Application 10/1177/MFUL by Tesco Stores for Seaton
Critique of the Estimate for Noise emitted by the Pipeline

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1. Application 10/1177/MFUL imports gravel by sea, pumps it as a seawater slurry along a surface-mounted steel pipeline through Seaton to the Tesco site, and then spreads and compacts it using earth-moving machinery. There are thus two sources of noise :
   a) machinery on-site;
   b) gravel slurry moving through the pipeline.

2. Noise from on-site machinery :-
   a) is tabulated in various reference sources;
   b) will be confined to working hours, five and a half days a week;
   c) will be partly shielded by earth bunds from nearby buildings.

   The estimates provided by Tesco are still being checked and will be reported on at a later date.

3. Noise from the pipeline :-
   a) is not tabulated in standard sources
   b) can take place at any hour of the day or night, seven days a week
   c) is not attenuated by acoustic shielding
   d) is emitted close to houses on Trevelyan and Harbour Roads in Seaton.

   The pipeline thus presents the most serious and potentially disruptive aspect of this application.

4. Tesco have retained a consultant (Hydronamic bv) [1] to provide an estimate of pipeline noise. Their report predicts " *. . . an average measured sound pressure level of 54 dB(A) at a distance of 4m from the pipeline. This would be the same, in terms of the LAeq,1hour noise level, as a single vehicle with a sound power level of 110 dB LWA passing along a haul road at a speed of 50km/h"* [2]

5. This noise is bad enough, but appears to be a serious underestimate. This critique analyses the assumptions made, describes how they diverge from the Seaton situation and what this means for emitted noise.

6. The Hydronamic bv report [3] measured sound from a pipeline in Rotterdam with the following parameters :-
   a) straight run across level ground;
   b) length not stated, but estimated at 100m from a Google Earth view of the site in Rotterdam;
   c) using sand with average diameter 0.228mm;
   d) solids content of slurry not stated;
   e) flow rate of 230 m3/minute (3.8 m3/s);
   f) diameter 1000 mm.

7. This compares with the Seaton pipeline, which has the following parameters:
   a) convoluted run with two vertical rises and two falls of 5 m;
   b) length about 2000 m, depending on pontoon location;
   c) using gravel with wide size range [4] (ex. 10% larger than 20 mm);
   d) solids content about 35%;
   e) flow rate about 4.2 m3/s (for 2 hour pumping time);
   f) diameter 800 mm.

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[1] *Sound intensity discharge pipeline* (prepared by Hydronamic bv on behalf of Westminster Dredging Co. Ltd., dated 24-Mar-10);
2 Environmental Impact Analysis Vol 1A page 44 table 5-14
3 EIA Vol 1B Appendices for chapter 1-9, page 128 Appendix 7.2 *Sound Intensity Discharge Pipeline*
[4] Construction & Environment Management Plan Appendix B Overview of Typical Particle Size Distribution

8. **Pipeline geometry** has a major effect on emitted noise.
    a) In the flat straight pipe measured by Hydronamic bv, much of the solid material can lie on the floor of the pipe (bedload) and move along relatively slowly, either by sliding or by "saltation" – the process whereby individual particles are picked up by the fluid and re-deposited further down the pipe. This low speed reduces emitted noise and pumping power, and hence cost : " . . *transporting sand as bedload may be more efficient (in terms of energy losses) than moving the sand as suspended load."* [5] Thus, although no information was provided about the flow regime in the Hydronamic bv test, slow bedload transport of this type constitutes acceptable low-cost industry practice.
    b) The Seaton pipe must rise and descend vertically by 5 metres at two locations to cross roads, so the bedload method of sediment transport is excluded. All solid material must be held in suspension (suspended load) by greatly increasing fluid velocity, with a corresponding increase in pumping power. These faster moving particles will hit the side of the pipe harder, and thus produce more noise.
    c) The Seaton pipe also includes eight right angle bends as it goes up and over the two roads. At these points the suspended particles have to hit the pipe walls to change direction, so producing more noise than when travelling along the straight pipe tested by Hydronamic bv.

9. **Particle Size Range** has a major effect on emitted noise.
    a) The Hydronamic bv test uses sand with an average diameter of 0.228 mm. This is relatively easy to suspend and/or move along a pipeline (see 8(a) above)
    b) The Seaton pipeline will carry gravel composed of much larger particles (see 7(c) above). In suspension, large particles sink quicker than small particles [6], so fluid velocity must be increased to keep large particles in suspension. *" In general, when pipelines are used to transport coarse slurry, the slurry velocity must be relatively high in order to suspend the solids." 7* The faster moving particles hit the walls of the pipe harder, and thus produce more noise than slower moving particles.

10. **Solids content** has a major effect on emitted noise, with high concentrations of solids producing more collisions with the walls – and so more noise - than low concentrations. The Hydronamics bv test does not state the solids content tested, and this deficit largely invalidates the noise levels measured, since their pipeline might have been carrying very low solids content, and so emitting very little noise. The Seaton slurry solids content is set by the proposed production schedule at about 35% by volume.

11. **Pipeline diameter** has a major effect on slurry velocity, and hence on emitted noise. To pass the same volume of slurry through the narrow Seaton pipe requires a flow velocity 56% higher than through the wider pipe used in the Hydronamic bv test. As discussed in 9 above, faster slurry flow means higher noise levels.

12. **The poverty of theoretical predictions**. The flow of coarse slurries in pipes cannot be predicted from theory, and hence neither can the noise they emit. The distinguished engineers Sinclair Knight Merz concluded that: "*There is no clear agreement on the forces and friction associated with various mechanisms, (e.g. fluidised bed, heterogeneous flow, homogeneous flow etc) or the velocities at which they occur. Many of the theories "blow up" when large particles are involved. Say > 2mm. Comparison between calculations at these sizes indicates a need for model studies in future developments*." [8]
    The Seaton pipeline thus clearly falls within this region of theoretical indeterminacy.

13. **Conclusions**
    a) The Hydronamics bv test noise levels are lower than will be experienced in practice at Seaton.
    b) It is not currently possible to model theoretically the flow or noise emission for the Seaton pipeline.
    c) A full scale physical model of the Seaton pipeline must therefore be built and directly tested for noise before planning permission can be considered.

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[5] Admiraal, D.M. *Influence of pipe angle on bedload transport in an inclined pipe*, International Journal of Sediment Research, Vol. 18, No. 2, 2003, pp. 123

[6] http://en.wikipedia.org/wiki/Sediment_transport, Ferguson and Church (2006) equation

[7] http://www.bookrags.com/eb/pipeline-eb/

[8] Bremer.J, *Pipeline Flow of Settling Slurries,* Presentation to Institution of Engineers Australia 23rd April 2008