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# Red John Pumped Storage Hydro Scheme

## Volume 5, Appendix 16.4: Uncertainty in Modelling

ILI (Highlands PSH) Ltd.

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## Quality information

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## Revision History

| Revision | Revision date | Details | Authorized | Name | Position |
|---|---|---|---|---|---|
| 1 | November 2018 | Submission | CA | Catherine Anderson | Associate Director |
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# Appendix 16.4 Uncertainty in Modelling

## 16.1 Acoustic modelling details

16.1.1 Modelling of sound levels from the Dvelopment have been undertaken using SoundPLAN (version 8.0) acoustic modelling software. This software implements the sound propagation calculation methodology set out in BS 5228-1.

## 16.2 Acoustic modelling input data

16.2.1 Data sources used for this modelling are shown in Table 16.1.

**Table 16.1 Data sources**

| Data | Source file | Received from |
|---|---|---|
| OS mapping | 60540914-REF-20-0000-C-0007 OS 10k Vector Mapping.dwg | AECOM |
| Existing topography | NextMap_5m_Contour.DWG | AECOM |
| Proposed ground levels at Headpond area | 60540914-REF-20-0000-C-0001 HEADPOND CONTOURS.dwg | AECOM |
| Proposed development layout | S01-ACM-Z0-00-SH-CE-100101-B.pdf (also known as Figures 2.3, 2.4 and 2.5 of Volume 3) | AECOM |

16.2.2 Sound power levels for sources included in the acoustic model are set out in Table 16.2 below.

**Table 16.2 Sound power levels of modelled sound sources**

| Source | Source Type (Sound Power Descriptor) | Sound Power Levels at Octave Band Centre Frequency (Hz) | | | | | | | | Total A-weighted (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 | |
| Construction – Sweepers at road crossings | Area source (dB per unit) | 108 | 103 | 97 | 103 | 99 | 95 | 89 | 86 | 104 |
| Access road construction – site clearance | Area source (dB per unit) | 133 | 130 | 123 | 119 | 118 | 115 | 116 | 110 | 124 |
| Access road construction – road surfacing | Area source (dB per unit) | 128 | 121 | 117 | 120 | 119 | 116 | 111 | 101 | 123 |
| Compound 1 set up | Area source (dB per unit) | 129 | 122 | 118 | 121 | 120 | 117 | 112 | 102 | 124 |
| Compound 3 set up | Area source (dB per unit) | 116 | 114 | 109 | 110 | 115 | 103 | 98 | 91 | 116 |
| Headpond works– mobile plant | Area source (dB per unit) | 128 | 122 | 118 | 120 | 119 | 116 | 111 | 102 | 124 |

| Source | Source Type (Sound Power Descriptor) | Sound Power Levels at Octave Band Centre Frequency (Hz) | | | | | | | | Total A-weighted (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 | |
| Headpond works – generators & pumps | Point source (dB) | 113 | 107 | 106 | 104 | 104 | 102 | 95 | 87 | 108 |
| Headpond works – conveyor drive unit | Point source (dB) | 99 | 97 | 96 | 99 | 103 | 95 | 91 | 85 | 105 |
| Headpond works – conveyor belt | Line source (dB per m) | 72 | 66 | 66 | 57 | 57 | 56 | 61 | 61 | 66 |
| Headpond works – concrete batching plant | Area source (dB per unit) | 110 | 107 | 106 | 104 | 102 | 102 | 97 | 94 | 108 |
| Headpond site clearance | Area source (dB per unit) | 133 | 130 | 123 | 119 | 121 | 116 | 112 | 103 | 125 |
| Headpond Embankment excavation – mobile plant at Headpond | Area source (dB per unit) | 132 | 131 | 125 | 124 | 125 | 123 | 118 | 113 | 129 |
| Headpond Embankment excavation – stationary plant at Headpond | Point source (dB) | 128 | 126 | 123 | 122 | 120 | 118 | 113 | 103 | 125 |
| Headpond Embankment excavation – mobile plant at Compound 4 | Area source (dB per unit) | 119 | 112 | 108 | 111 | 110 | 107 | 102 | 92 | 114 |
| Headpond trench excavation | Area source (dB per unit) | 123 | 123 | 120 | 115 | 117 | 115 | 113 | 108 | 122 |
| Headpond Embankment construction | Area source (dB per unit) | 130 | 127 | 123 | 122 | 122 | 119 | 114 | 105 | 126 |
| Headpond Landscape Embankment construction | Area source (dB per unit) | 123 | 116 | 112 | 115 | 114 | 111 | 106 | 96 | 119 |
| Headpond Spillway Pipe – mobile plant at Compound 3 | Area source (dB per unit) | 116 | 114 | 109 | 110 | 115 | 103 | 98 | 91 | 116 |
| Headpond Inlet / Outlet works | Area source (dB per unit) | 106 | 104 | 99 | 100 | 107 | 99 | 91 | 82 | 108 |
| Headpond Inlet / Outlet housing | Area source (dB per unit) | 106 | 104 | 99 | 100 | 107 | 99 | 91 | 82 | 108 |
| Tailpond works – mobile plant | Area source (dB per unit) | 122 | 115 | 111 | 114 | 113 | 110 | 105 | 95 | 117 |
| Tailpond works – generators and pumps | Point source (dB) | 115 | 110 | 111 | 107 | 107 | 105 | 97 | 90 | 112 |

