Modelling Rail Noise & Vibration

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Basic Concepts - Noise

- Noise Source from
  - Wheel/Rail Interaction
  - Propulsion System – Accelerating/High Speed
  - Brakes
  - Wheel Squeal – On tight bends

Modelling Considerations

- Spatial
  - Distance from Train to Receiver
  - Ground Elevations
  - Barriers – Natural/Structural
- Source
  - Train Properties –
    - Length
    - Speed
    - Source Height
    - Specified Criteria

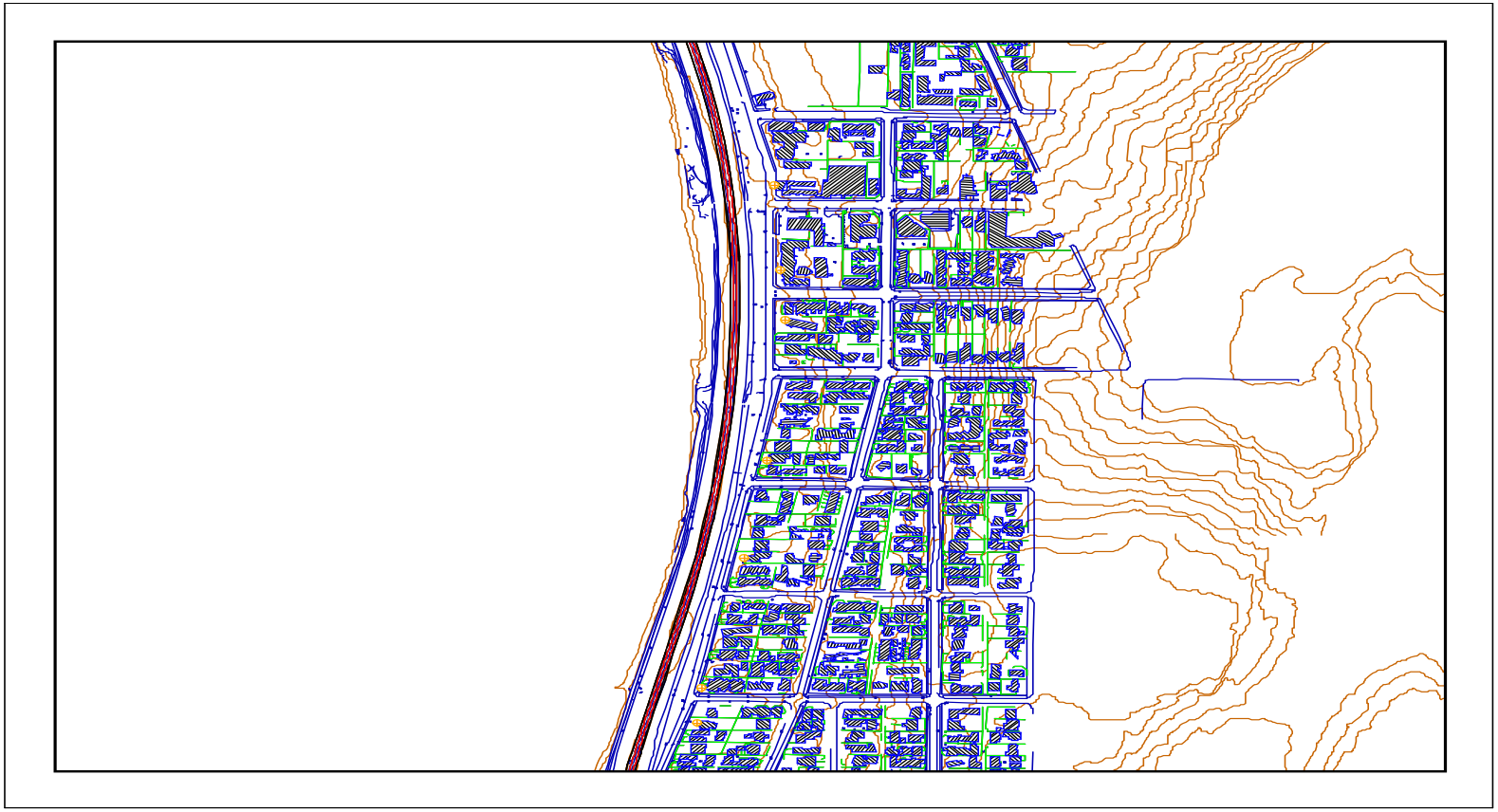
Modelling Process - Noise

- Develop Digital Terrain Model
  - 3D Land Contours -DLI
  - Rail Alignment (x,y,z) at 10m Centres
  - Receiver Locations (x,y,z)
    - Often required visual survey to identify houses, schools, care facilities, sheds, etc
  - Existing Barriers – Fences, Safety Barriers
    - Height, condition, location

