Lime Stabilization Report

1. Lime stabilization (or similar) is deemed necessary at Seacourt

The Applicant's Factual and Interpretive Ground Investigation Report (published 23 November, 2016) states:

> "The Cohesive Superficial Deposits at the site were typically of high volume change potential. The Oxford Clay Formation encountered at the site was of medium volume change potential (based on the result of one test). The cohesive superficial deposits will require treatment to reduce their swelling potential… Specialist advice should be sought in respect of the use of lime stabilization; additional sampling and testing may be required." (Executive Summary)

Para 10.1 (p.23) states:

> "The majority of the site is underlain at shallow depth by firm clay. The CBR results… undertaken in the firm clay vary from between 2.4% and 6.0%.... a design CBR of 2.5% would be appropriate for the site; however, attention is drawn to the presence of high plasticity clay. Five of the six tests conducted in the superficial clays produced results of very high or extremely high plasticity, with associated high volume change potential. ***There is a clear potential for swelling and damage to the car park pavement if these materials are left in place or untreated. Due to the depth of the clays (on average 1.5m) excavation and replacement would be uneconomic. Alternatively, lime stabilization may be a suitable treatment.*** Lime stabilization reduces the plasticity index of the soil, increases its strength and allows the use of thinner pavement construction. The limited testing undertaken indicates that there is not an abundance of sulphates present, which are a major hazard in the use of the lime stabilization technique. ***It is recommended that specialist advice is sought regarding the use of the technique. It should be recognized that further sampling and specific testing may be required in order to confirm the suitability and improvements achievable for this site.*** Guidance for the use of the lime stabilization technique is given in HA74/07 [8]."
>
> (emphasis added)

No further details about the lime stabilization process have been added into any of the subsequent documents, despite these having been submitted 12 months ago.

2. Potential risks of lime stabilization: summary

The lime treatment is likely to have an impact on the permeability of the soil below the car park. Graymont, a leading American company in the supply of lime products, states that, 'Following compaction, the lime-treated layer is largely impervious to moisture

and it sheds rainwater similar to a paved road.'[1] If this were the case at this site, the lime stabilization process could seriously jeopardize the effects of the SuDS layer and result in considerable run-off in sudden storm events. Some research indicates that lime treatment might improve the hydraulic conductivity of clay soils, but other studies show that this improvement is only temporary and that as the treated soil becomes cementitious over time its permeability decreases.[2] It is unclear whether the attenuation capacity of the Applicant's planned SuDS has been designed with existing ground conditions assumed, or for soil that has been treated with lime. Building what may become over time a cement-like layer underneath the development runs the risk of creating a 'swimming pool' with exceptionally poor drainage that may often necessitate the car park to be shut for pumping the water out. This would also increase the risk during a major storm of run-off water causing flooding in the immediate vicinity, especially in the properties to the south of the site which are already highly sensitive to very small fluctuations on the flood plain, and some of which have already flooded. It is unclear from the Applicant's documents whether lime stabilization is to be used, and whether the implications of this have been fully considered when modeling attenuation of run-off from the site.

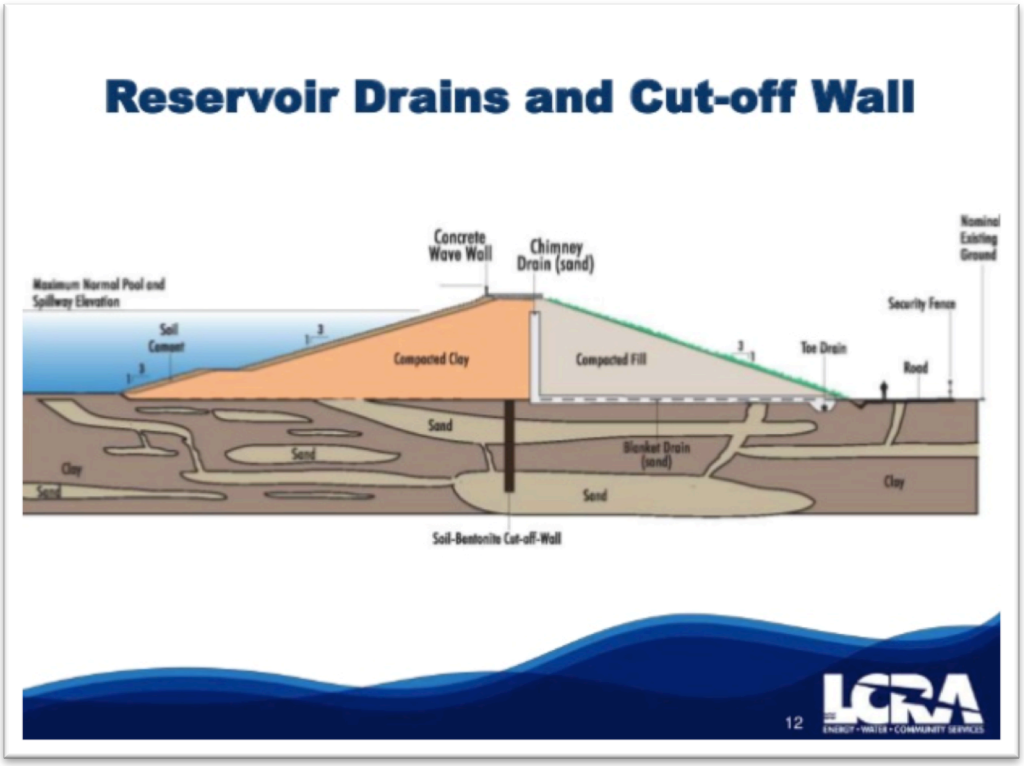
3. Lime stabilization can reduce permeability

