Appendix F. Updated Memorandum: Noise Analysis of Eastbank Esplanade
UPDATED MEMORANDUM: Noise Analysis of Eastbank Esplanade

I-5 Rose Quarter Improvement Project

Original: May 31, 2019 Updated: September 16, 2020

Note: This analysis has been updated to reflect the Build alternate as shown in the Revised Environmental Assessment.

Analysis by: Daniel Burgin, ODOT Noise Program Coordinator

Reviewed by: Natalie Liljenwall, P.E., Air Quality Program Coordinator and Noise Engineer
Executive Summary

This memorandum documents a noise analysis conducted by Oregon Department of Transportation (ODOT) to analyze noise impacts at the Eastbank Esplanade in Portland, Oregon. In January 2019, a Noise Study Technical Report for the I-5 Rose Quarter Improvement Project was published as a part of the Environmental Assessment for the project. The Eastbank Esplanade was not included as a noise sensitive land use in that analysis because ODOT does not typically consider bicycle and pedestrian facilities as noise sensitive resources unless they are clearly recreational rather than for transportation use such that users spend at least an hour at one location. Since then, it has been determined that the Eastbank Esplanade is a park. As a park, the Eastbank Esplanade is classified as Noise Abatement Criteria (NAC) Category C. (Refer to Table 3.) Category C receptors are considered noise sensitive and are to be included in federally funded highway noise analysis. This noise analysis showed that the Eastbank Esplanade is noise impacted with the project (72 dBA in design year) however, no mitigation is recommended for this location because it is not cost reasonable based on usage. The difference between existing (2017) traffic noise level (71 dBA) and Build Alternative (2045) noise level (72dBA) is not perceivable by the human ear, so the noise environment will not be noticeably changed by the project.

Affected Area Description

The Eastbank Esplanade is a pedestrian and bicycle path along the east shore of the Willamette River which extends from the Hawthorne Bridge to the Steel Bridge. In addition to highway noise from nearby I-5, the Eastbank Esplanade is affected by noise from on-road vehicles and light rail on the upper deck Steel Bridge and freight and passenger rail on the lower deck of the steel bridge and on nearby rail lines.

The I-5 Rose Quarter Improvement project, as described in the project’s Revised Environmental Assessment (EA) and related documentation, includes improvements on I-5 adjacent to the section of Eastbank Esplanade between the Steel Bridge and Burnside Bridge. These improvements will not widen the structure that I-5 is on where it is directly adjacent to the esplanade, but will preserve and restripe existing pavement on that structure to create a new auxiliary lane.

Methodology

The same methodology used in the EA Noise Technical Report was used to evaluate existing and future noise levels and impacts at the Eastbank Esplanade receptor in accordance with the ODOT Noise Manual and 23 CFR 772. The FHWA Traffic Noise Model 2.5 (TNM), which was used to predict sound levels at noise sensitive receptors along the project corridor, was also used to predict sound levels at the Eastbank Esplanade as part of this analysis. The specific location for measurement and modelling was selected because it is a representational point where the shifting of the highway overhead is most pronounced and where traffic noise is the primary noise source whenever freight trains are not present. To validate the model, traffic counts from during the measurement period were converted to 1-hour traffic volumes and used as input to the model. If the difference in the model output noise level and the actual measured sound level are less than three decibels, the model is considered validated.
Noise Measurement and TNM Validation

A noise measurement was taken at the Eastbank Esplanade at the location shown in Figure 1 below on May 22, 2019 starting at 10:43 a.m. The weather during the measurement was partly sunny, with dry pavement, and calm wind conditions. The measurement was taken in the late morning to avoid peak hour traffic when congestion forces vehicles to slow down. During the measurement, videos were taken of traffic on mainline I-5 NB and SB and the I-5 SB ramp to I-84 EB so that traffic counts could be obtained.