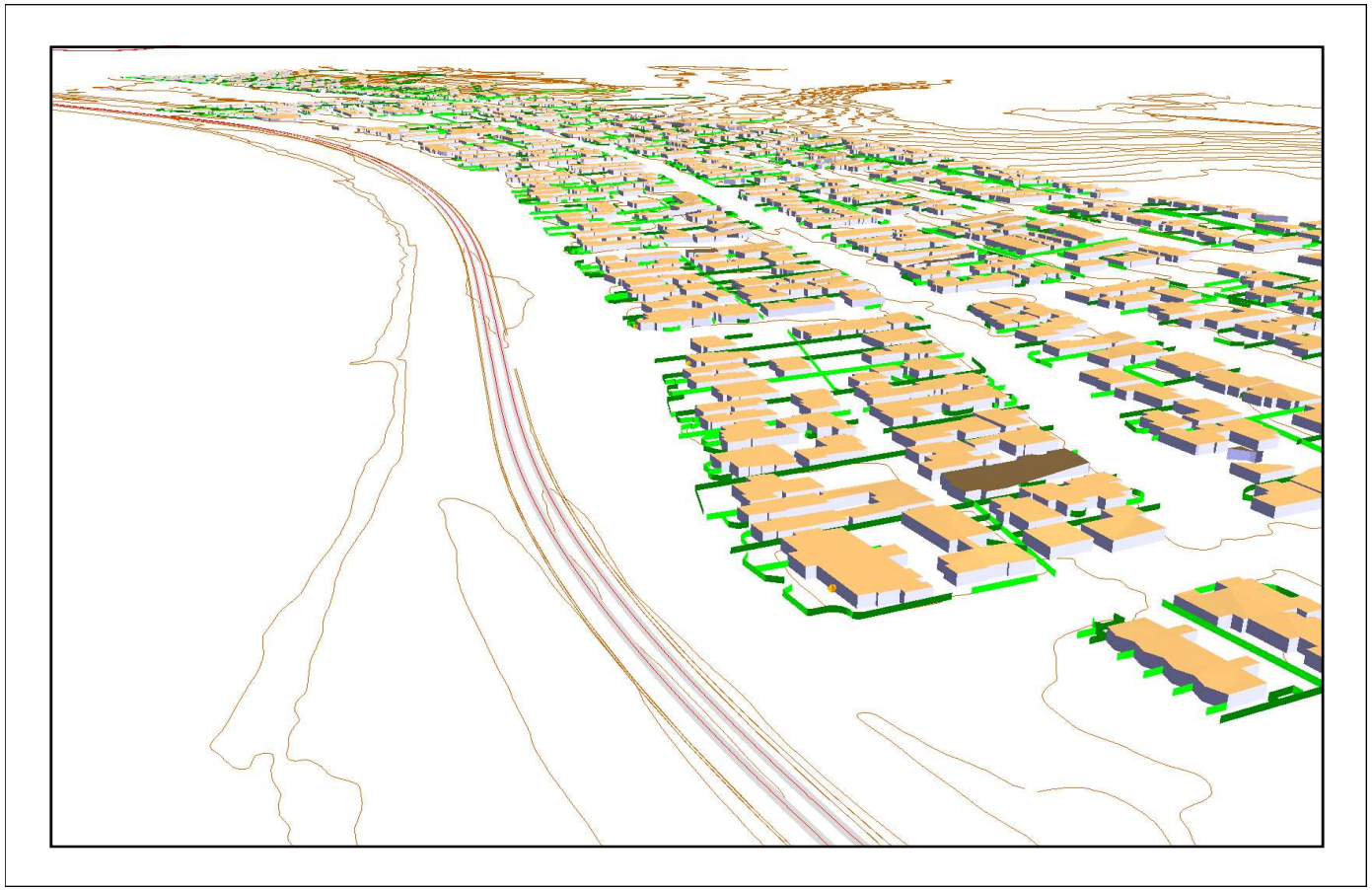
Modelling Process - Noise

- Input Noise Source
  - Source Height – Affects Barrier Performance
  - Train Length
  - Ground Absorption
  - Movements during Daytime/Night-time period
  - Train Speed along Track Section
  - Ignore Stations

