ENVIRONMENTAL NOISE ASPECTS OF LANDFILL SITE SELECTION

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Introduction

Finding a suitable landfill site is a complicated process. Many disciplines must interact in selecting a preferred site; Design and Operations, Social Impact, Land Use Planning, Economics, Transportation and Heritage are the main disciplines interacting with Acoustics. As well, public input must be taken into account. Comparing sites from a noise perspective is difficult due to conflicting models for outdoor noise propagation and for community reaction to noise impact.

The Problems

In Ontario, maximum hourly sound exposures of 55 dBA during the daytime and 45 dBA at night, or the existing ambient, if higher, are applicable for approval of landfills. However, these types of guidelines provide no assistance in evaluating and comparing potential landfill sites. For example, one site may be in a very quiet area (i.e. ambient about 40 dBA) and another may be in a noisier area (i.e. ambient about 50 dBA). Thus, for one site, the increase in daytime sound exposure could be up to 15 dBA while at the other, up to 5 dBA. The site with the lower change to the environment is potentially preferable; even if the applicable guidelines are met at both.

Site selection is a multi-stage process of determining a (long) list of candidates, selecting a short list and finally determining a preferred site, including access routes. The potential zones of real or perceived environmental effects can extend to one kilometre or more around each site and along many kilometres of alternative haul routes. The amount of data gathering required is formidable, as is the time and budget required to study each site in great detail. Meaningful compromises in the technical modelling must be made to allow decision making to proceed with reasonable timing and costs. As the candidate list is shortened, the amount of detail increases.

It is desirable to compare the potential site impacts (i.e. environmental changes) taking into account, qualitatively or quantitatively, the population affected. However, there are no universally agreed-on techniques. One approach is to weight the expected environmental (noise) changes directly by the number of people or family units affected. It may also be relevant to adjust the weighting for sound exposure change, based on where on the absolute scale the resulting sound exposure is. However, there is a paucity of information on the relationship between change and absolute magnitude, and how to formulate the weighting factors; as well as potential disagreement between experts.

Simple population weightings may not be appropriate because landfill operating hours (and times of potential noise impact) tend to correspond to normal working hours. Thus, some people may not be present at their properties to experience the impacts because they leave for work or school.

Aside from comparing the noise impacts between sites, there is also the desire by disciplines such as Social Impact to account for cumulative impacts from unrelated nuisance factors such as dust and smell; or at least be able to integrate and deal with multiple effects in ranking sites. Again, there is little or no guidance in the technical literature as to how noise may interact with the other factors to shape community response.

It may be that the stigma of proximity to a project such as a landfill and the connotation of the noise from site operations or refuse trucks will outweigh the reactions to the characteristics of the sound itself.

Using worst case assumptions is appropriate and commonly done for noise assessments of a selected site. However, this approach is subject to criticism from the public, for site selection. The process could be biased against sites with a large number of proximate receptors even if the potential impacts are low; compared to more remote sites with fewer receptors and much larger individual impacts. The bias may also be due, in part, to worst case conditions occurring for only a small fraction of the site life.

Developing a model which realistically predicts off-site sound exposures involves controversial factors. Atmospheric effects, including wind, temperature inversions/gradients and air absorption will not only vary from day to day, but also very likely from hour to hour. The effects of excess ground attenuation are difficult to apply in practice. The landfill will start below grade and rise up in elevation well above existing grade. Thus, the amount of ground attenuation will vary depending upon the landfill elevation, as well as with wind and vegetation. There are no universally accepted modelling techniques for any of the above mentioned factors.

Using worst case conditions simplifies the analysis. It is thus more practicable because less detailed information about each site is needed. Using more typical or average conditions is subject to criticism by the public because there could be a significant amount of time (e.g. up to 50%) where there could be more noise impact, with no upper bound defined. In any event, adequately detailed site design and operation information to reliably determine typical conditions is generally not available at the site selection stage.

Questions also arise about potential noise effects on wildlife or other animals, on property values, and on businesses. Assessment criteria in these areas are less developed than those relative to impact on people.