Lime stabilization is used to create barriers that are impermeable to water, for instance in the creation of reservoirs, as these photographs from the Lane City Reservoir, Texas, demonstrate:

Lime stabilized reservoir wall 1

[1] http://www.graymont.com/sites/default/files/pdf/tech_paper/lime_treated_soil_construction_manual.pdf

[2] Literature review in Jawad et al., "Soil Stabilization using Lime: Advantages, Disadvantages, and Proposing a Potential Alternative" *Research Journal of Applied Sciences, Engineering and Technology* 8 (4): 510-520, 2014. It is not clear whether the experiments showing initially increased hydraulic conductivity included representative soil compression.



Lime stabilization wall cut-through 1

4. Compromising soil stability leads to problems

The Applicant's Factual and Interpretive Ground Investigation Report (published 23 November, 2016) states:

> 'The cohesive superficial deposits at the site are highly plastic with high volume change potential; this indicates that heave/swelling of the cohesive deposits is probable which would damage any pavement laid at the site.'[3]

At the proposed Seacourt extension site, there are long rows of trees proposed in the new site. It is not clear how these trees will be located in conjunction with the stabilized soil. Stabilized and compacted soil might be unsuitable for trees and not allow them the root exploration and growth potential needed to thrive, and if there are gaps in the stabilized and compacted areas to allow for tree root growth this may compromise the effectiveness of the stabilization over time, especially in a flood zone with considerably groundwater emergence such as this site.

The Applicant's Factual and Interpretive Ground Investigation Report (published 23 November, 2016) states 'Small areas of landscape planting are proposed around the periphery of the site.'[4] This is inconsistent with the diagrams that show considerable numbers of trees within the site area itself, interspersed with the parking bays, and may

[3] Para 11.0 Summary and Conclusions, p.25.
[4] Para 2.2, page 3

be a deliberate mistake in order to avoid the question of the interaction of lime stabilization with tree planting.

The combination of soil that has a naturally 'high volume change potential', flood zone 3b, trees, and lime stabilization seems to be one that carries high risk of failure as well as of long term degradation of the site and ongoing maintenance costs.

Both groundwater rising up through paving as well as floodwaters passing over them can cause considerable damage, especially from prolonged or repeated floods.

The pictures below show where floodwaters in 2007 at Tewkesbury destroyed tarmac, brick walls and pavement edges. The pavement edges in particular were destroyed because they were 'weak spots' where groundwater forcing its way upwards lifted the paving away. Similar 'weak spots' could be produced in the Seacourt extension area in the vicinity of the street trees.

Loose bricks, paving slabs and chunks of tarmac cause a serious hazard to people trying to walk through floodwater, as any obstructions below the surface of murky floodwater can be very difficult to see.

Tewkesbury 2007 flood damage 1

Tewkesbury 2007 flood damage 2

Tewkesbury 2007 flood damage 3[5]

[5] All Tewkesbury photographs copyright and courtesy of Steve Goodchild.

5. Threat to properties at south end of car park extension

It is not clear whether sufficient attention has been paid to the interaction of the stabilized soil layer with the properties at the southern boundary of the site.

The stabilized soil layer, if it creates a concrete-like slab over time, will affect the way that water moves through the ground in the car park site. It may cause increased groundwater flooding in neighbouring areas if water cannot move vertically through the layer beneath the paving, which could threaten adjacent houses with flooding.

6. Lime stabilization (or similar) may require dewatering during installation

The Applicant's Factual and Interpretive Ground Investigation Report (published 23 November, 2016) states:

> "Construction of building foundations may require the use of dewatering / water exclusion measures during construction." (Executive Summary)

The application does not make clear what compensation will be provided in case of flood events during the construction process.

Furthermore, the calculation of the flood compensation areas may not have taken into account the fact that potentially up to 1.5m below the entire extension area may have extremely reduced permeability and water holding capacity.

7. Conclusion

The impacts of lime stabilization of the soil at the proposed site should be examined in close detail and over the immediate, medium, and long term, before planning permission is granted, especially in terms of the interaction of this process with (1) run-off water risks, (2) street tree planting over the site, (3) ongoing maintenance costs, and (4) compensation allowances for dewatering during construction, and potentially repair, of the site.

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