Modelling Process – Example Layout



Modelling Process – Example Layout

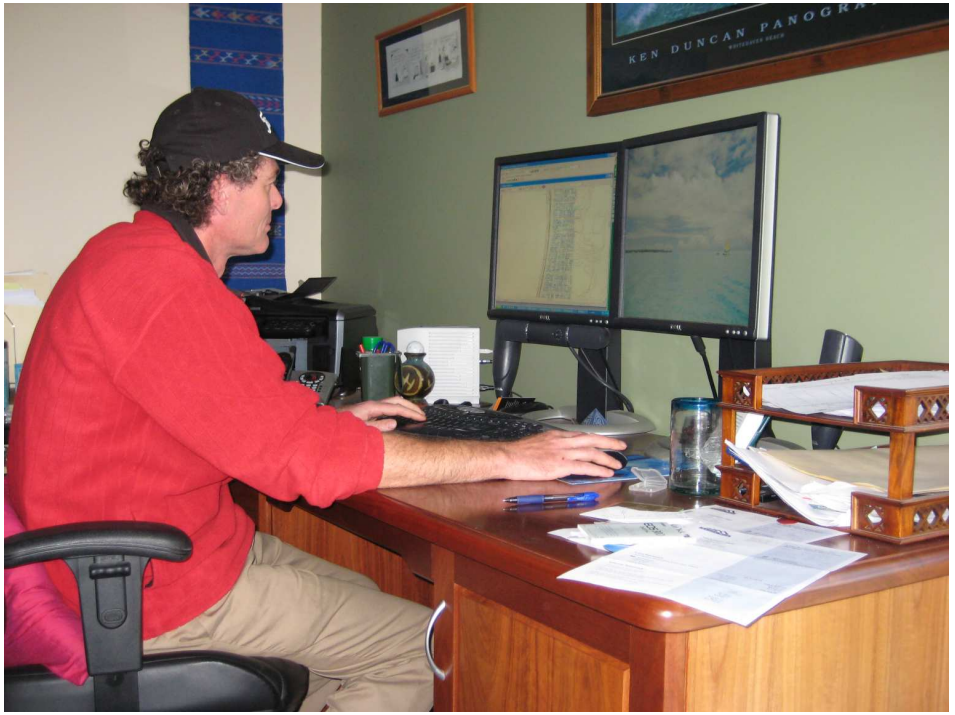


Modelling Process - Noise

- Select Algorithm
  - Nordic Railway Prediction Method (Kilde Report 130)
    - Gives both LAeq Day/night and LAmax
- Calibration
  - Compare against criterion (Initial)
  - Compare against measured data (Final)

