12th National LRT Rail Conference

Noise and Vibration Issues of Modern Streetcars

Shankar Rajaram, PhD
srajaram@atsconsulting.com

Shannon McKenna
smckenna@atsconsulting.com

Hugh Saurenman, PhD, PE
hsaurenman@atsconsulting.com

ATS Consulting
215 N. Marengo Avenue, Suite 100
Pasadena, CA 91101
(626) 710-4400

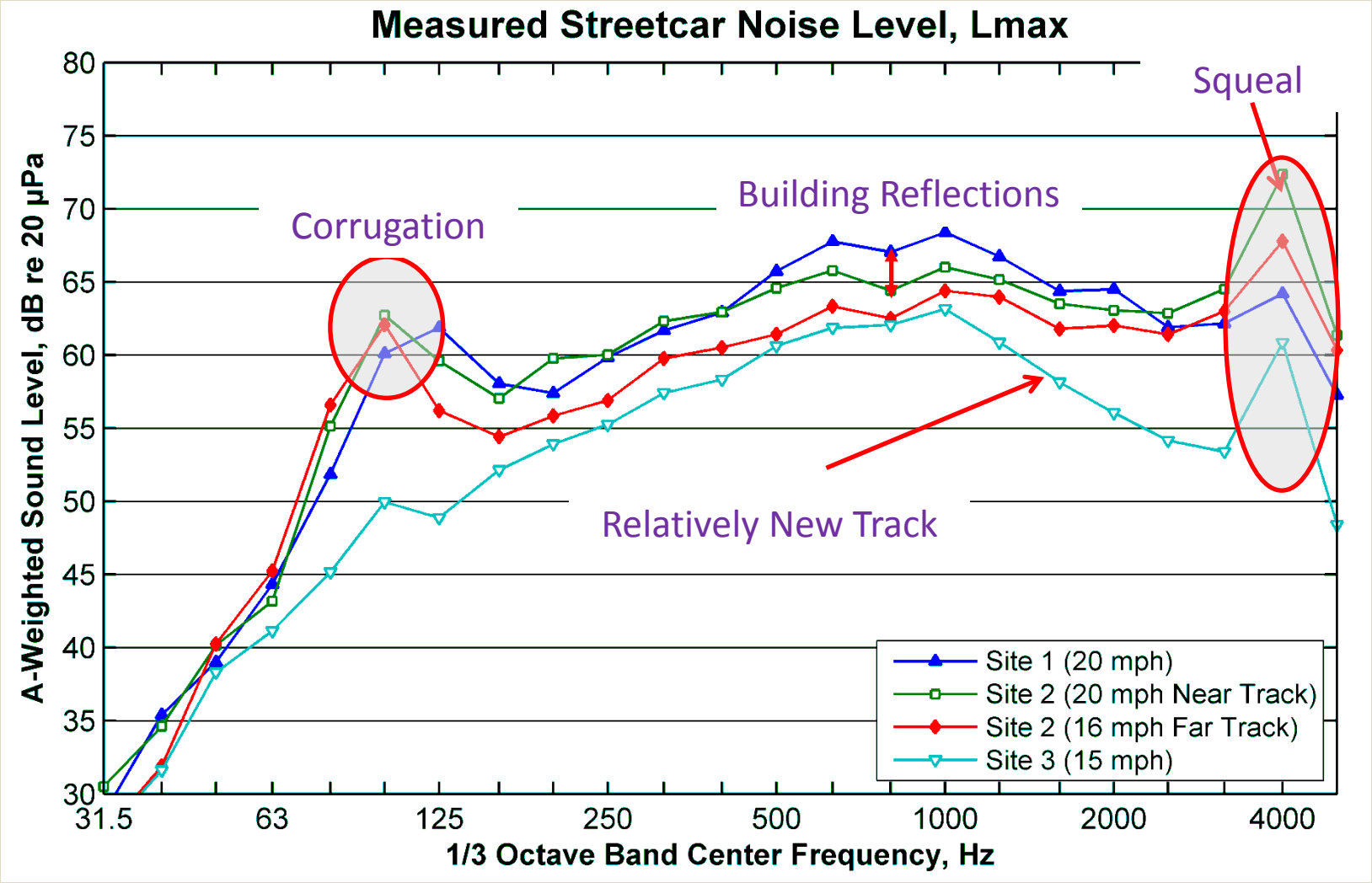
ATSConsulting
acoustics, transportation + strategy

Some Streetcar Projects

Issues in Recent Projects

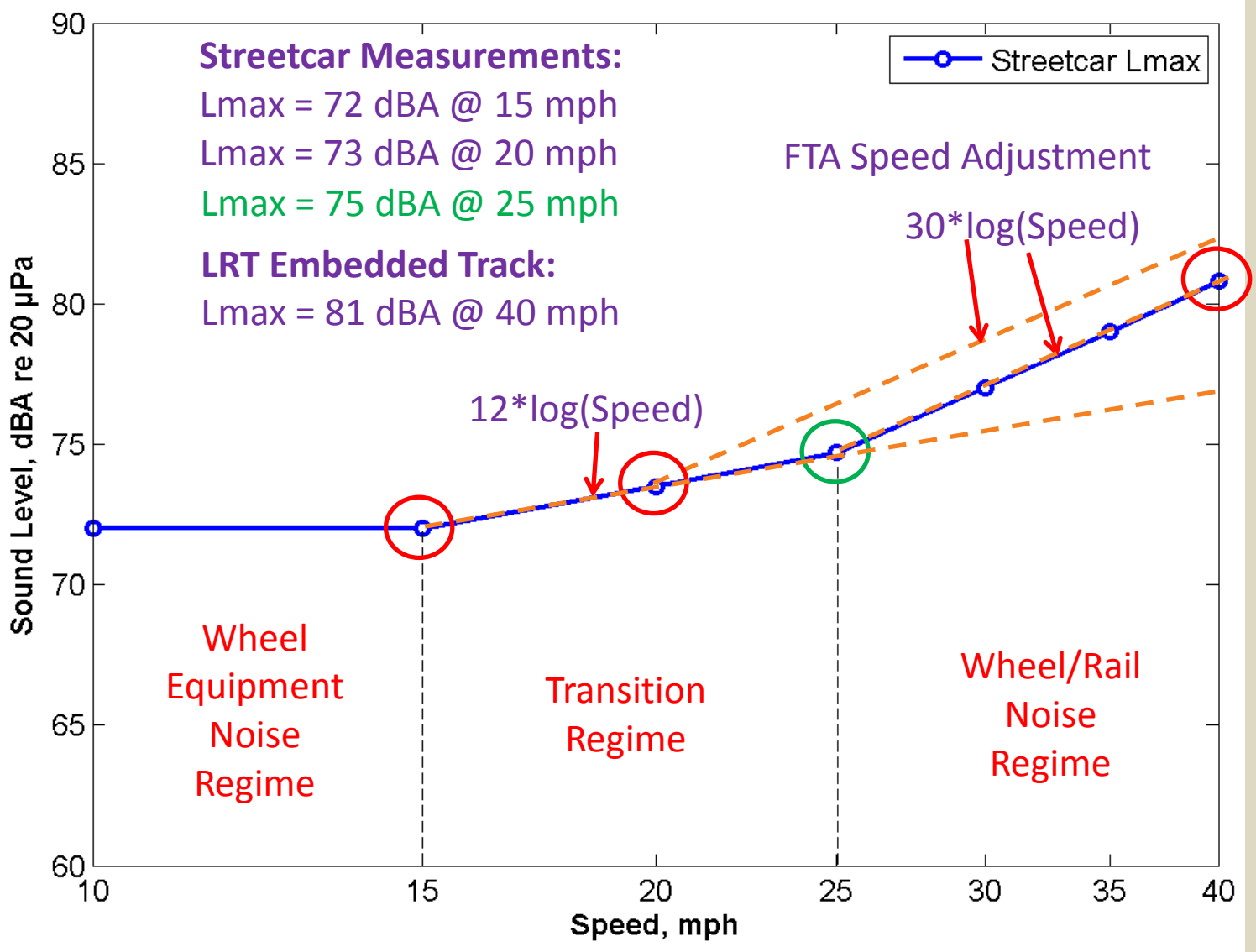
- Limited information available on noise and vibration characteristics
- Relatively high speeds in some area
- Route passing through university research area
- Special trackwork that will be located near residences
- Wheel squeal