Some Solutions

Noise modelling of site-operations should be based on realistic but somewhat conservative assumptions about equipment, sound emission levels and duty cycles. Activity levels for the peak hour of the "average worst" case day can be used.

To predict off-site sound propagation, the tipping face activity can be modelled as a point source located on the outside embankment of landfill (e.g. half-way up), moving around the site on a locus parallel to the defined operational boundary (toe of embankment).

Contours of sound exposure and sound exposure change based on this locus can be drawn. Clearly, this is representative of worst case conditions since relative to any receptor, this level of sound exposure would not apply for much of the time, when the operations are elsewhere on-site.

The worst hour of the day can be determined for the haul routes based on comparing trucking volumes to ambient traffic. Noise analysis for haul routes is not controversial, using well established traffic noise models such as MOEE ORNAMENT.

Once a preferred site is selected, it will require a detailed environmental noise assessment. In Ontario, the MOEE practice is to not account for excess ground attenuation, regardless of the source elevation. Thus, for consistency, at the site comparison stage, it is desirable to also neglect any ground attenuation effects. Otherwise, there could be significant and undesirable changes in the size of potential impact zones between stages of the study.

Having determined off-site sound exposures, and expected zones of change, the feasibility of various mitigation measures should be considered, together with those designing the landfill and its operations. Generally, at the site selection stage, detailed engineering of cell progression will not be done. However, a preliminary site plan showing the site entrance, primary on-site perimeter haul road, scale house, support facilities and final contours will be available. The purpose of the mitigation is to minimize the zones of change and the number of potential receptors at which the approval guideline may not be consistently met.

With the analyses updated for mitigation, the sites can be compared. Quantitative techniques such as in References 1 and 2 can be used. For each zone or receptor, a composite weighting factor is determined, based on both change and absolute sound exposure. An acoustically weighted population count is then determined to rank sites. Judgements are required on the use of weighting factors. For example, how many people experiencing a change of 2, 3, 4 or 5 dBA are equivalent to individuals with changes of 10, 15 or 20 dBA, and how should the weightings change with increasing sound exposures? In some cases, it may be possible to resolve these issues and how important noise is relative to other factors, by obtaining input from the public to be potentially affected.

Another approach is to qualitatively compare sites using the acoustical data together with lifestyle analyses obtained from detailed interviews of residents in the areas surrounding candidate sites. These letter studies are usually conducted by Social Impact specialist.

Generally, most businesses, wildlife and animals are less sensitive to the type of noise produced by landfills (trucks and engine powered equipment). Potentially noise sensitive situations must be assessed qualitatively on a case-by-case basis.

Mitigation

Various alternatives may be practicable: choosing quiet equipment where available; perimeter sound barriers/berms to screen internal roads; road network or intersection improvements, particularly at the entrance, to facilitate truck turning movements; operational berms inherent to tipping face design. The operational berm technique starts each cell at the outside edge with a large berm of soil or soil and refuse and then works away from the edge with the trucks and equipment screened by the berm. Technically, off-site mitigation can sometimes be effective, in the form of adding air conditioning, upgraded windows or sound barriers at residential receptors. However, in practice, implementing these methods presents policy and administrative difficulties, as well as potential liability concerns. Compensation for nuisance effects and a property value protection strategy might also be viewed as mitigation. As a last resort, buy-out or expropriation of neighbouring properties that cannot be adequately mitigated can be considered.

Summary and Conclusions

Current noise guidelines used for approval purposes offer little guidance for site selection. In addition to off-site sound exposure due to the operation, changes to the ambient environment should be considered in comparing sites. As yet, there are no universally agreed-on procedures to compare sites accounting for both factors together. Further research into community reaction to changes at various levels of noise exposure is needed. Nevertheless, there are quantitative and qualitative means to usefully compare and rank sites based on noise. Many of the concerns and techniques would apply to other types of projects besides landfills.

References

1. "Acoustic Impact Assessment Procedure Used in Industrial Plant Site Selection", F.M.Costlier, Noise Control Engineering, Jan/Feb. 1976.

2. "A Technique For Comparing Alternative Transportation Corridor Alignments Based on Noise Impact", A.D. Lightstone et al, Inter-Noise 92, 947-950, July 1992.