Modelling Process - Noise

- Data Input

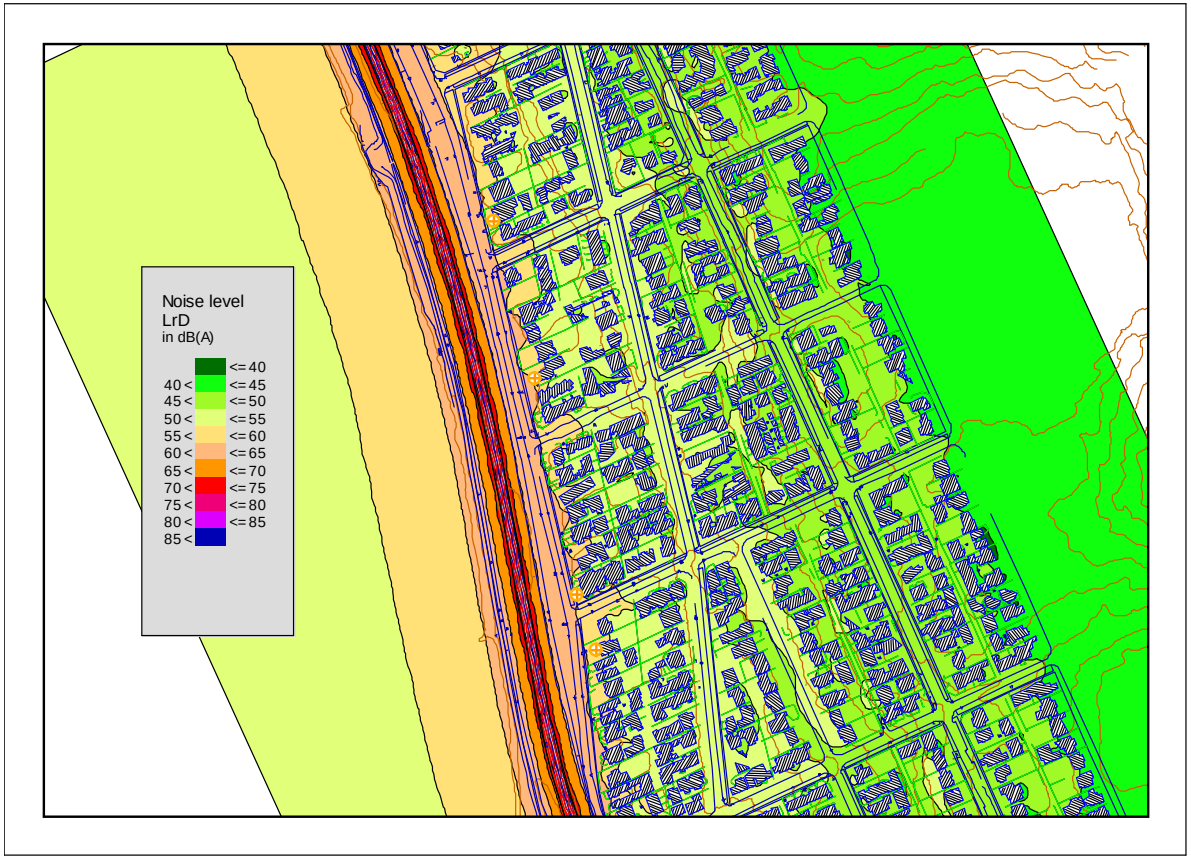


Modelling Process - Noise

- Running The Model

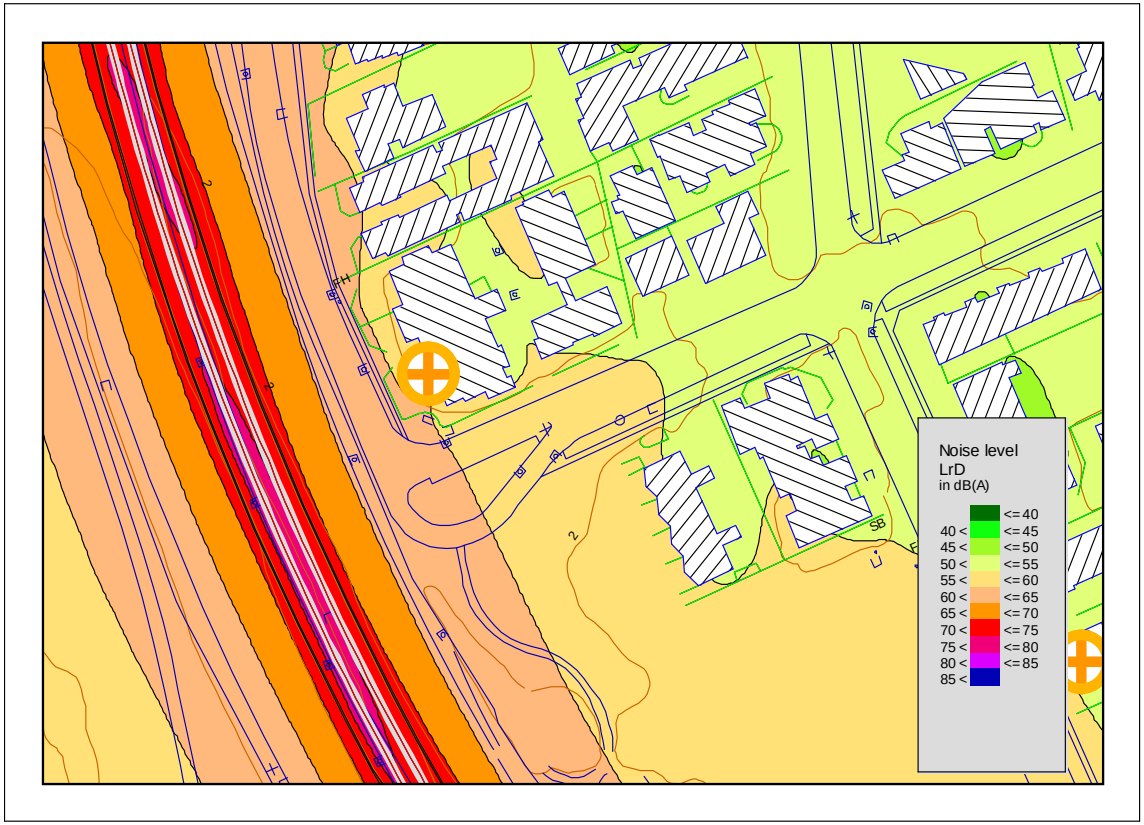
Modelling - Noise

- Results



Modelling - Noise

- Results

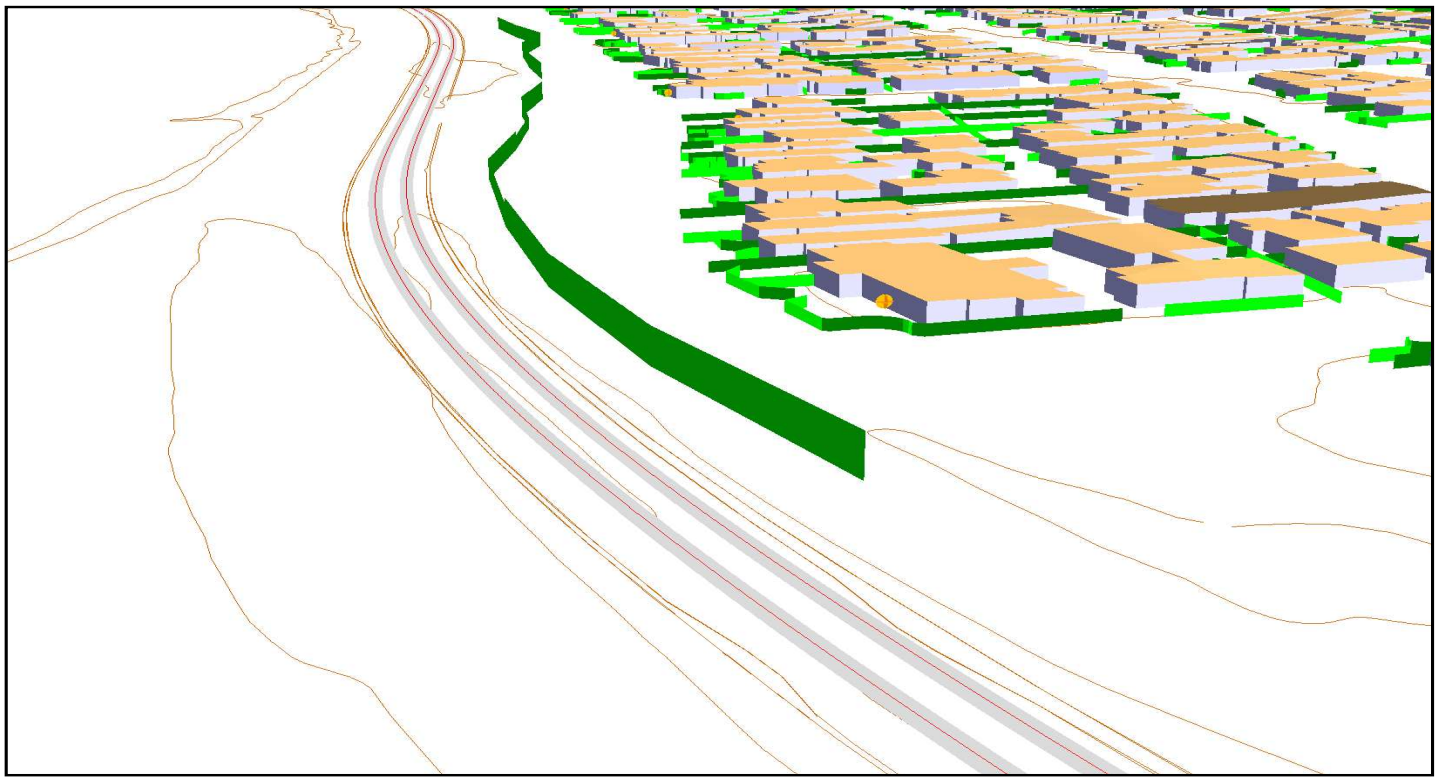


Modelling - Noise

- Results

Receiver	X m	Y m	Z m	LrD dB(A)
A1	52840.13	261802.63	3.40	56.4
A10	53005.44	261018.18	3.02	56.0
A11	53023.66	260936.52	2.85	55.3
A12	53035.36	260868.70	2.94	55.7
A13	53043.15	260827.47	3.40	54.7
A14	53061.91	260715.32	3.40	54.9
A15	53063.40	260600.38	3.40	53.1
A16	53538.49	259407.25	3.39	57.3
A17	53562.36	259343.63	3.40	58.8
A18	53598.16	259260.50	3.85	57.7
A19	53698.99	258871.41	4.31	58.4
A2	52830.78	261768.35	3.40	58.3
A20	53705.68	258732.56	3.65	58.6
A21	53710.87	258650.55	3.80	58.0
A22	53687.84	258421.16	3.40	56.9
A23	53659.47	258261.85	3.40	58.6
A24	53607.39	258050.63	3.40	59.1
A25	53602.16	257991.98	3.40	57.5

