavated to form maximum overall slope angle of 1V:1H. Erosion protection matting installed across face of slope. Anchor trench to be located 1 m from excavated slope crest. Matting to be pinned at 1 m intervals longitudinally along the matting overlaps and at 1.2 m intervals across width of matting. 	**$500 – $1000 /m** **(approx. $100,000-$200,000 based on 200m length)** Includes: ■ Site preparation / excavation and disposal of soil. ■ Supply and installation of erosion matting. Excludes: ■ Approvals, land acquisition, demolition, and other site access constraints, etc. ■ Geotechnical investigation. ■ Detailed design and documentation.	■ Addresses the primary hazard of slope erosion. ■ Does not contribute to global stability of slope.	■ Site preparation dependent on existing geometry (i.e., volume of material to be removed based on presence of soil cliff at crest of slope and existing overall slope angle. ■ Further considerations to be addressed include access to the crest, toe and slope; anchoring of the erosion protection at the crest and toe of the slope; and global stability assessment. ■ Access to the toe and crest of the slope would be required for earthworks and lifting equipment and this would require access through/to private properties and would also impact on the billabong.
2	**Earthworks solution**	Flattening of the slope (from 1H:1V to an overall batter of 3H:1V to 4H:1V). Crest and batter slope excavated to achieve a maximum overall batter slope of 3H:1V.  *Consideration could also be given to flattening the slope by extending the batter into the billabong, or a combination of cut and fill.*	**$1,500 – $3,000 /m** **(approx. $300,000-$600,000 based on a 200m length)** Includes: ■ Site preparation / excavation and disposal of soil. Excludes: ■ Supply and installation of erosion protection (refer above). ■ Approvals, land acquisition, demolition, and other site access constraints, etc. ■ Geotechnical investigation. ■ Detailed design and documentation.	■ Does not address the primary hazard of slope erosion. ■ Reduces risk of slope instability.	■ Site preparation dependent on existing geometry (i.e., volume of material to be removed based on existing overall slope angle). ■ Costs based on excavating the crest and batter slope from an assumed average slope of 1H:1V and 10 m high to a slope of 3H:1V. Would require excavation and disposal of approximately 90 m^3 of soil per linear metre. ■ Requires acquisition of land, access to private properties in places and possible demolition of buildings in places. ▪ Access to the toe and crest of the slope would be required for earthworks machinery and construction equipment. ▪ Flattening of the slope from 1H:1V would require set back of the crest in the order of 20 m from its existing position (and into the residential properties). ■ Flattening of the slope could also be achieved by: ▪ Placing of fill at the toe (and into the billabong), or ▪ A cut/fill combination whereby flattening of the slope is achieved partially by excavation of the upper portion of the slope (and into the residential properties) and partially by placing fill at the toe (and into the billabong).

Option no.	Engineering solution type	Outline design	Indicative range of construction costs (per linear metre)	Erosion and global stability impacts	Construction and other considerations / assumptions

3	**Piled wall (embedded)**	Secant (or contiguous) piles installed at crest of slope with regularly spaced ground anchors.
		
		Outline design considers piles approximately 20 m long (i.e., depth of embedment equivalent to height of slope) installed from top of slope.
		
		Costs based on 500 mm diameter reinforced concrete piles at 1.2 m centres. Allowance of 1 ground anchor per 5 m^2 of wall.
		
		Piled wall allows excavation of downslope material to flatten slope if required.
		
		 
		
		Consideration could also be given to a combined earthworks/piled approach, whereby piles are installed downslope of the crest and backfilled behind to reclaim additional land at the crest.
			$15,000 – $35,000 /m
			
			(approx. $3.0M-$7.0M based on a 200m length)
			
			Includes:
			■ Site preparation / excavation and disposal of soil.
			■ Mobilisation & setup of piling rig and construction of pile wall.
			■ Installation of ground anchors.
			
