

System-wide OBSI study to evaluate success of diamond grinding to attain project noise reduction goal

J. Eric Cox

Christopher Menge



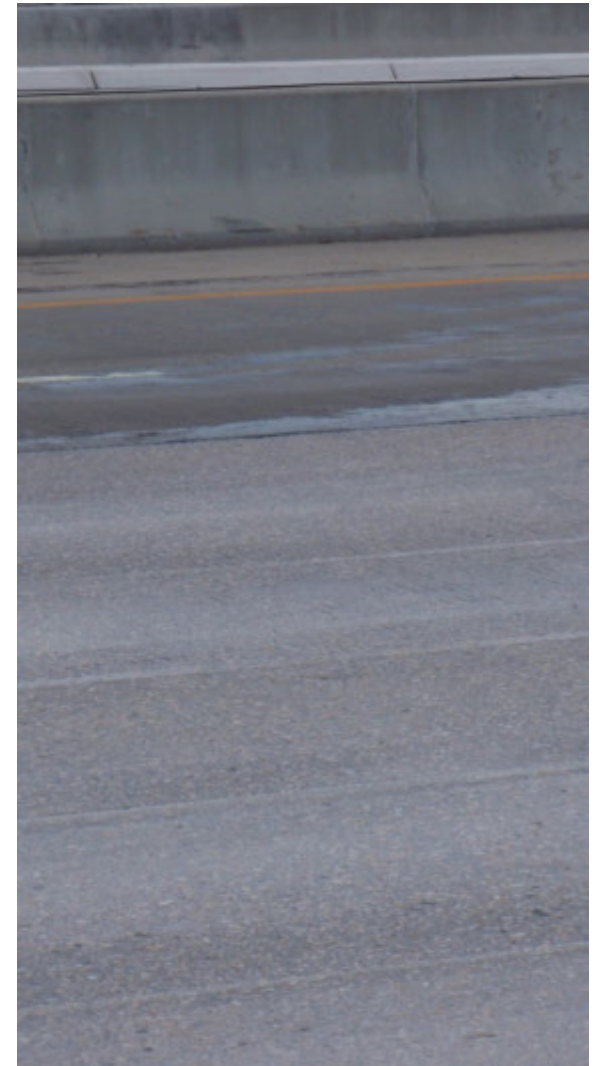
HARRIS MILLER MILLER & HANSON INC.

**NOISE-CON 2013
Denver, Colorado**

Overview

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- **OBSI study for RIDOT Interstate 195 Concrete Wearing Surface Modifications (Diamond Grinding) Project**
- **Measurements – Fall 2012 along I-195 at I-95 interchange near Providence RI**
- **Measured before/after diamond grinding of ALL lanes of existing mainline concrete bridge decks and on/off-ramps**
- **Project Goal – reduce noise & complaints due to traffic on new transverse-tined concrete on I-195 bridges**



