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Dear Louise

Lower River Murray – Task 8.1 – Influence of Water level rises from +0.10mAHD to +0.75mAHD on the potential for a River Bank collapse to occur

DWLBC commissioned SKM on 21 June 2010 to undertake a desk study on the influence of river water level rises on river bank collapse in the Lower River Murray. It is understood that this study will assist DWLBC in managing potential impacts from the change in water levels in the area of the study.

1. Stability Assessments

The stability of river banks at the following previously investigated sites has been assessed for higher water levels representing "normal" pool levels:

- South Punyelroo
- Caloote
- East Front Road Section 1
- East Front Road Section 2
- Riverfront Road Section 1 at Sturt Reserve;
- Riverfront Road Section 2 at Sturt Reserve;
- Woodlane Reserve
- Swan Reach and
- Walker Flat

This assessment was undertaken to extend the Factor of Safety (FoS) with Water Level Rise graphs which were presented in Figure 2 in our letter on 24th March 2010. The additional analyses were performed to assess the effect of river water level rises from +0.10mAHD to +0.75mAHD, in 0.1m steps.

The existing limit equilibrium models for SLOPE/W software (Ver. 7.16), which were developed for the river bank stability investigation, have been used for the assessment. No sensitivity analyses for the materials properties, slope of the layers or depth of the tension cracks has been carried out.

The FoS results at different water levels are summarised in **Figure 1** in which the vertical axis represents FoS and the horizontal axis is River Water Level in m AHD, over the range of relevant water levels for each site described in the legend.

