Application of The New FHWA Measurement Handbook and Caltrans Guidance: Interior-Exterior Measurements

Roberto Della Neve L.
Associate, ATS Consulting

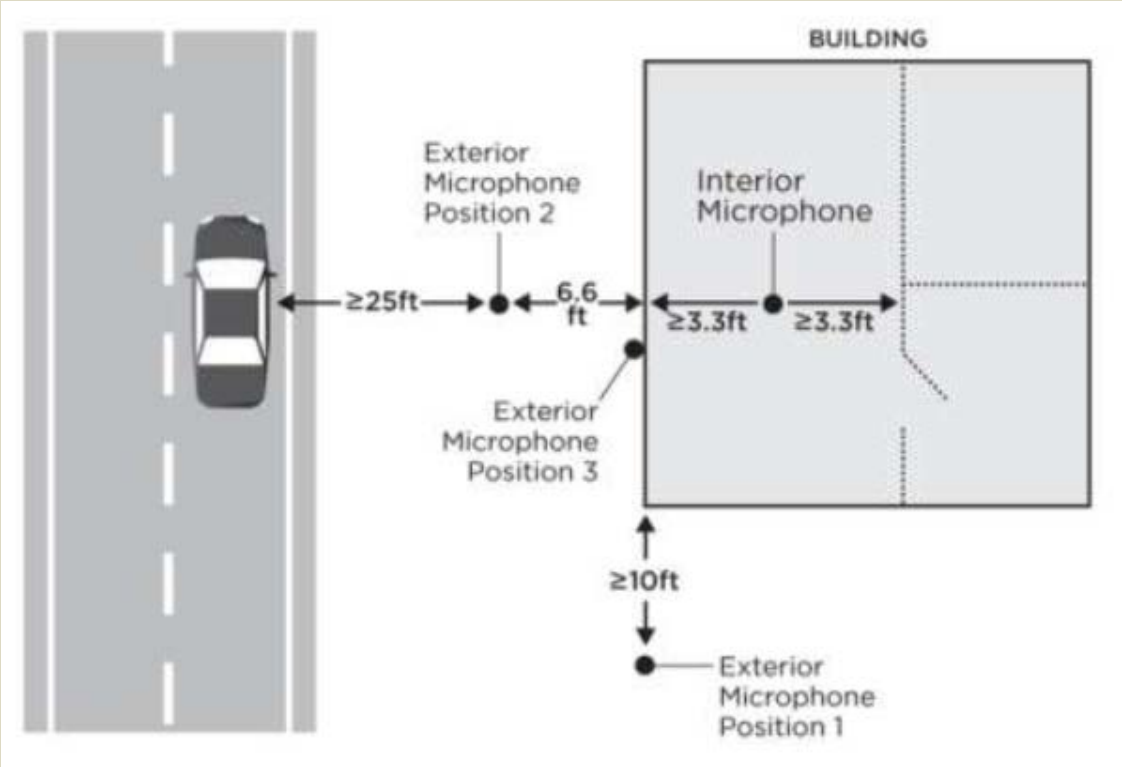
Judy Rochat, Ph.D.
Principal Associate, Cross-Spectrum Acoustics