For the first 11 minutes of the 15 minute noise reading, highway noise was the primary noise source. The A-weighted $L_{eq}$ for this period of time was 68 dBA. For the remainder of the measurement period, a freight train was approaching and passing which resulted in a much higher sound levels. For example, the $L_{eq}$ for the 13th minute of the measurement was 78 dBA and the $L_{max}$ in the final minute of the measurement was 114 dBA. Consequently, the 15 min $L_{eq}$ was 71 dBA, which was higher than the $L_{eq}$ for the time where traffic noise was the primary traffic source.

It was determined that the appropriate time period to use for validation at this location was the 11 minutes of the measurement before the arrival of the freight train since TNM is only able to predict highway noise and not noise from other sources such as freight trains. The resulting TNM predicted sound level of 70 dBA is within 3 decibels of the measured sound level of 68 dBA, so the model is considered validated. See Table 1 for measurement and validation results. Attachment A contains supporting documentation about the noise measurements and validation.
Figure 1. Measurement and Modeling Location
Table 1. Measurement and Validation Results

<table>
<thead>
<tr>
<th>Monitoring Site</th>
<th>Land Use (Activity Category)</th>
<th>Distance to Nearest Major Roadway (Feet) [Roadway Name]</th>
<th>Monitored Noise Level (dBA)</th>
<th>TNM Predicted Noise Level (dBA)</th>
<th>Difference between Monitored and TNM Predicted Noise Levels (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastbank Esplanade (full 15 minute duration with rail noise)</td>
<td>Park (C)</td>
<td>10 [I-5 SB]</td>
<td>71</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Eastbank Esplanade (11 minutes while traffic noise dominates; no rail noise)</td>
<td>Park (C)</td>
<td>10 [I-5 SB]</td>
<td>68</td>
<td>70</td>
<td>2</td>
</tr>
</tbody>
</table>

Existing and Predicted Sound Levels for Worst Noise Hour

The same TNM model which was used for the Noise Study Technical Report and validated for the Eastbank Esplanade location was used to predict sound levels for the worst noise hour for existing traffic conditions, No-Build Alternative with 2045 traffic conditions, and the Build Alternative with 2045 traffic conditions. Table 2 summarizes those predicted noise levels.

Table 2. Worst Noise Hour Predicted Sound Levels for Existing and Future Conditions (Leq-dBA)

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Noise Abatement Criteria</th>
<th>Existing (2017) Noise Level</th>
<th>No-Build (2045) Noise Level</th>
<th>Build (2045) Noise Level</th>
<th>Increase from Existing to Build</th>
<th>Increase from No-Build to Build</th>
</tr>
</thead>
<tbody>
<tr>
<td>R101-Eastbank Esplanade</td>
<td>Category C (67)</td>
<td>71</td>
<td>71</td>
<td>72</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Worst noise hour sound levels at the Eastbank Esplanade are predicted to stay the same at 71 dBA from existing year to design year for the No Build Alternate. For the Build Alternate, the sound level is predicted to increase to 72 dBA, a one decibel increase. An increase of 3 decibels is generally considered the smallest change in sound level that the average human can detect, so it is not expected that building the project would result in a noticeable difference in noise compared to existing conditions. TNM output tables can be found in attachment A. The actual TNM files will be kept on file by ODOT.
Abatement Discussion

When traffic noise impacts are identified on a federal-aid project, abatement is considered. A receptor is impacted if it increases the sound level by more than 10 dBA from existing levels in the design year for the Build alternate, or if Build alternate design year sound levels approach (within 2 dBA) or exceed the Noise Abatement Criteria (NAC). Table 3 shows the NAC set for each land use type as defined by FHWA and ODOT.