Portland Streetcar Noise Spectrum



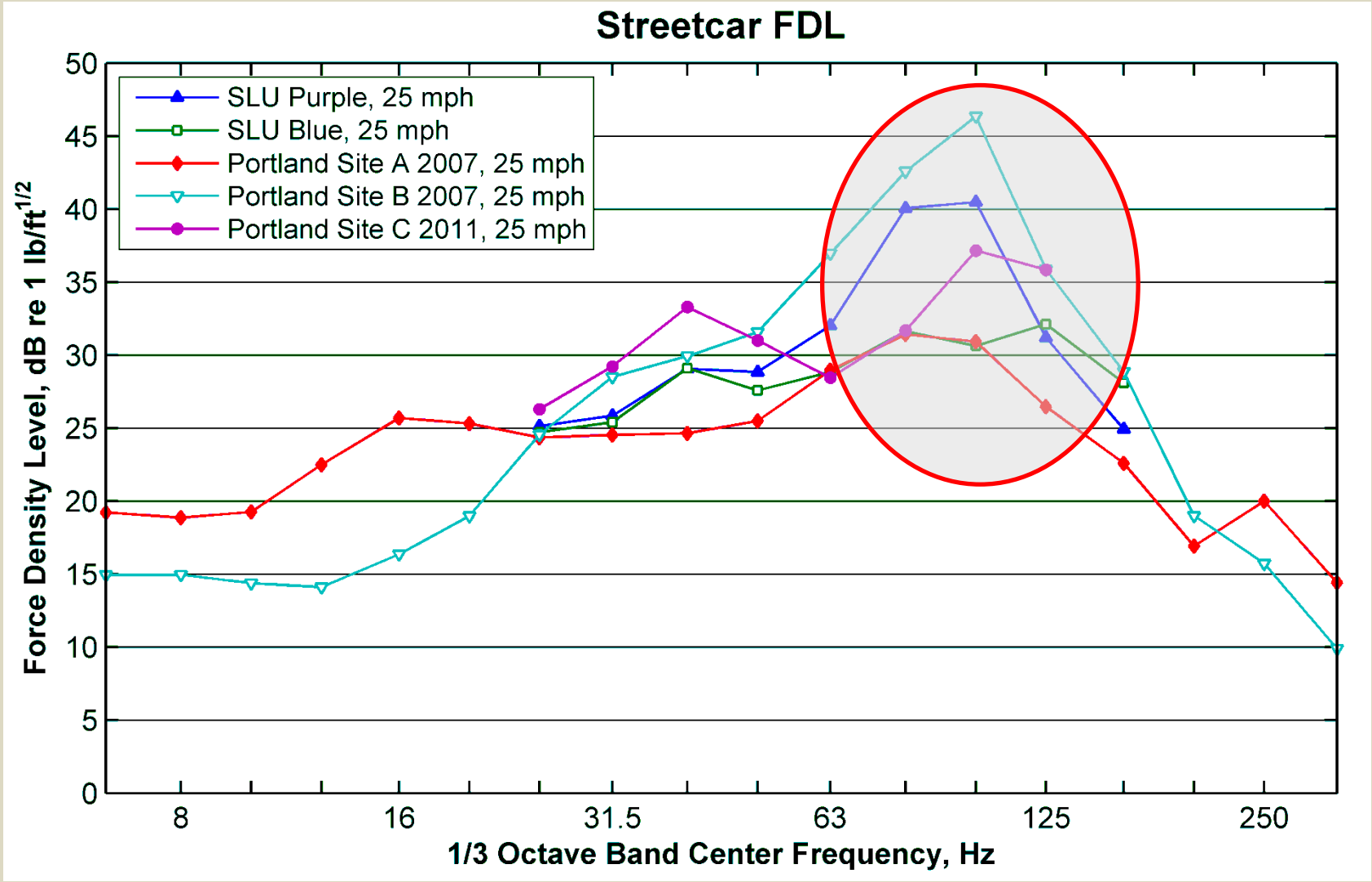
ATSConsulting
acoustics, transportation + strategy