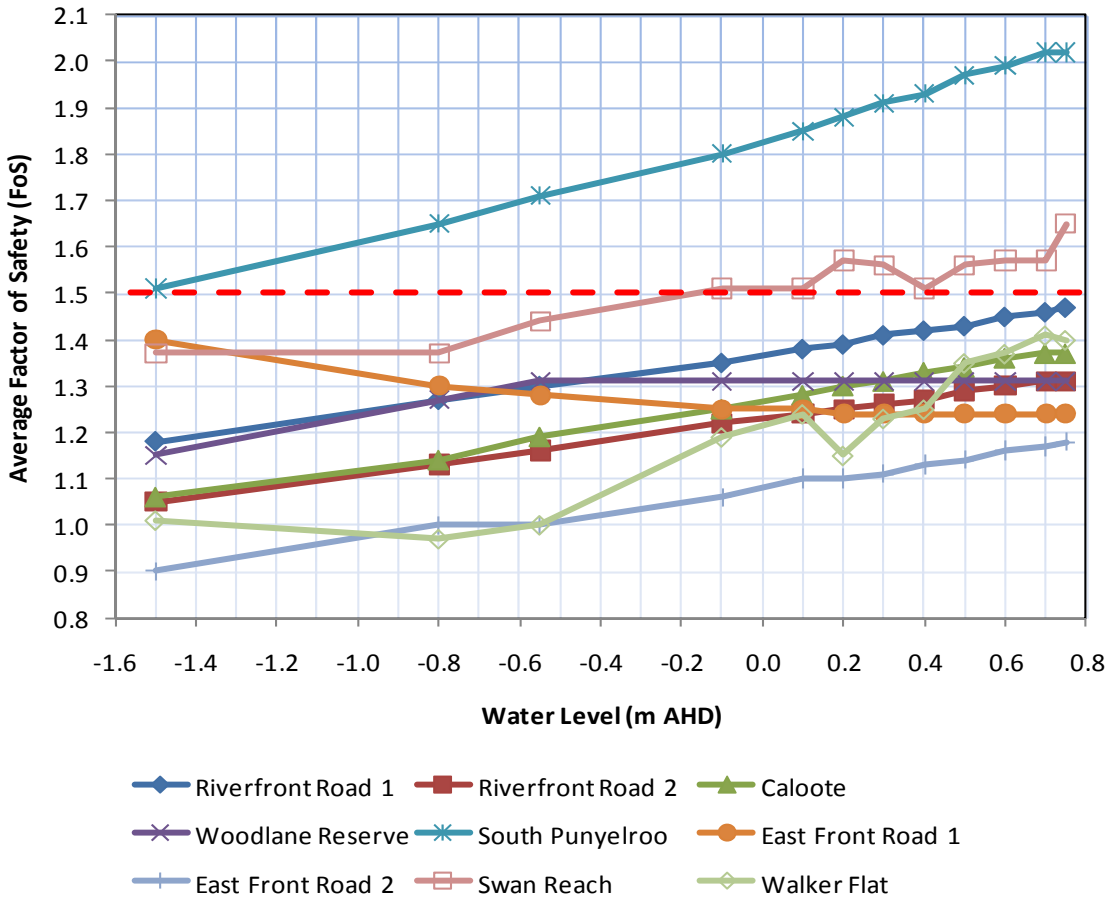

Figure 1: Summary of FoS at Investigated Sites for Various Pool Water Levels

Note 1: *The Factor of Safety (FoS) of a slope, is the ratio of the net force resisting slope movement to the net force causing movement. When the FoS is one, these forces are exactly balanced; so, as a consequence, any slight overestimation in the net force resisting movement, or underestimation of the net force causing movement, could initiate slope failure. Therefore, for long-term stability assessments, it is industry-standard practice to set the minimum*

allowable FoS to 1.5 to allow for uncertainties in the estimates of the net force resisting movement and the net force causing movement. Appropriate intervention is needed when FoS is less than 1.5.

The results of the stability analyses indicate that:

- South Punyelroo remains with FoS above 1.5 for the water level range considered.

- For the Swan Reach site, a sensitivity analysis of the effects of the slope of underlying layers and the depths of cracks on the Factors of Safety at the site has been carried out. In the preliminary stability assessment which has been presented in the report to DWLBC, maximum depth of 4m has been considered for the cracks. It has been observed that by increasing the depth of the cracks to 4.5m, the factor of safety falls below the recommended value of 1.50. It should be noted that the stability results are sensitive to the slope of the soft layers. At this stage, in absence of more accurate information for the alignment of the layers, the minimum factor of safety for Swan Reach has been reported in our Part A letter of 24 March to DWLBC, for 4.5m deep cracks. Results for 4m cracks have been given in our Geotechnical Report on the DWLBC website.
  Informal observations by SKM on 28 March 2010 and again on 20 June 2010 has shown no material change in existing cracks, (which appear to be deep tension cracks) north of the waste transfer station. There is no cracking visible south of the WTS.
  A separate proposal by SKM for additional offshore bores and bathymetric survey is in preparation for this site.

- At Riverfront Road and Caloote, rising water levels increase the FoS; however, for the water level range considered, the FoS remain below 1.5 which is considered to be the minimum FoS required for long term stability (refer to Note 1 under the figure above).

- At Walker Flat, rising water levels generally increase the FoS, but not to above 1.5.

- The multi-layered riverbank soil profiles at Swan Reach and Walker Flat result in the local non-linear behaviour in the FoS vs water level plots as the water levels rise to new layers.

- At Woodlane Reserve, the FoS increases for water level rises up to -0.55m AHD and then remains constant, but still below 1.5;

- At East Front Road section 1, sandy layers provide a significant proportion of the forces resisting slope stability failure. Unfortunately, in this situation, an increase in water level leads to a reduction in the resisting forces. However, the Factor of Safety is already less than 1.5, so the implications are not significant, as the site has already been designated "Very High Risk". Existing fencing needs to remain in place for the foreseeable future. Long term unrestricted access may require remedial works which would require a separate study. It is understood the road has been closed

- At East Front Road section 2, raising water levels increases the FoS, but not to above 1.5. The increasing FoS with water level at this section is due to the strength of the thick clay layers (not present at section 1) being unaffected by the river water level and the river water therefore providing a resisting force.

2. Closure

It should be noted that:

- After reduction in the water levels, new shrinkage cracks may appear at the sites which potentially have adverse effects on stability;
- The most rapid conditions of water level rise and fall occur as a consequence of temporary rapid changes in water levels. As reported in our previous letter on 24th March 2010, changes due to wind seiche are limited in magnitude to around +0.65/-0.15m in the lower pool, and correspond to rates of around 50mm per hour based on interpretation of DWLBC river level records. These wind driven changes in level are not known to cause any major bank stability incidents, and so have not been considered in our current analyses.
- Although wind induced rapid drawdown (up to 650mm over ~12hrs) is not known to affect global stability significantly, it may through wave action increase scouring or erosion locally depending on the friability of and vegetation on the river bank.

Further, it should be noted that this study is limited to:

- the selected sites only, because we do not have detailed stability modelling information at other locations; and
- the specified water levels.

This study does not cover the effects of possible new shrinkage cracks due to the water level changes because these will be site specific and beyond the scope of a desk study.

Please do not hesitate to contact me should you require more information.

Yours sincerely,

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