Table 3. Federal Highway Administration Noise Abatement Criteria—Oregon Department of Transportation Noise Abatement Approach Criteria Hourly A-Weighted Sound Level Decibels (dBA)

<table>
<thead>
<tr>
<th>Activity Category</th>
<th>Activity Criteriaa</th>
<th>Evaluation Location</th>
<th>Land Use Activity Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Leq (h)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>FHWA NACb</td>
<td>ODOT NAACc</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>57</td>
<td>55</td>
<td>Exterior</td>
</tr>
<tr>
<td>Bd</td>
<td>67</td>
<td>65</td>
<td>Exterior</td>
</tr>
<tr>
<td>Cd</td>
<td>67</td>
<td>65</td>
<td>Exterior</td>
</tr>
<tr>
<td>D</td>
<td>52</td>
<td>50</td>
<td>Interior</td>
</tr>
<tr>
<td>Ed</td>
<td>72</td>
<td>70</td>
<td>Exterior</td>
</tr>
<tr>
<td>F</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>G</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

a. The Leq(h) Activity Criteria values are for impact determination only and are not design standards for noise abatement measures.

b. Federal Highway Administration noise abatement criteria
c. Oregon Department of Transportation noise abatement approach criteria
d. Includes undeveloped lands permitted for this activity category

Since the Eastbank Esplanade is a Category C receptor and its predicted sound level in the design year for the Build Alternative was 72, it exceeds the NAC and is considered an impacted receptor. For this reason, abatement was considered.
Noise abatement is recommended for inclusion in the project if and only if it is found to be both feasible and reasonable as described in sections 7.3 and 7.4 of the ODOT Noise Manual.

Considering noise abatement at the Eastbank Esplanade poses many challenges:

- Since the Eastbank Esplanade is a trail that runs parallel to the highway, a barrier along I-5 SB designed to reduce sound levels for the esplanade would have to be very long, and thus expensive.
- People using the Eastbank Esplanade are in most cases, moving along the trail and not spending time in one place.
- A barrier along I-5 SB would do nothing to reduce train noise as that noise would still pass underneath I-5.
- A barrier along I-5 SB would do nothing to reduce traffic noise from the I-5 SB to I-84 EB ramp.
- A barrier along I-5 SB would cast a shadow on the Esplanade which could be considered undesirable.

Because of the issues described, such a barrier was not modeled to see how it would perform acoustically, but a hypothetical scenario was analyzed that shows that even if a barrier as short as 10 feet tall barrier was effective, it would not be cost reasonable by usage if analyzed using the methods in Appendix F of the ODOT Noise Manual (ODOT, 2011). The analysis, which concluded that, in order for noise abatement to be considered reasonable, the number of people using the Eastbank Esplanade would have to be significantly greater than that which was observed, is included as Attachment B of this memorandum. No noise abatement is recommended for the Eastbank Esplanade.

**Conclusion**

The Eastbank Esplanade is a popular bicycle and pedestrian facility despite currently high noise levels. Increases in highway noise at the esplanade due to the project are not predicted to exceed one decibel. This difference is smaller than the average human ear can detect, so there will be no appreciable change in the noise environment for users of the esplanade. While absolute noise levels do exceed the Noise Abatement Criteria, noise abatement in the form of barriers is found to not be cost effective and therefore not reasonable. Noise abatement at this location is not recommended.

**References**


Attachment A.

Documentation of Noise Measurements, Validation and Modelling of Existing and Predicted Sound Levels

Note: A TNM 2.5 map view of the receiver location and output tables are included in this attachment. The electronic TNM 2.5 files will be maintained on file with ODOT.