Overview

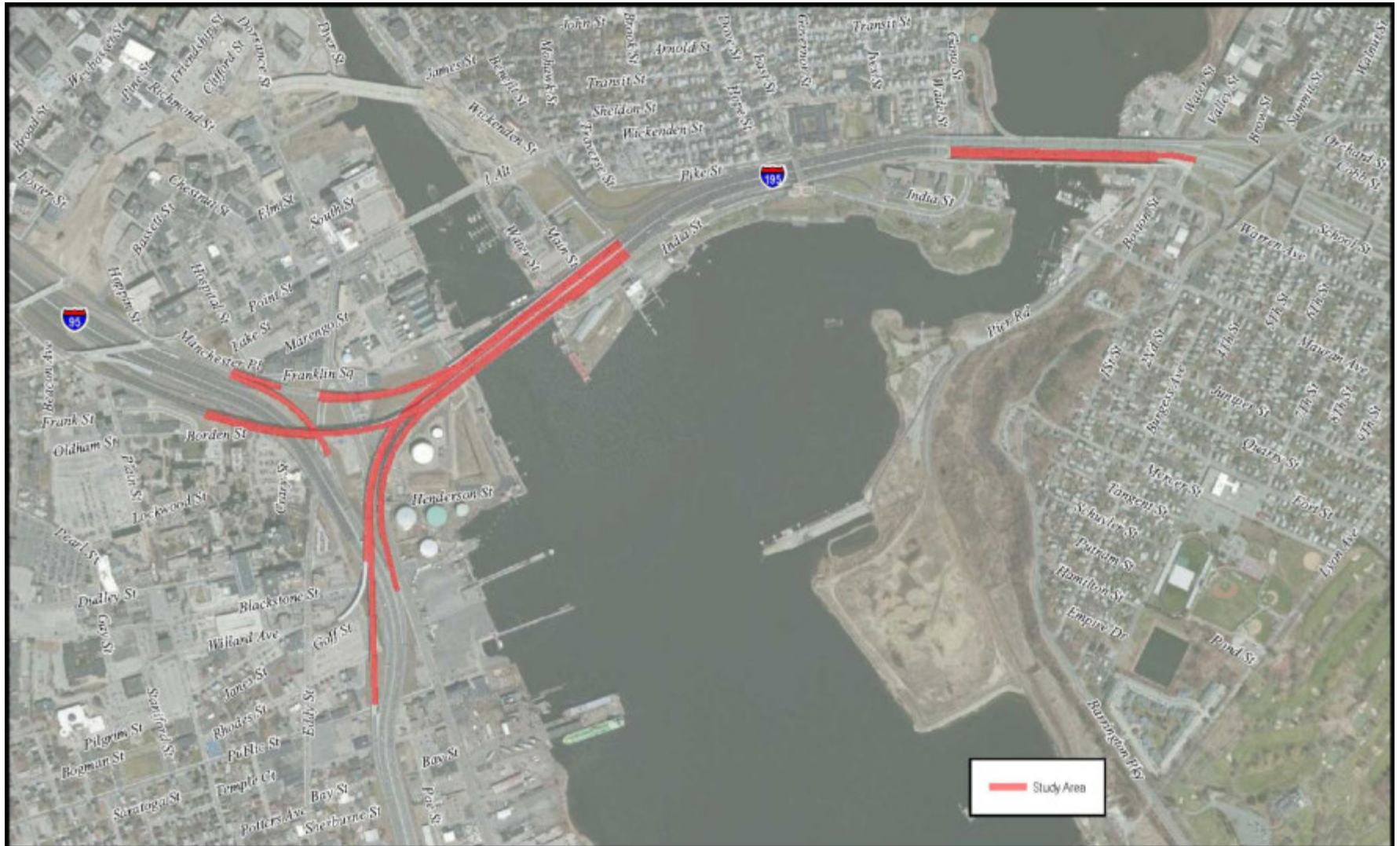
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- Contractor's payment bonuses / penalties based on OBSI levels after grinding – target of 104 dB(A)
- HMMH collected continuous OBSI time histories for entire study area:
 - 8 travel lanes plus 8 ramps
 - total of ~ 9 miles (15 km)
- Also addressed variation in OBSI levels with temperature

Study Area – Providence, Rhode Island

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Providence River Bridge

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Diamond Grinding

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- Conventional diamond grinding
- Approximately 5/16 inches (0.8 cm) of pavement removed



Before



After

OBSI Instrumentation

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- Standard vehicle mounting rig
- Bruel & Kjaer PULSE real-time data acquisition / analysis system
- Two tire-mounted pairs of phase-matched sound intensity probes
- Meets ANSI Type I specifications
- System calibrated before, during, & after use
- Results only accurate within ~ 0.5 dB(A) due to calibration drift

OBSI Measurement Procedures

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- Used 2012 Toyota Camry and Standard Reference Test Tire (SRTT)
- Tire pressure & hardness were checked
- Vehicle speedometer verified to within 1 mph (1.6 kph) – GPS unit
- Cruise control used for uniform 60 mph (96.6 kph) test speed



OBSI Measurement Procedures

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- **Verified suitable test conditions (roadway dry, free of debris, etc.)**
- **Measurements generally conducted during early morning hours**
- **Four OBSI runs collected over all pavement throughout study area**

Measurement Approach: Collect Continuous OBSI Time History Data

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- OBSI measurements used to assess grinding contractor's performance
- Results determined pay adjustment factors and/or need for corrective action (10% bonus to 0% payment)
- "Basis of Payment" section of RIDOT's Special Provision for Diamond Grinding PCC Bridge Deck and Pavement Surfaces
- HMMH required to determine OBSI sound levels for entire 9 miles (15 km) of pavement included in grinding project
- Standard 440 foot (134 m) roadway test length – not feasible
 - Would have required measuring over 100 individual test sections!
- Continuous on-site data collection and subsequent processing – only feasible way to collect all OBSI data in reasonable time
- Results presented in 0.2 mile (1056 feet) (0.3 km = 332m) sections as requested by RIDOT

