RUPERT TAYLOR
ACOUSTICS - NOISE - VIBRATION

A303 Amesbury to Berwick DownTR010025DM
STONEHENGE ALLIANCE REF. NO. 2001870
Principal Issue 11: Vibration from tunnel boring

2 April 2019

1. MATTERS CONSIDERED

1.1 This document addresses the topic of vibration from the boring of the proposed A303 tunnel and its effect on archaeological remains, artefactual material and assets potentially at risk of damage or disturbance by vibration.

2. APPROACH AND METHODOLOGY

2.1 The conclusions reached below are based on information contained in the Environmental Statement, available geotechnical information and experience of other projects involving the effects of vibration on comparable or relevant receptors.

2.2 While vibration is caused by many construction activities, in this project the works which are likely to generate the highest levels of vibration received in locations of archaeological remains are those associated with the driving of the tunnel, with particular reference to the tunnel boring machine.

2.3 Predictions of vibration from tunnelling are included in Chapter 9 of the Environmental Statement and these are given further consideration, below, from the point of view of criteria for vibration which have been used elsewhere in the context of conservation of historic and fragile material. Tunnel boring is referred to in Chapter 6, Cultural Heritage, but there is no reference to vibration effects on archaeological assets. Vibration may also occur at the same time as differential ground settlement, which is referred to in Chapter 6 at 6.4.1 (i) with the statement "It is assumed that ground settlement will be minimal at the surface from the boring of the twin bored tunnel and any changes to heritage assets on the surface would be negligible and imperceptible to the eye." The basis of the assumption made is not stated, and the matter of differential settlement is not referred to.

3. ARCHAEOLOGICAL ASSETS POTENTIALLY AFFECTED BY VIBRATION

3.1 The Heritage Impact Assessment (APP-205, ES Appendix 6.1) at 9.2.8 says "The tunnel passes directly beneath a long barrow 250m north of

Normanton Gorse (NHLE no. 1008953). Significant impacts due to construction vibration are not anticipated, however, in the absence of specific criteria regarding construction vibration impacts on barrows and as a precautionary approach, monitoring at this feature is proposed during nearby tunnelling works."

3.2 The potential effects of vibration on archaeological assets include dislodging archaeological remains from their original position, damage caused by dislodging, fracture of a fragile artefact, flaking of surface material on an artefact or dislodgement of flakes or other material weakly attached.

4. CRITERIA FOR ASSESSING THE EFFECT OF VIBRATION ON ARCHAEOLOGICAL ASSETS

4.1 The ES cites vibration criteria from BS 5228, BS 7385-2, ISO 4866:2010. However, these standards only contain criteria for the effects of vibration on buildings and structures.

4.2 The matter of vibration damage to archaeological material or assets most frequently arises in the context of museums. The British Museum has a set of criteria in a document "Vibration recommendation, Department of Conservation and Scientific Research, British Museum, Revision: v2 (April 2012)". This includes the following criteria:

Exhibition/storage (Collections) areas: 0.1 mm/s ppv (equivalent to an r.m.s. limit of 0.07 mm/s) (applied at any individual one third octave band frequency from 6 Hz upwards). (In terms of the equivalent generic vibration criterion curve this is between the VC-Operating theatre (ISO) (0.1 mm/s r.m.s.) and VC-A (0.05 mm/s r.m.s.) curves) and is designed also to stop objects "walking" on shelving)

Construction work in vicinity of collections material:

First Action Level (vertical ppv)
Continuous vibration limit (as recorded over 30 seconds) = 0.1 mm/s ppv (0.07 mm/s r.m.s.) Intermittent vibration limit (instantaneous) = 0.3 mm/s ppv (0.21 mm/s r.m.s.)

Second Action Level
Continuous vibration limit (as recorded over 30 seconds) = 0.3 mm/s ppv (0.21 mm/s r.m.s.) Intermittent vibration limit (instantaneous) = 0.6 mm/s ppv (0.42 mm/s r.m.s.)

5. THE ES VIBRATION PREDICTIONS

5.1 In Table 9.15 of Chapter 9 it is predicted that vibration at Stonehenge will be 0.16mm/s from the tunnel boring machine at a distance of "more than 100m" and at Stonehenge Cottages the prediction is 2mm/s.

6. CONCLUSIONS

6.1 If, hypothetically, the British Museum were located where Stonehenge is located, the predicted vibration from tunnelling would 1.6 times the museum's criterion of 0.1mm/s for exhibition/storage areas and similarly if it were located at Stonehenge Cottages which are a similar distance from the tunnel alignment to that of receptors such as the long barrow, the predicted tunnelling vibration would be approaching seven times the Museum's second action level. According to the ES Chapter 9, para 9.3.21, the predicted vibration of 2mm/s is between the negligible and cosmetic damage risk levels for "cosmetic – formation of hairline cracks in plaster or drywall surfaces and in mortar joints of brick/concrete blocks construction". Given that archaeological remains must be assumed to be more fragile than buildings of brick and concrete, it has to be said that there is a potentially substantial risk of damage to archaeological remains which has not been properly taken into account as a significant effect. The Heritage Impact Assessment (APP-205, ES Appendix 6.1) reports at 9.2.7. "The possibility of physical and other effects on heritage assets positioned above the tunnel would be managed through the placement and operation of tunnel movement monitoring stations during construction works." However, it is not known how monitoring will prevent damage until relevant damage thresholds are identified. Once the TBM has been launched the opportunities for mitigation of vibration are almost non-existent, as vibration from tunnel boring is only weakly dependent on controllable parameters such as cutter head rotation speed and thrust force.

Signed

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