Table A.1. Traffic Counts for Validation

<table>
<thead>
<tr>
<th></th>
<th>Count During 11 minute measurement for validation</th>
<th>Equivalent 1-hour traffic</th>
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<tbody>
<tr>
<td><strong>I-5 SB</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automobiles</td>
<td>336</td>
<td>1833</td>
</tr>
<tr>
<td>Medium Trucks</td>
<td>17</td>
<td>93</td>
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<tr>
<td>Heavy Trucks</td>
<td>46</td>
<td>251</td>
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<tr>
<td>Busses</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Motorcycles</td>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td><strong>I-5 NB</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automobiles</td>
<td>335</td>
<td>1827</td>
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<tr>
<td>Medium Trucks</td>
<td>23</td>
<td>125</td>
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<tr>
<td>Heavy Trucks</td>
<td>33</td>
<td>180</td>
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<tr>
<td>Busses</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Motorcycles</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>I-5 SB ramp to I-84 EB</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automobiles</td>
<td>191</td>
<td>1042</td>
</tr>
<tr>
<td>Medium Trucks</td>
<td>11</td>
<td>60</td>
</tr>
<tr>
<td>Heavy Trucks</td>
<td>16</td>
<td>87</td>
</tr>
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<td>Busses</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Motorcycles</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: All speeds were 50 mph.
Figure A.1. Photo of Sound Level Meter at measurement site facing east. I-5 is visible in the upper foreground. Union Pacific Railroad and the ramp from I-84 to I-5 NB are visible in the background.
Figure A.2 Photo of Sound Level meter at measurement site facing northeast. I-5 and Union Pacific Railroad are visible.
Figure A.3. Photo of Sound Level Meter at measurement site facing south. I-5 is on the left and the ramp from I-5 SB to I-84 EB is on the right.
<table>
<thead>
<tr>
<th>Project Name:</th>
<th>Rose Quarter</th>
<th>Key Number:</th>
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<tr>
<td>Measurement Site:</td>
<td>East bank Esplanade</td>
<td>Address:</td>
</tr>
<tr>
<td>Date:</td>
<td>10-22-18</td>
<td>Location:</td>
</tr>
<tr>
<td>Analyst:</td>
<td>DB w/ MY and SE</td>
<td>Noise Meter: LXT</td>
</tr>
<tr>
<td>Start Time:</td>
<td>10:43:57 AM</td>
<td>Duration: 15 min</td>
</tr>
</tbody>
</table>

**Weather:** Mostly Sunny  
**Temperature:** 60°F  
**Wind:** Calm  
**Calibration Pre-check:** 13.90  
**Calibration Post-check:** 13.93  

**Concurrent Traffic Count**  
Roadway Name: _____  
Autos: ________  
Medium Trucks: ________  
Heavy Trucks: ________  
Buses: ________  
Motorcycles: ________  
Speed: ________  

**Notes/Other Noises/Excluded minutes:**
- Min 11-12
- Freight train
- Flight over ramp
- River

**Sketch of meter location:**  
(include distances to important features and roadway details)
Measurement Report

Report Summary
Meter's File Name: LxT_Data.008
Computer's File Name: SLM_0003340_LxT_Data_008.00.ldbin
Meter: LxT SE 0003340
Firmware: 2.302
User: Daniel Burgin
Description: I-5 Rose Quarter

Note
Duration: 0:15:00.0
Run Time: 0:15:00.0
Pause Time: 0:00:00.0

Results

Overall Metrics
LAeq 71.0 dB
LAE 100.5 dB
EA 1.3 mPa²/h

LASpeak 113.8 dB 2019-05-22 10:58:29
LASmax 83.5 dB 2019-05-22 10:58:29
LASmin 64.2 dB 2019-05-22 10:50:11

LAeq 71.0 dB
LCeq 86.9 dB
LCeq - LAeq 15.9 dB
LAIeq 73.5 dB
LAIeq - LAeq 2.5 dB

Exceedances Count Duration
LAS > 85.0 dB 0 0:00:00.0
LAS > 115.0 dB 0 0:00:00.0
LASpeak > 135.0 dB 0 0:00:00.0
LASpeak > 137.0 dB 0 0:00:00.0
LASpeak > 140.0 dB 0 0:00:00.0

Community Noise
LDN LDay LNight
71.0 dB 71.0 dB 0.0 dB

LDEN LDay LEve LNight
71.0 dB 71.0 dB --- dB --- dB

Any Data
A C Z
Level Time Stamp Level Time Stamp Level Time Stamp
Leq 71.0 dB --- dB --- dB
Lav(max) 83.5 dB 2019-05-22 10:58:29 --- dB --- dB
Lav(min) 64.2 dB 2019-05-22 10:50:11 --- dB --- dB
Lav(Peak(max)) 113.8 dB 2019-05-22 10:58:29 --- dB --- dB