Study Methodology

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- **Collect 4 continuous OBSI time-history runs throughout study area**
- **No error-checking or data validation performed in the field**
- **OBSI data sets were post-processed to:**
 - Time-align the four individual runs
 - Remove unrepresentative data (expansion joints, other roadway discontinuities)
 - Divide data set into 0.2 mile (0.3 km) sections
 - Perform standard error checking (PI index, Coherence, etc.)
 - Remove further time history data, if necessary to pass checks
 - Calculate overall OBSI results for each 0.2 mile (0.3 km) section
- **General accordance with AASHTO TP076 standard**
- **OBSI data also analyzed in conformance with NCHRP Report 630**

Other Challenges

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- **Late-night measurements**
 - Data collection on busy urban highway was only possible in early morning hours
 - Staying awake while driving in endless circles was no easy task...
 - Required 9 nights 12AM to 6AM for all data collection!!
- **Accelerated start of project**
 - Grinding schedule accelerated by one month at last minute
 - Diamond grinding commenced at same time as baseline OBSI data collection
 - Close coordination with contractor needed to avoid conflicts and lane closure issues

Other Challenges

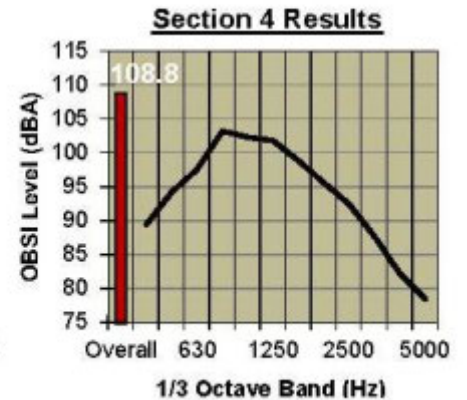
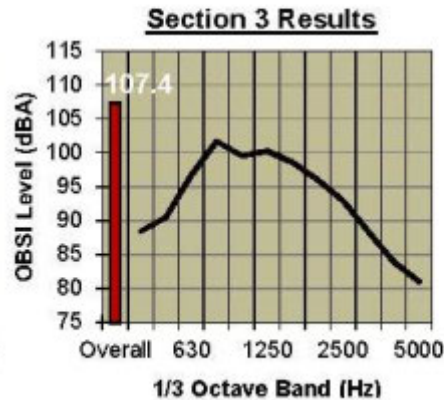
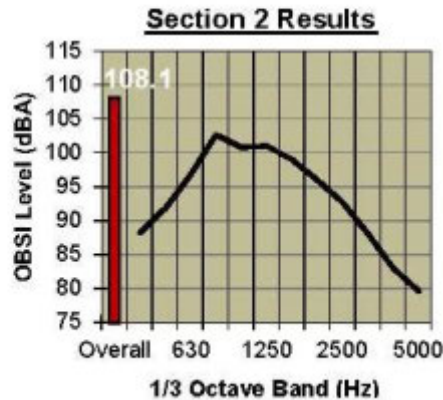
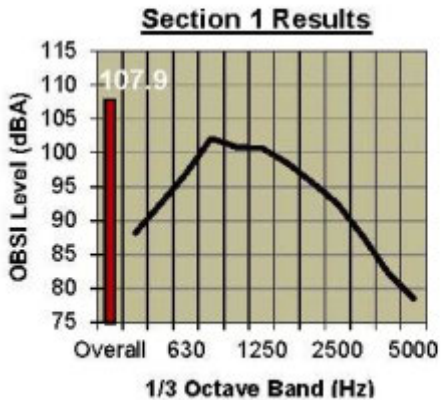
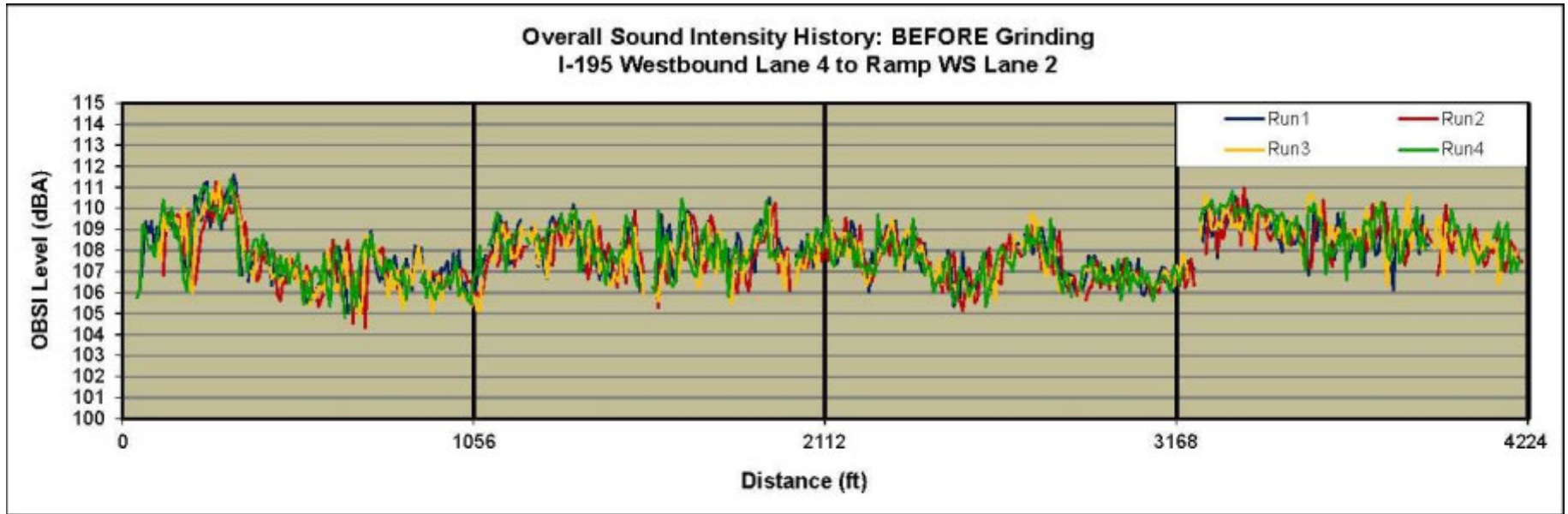
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- **Fast-tracked measurement & analysis schedule**
 - Out-of-state contractor's payment bonuses / penalties were determined based on OBSI levels after grinding
 - Need for near-immediate measurements of diamond-ground pavements
 - Quick turn around of results necessary to meet two-week billing cycle deadlines
- **Hastened final measurements to avoid Hurricane Sandy!**
 - Allowed a determination to be made on relocating the contractor's equipment