July 2018

ATSConsulting
acoustics, transportation + strategy

FHWA Guidance

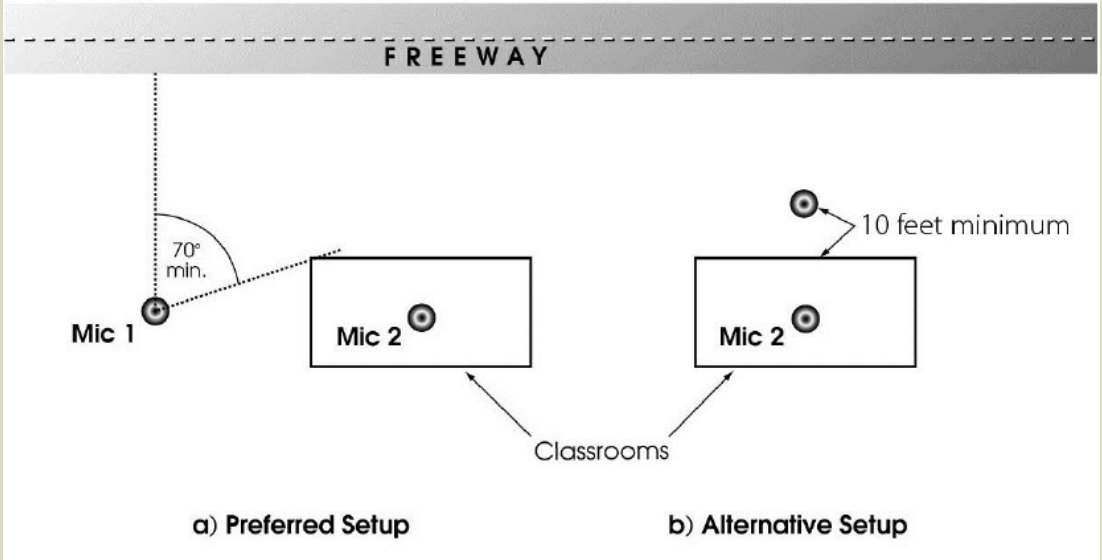
- Three different microphone positions
- Notice minimum distances
- Microphone Position 1 in line with façade
- Road parallel with building façade



From FHWA's forthcoming Noise Measurement Handbook Section 6.1

Caltrans Guidance

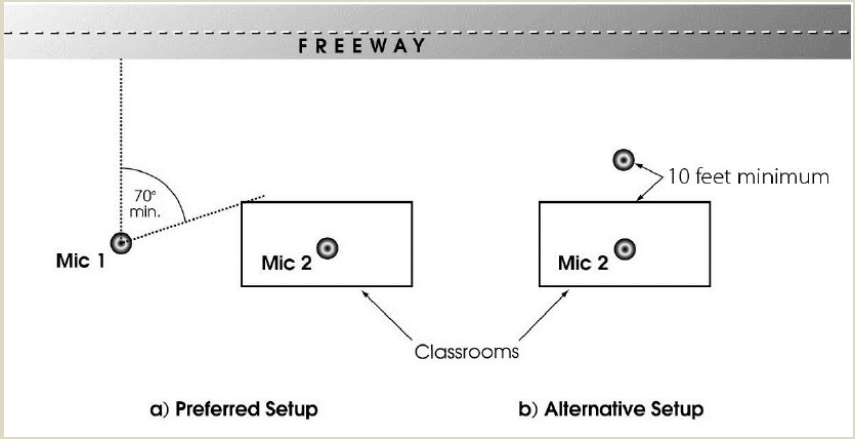
- Two different setups
- Minimum distance of 10 ft in Alternative Setup
- Microphone 1 in Preferred Setup not in line with façade but with interior microphone
- Road parallel with building façade