Overloads Count Duration OBA Count OBA Duration
0 0:00:00.0 1 0:14:59.9

Statistics
LAS 5.0 76.5 dB
LAS 10.0 73.6 dB
LAS 33.3 68.7 dB
LAS 50.0 67.7 dB
LAS 66.6 67.0 dB
LAS 90.0 65.7 dB
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<th>Record Type</th>
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<th>Time</th>
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<th>LApeak</th>
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Calculation of Leq for these 11

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<td>63295027.2</td>
<td>5754093.385</td>
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| 66.8 | 6.7 | 4734302.458 |
| 67.8 | 6.8 | 5969500.597 |
| 68.3 | 6.8 | 6734122.309 |
| 67.7 | 6.8 | 5875596.994 |
| 69.2 | 6.9 | 8326068.891 |
| 67.4 | 6.7 | 5505946.663 |
| 66.4 | 6.6 | 4372441.423 |
| 67.0 | 6.7 | 5004468.961 |
| 67.4 | 6.7 | 5515158.524 |
| 67.3 | 6.7 | 5412413.891 |
| 67.7 | 6.8 | 5845006.521 |
Calculation of Leq for these 11

=SUM(C6:C16) =B2/11 =10^LOG(C2)

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Calibration Certificate

Certificate Number 2019004926

Customer:
Oregon Department of Transportation
4040 Fairview Drive SE
Salem, OR 97302, United States

Model Number CAL200
Serial Number 16740
Test Results Pass

Initial Condition As Manufactured
Description Larson Davis CAL200 Acoustic Calibrator

Procedure Number D0001.8386
Technician Scott Montgomery
Calibration Date 24 Apr 2019
Calibration Due

Temperature 23 °C ± 0.3 °C
Humidity 32 %RH ± 3 %RH
Static Pressure 101.3 kPa ± 1 kPa

Evaluation Method The data is acquired by the insert voltage calibration method using the reference microphone's open circuit sensitivity. Data reported in dB re 20 µPa.

Compliance Standards Compliant to Manufacturer Specifications per D0001.8190 and the following standards:
IEC 60942:2017
ANSI S1.40-2006

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the SI through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005. Test points marked with a ± in the uncertainties column do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2015.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

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Calibration Certificate

Certificate Number 2019001226
Customer:
Oregon Department of Transportation
4040 Fairview Drive SE
Salem, OR 97302, United States

Model Number LxT SE
Serial Number 0003340
Test Results Pass
Initial Condition AS RECEIVED same as shipped
Description Sound Expert LxT
Class 1 Sound Level Meter
Firmware Revision: 2.302

Evaluation Method
Tested electrically using Larson Davis PRMLxT1 L SIN 027659 and a 12.0 pF capacitor to simulate microphone capacitance. Data reported in dB re 20 µPa assuming a microphone sensitivity of 23.6 mV/Pa.

Compliance Standards
Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8384:

- IEC 60651:2001 Type 1
- IEC 60804:2000 Type 1
- IEC 61252:2002
- IEC 61260:2001 Class 1
- IEC 61672:2013 Class 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005. Test points marked with a * in the uncertainties column do not fall within this laboratory’s scope of accreditation.

The quality system is registered to ISO 9001:2015.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

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Correction data from Larson Davis LxT Manual for SoundTrack LxT & SoundExpert LxT, 1770.01 Rev J Supporting Firmware Version 2.301, 2015-04-30

Calibration Check Frequency: 1000 Hz; Reference Sound Pressure Level: 114 dB re 20 µPa
Calibration Certificate

Certificate Number 2019001235

Customer:
Oregon Department of Transportation
4040 Fairview Drive SE
Salem, OR 97302, United States

Model Number PRMLxT1L
Serial Number 027659
Test Results Pass

Initial Condition AS RECEIVED same as shipped

Description Larson Davis 1/2" Preamplifier for LxT Class 1 -1 dB

Evaluation Method Tested electrically using a 12.0 pF capacitor to simulate microphone capacitance. Data reported in dB re 20 µPa assuming a microphone sensitivity of 50.0 mV/Pa.