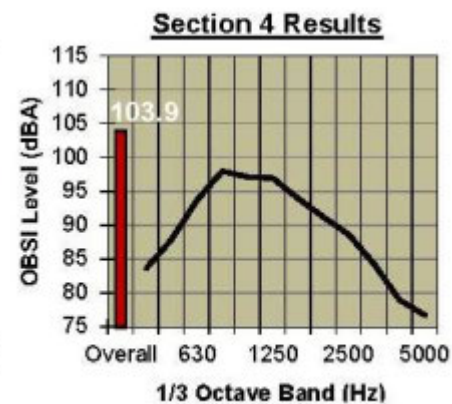
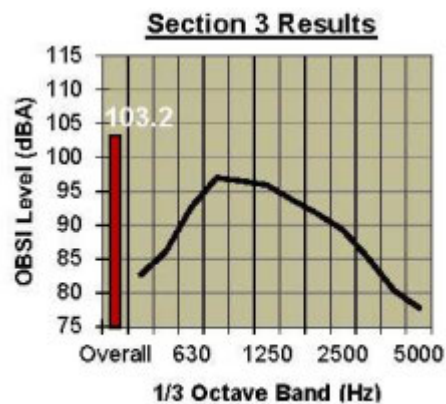
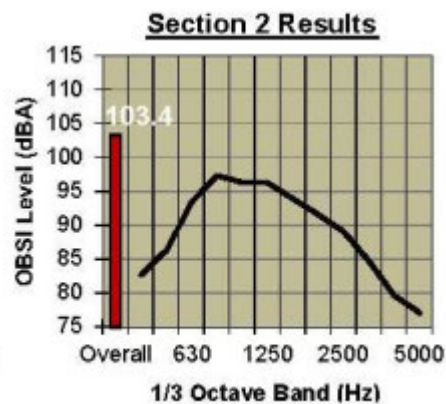
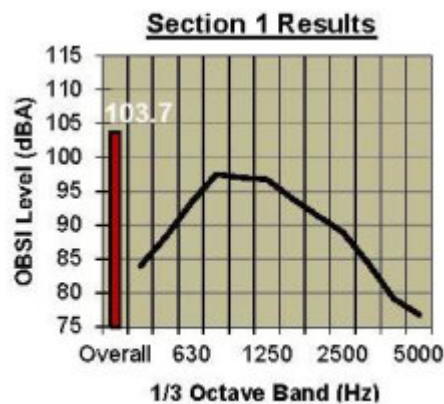
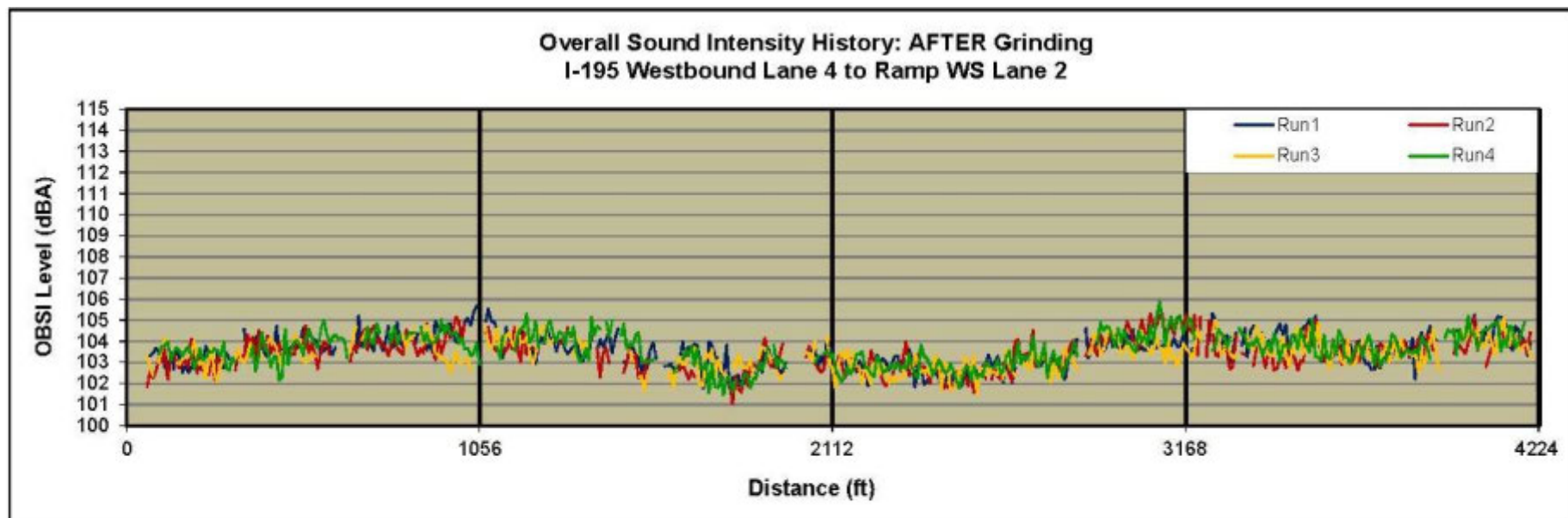
Before Grinding Sample Results

