Attachment 2

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22 April, 2004

Moonee Valley City Council
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835

Attention: [redacted]

Dear [redacted]

RE: PROPOSED FLEMINGTON RACECOURSE FLOOD PROTECTION WORKS - SUMMARY OF FLOOD RELATED ISSUES

This letter provides a summary of the key issues arising from technical reviews, undertaken by WBM Oceanics Australia and Water Technology Pty Ltd, of the Flemington Racecourse Flood Protection Report, which was prepared by GHD. Also included in this summary are other issues identified by WBM Oceanics Australia subsequent to the preparation of their technical review, and comments on the conditions in the Notice of Decision.

Both technical reviews identified a number of shortcomings in the methodology that led to the conclusion that the flood impacts and the benefits from the proposed mitigation measures presented in the report cannot be considered reliable. The key issues are listed below with a more detailed explanation following:

1. Approach to assessing the loss of floodplain storage;
2. Adopted Mannings 'n' flow resistance values;
3. Proximity of the boundary of the GHD FLS model to the proposed flood walls;
4. Impacts due to smaller, more frequent floods than the 100 year average recurrence interval (ARI) design flood event;
5. Assessment of the benefit of the mitigation measures.

Assessment of Loss of Floodplain Storage

The construction of the floodwalls will reduce the flood storage in the system. The GHD report correctly notes that a loss of floodplain storage can result in a redistribution of flow and a consequential increase in flood levels. However, it is suggested in the GHD report that the loss of storage at the peak of the flood is negligible because the available storage in the racecourse at the peak of the flood is reduced through backfilling earlier in the flood, initially via local drainage and then via overtopping of the banks. Figure 3.1 in the GHD report, which is a plot of storage versus flood level determined from the FLS model, is produced to support this argument. The figure indicates that, at equivalent flood levels, more floodwater is stored as the flood recedes (the falling limb) than when it is rising (the rising limb). The GHD report states that this difference in utilised storage between the rising and falling limbs is primarily because backup through local drains is not well represented in their FLS model and therefore the effect of loss of storage is overstated by the FLS model.

The assumption that the observed difference in storage between the rising and falling limb was a result of a modelling inadequacy ignores a recognised "real" phenomenon in river systems that is commonly referred to as hysteresis and could be a result of the following factors.

a) The hydraulic gradient between the river and floodplain can cause this effect. On the rising limb the flood level in the river would be higher than on the floodplain as water flows from the river onto the floodplain, and on the falling limb the flood level in the floodplain is higher as water drains back into the river.

b) The longitudinal hydraulic gradient is normally flatter on a receding flood than on the rising flood. This significance of this effect will depend on the hydraulic controls in the reach under consideration.

c) A floodplain may continue to fill after the peak if all storages were not filled and the flood level is above the bank level. This does not appear to be the case in this floodplain because Figure 3.1 shows that the peak flood level and peak storage occurs simultaneously.

Because of these limitations in the FLS model, the backfilling could not be reliably modelled and the storage effects were analysed separately. A key aspect of the separate analysis was that engineering judgement was used in determining the storage versus flood level relationship for the analysis, rather than rigorous calculations. The adopted storage versus flood level was an average of the rising and falling limbs presented in Figure 3.1 in the report. In adopting a relationship midway between the rising and falling limbs, the implied assumption is that there will be no significant gradient between the river and the floodplain at any stage (refer Note a) above). Given that the storage relationship is a dominant influence on the change in flow as a result of the loss of storage, it is believed that a more rigorous analysis, and sensitivity testing, should have been undertaken.

Further, Figure A.9 in the GHD report shows the racecourse filling from its Smithfield Road end. Along this boundary of the racecourse there is a fence that would significantly reduce the flow into the racecourse. Therefore, unless this restriction was modelled in FLS, the flow into the racecourse earlier in the flood would be lower than indicated in the GHD report, and the storage assumptions for the separate analysis may be flawed.

Unsteady state FLS modelling was undertaken by GHD, but the change in river flows were not presented. The change in river flows from this analysis could give an indication of an upper bound to the effects on flow.

Given that the storage relationship is a dominant influence on the change in flow as a result of the loss of storage, a more rigorous analysis and sensitivity testing should have been undertaken. The uncertainties associated with the GHD approach to modelling storage cast considerable doubt over the findings.

Adopted Manning's n values

The Manning's n is a coefficient that is used in hydraulic models to describe hydraulic roughness of a flow path. Manning's n values adopted in the models in the vicinity of the Racecourse were approximately half what would typically be adopted in a natural river such as this. The GHD report acknowledges that the values were lower than expected. This means that in the model, all else being equal, the flow in the main channel is about double what it should be for a given water level and hydraulic gradient. This in itself raises serious concerns over the reliability of the HEC-RAS model that was used as a basis for the analysis.