From Caltrans' 2013 Technical Noise Supplement (TeNS) Section 3.3.5

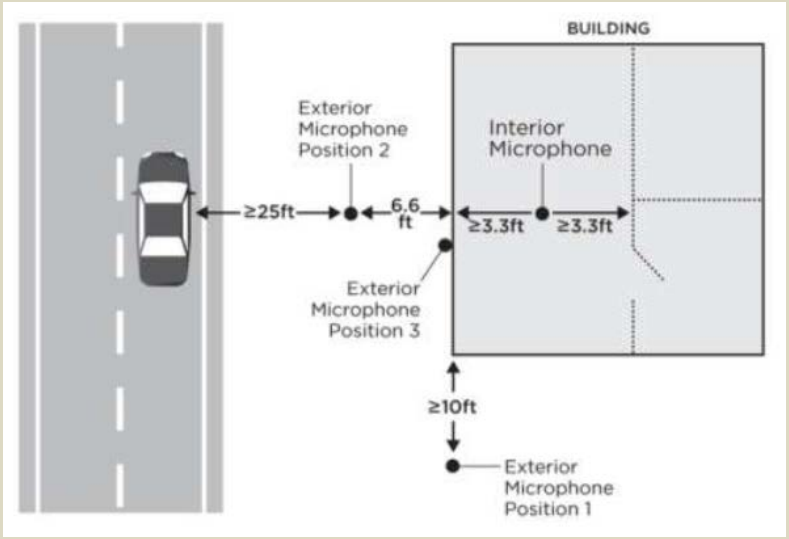
Similarities

- Both seek to compare the noise in the interior to a free field case
- In their secondary setups, adjustments are made to the exterior levels to compensate for reflections (FHWA) or distance (Caltrans)



Differences

- Microphone locations
- Number of interior microphones
  - Caltrans requires one
  - FHWA suggests multiple for big rooms
- Adjustment factors
- Other minor procedural differences



ATSConsulting
acoustics, transportation + strategy

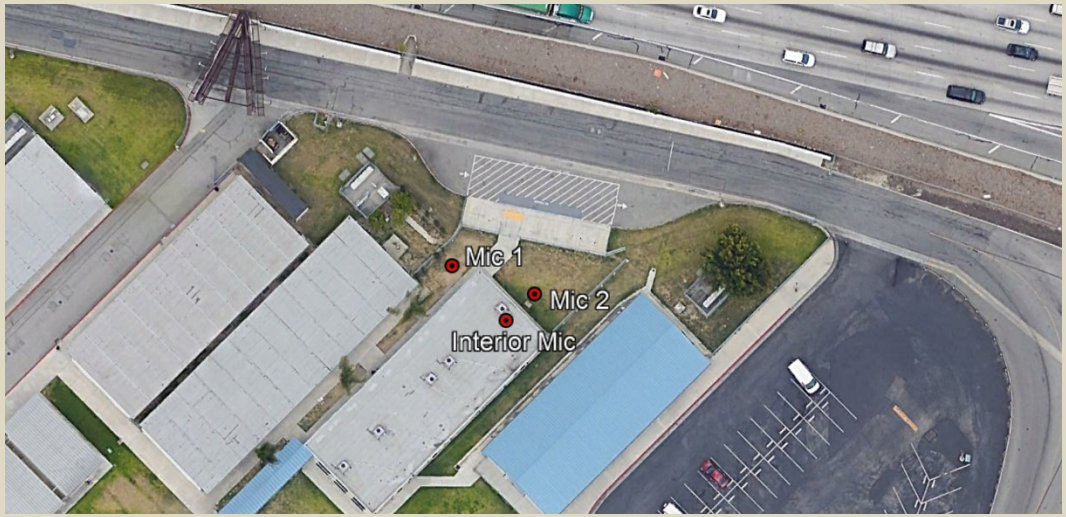
Measurement Location



- Part of a project in the Los Angeles area
- High density area with buildings close to highways
- Constant flow of traffic at high speeds
  - Loud source
  - Continuous noise source
- Wide variety in geometries and complexities for our case studies

Site 1 - Overview

- Fortunate geometry allows for a direct comparison of both Caltrans methods
- Reflections from other surfaces are unavoidable