Streetcar Noise verus Speed



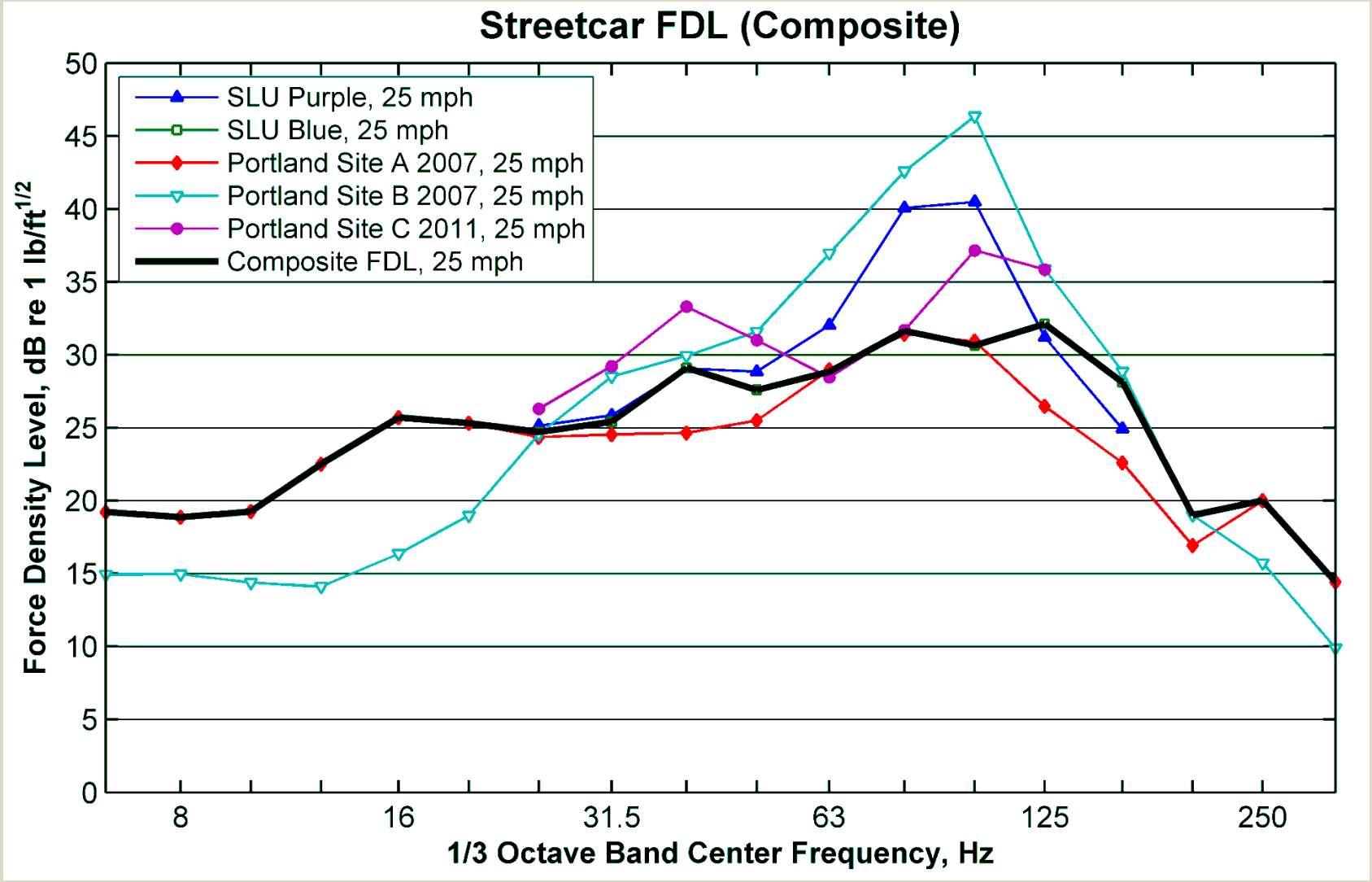
ATSConsulting
acoustics, transportation + strategy