			Excludes:
			■ Approvals, land acquisition, demolition, and other site access constraints, etc.
			■ Geotechnical investigation.
			■ Detailed design and documentation.
				■ Would provide a physical barrier and assist in reducing the overall rate of slope retreat.
				■ Factor of safety against global instability to form basis of design.
					■ Prices are based on a broad indication only for work in typical conditions (i.e., does not consider site access constraints – be it access for a drilling rig and other construction equipment at the crest, and/or toe of slope).
					■ Access to the crest of the slope would be required for relatively large construction equipment over an area of 10 m to 20 m. This would require acquisition of land, access to private properties and demolition of some of the buildings.
					■ Alternate designs could also be considered whereby piled wall is constructed downslope of the crest, such as:
					  ▪ Piled wall constructed at the toe of the existing slope and filled behind to create more usable space at the top of the slope.
					  ▪ Pile wall constructed midway between the property boundaries and the toe of slope and filled behind to either partially or fully to flatten the existing slope or create more useable space at the top of the slope.

Option no.	Engineering solution type	Outline design	Indicative range of construction costs (per linear metre)	Erosion and global stability impacts	Construction and other considerations / assumptions
4	**Soil nails**	Soil nails installed at approximately 1.5 m centres (horizontally and vertically). Site preparation activities to include minimal excavation to remove soil cliffs and form maximum overall slope angle of 1V:1H (as per erosion protection matting). Costs based on 3 to 4 nails per linear metre of wall. 	**$12,000 – $24,000 /m** **(approx. $2.4M-$4.8M based on a 200m length)** Includes: ■ Installation of soil nails. Excludes: ■ Supply and installation of erosion protection. ■ Approvals, land acquisition, demolition, and other site access constraints, etc. ■ Geotechnical investigation. ■ Detailed design and documentation.	■ Does not address the primary hazard of slope erosion. ■ Reduces risk of slope instability.	■ Prices are based on a broad indication only for work in typical conditions (i.e., does not consider site access constraints – be it access for a soil nailing rig and other construction equipment at the crest, and/or toe of slope). ■ Access to the crest and toe of the slope would be required for relatively large construction equipment over an area of 10 m to 20 m. This would require acquisition of land, access to private properties and possible demolition of some of the buildings in place at the crest of the slope and disturbance to the billabong.
5	**Gabion wall**	Full height gabion wall to be constructed in place of slope. Wall height approximately 10 m, base width approximately 8 m. Would require temporary excavation of slope to allow for installation of gabions. Some flexibility in face angle, dependent on design. Crib wall not considered feasible due to retained height. 	**$18,000 – $35,000 /m** **(approx. $3.6M-$7.0M total)** Includes: ■ Site preparation / excavation and disposal of soil. ■ Backfill behind wall. ■ Supply and installation of gabion baskets. Excludes: ■ Approvals, land acquisition, demolition, and other site access constraints, etc. ■ Geotechnical investigation. ■ Detailed design and documentation.	■ Would provide a physical barrier and assist in reducing the overall rate of slope retreat. ■ Factor of safety against global instability to form basis of design.	■ Prices are based on a broad indication only for work in typical conditions (i.e., does not consider site access constraints). ■ Access to the crest of the slope would be required for relatively large construction equipment over an area of 10 m to 20 m. This would require acquisition of land, access to private properties and possible demolition of some of the buildings in place at the crest of the slope and disturbance to the billabong.