ATSConsulting
acoustics, transportation + strategy

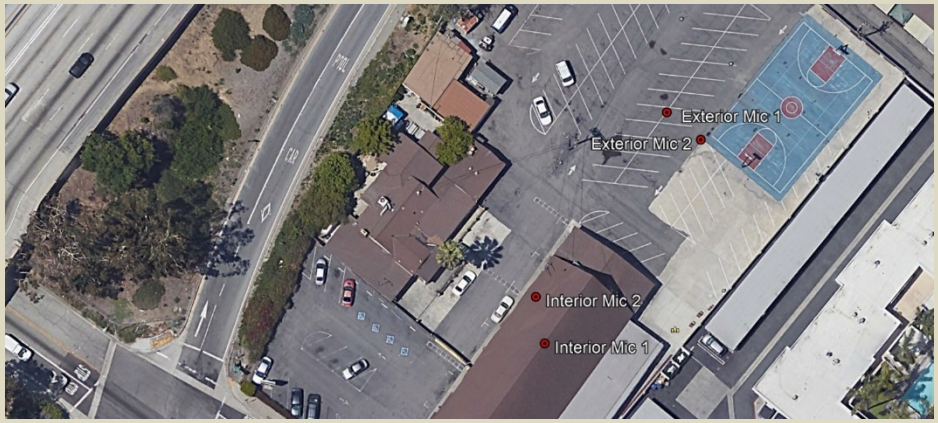
Site 1 - Results

	Measured Levels (dBA)	Building Insertion Loss (dBA)
Interior Microphone	40.1	--
Mic 1 – Caltrans Preferred	75.5	35.4 – 1[a] = 34.4
Mic 2 – Caltrans Alternate	75.1	35.0 – 1[a] = 34.0

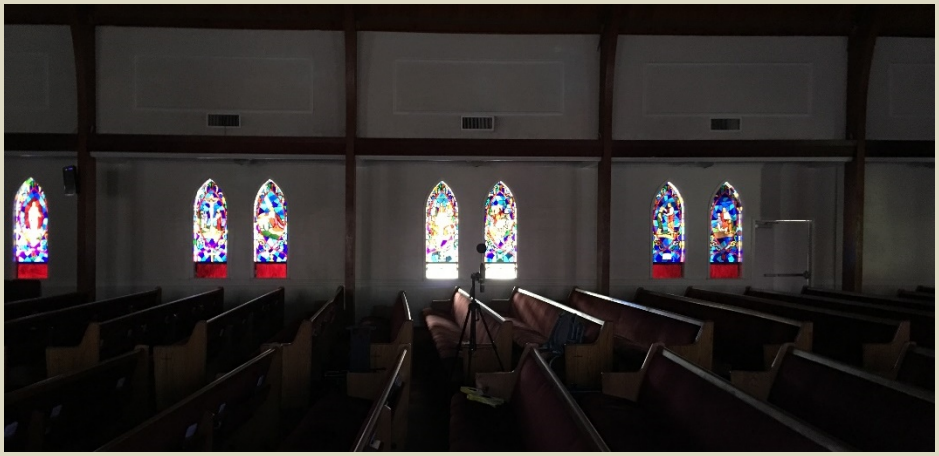
a – Adjustment based on distance difference

Site 2 - Overview

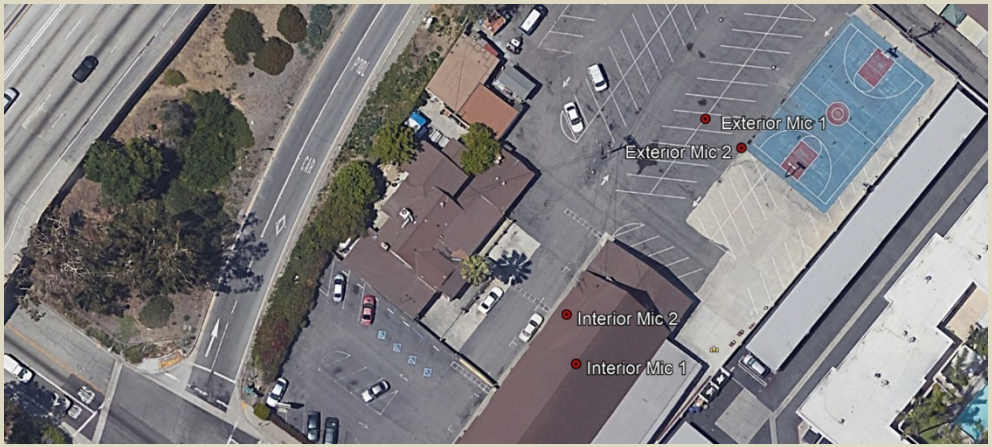
- Evaluation of FHWA's and Caltrans' preferred setups