Streetcar Vibration Force Density

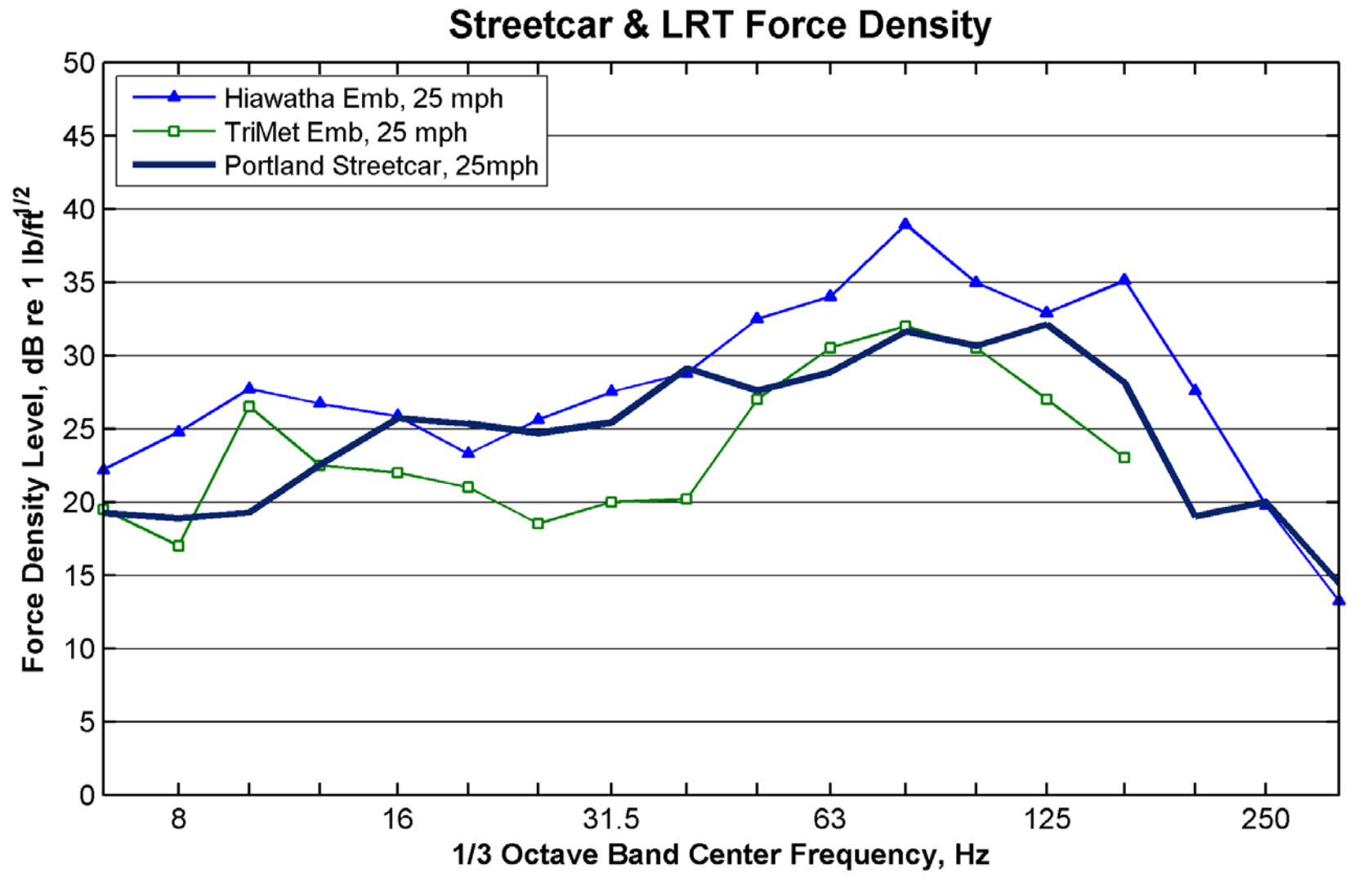


ATSConsulting
acoustics, transportation + strategy

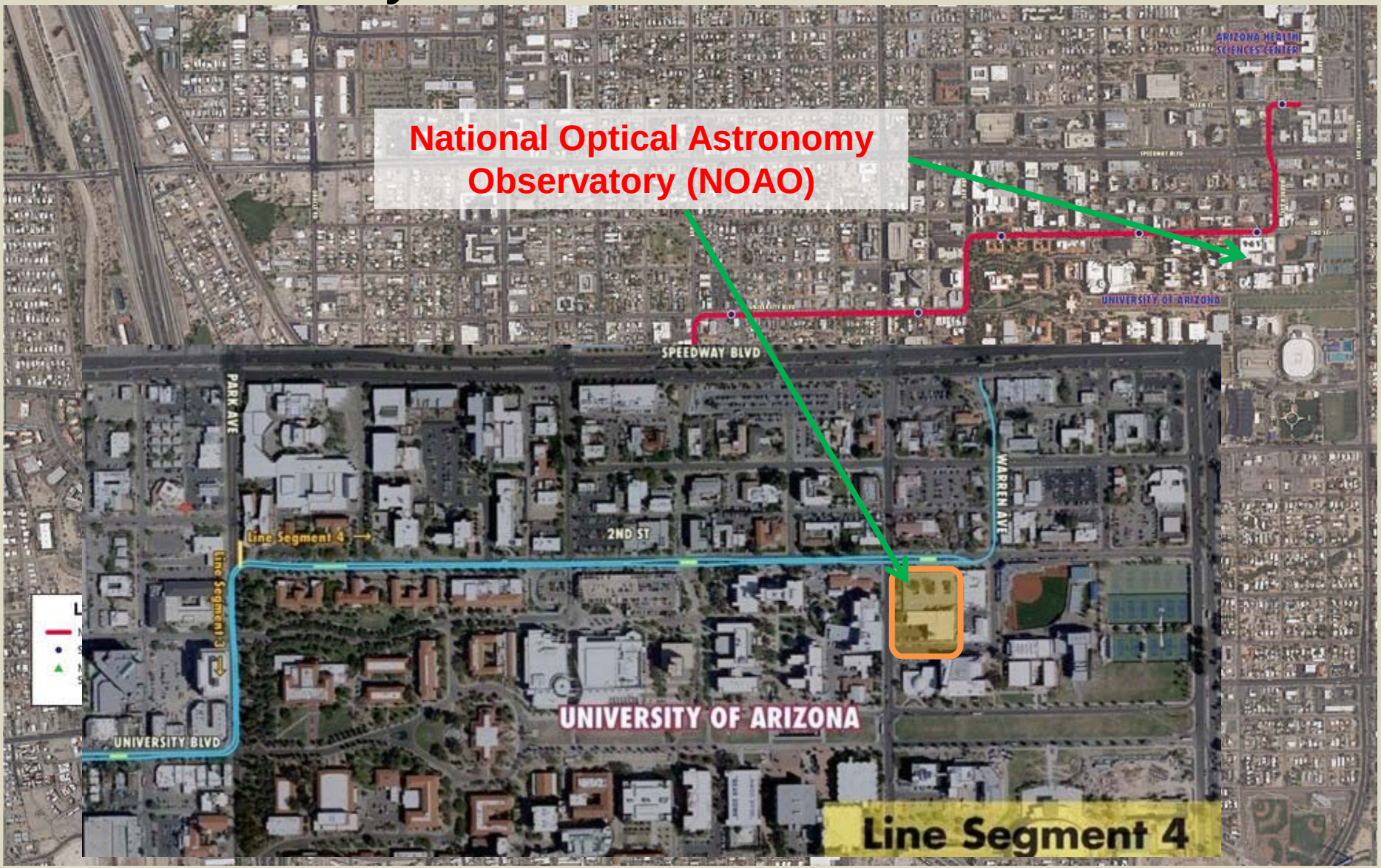
Streetcar Vibration Force Density



Streetcar versus LRT Force Density



Case Study 1: Tucson Streetcar

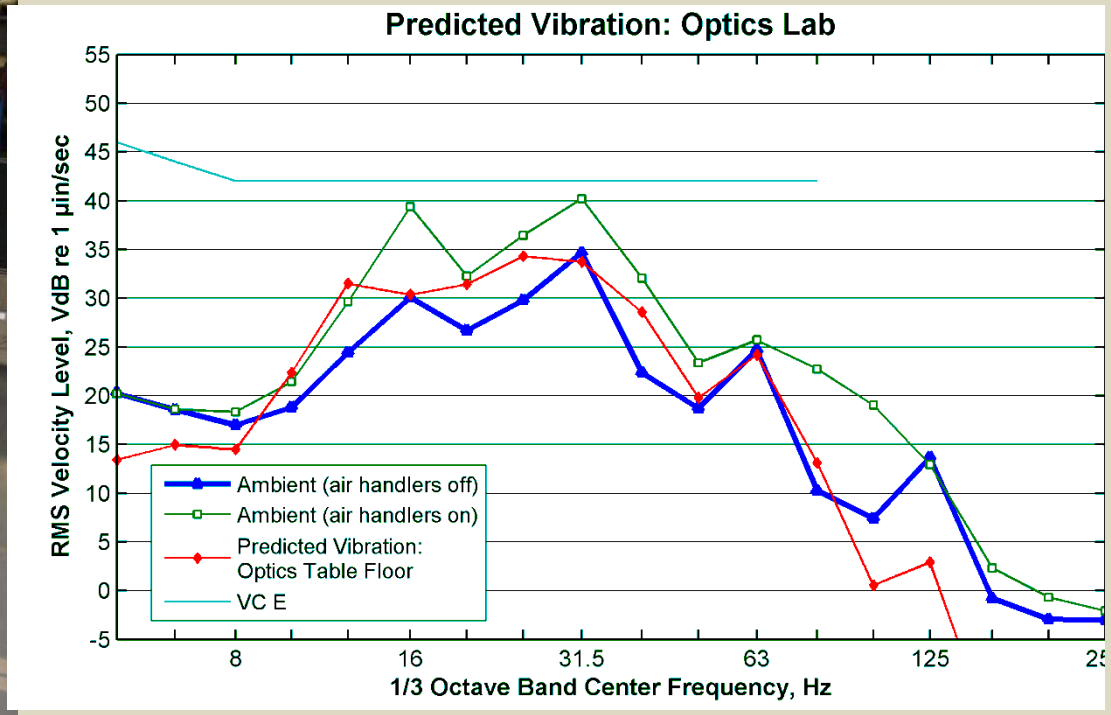


ATSConsulting
acoustics, transportation + strategy

Case Study 1: NOAO Measurements