| Source | Source Type (Sound Power Descriptor) | Sound Power Levels at Octave Band Centre Frequency (Hz) | | | | | | | | Total A-weighted (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 | |
| Tailpond temporary works in Loch Ness | Area source (dB per unit) | 115 | 122 | 123 | 119 | 118 | 113 | 109 | 100 | 122 |
| Tailpond TBM preparation | Point source (dB) | 117 | 125 | 110 | 111 | 112 | 111 | 108 | 106 | 118 |
| Tunnelling works – mobile plant at Compound 1 | Area source (dB per unit) | 116 | 113 | 111 | 109 | 107 | 104 | 99 | 91 | 112 |
| Tunnelling works – concrete batching plant at Compound 1 | Area source (dB per unit) | 110 | 107 | 106 | 104 | 102 | 102 | 97 | 94 | 108 |
| Tunnelling – Access Tunnel | Point source (dB) | 110 | 107 | 111 | 105 | 104 | 100 | 91 | 82 | 109 |
| Tunnelling – Construction Tunnel | Point source (dB) | 130 | 129 | 121 | 117 | 116 | 114 | 110 | 105 | 122 |
| Tunnelling – Waterways – generators at Compound 1 | Point source (dB) | 110 | 107 | 111 | 105 | 104 | 100 | 91 | 82 | 109 |
| Tunnelling – Waterways – conveyor drive unit | Point source (dB) | 99 | 97 | 96 | 99 | 103 | 95 | 91 | 85 | 105 |
| Tunnelling – Waterways – conveyor belt | Line source (dB per m) | 72 | 66 | 66 | 57 | 57 | 56 | 61 | 61 | 66 |
| Tunnelling – TBM decommissioning | Area source (dB per unit) | 103 | 108 | 105 | 103 | 102 | 101 | 98 | 91 | 108 |
| Hauling* - 10 Dump trucks (90 % on-time) | Moving point source (dB per unit) | 130 | 127 | 118 | 114 | 112 | 110 | 107 | 98 | 119 |
| Hauling* - 8 Tippers (90 % on-time) | Moving point source (dB per unit) | 116 | 125 | 112 | 108 | 111 | 108 | 106 | 100 | 116 |
| Hauling* - 10 Concrete Jaegers (80 % on-time) | Moving point source (dB per unit) | 117 | 108 | 100 | 103 | 104 | 112 | 94 | 89 | 114 |
| Hauling* - 6 Tractors (80 % on-time) | Moving point source (dB per unit) | 114 | 106 | 113 | 110 | 113 | 105 | 96 | 90 | 115 |

* *Hauling plant speed has been assumed to be 20 km / hr.*

## 16.3 Acoustic model settings

16.3.1 Acoustic modelling has been undertaken using the following model settings:

- Maximum search radius of 5000 m (this is to the maximum source to receiver distance which is considered in the calculations)

- Maximum number of reflections: 3
- Noise predictions carried out at a height of 1.5 m to represent ground floor levels.
- Side diffraction enabled (this setting includes calculation of sound travel not only over an obstacle but also around the sides of it).
- Heights of buildings assumed to be 6 m.
- Ground absorption has been set as below:
  - Acoustically hard ground (G=0) for water surfaces, roads and compound 1 area.
  - Remaining areas set to G=1 representing acoustically soft ground.

## 16.4 Uncertainty in modelling

16.4.1 It should be noted than any predictions of sound levels have an associated degree of uncertainty. Modelling and measurement processes have been carried out in such a way as to reduce such uncertainty; however it is unavoidable that some remains. In particular, the following sources of uncertainty have been noted:

- Sound source levels have been based on data provided by the manufacturers. The precise methodology by which these data were gathered, and hence the uncertainty associated with these is not known.
- Predictions of sound pressure levels according to BS5228 are based on an assumption of moderate downwind propagation, and hence could be considered as a worst-case calculation. However, the standard also indicates an estimated accuracy of ±3 dB(A) in predicted levels.

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