- Exploration of the multiple microphone setup suggested by FHWA



Site 2 - Results



	Measured Levels (dBA)	Building Insertion Loss (dBA)
Interior Mic 1 – room center	41.6	
Interior Mic 2 – near façade	40.8	
Exterior Mic 1 – aligned with façade	62.8	21.2 or 21.9 (FHWA)
Exterior Mic 2 – aligned with room's center	62.7	21.1 (Caltrans)

Site 3 - Overview

- Site could not accommodate exterior measurements off to the side
- Perpendicular to the highway allowed for exploring the effect of increasing distance from an exterior microphone to the façade, i.e. the effect of reflections
- Distance from highway to façade about 155 ft

Site 3 - Results

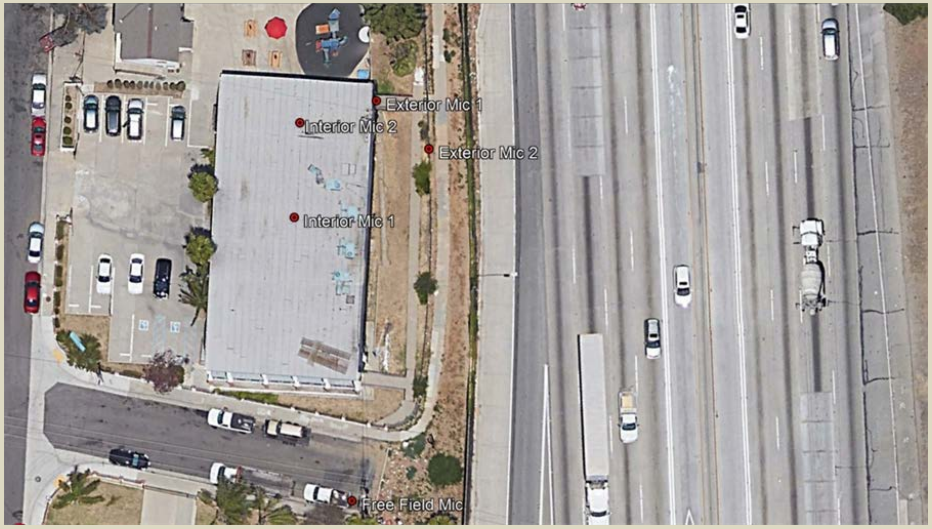
	Measured Levels (dBA)	Building Insertion Loss (dBA)
Interior Mic 1	38.3	
Exterior Mic 1 – 6.6 ft from façade (FHWA required)	68.4	30.1 – 2[a] = 28.1
Exterior Mic 2 – 10 ft from façade (Caltrans minimum)	68.6	30.3 – 1[b] = 29.3
Exterior Mic 3 – 25 ft from façade	68.4	30.1 – 1[b] = 29.1

a – Adjustment based on reflection estimates from ANSI/ASA & ASTM; b – Adjustment based on distance difference