ATSConsulting
acoustics, transportation + strategy

Case Study 1: NOAO Vibration



Case Study 1: Tucson Streetcar

Conclusion for NOAO, Mitigation required

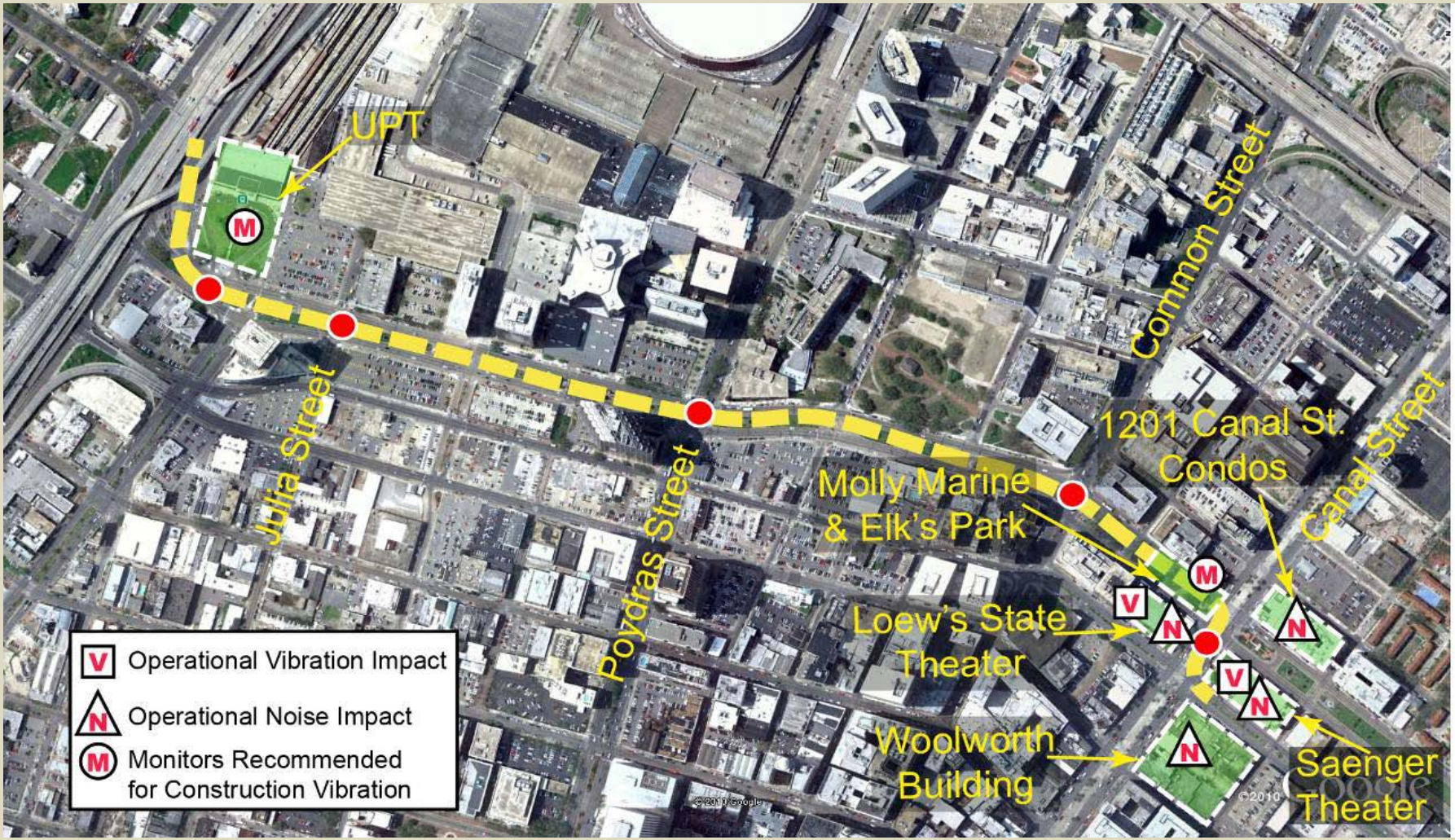
Options:

1. Track treatment to reduce vibration levels in 16 to 30 Hz range (approximately $0.5M to $1M)
2. Purchase new equipment interferometer equipment that is not vibration sensitive (~$150k)