Modelling Process – Example Layout

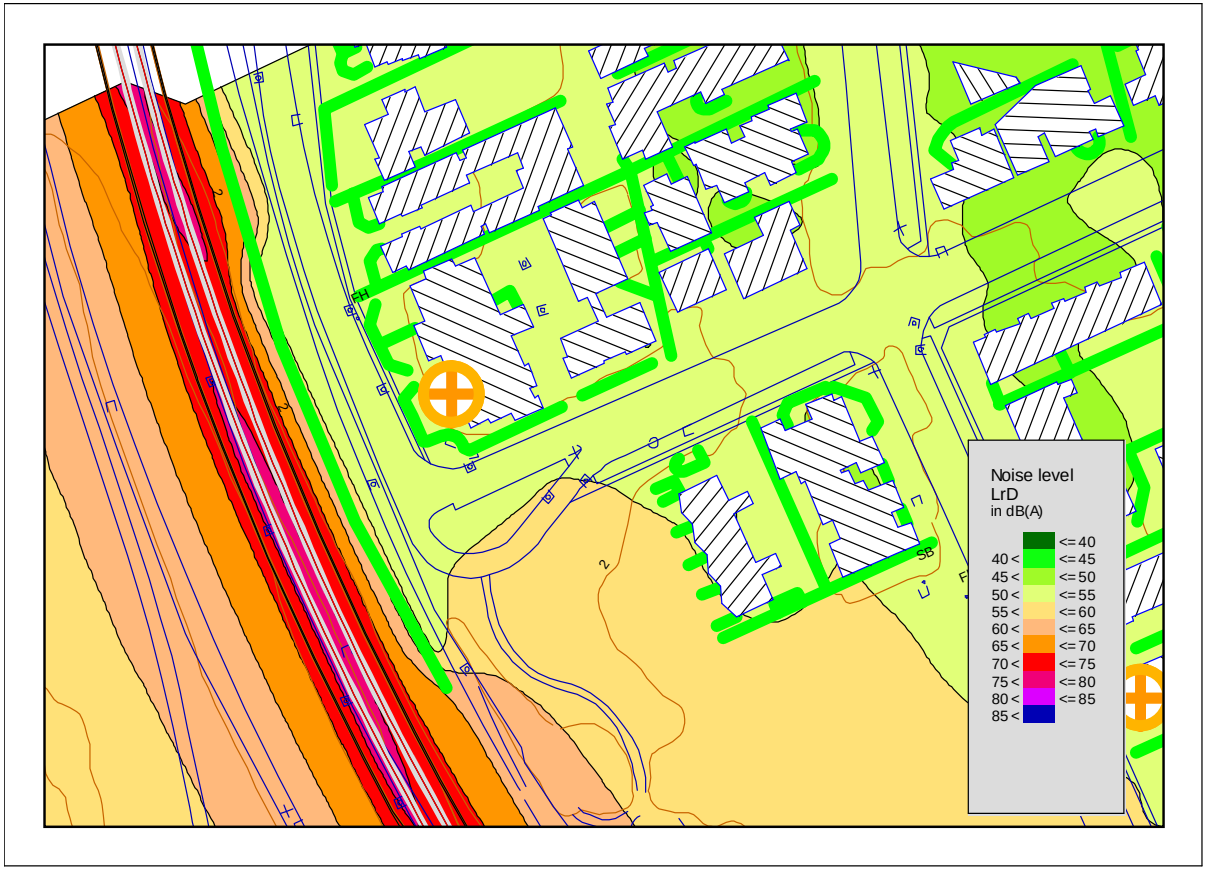


Modelling Process - Noise

- Running The Model

Modelling - Noise

- Results



Basic Concepts - Vibration

- Vibration Source from
  - Wheel/Rail Interaction
  - Feelable Vibration: Frequency range 4 Hz to 80 Hz. Has a low rate of attenuation with distance and is perceived as whole-body vibration in buildings near to the line.
  - Ground-borne Noise: Frequency range 30 Hz to about 200 Hz. Ground vibration may excite bending resonances in the floors and walls of buildings which then radiate a rumbling noise directly into the rooms.

Modelling - Vibration

- Predictions are extremely unreliable unless ground composition and conditions known between source and receiver.
- Better to measure

Modelling - Vibration

Modelling - Vibration

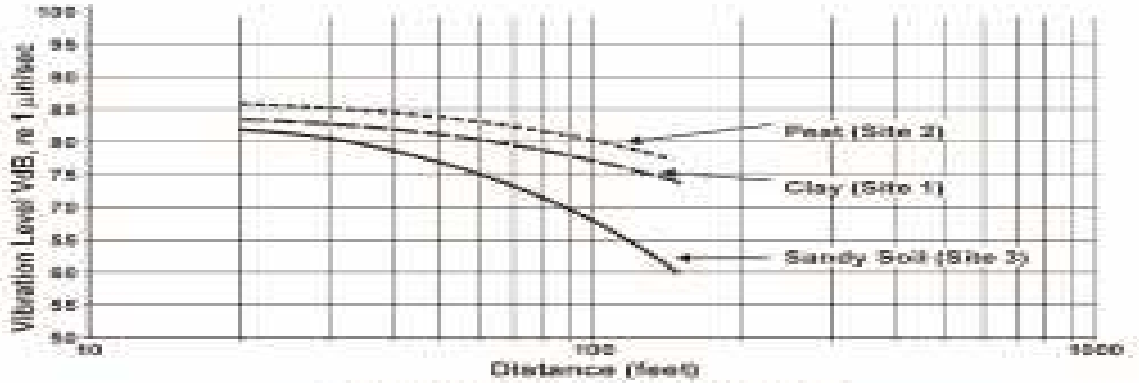


Figure 5. Propagation of Vibrations from SD70 Locomotive for Different Soil Types (Spring)