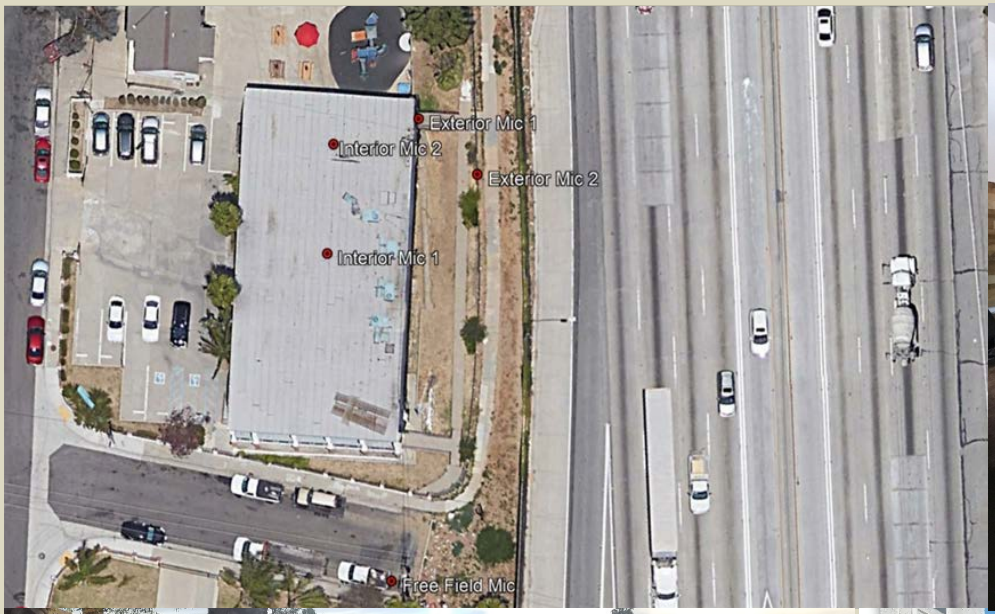
ATSConsulting
acoustics, transportation + strategy

Site 4 - Overview

- Unexplored geometry in either guidance:
  - Existing sound barrier very close to the building
- A lot of reflections
- Raises the question of exactly what energy we want to account for