Case Study 2: New Orleans Streetcar

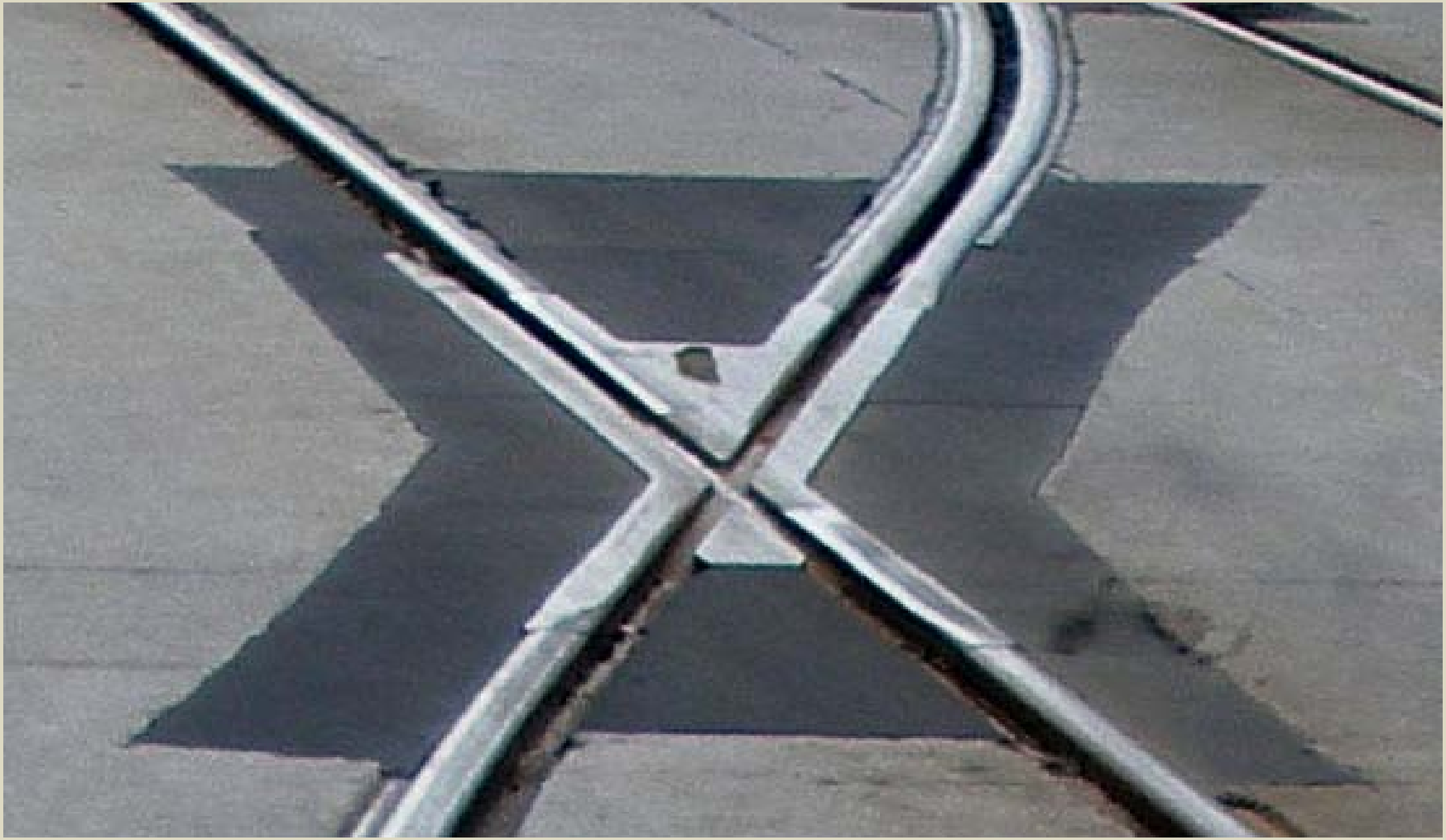
ATSConsulting
acoustics, transportation + strategy