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After Grinding Sample Results

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Consideration of Temperature Effects

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- Baseline OBSI measurements conducted late September to early October
- Data collection following diamond grinding occurred later in October
- HMMH acquired after-grinding data in one area on two different nights with 20 degree Fahrenheit (11 degree Celsius) temperature difference to investigate change in OBSI level
- OBSI levels known to vary with ambient temperature by approximately:
 - 0.04 dB(A) per degree Fahrenheit (inverse relationship)
 - 0.072 dB(A) per degree Celsius (Lodico & Donovan, 2012)
 - Estimated a difference in OBSI levels of about 0.8 dB(A)
- Measured a difference of about 1.0 dB(A) – good agreement
- Project noise reduction goal – adjusted from original after-grinding target OBSI level of 103 dB(A) or below to a final target of 104 dB(A) or less and at least a 4 dB(A) improvement

Summary of OBSI Results

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BEFORE GRINDING

- Baseline OBSI levels varied between approximately 108 to 110 dB(A)
- A few slightly lower results in the range of 106 to 107 dB(A)

AFTER GRINDING

- OBSI results generally fall between approximately 101 to 103 dB(A)
- Slightly higher results of about 104 dB(A) occasionally observed

IMPROVEMENT

- OBSI levels were reduced by 4 to 8 dB(A) due to the diamond grinding

Conclusions

- **OBSI levels measured along I-195 were reduced 4 to 8 dB(A) due to RIDOT Diamond Grinding Project**
- **All after-grinding OBSI results at or below 104 dB(A)**
- **Grinding contractor was successful in meeting or exceeding project noise reduction goal system-wide**
- **Local neighborhood group that advocated for noise reduction was satisfied with the project outcome**