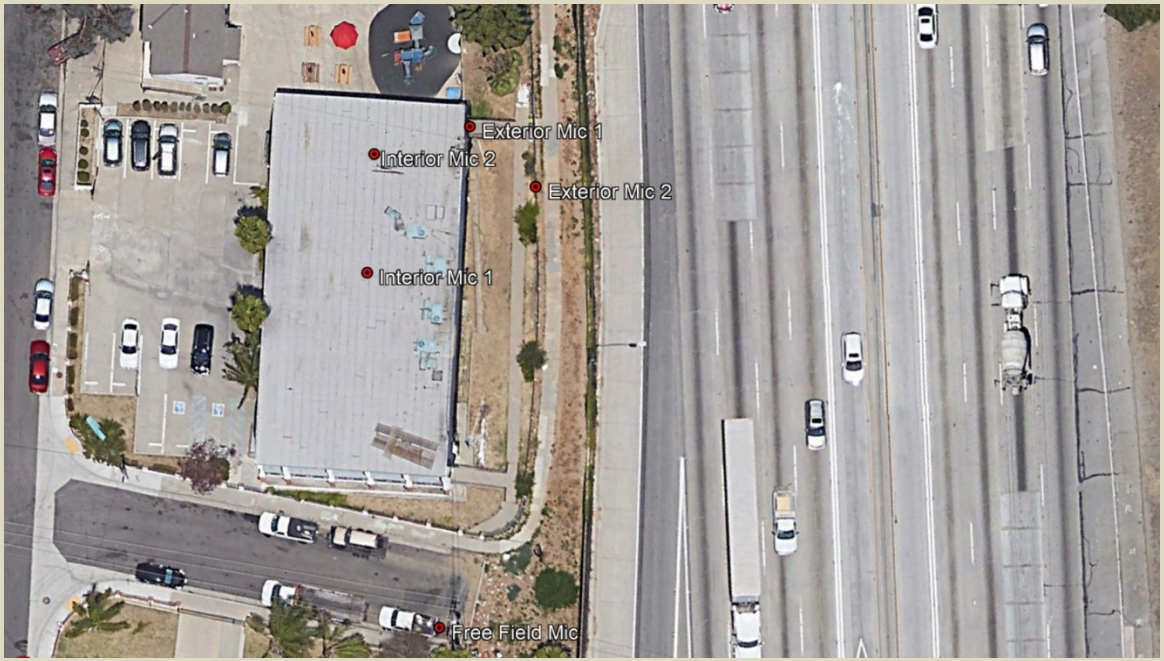


Site 4 - Images



ATSConsulting
acoustics, transportation + strategy

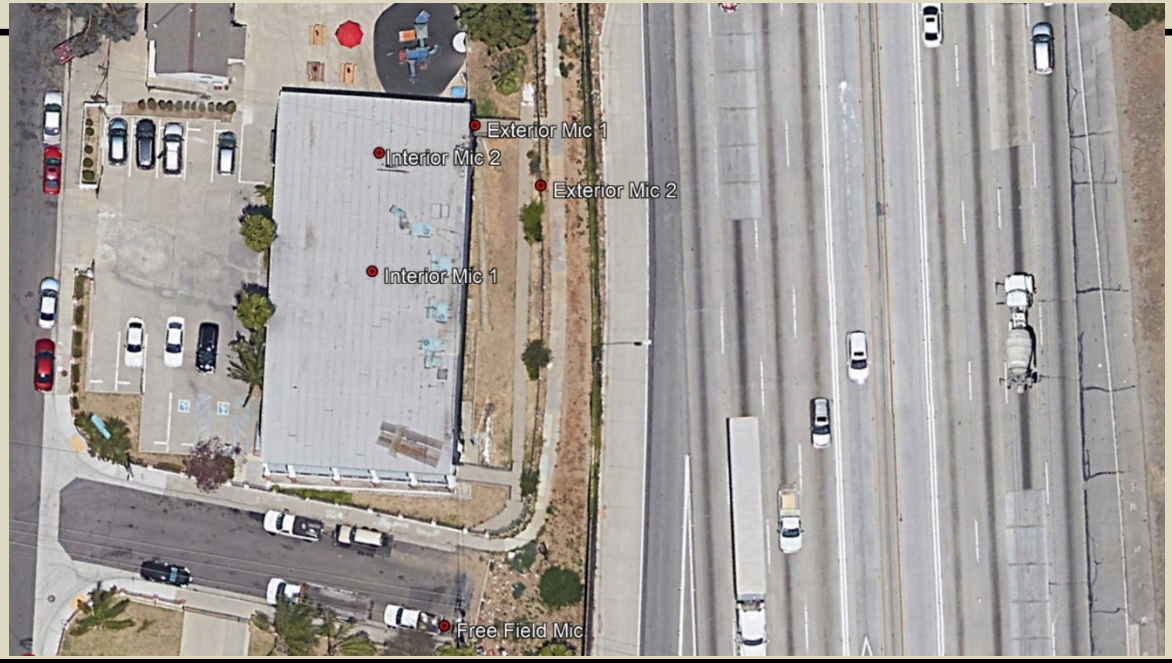
Site 4 - Results



FHWA Methodology	Measured Levels (dBA)	Building Insertion Loss (dBA)
Interior Mic 1 – room center	40.4	--
Interior Mic 2 – balcony	41.2	--
Exterior Mic 1 – FHWA, min distance impossible	69.9	28.7 or 29.5
Free Field Mic - FHWA	62.1	20.9 or 21.7

ATSConsulting
acoustics, transportation + strategy

Site 4 - Results



Caltrans Methodology	Measured Levels (dBA)	Building Insertion Loss (dBA)
Interior Mic 1 – room center	40.4	--
Exterior Mic 1 – Caltrans	69.9	29.5 – 1.5[a] = 28.0
Exterior Mic 2 – 22 ft from façade, 15 ft from sound wall	71.2	30.8 – 2.4[a] = 28.4
Free Field Mic - Caltrans	62.1	21.7 – 1.5[a] = 20.2

a – Distance adjustments based on a simplified TNM model

ATSConsulting
acoustics, transportation + strategy

Summary

- Ideal sites are rare – though certainly welcome. Many sites will present challenges that will force you beyond guidance.
- Acoustical reasoning must be employed to find the appropriate microphone location for the site's geometry.
- Sound walls - especially when close to the receptor - provide a significant increase in the amount of energy that reaches the façade.
- The procedure described in both sets of guidance produce fairly similar results despite significant differences in the setup.

Questions?