Case Study 2: NOUPT Streetcar



ATSConsulting
acoustics, transportation + strategy

Case Study 2: N&V Impacts from Frogs

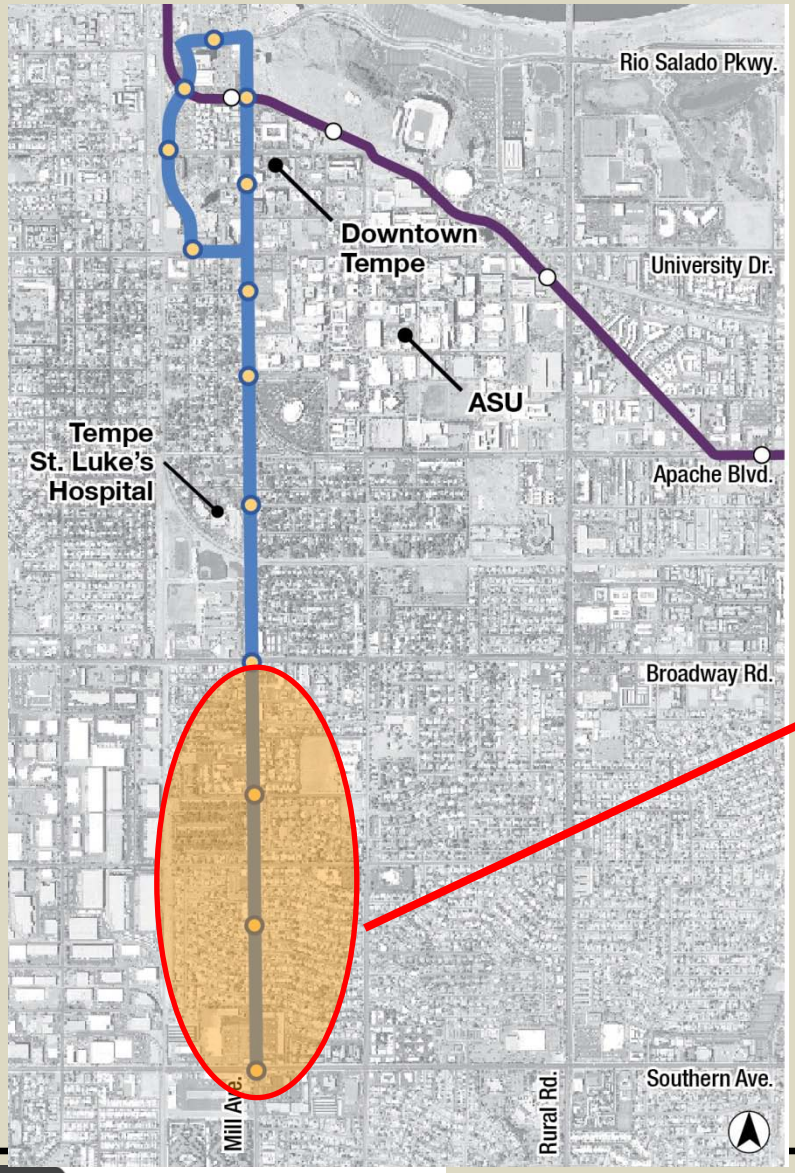


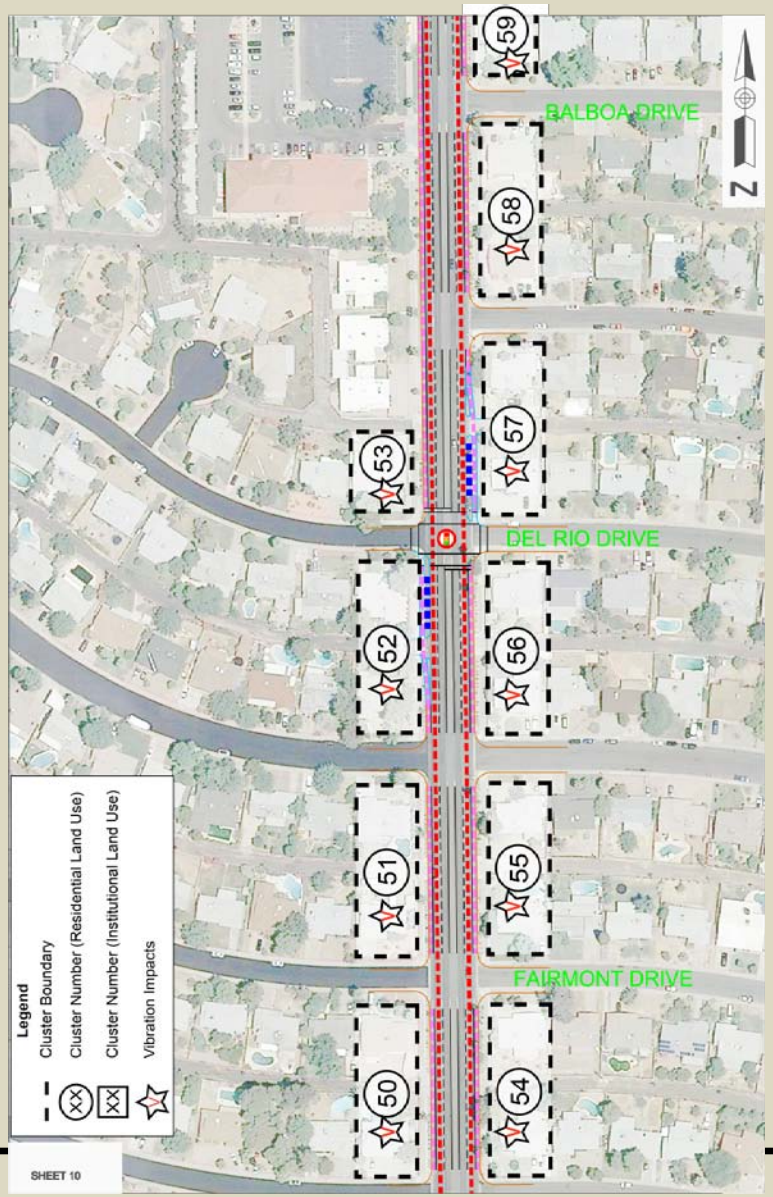
Case Study 2: NOUPT Streetcar

Conclusion: Potential Vibration Impacts from Wheel Impacts at Special Trackwork Frogs