Even though the same Manning's n was used in the models with and without the flood walls in place, the assessment of the impact on flood levels of flow redistribution cannot be considered reliable if the Manning's n is substantially in error. As documented in the GHD report, the construction of the flood walls will result in an increase in flow adjacent to and downstream of the Racecourse. Therefore, given the uncertainty over the adopted Manning's values that was noted by GHD in the report, sensitivity testing should have been undertaken to assess the significance of Manning's n on the impact assessment.

The lower than typical Manning's n values raises serious concerns over the reliability of the HEC-RAS model upon which the analysis was based. The low Manning's n values used are likely to have resulted in an underestimate of the increase in flood levels. Sensitivity testing of the significance of Manning's n on the impact assessment should have been undertaken.

Proximity of the Boundary of the FLS Model to the Proposed Flood Walls

FLS was used to assess the flood level impact in the reach from Fishers Road to Lynchs Bridge. The model was run in steady state (constant flow over time) with and without the floodwall in place to determine the change in flood level as a result of the loss of conveyance only. Both the with and without floodwall models were run with the same flood level at the downstream boundary (the downstream extent of the model). This forces both models to have the same flood level at the location of the downstream.

This is generally acceptable if the downstream boundary is sufficiently far downstream of the area of interest so that any uncertainties associated with an ill-conditioned boundary do not influence the results in the area of interest. However, in this case the downstream boundary is in close proximity (estimated to be about 150 m from Figure A.3 in the GHD report) to the proposed floodwalls. The adoption of the same downstream boundary condition for the with floodwall case may result in an underestimate of the impacts of the floodwall in the vicinity of the downstream boundary, with the effects possibly extending further upstream.

The proximity of the downstream boundary may have resulted in an underestimate of the increase in food levels. No sensitivity testing was carried out to ascertain this effect.

Impacts in Smaller, More Frequent Floods

An investigation into the impacts of the proposed flood walls has not been done for more frequent, smaller floods than the 100 year average recurrence interval (ARI) design flood event. It is possible that significantly larger impacts may occur in smaller events because the effects of loss of storage may be more significant in a smaller event (that flows onto the floodplain). This may be important if it causes above floor flooding at properties not previously inundated in smaller events, or if it increases the depth of above floor flooding in properties currently inundated .

Impacts may be greater in smaller flood events and should have been considered if flooding problems exist in these smaller events.

Assessment of the Benefit of Mitigation Options

Condition 2 of the Notice of Decision requires that mitigation works be undertaken at the Fitzroy Road bridge and the Northern Railway embankment. There are a number of concerns in relation to the assessment of the benefits of the mitigation measures.

1. The reduction in the contraction and expansion loss coefficients at the Fitzroy Road Bridge appears to be based on engineering judgment, and may be overstating the benefits given

the relatively minor change to only one abutment of the bridge. Given that the proposed works are in a highly urbanised area with the potential for significant impacts, a more rigorous approach should have been adopted. Options for a more rigorous assessment include detailed two-dimensional or three dimensional numerical modelling locally at the bridge, physical modelling of the bridge, or a review of literature.

2. The one-dimensional HEC-RAS model was used to assess the benefits of the proposed mitigation works. The flow in the vicinity of the Northern Railway embankment will be two-dimensional in nature. Therefore, it is considered inappropriate to use the one-dimensional HEC-RAS model for this assessment. A more rigorous analysis should be done using a fully two-dimensional hydraulic model. It is noted that the GHD report did not recommend that these works be undertaken, and so the reliability of the modelling in this area was not as significant. However, the requirement in Condition 2 for these works to be undertaken places a greater emphasis on the reliability of this aspect of the assessment.

3. More realistic Manning's n values would provide greater attenuation of any benefits, ie, the benefits would not extend as far upstream as indicated in the report.

Comments on Notice of Decision

The following amendments and additions are recommended.

Condition 9 expanded to include "*A Design Certification Statement, signed by a suitably qualified hydraulic engineer, must accompany the design plans.*"

Condition 16 (a) reworded to say "*…signed by suitably qualified structural and hydraulic engineers.*"

Condition 17 expanded to include "*A Design Certification Statement, signed by a suitably qualified hydraulic engineer, must accompany the design plans.*"

Condition 21 (b) reworded to say "*…signed by suitably qualified structural and hydraulic engineers.*"

A condition should be written that requires that an annual survey of the apex level of the flood wall be compared with the design level to ensure that it is not higher than design. The survey and comparison should be submitted to Melbourne Water on an annual basis.

Summary

A number of shortcomings were identified that has led to the conclusion that the assessment methodology is not appropriate for the proposed development in a highly urbanised area with the potential for significant impact. Sensitivity testing of the key assumptions should have been undertaken.

A convoluted methodology combining three models was required to assess the impacts of the proposed floodwalls, because neither HEC-RAS nor FLS could adequately model the system in its entirety for the purposes of this study. Hydraulic modelling software is available (and has been for some years) that can model the system within one package by utilising dynamic links between one-dimensional and two-dimensional domains. The use of such software would have eliminated a number of the concerns raised above.

Please do not hesitate to call Mark Jempson should you require additional information or further explanation of the issues raised here.

Yours sincerely

[redacted]

Manager Victoria