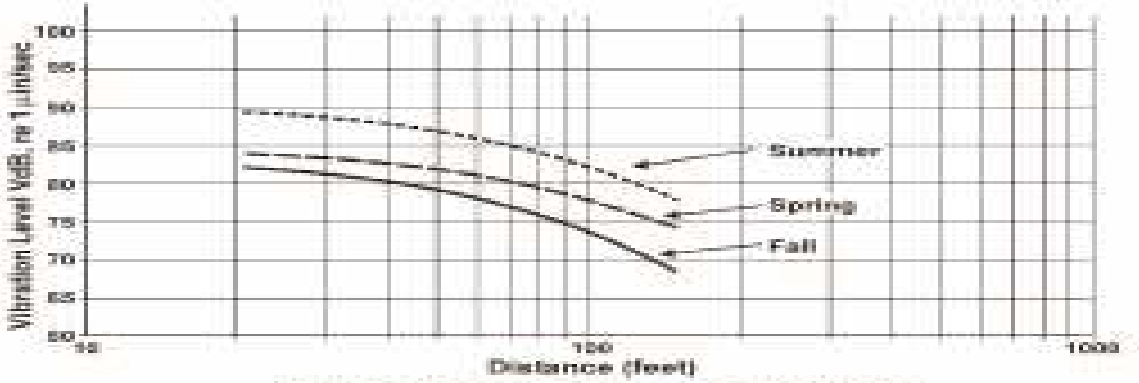
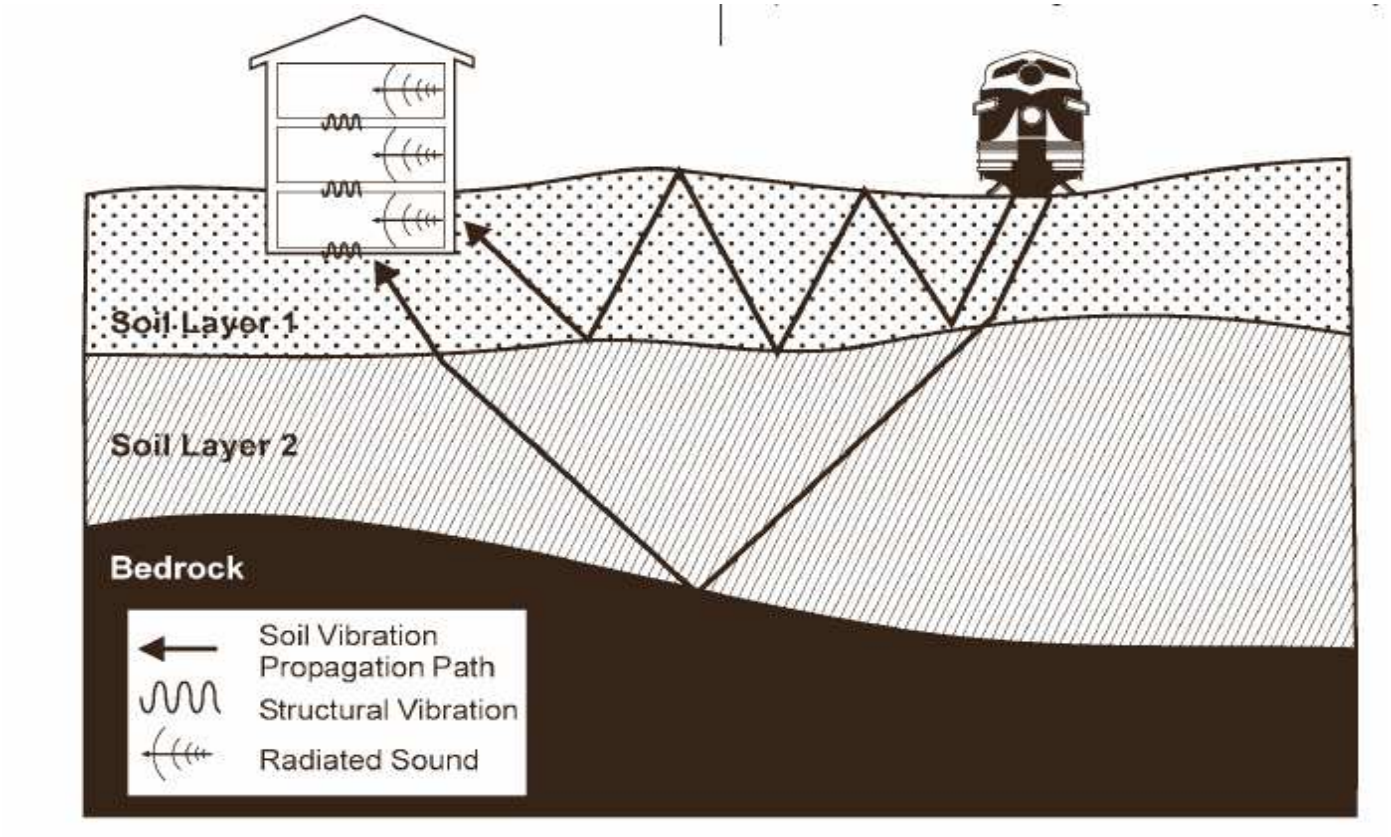
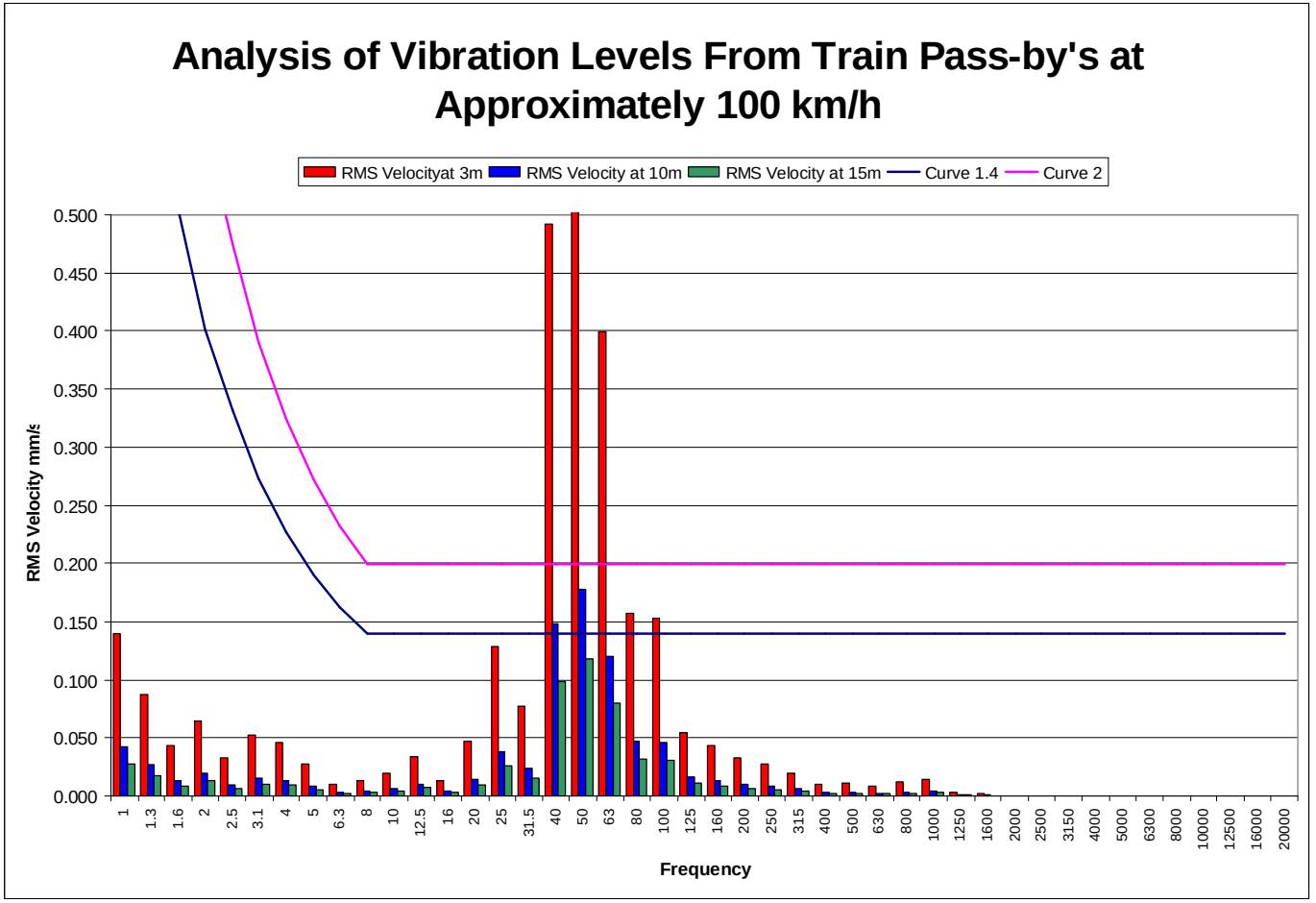


Figure 6. Seasonal Propagation of Vibrations from SD70 Locomotive at Nulbay Park (Site V1)

Modelling - Vibration



Modelling - Vibration



Modelling - Vibration

- From measured results, develop an algorithm for predictions based on distance and train speed.
- Use CAD programs to determine distance of each receiver from rail
- Apply algorithm.

Modelling - Vibration

- Results