Compliance Standards Compliant to Manufacturer Specifications

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the SI through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005. Test points marked with a ± in the uncertainties column do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2015.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

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Standards Used

<table>
<thead>
<tr>
<th>Description</th>
<th>Cal Date</th>
<th>Cal Due</th>
<th>Cal Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larson Davis Model 2900 Real Time Analyzer</td>
<td>03/07/2018</td>
<td>03/07/2019</td>
<td>003003</td>
</tr>
<tr>
<td>Hart Scientific 2626-H Temperature Probe</td>
<td>02/02/2018</td>
<td>02/02/2019</td>
<td>006767</td>
</tr>
<tr>
<td>Agilent 34401A DMM</td>
<td>06/29/2018</td>
<td>06/29/2019</td>
<td>007165</td>
</tr>
<tr>
<td>SRS DS360 Ultra Low Distortion Generator</td>
<td>10/04/2018</td>
<td>10/04/2019</td>
<td>007167</td>
</tr>
</tbody>
</table>
Calibration Certificate

Certificate Number 2019001236

Customer:
Oregon Department of Transportation
4840 Fairview Drive SE
Salem, OR 97302, United States

Model Number  LxT SE
Serial Number  0003340
Test Results  Pass

Initial Condition  AS RECEIVED same as shipped
Description  Sound Expert LxT
Class 1 Sound Level Meter
Firmware Revision: 2.302

Procedure Number  D0001.8384
Technician  Ron Harris
Calibration Date  30 Jan 2019
Calibration Due  30 Jan 2020
Temperature  22.79 °C ± 0.25 °C
Humidity  50.9 %RH ± 2.0 %RH
Static Pressure  86.4 kPa ± 0.13 kPa

Evaluation Method  Tested with:
Larson Davis PRMLxT1L. S/N 027659
PCB 377B02. S/N LW136694
Larson Davis CAL200. S/N 9079
Larson Davis CAL291. S/N 0108

Data reported in dB re 20 µPa.

Compliance Standards  Compliant to Manufacturer Specifications and the following standards when combined with
Calibration Certificate from procedure D0001.8378:

IEC 60651:2001 Type 1  ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1  ANSI S1.4 (R2006) Type 1
IEC 61252:2002  ANSI S1.11 (R2009) Class 1
IEC 61260:2001 Class 1  ANSI S1.25 (R2007)
IEC 61672:2013 Class 1  ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure
(unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI)
through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the

Test points marked with a ± in the uncertainties column do not fall within this laboratory’s scope of accreditation.

The quality system is registered to ISO 9001:2015.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to
complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by
the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A
coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at
approximately 95% confidence level.

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from the organization issuing this report.

Correction data from Larson Davis LxT Manual for SoundTrack LxT & SoundExpert LxT, I770.01 Rev J Supporting Firmware Version
2.301, 2015-04-30
Attachment B.

Documentation that a barrier along I-5 at Eastbank Esplanade would not be cost effective.

The purpose of this hypothetical barrier analysis is to show that even if a barrier was acoustically feasible to benefit the Eastbank Esplanade, it would not be found to be reasonable in the cost effectiveness calculation. This calculation follows the methods in Appendix F of the ODOT Noise Manual.

A number of assumptions were made. These are generous assumptions to show that it would be very difficult if not impossible to justify a barrier. For example, 10 feet is used as barrier height, when a taller barrier may be required to achieve the appropriate noise reduction, and the rate of bike/ped travel is assumed to be 3mph while the actual average speed would certainly be something greater.