- Mitigation: “Low Impact” frogs

Case Study 3: Tempe Streetcar



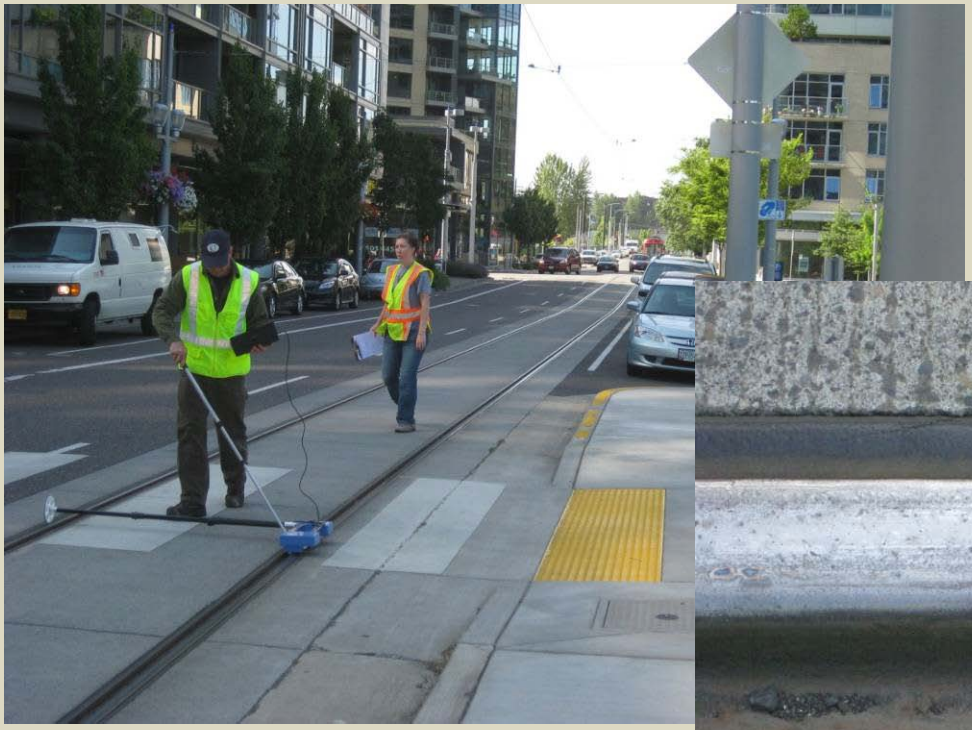


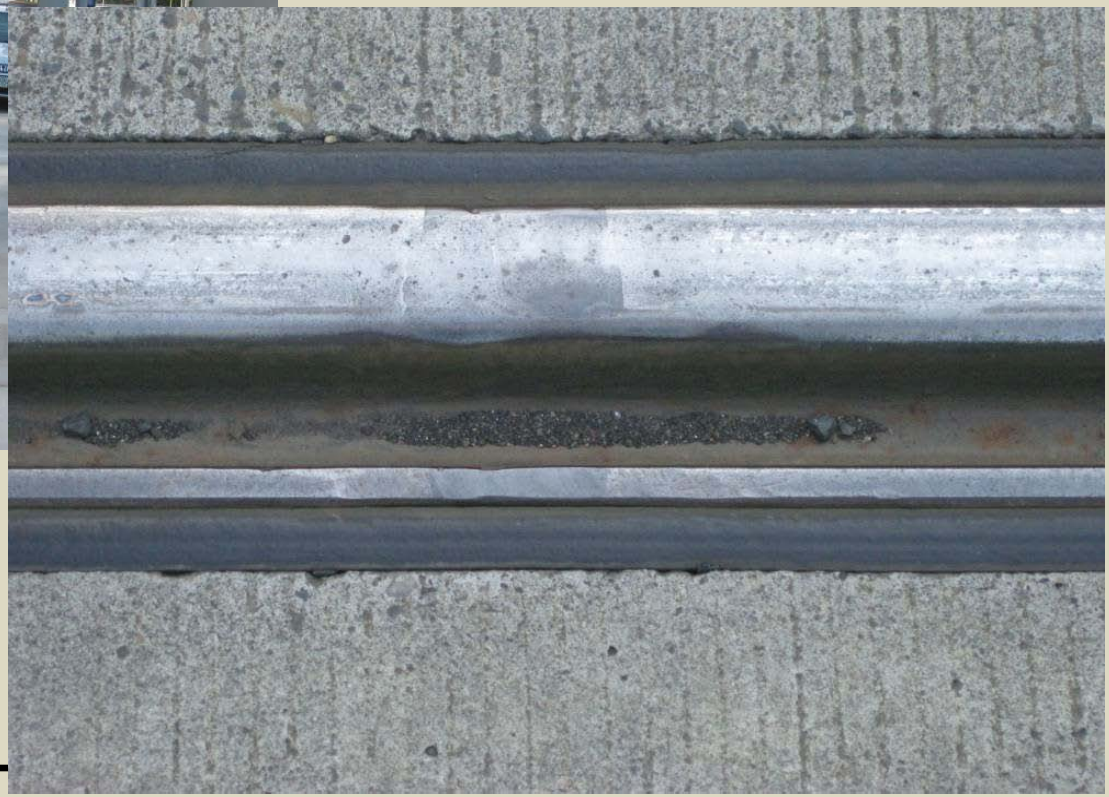
ATSConsulting
acoustics, transportation + strategy

Case Study 3: Tempe Streetcar

- Conclusion: Potential for vibration impact (20 residences) because of 40 mph speed and proximity to residences
- Mitigation options:
  1. Low vibration trackforms
  2. Maintenance to minimize vibration

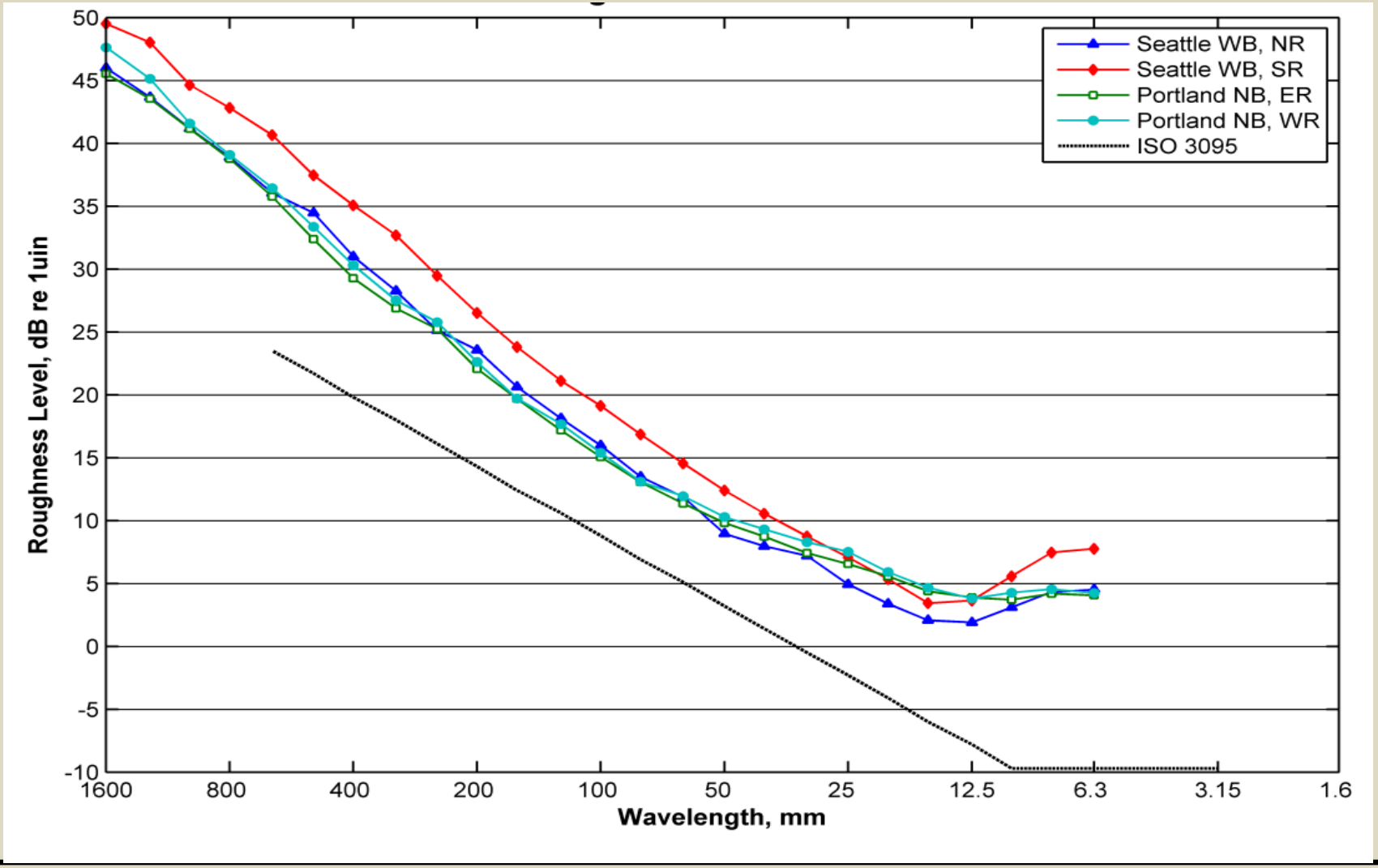
Rail Roughness Measurements





ATSConsulting
acoustics, transportation + strategy

Results of Rail Roughness Measurements



ATSConsulting
acoustics, transportation + strategy

Conclusions

- Streetcars do not have noise and vibration issues under normal conditions (low speed, busy urban areas).
- Potential for noise and vibration issues when:
  - Speeds will exceed 25 mph
  - Streetcar route is close to buildings housing sensitive equipment
  - Special trackwork will be located near sensitive receptors
- Several track-based mitigation options are available to reduce vibration
- Maintenance of optimal wheel profile and smooth rails could reduce N&V levels