The costs provided in Table 1 give a broad indication only for work in typical conditions. The costs do not take into consideration site access constraints due to either the presence of the Billabong at the toe of the slope or the residential properties at the crest of the slope. In addition to the comments provided in Table 1, they have been based on the following:

- The costs have generally been based on information provided in Rawlinson's Construction Cost Guide 2018. Quantities for excavation, retained height, etc have been based on the survey provided in the Coffey 2000 report.
- Rates for installation of the erosion matting (MacMatR) were provided by Geofabrics Australasia Pty Ltd. Note the rates for installation have assumed access including rope access to the slope.
- Rates for installation of gabion baskets were provided by Prospect Contractors Pty Ltd. and Geofabrics Australasia Pty Ltd. and are based on typical site conditions.
- Costs for clearing & grubbing included with site preparation are for medium vegetation only & do not include removal of large trees. We have assumed that the earthworks and other construction activities could generally be undertaken from the crest.
- Costs associated with approvals, land acquisition, demolition, and other site access constraints such as working over water or creating cofferdams or similar have not been included.
- Costs for investigation, development of design, technical specification and drawings, etc have not been included.

4.0 IMPORTANT INFORMATION

Your attention is drawn to the document titled - "Important Information", which is included in Attachment 1 of this letter. The statements presented in that document are intended to inform a reader of the report about its proper use. There are important limitations as to who can use the report and how it can be used. It is important that a reader of the report understands and has realistic expectations about those matters. The Important Information document does not alter the obligations Golder Associates has under the contract between it and its client.

5.0 CLOSING

If you have any questions, or require additional information, please contact the undersigned on (08) 8213 2100.

Yours Faithfully,

Golder Associates Pty Ltd

Adelaide Harbison
Senior Geotechnical Engineer

Derek Arnott
Principal Geotechnical Engineer

AMH/DFA/as

Attachments: 1 – Important Information

https://golderassociates.sharepoint.com/sites/122955/project files/6 deliverables/006 st peters options & budgets/20139217-006-l-rev0.docx

ATTACHMENT 1

Important Information

The document ("Report") to which this page is attached and which this page forms a part of, has been issued by Golder Associates Pty Ltd ("Golder") subject to the important limitations and other qualifications set out below.

This Report constitutes or is part of services ("Services") provided by Golder to its client ("Client") under and subject to a contract between Golder and its Client ("Contract"). The contents of this page are not intended to and do not alter Golder's obligations (including any limits on those obligations) to its Client under the Contract.

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This Report has been prepared in the context of the circumstances and purposes referred to in, or derived from, the Contract and Golder accepts no responsibility for use of the Report, in whole or in part, in any other context or circumstance or for any other purpose.

The scope of Golder's Services and the period of time they relate to are determined by the Contract and are subject to restrictions and limitations set out in the Contract. If a service or other work is not expressly referred to in this Report, do not assume that it has been provided or performed. If a matter is not addressed in this Report, do not assume that any determination has been made by Golder in regards to it.

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Golder accepts no responsibility for and makes no representation as to the accuracy or completeness of the information provided to it by or on behalf of the Client or sourced from any third party. Golder has assumed that such information is correct unless otherwise stated and no responsibility is accepted by Golder for incomplete or inaccurate data supplied by its Client or any other person for whom Golder is not responsible. Golder has not taken account of matters that may have existed when the Report was prepared but which were only later disclosed to Golder.

Having regard to the matters referred to in the previous paragraphs on this page in particular, carrying out the Services has allowed Golder to form no more than an opinion as to the actual conditions at any relevant location. That opinion is necessarily constrained by the extent of the information collected by Golder or otherwise made available to Golder. Further, the passage of time may affect the accuracy, applicability or usefulness of the opinions, assessments or other information in this Report. This Report is based upon the information and other circumstances that existed and were known to Golder when the Services were performed and this Report was prepared. Golder has not considered the effect of any possible future developments including physical changes to any relevant location or changes to any laws or regulations relevant to such location.

Where permitted by the Contract, Golder may have retained subconsultants affiliated with Golder to provide some or all of the Services. However, it is Golder which remains solely responsible for the Services and there is no legal recourse against any of Golder's affiliated companies or the employees, officers or directors of any of them.

By date, or revision, the Report supersedes any prior report or other document issued by Golder dealing with any matter that is addressed in the Report.

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