- Assume a barrier 600 foot long and 10 feet tall along I-5, adjacent to Eastbank Esplanade as shown in Figure 2.
- The average amount of time a person spends per visit must be estimated
  - During the 15 minute field measurement the following bicycle and pedestrian pass-bys were observed:
    - 10 bicycling
    - 9 running or jogging
    - 4 walking
  - On another occasion, lunchtime on Friday May 24, 2019, the following were observed over 20 minutes:
    - 26 bicycling
    - 16 running or jogging
    - 11 walking
  - Despite this, for the sake of counting the most time, for this hypothetical, visitors will be assumed to walk at a moderate pace of 3 mph
  - It takes 136 seconds to walk 600 feet at 3mph so this will be the assumed time spent by each visitor in the area protected by the noise wall.
Figure B.1. Hypothetical 600 foot barrier along I-5 SB
Table B.1. Cost effectiveness calculation for Hypothetical 600 foot barrier along I-5 SB

<table>
<thead>
<tr>
<th>Line number</th>
<th>Criteria</th>
<th>Input</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Enter length of proposed barrier</td>
<td>600 ft</td>
<td>Assumption described above</td>
</tr>
<tr>
<td>2</td>
<td>Enter height of proposed barrier</td>
<td>10 ft</td>
<td>Assumption described above</td>
</tr>
<tr>
<td>3</td>
<td>Multiple line 1 by line 2</td>
<td>6000 ft²</td>
<td>Calculation</td>
</tr>
<tr>
<td>4</td>
<td>Enter the average amount of time that a person stays at the site per visit</td>
<td>136 sec = 0.0378 hr</td>
<td>Assumption described above and converted to hours</td>
</tr>
<tr>
<td>5</td>
<td>Enter the average number of people that use this site per day that will receive at least 5 dBA benefit from abatement at the site</td>
<td>Number of daily visitors = x</td>
<td>Choosing to represent this as variable x.</td>
</tr>
<tr>
<td>6</td>
<td>Multiply item 4 by item 5</td>
<td>0.0378x person-hrs</td>
<td>Calculation</td>
</tr>
<tr>
<td>7</td>
<td>Divide item 3 by item 6</td>
<td>158,730 ft² / x person - hr</td>
<td>Calculation</td>
</tr>
<tr>
<td>8</td>
<td>Multiply $25,000 by item 7</td>
<td>$3,968,253,968 ft² / x person hour</td>
<td>Calculation</td>
</tr>
</tbody>
</table>
| 9          | Does item 8 exceed the “abatement cost factor” of: English units = $518,758/person-hr/ft²? | No, if $x > 7650$  
Yes, if $x \leq 7650$  
Because:  
\[
\frac{518,758}{x} \text{ ft}^2/\text{person-hr} = \frac{3,968,253,968}{x} \text{ ft}^2/\text{person-hour}
\]  
Results in:  
\[x = 7650\]  
The result varies depending on the value of x. Setting Line 8 equal to the “abatement cost factor” in the line 9 description and solving for x allows for determining a threshold number of daily visitors that must be present for the criteria to be met. | |
| 10         | If item 9 is no, abatement meets reasonable criteria |                     | |
| 11         | If item 9 is yes, abatement does not meet reasonable criteria |                     | |

As table B.1. demonstrates, using the assumptions set forth for this hypothetical situation, noise abatement would only be reasonable if there were greater than 7650 average daily users on this section of the Eastbank Esplanade. For reference, if the number of users who were observed on the day of the measurement over 15 minutes is multiplied by 4 (15 min to 1 hour) and 24 (hours to day) to obtain a daily average, it would be 2208 people. Similar extrapolation of the Friday lunchtime count leads to
3816 people. This does not take into account the fact that most users are travelling through the area faster than a moderate walking pace and that traffic varies by hour especially overnight.

Since the average daily number of users of this portion of the Eastbank Esplanade is certainly less than 7650, this shows that even in an ideal scenario, noise abatement would not be found reasonable at this location.