A10.4 Extract from Geotechnical Investigations Report on Groundwater Conditions

APPENDIX 10.4 : EXTRACT FROM GEOTECHNICAL INVESTIGATION REPORT ON GROUNDWATER CONDITIONS

5.6 Groundwater Conditions

Groundwater was encountered in all the boreholes at depths ranging between about 7m and 14m in boreholes in the vicinity of the proposed Visitors Centre building. In borehole 9 adjacent to the existing services groundwater was encountered at about 1.5m depth. Monitoring of standpipes has revealed the groundwater to be standing at an elevation of between about 69m – 70m AOD. The interpolated upper surface of the groundwater is shown on section Drawing No 04 to 06. From this it can be seen that the groundwater flow is within the chalk and probably within structured chalk. The gradient of the upper surface of the groundwater is very slight being inclined down towards the River Avon. The level of the groundwater is also such that it is most likely in direct continuity with the level of water in the River Avon.

In respect of site development proposals the groundwater is at a level well below any earthworks.

The chemistry of the groundwater has been analysed in one sample obtained from BH8. The results of this indicate that the water has a pH value of 6.7 a temperature of 16.2°C, conductivity of 780μS/cm a total hardness of 338mg/l and a saturation of -42mg/l.

In consideration of these results the temperature of the groundwater at this location was unexpectedly high. In addition the water was undersaturated (-42mg/l Ca CO_3). Borehole 8 from which the sample was obtained was within the borrow pit and it is likely there is a pathway for surface water to travel to the groundwater easily in this area as the less pervious colluvial soil cover has been removed. In this respect and in consideration of the temperature and degree of saturation it is likely that dilution of the groundwater has occurred due to percolation rain and surface water run off entering the ground due to the lack of impermeable colluvial soil cover.

The natural solution of limestone (including chalk and dolomites) is known as the Karst Process. Only naturally occurring carbonates with a soluble hydrogen (bi-) carbonate undergo this process. The solution chemistry of rocks composed mostly of such minerals is dependent on two types of dissolution process; physical and chemical. Physical solution of calcium carbonate in pure water is low and saturation would occur very quickly if this were the only process present. However, as calcium hydrogen carbonate is soluble, carbon dioxide in solution can greatly increase the solubility of the calcium carbonate ($CaCO_3$).

If the potential solubility of the $CaCO_3$ were only controlled by these two processes then saturation of any percolating water would soon be achieved and further solution would not be possible. Active solution on limestone does however occur due to a process known as mixture corrosion. This occurs when two solutions saturated at different concentrations due to variances in their equilibrium carbon dioxide content mix together. Mixing can occur at any depth below the surface. On mixing the resulting solution could become undersaturated and the further solutioning could occur.

The saturation of any solution with respect to calcium carbonate depends on the equilibrium level of CO_2. If CO_2 becomes degassed from solution the solution can become supersaturated with respect to calcium carbonate and may begin to precipitate the excess.

Water can vary between undersaturated and supersaturated seasonally. In summer when plant and soil organism respiration is at a maximum, soil CO_2 levels are high and therefore the potential for CO_2 in solution and hence solution of $CaCO_3$ is higher with a greater chance that supersaturated solutions would develop with respect to ambient CO_2 concentrations (partial pressure). In winter solution rates and concentration may be much less.

In consideration of the analysis of water from BH8 it is likely that mixing has occurred resulting in the degree of undersaturation detected. Similar mixing could occur within the doline field as identified in the geophysics particularly where there is little or no clayey colluvial soils overlying the chalk and where there are more permeable reworked gravelly chalk materials infilling solution features.

In respect of groundwater solutioning there is considered to be some slight risk of potential for ongoing solutioning in the area of the doline field. However, in consideration of development proposals, the potential for mixing of surface water with groundwater is likely to be low except outside the footprint of the proposed building and particularly where soakaways are to be sited.